US Army Corps
of Engineers
Construction Engineering
Research Laboratory

CERL Technical Report 99/65
July 1999

# Fort Hood Land Management System (LMS) Military Field Application Site FY99 In-progress Review

Alan B. Anderson, William Goran, Richard Duncan, and Lisa Garrett

The purpose of the Land Management System (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 field application site efforts provide opportunities to test, evaluate, modify, and document how LMS capabilities help to address specific user problems and how LMS capabilities fit into decision processes at user sites.

Field application site in-progress reviews are designed to ensure that the stages of evaluation, modification, and documentation are fulfilled. These reviews also allow other interested parties to be involved at the host site and evaluate the value of applying LMS investments and results at other sites.

This report documents the presentations, discussions, and results of the second Fort Hood Land Management System In-progress Review.

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# Executive Summary

The Fort Hood Land Management System (LMS) Military Field Application In-progress Review (IPR) was held March 10-11, 1999 at the Park Inn International Hotel in Killeen, TX. The objective of the IPR was bring to one location the key personnel involved with each Fort Hood Military Field Application project to discuss the progress of each effort, identify required relationships between projects, and solicit input from potential users of the resulting products.

In general, the meeting was very informative and gave participants a better understanding of the current Land Management System initiative. A number of technological concerns and unresolved issues were identified. The project investigators are addressing these issues for each individual project. Specific issues of concern include the need for better communication and interaction among project personnel, better dissemination of information about LMS, and an LMS user advisory committee.

# Foreword

This study was conducted for the U.S. Army Corps of Engineers Research and Development Directorate, which established the LMS Special Project Office in March, 1997. 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 Levernz, Deputy Director of CERD.

The work was performed by the Ecological Processes Branch CN-N of the Installations Division, Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Alan B. Anderson. Portions of this work were completed by Richard Duncan and Lisa Garrett, Sam Houston State University. Dr. Harold E. Balbach is Branch Chief, CECER-CN-N, and Dr. John T. Bandy is Division Chief, CECER-CN. The technical editor was Gloria J. Wienke, Information Technology Laboratory.

The Director of CERL is Dr. Michael J. O'Connor.

# Contents

# 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-site 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 landscape or geoprocesses. After this study, the Director of Research and Development, in consultation with 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 per-

form 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://denix.cecer.army.mil/denix/DOD/Working/LMS/lms.html) under the Defense Environmental Network Information eXchange (DENIX). The following text summarizes the Fort Hood LMS Military Field Application. 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 LMS2000 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 host sites for demonstrations and at other similar sites.

Field application sites were selected based on the following criteria:

1. Interest from land/water resources managers in infusing new capabilities into their business practices, and developing collaborative partnerships with scientists and technology providers.

2. Representative land/water resource 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.

Dr. John Barko serves as the LMS Field Application Program Director. In addition, there is a Field Application Site Coordinator for each site, and a user point of contact.

The original sites selected for field applications were Fort Hood, TX and the Upper Mississippi River System (UMRS), with three locations in the Upper Mississippi River Basin: Redwood Basin, along the Minnesota River in southern Minnesota; Pool 8 on the Mississippi River near LaCrosse, WI; and Peoria Lakes on the Illinois River at Peoria, IL. In 1998, plans were developed to add the Marine Corps Air Ground Combat Center at 29 Palms, California as an additional military installation site.

### *The Fort Hood LMS Military Field Application Site*

A workshop was held at Fort Hood, TX during September 1997 to identify and prioritize land/water resource management issues at this site. A site plan was then developed and projects initiated to address these plans. Reviews are scheduled regularly for activities at this site

Fort Hood is the only post in the United States capable of stationing and training two Armored Divisions. Fort Hood is approximately 340 square miles (217,337 acres). The rolling, semiarid terrain is ideal for multifaceted training and testing of military units and individuals. Fort Hood is "The Army's Premier Installation to train and deploy heavy forces." Fort Hood is residence for the Headquarters Command III Corps. III Corps major units are the 1st Cavalry Division, 4th Infantry Division, 3rd Armored Cavalry Regiment, the III Corps Artillery, and the 13th Corps Support Command.

Some of the enduring land and resource management issues that Fort Hood faces are monitoring the impacts that training has on Threatened and Endangered Species (TES) populations and testing TES population viability under alternative land management strategies. Land managers are also responsible for ensuring sustained usefulness of the training areas by minimizing sediment runoff. Land managers need to know estimates of erosion potential, trafficability problems, and flooding hazards in order to ensure safe and excellent training today while making sure that future training will be accommodated on the same landscape.

The Fort Hood Site Coordinator is Alan Anderson. The Fort Hood Host Site POC is Emmet Gray.

### *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 resource 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 al-low 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.

## Objectives

The objective of this project was to bring key personnel involved with each Fort Hood Land Management System Military Field Application project to one location to discuss the progress of each effort, identify the relationships between projects, and solicit input from potential users of the resulting products. This report documents the IPR, user recommendations, and post-IPR follow-on actions.

## Approach

An In-progress Review workshop was held March 10-11, 1999 at the Park Inn International Hotel in Killeen, Texas. The IPR consisted of presentations on LMS and individual projects. Following project presentations, input from installation, MACOM, and HQDA personnel was obtained. Following the meeting, 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 Fort Hood Land Management System Military Field Application In-progress Review only addresses projects associated with the Fort Hood LMS Military Field Application. This report does not attempt to address projects and issues associated with the other military and civil works LMS field applications. However, lessons learned from the Fort Hood field application will be made available to the other field applications.

## Mode of Technology Transfer

This report documents the presentations and discussions of the Fort Hood 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.

# 2 Fort Hood LMS Military Demonstration In-progress Review Agenda

The agenda for the Fort Hood Land Management System Military Demonstration FY99 In-progress Review is provided below.

March 10, 1999

| | |
|---|---|
| 8:15-8:45 | Introduction – Richard Duncan<br>Introduce participants<br>Distribute attendance sheet<br>Objectives of meeting |
| 8:45-9:45 | General LMS – Bill Goran<br>Background<br>Overview<br>Current direction<br>Fort Hood and LMS<br>Goals/objectives of Fort Hood demos |
| 9:45-10:00 | Break |
| 10:00-11:00 | QA/QC Procedures for ITAM Data – Kelly Dilks, Doug Johnston, Paul Sovelius |
| 11:00-12:00 | TES Habitat Modeling – Anne-Marie Trame |
| 12:00-13:15 | Lunch Break |
| 13:15-14:45 | Land Based Carrying Capacity Demonstration – David Price, Pat Guertin, Scott Tweddale, Dick Gebhart, Alan Anderson, Kim Michaels |
| 14:45-15:00 | Break |
| 15:00-16:00 | Vegetation Mapping – Paul Loechl, Jean O'Neil, Michael Warnock, Paul Hardwick |
| 16:00-17:00 | Carrying Capacity – Alan Anderson |

March 11, 1999

| | |
|---|---|
| 8:15-9:15 | WIARS – Jaimie Hebert, Scott Tweddale |
| 9:15-10:15 | Stream Stage Modeling – Jeff Jorgeson, Mark Leipnik, Alan Anderson |
| 10:15-10:30 | Break |
| 10:30-11:30 | Web Based Courses – James Carter, Nelda Volk |
| 11:30-12:45 | Lunch Break |
| 12:45-13:45 | Fort Hood Feedback<br>Specific projects<br>General direction of Fort Hood military demo<br>Future direction<br>Prioritization of future projects |
| 1:45-2:00 | Break |
| 14:00-15:00 | Input from Other Participating Organizations<br>FORSCOM<br>Other participants |
| 15:00-16:00 | IPR Conclusion – Bill Goran |

# 3 Fort Hood LMS Military Demonstration In-progress Review Attendees

The following individuals attended the Fort Hood Land Management System Military Demonstration FY99 In-progress Review.

| ATTENDEE | ORGANIZATION |
|---|---|
| Alan Anderson | USACERL |
| Bill Goran | USACERL |
| John Barko | USACE-WES-EB-E |
| Paul Thies | USAEC |
| Hal Balbach | USACERL |
| Emmett Gray | Fort Hood |
| Jaimie Hebert | TRIES, SHSU |
| Anne-Marie Trame | USACERL |
| Nelda Volk | EARC |
| Kelly Dilks | USACERL |
| Jim Carter | TRIES, SHSU |
| Justin Williams | TRIES, SHSU |
| Ted Reid | FORSCOM |
| Pat Guertin | USACERL |
| Leslie Winters | ATSC |
| Laura Sanchez | TNC |
| Brett Russell | Fort Bliss |
| Ron Rowland | DCOE, Ft. Hood |
| Paul Sovelius | TRIES, SHSU |
| Doug Johnston | University of Illinois |
| David Price | USACERL |
| Jeff Jorgeson | WES |
| Kim Michaels | USACE |
| Malcolm Boswell | TRADOC |
| Tony Palazzo | USACERL |
| Wade West | WES |
| Tim Buchanan | Fort Hood |
| John Schrader | Fort Hood |
| Homer Sanchez | NRCS |
| Don Jones | Fort Hood |
| Dalton Murz | NRCS –USDA |
| Roger Hamilton | WES |
| Peter Cooper | TRIES, SHSU |
| Jerry Paruzinski | Ft. Hood ITAM |
| Dalton Burke | USDA |
| Michael Warnock | TRIES, SHSU |
| Lisa Garrett | TRIES, SHSU |

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|---|---|
| Richard Duncan | TRIES, SHSU |
| Mark Leipnik | TRIES, SHSU |
| P. B. Black | USATEC |
| Dick Gebhart | USACERL |
| Jason Walters | Fort Hood |
| Dennis Hoffman | TAES/TAEX |
| Monty Dozier | TAEX/NRCS |
| Steve Sekscienski | USAEC |
| Colonel Walter | USARMY-ERDC |
| Jerry Thompson | Ft. Sam Houston/Camp Bullis |
| Fredrich Schrank | USDA NRCS |
| Dick Strimel | Ft. Sam Houston/Camp Bullis |
| June Wolfe, III | Texas Agriculture Experiment Station |
| Tom Macia | ODCSOPS |

# 4 Fort Hood LMS Military Field Application In-progress Review Summary Comments and Responses

The following pages summarize comments provided by participants in the Fort Hood LMS Military Demonstration IPR. Each participant was asked to provide comments on specific projects, general direction of Fort Hood military demonstration, future direction, and prioritization of future projects. Along with each comment is a summary of the LMS response and tasks derived from the user input.

| Number | Organization | Comment | Response |
|---|---|---|---|
| 1 | Fort Hood | Fort Hood requires something similar to ATTACC but which includes other stressors such as fire and cattle. Fort Hood needs to be able to assess grazing rotation plans on military carrying capacity. | Concur. Issue of multiple use carrying capacity is being forwarded to the Army Conservation Technology Team because the carrying capacity user requirement is being redrafted. CTT leadership has been informed of the issue. However, some LMS projects like EDYS provide the underlying technologies partially required to address this issue. |
| 2 | Fort Hood | Some projects like the QAQC effort are being done by LMS and Fort Hood separately. Need improved coordination to ensure that there is not duplication of effort. | Concur. LMS project principal investigators will keep all three primary Fort Hood POCs informed of project status. Primary Fort Hood POCs are Mr. Gray, Mr. Cornellius, and Mr. Paruzinski. |
| 3 | Fort Hood | The IPR was worthwhile to disseminate information to installation POCs. | Concur. No response required. |
| 4 | Fort Hood | Need an evaluation of hyperspectral imagery appli- | Mr. Goran will forward to three Fort Hood |

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| | | cations in support of installation natural resources management. Fort Hood needs to know what information is available and which information can support land management issues. | POCs information on TEC's hyperspectral library. The WIARS team will also be provided this information. |
| 5 | Fort Hood | Need tank trail dust control alternatives to existing maintenance practices. | Concur. The new user requirement in compliance may address this issue. Issue will be communicated to Army Compliance Technology Team. |
| 6 | Fort Hood | Need management strategies for existing TES set aside lands. Need to be able to manage set aside lands for management objectives. | Concur. Issue needs more dialogue from Fort Hood POCs to more clearly define the issue. However this issue could evolve into a future LMS project. Ms. Trame and Mr. Price are tasked to pursue this topic. |
| 7 | Fort Hood | Need better coordination with Fort Hood's primary POCs. Need to keep everyone aware of the big picture by keeping everyone updated on each project. | Concur. See response item 2. |
| 8 | Fort Hood | Resolution of vegetation mapping effort needs to be resolved. | Concur. Mr. Loechl tasked to address this issue with Fort Hood POCs. |
| 9 | Fort Hood | Source of imagery for vegetation mapping effort needs to be resolved. | Concur. Mr. Loechl tasked to address this issue with Fort Hood POCs. |
| 10 | Fort Hood | LMS needs to be more integrated to match its mission statement. | Concur. See response item 2. Future LMS efforts at Fort Hood will focus more on integration as the demonstration project evolves and matures. |
| 11 | FORSCOM | Need better coordination, cooperation, interaction between individual projects and project managers. | Concur. See response item 2. |

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| 12 | FORSCOM | Need standard protocols for fielding LMS technologies | Concur. A key goal of LMS is consistent delivery of technology to the user community. A new effort at Fort Hood will address model validation protocols preceding fielding. |
| 13 | FORSCOM | Research needs to address future doctrine (activities and systems) not just existing doctrine. Need to keep current with Army XXI initiatives. | Concur. |
| 14 | FORSCOM | Need to do a better job of disseminating information about LMS. Need a clearly defined objectives, products, and approaches. | Concur. A report titled *Plans for the Land Management System (LMS) Initiative* is in draft form and should be published by late spring. This information will be available on the LMS website. (http://denix.cecer.army.mil/denix/DOD/Working/LMS/lms.html) under the Defense Environmental Network Information eXchange (DENIX). (Mr. Goran) |
| 15 | FORSCOM | Need a LMS field advisory group that meets regularly to broaden applicability of LMS investment. | Concur. Recommendations for LMS advisory forums are being presented to CERD at the July 99 LMS review (Mr. Goran) |
| 16 | FORSCOM | Need to protect military information as LMS makes disseminating information easier. | Concur. LMS protocols will not define access to installation information or how that information is disseminated. Control of information will remain with the installation following MACOM/Service guidance. |
| 17 | FORSCOM | Need to field more user friendly software and tools. | Concur. This is a key goal of LMS. |
| 18 | FORSCOM | Need to address how much of a solution is required to | Concur. Affordability is a concern in designing |

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| | | solve a problem. The cost of the solution must be balanced with the benefit to the Army. | and prioritizing projects and in transferring results. |
| 19 | FORSCOM | Need to involve military trainers into the research program. | Concur. |
| 20 | FORSCOM | Need to include noise land management issues into LMS. Need to investigate cumulative noise models to make tools more applicable to military land management problems. | Concur. Will attempt to resource integration of noise models and LMS in FY2000 program. (Mr. Goran) |
| 21 | ODCSOPS | Information about LMS needs to more clearly explained and effectively disseminated. Need to clearly articulate objectives, purpose, and products. | Concur. See item 14 response. |
| 22 | ODCSOPS | Need to look at maturity of LMS technologies before they are fielded and incorporated into user products. | Concur. A validation protocol along with demonstrations should help ensure product maturity. |
| 23 | ODCSOPS | Research community needs to provide relevant information to prioritize what non-training impacts/stressors are most critical to quantify/model on military installations. | This issue is best handled through the Army Conservation Technology Team prioritization process. |
| 24 | ODCSOPS | LMS needs to address how much standardization is required/desired for LMS to be successfully implemented. How will LMS be successfully implemented to meet both Army wide standardization requirements and installation unique solution requirements. | Concur. LMS projects are selected to respond to Army wide issues. Solutions are intended to be for Army wide implementation with the least possible adaptation required. This does vary from project to project. |
| 25 | ODCSOPS | Army training simulations are in three domains: 1) Live, 2) Virtual, and 3) Constructive. Live simulations enhance training with live soldiers on the ground. An example is MILES. Vir- | Concur. The NSC will be contacted. (Mr. Anderson) |

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| | | tual simulations replicate weapons with live soldiers in a virtual environment. An example is Close Combat Tactical Trainer (CCTT). Constructive simulation replaces units, weapons, and terrain with war-gaming. An example is Janus. Constructive simulation tools are what is required to model military training footprints. Land carrying capacity should access constructive simulations only. The combat developer for the Army's family of constructive simulations is the National Simulation Center (NSC) at Fort Leavenworth. CERL should consider the following constructive simulations: 1) Janus, 2) BBS and 3) CBS. | |
| 26 | ODCSOPS | The Center for Army Lessons Learned (CALL), also at Fort Leavenworth, archives AARs from the Army's Combat Training Centers (CTC). Some of these AARs may contain digitized files from CTCs showing actual unit maneuver patterns for various missions within CTC rotations. | Concur. The CALL will be contacted. (Mr. Anderson) |
| 27 | ODCSOPS | The army environmental research community must hire a military subject matter expert (SME) to help translate the military doctrine to the researchers. Such an SME should be a combat arms officer with experience with constructive simulation use. | Concur. |
| 28 | ATSC | Need installation advisory group to ensure broader Army relevance. | Concur. See response to item 15. |

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| 29 | ATSC | ATSC is encourage by the training distribution modeling but would like more involvement in the process. Better guidance/procedures are required for developing and implementing training distribution models. | Concur. ATSC will be kept informed of project efforts. Guidance will be developed. (Mr. Guertin) |
| 30 | ATSC | LMS needs to be better interfaced with RFMSS. LMS needs to address the implementation windows and time frame constraints associated with the RFMSS development process. | Concur. A new project has been initiated to address this issue. (Mr. Anderson) |
| 31 | ATSC | Need to better disseminate details of LMS components to user communities. | Concur. See response to item 14. |
| 32 | AEC | LMS needs to coordinate efforts with Signal Command. | Concur. The Signal Command will be contacted. (Mr. Goran) |
| 33 | AEC | AEC needs to know where LMS projects are going to be able to estimate and allocate funding for AEC's Conservation Technology Team (CTT) responsibilities. AEC is responsible for validating, demonstrating, and transferring conservation related technologies. | Concur. This issue is being address through the Army Conservation Technology Team process. A team consisting of Mr. Theis, Mr. Goran, Ms. Dilks, and Ms. Michaels are addressing this issue. |
| 34 | Fort Bliss | LMS needs to address if integrating old models is efficient and if integrated models give significantly better results than using models that are not fully integrated. | Concur. This is not an easy issue to address. However, LMS is collaborating with the University of Illinois on a SERDP funded project that is attempting to partially address this issue. This project is using a number of the models being incorporated into LMS. The project is looking at the uncertainty of model predictions, sources of errors, and how these errors propagate through models. |

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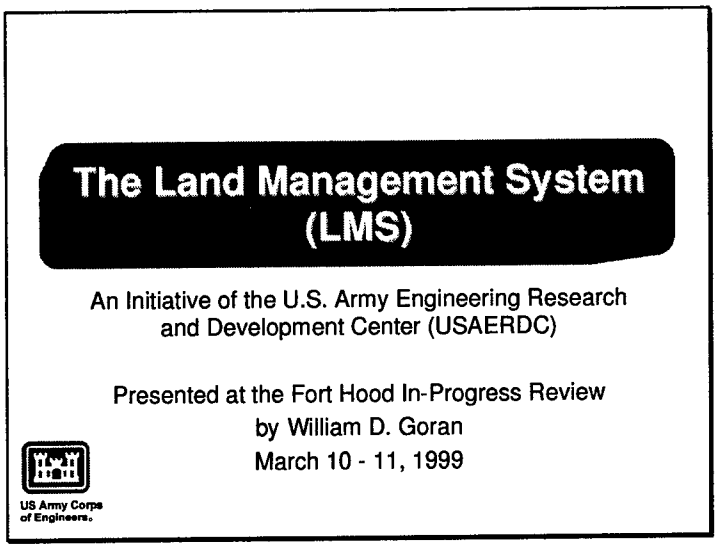
| 35 | Fort Bliss | LMS needs to look at cumulative impacts/stressors. | Concur. This is a key driver for LMS. |
| 36 | Fort Bliss | User needs may be more for easier interfaces to existing products than for improved technologies. | Concur. This is a key driver for LMS. |
| 37 | Fort Bliss | Resources to support LMS type tools are often difficult for installations to acquire. LMS may need to address this issue if LMS is to be successfully implemented. | Concur. This is a key drive for LMS. |
| 38 | TRADOC | Need a systems approach to LMS. Individual research efforts need to be more tightly integrated. | Concur. See response to item 10. |
| 39 | TRADOC | Need a clearer definition of what LMS is. | Concur. See response to item 14. |
| 40 | TRADOC | LMS needs to be careful that research does not lead to a higher standard of compliance that military installations must adhere to. | Site instrumentation at Fort Hood is focused on technology testing and verification. It is not intended as a template for other installations, nor should such instrumentation "raise the bar" for regulatory requirements. |

# Appendix: Fort Hood LMS Military Demonstration In-progress Review Project Presentations

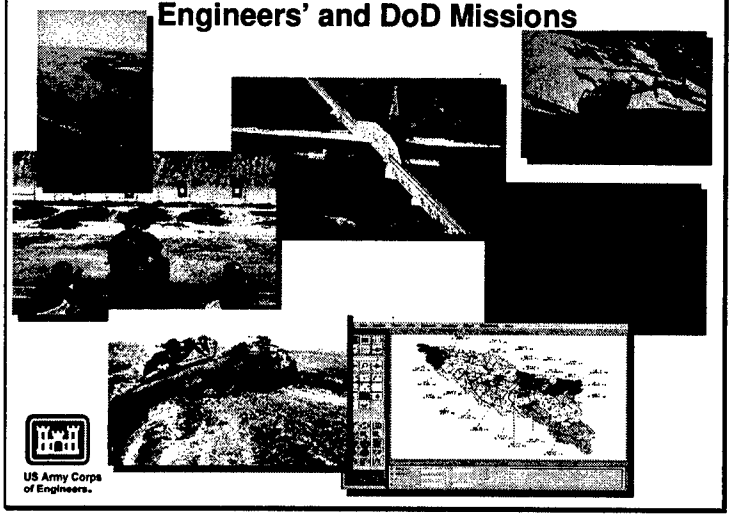
The following sections provide briefing materials presented at the Fort Hood Land Management System Military Field Application In-progress Review.

## General LMS

Presenter: Bill Goran



## Common Ground Issues Across the Corps of Engineers' and DoD Missions



US Army Corps of Engineers.

| Military Installation Land Management | Military Analysis of Landscapes | Army Civil Works Operations |
|---|---|---|
| • Training Lands Management<br>• Contaminated Site Cleanup<br>• Testing Ranges<br>• Integrated Resources Planning<br>• Noise Propagation Management<br>• Installation Ecosystems Management<br>• Land Rehabilitation | • Chemical/Biological Threat Assessment<br>• Trafficability Analysis<br>• Military Littoral Operations<br>• Military Hydrology Analysis<br>• Obstacle Analysis | • Wetland Permit Evaluations<br>• Coastal Zone Management<br>• Watershed Management<br>• Aquatic Ecosystem Restoration<br>• Dredging Operations Management<br>• Multiple Use Planning |

Across DoD. . .
- Over 25 Different Technology Programs
- 150 - 200 Million/Year in Technology Investments

US Army Corps of Engineers.

## LMS Objectives

- Build a Capability that Serves Multiple Application Domains Related to Land and Water Resource Management and Analysis
- More Bang for the Buck Between Corps of Engineers Technology Programs and Across DoD Technology Programs (greater interoperability of technology products)
- Improve System for Delivery of Computer-Based Technology Products (reduce end users and support organizations costs)
- Creation of Network of Testing and Demonstration Facilities with Field Instrumentation, Repositories of Data, Site POCs, Collaboration Across Multiple Research Efforts, and Planning and Review Processes

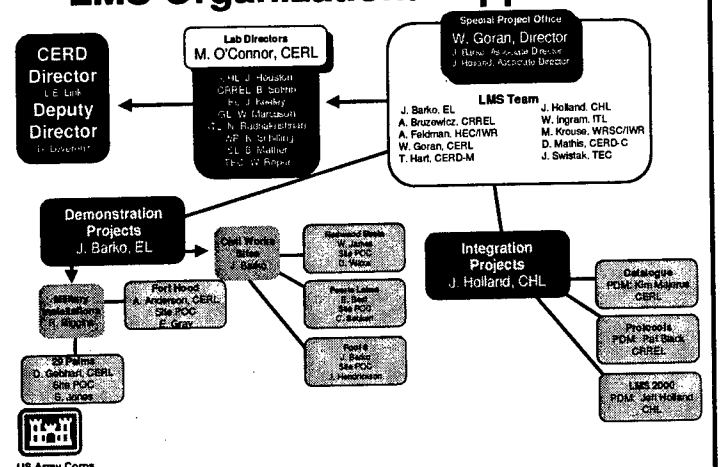
US Army Corps of Engineers.

# LMS Background Studies

- 1995 Defense Science Board Report on Modeling and Simulation in Environmental Quality
- 1994-1995 Corps of Engineers Lab Committee on Cross-Connections Between Civil Works and Military Conservation Technology Programs (W. Severinghaus, CERL; R. Engler, WES-EL)
- 1995-1996 Corps of Engineers Lab Committee on Land Modeling and Simulation Opportunities/ Technologies in Civil Works, Military Land Management and Military Hydrology (D. Tazik, CERL; R. Price, WES-EL)
- Dec. 1996 Committee Brief Findings -- Recommendation for Starting LMS Initiative

US Army Corps of Engineers.

# LMS Organizational Approach




US Army Corps of Engineers.

# Customer Input

- Customer Advisory Board (being formed)
  - Advice on overall initiative
- Configuration Control Board
  - Manage system
- Demonstration Site Plans and IPRs
  - Host sites and proponent organizations

US Army Corps of Engineers.

## LMS Chronology of Events

- March 1997 — LMS Special Project Office Created
- May 1997 — Transition Meeting from Tazik/Price Committee to Special Project Office
- June 1997 — In Progress Review
  - Plan for LMS to include integration and demonstration components
  - Selections for first demos sites
- Summer 1997 — Coordination with AEC on Suite of Demos -- Carrying Capacity Related
- September 1997 — Workshops Held in La Crosse, WI and Killeen, TX
- October 1997 — SERDP and DoD High Performance Computing Program Fund Creation of LMS Pilot and Software Evaluation Effort
- Civil Works geospatial funds catalog effort

US Army Corps of Engineers.

## LMS Chronology of Events

- November 1997 — In-Progress Review
  - Results of workshops reviewed
  - Projects identified at demo sites
  - Concept for use of Congressional funds at Military Demo briefed
- February 1998 — Ft. Hood LMS POC (E. Gray) visits CERL and reviews and helps prioritize demo projects
- March 1998 — In-Progress Review for LMS Investment Strategy Briefed and Approved, Including use of Congressional Computer-Based Land Management Resources

US Army Corps of Engineers.

## LMS Chronology of Events

- June 1998 — In-Progress Review for LMS (La Crosse, WI)
  - Fort Hood projects defined and briefed.
  - Hood IPR proposed
  - 29 Palms proposed as demo site
  - Upper Miss status reviewed. Tour of Pool 8
- July 1998 — Web-Based GIS Installed (UI/CERL) at Hood
- Aug/Sept 1998 — Computer-Based Land Management Projects Contracted for Start
- November 1998 — LMS System Pilot (DC)
- Oct/Nov/Dec 1998 — Project Planning and Initiation. IPR Date Sought.

US Army Corps of Engineers.

## Resources for LMS

- Army Military
  - Military Hydrology
  - Risk Assessment
  - Environmental Quality
  - Computer-based Land Management (98,99)
  - Terrain Analysis
- Army Civil Works
  - Civil Works Geospatial
  - Civil Works Planning
  - Civil Works Hydrology
  - Civil Works Environmental Quality

US Army Corps of Engineers.

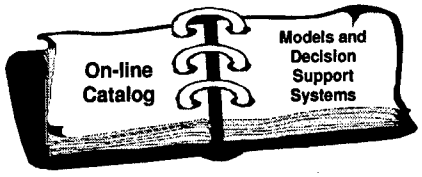
## LMS Integration Projects

- LMS Catalog
- LMS Protocols
- LMS 2000

US Army Corps of Engineers.

Protocol Process

## LMS Catalog




**Documenting All Our Computer-based Tools**

US Army Corps of Engineers.

# On-Line Catalog

**http://owww.cecer.army.mil/ll/landsimsurvey/homepage.html**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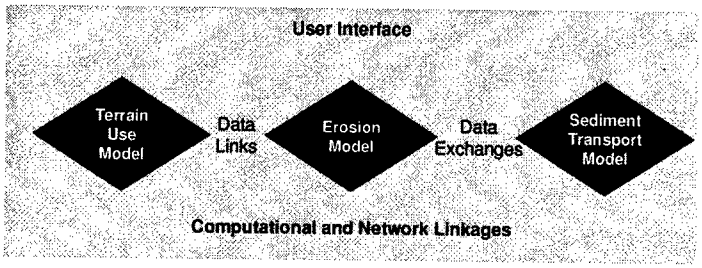
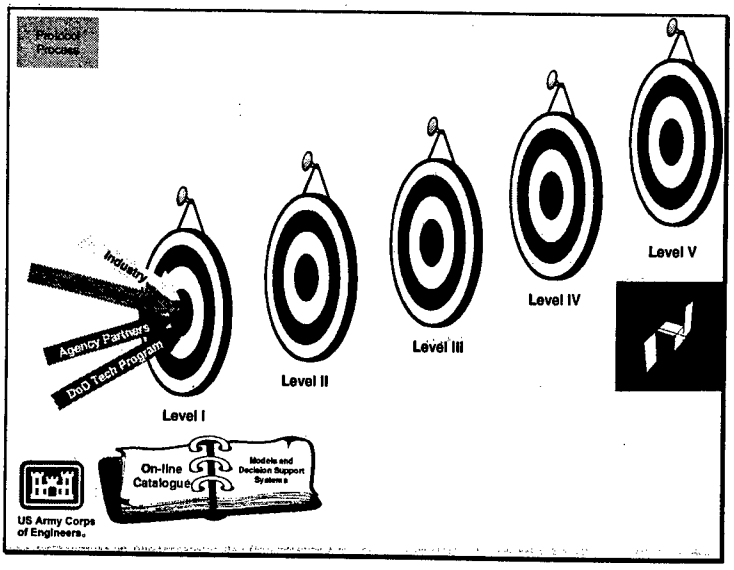
# LMS Protocols

**Specifications For the Way Computer-based Tools Interact**




US Army Corps of Engineers.

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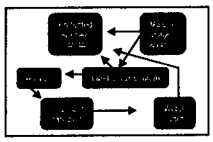
# LMS Protocols

- **Specifications For the Way We Represent Landscape Processes**
  - Independent Tools that 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

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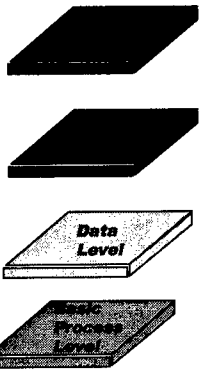
# LMS Design Levels




**Provides**

- Access to Resources
- Navigation Tools
- Visualization Capabilities
- Scoping
- Collaborative Tools

- Modeling Systems (numeric)
- Conceptual Modeling Tools
- Uncertainty Analysis Tools
- Model Integration Guidance

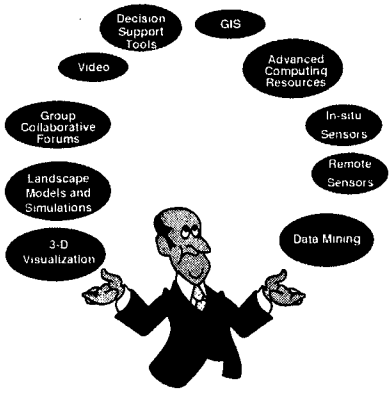
- Metadata
- Data Locator Tools
- Common Data Formatting
- Parameter Database

- Gaps Analysis
- Process Integration Mapping
- Programs & Projects Listing

US Army Corps of Engineers.

# LMS 2000

**Bringing Capabilities Together to Reduce End User Workload and Adding Capability to Legacy System**

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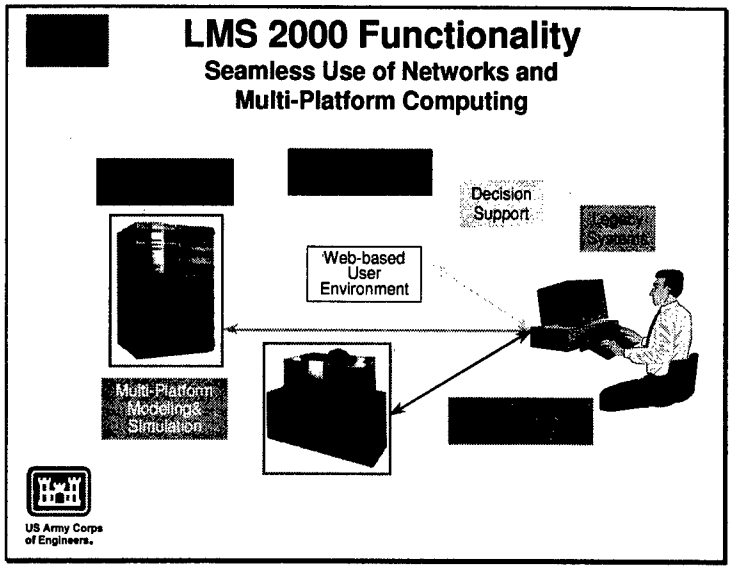
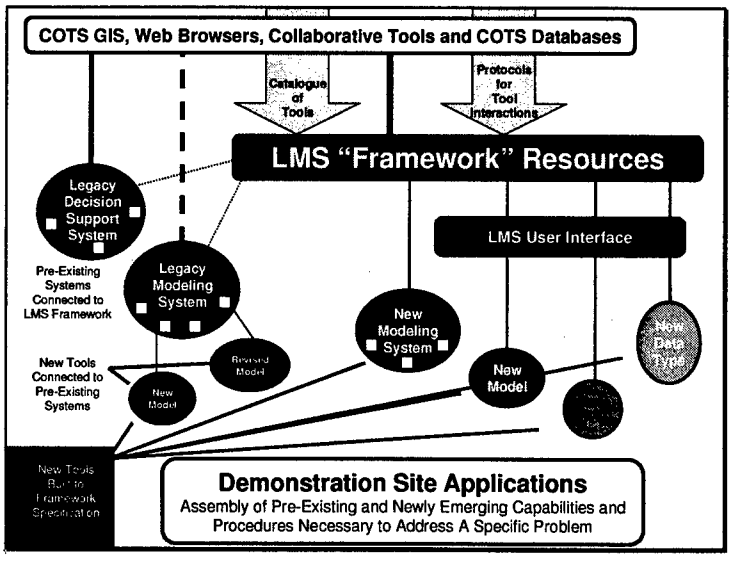
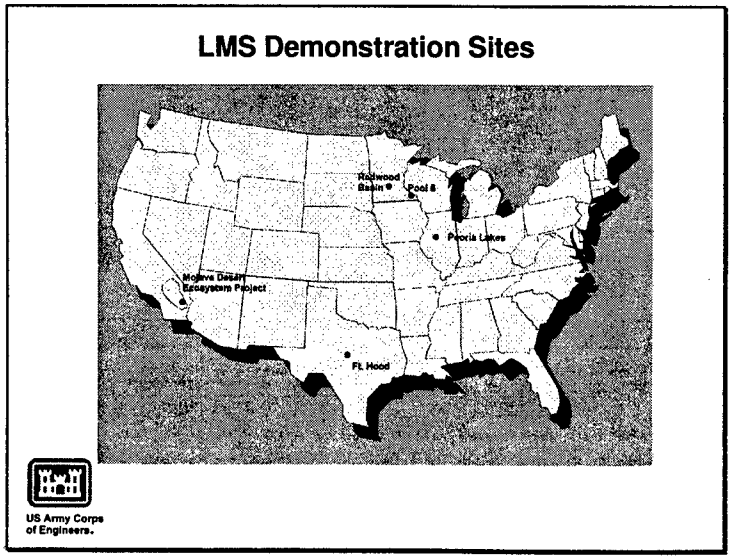

LMS 2000 Functionality
Seamless Use of Networks and
Multi-Platform Computing
Decision
Support
Web-based
User
Environment
Multi-Platform
Modelings&
Simulation
US Army Corps
of Engineers.


COTS GIS, Web Browsers, Collaborative Tools and COTS Databases
Catalogue
of
Tools
Protocols
for
Tool
Interactions
LMS "Framework" Resources
Legacy
Decision
Support
System
LMS User Interface
Pre-Existing
Systems
Connected to
LMS Framework
Legacy
Modeling
System
New
Modeling
System
New
Model
New Tools
Connected to
Pre-Existing
Systems
New Model
Demonstration Site Applications
Assembly of Pre-Existing and Newly Emerging Capabilities and
Procedures Necessary to Address A Specific Problem

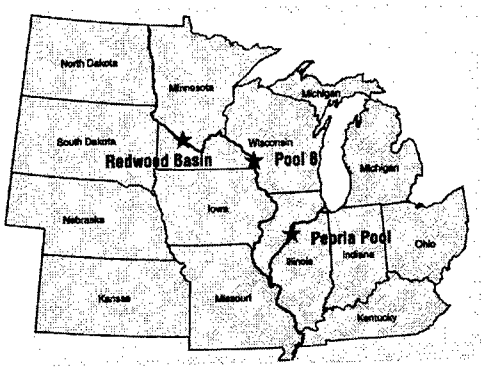

LMS Demonstration Sites
Redwood
Basin
Pool 8
Peoria Lakes
Mojave Desert
Ecosystem Project
Ft. Hood
US Army Corps
of Engineers.

## Purpose of Demonstration Program

- Provide Problem Solving and Partnering Relations Between the Corps of Engineers Scientists, Technology Developers and Landscape/ Natural Resource Managers
- Provide Site-specific and Problem-specific Input into the Design of LMS 2000 Functional Capabilities
- Provide Technology Test Environments to Tackle Issues, Test Solutions, Adjust Approaches, Capture Costs and Benefits and "Demonstrate" the Results
- Provide a Framework for Planning the Transfer of LMS Technology to Land/Water Resource Managers

US Army Corps of Engineers.

## The Upper Mississippi River System Demonstration Project



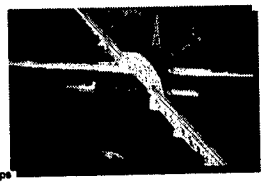

US Army Corps of Engineers.

## Upper Mississippi LMS Demonstrations

**Spatial Evaluations of Aquatic Habitat Conditions**

**Development and Evaluation of Habitat Restoration Alternatives**

**Ecosystem Management in Context of Project O&M**



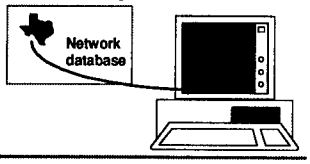
**Watershed Management**

US Army Corps of Engineers.

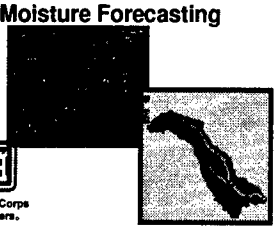
# Ft. Hood, Texas
## LMS Demonstrations

**TES Modeling**

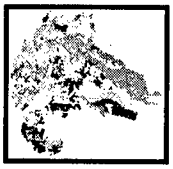
**Web Map Dissemination**




**Stage-Stream/Soil Moisture Forecasting**



**Test of Multi-Tiered Vegetation Mapping Protocols for Ft. Hood**



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# Project Selection Process

Identify Specific Site Issues

formal statements, workshops, discussions, informal write-ups

Relationship to BROAD ORGANIZATIONAL PROBLEMS

Issues Shaped to Conceptual Projects

resource unconstrained

Projects Prioritized

resource constrained

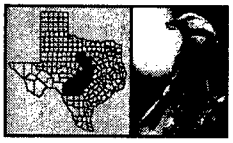
High Priority Projects Matched to Resources

constrained by source goals/rules

Full Project Plans Initiation

US Army Corps of Engineers.

## TES Modeling



- Objective:
  - Population viability analyses of Hood's 2 TES birds using spatially explicit modeling
  - Efficient trapping of Cowbirds
- PI(s):
  - Ann-Marie Trame - CERL
  - Tim Hayden - CERL
- Cooperators :
  - Tom Maxwell - U of Md
  - Doug Johnston - U of Ill
  - Dave Price - CERL
  - Mike Childress - Shepperd-Miller Inc.
- Fort Hood POC:
  - Mr. John Cornelius (Hood)
- Funding Sources / Levels:
  - A896 - 250K
  - Ft. Hood - 212K
- Major FY98 milestone:
  - WWW based Fort Hood Avian Simulation Model (FHASM)
  - WWW based Individual Cowbird Behavior Model (ICBM)
  - Population viability analysis for alternative management scenarios
  - Validation of cow and Cowbird behavior submodels
- Major FY99 milestone:
  - Integrate FHASM, ICBM, EDYS

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## LBCC DemVal

- Objective:
  - Demonstration and validation of land based carrying capacity (LBCC) technologies
    - LS (RUSLE topography factor)
    - C (RUSLE vegetative factor)
    - Ttraining distribution
    - EDYS (community succession)
- PI(s):
  - Alan Anderson (CERL)
  - Dave Price (CERL)
  - Pat Guertin (CERL)
  - Scott Tweddale (CERL)
- Cooperators :
  - Shepperd-Miller Inc.
    - Terry McLendon
    - Mike Childress
  - U of Ill
    - Helena Mitasova

- Fort Hood POC:
  - Jerry Paruzinski (ITAM)
- Fort Bliss POC:
  - Brett Russell
- Funding Sources / Levels:
  - AEC - $380K
- Major FY98 milestone:
  - Field studies established
- Major FY99 milestone:
  - C and distribution validated

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## Test of Multi-Tiered Vegetation Mapping Protocols for Ft. Hood

- Objective:
  - Develop a vegetation hierarchical prototype using Fort Hood as a test case
  - Develop a Fort Hood Vegetation Map
- PI(s):
  - Paul Loechl (CERL)
  - Jean O'Neil (WES)
- Contractor:
  - Texas Regional Institute for Environmental Studies
- Fort Hood POC:
  - Dennis Herbert (Hood) and Laura Sanchez (TNC)

- Interagency working group:
  - NBS/NPS Vegetation Mapping Prog.
  - Ecological Society of America (ESA)-
  - The Nature Conservancy
- Funding Source(s):
  - Congressional
- Funding Level:
  - $700K (FY98)
- Major FY98 milestone:
  - status report
- Major FY99 milestone:
  - 1) Hierarchical Prototype using Fort Hood as Test Case
  - 2) Vegetation Map (Prelim)

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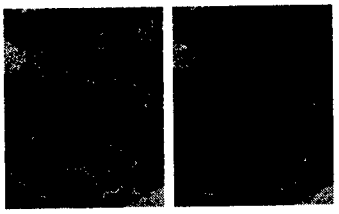
## Web Image Analysis Remote Sensing (WIARS) Change Assessment

- Objective:
  - Develop a web-based image analysis system that integrates all necessary tools to perform image comparison and change assessment
  - Test and validate capabilities to assess change in TES habitat in Ft. Hood region
- PI(s):
  - Scott Tweddale (CERL)
- Contractor:
  - Virginia Dale, ORNL
  - Jamie Hebert (TRIES)
- Cooperators:
  - Lisa O'Donnell - U.S. Fish and Wildlife Service
- Fort Hood POC:
  - Mr. John Cornelius (Hood)



50% Change Severity 99% Change Severity

- Funding Source(s):
  - Congressional
- Funding Level:
  - $850K (FY98)
- Major FY98 milestone:
  - Develop, refine, and demonstrate WIARS
- Major FY99 milestone:
  - Demonstrate capabilities through assessment of regional changes in Golden-Cheeked Warbler habitat

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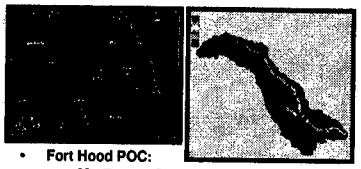
## Stage-Stream/Soil Moisture Forecasting

- Objective:
  - Provide a warning system for flooding on the reservation and a system for determining when soil moisture conditions as they affect training and land damage
- PI(s):
  - Bill Martin - CHL
  - Mark Jourdan - CHL
  - Bill Johnson - CHL
  - Mickie Hayward - CHL
  - Alan Anderson - CERL
  - Dave Price - CERL
- Cooperators :
  - Mike Childress - Shepperd-Miller Inc.
  - June Wolf - TRIES
  - Dr. Fred Ogden - Univ of Connecticutt
  - Dr. Ehab Meselhe - Southwest Louisianna University
  - Dr. Mark Leipnik - TRIES



- Fort Hood POC:
  - Mr. Emmet Gray
- Funding Sources / Levels:
  - SERDP-$156K
  - Congressional - $500K
  - RDT&E - $120
- Major FY98 milestone:
  - Initial Cowhouse Creek watershed model with sediment yield
  - Demo of coupled EDYS and CASC2D models
- Major FY99 milestone:
  - Field data collection and analyses
  - Calibration and verification of stream-stage and soil moisture model output to best available data
  - Integrate NEXRAD data with the watershed model

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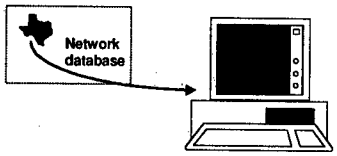
## Web Map Dissemination

- Objective:
  - To distribute military installation spatial data to installation personnel in the form of maps using the Internet.
  - To assist the soldier in finding relevant information for training purposes.
  - To conduct QA/QC on military installation spatial data
- PI(s):
  - Kelly Dilks - CERL
- Cooperators :
  - Doug Johnston - U of Ill
  - Dave Price - CERL
  - Mike Childress - Shepperd-Miller Inc.
  - Paul Sovelius, TRIES




- Fort Hood POC:
  - Emmet Gray (DPW)
  - Jerry Paruzinski (ITAM)
- Funding Sources / Levels:
  - A896 75K
  - Congressional funds 200K
- Major FY98 milestone:
  - Hood will have Internet Map Serving capability
  - WWW based Individual Cowbird Behavior Model (ICBM)
- Major FY99 milestone:
  - Review the quality of Hood digital map data
  - WWW enabled MAGIC to support the ITAM community

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## LMS Partners

**Agency Partners**

- Department of Energy (DOE)
- Environmental Protection Agency (EPA)
- Natural Resource Conservation Service (NRCS)
- State Agencies
- Department of Interior (DOI)
  - US Geological Survey (USGS)
  - Fish and Wildlife Service (FWS)
  - National Park Service

**Industry Partners**

- Environmental Systems Research Institute (ESRI)
- Open GIS Consortium (OGC)
- Pacific Meridian

**Academic Partners**

- Syracuse University
- University of Illinois
- Brigham Young University
- Texas Regional Institute for Environmental Studies (TRIES)
- Colorado State University
- University of Maryland
- University of Connecticut
- University of Miami
- University of Minnesota
- Mankedo State University
- St. Mary's College
- Illinois State Water Survey

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## Where To From Here

- Plan for Data Repository (demo sites)
  - Increase value to host installation
  - Include non-LMS studies and contracted work
  - Provide extensive metadata for all inputs
  - Publish repository plans and standards
  - Source of data for all future studies
- Post Meeting Report
- Adjustments to Projects
- Building a Future Plan (FY99 and beyond)

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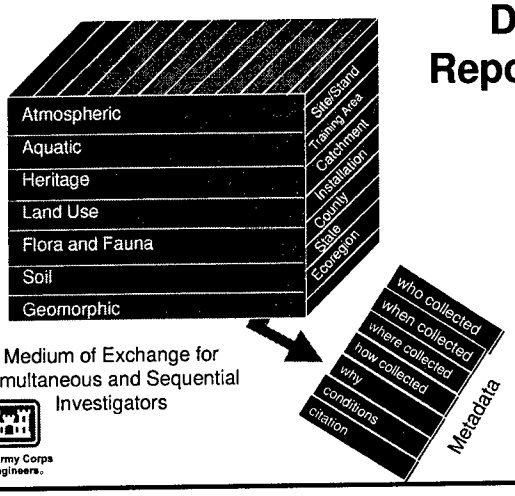
## Site Data Repository




Medium of Exchange for Simultaneous and Sequential Investigators

US Army Corps of Engineers

## Post IPR Plans

| | | |
|---|---|---|
| _____ | Put together a complete report | Duncan |
| _____ | Identify all action items | Duncan |
| _____ | Site POC and Site Coordinator will staff action items | Anderson Gray |
| _____ | Adjustment to on-going efforts as suggested | Anderson, PIs |
| _____ | Additional year funding requirements reviewed | Goran, Barko, Riggins, Anderson Hood Staff |
| _____ | Development of "plan" for continuation | Above Group PIs |

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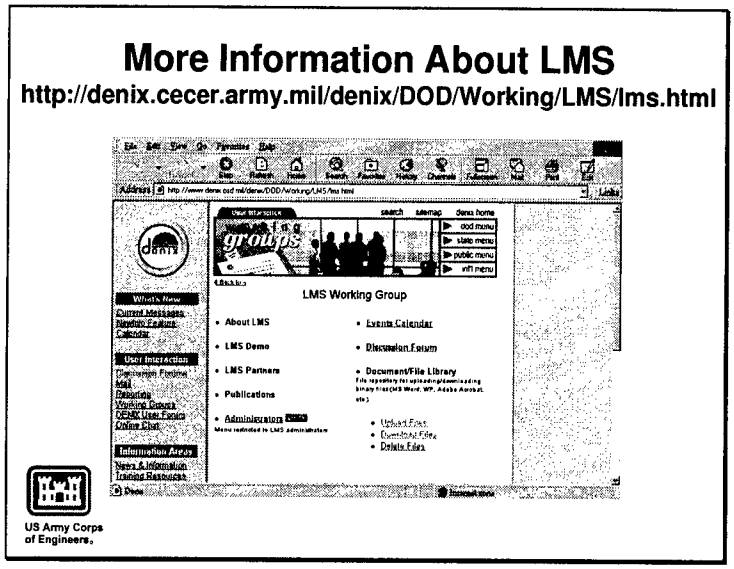
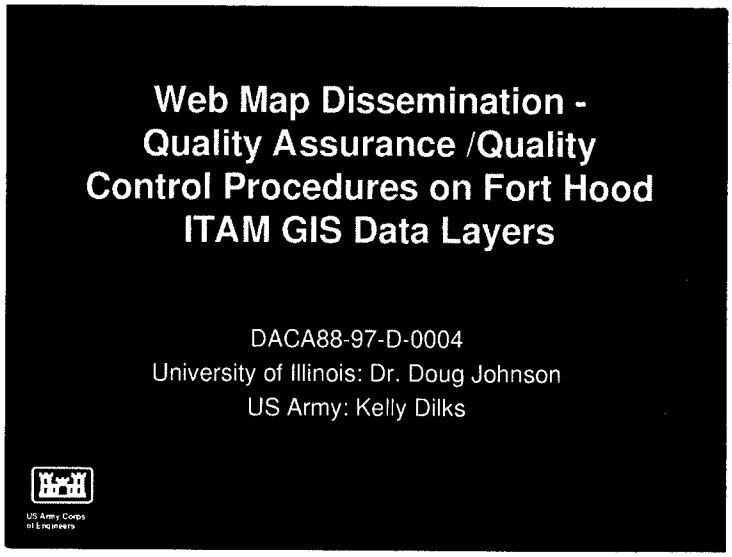



## QA/QC Procedures for ITAM Data

Presenters: Kelly Dilks, Doug Johnston, Paul Sovelius



# Purpose of Project
# Web Map Dissemination

Evaluate web mapping technology
Create common views for Ft. Hood Data
Set up web mapping functionality

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# FY 98 Accomplishments

Web prototypes developed
- ESRI Internet Map Server
- Microsoft Frontpage
- Active Server Pages (ASP)
- Java Server Application

Web mapping implemented at Hood June 1998

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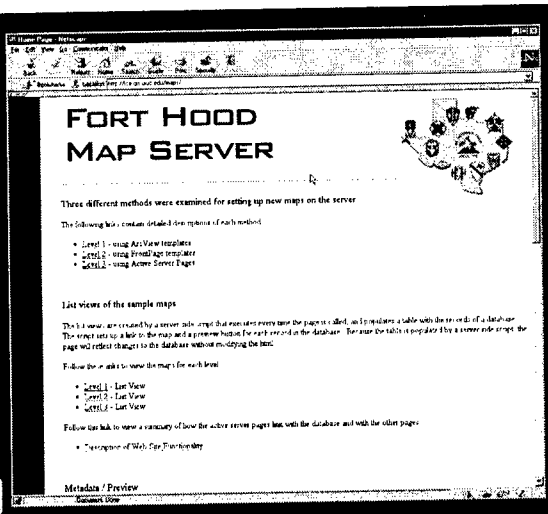


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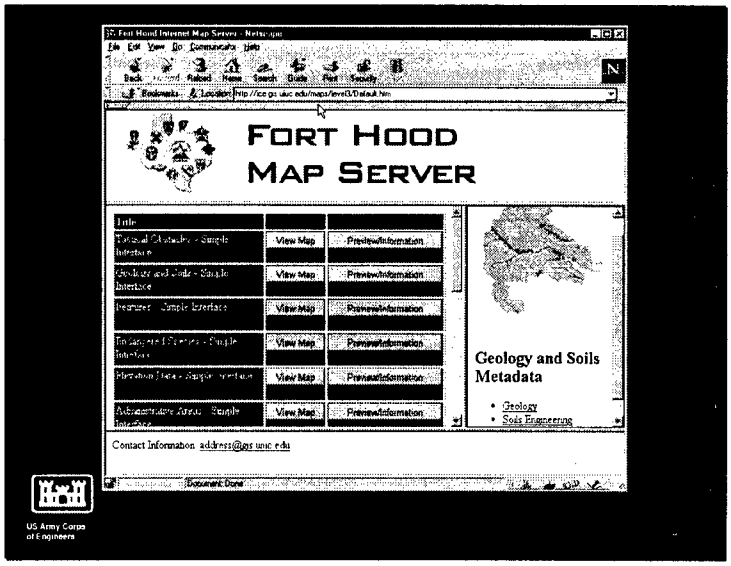


## Purpose of Project QA/QC Procedures

Quality Assurance and Quality Control (QA/QC) procedures on Fort Hood Integrated Training Area Management (ITAM) GIS data layers

Document core ITAM GIS data layers using the FGDC Content Standard for Digital Geospatial Metadata

Map Fort Hood ITAM data into the Military Area Geographic Information Computer (MAGIC) ArcView Interface

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## Problem Description

Data collected over time by different organizations with different purposes

Lack of data on fitness for use, datedness, accuracy, source data, etc.

Need core set of documented/evaluated data

Need process and tools for evaluating and maintaining data quality

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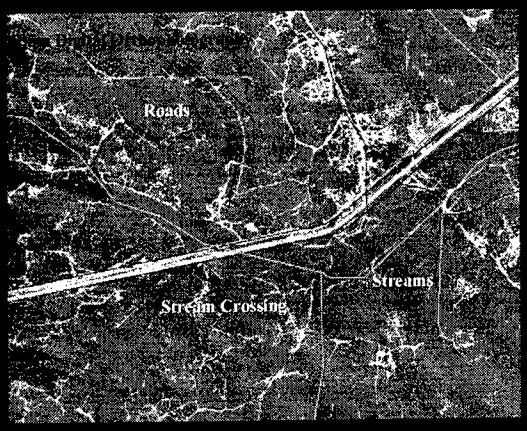
## Example of data sets and comparison data

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## Offices at Fort Hood

G3 Range Control Division
- Jerry Paruzinski, ITAM Coordinator
- Jason Walters, ITAM GIS Coordinator

DPW - Environmental Division
- Emmet Gray, Chief, Environmental Branch

US Army Corps of Engineers

## Funding Sources

| | | | |
|---|---|---|---|
| FY98 | A896 | 75K | Web Mapping |
| FY99 | Congressional | 200K | QA/QC |

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## Performers

University of Illinois at Urbana/Champaign Geographic Modeling Systems Lab
Dr. Doug Johnston (GMS Lab and NCSA)
Diane Timlin (GMS Lab)
Dr. Zorica Budic (Urban and Regional Planning)
Prof. Jenny Johnson (Map and Geography)

Pending subcontract with SHSU/TRIES
Dr. Paul Sovelius

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## Major Steps in Process

Document existing data sets
Develop QA/QC procedures
Assess data sets
Evaluate procedures
Report on procedures and prospects for automation
etc.

US Army Corps of Engineers

## Document existing ITAM data

Sample selected by Ft. Hood ITAM Coordinator and GIS Coordinator

- Installation Boundaries
- Training Area Boundaries
- Roads
- Surface Hydrology
- Crossings (Stream and Utilities)
- Elevation and Derivative Products (slope, aspect, contours)…
- Options

US Army Corps of Engineers

## Current Status

- ✓ Draft Procedure
- ✓ Collecting ITAM data sets
- ✓ Collecting comparison data sets
  - Digital Orthophotography
  - Higher Accuracy Base Mapping
  - Field Data
- ✓ Planning field verification/data collection for April/May 1999

US Army Corps of Engineers

## Problems, Concerns, Coordination Issues

Subcontract award

Data gathering

US Army Corps of Engineers

## Results

Assessment of current state of selected Ft. Hood ITAM data sets

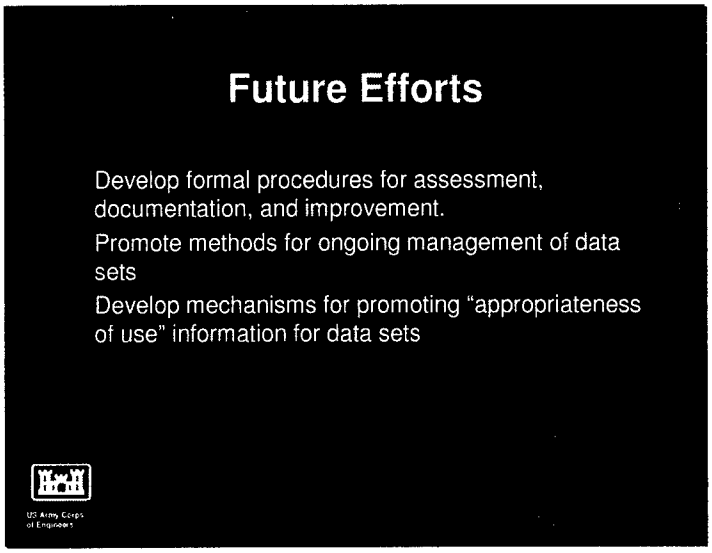
Development of procedures

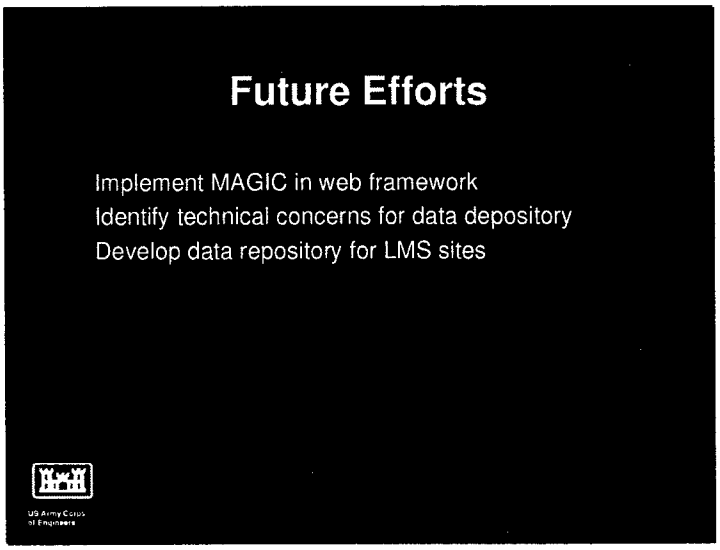
– Requirements

– Tools

Cost (labor…) of data quality improvement

US Army Corps of Engineers




## TES Habitat Modeling

Presenter: Anne-Marie Trame

## The Fort Hood Avian Simulation Model

## The Individual Cowbird Behavior Model

- John Cornelius- primary user and sponsor
- Jim Westervelt, Steve Harper and Ann-Marie Trame - primary development team
- Randy Craft, Sheila Jackson, Gil Eckrich, Jim Koloszar -- Texas Nature Conservancy
- Tim Hayden, Bob Melton, Howard Weinberg, Leslie Jette - CERL field data team
- Steve Briggs, Bruce Macallister, Ibnu Syabri, Dan Lapine - CERL technical modeling team
- Geographic Modeling Systems Lab, U of IL

- **Two endangered species, two different habitat types**
- **Habitat affected by proactive management, fires, and other processes such as grazing and mechanized training**

- Answers questions such as:
  - What is the effect of increasing/ decreasing habitat management?
  - What is the effect of changing fire control policies?
  - What is the optimal balance between two habitat types?

- STELLA software allows non- programmers to input their own knowledge- point and click !
- General dynamic model is repeated in each grid cell of mapped landscape
- GRASS (GIS) and Spatial Modeling Environment (SME) unite spatial and temporal dimensions
- Software interactions, intermediate GIS analysis and output production managed by scripts

- Powerful tools
- Customizable to meet needs of a particular application
- Limiting factor: data inputs, especially spatially explicit knowledge of landscape and significance of landscape to the question of interest
- Some issues related to SME updates

- FOUR SUBMODELS:
  - Management Efforts
  - Accidental Fire
  - Habitat Changes (vegetation submodel)
  - Avian Demographics

- Capture ecological relationships in STELLA
- GIS analyses
- SME configuration
- Scripts to control input- output between SME and GRASS

- 1995 Population Viability Habitat Analysis (RAMAS) used in Fort Hood ESMP
- Compare FHASM results to 1995 results in response to FWS request (ESMP)
- STEP 1 -- "most exact comparison" - demographics only, compare model structure
- STEP 2 -- "full comparison" - no control over spatially explicit and dynamic

## WWW Interface for FHASM

**Welcome to the World Wide Web interface for the Fort Hood Avian Simulation Model (FHASM).**

**To request a simulation, simply:**

**1) enter your e-mail address**
**2) enter the desired values for each variable**
**3) press the Submit button at the bottom of this window**

Overwinter/migration losses

Input type: positive integers from 0 to 100
Units: percent that do not return

| INPUT NAME | VALUE |
|---|---|
| After-Second-Year BCV | 35 |
| Second-Year BCV | 30 |
| After-Second-Year GCW | 45 |
| Second-Year GCW | 60 |

**Overwinter/migration losses (percent that do not return)**

This value, between 0 and 100, indicates the percent of migrating birds that leave Fort Hood at the end of a breeding season but do not return the following breeding season. Default values represent the best estimates available from data collected to date. Effects of increasing or decreasing return rates (e.g., through changes in survival on overwintering grounds) for one or both age classes can be simulated by changing these values.

**Temporal Resolution**

- 200 m X 200 m grid cells = 4 ha = territory size
- 48,400 cells on Fort Hood
- 3- month time steps
- typical run lasts 100 years

Maps depicting cattle grazing policy

Cattle Grazing Map 1
Cattle Grazing Map 2
Cattle Grazing Map 3
Cattle Grazing Map 4
Cattle Grazing Map 5

Presently, leases permit ranchers to graze their cattle within the boundary of Fort Hood. While most of the area is accessible to cattle, not all locations are grazed evenly...

## Output Generated by FHASM

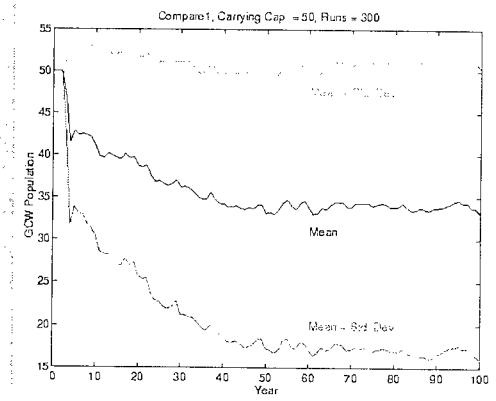
FHASM generates the following output for each simulation. You will be notified of the location containing output graphs and movies after your request has been processed. At that time, you may download any or all output files to your local machine.

Habitat Quality for BCV and GCW (movies)
Breeding Sites of BCV and GCW (movies)
Population Size for BCV and GCW (graphs)
Plant Communities (movie)
Accidental Fires (movie)
Area Burned (graph)

Most exact comparison

Carrying Capacity = 50

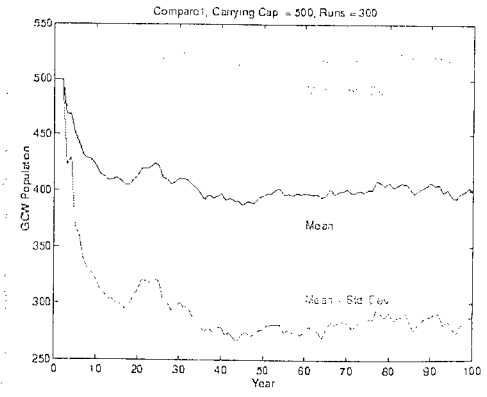
P(e) = 0.115




Most exact comparison

Carrying Capacity = 500

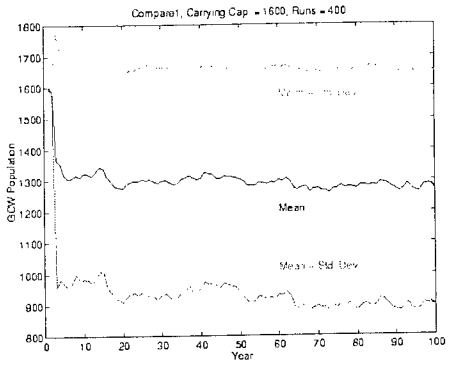
P(e) = 0.005



Most exact comparison

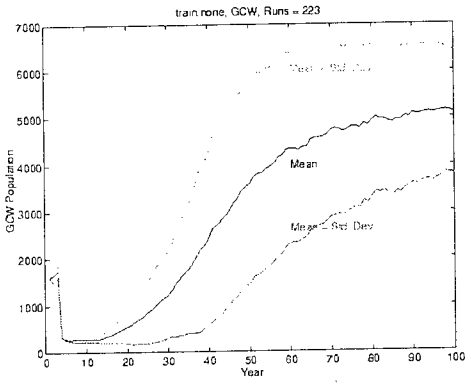
Carrying Capacity = 1600

P(e) = 0.00



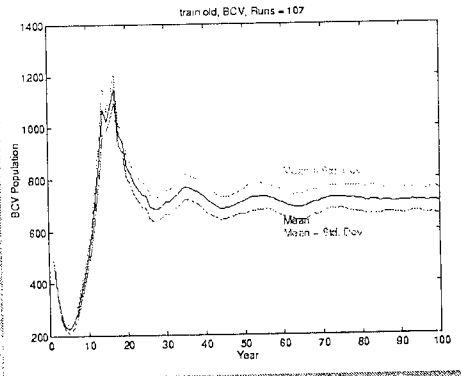

Training map generated from imagery, no additional restrictions

GCW P(e) = 0.00



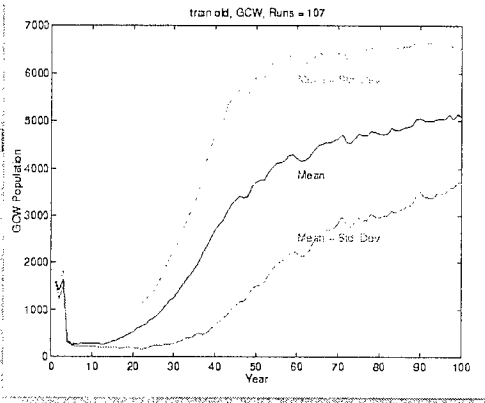

Training map generated from imagery, restricted from endangered areas (pre- ESMP)

BCV P(e) = 0.00



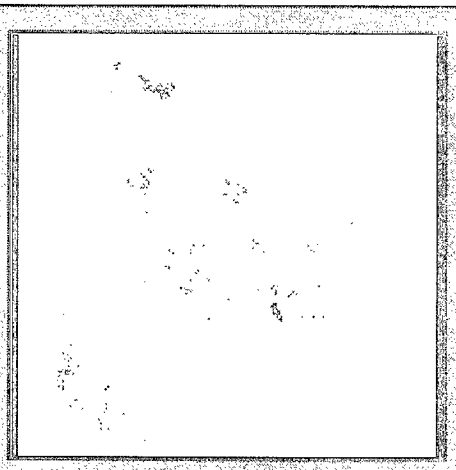
Training map generated from imagery, restricted from endangered areas (pre- ESMP)

GCW P(e) = 0.00



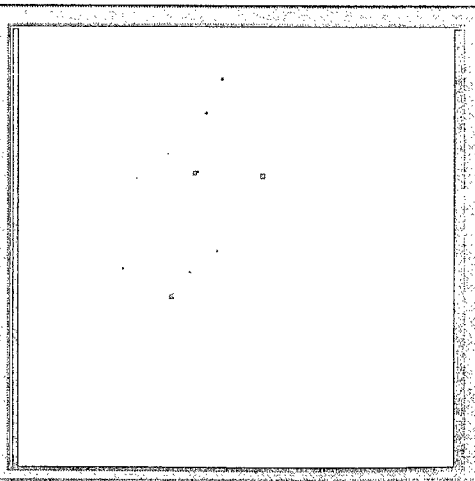

Sample vireo occupation map

blue = SY females
red = ASY females



Sample Accidental Fire Map

336 acres burned

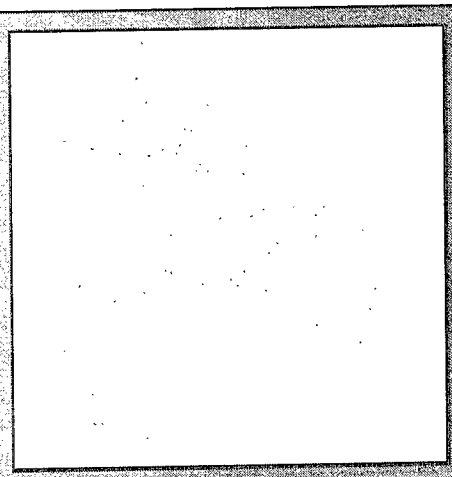


1600 random cells used for most exact comparison

represent simple carrying capacity

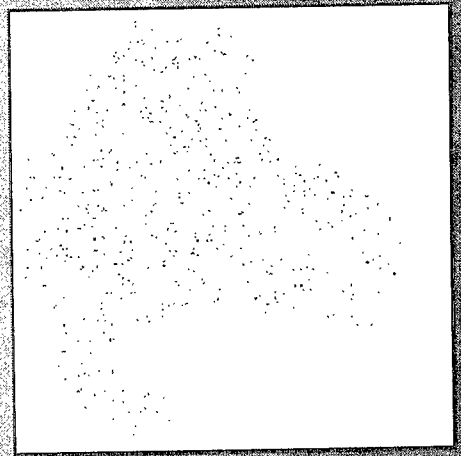
50 random cells used for most exact comparison

represent simple carrying capacity



500 random cells used for most exact comparison

represent simple carrying capacity



Combination of imagery and Oct 98 ESMP proposed training restrictions

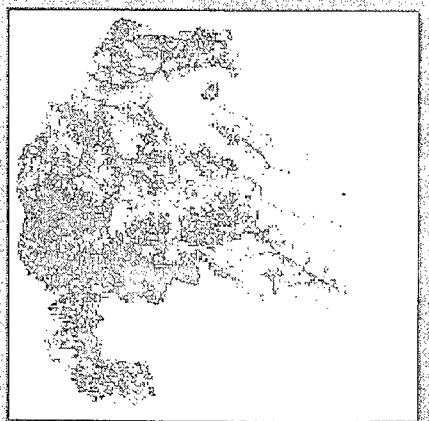
yellow & green = no / low mech training
blue = moderate
red = high

Imagery analysis without additional training restrictions

yellow = no / low mech training
blue = moderate
red = high

Combination of imagery and restrictions on mech training within TES areas

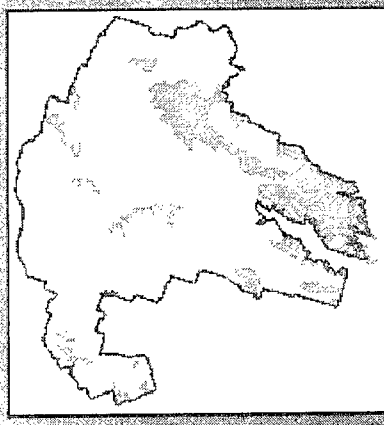
yellow = no / low mech training
blue = moderate
red = high



Sample warbler occupation map

blue = SY females
red = ASY females

Recognized endangered species areas, used to restrict training in one scenario



Impact Comparison

| GCW Carrying Capacity | FHASM-V | Melton 1996 |
|---|---|---|
| 50 | 0.13 | 0.521 |
| 500 | 0.01 | 0.041 |
| 1600 | 0.00 | 0.005 |

## Implementation

- FHASM (original approach)
- Trame, et al. 1997 CERL Tech Report 97/88
- FHASM- V (PVA approach)
- FHASM - L (linked to the ICBM)
- WWW Interface
- http://blizzard.gis.uiuc.edu/htmldocs/IES.html

## Integrated Behavior Model

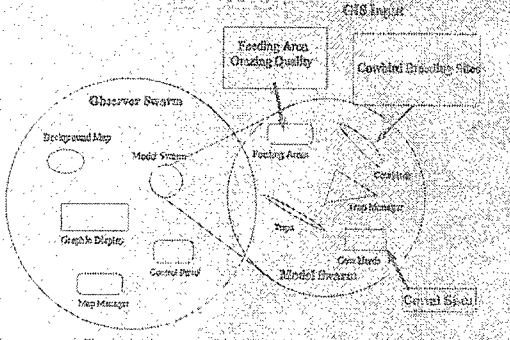
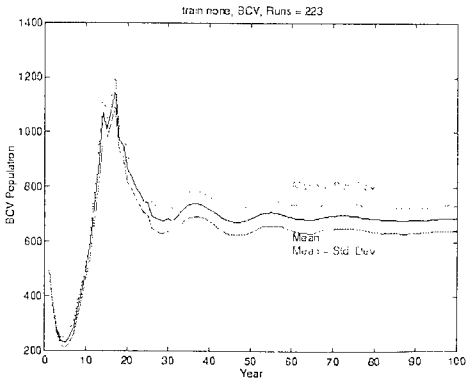
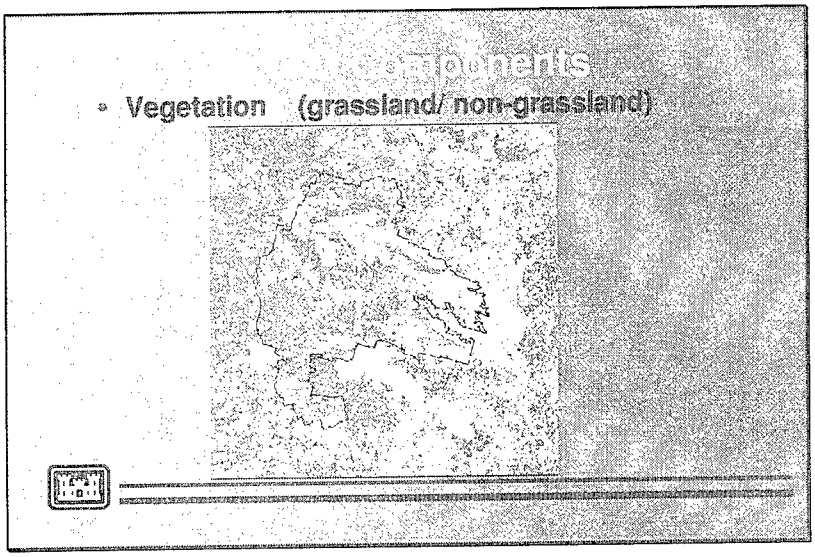


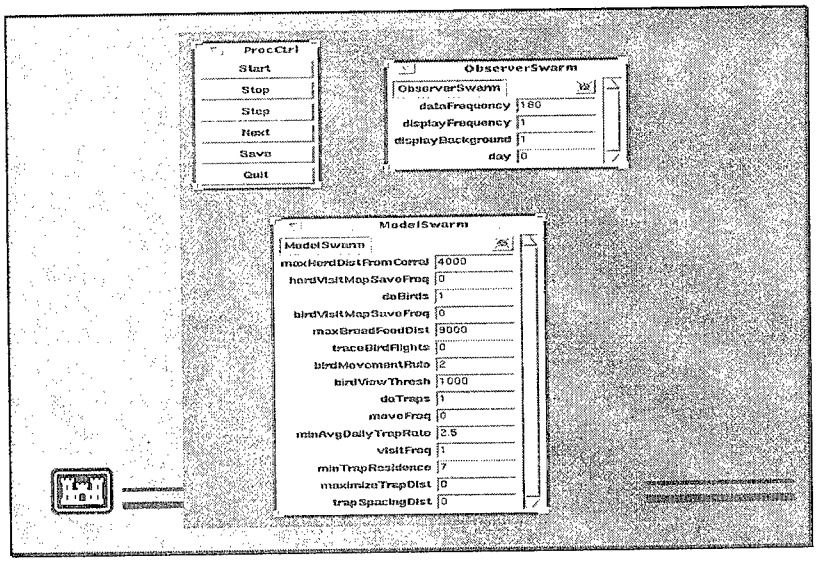

Fig. 1. An Overview of the ICBM Model Structure

## Training map generated from imagery, no additional restrictions

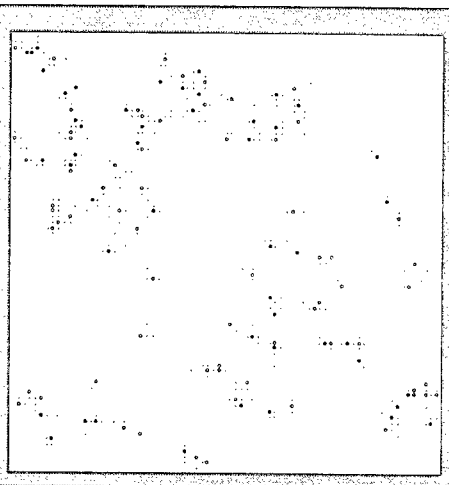
BCV P(e) = 0.00



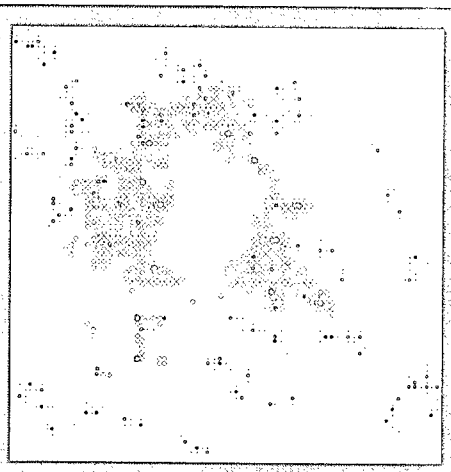

Components
• Vegetation (grassland/ non-grassland)


ProcCtrl
Start
Stop
Step
Next
Save
Quit
ObserverSwarm
ObserverSwarm
dataFrequency 180
displayFrequency 1
displayBackground 1
day 0
ModelSwarm
ModelSwarm
maxHerdDistFromCentrd 4000
herdVisitMapSaveFreq 0
daBirds 1
birdVisitMapSaveFreq 0
maxBroadFeedDist 9000
traceBirdFlights 0
birdMovementRule 2
birdViewThresh 1000
doTraps 1
moveFreq 0
minAvgDailyTrapRate 2.5
visitFreq 1
minTrapResidence 7
maximizeTrapDist 0
trapSpacingDist 0

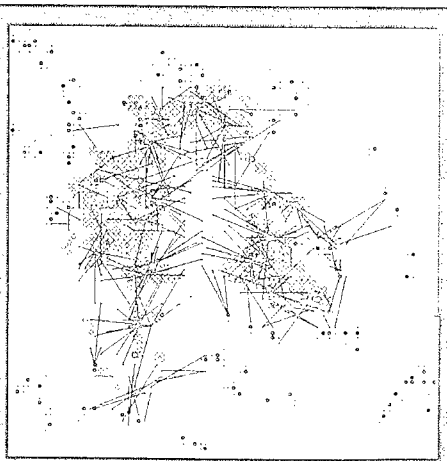
Corrals (green) and cattle (brown) on the ICBM landscape



Corrals, cattle and traps (solid red circles) on ICBM landscape



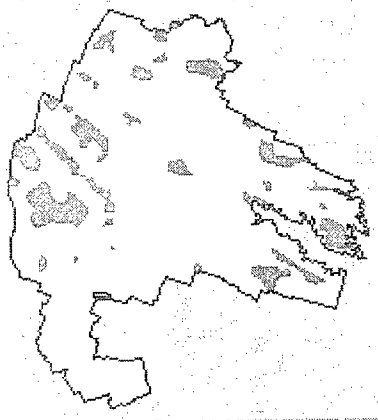
Corrals, cattle and traps and BHCO movement decisions on the ICBM landscape



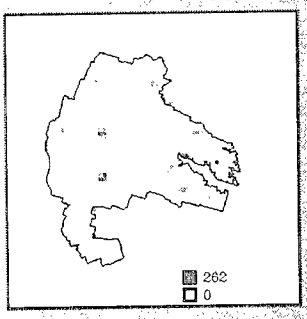
## Model Components

- Cattle Herds -- affected by water, corrals, characteristics of grassland, previous movements
- Female Brown-Headed Cowbirds -- daily movement decisions, affected by cattle and previous movements

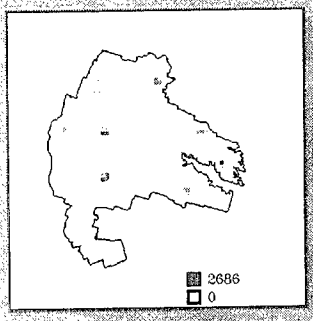
## Example grazing input map for FHASM



## Relative Visitation

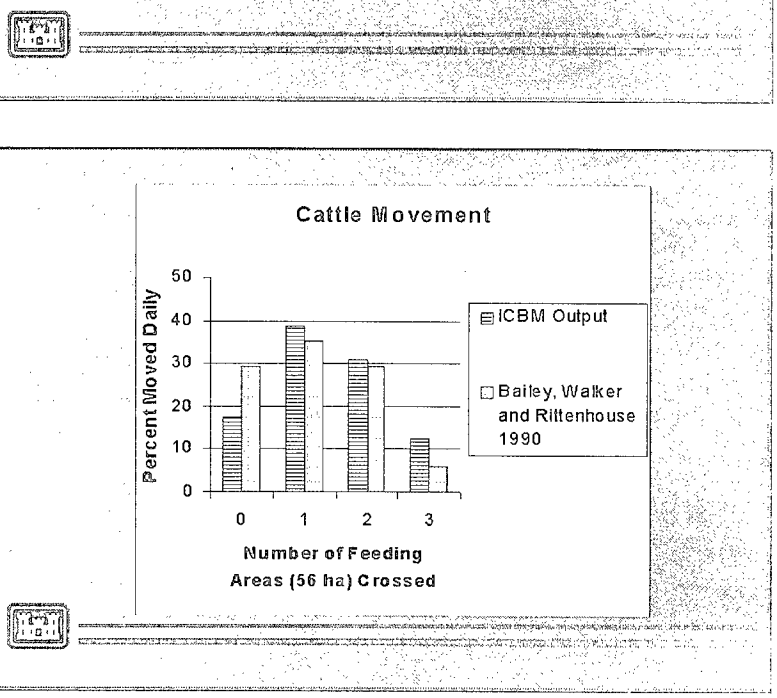


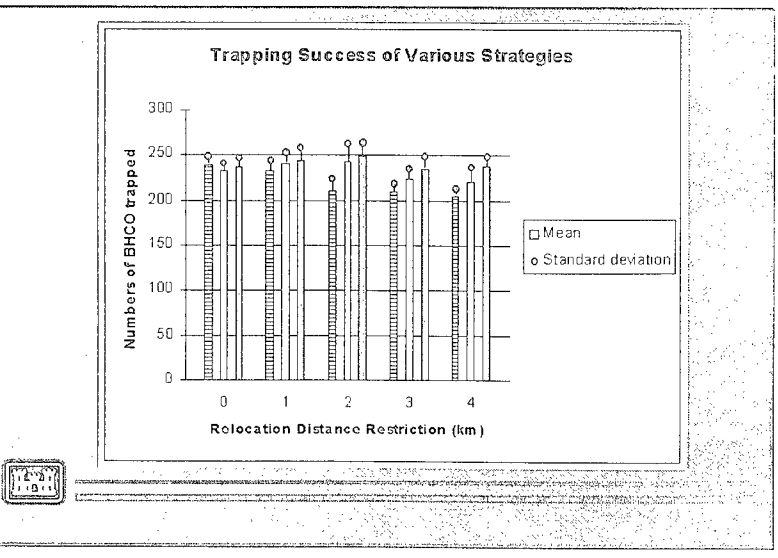

Cattle

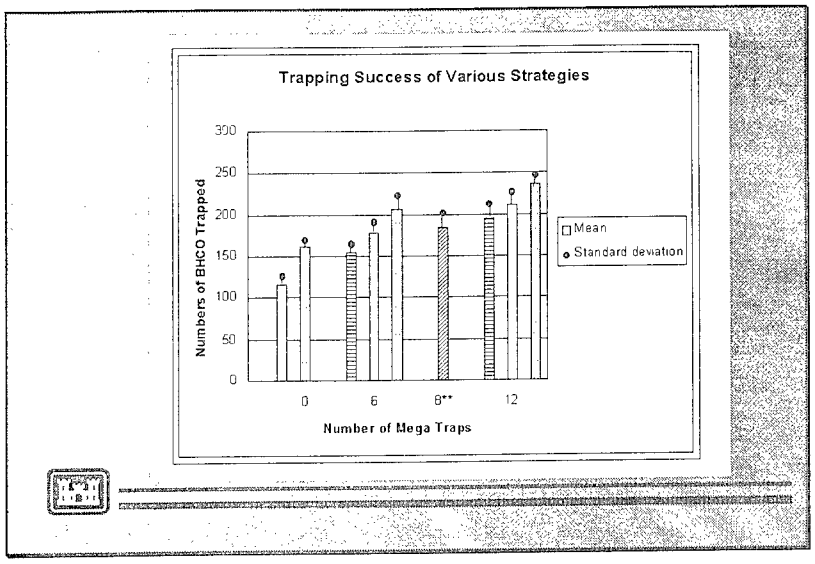


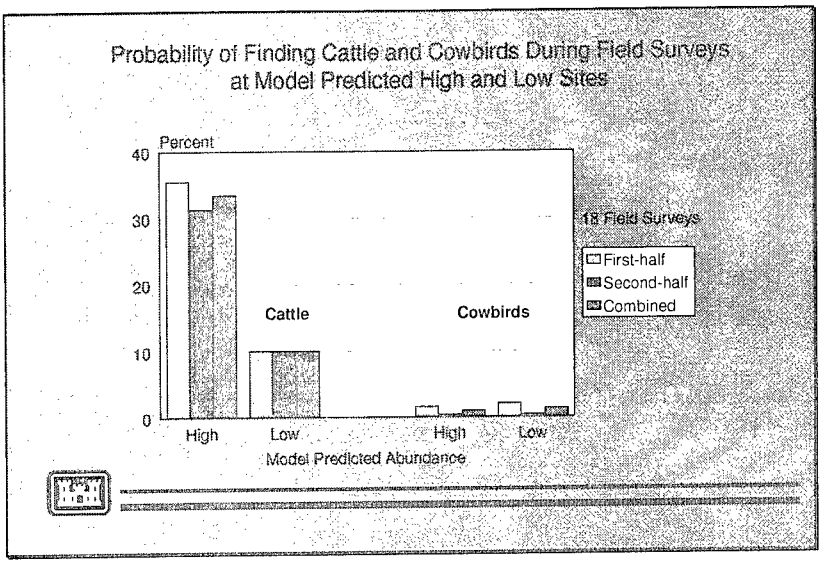

Cowbirds

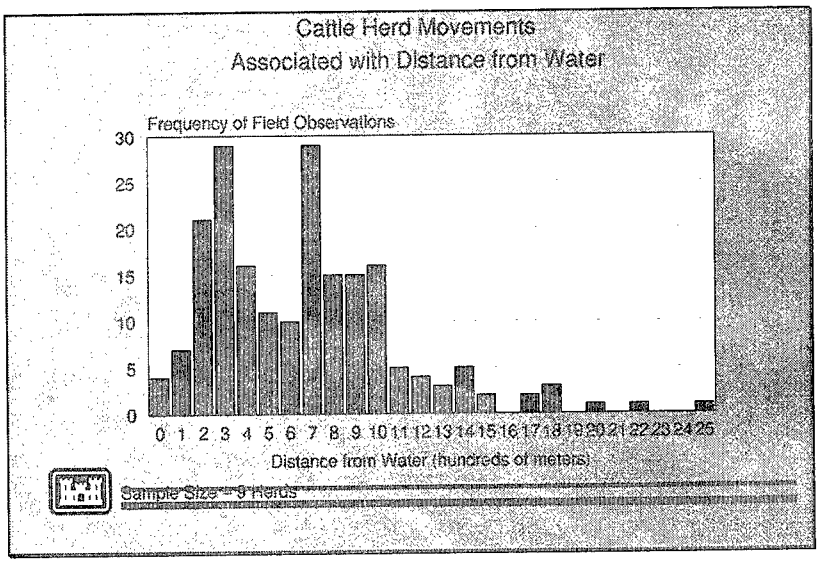
- 2 types of traps – total numbers & proportions
- Relocation rules: How often? How far from previous trapping sites?

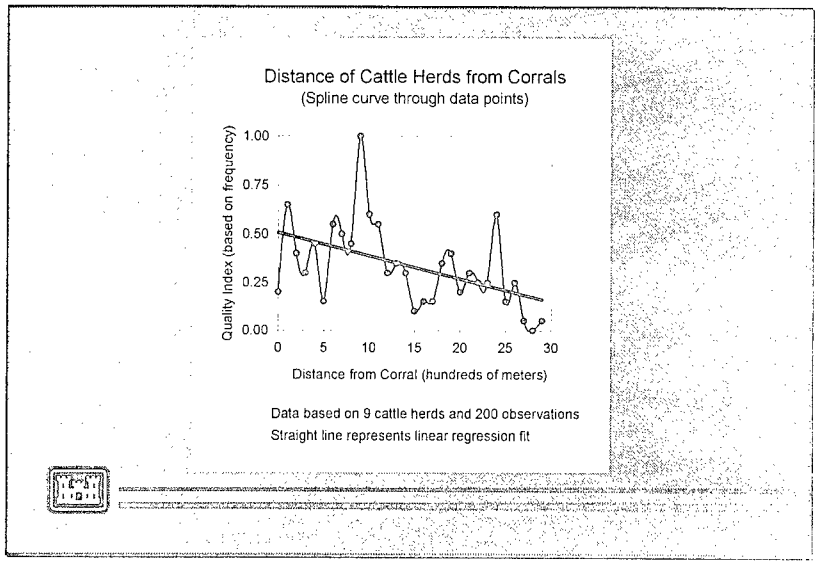


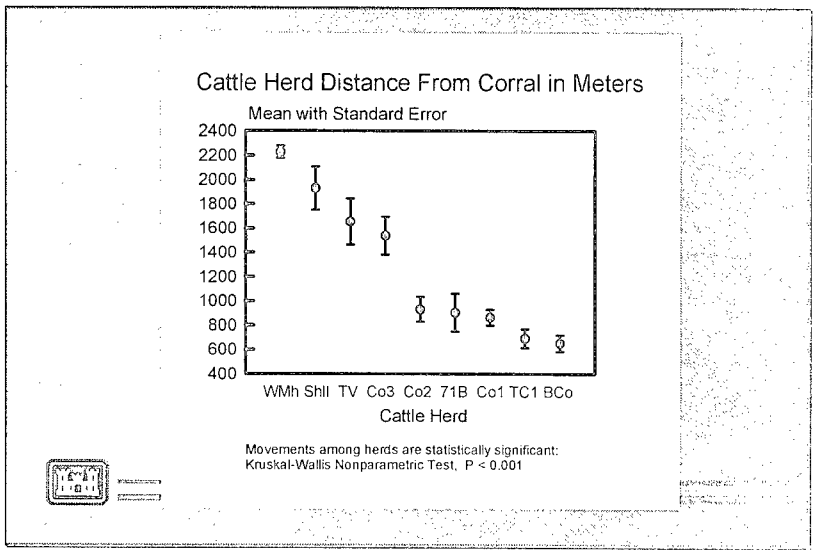



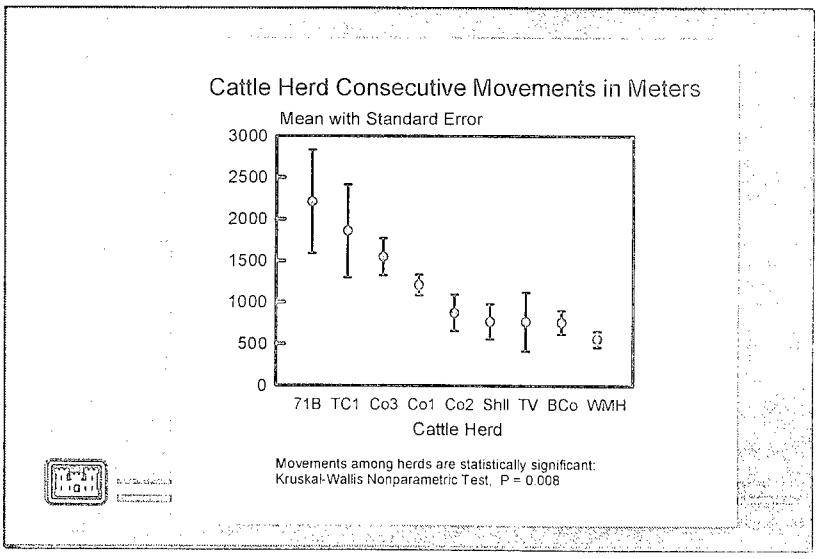

Trapping Success of Various Strategies
Numbers of BHCO Trapped
300
250
200
150
100
50
0
0
6
8**
12
Number of Mega Traps
Mean
Standard deviation

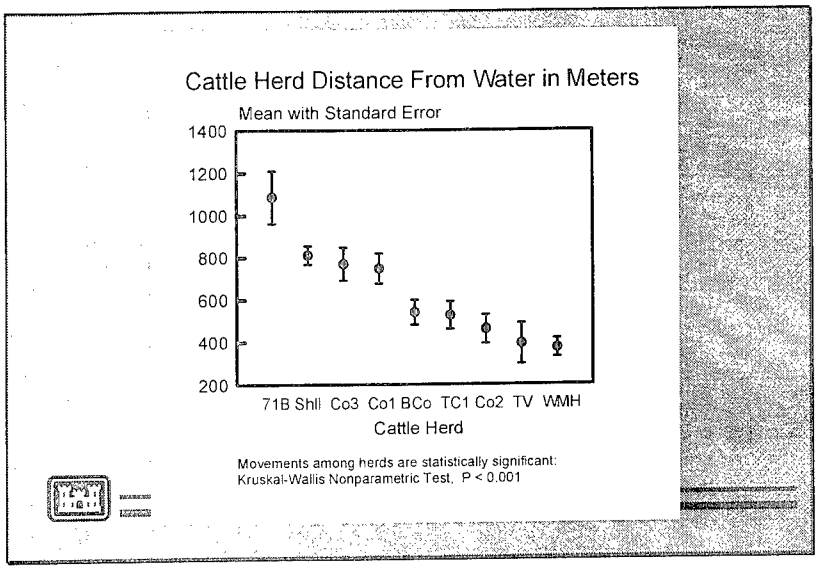

Probability of Finding Cattle and Cowbirds During Field Surveys
at Model Predicted High and Low Sites
Percent
40
30
20
10
0
Cattle
Cowbirds
18 Field Surveys
First-half
Second-half
Combined
High
Low
High
Low
Model Predicted Abundance

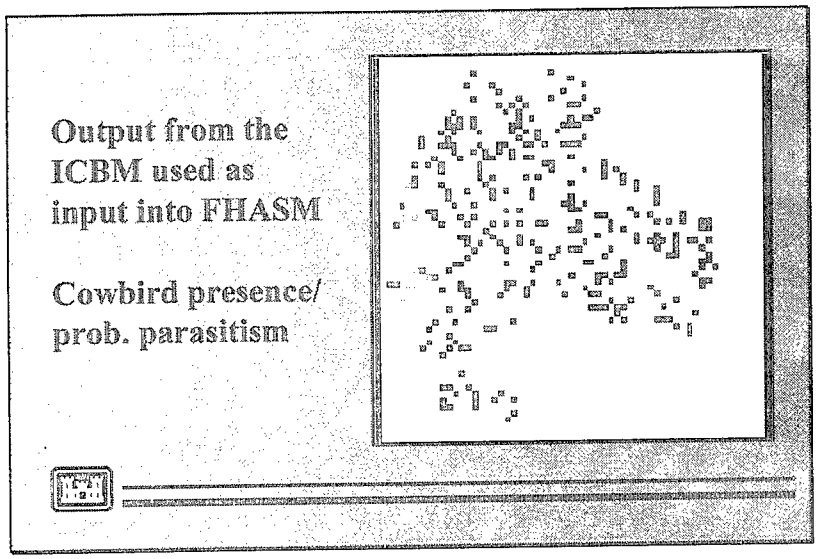

Cattle Herd Movements
Associated with Distance from Water
Frequency of Field Observations
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Distance from Water (hundreds of meters)
Sample Size = 9 Herds

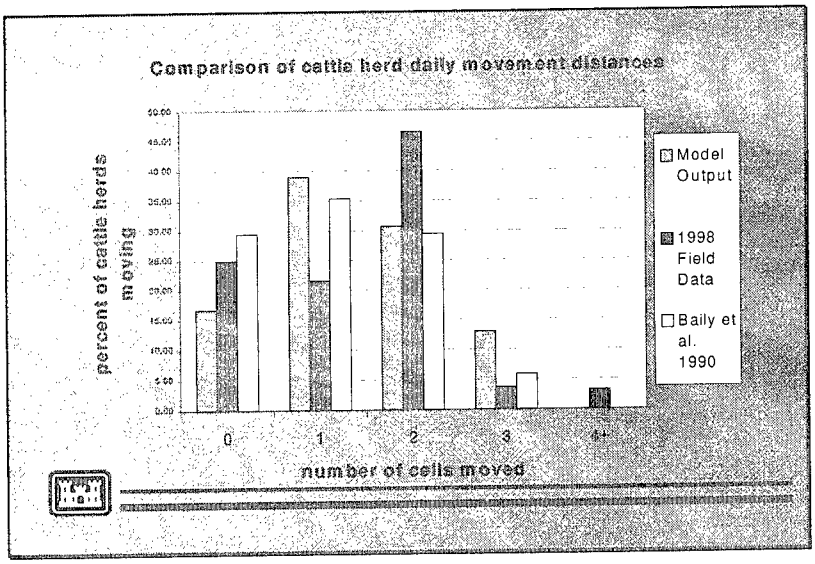

Distance of Cattle Herds from Corrals
(Spline curve through data points)
Quality Index (based on frequency)
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
Distance from Corral (hundreds of meters)
Data based on 9 cattle herds and 200 observations
Straight line represents linear regression fit


Cattle Herd Distance From Corral in Meters
Mean with Standard Error
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
WMh Shll TV Co3 Co2 71B Co1 TC1 BCo
Cattle Herd
Movements among herds are statistically significant:
Kruskal-Wallis Nonparametric Test, P < 0.001


Cattle Herd Consecutive Movements in Meters
Mean with Standard Error
3000
2500
2000
1500
1000
500
0
71B TC1 Co3 Co1 Co2 Shll TV BCo WMH
Cattle Herd
Movements among herds are statistically significant:
Kruskal-Wallis Nonparametric Test, P = 0.008

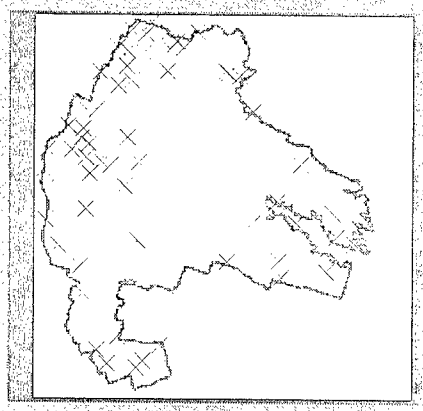

Cattle Herd Distance From Water in Meters
Mean with Standard Error
1400
1200
1000
800
600
400
200
71B Shli Co3 Co1 BCo TC1 Co2 TV WMH
Cattle Herd
Movements among herds are statistically significant:
Kruskal-Wallis Nonparametric Test, P < 0.001


Output from the ICBM used as input into FHASM
Cowbird presence/ prob. parasitism


Comparison of cattle herd daily movement distances
percent of cattle herds moving
Model Output
1998 Field Data
Baily et al. 1990
0
1
2
3
4+
number of cells moved

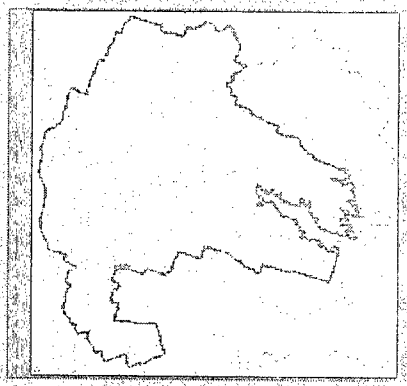
Locations of cattle corrals

1998 field data



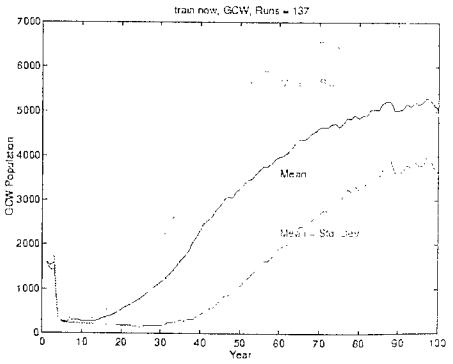
Rivers on Fort Hood

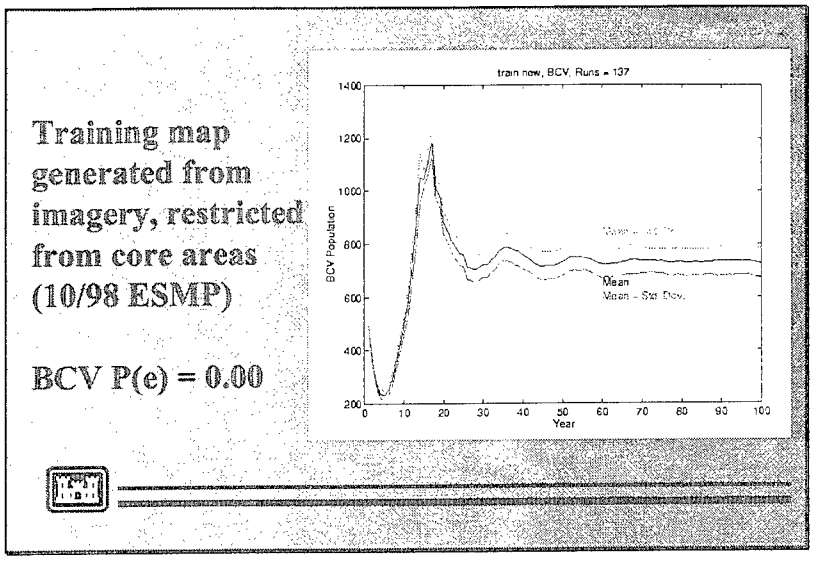
Used in ICBM

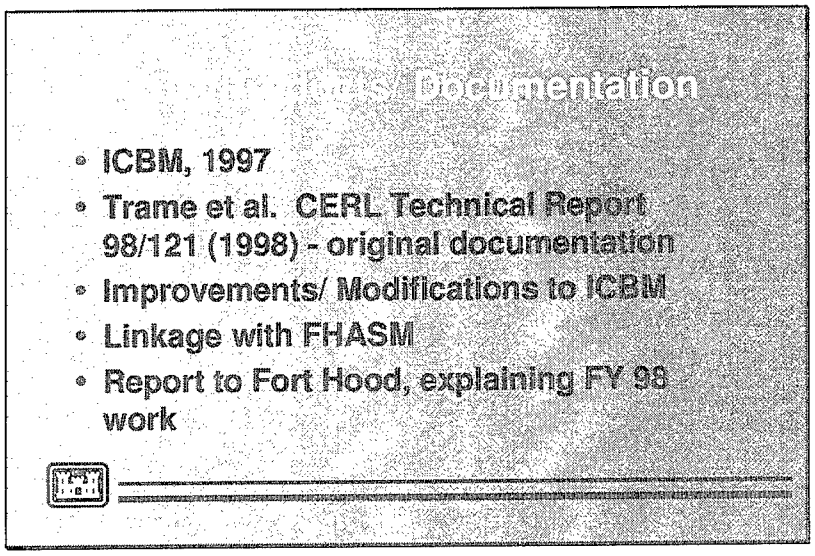


Training map generated from imagery, restricted from core areas areas (10/98 ESMP)

GCW P(e) = 0.00






## Land Based Carrying Capacity Demonstration

Presenters: David Price, Pat Guertin, Scott Tweddale, Dick Gebhart, Alan Anderson, Kim Michaels

# Land Based Carrying Capacity Demonstration Validation Study

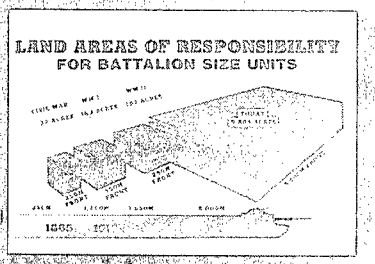
Alan Anderson
David Price
Scott Tweddale
Dick Gebhart
Pat Guertin
U.S. Army Construction Engineering Research Laboratory
Champaign, Illinois

Kim Michaels
U.S. Army Environmental Center
Aberdeen Proving Grounds, Maryland

## Problem Statement

"The basic mission of the US Army is to fight and win in combat. The training of soldiers...is the vital ingredient that assures readiness of the force to accomplish this mission...The most difficult problem ... is the lack of adequate land to conduct realistic training.... An integrated program of land management is the only means of ensuring continued land use." (TC25-1)

- The DoD manages over 24 million acres of land. The Army spends over $50M in training land repair and maintenance.
- Base Realignment and Closure Act (BRAC) will increase the intensity of use on remaining DoD lands.
- The footprint of military training and testing activities is growing.
- Budgets are declining while environmental requirements are increasing.




## User Requirements

DoD Tri-Service User Requirement #4 - Land Capability/Characterization. "There is a research need to determine to what extent given parcels of land are suitable and contain the carrying capacity for sustaining specific activities. It should address the type, magnitude, frequency, and duration of activities, as well as spatial and temporal parameters."

Army Integrated Training Area Management (ITAM) Requirement. "Identify carrying capacity of lands... modeling and predicting carrying capacity and usage impacts."

## Conservation Technology Team

Requirements
Directorate of Environmental Programs

Technology Support
Army Environmental Center

Technology Development
Corps of Engineers Laboratories

Technology Demonstration and Transfer
Army Environmental Center

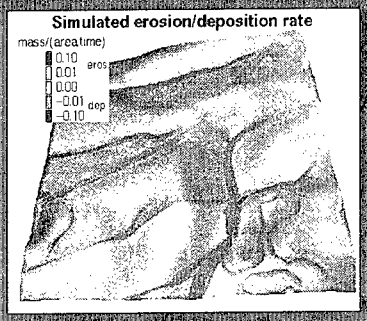
Vision: *Develop and implement a life cycle approach to Conservation technologies that support Army missions.*

## Current Erosion Modeling

Revised Universal Soil Loss Equation (RUSLE)

ES=RKLSCP/T
R: Climatic factor
K: Soil Erodibility factor
LS: Topographic factor
C: Cover factor
P: Conservation factor
T: Soil loss tolerance factor

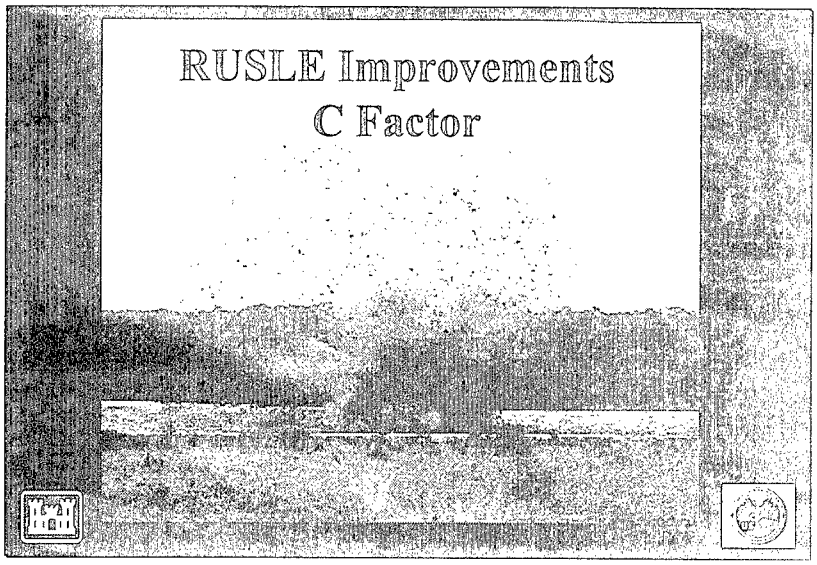
Sensitivity analysis of model for military lands indicates that the LS and C factors are the most critical components of the model

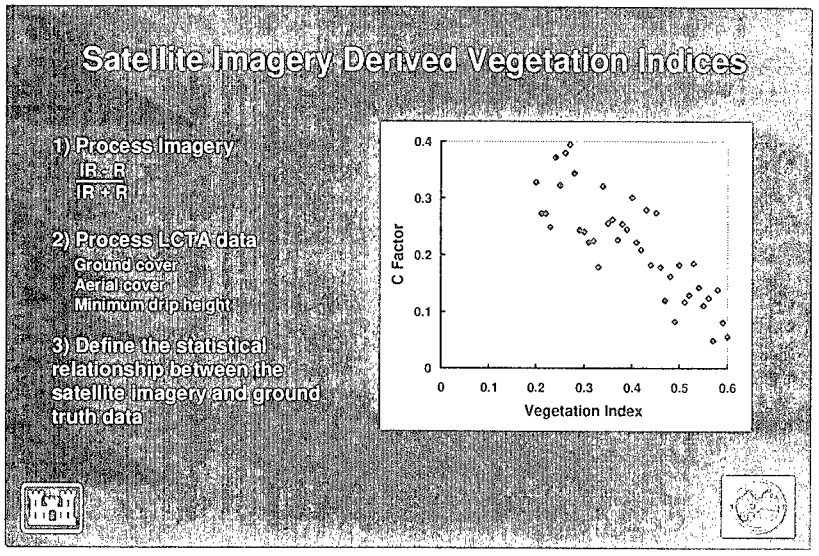


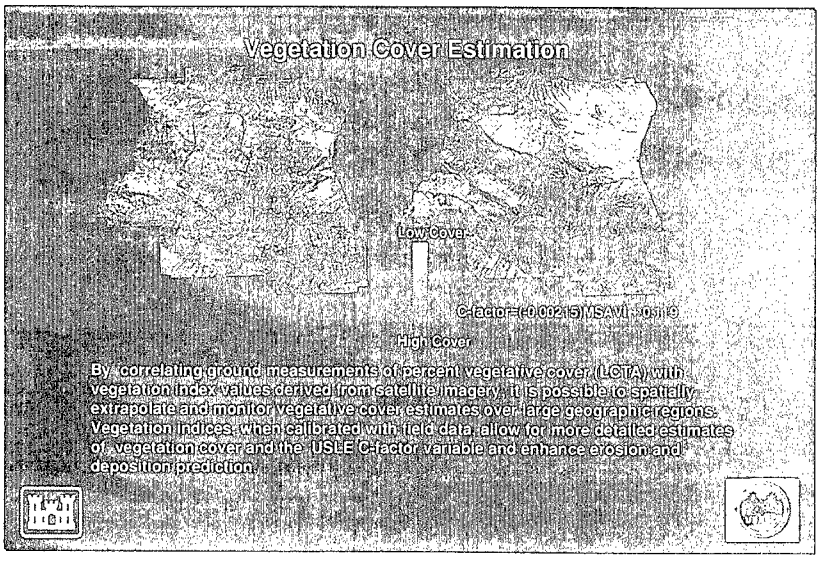

## Project Objectives

The objective of this project is to demonstrate and validate three carrying capacity related products

- Improved Revised Universal Soil Loss Equation (RUSLE).
  - Vegetation Factor (C)
  - Topography Factor (LS)
- Training Use Distribution model
- Ecological Dynamics Simulation (EDYS) model


RUSLE Improvements
C Factor


Satellite Imagery Derived Vegetation Indices
1) Process Imagery
IR - R
IR + R
2) Process LCTA data
Ground cover
Aerial cover
Minimum drip height
3) Define the statistical relationship between the satellite imagery and ground truth data
C Factor
Vegetation Index
0.4
0.3
0.2
0.1
0
0 0.1 0.2 0.3 0.4 0.5 0.6


Vegetation Cover Estimation
Low Cover
C-factor=(-0.0215) NSAVI + 0.5116
High Cover
By correlating ground measurements of percent vegetative cover (LCTA) with vegetation index values derived from satellite imagery, it is possible to spatially extrapolate and monitor vegetative cover estimates over large geographic regions. Vegetation indices, when calibrated with field data, allow for more detailed estimates of vegetation cover and the USLE C-factor variable and enhance erosion and deposition prediction.

## Project Resources

- Army Environmental Center
- A896 Terrain Modeling
- SERDP

## Purpose of the Demonstration/ Validation

- Current LS factor used in ATTACC doesn't account for complex topography associated with military landscapes
- Current LS factor assumes erosion is occurring everywhere and can not account for deposition
- These lead to an overestimation of erosion and underestimation of carrying capacity

## LS Factor Approach

- Three different LS factor calculations
  - Current ATTACC methodology using LS values derived from LCTA plots
  - LS values derived from GIS Digital Elevation Models (DEM's)
  - LS values derived from high resolution DEM's and use of Unit Steam Power Theory which accounts for upslope contributing area/ topographic complexities

## LS Factor Approach

- Each of the three LS factor calculations were used to develop an LS data layer for the demonstration watershed at Fort Hood
- These LS data layers were then combined with the other RUSLE component data layers (soils, vegetation cover, rainfall/ runoff) to produce maps illustrating predicted long term soil erosion

## LS Factor Approach

- Comparison and validation of the different long term soil erosion predictions were done using Cs-137 methodologies
- Cs-137
  - by-product of nuclear testing
  - strongly adsorbed to soil particles
  - emits easily measured gamma rays
  - spatial distribution of Cs-137 across the watershed can be used to map erosion and deposition areas
    - high Cs-137 = net deposition
    - low Cs-137 = net erosion

## LS Factor Approach

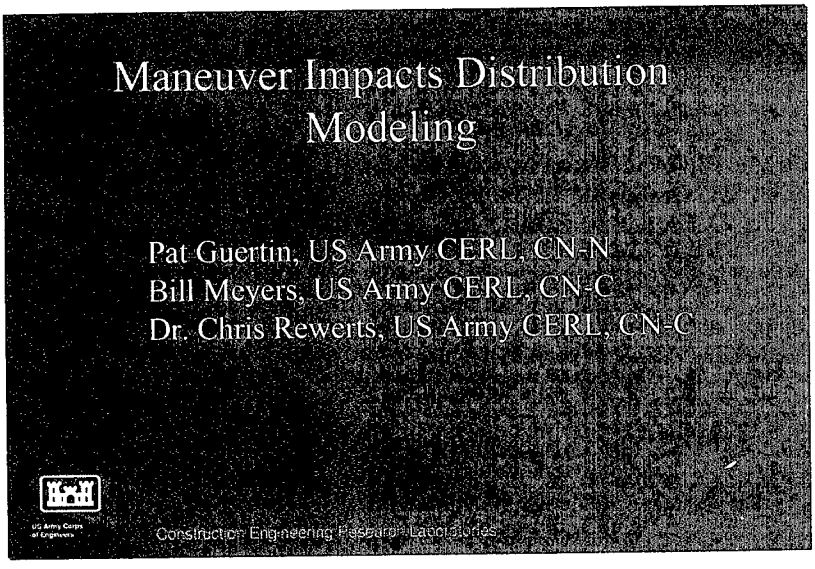
- About 200 soil samples were collected from a grid pattern within the watershed, analyzed for Cs-137, and used to calculate erosion/ deposition

## LS Factor Status

- Cs-137 analysis has just been completed and will be analyzed to produce watershed estimates of erosion/ deposition
- Cs-137 erosion/ deposition estimates will then be compared to model estimates using the there different LS factor calculations (30 Jun 99)

## Results/ Products

- Identification of "most accurate" LS factor for use in ATTACC
- Improved estimates of soil erosion/ deposition
- Improved estimates of carrying capacity



## Project Focus

Develop method to extrapolate cumulative disturbance distribution on landscape

- ATTACC
- LCTA Analysis

Provide for disturbance projection in LBCC research.

- LMS

Construction Engineering Research Laboratories

## Cooperation and Funding

Cooperators:

- Jerry Paruzinski, Fort Hood, ITAM
- Kim Michaels (AEC)

Funding:

- A896
- AEC - DEM/VAL

Construction Engineering Research Laboratories

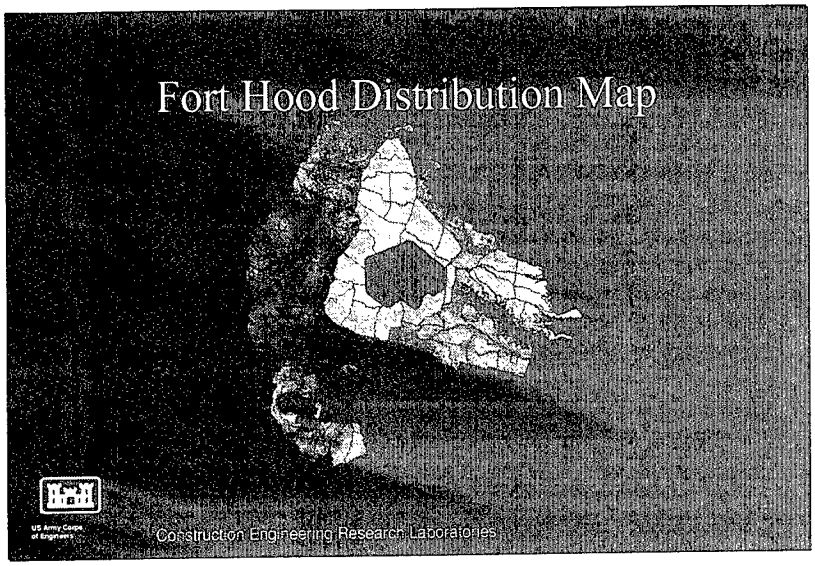
## Project Approach

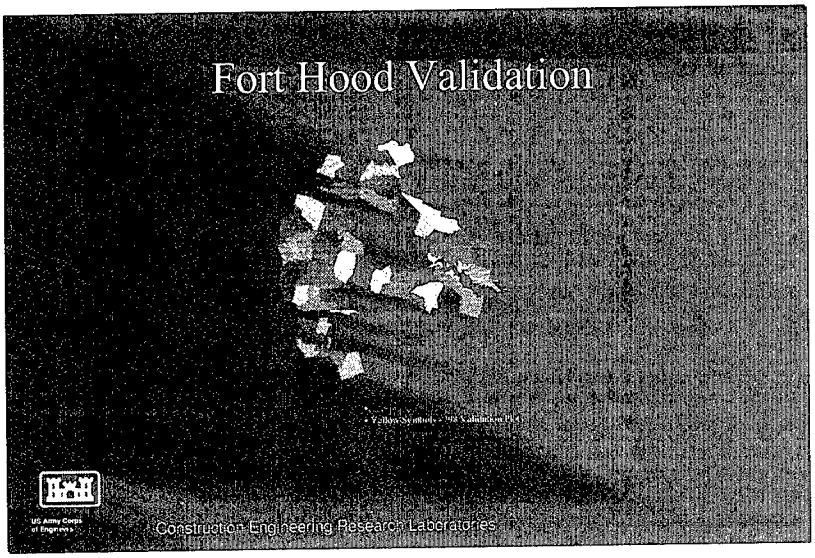
Project developed with existing LCTA, GIS, training data.

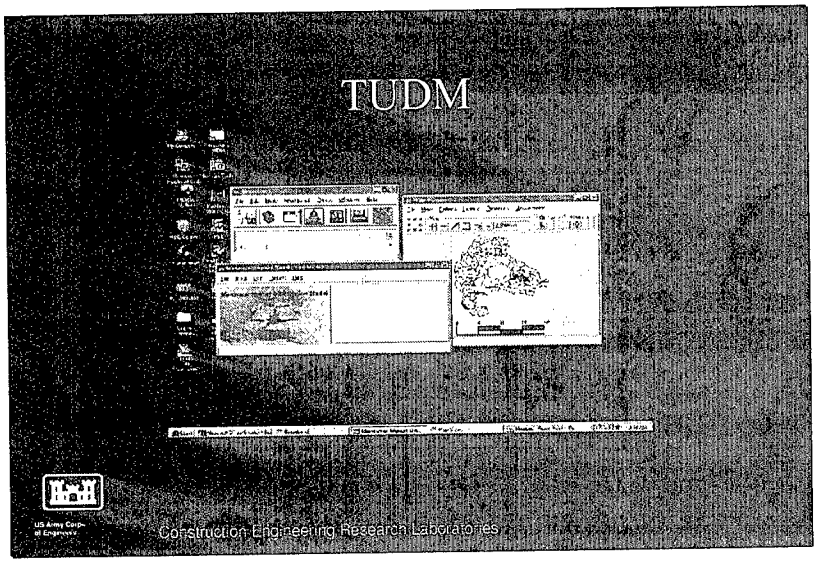
Development approach split into 2 categories:

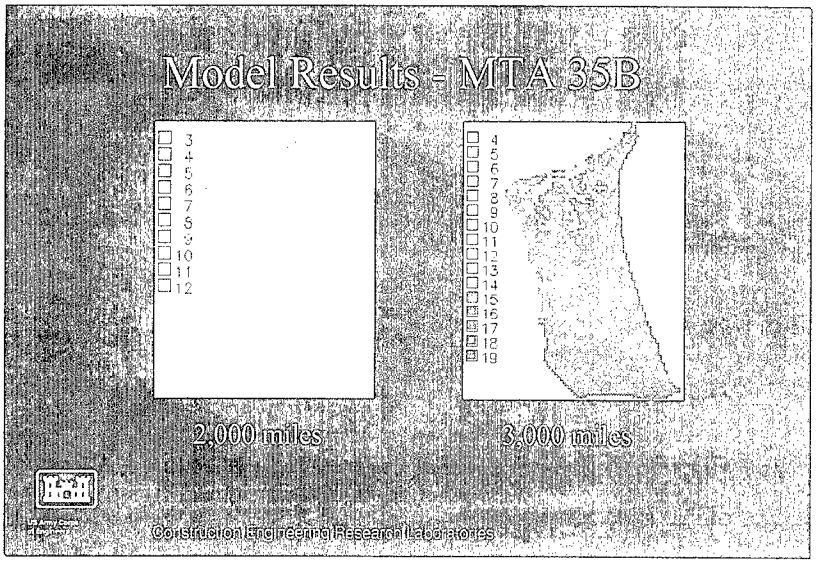
1. Distribution Mapping
2. LBCC modeling

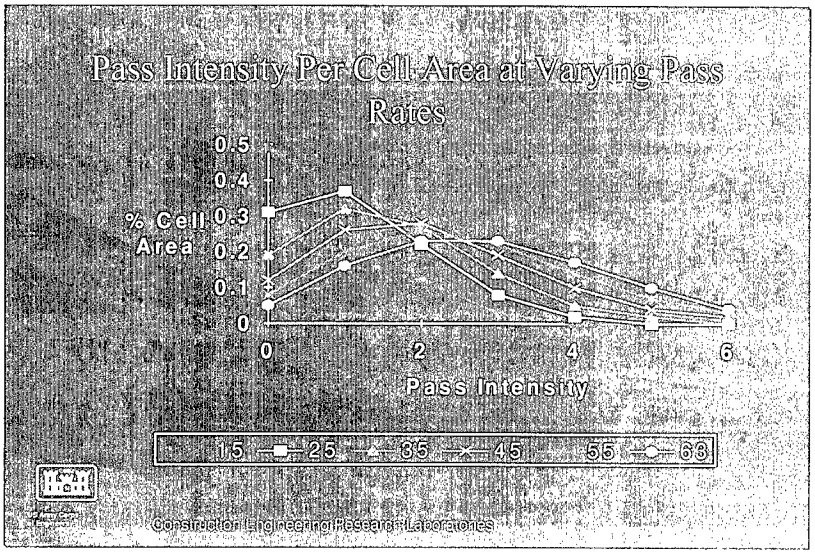
Construction Engineering Research Laboratories

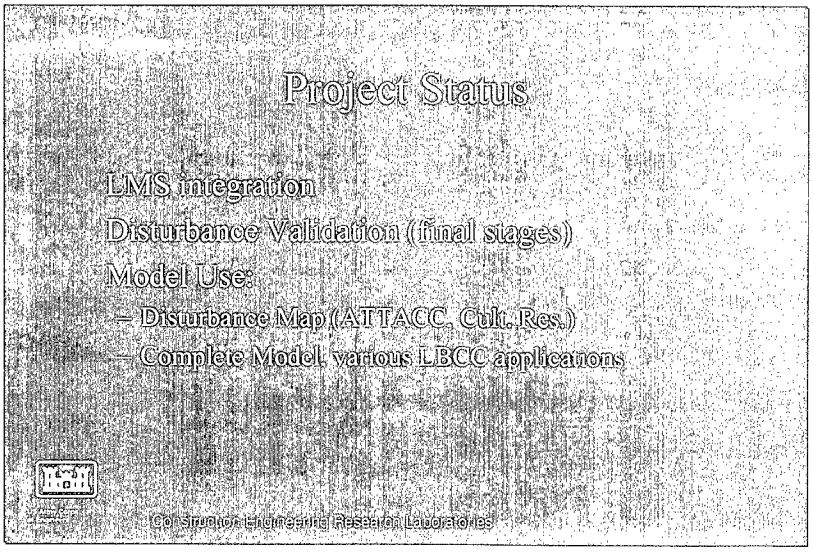

Fort Hood Distribution Map
US Army Corps of Engineers
Construction Engineering Research Laboratories

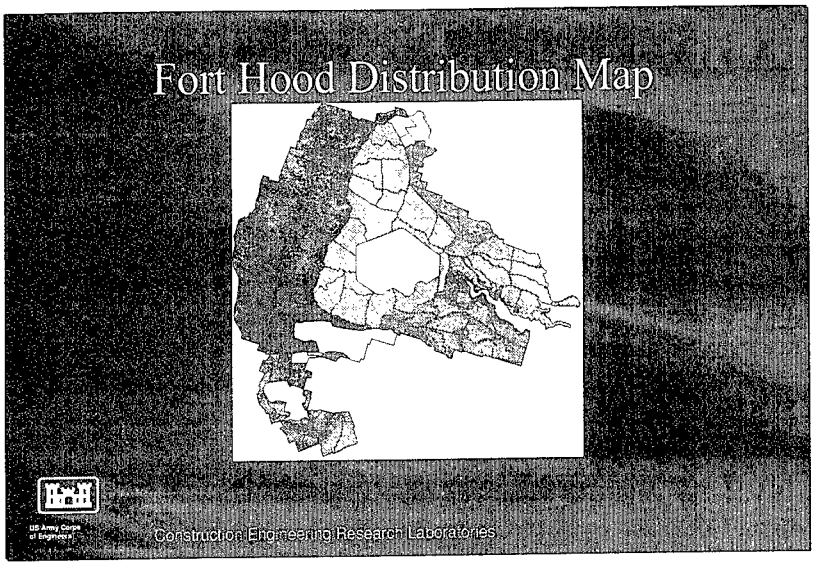

Fort Hood Validation
US Army Corps of Engineers
Construction Engineering Research Laboratories

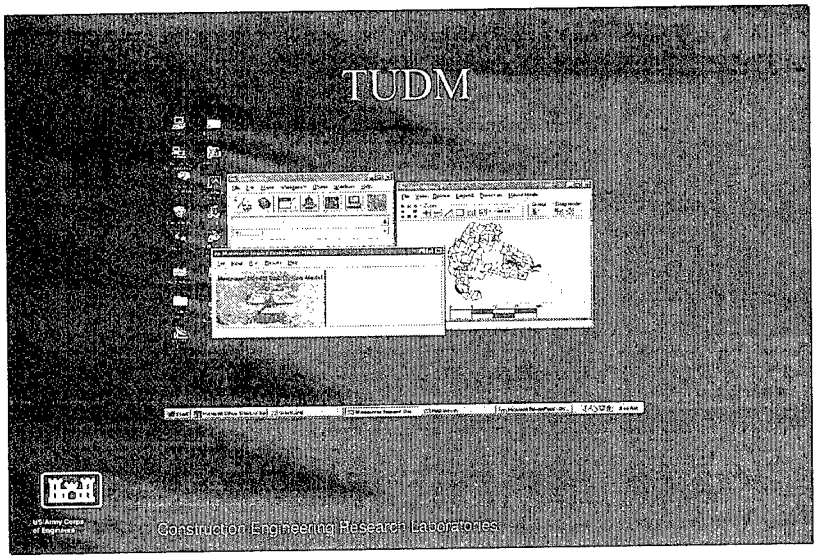

TUDM
US Army Corps of Engineers
Construction Engineering Research Laboratories


Model Results - MTA 35B
3
4
5
6
7
8
9
10
11
12
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
2,000 miles
3,000 miles
Construction Engineering Research Laboratories


Pass Intensity Per Cell Area at Varying Pass Rates
% Cell Area
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
Pass Intensity
15
25
35
45
55
68
Construction Engineering Research Laboratories


Project Status
LMS integration
Disturbance Validation (final stages)
Model Use:
– Disturbance Map (ATTACC, Cult. Res.)
– Complete Model, various LBCC applications
Construction Engineering Research Laboratories




# Land Based Carrying Capacity Demonstration IPR

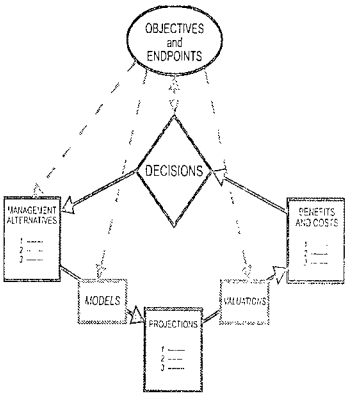
## Ecological Dynamics Simulation (EDYS)

David Price, Alan Anderson ERDC/CERL
Terry McLendon, Mike Childress, Cade Coldren SMI

# Purpose

## EDYS Model Validation & Demonstration

- Validate the accuracy of the EDYS model predictions
- Validate the utility of the EDYS model in a decision framework
- Demonstrate the utility of the EDYS model in real training land management scenarios




# Offices Involved

- Fort Hood, TX
  - DPW/Natural Resources
  - ITAM
- Fort Bliss, TX
  - DPW/Directorate of Environment
  - ITAM
- US Army Environmental Center
- USDA NRCS Water Management Center

# Performers

- ERDC/USACERL
  - David Price and Alan Anderson
- Shepherd Miller Inc.,
  - Terry McLendon, Mike Childress, Cade Coldren
- USAEC
  - Kim Michaels
- Forts Hood and Bliss
  - Don Jones, Kevin Vonfinger, Brett Russell
- USDANRCS
  - Terry Atwood

## Project Resources

- ERDC/USACERL Direct Program
  - Land Based Carrying Capacity
  - Installation Capacity Factors
  - Land Management System (LMS)
- USAEC Technology Transfer Program
- In-Kind leverage, Forts Hood and Bliss
  - Personnel time
  - Available data
- USDA/NRCS Technology Acquisition Program

## Approach and Content

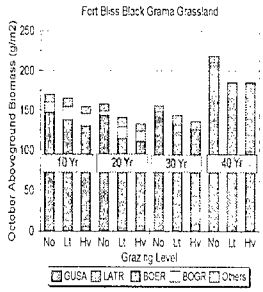
- Verification of the mechanics of the model
  - Nitrogen, Water, Fire, Training, Grazing
- Validation of the accuracy of the model
  - Vegetation composition, structure, production
  - Small scale water and nitrogen dynamics
- Demonstration via a case study
  - Fort Bliss grazing versus training
  - Fort Hood juniper encroachment

## Current Timetable, Steps, Status

- Establish validation plots, Fall 97
- Collect and summarize impacts data, Fall 97
- Collect validation data and apply nitrogen and water treatments, Spring 98, Fall 98
- EDYS verification/validation, Spring 99
- Collect validation data, Spring 99, Fall 99
- EDYS verification/validation, Fall 99
- Final Report and case study, January 00

# EDYS results and products

- Progress to date, example simulation from Ft. Bliss, TX
  - Simulation of biomass changes with livestock grazing and no fire
  - Similar simulation with grazing and fire maintains grassland through year 40

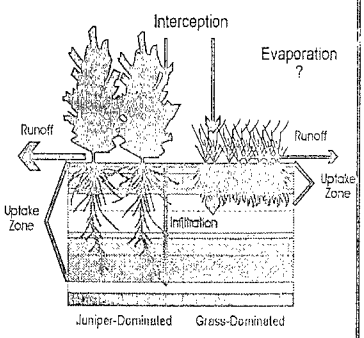



# EDYS results and products

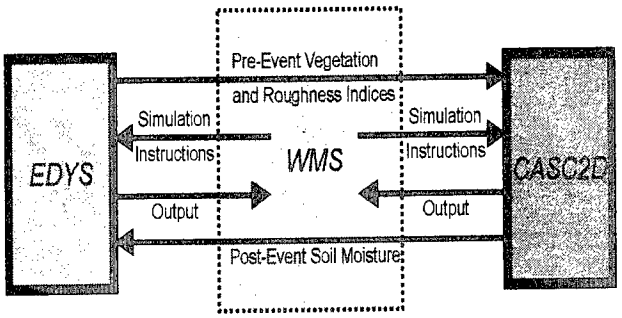
| Input Data | | Simulation Accuracy | | | |
|---|---|---|---|---|---|
| Vegetation | Precipitation | Total Above-ground | Shrubs | Perennial Grasses | Species Weighted Average |
| Feb 98 Site Samples | 1998 Site | 1.044 | 0.223 | 1.184 | 0.674 |
| Feb 98 Site Samples | 1998 El Paso | 0.697 | 0.138 | 0.797 | 0.693 |
| Feb 98 Site Samples | 1948 El Paso | 0.687 | 0.185 | 0.762 | 0.660 |
| 1989 LCTA 7 Plots | 1998 Site | 1.010 | 0.682 | 1.065 | 0.769 |
| 1989 LCTA 7 Plots | 1998 El Paso | 0.680 | 0.524 | 0.723 | 0.606 |
| 1989 LCTA 7 Plots | 1948 El Paso | 0.661 | 0.579 | 0.686 | 0.582 |
| 1989 LCTA 34 Plots | 1998 Site | 0.594 | 0.867 | 0.503 | 0.083 |
| 1989 LCTA 34 Plots | 1998 El Paso | 0.373 | 0.558 | 0.329 | 0.240 |
| 1989 LCTA 34 Plots | 1948 El Paso | 0.472 | 0.545 | 0.319 | 0135 |

# EDYS results and products

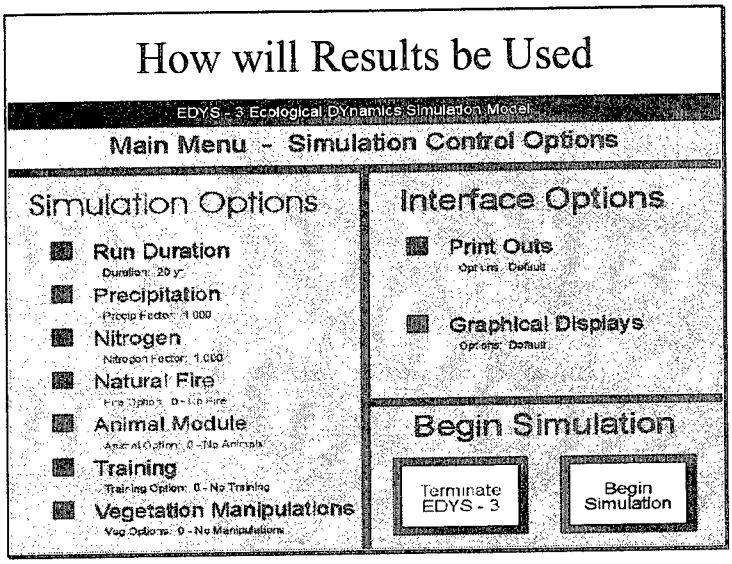
- Progress to date, example simulation from Ft. Hood, TX
  - Simulation of biomass changes with livestock grazing and no fire
  - Simulation of changes in water quality and quantity via juniper control



## How will Results be Used

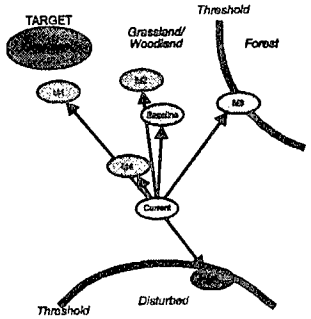



## How will Results be Used



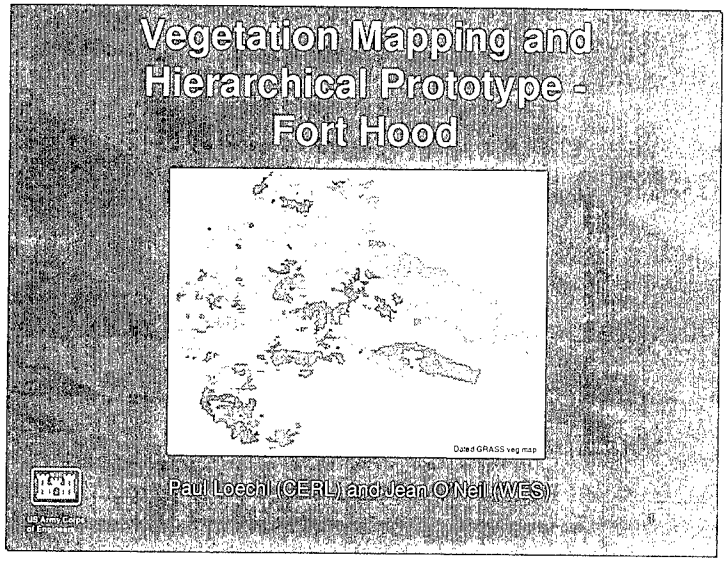

## Ecological Restoration Potential and Impact Thresholds

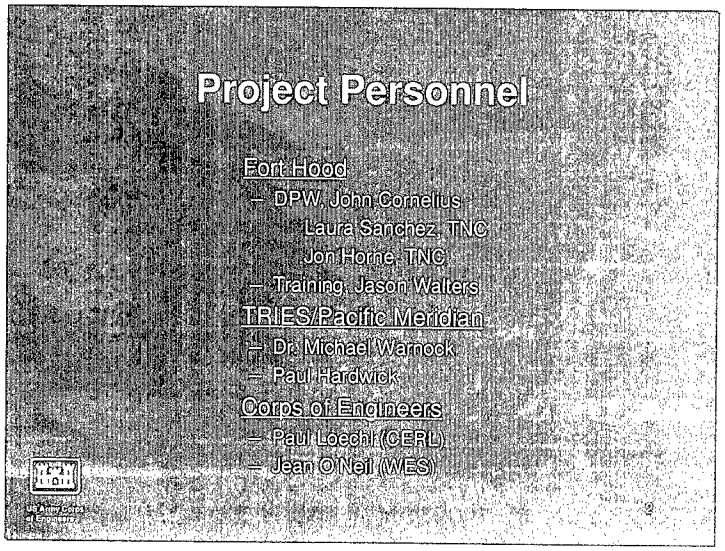
- Management and Restoration Strategies
  - ID Ecological risks or risks to mission
  - ID management or restoration strategies'
  - Run simulations to bound likely outcomes
  - Prioritize management actions and thresholds

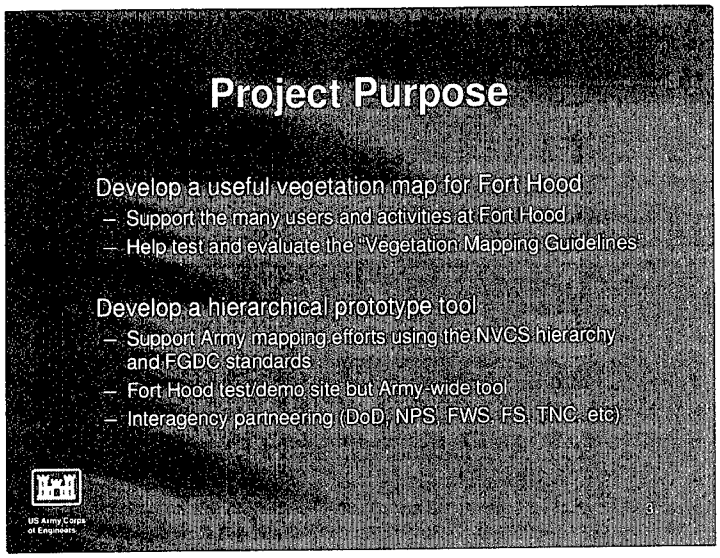


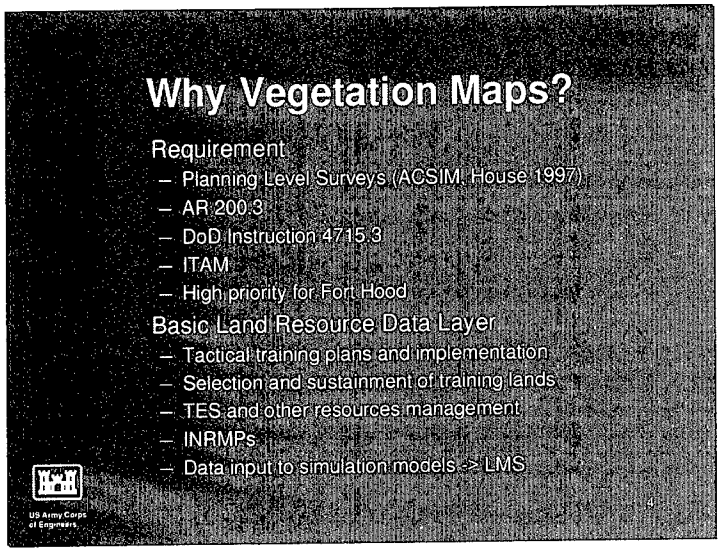
## Vegetation Mapping

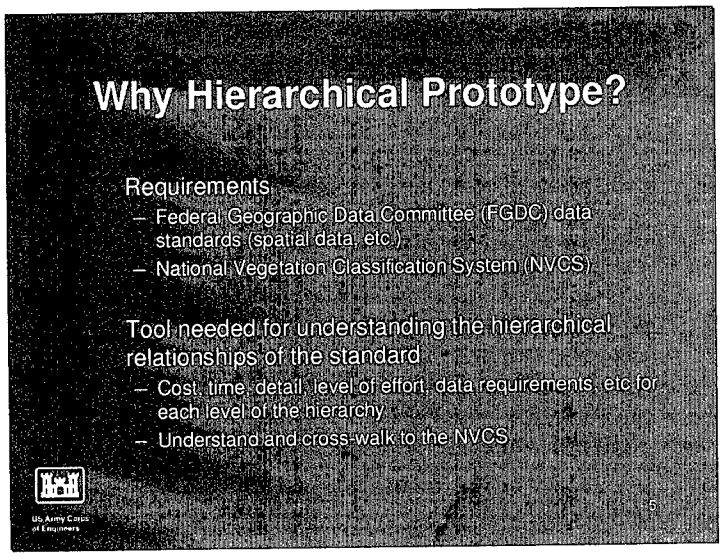
Presenters: Paul Loechl, Jean O'Neil, Michael Warnock, Paul Hardwick

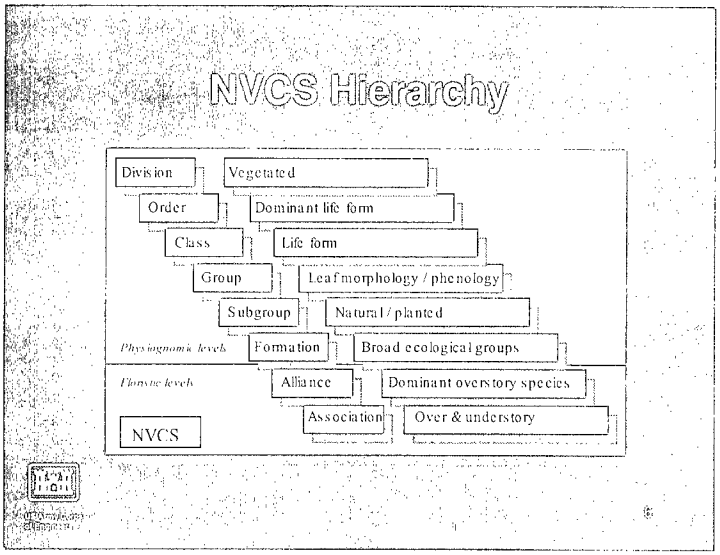


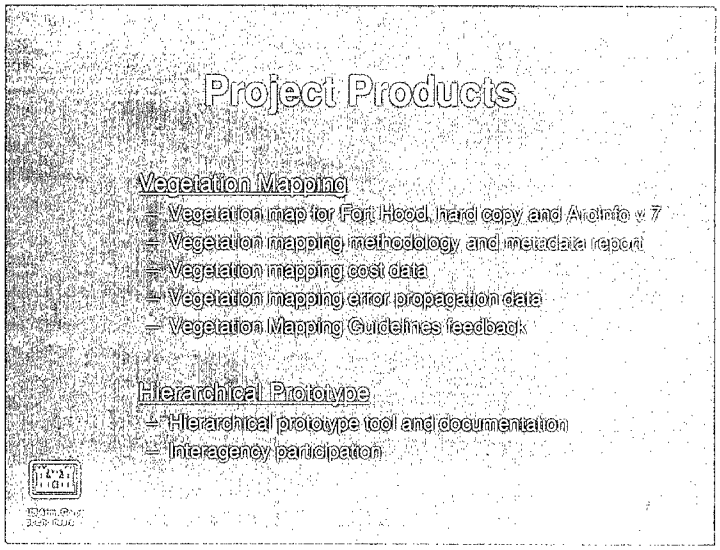



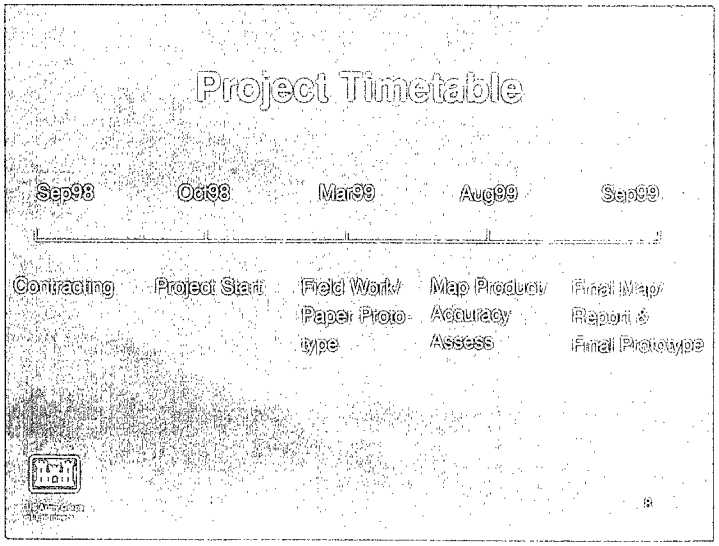

Project Purpose
Develop a useful vegetation map for Fort Hood
– Support the many users and activities at Fort Hood
– Help test and evaluate the "Vegetation Mapping Guidelines"
Develop a hierarchical prototype tool
– Support Army mapping efforts using the NVCS hierarchy and FGDC standards
– Fort Hood test/demo site but Army-wide tool
– Interagency partneering (DoD, NPS, FWS, FS, TNC, etc)
US Army Corps of Engineers
3


Why Vegetation Maps?
Requirement
– Planning Level Surveys (ACSIM, House 1997)
– AR 200-3
– DoD Instruction 4715.3
– ITAM
– High priority for Fort Hood
Basic Land Resource Data Layer
– Tactical training plans and implementation
– Selection and sustainment of training lands
– TES and other resources management
– INRMPs
– Data input to simulation models -> LMS
US Army Corps of Engineers
4


Why Hierarchical Prototype?
Requirements
– Federal Geographic Data Committee (FGDC) data standards (spatial data, etc.)
– National Vegetation Classification System (NVCS)
Tool needed for understanding the hierarchical relationships of the standard
– Cost, time, detail, level of effort, data requirements, etc for each level of the hierarchy
– Understand and cross-walk to the NVCS
US Army Corps of Engineers
5


NVCS Hierarchy
Division
Vegetated
Order
Dominant life form
Class
Life form
Group
Leaf morphology / phenology
Subgroup
Natural / planted
Physiognomic levels
Formation
Broad ecological groups
Floristic levels
Alliance
Dominant overstory species
Association
Over & understory
NVCS


Project Products
Vegetation Mapping
– Vegetation map for Fort Hood, hard copy and ArcInfo v 7
– Vegetation mapping methodology and metadata report
– Vegetation mapping cost data
– Vegetation mapping error propagation data
– Vegetation Mapping Guidelines feedback
Hierarchical Prototype
– Hierarchical prototype tool and documentation
– Interagency participation


Project Timetable
Sep98
Oct98
Mar99
Aug99
Sep99
Contracting
Project Start
Field Work/ Paper Proto-type
Map Product/ Accuracy Assess
Final Map/ Report & Final Prototype

## Project Milestones

| Date | Vegetation Mapping | Hierarchical Prototype |
|---|---|---|
| Oct98 | Startup meeting | Startup meeting |
| Nov98 | POW | POW/Interagency review |
| Jan99 | Pilot study plan/data acquisition | Paper prototype |
| Mar99 | Pilot study begin w/ 1995 DOQs | Interagency prototype briefing |
| Apr99 | Pilot study report | Draft prototype |
| May99 | Data acquisition and full field work | Data collection |
| Jun99 | Field keys and accuracy assessment | Prototype build |
| Aug99 | Map production and metadata | Completed draft prototype |
| Sep99 | Final map/accuracy assessment report | Final prototype tool and demo |

US Army Corps of Engineers

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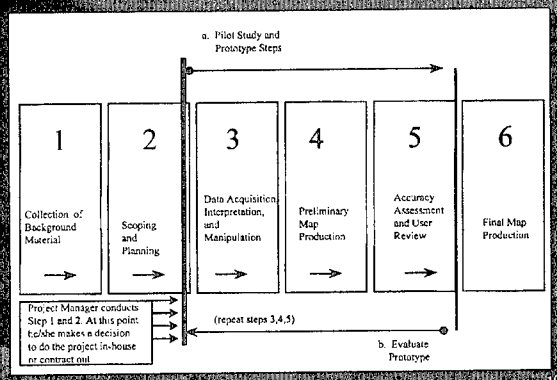
## Vegetation Mapping Process




US Army Corps of Engineers

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## Fort Hood Vegetation Mapping Requirements

1. Classify minimum map unit of 1 acre
2. Identify % juniper in stands at 10% increments
3. Identify % woody vegetation in stands at 10% increments
4. Differentiate live oak from juniper
5. Differentiate evergreen trees from hardwood
6. Differentiate woody vegetation from herbacious vegetation
7. Differentiate vegetated areas from non-vegetated areas
8. Differentiate water from other areas

US Army Corps of Engineers

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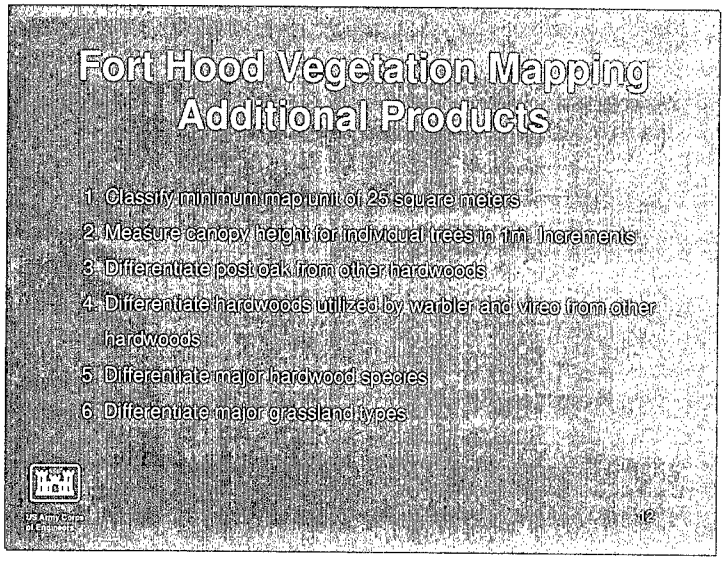
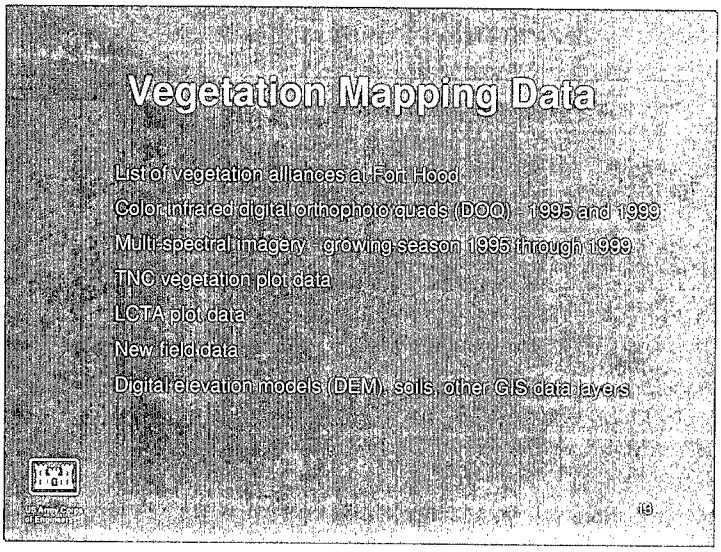
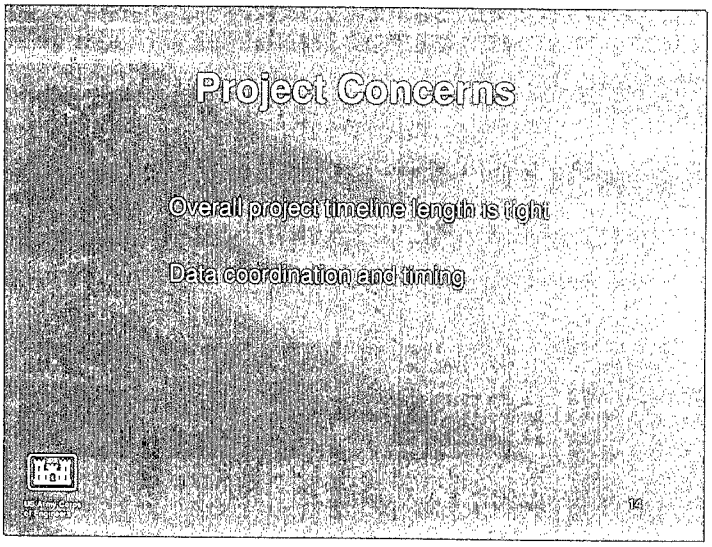
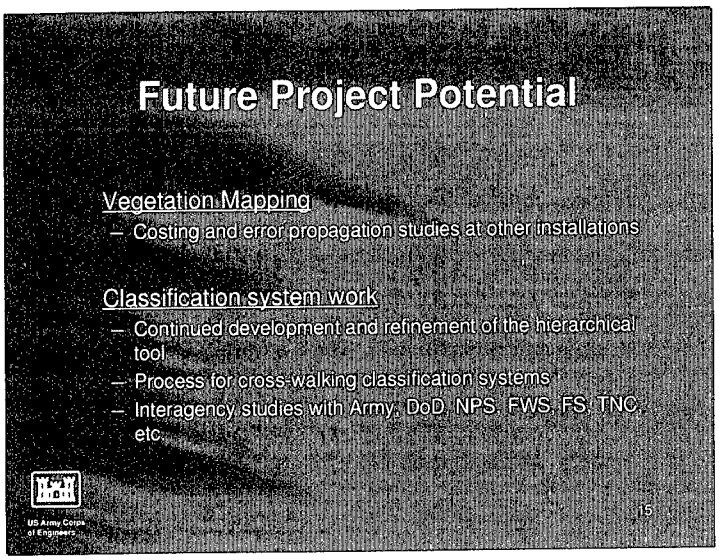

Fort Hood Vegetation Mapping
Additional Products
1. Classify minimum map unit of 25 square meters
2. Measure canopy height for individual trees in 1m. increments
3. Differentiate post oak from other hardwoods
4. Differentiate hardwoods utilized by warbler and vireo from other hardwoods
5. Differentiate major hardwood species
6. Differentiate major grassland types
12

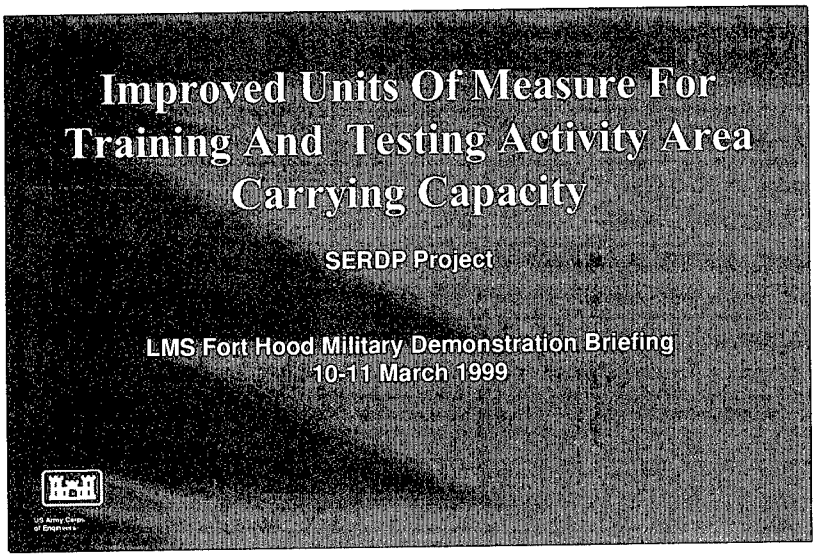

Vegetation Mapping Data
List of vegetation alliances at Fort Hood
Color infrared digital orthophoto quads (DOQ) - 1995 and 1999
Multi-spectral imagery - growing season 1995 through 1999
TNC vegetation plot data
LCTA plot data
New field data
Digital elevation models (DEM), soils, other GIS data layers
13


Project Concerns
Overall project timeline length is right
Data coordination and timing
14




## Carrying Capacity

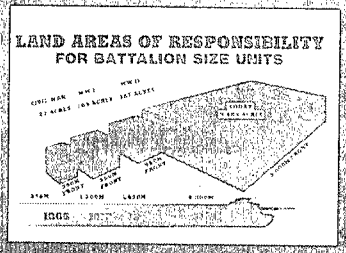
Presenter: Alan Anderson



## Problem Statement

"The basic mission of the US Army is to fight and win in combat. The training of soldiers...is the vital ingredient that assures readiness of the force to accomplish this mission...The most difficult problem ... is the lack of adequate land to conduct realistic training.... An integrated program of land management is the only means of ensuring continued land use." (TC 25-1)

- The DoD manages over 24 million acres of land. The Army spends over $50M in training land repair and maintenance.
- Base Realignment and Closure Act (BRAC) will increase the intensity of use on remaining DoD lands
- The footprint of military training and testing activities is growing
- Budgets are declining while environmental requirements are increasing




## User Requirements

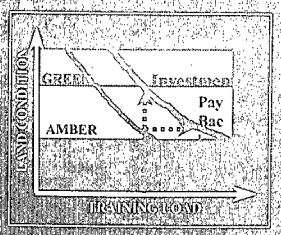
DoD/Tri-Service User Requirement #4 - Land Capability Characterization. "There is a research need to determine to what extent given parcels of land are suitable and contain the carrying capacity for sustaining specific activities. It should address the type, magnitude, frequency, and duration of activities, as well as spatial and temporal parameters."

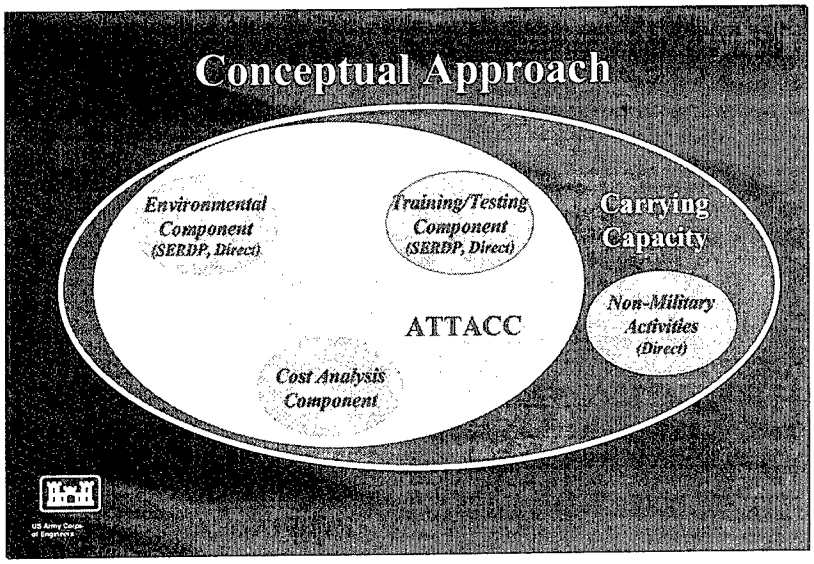
Army Integrated Training Area Management (ITAM) Requirement - "Identify carrying capacity of lands...modeling and predicting carrying capacity and usage impacts."

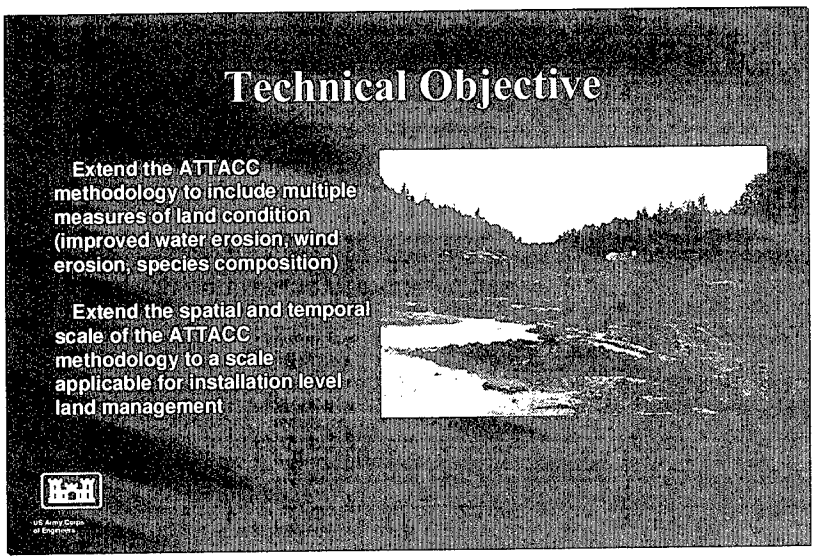
## Army Training and Testing Area Carrying Capacity

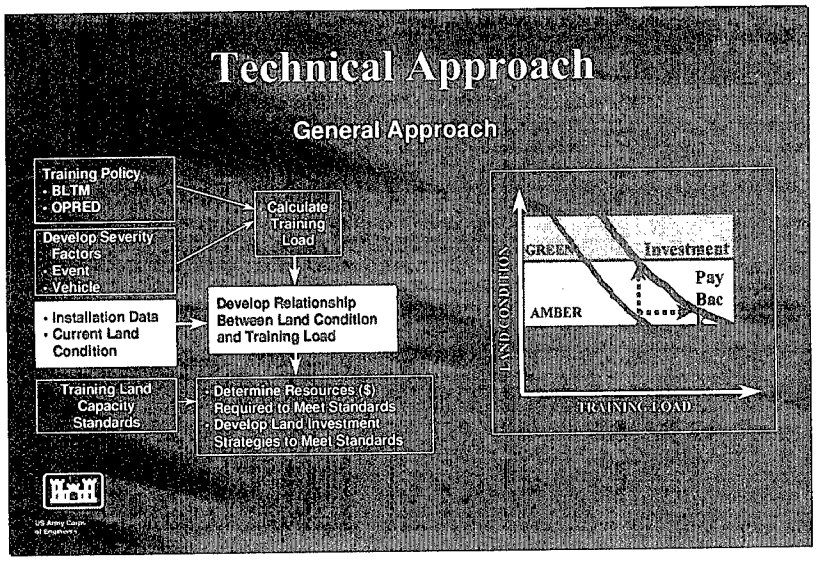
Training Land: A Priceless Asset
Facilities & Equipment are Repairable & Replaceable
*Land is Repairable...Not Replaceable*

- Operate as a business
- Investment planning
- Training is the product/commodity
- Sustain for long term use
- Maintain like a vehicle
  - *Investment*:
    - Maintenance and Rehabilitation
  - *Pay Back*:
    - Training Capability Into the Future




Conceptual Approach
Environmental Component (SERDP, Direct)
Training/Testing Component (SERDP, Direct)
Carrying Capacity
ATTACC
Non-Military Activities (Direct)
Cost Analysis Component
US Army Corps of Engineers


Technical Objective
Extend the ATTACC methodology to include multiple measures of land condition (improved water erosion, wind erosion, species composition)
Extend the spatial and temporal scale of the ATTACC methodology to a scale applicable for installation level land management
US Army Corps of Engineers


Technical Approach
General Approach
Training Policy
• BLTM
• OPRED
Develop 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
Investment
Pay Bac
TRAINING LOAD
US Army Corps of Engineers

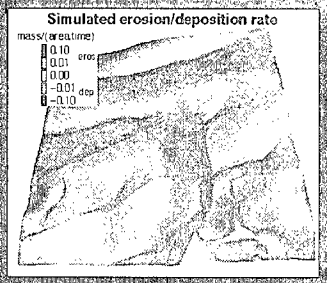
## Technical Approach

- Improved measure of land condition
  - Water erosion
    - More accurate models
      - Erosion/sedimentation
  - Wind erosion
    - Plant species composition
- Improved temporal/spatial scale
- Incorporation of testing activities

## Improved Water Erosion and Deposition Modeling

Current: Revised Universal Soil Loss Equation (RUSLE)

ES=RKLSCP/T
R: Climatic factor
K: Soil Erodibility factor
LS: Topographic factor
C: Cover factor
P: Conservation factor
T: Soil loss tolerance factor




Proposed: Utilize the unit stream power approach to estimate the topographic factor (LS) in RUSLE. This will account for complex topography and predict sediment deposition. (SERDP Project 752, Terrain Modeling and Soil Erosion Simulation)

## Improved Water Erosion and Deposition Modeling

Accomplishments:

- Utilized RUSLE2d LS factor in ATTACC at Fort Hood, TX.
- Collaborating with USACERL direct funded project to implement technology into ArcView tool.
- Coordinating with USACERL/AEC and USACERL/WES funded validation studies.

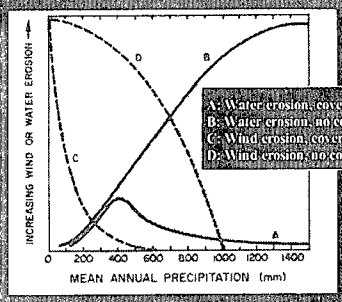
Future:

- Collaborating with WES to integrate ATTACC with CASC2D.
- Coordinating with USACERL/WES funded validation studies.

## Wind Erosion

Current: Wind erosion not accounted for in ATTACC. Wind erosion identified are key unit of measure.

Proposed: Modify and incorporate wind erosion model into the ATTACC methodology.
- Evaluate existing models (WEQ,RWEQ, WEPS, Others)
- Develop mission/soil/climate interface
- Incorporate into GIS
- Validate model with field studies




## Wind Erosion

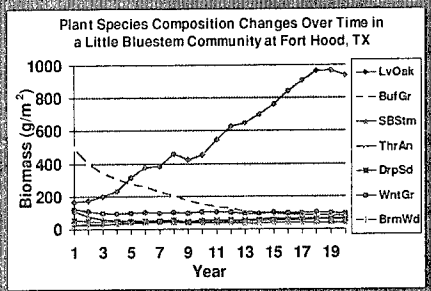
Accomplishments:
- Evaluated existing models based on literature and model documentation (WEQ,RWEQ, WEPS, TEAMS, EPIC, Others)
- Implementing subset of models at well documented agricultural site in Texas. Effort leveraged with USDA-ARS.
- Implementing subset of models at well documented military site. Effort leveraged with Fort Bliss, TX.
- Attempting to support ATTACC WEAG effort.

Future:
- Incorporate mission impacts interface to management component
- Incorporate land repair practices into management component
- Incorporate model into GIS
- Validate model with field studies

## Plant Species Composition

Current: Plant species composition was identified a critical unit of measure

Proposed: Incorporate plant species composition
- Utilize the Ecological Dynamics Simulation Model (UTEP, USACERL, NRCS, NPS, DoE)
- Develop and incorporate a mission impacts submodel
- Develop meaningful capacity standards
- Validate model predictions



## Plant Species Composition

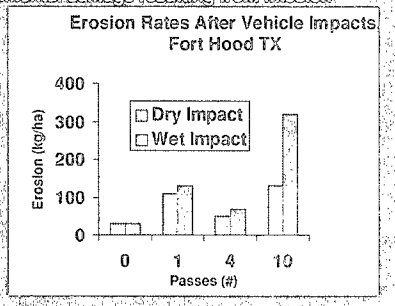
Accomplishments:
- EDYS mission impacts component completed
- Collaborating with AEC/USACERL funded validation study
- Collaborating with WES/USACERL/SMI integration of EDYS and CASC2D

Future:
- Develop meaningful capacity standards
- Incorporate plant success into land condition curve.

## Temporal Scale Extension

Current: The current ATTACC methodology does not account for seasonal variation in the probability and magnitude of environmental damage resulting from mission activities.

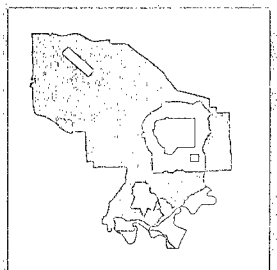
Proposed: Modify method to account for annual climatic variation.
- Develop time varying modified RUSLE factors using existing methodology
- Model climate/mission impact interactions from DoD impact studies
- Validate model with field validation trial study




## Spatial Scale Extension

Current: Military use distributions are estimated using field, GIS, and RS data. These distributions represent a historical annual use estimate. These distributions do not predict the impact footprint of individual events, new missions, or alternative scheduling scenarios.

Proposed: Land use activity will be estimated based on training and testing doctrine.
- Develop approach to capture mission doctrine to predict the distribution of military land use activities
- Demonstrate model



Predicted Land Use Distribution, Fort Riley KS

## Spatial Scale Extensions

Accomplishments:
- "Literature review" of military systems completed.
- Simulation system identified.
- Simulation system augmented.
- Preliminary footprints developed for unit activities.
- Identified potential databases to validate approach.

Future:
- Translate scheduling information into simulation scenarios.
- Examine alternative methods to capture training doctrine.

US Army Corps of Engineers

## Testing Land Carrying Capacity

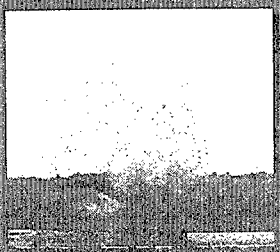
Problem: Current carrying capacity models primarily based on training activities and do not adequately address testing activities.

Objective: To develop a testing carrying capacity methodology consistent with the existing training methodology.

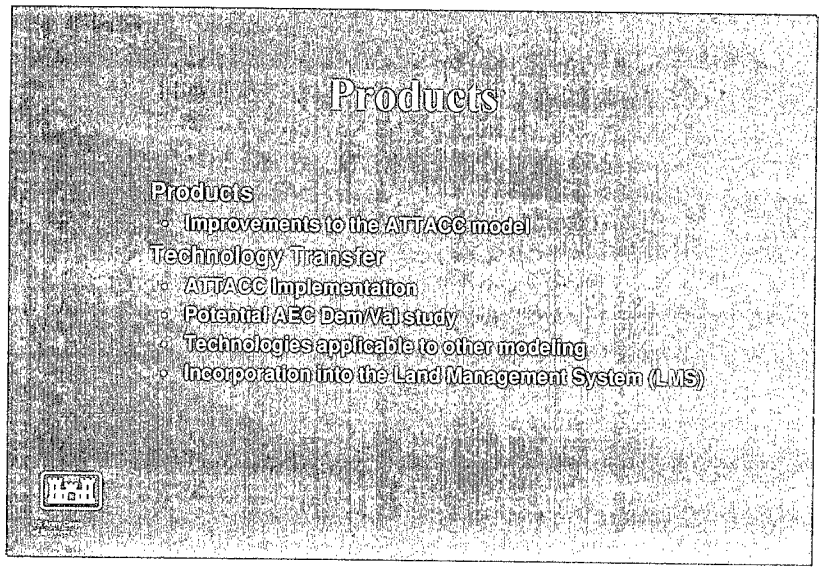
US Army Corps of Engineers

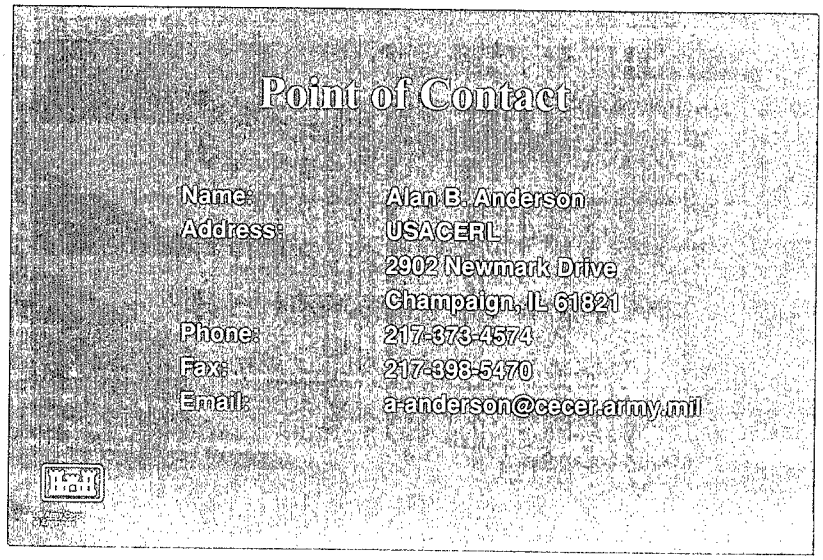
## Testing Land Carrying Capacity

- Define a method to characterize testing activities in a manner consistent with training characterization.
- Identify standard DoD systems, databases, models to characterize testing activities.
- Provide models to predict environmental impacts associated with testing.
- Estimate land repair and maintenance funding requirements.



US Army Corps of Engineers




## WIARS

Presenters: Jaimie Hebert, Scott Tweddale

# Image Analysis in Support of TES

## Image Analysis in Support of TES Habitat Monitoring

**Objectives**
1. Develop a web-based image analysis system that integrates tools necessary to perform image comparison and change assessment.

2. Test/validate capabilities through comparison of *WIARS* output with independent change assessment of TES habitat at Ft. Hood (CERL) and predicted changes from a transition matrix model at Ft. Stewart (ORNL).

**PI(s)**
Virginia Dale (ORNL)
Tom Ashwood (ORNL)
Scott Tweddale (CERL)

**Contractor**
Jaimie Hebert (SHSU/TRIES)

**Ft. Hood POC**
John Cornelius (Hood)

**Funding Sources**
Congressional

**Funding Level**
$800K (FY98)

**Major FY99 Milestones**
1. Develop, refine, and demonstrate *WIARS* (improve user interface, image registration and classification).

2. Demonstrate/validate *WIARS* capabilities using independent change assessments.

*Fort Hood IPS*

*10–11 March, 1999*

## Problem Statement

Many natural resource managers (NRM) are interested in using remote sensing/GIS packages to assist in the monitoring and maintenance of habitats on their installations.

How to handle large data sets that are available in a wide variety of formats and often located at remote sites?

Problems encountered with remote sensing/GIS Packages include:
- Not designed with the NRM in mind.
- Lack of user-friendly interface.
- Lack important statistical tools.
- Do not provide easy access to data at remote locations.
- Technical Support is limited.
- Hardware requirements exceed NRM's resources.

*Fort Hood IPR*

*10–11 March, 1999*

## Project Goals

Develop software modules for performing various image analysis tasks. Modules are developed from:
- faculty theoretical research.
- known routines.
- popular GIS/remote sensing packages.

Connect these modules with a computer program that can be accessed by NRM's via the internet using a World Wide Web browser.

Design an interface that is easy to use.

Provide a proof-of-concept that image analysis can be performed over the internet.

*Fort Hood IPR*

*10–11 March, 1999*

## System Advantages/Disadvantages

Advantages:

- Minimal hardware/software requirements for NRM.
- Software installation/maintenance by NRM no longer necessary.
- Modules can easily be added/removed.
- Allows access to data at remote locations.
- Computations are performed on a high-end computer.
- Platform independence.
- Easy access to important routines from existing software.

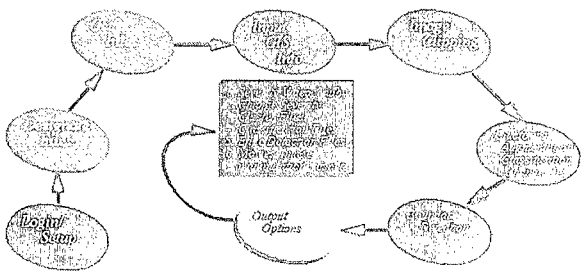
Disadvantages:

- User license limitations.
  NRM may not have internet access.
- Network bandwidth or volatility may cause delays.

*Fort Hood IPR*

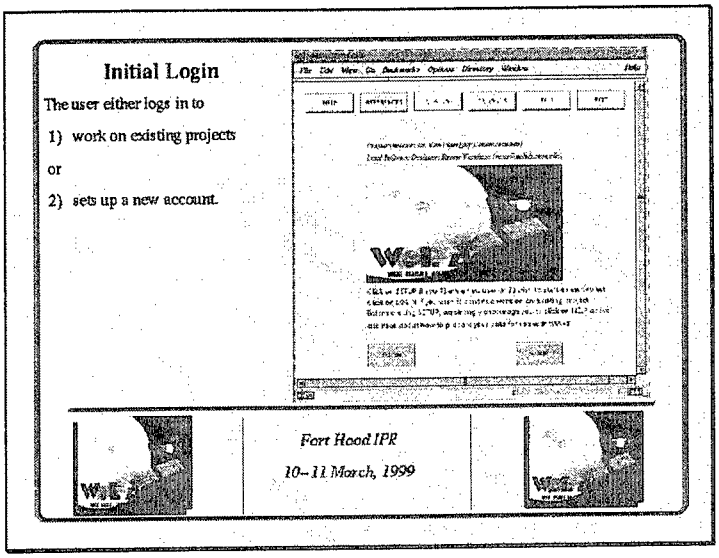
*10–11 March, 1999*

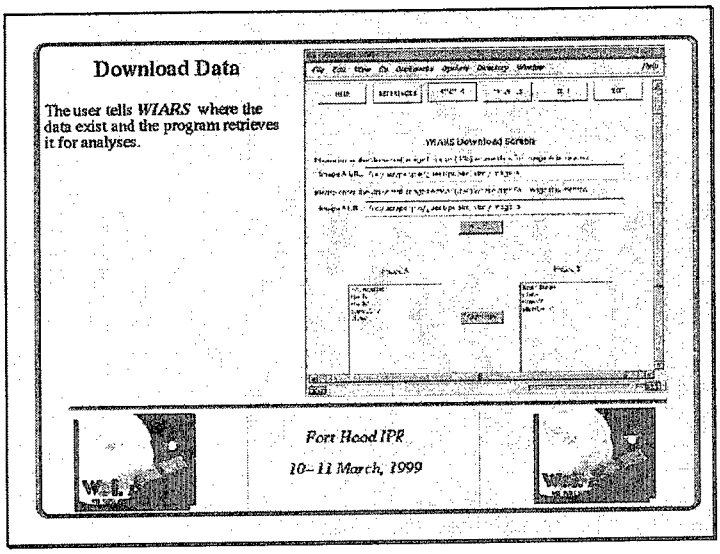
## Program Flow




*Fort Hood IPR*

*10–11 March, 1999*


Initial Login
The user either logs in to
1) work on existing projects
or
2) sets up a new account.
Fort Hood IPR
10–11 March, 1999


Download Data
The user tells WIARS where the data exist and the program retrieves it for analyses.
Fort Hood IPR
10–11 March, 1999

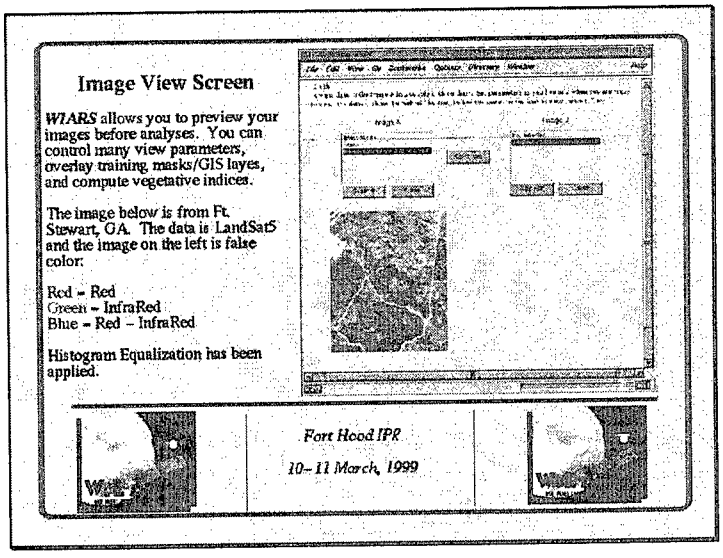
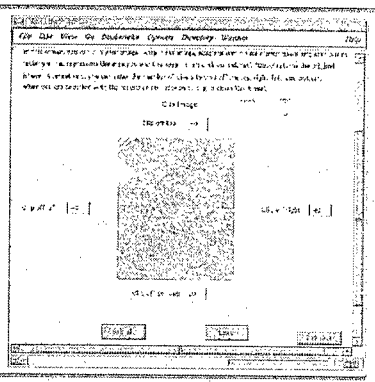


Image View Screen
WIARS allows you to preview your images before analyses. You can control many view parameters, overlay training masks/GIS layes, and compute vegetative indices.
The image below is from Ft. Stewart, GA. The data is LandSat5 and the image on the left is false color:
Red = Red
Green = InfraRed
Blue = Red – InfraRed
Histogram Equalization has been applied.
Fort Hood IPR
10–11 March, 1999

## Image Clip Screen

*WIARS* allows you to clip your data and zoom in on specific portions for analysis.



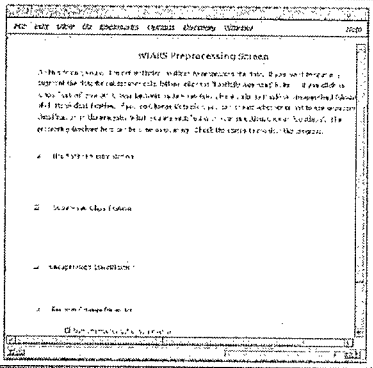
*Fort Hood IPR*

*10–11 March, 1999*

## Preprocessing Screen

At this point, you're ready to begin processing your data. Here you can:

1) Spatially augment the data
2) Configure Supervised Classification
3) Configure Clustering Methods
4) Configure the Change Detection Module



*Fort Hood IPR*

*10–11 March, 1999*

## Module Output – Unsupervised Classification

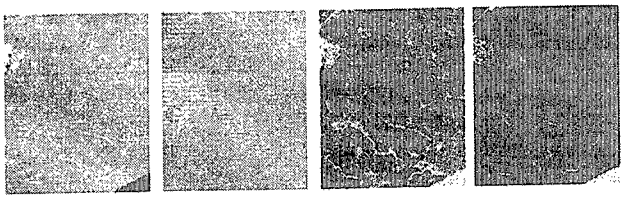
*Original Image* *Seven Clusters* *Disturbance Cluster*

*Analysis of a Camp Navajo LandSat5 Image*

*Fort Hood IPR*

*10–11 March, 1999*

## Module Output – Change Detection / Assessment

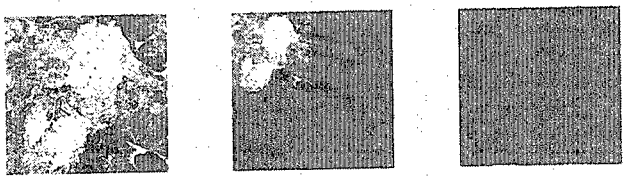


Ft. Stewart GA, 6/92 | Ft. Stewart, GA 3/94 | 50% Change Severity | 99% Change Severity

*Fort Hood IPR*

*10–11 March, 1999*

## Module Output – Boundary Detection



*Original image* | *Wavelet decomposition* | *Detected boundaries*

*Boundary Detection on a Ft. Navajo LandSat5 Image*

*Fort Hood IPR*

*10–11 March, 1999*

## Current Project Objectives

Note: A timeline covering subtasks for each of these objectives was approved by ORNL (4 Jan 99).

1. Assessment of Algorithms and Program Flow
   - progressing according to timeline
   - demo by Peter Cooper
2. Upgrade Classification Capabilities
   - progressing according to timeline
   - algorithms developed and tested
3. Create and Integrate Image Registration Module
   - one month behind timeline due to software problems
   - algorithms identified and modified
4. Create and Integrate Object Detection Module
   - progressing according to timeline
   - anticipated delay due to software problems
5. Assessment/Enhancement of User Support Configuration
   - progressing according to timeline
   - will develop lead-in information screens for *WIARS*

*Fort Hood IPR*

*10–11 March, 1999*

## WIARS

- Overview
- Objectives
- Class hierarchy
  - interface
  - management
- Communications

## Overview

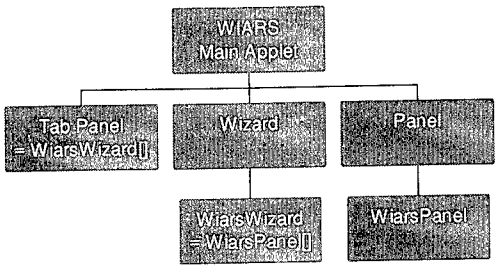
- Distributed application
  - Web oriented client
  - platform independent Server
- Rationalize interface
- Rationalize communications
- Extend functionality
- Ease extensions to functionality

## Objectives

- Analysis of program flow
- Analysis of communications requirements
- Analysis of resource requirements
- RetroEngineer WIARS
- Platform independence

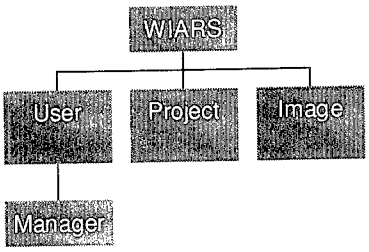
# WIARS Client Interface

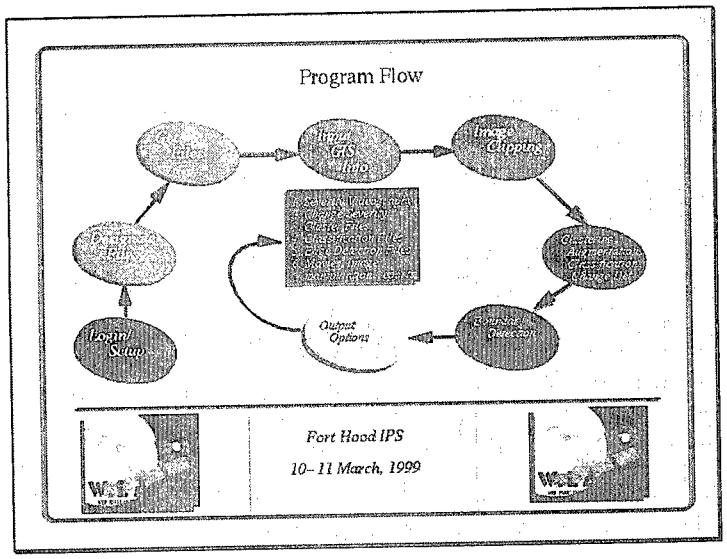
WIARS Class Structure




# WIARS Client

WIARS Class Structure



## Analysis of Program Flow

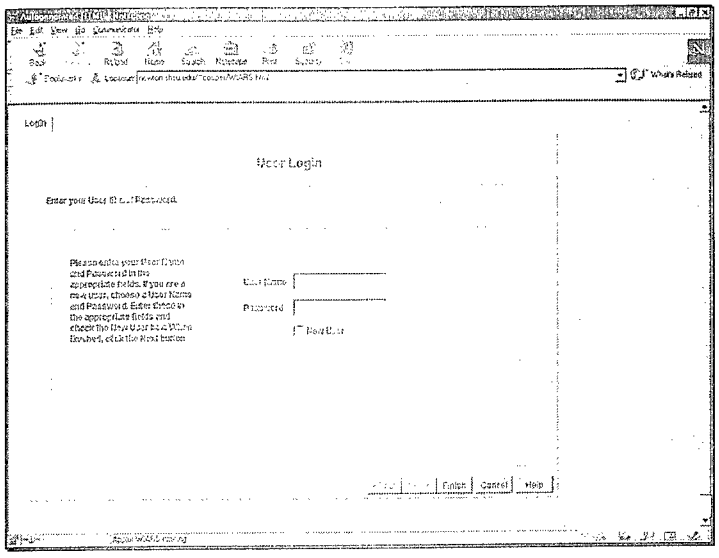
- Program Structure
- Data Structures
- Data Flow

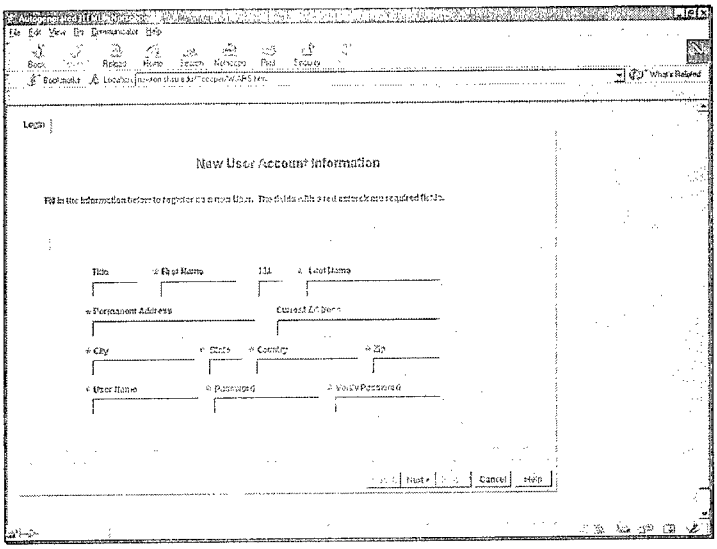
## Communications

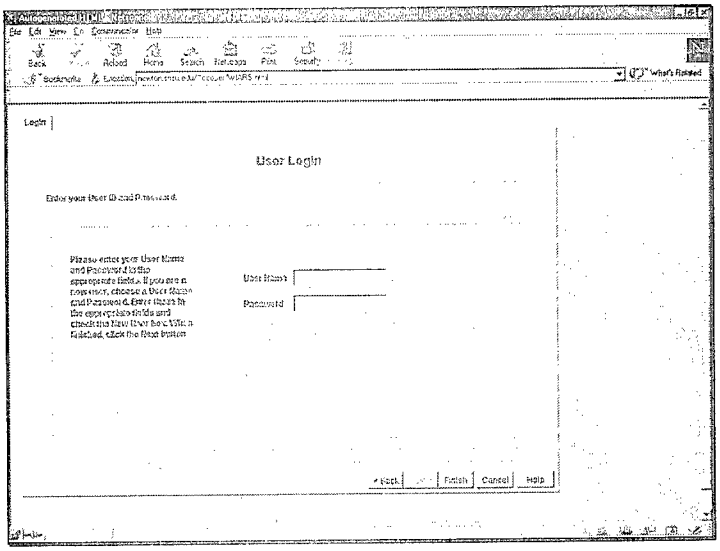
- User Object
- Project Object
- Image Object
- Control Information
- email
- ftp

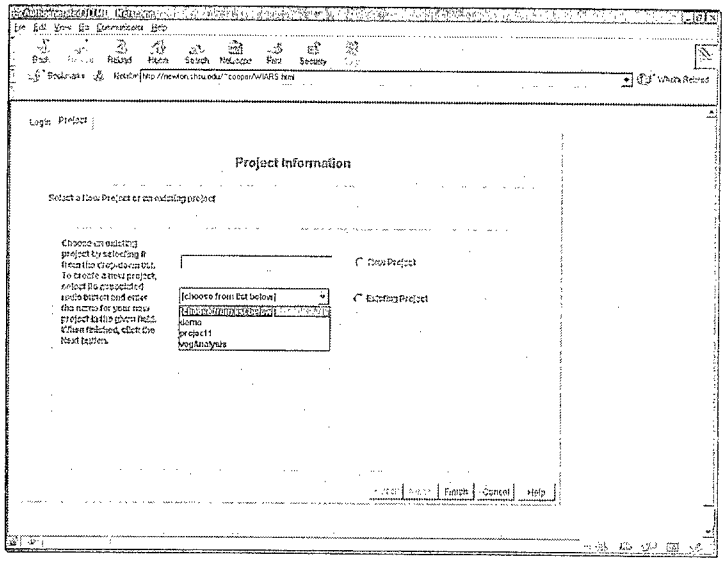
## Resource Requirements

- Data Storage Requirements
  - Program size
  - CPU cycles
    - Client
    - Server
- System Requirements
  - 4.0 Browser
  - Any platform


Login
User Login
Please enter your User ID and Password in the appropriate fields. If you are a new user, choose a User Name and Password. Enter them in the appropriate fields and check the New User box. When finished, click the Next button
User Name
Password
New User
Finish
Cancel
Help


Login
New User Account Information
Fill in the information below to register as a new User. The fields with a red asterisk are required fields.
Title
* First Name
MI
* Last Name
* Permanent Address
Current Address
* City
* State
* Country
* Zip
* User Name
* Password
* Verify Password
Next
Cancel
Help


Login
User Login
Please enter your User Name and Password in the appropriate fields. If you are a new user, choose a User Name and Password. Enter them in the appropriate fields and check the New User box. When finished, click the Next button
User Name
Password
Back
Finish
Cancel
Help


Project Information
Select a New Project or an existing project
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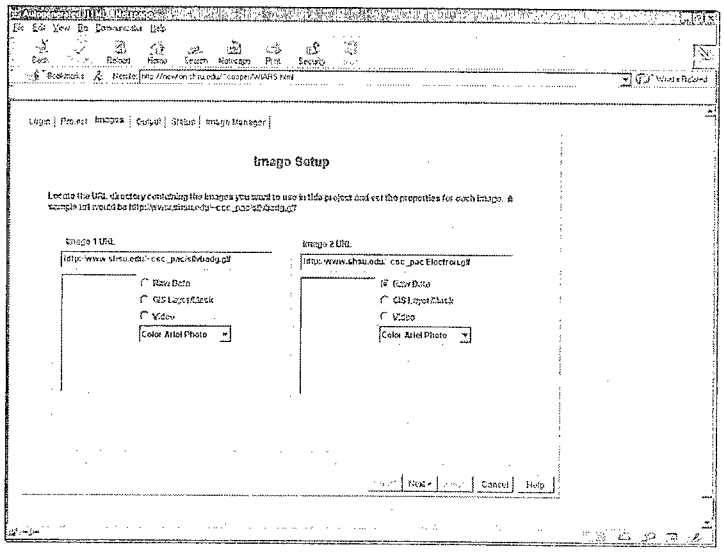
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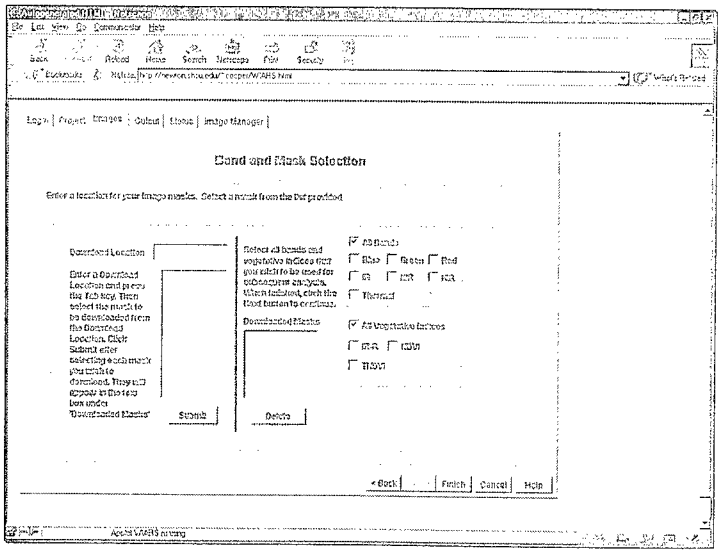
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Band and Mask Selection
Enter a location for your image masks. Select a mask from the list provided.
Download Location
Enter a Download Location and press the Tab key. Then select the mask to be downloaded from the Download Location. Click Submit after selecting each mask you want to download. They will appear in the text box under "Downloaded Masks"
Select all bands and vegetative indices that you want to be used for subsequent analysis. When finished, click the next button to continue.
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## Stream Stage Modeling

Presenters: Jeff Jorgeson, Mark Leipnik, Alan Anderson

### Stream Stage / Soil Moisture Modeling

Mr. Jeff Jorgeson
U.S. Army Engineer Research and Development Center
Waterways Experiment Station
Coastal and Hydraulics Laboratory

Dr. Mark Leipnik
Texas Research Institute for Environmental Studies
Sam Houston State University

Mr. Alan Anderson
U.S. Army Engineer Research and Development Center
Construction Engineering Research Laboratory

### Objectives

- Demonstrate a system for monitoring and modeling stream stage and soil moisture conditions in real time.
- Provide a flood alert system for a critical low-water road crossing.

## Performers

- Mr. Jeff Jorgeson - WES, CHL
- Dr. Mark Leipnik, SHSU, TRIES
- Mr. Alan Anderson, CERL
- Fort Hood POC - Mr. Emmet Gray

## Project Funding

- SERDP
- Congressional
- RDT & E

## Approach

- Install instrumentation for stream flow, sediment, soil moisture, and meteorology on 3 representative watersheds
- Model basins with the CASC2D watershed model
- Incorporate telemetered data into models
- Integrate radar data into models
- Provide soil moisture maps of basins

## FY 1999 Milestones

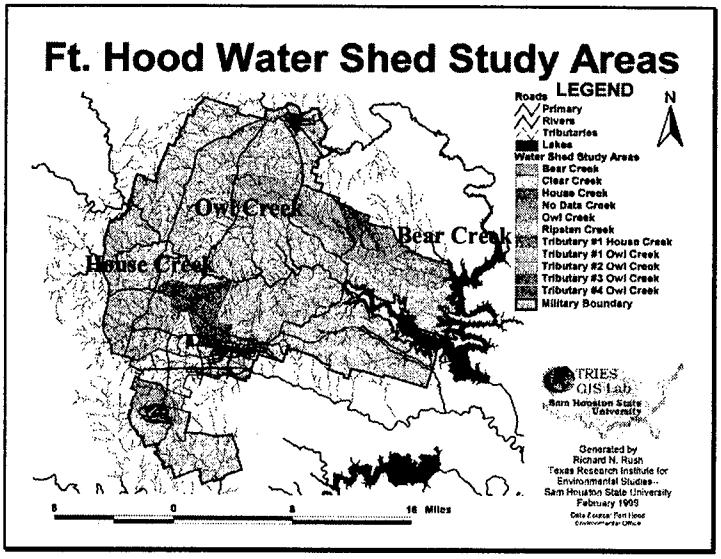
- Field data collection and analyses
- Model calibration and verification for stream stage and soil moisture to best available data
- Integration of real-time data with models

## Project Steps

- Site selection/GIS based stream mapping
- Stream stage monitoring
- Groundwater/soil moisture monitoring
- Weather monitoring
- Flood alert system installation
- Modeling / data integration

## Selection of Study Watersheds

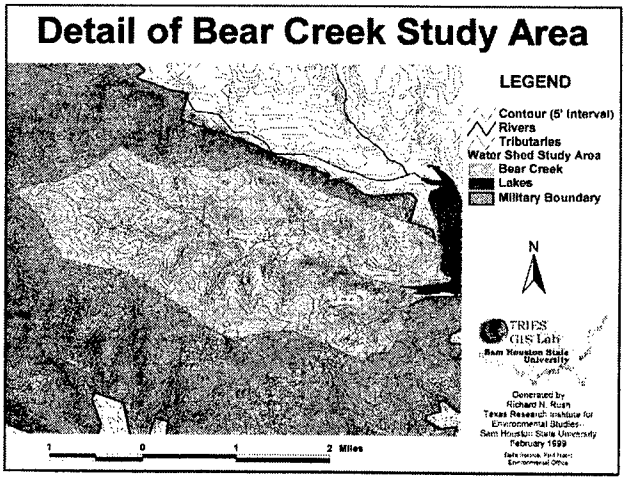
- Bear Creek Watershed
  - smallest watershed, flows to Lake Belton
- Owl Creek Watershed
  - medium sized watershed, gauge at East Range Road
- House Creek Watershed
  - largest of 3 watersheds, gauge at West Range Road




## Bear Creek Watershed

- Bear Creek Watershed: smallest watershed, flows to Lake Belton.
- Protected from disturbance, due to endangered species & remoteness.
- Most difficult to monitor/telemeter due to lack of access, irregular cross-section and no utilities.
- Base-line for training impact analysis.

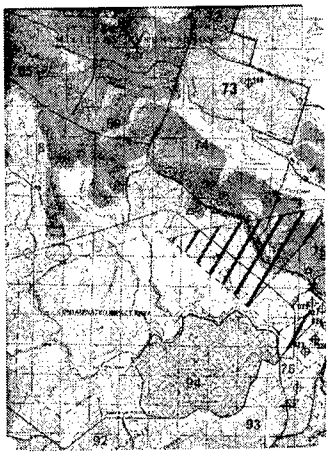
Topography of Bear Creek from GIS.



## Owl Creek Watershed

- Moderate level of disturbance
- Limited tank training/some portions of basin in artillery impact/live fire areas
- Second largest watershed
- Intermediate flow

Live fire areas and impact zones are within basin.



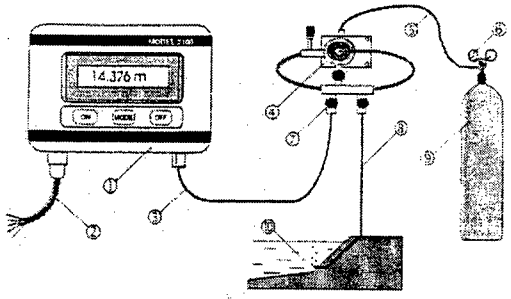
## House Creek Watershed

- Greatest level of disturbance, tank training areas in basin
- Largest flow and watershed
- Subject to serious flooding
- Low-water crossing of public road (West Range Road ) is a flood and safety hazard

## Stream Stage Monitoring

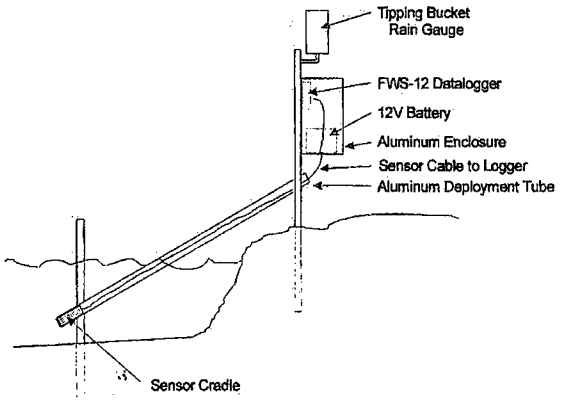
- Install stream stage monitoring stations using bubbler/pressure transducer gauges
- Real time water quality/turbidity monitoring
- Soil moisture monitoring
- Weather station
- All telemetered with solar power

Bubbler & Pressure transducer based stage monitoring set-up.

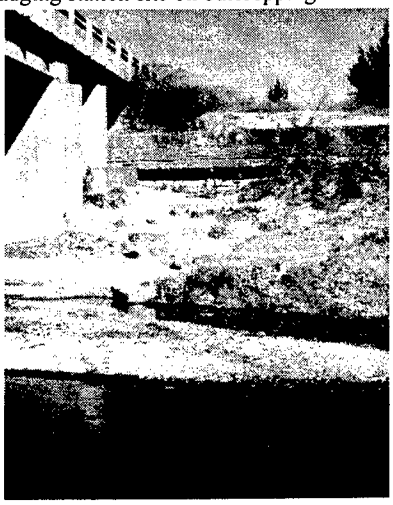



① Model 2100 Gasline Level Sensor
② 2100 sensor cable assembly
③ 2100 gas tubing assembly
④ Model HS-23 Dry Bubble Unit
⑤ Gas supply line
⑥ Gas bottle primary regulator
⑦ Isolation valve and manifold
⑧ Main gas bubbler line
⑨ Dry nitrogen gas bottle
⑩ Bubble orifice in water

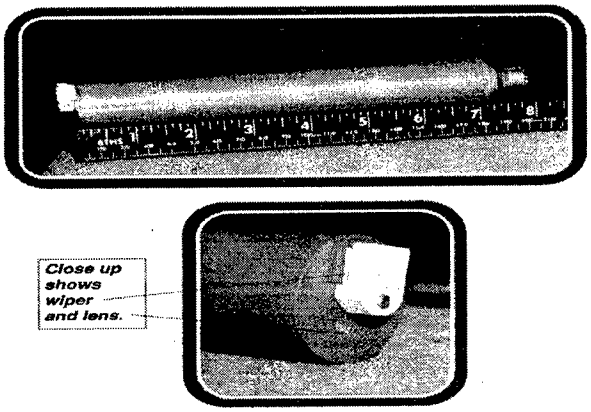
Gauging station design



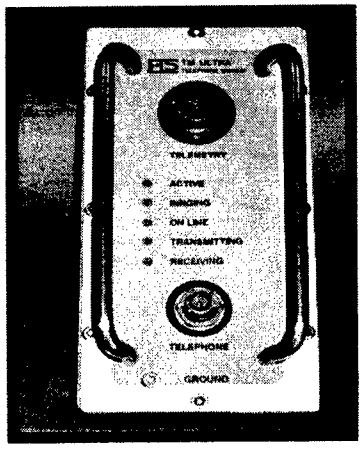
House Creek Gauging station site on outcropping behind bridge abutment.



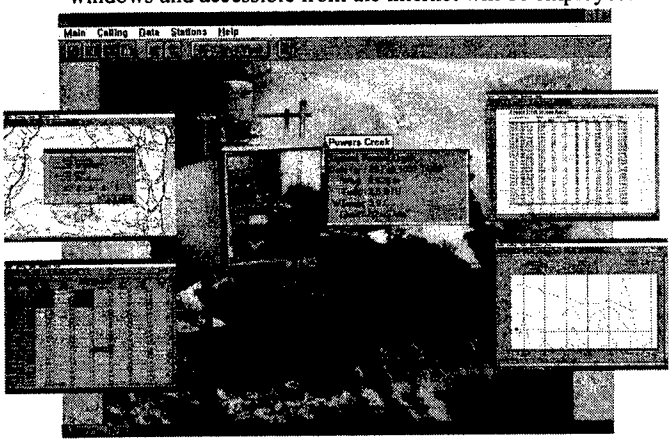
In-situ turbidity sensors will be installed.




Modems/cell phone telemetry & data loggers will be used to store and transmit data to terminal located at Ft. Hood and connected to internet.



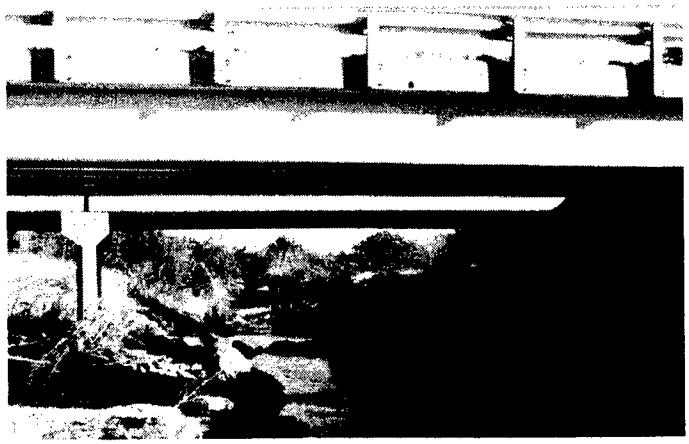
Data analysis software for stage and weather data compatible with windows and accessible from the internet will be employed.




Stream Gauging Station & Monitoring Software.

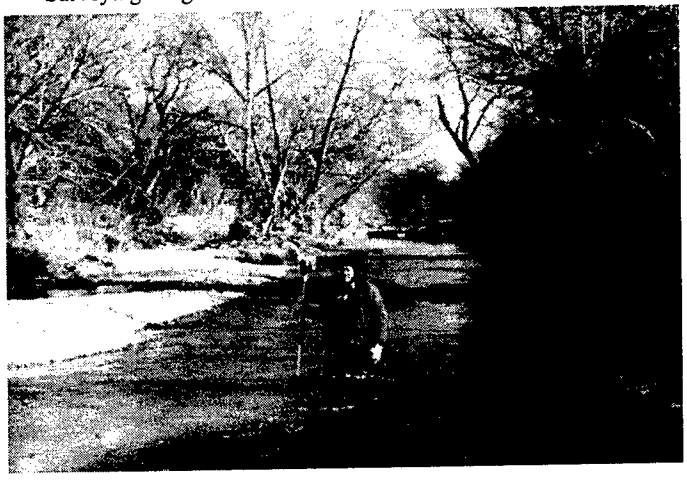
Owl Creek Cross-section at gauging station location (Side view).


Owl Creek Cross-section at gauging station location.



Total Station Based survey of cross-section & gradient performed for each site.

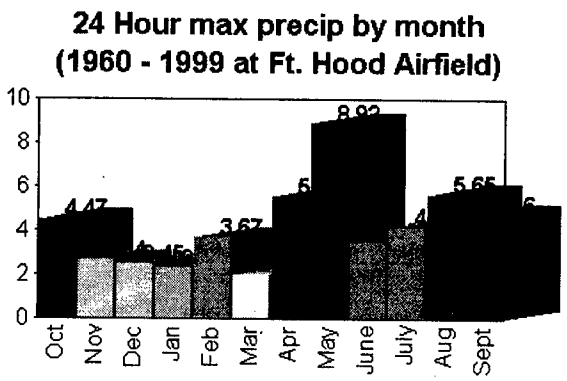
Surveying the gradient of bottom & water surface of House Creek



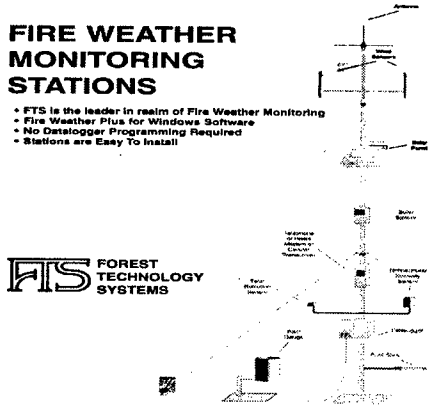
## Weather Data Analysis and Monitoring

- Airfield has daily precipitation since 1960
- Maximum 24 hour storm can be calculated from this source
- 2 telemetered weather stations since 1994 provide hourly intensity data, spatial variation information

Historical data has been used to compute max. 24 hour precipitation.

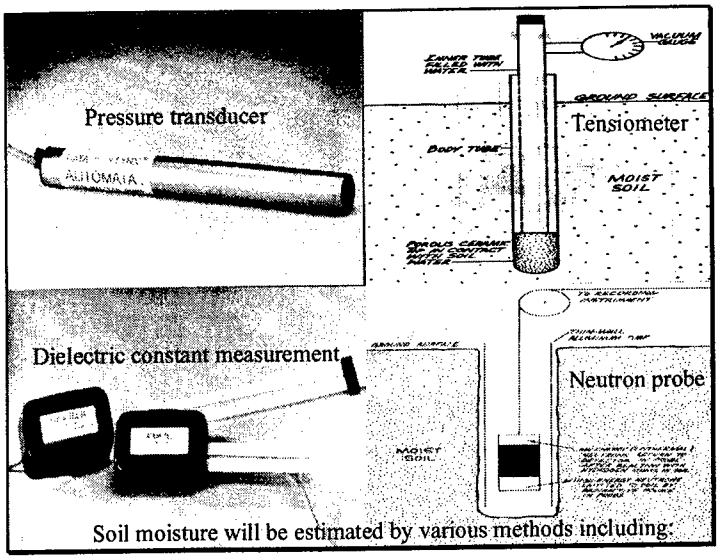



Two existing weather stations maintained by Base meteorological section will be supplemented with three more will provide rainfall Temp, humidity, wind speed & direction as well as fuel stick moisture.




## Soil Moisture/groundwater Monitoring

- Soil moisture/groundwater monitored at each basin in upland, mid-slope & riparian zones using:
  - Shallow monitoring wells with PT's
  - Tensiometers, dielectric constant & resistively soil moisture measurement
- Calibrated by neutron probe and lab. soils analysis

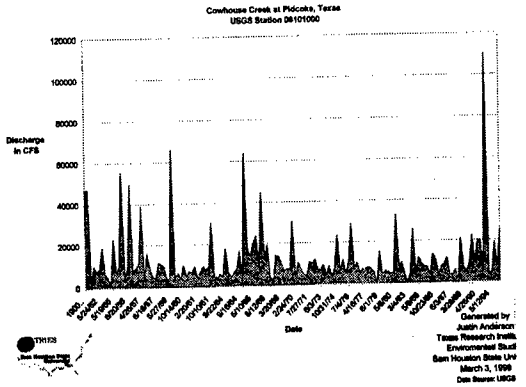



## Ft. Hood Flood Alert system, Background:

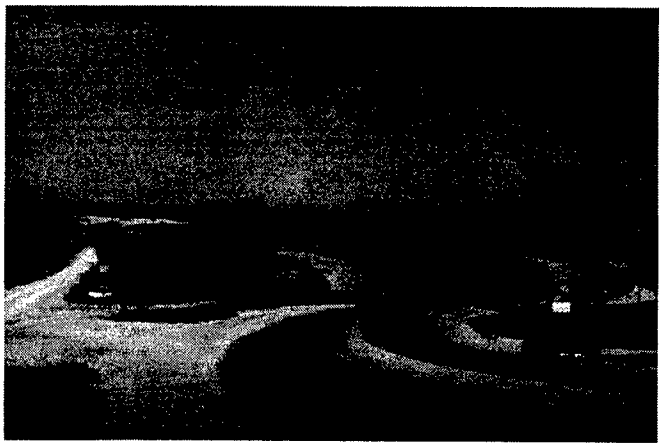
- History: extreme variability and flash floods at less than 10 year intervals
- 7 fatalities at low water crossings (House Creek and Cow House Creek)
- 27 total flood fatalities 1942-present
- Major flood events in 57, 60, 66 & 92
- Flood estimates from Cow House Creek at Pidcoke and weather data

Peak annual discharge of Cow House Creek at Pidcoke 1900-1994

Annual peak discharge ranges from 110,000 CFS Dec. 20, 1991 to only 70 CFS April 10, 1978.



West Range Road crossing is down-stream from old bridge and below stream banks.



Crossing is two lane without shoulder or guard rail, punctuated by four culverts.

Flood debris in House Creek below West Range Road crossing indicates floods over-top bridge structure periodically.

## Flood Alert System Installation

- At Low water crossing of House Creek several fatalities have occurred in prior flood events.
- Warning system uses stream level sensor (PT) to trigger illuminated warning signs/lights on road.
- Also sends warning to MP's.

## Watershed Modeling

- CASC2D Model
  - Distributed Watershed Model
  - Erosion / Sedimentation
  - Long Term Simulations
- Watershed Modeling System (WMS)
  - Extensive GIS Linkages
  - Weather Radar Data Support

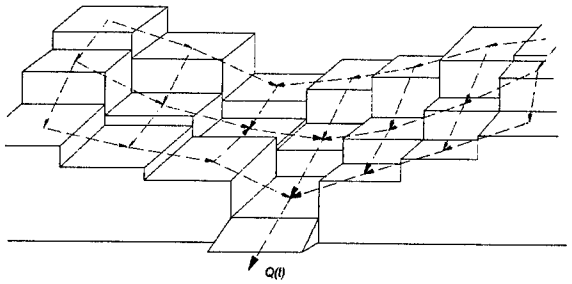
## CASC2D Overview

- Distributed, physically based watershed model
  - 2-D overland flow
  - 1-D channel flow
  - Green-Ampt infiltration
  - Long-term simulation and overland erosion options
- Current Research / Development
  - Surface Water - Groundwater Interaction
  - Improved Modeling of Hydraulic Structures
  - Automated Calibration Routines

## CASC2D Data Requirements

- Input Requirements
  - Elevation
  - Land Use
  - Soil
  - Channels
  - Precipitation
- Output
  - Outflow Hydrograph
  - Net Erosion / Deposition
  - Soil Moisture

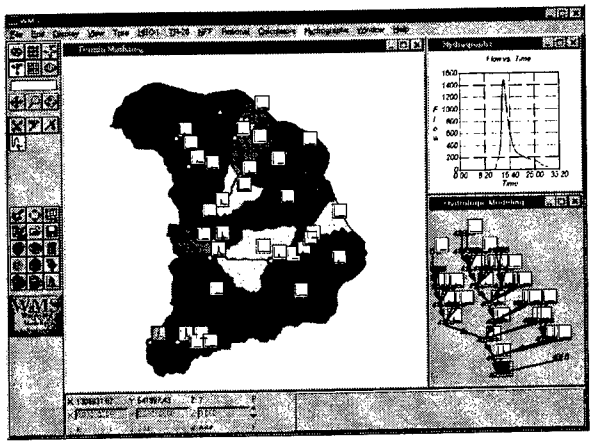
## CASC2D Overland Flow



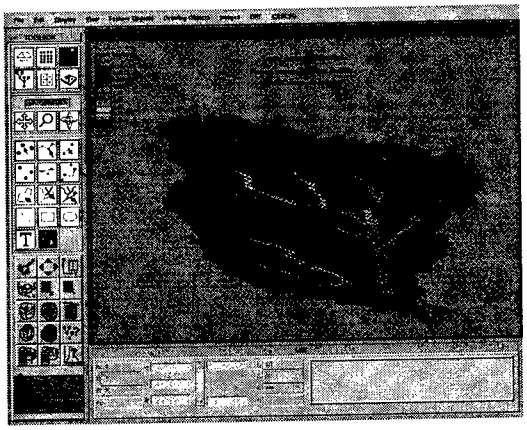

## Watershed Modeling System (WMS) Overview

- Comprehensive system for watershed modeling
- Extensive GIS import / export capabilities
- Supports many watershed models
  - HEC-1
  - TR-20
  - CASC2D
  - HSPF
- Widely used for civil and military applications

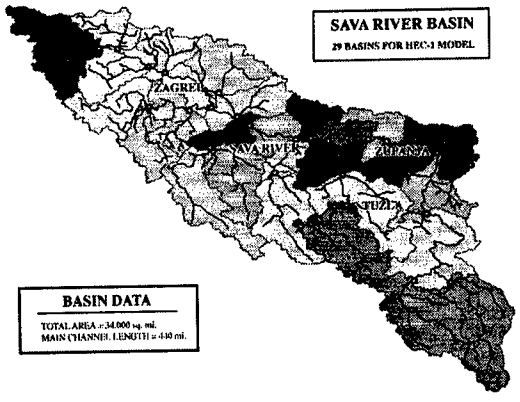
## WMS Interface



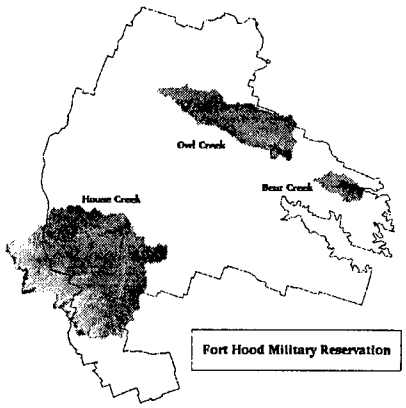
## Military Training Lands



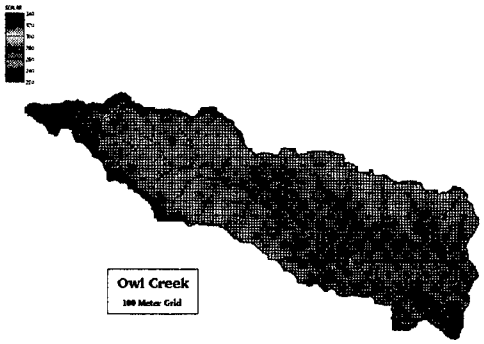
## Military Operations



## Demonstration Watersheds




## CASC2D Computational Grid

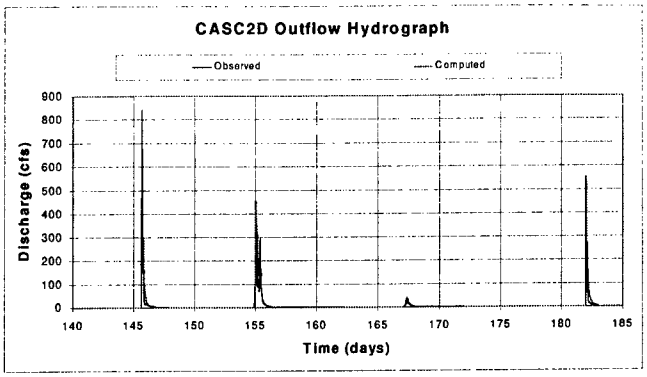



## Radar Rainfall Data

Hourly radar rainfall maps available from NWS

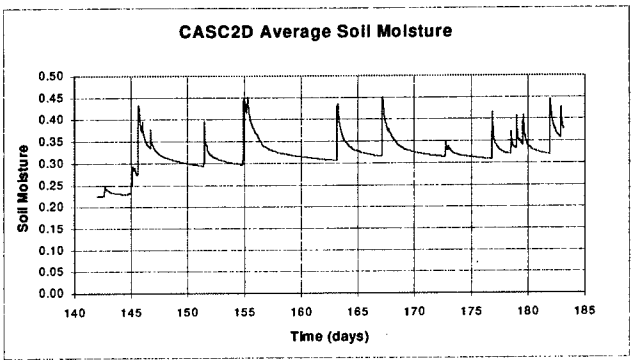
# CASC2D Model Output

Discharge Hydrograph



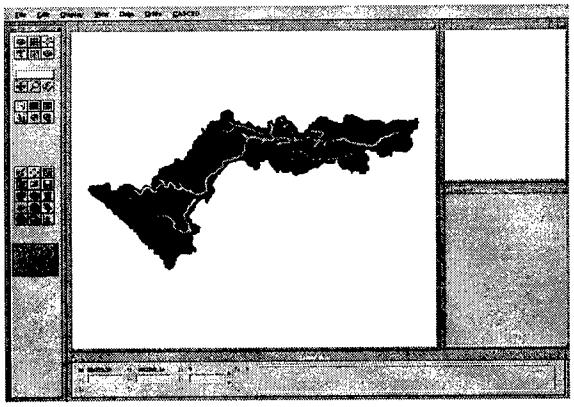

# CASC2D Model Output

Soil Moisture



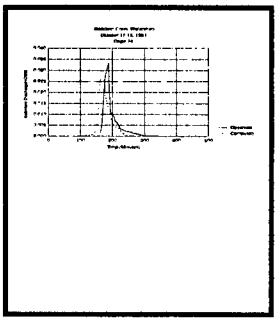

# CASC2D Model Output

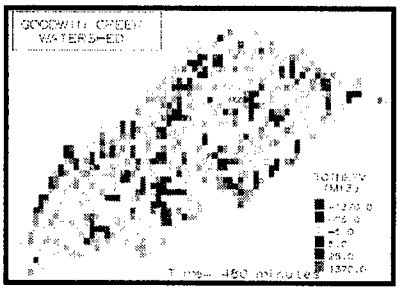
Surface Water Depth



## CASC2D Model Output

Erosion / Deposition





## Current Status

- GIS data acquisition largely complete
- Gauging station sites selected
- Cross-sections and gradients mapped
- Analysis of existing stream stage and meterological data underway
- Parameterization of CASC2D models underway
- Analysis of recurrence intervals, development of rating curves underway
- Next step: acquisition of equipment

## Coordination Issues

- Coordination with base facilities management personnel is underway on connection of gauging stations to power & phone grid
- Coordination with traffic/PM on warning system design is underway
- Coordination with weather squadron is underway

## Anticipated Results

- Installation of monitoring stations to provide high quality real-time data
- Estimates of probable maximum storm events, recurrence intervals and rating curves for each basin
- Watershed models capable of providing soil moisture estimates
- Linkage of models to real-time gage and radar data
- Installation of flood warning system

## Opportunities for Continuation of Watershed/Flooding Research

- Incorporate new vegetation and digital terrain models into rainfall/run-off model
- Correlate data gathered at these sites in real-time with weather radar and NRCS monitoring efforts water quality data
- Install digital video cameras to allow web based viewing of flood events
- Improve model calibration with increased period of record for data collection

### Web Based Courses

Presenters: James Carter, Nelda Volk

## DOD Conservation Web Site

- To provide a central location for useful web links to DOD conservation community
- To provide a vehicle to enroll in selected conservation training courses
- To provide information relevant to job performance in natural and cultural resources within DOD
- Completion date 4Qtr99 or 1Qtr00

## DOD Conservation Web-Based Courses and Web Site

- Contracted with Texas Research Institute for Environmental Studies (TRIES)
- Managed by Army's Environmental Awareness Resource Center (EARC)
- Approval through Interservice Environmental Education Review Board (ISEERB) Conservation Subcommittee
- Subject Matter Experts (SMEs) provided by DOD components and Coast Guard

## Biodiversity on Military Lands Non-Indigenous/Invasive Species

- Modular format
- Single module enrollment possible
- User-friendly design will accommodate variety of computers within DOD target audience
- Quick updates and changes possible
- Wider availability for more students
- Convenient training
- Completion 4Qtr99 or 1Qtr00