

# **A Comparison of Design-Based and Model-Based Approaches for Spatial Data**

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# Overview

## Why This Paper?

We believe the distinction between these approaches is often misunderstood and there are several ways we could enhance the literature surrounding this topic:

1. There are no comparisons in the literature between spatial model-based approaches and \*spatially balanced\* design approaches. From what we have seen, these comparisons are between spatial model-based approaches and independent random sample designs. While important to study this behavior, this comparison is no longer fair nor modern. Spatially balanced sampling has exploded in popularity throughout the last decade, and the design-based vs model-based literature needs to reflect this trend.
2. A “fair” comparison
3. Misspecification
4. Finite AND infinite populations
5. Centered around the pragmatic questions practitioners will be faced with
6. Provide reliable software

## Initial Literature

- Design-Based Overview ([Särndal et al., 2003](#); [Lohr, 2009](#))
- Model-Based Overview ([Cressie, 2015](#); [Schabenberger and Gotway, 2017](#))
- Design-Based and Model-Based Comparisons ([Hansen et al., 1983](#); [Brus and De Gruijter, 1997](#); [Ver Hoef, 2002](#); [Cooper, 2006](#); [Sterba, 2009](#); [Brus, 2020](#); [Chan-Golston et al., 2020](#))

- 22 • Spatially Balanced Design and Analysis ([Stevens Jr and Olsen, 2003, 2004](#))
- 23 • Finite Population Block Kriging ([Ver Hoef, 2002, 2008](#); [Higham et al., 2020](#))

24 **Potential Journals**

## 25 **OUTLINE**

### 26 **1. INTRODUCTION**

### 27 **2. BACKGROUND**

### 28 **3. NUMERICAL ANALYSIS**

#### 29 **3.1 Simulation-Based**

#### 30 **3.2 Data-Based**

#### 31 **3.3 Software**

### 32 **4. DISCUSSION**

## References

- Brus, D. and De Gruijter, J. (1997). Random sampling or geostatistical modelling? choosing between design-based and model-based sampling strategies for soil (with discussion). *Geoderma*, 80(1-2):1–44.
- Brus, D. J. (2020). Statistical approaches for spatial sample survey: Persistent misconceptions and new developments. *European Journal of Soil Science*.
- Chan-Golston, A. M., Banerjee, S., and Handcock, M. S. (2020). Bayesian inference for finite populations under spatial process settings. *Environmetrics*, 31(3):e2606.
- Cooper, C. (2006). Sampling and variance estimation on continuous domains. *Environmetrics: The official journal of the International Environmetrics Society*, 17(6):539–553.
- Cressie, N. (2015). *Statistics for spatial data*. John Wiley & Sons.
- Hansen, M. H., Madow, W. G., and Tepping, B. J. (1983). An evaluation of model-dependent and probability-sampling inferences in sample surveys. *Journal of the American Statistical Association*, 78(384):776–793.
- Higham, M., Ver Hoef, J., Madsen, L., and Aderman, A. (2020). Adjusting a finite population block kriging estimator for imperfect detection. *Environmetrics*, page e2654.
- Lohr, S. L. (2009). *Sampling: design and analysis*. Nelson Education.
- Särndal, C.-E., Swensson, B., and Wretman, J. (2003). *Model assisted survey sampling*. Springer Science & Business Media.
- Schabenberger, O. and Gotway, C. A. (2017). *Statistical methods for spatial data analysis*. CRC press.
- Sterba, S. K. (2009). Alternative model-based and design-based frameworks for inference from samples to populations: From polarization to integration. *Multivariate behavioral research*, 44(6):711–740.
- Stevens Jr, D. L. and Olsen, A. R. (2003). Variance estimation for spatially balanced samples of environmental resources. *Environmetrics*, 14(6):593–610.
- Stevens Jr, D. L. and Olsen, A. R. (2004). Spatially balanced sampling of natural resources.

- 60     *Journal of the american Statistical association*, 99(465):262–278.
- 61     Ver Hoef, J. (2002). Sampling and geostatistics for spatial data. *Ecoscience*, 9(2):152–161.
- 62     Ver Hoef, J. M. (2008). Spatial methods for plot-based sampling of wildlife populations.
- 63     *Environmental and Ecological Statistics*, 15(1):3–13.