GRASS4LEED: Building geospatial support for leadership in environmental and energy design

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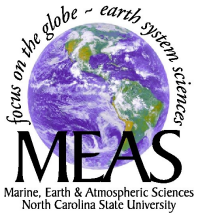


Sustainable development

Development that "**meets the needs of the present without compromising the ability of future generations to meet their own needs**" Brundtland Report, 1987 UN

Pillars of sustainable development:

- economic and
- social development,
- environmental protection

GRASS GIS: a long tradition in support of sustainable development

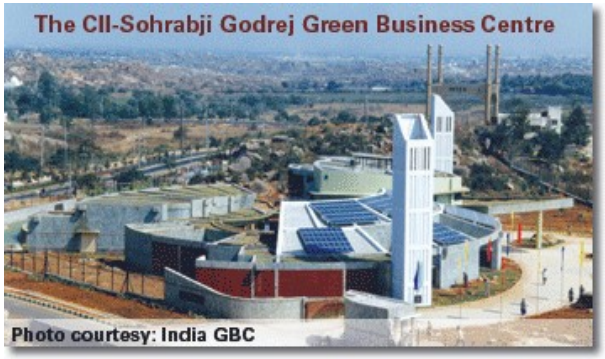
LEED® : Leadership in Energy and Environmental Design

US GBC – established **LEED** rating to **quantify** sustainable design, SPIRIT used for Army

Important for development of business model:

- golden rating required for all new projects
- LEED has set off a competition for high rating

Well established for buildings, global GBC



LEED®: geospatial, open source?

What is **geospatial** about LEED?

Individual buildings are not enough, we need sustainable communities and cities:
LEED-ND for neighborhood development
has focus on location, compactness and environment
(2006 pilot, 2008 official launch)

Where is **open source**?

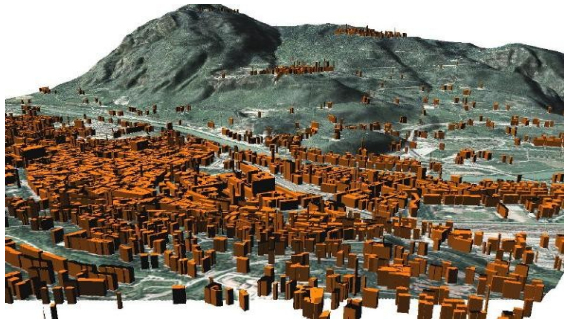
Tools for rating buildings and facilities:
GBCAustralia : Green Star
ERDC Facility Composer: free, open-source suite of criteria-based facility modeling tools.
USGBC products and service directory runs under OS

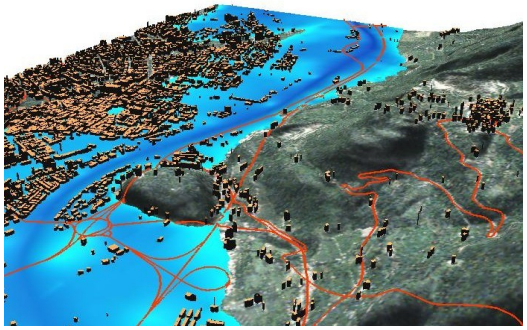
Geospatial LEED-ND®

Draft LEED – ND: 70 prerequisits and credits

1. **Location efficiency**
2. **Environmental preservation**
3. **Compact and connected neighborhoods**
4. **Resource efficiency: water, energy.**

Couple **OSGEO tools**,**numerical modeling**, and **tangible interface** to create an interactive, collaborative analysis, design and rating system.





Images Markus Neteler

Carlo Ratti, MIT

Example LEED-ND® ratings

Combines social, environmental and economic issues

Environmental Preservation (5 Prerequisites / 11 Credits / 13 Points / 11% of total points)	
Prerequisite: Imperiled Species and Ecological Communities	--
Prerequisite: Parkland Preservation	--
Prerequisite: Wetland & Water Body Protection	--
Prerequisite: Farmland Preservation	
Prerequisite: Erosion & Sedimentation Control	--
Credit: Support Off-Site Land Conservation	2

Compact, Complete, & Connected Neighborhoods (3 Prereq / 22 Credits / 42 Points / 37% of total	
Prerequisite: Open Community	--
Prerequisite: Compact Development	--
Prerequisite: Diversity of Uses	--
Credit: Compact Development	1 to 5
Credit: Transit-Oriented Compactness	1
Credit: Diversity of Uses	1 to 3
Credit: Housing Diversity	4
Credit: Affordable Rental Housing	1 to 2
Credit: Affordable For-Sale Ho	
Credit: Reduced Parking Footp	

Certified:	46 – 56 points (40% of total points)
Silver:	57 – 67 points (50% of total points)
Gold:	68 – 90 points (60% of total points)
Platinum:	91 – 114 points (80% of total points)

Can OSGEO make a difference?

When LEED-ND is adopted in 2008 there will be a great need for tools to support it.

Unique opportunity to get involved and help WorldGBC make sustainable (green) development mainstream at community / landscape scale.

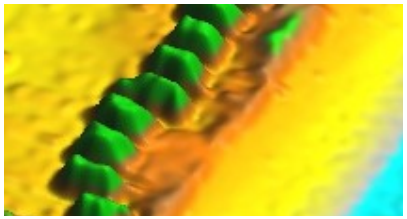
Key components
data, software, interface

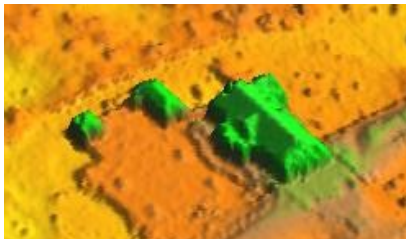
Data

Local, high resolution geospatial and socio-economic data are needed: time consuming

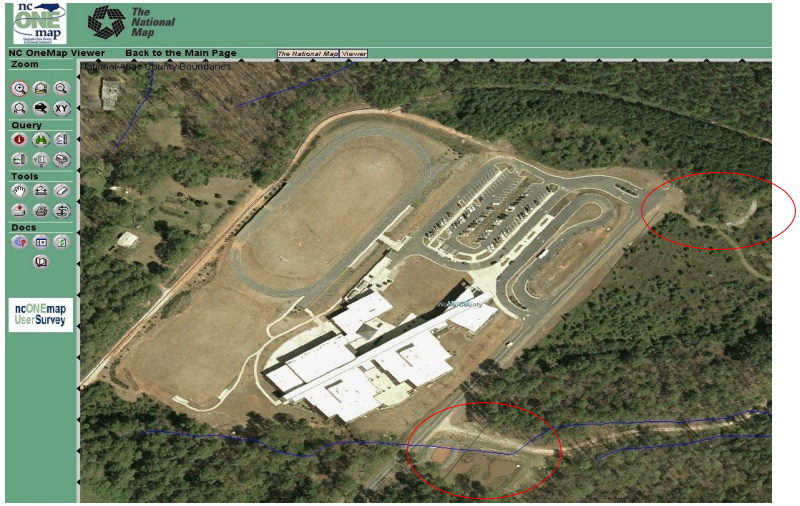
New technologies bring accessibility, efficiency:

- **Local government WebGIS services**: NC One map, Johnston county runs FOSS4G
- **New mapping technologies**: high resolution orhtos and lidar data, new sensors





GRASS GIS



Open Source Geospatial Foundation

FOSS4G Software Stack

Portability, interoperability

Geostatistics
Predictive
modeling

R-stats

QGIS
TanGIS

Viewing
Interaction
Design

External
data

GDAL/OGR

raster

vector

GRASS

Spatial Analysis
Modeling
Visualization

Web
services

Mapserver
Chameleon

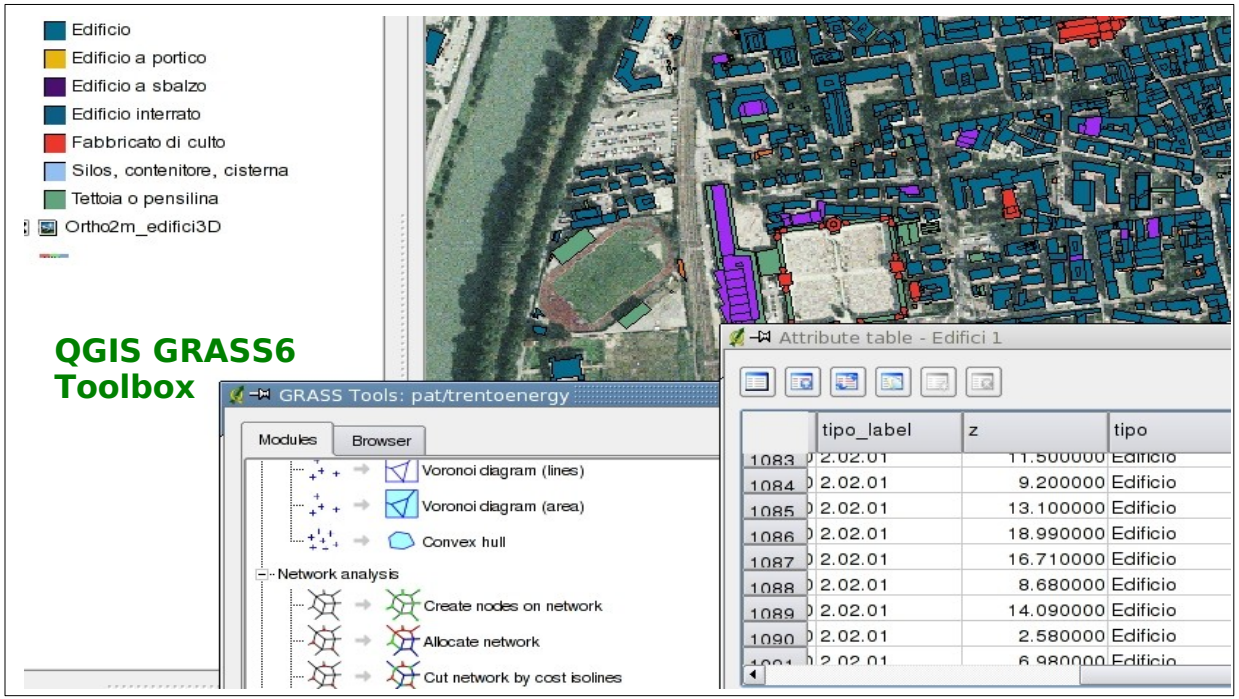
MySQL
PostgreSQL
DBF

Database
engine:
Tables,
attributes

GRASS6 tools

Location Efficiency: transportation, water and stormwater infrastructure, brownfields redevelopment

Compact, Complete and Connected Neighbourhood: open community, diversity of housing and uses, walkability, transit and access

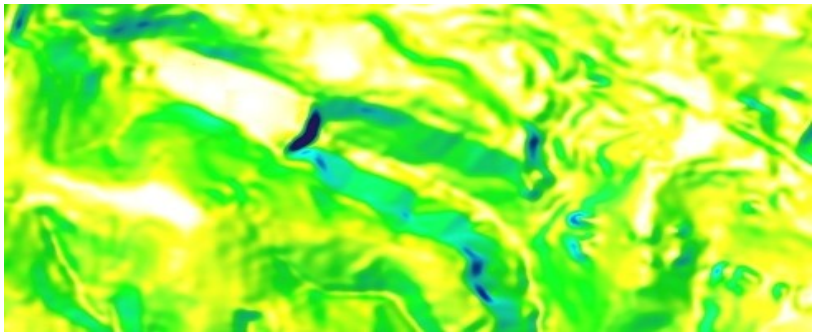


vector: overlays, network analysis
raster: cost surfaces, map algebra
DBMS

GRASS6 tools

Environmental Preservation:
habitat, wetland, parkland preservation, erosion control, minimize disturbance, maintain/reduce runoff

Resource Efficiency
on-site power, renewable energy, water efficiency, waste management, light pollution reduction

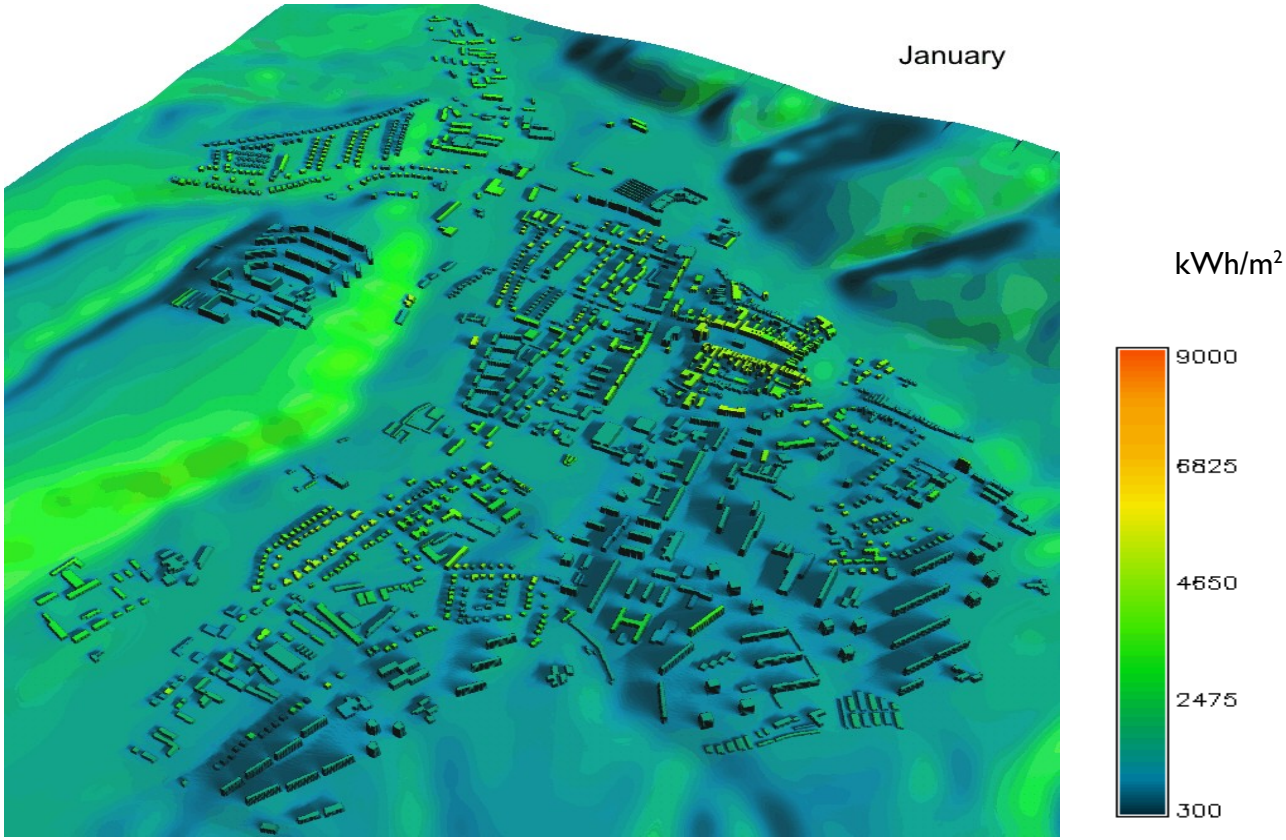


raster: watershed analysis, hydrologic and erosion modeling, solar irradiation, map algebra
vector: network analysis

HydroFOSS
JGRASS

Solar radiation modeling

Application of r.sun in urban areas with 3-D city models (cost/revenue analysis for solar panels, building design, urban greenery, thermal conditions,...)



Jaro Hofierka
University of Presov

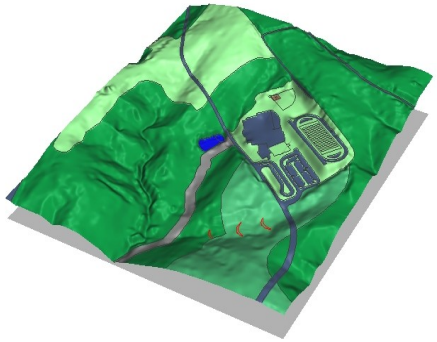
Photovoltaic potential

Seasonal changes in photovoltaic potential in urban area

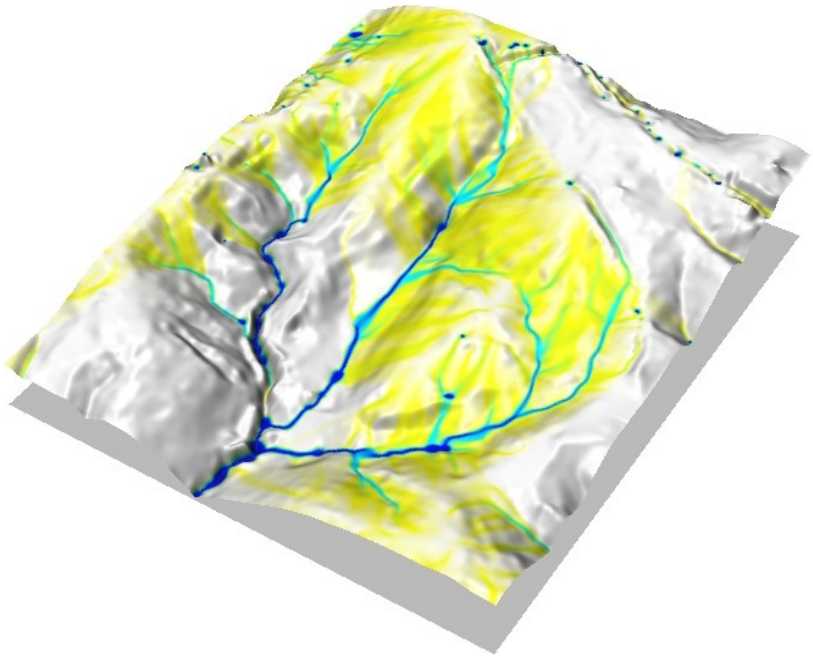
Monthly values of electricity potentially produced by each building using solar panels; impact of roof area, slope, aspect,material was included

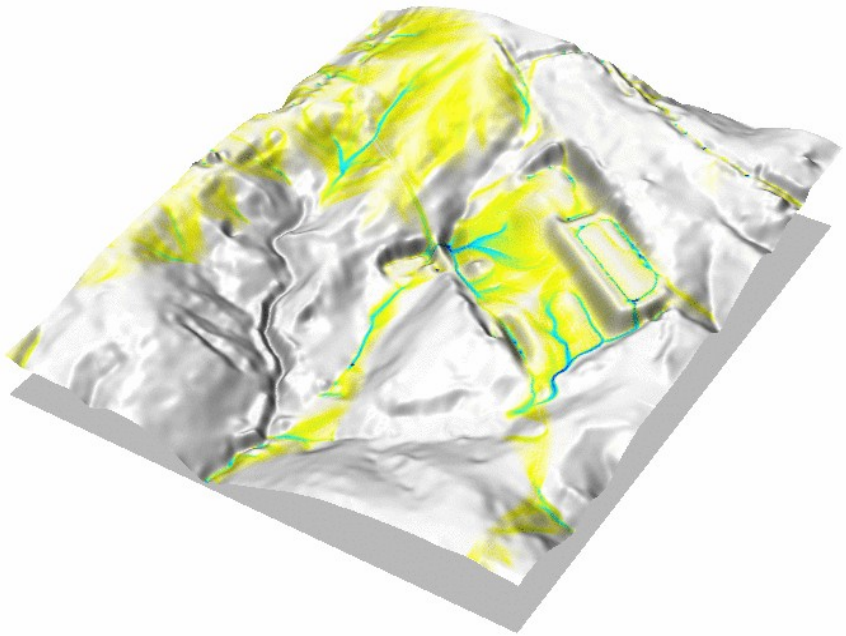
Jaro Hofierka
University of Presov

Preserve water flow pattern

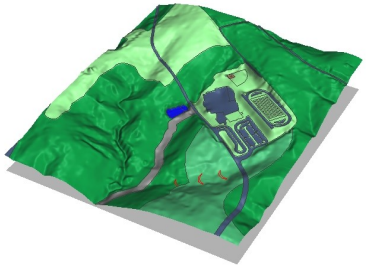


School built, wetland and checkdams added for stormwater control

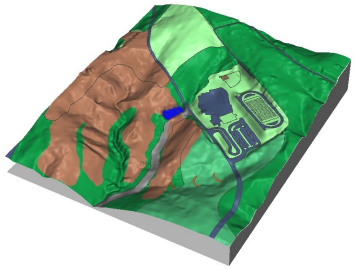




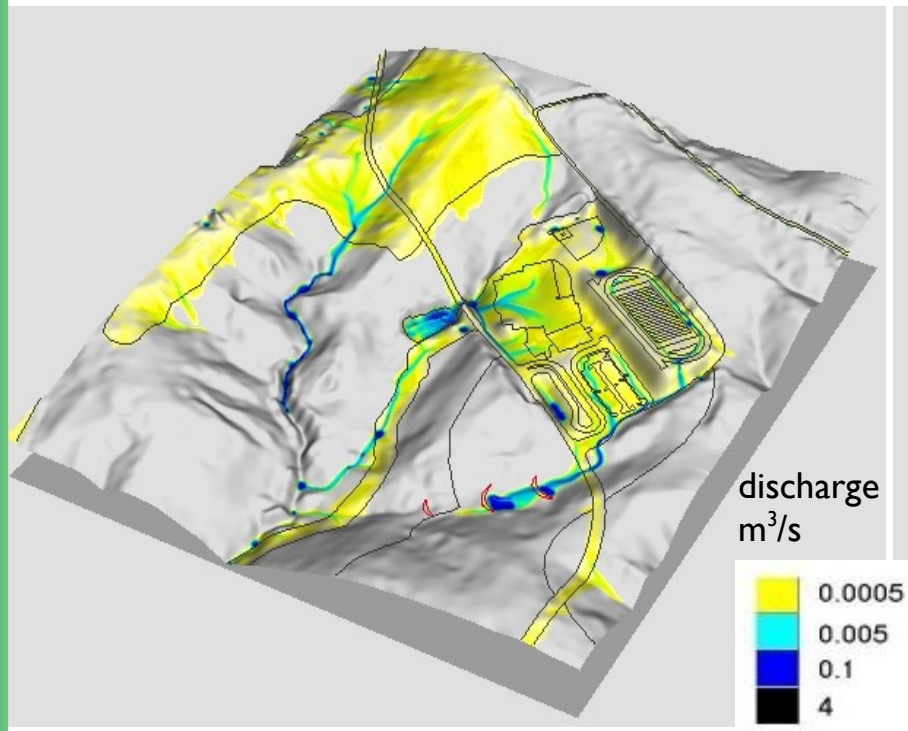
Maintain runoff

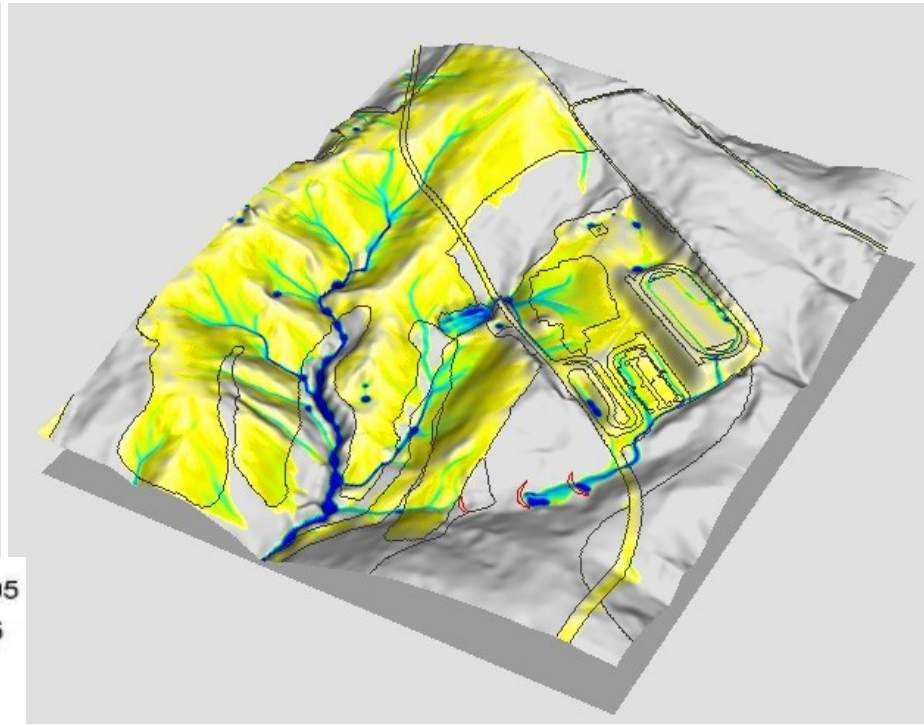


current
49% forest



construction
24% forest





discharge
m^3/s

Geospatial Design

Multidisciplinary team – stakeholders and experts - holds **charrette** – intensive workshop - to set goals, assess and modify the proposed project to achieve high sustainability expressed by LEED rating.

Traditional approach:
maps and slides

Limited
- log from discussion
- access to info
- feedback on impact of proposed modification

Advantage
face to face,10+ people

New technologies: Touch tables

IEEECG&A
Sept/Oct 2006
Interacting with digital tabletops

Interactive access to geospatial information

2D representation

Face-to-face collaboration

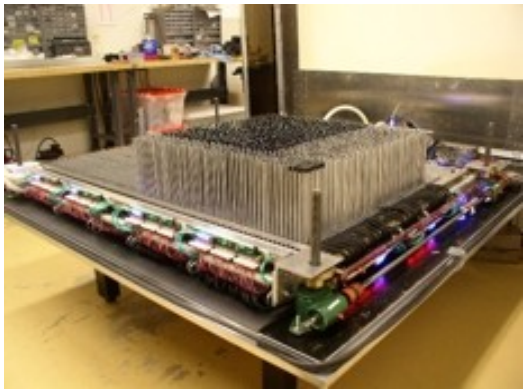
Limited design capabilities

1 Tabletop iDwidgets in action: (a) DTMap, (b) TeamTag, (c) UbiTable, and (d)Table-for-*N*. Each application uses a MERL DiamondTouch table, which serves as an interactive tabletop.

Dynamic physical 3D models

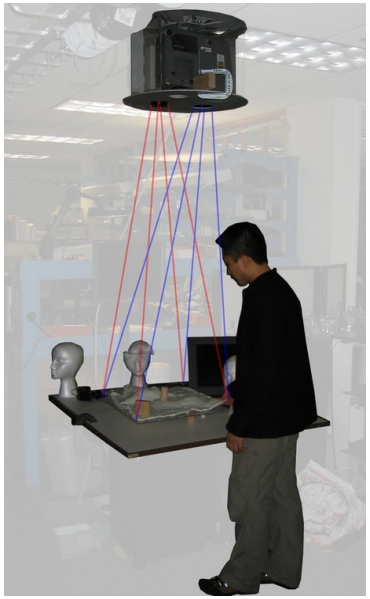
Combine easy to interpret **3d physical models** of landscape with **geospatial data** to facilitate communication and collaboration

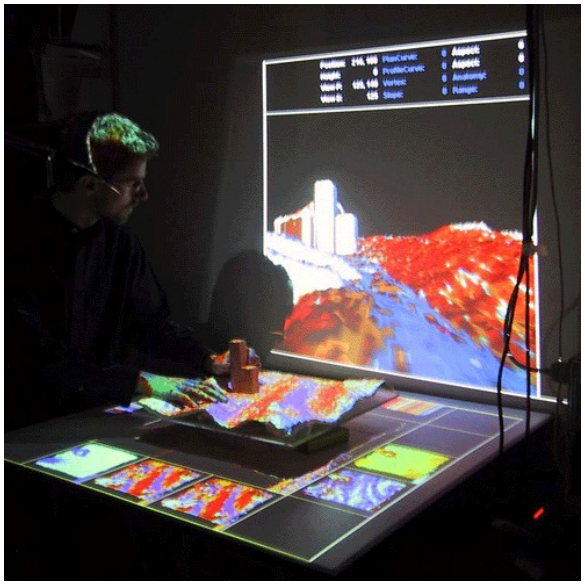
http://www.xenotran.com/xenovision_clips.html

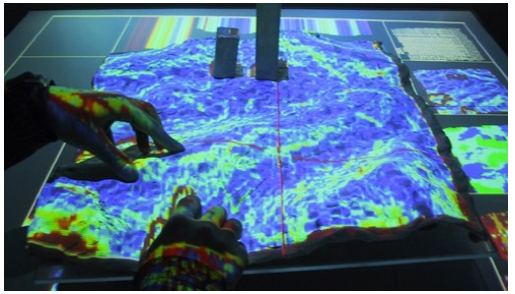


XenoVision Mark III
Northrop Grunman TerrainTable™
includes TouchTable capabilities

Illuminated Clay: 3D interaction







developed by MIT Media Lab
and SENSEable City lab

Combines **virtual representation** with **solid model** and 2D images, re-computes and displays terrain parameters in near-real-time

Traditional GIS: design with mouse+GUI: need to make a connection between hand and the image on the screen
Illuminated Clay: hand and eye works with the same object (physical model) freeing the brain for more creative thinking

Test study

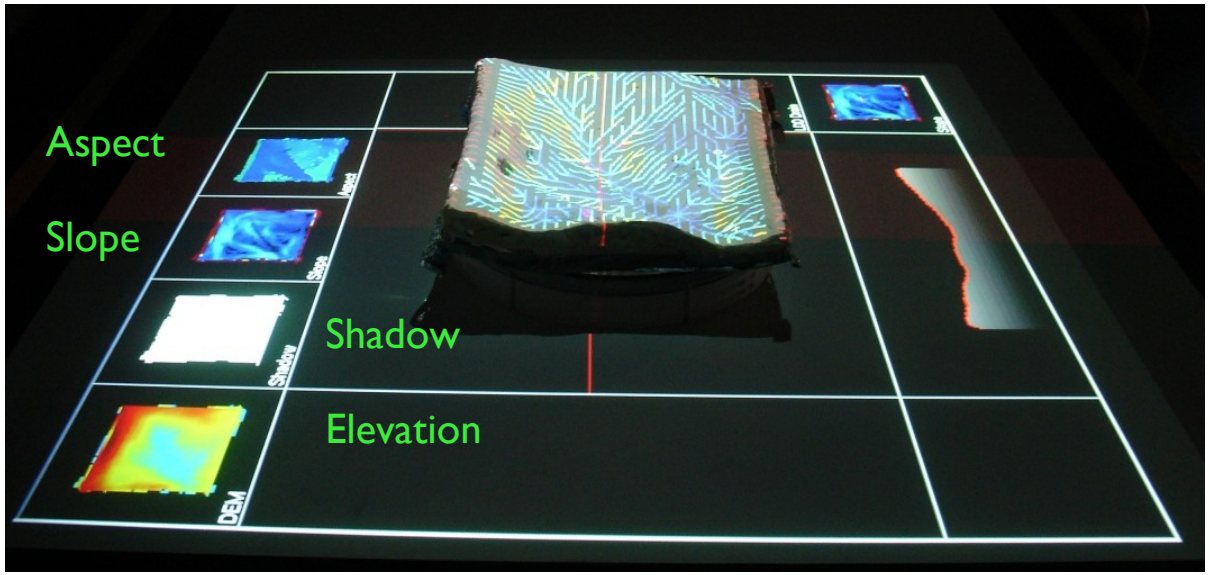
explore how TanGIS can be used to solve real-world problems common at communities and installations

investigate what new development is needed to make the practical applications feasible

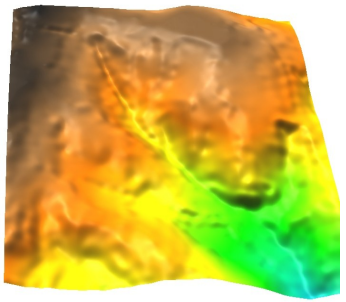
20 ha area at NCSU exp. farms: sediment and flood control

Analysis using a physical model

Flow computed by Illuminated Clay in synchronous mode

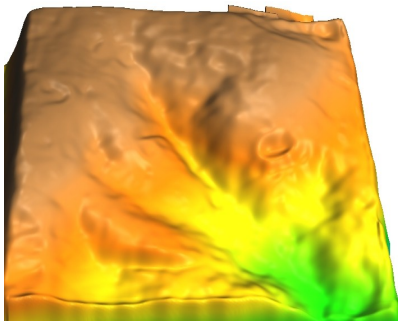


Data

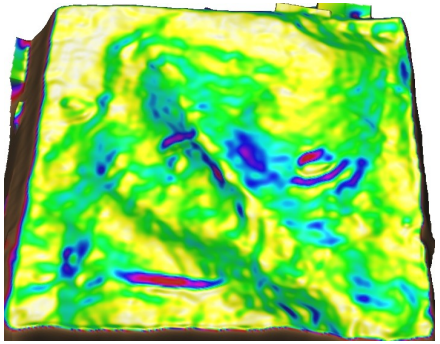


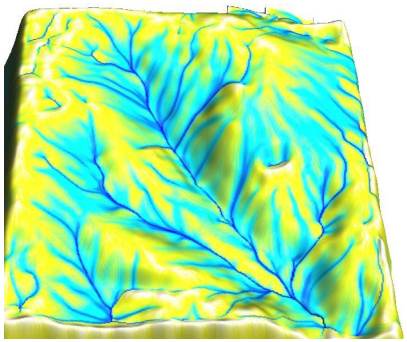
Physical Model

Scanned phys. model



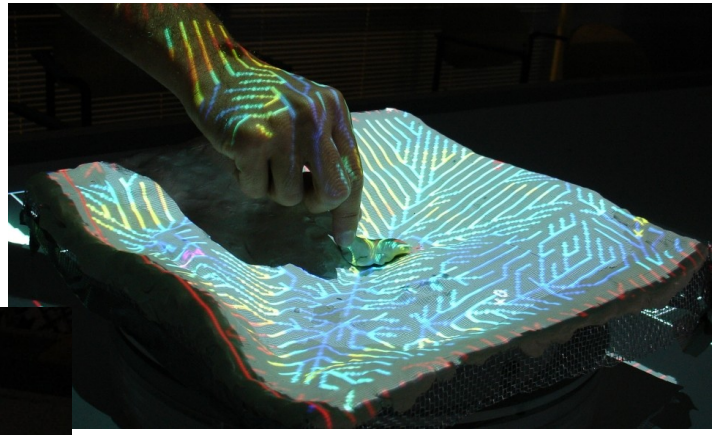
Slope and flow computed in GRASS in asynchronous mode

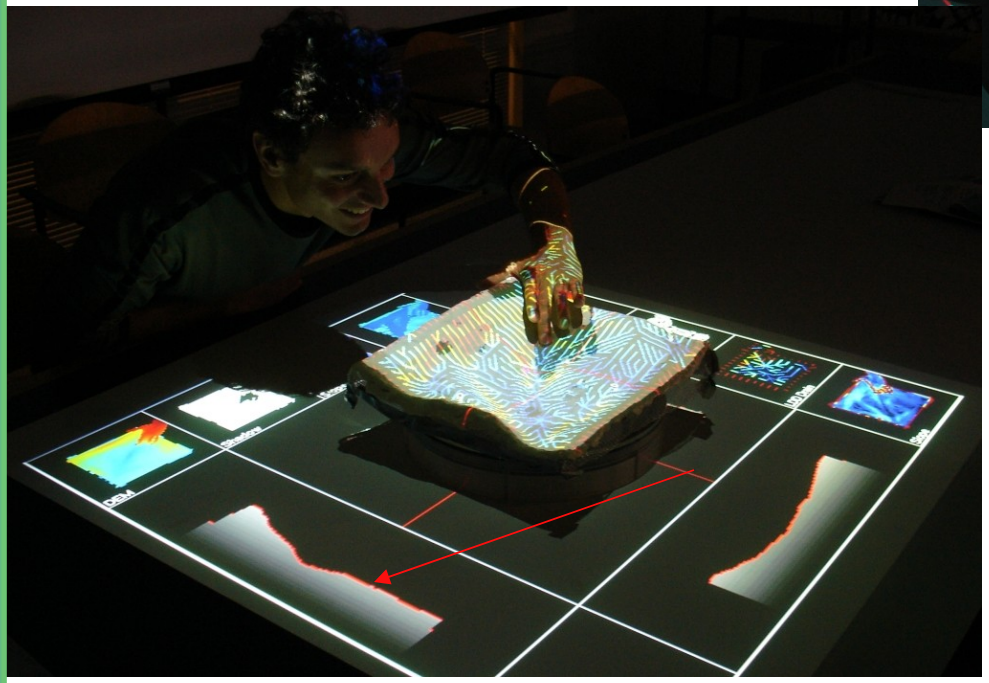


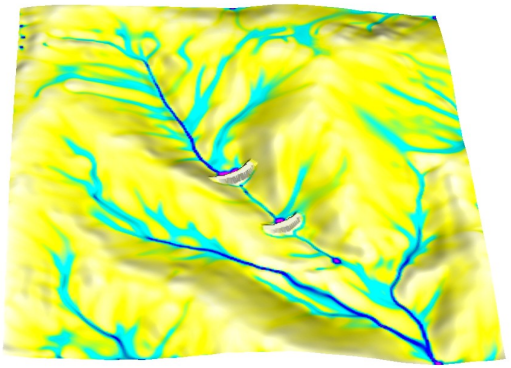


Design with TanGIS

adding a checkdam,
creating a depression,
while watching the flow
and slope to change

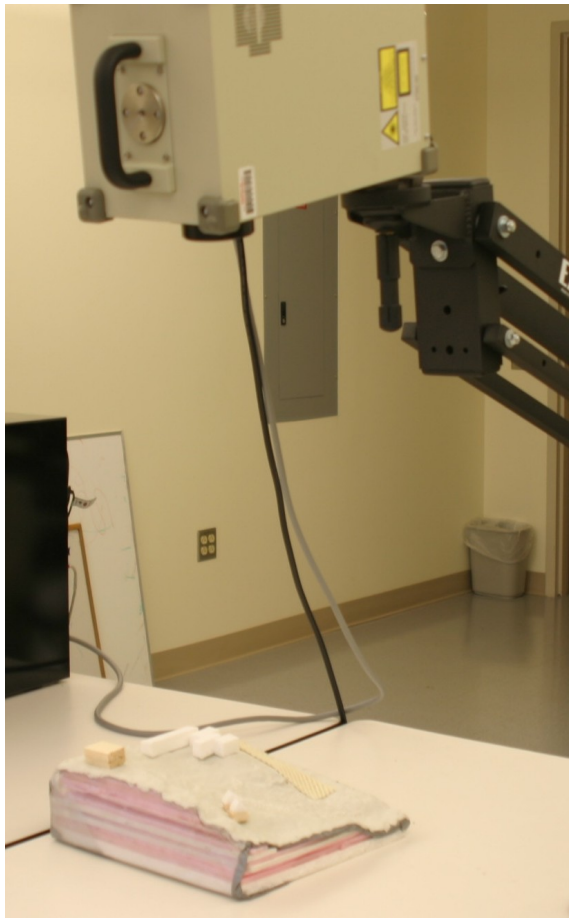


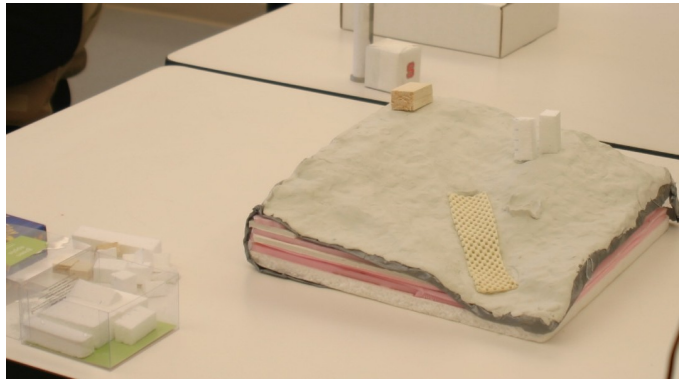




simulated overland flow
depth for modified surface

Building TanGIS at VISSTA lab





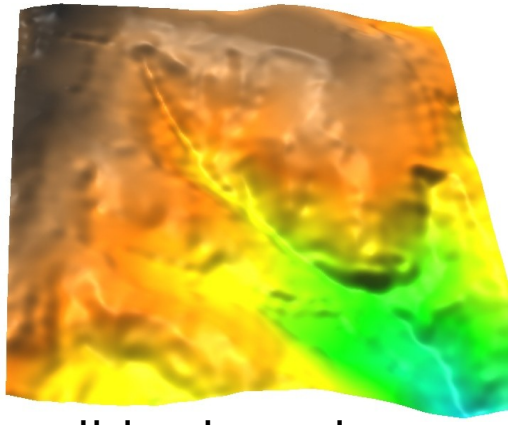
VIVID 910
laser scanner
1 scan/ 0.3sec
real-time
interaction
higher accuracy
than needed

IR sensors
cheaper, smaller
need to be
tested

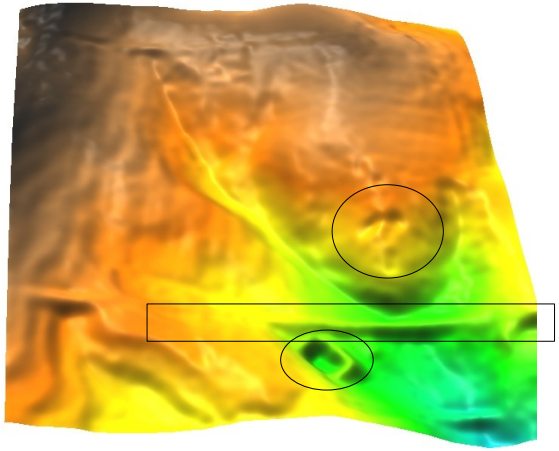
Multipurpose
facility at
VISSTA Lab at
ECE NCSU:
Prof. Hamid Karim

Real-world and model DEMs

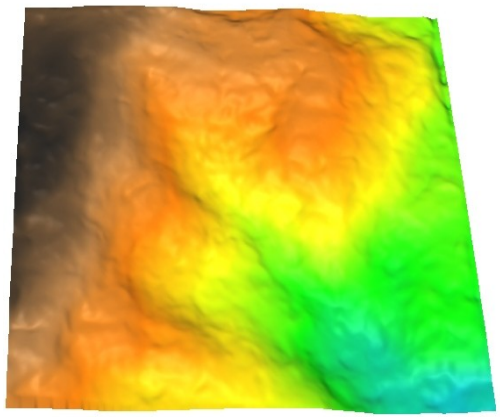
photogr.-based
2m DEM 1993

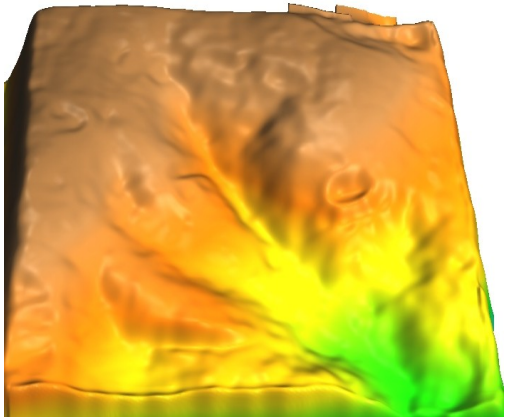


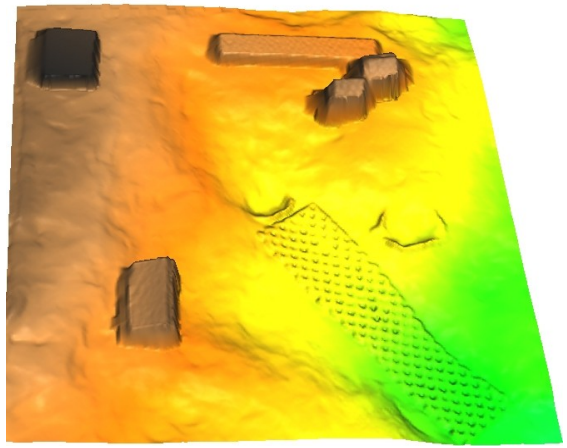
lidar-based
2m DEM 2001

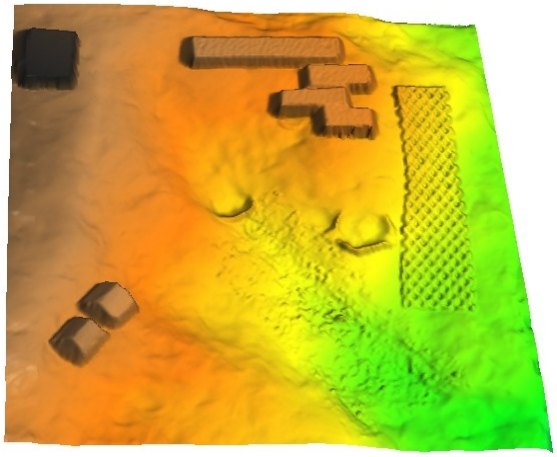


scanned model-based 1mm (2m) DEMs
with various modifications





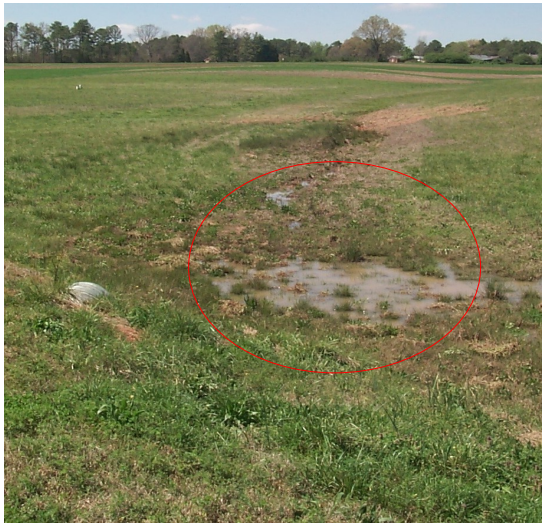


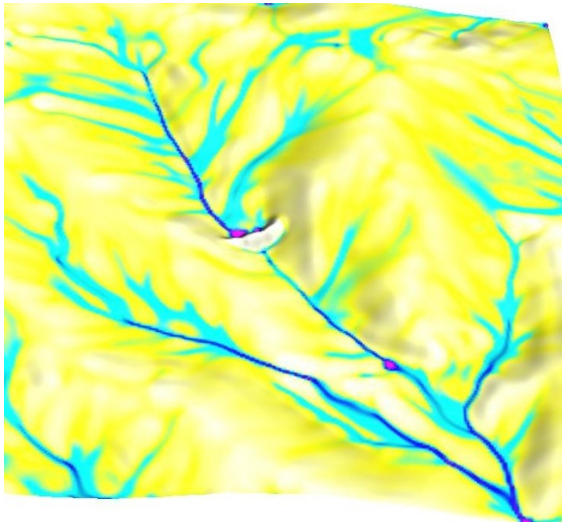


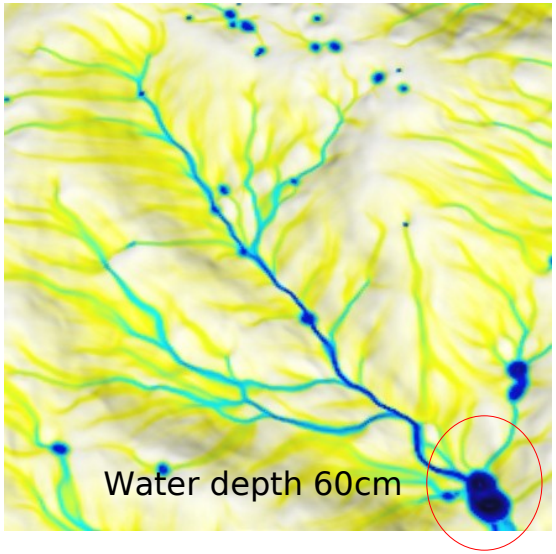
Exploring runoff with TanGIS

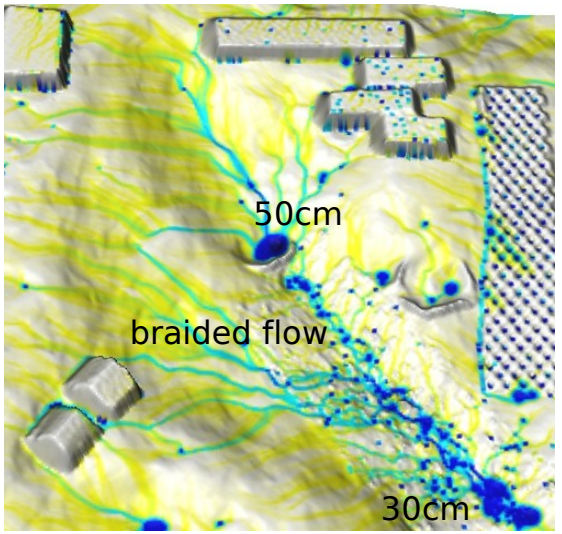
Simulating flow
over modified surface:

testing algorithms
exploring impacts







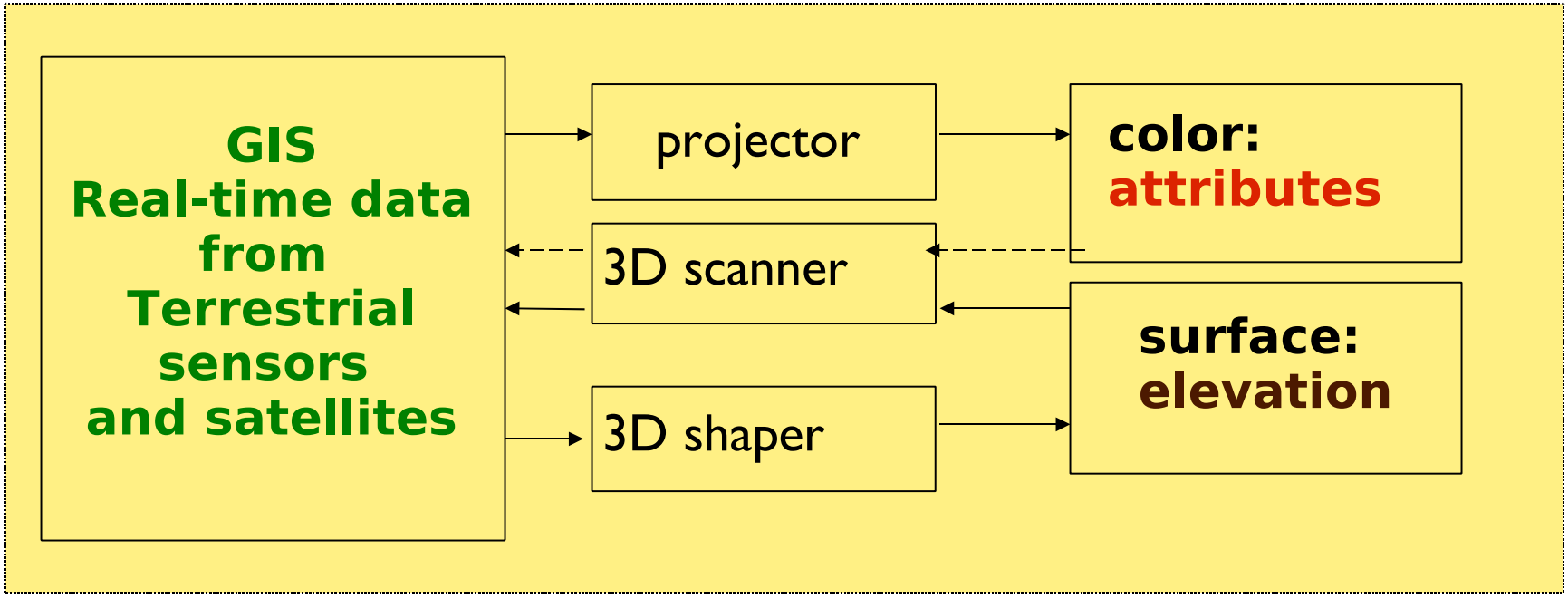


Smoothed real-world data

modified models

Future TanGIS

Computer **Physical model**



Desktop or large collaborative systems

Vision for GRASS/OSGEO4LEED

Geospatial Sustainability Analyst (GSA)
analysis of pre-construction landscape, the initial site plan

Geospatial Designer (GD)
modify design, explore alternatives. Tangible GIS can provide an intuitive collaborative environment

Geospatial Sustainability Evaluator(GSE)
assign LEED rating

Support **Whole system approach:**
takes into account spatial and temporal interactions between natural systems and development projects: can reveal potential conflicts and lead to discovery of new approaches to sustainable design

What is next?

Establish contacts with US GBC and WorldGBC, and explore collaboration at OSGEO foundation and project levels

Get more funding

Solve technical issues

Acknowledgment

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US Army Research Office,
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We also thank **Bill Goran**, USACERL for valuable discussions and ideas on geospatial research for sustainable development