ERDC/CERL TR-02-18

US Army Corps of Engineers®
Engineer Research and Development Center

Marine Corps Air Ground Combat Center (MCAGCC) Land Management System (LMS) Military Field Application Site FY02 In-Progress Review

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September 2002

Construction Engineering Research Laboratory

Approved for public release; distribution is unlimited.

Foreword

This study was conducted for the U.S. Army Corps of Engineers Research and Development Directorate, which established the Land Management System (LMS) Special Project Office in March 1997. The work was done under 622720A917, Congressional funding. The proponents are Dr. Lewis E. Link, Director of Research and Development for the U.S. Army Corps of Engineers (CERD-Z), and Dr. Donald Leverenz, Deputy Director of CERD.

The work was performed by the Land and Heritage Conservation Branch (CN-C) and Ecological Processes Branch (CN-N) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Dick Gebhart and the Assistant Investigator was Heidi Howard. The technical editor was Gloria J. Wienke, Information Technology Laboratory. Lucy A. Whalley is Chief, CEERD-CN-C, Stephen E. Hodapp is Chief, CEERD-CN-N and Dr. John T. Bandy is Chief, CEERD-CN. The associated Technical Director was Dr. William D. Severinghaus, CEERD-TD. The Director of CERL is Alan W. Moore.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Commander and Executive Director of ERDC is COL John Morris III, EN and the Director of ERDC is Dr. James R. Houston.

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1 Introduction

Background

The Land Management System

The Land Management System (LMS) is an initiative of the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) focused on improving landscape analysis and landscape management capabilities in several of the Corps of Engineers major mission areas. These mission areas include the U.S. Army Civil Works Programs (navigation, flood control, water supply and quality, recreation, etc.), military installations operations and management (specifically military land management), and military engineering and terrain related operations (trafficability analysis, military hydrology, littoral operations, line of sight analysis, etc.).

The purpose of LMS is to provide relevant science, tools, and information to land and water resource managers and decisionmakers with the goal of enhancing their ability to understand and communicate past, current, and potential impacts of management actions on land and water resources. LMS was established, in part, to improve synergism in technology development across each of these mission areas, to improve USACE's and the Department of Defense's (DoD's) ability to represent landscape processes and features, and forecast future landscape conditions, based upon alternative scenarios.

The LMS initiative had its roots in a study initiated in autumn 1995 related to modeling and simulation capabilities developed or used by the Corps of Engineers, related to landscapes and geoprocesses. After this study, the Director of Re-search and Development, in consultation with the USACE laboratory directors and others, decided to establish the LMS initiative.

To accomplish the goals of LMS, a Special Project Office for LMS was established, with representatives from most of the ERDC Laboratories, the Hydrologic Engineering Center of the Water Resources Support Center, and several Corps of Engineer Districts. The project director, associate directors, and the various organizational representatives comprise the LMS Development Team. Researchers throughout the ERDC laboratories (and their partners) form work teams to perform specific tasks associated with LMS; these efforts are dovetailed into numerous existing technology programs.

Plans for the LMS Initiative are available (and updated) on the LMS website (http://www.denix.osd.mil/LMS) under the Defense Environmental Network Information eXchange (DENIX). For more information please see the ERDC/CERL Technical Report 99/60, *Plans for the Land Management System (LMS) Initiative* on the LMS website.

The LMS Field Application Program

The LMS Field Application Program has four major purposes:

1. To provide problem-solving and partnering relations between the Corps of Engineers scientists, technology developers, and interested and innovative landscape/natural resource managers in USACE's major mission areas.
2. To provide site-specific and problem-specific input into the design of land management functional capabilities.
3. To provide technology test environments where scientists, technology developers, and resource managers/analysts together can tackle issues, test solutions, adjust approaches, capture costs and benefits, and "demonstrate" the results to interested parties.
4. To provide a framework for planning the transfer of LMS technology to land/water resource managers, both at the sites for demonstrations and other similar sites.

Field application sites were selected based on the following criteria:

1. Interest from land/water resource managers in infusing new capabilities into their business practices, and developing collaborative partnerships with scientists and technology providers.
2. Representative land/water resources management issues — such as high levels of use, sensitive resources, competing multiple uses and stakeholders, and other problems and issues identified by user groups as important.
3. Importance of the site or problem set to the mission.
4. Support and concurrence for LMS Field Applications not only at the local level, but also from across the organizational management.
5. Synergism with existing programs/efforts.

The original sites selected for field applications were Fort Hood, TX, and three locations in the Upper Mississippi River Basin: (1) Redwood Basin, along the Minnesota River in Southern Minnesota, (2) Pool 8 on the Mississippi River near LaCrosse, WI, and (3) Peoria Lakes, on the Illinois River at Peoria, IL. In 1999, the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms, CA, was officially designated as a field application site. In 2001, Fort Benning, GA, was also designated as a field application site and in 2002, Holloman Air Force Base, NM, was added as another field site.

There is a Field Application Site Coordinator for each site. Dr. Dick Gebhart serves in this capacity for the MCAGCC site. MCAGCC's user point of contact (POC) is Mr. Kip Otis-Diehl from the Natural Resources and Environmental Affairs Directorate at MCAGCC.

The MCAGCC Military Field Application Site

MCAGCC is composed of 596,480 acres (932 square miles [2414 sq km]) within the heart of the Mojave Desert, 40 miles (64 km) north of Palm Springs, CA. It was established in 1952. The desert terrain and arid climate offer prime training conditions to carry out MCAGCC's mission. The primary mission is to develop, administer, and evaluate the Marine Corps' Combined Arms Exercise (CAX) training. Annually, 50,000 to 60,000 soldiers are processed through the CAX program. An additional 8,000 Marines are trained in electronic fundamentals, operational communications, air control/anti-air warfare operations, and communication/electronic maintenance at the Marine Corps Communication-Electronics School (MCCESS) at MCAGCC.

The topography and climate at MCAGCC present unique natural resource management issues. The fragile desert ecosystem is highly susceptible to impacts that in most areas are normally insignificant. The repair of these impacts through natural processes may take thousands of years. Land managers are responsible for ensuring the sustainable usefulness of training areas by minimizing impacts on plant communities, soils, water, and animal communities, and through monitoring of training impacts. Land managers need accessible tools for monitoring and predicting these impacts. Monitoring and predicting impacts on training lands will ensure safe and effective training lands for both troops and the Mojave Desert ecosystem.

LMS Field Application Program Transitions

The field application program for LMS both shapes the development of new LMS capabilities and tests these capabilities to help solve management and landscape analysis problems in the field. The field application efforts provide opportunities to test, evaluate, modify, and document how LMS capabilities help to address specific user problems and how LMS results and capabilities fit into decision processes at user sites.

Field Application Site In-Progress Reviews (IPRs) are designed to ensure that the stages of evaluation, modification, and documentation are fulfilled. These reviews also allow other interested parties to look over the shoulders of those involved at the host site and evaluate the value of applying LMS investments and results at other sites.

Preliminary contact with MCAGCC was initiated in September of 1998, followed by a letter of invitation to serve as a field application site in January of 1999. The initial LMS Needs Assessment workshop was held at MCAGCC during February of 1999 to identify and prioritize land/water resource management issues at the site. A plan was then developed and projects initiated to address these plans. This report documents the second IPR, user recommendations, and post-IPR follow-up actions.

Objectives

The objectives of this IPR were to provide a forum where personnel involved with specific MCAGCC Land Management System Military Field Application projects could discuss the progress of each effort, identify the relationships between projects, and solicit input from potential users of the resulting products.

Approach

The IPR workshop was held 21 February 2002, at the Holiday Inn - Palm Mountain Resort in Palm Springs, CA. The IPR consisted of presentations on LMS and individual projects. Following project presentations, inputs from installation personnel and others present were obtained. Prior to the meeting closure, user input was discussed and actions were defined to address each issue. Results of the IPR are documented in this report to ensure project improvements and adjustments occur and to assist with the next IPR.

Scope

The MCAGCC LMS Military Field Application IPR addresses only projects associated with the MCAGCC LMS Military Field Application. This report does not attempt to address projects and issues associated with other military and civil works LMS field applications.

Mode of Technology Transfer

This report documents the presentations and discussions of the MCAGCC LMS Military Field Application IPR. Technical concerns and unresolved issues associated with individual projects are being addressed by the project investigators on an individual project basis.

This report will be made accessible through the World Wide Web (WWW) at URL:

http://www.cecer.army.mil

2 Agenda for the FY02 MCAGCC LMS Military Field Application Site IPR

The agenda for the MCAGCC LMS Military Demonstration FY02 IPR is provided below.

Thursday, 21 February 2002

8:00-8:30	IPR Opens at Holiday Inn Palm Mountain Resort
8:30-9:00	Overview LMS Introduction: Mr. Bill Goran
9:00-09:30	MCAGCC Introduction: Dr. Dick Gebhart Inter-connection of projects and user requirements
09:30-10:30	Wind Erosion: Dr. Ed Skidmore
10:30-10:45	Break
10:45-11:45	Ecological Dynamics Modeling: Dr. Jeff Fehmi
11:45-13:00	Lunch Break
13:00-13:45	Catastrophic Erosion Events and Nutrient Dynamics: Dr. Chris Baldwin
13:45-14:30	Change Detection / Remote Sensing at MCAGCC: Dr. Tom Frank & Mr. Scott Tweddale
14:30-15:00	Research Directions @ the National Training Center Fort Irwin, CA: Ms. Ruth Sparks
15:00-15:30	Break
15:30-16:15	Comment and Review ▪ Feedback from MCAGCC POCs ▪ General direction on MCAGCC Military Demonstration
16:15-16:30	Closing remarks, IPR conclusion.

3 MCAGCC LMS Military Field Application Site IPR Attendees

The following individuals attended the FY02 MCAGCC LMS Military Field Application Site IPR.

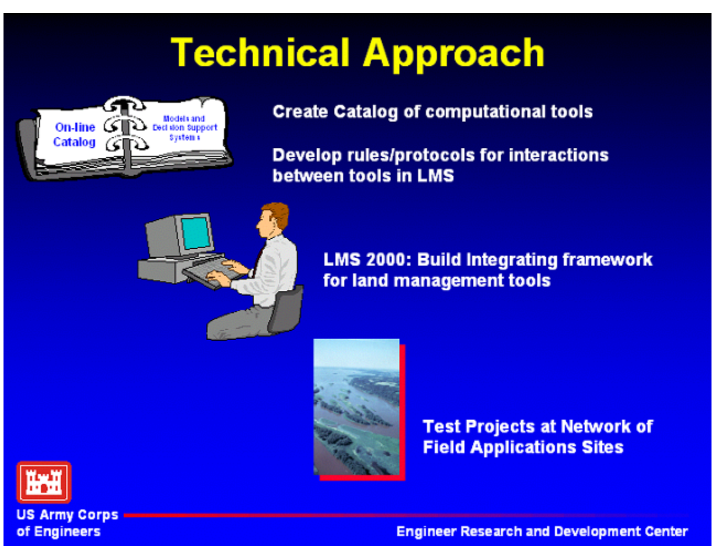
NAME	ORGANIZATION
Christopher Baldwin	Sam Houston State University
Kevin Bartsch	UT ARNG
Marie Cottrell	MCAGCC
Rhys Evans	MCAGCC
Tom Frank	University of Illinois
Dick Gebhart	ERDC/CERL
Bill Goran	ERDC/CERL
Trish Griffin	Naval Facilities Eng.
Heidi Howard	ERDC/CERL
Randy Karalus	ERDC/TEC
Dave Mouat	Desert Research Institute
Kip Otis-Diehl	MCAGCC
Rob Palmer	Naval Facilities Eng.
Doug Ramsey	Utah State University
Richard Rush	Sam Houston State University
Ed Skidmore	U.S. Department of Agriculture - Agriculture Research Service
Ruth Sparks	Fort Irwin
Paul Tueller	University of Nevada Reno
Scott Tweddale	ERDC/CERL
Robert Washington-Allen	Oakridge National Laboratories
T. J. Williams	MCAGCC

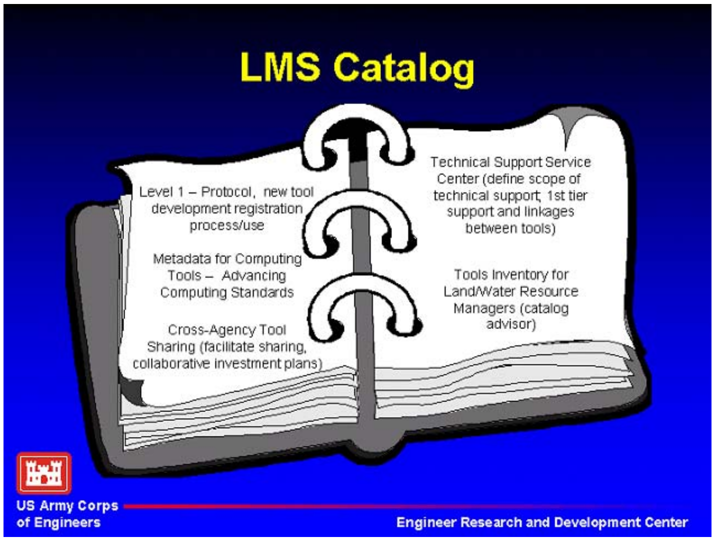
4 MCAGCC LMS Military Field Application Site IPR Project Presentations

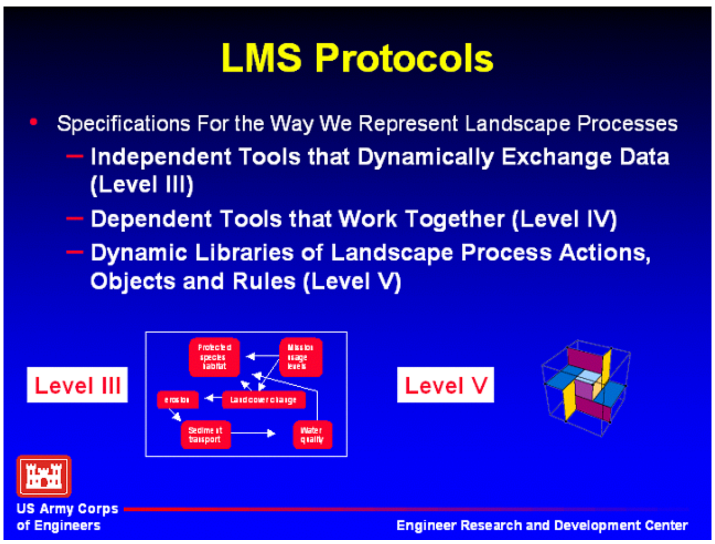
The following pages provide briefing materials presented at the MCAGCC LMS Military Field Application Site IPR. Each section provides the presenter's name and the presentation materials.

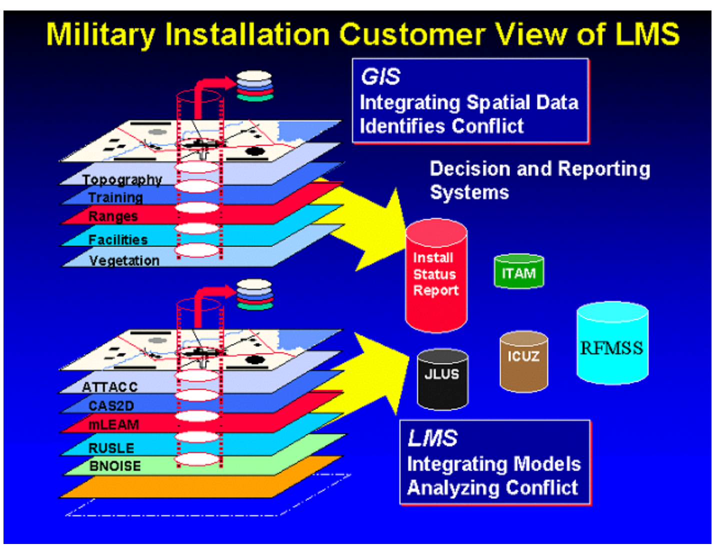
PRESENTATION: The Land Management System.

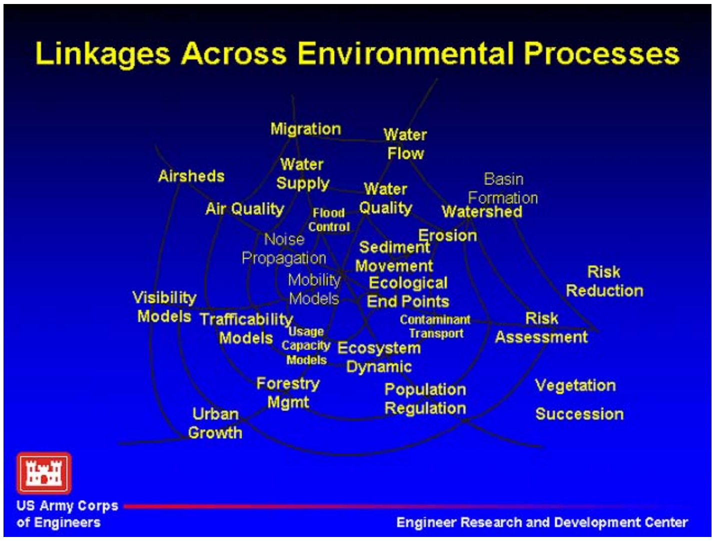
PRESENTER: Mr. William Goran.

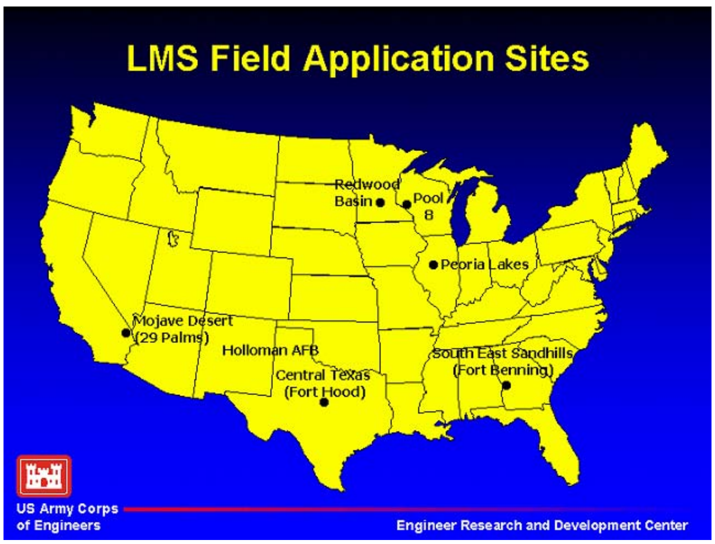



LMS Catalog
Level 1 – Protocol, new tool development registration process/use
Metadata for Computing Tools – Advancing Computing Standards
Cross-Agency Tool Sharing (facilitate sharing, collaborative investment plans)
Technical Support Service Center (define scope of technical support, 1st tier support and linkages between tools)
Tools Inventory for Land/Water Resource Managers (catalog advisor)
US Army Corps of Engineers
Engineer Research and Development Center

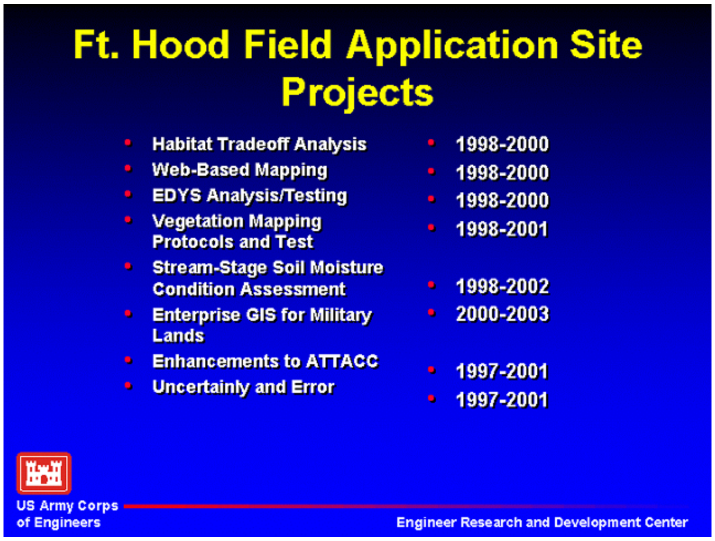

LMS Protocols
Specifications For the Way We Represent Landscape Processes
– Independent Tools that Dynamically Exchange Data (Level III)
– Dependent Tools that Work Together (Level IV)
– Dynamic Libraries of Landscape Process Actions, Objects and Rules (Level V)
Level III
Level V
US Army Corps of Engineers
Engineer Research and Development Center

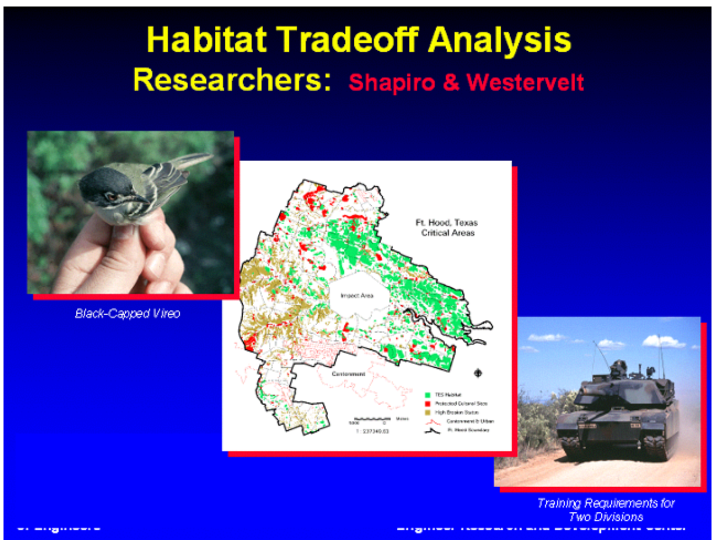

Military Installation Customer View of LMS
GIS
Integrating Spatial Data
Identifies Conflict
Decision and Reporting Systems
Topography
Training
Ranges
Facilities
Vegetation
Install Status Report
ITAM
RFMSS
ICUZ
JLUS
ATTACC
CAS2D
mLEAM
RUSLE
BNOISE
LMS
Integrating Models
Analyzing Conflict

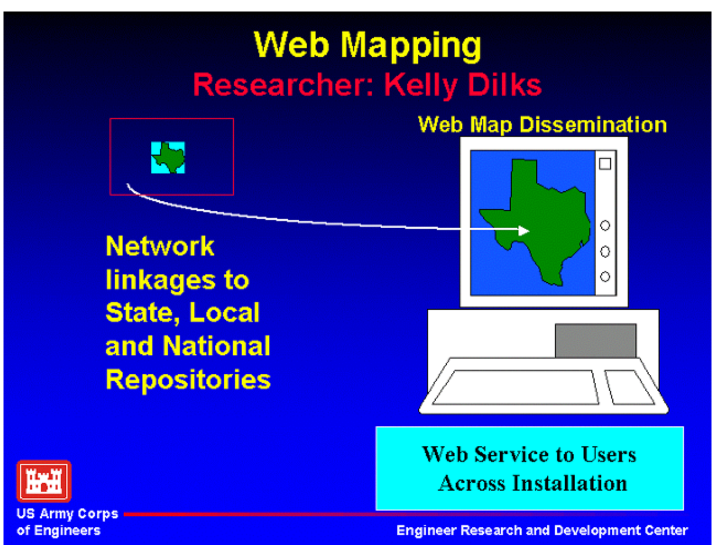

Linkages Across Environmental Processes
Migration
Water Flow
Airsheds
Water Supply
Water Quality
Basin Formation
Air Quality
Flood Control
Watershed
Noise Propagation
Sediment Movement
Erosion
Mobility Models
Ecological End Points
Risk Reduction
Visibility Models
Trafficability Models
Usage Capacity Models
Contaminant Transport
Risk Assessment
Ecosystem Dynamic
Forestry Mgmt
Population Regulation
Vegetation Succession
Urban Growth
US Army Corps of Engineers
Engineer Research and Development Center

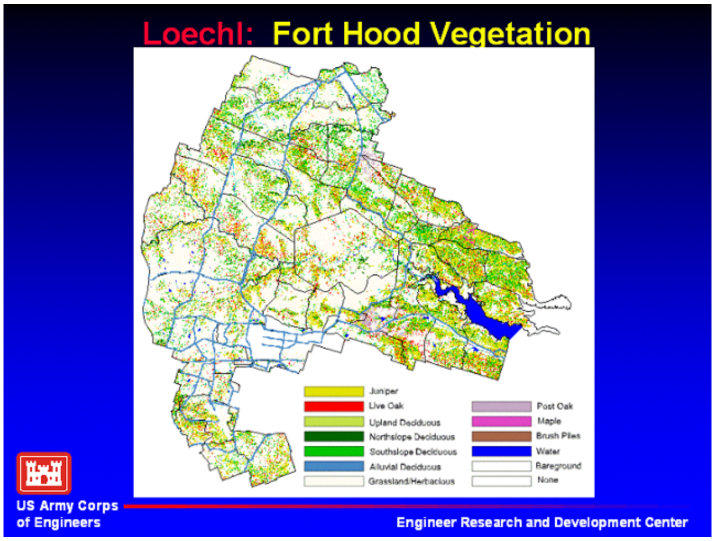

LMS Field Application Sites
Redwood Basin
Pool 8
Peoria Lakes
Mojave Desert (29 Palms)
Holloman AFB
Central Texas (Fort Hood)
South East Sandhills (Fort Benning)
US Army Corps of Engineers
Engineer Research and Development Center

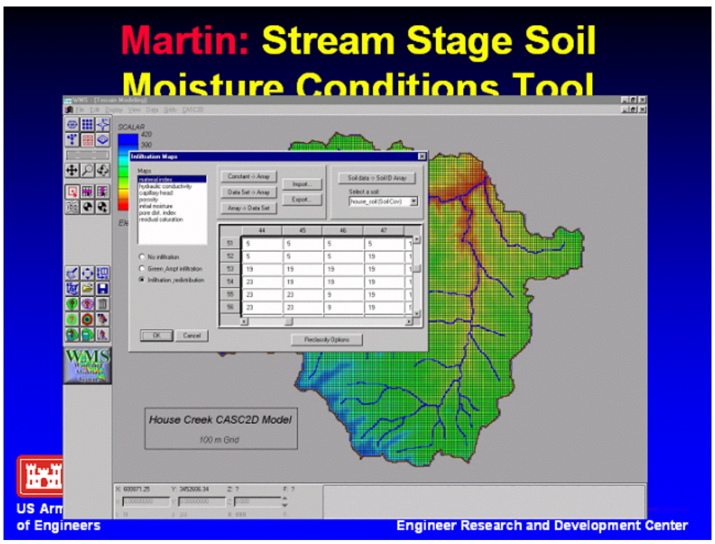

LMS Military Field Application Sites
• Ft. Hood, TX
• Marine Corps Air Ground Combat Center, CA
• Ft. Benning, GA
• Holloman Air Force Base, NM
US Army Corps of Engineers
Engineer Research and Development Center

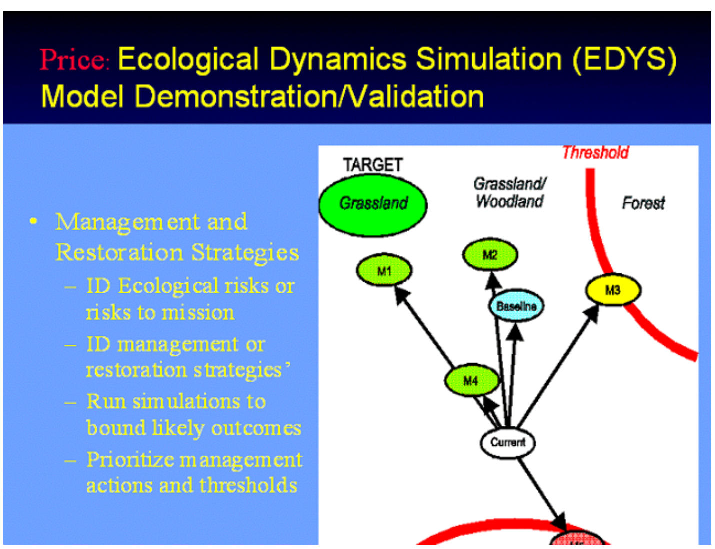

Ft. Hood Field Application Site Projects
• Habitat Tradeoff Analysis • 1998-2000
• Web-Based Mapping • 1998-2000
• EDYS Analysis/Testing • 1998-2000
• Vegetation Mapping Protocols and Test • 1998-2001
• Stream-Stage Soil Moisture Condition Assessment • 1998-2002
• Enterprise GIS for Military Lands • 2000-2003
• Enhancements to ATTACC • 1997-2001
• Uncertainly and Error • 1997-2001
US Army Corps of Engineers
Engineer Research and Development Center

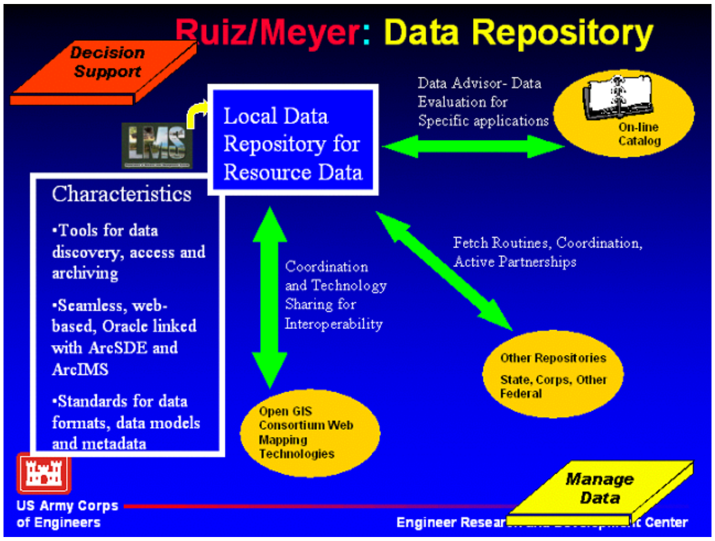

Habitat Tradeoff Analysis
Researchers: Shapiro & Westervelt
Black-Capped Vireo
Ft. Hood, Texas
Critical Areas
Impact Area
Training Requirements for Two Divisions

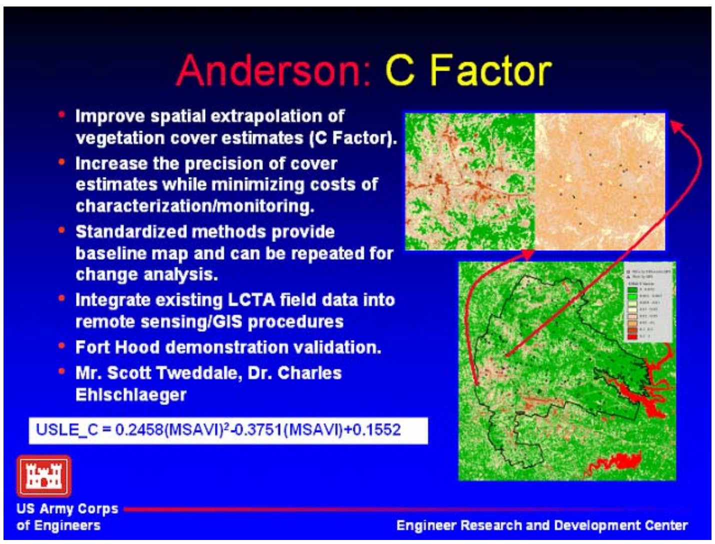

Web Mapping
Researcher: Kelly Dilks
Web Map Dissemination
Network linkages to State, Local and National Repositories
Web Service to Users Across Installation
US Army Corps of Engineers
Engineer Research and Development Center

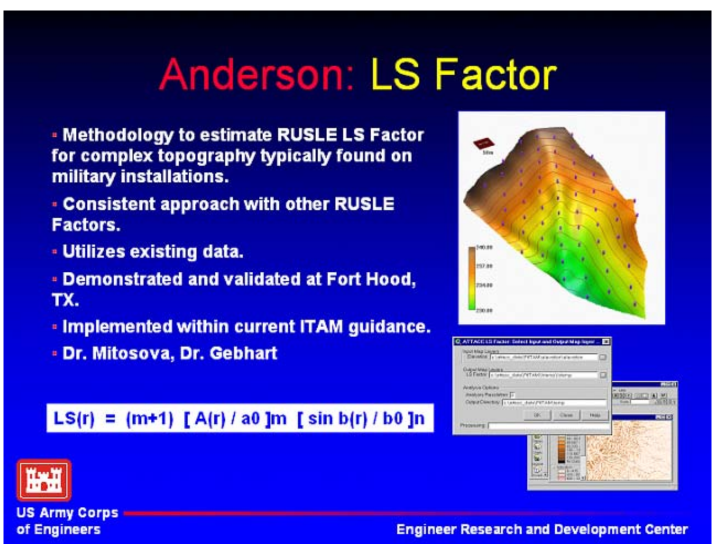

Loechl: Fort Hood Vegetation
Juniper
Live Oak
Upland Deciduous
Northslope Deciduous
Southslope Deciduous
Alluvial Deciduous
Grassland/Herbaceous
Post Oak
Maple
Brush Piles
Water
Bareground
None
US Army Corps of Engineers
Engineer Research and Development Center

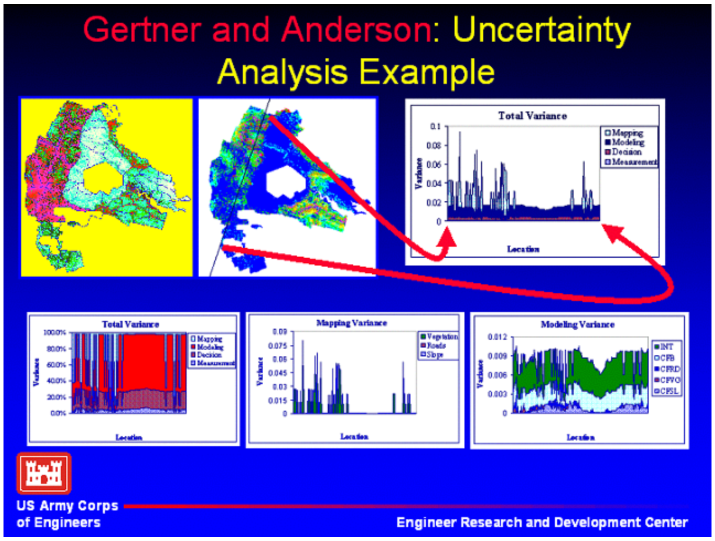

Martin: Stream Stage Soil Moisture Conditions Tool
House Creek CASC2D Model
100 m Grid
US Army Corps of Engineers
Engineer Research and Development Center

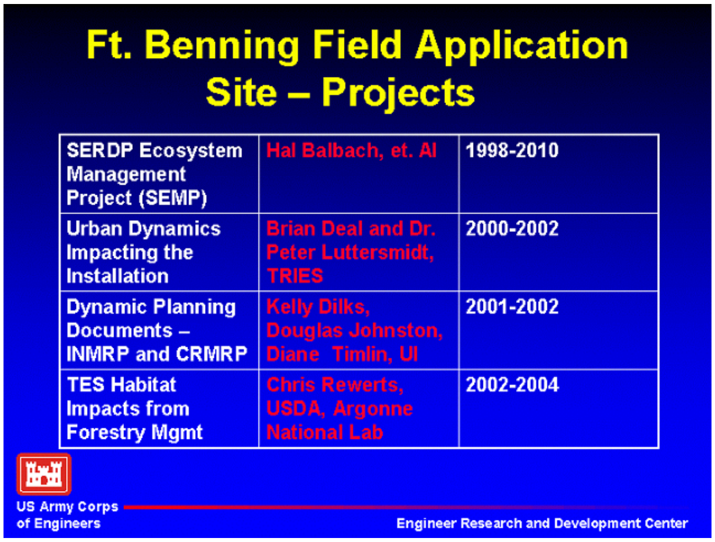

Price: Ecological Dynamics Simulation (EDYS) Model Demonstration/Validation
• Management and Restoration Strategies
– ID Ecological risks or risks to mission
– ID management or restoration strategies'
– Run simulations to bound likely outcomes
– Prioritize management actions and thresholds
TARGET
Grassland
Grassland/ Woodland
Threshold
Forest
M1
M2
M3
M4
Baseline
Current

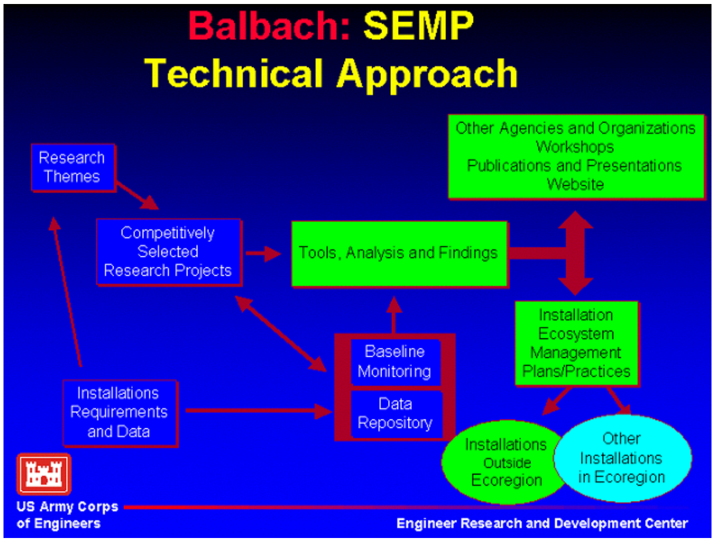

Ruiz/Meyer: Data Repository
Decision Support
Local Data Repository for Resource Data
Data Advisor- Data Evaluation for Specific applications
On-line Catalog
Characteristics
•Tools for data discovery, access and archiving
•Seamless, web-based, Oracle linked with ArcSDE and ArcIMS
•Standards for data formats, data models and metadata
Coordination and Technology Sharing for Interoperability
Fetch Routines, Coordination, Active Partnerships
Other Repositories
State, Corps, Other Federal
Open GIS Consortium Web Mapping Technologies
Manage Data
US Army Corps of Engineers


Anderson: C Factor
• Improve spatial extrapolation of vegetation cover estimates (C Factor).
• Increase the precision of cover estimates while minimizing costs of characterization/monitoring.
• Standardized methods provide baseline map and can be repeated for change analysis.
• Integrate existing LCTA field data into remote sensing/GIS procedures
• Fort Hood demonstration validation.
• Mr. Scott Tweddale, Dr. Charles Ehlschlaeger
USLE_C = 0.2458(MSAVI)²-0.3751(MSAVI)+0.1552
US Army Corps of Engineers
Engineer Research and Development Center

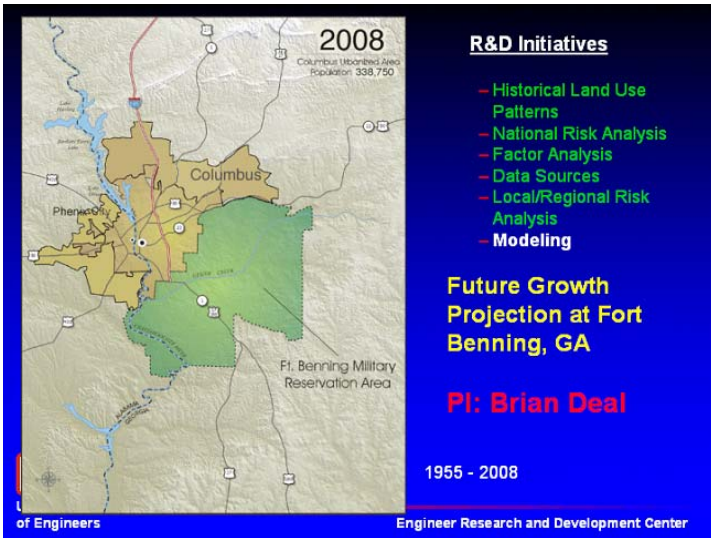

Anderson: LS Factor
• Methodology to estimate RUSLE LS Factor for complex topography typically found on military installations.
• Consistent approach with other RUSLE Factors.
• Utilizes existing data.
• Demonstrated and validated at Fort Hood, TX.
• Implemented within current ITAM guidance.
• Dr. Mitosova, Dr. Gebhart
LS(r) = (m+1) [A(r) / a0]m [sin b(r) / b0]n
US Army Corps of Engineers
Engineer Research and Development Center

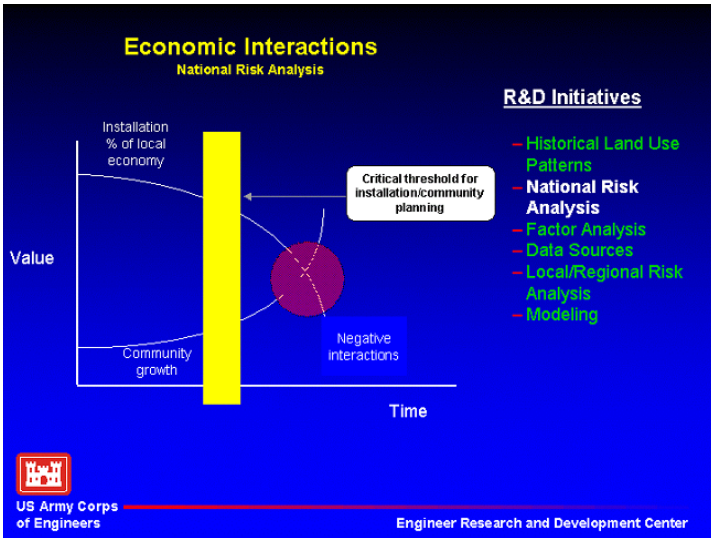

Gertner and Anderson: Uncertainty Analysis Example
Total Variance
Location
Total Variance
Mapping Variance
Modeling Variance
US Army Corps of Engineers
Engineer Research and Development Center

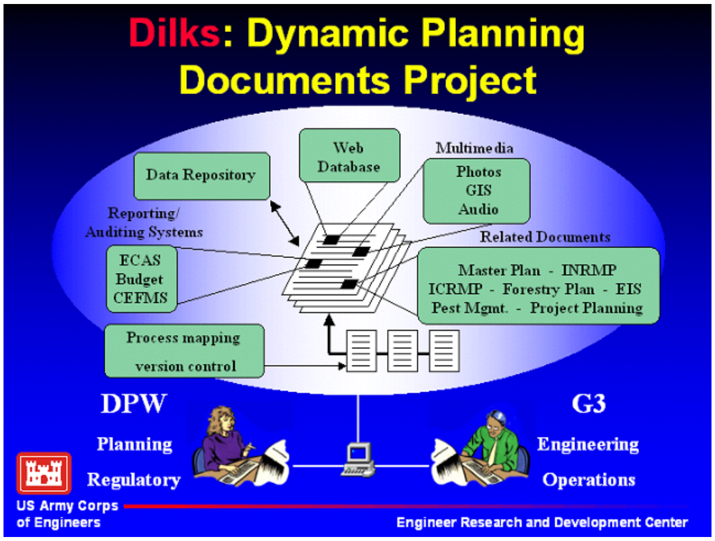

Ft. Benning Field Application Site – Projects
SERDP Ecosystem Management Project (SEMP)
Hal Balbach, et. Al
1998-2010
Urban Dynamics Impacting the Installation
Brian Deal and Dr. Peter Luttersmidt, TRIES
2000-2002
Dynamic Planning Documents – INMRP and CRMRP
Kelly Dilks, Douglas Johnston, Diane Timlin, UI
2001-2002
TES Habitat Impacts from Forestry Mgmt
Chris Rewerts, USDA, Argonne National Lab
2002-2004
US Army Corps of Engineers
Engineer Research and Development Center

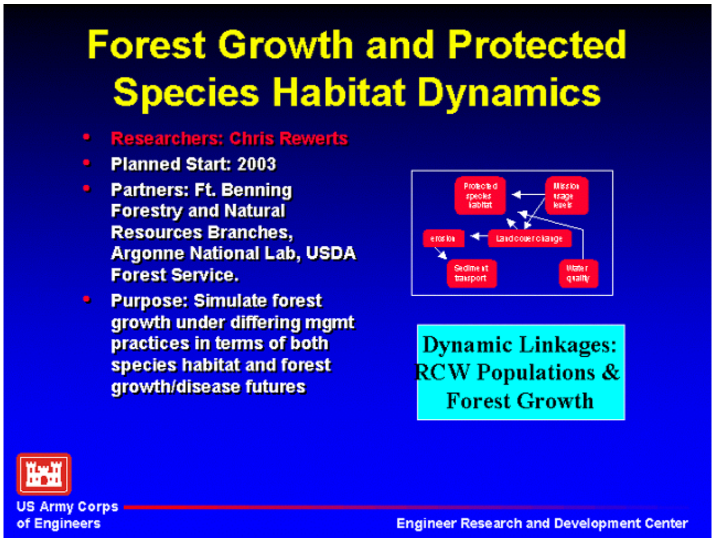

Balbach: SEMP Technical Approach
Other Agencies and Organizations
Workshops
Publications and Presentations
Website
Research Themes
Competitively Selected Research Projects
Tools, Analysis and Findings
Installation Ecosystem Management Plans/Practices
Baseline Monitoring
Data Repository
Installations Requirements and Data
Installations Outside Ecoregion
Other Installations in Ecoregion
US Army Corps of Engineers
Engineer Research and Development Center

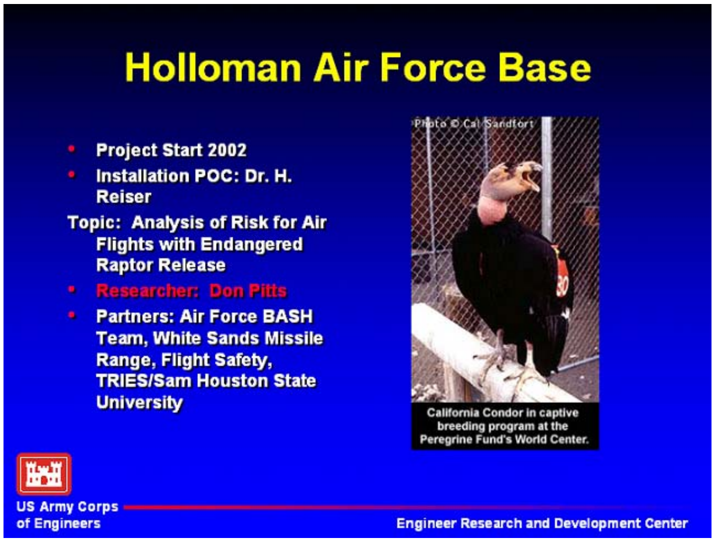

SEMP Website
http://www.denix.osd.mil/SEMP
SERDP Ecosystem Management Project (SEMP)
SEMP
about
research
locations
publications
calendar
links
SERDP
US Army Corps
of Engineers
Engineer Research and Development Center


2008
Columbus
Phenix City
Ft. Benning Military
Reservation Area
R&D Initiatives
– Historical Land Use Patterns
– National Risk Analysis
– Factor Analysis
– Data Sources
– Local/Regional Risk Analysis
– Modeling
Future Growth Projection at Fort Benning, GA
PI: Brian Deal
1955 - 2008
of Engineers
Engineer Research and Development Center


Economic Interactions
National Risk Analysis
Installation
% of local
economy
Critical threshold for
installation/community
planning
Value
Negative
interactions
Community
growth
Time
R&D Initiatives
– Historical Land Use Patterns
– National Risk Analysis
– Factor Analysis
– Data Sources
– Local/Regional Risk Analysis
– Modeling
US Army Corps
of Engineers
Engineer Research and Development Center


Dilks: Dynamic Planning Documents Project
Web Database
Multimedia
Data Repository
Photos
GIS
Audio
Reporting/ Auditing Systems
Related Documents
ECAS
Budget
CEFMS
Master Plan - INRMP
ICRMP - Forestry Plan - EIS
Pest Mgmt. - Project Planning
Process mapping
version control
DPW
Planning
Regulatory
G3
Engineering
Operations
US Army Corps of Engineers
Engineer Research and Development Center


Forest Growth and Protected Species Habitat Dynamics
• Researchers: Chris Rewerts
• Planned Start: 2003
• Partners: Ft. Benning Forestry and Natural Resources Branches, Argonne National Lab, USDA Forest Service.
• Purpose: Simulate forest growth under differing mgmt practices in terms of both species habitat and forest growth/disease futures
Protected species habitat
Mission usage levels
erosion
Land cover change
Sediment transport
Water quality
Dynamic Linkages: RCW Populations & Forest Growth
US Army Corps of Engineers
Engineer Research and Development Center


Holloman Air Force Base
• Project Start 2002
• Installation POC: Dr. H. Reiser
Topic: Analysis of Risk for Air Flights with Endangered Raptor Release
• Researcher: Don Pitts
• Partners: Air Force BASH Team, White Sands Missile Range, Flight Safety, TRIES/Sam Houston State University
Photo © Cal Sandfort
California Condor in captive breeding program at the Peregrine Fund's World Center.
US Army Corps of Engineers
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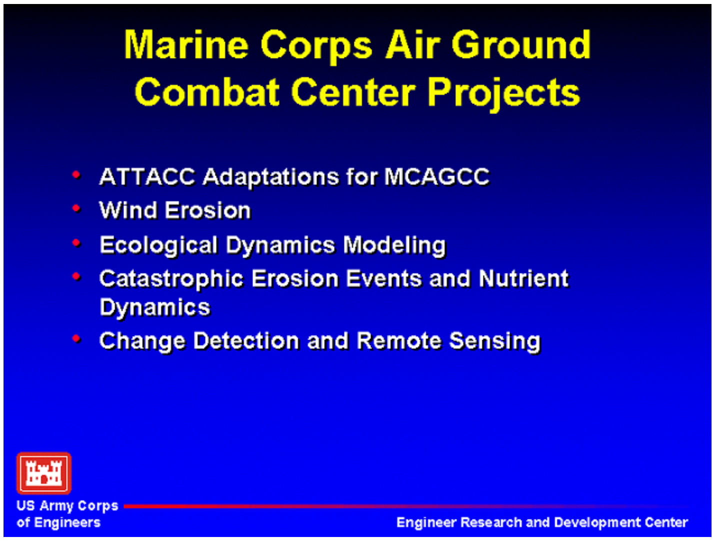
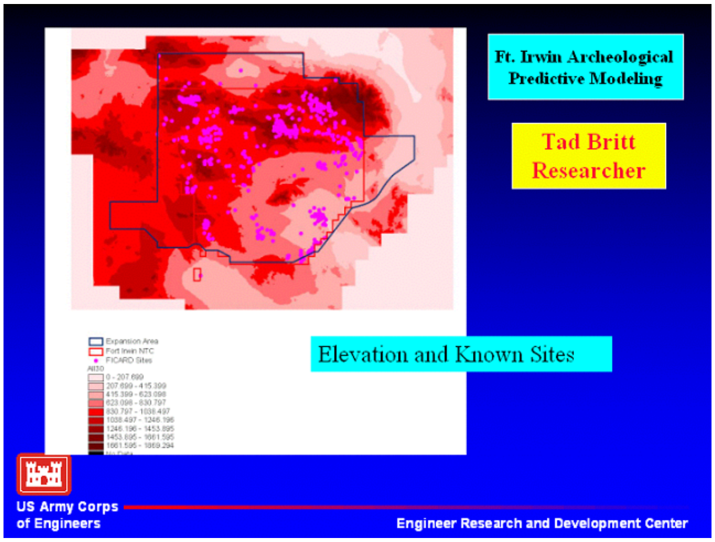
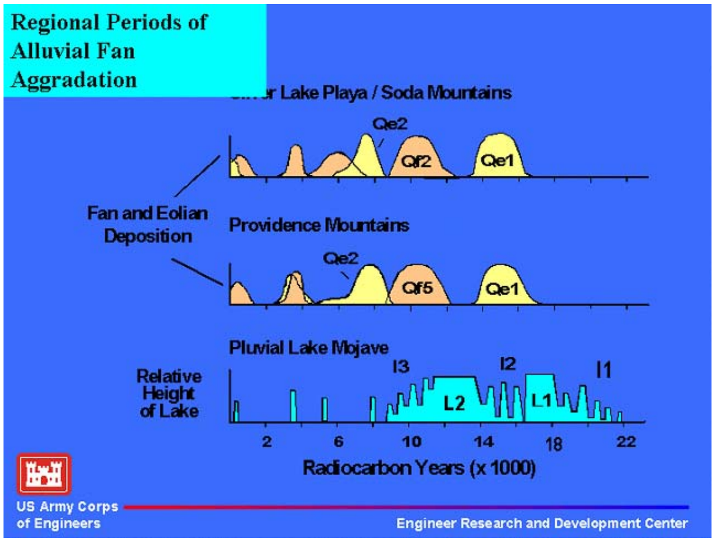
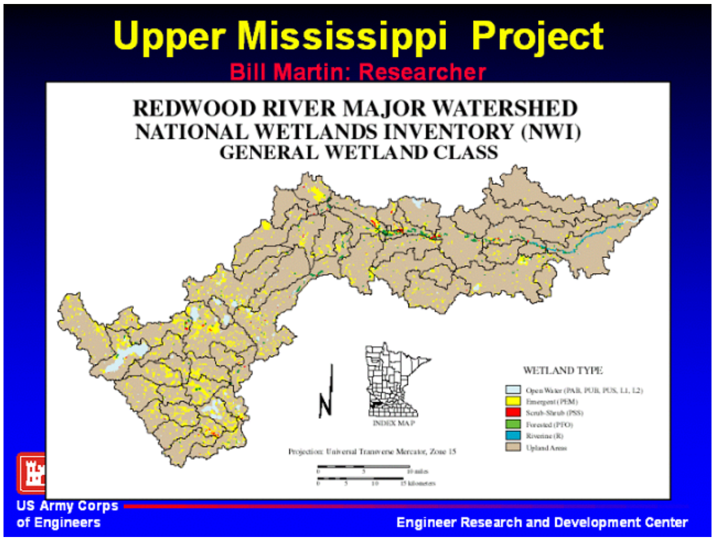

Marine Corps Air Ground Combat Center Projects
ATTACC Adaptations for MCAGCC
Wind Erosion
Ecological Dynamics Modeling
Catastrophic Erosion Events and Nutrient Dynamics
Change Detection and Remote Sensing
US Army Corps of Engineers
Engineer Research and Development Center


Ft. Irwin Archeological Predictive Modeling
Tad Britt Researcher
Elevation and Known Sites
US Army Corps of Engineers
Engineer Research and Development Center


Regional Periods of Alluvial Fan Aggradation
r Lake Playa / Soda Mountains
Qe2
Qf2
Qe1
Fan and Eolian Deposition
Providence Mountains
Qe2
Qf5
Qe1
Pluvial Lake Mojave
I3
I2
I1
L2
L1
Relative Height of Lake
2
6
10
14
18
22
Radiocarbon Years (x 1000)
US Army Corps of Engineers
Engineer Research and Development Center


Upper Mississippi Project
Bill Martin: Researcher
REDWOOD RIVER MAJOR WATERSHED
NATIONAL WETLANDS INVENTORY (NWI)
GENERAL WETLAND CLASS
N
INDEX MAP
WETLAND TYPE
Open Water (PAB, PUB, PUS, L1, L2)
Emergent (PEM)
Scrub-Shrub (PSS)
Forested (PFO)
Riverine (R)
Upland Areas
Projection: Universal Transverse Mercator, Zone 15
0 5 10 miles
0 5 10 15 kilometers
US Army Corps
of Engineers
Engineer Research and Development Center


LMS Website
(http://www.denix.osd.mil/LMS)
Home
About
Field Sites
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Demos
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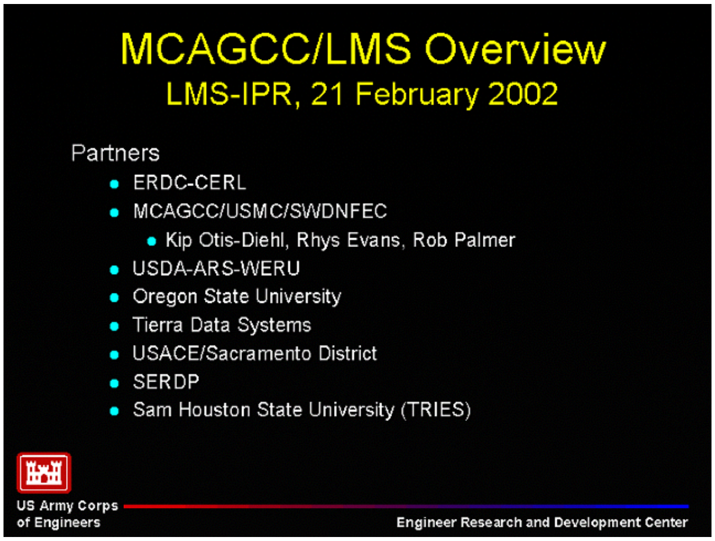
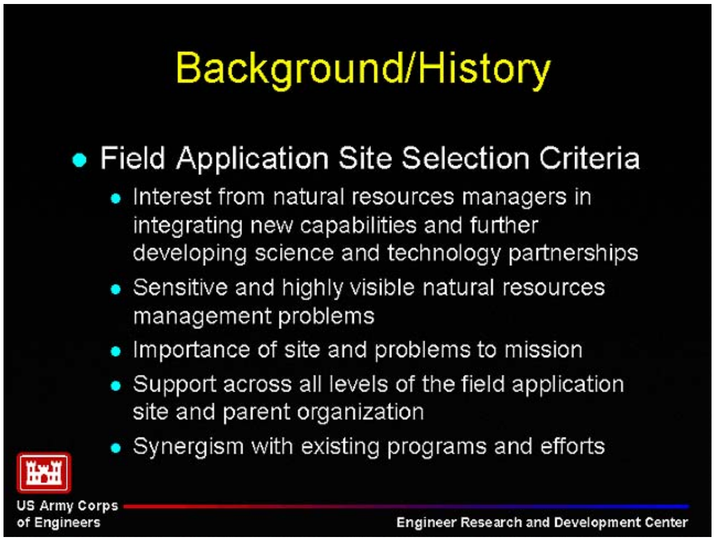
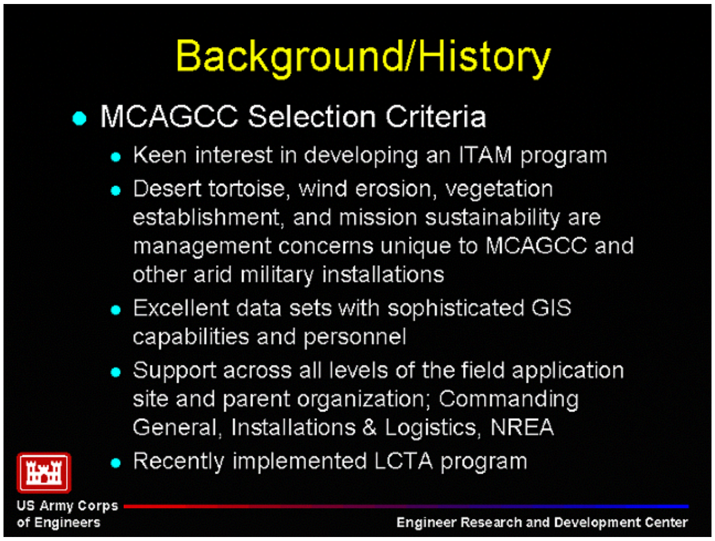
Your feedback and comments are welcomed
Document last updated September 09, 1999
US Army Corps
of Engineers
Engineer Research and Development Center

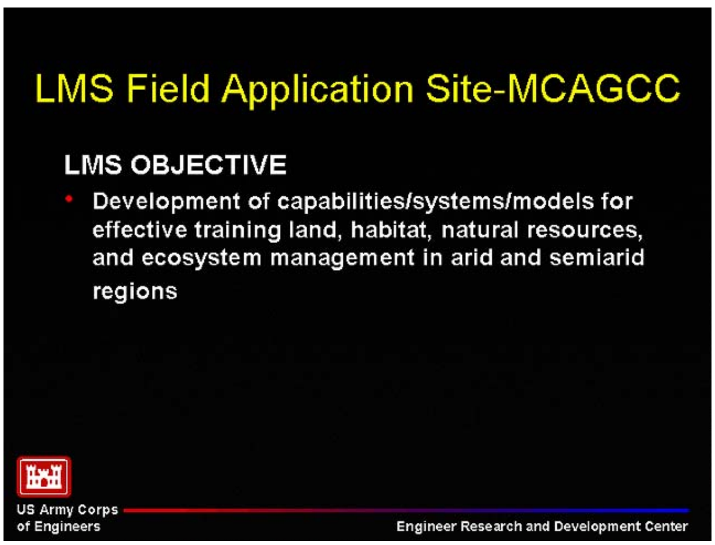
PRESENTATION: MCAGCC LMS Military Field Application Program Overview.

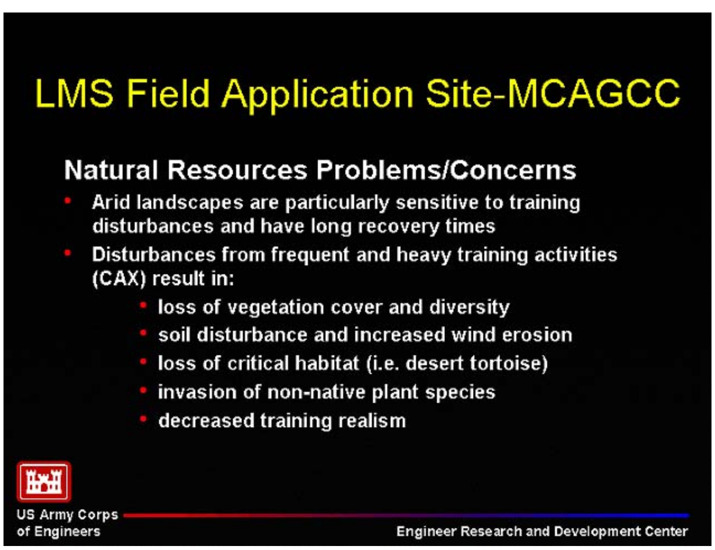
PRESENTER: Dr. Dick Gebhart.

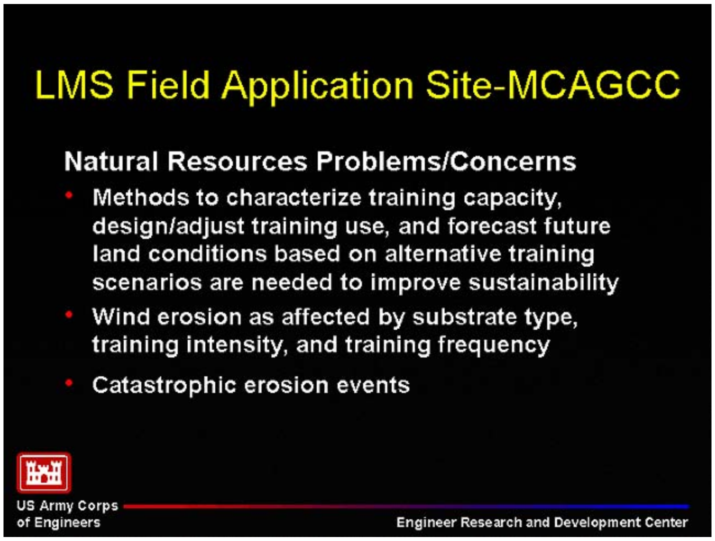


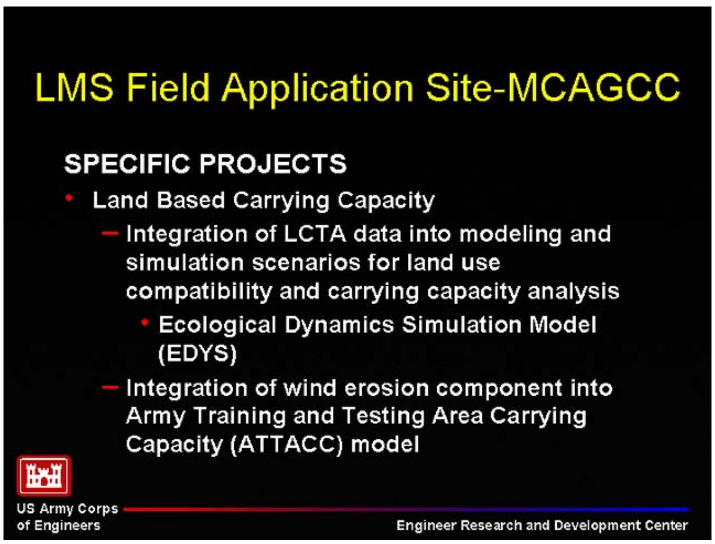


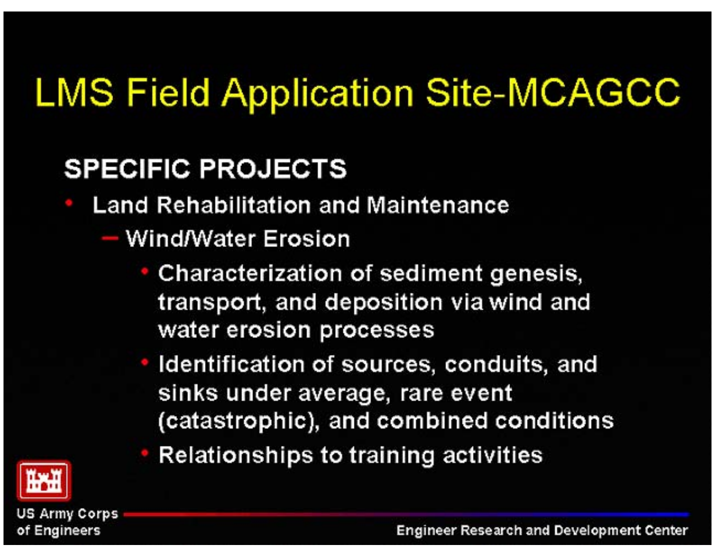

Background/History
MCAGCC Selection Criteria
Keen interest in developing an ITAM program
Desert tortoise, wind erosion, vegetation establishment, and mission sustainability are management concerns unique to MCAGCC and other arid military installations
Excellent data sets with sophisticated GIS capabilities and personnel
Support across all levels of the field application site and parent organization; Commanding General, Installations & Logistics, NREA
Recently implemented LCTA program
US Army Corps of Engineers
Engineer Research and Development Center

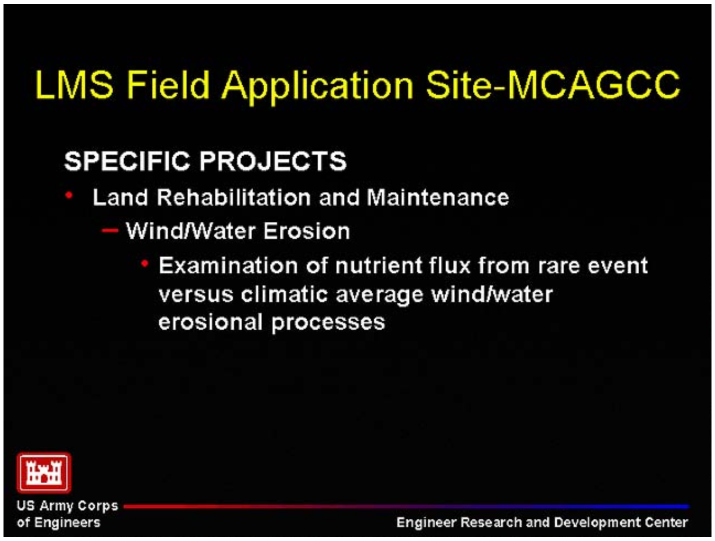

LMS Field Application Site-MCAGCC
LMS OBJECTIVE
Development of capabilities/systems/models for effective training land, habitat, natural resources, and ecosystem management in arid and semiarid regions
US Army Corps of Engineers
Engineer Research and Development Center

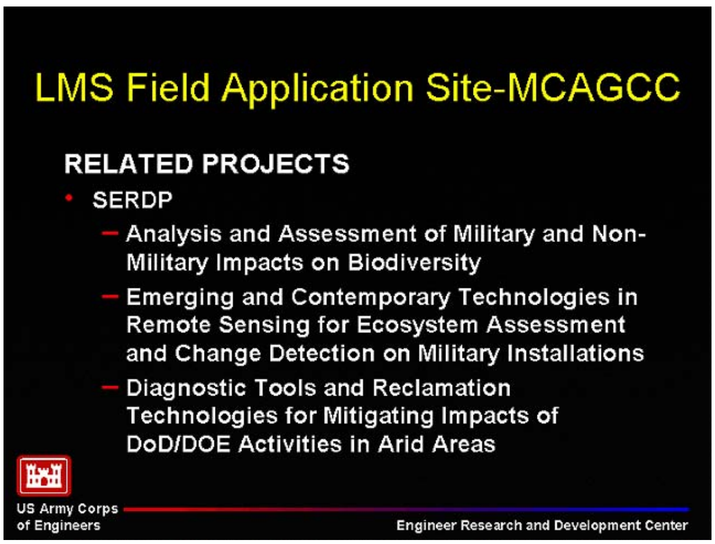

LMS Field Application Site-MCAGCC
Natural Resources Problems/Concerns
Arid landscapes are particularly sensitive to training disturbances and have long recovery times
Disturbances from frequent and heavy training activities (CAX) result in:
loss of vegetation cover and diversity
soil disturbance and increased wind erosion
loss of critical habitat (i.e. desert tortoise)
invasion of non-native plant species
decreased training realism
US Army Corps of Engineers
Engineer Research and Development Center

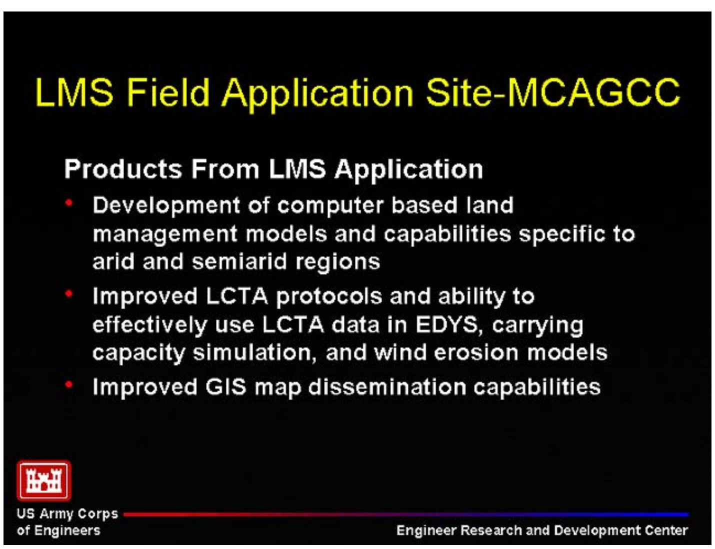

LMS Field Application Site-MCAGCC
Natural Resources Problems/Concerns
• Methods to characterize training capacity, design/adjust training use, and forecast future land conditions based on alternative training scenarios are needed to improve sustainability
• Wind erosion as affected by substrate type, training intensity, and training frequency
• Catastrophic erosion events
US Army Corps of Engineers
Engineer Research and Development Center

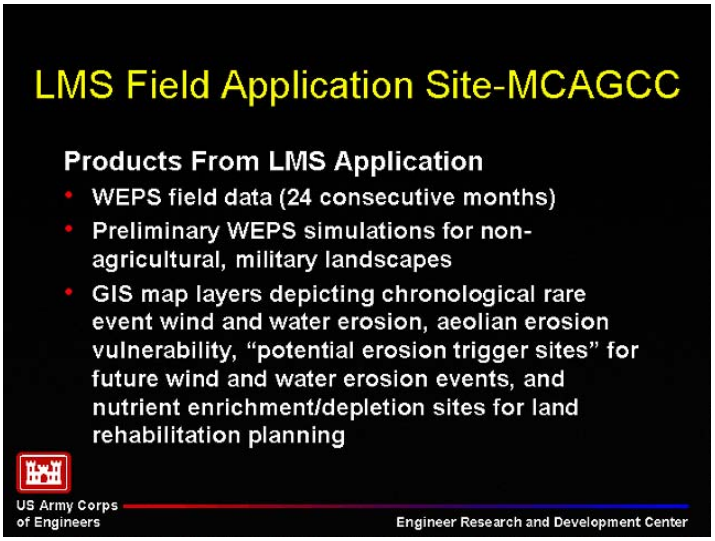

LMS Field Application Site-MCAGCC
SPECIFIC PROJECTS
• Land Based Carrying Capacity
– Integration of LCTA data into modeling and simulation scenarios for land use compatibility and carrying capacity analysis
• Ecological Dynamics Simulation Model (EDYS)
– Integration of wind erosion component into Army Training and Testing Area Carrying Capacity (ATTACC) model
US Army Corps of Engineers
Engineer Research and Development Center

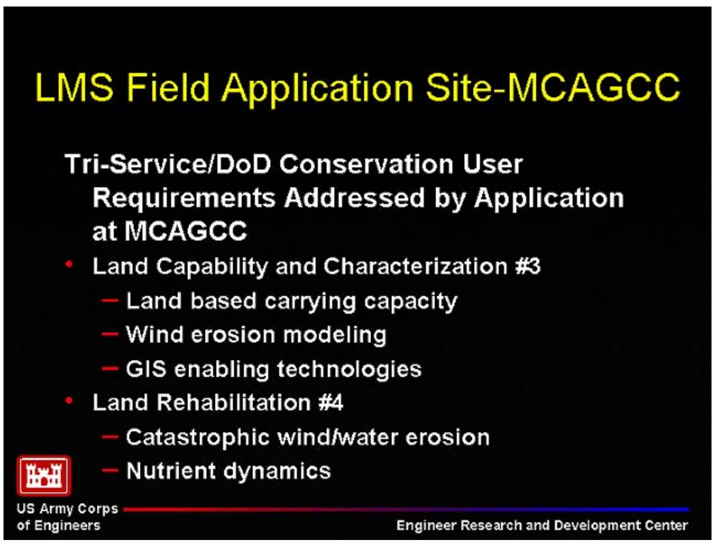

LMS Field Application Site-MCAGCC
SPECIFIC PROJECTS
• Land Rehabilitation and Maintenance
– Wind/Water Erosion
• Characterization of sediment genesis, transport, and deposition via wind and water erosion processes
• Identification of sources, conduits, and sinks under average, rare event (catastrophic), and combined conditions
• Relationships to training activities
US Army Corps of Engineers
Engineer Research and Development Center

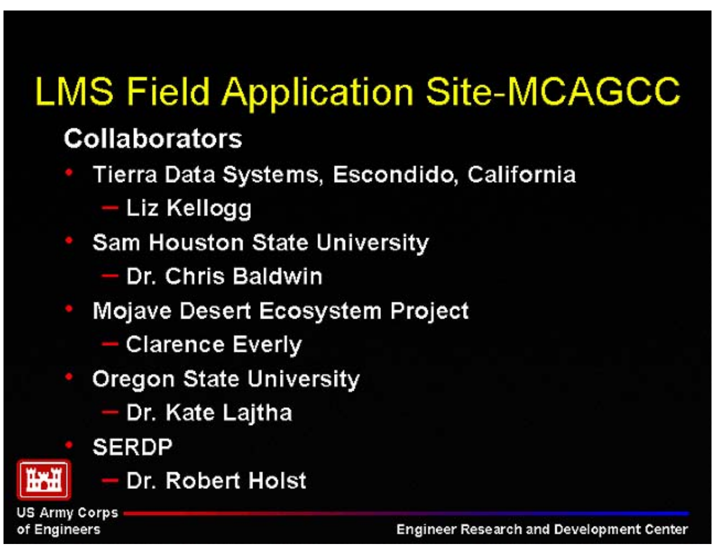

LMS Field Application Site-MCAGCC
SPECIFIC PROJECTS
Land Rehabilitation and Maintenance
Wind/Water Erosion
Examination of nutrient flux from rare event versus climatic average wind/water erosional processes
US Army Corps of Engineers
Engineer Research and Development Center

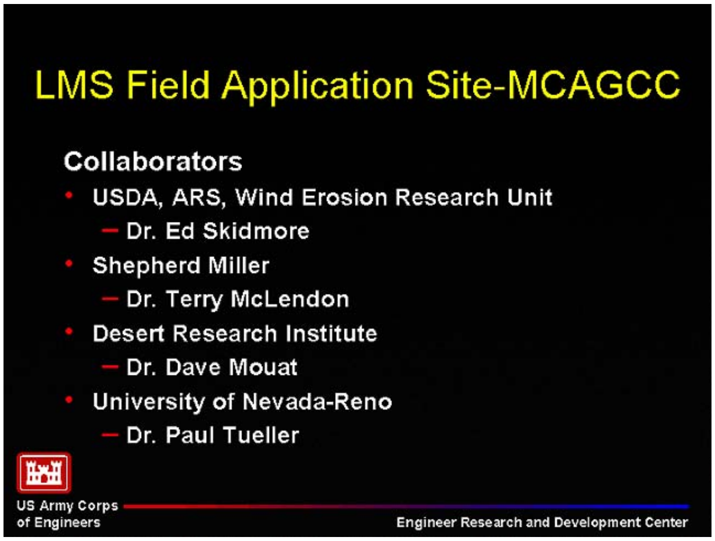

LMS Field Application Site-MCAGCC
RELATED PROJECTS
SERDP
Analysis and Assessment of Military and Non-Military Impacts on Biodiversity
Emerging and Contemporary Technologies in Remote Sensing for Ecosystem Assessment and Change Detection on Military Installations
Diagnostic Tools and Reclamation Technologies for Mitigating Impacts of DoD/DOE Activities in Arid Areas
US Army Corps of Engineers
Engineer Research and Development Center


LMS Field Application Site-MCAGCC
Products From LMS Application
Development of computer based land management models and capabilities specific to arid and semiarid regions
Improved LCTA protocols and ability to effectively use LCTA data in EDYS, carrying capacity simulation, and wind erosion models
Improved GIS map dissemination capabilities
US Army Corps of Engineers
Engineer Research and Development Center


LMS Field Application Site-MCAGCC
Products From LMS Application
WEPS field data (24 consecutive months)
Preliminary WEPS simulations for non-agricultural, military landscapes
GIS map layers depicting chronological rare event wind and water erosion, aeolian erosion vulnerability, "potential erosion trigger sites" for future wind and water erosion events, and nutrient enrichment/depletion sites for land rehabilitation planning
US Army Corps of Engineers
Engineer Research and Development Center

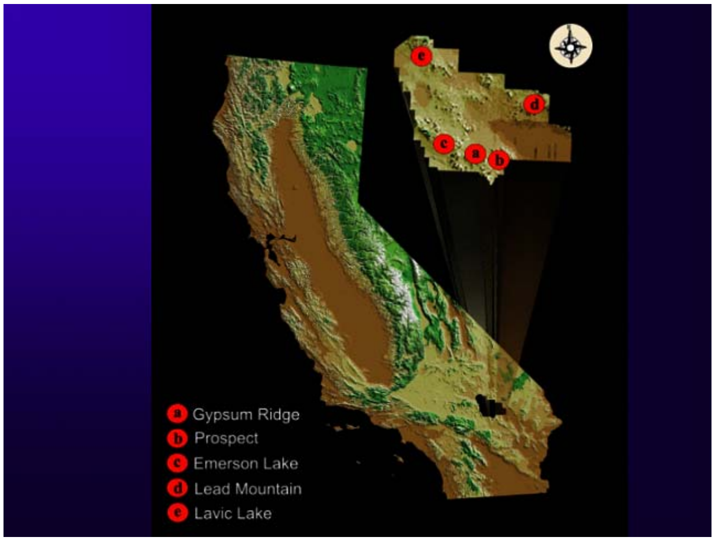

LMS Field Application Site-MCAGCC
Tri-Service/DoD Conservation User Requirements Addressed by Application at MCAGCC
Land Capability and Characterization #3
– Land based carrying capacity
– Wind erosion modeling
– GIS enabling technologies
Land Rehabilitation #4
– Catastrophic wind/water erosion
– Nutrient dynamics
US Army Corps of Engineers
Engineer Research and Development Center

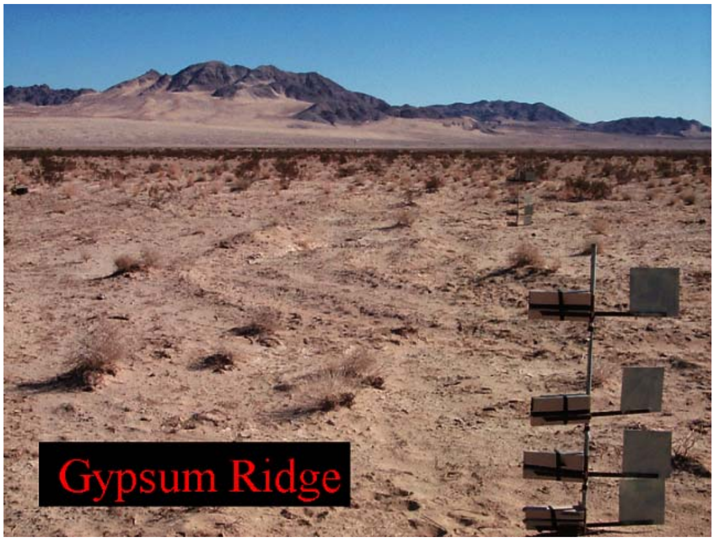

LMS Field Application Site-MCAGCC
Collaborators
Tierra Data Systems, Escondido, California
– Liz Kellogg
Sam Houston State University
– Dr. Chris Baldwin
Mojave Desert Ecosystem Project
– Clarence Everly
Oregon State University
– Dr. Kate Lajtha
SERDP
– Dr. Robert Holst
US Army Corps of Engineers
Engineer Research and Development Center

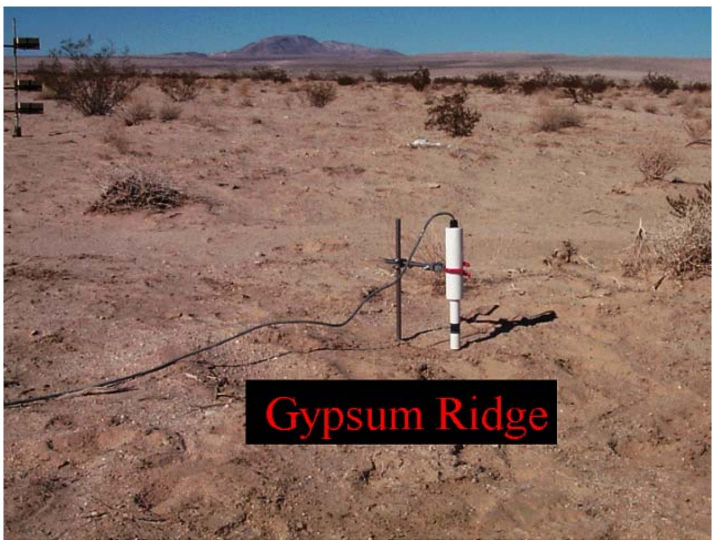

LMS Field Application Site-MCAGCC
Collaborators
USDA, ARS, Wind Erosion Research Unit
Dr. Ed Skidmore
Shepherd Miller
Dr. Terry McLendon
Desert Research Institute
Dr. Dave Mouat
University of Nevada-Reno
Dr. Paul Tueller
US Army Corps of Engineers
Engineer Research and Development Center

PRESENTATION: MCAGCC Wind Erosion.

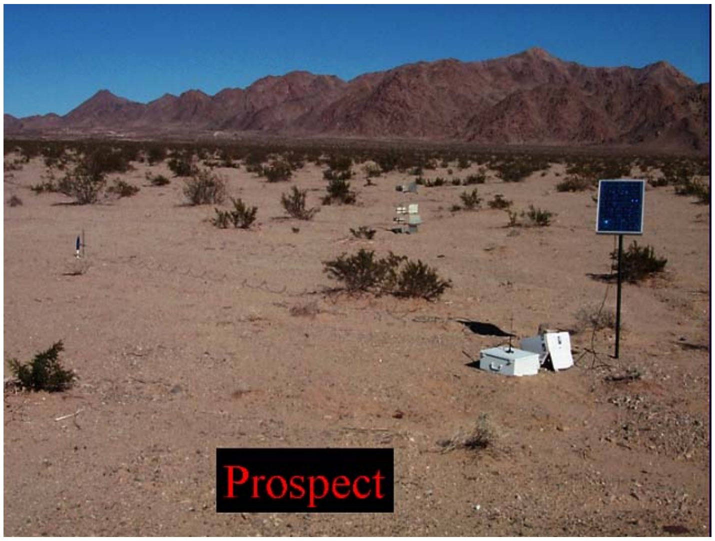
PRESENTER: Dr. Ed Skidmore.



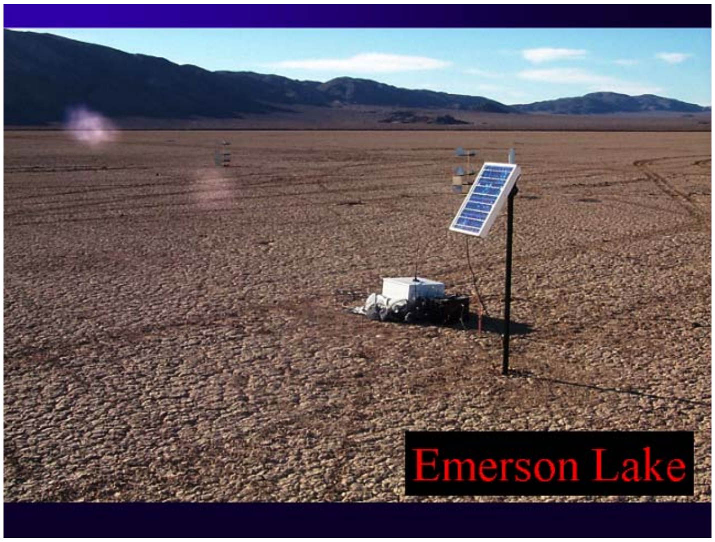

Gypsum Ridge

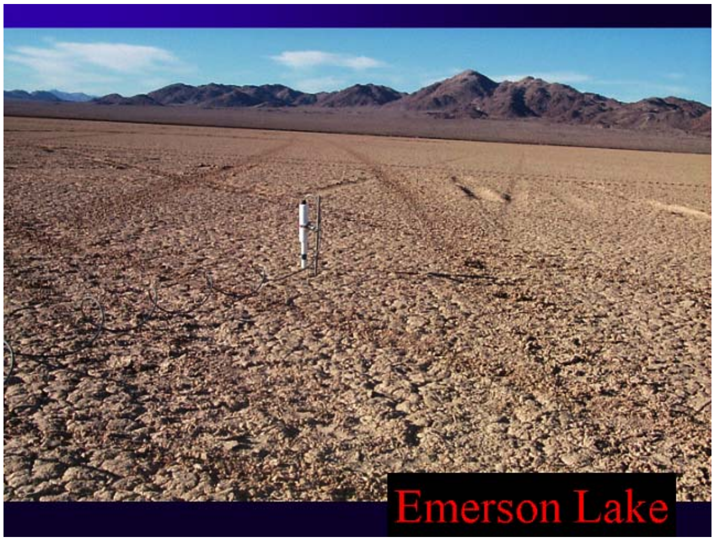

Gypsum Ridge


Prospect

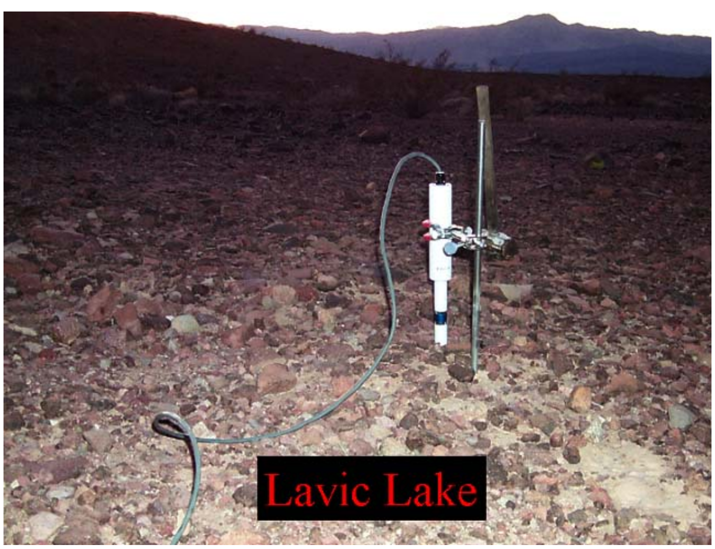

Prospect


Emerson Lake


Emerson Lake


Emerson Lake

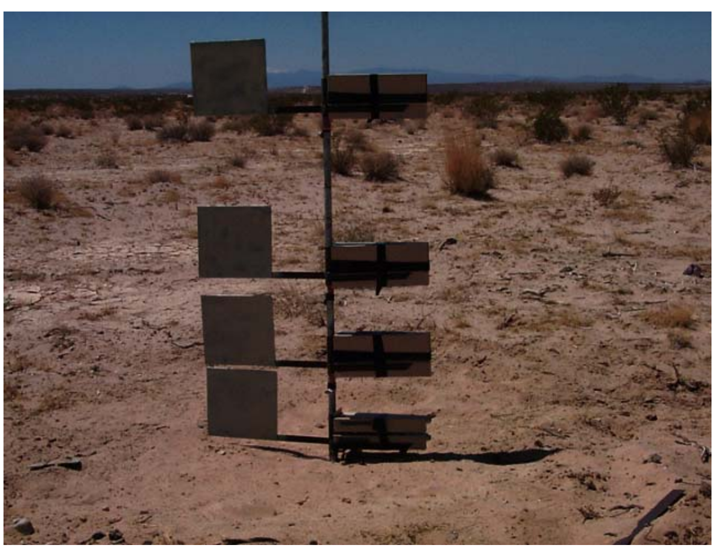

Lavic Lake

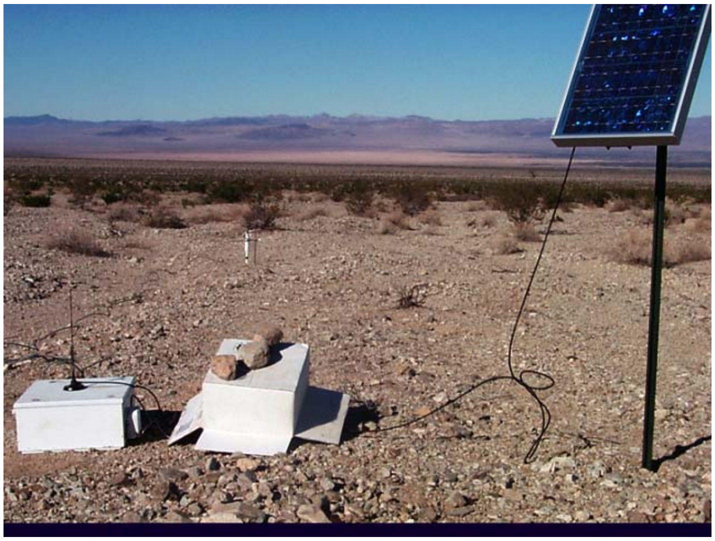

Lavic Lake

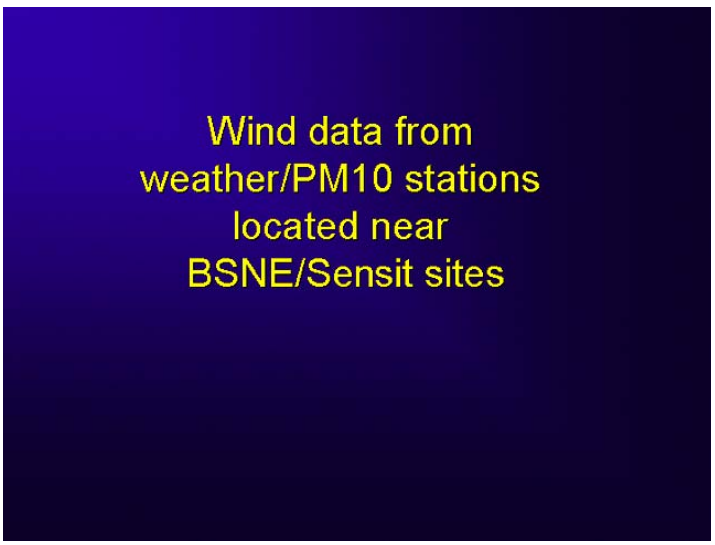

Lead Mountain

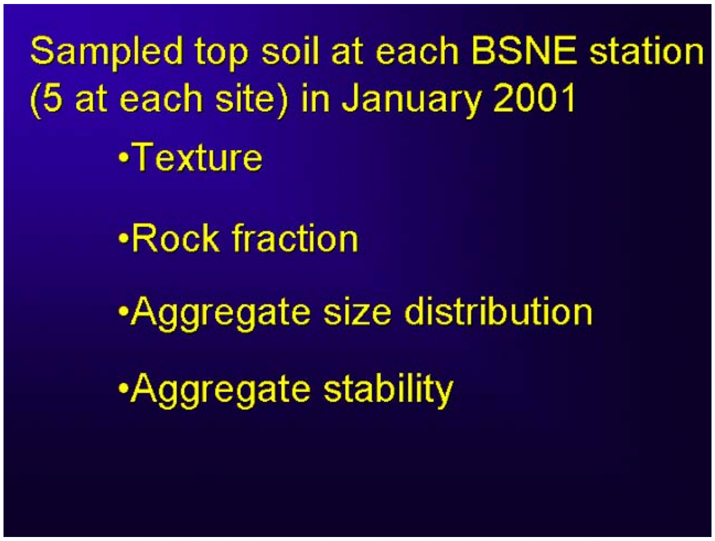

Lead Mountain

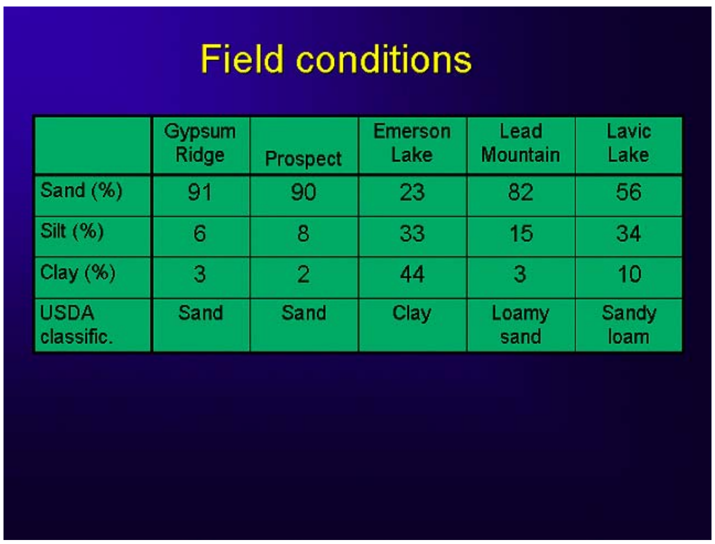

Lead Mountain



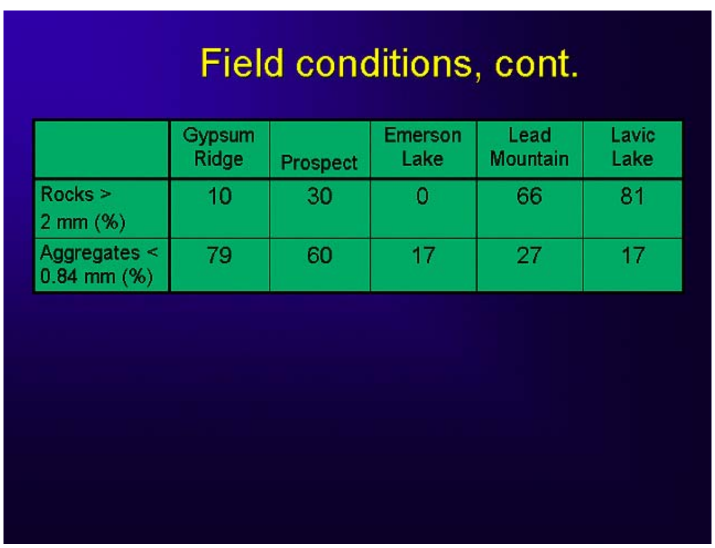



Wind data from
weather/PM10 stations
located near
BSNE/Sensit sites


Sampled top soil at each BSNE station (5 at each site) in January 2001
•Texture
•Rock fraction
•Aggregate size distribution
•Aggregate stability


Field conditions

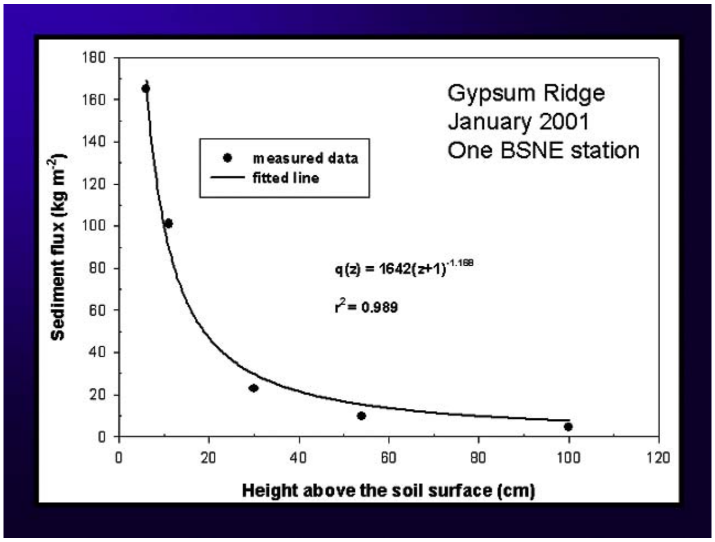
	Gypsum Ridge	Prospect	Emerson Lake	Lead Mountain	Lavic Lake
Sand (%)	91	90	23	82	56
Silt (%)	6	8	33	15	34
Clay (%)	3	2	44	3	10
USDA classific.	Sand	Sand	Clay	Loamy sand	Sandy loam


Field conditions, cont.

	Gypsum Ridge	Prospect	Emerson Lake	Lead Mountain	Lavic Lake
Rocks > 2 mm (%)	10	30	0	66	81
Aggregates < 0.84 mm (%)	79	60	17	27	17

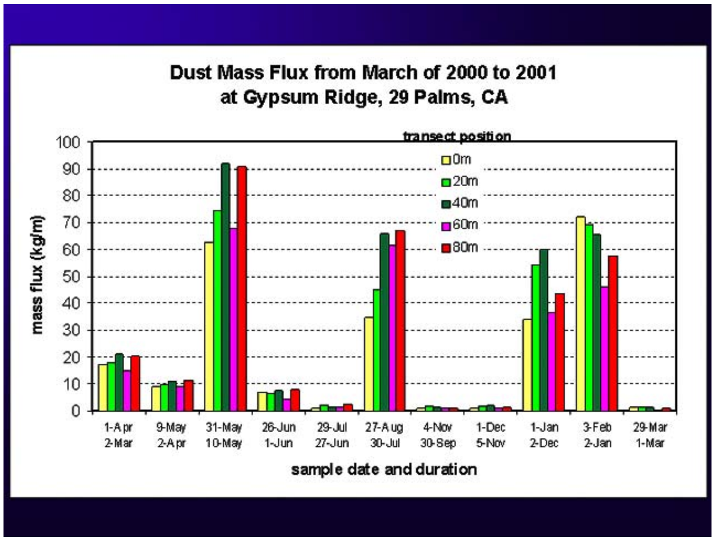
Field conditions, cont.

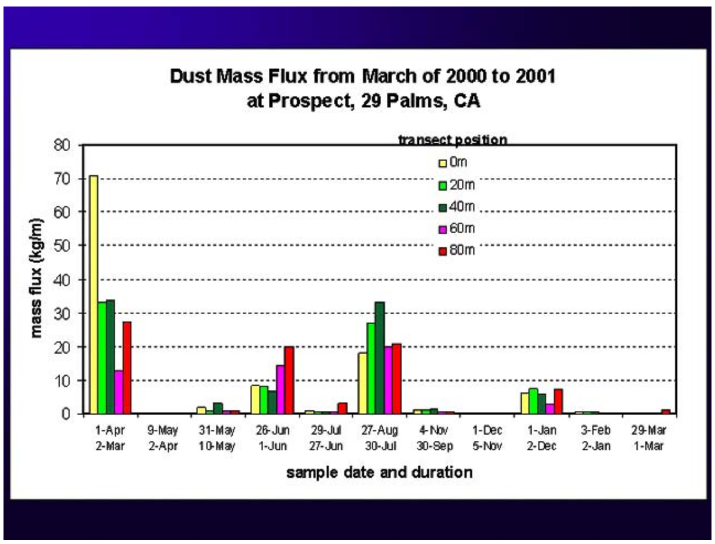
	Gypsum Ridge	Prospect	Emerson Lake	Lead Mountain	Lavic Lake
Dry agg. stab. (ln[J/kg])	-	-	2.61	-	-
Wet agg. stab. (%)	0	0	2.5	0	0

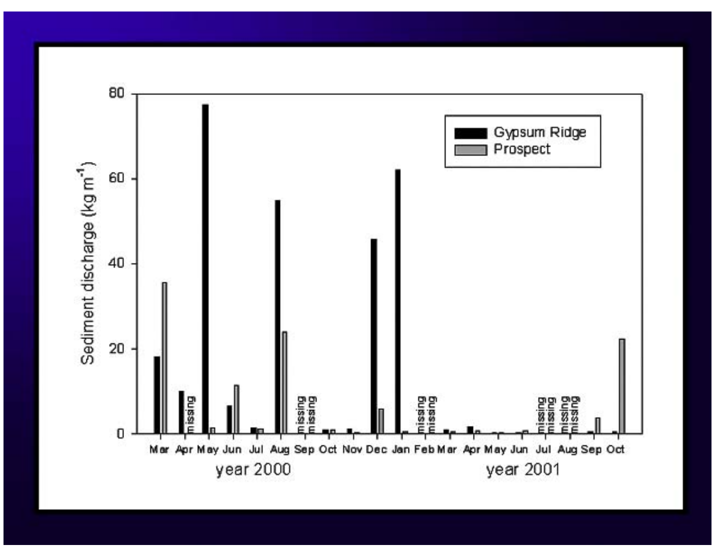


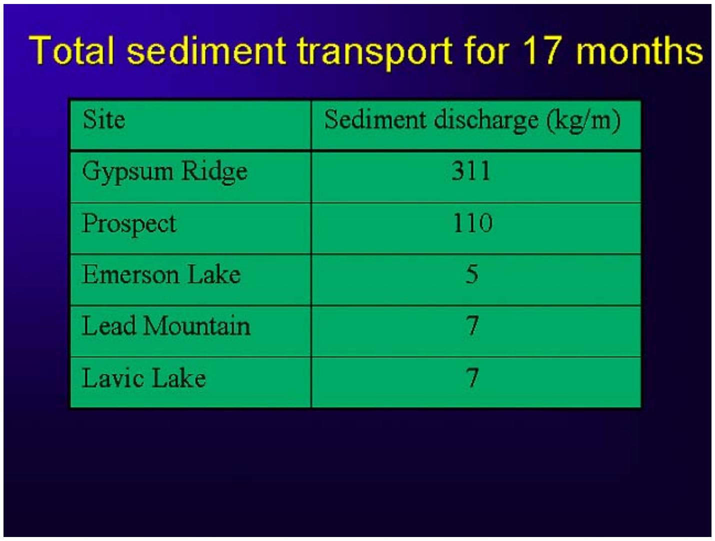
Sediment flux (kg/m²) for Gypsum Ridge, Jan. 2001

Height (cm)	0*	20*	40*	60*	80*
5	205	205	221	145	165
10	174	112	148	95	101
30	27	24	23	22	23
55	11	10	10	9	9
100	5	5	5	4	4
kg/m	**71**	**69**	**65**	**45**	**57**


Dust Mass Flux from March of 2000 to 2001
at Gypsum Ridge, 29 Palms, CA
transect position
0m
20m
40m
60m
80m
mass flux (kg/m)
1-Apr 2-Mar
9-May 2-Apr
31-May 10-May
26-Jun 1-Jun
29-Jul 27-Jun
27-Aug 30-Jul
4-Nov 30-Sep
1-Dec 5-Nov
1-Jan 2-Dec
3-Feb 2-Jan
29-Mar 1-Mar
sample date and duration

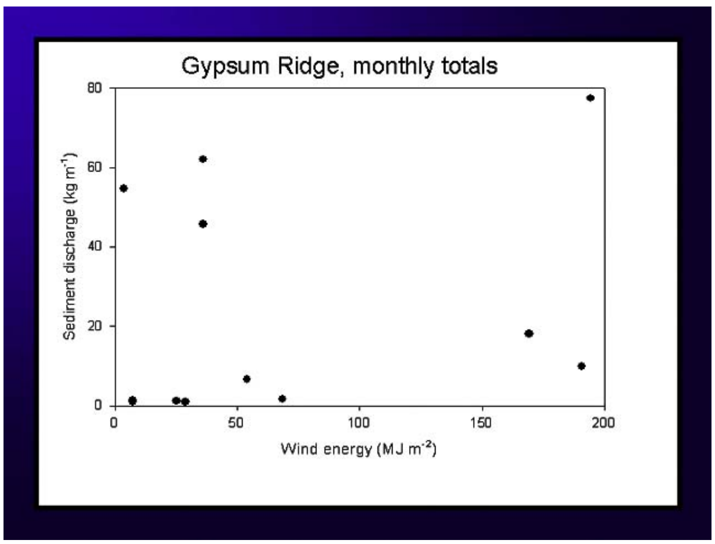

Dust Mass Flux from March of 2000 to 2001
at Prospect, 29 Palms, CA
transect position
0m
20m
40m
60m
80m
mass flux (kg/m)
1-Apr 2-Mar
9-May 2-Apr
31-May 10-May
26-Jun 1-Jun
29-Jul 27-Jun
27-Aug 30-Jul
4-Nov 30-Sep
1-Dec 5-Nov
1-Jan 2-Dec
3-Feb 2-Jan
29-Mar 1-Mar
sample date and duration

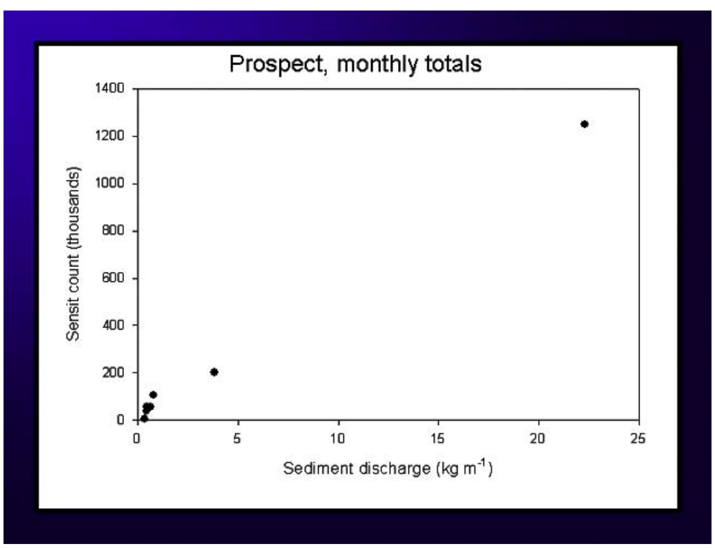

Gypsum Ridge
Prospect
Sediment discharge (kg m-1)
missing
Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct
year 2000
year 2001

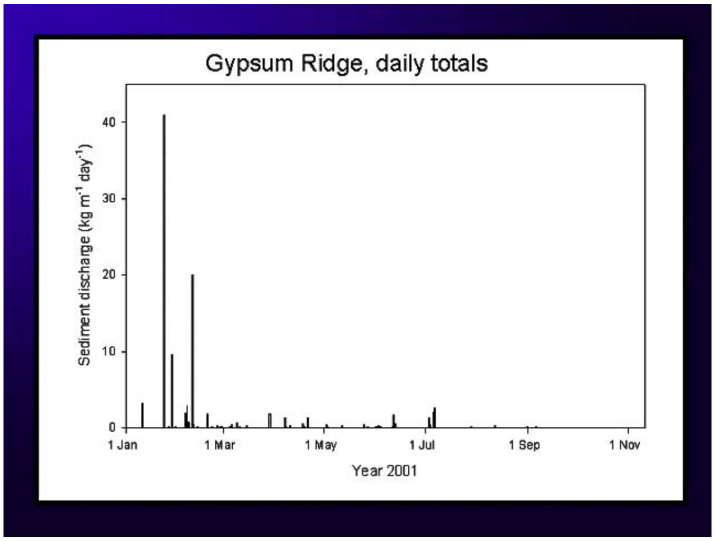


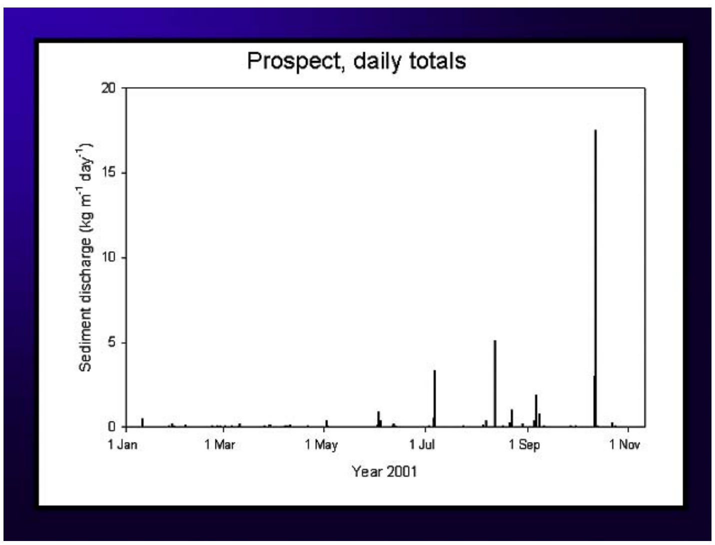
Total sediment transport for 17 months

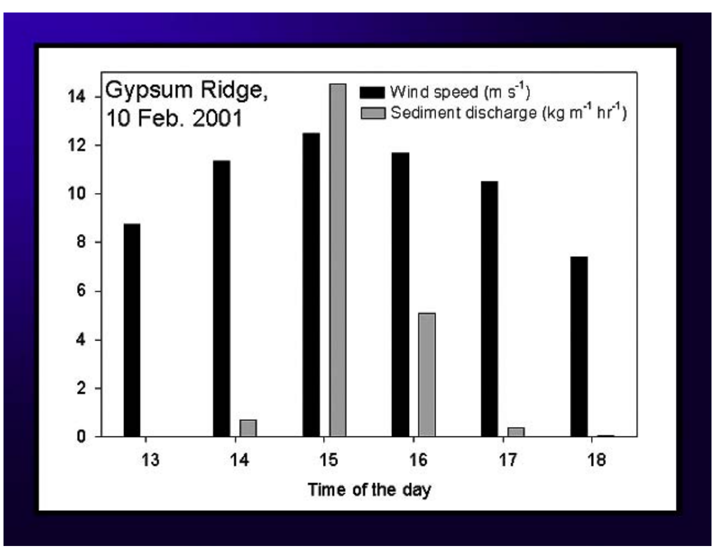
Site	Sediment discharge (kg/m)
Gypsum Ridge	311
Prospect	110
Emerson Lake	5
Lead Mountain	7
Lavic Lake	7

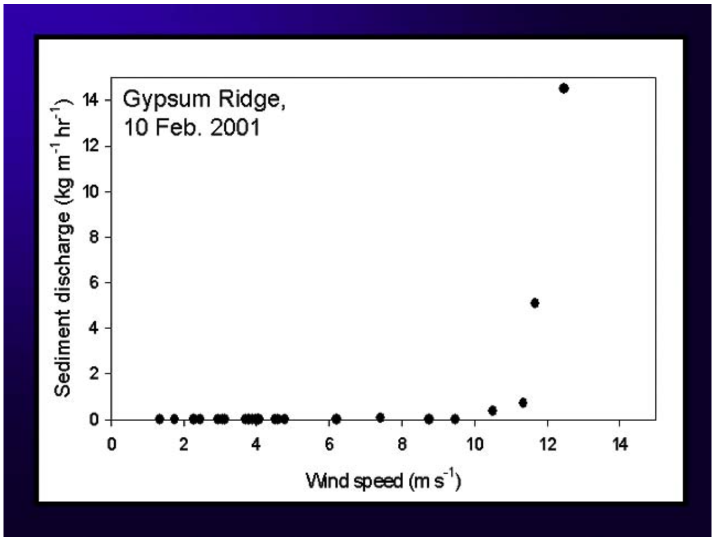


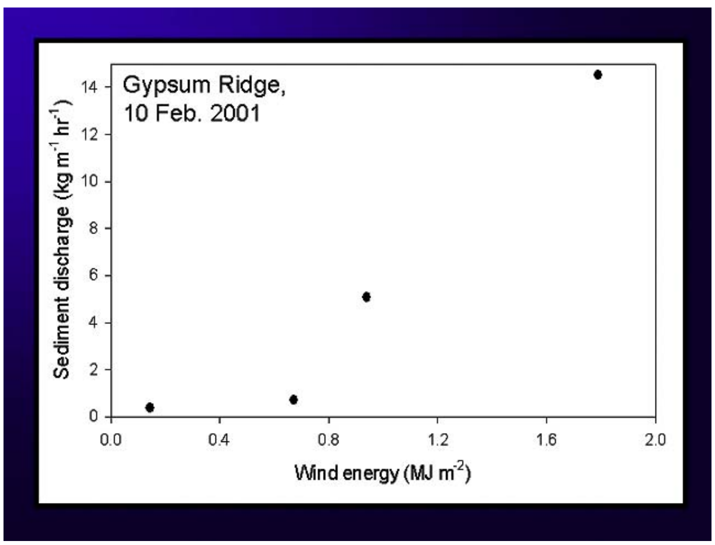


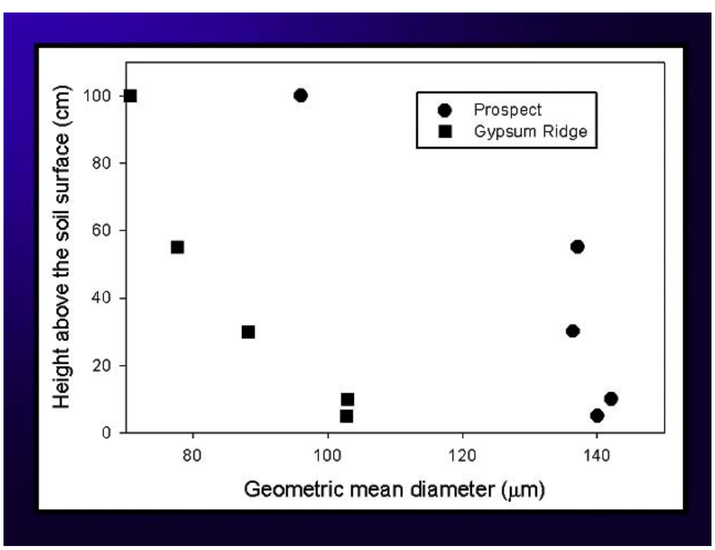

Gypsum Ridge, daily totals
Sediment discharge (kg m^{-1} day^{-1})
0
10
20
30
40
1 Jan
1 Mar
1 May
1 Jul
1 Sep
1 Nov
Year 2001

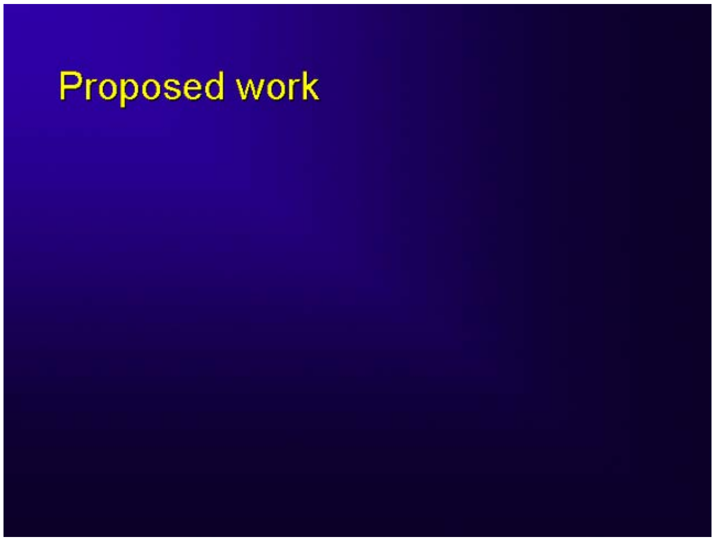

Prospect, daily totals
Sediment discharge (kg m^{-1} day^{-1})
0
5
10
15
20
1 Jan
1 Mar
1 May
1 Jul
1 Sep
1 Nov
Year 2001


Gypsum Ridge,
10 Feb. 2001
Wind speed (m s^{-1})
Sediment discharge (kg m^{-1} hr^{-1})
0
2
4
6
8
10
12
14
13
14
15
16
17
18
Time of the day


Gypsum Ridge,
10 Feb. 2001
Sediment discharge (kg m^{-1} hr^{-1})
Wind speed (m s^{-1})


Gypsum Ridge,
10 Feb. 2001
Sediment discharge (kg m^{-1} hr^{-1})
Wind energy (MJ m^{-2})

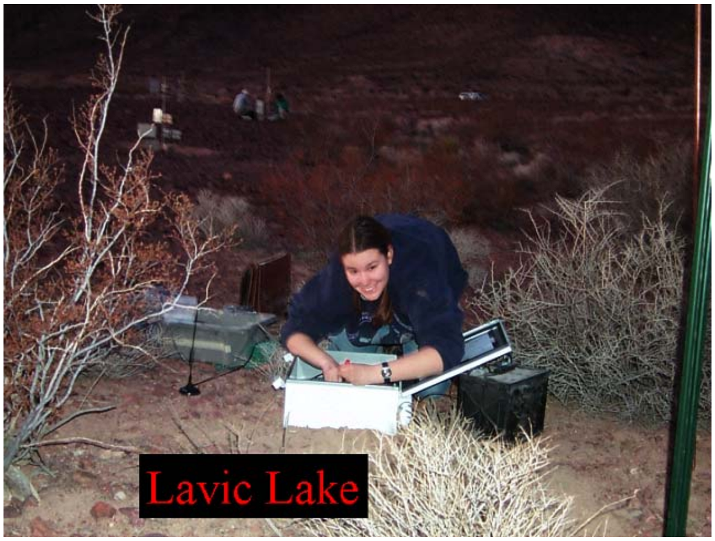

Prospect
Gypsum Ridge
Height above the soil surface (cm)
Geometric mean diameter (µm)

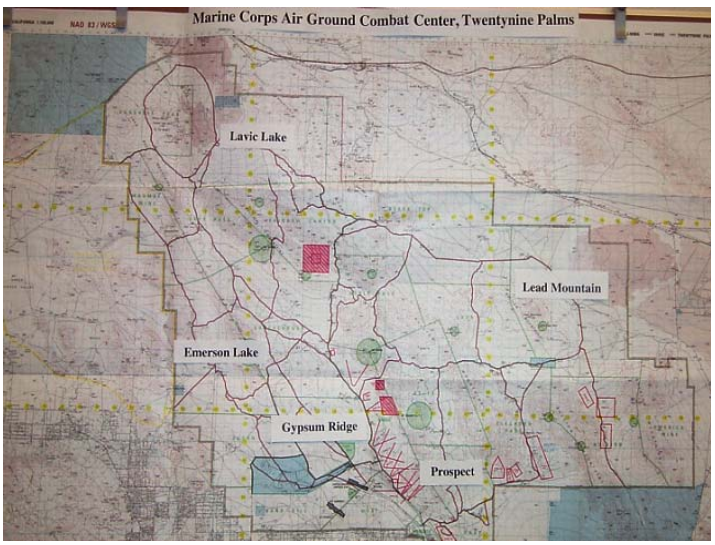

Proposed work

conclusions

- conclusion1
- conclusion2
- conclusion3
- conclusion4

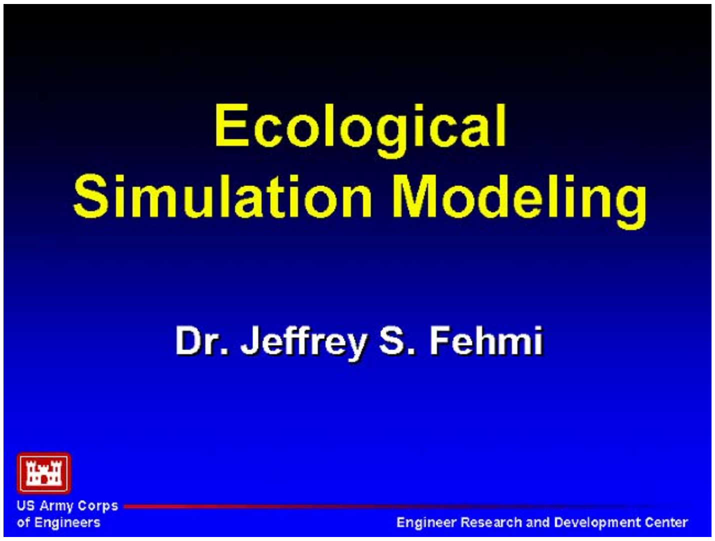
extra slides follow

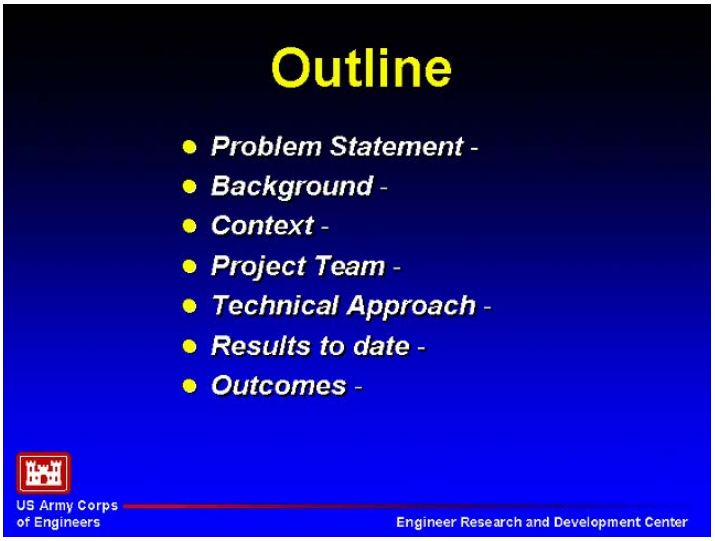

Lavic Lake

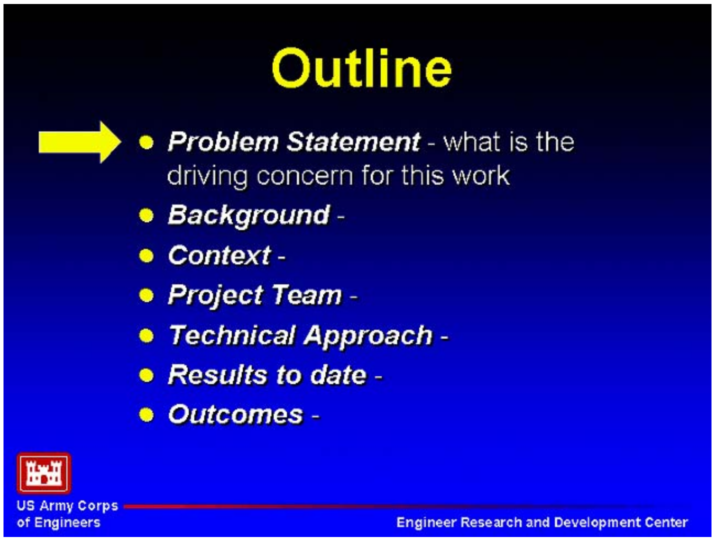

Marine Corps Air Ground Combat Center, Twentynine Palms
Lavic Lake
Lead Mountain
Emerson Lake
Gypsum Ridge
Prospect

PRESENTATION: Ecological Dynamics Modeling.

PRESENTER: Dr. Jeffrey Fehmi.






Outline
Problem Statement - what is the driving concern for this work
Background -
Context -
Project Team -
Technical Approach -
Results to date -
Outcomes -
US Army Corps of Engineers
Engineer Research and Development Center


Why we want computer models for land management
Land management is complex and lacks well documented mechanistic cause-and-effect relationships.
It is locally unique.
It is dynamic – changing as conditions, force structure, and public concern change.
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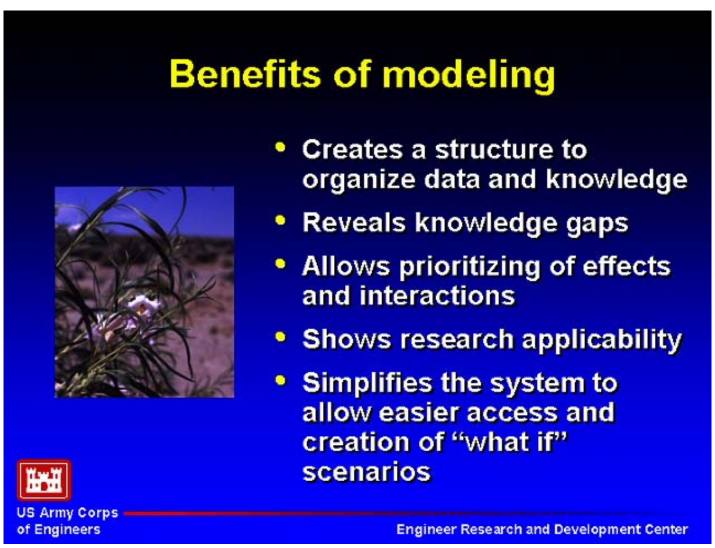
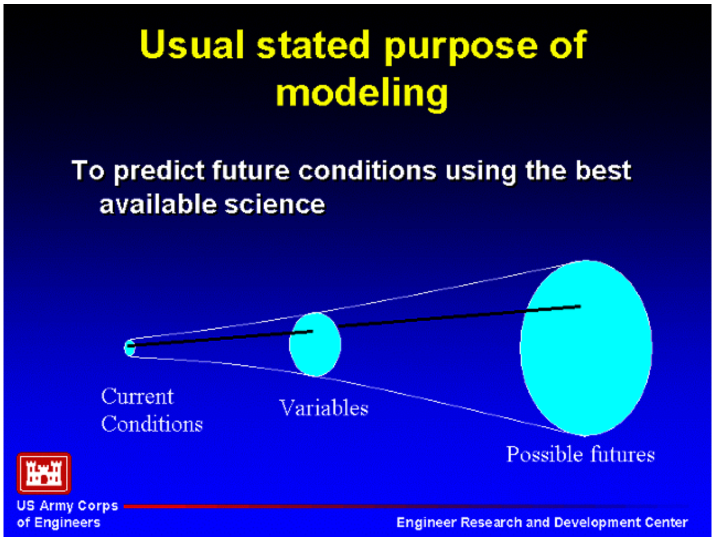
Engineer Research and Development Center


Benefits of modeling
Creates a structure to organize data and knowledge
Reveals knowledge gaps
Allows prioritizing of effects and interactions
Shows research applicability
Simplifies the system to allow easier access and creation of "what if" scenarios
US Army Corps of Engineers
Engineer Research and Development Center


Usual stated purpose of modeling
To predict future conditions using the best available science
Current Conditions
Variables
Possible futures
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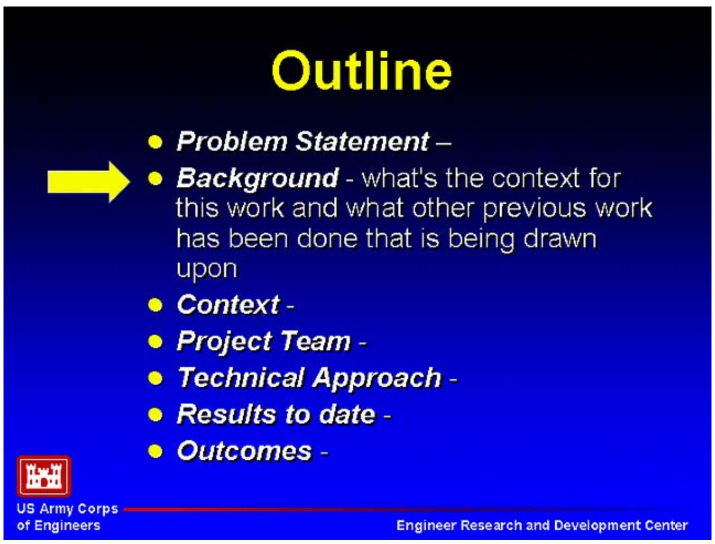
Outline
Problem Statement –
Background - what's the context for this work and what other previous work has been done that is being drawn upon
Context -
Project Team -
Technical Approach -
Results to date -
Outcomes -
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Military training
US Army Corps of Engineers
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Military Training
• Military training is unique disturbance
• Training is different from other sorts of natural landscape disturbances such as grazing or fire.
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Training occurs independently of the ability of the land to support it and frequency and intensity are often fixed by installation mission.
Training can occur in all weather conditions and across almost all soils, topographic aspects and vegetative types.
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Training is not selective, impacting all vegetation in some areas while others are untouched.
No nutrients are removed and manipulation of the vegetation is not the purpose.
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Military Land Management
• There are many complex variables including:
– Weather
– Season
– Soil type
– Training history
– Vegetation
– Intensity and unit type impacts vary
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Military Land Management

- Training is not linked to resource status
- Monitoring and analysis are constrained
- Scientific research generally does not effectively address management implications
- Knowledge not well captured in documetation

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Outline

- ***Problem Statement*** –
- ***Background*** -
- ***Context*** - how does this specific project fit into the whole (is it a portion of another project)
- ***Project Team*** -
- ***Technical Approach*** –
- ***Results to date*** -
- ***Outcomes*** -

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Context

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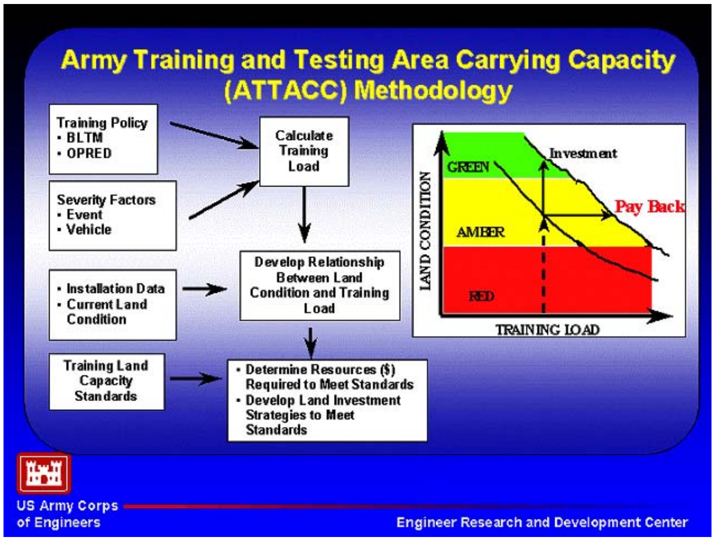
Army Training and Testing Area Carrying Capacity (ATTACC) Methodology
Training Policy
• BLTM
• OPRED
Severity Factors
• Event
• Vehicle
• Installation Data
• Current Land Condition
Training Land Capacity Standards
Calculate Training Load
Develop Relationship Between Land Condition and Training Load
• Determine Resources ($) Required to Meet Standards
• Develop Land Investment Strategies to Meet Standards
LAND CONDITION
GREEN
AMBER
RED
Investment
Pay Back
TRAINING LOAD
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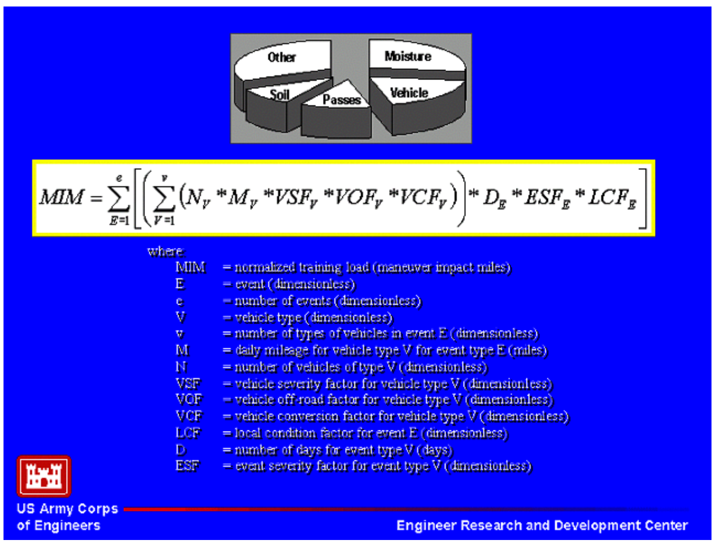
Other
Moisture
Soil
Passes
Vehicle
$$MIM = \sum_{E=1}^{e}\left[\left(\sum_{V=1}^{v}(N_V * M_V * VSF_V * VOF_V * VCF_V)\right) * D_E * ESF_E * LCF_E\right]$$
where:
MIM = normalized training load (maneuver impact miles)
E = event (dimensionless)
e = number of events (dimensionless)
V = vehicle type (dimensionless)
v = number of types of vehicles in event E (dimensionless)
M = daily mileage for vehicle type V for event type E (miles)
N = number of vehicles of type V (dimensionless)
VSF = vehicle severity factor for vehicle type V (dimensionless)
VOF = vehicle off-road factor for vehicle type V (dimensionless)
VCF = vehicle conversion factor for vehicle type V (dimensionless)
LCF = local condition factor for event E (dimensionless)
D = number of days for event type V (days)
ESF = event severity factor for event type V (dimensionless)
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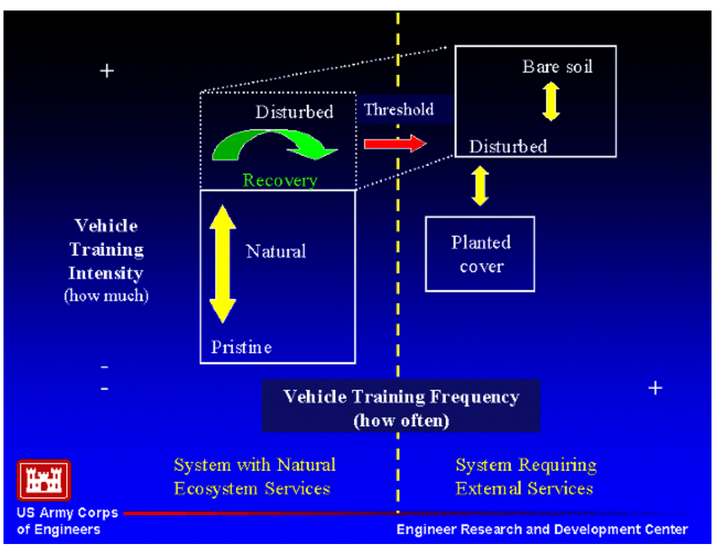
+
Bare soil
Disturbed
Threshold
Disturbed
Recovery
Vehicle Training Intensity (how much)
Natural
Pristine
Planted cover
-
-
+
Vehicle Training Frequency (how often)
System with Natural Ecosystem Services
System Requiring External Services
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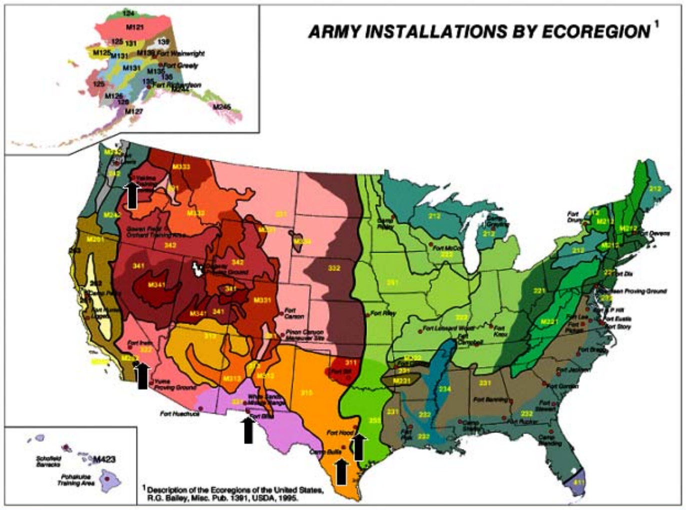

Outline

- ***Problem Statement*** –
- ***Background*** -
- ***Context*** -
- ***Project Team*** - who are the performers
- ***Technical Approach*** –
- ***Results to date*** -
- ***Outcomes*** -

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Project Team

- **ERDC - David Price, Patrick Guertin, Dick Gebhart, Jeffrey Fehmi, William Severinghaus, William Goran**
- **Contractor - Terry McLendon, Michael Childress, Cade Coldren, Michael Meyer**
- **MCAGCC - Rhys Evans, Val Prehoda, Roy Madden, Kip Otis-Diehl, Chris White, Rob Palmer, Dawn Lawson**

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Outline

- ***Problem Statement*** –
- ***Background*** -
- ***Context*** -
- ***Project Team*** -
- ***Technical Approach*** - what is the technical approach
- ***Results to date*** -
- ***Outcomes*** -

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Technical Approach

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Putting a model together

- Identify plant and animal communities through analyzing monitoring data
- Get soil, climate, and elevation data
- Develop an exhaustive bibliography of everything published about the plants, animals, soils and climate
- Divide the landscape into smaller units and build list of characteristics for each unit
- Begin to put together model using best available data for knowledge gaps

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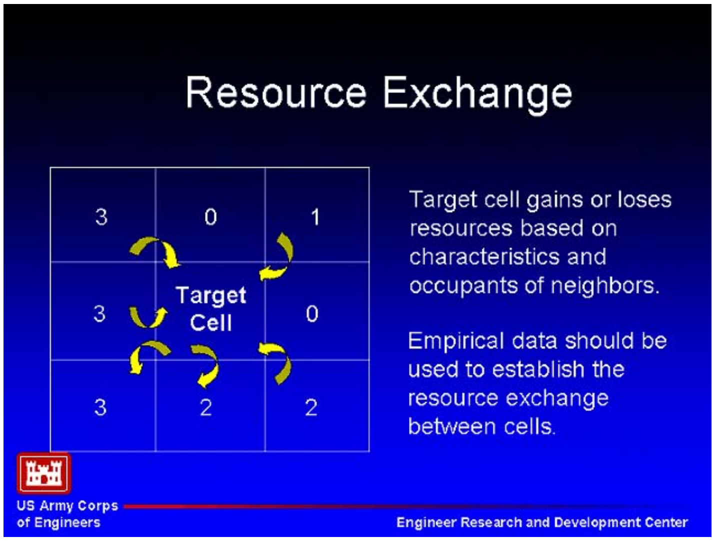
Resource Exchange
3
0
1
3
Target Cell
0
3
2
2
Target cell gains or loses resources based on characteristics and occupants of neighbors.
Empirical data should be used to establish the resource exchange between cells.
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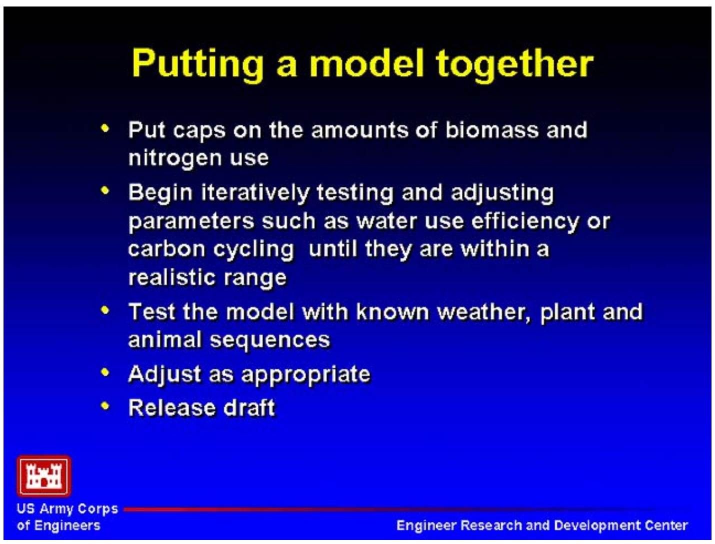
Engineer Research and Development Center


Putting a model together
• Put caps on the amounts of biomass and nitrogen use
• Begin iteratively testing and adjusting parameters such as water use efficiency or carbon cycling until they are within a realistic range
• Test the model with known weather, plant and animal sequences
• Adjust as appropriate
• Release draft
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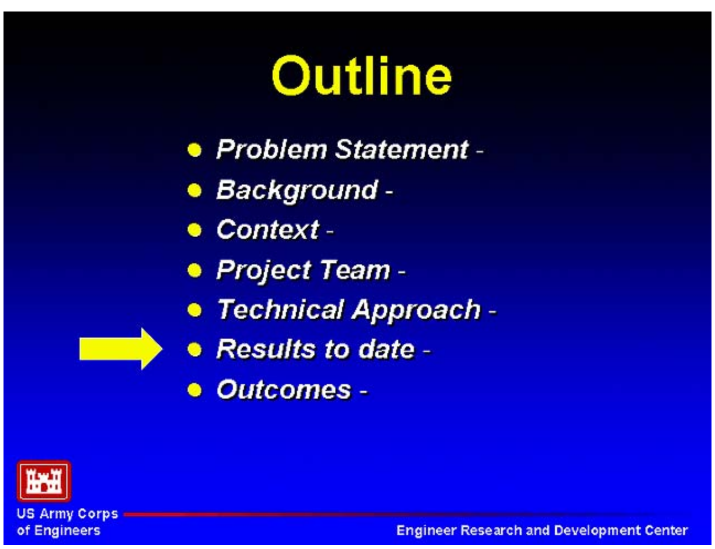
Outline
• Problem Statement -
• Background -
• Context -
• Project Team -
• Technical Approach -
• Results to date -
• Outcomes -
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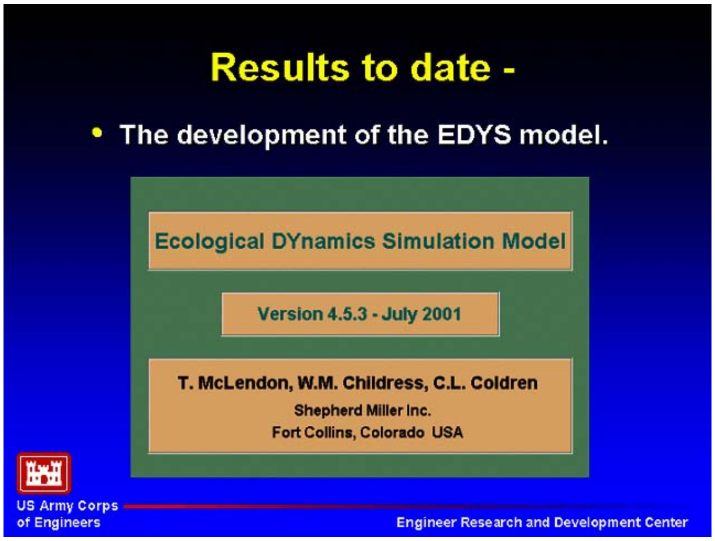
Results to date -
• The development of the EDYS model.
Ecological DYnamics Simulation Model
Version 4.5.3 - July 2001
T. McLendon, W.M. Childress, C.L. Coldren
Shepherd Miller Inc.
Fort Collins, Colorado USA
US Army Corps of Engineers
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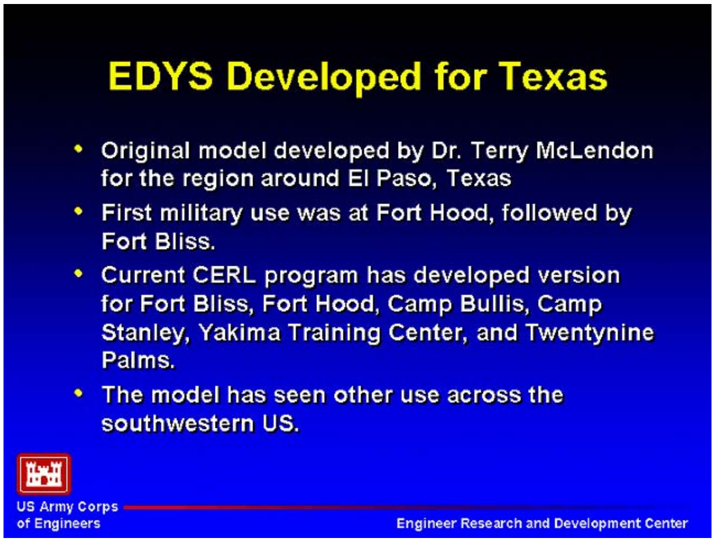
EDYS Developed for Texas
• Original model developed by Dr. Terry McLendon for the region around El Paso, Texas
• First military use was at Fort Hood, followed by Fort Bliss.
• Current CERL program has developed version for Fort Bliss, Fort Hood, Camp Bullis, Camp Stanley, Yakima Training Center, and Twentynine Palms.
• The model has seen other use across the southwestern US.
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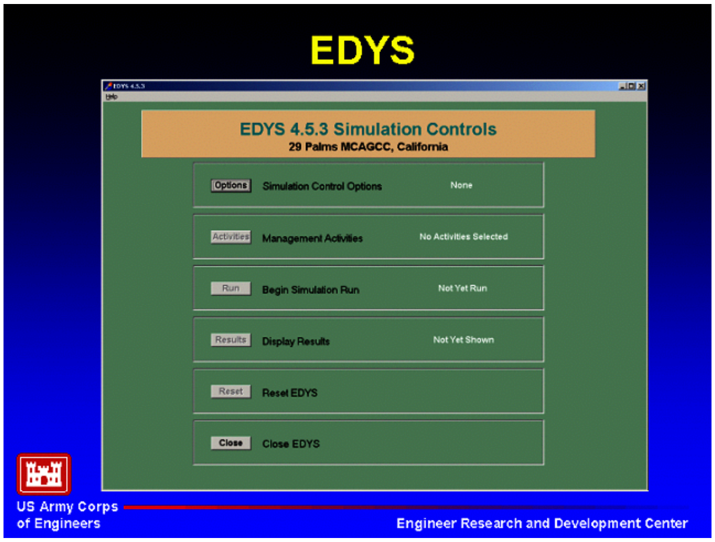
EDYS
EDYS 4.5.3 Simulation Controls
29 Palms MCAGCC, California
Options
Simulation Control Options
None
Activities
Management Activities
No Activities Selected
Run
Begin Simulation Run
Not Yet Run
Results
Display Results
Not Yet Shown
Reset
Reset EDYS
Close
Close EDYS
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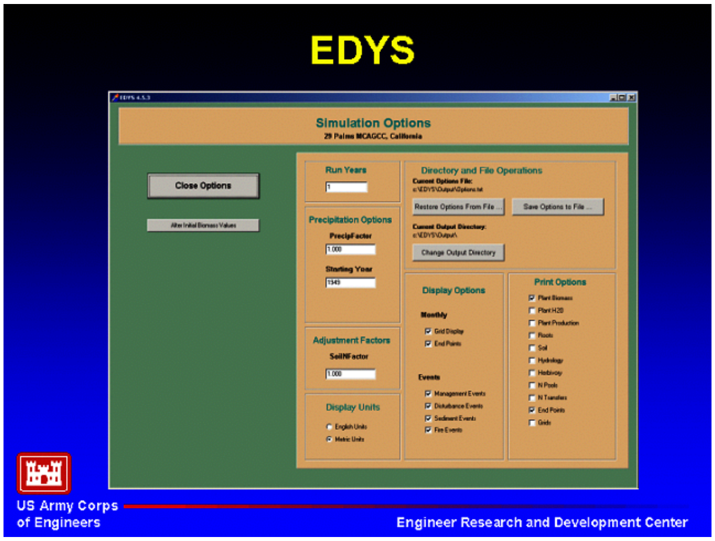
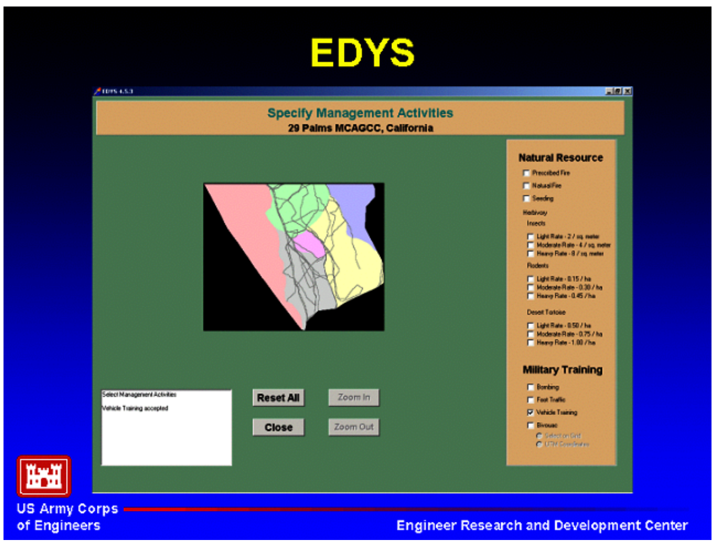
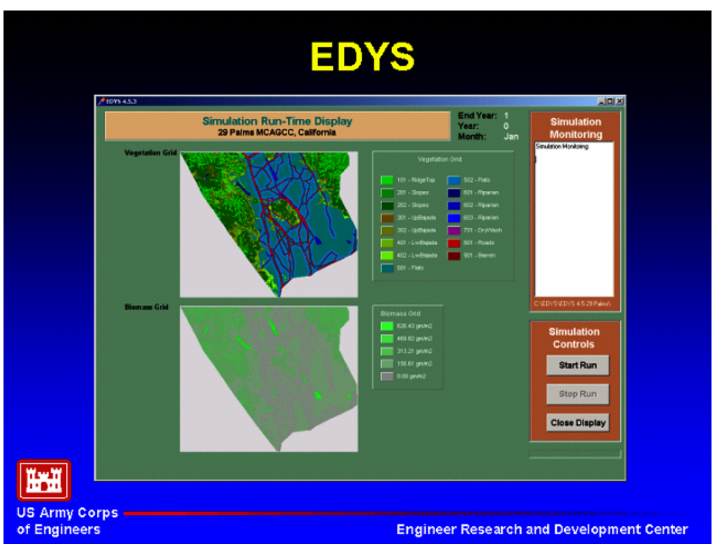

EDYS
Simulation Options
29 Palms MCAGCC, California
Close Options
Run Years
Directory and File Operations
Precipitation Options
PrecipFactor
Starting Year
Display Options
Print Options
Adjustment Factors
SoilNFactor
Display Units
US Army Corps
of Engineers
Engineer Research and Development Center


EDYS
Specify Management Activities
29 Palms MCAGCC, California
Natural Resource
Military Training
Reset All
Zoom In
Close
Zoom Out
US Army Corps
of Engineers
Engineer Research and Development Center


EDYS
Simulation Run-Time Display
29 Palms MCAGCC, California
End Year:
Year:
Month:
Jan
Simulation Monitoring
Simulation Controls
Start Run
Stop Run
Close Display
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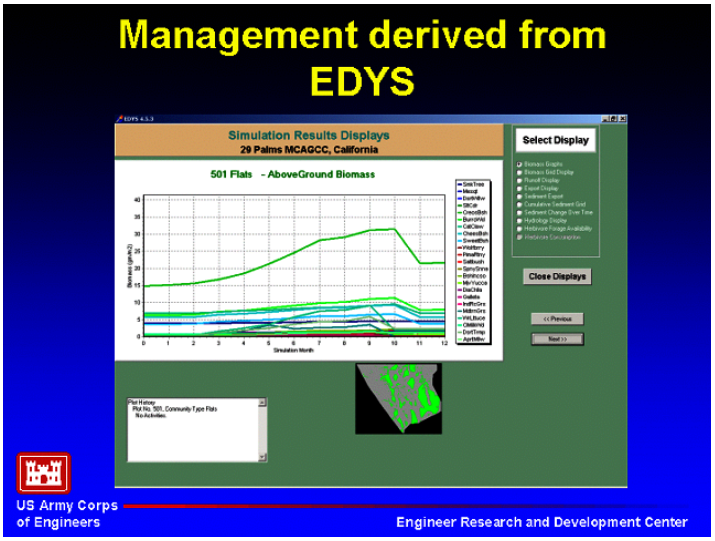
of Engineers
Engineer Research and Development Center


Management derived from EDYS
Simulation Results Displays
29 Palms MCAGCC, California
501 Flats - AboveGround Biomass
Select Display
Close Displays
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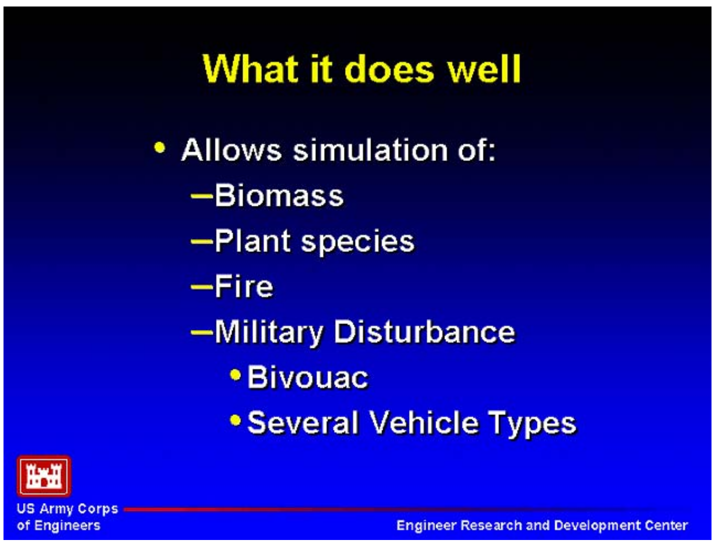
What it does well
• Allows simulation of:
–Biomass
–Plant species
–Fire
–Military Disturbance
• Bivouac
• Several Vehicle Types
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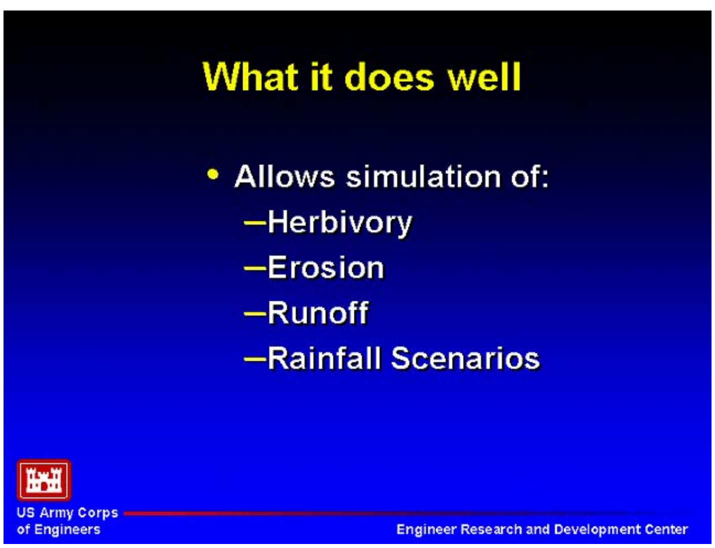
What it does well
• Allows simulation of:
–Herbivory
–Erosion
–Runoff
–Rainfall Scenarios
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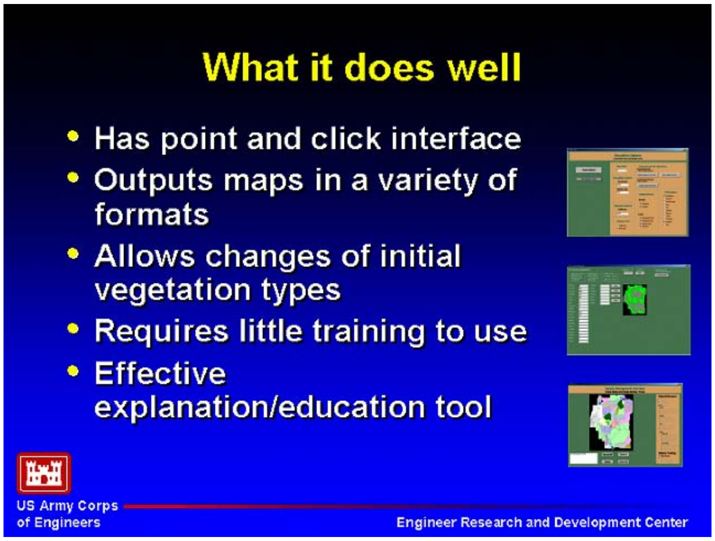
What it does well
Has point and click interface
Outputs maps in a variety of formats
Allows changes of initial vegetation types
Requires little training to use
Effective explanation/education tool
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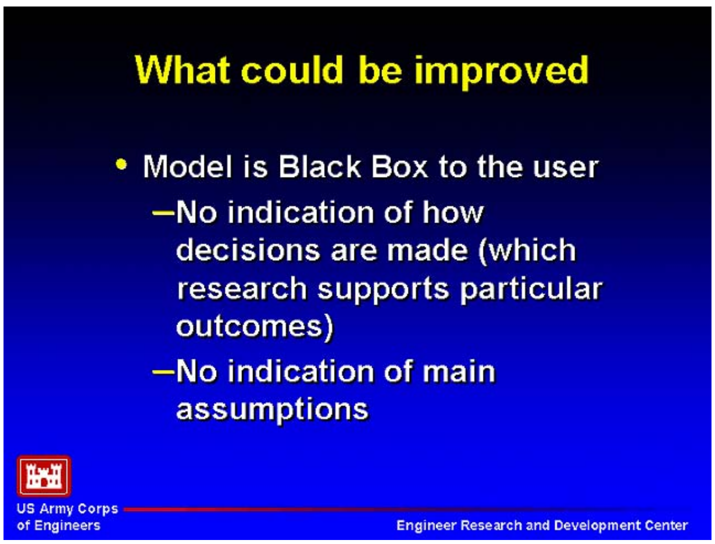
What could be improved
Model is Black Box to the user
–No indication of how decisions are made (which research supports particular outcomes)
–No indication of main assumptions
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What could be improved
Program crashes
Program runs slowly
Validation results are inconclusive
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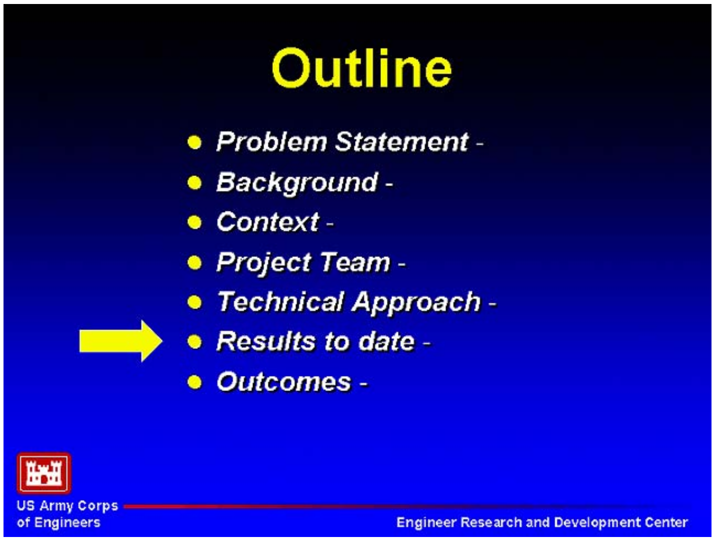
Outline
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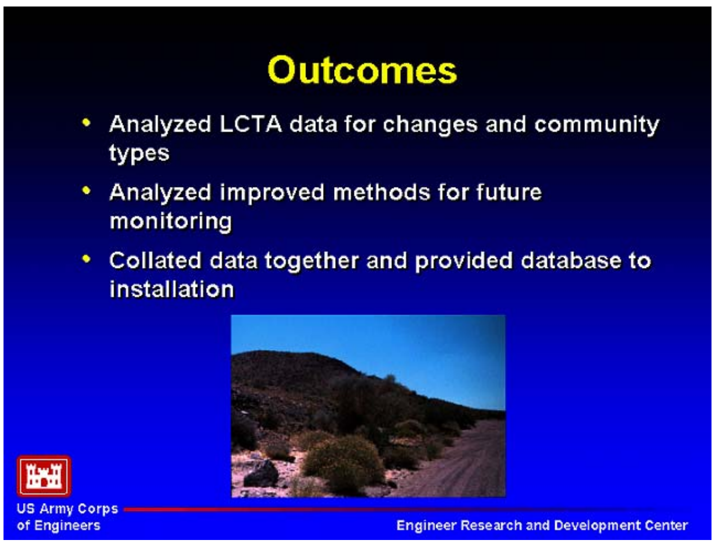
Outcomes
Analyzed LCTA data for changes and community types
Analyzed improved methods for future monitoring
Collated data together and provided database to installation
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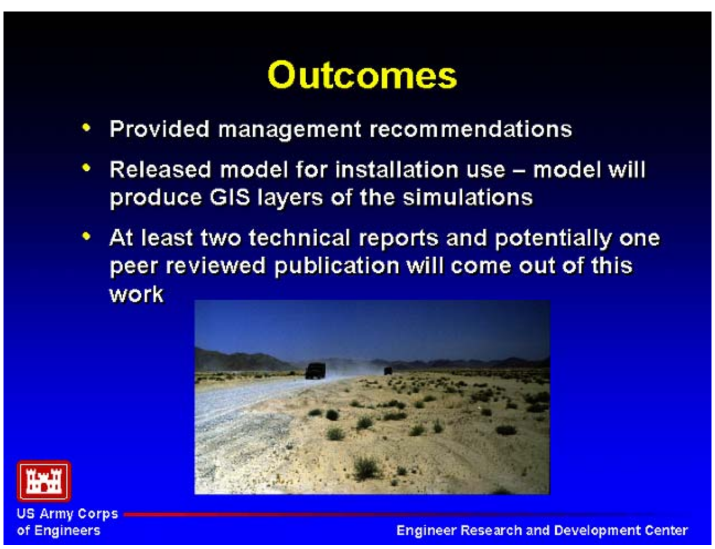
Outcomes
Provided management recommendations
Released model for installation use – model will produce GIS layers of the simulations
At least two technical reports and potentially one peer reviewed publication will come out of this work
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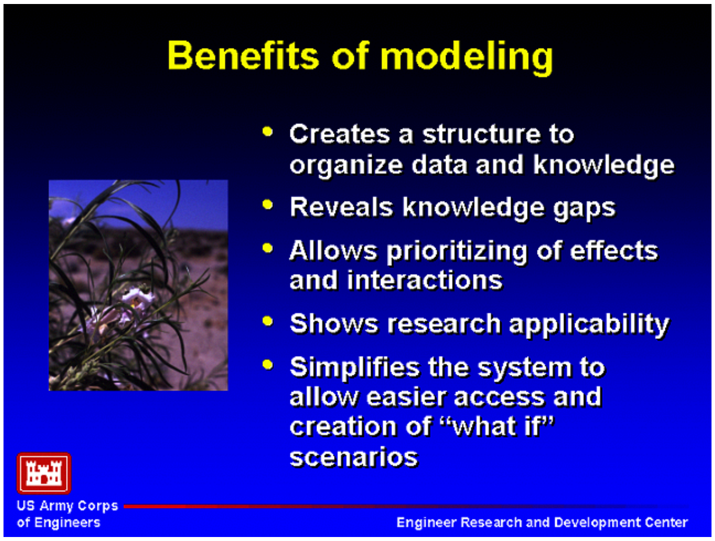
Benefits of modeling
Creates a structure to organize data and knowledge
Reveals knowledge gaps
Allows prioritizing of effects and interactions
Shows research applicability
Simplifies the system to allow easier access and creation of "what if" scenarios
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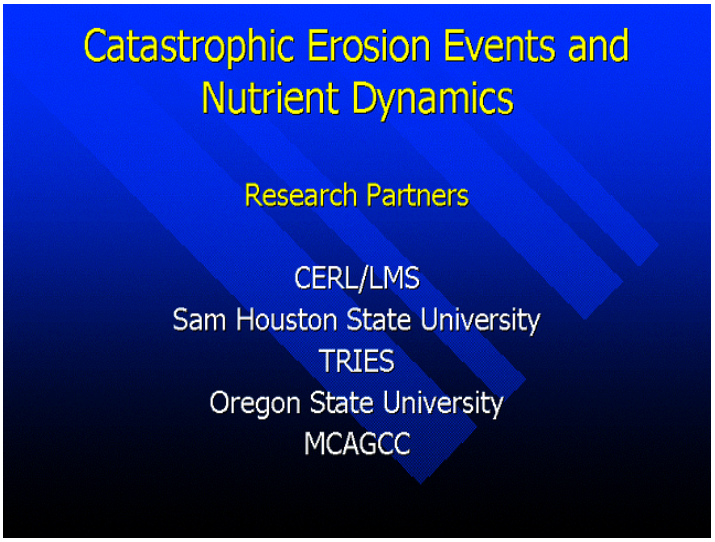
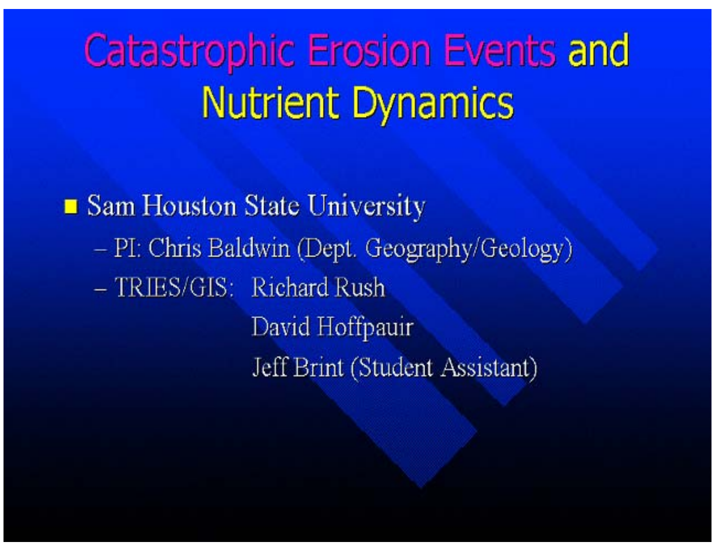
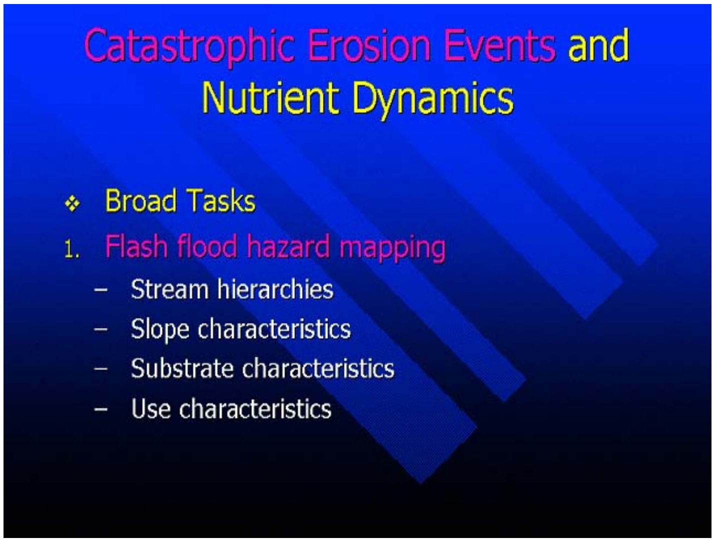
Fax: 217-373-7266
jeffrey.s.fehmi@erdc.usace.army.mil
US Army Corps of Engineers
Engineer Research and Development Center

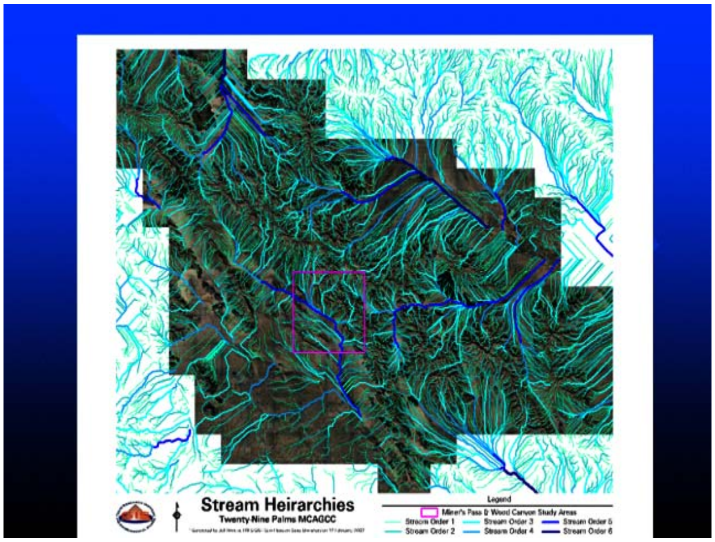
PRESENTATION: Catastrophic Erosion Events and Nutrient Dynamics.

PRESENTER: Dr. Chris Baldwin.



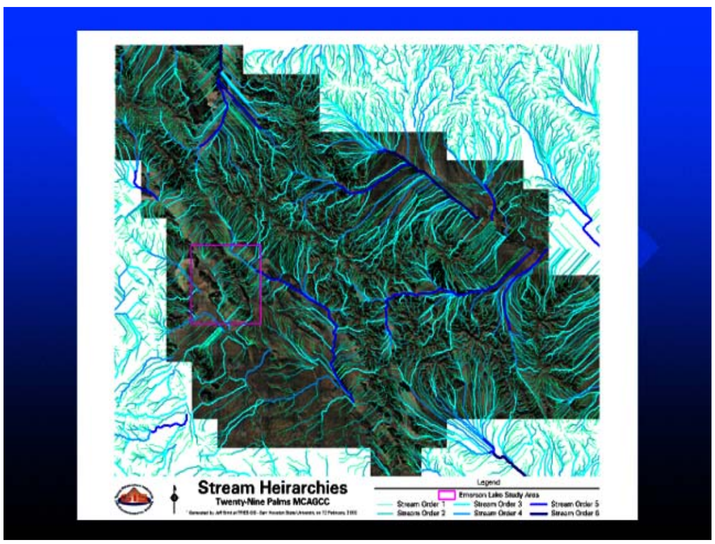



Catastrophic Erosion Events and Nutrient Dynamics
Broad Tasks
1. Flash flood hazard mapping
– Stream hierarchies
– Slope characteristics
– Substrate characteristics
– Use characteristics


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Miner's Pass & Wood Canyon Study Areas
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Miner's Pass & Wood Canyon Study Areas
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Miners Pass Study Area - 3D Virtual GIS View
Twenty-Nine Palms MCAGCC
(30m - Digital Elevation Model overlayed with 5m Aerial Photography)
Stream Heirarchies Overlay
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Emerson Lake Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Emerson Lake Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6

Catastrophic Erosion Events and Nutrient Dynamics

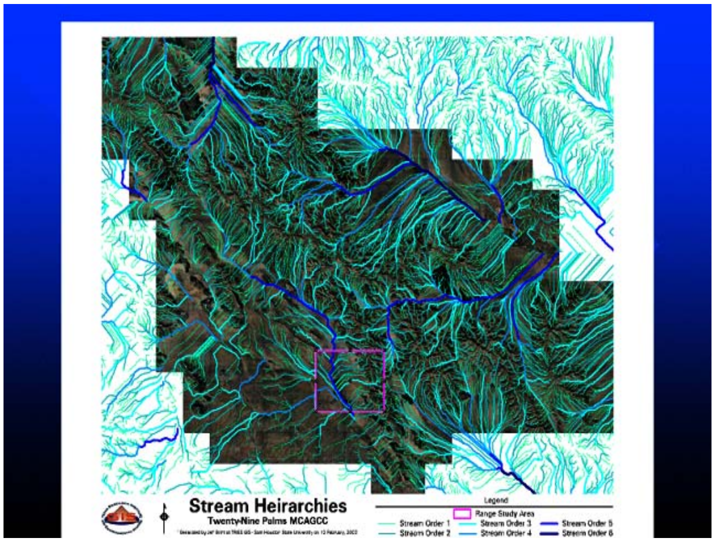
- **Broad Tasks**

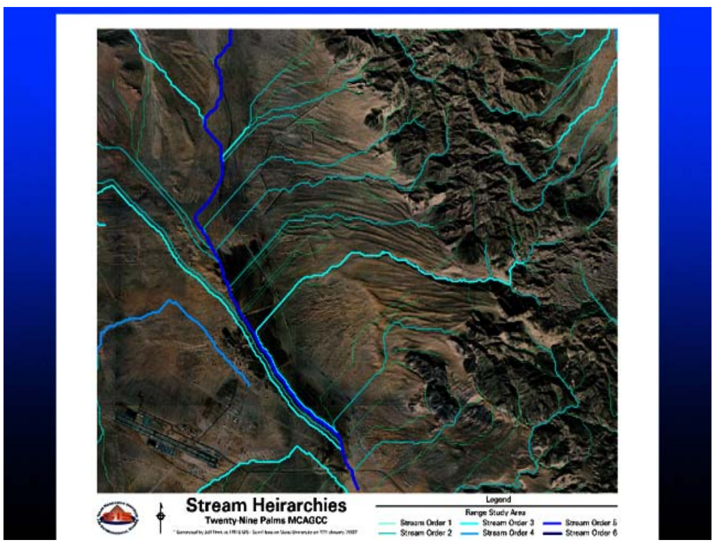
1. Flash Flood Hazard Mapping
2. Sediment Sources and Sinks
   - Ambient circulation
     - regional + playas
   - Base circulation
     - natural + anthropogenic
   - Closed loop fan circulation

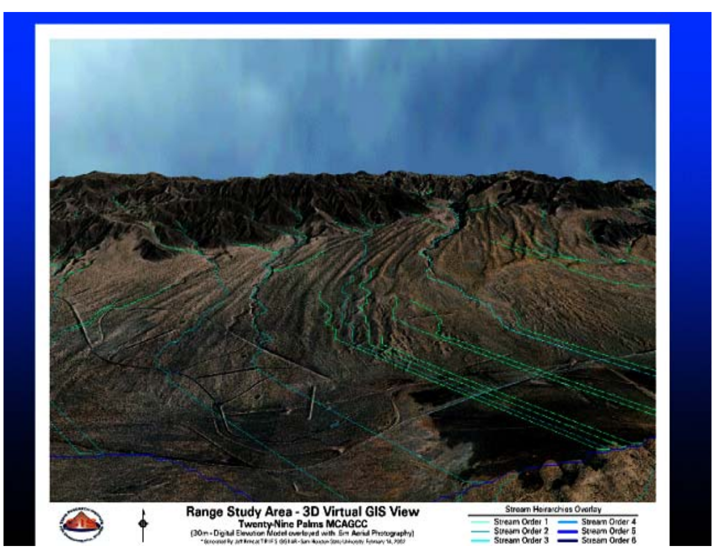
Catastrophic Erosion Events and Nutrient Dynamics

- Broad Tasks

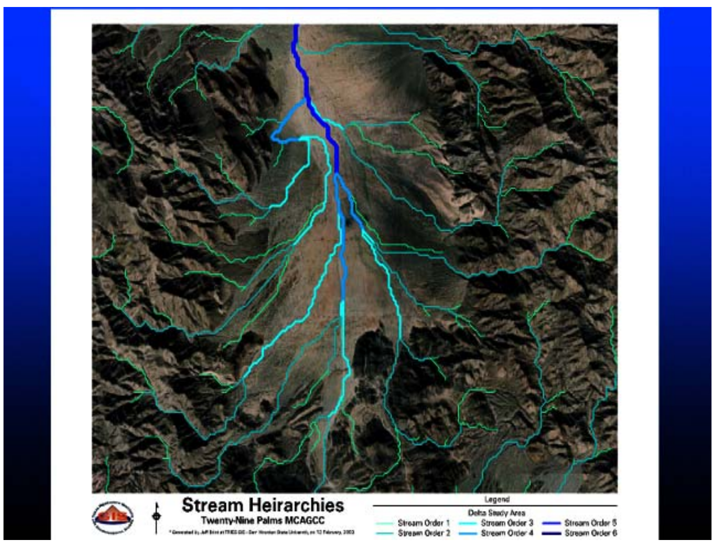
1. Flash Flood Hazard Mapping
2. Sediment Sources and Sinks
   - Bajada sand ramps
   - High elevation conduits and leakage
   - Secondary ramps
   - Changed fan drainage characteristic
   - Resources and Hazards

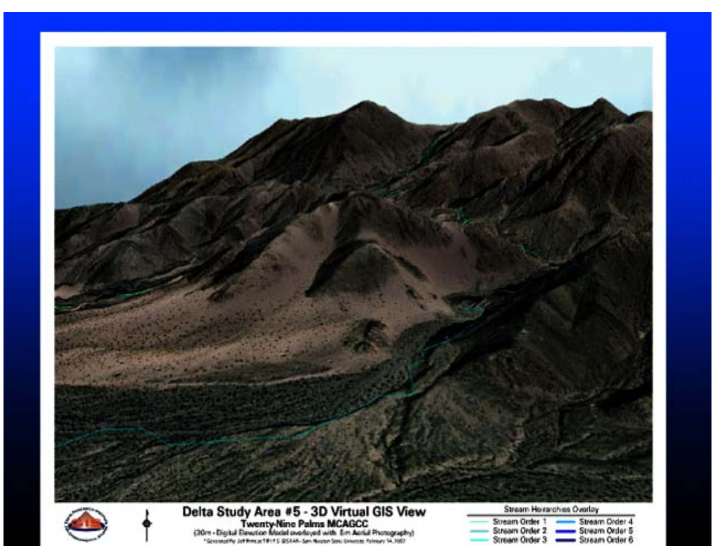

Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Range Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Range Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6

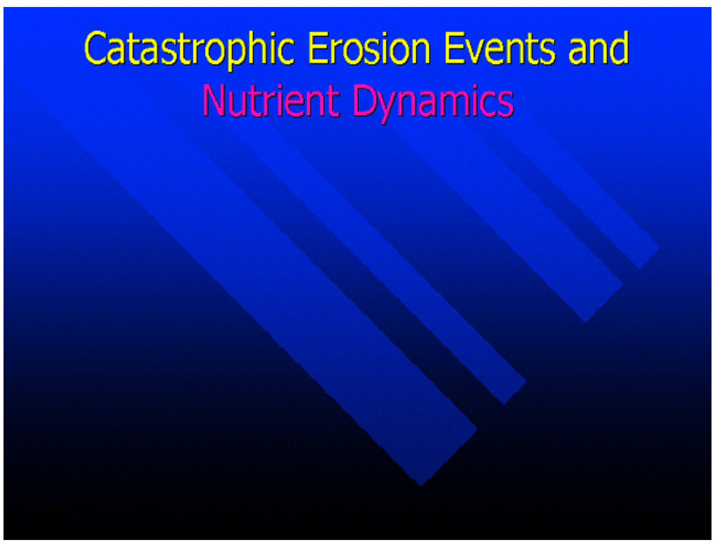

Range Study Area - 3D Virtual GIS View
Twenty-Nine Palms MCAGCC
(30m - Digital Elevation Model overlayed with .5m Aerial Photography)
Stream Heirarchies Overlay
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6

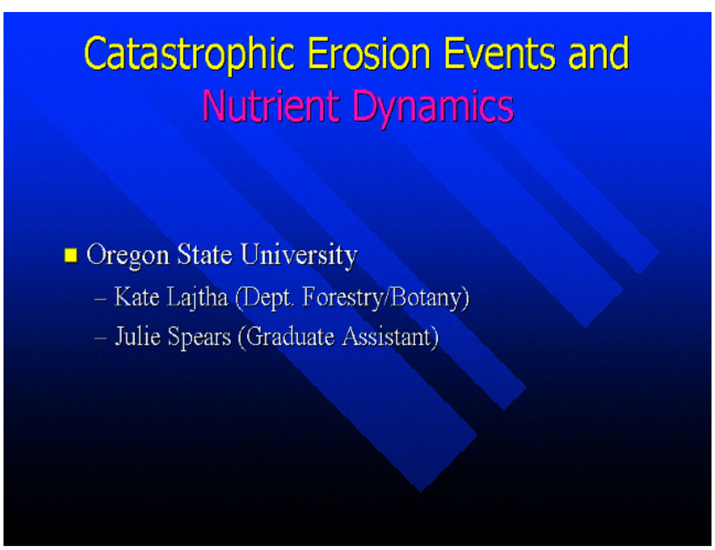

Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Delta Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Stream Heirarchies
Twenty-Nine Palms MCAGCC
Legend
Delta Study Area
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6


Delta Study Area #5 - 3D Virtual GIS View
Twenty-Nine Palms MCAGCC
Stream Heirarchies Overlay
Stream Order 1
Stream Order 2
Stream Order 3
Stream Order 4
Stream Order 5
Stream Order 6

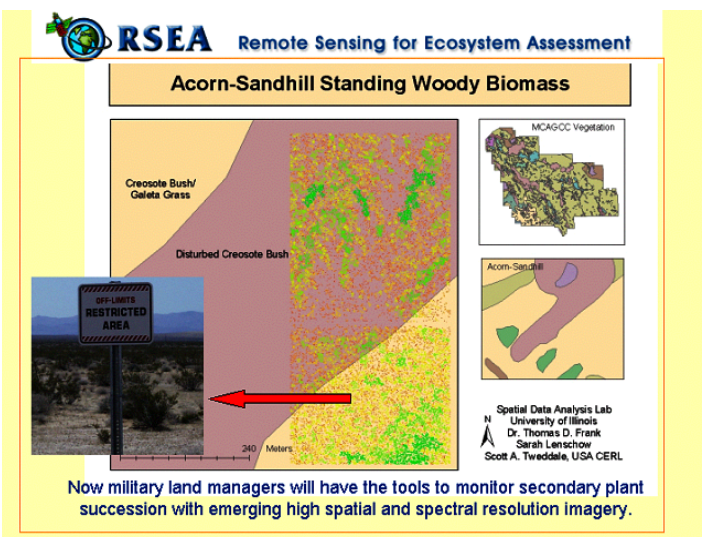

Catastrophic Erosion Events and
Nutrient Dynamics
Broad Tasks
1. Flash Flood Hazard Mapping
2. Sediment Sources and Sinks
3. MIS inputs to military use of desert systems
4. Nutrient Dynamics


Catastrophic Erosion Events and
Nutrient Dynamics


Catastrophic Erosion Events and
Nutrient Dynamics
Oregon State University
– Kate Lajtha (Dept. Forestry/Botany)
– Julie Spears (Graduate Assistant)

PRESENTATION: Change Detection / Remote Sensing at MCAGCC.

PRESENTER: Dr. Tom Frank & Mr. Scott Tweddale.



RSEA Remote Sensing for Ecosystem Assessment

Research Objectives

Image Cover Measurements to Field Transect Cover:

What spatial resolution agrees most closely with field observations?

Image Biophysical Variables to Field Transect Cover:

Is it possible to predict cover directly from image variables such as NDVI, albedo, and texture directly without performing image classification and recoding to cover?

Scaling up cover from High Resolution to Landscape Scales:

How can detailed observations be sampled and then extrapolated over larger geographic extents (up-scaling)?

Extrapolating standing biomass estimates across the landscape:

What is the effect of using shrub area from multiple resolutions to predict standing woody biomass across the landscape. (Based on 2001 IPR discussion about wind erosion and succesional modeling.)

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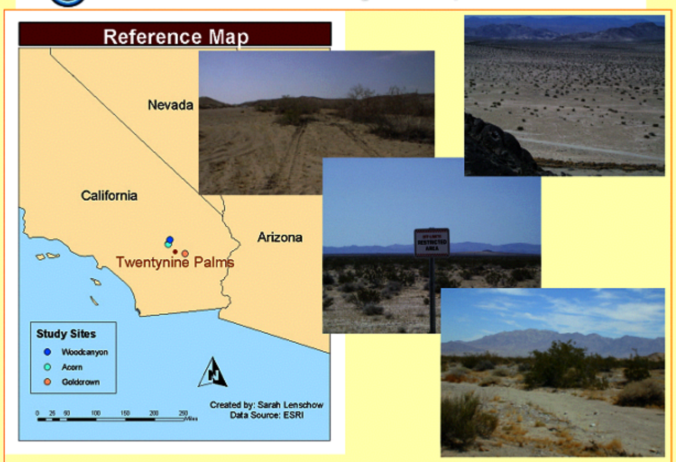
Reference Map



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Mapping Vegetation Cover

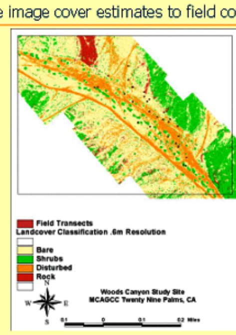
Step1

- Aquire nested spatial resolution imagery
- Georeference frames and mosaic imagery

Step 2

- Unsupervised training and maximum likelihood classification
- Recode classes to cover categories
- Compare image cover estimates to field cover

- 0.2m Kodak
- 0.6m Camis
- 1.0m Camis
- 2.0 m Camis
- 1m IKONOS
- 4m IKONOS



5

RSEA Remote Sensing for Ecosystem Assessment

Fixed radius plots, 2.5m radius, were selected as the means to measure total cover in the field.

- Random selection of sites within a study site
- Real-time differential correction of GPS point at center of study plot
- 10cm colored bands on a 2.5 meter scale rotated about center point
- size of each plant in the plot measured
- area of each plant calculated
- total cover of each plot measured as percent
- number of different plant species listed

For grass plots, 5 random azimuths centered on fixed radius plots were measured to acquire grass coverage

RSEA Remote Sensing for Ecosystem Assessment

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Cover estimates were derived from each of the nested spatial resolutions for each of the fixed radius transects

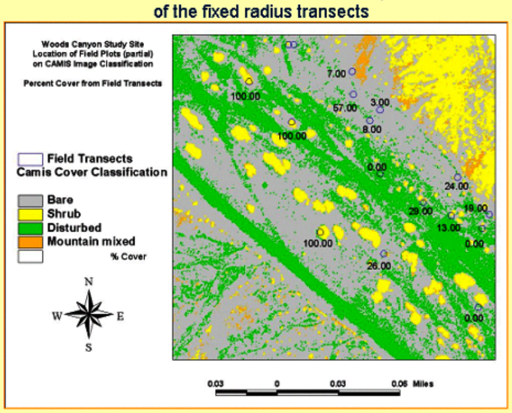

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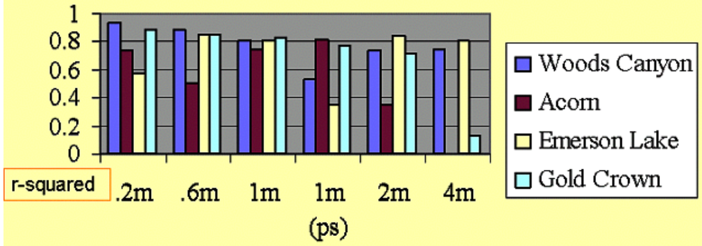
Image Cover Measurements Were Regressed Against Fixed Radius Transects to Determine Best Spatial Resolution to Map Arid Lands Vegetation Density



The correlation between image cover measurements and field cover measurements vary slightly from site to site along the environmental disturbance gradient, but overall, it appears that 1.0m spatial resolution provides most consistent relationship at all sites.

Testing of Significant Difference Between Area Measurements from Nested Spatial Resolutions

A multiple regression model was developed to determine if a significant difference existed between area measurements from the nested spatial resolutions.

where $Y_{i,j,k,l}$ is the response variable, ln cover;

Sp_i is the fixed effect of the ith Species;

$RSp_{i,j}$ is the interactive effect of ith Species and jth Resolution;

Si_k is the random effect of kth site, is normally distributed with 0 mean and σ_1^2 variance;

$SpSi_{i,k}$ is the random interaction of site and species, $\sim N(0, \sigma_2^2)$;

$I_{i,k,j}$ is random interaction of ID, Site and Species, $\sim N(0, \sigma_3^2)$;

$E_{i,j,k,l}$ is the random error, $\sim N(0, \sigma^2)$

RSEA Remote Sensing for Ecosystem Assessment

Pair Wise Comparison of Resolutions for *Chilopsis linearis*

Spatial Resolution	Sensor	Spatial Resolution .2m	.6m	1m	1mrg	2m
.2m	Kodak					
.6m	Camis	0.78				
1m	Camis	0.11	0.19			
1mpan	IKONOS	0.00	0.00	0.09		
2m	Camis	0.00	0.00	.0001	.0001	
4m	IKONOS	0.00	0.00	.0001	.0001	0.80

Significancant when p-value < .05

Note: 1m is not statistically different from other resolutions until 2m and 4m, thus 1m is the best resolution to map vegetation cover in this arid environment.

RSEA Remote Sensing for Ecosystem Assessment

Pair Wise Comparison of Resolutions for *Larrea tridentata*

Spatial Resolution	Sensor	Spatial Resolution .2m	.6m	1m	1mrg	2m
.2m	Kodak					
.6m	Camis	.0001				
1m	Camis	.0001	.73			
1mpan	IKONOS	.0001	.37	.61		
2m	Camis	.0001	.0001	.00	.00	
4m	IKONOS	.0001	.0001	.0001	.0001	0.01

Significancant when p-value< .05.

RSEA Remote Sensing for Ecosystem Assessment

Pair Wise Comparison of Resolutions for *Psorathamnus spinosus*

Spatial Resolution	Sensor	Spatial Resolution .2m	.6m	1m	1mrg	2m
.2m	Kodak					
.6m	Camis	.0001				
1m	Camis	.00	.22			
1mpan	IKONOS	.00	.15	.84		
2m	Camis	.0001	.90	.24	.17	
4m	IKONOS	.0001	.00	.00	.0001	0.01

Significancant when p-value< .05.

RSEA Remote Sensing for Ecosystem Assessment

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Study Site	Resolution	r^2	a_0	a_1	a_2
Wood Canyon					
	Kodak 0.2m	.91	- 24.40	-0.004	2.79
	CAMIS 0.6m	.94	191.00	-1.020	1.66
	CAMIS 1.0m	.92	192.00	-1.050	2.13
	CAMIS 2.0m	.79	112.00	-0.640	4.10
	IKONOS 1.0m	.85	220.00	-0.640	0.93
Sandhill					
	Kodak 0.2m	.78	134.00	-0.390	-0.19
	CAMIS 0.6m	.49	183.00	-0.910	-0.72
	CAMIS 1.0m	.69	215.00	-1.100	-0.21
	CAMIS 2.0m	NA	NA	NA	NA
	IKONOS 1.0m	.29	222.00	-0.260	-0.78
Gold Crown					
	Kodak 0.2m	.72	- 69.60	0.300	1.58
	CAMIS 0.6m	.91	222.00	-1.140	0.45
	CAMIS 1.0m	.74	279.00	-1.440	0.80
	CAMIS 2.0m	.70	453.00	-2.530	-1.34
	IKONOS 1.0m	.80	332.00	-0.540	0.24

Correlation between biophysical variables (albedo and texture) and fixed radius transects indicate that an accurate predicted cover map can be made from these regression equations.

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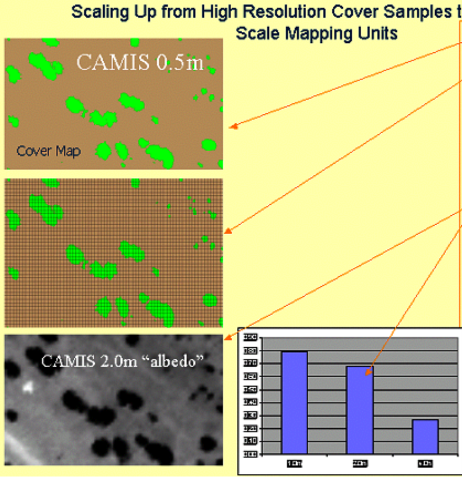
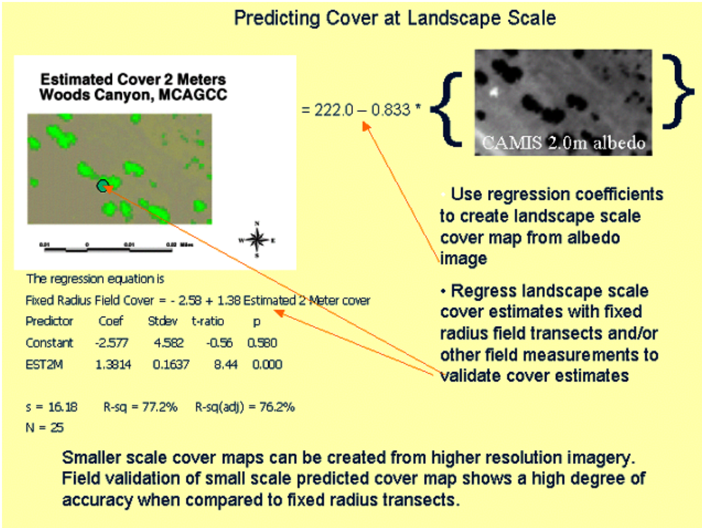
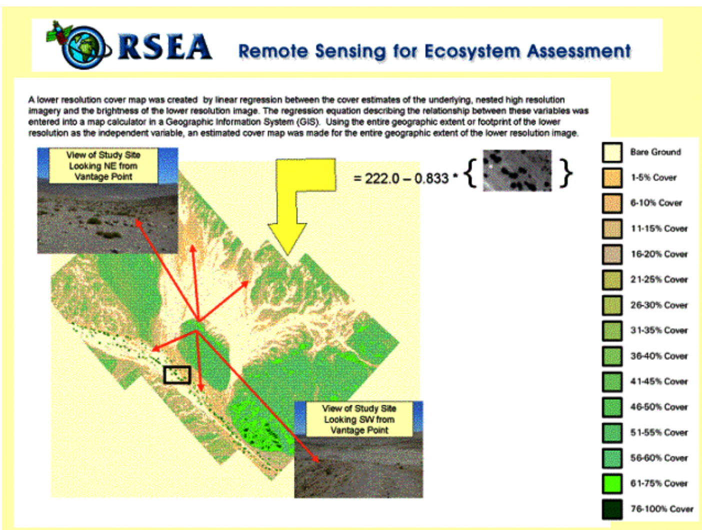
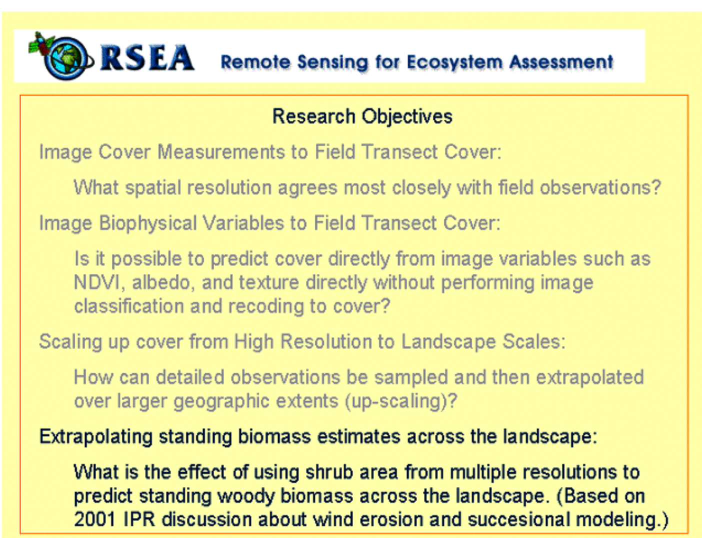
Scaling Up from High Resolution Cover Samples to Landscape Scale Mapping Units



- Cover maps created
- Drop grid of landscape scale resolution on higher resolution cover image to measure cover for a larger pixel size
- Regress this larger pixel size cover to same landscape scale image albedo
- Use regression coefficients to create landscape scale cover map from albedo values
- Validate landscape scale cover estimates with field procedure


Predicting Cover at Landscape Scale
Estimated Cover 2 Meters
Woods Canyon, MCAGCC
= 222.0 – 0.833 *
CAMIS 2.0m albedo
Use regression coefficients to create landscape scale cover map from albedo image
• Regress landscape scale cover estimates with fixed radius field transects and/or other field measurements to validate cover estimates
The regression equation is
Fixed Radius Field Cover = - 2.58 + 1.38 Estimated 2 Meter cover
Predictor Coef Stdev t-ratio p
Constant -2.577 4.582 -0.56 0.580
EST2M 1.3814 0.1637 8.44 0.000
s = 16.18 R-sq = 77.2% R-sq(adj) = 76.2%
N = 25
Smaller scale cover maps can be created from higher resolution imagery. Field validation of small scale predicted cover map shows a high degree of accuracy when compared to fixed radius transects.


RSEA Remote Sensing for Ecosystem Assessment
A lower resolution cover map was created by linear regression between the cover estimates of the underlying, nested high resolution imagery and the brightness of the lower resolution image. The regression equation describing the relationship between these variables was entered into a map calculator in a Geographic Information System (GIS). Using the entire geographic extent or footprint of the lower resolution as the independent variable, an estimated cover map was made for the entire geographic extent of the lower resolution image.
View of Study Site Looking NE from Vantage Point
= 222.0 – 0.833 *
View of Study Site Looking SW from Vantage Point
Bare Ground
1-5% Cover
6-10% Cover
11-15% Cover
16-20% Cover
21-25% Cover
26-30% Cover
31-35% Cover
36-40% Cover
41-45% Cover
46-50% Cover
51-55% Cover
56-60% Cover
61-75% Cover
76-100% Cover


RSEA Remote Sensing for Ecosystem Assessment
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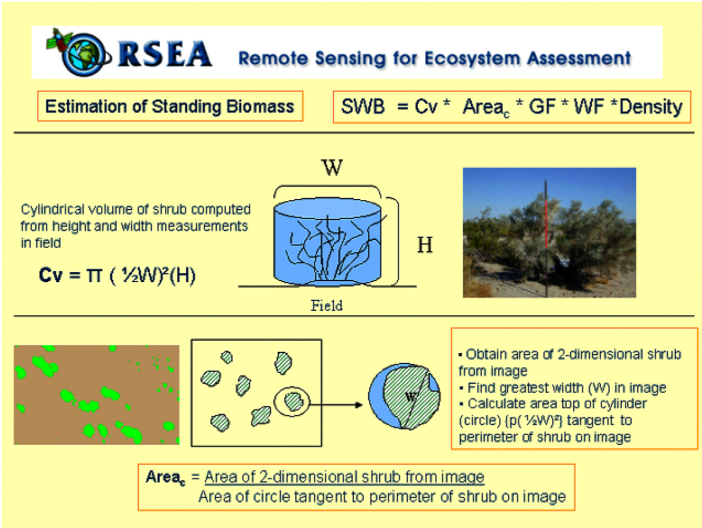
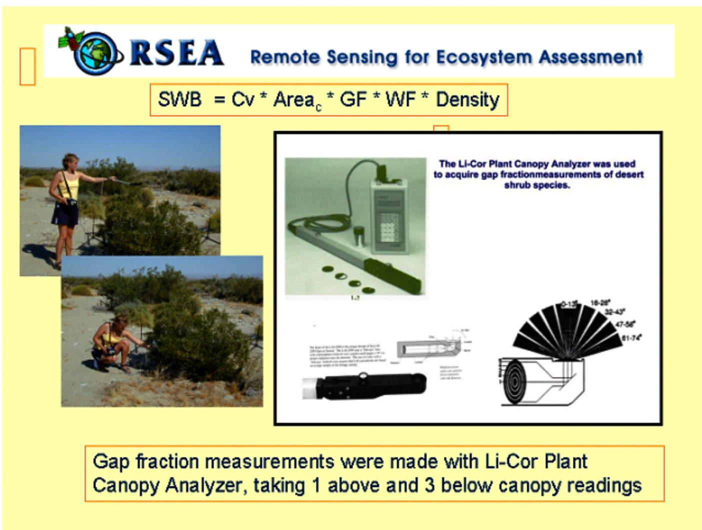
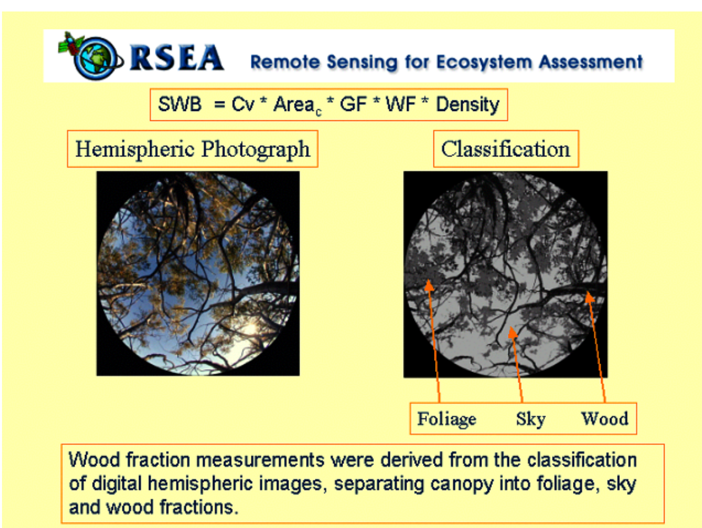

RSEA Remote Sensing for Ecosystem Assessment
Estimation of Standing Biomass
SWB = Cv * Area_c * GF * WF * Density
W
H
Field
Cylindrical volume of shrub computed from height and width measurements in field
Cv = π (½W)²(H)
W
• Obtain area of 2-dimensional shrub from image
• Find greatest width (W) in image
• Calculate area top of cylinder (circle) (p(½W)²) tangent to perimeter of shrub on image
Area_c = Area of 2-dimensional shrub from image / Area of circle tangent to perimeter of shrub on image


RSEA Remote Sensing for Ecosystem Assessment
SWB = Cv * Area_c * GF * WF * Density
The Li-Cor Plant Canopy Analyzer was used to acquire gap fractionmeasurements of desert shrub species.
Gap fraction measurements were made with Li-Cor Plant Canopy Analyzer, taking 1 above and 3 below canopy readings


RSEA Remote Sensing for Ecosystem Assessment
SWB = Cv * Area_c * GF * WF * Density
Hemispheric Photograph
Classification
Foliage
Sky
Wood
Wood fraction measurements were derived from the classification of digital hemispheric images, separating canopy into foliage, sky and wood fractions.

RSEA Remote Sensing for Ecosystem Assessment

SWB = Cv * Area$_c$ GF * WF * Density

Plant densities were derived using specific gravity (g/cm^3) of shrub species, which were then converted to density in kg/m^3

Species	Specific Gravity
Chilopsis linearis	0.59 g/cm^3
Larrea tridentata	1.10 g/cm^3
Psorothamnus spinosa	0.55 g/cm^3

RSEA Remote Sensing for Ecosystem Assessment

Regression Equations and Coefficients for Standing Woody Biomass vs. Imagery Area

Spatial Resolution	Acorn		Gold Crown		Wood Canyon	
	Equation	R^2	Equation	R^2	Equation	R^2
.2m	$SWB = 4.40Cov^{.951}$	.54*	$SWB = 4.05Cov^{1.50}$	.88*	$SWB = 4.87Cov^{.957}$	.62*
.6m	$SWB = 3.65Cov^{1.24}$	.77*	$SWB = 2.06Cov^{1.86}$	.68*	$SWB = 4.91Cov^{1.06}$	.72*
1m	$SWB = 3.13Cov^{1.33}$	0.28	$SWB = 2.99Cov^{1.44}$	.73*	$SWB = 4.05Cov^{1.26}$	.89*
1mpan	$SWB = 1.26Cov^{1.86}$	.56*	$SWB = 3.83Cov^{1.20}$	.85*	$SWB = 5.38Cov^{.89}$	.71*
2m	$SWB = .204Cov^{2.00}$	.90*	$SWB = 3.67Cov^{1.08}$	.38*	$SWB = 5.08Cov^{.848}$	.36*
4m			$SWB = 3.73Cov^{.964}$	.51*	$SWB = 7.86Cov^{.018}$	0

(SWB) represents standing woody biomass. (Cov) represents imagery cover estimates.

* significant correlation ($P<.05$).

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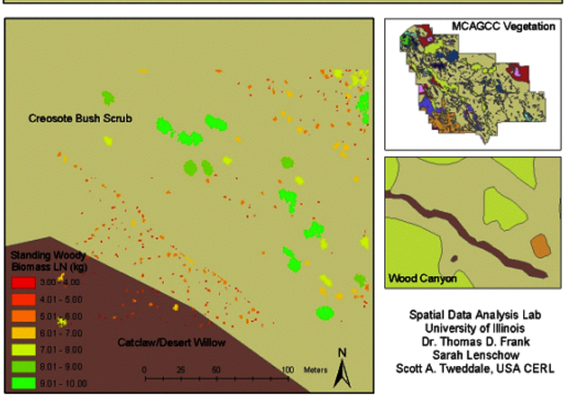
Wood Canyon Standing Woody Biomass



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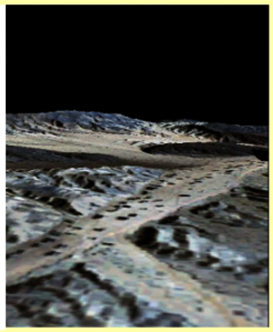
Future effort:

- Apply regression equations to 1 meter DOQ albedo to estimate vegetation cover over larger regions.
- Develop field sampling strategy to validate estimates.



RSEA Remote Sensing for Ecosystem Assessment

Future effort:

- Use Regression Equations and Coefficients for Standing Woody Biomass vs. Shrub Area to Estimate Standing Woody Biomass Using 1m DOQ
- Develop field sampling strategy to validate biomass estimates

Spatial Resolution	Acorn		Gold Crown		Wood Canyon	
	Equation	R^2	Equation	R^2	Equation	R^2
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4m			$SWB = 3.73Cov^{.964}$	.51*	$SWB = 7.86Cov^{.018}$	0

RSEA Remote Sensing for Ecosystem Assessment

Questions?

RSEA Remote Sensing for Ecosystem Assessment

Remote sensing based protocols and tools have been developed to assess and monitor the status and trends of military landscapes in arid and semi-arid environments.

This research has evaluated high spatial and spectral resolution sensors to map species composition, cover, and standing biomass along environmental, disturbance and successional gradients.

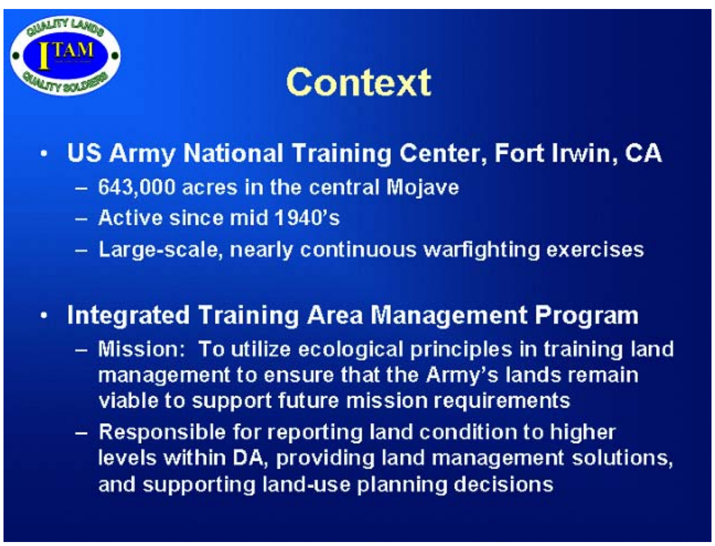
Plant species that are often associated with land degradation have been identified, and procedures for determining changes in plant species and plant communities related to degradation have been developed.

Ecotone boundaries have been examined to test the ability of various scales of imagery to define them in terms of both floristics, total vegetation cover, and soil surface differences.

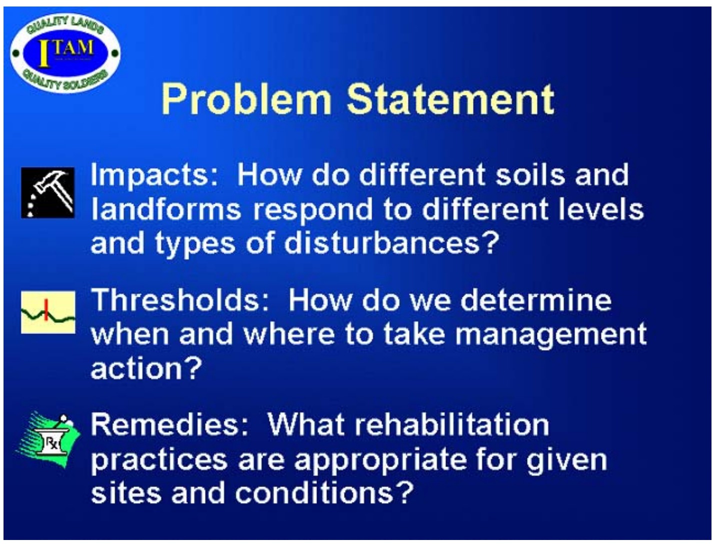
A method to scale up vegetation cover estimates to larger geographic extents has been developed and tested for accuracy.

PRESENTATION: Research Directions at the National Training Center Fort Irwin, CA.

PRESENTER: Ms. Ruth Sparks.




ITAM
QUALITY LANDS
QUALITY SOLDIERS
Background
• Need to integrate monitoring and rehabilitation components
• Need to better understand plant-soil-water relationships
• Need to understand how vulnerability and recoverability vary across the landscape


ITAM
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Problem Statement
Impacts: How do different soils and landforms respond to different levels and types of disturbances?
Thresholds: How do we determine when and where to take management action?
Remedies: What rehabilitation practices are appropriate for given sites and conditions?

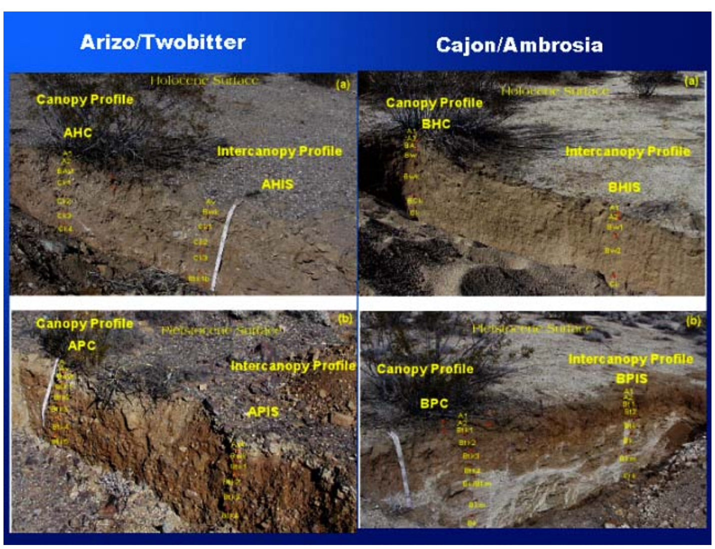

ITAM
QUALITY LANDS
QUALITY SOLDIERS
Current Research (1)
• CHARACTERIZATION OF SOIL DISTURBANCE
• Desert Research Institute (Dr. Eric MacDonald)
• Objectives
– Identify key soil properties for quantifying disturbance
– Quantify the relationship between degree of disturbance and surface age, soil development, and hydrologic processes

Soil Characterization
Approach

- Sampling locations
  - Three soil map units (different lithology)
  - Two surface ages (Pleistocene, Holocene)
  - Three disturbance levels
  - Shrub and inter-shrub space
- Sampling protocol
  - Full profile description for undisturbed site
  - Description of top 30-45 cm for disturbed sites
  - Texture, structure, roots, pores, cutans
- Parameters measured
  - Compaction (bulk density and penetrometer)
  - Infiltration (disc permeatry)
  - Nutrients and chemistry (C, H, N, OM, CaCO3, EC)

Soil Characterization
Progress to date

- Profile descriptions of undisturbed sites for old and young surfaces within two map units are complete
- Description of disturbed locations and third soil map unit is in process
- Measurement of hydrologic and disturbance-related parameters scheduled for Spring FY02



Soil Characterization
Outcomes

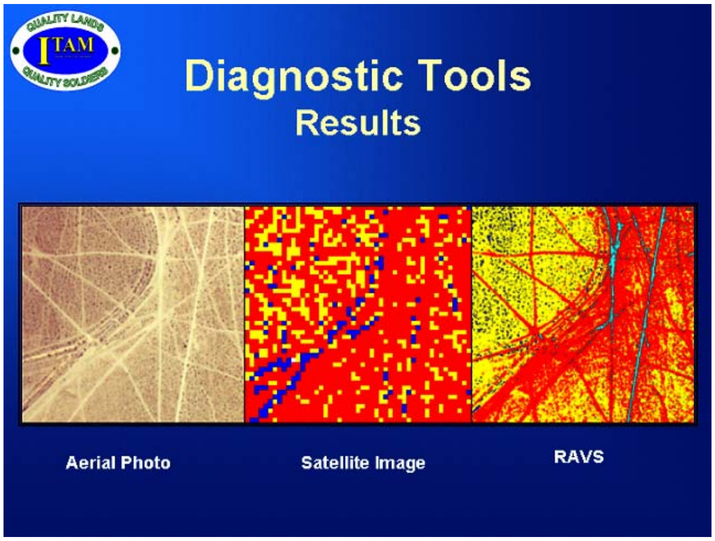
- Products
  - Identification of key soil parameters for quantifying disturbance
  - Disturbance gradient for several soil types and surface ages
- Applications
  - Interpretation of soil measurements from long-term monitoring plots
  - Determining site preparation techniques appropriate to different levels of disturbance on different soils

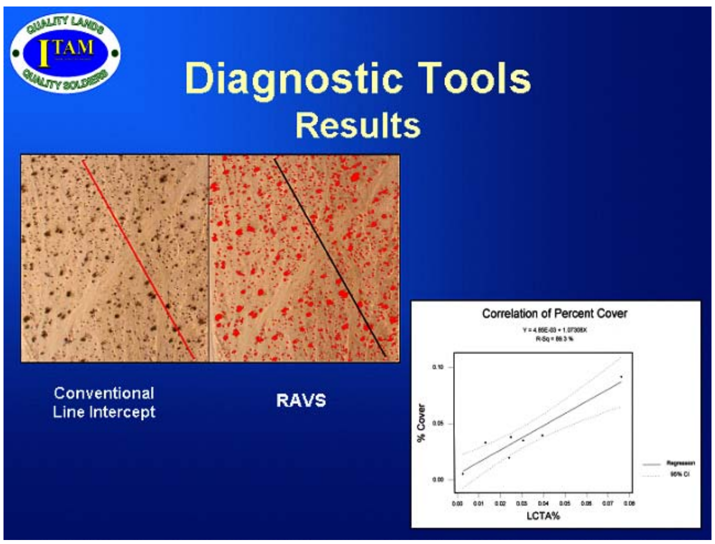
Current Research (2)

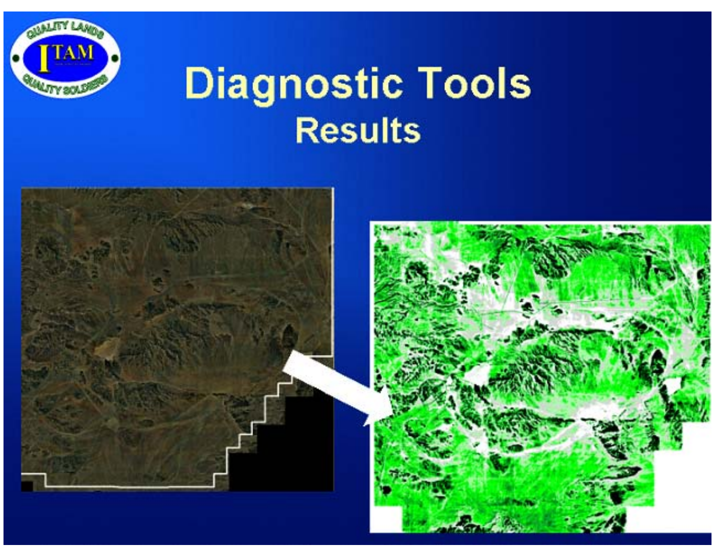
- DEVELOPMENT OF DIAGNOSTIC TOOLS
- SERDP - Bechtel-Nevada (Dr. Dennis Hansen)
- Objectives:
  - Bridge the gap between labor-intensive and costly ground-based vegetation sampling and less expensive but less precise satellite imagery
  - Develop cost effective techniques for measuring vegetation and other objects from digital images

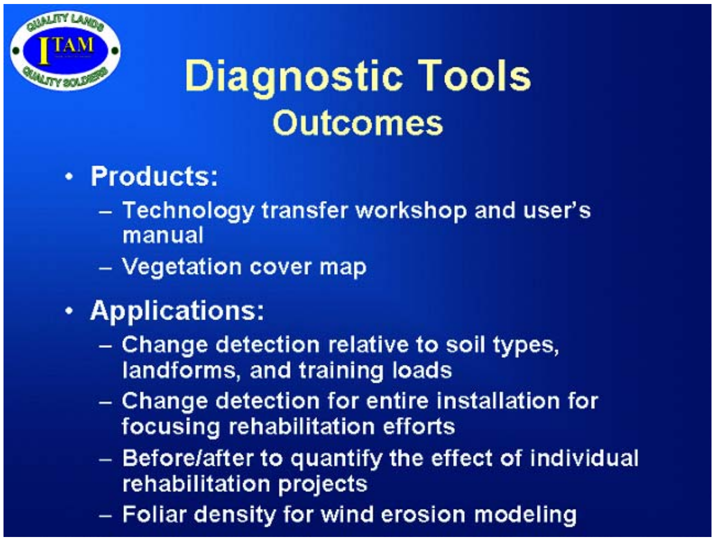
Diagnostic Tools
Approach

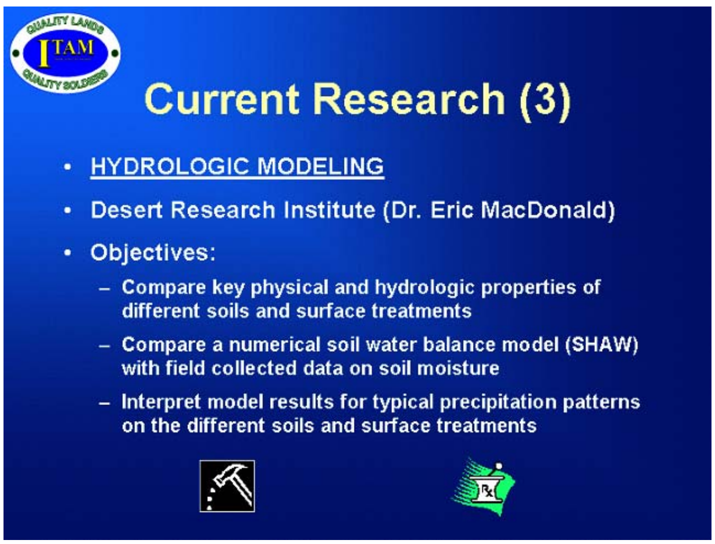
- Image capture
  - Scale
  - Lenses
  - Film type and developing
  - Scanning resolution
- Software application and development
  - Image processing (Rapid Assessment of Vegetation Structures – RAVS)
  - Geo-referencing and raster-to-polygon conversion

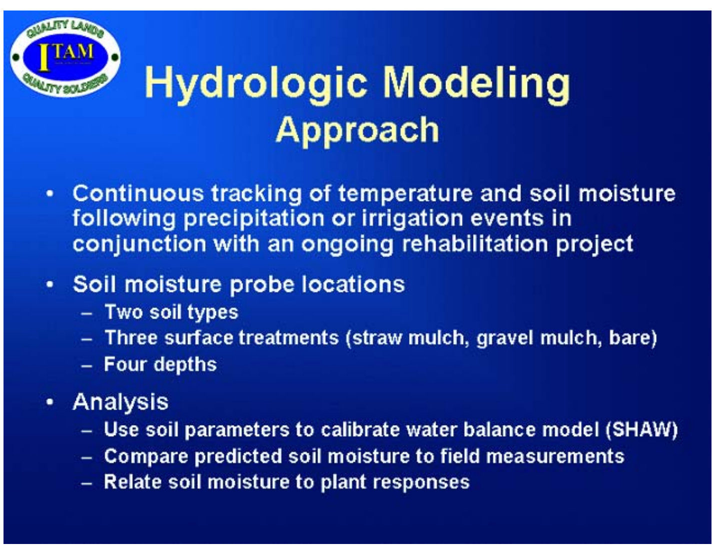

QUALITY LANDS
ITAM
QUALITY SOLDIERS
Diagnostic Tools
Results
Aerial Photo
Satellite Image
RAVS

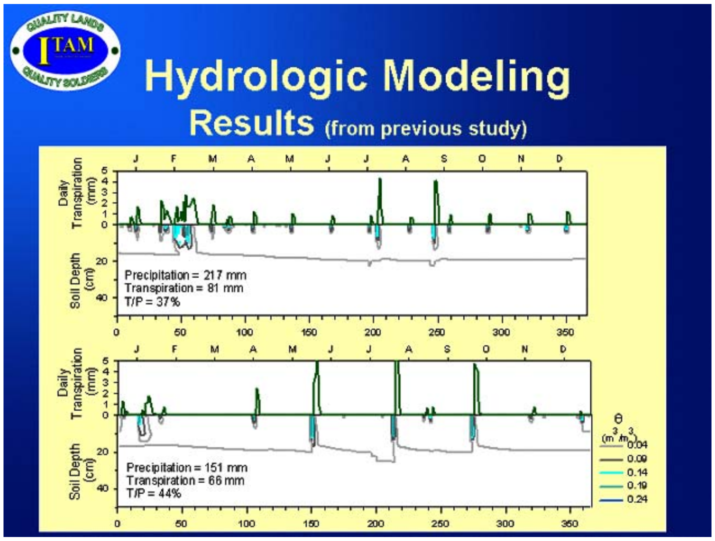

QUALITY LANDS
ITAM
QUALITY SOLDIERS
Diagnostic Tools
Results
Conventional
Line Intercept
RAVS
Correlation of Percent Cover
% Cover
LCTA%

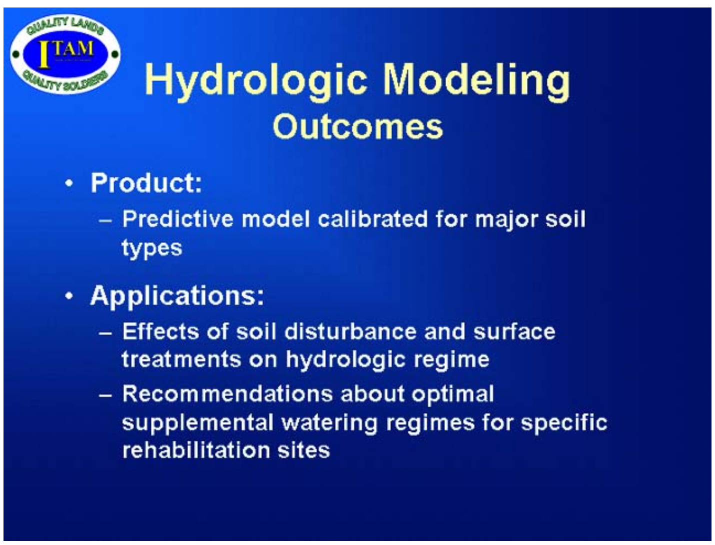

QUALITY LANDS
ITAM
QUALITY SOLDIERS
Diagnostic Tools
Results


Diagnostic Tools
Outcomes
• Products:
– Technology transfer workshop and user's manual
– Vegetation cover map
• Applications:
– Change detection relative to soil types, landforms, and training loads
– Change detection for entire installation for focusing rehabilitation efforts
– Before/after to quantify the effect of individual rehabilitation projects
– Foliar density for wind erosion modeling

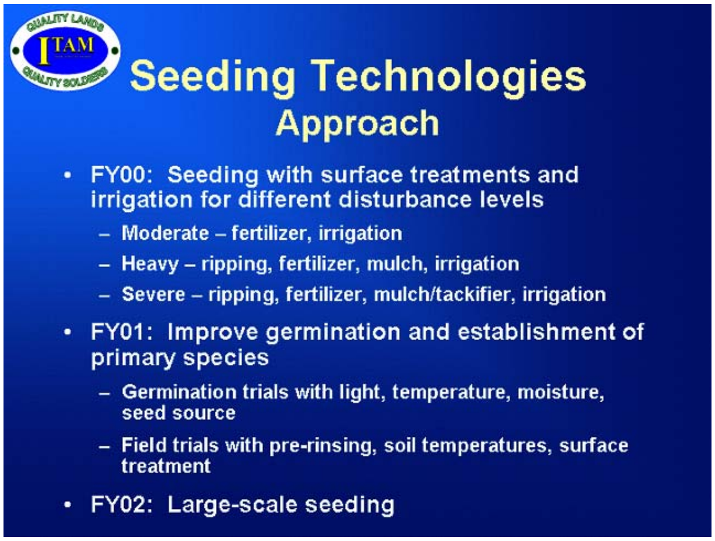

Current Research (3)
• HYDROLOGIC MODELING
• Desert Research Institute (Dr. Eric MacDonald)
• Objectives:
– Compare key physical and hydrologic properties of different soils and surface treatments
– Compare a numerical soil water balance model (SHAW) with field collected data on soil moisture
– Interpret model results for typical precipitation patterns on the different soils and surface treatments

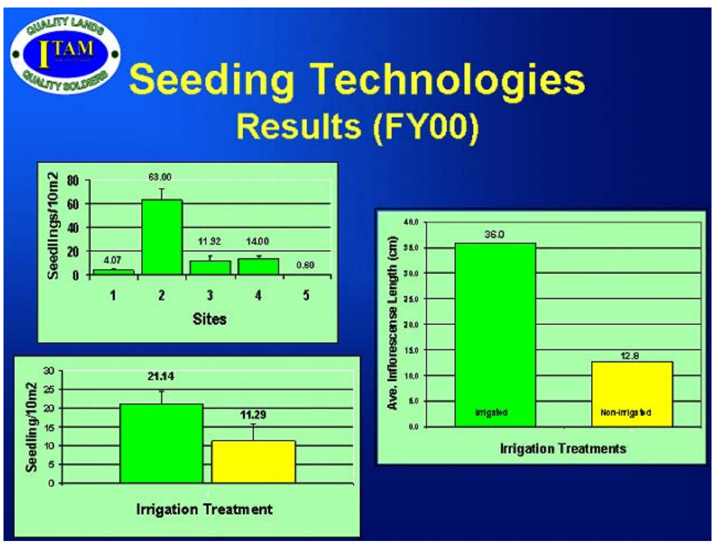

Hydrologic Modeling
Approach
• Continuous tracking of temperature and soil moisture following precipitation or irrigation events in conjunction with an ongoing rehabilitation project
• Soil moisture probe locations
– Two soil types
– Three surface treatments (straw mulch, gravel mulch, bare)
– Four depths
• Analysis
– Use soil parameters to calibrate water balance model (SHAW)
– Compare predicted soil moisture to field measurements
– Relate soil moisture to plant responses

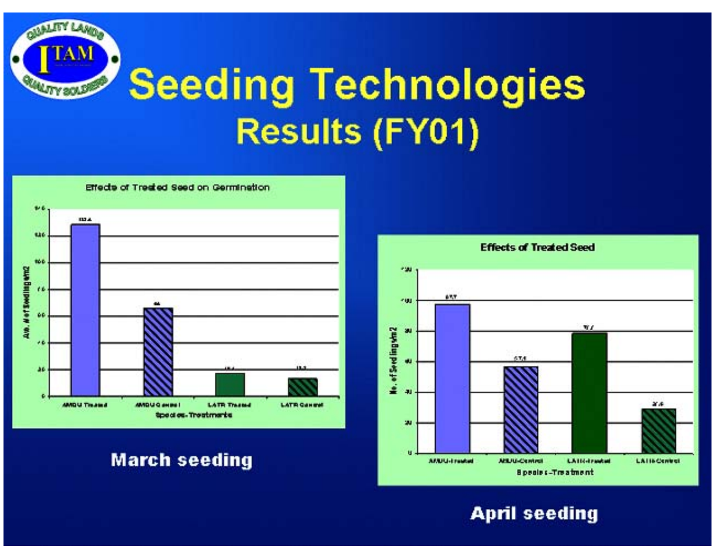

Hydrologic Modeling
Results (from previous study)
Daily Transpiration (mm)
Soil Depth (cm)
Precipitation = 217 mm
Transpiration = 81 mm
T/P = 37%
Precipitation = 151 mm
Transpiration = 66 mm
T/P = 44%
J F M A M J J A S O N D
0 50 100 150 200 250 300 350
0.04
0.09
0.14
0.19
0.24

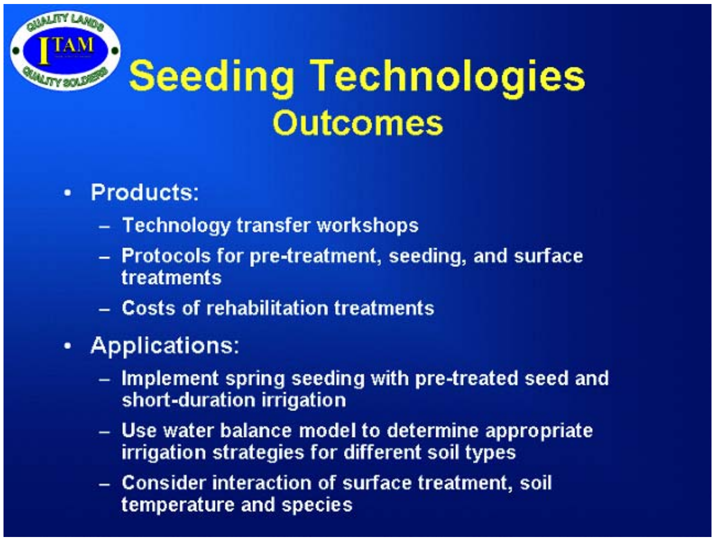

Hydrologic Modeling
Outcomes
• Product:
– Predictive model calibrated for major soil types
• Applications:
– Effects of soil disturbance and surface treatments on hydrologic regime
– Recommendations about optimal supplemental watering regimes for specific rehabilitation sites


Current Research (4)
• SEEDING TECHNOLOGIES
• SERDP - Bechtel-Nevada (Dr. Kent Ostler)
• Objectives:
– Identify appropriate management actions for different levels of disturbance
– Develop and refine seeding techniques, surface treatments, and irrigation strategies for soils and environmental conditions in the Mojave Desert


ITAM
QUALITY LANDS
QUALITY SOLDIERS
Seeding Technologies
Approach
• FY00: Seeding with surface treatments and irrigation for different disturbance levels
– Moderate – fertilizer, irrigation
– Heavy – ripping, fertilizer, mulch, irrigation
– Severe – ripping, fertilizer, mulch/tackifier, irrigation
• FY01: Improve germination and establishment of primary species
– Germination trials with light, temperature, moisture, seed source
– Field trials with pre-rinsing, soil temperatures, surface treatment
• FY02: Large-scale seeding


Seeding Technologies
Results (FY00)
Seedlings/10m2
63.00
4.07
11.32
14.00
0.60
Sites
Seedling/10m2
21.14
11.29
Irrigation Treatment
Ave. Inflorescense Length (cm)
36.0
12.8
Irrigated
Non-irrigated
Irrigation Treatments


Seeding Technologies
Results (FY01)
Effects of Treated Seed on Germination
March seeding
Effects of Treated Seed
April seeding


ITAM
Seeding Technologies
Outcomes
• Products:
– Technology transfer workshops
– Protocols for pre-treatment, seeding, and surface treatments
– Costs of rehabilitation treatments
• Applications:
– Implement spring seeding with pre-treated seed and short-duration irrigation
– Use water balance model to determine appropriate irrigation strategies for different soil types
– Consider interaction of surface treatment, soil temperature and species


Questions

5 Summary of Comments and Responses

During the workshop, each participant was asked to provide comments on specific projects, general direction of MCAGCC military demonstration, future direction and/or prioritization of future projects. This section summarizes the comments provided by the workshop participants. Table 1 lists each comment, who provided the comment, and the LMS response to the comment. Along with the response, the person responsible for addressing the issue is provided.

No.	Commenter	Comment/Question	Response
1	CERL	LUC model – when will it be available and if possible please provide to Jeff Fehmi for fulfillment of one of the original contracts that involved Dave Price (WES).	Answer: Will provide. (MCAGCC); LUC delivered to CERL in April 2002
2	MCAGCC	Scheduling fieldwork has been problematic, please give Rhys Evans a minimum of 10 days notice, any less will be ignored.	Will try to schedule fieldwork within the allotted MCAGCC time frame but due to weather constraints fieldwork scheduling may change on short notice. (CERL)
3	MCAGCC	MCAGCC POM cycle is 2003-2005. Any submissions of current projects, which have been appropriately revised to accommodate Class 1 Compliance perspectives, should be submitted by Jan 2003.	Noted. (CERL)
4	MCAGCC	MCAGCC wants to make sure that LMS projects are Class 1 Compliance driven.	The current projects funded by CERL were chosen by MCAGCC in 1998. With appropriate long term planning, MCAGCC should be able to integrate the end products into their compliance driven programs. (CERL)
5	Skidmore	Would like to put passive dust collectors within the PM monitoring sites at MCAGCC; so would Baldwin.	Request will be addressed by Otis-Diehl. (MCAGCC)
6	Skidmore / Baldwin	Asked for access to MCAGCC weather data.	Request will be addressed by Otis-Diehl. (MCAGCC). Access provided in April 2002.

Appendix A: MCAGCC LMS IPR Letter of Invitation and List of Invitees

CEERD-CN-C (70-1s) 31 December 2001

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: FY02 In-Progress Review (IPR) for Mojave Desert (Twentynine Palms) Land Management System (LMS) Military Field Application Site, 21 February 2002, Palm Springs, California

1. The second IPR for the Mojave Desert Marine Corps Air Ground Combat Center (MCAGCC) LMS Military Field Application Site will be held at the Holiday Inn - Palm Mountain Resort, 155 South Belardo, Palm Springs, CA. This IPR is designed to provide participants with an opportunity to learn about and influence the projects underway or planned for the Mojave Desert region and MCAGCC related to LMS. We will also be discussing how MCAGCC and other interested installations will use the outcomes of these projects.

2. There will be an opportunity during the IPR for MCAGCC and other interested installation personnel to provide feedback on specific projects, relate information on the general direction of the MCAGCC military demo, and input to prioritize future LMS (and related) projects at MCAGCC. Other participating organizations will also have the opportunity to contribute their input.

3. For additional information on LMS, see the enclosed brochure and review the LMS website at http://www.denix.osd.mil/LMS.

4. A block of rooms has been reserved at the Holiday Inn - Palm Mountain Resort, 155 South Belardo. Rooms must be reserved by 21 January 2002 to ensure availability. Rooms are $89.00 plus tax, to make your reservations contact (800) 622-9451 or (760) 325-1301. You must mention that you are taking part in the *Twentynine Palms IPR* meeting to receive this special rate. Further information regarding local restaurants and attractions can be found at http://www.palm-springs.org/ or http://www.palmsprings.com.

5. RSVP to Ms. Heidi Howard by Thursday, 14 February 2002 if you plan to attend this IPR. For questions concerning the IPR, please contact Ms. Heidi Howard at (217) 352-6511 ext. 7601, heidi.r.howard@erdc.usace.army.mil. Ms. Howard is helping coordinate the IPR and can assist you with any issues.

Encl WILLIAM D. GORAN

LMS Coordinator

CEERD-CN-C (70-1s)

SUBJECT: FY02 In-Progress Review (IPR) for Mojave Desert (Twentynine Palms) Land Management System (LMS) Military Field Application Site, 21 February 2002, Palm Springs, California

DISTRIBUTION:

Lorrie Agnew
Anak Agung
Alan Anderson
Christopher Baldwin
Pat Black
Kelly Dilks
Rhys Evans
Clarence Everly
Jeff Fehmi
Jeff Foisy
Patrick Fowler
Tom Frank
Dick Gebhart
William Goran
Russell Harmon
Steve Hodapp
Robert Holtz
Heidi Howard
Wayne Johnson
Bruce Jones
Randy Karalus
Liz Kellogg
Robert Koenigs
Richard Lawrence
Dawn Lawson
Roy Madden
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Dave Mouat
Jim Omans
Kip Otis-Diehl
Rob Palmer
Doug Ramsey
Ed Skidmore
Ruth Sparks
Paul Tueller
Scott Tweddale
Robert Washington-Allen
Lucy Whalley

CEERD-CN-C (70-1s)

SUBJECT: FY00 In-Progress Review (IPR) for Mojave Desert (Twentynine Palms) Land Management System (LMS) Military Field Application Site, Thursday, February 21, 2002, Palm Springs, California

TENTATIVE AGENDA

0800	IPR Opens at Holiday Inn Palm Mountain Resort
0815-0845	Overview LMS Introduction, Bill Goran
0845-0915	MCAGCC/LMS Overview, Dr. Gebhart
0915-1015	ATTACC, Mr. Anderson
1015-1030	Break
1030-1130	Wind Erosion, Ed Skidmore
1130-1200	Ecological Dynamics Modeling, Dr. Fehmi
1200-1300	Lunch Break
1300-1330	Catastrophic Erosion Events and Nutrient Dynamics, Dr. Baldwin
1330-1415	TBA
1415-1500	TBA
1500-1545	Change Detection/Remote Sensing at MCAGCC, Mr. Tweddale
1545-1600	Break
1500-1600	Comment and Review
1600-1645	Input from other participating organizations IPR conclusion.

Appendix B: MCAGCC LMS IPR List of Attendees Information

NAME	ORGANIZATION	ADDRESS	PHONE and EMAIL
Chris Baldwin	Sam Houston State University	SHSU Dept GEO/GEO Box 2148 Huntsville, TX 77341-2148	(936) 294-1593 baldwin@shsu.edu
Kevin Bartsch	UTARNG	Dept of Forest Resources 5215 Old Main Hill Utah State University Logan UT 84322	(435) 797-0741 kpb@cc.usu.edu
Marie Cottrell	MCAGCC	MCAGCC Bldg 1451 Box 788110 Attn: M. Cottrell CR 29 Palms, CA 92278	(760) 830-7396 ext. cottrellm@29palms.usmc.mil
Rhys Evans	MCAGCC	MCAGCC Bldg 1451 Box 788110 Attn: R. Evans NREA 29 Palms, CA 92278	(760) 830-7396 ext. 234 evansrm@29palms.usmc.mil
Jeff Fehmi	USACERL	USACERL PO Box 9005 Champaign, IL 61826	(217) 352-6511 jeffery.s.fehmi@erdc.usace.army.mil
Tom Frank	University of Illinois	University of Illinois 220 Davenport Urbana, IL 61801	(217) 333-7248 t-frank@uiuc.edu
Dick Gebhart	USACERL	USACERL PO Box 9005 Champaign, IL 61826	(217) 352-6511 dick.l.gebhart@erdc.usace.army.mil
William Goran	USACERL	USACERL PO Box 9005 Champaign, IL 61826	(217) 352-6511 william.d.goran@erdc.usace.army.mil

NAME	ORGANIZATION	ADDRESS	PHONE and EMAIL
Trish Griffin	Naval Facilities Eng.	SW Naval Facilities Eng. Command Code: 5GPN.PG 1220 Pacific Hwy. San Diego, CA 92132	(619) 532- 1817 griffinpl@efdsw.navfac.navy.mil
Heidi Howard	USACERL	USACERL PO Box 9005 Champaign, IL 61826	(217) 352-6511 heidi.r.howard@erdc.usace.army.mil
Randy Karalus	TEC	Commander US Army Topographic Engineering Center Topographic Technology Laboratory ATTN: CECTEC-TD (R. Karalus) 7701 Telegraph Road Alexandria, VA 22315-3864	(703) 428-7251 randall.s.karalus@erdc.usace.army.mil
Dave Mouat	DRI	DRI 2215 Raggio Pkwy Reno, NV 89512	(775) 673-7402 dmouat@dri.edu
Kip Otis-Diehl	MCAGCC	MCAGCC Box 788110 Attn: P. Otis-Diehl NREA 29 Palms, CA 92278	(760) 830-7641 otisdiehlpk@29palms.usmc.mil
Robert Palmer	Naval Facilities Eng.	SW Naval Facilities Eng. Command Code: 5GPN.RP 1220 Pacific Hwy. San Diego, CA 92132	(619) 532- 3266 palmerrl@efdsw.navfac.navy.mil
Doug Ramsey	Utah State University	Director, Remote Sensing/GIS Lab 9635 Ordmann Hill, USU Logan UT, 84322-9635	(435) 797-3783 dougr@cnr.usu.edu
Richard Rush	Texas Research Institute for Env Studies	SHSU Dept GEO/GEO Box 2148 Huntsville, TX 77341-2148	(936) 294-3976 ENV_RNR@shsu.edu
Ed Skidmore	USDA-ARS	Kansas State University 1007B Throckmorton Hall Manhattan KS, 66506	(785) 532-6726 skidmore@ksu.edu

NAME	ORGANIZATION	ADDRESS	PHONE and EMAIL
Ruth Sparks	Fort Irwin	Commander NTC and Fort Irwin AFZJ-PT PO Box 105100 ATTN: ITAM Office (Sparks) Fort Irwin, CA 92310-5100	(760) 380-5903 sparksr@irwin.army.mil
Paul Tueller	UNR	Dept Environmental & Resource Science University of Nevada Reno 1000 Valley Road Reno, NV 89512	(775) 784-4053 ptt@equinox.unr.edu
Scott Tweddale	USACERL	USACERL PO Box 9005 Champaign, IL 61826	(217) 352-6511 scott.a.tweddale@erdc.usace.army.mil
Robert Washington-Allen	Oakridge	ORNL P.O. Box 2008, M56407, Bldg 1507 Oak Ridge, TN 37831-6407	(865) 241-5159 obq@ornl.gov
T.J. Williams	MCAGCC	MCAGCC Box 788110 Attn: T. J. Williams NREA 29 Palms, CA 92278	(760) 830-7396 x 242 williamstj@29palms.usmc.mil

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LMS IPR Attendees (22)

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ATTN: ERDC, Vicksburg, MS
ATTN: Cold Regions Research, Hanover, NH
ATTN: Topographic Engineering Center, Alexandria, VA

Defense Tech Info Center 22304
ATTN: DTIC-O

29
8/02

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Approved for public release; distribution is unlimited.

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14. ABSTRACT
The Land Management System (LMS) is an initiative of the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) focused on improving landscape analysis and landscape management capabilities in several of the Corps of Engineers' major mission areas. The LMS provides relevant science, tools, and information to land and water resource managers and decisionmakers with the goal of enhancing their ability to understand and communicate past, current, and potential impacts of management actions on land and water resources.

In 1999, the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms, CA, was officially designated as a field application site. Field Application Site In-Progress Reviews (IPRs) are designed to ensure that the stages of evaluation, modification, and documentation are fulfilled. This document presents information from the second IPR workshop held 21 February 2002. The IPR consisted of presentations on LMS and individual projects. Following project presentations, inputs from installation personnel and others present were obtained. Prior to the meeting closure, user input was discussed and actions were defined to address each issue. Results of the IPR are documented in this report to ensure project improvements and adjustments occur and to assist with the next IPR.

15. SUBJECT TERMS
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Land Management System (LMS)
integrated software
modeling and simulation
land management
water management

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