PALS Soil Moisture Data
The new Frontier in Soil Related Sciences

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MWH Soft
July 2009
Project Overview

- Investigate PALS Soil Moisture Data
- Create Soil Moisture Surfaces from Point Data
- Compare Similarities between Soil Classification and Soil Moisture
- Determine Applicability for use of JPL data and Further Research
Project Overview

- **Data Utilized**
  - PALS Soil Moisture Data (JPL)
  - Elevation Data (USGS)
  - SSURGO Soil Data (SCS/NRCS)
  - StreetMap Data (ESRI)

- **Tools Used**
  - ArcEditor
  - **GeoStatistical Analyst**
  - Spatial Analyst
  - InfoSWMM
PALS Data

- Obtained by NASA’s Jet Propulsion Laboratory
- Collected via Airborne Sensor
- Used Data for 8 Days in Summer 2007
- Project Area – Southern Oklahoma ~35 sq. mi.
- Data collected at approximately 450’ intervals
Who Cares About Soil Moisture?

- Hydrologists
- Sewer System Managers
- Farmers
- Environmental Sciences
- Average People
PALS Data Analysis

- Statistics
  - Normal Distribution?
- QQ Plots
- Trend Analysis
- Semivariograms
- Surface Creation – Kriging
- Surface Analysis
- Application – Hydrology
- Conclusions
Statistical Analysis

- GeoStatistical Analyst
- Review Histograms
- Normal Distribution Overall
- Somewhat Skewed after Rainfall
- Statistics to Excel for Temporal View of Data
GeoStatistical Interaction

- Select statistical output
- Features are highlighted on the map
- Visual Exploration

July 4
Statistical Summary Over Time

- Apparent Rain Events July 3, 4, and 7
- Skewness and Deviation increase with Wetness
- Kurtosis changes with multiple rain events
- July 4 Wettest Day
- Why?

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Q/Q Plots

- Compare Data vs. Theoretical Normal Distribution
- Plot Rankings From 2 Datasets
Trend Analysis

- View Data in Space
- Find Directional Trends
- Latitude and Longitude make simple example
- Polynomial trends possible
- Trends can be removed during surface creation if necessary
GeoSpatial

Semivariogram / Covariance

- Variogram – Degree of Spatial Dependence
- Can Display Covariance as a function of Distance
- Latitude and Longitude used as initial example
- 280 Points Selected for Analysis
Interacting with Semivariogram Models

- Where is there Spatial Independence?
- Highest Variance Changes over Time (amount and locations)
Surface Creation

- Kriging Used
- Estimates areas with no return
- Trends Removed – 3rd Order
- Directional Searching utilized
- Tetraspherical Semivariogram model used
  - Lag Size (Auto Calc)
  - # of Lags (Auto Calc)
  - Partial Sill (Auto Calc)
  - Anisotropy (Auto Calc)
Kriging – Trend Removal
Kriging – Searching Neighborhood
Kriging – Cross Validation

- Take One Point Away
- Create a Test Surface
- Compare Created Point to Actual Value
Created Dataset

Layers
- PALS_2007_06_11
  - SoilMap
    - 23.713722 - 22.935000
    - 27.938011 - 27.799999
    - 24.700001 - 25.779938
    - 25.779939 - 26.420000
    - 26.420001 - 26.820000
    - 26.820001 - 27.220000
    - 27.220001 - 27.860000
    - 27.860001 - 28.940000
    - 28.940001 - 30.710000
    - 30.710001 - 33.623657
- Rivers and Streams
  - Stream
  - Stream Intermittent
  - Canal
  - Canal Intermittent
  - Aqueduct
  - Falls
  - Intercostal Waterway
  - Dam
- Ordinary Kriging
  - Prediction Map
    - [PALS_2007_06_11] [SOIL]
- Filled Contours
  - 20.021013 - 22.9354578
  - 22.9354578 - 24.7037007
  - 24.7037007 - 25.7765235
  - 25.7765235 - 26.4274233
  - 26.4274233 - 26.9409698
  - 26.9409698 - 30.7092127
  - 30.7092127 - 33.6236572
- PALS Data
Filling in Gaps

- **PALS_2007_06_11**
  - **SOILMOIST**
    - 20.713722 - 22.935000
    - 22.935001 - 24.700000
    - 24.700001 - 25.779930
    - 25.779939 - 26.420000
    - 26.420001 - 26.820000
    - 26.820001 - 27.220000
    - 27.220001 - 27.860000
    - 27.860001 - 28.940000
    - 28.940001 - 30.710000
    - 30.710001 - 33.623657

- **June11**
  - **Value**
    - High : 33.5605
    - Low : 20.0833
Surface Summary

- Probability Map exported to Raster

- 10 Meter Cell Size

- Surfaces for each day with recordings

- Missing Data estimates for final surface creation not applied
Change Datasets

- Raster Calculator
  - Spatial Analyst
- Subtracted later date from earlier date
- Output is change in Soil Moisture Over time
Watching Change in Soil Moisture

July 1 - 3

July 3 - 4
Watching Change in Soil Moisture

July 4 - 5

July 5 - 6

July 6 - 7
Cokriging vs. Averaging

- Both provide similar data
- Cokriging maintains data extremes
- Cokriging is an in-depth estimator
- Cokriging maintains global trends across multiple datasets
Overlay Analysis - Elevation

Calculations

Value

High: 11.381
Low: -39.52765

5-6
4-5
3-4
2-3
1-2
0
1-3

Rasters
Surfaces
RADS Data
Clip
Rivers and Streams
NRCS Soil Data
Counties
State Boundaries

Value

High: 305.712730
Low: 216.356659
Overlay Analysis - SSURGO
Spatial Analysis - SSURGO

1. Determine Soil Stats within each SSURGO polygon
2. Join Output to SSURGO database
3. Summarize information on MUKEY field
Human Analysis - SSURGO

- 3 Polygons
- Similar spatial proximity
- Similar elevation
- Large variability in soil moisture among the 3 polygons
Spatial Analysis – SSURGO - Summary

- Large variability in soil moisture among polygons with the same MUKEY
- The MUKEY field is used to assign hydrologic code
- Hydrologic code very important for rainfall / runoff modeling
Overlay Analysis - Hydrology

- 1 – Create Subcatchments (Elevations / InfoSWMM)
- 2 – View Soil Moisture within Catchments

- Large Variability
Spatial Analysis - Hydrology

- Can utilize this data to assign Horton or Green-Ampt Infiltration Parameters
- Can check current model response
- Rainfall Data needed for model verification
Conclusions

- Soil Moisture varies significantly in time and space

- Soil Moisture is not directly correlated to any one factor; Factors include:
  - Rainfall
  - Soil Characteristics
  - Proximity to Rivers / Lakes
  - Temperature
  - Amount of Sunlight
  - Elevation
  - Etc.
Conclusions

- JPL’s PALS Data significantly enhances understanding of Soil Moisture
- PALS Data can greatly benefit earth and water sciences
- Expanded research on PALS data is highly recommended in conjunction with calibrated radar-rainfall data
- Geostatistical Analyst and ArcMap provide a powerful environment for examining the PALS Data
Conclusions

- The hydrologic codes used in SSURGO data may be relatively generic
  - Source Data is from the 1920’s
  - SSURGO data is impressive considering the limitations of data collection

- Watershed delineation using elevation as the only consideration may lead to force fitting models
Questions?

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