# VecLI: Vector-based Landscape Index Calculation and Analysis System

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# Catalogue

	VecLI: Vector-based Landscape Index Calculation and Analysis System	1
1.	Product Introduction	4
	1.1. VecLI Product	4
	1.2. Target Users	4
	1.3. Installation	4
	1.4. User Interface	4
	1.5. Software Control Panel Description	5
	1.5.1. Menu Bar	5
	1.5.2. Tool Bar	5
	1.5.3. Data Management Panel	5
	1.5.4. Current Directory Browser Panel	6
	1.5.5. Log Output Panel	6
	1.5.6. Data Visualization Panel	6
	1.5.7. Directory Selection Dialog Box	7
	1.5.8. Exception Prompt Dialog Box	7
2.	Data Display Function	8
	2.1. Basic Function	8
	2.1.1. Import Files	8
	2.1.2. Basic GIS Operations	8
	2.1.3. Zoom to Layer	9
	2.1.4. Show Attribute Table	9
	2.1.5. Select the Current Layer to Operate	9
	2.1.6. Edit Vector Symbol	9
	2.1.7. Remove Layer	.16
	2.1.8. Open Project File (.xml)	.16
	2.1.9. Save Project File (.xml)	.17
	2.1.10. Change Working Directory	.18
	2.1.11. Import Files from Current Directory Browser Panel	.19
3.	Vector-based Landscape Index Calculation and Output Function	.20
	3.1. Operate Files	.20
	3.2. Parameter Settings	.21
	3.3. Overview of parameter settings	.23
	3.4. Landscape index setting	.23
	3.5. Vector-based Landscape Index Calculation	.24
	3.6. Results Export	.25
4.	Domain Effects Exploration and Parcel Consolidation	.26
	4.1. Domain effects exploration	.26

	4.1.1. Import File	
	4.1.2. Parameter Settings	27
	4.1.3. Calculate	27
	4.1.4. Export Results	27
	4.2. Parcel Consolidation	
	4.2.1. Parameter Settings	
	4.2.2. Calculate	
5.	Vector FoM Calculation	
	5.1. Import File	
	5.2. Parameter Setting	
	5.3. Calculate	
6.	Introduction of the Landscape Index	
	6.1. Parcel Level Index	
	6.2. Other landscape indexs	
	6.2.1. Distributive Indexes	
	6.2.2. Category Level Index	40
	6.2.3. Overall Level Index	44
7.	Copyright and Contact	45

# **1. Product Introduction**

# 1.1. VecLI Product

VecLI is a system for calculating and evaluating landscape indices of land-parcels in vector-based data format, which could be used to calculate landscape indices based on real plots and analyze the landscape similarity between different cities.

# 1.2. Target Users

GIS Practitioner, Urban planners and researchers.

# **1.3.** Installation

Please *unzip* the program to the full English file path. *Double-click* "Setup.exe" in the program directory to start the installation program. After installation *click* "VecLI.exe" to run.

# 1.4. User Interface



# 1.5. Software Control Panel Description

#### 1.5.1. Menu Bar

The menu bar of VecLI includes three parts:

"File", "Landscape Analysis", "Index Caculation" and "Help".

🏠 VecLI v2.6.0(3.0.0 beta	a)
File Landscape Analysis	Index Calculation Help
📇 🖸 🌄 🔄	🕒 🗸 🗈 🌐 🕅

#### 1.5.2. Tool Bar

The tool bar of VecLI includes 11 parts:

"Open Vector File", "Open Raster File", "Open CSV File", "Open Project File", "Save Project File", "Data Preprocessing", "Parcel Merge", "Vector FoM", "Landscape Index", "Website and Update" and "About Us".



#### 1.5.3. Data Management Panel

A brand-new IO, operational and roaming interface for operating spatial data (raster and vector data) is designed. Basic functions of GIS such as attribute editing, layer symbolization, zoom in and out operation, etc. are included.

Data imported into VecLI will be displayed and grouped to "vector layer", "raster layer" and " CSV file" layer according to its file format.



To determine a specific GIS operation, Right-Click the selected data and a GIS operation widget will pop up on hand. Available GIS operations include "Zoom to Layer", "Show Attribute Table", "Select the Current Layer to Operate", "Export

Layer", "Edit Vector Symbol", and "Remove Layer".

	Zoom to Layer
⊞	Show Attribute Table
$\bigcirc$	Select the Current Layer to Operate
Ð	Export Layer
5	Edit Vector Symbol
$[\rightarrow$	Remove Layer

#### 1.5.4. Current Directory Browser Panel

This panel provides directory browser to search, find, view, and open VecLI related directories and files.



#### 1.5.5. Log Output Panel

VecLI provides a real-time output monitor and generates log files for the whole computation process of vector-based landscape index.



#### 1.5.6. Data Visualization Panel

The panel supports roaming and displaying vector and raster files imported into the system.



### 1.5.7. Directory Selection Dialog Box

This module provides a UI for directory and file selection, which is used to *specify* the location of the importing, saving and exporting data files.

🏠 Open shape file			×
← → · ↑ Ⅰ · ⊭	比电脑 〉 娱乐 (E:) 〉 Nanshan_data 〉	۷ 0	搜索"Nanshan_data"
组织▼ 新建文件夹			:=
狊 此电脑	<b>^</b> 名称 ^	修改日期	类型 大小 <b>^</b>
🧊 3D 对象	📕 e_canyin	2020/10/17 23:24	文件夹
📑 视频	📙 e_chaoshi	2020/10/17 23:24	文件夹
▶ 图片	<pre>e_d_district</pre>	2020/10/17 23:24	文件夹
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	e_d_railway	2020/10/17 23:24	文件夹
	📕 e_d_road	2020/10/17 23:24	文件夹
	📕 e_dem	2020/10/17 23:24	文件夹
■ 桌面	e_gongchang	2020/10/17 23:24	文件夹
🐛 系统 (C:)	📕 e_gongjiao	2020/10/17 23:24	文件夹
🥪 文档 (D:)	📕 e_gongyuan	2020/10/17 23:24	文件夹
、 娱乐 (E:)	e_shangchang	2020/10/17 23:24	文件夹
🥌 学习 (F:)	✓ <		>
文作	牛名(N): landuse 2009.shp	~ *.shp	~
		打	开(O) 取消

# 1.5.8. Exception Prompt Dialog Box

These dialog boxes prompt the errors and provide the necessary information to debug.



<u>Y</u>es

<u>N</u>o

# 2. Data Display Function

# 2.1. Basic Function

#### 2.1.1. Import Files

*Click* the "Open Vector File" button in the toolbar, it will automatically jump to the Directory Selection Dialog Box for vector file selection.

🏠 Open shape file			×
$\leftarrow$ $\rightarrow$ $\checkmark$ $\uparrow$ $\blacksquare$ $\diamond$	此电脑 〉 娱乐 (E:) 〉 Nanshan_data 〉	<ul><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li></ul>	搜索"Nanshan_data"
组织▼ 新建文件表	Z.		:= • 🔳 ?
🍤 此电脑	<b>^</b> 名称 <sup>^</sup>	修改日期	类型 大小 <b>^</b>
🧊 3D 对象	📙 e_canyin	2020/10/17 23:24	文件夹
📑 视频	📙 e_chaoshi	2020/10/17 23:24	文件夹
■ 图片	e_d_district	2020/10/17 23:24	文件夹
□ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	📙 e_d_highway	2020/10/17 23:24	文件夹
↓下载	e_d_railway	2020/10/17 23:24	文件夹
▶ 音乐	e_d_road	2020/10/17 23:24	文件夹
	e_dem	2020/10/17 23:24	文件夹
二 呆山	e_gongchang	2020/10/17 23:24	文件夹
🐛 系统 (C:)	📕 e_gongjiao	2020/10/17 23:24	文件夹
🧼 文档 (D:)	e_gongyuan	2020/10/17 23:24	文件夹
👡 娱乐 (E:)	e_shangchang	2020/10/17 23:24	文件夹 🗸
🥧 学习 (F:)	✓ <		>
	文件名(N): landuse 2009.shp	✓ *.shr	) ~
	_ 1	1	I开(O) 取消

*Click* the "Open Grid File" button in the toolbar, it will automatically jump to the Directory Selection Dialog Box for raster file selection.

<i>Click</i> the "Open CSV File" button	in the toolbar, it will automatically
jump to the Directory Selection Dialog Box for	or CSV file selection.

#### 2.1.2. Basic GIS Operations

*Right-click* the selected data layer, it will pop up a GIS operation widget, as shown in the figure below:



#### 2.1.3. Zoom to Layer

*Click* the "Zoom to Layer" button to display the data layer in a full view of either a vector or raster data layer.

#### 2.1.4. Show Attribute Table

*Click* the "Open Attribute Table" button to show the attribute table of a selected CSV file.

Attribute *edit* is allowed for each entry, as shown in the figure below:

OBJECT	BSM	YSDM	TBYBH	TBBH	DLBM	DLMC	QSXZ	QSDWDM	QSDWMC	ZLDWDM	ZLDWMC	GDL
33757	138.00000000	2001010100	建设	270	102	公路用地	10	440304004001	梅林街道	440304004001	梅林街道	
38355	43071.00000000	2001010100	建设	5610	201	城市	10	440306007001	石岩街道	440306007001	石岩街道	
38356	43000.00000000	2001010100	建设	5604	201	城市	10	440306007001	石岩街道	440306007001	石岩街道	
40054	1364.00000000	2001010100	建设	535	201	城市	10	440304004001	梅林街道	440304004001	梅林街道	
40055	1372.00000000	2001010100	建设	536	201	城市	10	440304004001	梅林街道	440304004001	梅林街道	
39645	108.00000000	2001010100	农用	249	031	有林地	10	440304004001	梅林街道	440304004001	梅林街道	
39315	4044.00000000	2001010100	建设	658	201	城市	10	440304006001	沙头街道	440304006001	沙头街道	
40488	1800.00000000	2001010100	建设	398	201	城市	10	440304007001	香蜜湖街道	440304007001	香蜜湖街道	
41149	3760.00000000	2001010100	建设	723	201	城市	10	440304006001	沙头街道	440304006001	沙头街道	
41654	3793.00000000	2001010100	建设	77	201	城市	10	440304006001	沙头街道	440304006001	沙头街道	
41105	4042.00000000	2001010100	农用	72	033	其他林地	10	440304006001	沙头街道	440304006001	沙头街道	
41889	3243.00000000	2001010100	建设	722	201	城市	10	440304006001	沙头街道	440304006001	沙头街道	
42798	46609.00000000	2001010100	建设	184	201	城市	10	440306010001	新安街道	440306010001	新安街道	
43313	451.00000000	2001010100	农用	393	031	有林地	10	440304004001	梅林街道	440304004001	梅林街道	
43468	48511.00000000	2001010100	建设	957	201	城市	10	440306010001	新安街道	440306010001	新安街道	
43318	1872.00000000	2001010100	农用	176	033	其他林地	10	440304007001	香蜜湖街道	440304007001	香蜜湖街道	
43750	45385.00000000	2001010100	建设	5810	201	城市	10	440306007001	石岩街道	440306007001	石岩街道	
42472	4046.00000000	2001010100	未利	212	115	沿海滩涂	10	440304006001	沙头街道	440304006001	沙头街道	
42473	4104.00000000	2001010100	未利	213	115	沿海滩涂	10	440304006001	沙头街道	440304006001	沙头街道	
42555	44927 0000000	2001010100	zəəə	5746	201	tet=	10	440206007001	石岩体道	440206007001	万字供道	

#### 2.1.5. Select the Current Layer to Operate

*Click* the "Select the Current Layer to Operate" button, it will enable the selected layer for the vector symbolization function.

#### 2.1.6. Edit Vector Symbol

*Click* the "Edit Vector Symbol" button to enable the file property option, symbolization option and annotation option.

Property

Select "property" to view the property information of the current open vector file:

```
👯 Symbolization
                                                                 \times
  Property
              Symbolization
                                Annotation
    Name: landuse_2009.shp
                                                                       ~
    Path: E:/Nanshan_data/landuse_2009.shp
    Storage: ESRI Shapefile
    Geometry: 3
    CRS: EPSG:4326 - WGS 84 - Geographic
    Extent: ((786039, 2.48086e+06); (810719, 2.50886e+06))
    Feature count: 7415
    Field:OBJECTID
         OBJECTID
         BSM
         YSDM
         TBYBH
         TBBH
         DLBM
         DLMC
         QSXZ
         QSDWDM
         QSDWMC
         ZLDWDM
         ZLDWMC
         GDLX
         KCLX
         KCDLBM
         TKXS
         TBMJ
         XZDWMJ
         LXDWMJ
         TKMJ
         TBDLMJ
                                                                       \sim
```

The property sheet will show contents such as Name, Path, Storage (File type), Geometry, CRS (coordinate reference system), Extent, Feature count (number of features), and Field information of the current layer for users to *consult*.

Symbolization

*Select* "Symbolization" to carry out symbolization operation. Users can set a classified display for different attribute fields:

( 0)	ation					-		>
Property	Symbol	ization	Annot	ation				
-Setup Co	rrespondi	ng Colors	s and Va	alues for Ea	ach Land	l Use	Туре —	
Classifi	ication							$\sim$
Value	OBJECTI	)						$\sim$
Label	OBJECTI	)						$\sim$
Land U	se Code	Land Use	e Type	Color Sele	ction	С	olor	
Classi	fyr		Delete	<u>11</u>				
Classi	fy 🕇		Delete	All				
Classi	fy 🕇		Delete	A11	OK		Cance	1

In the "classification" drop-down box, users can *select* a specific Symbolization Method for the currently operating data layer.

In the "Value" drop-down box, users can *select* a specific field name that needs classification.

In the "Label" drop-down box, users can *select* a specific field name that labels the category.

Setup	Corresponding C	olors and Values	for Each Land Use Type —	
Class	ification			$\sim$
Value	OBJECTID			$\sim$
Label	OBJECTID			$\sim$

Note: if a non-numeric field is selected in the "Value" drop-down box, Exception

Prompt Dialog Box will pop up and require the user to *reselect* a valid field:



*Click* the "Classify" Classify button to conduct Vector Symbolization and

initialize classification automatically. A sample of classification result is shown as below:

÷۷	🖁 Sym	bolization			- 🗆	$\times$
	Prope	erty Symboliz	ation Annota	tion		
	Seti	up Corresponding	g Colors and Va	lues for Each La	ind Use Type –	
	Cla	ssification				$\sim$
	Valı	ue type_id				$\sim$
	Lab	el NEW_XHDLM	IC .			~
		Land Use Code	Land Use Type	Color Selection	Color	<u>^</u>
	1	1	交通物流用地	Set Color		
	2	7	居住用地	Set Color		
	3	9	市政公用设施	Set Color		
	4	5	农用地	Set Color		
	5	13	道路	Set Color		
	6	12	绿地	Set Color		
	7	10	未利用地	Set Color		
	8	2	保护区	Set Color		
		accify 📥	Doloto	۵11 I		· ·
	0.	Lassily	Delete	07 OF	Como	.1
				лО	Cance	ŝΤ
· · · ·	1 44	11 1 1	+ 1	.1 .	·11 /	11
IICK	ine a	add a class	butt	on, the system	will automa	atically a
	s sho	wn below:				
ory, as						
14				Set Colo	or	

12

13 4 公用设施用地	Set Color
-------------	-----------

*Click* the "delete all classes" button, the system will automatically clear the current contents.

Users can adjust the field in either "Value" or "Label" drop-down box. Click the

```
"Classify" Classify button to redo the classification initialization process.
```



Click the "Set Color" Set Color button, the system will automatically jump to a color selection widget to select the color of this label, as shown below:

Property	Symbolization	Annotation			
Select	the color of this la	pel			×
<u>B</u> asic col	.ors	-			
				•	
<u>P</u> ic	k Screen Color	_			
		The second se	241 A D	- J. 101 🗎	1
	1	nu <u>e</u> : Sati	<u>341</u> ▼ <u>⊼</u> 235 ≜ Cre	eu: 101 🗣	]
<u>u</u> stom co		Val:	101 🗣 Bl	ue: 36 🗣	1
			Alpha chann	el: 255 🖨	
Add t	o Custom Colors	нти.	#650824		7
		L	OK	Cancel	
			OK	Cancel	
			OK	Calicer	

*Click* the "OK" OK button to exit the "Layer Symbolization" interface

after all parameter settings are done. The system will refresh the display interface and change the layer style based on user's layer symbolization settings. A sample rendering result is shown as below:



Annotation

*Select* "Annotation" to conduct annotation configuration:

Annotation Style:		
Font	SimSun	
Size	9	
Color		
Bold	0	
Italics	0	
Preview	Example!	

In the "Annotation Field" drop-down box, users can *select* a specific attribute which needs annotation setting.

Annotation	n Field:	
OBJECTID		~

Users can *configure* annotation styles including Font, Size, Color, Bold, Italics and Preview as provided by VecLI:

roperty	Symbolization	Annot	tation		
Annotat	ion Text				
Appotat	ion Riold.				
0] 🔳 S	elect Font				×
Ar <u>F</u> on	t		Font style	Size	
Ado	be Devanagari		Regular	9	
F Ad	obe Devanagari	^	Regular	6	^
s Ag	ency FB		Bold	7	
Alg	erian		Bold Italic	8	_
C An	al	$\sim$	Italic	9	
в <		>			~
Ef	fects		Sample		
lt _	Strikeout				
P	Underline		A DI	N. 7	
Wash	ine Coster		Aabt	1 yz.z	
Anv	ting System	~			
				_	
			OK	Can	cel
					.::

A color selection widget is provided for selecting the annotation color. User can edit the color for annotation by *clicking* the color bar

Symbolization	- 🗆 X
Property Symbolization Ar	notation
Select the color of this label	×
Easic colors	+
Qustom colors	Hug: 134 ‡ Red: 109 ‡ Sat: 91 ‡ Green: 170 ‡ Yal: 170 ‡ Blue: 123 ‡ Alpha channel: 255 ‡ HTML: #6daa7b
	OV CAUCAL
	OK Cancel

Click the "OK"

button to exit the "Layer Symbolization" interface

after all parameter settings are done. The system will refresh the display interface and change the layer style based on user's layer symbolization settings. A sample rendering result is shown as below:



#### 2.1.7. Remove Layer

*Click* the "Remove Layer" button in the GIS operation widget, the selected layer will be removed immediately from the current project.

#### 2.1.8. Open Project File (.xml)

*First-Click* the "File" in the menu bar and *choose* the "Open Project File", the system will automatically jump to the Directory Selection Dialog Box for opening an

existing project. Clicking the toolbar's  $\mathfrak{O}$  button would work in the same way:

VecLI: Vector-based Landscape Index Computation and Analysis System

Open project file						×
$\leftarrow \rightarrow \land \uparrow \blacktriangleright$	> 此电脑 > 娱乐 (E:)	) >	~	ې ن	) 搜索"娱乐 (E:)"	
组织▼ 新建文件	夹				↓ ▼	
▶ 此电脑	<b>^</b> 名称	^	修改日期		类型	大小 ^
3D 对象	📙 GeoVC	CA	2021/1/5 1	3:07	文件夹	
→ 10 +石	📙 GeoVC	CA_examples	2020/12/3	1 0:59	文件夹	
	📙 Nansh	an_data	2021/1/9 1	9:51	文件夹	
▶ 图片	POI数排	居	2020/11/8	21:01	文件夹	
🗐 文档	📜 📜 temp		2021/1/9 2	2 <b>0:</b> 31	文件夹	
🖊 下载	📕 test_d	ata	2020/11/4	0:22	文件夹	
🎝 音乐	📙 tifData	3	2020/10/2	6 20:16	文件夹	
💻 桌面	📕 VCA_d	lata	2021/1/25	2:28	文件夹	
💺 系统 (C:)	📙 VCA论	汶	2021/2/5 1	4:33	文件夹	
	📙 VecEl		2021/2/5 1	:49	文件夹	
。 堤岳 (E·)	📕 VecLl_	data	2021/2/6 1	:27	文件夹	
。 学习 (F:)	<ul><li>✓ &lt;</li></ul>		2024 /27/54		<del></del>	>
	文件名(N): 1.xml			× *.x	ml	$\sim$
					打开(O)	取消

The user interface after opening a project file is as follow:



#### 2.1.9. Save Project File (.xml)

*First-Click* the "File" in the menu bar and *choose* the "Save Project File" option, the system will automatically jump to the Directory Selection Dialog Box to save the currently operating project in user's specified directory path. *Clicking* the toolbar's



button would work in the same way:

VecLI: Vector-based Landscape Index Computation and Analysis System

Select Project Save Pa	th			×
← → ` ↑ • ₩	℃电脑 〉 娱乐 (E:) 〉	ע <b>צ</b>	) 搜索"娱乐 (E:)"	
组织▼ 新建文件夹			• • •	≣ - ?
3D 对象 ^	名称	修改日期	类型	大小 ^
📑 视频	AdobeCC	2020/12/27 12:34	文件夹	
▶ 图片	BaiduNetdiskDownload	2020/11/15 23:49	文件夹	
🖹 文档	📙 GeoVCA	2021/1/5 13:07	文件夹	
➡ 下载	GeoVCA_examples	2020/12/31 0:59	文件夹	
♪ 音乐	📕 Nanshan_data	2021/1/9 19:51	文件夹	
三 桌面	📙 POI数据	2020/11/8 21:01	文件夹	
🐛 系统 (C:)	📕 temp	2021/1/9 20:31	文件夹	
<ul> <li>文档 (D:)</li> </ul>	📕 test_data	2020/11/4 0:22	文件夹	
、娱乐 (E:)	📕 tifData	2020/10/26 20:16	文件夹	~
······································	<			>
文件名(N):				~
保存类型(T): xml(	*.xml)			~
> 隐藏文件夹			保存(S)	取消

#### 2.1.10. Change Working Directory

Users can change the working directory by *right-clicking* the Current Directory Browser Panel, which is shown as below:



This will automatically open a Directory Selection Dialog Box after *clicking* the "Change Working Directory" option, as shown in the figure below:

Select a folder as th	he initial working directory		×
$\leftarrow$ $\rightarrow$ $\checkmark$ $\uparrow$ $\checkmark$ $\checkmark$	→ 此电脑 > 娱乐 (E:) >	✓ Ŭ	搜索"娱乐 (E:)"
组织 ▼ 新建文件夹	Z		
💄 此电脑	<b>^</b> 名称 <sup>^</sup>	修改日期	类型 大小 ^
🧊 3D 对象	AdobeCC	2020/12/27 12:34	文件夹
- 视频	📒 BaiduNetdiskDownload	2020/11/15 23:49	文件夹
■ 图片	GeoVCA	2021/1/5 13:07	文件夹
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	Nanshan_data	2021/1/9 19:51	文件夹
	POI数据	2020/11/8 21:01	文件夹
	📕 temp	2021/1/9 20:31	文件夹
	📕 test_data	2020/11/4 0:22	文件夹
🐛 系统 (C:)	📕 tifData	2020/10/26 20:16	文件夹
) 💊 文档 (D:)	VCA_data	2021/1/25 2:28	文件夹
。 娱乐 (E:)	VCA论文	2021/2/5 14:33	文件夹 🗸
🥧 学习 (F:)	✓ <		>
2	文件夹: VCA_data		
		选择	这件夹 取消

### 2.1.11. Import Files from Current Directory Browser Panel

**Double-click** any file shown in the Current Directory Browser Panel, users can quickly import the corresponding data into the system. Exception Prompt Dialog Box will pop up if the chosen file has an invalid format:



Note: Supported formats are only among vector files, raster files and CSV files.

# 3. Vector-based Landscape Index Calculation and Output Function

This module is designed for the calculation of vector landscape indices.

*First-Click* the "Landscape Index" in the menu bar and *choose* the "Landscape Index", the system will automatically jump to the Landscape Index Window.

	🛓 VecLl v2	2.6.0(3.0.0 be	eta)				
	File Lands	cape Analysi	s Index Calcu	lation	Help		
	<u></u>	ແຫຼ່ງ 🚦	🗈 Landsc	ape Ind	lex		
<i>Click</i> the too	lbar's	b button	would work	in the	same w	/ay:	
Landscape Index						- 🗆	×
Data			Data Parameters				
D:/data/Vector_data.shp			Caculation Paramet	ers			
			Type_id		ECON		
		Add Laver		~	Get	t File	
					PROX Radius	5	
			Core Depth		400.00		•
		Remove Laver	10.00	÷	CONNECT Rad	lius	
		Remove Eayer	10100		400.00		×
			Current Layer Para	umeters			
		Remove All					
Via						Selecte	d
Parcel Metrics		Class Metrics	Lands	Scape Metri	ics		
Area and Edge							
Shape							
Core Area							
Contrast							
Aggregation							
Diversity						Cacu	late
Output							
-							

# 3.1. Operate Files

*Click* the "Vector file Import" button Add layer, the system will automatically

jump to the Directory Selection Dialog Box for vector file selection (vector-based landparcel files from different times):

Pick some land-us	e data(s	hp) to input				×
← → ∽ ↑ 📕	> 此电脑	š 〉 桌面 〉 data		~	ひ 夕 搜索	data"
组织▼ 新建文件	夹					<b>■</b> • <b>■</b> ?
● OneDrive _> 此电脑 3D 对象	^	A SHP	SHP	A	<b>A</b> SHP	A SHP
■ 视频 ■ 図片 ③ 文档	ł.	2014_actual_pr o.shp	ans.shp	ans1.shp	ans2.shp	ans3.shp
■ <1 ↓ 下载 ♪ 音乐 ■ 桌面	l	SHP	<b>≣A</b> SHP	<b>■A</b> SHP	<b>A</b> SHP	A SHP
🐛 本地磁盘 (C:) 🥪 新加卷 (D:)	~	ans4.shp	ans19.shp	ans20.shp	ans21.shp	Export_Output. shp
	文件名(I	N):			<ul> <li>✓ shape file(* 打开(O)</li> </ul>	.shp) ~

*Click* the "Remove layer" button Remove layer to remove the selected layer, if no layer is selected or the current catalogue does not contain any layers, a pop-up box will be displayed to remind the user.



You can also remove all layers by *clicking* the "Remove all layers" button Remove all

#### **3.2.** Parameter Settings

After users have selected vector file, the relevant function buttons are open for use. Users are asked to *set* necessary parameters for vector-based landscape index calculation. Parameters include: 1). Land-use Type; 2). ECON; 3). Core Depth; 4). PROX Radius; and 5) CONNECT Radius

Caculation Parameters	3		
Type_id		ECON	
	~	Get File	
		PROX Radius	
Core Depth		400.00	×
10.00		CONNECT Radius	
10.00	v	400.00	*

"Land-sue Type" refers to the attribute field name of the vector file labeled parcel type. The drop down box will automatically read all the fields contained in the vector file and users can select the appropriate field in the drop down menu.

Type_id	
DLMC	$\sim$
DLMC	-
Type id	
constrain	
CenterX	
CenterY	
darea	
FID	
Perimeter	

Note that exceptions will throw out to notify the cause of failure.

■ question ×			
?	Wrong type of Type_id		
	<u>Y</u> es	<u>N</u> o	

"ECON", the second parameter, refers to the contrast file between the different types of parcels when calculating the contrast indexs. *Click* the "Get File" button to open the corresponding txt file. If no file is selected, the system will pop up a prompt window.



The ECON file format is as follows, each line contains three numbers separated by a space. The first two digits are the land-use type and the third digit is the contrast value (Default value is 1). Users can use the file to set the contrast between different parcel types.

1	2	0.8
1	3	1.2
1	4	0.9
2	3	1.0
2	4	1.1
3	4	1.0

"Core Depth", the third parameter (Default value is 10 metres), is the depth of the edge set to find the core area of the parcel. The smaller the Core Depth, the larger the core area. If users do not select an index for the core area, the value of "Core Depth" will have no effect on the results of the other indices.

Core Depth	
10.00	<b>\$</b>

"PROX Radius", the forth parameter (Default value is 400 metres), refers to the radius when calculating the PROX index, using the centre of mass of the parcel as the centre of a circle to find the surrounding parcels. If users do not select an index related to the core area, the value of "PROX Radius" will have no effect on the results of the other indices. To ensure the efficiency of the calculation, "PROX Radius" is also the radius of SIMI index.

PROX Radius	
400.00	-

"CONNECT Radius", the last parameter (Default value is 400 metres), refers to the radius of a parcel when calculating the CONNECT index. When other parcel in the mass of a parcel as the centre is of the same type, the parcel is judged to be within the neighbourhood. If the user does not select an index relating to the core area, the value of CONNECT Radius will have no effect on the results of the other indices. "CONNECT Radius" should be manually entered by users:

CONNECT	Radius —	
400.00		<b>A</b> <b>V</b>

#### **3.3.** Overview of parameter settings

After selecting the vector file, the window will display some of the parameters of the file, including the file name, the number of attribute fields and the number of parcels.

Current Layer Params	
Shape file: C:/Users/Alive/Desktop/	
Fields Count: 8	
Features Count: 120	

In this new version, users do not need to select fields such as area and perimeter, and the software simplifies the input parameters for easy operation.

#### **3.4.** Landscape index setting

As the software supports a large number of vector landscape indices, users can

select a specific landscape index for their needs. As shown in the figure below:

Via				Selected
Parc	el Metrics	Class Metrics	LandScape Metrics	
Area and Edge				
Shape	Area			
Core area	Perimeter			
Aggregation	<b>GYRATE</b>			
Diversity				Caculate

*Click* the three buttons above to select the index module. For the index to be calculated, click on the box in front of the index to put a check mark.



To make it easier for users to keep track of the indices that have been ticked, there is a table of selected indices on the right side of the indices module for easy access so that users do not miss a tick or make a mistake.

Se.	lected	
1	Area	^
2	Perimeter	
3	GYRATE	
4	TA	
5	PLAND	~

## 3.5. Vector-based Landscape Index Calculation

Click the "Calculate"	Calculate	button to start the vector-based
-----------------------	-----------	----------------------------------

landscape index calculation after all the parameter settings are done.

<mark>፺</mark> Re	esults				_		×
Metr	rics Results						
	Туре	Original Type	AREA	PERIM			^
1	1	1	0.032025	177.748053			
2	1	1	0.237077	372.908615			
3	1	1	0.016532	65.137889			
4	1	1	0.058495	250.788424			
5	1	1	0.000884	102.989911			
6	1	1	0.000341	13.460443			
7	1	1	0.004649	213.145371			~
Parcel Metrics Class Metrics LandScape Metrics							
Export Results							
.tx	t			Export			

For parcel-level indices, the first column shows the type id used in the calculation and the second row shows the actual type id.

*Click* the button above to display the results of the index calculation for the different modules.

### 3.6. Results Export

Once the results have been calculated, users can export the results.

Export Results	
. txt 🗸 🗸	Export

Users can save to Shape File, TXT File and CSV File. The Shape File will only save indices at the parcel level, while the CSV File and TXT File will save all indices.

# 4. Domain Effects Exploration and Parcel Consolidation

This module calculates the optimal neighborhood radius based on the imported vector data and sets the neighborhood radius to enable the parcel consolidation.

First-Click the "Landscape Analysis" in the menu bar and choose the "Parcel Merge", it will automatically jump to the Parcel Merge Window:

🖢 VecLl v2.6	.0(3.0.0 beta	)			
File Landsca	pe Analysis	Index Calc	ulatic	n Help	
📔 🕘 Parc	el Merge	Ctrl+1	Eh	3	3
Laye Vect	tor FoM	Ctrl+3			1.
toolbar's butto	n 🛄 w	ould work	in th	ne same	way:
Parcel Merge			_		$\times$
Data Parameters - Input File					
D:/data/Vector_	data.shp			×	
Type_id DLMC	Search 1	Radius	Searc 50.0	ch Interva	1
Calculated Parame	eters				
Traversal Times		Caculate			
3	•		Ru	n	
Result					
Radius	NP	Buffer N	IP	Adjoining	I NP
Clear Form		Export Fr	om		

*Click* the

#### 4.1. **Domain effects exploration**

Type\_id

DLMC

Output File

Clear

Parcel Merging Based on Optimal Neighborhood

800

#### 4.1.1. Import File

First, users should select a vector file for processing. Options in the "Input File"

Optimal Neighborhood

Export

-

. . . Parcel Merging

Merge

drop-down box include all the vector files that have been imported into the system. The drop-down box for selecting vector files is shown as below:

~	
L	

*Click* button to import new vector files.

#### 4.1.2. Parameter Settings

Type\_id is the field of land use type in the vector file. After selecting the file, the drop-down box will automatically read all the fields contained in the vector file and users can select the correct field of Type\_id.

#### 4.1.3. Calculate

*Click* button "run" to start the search of optimal neighborhood radius. After completing the calculation, the results will display in the table.

	Radius	NP	Buffer NP	Adjoining NP	^
1	650.0	65	4378	62	
2	700.0	130	11198	62	
3	750.0	195	20869	62	
4	800.0	260	33571	62	
5	850.0	324	49482	63	$\checkmark$

The software uses a breadth-first search method to search for neighborhood parcels. In the form, Radius is neighborhood radius, NP is the number of parcels after consolidation at that radius, Buffer NP is the sum of the number of parcels in all neighborhoods when searching for parcels in the neighborhood at that radius, Adjoining NP is the sum of the number of neighboring parcels when searching for parcels in the neighborhood at that radius.

#### 4.1.4. Export Results

Click button "Export" to export results and click button "Clear" to clear the form.

Clear Form	Export From
Clear	Export

# 4.2. Parcel Consolidation

#### 4.2.1. Parameter Settings

## **Output path**

Click button	to open Select Vector File Window and set Outpu	t path.
Output File		

#### Land use type

The field of Type\_id is automatically aligns with the search in the Domain effects exploration.

Type_id —		

## **Optimal Neighborhood Radius**

This parameter refers to the optimal neighborhood radius when parcels are combined.

Optimal	Neighborhood-
800	<b></b>

#### 4.2.2. Calculate

Click button "Merge" to start of parcel consolidation.

Parcel	Merging
Me	rge

# 5. Vector FoM Calculation

This module is mainly used to calculate FoM metrics based on the imported vector data.

*First-Click* "Landscape Analysis" in the menu bar, and select "Vector FoM" in the pop-up menu to open the corresponding interface:

	🏠 Vec	LI v2.6.0(3	3.0.0 beta)				
	File La	ndscape .	Analysis	Index Ca	lculatio	on He	lp
	P <sup>2</sup> 5	Parcel I	Merge	Ctrl+1	Ēħ		R
	Laye	Vector	FoM	Ctrl+3		Y	
Click the	toolbar	's button	<b>N</b> w	vould wo	ork in	the sa	me way:
	Vect	or FoM			_		×
	Laward						
	-Origina	al type_id-	Simulated	d type_id -	-Real t	 ype_id -	
	Field	$\sim$	Field	$\sim$	Field		$\sim$
		Metrics	Value	2			^
	1						
	2						~
				Calcul	late	Clear	

# 5.1. Import File

*Click* button \_\_\_\_\_ to import new vector file and data will be displayed in the canvas.



# 5.2. Parameter Setting

"Original type\_id" indicates the land use type before the simulation.

"Simulated type\_id" indicates the land use type after the simulation.

"Real type\_id" indicates the land use type after the real development.

Users can intersect the simulated data with the real data to connect all the attribute fields.

```
    Original type_id
    Simulated type_id
    Real type_id

    Field
    FID_RF_201 \simed
    Field
    FID_RF_201 \simed
```

# 5.3. Calculate

*Click* button "calculate" to start calculation and results will display in the form.

Metrics	Value
Fom	0.123
PA	0.218
UA	0.219

# 6. Introduction of the Landscape Index

The landscape indices provided by VecLI are modularly divided into three categories, including parcel, category and global levels. The indices at each level are divided into five categories, namely area and edge indicators, shape indicators, core area indicators and agglomeration indices, with the plot level indices containing a plot diversity index. For the parcel-level indices, each parcel corresponds to a result. The following indices are described in the help file for Fragstats v4.2.

	Area_edge
Parcel	
P1	Parcel AREA (AREA)
P2	Parcel Perimeter (PERIM)
P3	Radius of Gyration(GYRATE)
Class	
C1	Total (Class) Area (CA)
C2	Percentage of Landscape (PLAND)
C3	Largest Patch Index (LPI)
C4	Total Edge (TE)
C5	Edge Density (ED)
C6-C11	Patch Area Distribution (AREA_MN, _AM, _MD, _RA, _SD, _CV)
C12-C17	Radius of Gyration Distribution (GYRATE_MN, _AM, _MD, _RA, _SD, _CV)
Landscape	
L1	Total (Landscape) Area (TA)
L2	Largest Patch Index (LPI)
L3	Total Edge (TE)
L4	Edge Density (ED)
L5-L10	Patch Area Distribution (AREA_MN, _AM, _MD, _RA, _SD, _CV)
L6-L11	Radius of Gyration Distribution (GYRATE_MN, _AM, _MD, _RA, _SD, _CV)

Shape	
Parcel	
P1	Perimeter-Area Ratio (PARA)
P2	Shape Index (SHAPE)
P3	Fractal Dimension Index (FRAC)
P4	Related Circumscribing Circle (CIRCLE)

P5	Linearity Index LINEAR)
Class	
C1	Perimeter-Area Fractal Dimension (PAFRAC)
C2-C7	Perimeter-Area Ratio Distribution (PARA_MN, _AM, _MD, _RA, _SD, _CV)
C8-C13	Shape Index Distribution (SHAPE_MN, _AM, _MD, _RA, _SD, _CV)
C14-C19	Fractal Index Distribution (FRAC_MN, _AM, _MD, _RA, _SD, _CV)
C20-C25	Linearity Index Distribution (LINEAR_MN, _AM, _MD, _RA, _SD, _CV)
C26-C31	Related Circumscribing Square Distribution (SQUARE_MN, _AM, _MD,
	_RA, _SD, _CV)
Landscape	
L1	Perimeter-Area Fractal Dimension (PAFRAC)
L2-L7	Perimeter-Area Ratio Distribution (PARA_MN, _AM, _MD, _RA, _SD, _CV)
L8-L13	Shape Index Distribution (SHAPE_MN, _AM, _MD, _RA, _SD, _CV)
L14-L19	Fractal Index Distribution (FRAC_MN, _AM, _MD, _RA, _SD, _CV)
L20-L25	Linearity Index Distribution (LINEAR_MN, _AM, _MD, _RA, _SD, _CV)
L26-L31	Related Circumscribing Square Distribution (SQUARE_MN, _AM, _MD, _RA, _SD, _CV)

	Core area		
Parcel			
P1	Core Area (CORE)		
P2	Number of Core Areas (NCA)		
P3	Core Area Index (CAI)		
Class			
C1	Total Core Area (TCA)		
C2	Core Area Percentage of Landscape (CPLAND)		
C3	Number of Disjunct Core Areas (NDCA)		
C4	Disjunct Core Area Density (DCAD)		
C5-C10	Core Area Distribution (CORE_MN, _AM, _MD, _RA, _SD, _CV)		
C11-C16	Disjunct Core Area Distribution (DCORE_MN, _AM, _MD, _RA, _SD, _CV)		
C17-C22	Core Area Index Distribution (CAI_MN, _AM, _MD, _RA, _SD, _CV)		
Landscape			
L1	Total Core Area (TCA)		
L2	Number of Disjunct Core Areas (NDCA)		
L3	Disjunct Core Area Density (DCAD)		

L4-L9	Core Area Distribution (CORE_MN, _AM, _MD, _RA, _SD, _CV)
L10-L15	Disjunct Core Area Distribution (DCORE_MN, _AM, _MD, _RA, _SD, _CV)
L16-L21	Core Area Index Distribution (CAI_MN, _AM, _MD, _RA, _SD, _CV)

Contrast		
Parcel		
P1	Edge Contrast Index (ECON)	
Class		
C1	Contrast-Weighted Edge Density (CWED)	
C2	Total Edge Contrast Index (TECI)	
C3	Edge Contrast Index Distribution (ECON_MN, _AM, _MD, _RA, _SD, _CV)	
Landscape		
L1	Contrast-Weighted Edge Density (CWED)	
L2	Total Edge Contrast Index (TECI)	
L3	Edge Contrast Index Distribution (ECON_MN, _AM, _MD, _RA, _SD, _CV)	

	Aggregation			
Parcel				
P1	Euclidean Nearest Neighbor Distance (ENN)			
P2	Proximity Index (PROX)			
P3	Similarity Index (SIMI)			
Class				
C1	Interspersion & Juxtaposition Index (IJI)			
C2	Landscape Shape Index (LSI)			
C3	Number of Patches (NP)			
C4	Patch Density (PD)			
C5	Splitting Index (SPLIT)			
C6	Landscape Division Index (DIVISION)			
C7	Effective Mesh Size (MESH)			
C8-C13	Euclidean Nearest Neighbor Distance Distribution (ENN_MN, _AM, _MD,			
	_RA, _SD, _CV)			
C14-C19	Proximity Index Distribution (PROX_MN, _AM, _MD, _RA, _SD, _CV)			
C20-C25	Similarity Index Distribution (SIMI_MN, _AM, _MD, _RA, _SD, _CV)			
C26-C31	Connectance (CONNECT)			
Landscape				
L1	Interspersion & Juxtaposition Index (IJI)			
L2	Landscape Shape Index (LSI)			

L3	Number of Patches (NP)
L4	Patch Density (PD)
L5	Splitting Index (SPLIT)
L6	Landscape Division Index (DIVISION)
L7	Effective Mesh Size (MESH)
L8-L13	Euclidean Nearest Neighbor Distance Distribution (ENN_MN, _AM, _MD,
	_RA, _SD, _CV)
L14-L19	Proximity Index Distribution (PROX_MN, _AM, _MD, _RA, _SD, _CV)
L20-L25	Similarity Index Distribution (SIMI_MN, _AM, _MD, _RA, _SD, _CV)
L26-L31	Connectance (CONNECT)

The calculation of some common indices is shown below:

# 6.1. Parcel Level Index

Name	Area	Abbreviation	Area
E		Area = $a_{ij}/10000$	
Formula	$a_{ij}$ : Area of parcel		
Unit	Hectare		
Range		Area > 0	
Description	Area of parcel.		

Name	Perimeter	Abbreviation	Perimeter
Eamoula	Perimeter = $p_{ij}$		
Formula	$p_{ij}$ : Perimeter of parcel		
Unit	Meter		
Range	Perimeter > 0		
Description	Perimeter of parcel.		

Name	Radius of Gyration	Abbreviation	GYRATE
Formula	$GYRATE = \sum_{i=1}^{z} \frac{h_{ijr}}{z}$ <i>h</i> <sub>im</sub> : Distance from each subcellular center of mass to the		
	center of mass of the synthesized parcel		
	z: Number of plots before combination		
Unit	Meter		
Range	GYRATE > 0		

	The average distance between the centre of mass of each
Description	metacellular parcel before the parcels are combined and the
	centre of mass of the combined parcel.

Name	Perimeter-Area Ratio	Abbreviation	PARA
		$PARA = p_{ij}/a_{ij}$	
Formula	$a_{ij}$ : Area of parcel		
	$p_{ij}$ : Perimeter of parcel		
Unit	metres per hectare		
Range	PARA > 0		
Description	Ratio of perimeter to area.		

Name	Fractal Dimension Index	Abbreviation	FRAC
Formula	FRAC = $\frac{2 * \ln 0.25 * p_{ij}}{\ln a_{ij}}$ $a_{ij}$ : Area of parcel		
	$p_{ij}$ : Perimeter of parcel		
Unit	/		
Range	0 < FRAC < 2		
Description	For describing the complexity of parcels.		

Name	Related Circumscribing Circle	Abbreviation	CIRCLE
	$CIRCLE = 1 - a_{ij} / a_{ij}^{circle}$		
Formula	$a_{ij}$ : Area of parcel		
	$a_{ij}^{circle}$ : Area of the Minimum Circumscribed Circle per parcel		
Unit	/		
Range	0 < CIRCLE < 1		
Description	/		

Name	Core Area	Abbreviation	CA
Formula		$CA = a_{ij}^{core}/10000$	

	$a_{ij}^{core}$ : Core Area of parcel
Unit	Hectare
Range	CA > 0
Description	Area within the parcel beyond a specified depth distance from
Description	the edge of the parcel.

Name	Core Area Index	Abbreviation	CAI
Ferreral	$CAI = \frac{a_{ij}^{core}}{a_{ij}} * 100$		
Formula	$a_{ij}^{core}$ : Core Area of $a_{ij}$ : Area of parcel	parcel	
Unit	/		
Range	$0 \le CAI < 100$		
Description	Ratio of Core Area to Area.		

Name	Euclidean Nearest- Neighbor Distance	Abbreviation	ENN
Formula	$ENN = h_{ij}$ $h_{ij}$ : Distance of the parcel to the nearest parcel of the same category		
Unit	Meter		
Range	ENN > 0		
Description	Distance from the centre of mass of the parcel to the centre of mass of the nearest parcel of the same category. Distance from the centre of mass of the plot to the centre of mass of the nearest parcel of the same category.		

Name	Proximity Index	Abbreviation	PROX
Formula	$PROX = \sum_{s=1}^{m} \frac{a_{ijs}}{h_{ijs}^2}$ $a_{ijs}$ : The area of a parcel within a distance $h_{ijs}$ : Average distance between parcels and parcels of the same type within a certain range		e d parcels of the
Unit	/		
Range	PROX > 0		

veels. veelor bused Eunascupe maex computation and marysis system	cLI: Vector-based Landscape Index Computation and Analys	is Systen
-------------------------------------------------------------------	----------------------------------------------------------	-----------

Description	/

Name	Patch Richness	Abbreviation	PR
E	PR = n		
гоппита	<i>n</i> : Number of parcel types		
Unit	/		
Range		PR > 0	
Description	/		

Name	Patch Richness Density	Abbreviation	PRD
Formula	$PRD = \frac{m}{A * 10000 * 100}$ m: Number of parcel types		00
	A: Total landscape area		
Unit			
Range	PRD > 0		
Description	Number of parcel types per 100 ha area		

Name	Shannon's Diversity Index	Abbreviation	SHDI
Formula	$SHDI = -\sum_{i=1}^{m} (P_i * \ln P_i)$		
	$P_i$ : Proportion of landscape area occupied by type i		
Unit	/		
Range	SHDI > 0		
Description	Reflects the abundance of land masses in a given area.		

Name	Simpson's Diversity Index	Abbreviation	SIDI
Formula	SIDI = $1 - \sum_{i=1}^{m} (P_i^2)$ <i>P</i> : Proportion of landscape area occupied by type i		
Unit			
Range	$0 \leq \text{SIDI} < 1$		
Description	/		

	Modified			
Name	Simpson's	Abbreviation	MSIDI	
	Diversity Index			
Formula	$MSIDI = -\ln \sum_{i=1}^{m} (P_i^2)$			
	$P_i$ : Proportion of landscape area occupied by type 1			
Unit	/			
Range	$MSIDI \ge 0$			
Description	/			

Name	Shannon's Evenness Index	Abbreviation	SHEI
Formula	SHEI = $\frac{-\sum_{i=1}^{m} (P_i * \ln P_i)}{\ln m}$ m: Number of parcel types $P_i$ : Proportion of landscape area occupied by type i		
Unit	/		
Range	$0 < \text{SHEI} \le 1$		
Description	/		

Name	Simpson's Evenness Index	Abbreviation	SIEI
Formula	SIEI = $\frac{1 - \sum_{i=1}^{m} (P_i^2)}{1 - (\frac{1}{m})}$ m: Number of parcel types		
	$P_i$ : Proportion of landscape area occupied by type i		
Unit	/		
Range	$0 < \text{SIEI} \le 1$		
Description	/		

Modified Simpson's Evenness Index	Abbreviation	MSIEI
$MSIEI = \frac{-\ln \sum_{i=1}^{m} (P_i^2)}{\ln m}$		
m: Number of parcel types <i>P</i> : Proportion of landscape area occupied by type i		
	Modified Simpson's Evenness Index M m: Number of parce P <sub>i</sub> : Proportion of lan	Modified Simpson'sAbbreviationEvenness Index $MSIEI = \frac{-\ln \sum_{i=1}^{m} (P_i)^2}{\ln m}$ m: Number of parcel types $P_i$ : Proportion of landscape area occupied

Unit	/
Range	$0 \leq MSIEI \leq 1$
Description	/

# 6.2. Other landscape indexs

#### 6.2.1. Distributive Indexes

For larger scale studies in the landscape pattern, the calculation of the distribution of each landscape index is of great significance. VecLI offers the following distributed indexs of parcel level:

Name	Formula	Description
Mean (MN)	$MN = \frac{\sum_{j=1}^{n} X_{ij}}{n_i}$	The sum of the corresponding index values for all parcels of the corresponding parcel type divided by the number of parcels of the same type.
Area-weighted Mean (AM)	$AM = \sum_{j=1}^{n} (X_{ij} \left( \frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}} \right))$	The sum of the corresponding parcel metric values for all parcels of the corresponding parcel type multiplied by the proportional abundance of the parcels.
Median (MD)	$MD = X_{50\%}$	The metric of the median value in the middle of the order.
Range (RA)	$RA = X_{max} - X_{min}$	Difference between the maximum and minimum observation.
Standard deviation (SD)	$SD = \sqrt{\frac{\sum_{j=1}^{n} (X_{ij} - MN)^2}{n_i}}$	Degree of dispersion of each parcel metric.
Coefficient of variation (CV)	$CV = \frac{SD}{MN} \cdot 100$	Standard deviation divided by the mean.

VecLI offers the following distributed indexs of overall level:

Name	Formula	Description
		The sum of the
Mean (MN)	$MN = \frac{\sum_{i=1}^{m} \sum_{j=1}^{n} X_{ij}}{N}$	corresponding index
		values for all parcels of
		the corresponding parcel

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### 6.2.2. Category Level Index

Name	Total Area	Abbreviation	TA
Formula	TA = A/10000		
гоппита	A: Total landscape area		
Unit	Hectare		
Range	TA > 0		
Description	Area of all included	parcels.	

Name	Percentage of Landscape	Abbreviation	PLAND
Formula	PLA $P_i$ : Proportion of lan $a_{ij}$ : Area of parcel A: Total landscape a	$ND = P_i = \frac{\sum_{j=1}^{n} a_{ij}}{A}$ (dscape area occupied rea	100) by type i
Unit	/		

Range	$0 \le PLAND \le 100$
Description	Percentage of the area of the corresponding type of parcel to
	the total landscape area.

Name	Largest Patch Index	Abbreviation	LPI
Formula	$LPI = \frac{max(a_{ij})}{A} (100)$ a <sub>ij</sub> : Area of parcel A: Total landscape area		
Unit	/		
Range	$0 \le LPI \le 100$		
Description	Percentage of the lan parcel to the total lan	rgest area of the corres	sponding type of

Name	Total Edge	Abbreviation	TE
Formula	<i>e<sub>ik</sub></i> : Total length of e the landscape	$TE = \sum_{k=1}^{m} e_{ik}$ edge of parcel of corre	esponding type i in
Unit	Meter		
Range		TE > 0	
Description	Total length of edge landscape.	of parcel of correspon	nding type i in the

Name	Edge Density	Abbreviation	ED
		$ED = \frac{\sum_{k=1}^{m} e_{ik}}{A}$	
Formula	$e_{ik}$ : Total length of e	edge of parcel of corre	esponding type i in
	the landscape		
	A: Total landscape area		
Unit	metres per square me	etre	
Range	ED > 0		
Description	Ratio of the total length of edge of parcel of corresponding		
	type i to the total area of the landscape.		

	Name	Perimeter-Area Fractal Dimension	Abbreviation	PAFRAC
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Formula	$PAFRAC = \frac{\frac{2}{\left[n_i \sum_{j=1}^n (lnp_{ij} * lna_{ij})\right] - \left[\left(\sum_{j=1}^n lnp_{ij}\right)\left(\sum_{j=1}^n lna_{ij}\right)\right]}{\left(n_i \sum_{j=1}^n lnp_{ij}^2\right) - \left(\sum_{j=1}^n lnp_{ij}\right)^2}$ $a_{ij}: \text{ Area of parcel}$ $p_{ij}: \text{ Perimeter of parcel}$ $n_i: \text{ Number of parcels of type i}$
Unit	/
Range	$1 \leq PAFRAC \leq 2$
Description	/

Name	Total Core Area	Abbreviation	TCA
Formula	$TCA = \sum_{k=1}^{m} a_{ij}^{core} / 10000$ $a_{ij}^{core}: \text{Core Area of parcel}$		
Unit	Hectare		
Range		TCA > 0	
Description	Total core area of a t	ype.	

Name	Core Area Percentage of Landscape	Abbreviation	CPLAND
Formula	$CPLAND = \frac{\sum_{k=1}^{m} a_{ij}^{core}}{\sum_{i=1}^{m} \sum_{j=1}^{n} a_{ij}} * 100$ $a_{ij}^{core}: \text{Core Area of parcel}$ $a_{ij}: \text{Area of parcel}$		
Unit	/		
Range	$0 \le CPLAND \le 100$		
Description	Proportion of the core area of a type to the total landscape area.		

Name	Patch Cohesion Index	Abbreviation	COHESION
Formula	COHESION =	$1 - \frac{\sum_{k=1}^m P_{ij}}{\sum_{k=1}^m P_{ij}\sqrt{a_{ij}}} \Big] [1$	$-\frac{1}{\sqrt{A}}]^{-1} * 100$

	$a_{ii}$ : Area of parcel
	$p_{ij}$ : Perimeter of parcel
	A: Total landscape area
Unit	/
Range	$0 \le \text{COHESION} \le 100$
Description	/

Name	Number of Patches	Abbreviation	NP
Formula	$NP = n_i$		
гоппиа	$n_i$ : Number of parce	ls of type i	
Unit	/		
Range		$NP \ge 0$	
Description	Number of parcels o	f the corresponding ty	/pe.

Name	Patch Density	Abbreviation	PD
	$PD = \frac{n_i}{A} * 10000 * 100$		
Formula	$n_i$ : Number of parce	ls of type i	
	A: Total landscape a	rea	
Unit	/		
Range		$PD \ge 0$	
Description	/		

Name	Landscape Division Index	Abbreviation	DIVISION
Formula	DIVISION = $\left(1 - \sum_{i=1}^{m} \sum_{j=1}^{n} \left(\frac{a_{ij}}{A}\right)^{2}\right) * 100$ $a_{ij}$ : Area of parcel A: Total landscape area		
<b>* *</b> •	1		
Unit	/		
Range		$0 \le \text{DIVISION} \le 100$	
Description	/		

Name	Splitting Index	Abbreviation	SPLIT
Formula	a <sub>ij</sub> : Area of parcel	$\text{SPLIT} = \frac{A^2}{\sum_{j=1}^n a_{ij}^2}$	

	A: Total landscape area
Unit	
Range	SPLIT > 1
Description	/

Name	Connectance Index	Abbreviation	CONNECT
Formula	$CONNECT = \frac{\sum_{j=k}^{n} c_{ijk}}{\frac{n_i(n_i-1)}{2}} * 100$ $c_{ijk}: \text{ Number of connections between parcels of the same parcel type for a given threshold condition}$ $n : \text{ Number of parcels of type i}$		
	$n_i$ : Number of parcels of type 1		
Unit	/		
Range	$0 \le \text{CONNECT} \le 100$		
Description	Sum of the number of functional connections between all		
	parcels of the corresponding parcel type for a given threshold		
	condition.		

# 6.2.3. Overall Level Index

The overall level indices are calculated in a similar way to the given category level indices and will not be elaborated upon.

# 7. Copyright and Contact

More indices are designed to VecLI V2.6/V3.0 beta (a total of 218 landscape indices are supported). If you have questions about the software or need to add new indices to the software, please contact us by leaving a comment on our website.

VecLI: Vector-based Landscape Index Calculation and Analysis System

Website: https://urbancomp.net/archives/vecliv3beta

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