Introduction to InVEST 3.3.2 An Economic Valuation and Assessment Analysis of the Pellicer Watershed

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Florida State University

Center for Economic Forecasting and Analysis (CEFA)

Specializes in applying advanced, computer-based economic models and technique to perform economic analysis and to examine public policy issues across a spectrum of researches areas. FSU CEFA also serves as a foundation for training students on the uses and applications of advanced economics and statistical tools.

Key Areas of Expertise:

- Economics, Sustainable Energy, High Tech Economic Research
- Environmental/Natural Resources, Economic Development
- Econometrics, Economic Impact Analysis

Project Scope



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Project Goals

- Literature Review
- Identification Gaps in the Data
- Run Land Use (LU) Models and Generate Results
- InVEST Software Training
- Evaluation of the InVEST Model Data and Results
- Identification and Ranking of Priority Conservation Areas

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• Final Report: due by May 30, 2017

Software Selection

- Top-three models selected
- 1. Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)
- 2. Artificial Intelligence for Ecosystem Services (ARIES)
- 3. MARXAN and MARXAN with Zones
- Advantages of InVEST
 - A wide range of ecosystem service modules for mapping and valuing ecosystem services

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- Variety of scales: global, regional, and local scales
- Multi-service or single-service system analysis based on availability of data and expertise

Software Selection

Limitation on quality and availability of the data for multi-service system analysis: start from single-service analysis

Part of Data Collection Matrix

	A	B	C	D	E	F
1	InVEST Data Matrix-Pellicer					
2	InVEST Models (18 shown below)	Researchers' Priority	Data Description	Data Source	Data Gaps	Comments
3		7	1. Land use land cover (LULC) M	http://data.floridarv.ater.opendata.arogir.o om/	1 Identify impact weights and decay	2009 Dissict Land Use Land Cover (SJRMMD)
4			2. Threat impact by threat type T	htps://vebsolsuvey.sc.egos.usda.gov/A pp/WebSolSuvey.aspx	functions in threats.csv 2 Find the habitat sensitivity to	Roads, development, stikoulture, invasive species, over tishing/hunting, recreation disturbance (boat values and mudding trucks) and sea level rise. Convert table vect sater based data using the arc gis link below.
5			3. Threat impact weights by threat type T		threats	http://desitop.acgis.com/en/acmap/10.3/manage-data/sater-and-images/sate tools.htm
6			4. Decay function by threat type T			We fiven need to oreate a covitable that indicates the effective distance, weight, an for each threat layer and a polygon layer that delineates barriers to threats
7			5. Threat maps M	mps measurers of agencies of government	1	
8			6. Habitat preference by species group T	Service and a service of a service of the service o		
9			7. Habitat sensitivity to threats T	Haster Pranting Hakanzas (Priority rokole		A habitar sise binary to the as shoold be based on general philopies normalities a
10			8. Hall saturation constant T	The of the set of the		Default value 0.5
11			3. Optional: Status			
12			10. Other (Invasive Species)	http://www.fnai.org/gisdata.ofm		https://www.eddmaps.orgi
13			11 Transportation	- the set of the set o		
14			1. LULCM	and an	Only have	
15			2. Carbon in aboveground biomass T	ContactNikki	carbon stock	nêds.dev@dep.state.fl.us
16	Carbon	11	3. Carbon in below ground biomass T	ContactNikki	data for Marsh,	náší, disý dep. state fl. us
17	Carbon		4. Carbon in dead organic matter T	ContactNikki	Puture LLC,	default values from the IPCC (2005) can be assigned
18			S. Carbon in soil T	ContactNikki	REDUCC	nåds.dkog/dep.state.fl.us
13			Other: IPCC 2005 provides default values	all blocks and date all all all	ocenano	
20			1 LULCM	and and a second and a second	Specieztable	0
21			2. Polinator species, nesting and foraging season T	a is down Warneth to be down Warnet		
22	Pollination	1	3. Nesting and foraging availability by LULC T			
23			4. Half saturation constant PV	0.125		
24			5. Proportion of total yield to vild polinators PV by crop			
25			6. Other			InVEST model focuses on the resources need and flight behaviors of wild bees
26			1.UULCM	12		0
27			2. Annual augprecip M	ICTMAEDO0		http://odmo.baruch.sc.edu/get/landing.c/m
28			3. Annual avgret evapotranspiration M	https://fl.water.usgs.gov/en/		
29			4. Plant available viater content M			
30			5. ETK/crop coefficient by LULC T			
31	Annual Mater Vield	1	6. Root depth by LULC T			
32			7. Effective soil depth M	and lake all men and		
33			5. Zhang coefficient			
34			S. Consumptive use by LULC T			
35			10. Watersheds above points of interest S	5-USDA Geospatial DataGateway.		https://gdg.so.egox.usda.gow
36			11 Subv atersheds above points of interest S	S-USDA Geospatial DataGatevay.		https://gdg.sc.egos.urda.gov/
37			12. Other			https://rinkd.usgs.gov/vbd.html

Outline

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- Introduction
- Installation
- Model Components of InVEST 3.3.2
- Application of the InVEST Model
- Organization
- Data Management
- Results
- Visitation: Recreation and Tourism Model

Introduction

InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs)

- Quantify and map the values of ecosystem services
- Explore how changes in ecosystems are likely to lead to changes in benefits that flow to people
- Employ a production function approach: "supply, service, and value"

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• An open source software

Installation

- Go to http://www.naturalcapitalproject.org/invest/
- Download InVEST_3.3.2_Setup.exe (for Windows)



• Choose the folder where the InVEST toolsets and sample data will be installed (available spaces)

Model Components of InVEST 3.3.2

- 19 models of ecosystem services, and tools to facilitate and support ecosystem service analyses
 - Supporting ecosystem services
 - Final ecosystem services
 - Tools to facilitate and support ecosystem service analysis

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• Software updates: "InVEST_3.3.3_Setup.exe"

Model Components of InVEST 3.3.2

- Selected models for specific topic (shown in InVEST 3.3.2 x86)
 - Supporting ecosystem services (4): habitat quality, habitat risk assessment, marine water quality, and pollination
 - Final ecosystem (14): forest carbon edge effect, carbon, coastal blue carbon, seasonal water yield, water yield, NDR, SDR, scenic quality, recreation, wave energy, wind energy, finfish aquaculture, fisheries, and crop production
 - Tools to facilitate and support ecosystem service analysis (1): coastal vulnerability

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Application of the InVEST Model

- Supporting ecosystem services: habitat quality
- Final ecosystem: scenic quality, recreation, and fisheries

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Organization

- Summary
- Introduction: research fields and relating questions \Rightarrow choose the fit model
- Mathematical model: theoretical mechanism \Rightarrow organize data
- Data needs: requirements for inputs (required and optional)

- Running the model
- Interpreting results

Data Management

Data Types Used in the InVEST Models

Type	Description or Extension
Input Workspace	$\operatorname{path}/\operatorname{folder}$
GIS Raster	. tiff
GIS Vector	points, lines, and polygons (.shp, .shx, .dbf, .lyr)
Tables	.CSV
Parameters	numbers

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Data Management

- All GIS inputs must be in the same projected coordinate system.
- All distance, length, and area calculations use the same units.
 - ArcMap > Catalog > Toolboxes > System Toolboxes > Data Management Tools > Projections and Transformations
 - ArcMap > Catalog > Toolboxes > System Toolboxes > Data Management Tools > Raster > Raster Processing
 - ArcMap > Catalog > Toolboxes > System Toolboxes > Conversion Tools (Table and Excel, GIS Vector and Raster, etc.)

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Results

Output Workspace

Name	Date modified	Туре	Size	
 File folder (2) 				
\mu output	4/30/2017 1:42 PM	File folder		
🍶 intermediate	4/30/2017 12:45 PM	File folder		
Text Document (1)				
natcap.invest.pollination.pollination-log	4/30/2017 1:58 PM	Text Document	14 K	В

Results

Result Types

Type	Description or Extension
GIS Raster	.tiff
GIS Vector	points, lines, and polygons (.shp, .shx, .dbf, .lyr)
Tables	.CSV

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- Supporting Ecosystem Services
- Final Ecosystem Services
 - Visitation: Recreation and Tourism

Visitation: Recreation and Tourism Model Organization

- Introduction
 - Services
 - Area of interest (AOI)
 - Purpose
- Model
 - Linear Regression
 - Assumptions and Simplifications
- Data
 - Photo-User-Days
 - Predictor Variables
- Data Statistics
- Results
- Interpretation and Preliminary Conclusion

Visitation: Recreation and Tourism Model Introduction

The services provided by recreation and tourism

• Important components of national and local economies

• Contribution to quality of life

Visitation: Recreation and Tourism Model Introduction

Area of interest (AOI): Pellicer watershed and its tributaries Purpose: To quantify the value of the AOI and predict the spread of person-days of recreation

Scenario: How future changes to natural features will alter visitation rates

Visitation: Recreation and Tourism Model Model: Linear Regression

$$y_i = \beta_0 + \beta_1 x_{i1} + \dots + \beta_{p-1} x_{ip-1} + \beta_p x_{ip}, \qquad i = 1, \dots, n$$

 y_i : empirical data on visitation for part *i* in the AOI x_{ip} : predictor *p* of land use (LU) type for part *i* in the AOI

Visitation: Recreation and Tourism Model Model: Assumptions and Simplifications

- People's responses to attributes that serve as predictors in the model will not change over time.
- The model does not presuppose that any predictor variable has an effect on visitation.
- The model estimates the magnitude of each predictor's effect based on its spatial correspondence with current visitation in the area of interest.

- Empirical data on visitation y_i
 - Photo-User-Days (PUD) of recreation and tourism, based on the *locations* of natural habitats, accessibility.

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- A crowd-sourced measure of visitation: *geotagged* photographs posted to the website *flickr* (2005-2014)
- Data are available as the results of the regression

- Predictor Variables
 - Selection:
 - natural capital (e.g. habitats, lakes)
 - built capital (e.g. roads, hotels)
 - industrial activities
 - access or cost (e.g. distance to major airport)
 - Scenario Analysis: a set of modified predictors that represent a future or alternative scenario (e.g. modified road networks, additional hotel points, altered habitat distributions, etc)

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• Predictor Variables

Visit Florida: www.visitflorida.org Research FAQ

- Do most visitors come to Florida by car or plane?
- How many nature parks are in Florida?
- What activities do Florida visitors participate in the most?

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• How many hotel rooms are in Florida?

- Predictor Variables
 - 1. Major highways: I-95, Palm Coast Pkwy, Hammock Dunes Bridge, Matanzas Woods Pkwy, Moody Blvd, US 1/SR 5, and US 1

- 2. Airports: Flagler County and St. Johns County
- 3. Parks and recreational facilities
- 4. Salt marshes habitat
- 5. Swimming beaches:
- 6. Hotels

Visitation: Recreation and Tourism Model Data Statistics: Input Dialog Box

L D				
e De	evelopment			
		InVEST Version 3.3.2 (32bit) Model documentation	n I Repo	art an issue
	Note, this computer must have an Internet connection in order to run this model.			
1	Workspace	C:\Users\sfeng/Documents/recreation_workspace2		0
	Results Suffix (Optional)			
1	Area of Interest (Vector)	/atershed/Shuang_data/!!Modules/Recreation_done/Watersheds.shp		0
	Start Year (inclusive, must be >= 2005)	2011		0
	End Year (inclusive, must be <= 2014)	2014		0
E Co	ma da Degracian			
				and the second se
	Scenario Predictor Table (optional)		(0
G	Scenario Predictor Table (optional)			0
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C Gr	Scenario Predictor Table (optional) id the AOI	cent run of the model. <u>Deset to defaulte</u>		0

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Visitation: Recreation and Tourism Model Data Statistics: Visitation



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Visitation: Recreation and Tourism Model Data Statistics: Visitation

Average Annual Photo User Days



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Visitation: Recreation and Tourism Model Data Statistics: Visitation



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Visitation: Recreation and Tourism Model Data Statistics: Predictor Variables



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Visitation: Recreation and Tourism Model Data Statistics: Predictor Table

id	path	type
habitats	saltmarshes.shp	polygon_area_coverage
rds	main_hwy.shp	line_intersect_length
hotels	hotel.shp	point_count
airdist	airports.shp	point_nearest_distance
beach	swimbeach.shp	polygon_area_coverage
park_rf	park_rf.shp	point_count

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• Units: Maps/Display (Meters)

Predictor p	Pellicer	Pellicer Creek-Big	Pringle	Stevens	
	Creek	Mulberry	Branch	Branch	
		Branch Frontal			
Main Highways	0.233	0.088	0.008	0.152	
Airports	0.082	0.059	0.100	0.075	
Parks and	1 22	0	n		
Recreational Facilities	4	00	0	4	
Marsh Habitat	0	0.001	0	0	
Swimming Beaches	0	0	0	0	
Hotels	0	7	0	0	

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*The significant of predictors is depicted in bold font.

Visitation: Recreation and Tourism Model Interpretation and Preliminary Conclusion

- Roads: I-95, Palm Coast Pkwy, Hammock Dunes Bridge, Matanzas Woods Pkwy, Moody Blvd, US 1/SR 5, and US 1. The length of roads intersecting with watersheds has significant impacts on the visitation of Pellicer Creek and Stevens Branch Watershed.
- Airports: The distance of the nearest airport has positive effects on the visitation of Pringle Branch Watershed. With less disturbance of airports, the number of visitation will increase.

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Visitation: Recreation and Tourism Model Interpretation and Preliminary Conclusion

- Parks and recreational facilities: the number of park and recreational facilities is an important driven factor for the development of tourism in Pellicer Creek-Big Mulberry Branch Frontal. One more park or recreational facility can increase the time of visitation dramatically in Pellicer Creek-Big Mulberry Branch Frontal Watershed by 33 PUD.
- Marsh Habitat: The overlap area of marsh habitat has no significant impact on the visitation of all watersheds.
- Hotels: The number of hotels is also a driven factor for the development of tourism in Pellicer Creek-Big Mulberry Branch Frontal. Everything else constant, one more hotel increases 7 PUD in Pellicer Creek-Big Mulberry Branch Frontal.
- Swimming beaches: The overlap area on the map is relatively small.

Visitation: Recreation and Tourism Model Model Application Discussion

- Where do you plan to apply this model?
 - Area of interest can be narrowed down.
- What other predictor variables do you think important?

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• What are the key policy questions?

Questions and Comments

