A Global Analysis of Agricultural Fertilizer Inputs and Soils
Edwin A. Willig

Department of Earth, Environmental and Planetary Sciences, Brown University

Motivation
- Modern agriculture depends on nitrogen and phosphorus fertilizers to produce enough food for the population.
- By 2050 our population is expected to increase to 10 billion people, and additional fertilizer use is necessary to feed the planet in a way that does not further destroy habitat. However, fertilizer application can result in significant environment degradation if mismanaged. Understanding fertilizer consumption is therefore vital to sustainable agricultural growth.
- Soil properties are an important factor in regulating the availability of nitrogen and phosphorus within agricultural systems, but have not been widely considered when predicting future consumption of fertilizers.
- The aim of this project is to evaluate how the inputs of nitrogen and phosphorus vary across crop and soil type globally.

GIS to Analyze Trends
- Raster maps on fertilizer inputs, crop type, and yield was taken from EarthStat.
- Soil Map taken from the Food and Agricultural Organization of the United Nations
- Map of the top 5 crops was generated using the Highest Position tool in ArcToolbox.
- Values for fertilizer inputs, crops, and yield were gathered by soil type using the Zonal Statistics by Table tool in ArcToolbox and the Join Table tool.
- Additional tools used for data cleaning included raster resample, join table, field.

Acknowledgments:
Thank you to Lynn Carlson for her invaluable assistance and instruction. Thank you as well to Professor Stephen Porder, Eric Roy, and Luiz Martinelli for their input and advice.

Global Variability in Nitrogen and Phosphorus

Figure 1. Global Soils Map
Figure 2. Global Crop Cover map of Top 5 Crops
Figure 3. North America N:P by Soil
Figure 4. South America N:P by Soil
Figure 5. Europe N:P by Soil
Figure 6. Africa N:P by Soil
Figure 7. Asia N:P by Soil
Figure 8. Global Distribution of Nitrogen Fertilizers
Figure 9. Global Distribution of Phosphorus Fertilizers

Nitrogen Inputs Higher Globally
- Globally, nitrogen fertilizer inputs are higher than phosphorus inputs. However, no relationship was found between soil type and nutrient ratio, likely due to poor resolution of fertilizer data and economic access factors to fertilizers.
- Future research with this data includes incorporating yield gap data for crops to assess where soils yield gaps are the highest in order to develop predictions for fertilizer consumption. Preliminary examination reveals that the highest yield gaps are on oxygen-poor soil, which have a high demand for phosphorus.
- Updated, higher resolution fertilizer data needed for better predictions.

References:
1) Potter, P. N., Ramankutty, E. Bennett, and S. Donner., Characterizing the Spatial Patterns of Global Fertilizer Application and Manure Production, Earth Interactions, 14, 2010.