Use of GIS as a Decision Support System

GEOM 4008 - November 2, 2015

Group 2 : Fernanda Amaral, Eric Purdie, Carina Saab, Nahom Seyoum, Uzayr Siddiqui

- computer based information systems that gather and present data in order to assist and support businesses and organizations in the decision-making process

What are Decision Support Systems (DSS)?

Carina

- Use of GIS as a technology has transformed over the years

Information Database → Analytical Tool → Decision Support System

Where does GIS come in?

1. **Multi-Criteria Decision Making (MCDM)**

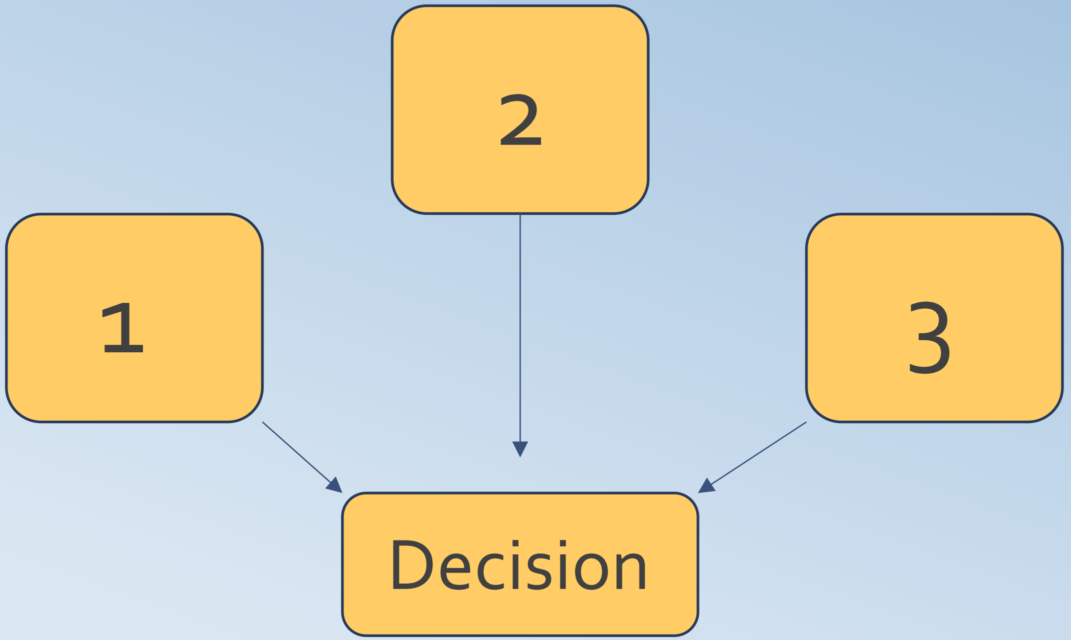
a. Weighted Linear Combination

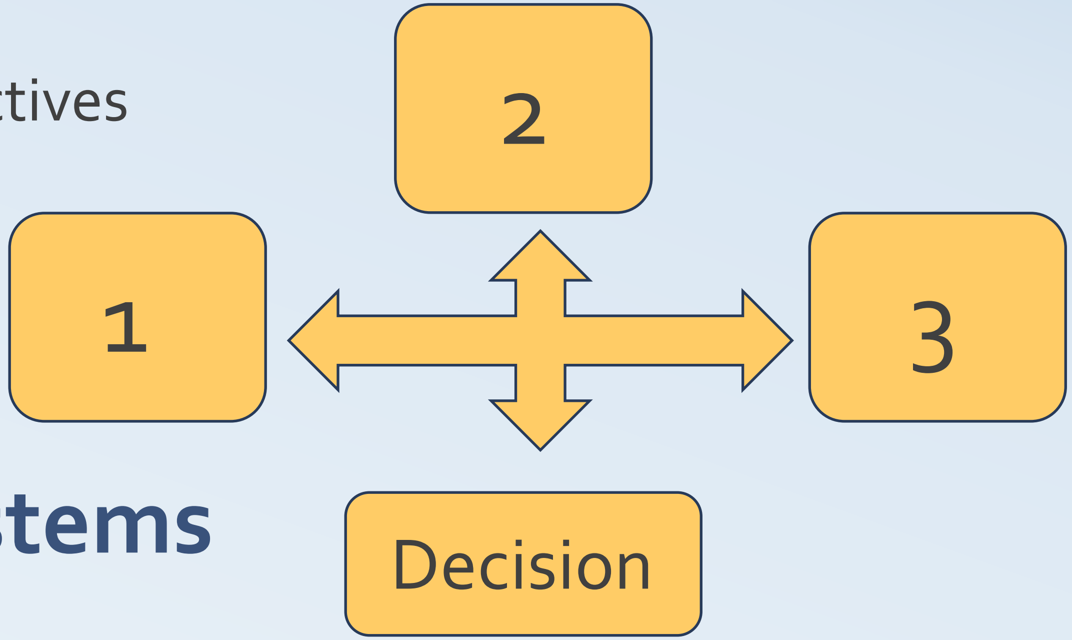
b. Concordance-Discordance Analysis

2. **Multi-Objective Decision Making (MODM)**

a. Complementary Objectives

b. Conflicting Objectives





Three Types of Decision Support Systems

3. Multicriteria Spatial Decision Support Systems (MC-SDSS)

(Geographic Information Systems (GIS) + Multi - Criteria Decision Making (MCDM))

Three Types of Decision Support Systems

- In most MCDAs, ***sensitivity analysis*** is recommended as a means of **checking the stability of the results** against t**he subjectivity of the expert judgements** and the **uncertainty in the factors' scores**
- The information available to the decision makers is often uncertain and imprecise because of measurement and conceptual errors
- **Sensitivity analysis** considers how and how much such errors affect the final result of the evaluation (Geneletti, 2005 *apud* Ferretti, 2011).
- Sensitivity analysis is not a common practice in the field of spatial MCDA

Sensitivity Analysis

Using Participatory Design to Develop (public) Health Decision Support Systems Through GIS

S. Michelle Driedger, Anita Kothari, Jason Morrison, Michael Sawada, Eric J Crighton and Ian D Graham

Eric

- Health based organizations process large amounts of data on a daily basis
- Geographic Information Systems (GIS) has come a long way
- GIS has been successful in influencing policy/decision making
- Web maps, have made it easier to further disseminate data

Using participatory design to develop (public) health decision support systems through GIS

- Their primary purpose is to “improve child developmental health”
- This project had two stages

Ontario Early Years Centres (OEYCs) and EYEMAP

- Originally interactivity and movement of research between persons "Scientist to user" was only one way
- GIS has gained much traction in the health field, especially when it comes to "planning, policy and analysis"
- The use of web maps has been of particular success

Background

Ontario Early Learning Centers within the Ottawa Area

- The essential part of the PD process is to use knowledge and skills gained from people living in and around the project areas
- Looking at the "third space" introduced by Muller, using PD can enable cooperation between people who use GIS and people who develop GIS software

"Participatory Design"

- The initial work that was done was to conduct a “survey”.
- It was outlined that “mapping” was important
- “Phase one” involved having a system where people would be able to provide input to the web map software development team for the development of the EYEMAP software
- The purpose of these phases was to make sure the final resulting product took into account wide variety of views

Methodology

- The research underpinning this project included “The Ottawa Model of Research Use”
- The area of work (e.g. health field) data analysts and managers who might use the web map software

“The Ottawa Model of Research Use”

- The initial meeting, determined that a web mapping tool would have to be “easy to use” and enable an individual to adopt it quickly.
- According to the first phase of the project the “participatory design” helped the design team develop a web map software
- EYEMAP was created “using the University of Minnesota’s MapServer and map tool resources.”

Conclusion

- It is difficult to develop a software without the participation of users
- This project is a good first attempt to merge users with developers.
- ESRI, provides a web program API that can be modified to users needs, this could be beneficial for future EYEMAP web map software development
- Another example, Google Maps API, can be configured to users needs, and can serve almost any purpose including EYEMAP

Conclusion/Opinion

Integrating Buildings into a Rural Landscape Using a Multi-Criteria Spatial Decision Analysis in GIS-enabled Web Environment

Jin Su Jeong, Lorenzo Garcıa-Moruno, Julio Hernandez-Blanco

Uzayr

- Relationship between Rural buildings and Landscape
  - Tourism & New Development Areas
- Methodologies used in intermediate sustainable maps by taking FIVE criteria into consideration
  - Overlay Method
  - Index Method
- GIS TOOLS (web enabled application)
  - MCSD
- Fuzzy functionality

Introduction

- Location ...location and Location.. (SITE SELECTION*)
- Complex (Multiple ShareHolders)
- Collaborative Process = Complicated decision making
- Multi-criteria evaluation - important tool (Spatial Planning)
  - Analytical & communication
- Unique Framework
  - Parallel and distributed collaboration

Decision Making Attributes to Consider

- To present a spatial methodology for the integration of new rural buildings associated with tourist functions and their landscapes *coupling both MCE and GIS technologies*

Objective

- To design and implement GIS enabled web application.
- A proposed methodology which can identity and formulate suitable criteria and spatial models
- To get the right spatial planning integration.
- Primary aim of highlighting the interrelationships between rural buildings and their landscapes.

Objectives Emphasized

- GIS Tools
  - ArcGIS and Data collection
- Overlay Method
  - Digitizing...polygons...points...line (all attributes)
  - Combine the characteristics of several datasets into one
- Index Method
- GIS with MCE (Multi- Criteria Evaluation)
  - 5 main categories
  - Enhances Fuzzy Factor

Methodology

- Fuzzy Method
  - Standardized Maps
  - Each Pixel Belonging
- Analytic Hierarchy Process (AHP)
  - Comprehensive and rational framework
  - Weights of the criteria
  - Accurate estimation - pertinent data (Relevancy) - Pairwise comparisons
  - Qualitative = difficult to quantify
  - Specifying Hierarchy Structure & importance

Methodology Continued

1.	Morphology	7.	Presence of Water
2.	Orientation	8.	Land use types and planning policies
3.	Vegetation type	9.	Population density
4.	External visibility	10.	Proximity to urban areas
5.	Internal visibility	11.	Site access
6.	Presence of sensitive ecosystem following European commission's regulations for Nature & Biodiversity Policy	12.	Proximity to residential area
		14.	Proximity to tourist and agricultural areas

Hierarchy Structure (14 sub-criteria)

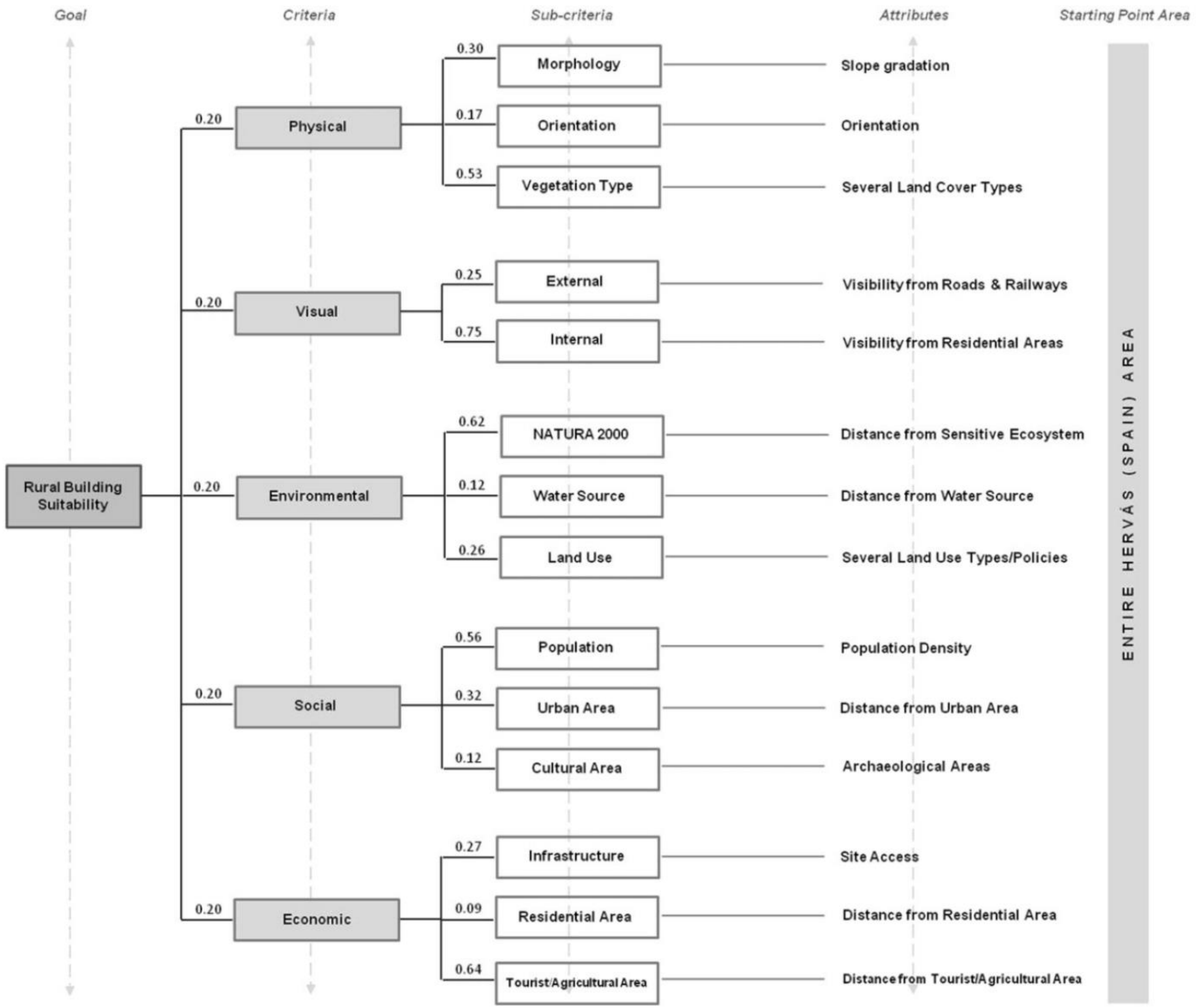


Fig. 2 – Hierarchical structure of decision evaluation problem.

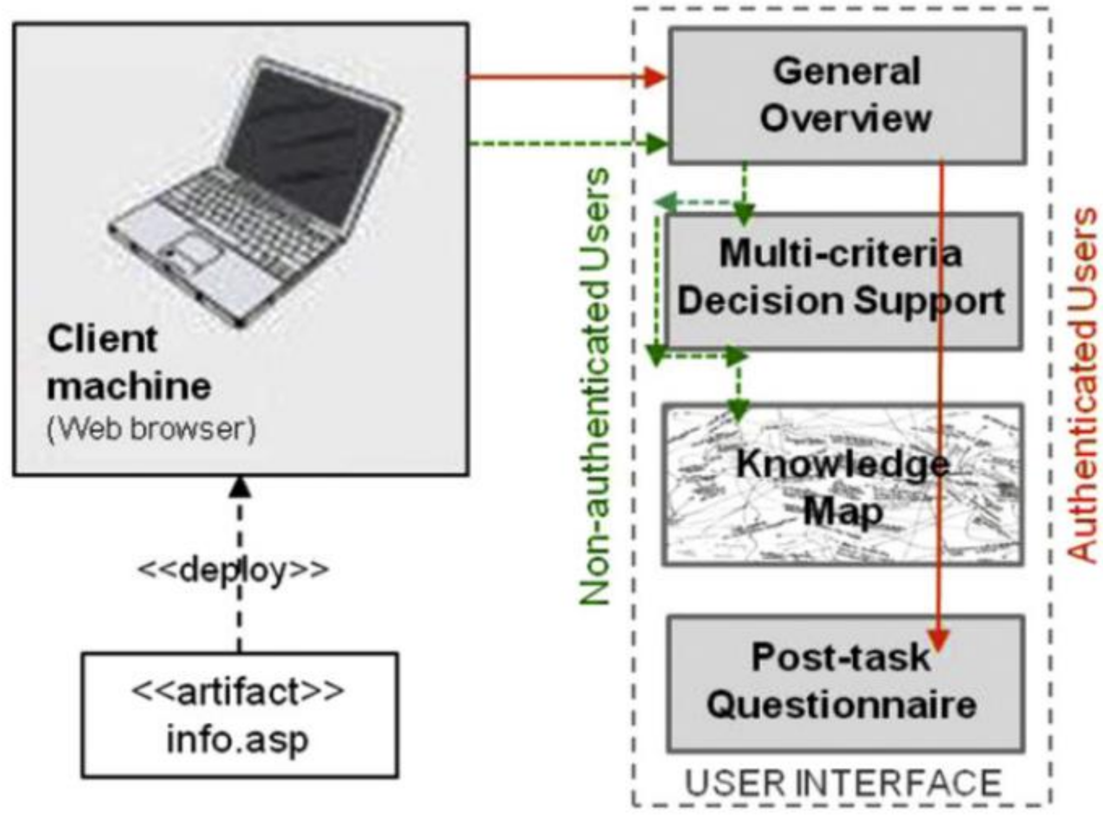


Fig. 3 – The conceptual framework of the interoperable web-based GIS application.

- General Overview
- MCSD
- Knowledge Map area
- Post questionnaire area

General System Architecture

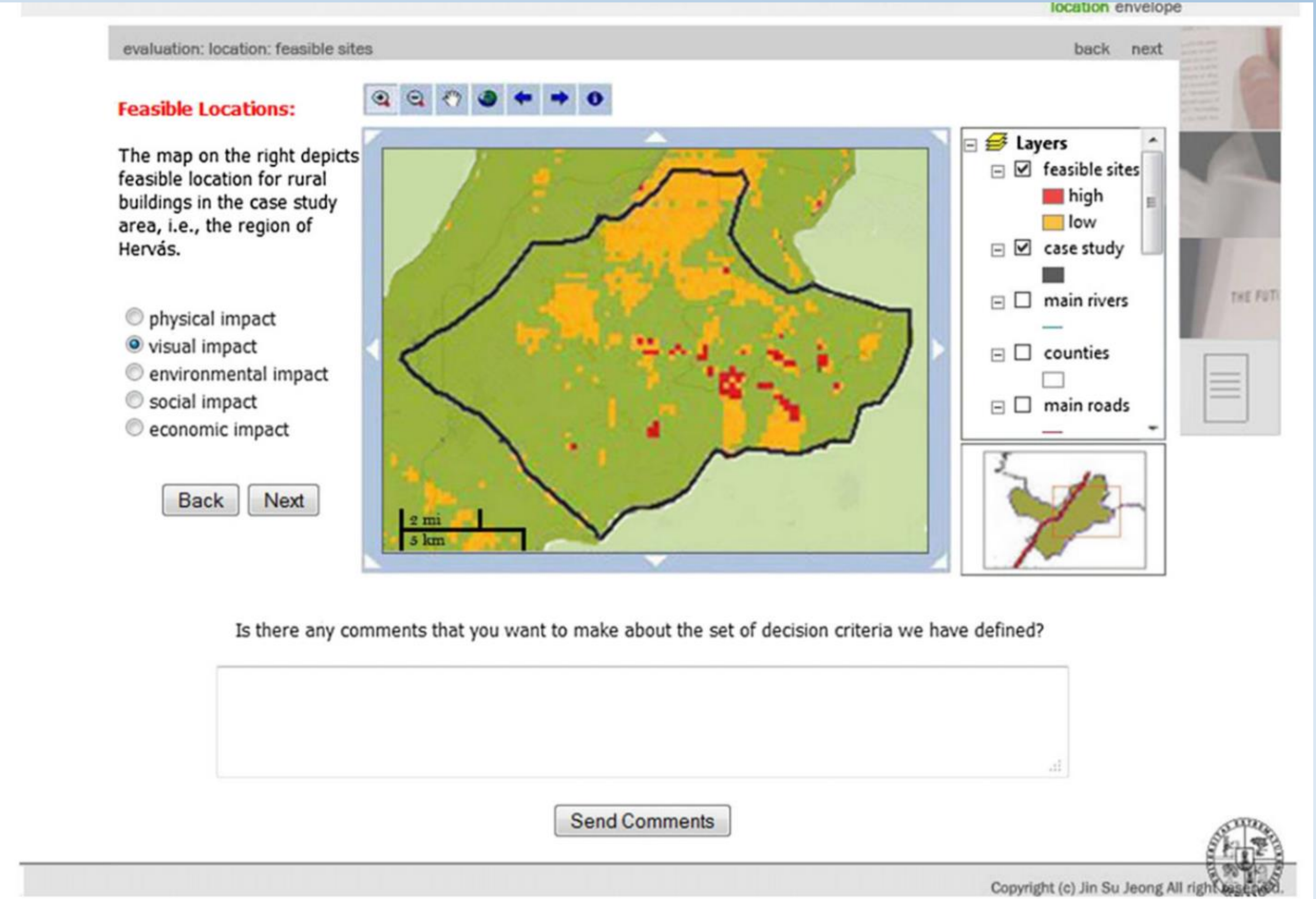
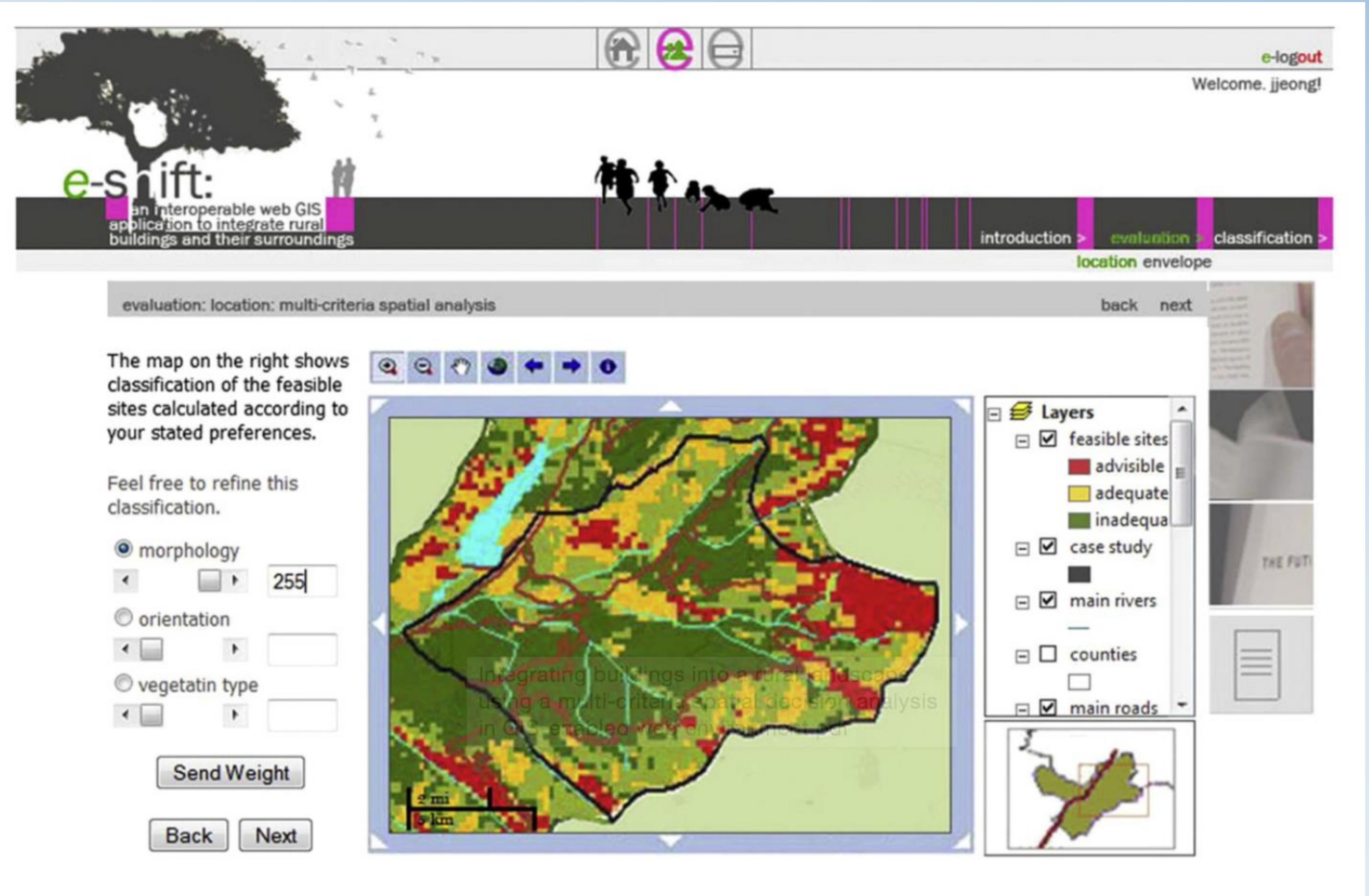


Fig. 5 – **Web page that presents the feasible locations for rural buildings and the five criteria that the users must weight to classify one of them, the most important decision criteria, after logged in.**

- Conceptual Framework (internet information server)
  - Prototype - feedback
- Little experience vs experienced Professionals
  - Professionals
  - General public
- User analysis & User interface
  - Cognitive factors
  - Course of action
  - Visuals and Colours

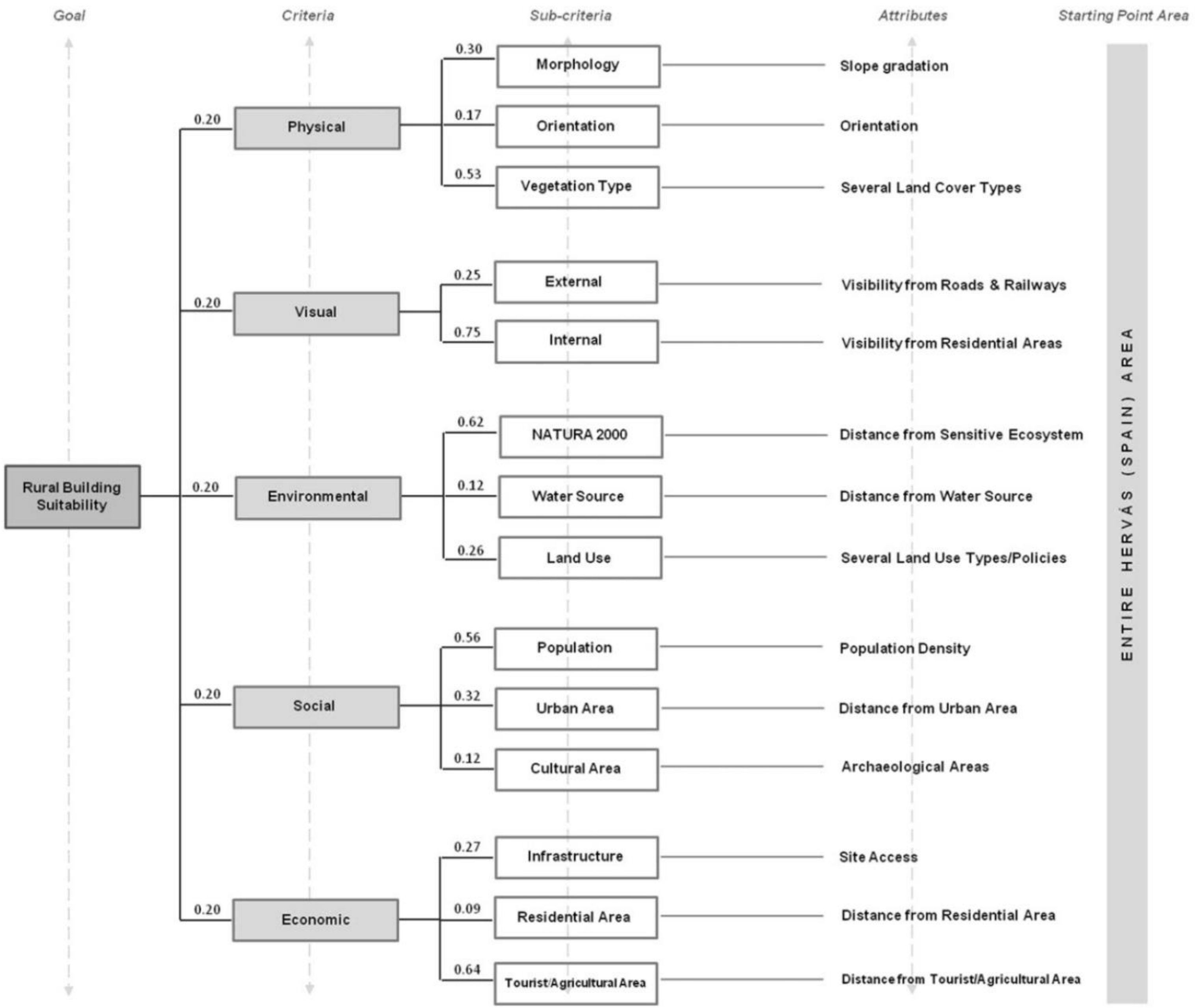
Results and Discussion



Web page that shows the classified feasible sites with the users' submitted weights of the decision criteria and displays the sub-criteria of the submitted criterion that the users submit the relative importance weights using slider bars and text fields

- Rasterized into 10m x 10m Grid Cells
- 5 Categories
- Single site sized land parcel
- 0-255 byte (least important to most important)

Study Area



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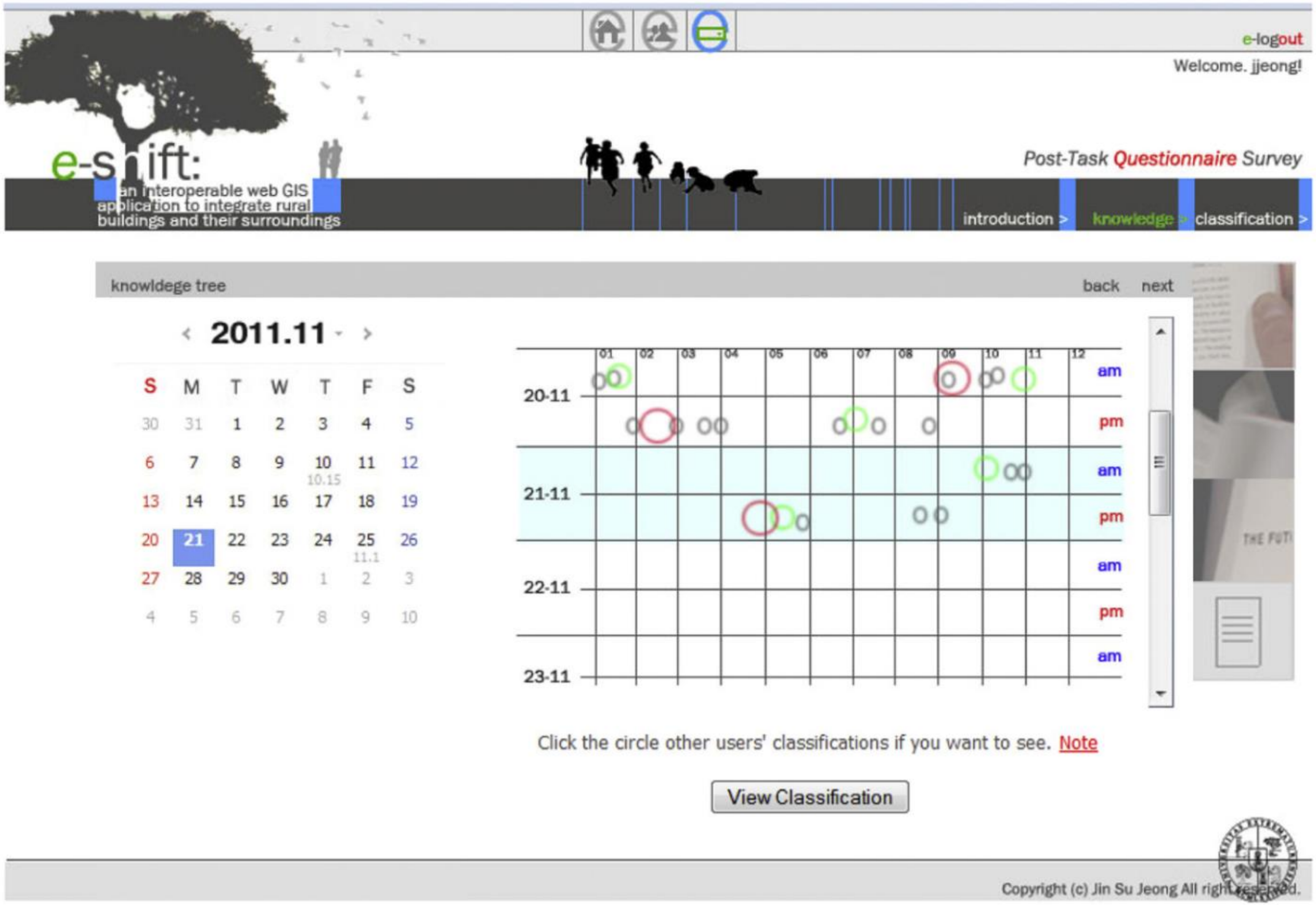


Fig. 7 – Web page that displays the users' submitted classifications according to a time rate, a knowledge map, and enables the users to check other users' classifications, supporting communication.

Combination of MCE and GIS

GIS models - Spatial Planning

Incorporating four Elements

Learning interactively and iteratively

User Preferences

Conclusion

A Multicriteria Spatial Decision Support System Development for Siting a Landfill in the Province of Torino (Italy)

VALENTINA FERRETTI
Land, Environment and Geo–Engineering Department, Politecnico di Torino, Torino, Italy

Fernanda

Introduction

- Location of the landfill - Province of Torino (Northern Italy)
- Capacity **3 500 000 m**
- Life cycle: **10-11 years**

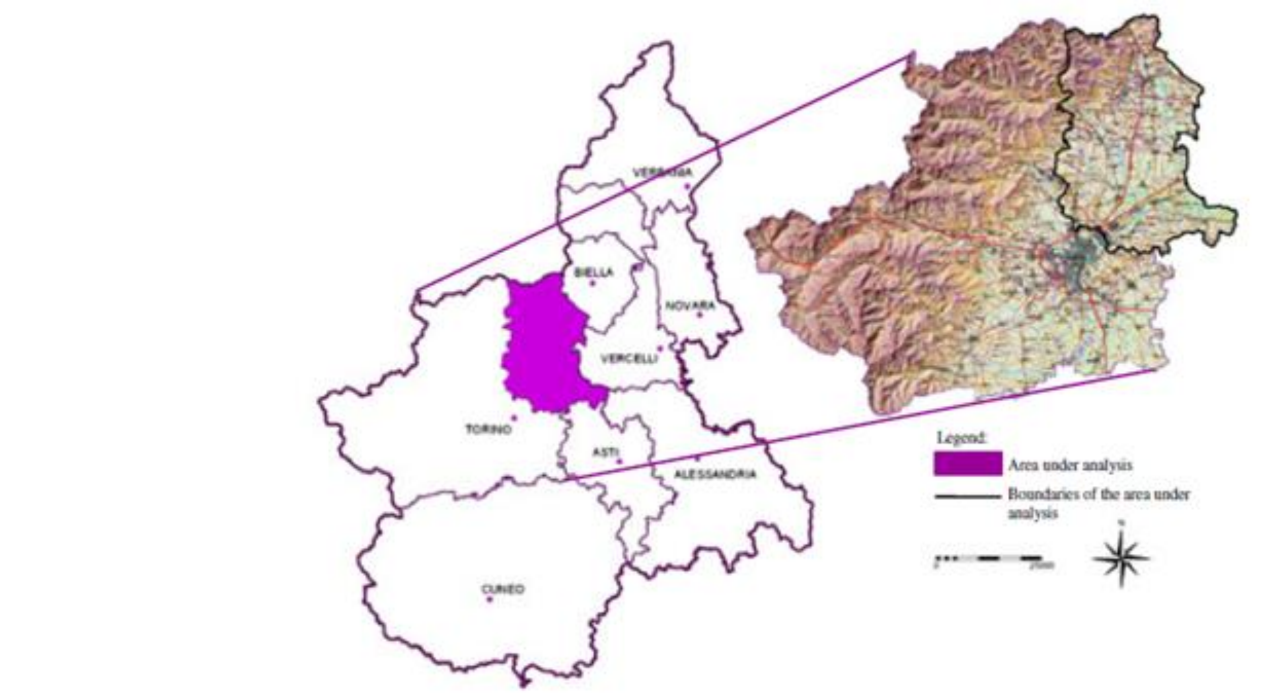


Figure 1. The area under analysis.

- These types of industrial plants belong to the group of **undesirable facilities** whose location presents two main problems:

i. **social opposition** and

ii. a huge number of **social**, **economic** and **environmental data** that have to be taken into account (Aragonés-Beltrán et al., 2010).

- **Challenging task** : various **interconnected** and **conflicting parameters** should be considered
- **Complex multicriteria decision-making problem:** requires an extensive evaluation process of the **potential locations** and other factors such as: **economic**, **technical**, **legal**, **social** or **environmental** issues (Geneletti, 2010).

Introduction

The purpose of the study is to ***generate a suitability map of the area under analysis for locating a waste landfill***, paying particular attention to the contribution that the spatial **Analytic Network Process (ANP)** offers to sustainability assessments of undesirable facilities.

Objective

- Development of a **Multicriteria-Spatial Decision Support System** based on the integration between **GIS** and the **ANP (Analytic Network Process)** methodology

- **ANP (Analytic Network Process)** methodology:

- **network model structuring**, which reflecting interdependence between real-world elements

- incorporates the influences and interactions among the elements of the system and groups them into **clusters** inside the network

Methodology

The development of the spatial **ANP model** applied in the present study involves the following steps:

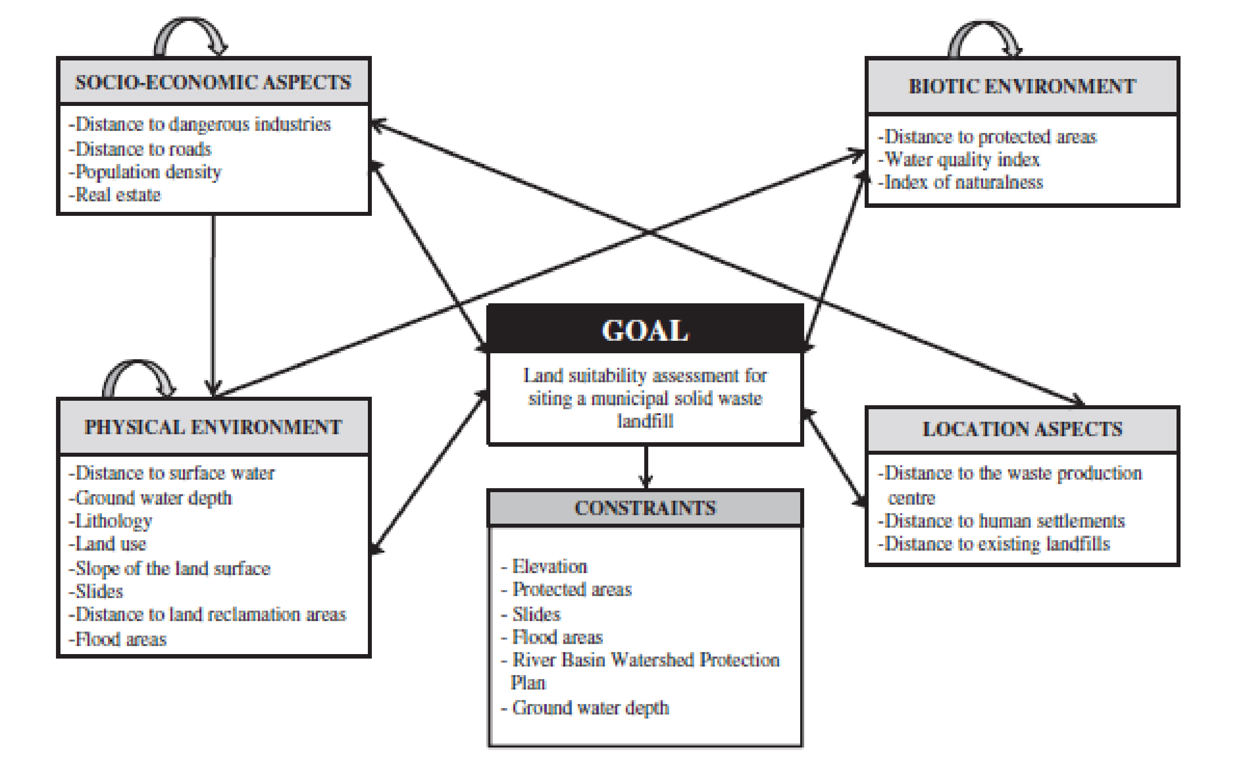
Table I. Sequence of activities performed in the study

Phases	Activities
Intelligence	1. Problem structuring and model development: -identification of the main objective -definition of the criteria structure according to the network approach -definition of constraints 2. Raw data acquisition 3. Processing
Design	4. Standardization 5. Pairwise comparisons and relative weight estimation 6. Super-matrices formation
Choice	7. Results aggregation
Detailed analysis and implementation (Review)	8. Sensitivity analysis 9. Results and recommendations

Methodology

1) **Intelligence phase**

- **24 criteria**
- **6 exclusionary** (constraints) and **18 non-exclusionary** (factors)
- **5** main **groups**:
  - socio-economic aspects
  - locations aspects
  - biophysical environment
  - biotic environment
  - constraints



Methodology

1) Intelligence phase

- **Thematic raster map** for each identified factor and constraint

Table II. Maps used to represent the criteria

	Criteria	Data source and scale	Source map	Derived map
Constraints	Ground water depth	TP, 1:50 000	Map of ground water depth	Map of ground water depth
	Flood areas	TP, 1:100 000	Map of flood areas	Map of flood areas
	Protected areas	TP, 1:10 000	Map of protected areas	Map of protected areas
	Elevation	TP, 1:10 000	Map with surface elevation values	Map with surface elevation values
	Slides	TP, 1:100 000	Map of dormant and active slides	Map of dormant and active slides
	River basin watershed protection plan	TP, 1:25 000	Map of the protection buffers for the river basins	Map of the protection buffers for the river basins
Factors	Distance to surface waters	PR, 1:100 000	Map of surface water bodies	Distance map
	Ground water depth	TP, 1:50 000	Map of ground water depth	Map of ground water depth
	Water quality index	PR, 1:100 000	Map of the water quality index	Distance map to the highly quality classes
	Index of naturalness	PR, 1:100 000	Land use map	Map with the naturalness index values
	Lithology	PR, 1:100 000	Map of the lithological composition of the soil	Map of the lithological composition of the soil
	Slope of the land surface	PR, 1:100 000	Digital elevation model	Map with slope values between 0 and 100%
	Land use	PR, 1:100 000	Land use map	Map of land use classes (urban areas, agricultural areas, protected areas, forest and wetlands)
	Distance to human settlements	PR, 1:100 000	Map of human settlements	Distance map
	Distance to protected areas	PR. 1:100 000	Map of protected areas	Distance map
	Distance to roads	PR, 1:10 000	Map of roads	Distance map
	Distance to existing landfills	TP, 1:100 000	Map of the existing landfills	Distance map
	Residential real estate	AG***, 1:100 000	Real estate values	Map with the real estate values of each municipality
	Distance to the waste production centre	PR, 1:100 000	Map of the municipalities	Distance map
	Slides	PR, 1:100 000	Map of slides classes	Map of slides classes
	Flood areas	PR, 1:100 000	Map of flood areas	Map of flood areas
	Distance to dangerous industries	TP, 1:100 000	Map of dangerous industries	Distance map
	Population density	IM****, 1:100 000	Population density values	Map with the population density values for each municipality
	Distance to contaminated areas	TP, 1:100 000	Map of contaminated areas	Distance map

Methodology

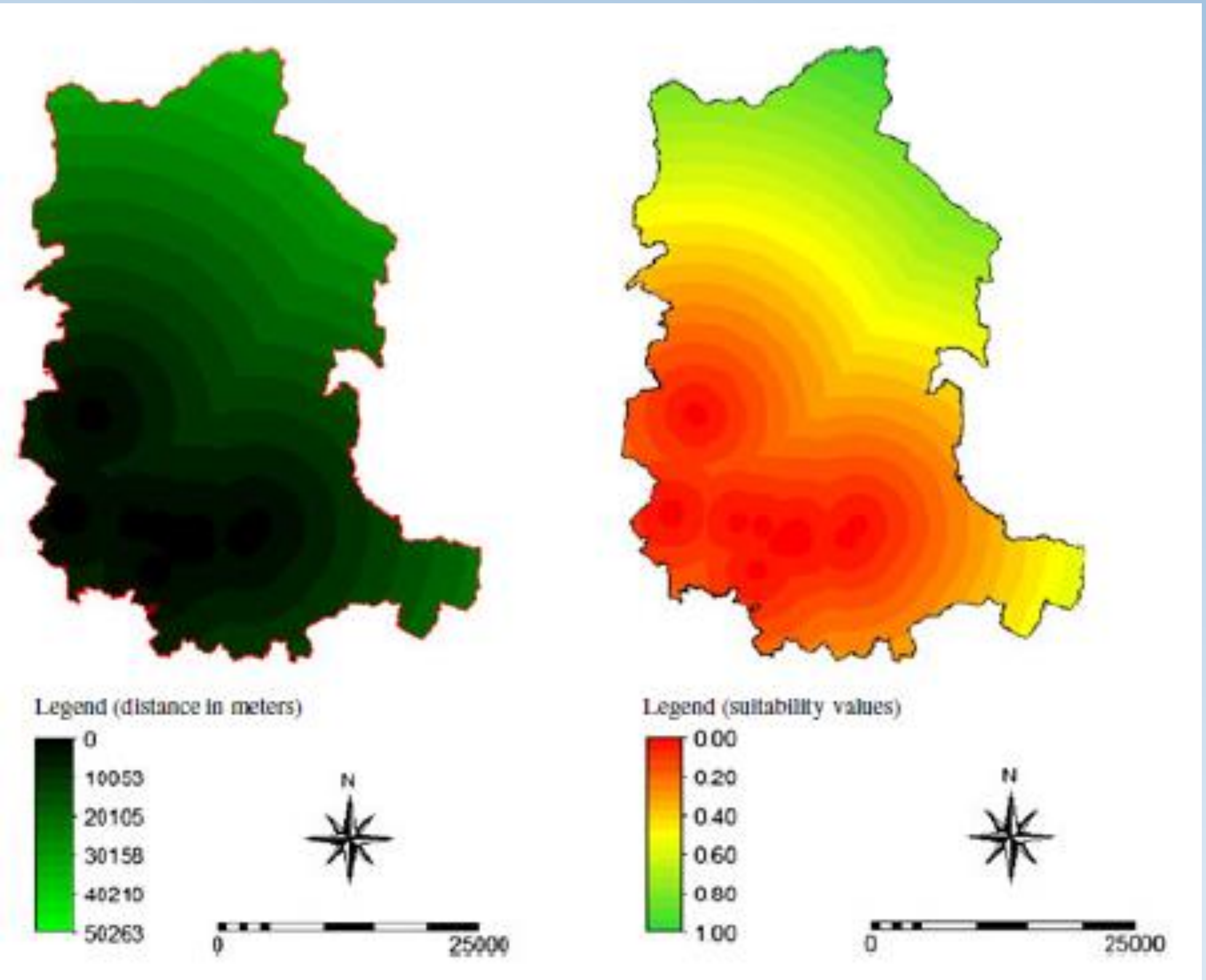
- **2) Design phase:**
- Involves the **standardization** and **weighting** of all the factors being considered in the analysis
- **Standardization**: **linear functions** that converted the original factor scores (each expressed in its own unit of measurement) into dimensionless scores in the **0 (worst situation) 1 (best situation)** range.
- E.g.:

	Criteria	Description	Standardization
CONSTRAINTS	Ground water depth	Areas with ground water depth between 0 and 3 m are excluded from the analysis.	Depth ≤ 3 m is standardized to 0; all other values are standardized to 1.
FACTORS	Distance to dangerous industries	The criterion considers the presence of dangerous industries inside the area under examination.	Linear standardization (the higher the distance, the higher the score).

Methodology

2) Design phase:

- E.g.: Source map and standardized map for the factor ‘distance to dangerous industries’:



Methodology

2) Design phase:

Weighting:

- **Constraints** do not participate in the weight assignment process
- All **factors** are assigned factor weights, according to their relative importance, based on the ANP technique (Saaty, 2005)

Methodology

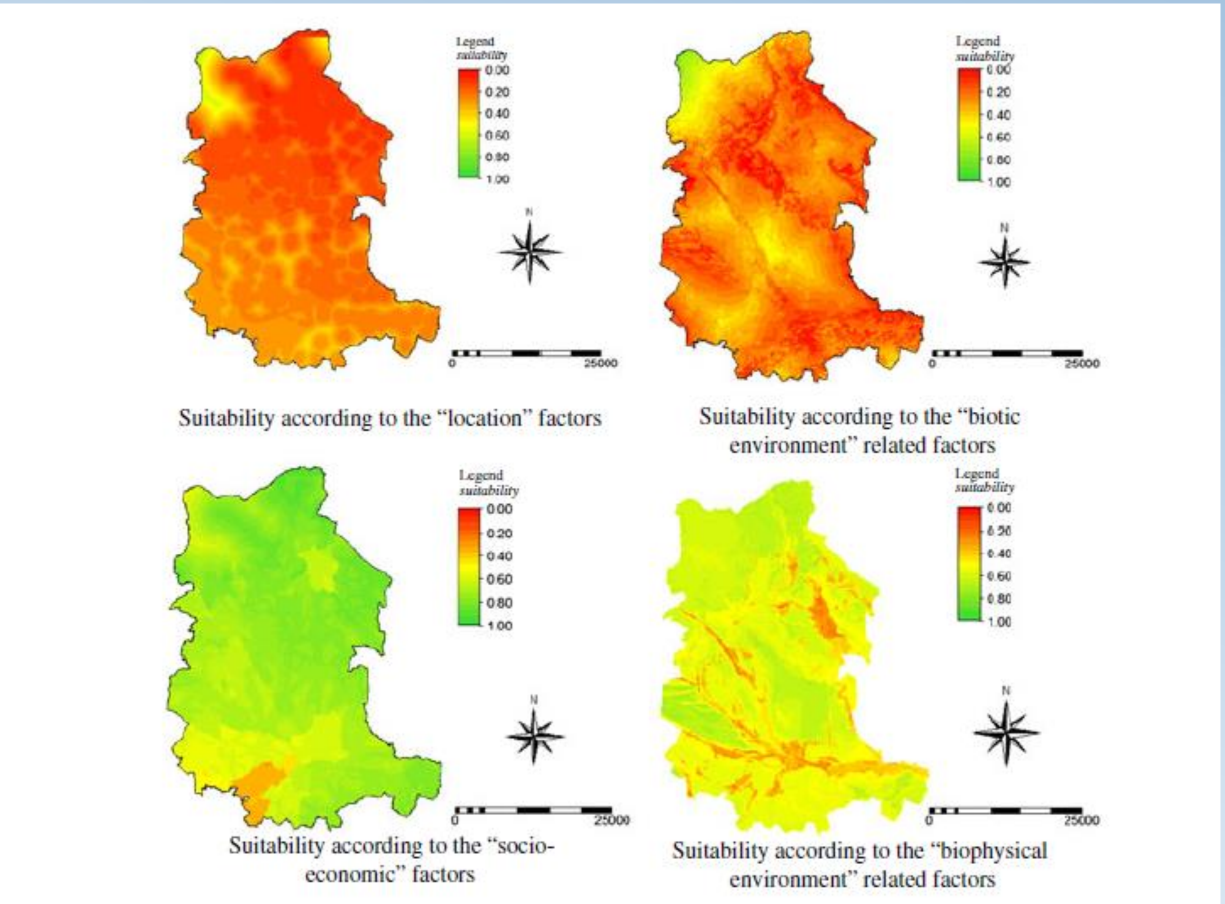
Table IV. Priorities of all the elements considered in the network

Elements of the network	Normalized priorities
Biophysical environment (0.073)	
Flood areas	0.014
Slope of the land surface	0.005
Ground water depth	0.014
Distance to surface water	0.009
Slides	0.020
Lithology	0.013
Land use	0.009
Distance to contaminated areas	0.009
Biotic environment (0.019)	
Distance to protected areas	0.118
Water quality index	0.016
Naturalness index	0.040
Location (0.426)	
Distance to human settlements	0.201
Distance to the waste production centre	0.127
Distance to existing landfills	0.049
Socio-economic aspects (0.311)	
Distance to dangerous industries	0.060
Population density	0.114
Distance to roads	0.123
Residential real estate	0.060

3) Selection and choice phase

- An intermediate suitability

map has been obtained for each cluster:



Suitability according to the "location" factors

Suitability according to the "biotic environment" related factors

Suitability according to the "socio-economic" factors

Suitability according to the "biophysical environment" related factors

Methodology

3) Selection and choice phase

- A **weighted linear combination** has then been used, that combines the factors and constraints maps according to the following formula: $S_j = \sum W_i X_i \prod C_k,$

Sj = suitability for pixel j

Wi = the weight of factor i

Xi = the standardized criterion score of factor i

Ck = the constraint k

Methodology

4) Detailed analysis and implementation phase: sensitivity analysis

- The performed sensitivity analysis considers the effect of changes in the clusters weights upon the overall suitability index.

Scenario I: all criteria have equal weights;

Scenario II : the 'biophysical environment' cluster dominates the others;

Scenario III: the 'biotic environment' cluster dominates the others;

Scenario IV : the 'location' cluster dominates the others;

Scenario V : in this case, the 'socio-economic aspects' cluster dominates the others.

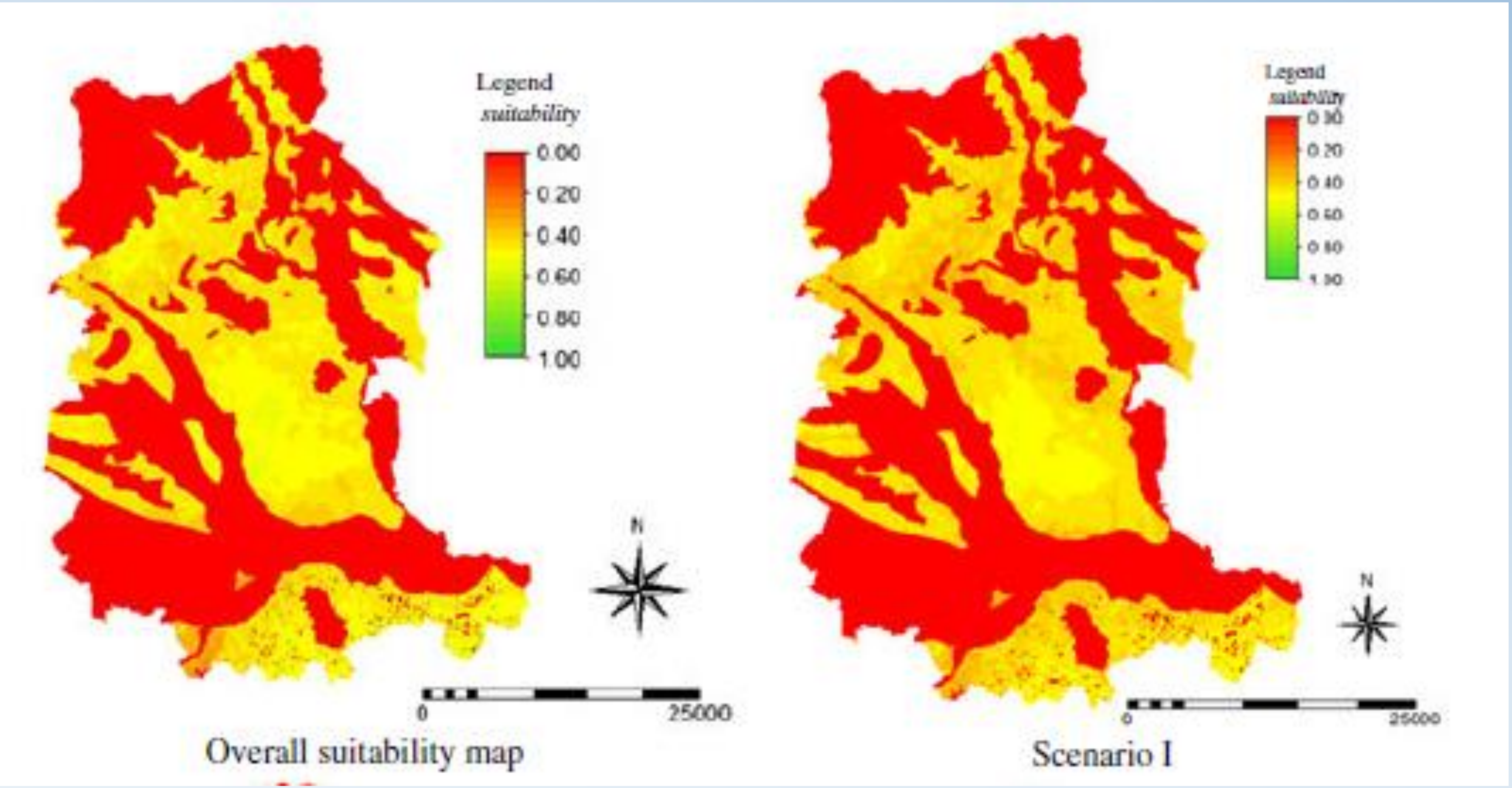
Methodology

4) Detailed analysis and implementation phase: sensitivity analysis

Table V. Combination of weights for the sensitivity analysis

Scenarios	Clusters weights			
	Biophysical environment	Biotic environment	Location	Socio-economic factors
I	0.25	0.25	0.25	0.25
II	0.55	0.15	0.15	0.15
III	0.15	0.55	0.15	0.15
IV	0.15	0.15	0.15	0.55
V	0.15	0.15	0.55	0.15

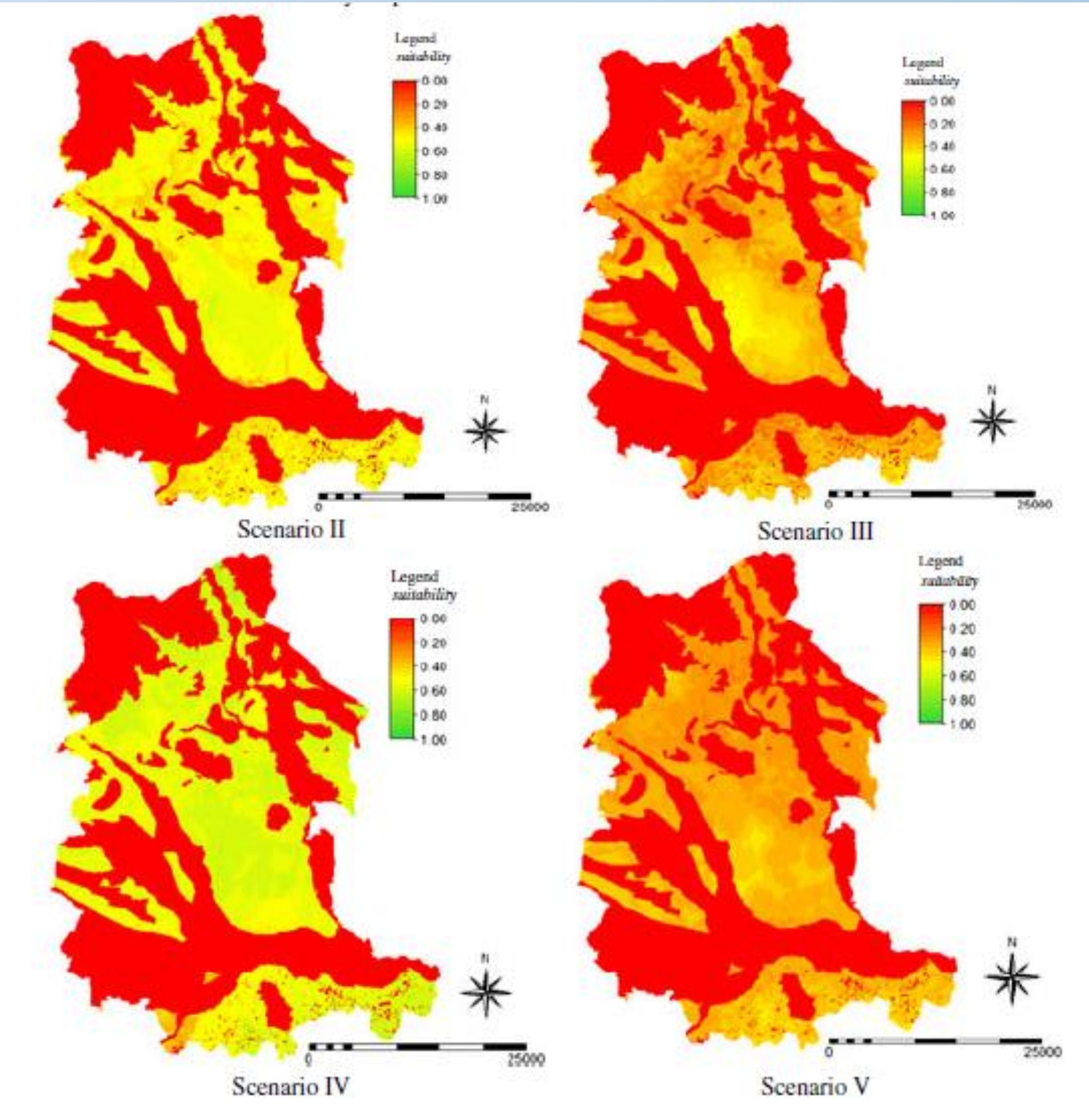
Methodology



Results

FERRETTI, 2011

Results



FERRETTI, 2011

- **ILWIS' GIS software** and its **spatial multicriteria evaluation module**: is an effective tool for managing and combining a large amount of spatial and non-spatial information

- **ANP**: **represent the real problems** of a territorial system and the complexity of the decision under examination, leading towards an **integrated assessment**

- **However, it** prescribes a **high number of comparisons** that occasionally become **too complex** for DMs to understand if they are not familiar with the method

- **Sensitivity analysis**: DMs achieve a **deeper understanding** of the structure of the problem (Khan and Faisal, 2008).

- Considering the **public opposition risk** associated with undesirable facilities location, it would be of scientific interest to **develop an online collaborative MC-SDSS**. Providing a system that can potentially **fill the gap between the general public and experts** (Malczewski, 2006).

Discussion

The **integration of GIS and MCDA** constitutes a **very promising research line** in the broad field of sustainability assessments of territorial transformation projects and, particularly, in that of **undesirable facilities location problems**, thanks to the greater **effectiveness** and **efficiency** gained by the **spatial decision-making process.**

Conclusion

A GIS-Based Adaptive Management Decision Support System to Develop a Multi Objective Framework: A Case Study Utilizing GIS Technologies and Physically-Based Models to Achieve Improved Decision Making for Site Management

Andre M. Coleman, Mark S. Wigmosta, Leonard J. Lane, Jerry D. Tagestad, Damon Roberts

Carina

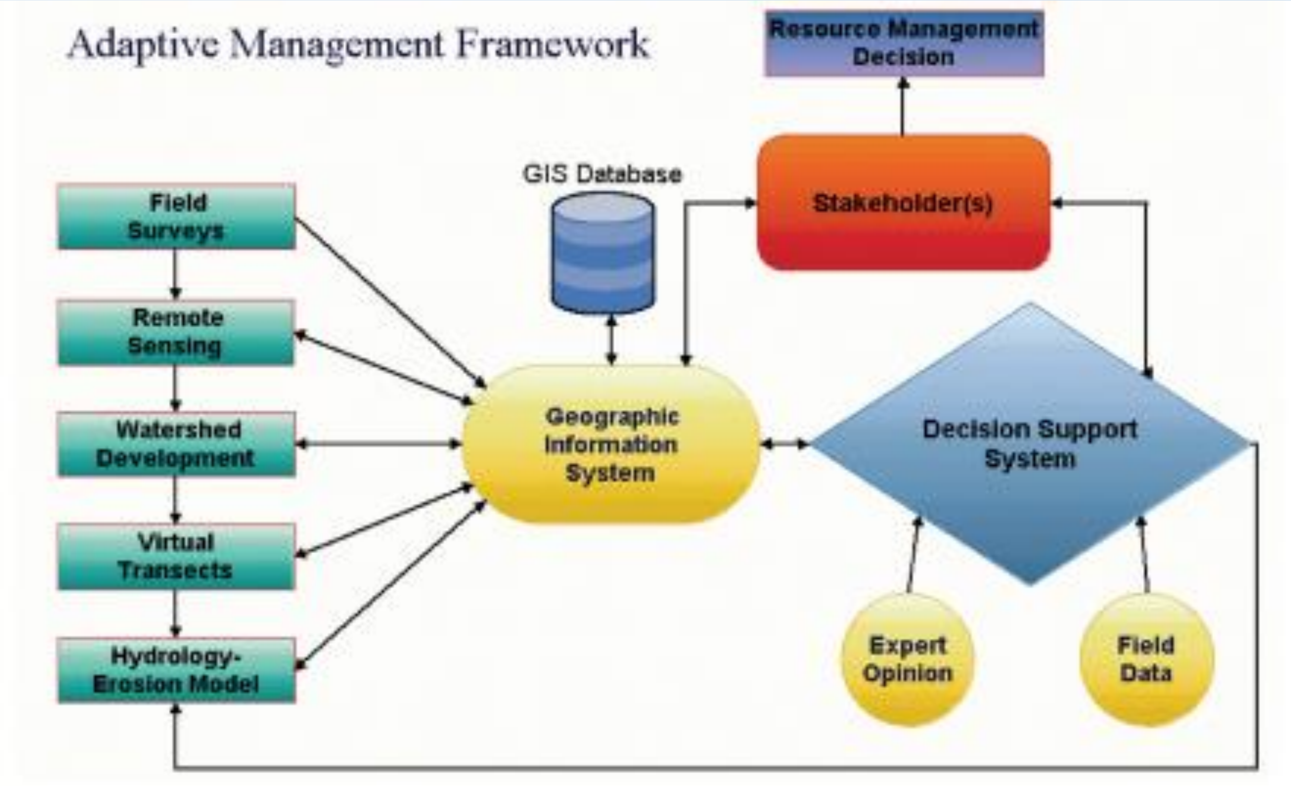
- United States Department of Defense is looking for ways to reduce environmental impact on land being used for troop training and the surrounding watersheds

Yakima Training

http://wdfw.wa.gov/conservation/research/projects/shrubsteppe/

Shrub-steppe Ecosystem

A problem that requires a solution…



Coleman et al, 2008

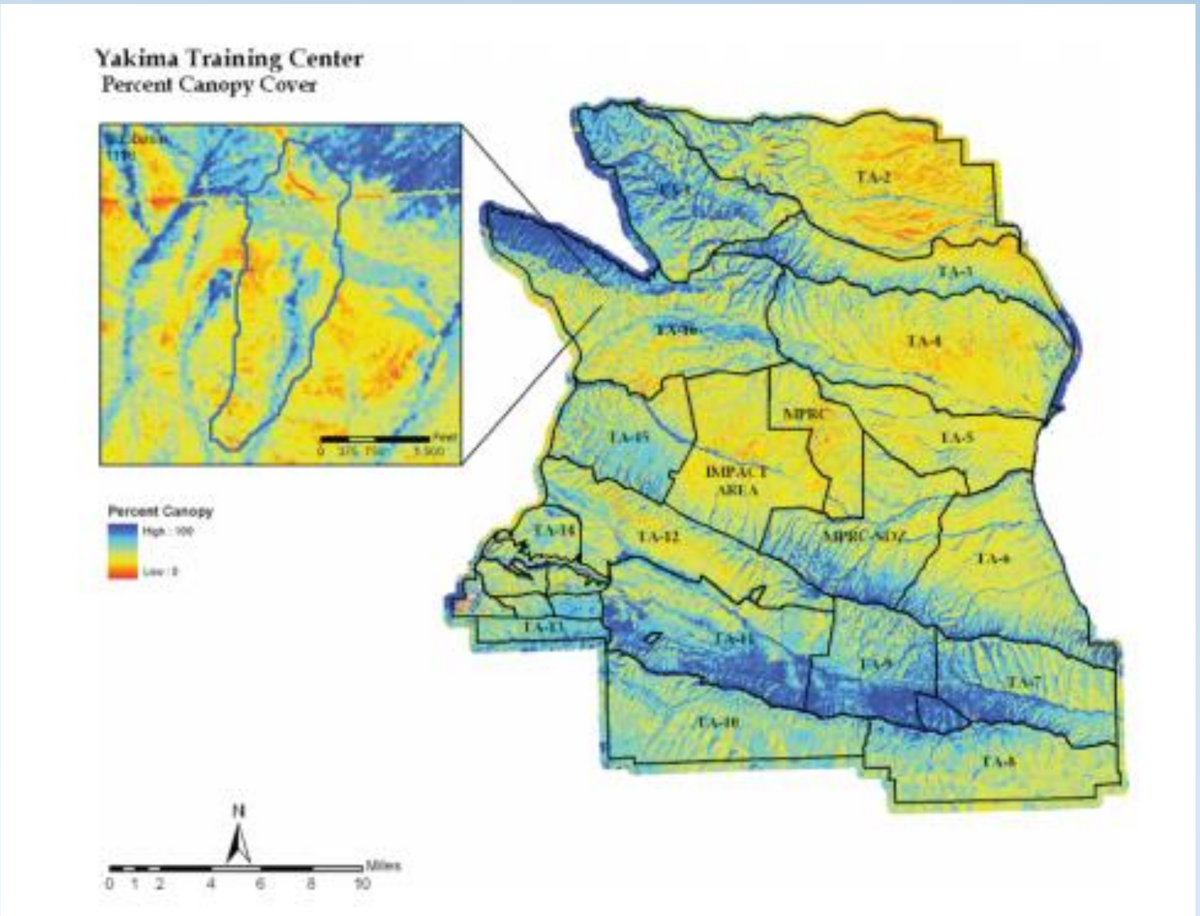
- The ultimate goal of the framework is to **reduce uncertainty in the decision making process**

Adaptive Management Framework

Field Surveys

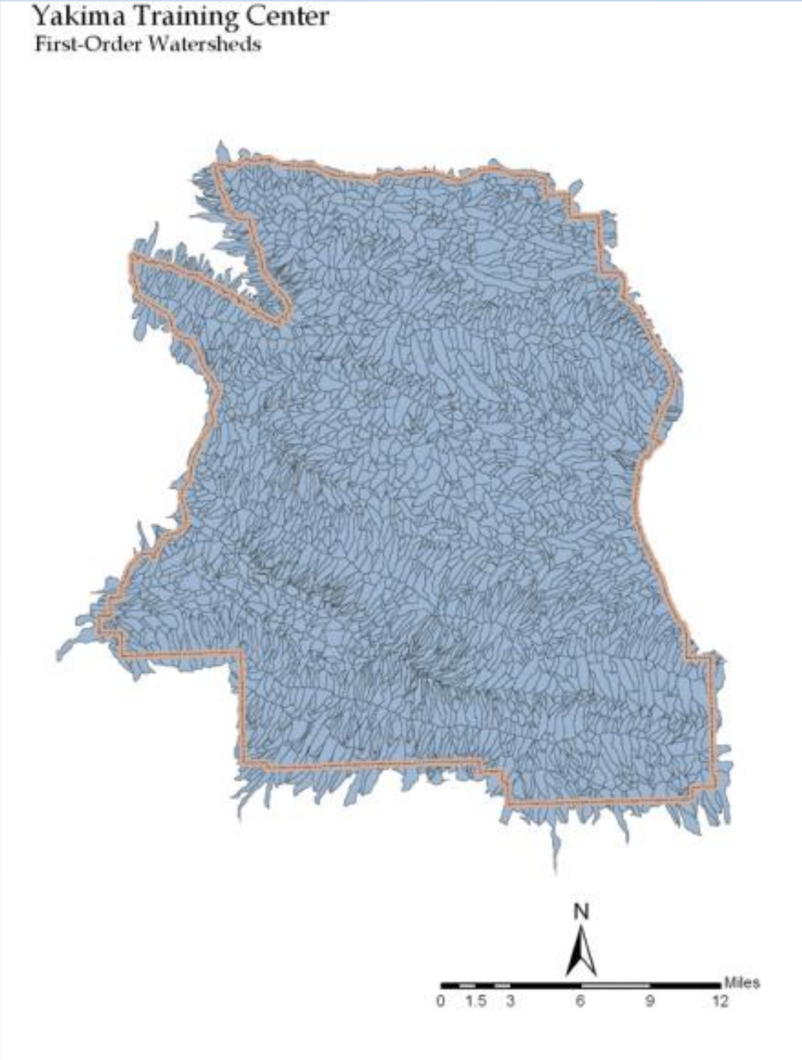
Coleman et al, 2008

Remote Sensing

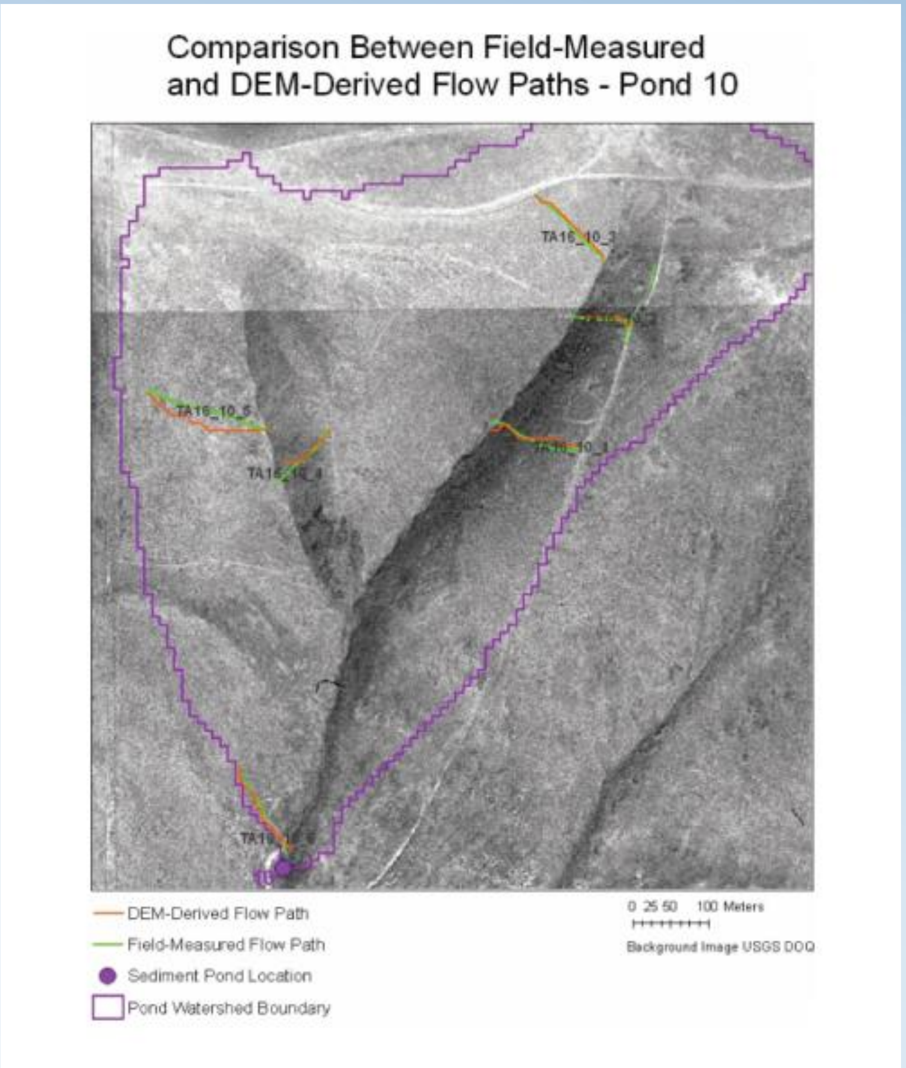


Percent vegetation canopy cover.

Methods



Watershed Development



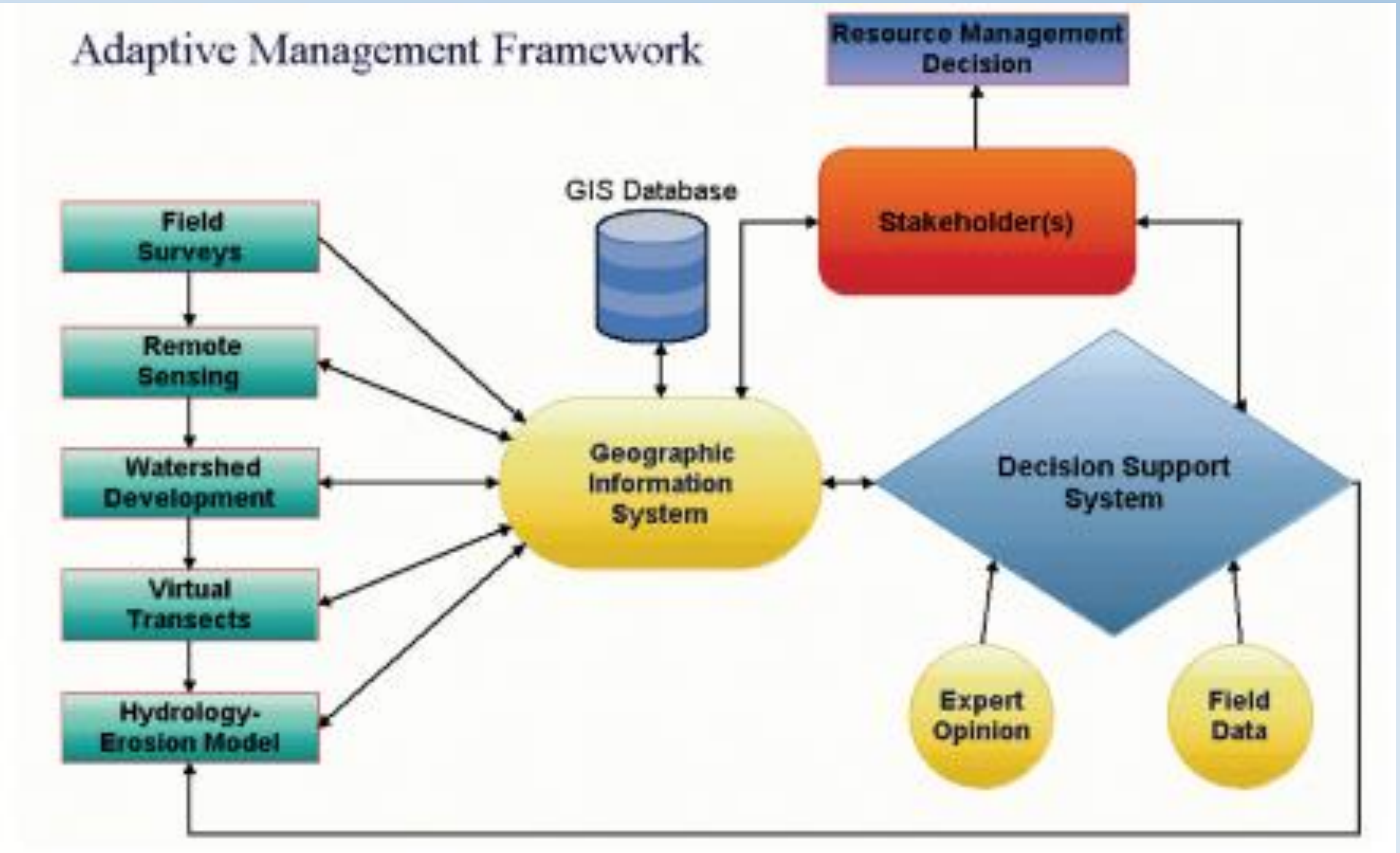
Virtual Transect Model

Methods Cont.

Coleman et al, 2008

- Working with and presenting the data in a spatial context increases the stakeholders' understanding of the issue and allows the stakeholder to become more solution oriented
- GIS framework will allow other components to be easily brought in and create an easy-to- use decision environment

Why a GIS Based Adaptive Management Decision Support System?



Coleman et al, 2008

Adaptive Management Framework

A Web-based GIS Decision Support System for Managing and Planning USAD’s Conservation Reserve Program

Mahesh Rao, Guoliang Fan, Johnson Thomas, Ginto Cherian, Varun Chudiwale, Maheeb Awawdeh

Nahom

Introduction

- This paper outlines the design and development of a **prototype web-based GIS Decision Support System (DSS)** for Conservation Reserve Program.
- This DSS is targeted toward aiding USDA to better manage and plan CRP enrollments.
- The DSS is based on:

1. Standard web-based GIS platform: ArcIMS (Internet mapping Software)
2. Image classification tool: AFIRS (Automated Feature Information Retrieval System)
3. A modeling component: SWAT (Soil and Water Assessment Tool)

- **Prototype web-based GIS Decision Support System (DSS)** for Conservation Reserve Program (CRP)
  - aiding USDA to better manage and plan CRP enrollments
  - program is based on:
    - Standard web-based GIS platform: ArcIMS (Internet mapping Software)
    - Image classification tool: AFIRS (Automated Feature Information Retrieval System)
    - A modeling component: SWAT (Soil and Water Assessment Tool)

Introduction

- **Conservation Reserve Program** (CRP) is one of the largest programs of the **U.S. Department of Agriculture (USDA)**
- Under the CRP, agricultural producers voluntarily **retire** environmentally **sensitive land** for **10 to 15** years. This contractual program encourages farmers to plant long-term resource-conserving vegetative covers to improve soil, water and wildlife resources.
- **16 million** acres expiring in 2007, important decisions and management policies need to be formulated to continue the benefits of CRP.
- **Environmental Benefit Index (EBI):** is a basic decision support tool to rank land offered for enrollment into the CRP during the general signup period

Background

- Conservative Reserve Program (CRP)
  - agricultural producers voluntarily **retire** environmentally **sensitive land** for **10 to 15** years
  - encourages farmers to plant long-term resource-conserving vegetative covers to improve soil, water and wildlife resources
- **In 2007, 16 million** acres are expiring - requires new decision and management policies to continue CRP
- **Environmental Benefit Index (EBI):**
  - is a basic decision support tool
  - ranks land offered for enrollment into the CRP

Background

- The project aims is to create a **prototype** Web-based GIS DSS equipped with a full range of analytical capabilities involving GIS and image data to aid in the **CRP decision-making process**.
- To implement a single, seamless interactive system that fully integrates an image classification tool (AFIRS) and a hydrologic-crop management model (SWAT) within ArcIMS to function as a decision support system for CRP management and planning.

Objective

- Create a **prototype** Web-based GIS DSS equipped with a full range of analytical capabilities involving GIS and image data to aid in the **CRP decision-making process**.
- To implement a single, seamless interactive system that fully integrates an image classification tool (AFIRS) and a hydrologic-crop management model (SWAT) within ArcIMS to function as a decision support system for CRP management and planning.

Objective

- Implemented using web server and Java servlet technology over an ArcIMS platform to support data access and processing in a distributed environment.

Advantages

- Modeling systems that are interoperable **across the Internet.**
- Spatial information can be easily accessed by geographically dispersed groups
- **Real-time** (or near real-time) access to critical, accurate, complete and up-to date spatial data

Web-based GIS DSS

Methodology

- Integrated Components of the CRP-DSS

1. Users end: Farmers, Decision makers..

2. User interface:
- ArcIMS(Internet Map server)

3. Modelling System:
- AFIRS: Image Classifier
- SWAT: Modelling system

4. Servers: OSU-CARS, OSU-VCIPL & OSU-TULSA

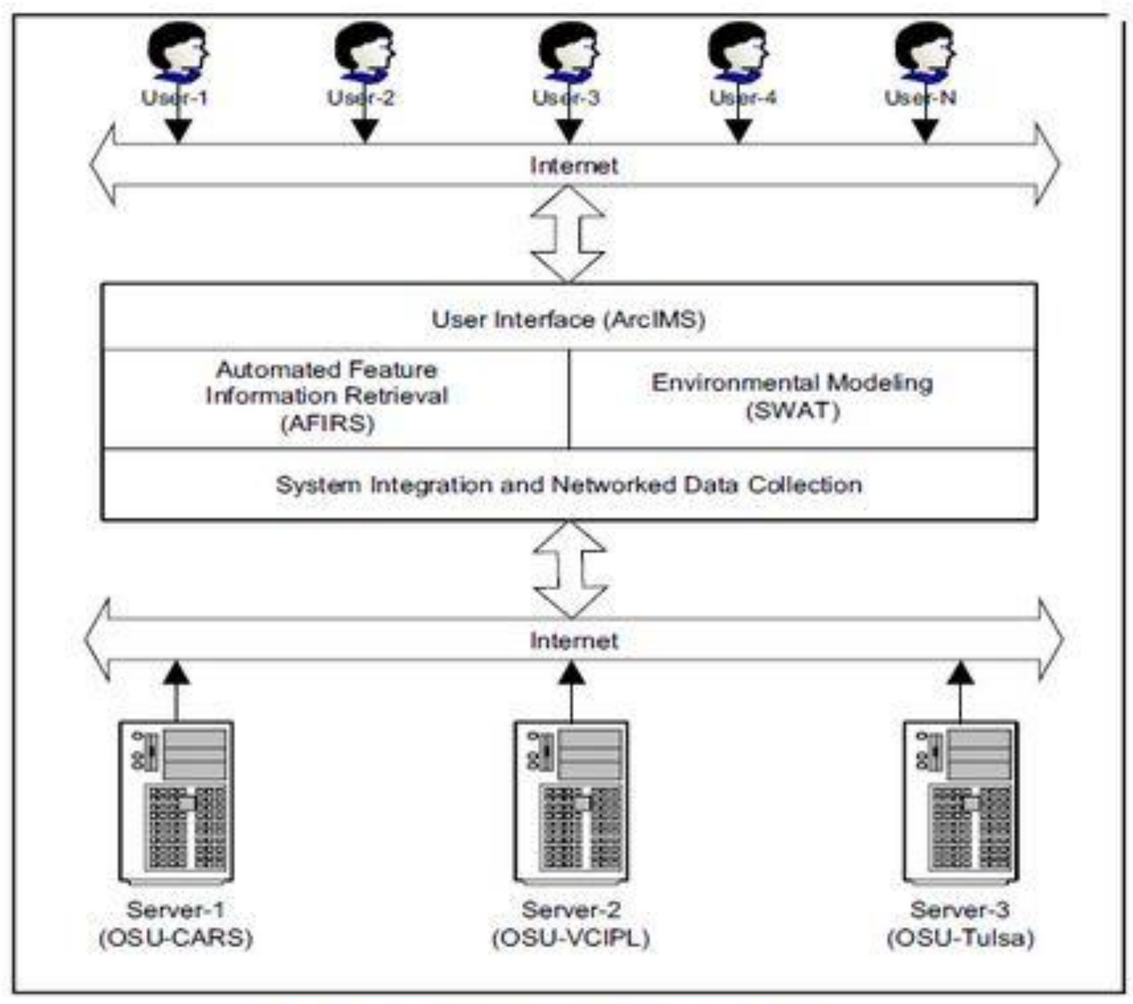


Fig. 1. Integrated system components of the CRP-DSS.

Rao et al. 2007

1. **User end**
    - Provides a user- friendly interface for map viewing, inputting user specifications and allowing the user to remotely access and interact with ArcIMS and AFIRS/SWAT.
2. **Application server**:
    - Provides seamless integration of ArcIMS, SWAT, AFIRS and GIS data stores. The application server includes a data retrieval system developed using Java servlets.
3. **Database/Web server**:
    - handles requests and responses from the user end.

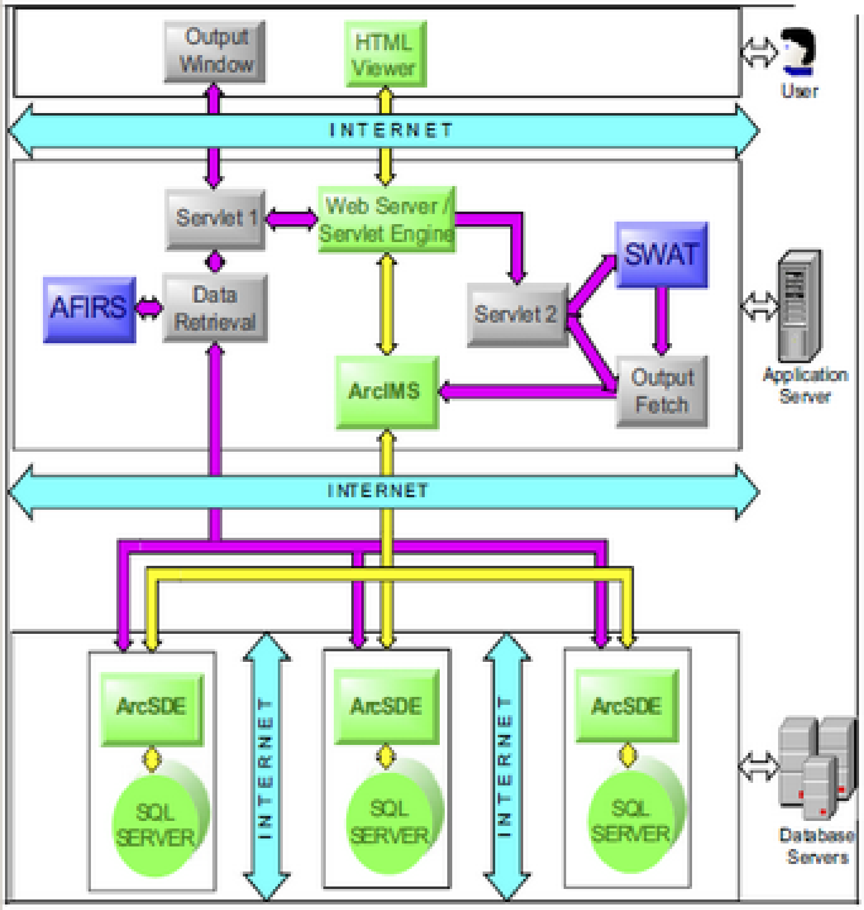


Fig. 3. Basic architecture of the CRP-DSS.

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The basic architecture of the CRP-DSS system

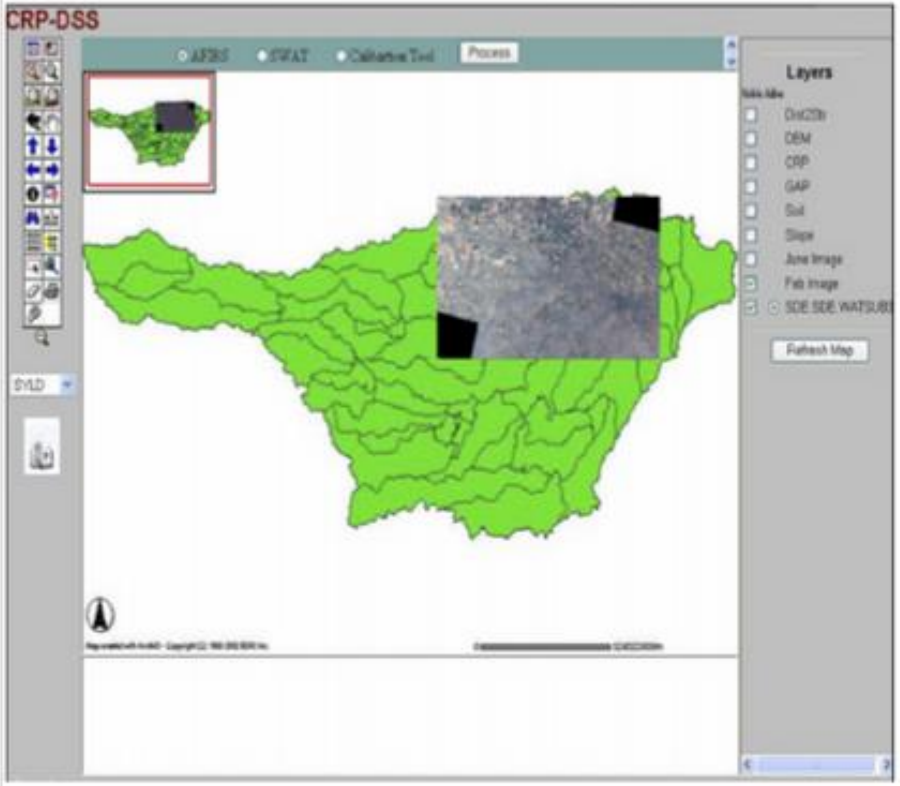

Fig. 2. Graphical user interface of the CRP-DSS.

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Table 1
Multisource geospatial database developed for AFIRS and SWAT tools in CRP-DSS

Data	Resolution/ Scale	Source	Description
Landsat TM	30 m	USGS EROS	Multispectral Image
DEM	30 m	http://www.mapmart.com	Elevation, slopes, and slope length
Land use	30 m	OSU Center for Applications of Remote Sensing (OSU-CARS)	Land use land cover categories
CRP Reference	30 m	NRCS, Stillwater, Oklahoma	The spatial distribution of the CRP sites in Texas County
Soils	1:100,000	STATSGO (NRCS Soil Data Mart)	Soil physical properties e.g. texture, bulk density, etc.
Streams	1:100,000	Oklahoma Digital Atlas	Major Streams and Rivers in Oklahoma

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Graphical User Interface and Database Development

- **Layer A:** consists of the Landsat TM multispectral images
- **Layer B**: contains vegetation indices that include the normalized vegetation difference index (NDVI) and band ratios.
- **Layer C**: consists of 20 layers of texture information, including local mean and local variance of each band.
- **Layer D**: including elevation ranges, slope and distance-to-waterbody.
- **Layer E:** The LULC data could be used for more robust image analysis with respect to different cover types.
- **CRP reference data/Map** for training and/or evaluation purposes.

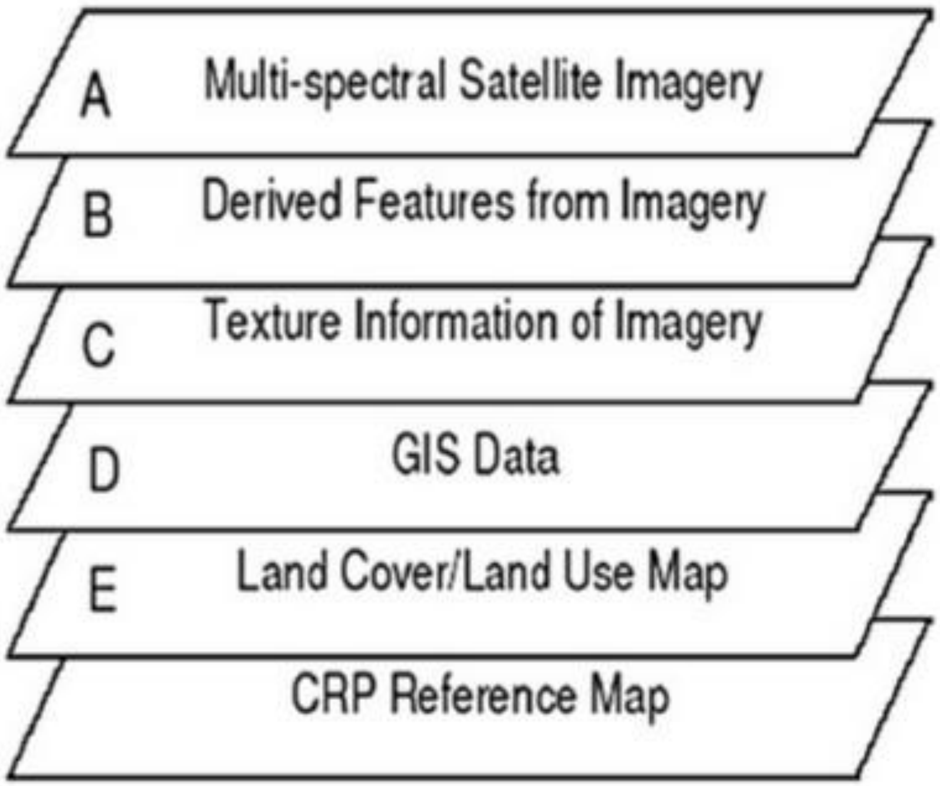

Fig. 4. Multisource Geospatial Database used in CRP-DSS.

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Multisource Geospatial Database used in CRP-DSS

- Graphical user interface component.
- A semi-supervised image segmentation process developed for CRP.
- Feature delineation and extraction using sampled reference data.
- It's a tool for classifying image data using the multi-source spatial data.
- Applies Decision Tree classification (DTC).

Automated feature information retrieval system (AFIRS)

- **Decision Tree Classification** (DTC): is a tree-structured classifier built from a training data set, representing rules underlying training data with hierarchical and sequential structures.
- These technique have substantial **advantages** due to their flexibility, intuitive simplicity, and computational efficiency in the classification procedures.
- Uses **C4.5 algorithm** to generate decision tree.
- **Error based pruning** (EBP) is applied to mitigate overfitting problem.
    - post-pruning approach.

Decision Tree Classification in the AFIRS

- **Decision Tree Classification** (DTC)
  - tree-structured classifier built from a training data set,
  - represents rules underlying training data with hierarchical and sequential structures.
- flexible, intuitive simple, and computationally efficient classification procedures.
- Uses **C4.5 algorithm** to generate decision tree.
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  - post-pruning approach.

Decision Tree Classification in the AFIRS

1. **Extracts features:** based on decision tree algorithm.
2. **Area selection tool:** Using the coordinates, a clipping algorithm is executed to the data.
3. **Analysis tool:** using the CRP reference data.

- The **accuracy** of the AFIRS's provided in terms of three **accuracy indices**

1. **Overall accuracy (Pa):** how well the classifier delineates different feature classes in the image
2. **Users accuracy (Pb):** indicates the probability that a sample from land cover map actually matches what it is from the reference data
3. **Producers accuracy (Pc):** relates to the probability that a reference data will be correctly mapped.

AFIRS tool functionality and Accuracy analysis

1. Extracts features
2. Area selection tool
3. Analysis tool
4. Accuracy indices
   a) Overall accuracy (Pa)
   b) User accuracy (Pb)
   c) Producer accuracy (Pc)

AFIRS tool functionality and Accuracy analysis

- A hydrologic/water quality model.
- SWAT is a **continuous-time** model that operates on a daily time step to predict the impact of management on sediment, water and agricultural chemical yields.
- **Input**: elevation, land use/land cover, soil, etc.
- Capable of simulating long period of management operations.
- It is a distributed hydrologic model that allows a watershed to be subdivided into smaller sub-basins to incorporate spatial detail.

Soil and Water Assessment Tool (SWAT)

- Hydrologic/water quality model.
- Predicts the impact of management on sediment, water and agricultural chemical yields.
    - Continuous-time model
- Capable of simulating long period of management operations.
- Allows a watershed to be subdivided into smaller sub-basins to incorporate spatial detail.

Spatial Detail Modelling

1. **Land phase**
2. **Routing phase**

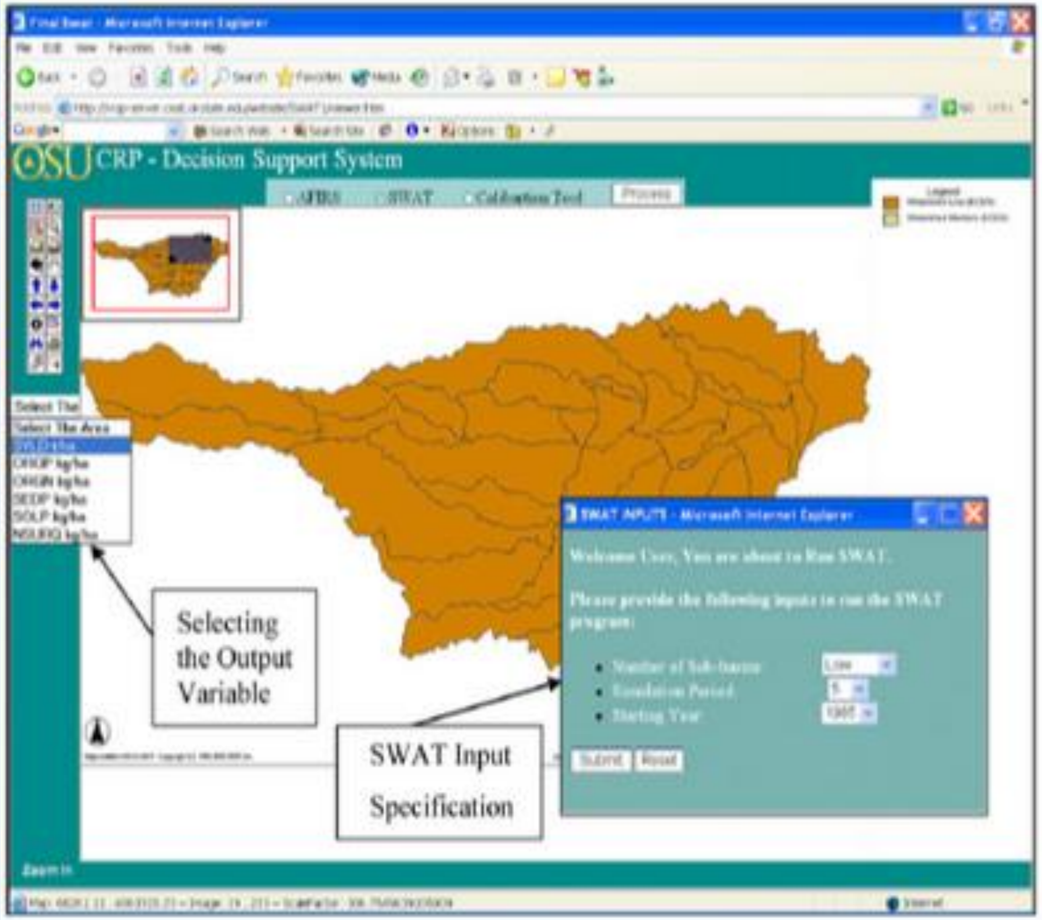
Soil and Water Assessment Tool (SWAT)

- **Hydrologic Response Units (HRU)** is more detailed modelling which divide a sub-basin into units **with unique land use and soil type** to capture the variability within the sub-basin.
- The model simulates watershed hydrology in **two phases**:

1. **The land phase**: accounts for the amount of water, sediment, nutrients, and pesticides loading to the main channel of each drainage area.
2. **The routing phase**: determines the transport of water, sediment, and chemical from the stream network to the watershed outlet.

Spatial detail modelling in SWAT

Executing Model Run in SWAT



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1. Specific input
2. User Area of Interest

- **Texas County** ranks **the first** in Oklahoma in terms of CRP acreage.
  - 20.54% of all Oklahoma acreage.
- CRP features were extracted using the multisource geospatial database and **long-term sediment yields were** simulated in the Beaver River Watershed.

Study area: Texas County, Oklahoma State

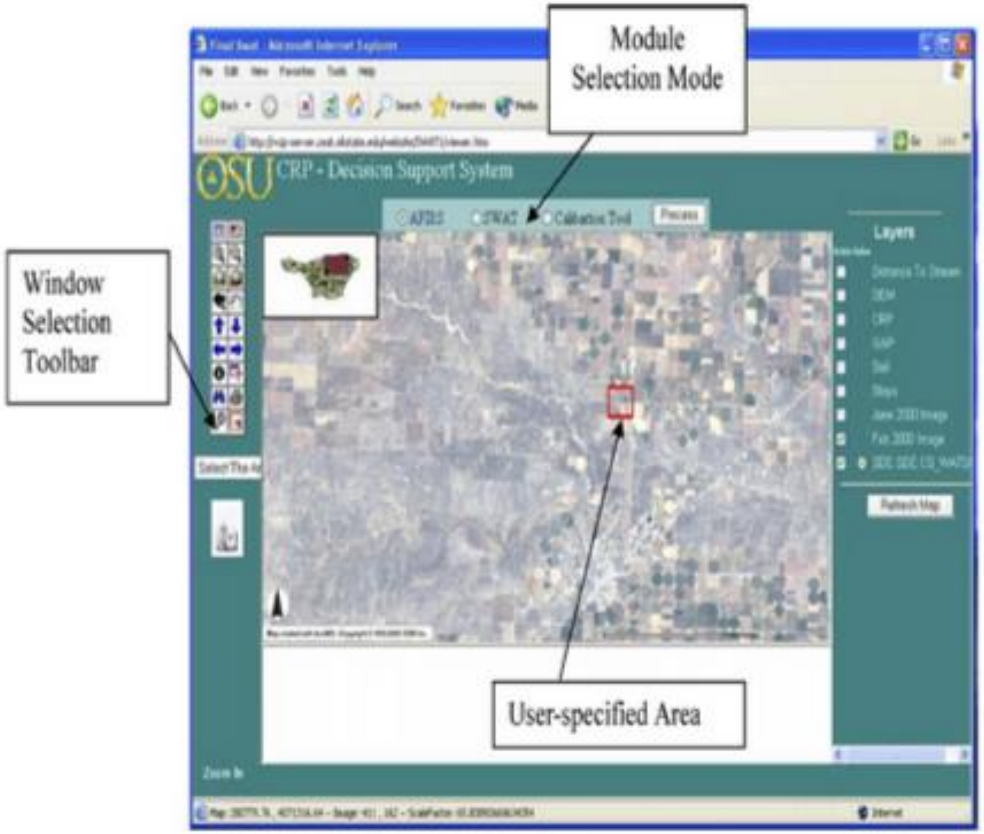

Fig. 7. User-specified processing window in CRP-DSS.

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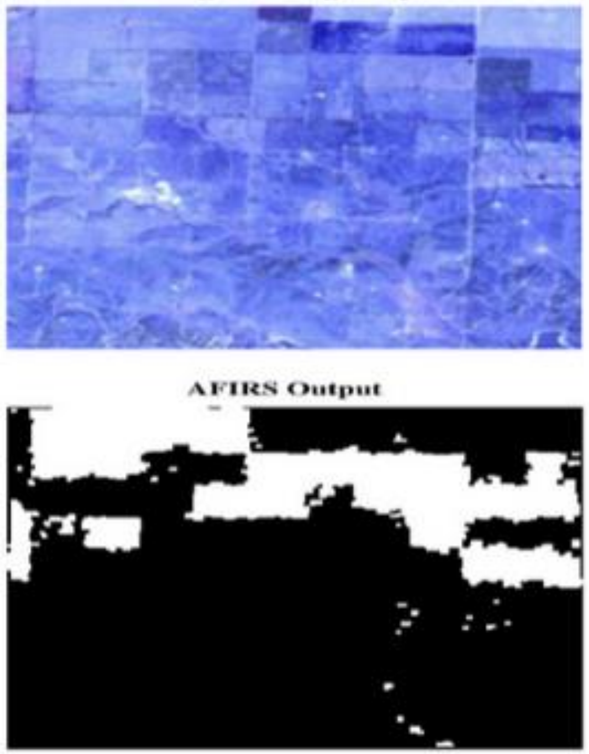

Output figures for selected Region
Pa = 92.497143% Pb = 85.197054% Pc = 85.264165%

Fig. 5. A display of AFIRS output for the user-specified area. Bright areas indicate CRP pixels, while dark areas indicate non-CRP pixels.

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AFIRS Model Run

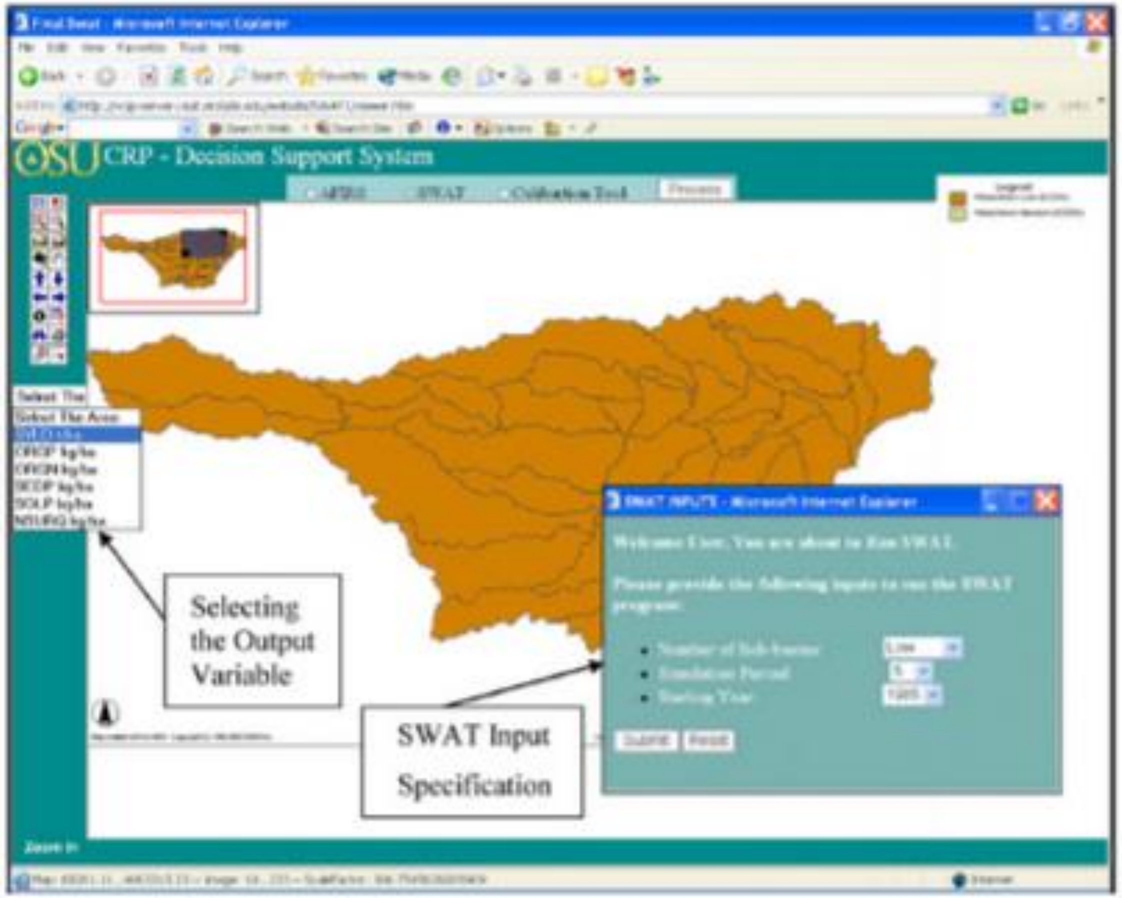

Fig. 8. SWAT input and output variable selection within the SWAT module of CRP-DSS.

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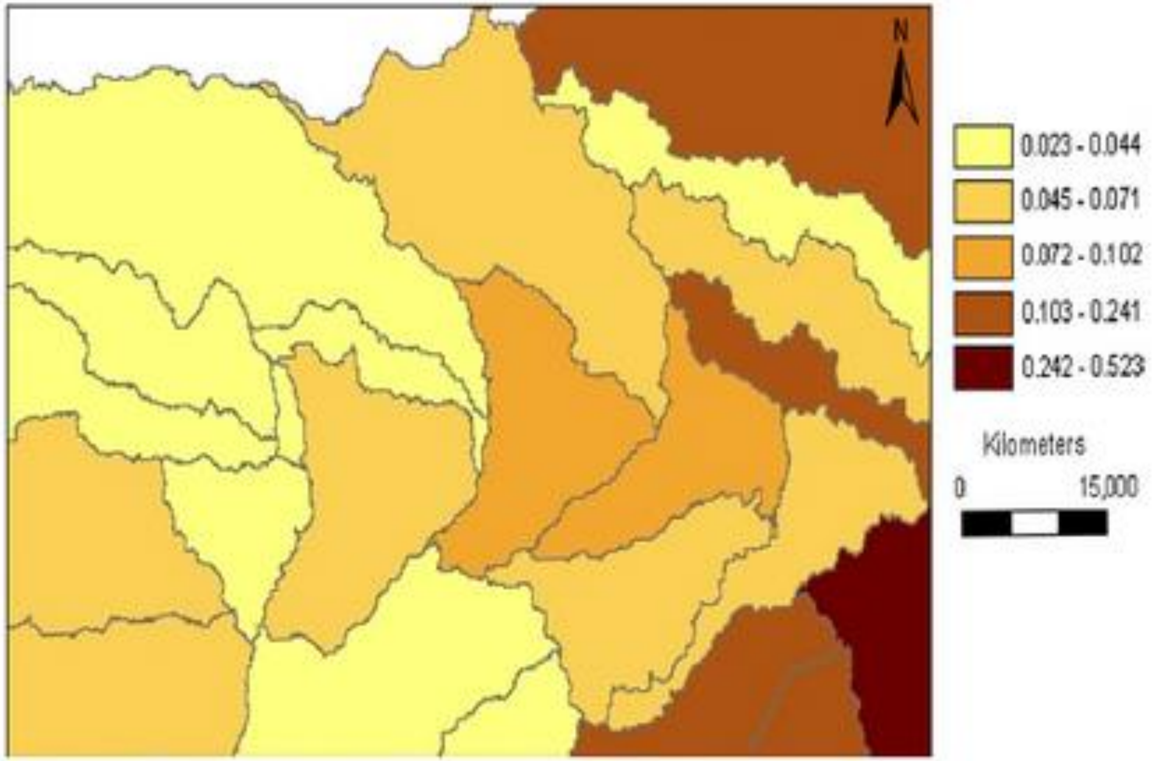

Fig. 9. Simulated sediment loss (tons/ha/year) output for the subbasins in Texas County, Oklahoma.

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Simulated Sediment Loss Output

- Ingegration of AFIRS and SWAT
  - image classification algorithm and hydrologic-crop management model,
- ArcIMS and ArcSDE
  - integration of diverse spatial data into database.

Discussion

- Integrating AFIRS and SWAT within the CRP-DSS provides a robust image classification algorithm for a rapid and accurate extraction of CRP features using a multisource geospatial database.
- Decision makers and planner can effectively use the CRP-DSS by simulating the relative environmental/economic benefits of CRP enrollments under a variety of scenarios.

Conclusion

Questions?