Preface

This book brings together two dynamic subjects, precision agriculture and geostatistics, that have spatial variation at their core. Geostatistics is applied to many aspects of precision agriculture (PA) including sampling, prediction, mapping, decision-making, variable-rate applications, economics and so on. Contributions from experts in several fields of study illustrate how geostatistics can and has been used to advantage with data such as yield, soil, crops, pests, aerial photographs, remote and proximal imagery. Geostatistical techniques applied include variography, ordinary-, disjunctive-, factorial-, indicator-, regression-, simple-, space-time- and co-kriging, and geostatistical simulation. This book was requested by participants at the Sixth European Conference on Precision Agriculture in Skiathos, 2007 because the link between geostatistics and PA will increase as more intensive information on the soil and crops becomes available from sensors and on-the-go technology. This is not a recipe book, but is intended to guide readers in the use of appropriate techniques for the types of data and needs of the farmer in managing the land. All chapters include one or more case studies to illustrate the techniques.

Chapter 1 sets the scene for the two main topics of the book. The two core techniques of geostatistics, variography and kriging, are described, together with examples of how they can be applied. Sampling for geostatistics is an important issue because it underpins sound results. Chapter 2 considers the importance of spatial scale in sampling, the use of ancillary data, a nested survey and existing variograms of soil or crop properties to guide sampling. Chapter 3 demonstrates the potential to optimize the design of soil sampling schemes if the variation of the target property is represented by a linear mixed model. Chapter 4 describes how calibrated yield data from monitors can be used to target crop and soil investigations and nutrient applications, and for on-farm experiments. This chapter uses spatial statistics rather than only geostatistics because it lends itself better to econometrics. Many environmental variables that are relevant to precision agriculture, such as crop and soil properties and climate, vary in both time and space; Chapter 5 explains the basic elements of space-time geostatistics. Chapter 6 provides an overview of mobile proximal sensors, such as those used to measure apparent soil electrical conductivity (ECₐ), and how geostatistics can be used to direct soil sampling to create site-specific management units. Three geostatistical methods to incorporate secondary information into the mapping of soil and crop attributes to improve
the accuracy of their predictions are the topic of Chapter 7. For soil and crop
properties that require costly sampling and analysis, there are often insufficient data
for geostatistical analyses and Chapter 8 shows how management zones can provide
an interim solution to more comprehensive site-specific management. Weeds and
plant-parasitic nematodes occur in patches in agricultural fields; Chapter 9 describes
how standard geostatistical methods have been used successfully to analyse counts
of both weed seedlings and nematodes in the soil and to map their distributions
from kriged predictions. Chapter 10 shows how geostatistics can play an important
role in analysing experiments for site-specific crop management. Two broad classes
of experimental design for precision agriculture (management-class experiments
and local-response experiments) are considered and how each may be analysed
geostatistically. Geostatistical simulation provides a means to mimic the spatial
and/or temporal variation of processes that are relevant to precision agriculture, and
Chapter 11 shows how it can incorporate uncertainty into modelling to obtain a more
realistic impression of the variation. The book has raised several issues, ideas and
questions, which are summarized in Chapter 12. Geostatistics needs to be tailored
better to the needs of the various groups involved; farmers, advisors and researchers
which have their own particular requirements. The potential for geostatistics and
precision agriculture for the rest of the twenty-first century appears great.

The Appendix gives examples of software that can be used for geostatistical
analyses, and there are brief descriptions of GenStat, VESPER and SGeMS.

Reading, United Kingdom
Margaret A. Oliver
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