

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA, 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) 22-07-2014	2. REPORT TYPE Final Report	3. DATES COVERED (From - To) 15-Apr-2009 - 31-May-2012
---	--------------------------------	---

4. TITLE AND SUBTITLE Terrain/Landscape Monitoring, Dynamics, and Sustainability	5a. CONTRACT NUMBER
	5b. GRANT NUMBER W911NF-04-D-0003
	5c. PROGRAM ELEMENT NUMBER 611102

6. AUTHORS Harmon, R.S., Mitasova, H.M.	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES North Carolina State University 2701 Sullivan Drive Admin Srvcs III, Box 7514 Raleigh, NC 27695 -7514	8. PERFORMING ORGANIZATION REPORT NUMBER
--	--

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS (ES) U.S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211	10. SPONSOR/MONITOR'S ACRONYM(S) ARO
	11. SPONSOR/MONITOR'S REPORT NUMBER(S) 53470-EV-SR.7

12. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited
--

13. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

14. ABSTRACT The proposed research investigated 3D dynamics of landscapes undergoing rapid transition from one state to another, for example due to construction or establishment of military training areas. The focus was on identification of the vulnerable phases in the progression of metastable landscapes, and investigation of the most important differences between sustainability of natural and intensively used lands. The possibility to find or define special configurations, rules or general laws of landscape development patterns that lead to stable landscapes was explored using a unique modeling system based on coupling of a tangible physical laboratory model, GIS based virtual
--

15. SUBJECT TERMS tangeoms, sustainability, landscape dynamics, lidar
--

16. SECURITY CLASSIFICATION OF:	17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT UU	UU		Russell Harmon
b. ABSTRACT UU			19b. TELEPHONE NUMBER 919-549-4326
c. THIS PAGE UU			

Report Title

Terrain/Landscape Monitoring, Dynamics, and Sustainability

ABSTRACT

The proposed research investigated 3D dynamics of landscapes undergoing rapid transition from one state to another, for example due to construction or establishment of military training areas. The focus was on identification of the vulnerable phases in the progression of metastable landscapes, and investigation of the most important differences between sustainability of natural and intensively used lands. The possibility to find or define special configurations, rules or general laws of landscape development patterns that lead to stable landscapes was explored using a unique modeling system based on coupling of a tangible physical laboratory model, GIS-based virtual models, and numerical simulations. The simulation results were projected over the laboratory model with the aim to study physical processes and conditions that can elucidate poorly understood aspects of landscape dynamics and lead to improved knowledge about response of landscapes to disturbances, with focus on change in runoff and sediment transport. The tangible model was used to generate land management alternatives that served as inputs to simulations of landscape response disturbances and modifications, and assessment of effectiveness of various approaches to prevention, control, and mitigation.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

<u>Received</u>	<u>Paper</u>
07/22/2014	3 Helena Mitsova, Nathan J. Lyons, Margery F. Overton, Russell S. Harmon, Katherine J. Weaver. Scientific visualization of landscapes and landforms, <i>Geomorphology</i> , (01 2012): 122. doi: 10.1016/j.geomorph.2010.09.033
07/22/2014	1 Helena Mitsova, Margery F. Overton, Juan José Recalde, David J. Bernstein, Christopher W. Freeman. Raster-Based Analysis of Coastal Terrain Dynamics from Multitemporal Lidar Data, <i>Journal of Coastal Research</i> , (03 2009): 0. doi: 10.2112/07-0976.1
07/22/2014	4 Michael J. Starek, Helena Mitsova, Eric Hardin, Katherine Weaver, Margery Overton, Russell S. Harmon. Modeling and analysis of landscape evolution using airborne, terrestrial, and laboratory laser scanning, <i>Geosphere</i> , (11 2011): 1340. doi:
07/22/2014	5 Helena Mitsova, Eric Hardin, Margery F. Overton, Mustafa Onur Kurum. Geospatial analysis of vulnerable beach-foredune systems from decadal time series of lidar data, <i>Journal of Coastal Conservation</i> , (01 2010): 161. doi: 10.1007/s11852-010-0088-1
07/22/2014	6 Eric Hardin, M. Onur Kurum, Helena Mitsova, Margery F. Overton. Least Cost Path Extraction of Topographic Features for Storm Impact Scale Mapping, <i>Journal of Coastal Research</i> , (07 2012): 970. doi: 10.2112/JCOASTRES-D-11-00126.1
TOTAL:	5

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

<u>Received</u>	<u>Paper</u>
-----------------	--------------

TOTAL:	1
---------------	----------

(c) Presentations

Selected presentations

- Mitasova H; M.J. Starek; *E.J. Hardin; K.W. Wegmann; B.S. Blundell, Space-Time Cube Analytics of Evolving Landforms Captured by Airborne and Terrestrial Lidar, invited talk at AGU Fall meeting 2012
- Mitasova H; *E.J. Hardin; *A. Kratochvilova; M. Landa, From Particles and Point Clouds to Voxel Models: High Resolution Modeling of Dynamic Landscapes in Open Source GIS, invited talk at AGU Fall meeting 2012
- *Lyons, N.J., Mitasova H., Starek M.J.; Wegmann, K.W., Terrestrial Laser Scanning of a Stream Bank During Naturally and Experimentally Induced Erosion by Groundwater Seepage, poster AGU Fall 2012
- Starek MJ, H. Mitasova, K. Wegmann, *N. Lyons, *K. Cepero, Spatiotemporal Representation of Stream Bank Evolution Mapped by Terrestrial Laser Scanning, talk, AGU Fall 2012
- Russ, E. Mitasova, H., Time series and space-time cube analyses on North Carolina Outer Banks, GSA 2012
- Hardin, E., *Kurum, O., Mitasova, H., Overton, M.F., GIS-based approach to analysis of storm vulnerability change at PeaIsland, NC, new breach location, 33rd International Conference on Coastal Engineering (ICCE 2012), Santander, Spain, July 2012.
- Michael J. Starek; Helena Mitasova; Karl W. Wegmann, Terrestrial Laser Scanning for Measuring Stream Bank Erosion within Legacy Sediments: Data Processing and Analysis Methods, AGU Fall meeting, Abstract, EP41A-0581, Dec. 2011.
- Katherine Weaver; Helena Mitasova; Margery Overton, Impacts of Vegetation and Development on the Morphology of Coastal Sand Dunes Using Modern Geospatial Techniques: Jockey's Ridge Case Study, AGU Fall meeting, Abstract, EP33A-0886, Dec. 2011.
- Harmon, RS, Starek MJ, Mitasova H. Ft. Fisher, NC Past and Present: A Geospatial Analysis using LiDAR and GIS, 9th International Military Geosciences Conference, Desert Research Institute, Las Vegas June 2011
- Tateosian, L.G., Sidharth T., *Hardin E., Mitasova, H., *Weaver K., and Overton M.F., Visualizing Coastal Spatial-Temporal Dynamics, IEEE Visualization Conference, Oct. 2011
- Mitasova, *Hardin, Dynamic Earth in GRASS7 FOSS4G Denver, September 2011
- Mitasova, *Hardin, Landscape dynamics from LiDAR data time series. Invited keynote, Geomorphometry 2011, Redlands September 2011
- Hardin, Starek, Mitasova, Overton, Harmon Least cost path feature extraction for automated mapping of storm impact scale, Coastal lidar conference JABLTx, Baltimore, June 2011
- *Kurum, O., Mitasova, H., Overton, M.F., 2011, Geospatial techniques to derive short term dynamics of coastal morphology, Proc. Coastal Sediments, Miami, May 2011
- *Hardin, E., Mitasova, H., Overton, M.F., 2011, Quantification and characterization of terrain evolution on the Outer banks, NC, Proc. Coastal Sediments, Miami, May 2011
- Starek, M., Mitasova H., Harmon R.S.: Optimization of Terrestrial Laser Scanning Survey Design for Dynamic Terrain Monitoring, EOS Trans. AGU, 91(52), Fall Meet. Suppl., Abstract G21A-0796, San Francisco, Dec. 2010.
- *Hardin E., Mitasova H., Overton M., Sensitivity Analysis of Dune Height Measurements Along Cross-shore Profiles Using a Novel Method for Dune Ridge Extraction, AGU, Fall Meeting Abstract EP33B-0765, Dec. 2010.
- *Weaver K., Mitasova H.: Geospatial Analysis of the Dynamics of a Coastal Sand Dune Using Time Series of LiDAR Data and Tangible Geospatial Modeling System, GSA. Geological Society of America Annual Meeting, Denver, CO, Nov. 2010.
- Mitasova H., Modeling and analysis of landscape evolution at multiple scales using airborne, ground, and laboratory laser scanning, invited talk, Pardee Keynote Symposium Seeing the True Shape of Earth's Surface: Applications of Airborne and Terrestrial LiDAR in the Geosciences, GSA Annual meeting, Denver, November 2010.
- Mitasova H. Scientific Visualization of Landscapes and Landforms, invited talk, 41st International Binghamton Geomorphology Symposium on Geospatial Technologies and Geomorphological Mapping, Columbia, South Carolina, October, 15-17, 2010.
- *Weaver, K., *di Leo, M., Mitasova, H., Tateosian L.: Exploring Topographic Change Impacts with a Tangible Geospatial Modeling System, International Binghamton Geomorphology Symposium on Geospatial Technologies and Geomorphological Mapping, Columbia, SC, October, 15-17, 2010
- Hardin, E., *Paris, P., Mitasova, H., Overton M., Geospatial relationship between the shoreface topography and decadal core- envelope surfaces on a North Carolina's barrier island, International Binghamton Geomorphology Symposium on Geospatial Technologies and Geomorphological Mapping, Columbia, SC, October, 15-17, 2010
- Mitasova, H., Geospatial analysis of terrain dynamics using airborne, ground, and laboratory laser scanning technology. Coastal lidar mapping workshop, USACE FRF Duck, March 2010. Mitasova H. and Harmon, R.S, Tangible Geospatial Modeling System, invited talk, Geodesign summit, ESRI, Redlands, January 2010, http://www.youtube.com/watch?v=jbr-Ltu_SmM
- Starek, M.J., H. Mitasova, High resolution, LiDAR-based monitoring of terrain change in an experimental watershed. EOS Trans. AGU, 90 (52), Fall Meet. Suppl., Abstract G23A-0658, December 2009.
- Mitasova H., Hardin E., Overton M.F., Harmon R.S., Mapping coastal terrain dynamics and structural change using a GIS-based analysis of lidar data time series GSA. Geological Society of America Annual Meeting, Abstract No. 165-12, October 2009.

Number of Presentations: 29.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received Paper

TOTAL:

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received Paper

TOTAL:

Number of Manuscripts:

Books

Received Book

TOTAL:

Received

Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Weaver (graduate student): Best student poster award at Binghamton Geomorphology Symposium, Columbia SC, 2010

Graduate Students

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	<u>Discipline</u>
Eric Hardin	0.30	
Katherine Weaver	0.10	
Emily Russ	0.10	
FTE Equivalent:	0.50	
Total Number:	3	

Names of Post Doctorates

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>	<u>National Academy Member</u>
Helena Mitasova	0.10	
FTE Equivalent:	0.10	
Total Number:	1	

Names of Under Graduate students supported

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00

The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00

Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00

Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00

The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00

The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:..... 0.00

Names of Personnel receiving masters degrees

<u>NAME</u>
Katherine Weaver
Emily Russ
Total Number: 2

Names of personnel receiving PHDs

<u>NAME</u>
Eric Hardin
Total Number: 1

Names of other research staff

<u>NAME</u>	<u>PERCENT SUPPORTED</u>
FTE Equivalent:	
Total Number:	

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See Attachment

Technology Transfer

Terrain/Landscape Monitoring, Dynamics, and Sustainability

Russell Harmon – PI ARO, Helena Mitasova – NCSU Scientific manager

Abstract

Previous research has demonstrated the importance of understanding 3D landscape dynamics when addressing land management issues like conservation, environmental compliance, and impacts of development. Underestimation of terrain change impact can lead to costly and often ineffective land management decisions, especially in coastal areas, regions of extreme climate (i.e., deserts, cold regions, and tropics), and in temperate watersheds exposed to large impacts or disturbances. Terrain affects all aspects of Army operations. The effective understanding and use of terrain is critical to military success on the battlefield. A capability to remotely sense, analyze, and interpret the features of and upon the earth's surface, both natural and anthropogenic, an in-depth understanding of individual environments at different spatial scales, and the capability to predict environmental effects and behavior at any place and time is essential components for military success in the 21st century.

The proposed research focused on 3D dynamics of landscapes undergoing rapid transition from one state to another, due to anthropogenic or natural forces. The project studied the most vulnerable phases in the progression of metastable landscapes, and investigated the important differences between sustainability of natural and intensively used lands. The possibility to find or define special configurations, rules or general laws of landscape development patterns that lead to stable landscapes were explored, with the aim to provide foundation for the development of new approaches for management of disturbances and implementation of control measures at a minimum cost. The investigation combined observations with a tangible physical laboratory model, GIS-based virtual models, and numerical simulations. The observation-based data and simulation results were overlayed over the laboratory model to study physical processes and conditions the response of landscapes to disturbances, with focus on change in runoff and sediment transport. The tangible model was used to generate land management alternatives that served as inputs to simulations of landscape response disturbances and modifications, and assessment of effectiveness of various approaches to prevention, control, and mitigation. The study areas included environments affected by different kinds and degrees of development activity and natural impacts, including watersheds and streams in the NC Piedmont and NC barrier islands.

The research provided new insights into the links between terrain dynamics and sustainability. New GIS methods and tools for processing and analysis of georeferenced, multi-temporal topographic data were developed (see the listed publications) and the numerical simulation of physical processes such as erosion, sediment transport and deposition were improved. Combining a landscape-scale sustainable design system with geospatial analysis in a tangeoms environment, has the potential to improve the sustainable design process at military installations and across the civilian sector. The whole-system approach to design and analysis can reveal design redundancies, avert potential conflicts and lead to new approaches that take advantage of the natural properties of the site. In addition to sustainable development, several components of the proposed methodology will provide benefits in education, training, as well as improved diagnostic and predictive physical modeling.

Project report

Objectives

Previous research has demonstrated the importance of understanding landscape dynamics and short-term terrain change, when addressing land management issues such as conservation, environmental compliance, and impacts of development. Underestimation of terrain dynamics impact can lead to costly and often ineffective land management decisions, especially in coastal areas or watersheds exposed to large disturbances, typical for military installations or rapidly developing urban regions. Geospatial analysis of the new, multi-temporal, high resolution lidar-based DEMs, developed during the course of the previous research, provided new insights into impacts of natural and human-induced terrain change over relatively short periods of time. At the same time, the widely accepted approach for measuring sustainability has been extended to capture the role of landscape in sustainable development by incorporating important rating categories with geospatial components, such as location efficiency, land conservation, protection of habitats, or preservation of natural spatial pattern of runoff. In-depth understanding of 3D landscape surface dynamics and its interaction with human activities, is essential for high environmental and energy performance of developed landscapes, including military installations, and may lead to fundamentally new approaches to sustainable land management.

The project addressed the following objectives: (a) development of quantitative metrics to improve our understanding of the dynamics of landscapes undergoing a rapid transition from one state to another and identification of the phase in the progression of metastable landscape states that is the most vulnerable; (b) study the dynamic responses that characterize a sustainable landscape and identify conditions when a landscape becomes vulnerable to small changes, (c) combine numerical simulations, GIS-based virtual models and physical laboratory models to elucidate poorly understood aspects of landscape dynamics that affect sustainability, (d) explore how the new knowledge about properties of sustainable landscapes can provide basis for the development of a new generation of (self)adaptive or just-in-time best management practices (BMPs) that can improve effectiveness of land management at military installations at minimum cost.

Approach

The investigation of landscape dynamics and its relation to sustainability employed an innovative system that combined tangible 3D physical laboratory model, GIS-based virtual models, and numerical simulations (Figure 1). The geospatial monitoring and modeling results for each phase of landscape development were integrated within a GIS, analyzed and coupled with the physical laboratory models with the aim to study the physical processes and conditions that influence landscape sustainability under different conditions and types of disturbances. Special focus was on interactions between phases of land development, terrain change, runoff characteristics, and sediment transport. Tangible landscape model was used to undertake laboratory experiments coupled with virtual simulations to study the landscape dynamics at the study sites for a wide range of alternative development or military training scenarios, specially targeted at answering the sustainability questions defined as objectives of this project. In the following sections, the individual components of the proposed approach are explained in more detail along with the selection of study sites.

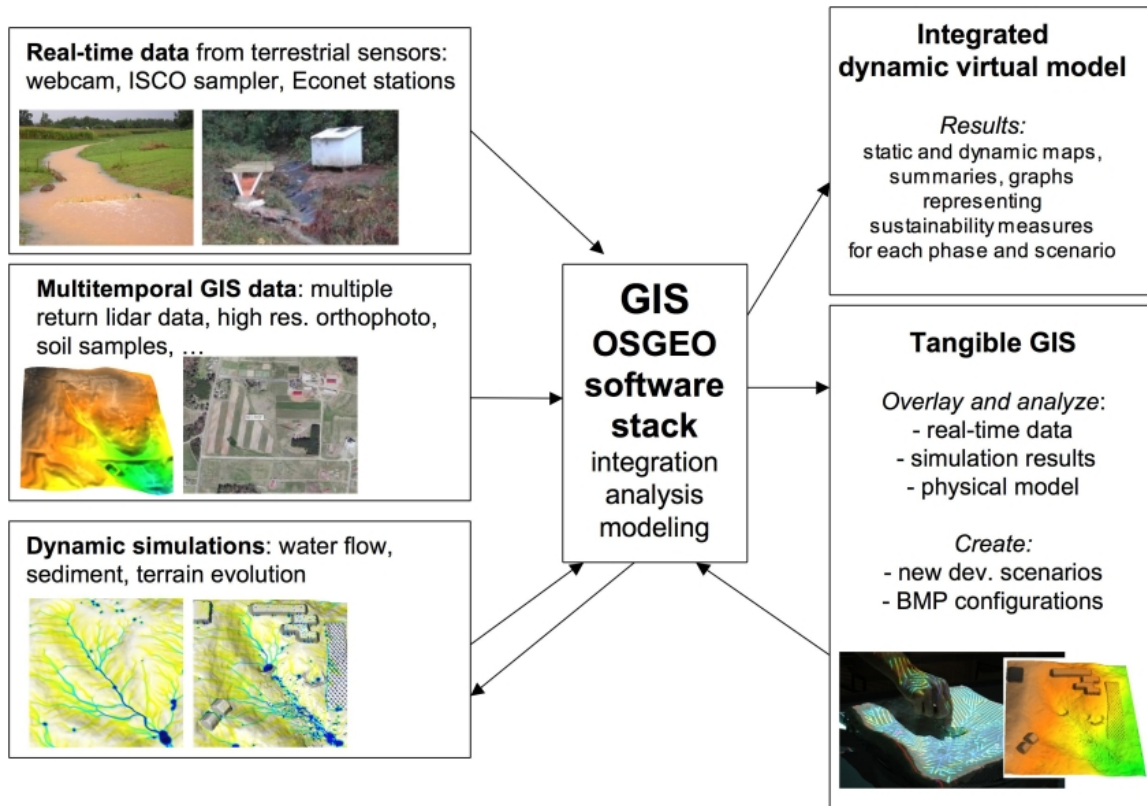


Figure 1. Landscape dynamics and sustainability analysis and simulations system.

The key model components were based on integration of multitemporal lidar-based topographic surveys, high accuracy photogrammetric data, and ground based 3D laser scanning. Baseline land use / land cover change, soil properties and infrastructure data (transportation, utilities) were derived from multitemporal series of high resolution orthophotography and local government data. Climate and environmental data (precipitation, runoff, sediment, soil moisture, etc.) that are essential for modeling of landscape dynamics were acquired from existing sensor networks, such as the Econet stations. This allowed us to create multitemporal 3D models for study areas and analyze recent landscape evolution. The multitemporal models also served as a baseline for generating innovative alternatives for each development phase to investigate the best approaches to achieve sustainability. To capture critical terrain change such as stream bank collapse a series of 3-D surveys, using ground-based laser scanner was performed (Figure 2).

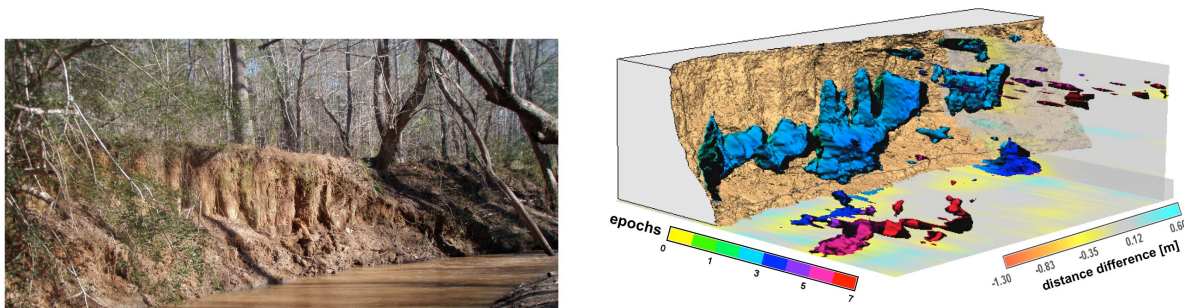


Figure 2. Analysis of collapsing stream bank in a location of past millpond (left) using data

acquired by terrestrial laser scanning. Spatial and temporal distribution of mass loss from the bank derived from the series of terrestrial scans (right), see more details in Starek et al. 2013.

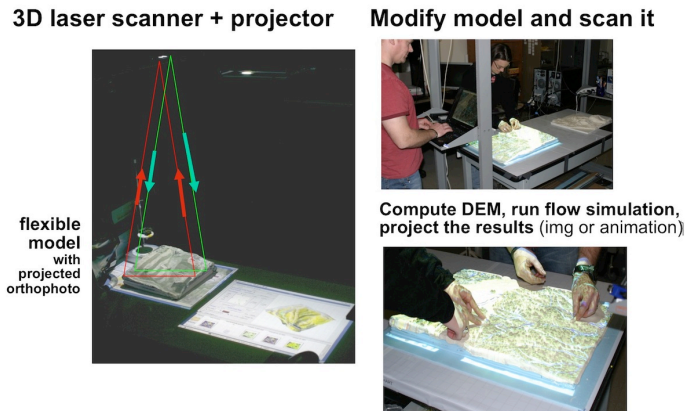


Figure 3. Tangeoms: tangible geospatial modeling system based on coupling of 3d laser scanner, projector, 3D model and GIS.

The key component of the project focused on simulations of landscape response to various configurations of disturbances, modifications, and control measures. This component employed an exploratory environment called tangeoms (Ratti et al., 2004; Mitasova et al., 2006) that integrates both landscape ‘representation’ and ‘control’ within a single tangible physical model that is coupled to its virtual digital representation. A tangeoms system consists of a user-interactive flexible landscape model, a laser scanner, and a projector (Figure 3). The laser scans the 3D topographic model, which can be modified by hand, and the impact of the terrain modification on a selected parameter (e.g. slope, water flow direction, shadowing) is then projected as a variable color map on the surface of the model in real time. The system permits visualization of the impact of terrain modifications while they are performed, so the user can continue to make adjustments until the desired outcome is achieved. The unique capability to easily change the terrain surface roughness, as well as add models of structures and buildings, permits exploration of design alternatives for the placement of facilities and special activity areas, storm water and sediment control structures, and numerous other creative landscape design tasks that require human input and the analysis of alternatives (Figure 4). More than one user can make changes on the landscape model simultaneously without the need of special equipment such as glasses or complex navigation devices, which facilitates natural, face-to-face communication and keeps the focus on the project design rather than the technology.

To provide the functionality needed for the proposed applications, it was necessary to expand the system beyond landscape elevation surface by including additional landscape attributes and investigate the issues of scale and accuracy. Impact of the physical model scale was assessed for various types of terrain modifications including placing of structures and incorporation of land surface properties. Results of fast, approximate algorithms were compared with slower, highly accurate methods to assess the trade-off between real-time response and accuracy.

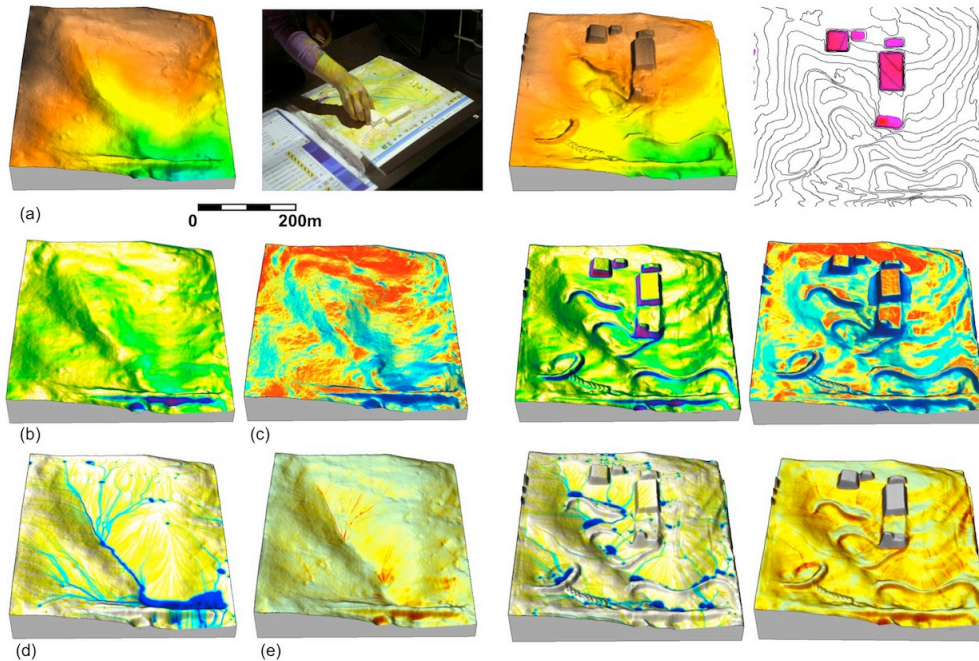


Figure 4. Coupling of tangeoms with GIS provides tools for a comprehensive landscape analysis: (I-left) original landscape and its parameters, (II-right) modified landscape with buildings and terraces leading to new parameters, buildings were extracted by map algebra and assigned appropriate parameters for modeling. The color maps (that were projected over the models) represent: (a) elevation, (b) slope, (c) solar irradiation during summer solstice, (d) water flow,(e) erosion.

Significance and Army Value

The research provided new insights into the links between terrain dynamics and sustainability. New GIS methods and tools for processing and analysis of georeferenced, multi-temporal topographic data were developed (see the listed publications) and the numerical simulation of physical processes such as erosion, sediment transport and deposition were improved. Combining a landscape-scale sustainable design system with geospatial analysis in a tangeoms environment, once mature, has the potential to significantly improve the sustainable design process at military installations and across the civilian sector. The whole-system approach to design and analysis can reveal design redundancies, avert potential conflicts and lead to new approaches that take advantage of the natural properties of the site, beyond what is known and practiced today. In addition to sustainable development, several components of the proposed methodology will provide benefits in education, training, as well as improved diagnostic and predictive physical modeling.

Highlights of Accomplishments

The most innovative component of the project with significant accomplishments was the development and applications of tangible geospatial modeling systems (see the published papers). The research has provided a foundation for the development of a new, affordable version of tangeoms in a follow-up ARO-funded research project with broadly expanded applications and implementation of several systems in educational and research settings. When

coupled with advances in geodesign discipline the system has a potential to transform sustainable land management at installations and beyond.

In addition to the tangeoms, new methods for analysis of elevation data time series and for quantification and visualization of terrain dynamics were developed, including efficient extraction of topographic features using cost surfaces and least cost paths. These techniques represent a significant contribution to assessment of vulnerability of coastal landscapes.

New techniques were also developed for processing and analysis of terrestrial lidar scans, analysis of changes in microtopography using flow tracing and these techniques have provided a foundation for analysis of collapsing stream banks using space-time voxel models.

Technology Transfer

USACE Field Research facility, Duck, NC, March 2010: Coastal Lidar workshop

Ft. Bragg visit at NCSU May 2009: TanGeoMS for runoff and erosion control

Ft Bragg workshop February 2012: Analysis of lidar data time series

Education and Training

Weaver MS

Russ MS

Hardin PhD

Paris PhD

Publications

Peer reviewed

Starek, M.J., **Mitasova H.**, Wegmann, K, Lyons, N., 2013, Space-Time Cube Representation of Stream Bank Evolution Mapped by Terrestrial Laser Scanning, *IEEE Geoscience and Remote Sensing Letters* 10(6), p. 1369-1373, PP(99), DOI 10.1109/LGRS.2013.2241730

Hardin E., Kurum O., Mitasova H., Overton MF, 2012, Least cost path extraction of topographic features for storm impact scale mapping, *Journal of Coastal Research* 28(4), p. 970-978.

Mitasova H., Harmon R.S., Weaver K.J., Lyons, N.J. and Overton, M.F., 2012, Scientific visualization of landscapes and landforms, *Geomorphology* 137(1), p. 122-137.

Starek, M.J., Mitasova H., Hardin, E., Overton, M.F., Harmon, R.S., 2011, Modeling and analysis of landscape evolution using airborne, terrestrial, and laboratory laser scanning, *Geosphere*, 7(6), p. 1340–1356, doi:10.1130/GES00699.1.

Metz M., Mitasova H., and Harmon R.S., 2011, Efficient extraction of drainage networks from massive, radar-based elevation models with least cost path search, *Hydrology and Earth System Sciences*, 15(2), 667-678.

Mitasova H., Hardin E., Starek, M.J., Harmon R.S, and Overton, M.F, 2011, Landscape dynamics from LiDAR data time series, In: *Geomorphometry 2011*, Hengl, T., Evans, I.S., Wilson, J.P., Gould, M. (eds.), Redlands, CA, p. 3-6.

Tateosian, L.G., Mitasova, H., Fogleman, B., Harmon, B., Weaver K., and Harmon R.S., 2010, TanGeoMS: Tangible geospatial modeling system, *IEEE Transactions on Visualization and Computer Graphics* 16(6), p. 1605-1612.

Mitasova, H., Hardin, E., Kurum, M.O., Overton, M.F., 2010, Geospatial analysis of vulnerable beach-foredune systems from decadal time series of lidar data, *Journal of Coastal Conservation, Management and Planning* 14(3), p. 161-172.

Mitasova, H., Overton, M., Recalde, J.J., Bernstein, D., and Freeman, C., 2009, Raster-based

Analysis of Coastal Terrain Dynamics from Multitemporal Lidar Data, *Journal of Coastal Research*, 25(2), p. 507-514.

Proceedings

- Hardin, E., *Kurum, O., **Mitasova, H.**, Overton, M.F., 2012, GIS-based approach to analysis of storm vulnerability change at Pealsland, NC, new breach location, Proceedings of the 33rd International Conference on Coastal Engineering (ICCE 2012), Santander, Spain.
- Kurum, O., Overton, M.F., **Mitasova, H.**, 2012, The influence of antecedent topographic conditions and geologic layers on post-storm coastal morphology, Proceedings of the 33rd International Conference on Coastal Engineering (ICCE 2012), Santander, Spain.
- Starek, M.J., **Mitasova H.**, Harmon, R.S., 2011, Fort Fisher, NC Past and Present: A Geospatial Analysis using LiDAR and GIS, Proc. 9th International Military Geosciences Conference.
- Kurum, O., **Mitasova, H.**, Overton, M.F., 2011, Geospatial techniques to derive short term dynamics of coastal morphology, Proc. Coastal Sediments 2011, Miami, FL.
- Hardin, E., **Mitasova, H.**, Overton, M.F., 2011, Quantification and characterization of terrain evolution on the Outer banks, NC, Proc. Coastal Sediments 2011, Miami, FL, p. 739-753.
- Kurum O., Kumar, M., Overton M.F., **Mitasova H.**, Edge W., 2010, Effects of coastal landform change on storm surge along the Hatteras island breach area, 32nd International Conference on Coastal Engineering (ICCE 2010) Shanghai, China.
- Metz M., **Mitasova H.**, and Harmon R.S., 2009, Fast stream extraction from large, radar-based elevation models with variable level of detail, In: *Geomorphometry 2009 Conference Proceedings*, Edited by R. Purves, S. Gruber, R. Straumann and T. Hengl. University of Zurich, Zurich, 2009.
- Mitasova, H.**, *Hardin, E., Overton, M., and Harmon, R.S., 2009, New spatial measures of terrain dynamics derived from time series of lidar data, *IEEE Proc. 17th Int. Conf. Geoinformatics*, Fairfax, VA, p. 363-368. DOI10.1109/GEOINFORMATICS.2009.5293539
- Pelletier, J., Mitasova, H., Harmon, R.S., and Overton, M., 2009, The effects of interdune vegetation changes on eolian dune field evolution: a numerical-modeling case study at Jockey's Ridge, North Carolina, USA, *Earth Surface Processes and Landforms*, 34(9), p. 1245-1254.

Awards/Honors Received in 2009-2012

Weaver (graduate student): Best student poster award at Binghampton Geomorphology Symposium, Columbia SC, 2010