





The Geography-Environment Nexus: Spatially-Explicit Environmental Analysis and Modeling

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International Conference of Geography and Environment
Mexico City
8 October 2013

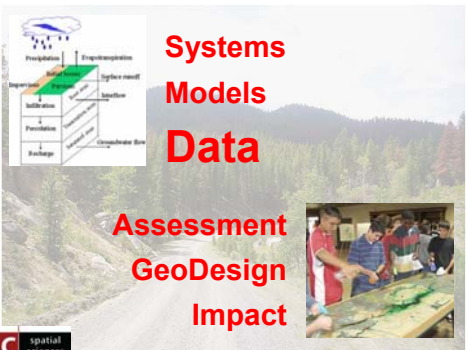


Outline


- Building Blocks
 - Climate
 - Topography
 - Soils / Geology
 - Land Use / Land Cover
 - Mobile Elements
- Sample Application
 - Characterizing Melanoma Risk
- Enduring Challenges
 - Geospatial Semantics
 - Managing Scale Issues
 - Modeling Space and Time
- Final Thoughts

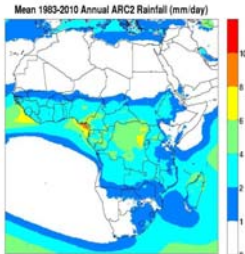
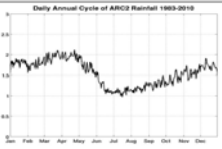
Building Blocks



**Systems
Models
Data
Assessment
GeoDesign
Impact**




Climate

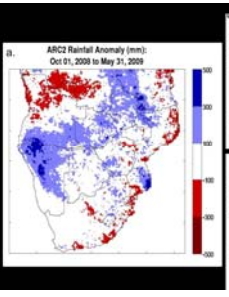
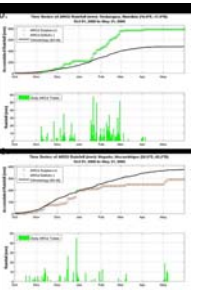
Annual cycle of ARC2 rainfall (mm/day) over Africa domain

Spatial mean of annual ARC2 rainfall (mm/day) at a 0.1° resolution over Africa from 1983-2010

NOAA NCEP CPC FEWS Africa DAILY ARC2 daily options – Columbia University




Climate Surfaces

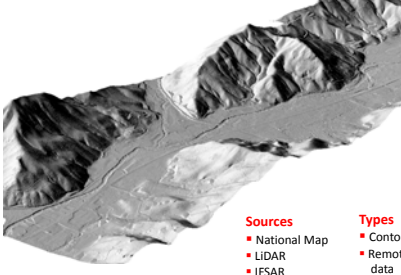



Map of ARC2 total rainfall anomaly (mm), plus observed & cumulative ARC2 rainfall time series for Ondangwa, Namibia, & Maputo, Mozambique for southern Africa rainy season (10/1/08-5/31/09)

Source: Novella & Thiaw, n.d.



Topography




Sources

- National Map
- LIDAR
- IFSAR
- GPS

Types

- Contour and stream line data
- Remotely sensed elevation data
- Surface specific point elevation data

Picture: Courtesy of David Maune



Topographic attributes

- Elevation (z)
- Slope gradient (α)
- Slope aspect (ω)
- Curvatures (κ)
- Distance to the nearest ridge
- Downslope length
- Upslope area

USC spatial sciences Slide: Courtesy of Bard Romstad 7

Sparse Data / Spatial Interpolation

USC spatial sciences Slide: Courtesy of Graeme Aggett 8

LiDAR / Spatial Filtering

- **Light Detection And Ranging**
- Measures distance to, or other properties of a target by illuminating target with light, using pulses from a laser
- Three components
 - Airborne scanning laser rangefinder
 - Differential GPS
 - Internal Navigation System
- Generates millions of points at relatively low cost ...

USC spatial sciences 9

Pre-Processing Decisions

- Source and granularity of DEM used
- Presence and handling of spurious pits (interpolation)
- Choice of drainage enforcement option (if any)
- Choice of flow routing algorithm
- Dynamic character of key variables and processes
- **Topographic shape matters most!**

USC spatial sciences Maps: Courtesy of David Tarboton 10

Geology / Soils

- Spatial granularity: Minimum mapping unit
- Choice and measurement of attributes

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Land Use / Land Cover

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Mobile Elements ...

Catalina Island Fox, Photo: Courtesy of Tim Coonan

Mission Blue Butterfly, Photo: Courtesy of Travis Longcore

Poronui Lodge: Home Ranges for Stags

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Applications

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Melanoma Risk ...

- One of most rapidly increasing cancers among white population in U.S.
- Studies consistently point to UV exposure as most important risk factor
- Individual sun exposure has proved difficult to quantify
- Initial research question ...
 - How well can we model spatial variations in UV radiation given measurement network & interpolation techniques available?

Collaborative work with Myles Cockburn (USC Keck School of Medicine) & Zaria Tatalovich (National Cancer Institute)

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Measurement Network

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Radiation Data Correlations

Springfield – Bondville, IL
Las Vegas – Desert Rock, NV
Boulder – Boulder, CO
Fort Peck – Glasgow, MT
Goldwin Creek – Memphis, TN
Penn State – Williamsport, PA
Sioux Falls – Sioux Falls, SD

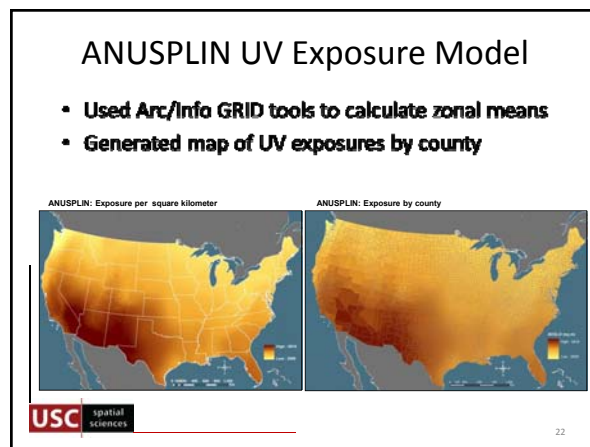
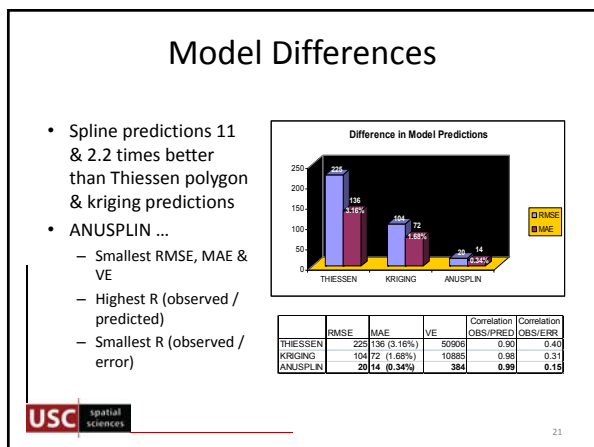
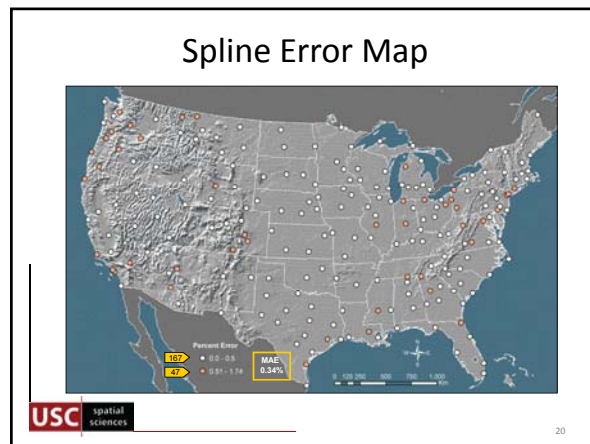
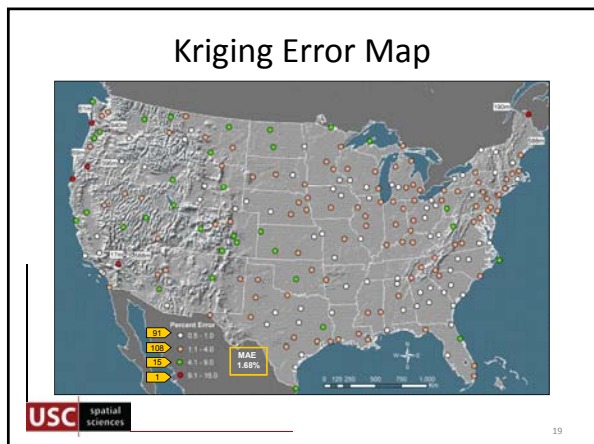
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Thiessen Error Map

Percent Error: 73, 100, 34, 15

MAE: 3.16%

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Case Control Dataset

- Los Angeles County Cancer Surveillance Program
 - 820 melanoma cases among white, non-Hispanic residents < 65 yrs
 - Cases older than 65 yrs excluded to minimize recall bias of events occurring in young age
 - Controls included 877 individuals who lived nearby and that were matched to cases for ethnicity, age, and gender
- Structured interviews
 - Residential history from birth to time of interview recorded as county or country of residence (if outside USA)
 - Time spent at each residence reported in years
 - Time spent in outdoor activity (average number of days per year of outdoor activity during age periods 15-24, 24-44, >44 yrs of age)

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Statistical Analysis

- Second research question ...
 - How is incidence of melanoma connected to place of residence and time spent outdoors?
- Conditional logistic regression used to estimate odds ratios for melanoma
 - Cumulative lifetime exposure: 4 classes (<150,000, 150-200,000, 200-250,000, >250,000 Wh/m²)
 - Analysis of time spent in outdoor activity in 3 age-specific classes because exposure at young age is important?
 - Self-reported time spent in outdoor activity: 4 classes (0-50, 51-100, 101-200, >200 days per year)
 - Examined 45+ year age group because younger adults have less chance for exposure and we controlled for matching variables of age, sex and socio-economic status

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Cumulative UV Exposure


Cumulative exposure (Wh/m ²)	Case-control	OR
< 150,000	118/143	1
150,000-200,000	160/174	1.62
200,000-250,000	168/201	2.64
> 250,000	215/191	6.01
p-Value		< 0.0001



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UV Adjusted Time Spent Outdoors

45+ years	Case-control	OR	p-Value
UV adjusted outdoor 15-24 years			
< 558,800	90/121	1	
558,800-1,042,671	123/124	1.33	
> 1,042,671	122/122	1.55	0.0955 (0.0333)
UV adjusted outdoors 25-44 years			
< 294,330	110/120	1	
294,330-645,333	125/125	1.91	
> 645,333	105/121	0.99	0.74 (0.61)
UV adjusted outdoor 44+ years			
< 299,720	123/121	1	
299,720-609,600	99/120	0.86	
> 609,600	116/127	0.91	0.74

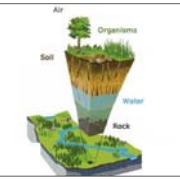


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Enduring Challenges



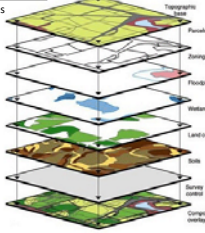
National Geographic Education Blog




Encyclopedia of Earth, Critical Zone Observatories



Consortium of Universities for the Advancement of Hydrologic Sciences, Inc.




Constraining Design Approach




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Big Geo-Data

- Spatial data infrastructures
- Key chore involves turning data into information
 - Janowicz's recent work may be key here
 - Proposes turning domain scientists into knowledge engineers
 - Relies on 80/20 rule of geospatial semantics ...
 - Choosing solutions that are neither too specific nor too general

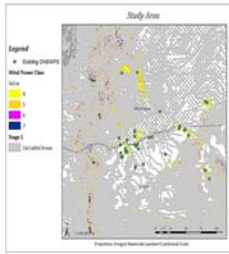





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Legacy Datasets

- National mapping programs
 - U.S. soil mapping program
 - Standard definitions and mapping protocols
 - Variations in implementation from one state to next, one field mapping crew to next, etc.
- Various forms of generalization rolled into these products
 - Geographic features
 - Attribute ranges








Map: Courtesy of Jeffrey Harrison




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Scale and Complexity

<p>Global</p> 	<p>Cloud cover and CO2 levels control primary energy inputs to climate and weather patterns</p>
<p>Meso</p> 	<p>Prevailing weather systems control long-term mean conditions; elevation-driven lapse rates control monthly climate; and geological substrate exerts control on soil chemistry</p>
<p>Topo</p> 	<p>Surface morphology controls catchment hydrology; slope, aspect, horizon, and topographic shading control surface insolation</p>
<p>Micro</p> 	<p>Vegetation canopy controls light, heat, and water for understory plants; vegetation structure and plant physiognomy controls nutrient use</p>
<p>Nano</p> 	<p>Soil microorganisms control nutrient recycling</p>

(Slide: Courtesy of Michael Hutchinson)



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Scale and Complexity (cont.)

- Strategies, processes, methods , ideas that work at one scale ... may not work at other scales
- Possible examples ...
 - Best Management Practices (to manage runoff and water quality)
 - Green Building Design (to support life)
 - Transit Oriented Development (to reduce congestion and vehicle emissions)
 - Smart Growth ...

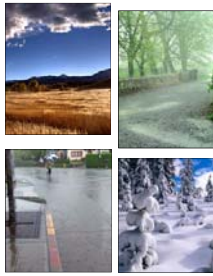
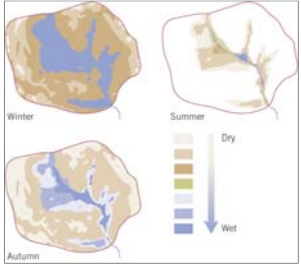








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Space and Time








Map: Courtesy of Tim Davie

Space and Time (cont.)











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Environmental Applications

- Focus on terrestrial environments
- Focus on what is or what has been
- Most of the world has been ignored
 - Oceans – cover 70% of Earth's surface
 - Buildings – people spend 85% of their lives indoors & dense urban areas have more interior space than land area
- Not well aligned with everyday places & non-expert users
- Not connected to sketch & recording needs of design disciplines




Close | Questions?

Project for Public Spaces

Placemaking plans

City-wide strategic plans

Capacity building and cultural change

Placemaking 101



Lighter

Quicker

Cheaper

<http://www.pps.org/>

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