## **KISA Interface Tutorial**

This document contains brief instructions for the following tasks:

- 1. Setting up data for KISA Interface.
- 2. Single-objective spatial pattern optimization.
- 3. Multi-objective spatial optimization.

## 1. Setting up data for KISA Interface

The KISA Interface only reads from and writes to ERDAS .lan or .gis files. To do spatial optimization in KISA Interface, you need to first read a land-cover file (or generate a random land-cover file) and, optionally, associate a zone file with the land-cover file. The zone file defines zones in which the land-cover proportions remain unchanged during the annealing process.

To load an existing land-cover file, select "Load existing land-cover map" from the "Map setup" pull-down menu and select the "landcover.gis" file. A map and a "SA Map Settings" dialog window will pop-up.

SA Map Settings									
Column (X) 40 Row (Y) 25 Total % 100 Number of Classes 6									
Class	Code	Color	Percent	Movable	Combine				
Impervious	10		14.3	True	10				
Grass	30		33.9	True	30	Cancel			
Tree	40		33.8	True	40				
Water(S)	50		5.7	False	50	ок			
Wetland(S)	60		10.0	False	40				
Wetland 61			2.3	True	40				
Add New Class Remove Class Save Setting to a Trailer File									

The "SA Map Setttings" window allows users to specify which land-cover classes are moveable and which classes are treated as the same cover type in the calculation of landscape metrics. In the example shown above, cover types 50 and 60 are not movable, because water (50) and existing wetland (60) are not subject to alteration in this particular application. However, designers are adding natural cover types, i.e., trees (40) and wetland (61), to promote the ecological function of the design site. The ecological function is measured as the compactness of landscape patches formed by these natural cover types. That is why tree, existing wetland, and wetland are combined to form an aggregated class. The settings can be modified by double-click individual cells in the table. Click on the map window to make it the active window and select "Load zone map" from the "Map setup" pull-down menu. Select the "zone\_grid.gis" file and click "Next" in the "Select inactive zones" dialog window. This will treat all zones in the zone map as active zones. Only the land-cover types of cells in an active zone can be reassigned to form a new map. User should make areas that cannot be managed as inactive zones.



To view the landscape metrics of the land-cover map, right-click on the "landcover.gis" window and select the "show map stats..." item. Users can click on the "toggle class definition" button in the metrics summary window to view the metrics of the "combined" land-cover classes.

	Metrics Summary of 1 (Class Table)						×	
	Col:	40 R	ow: <mark>25</mark>	Cellsize:	<mark>30</mark> #0	Class: 6		
	Area Unit: He	n						
	Toggle Class Definition			Dump Patch Info to text				
		SITE	Imperviou	Grass	Tree	Water(S		
	Code	-	10	30	40	50		
	Total Area	90.	12.87	30.51	30.42	5.1		
	% Area	100.	14.3	33.9	33.8	5.		
	#Patches	237	59	78	74	:		
	Patch Density	2.63333	0.65556	0.86667	0.82222	0.0222:		
	MPS	0.37975	0.21814	0.39115	0.41108	2.56		
	PSSD	1.06766	0.42994	1.15785	1.14514	1.03		
	Edge Density	362.	124.	240.	36.66667	17.3333:		
	MPFD	1.01738	1.01212	1.01946	1.02162	1.0461		
	SqP(Frohn)	0.88353	0.87142	0.89771	0.89642	0.4192		
	Core Area	9.9	0.63	1.89	1.89	2.10		
w.	Cohesion	0.77328	0.57024	0.79519	0.79185	0.8411		
	Contagion	0.26492	-	-	-			
Window	Shannon DI	1.49178	-	-	-			
s	Shannon El	0.83258	-	-	-			
Stats	Simpson DI	0.73661	-	-	-			
ctive SA	Simpson El	0.88393	-	-	-			
	PFF	-	0.35437	0.48009	0.48609	0.7657		
	MÇAL	0.11	N N4895	0.06195	0.06213	0 4210	•	

## 2. Single-objective spatial pattern optimization.

Right-click on the "landcover.gis" window and select the "Single objective SA..." item to open the "simulated annealing" dialog window. Set the target cover type to "Tree+Wetland+Wetland(S)" and the objective function to "PFF". Check the "refresh map every 100 iterations" checkbox. By maximizing the PFF of the natural land-cover types, the KISA Interface generates maps that have the most compact pattern of natural cover patches. Next, select the "SA" tab and set the initial T to 0.01 and check the "activate KISA" checkbox. Click the "Set KISA rules" button to open the KISA rules

dialog window. Click on the "compactness" radio button and click "OK" to close the window. These simulated annealing parameters were derived from pilot experiments to ensure the most effective and efficient performance in maximizing PFF. Different initial T and KISA rules should be used for other objective functions.

Objective SA Cost	Objective SA Cost	
Objectives	Simulated Annealing Settings	
Target Cover Tree+Wetland+Wetlan	Cooling Schedule	
Obj. Function PFF	Boltzmann (Standard) 💌	
OFV (estimated bounds + observed)	Initial T (T0): 0.01	
0. <= 0.5966 <= 1.	Adjust T every 50 iterations.	KISA Rules
Optimization Options	Cells swapped / iteration 10 ( 1.0 %)	Obj. Function: <b>PFF</b>
⊙ Max O Min C User 1.	Activate KISA Set KISA Pules	Intensity (0-1)
	Activate KISA	C Contiguity 1
Use Zonemap as constraints		Compactness 1
Log every 100 iterations	Stop Criteria	Enhanced Options
in 1_log.txt 😰 🖉	Max Iteration: 1000000	None
	Distance to Target OFV: 0.004034	C 3 x 3 sieving
Display	Max # of retrials: 200	Conglomeration
✓ Refresh map every 100 iterations.		Default Cancel OK

Press the button to run the optimization, "pause" to stop the optimization, and "Stop/Reset" to restart another run. One needs to press the "Stop/Reset" button to change the simulated annealing settings.

Now, stop and reset the run and check the "Use zonemap as constraints" check box in the objective tab. Press the button to run the optimization with zone constraints. The results from both runs are displayed below. One should note that simulated annealing is a meta-heuristic optimization algorithm. It doesn't guarantee to find the optimal solution. Usually, if you let it run longer, it generates better solutions.

Without zone constraints





To save the maps just generated, right-click on the map and select the "save map as..." item. When done, press the "close" button in the simulated annealing dialog window to close the window.

## 3. Multi-objective spatial optimization.

Right-click on the "landcover.gis" window and select the "Pareto SA…" item to open the "multi-objective Pareto SA" dialog window. Set the optimization objectives and SA settings as those shown in the pictures below. To set an objective whose objective function is defined using a cost surface, select "defined by map" from the objective function pull-down list and click on the  $rac{1}{2}$  button to select the cost surface file. For this tutorial, select the "d\_river.lan" file. d\_river.lan is a raster map (see below) of the distance to a river on the upper-right corner in the study site. The objectives of this allocation problems are (1) maximizing the PFF (i.e., compactness) of the "tree+wetland+wetland(S)" cover type and (2) minimizing the distance of the combined cover type to a river.

MultiObjective Pareto SA: 1: landcover.gis								
Objectives SA Settings Re	sculte				00:00:00			
Objective Function	suns				Iteration: 0			
Target Cover Tree+Wetland+W		Accepted: 0						
Obj. Function Defined by map	Obj. Function Defined by map  d_river.lan							
Optimization Options								
O Max O Min O User	T: 0.01							
Cover Obj.F.	KISA	Pareto #: 0						
Tree+Wetland+Wi		Max	1	Стр	Cells swapped:			
Tree+Wetland+W( Maplayer	d_river.lan	Min		None	Accept rate:			
	Pause							
					T dubb			
	Stop / Reset							
Number of Obj. Functions	2				Class			

MultiObjective Pareto SA: 1: landcover.gis	
Objectives SA Settings Results	00:00:00
Pareto SA Settings	lteration: 0
Cooling Schedule Stop Criteria	Accepted: 0
Boltzmann (Standard)  Max Iteration: 1000000	
Init T (T0): 0.01	
Adjust T every     50     iterations.     Max # of retrials:     200	T: 0.01
Cells swapped / iteration 10 ( 1.0 %)	Pareto #: 0
Size of Generating Set: 10 Display	Cells swapped:
Use Zonemap as constraints	
BNG Information	Accept rate:
Rescale all OFV	Pause 🕨
Initialize Generating Set 😂 🔽 Log every 100 iterations	
Log file prefix 1_log	Stop / Reset
Add Existing Map to Generating Set	Close



Press the button to run the optimization, "pause" to stop the optimization, and "Stop/Reset" to restart another run. One needs to press the "Stop/Reset" button to change the simulated annealing settings.

The Pareto simulated annealing generates a set of solutions that are Pareto optimal. Pareto optimality refers to the condition that one cannot improve the value of one objective without sacrificing the value of at least one other objective. To view the Pareto set, you must first pause/stop the run. Then, click on the "results" tab, select both objectives, and press the 🖾 (scatter plot) button. Each point in the scatter plot corresponds to one entry in the Pareto set table shown in the "results" tab. You can click on the scatter plot or select an entry from the table and press the 🗳 button to view the map.

M	ultiO	bjective F	Pareto SA: 1: l	andcover.gi	s					
	Ohi	activas	SA Setting	Results	1					00:02:55
	-Doji	roto Sot	SA Settings	nesults						Iteration: 417
		Telu Sel		0		<b>-</b>	0			Accepted: 1010
				3	4	5	6	- /		1818
	<u>Tr</u>	ree+Wetla	nd+Wetland(S	67.00109	67.05893	66.84382	67.43854	<u>66.50</u>		
	Tr	ree+Wetla	nd+Wetland(S	35.96896	38.17343	35.91272	38.25217	<mark>31.43</mark>	<b>2</b>	
									G	
										1: 0.00481
										Pareto #: 9
									7	
									, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Cells swapped: 1
										Accept rate: 28
									<b>X</b>	
										Pause 🕨
									$\forall$	
										Stop / Reset
	•									
										Close
-										



To save individual maps, right-click on the map and select the "save map as..." item. You can also save the whole Pareto set into a map-pool file by pressing the button and selecting an output file name. The map-pool file can be viewed using the "GIS Map Pool Viewer" function found in the "tool" pull-down menu of the main window of KISA Interface. When done, press the "close" button to close the window.