FINAL REPORT

NATO/CCMS Pilot Study Organizational Meeting Use of Landscape Sciences for Environmental Assessment

Studie Pilote de L'OTAN/CDSM sur L'utilisation du Sciences du Paysages pour les 'Evaluations Environmentales

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3-5 April 2002
Las Vegas, Nevada, U.S.A

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Executive Summary – NATO/CCMS Pilot Study on the Use of Landscape Sciences for Environmental Assessment

The Pilot Study on the Use of Landscape Sciences for Environmental Assessment was accepted by the NATO Committee on the Challenges of Modern Society in March 2001 and it held its first organizational meeting on 3-5 April 2002 in Las Vegas, Nevada, USA. The purpose and scope of the first landscape sciences pilot study meeting was to establish a working group representative of NATO member and partner Nations to exchange information about landscape science approaches useful for environmental assessment. Additionally, our purpose will be to transfer landscape assessment technologies and data among the study group participants for use in environmental protection and preservation programmes. The pilot study not only faces the challenge of integrating advanced technologies of remote sensing, geographic information systems, spatial statistics, and process models with landscape ecology theory, but it also represents a grand experiment in bringing together the different traditions, histories, and cultures of nearly 50 nations that are a part of the NATO enterprise. Not only are priorities different among the countries, but also their ability to financially and technically support such an endeavor varies widely. At the April organizational meeting, more than 40 researchers, administrators, and national representatives met to form an international study group; define their objectives and schedules; discuss common needs and capabilities; and develop a study process in which to take full advantage of the diversity of the members in a way that produces the greatest benefits and advantages to all parties in regard to using landscape sciences for the purpose of environmental assessment, protection, and preservation.

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NATO/CCMS Introduction

The Challenges of Modern Society- *Historical background and Purpose*

The NATO Committee on the Challenges of Modern Society (CCMS) was established in 1969 in order to give new "social dimension" and peaceful use to the defence Alliance. Its focus was to address practical problems already under study at the national level and, by combining the expertise and technology available in member countries, arrive fairly rapidly at valid conclusions and to make recommendations for action to benefit all.

One of the most important advantages of CCMS is the fact that it represents a unique forum for discussion of environmental problems and the exchange of information, on both civilian and military environmental matters.

CCMS carries its research activities out on a decentralised basis through its pilot studies. Subjects for pilot studies cover a large spectrum dealing with many aspects of environmental protection and the quality of life, including defence-related environmental problems. Since the start of CCMS activities more than 65 pilot studies have been completed (see http://www.nato.int/ccms/).

Each pilot country is responsible for developing, conducting, and disseminating the results of a pilot study. Co-pilot countries and other participating countries share the workload according to their interest. The participation of the 19 NATO members and of the 27 Euro-Atlantic Partnership Council (EAPC) countries* in the pilot studies is always on a voluntary basis. As a part of the activities of the pilot study, workshops, seminars, or international conferences may be held. Reports on the progress of studies are submitted to the CCMS by pilot countries at regular intervals. On completion of a study, a summary report is submitted to the CCMS members and then forwarded to the North Atlantic Council. A technical report is usually also published by the pilot group and made available on a worldwide basis to anyone expressing interest.

*NATO countries:

Belgium, Canada, Czech Republic, Denmark, France, Germany, Greece, Hungary, Iceland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Turkey, United Kingdom, United States.

EAPC countries:

Albania, Armenia, Austria, Azerbaijan, Belarus, Bulgaria, Croatia, Estonia, Finland, Georgia, Ireland, Kazakhstan, Kyrghyz Republic, Latvia, Lithuania, Moldova, Romania, Russian Federation, Slovak Republic, Slovenia, Sweden, Switzerland, Tajikistan, the former Yugoslav Republic of Macedonia, Turkmenistan, Ukraine, Uzbekistan.

Further information on CCMS can be obtained from:

CCMS Secretariat
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B-1110 Brussels, Belgium
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Fax: (32-2) 707.42.32
http://www.nato.int/ccms/

Pilot Study on the Use of Landscape Sciences for Environmental Assessment

The purpose and scope of the landscape sciences pilot study proposal is to establish a working group representative of member and partner Nations to exchange information about landscape science approaches useful for environmental assessment and to transfer landscape assessment technologies among the study group participants for use in environmental protection and preservation programmes. Both land use and land cover characterization and the use of landscape indicators will be demonstrated for environmental assessment. The exact geographic areas, which will be used for the demonstration, landscape characterization approach, and the selection of landscape indicators to be demonstrated will be determined by the Study Group. It is anticipated that multiple geographic areas in the continental United States and Europe will be selected for this demonstration study. The pilot study will explore the possibility of quantifying and assessing environmental condition, processes of land degradation, and subsequent impacts on natural and human resources by combining the advanced technologies of remote sensing, geographic information systems, spatial statistics, and process models with landscape ecology theory.

It is expected that this Pilot Study will be accomplished within four years. The anticipated final product will be a published book that includes each of the separate landscape assessments for the selected geographic areas of the NATO member and partner nations. Additionally, landscape characterization, landscape indicators, assessment software tools, and databases will be included.

Messrs. Wm. Kepner, Frederick (Rick) Kutz, and Felix Mueller have agreed to serve as Pilot Co-directors. The purpose of the Las Vegas meeting is to form the Study Group, define objectives and schedules, gather an understanding of existing studies and capabilities, and integrate the information into a Pilot Study science plan.

MEETING OVERVIEW

General Features of CCMS Pilot Studies (Deniz Beten):

1) Objectives of Program
   - Exchange of views in social, health, and environmental issues
   - Cooperation between nations
   - Development of expert networks
2) Voluntary participation
3) Funding of projects from other sources
4) NATO support for meetings, travelling, and information exchange

Objectives and Products of the Pilot Study on the use of Landscape Sciences for Environmental Assessment:

1) Immediate Tasks
   - Demonstrate the use of landscape science in landscape assessment
   - Exchange information and methodologies for landscape assessment
   - Combine technologies of remote sensing, GIS, spatial statistics, process models and landscape theory
2) Future Tasks
   - Formulation of a study group
   - Define objectives and schedules
   - Develop a pilot study science plan
3) Objectives and key research areas (B. Jones)
   - Broad field of activities
   - Landscape atlas as a model

General introduction to the five proposed emphasis areas of our pilot study:

1) Landscape characterization (R. Tankersley)
   - Europe compared to the United States
   - Compatibility of approaches
2) Land cover change detection (W. Kepner and C. Edmonds)
   - Significance of historical aspects for landscape state and development
3) Landscape indicator development (B. Jones)
   - From landscape metrics to indicators
   - Regional quantification of ecological risks
4) Landscape models (S. Miller)
   - Potential of modelling to hydrology
   - Significance of endpoints and targets
5) Landscape assessment (D. Heggem)
   - Patterns, processes, goods and services
   - Decision support

Demonstrations of Computer Tools

- Tools for landscape assessment – Analytical Tools Interface for Landscape Assessments (ATtILA) (D. Ebert)
- Tools for watershed assessment – Automated Geospatial Watershed Assessment (AGWA) (S. Miller)
- Tools for regional vulnerability assessment – Regional Vulnerability Assessment (ReVA) (M. O'Connell)

Questions:

- How can we intensify cooperation?
- How can we activate the necessary "creativity"?
- Can we all fulfill the hardware/software requirements?
- How can we cooperate concretely within the NATO/CCMS framework?
- How can we link the national ideas and projects?
- Should we try to integrate out network with international findings?
- Should we conceive an additional project to be proposed to the European community?
- How can NATO support such a project?

Problems:

- Different traditions, histories, development, and priorities in different countries
- Different states of terminology in different countries
- Different financial and infrastructural potentials in different countries

Challenge: Bring all of those differences together in a way that produces profits and advantages for all parties.

TIMELINES/MILESTONES

Pilot Study Timeline

July 15, 2002 - Work plans are due to Pilot Study Directors. Work plans should be discussed with the National CCMS Coordinator throughout its preparation.

August – October 2002

- Develop and distribute questionnaire with the objective of identifying national landscape capabilities, expertise, hardware, data, and national resources
- Identification of national experts
- Identification of country projects to start collaboration

November 19 - 21, 2002 - Work plans will be distributed and discussed at the next Pilot Study meeting at the Schleswig-Holstein Cultural Center (Salzau Castle), Kiel, Germany.

Annual meetings thereafter for review of project progress

Project Period: approximately 3-5 years

Elements of Work Plan

- Scientific aspects
- Coordination with National CCMS Coordinator
- Coordination with public health or environmental decision makers
- Outreach considerations: How will the project involve an interested public?

Format of Work Plan

1) ***Project Title with Thematic Area***

- Landscape Characterization (land cover mapping)
- Landscape Cover Change Detection (land cover change over time)
- Landscape Indicator Development
- Landscape Models
- Landscape Assessments (interpretive reports, e.g., atlas)

2) ***Principal Investigator, Co-Principal Investigators, and Affiliations***

3) **Abstract (250 words or less)**

4) ***Project Timeline and Outputs***

NATIONS PARTICIPATING IN THE CCMS/NATO PILOT STUDY ON THE USE OF LANDSCAPE SCIENCES FOR ENVIRONMENTAL ASSESSMENT

(As of April 5, 2002)

NATO Member Nations

Canada
Czech Republic
Germany
Poland
Spain (Observer)
Turkey
Italy
United States

EAPC Partner Nations

Armenia
Bulgaria
Latvia
Lithuania
Moldova
Romania
Slovenia
Ukraine

Nonmember Nation

Australia

MEETING AGENDA

NATO/CCMS PILOT STUDY ON THE USE OF LANDSCAPE SCIENCES FOR ENVIRONMENTAL ASSESSMENT

STUDIE PILOTE DE L'OTAN/CDSM SUR L'UTILISATION DU SCIENCES DU PAYSAGES POUR LES 'EVALUATIONS ENVIRONMENTALES

FIRST WORKING GROUP MEETING

April 3-5, 2002
Embassy Suites
4315 Swenson Street
Las Vegas, Nevada 89119
USA
(702) 795-2800

Tuesday, April 2, 2002

5:30 p.m. Informal Meeting of Participants with Study Directors -- *Please meet the Study Directors in the Coconut Lounge of Embassy Suites*

Wednesday, April 3 -- ***Dr. Frederick W. (Rick) Kutz***, Moderator

7:30 a.m. Registration -- *Each participant must obtain a name badge at the Registration Desk. Please bring some form of identification containing a photograph with you (passport, driver's license, etc.).* (***Mrs. Joann Menke***, ***Ms. Rose-Marie Chelhot***)

9:00 a.m. Introduction of Pilot Study Directors and Participants
Dr. Frederick W. (Rick) Kutz and ***William G. Kepner***, *U.S. Environmental Protection Agency*
Dr. Felix Mueller, *University of Kiel*

9:15 a.m. Welcoming Remarks
Dr. John Lyon, *Director, National Exposure Research Laboratory, U.S. Environmental Protection Agency*
Dr. Deniz Beten, *Programme Director, NATO Committee on the Challenges of Modern Society*

9:45 a.m. Overview of Proposal for NATO/CCMS Pilot Study on the Use of Landscape Sciences for Environmental Assessment. The original proposal for the study that

was approved by the Plenary Session of the CCMS will be presented and discussed (***Dr. Fredrick W. Kutz***).

10:15 a.m. Break

10:30 a.m. Workshop Goals and Objectives (***William G. Kepner***)

10:45 a.m. Overview of Research on Landscape Approaches at the U.S. Environmental Protection Agency (***Dr. K. Bruce Jones****, U.S. EPA*)

11:45 a.m. Group Photograph

12:00 p.m. Lunch (on your own)

1:30 p.m. Landscape Characterization of the United States and Europe: An Introduction (***Dr. Roger Tankersley***, *Tennessee Valley Authority*)

2:00 p.m. Land Cover Change Detection (***William G. Kepner*** *and* ***Curtis M. Edmonds***)

2:30 p.m. Landscape Indicator Development (***Dr. K.B. Jones***)

3:00 p.m. Break

3:15 p.m. Landscape Models (***Dr. Scott N. Miller****, Agricultural Research Service, U.S. Department of Agriculture*)

3:45 p.m. Landscape Assessments (***Daniel T. Heggem****, U.S. EPA*)

4:15 p.m. Pilot Studies Sponsored by the Committee on the Challenges of Modern Society (***Dr. Deniz Beten****, CCMS Programme Director*)

4:30 p.m. NATO/CCMS Pilot Study on Environmental Decision-Making for Sustainable Development in Central Asia (***Dr. Roy C. Herndon****, Florida State University, and* ***Dr. Bulat Yessekin****, Regional Environmental Center for Central Asia - Kazakhstan*)

5:00 p.m. Orientation to Las Vegas (***Ms. Deanna Kirk****, Embassy Suite, Las Vegas*)

5:30 p.m. Briefing on the University of Nevada, Las Vegas (***Dr. Ray Alden****, Provost, UNLV*). *This briefing will be held at the UNLV Foundation Building. Transportation will be provided.*

Thursday, April 4, 2002 -- **Mr. William G. Kepner**, Moderator

8:30 a.m. Regional Vector-borne Disease Profiles (***LTC Richard N. Johnson****, Research Liaison Officer, Armed Forces Pest Management Board. Presenter:* ***Richard Wells***)

9:00 a.m.	Landscape Approaches for the Geospatial Study of Arthropod Vectors and for Pollution Prevention (***Richard Wells**, U.S. Army Center for Health Promotion and Preventive Medicine*)
9:30 a.m.	Demonstration: Analytical Tools Interface for Landscape Assessments (***Donald W. Ebert**, U.S. EPA*)
10:00 a.m.	Demonstration: Automated Geospatial Watershed Assessment – A GIS-Based Hydrologic Modeling Tool (***Dr. Scott N. Miller/Darius J. Semmens***)
10:30 a.m.	Break
10:45 a.m.	Demonstration: Web-based Decision Tool for the Regional Vulnerability Assessment Program (***Dr. Michael O'Connell**, President, Waratah Corporation, Durham, NC*)
11:15 a.m.	Discussion of Equipment (Hardware and Software) Requirements for Participation (***Curtis M. Edmonds** and **Clayton E. Lake***)
11:45 a.m.	Lunch (on your own)
1:00 p.m.	Review of Meeting Progress (***Dr. Felix Mueller***)
1:30 p.m.	Soil Erosion Monitoring Metadata for Modeling of Landscape Change (***Dr. Benediktas Jankauskas**, Kaltinenai Research Station, Lithuanian Institute of Agriculture*)
2:00 p.m.	Pilot Environmental Risk Assessment around the North Anatolian Fault Zone in Marmara Region, NW Turkey, Using Landscape and Geological Features (***Drs. Y. Yilmaz**, **Y. Erbay**, and **E. Yiğitbas**, Istanbul Technical University Faculty of Mines, Maslak-Istanbul and Nik Construction Trade Co., Sisli-Istanbul*)
2:30 p.m.	Map of Italian Nature (***Dr. Giovanni Zurlini**, University of Lecce, Lecce, Italy*)
3:00 p.m.	Break
3:15 p.m.	The Quality of Soil and Forests in Romania in 2000 (***Ms. Mihaela Lazarescu**, National Institute for Research and Development for Environmental Protection, Bucharest, Romania*)
3:45 p.m.	Use of Remote Sensing Data in Latvia (***Dr. Juris Zagars**, Ventspils University College, University of Latvia, Riga, Latvia*)
4:00 p.m.	Digital, Hydrographic Division Map of Poland (***Sylwia Krzoska** and **Stanislaw Wilczkowiak**, Ministry of the Environment, Wawelska 52/54, 00-922 Warsaw, Poland*)
4:15 p.m.	Poster Session

Friday, April 5, 2002 -- Dr. Felix Mueller, Moderator

8:30 a.m.	Individual Project Expectations and Participation Status (***Dr. F.W. Kutz***)
8:45 a.m.	Preliminary Project Description from the United States (***W.G. Kepner***)
9:00 a.m.	Preliminary Project Description from Germany (***Dr. R. Lenz*** and others)
9:15 a.m.	Preliminary Project Description from Canada (***Dr. Bob Woods***)
9:30 a.m.	Preliminary Project Description from Italy (***Dr. G. Zurlini*** and others)
9:45 a.m.	Preliminary Project Description from Poland (***Ms. Krzoska***)
10:00 a.m.	Break
10:15 a.m.	Preliminary Project Description from Turkey (***Dr. Y. Yılmaz***)
10:30 a.m.	Preliminary Project Description from Armenia (***Mrs. A. Aleksandryan***)
10:45 a.m.	Preliminary Project Description from Latvia (***Dr. J. Zagars***)
11:00 a.m.	Preliminary Project Description from Lithuania (***Dr. B. Jankauskas***)
11:15 a.m.	Preliminary Project Description from Czech Republic (***Dr. Petr Kozel***)
11:30 a.m.	Preliminary Project Description from Romania (***Mrs. M. Lazarescu***)
11:45 a.m.	Preliminary Project Description from Slovenia (***Ms. A. Pirc-Velkavrh***)
12:00 p.m.	Preliminary Project Description from Central Asia (***Dr. Bulat Yessikin***)
12:15 p.m.	Preliminary Project Description from Bulgaria (Drs. G. Knight and M. Staneva)
12:30 p.m.	Lunch (on your own)
1:30 p.m.	Preparation and Formatting of Work Plans (***Dr. F.W. Kutz***) *Each participating Nation will need to develop a work plan describing the project that is planned as a contribution to this pilot study. Work plans are expected to be received by the Pilot Directors by July 15, 2002.*
2:00 p.m.	Timelines and Milestones for Pilot Study (***Dr. F.W. Kutz***)
2:30 p.m.	Discussion of Time and Place of Next Meeting of Working Group (***Dr. F. Mueller***)
2:45 p.m.	Break
3:00 p.m.	Report to Next CCMS Plenary Session (***W.G. Kepner, T.D. Sajwaj***)
3:15 p.m.	Summary of Meeting and Closing Remarks (***Dr. John G. Lyon****, Director, Environmental Sciences Division, U.S. EPA*)

LIST OF PROJECT PARTICIPANTS

LISTING OF PARTICIPANTS IN THE NATO/CCMS PILOT STUDY ON THE USE OF LANDSCAPE SCIENCES FOR ENVIRONMENTAL ASSESSMENT

(STUDIE PILOTE DE L'OTAN/CDSM SUR L'UTILISATION DU SCIENCES DU PAYSAGES POUR LES ÉVALUATIONS ENVIRONNEMENTALES)

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PRESENTATION ABSTRACTS

NATO/CCMS Pilot Study on the Use of Landscape Sciences in Environmental Assessment

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The United States Environmental Protection Agency, in partnership with other Federal and State agencies, has developed through its research programs various landscape science approaches to environmental assessment. These approaches include both landscape characterization (land cover/land use mapping) and ecological (landscape indicator) techniques. These new developments have been made possible through the use of remotely-sensed data from aerial photography and satellite images coupled with sophisticated computer applications. Landscape approaches require a multidisciplinary perspective and reflect a convergence of geography, ecology, and other sciences. Many scientists and environmental managers believe that these landscape approaches will be the "wave of the future" for environmental protection and preservation in the 21st century.

Landscape metrics or indicators are calculated by combining various scientific databases using technologies from geographic information systems. These metrics facilitate the understanding that events that might occur in one ecosystem or resource can affect the conditions of many other adjacent and distant systems. Some important aspects of environmental change occur at broad spatial scales of whole landscapes, and these cannot always be detected in small-scale studies. For example, the condition of a forest has a direct effect on the condition of streams that flow through the forest. Forests in poor condition because of disease- and insect-induced defoliation and other stresses will export higher nutrient and sediment loads into streams than forests in healthy condition. Additionally, the shape, size, and condition of natural resources have a direct bearing on the intrinsic plant and animal communities that they support and the adjacent communities dependent upon them for some part of their development.

Landscape research has progressed to a stage where these approaches can be used to conduct ecological monitoring and assessments on areas of different sizes, particularly very large geographic regions. Examples of the application of this approach are contained in landscape atlases for various watersheds and multistate regions, e.g., Mid-Atlantic Region, across the United States.

The current proposal is to establish a working group representative of member Nations and Partners, to exchange information about landscape approaches useful for environmental assessment, and to transfer landscape technologies to member Nations for use in environmental protection and preservation programs. This pilot study would be advantageous for North Atlantic Treaty Organization (NATO) members considering the vast experience that it has developed in remote sensing. This proposal was accepted on 22-23 March 2001 by the NATO Committee on the Challenges of Modern Society (CCMS) in Brussels, Belgium.

Automated Geospatial Watershed Assessment (AGWA)

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ABSTRACT: Planning and assessment in land and water resource management are evolving from simple, local-scale problems toward complex, spatially explicit regional ones. Such problems have to be addressed with distributed models that can compute runoff and erosion at different spatial and temporal scales. The extensive data requirements and the difficult task of building input parameter files, however, have long represented an obstacle to the timely and cost-effective use of such complex models by resource managers. The USDA-ARS Southwest Watershed Research Center, in cooperation with the U.S. EPA Office of Research and Development, has developed a GIS tool to facilitate this process. A geographic information system (GIS) provides the framework within which spatially-distributed data are collected and used to prepare model input files and evaluate model results.

The Automated Geospatial Watershed Assessment (AGWA) tool uses widely available standardized spatial datasets that can be obtained via the Internet. The data are used to develop input parameter files for two watershed runoff and erosion models: KINEROS and SWAT. The Kinematic Runoff and Erosion Model (KINEROS) is an event-oriented, physically-based model developed at the USDA-ARS to describe the processes of interception, infiltration, surface runoff and erosion from small ($\leq \sim 100$ km^2) watersheds. The watershed is represented by a cascade of planes and channels, thereby allowing rainfall, infiltration, runoff, and erosion parameters to vary spatially. KINEROS may be used to determine the effects of various artificial features such as urban developments, small detention reservoirs, or lined channels on flood hydrographs and sediment yield. The Soil and Water Assessment Tool (SWAT) is a quasi-distributed model developed at the USDA-ARS to predict the impact of land management practices on water, sediment, and agricultural chemical yields in large (basin scale) complex watersheds with varying soils, land use, and management conditions over long periods of time (> 1 year). SWAT is a continuous-time model, i.e., a long-term yield model, using daily average input values, and it is not designed to simulate detailed, single-event flood routing.

Using digital data in combination with the automated functionality of AGWA greatly reduces the time required to use these two watershed models. Through a robust and intuitive interface, the user selects an outlet from which AGWA delineates and discretizes the watershed using the Digital Elevation Model (DEM). The watershed elements are then intersected with soil, land cover, and precipitation (uniform or distributed) data layers to derive the requisite model input parameters. The model is then run, and the results are imported back into AGWA for visual display. Model results that can be displayed in AGWA are shown in the table to the right. This option allows managers to identify problem areas where management activities can be focused or to anticipate sensitive areas in association with planning efforts. AGWA is designed to

evaluate relative change and can only provide qualitative estimates of runoff and erosion. It cannot provide reliable quantitative estimates of runoff and erosion without careful calibration. It is also subject to the assumptions and limitations of its component models, and it should always be applied with these in mind.

Analytical Tools Interface for Landscape Assessments (ATtILA)

Donald W. Ebert, *U.S. Environmental Protection Agency, Las Vegas NV*

ABSTRACT: Environmental management practices are trending away from simple, local-scale assessments toward complex, multiple-stressor regional assessments. Landscape ecology provides the theory behind these assessments while geographic information systems (GIS) supply the tools to implement them. A common application of GIS is the generation of landscape metrics, which are quantitative measurements of the environmental condition or vulnerability of an area (e.g., ecological region or watershed). The generation of these metrics can be a complex, lengthy undertaking, requiring substantial GIS expertise.

The Landscape Ecology Branch, in cooperation with U.S. EPA Region 4 and the Tennessee Valley Authority (TVA), are developing a user-friendly interface to facilitate this process. ATtILA is an easy to use ArcView extension that calculates many commonly used landscape metrics. By providing an intuitive interface, the extension provides the ability to generate landscape metrics to a wide audience, regardless of their GIS knowledge level. ATtILA is a robust, flexible program. It accepts data from a broad range of sources and is equally suitable across all landscapes, from deserts to rain forests to urban areas.

Four families of metrics are included in the extension: landscape characteristics, riparian characteristics, human stressors, and physical characteristics. Each group has a dialog to accept user input on which metrics to calculate and what input data to use. Landscape characteristics are related to land cover proportions and patch metrics (e.g., percent forest cover or number and size of forest patches). Riparian characteristics describe land cover adjacent to and near streams (e.g., percent of crop land within 30 meters of streams). Human stressors are concerned with population, roads, and land use practices (e.g., population change or road/stream crossings) and the physical characteristics that provide statistical summaries of such attributes as elevation and slope. Once metrics have been calculated, the extension has three types of output display available. The first displays areas ranked by individual metric values, the second ranks areas by a weighted index made up of two or more metrics, and the third displays a bar chart of selected areas and metrics.

Because of the size of landscape data sets and the complexity of the calculations to generate some metrics, we recommend a minimum of a Pentium II 266 MHz (or equivalent) with 32 MB of memory. A preferred system would be a Pentium II 400 MHz (or equivalent) with 64 MB of memory and a fast (<8 ms) hard drive or better. To use the ATtILA, version 3.1 or later of ArcView and the Spatial Analyst version 1.1 extensions is required. Both UNIX and Windows (95, 98, and NT) environments are supported.

EPA's Regional Vulnerability Assessment Program: Tools to Facilitate Regional to Local Decision-making

Michael O'Connell[1] and Elizabeth R. Smith[2]

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EPA's Regional Vulnerability Assessment (ReVA) program is developing and testing approaches to conducting comparative environmental risk assessments at the regional scale, considering impacts to ecological, human, and fiscal health endpoints. It seeks an objective and quantifiable answer to answer the question, "What are the greatest threats accompanying socio-economic growth in a region and which ecosystems are most vulnerable?" ReVA builds on the environmental monitoring base developed by the Environmental Monitoring and Assessment Program (EMAP) and monitoring done by other agencies, and incorporates the latest developments in remote sensing, landscape ecology, spatially explicit modelling, and ecological risk assessment. The research is being conducted in concert with EPA Region 3 as part of the Mid-Atlantic Integrated Assessment (MAIA) and includes collaboration across ORD and with other federal agencies, i.e., the U.S. Forest Service, the U.S. Geological Survey, and the Tennessee Valley Authority.

In addition to peer-reviewed publications on these new approaches, ReVA is producing a number of decision support tools that illustrate trade-offs associated with alternative management actions and policies. ReVA's prototype web-based application facilitates decision-making by allowing users to view maps of, and relationships between individual indicators, or integrated indices of relative vulnerability. Trade-offs can be evaluated by comparing different sets of indicators (e.g., those relating to water quality or human health) and by differentially weighting selected indicators (or decision criteria) based on stakeholder input. The web site will soon incorporate future scenarios as well, allowing insights into the impacts associated with projected land use change and population growth. The web-based application has been developed as a flexible framework that can be used in any region and with any scale data. This tool will be a critical aid to state and local governments and regional EPA offices and planning bodies to develop efficient and effective strategies for community-based environmental protection.

Soil Erosion Monitoring Metadata for Modelling of Landscape Change

Benediktas Jankauskas

Kaltinenai Research Station of Lithuanian Institute of Agriculture

Lithuania, as a lowland country, has two upland regions. The island-like Zemaiciai Upland is in the western part of the Republic, where the edge of the Baltic Uplands is in the eastern and southern parts. Some 51.9 percent of Lithuania's terrain is on the hilly-rolling relief, where the soil is erodible. The investigations were carried out on the

Zemaiciai Upland (approximately $55^0 34'$ N and $22^0 29'$ E). There, relief is exposed for erosion processes, since it is either steeply dissected hills with gullies or rolling areas on the central watershed part of the upland or rolling-hills and undulating plains on the outskirts of the upland. There are either long moderately and strongly sloping hills in the central part or short gently sloping and densely grouped hills on the outskirts of the upland. However, the natural vegetation (woods, shrubbery or grasslands) is able to protect soils against erosion processes.

The intensity of soil erosion on the arable land of Lithuania depends on the tillage erosion, which is the main cause of accelerated soil erosion by water or wind. The intensity and relative importance of tillage erosion on the hilly landscape of Lithuania depend on the slope inclination, on the type of tillage implements, on the intensity and technology of soil cultivation, and on other circumstances. The highest tillage erosion has been registered (Kiburys, 1989) under ploughing across the slope (12.2, 15.7 and 16.8 t ha^{-1} on the slopes of 5^0, 10^0 and 15^0, respectively). The least tillage erosion was under ploughing along the slope (2.7, 5.2 and 7.2 t ha^{-1}).

The research data at the Kaltinenai Research Station of Lithuanian Institute of Agriculture were obtained on the hilly-rolling relief, where loamy sand and clay loam Dystric Albeluvisols prevail. The thickness of the lost soil layer differed due to common effects of water, wind, and tillage erosion and varied from 0.12 to 1.07 m according to the slope inclination, and degree of soil erosion. The degree of soil erosion was determined by comparison of the thickness of lost soil layer, slope inclination, and thickness of genetic soil horizons over the calcareous soil layer. The annual losses of soil due to water erosion on the slopes of $2\text{-}5^0$, $5\text{-}10^0$, and $10\text{-}14^0$ were as follows according to 12 years of field experiments: 5-30 t ha^{-1} under winter rye, 18-60 t ha^{-1} under spring barley, and 44-196 t ha^{-1} under potatoes. Only perennial grasses completely prevented water erosion. The losses of soil under erosion-preventive grass-grain crop rotations decreased by 77-81 percent in comparison with the field crop rotation, while that under grain-grass crop rotation decreased by 22-25 percent.

There was a statement of the mentioned metadata that the loss of 10 t ha^{-1} of soil is approximately equal to the loss of 1 mm of topsoil from the eroded parts of slope and of the approximate accumulation of some layer on the footslope or export sediments into the streams. Therefore, soil erosion metadata would be of use for the modelling of landscape change. Farmland in poor condition will export higher sediment and nutrient into wetlands or water streams than farmlands in healthy condition due to unsatisfactory cover of soil surface and other stresses. Therefore, examples of landscape indicators would be supplemented by indicators of soil quality and of farmland condition.

The mentioned soil erosion monitoring investigations of Kaltinenai Research Station are part of the Core Research Programme of Global Change & Terrestrial Ecosystem (GCTE), which is under the International Geosphere Biosphere Programme (IGBP).

For Environmental and Risk Assessment a Pilot Study around the North Anatolian Fault Zone in Marmara Region, NW Turkey, using Landscape, and Geological Features.

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The Armutlu Peninsula, located in the east of the Sea of Marmara, was strongly affected by major earthquakes in 1999. As a result of the earthquakes, inadequate land use planning and urbanizations caused catastrophic damages environmental pollution in the western part of the peninsula where the North Anotolian Fault zone was reactivated. However, presently a number of towns and factories are still located on this "fertile" fault zone, waiting for a near future destruction.

The morphology of the Armutlu Peninsula and the surroundings is strongly controlled by the active tectonics of Anatolia, of which the major structural feature is the North Anatolian fault zone. This tectonic activity has caused the Armutlu mountain ranges along the Armutlu Peninsula to have recently been elevated to the present height of 1000 m above sea level. At the top of the hills is a recognized rather young, hanging erosional flat-lying plateau formed above the rocks of various ages and physico-mechanical in nature. The both flanks of the mountain ranges are bounded by active normal faults, which produced steep slopes. The headward erosion along these steep slopes is yet in an incipient stage. Therefore, there is only few flatlands of limited extend, developed in front of these steep fault scarps. The faults make a narrow angle with the present coastline and the dominant dip slip component of the fault planes is replaced by strike-slip components toward the East. Therefore, the hills are less pronounced and alluvial fans of the rivers draining the hills are larger. These alluvial coastal planes form vast piedmont flatlands, and together with ground water seepages aligned along with the faults, seem to provide ideal places for human settlement. For this reason, these coastal areas have long been the sites of dwellings for thousand of years.

Earthquake damages and landscape features are clearly seen from commercial optical satellites. Landscape analyses are done together with field studies and remote sensing techniques. Land use maps, tectonic maps, geological maps, and aspect maps of the area are prepared and their combinations are conducted to assess risk of hazards and environment.

A Digital Hydrographic Division Map of Poland

Sylwia Krzoska and Stanislaw Wilczkowiak

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In 1998, the Ministry of the Environment lunched a project on the digital hydrographic division map of Poland. The objective of the project has been to create a comprehensive information tool for water management. The project is nearly finished. The presentation includes description of project assumptions, GIS tools, sources of data, international cooperation, results, and future use of the map.

Computer Hardware and Software Recommendations for CCMS/NATO Pilot Study on the Use of Landscape Sciences for Environmental Assessment

Curtis M. Edmonds, Clayton E. Lake, and Rose-Marie Chelhot

U.S. Environmental Protection Agency

The following information represents minimum and optimal equipment requirements for landscape analyses. These recommendations include both hardware and software essentials required for the pilot project.

Hardware/Software	Optimal Configuration	Minimum Configuration
Computer	Pentium III Processor Windows NT Operating System Speed: 1 GHz 80 GB Hard Drive RAM: 512 MB 32 MB Video Card	Pentium III Processor Windows NT Operating System Speed: 500 MHz 28 GB Hard Drive RAM: 128 MB 8 MB Video Card
Monitor	21-inch	17 or 19-inch
Tape Back-Up	20 GB	8 GB
CD/DVD	Read-Write CD and/or DVD	Read-Write CD
Printer/Plotter	Color Printer capable of 11” X 17” paper or Color Plotter	Color Printer capable of 11” X 17” paper
Geographic Information Systems Software	ArcView with Spatial and Image Analyst ERDAS	ArcView with Spatial and Image Analyst
Remote Sensing Software	ENVI ERDAS Imagine	None (Use Image Analyst)
Statistical Software	SAS S-plus	S-plus ArcView extension

Regional Vector-borne Disease Profiles (DVEP)

LTC Richard N. Johnson

U.S. Armed Forces Pest Management Board

ABSTRACT: Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates, and plants that may adversely affect troops in specific countries or regions around the world. Primary emphasis is on the epidemiology of arthropod-borne diseases and the bionomics and control of disease vectors. DVEPs have proved to be of significant value to commanders, medical planners, preventive medicine personnel, and particularly medical entomologists. These people use the information condensed in DVEPs to plan and implement prevention and control measures to protect deployed forces from disease, injury, and annoyance caused by vector and pest arthropods. Because the DVEP target audience is also responsible for protecting troops from venomous animals and poisonous plants, as well as zoonotic diseases for which arthropod vectors are unknown, limited material is provided on poisonous snakes, noxious plants, and diseases like hantavirus.

Landscape Approaches for the Geospatial Study of Arthropod Vectors and for Pollution Prevention

Richard D. Wells, Brian C. Zeichner, Joseph T. Harkins, and Karl Neidhardt

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ABSTRACT: Geostatistical density contouring is a tool that allows us in the case of insects to draw population contour lines in much the same way elevation lines are drawn on a topographic map. This enables us to precision target our control and prevention strategies. This presentation describes how this methodology has been applied to cockroaches, ticks, and green June beetles. Effective control of pesticide-resistant cockroach infestations has been accomplished by targeting pesticide application at the foci of the infestations. Ninety-five percent control of the green june beetle was achieved using 30 percent of the acreage required using “standard practices.” New insight into population dynamics of the lone star ticks (Amblyomma americanum) was gained. A theoretical threat map was produced showing the probability of encountering lone star ticks by correlating “ground data” with IKONOS and SPOT satellite imagery.

POSTER ABSTRACTS

Developing Landscape Indicator Models for Pesticides and Nutrients in Streams of the Mid-Atlantic Coastal Plain

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ABSTRACT: A network of stream-sampling sites was developed for the Mid-Atlantic Coastal Plain (New Jersey through North Carolina), a collaborative study between the U.S. Environmental Protection Agency and the U.S. Geological Survey. A stratified random sampling with unequal weighting was used to select 175 first-order nontidal streams for synoptic sampling of base-flow water quality and benthic and riparian ecology during early 2000. Additional streams were selected for sampling to allow comparison of data from the base network to downstream conditions and to assess seasonal and temporal variability. The base network was designed to provide data for two distinct but complementary objectives: a probabilistic assessment of regional conditions and a gradient study over a range of land cover and hydrogeologic conditions. The base network included 25 sites within each of seven hydrogeologic subregions that were delineated on the basis of physiography and bulk texture of surficial sediments. Field reconnaissance resulted in several site replacements that yielded a final network of 174 streams. Alternative sampling sites were selected in the same manner if the primary base-network sites were unsuitable. Within each subregion, selection probabilities were adjusted to provide an approximately even distribution of network sites along a gradient of forested-to-developed (urban or agricultural) land in the contributing watershed. With these data, landscape indicator models were developed using stepwise regression to estimate in-stream concentrations of herbicides, nitrate plus nitrite, and chloride. By applying weights to the data to compensate for land-use bias incorporated in the network design, concentrations of pesticides and nutrients were estimated for the entire population of first-order streams in the study area.

Probability of South Carolina Watersheds Exceeding State Water Quality Standards for Fecal Coliform

Jonathan H. Smith, James D. Wickham, Douglas Norton, Timothy G. Wade, and K. Bruce Jones

U.S. Environmental Protection Agency

ABSTRACT: Many water-bodies within the United States are contaminated by non-point source (NPS) pollution, which is defined as those materials posing a threat to water quality arising from a number of individual sources and diffused through hydrologic processes. One such NPS pollutant is fecal coliform, which is derived from animal wastes, including humans, and is most often associated with urban and agricultural areas. It is postulated that by utilizing land cover indicators, those water-bodies that may be at

risk of fecal coliform contamination may be identified. This study utilized land cover information derived from the Multi-Resolution Land Characterization (MRLC) project to analyze fecal coliform contamination in South Carolina. Also utilized were 14-digit hydrologic unit code (HUC) watersheds of the state, a digital elevation model, and test point data stating whether the fecal coliform levels exceeded levels assigned in section 303(d) of the Clean Water Act. Proportions of the various land covers were identified within the individual watersheds and then analyzed using a logistic regression. The results reveal that watersheds with large proportions of urban land cover and agriculture on steep slopes had a very high probability of being impaired.

National Land-Cover Data (NLCD) Project: A product of the Multi-Resolution Land Characteristics (MRLC) Consortium

Jonathan H. Smith and James D. Wickham

U.S. Environmental Protection Agency, Research Triangle Park

ABSTRACT: The NLCD dataset is the first comprehensive, high-resolution land-cover dataset created for the conterminous United States derived from satellite data. The Landscape Characterization Branch of the U.S. EPA's National Exposure Research Laboratory is working with its MRLC partners to ensure a complete and accurate land-cover dataset for use by scientists and environmental planners.

REKA, A Spatial Water Quality Assessment System (Bulgaria)

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ABSTRACT: **R**iver **E**nvironmental **K**nowledge and **A**ssessment (**REKA**) is a spatial water quality assessment system designed to answer two kinds of questions: (1) If we invest in pollution control at a place, where and to what degree will stream quality goals be achieved, and (2) To attain certain quality standards for a given reach (or reaches) of the river, what alternative strategies could be implemented under various probabilistic levels of stream flow resulting from climatic variability and with input from the local community. **REKA** was developed in the context of the Yantra River Basin in Bulgaria (REKA = river in Bulgarian) as a transferable geographic information system (GIS)-based tool to link process and decision models related to water quality in a comprehensive framework. The project is collaboration among the Institute of Water Problems in the Bulgarian Academy of Sciences and the Environmental Resource Research Institute and the Center for Integrated Regional Assessment at the Pennsylvania State University.

REKA has three subcomponents. **B**asin **I**mpacts of **S**imulated **T**ransport from **R**ural **A**reas (**BISTRA**) (BISTRA = clear in Bulgarian) uses a new articulation of the Generalized Watershed Loading Functions (GWLF) model in the ArcView GIS program (AVGWLF: see http://www.avgwlf.psu.edu). This component calculates watershed runoff and loads of nutrients (N, P) and sediments based on weather, soil, topography, and land use, including both non-point and point sources of pollution.

Validation and **O**ptimization for **D**ecision **A**nalysis (**VODA**) (VODA = water in Bulgarian) is a substantial revision of the STREAMPLAN model of the International Institute of Applied Systems Analysis. This component uses a reduced-form process model to derive stream hydraulics and pollutant transport and processing. BISTRA delivers loadings and water volume data to VODA by stream reach. VODA then computes flows and pollutant concentration and loads by reaches.

In VODA, the user has several model design choices. VODA can be used to generate a scenario based on current conditions (e.g., for calibration and validation) or to simulate water quality impacts of proposed treatment facilities or discharge regulations. Alternatively, VODA can calculate financially optimal strategies to achieve water quality improvement goals or to meet specified standards for all or some of the stream reaches. Decision choices include alternative allocations of reservoir water for dilution (with lost value from alternative uses); temporary or permanent closing of polluting entities; and capital and operational costs of pollution pre-treatment and treatment.

VODA also provides for input of alternative weather conditions based on the validation period or a typical wet, average, or dry year. It is also possible to input temperature and precipitation change scenarios derived from global climate change models. Typically, simulations will be framed in terms of low-flow months during relatively dry years.

Ecological Assessments in Mauritius (large scale) and Germany (medium and small scale) with Aspects on Software Development

Karl-Heinz Mueller

Dept. Geography, University of Marburg, Marburg, Germany

ABSTRACT: Unavailable

Analyzing Current and Future Surface Mining using a Normalized Difference Vegetation Index (NDVI) Change Detection Method

Dennis Yankee[1] and Rick Kutz[2]

[1]Tennessee Valley Authority, Norris, TN; [2]U.S. Environmental Protection Agency, Ft. Meade, MD

ABSTRACT: Coal mining is a major resource extraction activity in the Appalachian Mountains. The increased size and frequency of a specific type of surface mining, known as mountaintop removal-valley fill, has in recent years raised various environmental concerns. During mountaintop removals, huge shovels and dozers shave off entire tops of

mountains to reach the valuable coal seams underneath. The rock and earth are placed in the valleys below, burying existing streams. These activities encompass relatively large areas, making identification via satellite imagery feasible.

The purpose of this study is to identify recent surface mining activity using remotely-sensed data. Using early 1990s raw and classified satellite imagery from the MRLC as our baseline and in conjunction with raw imagery from 1999, we are using a change detection procedure to identify areas that have been mined since the baseline. With this information we will estimate the rate at which mountaintop removal is occurring in the Appalachians.

Ecological Evaluation of Landscapes in Central Europe - Natural Regions as a Method of Data Aggregation

Matthias Gunter

Dept. of Geography, University of Marburg, Marburg, Germany

ABSTRACT: In medium scale, nature regions are an approved method to define areas of homogenous but complex parameters. Germany was divided by the "Bundesanstalt für Landeskunde und Raumforschung" (Federal Office for Spatial Research) into more than 500 main- and about 6000 subregions. Special software was developed to calculate a high-resolution multilayer assessment of landscapes. We use these well-defined areas, for example, to aggregate data from more than 8000 weather stations for a time period of 10 years to qualify and quantify the climatic situation in the natural regions. The distribution of settlements, the social and population data, and the historic development as well as the impact of human health are highly influenced by the natural and/or physical features and configurations of landscapes.

An Interactive GIS Landscape Change and Analysis Tool

Peter Claggett

Canaan Valley Institute, Valley Forge, PA

ABSTRACT: To better understand landscape change and assist in its management, the Canaan Valley Institute and the Natural Resource Analysis Center at West Virginia University have developed an ArcView GIS extension to evaluate the impacts of landscape changes using indicators related to water quality, wildlife habitat, and overall landscape condition. Users of the extension are able to interactively incorporate changes to the landscape or model potential landscape changes from urban expansion. The extension allows users to compare indicator values based on current landscape conditions with indicator values based on user-defined or modeled future landscape conditions. Potential applications for this tool include cumulative impact assessments, landscape ecological analyses, comprehensive planning, and natural resource management.

New York City's Water Supply Watersheds

Mehaffey, Megan, H., Maliha S. Nash, Timothy G. Wade, Curtis M. Edmonds, K. Bruce Jones, and Audrey Rager

U.S. Environmental Protection Agency, Las Vegas NV

ABSTRACT: A number of water bodies located within the New York City's water supply system are impaired by nutrients and pathogens. The objective of this study was to investigate the relationship between landscape and water quality in the Catskill/Delaware watersheds. Landscape data was collected using multiple snap shots in time spanning two decades (1975-1998). Biweekly water quality, rainfall, and discharge data from 1987-1998 were used to examine temporal trends in total nitrogen, phosphorous, and fecal coliform bacteria. Stepwise multiple regression analyses (n = 32) were used to determine the contribution of the landscape metrics to surface water quality measurements. Percentages of agriculture and urban development were the dominant landscape variables over the years and explained 25-65 percent of the variability in water quality measurements. The vast majority of agriculture and urban land use was located within 240 meters of streams. Barren, agriculture on steep slopes and agriculture on erodible soils also contributed significantly to water quality, but explained only a small portion (4-8 percent) of overall variability. During the past two decades the release of agricultural fields from farming has returned a small percentage of land (2 percent) to secondary growth forest. Most of these changes took place between 1985 and 1998, corresponding to significant decreasing trends in nitrogen and phosphorous. The results from this study suggest that combining approaches, such as increasing riparian forest within the 240-meter buffer zone and encouraging Best Management Practices (BMPs) on remaining farmlands, should provide an effective way of controlling non-point source pollution to surface waters in the Catskill/Delaware watersheds.

Environmental Monitoring of CFB Shilo Training Area: A Remote Sensing and GIS Approach

Robert Woods[1], Graeme Watson[2], and Jennifer Rowland[2]

[1]Dept. of National Defence, Ottowa Canada; [2]Royal Military College, Kingston Canada

ABSTRACT: Military training impacts the lands where they occur. To measure these impacts on large training areas can be difficult and costly. Remote sensing is being used with GIS to monitor changes on CBF Shilo as a pilot project to determine if changes can be detected by this method.

To date we have been successful to classify landcover types and measure their changes over time. These changes can be related to military training where they occur. This approach permits us to monitor and assess over time the real impacts of training on the base.

Outreach Activities of the Canaan Valley Institute

George Constantz

Canaan Valley Institute, Davis WV

ABSTRACT: Unavailable

CCMS Pilot Study of Landscape Sciences for Environmental Assessment

V. Heidt[1] and W. Sun[2]

[1]University of Mainz, Germany
[2]Dept. of Geography, Southern Illinois University

ABSTRACT: We propose an information fusion method for the extraction of land-use information based on both the panchromatic and multispectral IRS-1C satellite imagery. The method integrates spectral, spatial, and structural information existed in the image. A thematic map was first produced with a maximum likelihood classification (MLC) applied to the multispectral imagery. Probabilistic relaxation (PR) was then performed on the thematic map to involve neighborhood information in the classification. Furthermore, we incorporated edges extracted from the higher spatial resolution panchromatic imagery into the multispectral classification. A 1-pixel-width edge map was generated from the panchromatic data by using operations such as edge detection, edge thresholding, and edge thinning. Finally, a modified region-growing approach was used to improve image classification.

The procedure proved more effective in land-use classification than conventional methods based only on multispectral data. The improved land-use map is characterized with sharp interregional boundaries, reduced number of mixed pixels, and more homogeneous regions. The overall kappa statistics increased considerably from 0.52 before the fusion to 0.75 after the fusion.

A Landscape Approach to Monitoring and Assessing Environmental Condition in the Upper San Pedro River Basin

W. G. Kepner[1], C. Watts[2], C. Edmonds[1], H. Richter[3], W. Childress[4], B. Alberti[5], R. Blanchard[6], S. Stone[7], J. Guerra[8], R. Koehler[9], G. Luna[2], and D. Goodrich[10]

[1]U.S. Environmental Protection Agency, Las Vegas NV; [2]Instituto del Medio Ambiente y el Desarrollo Sustentable del Estado de Sonora, Hermosillo, Sonora, Mexico; [3]The Nature Conservancy, Hereford AZ [4]U.S. Bureau of Land Management, Sierra Vista AZ; [5]U.S. National Park Service, Hereford AZ; [6]City of Sierra Vista, Sierra Vista AZ; [7]U.S. Army Garrison, Fort Huachuca AZ; [8]Secretaria de Medio Ambiente, Recursos Naturales y Pesca, Hermosillo, Sonora Mexico; [9]Cochise County, Bisbee AZ; [10]USDA Agricultural Research Service, Tucson AZ

ABSTRACT: Vegetation change in the American West has been the subject of much concern and controversy throughout the 20th century. Over the years, a considerable number and variety of claims have been made regarding causes related to changes in land

cover. The evidence for vegetation change has primarily been provided through the use of comparative photography and anecdotal accounts. Rarely have changes been documented or quantitatively measured at scales as large as watersheds or entire biogeographic provinces. This research examines the potential to measure vegetation change over large areas and determine trends in an ecological condition using advanced space-based technologies. Specifically, a suite of landscape pattern measurements was developed from satellite remote sensing, spatial statistics, and geographic information systems technology for a semi-arid watershed in southeast Arizona and northeast Sonora, Mexico. Results from this study will provide the basis for developing landscape composition and pattern indicators as sensitive measures of large-scale environmental change and, thus, will further the understanding of disturbance regimes related to human and natural stress in the Southwest.

Ecological Assessment of Landscapes for Natural Conservation Scenarios in Mauritius

Reinhold Hill and Karl-Heinz Mueller

Phillips University, Marburg Germany, Dept. of Geography – GIS Research Laboratory

ABSTRACT: Mauritius formerly was an untouched island with tropical and partly endemic flora and fauna before the arrival of man. This unique nature has been almost destroyed because of the intensive economics of the island by the first generation of settlers.

Actually there are only a few remnants of natural vegetation and the indigenous and endemic flora and fauna is threatened by extinction by exotic plants and animals. The National Park in the Southwest, some nature and mountain reserves, and a dozen Conservation Management Areas (CMA), where the National Parks and Recreation Service (NPCS) tries to eradicate all alien species, are the last resorts for the endemic species.

The aim of this research was the most exact localization of the CMAs and the places, where the almost 40 most threatened plants are growing, with the help of a GPS unit. Furthermore, there have been eight transects in different ecological regions of the island created, where bird counts have been taken in order to get an impression of the composition of the bird communities.

PRELIMINARY PROJECT DESCRIPTIONS

Individual Project Expectations and Participation Status – Dr. F.W. Kutz

Objectives of Study

- To demonstrate the use of landscape sciences for environmental assessment
- To illustrate the utility of this approach in public health and environmental decision-making, land use planning, and ecological preservation/restoration projects
- Each participating Nation or Partner will select project of most utility

Landscape Approach

- Some important environmental changes occur at broad spatial scales – undetectable in localized studies
- Landscape patterns and trends reflect condition of embedded ecosystems
- Landscape information useful in both local and regional (large-area) assessments
- Landscape indicators based on land use/land cover information derived from satellite imagery and aerial photography
- High-Tech Approach: Power of remote sensing combined with geographic information sciences, computer technology, and spatial statistics

Emphasis Areas for Projects

- Landscape characterization (land use/land cover)
- Land cover change detection
- Landscape indicators
- Landscape models
- Landscape assessment

Proposed Products

- Working Group meetings
- NATO/CCMS (Blue Book) Reports to be published in book format (interested publishers include Kluwer Academic Publishers, CRC Press/Lewis Publishers)

Levels of Participation

- Full Participation -- Nation/Organization expected to conduct study contributing to objectives of pilot study
- Observer Status -- Nation/Organization desiring to observe study but not actively participate

Pilot Project Directors

- William G. Kepner, U.S. Environmental Protection Agency, Las Vegas, NV, USA
- Felix Mueller, University of Kiel, Kiel, Germany

Preliminary Project Description from the United States

Northwest Oregon Pilot Study Area (USA): Landscape Assessment with sub-elements of landscape characterization, land cover change analysis, landscape indicators, and landscape models.

William G. Kepner, Daniel T. Heggem, and Frederick W. Kutz

U.S. Environmental Protection Agency

PROJECT DESCRIPTION: The Northwest Oregon Pilot Study Area encompasses approximately 59,167 km^2 and varies in elevation from sea level to 3,200 m. Annual precipitation varies with elevation and meridian and ranges from 25 – 460 cm. The study area comprises a mixture of federal, state, and privately owned lands and includes estuarine, forest, and rangeland with both rural and metropolitan urban centers and agricultural areas. The pilot area supports 2.6 million inhabitants and the economy is primarily based on forest products, tourism, and agriculture.

This project proposes to develop two digital land cover maps using a 21-class system. Landsat TM satellite imagery for two periods, i.e., 1995 and 2000, will be converted into land cover and analyzed for change. Specific landscape metric and indicators will be developed related to important environmental endpoints, e.g., watershed condition, using spatial analysis tools developed by the U.S. Environmental Protection Agency and the USDA Agricultural Research Service, e.g., ATtILA and AGWA. These analyses, in addition to the change detection information, will be summarized in an interpretative report, i.e., landscape assessment atlas. We anticipate that the digital land cover maps will be completed by January 2003 and the primary data acquisition will be organized into a spatial data archive by that same period.

Subsequently, indicator development and analysis will follow land cover production and data acquisition and should be completed by winter of 2004. Change detection analysis is scheduled to be completed by June 2004 and the information from both the indicator and change analyses will be integrated into a final project report, i.e., landscape assessment, by December of 2004. Principal investigators will include Scott Augustine, Lillian Herger, and Andrew Weiss of EPA Region 10 (Seattle, Washington) and Daniel Heggem and William Kepner of EPA Office of Research and Development (Las Vegas, Nevada).

Preliminary Project Description from Germany

Functional system analysis of spatial Human-Environment-Interactions

Roman Lenz, Katharina Helmig, Angela Lausch, Felix Mueller, and Jamill Sabbagh

Related to socio-ecological research, we aim at a synthesis of already existing knowledge in order to better guide the society towards sustainable development. Coming from functional, spatially explicit Landscape Science and Landscape Indicators, we follow the systems-oriented Driving Force, Pressure, State, Impact, Response (DPSIR) concept in its

interactions between: "Space and Land use, Ecological (spatial) status, Economic Consequences (of use), Social consequences (of use), Awareness/Opinion development, and Decision Finding." These interactions will be integrated into a conceptual model for regional and spatial units, e.g., within two states of the Federal Republic of Germany. The individual degree of fulfillments and potentials of the functions will be displayed spatially explicit in digital maps. We extensively will use GIS and remote sensing technologies for that. GIS- and model-based scenarios of future potential developments will be elaborated and used in an evaluation process together with stakeholders as well as the public (outreach approach).

Many examples of landscape research show, that the scale of investigation has an essential impact on the results. Hence, we would like to identify which questions are related to which scale as well as to which spatial unit.

All elaborations in our research study will be related very much to practical problem solving. Therefore, we closely cooperate with administrations, stakeholders, and the public on various levels.

Preliminary Project Description from Canada

Robert Woods[1], Graeme Watson[2], and Jennifer Rowland[2]

[1]Dept. of National Defence, Ottowa Canada; [2]Royal Military College, Kingston Canada

PROJECT DESCRIPTION: The Canadian Military trains on nearly 2 million hectares of land across the country. These lands are critical to supporting the military readiness of our armed forces. Our training lands must be able to continuously support realistic military training, that is our military training must be sustainable on these lands. To enable bases and wings of the Department of National Defence (DND) to sustainably manage its training areas, a number of elements must be in place, most important of which is DND's Manoeuvre Area Planning System or MAPS. Included within MAPS is a natural resource inventory of the existing military lands, a description of the military training and other land uses, an assessment of the impacts of the military training activities on these areas, and plans to mitigate and repair consequential damage.

Bases/wings and other entities must manage relative large tracts of lands up to 1 million hectares in size. To assist in monitoring the environmental conditions on our lands, an initiative has been established to evaluate the effectiveness of using remote sensing in conjunction with a Geographic Information Systems (GIS) to detect and assess changes in the environmental conditions occurring on these lands.

This study will provide results from a trial carried out at Canadian Forces Base Shilo (Manitoba) to determine over a multiyear period the effectiveness of using Landsat image analysis combined with GIS to: 1) identify ecological cover types present; 2) measure both changes in and area of the cover types between images (years); and 3) produce quantitative data in numerical, graphical, and tabular formats to describe the changes.

Preliminary Project Description from Italy

Landscape Biodiversity and Biological Health Risk Assessment Procedures

Zurlini G.[1, 3], Rossi O.[2], Ferrarini A.[2], Rossi P.[2], Zaccarelli N.[1] and Petrosillo I.[1]

[1] Dept. of Biological and Environmental Sciences and Technologies, University of Lecce, Italy
[2] Dept. of Environmental Sciences, University of Parma, Italy
[3] Landscape Ecology Laboratory, Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università di Lecce, Pro.le Lecce-Monteroni, Lecce, 73100 – Italia

PROJECT DESCRIPTION: Our objective in the framework of the pilot study is to develop a prototype procedure of ecological risk assessment for conservation and ecosystem management policies at different organization levels, mainly for habitat and habitat composite based on the CORINE habitat (Biotopes) classification system. The CORINE classification (EU/DG XI 1991) permits a biophysical identification of ecosystems (*sensu* Tansley 1935) as patches, based on vegetation covers, physiognomy, soil types, and landforms. A habitat is defined as a patch differing from its surroundings in nature and/or appearance at the finest resolution of the available spatial data. Habitats are coded at different levels of a hierarchical system of mosaics of patches within patches that can go from very broad syntaxa at the landscape level down to alliances and associations. The CORINE Biotopes is a provisional classification open to further clarification and precision.

Such a prototype procedure will take profit of: (1) identification of ecological structural and functional indicators and indices at the landscape level; (2) identification, valuation, and integration of human-induced stresses, indicators, and indices; (3) procedures for statistical scale domain detection of landscape units; (4) supervised classification procedure and pattern detection through neural network techniques, and spatial modelling of remotely sensed multi- and hyperspectral imageries. The prototype procedure will be developed within the ArcView environment to integrate a user-friendly interface, traditional GIS methodologies and *ad hoc* C language code programs.

Preliminary Project Description from Poland

S. Krzoska

Summary unavailable.

Preliminary Project Description from Turkey

Y. Yilmaz

PROJECT DESCRIPTION: Risk assessment has been applied around the North Anatolian fault zone using landscape sciences and will be extended southward to the southern slope of the Armutlu Peninsula.

Preliminary Project Description from Armenia

A. Aleksandryan

Summary unavailable.

Preliminary Project Description from Latvia

Juris Zhagars and others

Ventspils University College, Latvia

PROJECT DESCRIPTION: Latvia proposes to develop an elaborate educational project aimed at disseminating knowledge about applications of geospatial tools and data to landscape and environmental issues. Specifically, the use of remotely sensed imagery and geographic information systems would be used to study landscape issues and develop monitoring protocols. The program would include courses for students in the natural sciences as well as students of the social and economic sciences. The establishment of an educational laboratory would be critical for instructing students in the theory and procedures for receiving and processing NOAA satellite imagery.

Preliminary Project Description from Lithuania

Landscape Change due to Water Erosion under Different Land Use and Land Cover on the Hilly Relief of Lithuania

[1]Benediktas Jankauskas, [2]Algimantas Tiknius, and [2]Vitalijus Juska

[1]Kaltinenai Research Station of Lithuanian Institute of Agriculture
[2]Klaipeda University

PROJECT DESCRIPTION: The intensity of soil erosion on the arable slopes of Lithuania depends on the tillage water or wind erosion. The research data showed that the annual losses of soil due to water erosion on the slopes of $2\text{-}5^0$, $5\text{-}10^0$, and $10\text{-}14^0$ were as follows: 5-17 t ha^{-1} under winter rye, 18-60 t ha^{-1} under spring barley, and 44-196 t ha^{-1} under potatoes. The losses of soil under erosion-preventive grass-grain crop rotations decreased by 77-81 percent in comparison with the field crop rotation, while that under grain-grass crop rotation decreased by 22-25 percent. The perennial grasses prevented soil against water erosion. Loss of 10 t ha^{-1} of soil is approximately equal to loss of 1 mm of topsoil from eroded parts of slope and to accumulation approximately of some layer on the footslope or export sediments into the streams. Therefore, land use and land cover variations on the slopes of different steppes will be examined for preparing of watershed landscape models' scenarios with perspective to 50 and 100 years in the future using CORINE and other databases. The presented point of view to landscape change will be only a fragment of the landscape characterization and environmental assessment problem in Lithuania. The project will develop the national program for rational use of natural resources for environmental protection. The estimated losses of nutrients will be used for

formation of self-regulation models of chemical matter concentrations in the soil, water, and atmosphere by biotype using the Le-Shatelje-Braun-Lotkos principle.

Therefore, the general objective is to collect the set of data of landscape features and evaluate its ability to execute and maintain the process of natural regulation. The actual biomass, total area of natural ecosystem, its successive maturity, adequacy to physical ambient, bio-production, destruction, state of soil (erosion including), and critical loads (water pollution and relative consumption of energy) are the main features to be examined for each landscape type. The difference of actual features and calculated criteria would be the background for assessment of the environment.

Preliminary Project Description from Romania

M. Lazarescu

Summary unavailable.

Preliminary Project Description from Slovenia

Pilot Study on the Use of Landscape Sciences for Environmental Assessment

Anita Pirc-Velkavrh

Ministry for Environment and Physical Planning, Ljubljana, Slovenia

PROJECT DESCRIPTION: Use of landscape sciences for environmental assessment, public health, and decision-making in Slovenia is not widespread. Scientific projects in this area are conducted separately, and consequently the results are not commonly used in decision-making processes. While this area of research has received little legislative attention and funding support, it is national potential on what we build our sustainable development.

It is established that:

- In Slovenia such a project is needed
- It must be directed toward policy making needs
- It will be on the topic of landscape indicators, according to priority areas (sustainable management of land, water management, and nature protection)
- We will use CORINE land cover 1995 and 2000, CORINE biotope (which are important for compatibility with international standards), and other relevant national databases
- Terrestrial indicators will be selected from a list prepared by European Environment Agency (attached is first draft for internal use only). We will select terrestrial indicators based on our policy needs and the availability of spatial data. They will be updated regularly and used for a variety of purposes, including state of environment reports, a range of assessments, examples of impacts on the state of land, and water and nature protection. We will start with few indicators and then expand it further according to intermediate results. Side effects of the project are also expected.

- The project should be constructed in a way to enable dynamic accommodations
- It is important to decide on the methodology (DPSIR is not appropriate for all purposes). We would like to exchange the opinions with U.S. EPA and other international experts on this matter.
- Computer hardware is available in Slovenia, while the necessary software is only partially-available (ArcView extensions are still needed)
- Time availability of experts is problematic, and training of our experts is desired
- Financial resources are available in limited amounts, so we are seeking other funding sources (EU) and are willing to explore a range of funding agreements (i.e., TAIEX, twinning, bilateral agreements). Assistance from NATO/CCMS in this area is desired.
- We will start activities for agreement on political level about the project

Preliminary Project Description from Moldova

S. Galitchi

Summary unavailable.

Preliminary Project Description from the Czech Republic

A Potential Czech Republic Contribution to NATO/CCMS Pilot Study on the Use of Landscape Sciences for Environmental Assessment

Petr Kozel

The Czech Republic contribution to the Pilot study will consist of following three points:

1. To simplify and refine the theoretical base and terminology of the Pilot Study:
    - *A classification of landscape sciences/landscape ecology*
    - *To refine terminology* (for example, Landscape science-Hydrology-Environmental Protection for necessity of the Pilot Study)
    - *Landscape definition – Landscape Model*

    Contribute to discussion on landscape boundary: What is a landscape boundary? Basin? Area of energy transportation? State? District? Etc.

2. Definition of sociopolitical measures (scales) of landscape processes, this subject is very important in countries with changing economies.

3. Information of landscape historical comparison methods in landscape research (elements of cultural landscape).

Preliminary Project Description from Bulgaria

A Potential Bulgarian Contribution to NATO/CCMS Pilot Study on the Use of Landscape Sciences for Environmental Assessment

C. Gregory Knight and Marieta P. Staneva

Geography and Center for Integrated Regional Assessment, Pennsylvania State University

PROJECT DESCRIPTION: There has been no submission of a Bulgarian pilot project. Thus, we suggest one kind of project that could be developed, based on the databases of the REKA river quality decision support system in the Yantra Basin. The Yantra Basin is characterized by having about 7500 km^2, elevation ranging from about 20-1850 m, and annual precipitation from 500-1500 mm. The basin is characterized by agriculture, forest, and urban areas dating from the earliest Bulgarian industrialization. Work is already complete to bring landscape data into a common geo-referenced ArcView framework, and soils data are already converted to U.S. soil characterization standards. Data on Land Use/Land Cover were derived from Landsat TM. A study in this region could draw upon the Bulgarian tradition of land quality studies; previously these have not been integrated in a GIS framework.

A project using the Yantra databases could fit the NATO/CCMS Pilot Study goals as follows:

- Land Characterization
  - Acquire CORINE data
  - Compare with Landsat TM classification
- Change Detection
  - Older Landsat Data
  - Extant Maps
- Landscape Indicators: explore possibilities
- Landscape Models: apply our own system (with AVGWLF), plus ATtILA and AGWA; explore also the CANAAN Interactive Tool
- Landscape Assessment: new possibilities include
  - Soil erosion risk potential
  - Threats by exploitation of privatized forest resources
  - Impacts of changes in agricultural practices

A study from Bulgaria could add several contributions to the pilot study:

- Issues of access to maps and digital environmental data
- Fitting local data into framework of international software
- Soil characterization
- Exploitation of existing studies
- Challenges of bridge building across institutes, ministries, and universities
- Value added to local knowledge: an example for other basins

Challenges ahead for a Bulgarian pilot project will include: identifying indicators that can be operationalized; identifying local researchers with interest (perhaps doctoral aspirant); endorsement by the Bulgarian CCMS representation; and funding for a local project.

The presenters will be in Eastern Europe June 2002-August 2003, based in Sofia, Bulgaria, where they could provide assistance to the pilot project as a whole and to a Bulgarian case study.

WEB PAGES OF INTEREST

NATO/CCMS
http://www.nato.int/ccms

North American Landscape Characterization (NALC)
http://www.epa.gov/mrlc

http://edcdaac.usgs.gov/pathfinder/pathpage.html#nalc

CORINE Land Cover Project
http://www.ec-gis.org/clc/

EPA's San Pedro Data Browser
http://www.epa.gov/nerlesd1/land-sci/html2/sanpedro_home.html

Environmental Decision-Making for Sustainable Development in Central Asia
http://www.nato.int/ccms/pilot-studies/pilot005/welcome.html

The Regional Environmental Centre for Central Asia
http://www.carec.kz

EPA's Mid-Atlantic Integrated Assessment Program
http://www.epa.gov/maia

Commonwealth Scientific & Industrial Research Organization (CSIRO) Land and Water
http://www.clw.csiro.au

United Nation's International Environmental Technology Centre
http://www.unep.or.jp

Armed Forces Pest Management Board – Regional Disease Vector Ecology Profiles
http://www.afpmb.org/pubs/dveps/dveps.htm

ARRANGEMENTS FOR FUTURE MEETINGS

1. NATO/CCMS Plenary Meeting, Vienna, Austria; 10-11 October 2002

2. Landscape Sciences CCMS Project Meeting. Schleswig-Holstein Cultural Center (Salzau Castle) near Kiel, Germany; 19-21 November 2002

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The next Landscape Sciences CCMS Project Meeting will review the national work plans provided by each of the NATO participants. The objectives and schedules for the project will be reviewed and it is anticipated that the individual study plans will be collectively organized into a single Pilot Study Science Plan.

Salzau is located about 20 km east of Kiel; it is a very remote place between lakes and the shore of the Baltic Sea. There are several meeting rooms for plenary sessions and working groups; all participants will be enabled to sleep there and we will have a full (and good) food service. The prices are generally rather low (e.g., 20 Euro per night). Salzau is well-known as the center of the Schleswig-Holstein Music Festival, which takes place every summer.

You can reach Salzau:
(a) By airplane to Hamburg (with a 1-hour bus ride to Kiel Main Station),
(b) By plane directly to Kiel (connections from Frankfurt, Berlin, Koeln, Munich),
(c) By ferry from Scandinavia, or
(d) By train to Kiel Main Station.

There will be a transfer service organized by our institute, which will bring participants from these places of arrival at Kiel to Salzau Castle and back again.

We have booked Salzau Castle from November 19-21, 2002. Afterwards (from November 22-23), the NATO Pilot Study Group from Middle Asia may come together in Kiel, meeting in the University of Kiel, Ecology Center.

The main target of our Salzau meeting will be the constitution of a common work program for the pilot study, based upon the national ideas from which we received during the summer of 2002. We hope that all participating countries will be able to send its scientific/technical experts where we hope to compose a concrete project strategy for the next 3-5 years. This should include a concept of integrated work packages, containing a

plan for the next meetings, a plan for the exchange of scientists, for "summer schools," and a concrete plan for the real scientific cooperation in different regional subprojects. One part of this has to be an organizational one: that is the question of how to conceive the future financial support for our cooperation. The focus of the workshop will be to discuss the contents, the research questions, the technology transfer modes, the methodologies, and the integration of all the parts.

Furthermore, there may be some new colleagues (e.g., there are interested scientists from Poland, Estonia, Norway, The Netherlands, Austria) who may like to present their works in order to introduce themselves to the group.

3. NATO/CCMS Plenary Meeting, Brussels, Belgium; 20-21 March 2003.

LANDSCAPE SCIENCES PILOT STUDY MEETING
GROUP PHOTOGRAPH (April 3, 2002;
Las Vegas, Nevada, USA)