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An Application of Kriging in the Study of Spatial Variability of Bacterial Biofilms Using Confocal Microscopy, Digital Image Processing, and Geographical Information Systems

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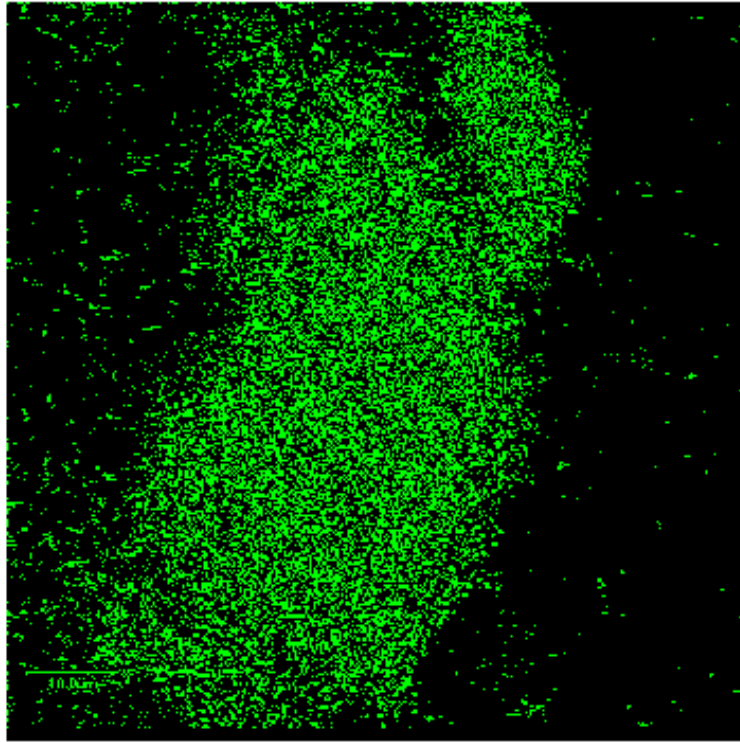
Outline of the Project

- Confocal microscopy used to obtain images of sections through biofilms taken at very well-determined positions
- Images classified through digital image processing to identify precisely components (bacteria, exopolymeric matrix, other elements)
- Classified images transformed into maps and outputted to ArcView GIS

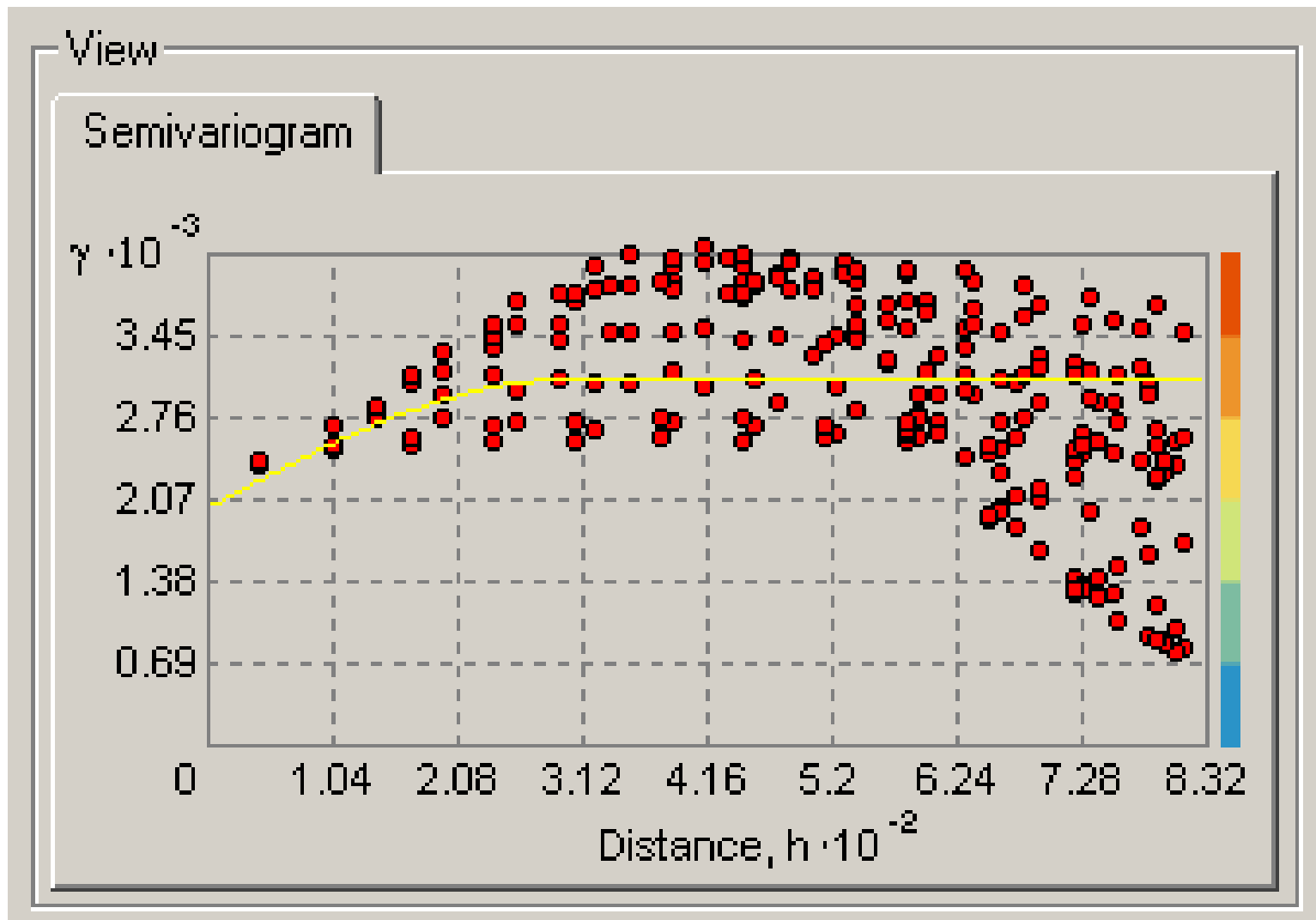
Outline of the Project (Continued)

- Classification process introduces errors and results into lack of information for some areas of the image
- Kriging is used to fill in the gaps and produce smooth, continuous images to be analyzed
- Given the size of each file, rigorous kriging available in SAS cannot be used
- Kriging is also available in Arc GIS

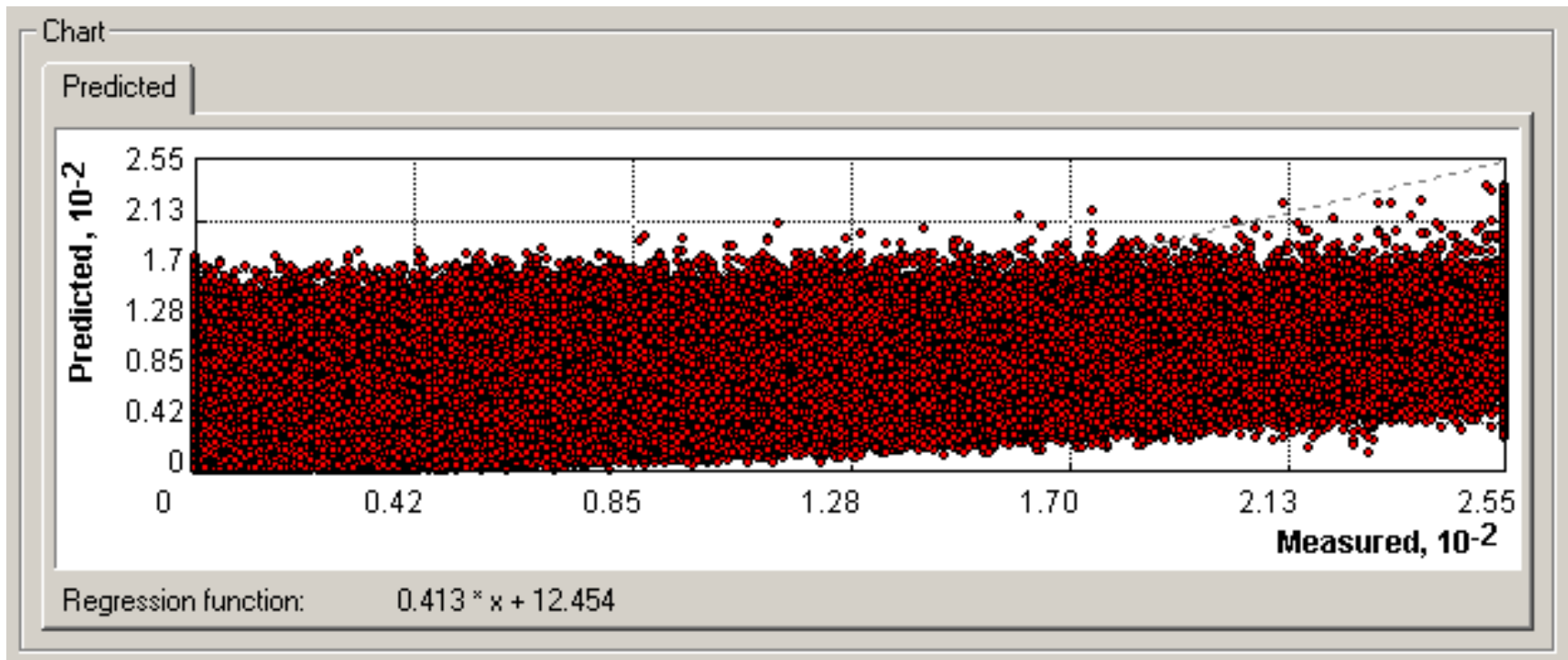
Initial Classified Map, Using GIS



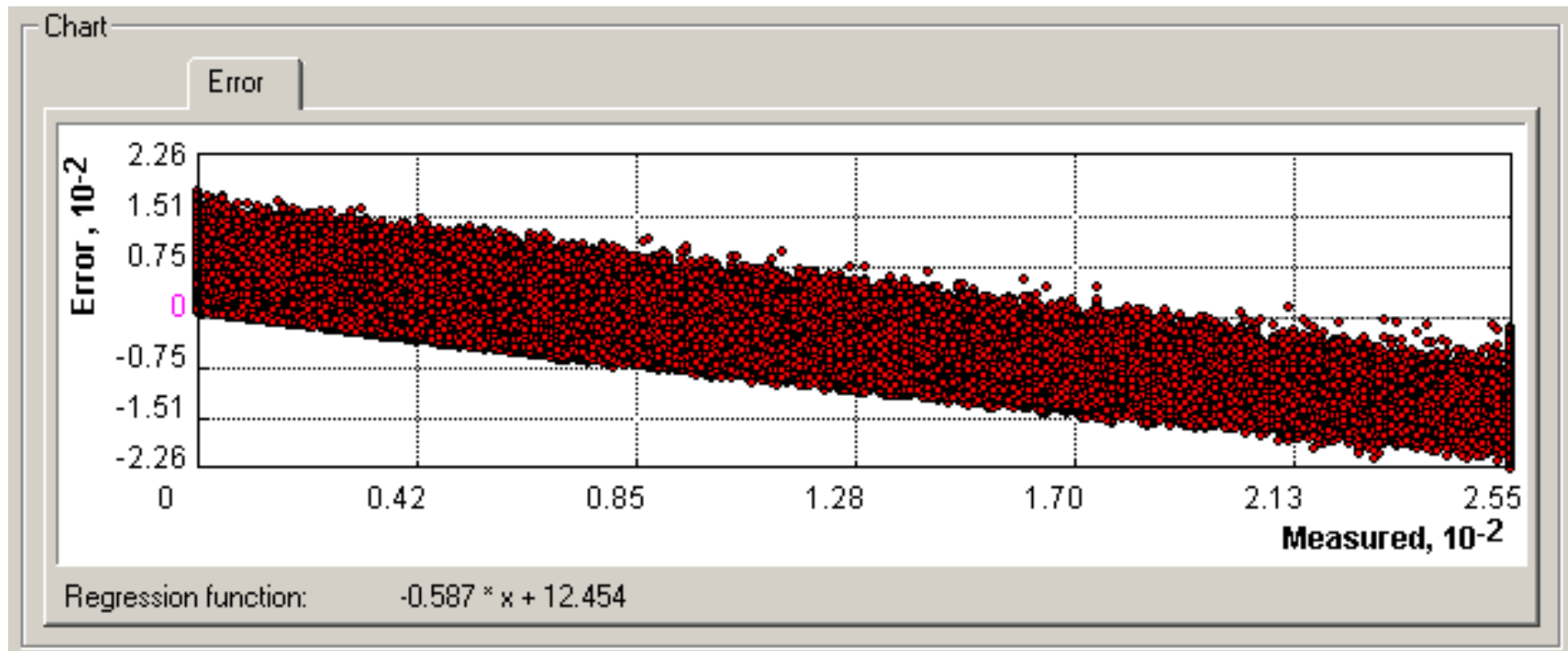
Semivariogram



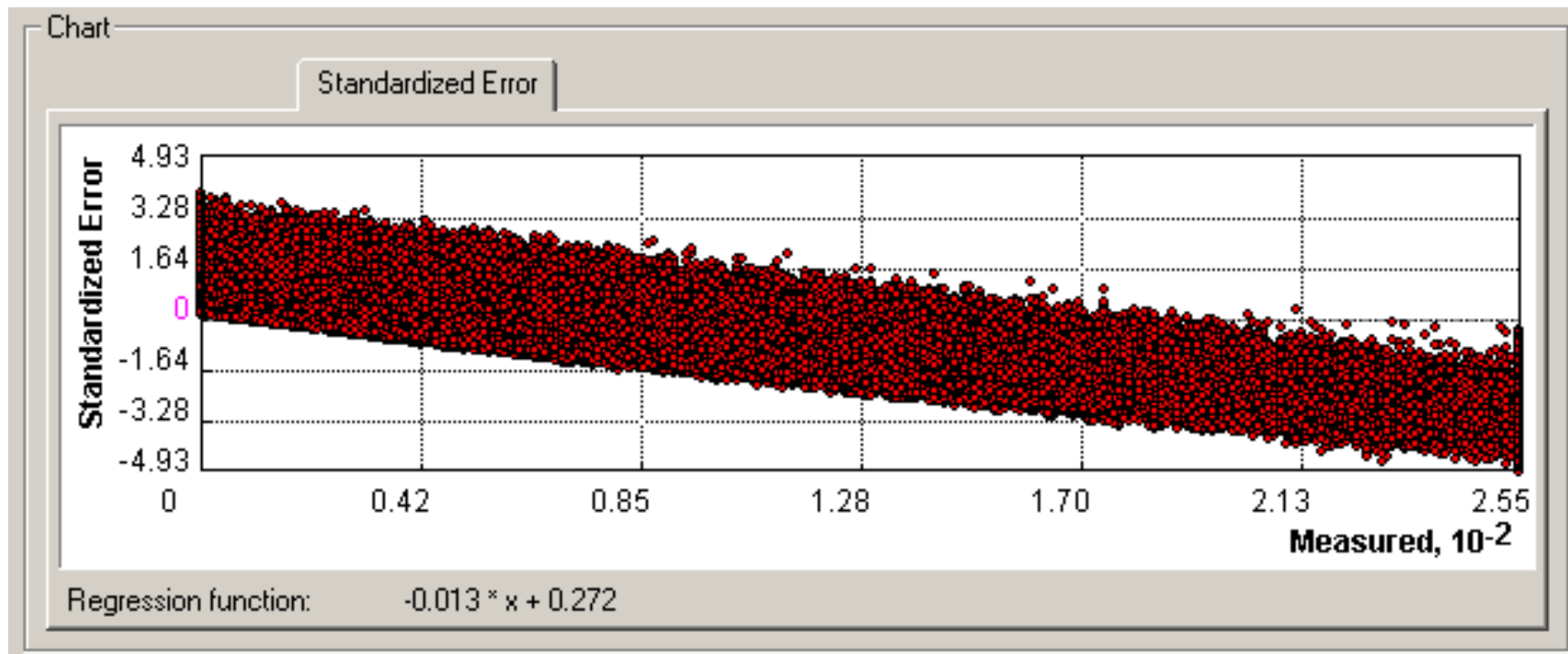
Distribution of Predicted Values



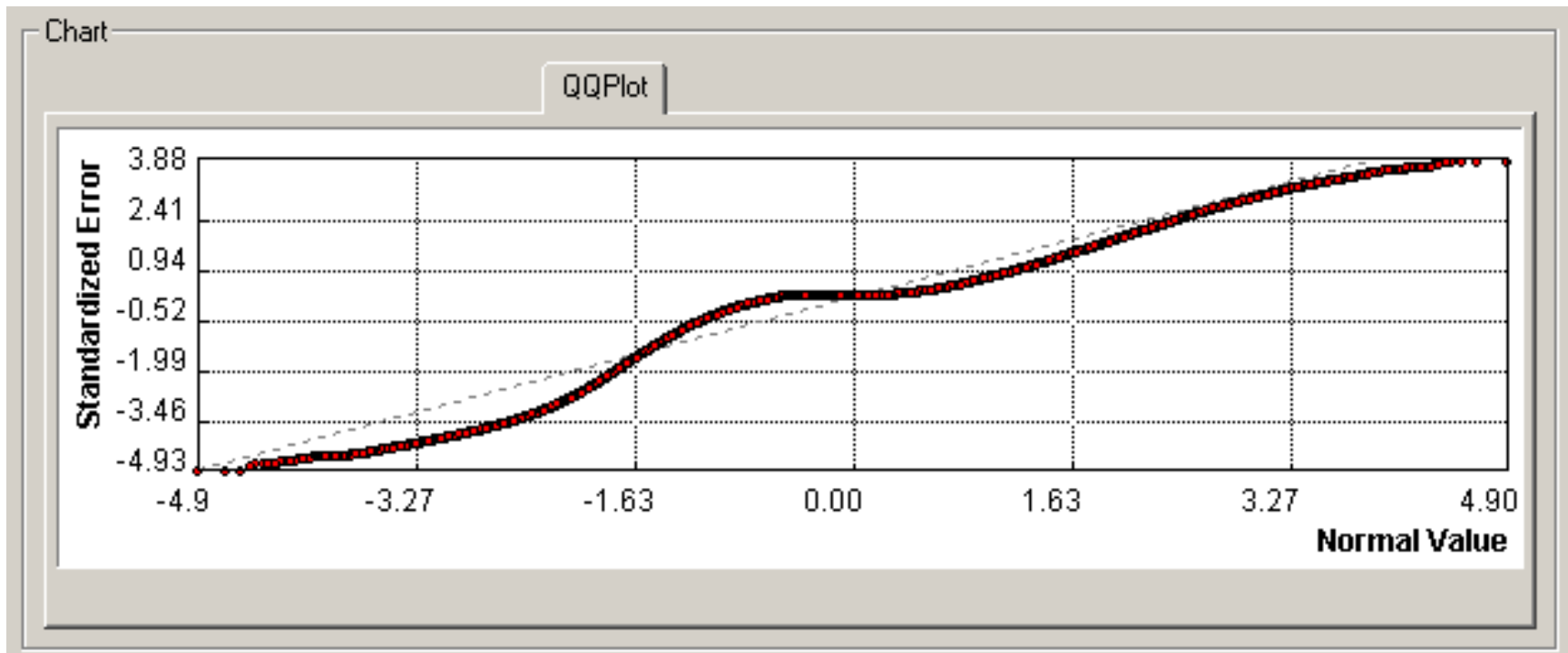
Distribution of Error



Distribution of Standardized Error



QQ Plot



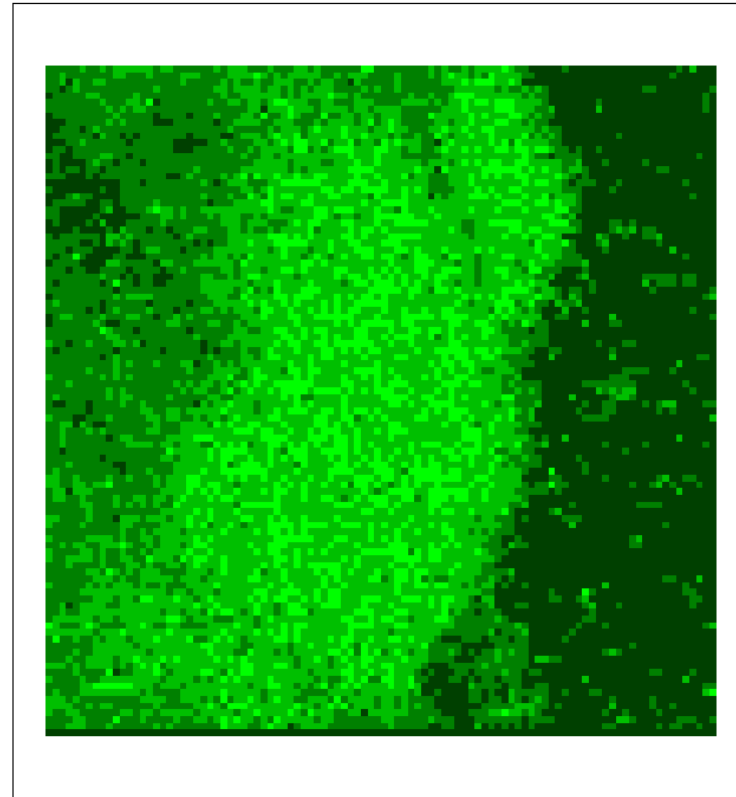
Model Specifications

- Selected Method: Simple Kriging
- Number of Points: 1048576
- Mean Value: 28.231
- Model: $1080 * \text{Spherical} (297.99) + 2002.5 * \text{Nugget}$
- Error modeling:
 - Microstructure: 2002.5 (100%)
 - Measurement error: 0 (0%)

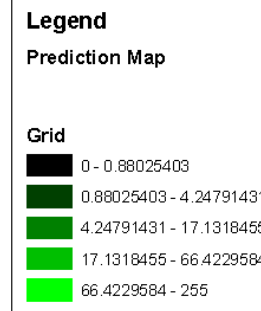
Model Specifications (Continued)

- Neighbors to include: 5 or at least 2 for each angular sector
- Searching Ellipse:
 - Angle: 0
 - Major Semiaxis: 297.99
 - Minor Semiaxis: 297.99
 - Angular Sectors: 4

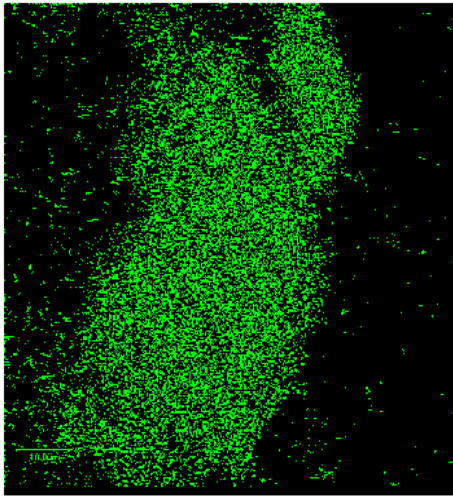
Final Prediction Map



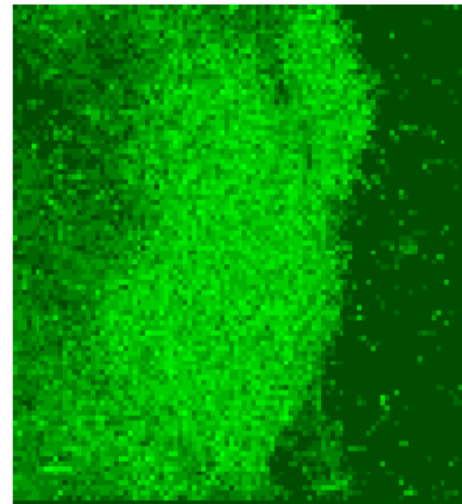
Simple Kriging:
Prediction Map
for Biofilm Image



Initial vs. Prediction Maps



Initial Map



Prediction Map

Conclusions

- Results are inconclusive
- It can not be argued whether the maps obtained using kriging provide a better description of the reality
- Since the final goal is to assess spatial variability within biofilms, this method is not reliable if using Arc GIS
- Necessity for deeper investigations