LAOS CARAVAN Training

Case Study 29 Nov 2005

Watershed Management

- Objective:
 - Discuss watershed management aspect based on soil erosion
 - Land cover/use extraction, DEM creation, soil erosion and GIS analysis planning support for planner
 - Capacity building for local staffs on the use of GIS and Remote Sensing for watershed management

Study area

- NamNgum watershed
- NamNgum Dam have two main upstream as show in figure.
- Case study was based on the watershed loacted at of the Dam.



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DATA

RS and GIS data

RS data

- Landsat
 - Path 128 Row $47 \rightarrow 27$ Dec 1999
- JERS OPS
 - Path 124 Row 269 \rightarrow 27 Dec 1995
 - Path 124 Row 269 → 30 Oct 1996
 - Path 124 Row 269 → 24 Apr 1997

GIS Data

- Layers
 - Land use 1993 and 1997
 - River network
 - Road network
 - Villages with population data (spreadsheet)
 - Contour
 - Province boundary and
 - District boundary

Using RS & GIS

- Update landuse
- Extract watershed boundary
- Create terrain data: elevation, surface
- Generate the drainage network
- Evaluate the soil erosion in watershed area
- Carry out Spatial analysis

Hands-On Content

- Introduction ArcGIS and Data Creation/Handling
- Landuse Classification: Visual Screen Editing
- Watershed Extraction
- GIS Analysis
 - 3 D analyst and Spatial Analyst
- Applying Parameters
 - Landuse, Slope and Transportation
- Case study area extraction

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Introduction ArcView

Data Creation/Handling

I. Overview of Arcview Software

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1.1 Arcview Components



- **Application Window**
- 2. Menu Bar

1.

- **Project Window**
- **View Window**
- Layout Window
- **Chart Window**

1.2 Graphical User Interface (GUI) for View

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Identify the feature

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Different GUIs for different windows



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1.3 Format of ArcView Data





District.shp

District.dbf (table data) District.shp (spatial data) District.shx (relations)

1.4 Themes



1.5 Data Display and Overlay

Add theme or themes Check box to visible a theme: *district.shp* Double click on theme for legend display: district.shp Select Legend type: Unique Value Values Field: Dname View1

Arrange for theme order: drag and drop



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1.6 Layout for printing map

- Activate View window
- Select View\Layout...
- •Select one paper style on Landscape Manager (portrait or landscape)
- •Choose <New Layout>, Try edit with objects on the layout.



1.7 Extension of ArcView

- Activate the project windows
- •Select File\Extension
- Select extension program (Geoprocessing)
- •Extension program will occur in menu, button or tools in individual interface
- (View Windows, menu View\Geoprocessing)
- •Try with another extension, Spatial Analysis and 3D Analysis

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Extension of ArcView

GIS 3.2 View Theme Surface Graphics Window Help Create **IIN** from Features... Add Features to TIN... 1000 Create Contours... Open Derive Slope 😟 Extensions Derive Aspect View1 Available Extensions: Calculate Viewshed.. 3D Analyst Area and Volume Statistics... ADRG Image Support CADRG Image Support Cad Reader Reset CIB Image Support Database Access Make Default Dialog Designer About: Extends ArcView to support surface modeling and 3D visualization (v1.0).

3D Analysis

Surface Graphics Window Interpolate Grid... Create Contours... **Spatial Analysis** Derive Slope Derive Aspect Calculate Viewshed. 🍭 Arc¥iew GIS 3.2 Edit View Theme Analysis Surface Graphics File 目 ÷ **F** 5 Properties... Find Distance Assign Progimity 🙋 Extensions 🔍 Untitled Available Extensions: New Open Cell Statistics... MrSID Image § View1 Summarize Zones... NITF Image St Histogram By Zone.. Views Projection Utili Tabulate Areas... Image to Map Map Query... Report Writer Map Calculator... Tables Spatial Analys Neighborhood Statistics.. • TIFF 6.0 Imag Charts About: Extends ArcView to support spatial modeling and analysis (v2.0).

Landuse Classification

Visual Screen Editing

Steps

- Landuse 1997
- Regroup
- Overlay with Landsat image
- Update landuse

Landuse 1997

Add theme



"Landuse fcm9397"

æ





Look up table Landuse code

🚳 Add Table File Name: mrc_fclc_type.dbl district.dbf

List Files of Type: dBASE (*.dbf)

Add Table "mrc_fclc_type" (Forest/Land cover type)

	🂐 Untitled		- U X	🍭 mrc	_fclc_type.dbf		_
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				1	1 forest	evergreen, high cover density	
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	Views			1	7 forest	mixed (evergreen and deciduous), high cover density	
				18	3 forest	mixed (evergreen and deciduous) medium-low cover	
				19	3 forest	mixed mosaic	
	Tables			20) forest	deciduous	
				22	2 forest	deciduous mosaic	
				40) forest	regrowth	
	Charts			4	1 forest	regrowth, inundated	
				5	2 forest	inundated	
				5	3 forest	mangrove	
	Layouts			54	4 forest	plantations	
				5	5 forest	other	
				56	5 forest	inundated mosaic	
	Scripts 🔻		-	6	1 non-forest	wood and shrub land, evergreen	
				67	2 non-forest	grassland	
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UDMOE (".ODI)		<u> </u>			3 non-forest	clouds	

Join attribute table



Open attribute table

of "Landuse_fcm9397"

Click field name

"Fclc_code" in

"mrc_fclc_type" table

 Click field name "F97" in "Landuse_fcm9397"

table

Press Join button



20 forest

22 Forest

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12	forest	ſ	evergreen, med	ium-low cover d	lensity		
13	forest	1	evergreen mosa	ыс			
17	forest	1	mixed (evergree	n and deciduov	us), high covr	er density	
18	forest	1	mixed (evergree	n and deciduov	us) medium-lo	w cover	
19	l forest mixed mosaic						

dooiduous moopia

deciduous

Display Landuse type

- In Legend editor, change
 Value Field as "Type"
- Click Apply button and change Symbol color

🍳 Legend Editor	
Theme: Landuse_fcm9397.shp	Load
Legend Type: Unique Value	Save
	Default
Values Field: F97 B_fcmp9397 F93 F97 Type Fclc 17 18 19 20 Color Schemes: Bountiful Harvest	Image: Count Ove n Image: Count Nixed (evergreen an Mixed (evergreen and Mixed (evergreen and Mixed (evergreen and Deciduous Image: Count Image: Count <
Advanced Statistics	Unde Apply

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	10542	61	61	non-forest	wood and shrub land, evergreen				
	10542	61	61	non-forest	wood and shrub land, evergreen				
	11373	61	61	non-forest	wood and shrub land, evergreen				
	11547	62	62	non-forest	grassland				
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	11547	62	62	non-forest	grassland				
	11547	62	62	non-forest	grassland				
	11000	C4 (<u> </u>	· ·					



Re-class Landuse type

 In order to make the landuse class to simply landuse classes, the landuse type can be group into forest and other landuse

Folo_code	Туре	Fak	
11	forest	evergreen, high cover density	
12	forest	evergreen, medium-low cover density	
13	forest	evergreen mosaic	
17	forest	mixed (evergreen and deciduous), high cover density	
18	forest	mixed (evergreen and deciduous) medium-low cover	
19	forest	mixed mosaic	
20	forest	deciduous	
22	forest	deciduous mosaic	- Forest
40	forest	regrowth	
41	forest	regrowth, inundated	
52	forest	inundated	
53	forest	mangrove	
54	forest	plantations	
55	forest	other	
56	forest	inundated mosaic	
61	non-forest	wood and shrub land, evergreen	
62	non-forest	grassland	
63	non-forest	bamboo	
64	non-forest	wood and shrub land, dry	
65	non-forest	wood and shrub land, inundated	
81	non-forest	cropping mosaic, cropping area <30%	
82	non-forest	cropping mosaic, cropping area > 30%	
91	non-forest	agriculture land	
92	non-forest	barren land	
93	non-forest	rocks	
94	non-forest	urban or built-over area	
95	non-forest	water	
96	non-forest	wetland	
97	non-forest	other	
99	non-forest	clouds	

Edit table / Add field

- Start Editing table, add new field, Set field definition
- Then query [Type] = "forest"

	File Edit Table	Field XTools	🍭 Field I	Definition	×
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	12184 12184	40	40 forest	regrowth	
	12187 12187	61	61 non-forest	wood and shrub land, evergreen	
	10100 10100	40	40 [†] ()	:	

Input new re-group landuse

Copy Type "Forest" into "Reg_lu97" field using calculator button



- Click switch selection button select the remaining landuse type
- Copy other landuse into "Reg_lu97" field click [Reg_lu97] = [Fclc] in

	calculator to	Field Calculator				1			
			Fields	1397]	Type O Number	Requests +			
	Stop Editing	-)	[F93]		 String 	++			
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				12236	12	12 forest	e	vergreen, medium-low cover density	forest
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[F93]	 String 	++		12247	61	61 non-fore	est w	ood and shrub land, evergreen	wood and shrub land, evergree
[F97]	O Date			12248	GIS 3.3	3	e	vergreen, high cover density	forest
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IFele			ОК	12258			re	egrowth	forest
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Display new re-class landuse

 Change color in Legend Editor according to new re-classed landuse (Field "Reg_lu97")



Open image and compare with landuse

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 Add image theme name "Tm_p128r47_9912b432.tiff" and "Tm_p128r47_9912b321.tiff"



Edit/Update Landuse theme



Using Edit Feature Tool



Watershed Extraction

How to defined watershed boundary?



From which data WS can extract



SRTM-DEM

Stream Network





GIS data-River

Satellite Image



SRTM-DEM→STREM Network



How can defined Watershed?

- 1) Boundary between rivers or river systems
- 2) Range between valleys or long depressions in the surface of the land
- 3) Major river catchments should be covered
Add Data Layers



 Add GIS layers and satellite imageries (river_utm48.shp, srtm_stream.shp, p128r047_7t19991227_z48_nn123_subset.tiff and srtm_u03_p128r047sub.tif)

Create New Layer



5) Select New Theme in View Menu to create new GIS layers, Select select the polygon features in pop-up windows

6) Then guide to the folder where new data file have to store and give name as **watershed.shp**

7) The watershed.shp file will be appear in the theme list

8) Use Draw Polygon Tool to digitize on screen to create watershed polygon

Watershed Boundary



GIS analysis and Parameters

- 3 D Analyst and Spatial Analyst
- Landuse
 - **1997**
- Slope
 - Contour
- Transportation
 - Road and Stream

GIS analysis



ArcView GIS Analysis

- There are two main ArcView GIS Analyst software extensions will be used in this case study.
- They are:
 - 1. 3 D Analyst
 - 2. Spatial Analyst

3 D Analyst

- Support for 3D shapes, surface modeling, and real-time perspective viewing to ArcView.
 - *3D shape* store z coordinates, in addition to x and y, for every point used to define a feature.
 - Two types of *surface models* are available grids and triangulated irregular networks (TINs).
 - *3D Scene* Document provides an interactive viewer that puts your data in a new perspective.

Spatial Analyst

- The main component of the Spatial Analyst is the grid theme. The grid theme is the raster equivalent of the feature theme.
- The Spatial Analyst also presents generic spatial analysis functionality on grid and feature themes.
- Main available function are: Find Distance, Assign Proximity, Calculate Density, Cell Statistics, Summarize Zones, Histogram By Zone, Tabulate Areas, Map Query, Map Calculator, Neighborhood Statistics, Reclassify, Interpolate Grid, Create Contour, Derive Slope, Derive Aspect, Compute Hillshade, Calculate Viewshed, Convert to Shapefile (not added, but modified to work with grid themes), Convert to Grid, Save Data Set, Edit Theme Expression, Manage Data Sources, Import Data Source, Export Data Source

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Semi-quantitative method Parameters

- Parameters
 - Landuse

Slope and

Transportation

LANDUSE Parameter



Scoring Landuse Parameter

- Defined four scores based on forest types
 - Score 0 has no erosion potential such as water body, wetland, Rock
 - Score 1 has less erosion potential such as evergreen/deciduous forest,
 - Score 2 has high erosion potential such as Grassland, Shrub and Urban, low cover forest
 - Score 3 has very high erosion potential such as barren land, agriculture land
- Erosion Experts can be defined with his/her experience on landcover/landuse

Landuse 1997



Forest Types

NO	Reclass (Score)	Code	Name
1	0	93	Rocks
2	0	95	Water
3	0	96	Wetland
4	1	11	Evergreen, high cover density
5	1	12	Evergreen, medium - low cover density
6	1	17	Mixed (evergreen and deciduous), high cover density
7	1	18	Mixed (evergreen and deciduous) medium - low cover density
8	1	40	Regrowth
9	2	13	Evergreen mosaic
10	2	19	Mixed mosaic
11	2	61	Wood- and shrub land, evergreen
12	2	62	Grassland
13	2	94	Urban or built-over area
14	3	81	Cropping mosaic, cropping area <30%
15	3	82	Cropping mosaic, cropping area >30%
16	3	92	Barren land

Landuse Scoring

- Converted -Landuse layers to Grid with pixel size 30
- Reclassification
- Score Landuse type
 - 0 = 96, 95, 93
 - $\bullet 1 = 11, 12, 17, 18, 40$
 - $\bullet \ 2 = 13, 19, 61, 62, 94$
 - $\bullet \quad 3 \quad = \quad 81, 82, 91, 92$

Find erosion values from internet

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Landuse 1997 Grid conversion

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Landuse GRID



Landuse GRID

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Scoring Landuse 1997

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CONTOUR Parameter



Scoring Slope Parameter

- Defined four scores based on slope degree
 - If the slope is 0° 7°, we defined score 1 and has Less erosion potential
 - If the slope is 7° 15°, we defined score 2 has medium erosion potential
 - If the slope is > 15°, we defined score 3 has high erosion potential
- Score can adjust based on regional elevation.
- In this case study, area is mostly undulated land.

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Select layers for Slope Scoring



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Create TIN from Contour

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TIN (Triangulated Irregular Network)



TIN to GRID



GRID from Contour



Drive Slope from GRID







Scoring Slope



Scoring Slope Grid



Reclassifies the values in a grid theme

Scores of Slope



Logically way of Thought

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Slope & Landuse



Slope Landuse



Logically way of Thought

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Slope & Landuse



Slope 😣 Landuse


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Comparison Adding and Multiplying



TRANSPORTATION Parameter



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Scoring Transportation Parameter

- Defined four scores based on how far from Transportation Route (River and Road)
 - Score 1 has very less erosion potential areas where the places located within 4 Kilometers far from Transportation route
 - Score 2 has less erosion potential areas where the places located within 3 Kilometers far from Transportation route
 - Score 3 has high erosion potential areas where the places located within 2 Kilometers far from Transportation route
 - Score 4 has very high erosion potential where the places located within 1 Kilometers far from Transportation route

Transportation



Included Road network and River network

Merged Layers



Buffering

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Buffering



Intersecting with Boundary



Intersecting with Boundary





Transportation Scoring

- Score Buffered distance
 - 1 = 3 to 4 Kilometers
 - 2 = 2 to 3 Kilometers
 - 3 = 1 to 2 Kilometers
 - 4 = Feature to 1 Kilometers

Converted GRID with Scores



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Landuse & Slope & Transportation



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Overlaid Watershed



1 km Buffered Watershed



Raster to Vector

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Raster to Vector



Extracting Case study area



Extracting Case study area



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Semi-Quantitative Watershed by Adding



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Semi-Quantitative Watershed by Multiplying

