Upscaling of Site-Specific Nitrate-Nitrogen Measurements to the Watershed Scale in the Santa Fe River Watershed

S. Lamsal, S. Grunwald, C. M. Bliss, I. Lopez-Zamora,
N. B. Comerford and M.W. Clark
University of Florida

Introduction

- The Santa Fe River watershed (SFRW) (3,585 km^2) is part of the Suwannee Basin (≈ 25,900 km^2)
- The Santa Fe River (SFR) Reach 2 covers 5.7 % of the basin
- In 1998, SFR Reach 2 (west) accounted for 15.9 % (1,130 tons) and SFR Reach 1 (east) accounted for 0.9 % (65.6 tons) of the total nitrate–nitrogen delivered to the Gulf of Mexico (SRWMD, 1998)
- In 2002, the contribution of SFR Reach 2 increased to 19.6 % (SRWMD, 2003)

Objective

- **Overall Goal**

  To gain a better understanding of the geo-temporal distribution and variability of nitrate – nitrogen (NO_3-N) in the SFRW

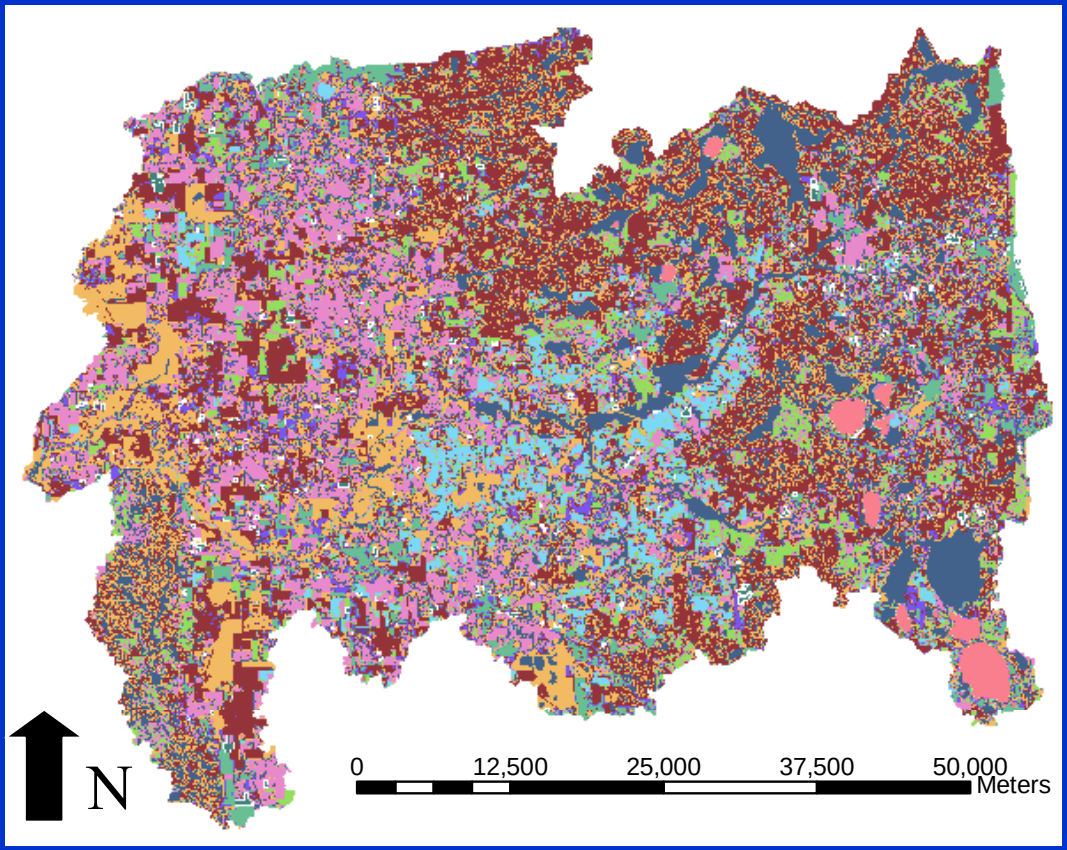
- **Objective**

  To upscale site-specific NO_3-N measurements to the watershed-scale using field observations and ancillary environmental datasets

Study Area

- Santa Fe River Watershed in north-east Florida
- Major soils: Ultisols (37 %), Spodosols (26 %), Entisols (15%), Histosols (2 %) (NRCS, SSURGO)

Land use



Data Sources
Land use: 1995 LANDSAT TM images processed by SRWMD & SJRWMD
Watershed boundary: SRWMD

Sampling Design

- Stratified random sampling: land use–soil combinations
- Composite sampling at 4 depth increments

  0-30, 30-60, 60-120, 120-180 cm
- Comprehensive space-time sampling, 2 years with 3 samplings per year (Sept. 2003, Jan. 2004, May 2004, and 3 future sampling events)

Nitrate-Nitrogen Measurements

- NO_3-N measurements at each site were profile averaged
- Distribution highly skewed to the right

Statistics of NO_3-N ($\mu g.g^{-1}$ soil) distribution

Statistics	Sept. 2003	Jan. 2004	May 2004
n	101	123	128
Mean	0.74	3.72	1.16
Min	0.01	0.06	0.10
Max	**9.88**	**193.83**	**90.12**
SD	0.11	1.84	0.68

High values in Jan. followed by May and Sept sampling events

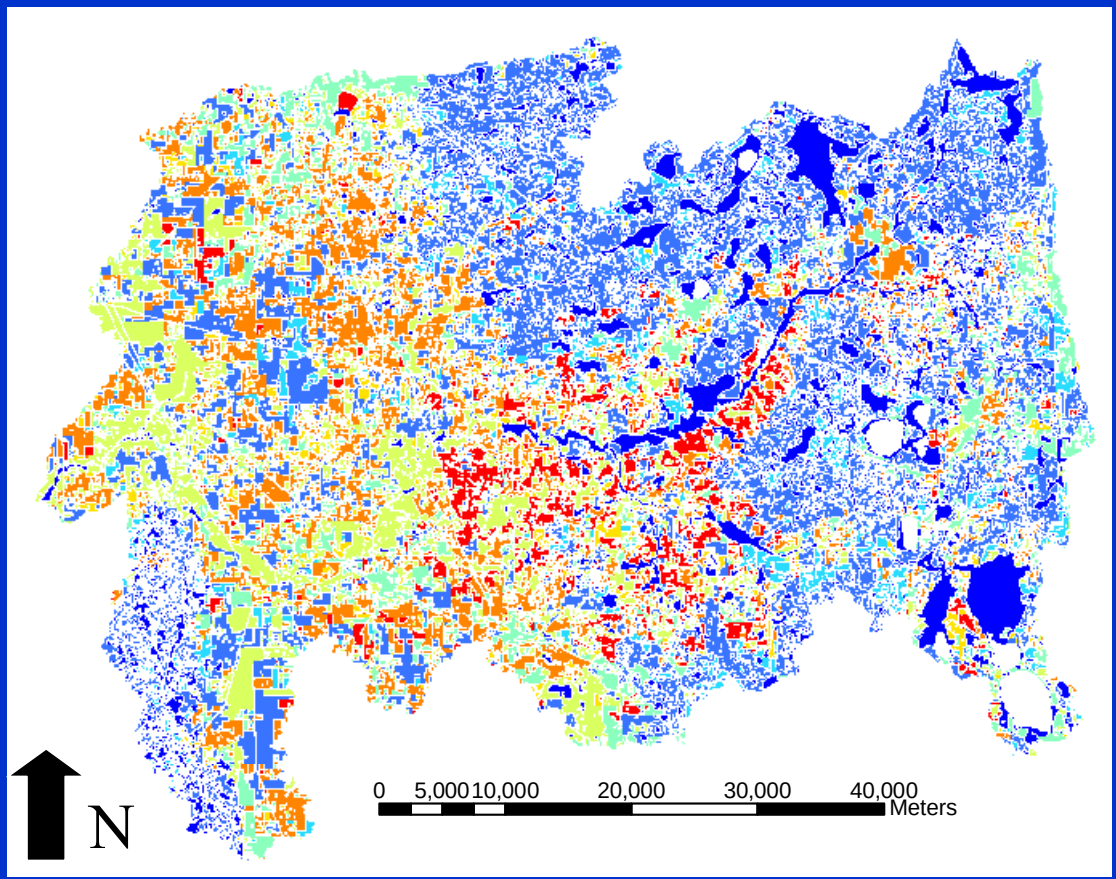
NO_3-N by Land Use

Land uses	Sept 2003		Jan 2004		May 2004	
	Mean	Max	Mean	Max	Mean	Max
Pine plantation	0.22	0.79	0.14	0.60	0.23	0.86
Crops	1.95	**5.02**	**26.88**	**103.12**	5.36	**13.96**
Forest regeneration	0.83	**10.1**	0.19	0.70	0.30	0.50
Improved pasture	1.17	**6.54**	11.40	**103.70**	3.01	**19.92**
Rangeland	1.58	**4.30**	**8.38**	**41.80**	1.49	**6.50**
Tree grove	3.07	**6.06**	2.79	5.36	4.22	**8.86**
Upland forest	0.78	4.58	3.66	**67.42**	0.22	0.39
Urban	0.14	0.39	0.19	0.61	0.38	1.12
Wetland	0.24	1.60	0.09	0.28	0.49	1.79

NO_3-N Trend Model

- Trend model based on mean NO_3-N under land use Pixel based upscaling

Jan. 2004

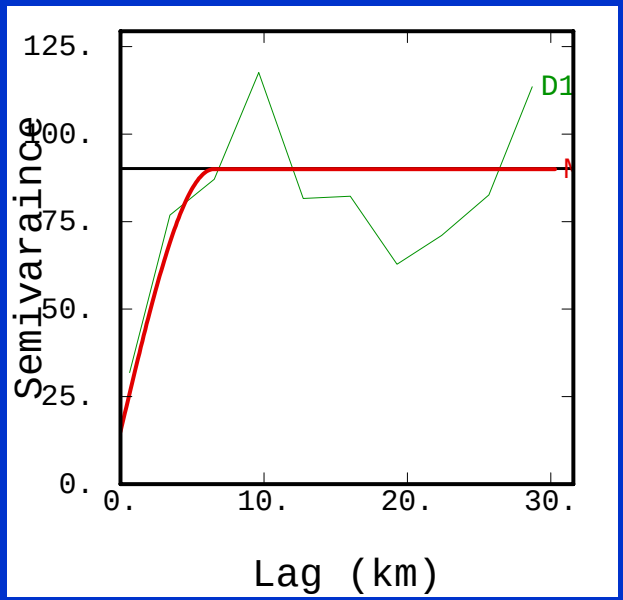


Residual Modeling

- Residuals were computed for each sampling location
- Spatial autocorrelation of residuals was modeled using semivariograms
- Residuals were interpolated using Ordinary Kriging
- Residuals compensated for under- and over-predictions made by the trend model

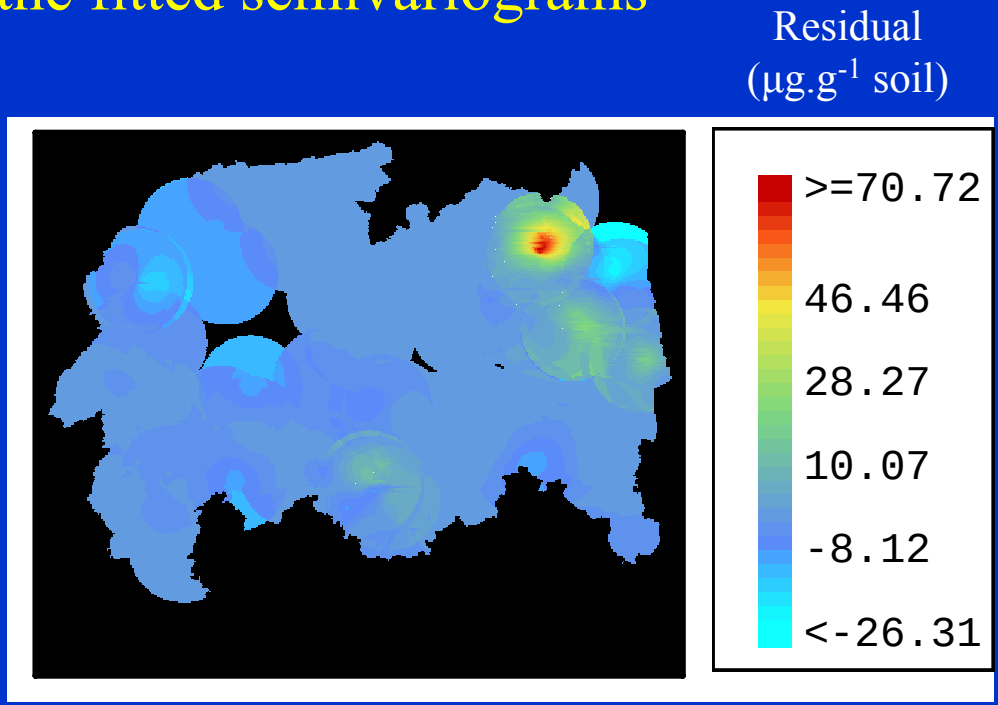
Autocorrelation of Residuals

January 2004



Spherical model
Nugget:15
Sill: 75
Range: 6,500 m

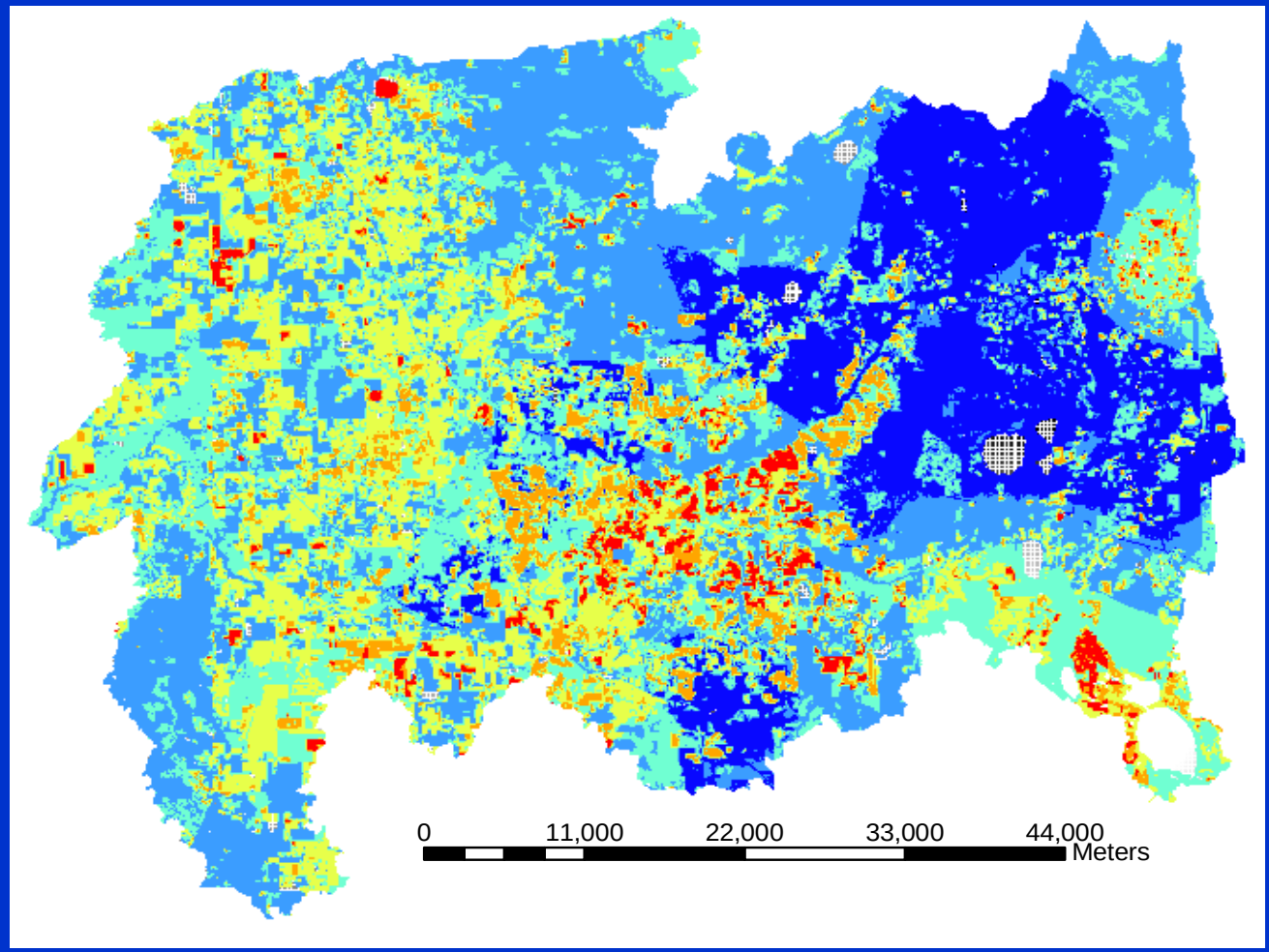
The residuals were interpolated using the fitted semivariograms



Spatial Distribution of NO_3-N

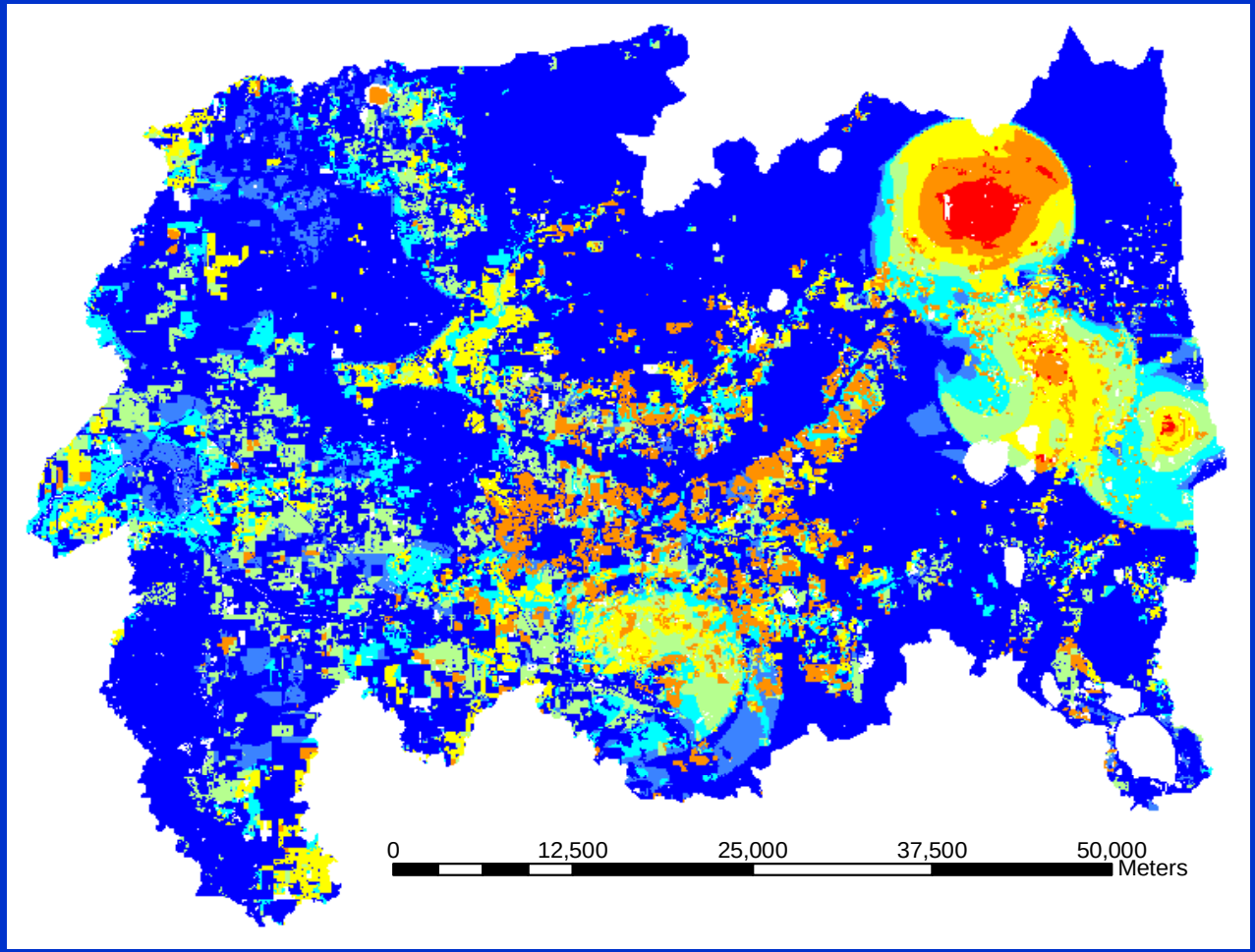
Trend model + Residual model → NO_3-N Model

Sept. 2003



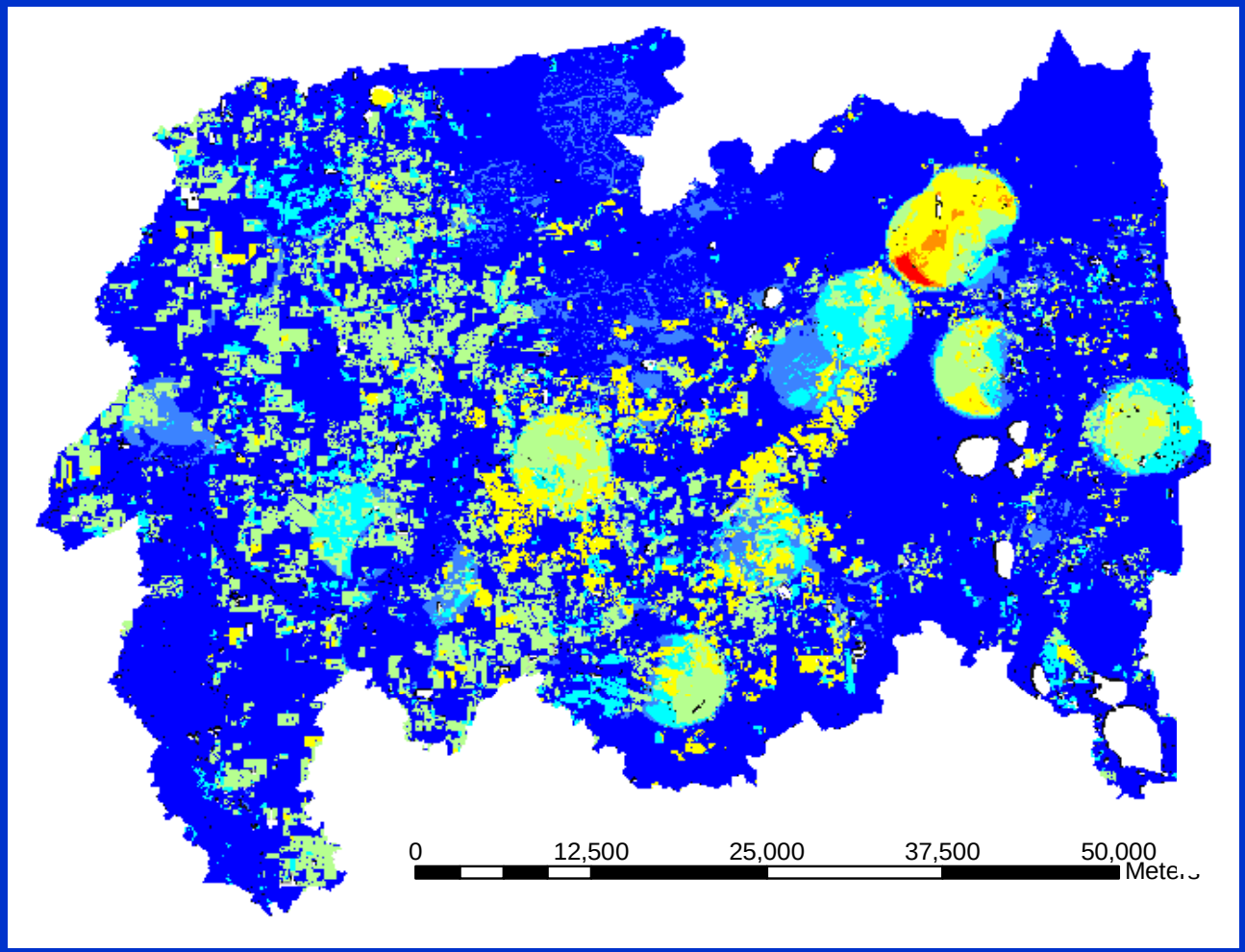
Spatial Distribution of NO_3-N

Jan. 2004



Spatial Distribution of NO_3-N

May 2004



Prediction Success

Prediction error is a composite of the error from the trend model and the residual model

Error statistics	Sept. 2003	Jan 2004	May 2004
Mean	-0.12	-0.37	-0.10
Variance	1.69	247.96	8.28

Conclusions

- Soil NO_3-N was variable in space and through time
- NO_3-N was highest in Jan. 2004 and lowest in Sept. 2003
- High NO_3-N was found in crops, improved pasture and rangeland
- Future research will focus on more advanced modeling of space-time distributions of NO_3-N across the SFRW


Thank you