Προηγμένα Γεωγραφικά Συστήματα Πληροφοριών: Συστήματα Σχεδιασμού και Λήψης Αποφάσεων

(Planning and Decision Support Systems)

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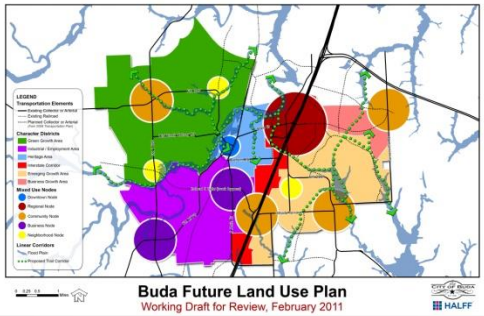
Ειδικός Συνεργάτης, Τμήμα Δημοσίων Έργων (-2017)
Επισκέπτης Ερευνητής, University of Leeds (-2018)

Εφαρμογές Γεωγραφικών Συστημάτων Πληροφοριών στην Κύπρο,
Διημερίδα 8-9 Οκτωβρίου 2014, Λευκωσία

Περιεχόμενα

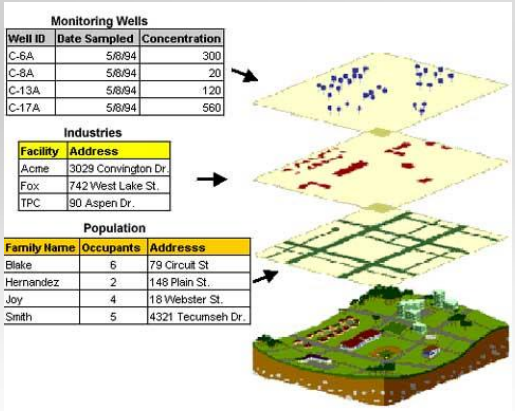
1. Σχεδιασμός και λήψη αποφάσεων (ΣΛΑ)
2. Γεωγραφικά Συστήματα Πληροφοριών (ΓΣΠ)
3. Συστήματα Σχεδιασμού και Λήψης Αποφάσεων
4. Σύγχρονες τάσεις
5. Παραδείγματα Συστημάτων ΣΛΑ
6. Συμπεράσματα

1. Σχεδιασμός και λήψη αποφάσεων (ΣΛΑ): Η διαδικασία



2.1 ΓΣΠ-Δυνατά στοιχεία

Διαχείριση



Monitoring Wells

Well ID	Date Sampled	Concentration
C-6A	5/8/94	300
C-8A	5/8/94	20
C-13A	5/8/94	120
C-17A	5/8/94	560

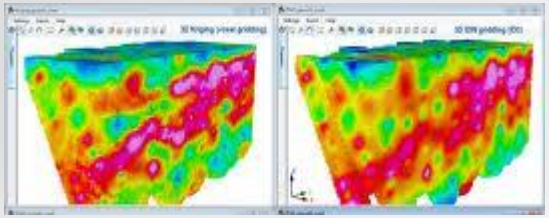
Industries

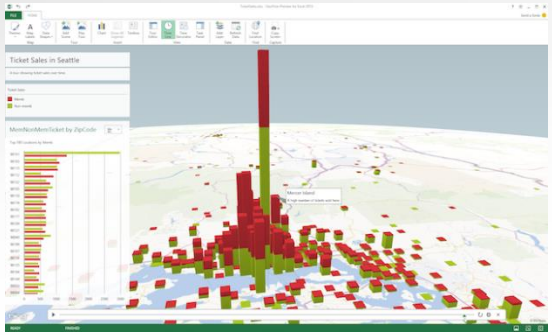
Facility	Address
Acme	3029 Convington Dr.
Fox	742 West Lake St.
TPC	90 Aspen Dr.

Population

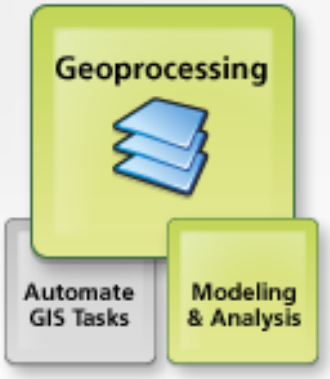
Family Name	Occupants	Addresss
Blake	6	79 Circuit St
Hernandez	2	148 Plain St.
Joy	4	18 Webster St.
Smith	5	4321 Tecumseh Dr.

Απεικόνιση

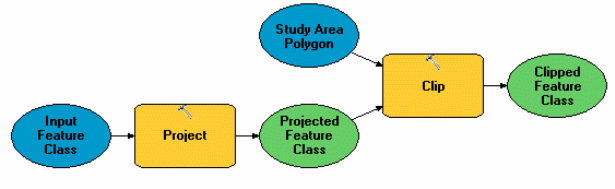




Ανάλυση



- Overlay
- Buffering
- Proximity
- Surfaces
- Statistical



Python

2.2 ΓΣΠ-Αδυναμίες σχετικά με το ΣΛΑ (ι)

- Προσομοίωση (simulation) ειδικών και περίπλοκων προβλημάτων
  - Εξέλιξη στο χρόνο (π.χ. ανάπτυξη πόλης, εξέλιξη πυρκαγιάς, κλιματολογική αλλαγή, ρύπανση περιβάλλοντος)
  - Ανθρώπινη συμπεριφορά/σκέψη
  - Εξειδικευμένη γνώση/νομοθεσία/κανονισμοί
- Δημιουργία/αυτοματοποίηση εναλλακτικών λύσεων
- Αξιολόγηση εναλλακτικών λύσεων
- Βελτιστοποίηση λύσεων (optimisation)

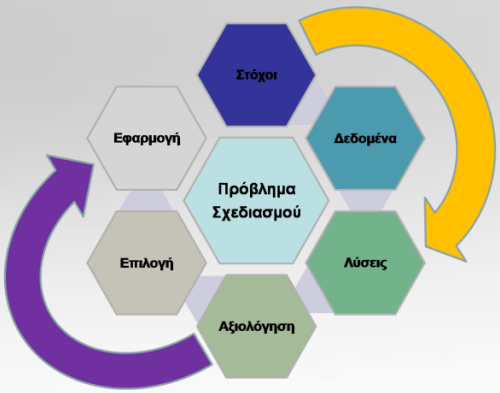
3.1 Συστήματα ΣΛΑ: Planning and Decision Support Systems

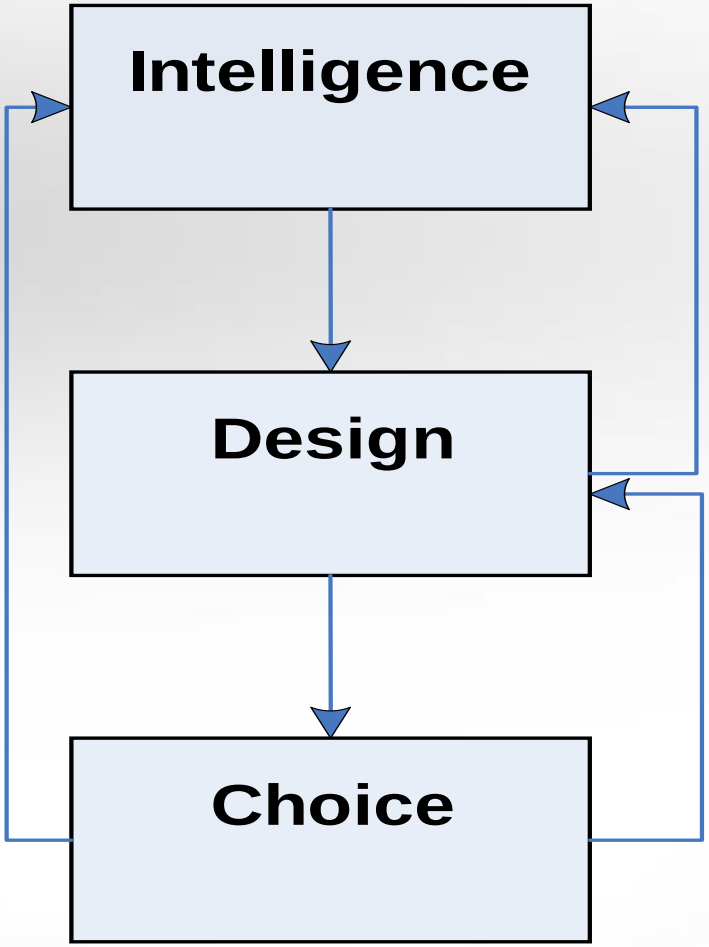
- Decision Support Systems (DSS)-1970’
  - “DSS is *an interactive computer-based system that helps decision makers to utilize data and models to solve unstructured problems” (G. Morton, 1964)*.
- GIS-1970’
- Spatial Decision Support Systems (SDSS)-1970’
  - “SDSS are specific purpose systems aimed at supporting the executive decision making process for a certain complex spatial problem.” *(Geertman and Stillwell, 2004)*

3.2 Συστήματα ΣΛΑ: Planning and Decision Support Systems

- Planning Support Systems (PSS)-1980’
  - *“PSS is a subset of computer-based geo-information instruments, each of which incorporates a unique suite of components that planners can utilise to explore and manage their particular activities”. (Geertman and Stillwell, 2004)*
- Integrated Planning and Decision Support Systems
  - SDSS+PSS=IPDSS

3.3 Συστήματα ΣΛΑ: Πλαίσιο ανάπτυξης Συστημάτων ΣΛΑ





Simon's model (1960)

The intelligence phase

"Is there a problem or opportunity for change?"

The design phase

"What are the available alternatives?"

The choice phase

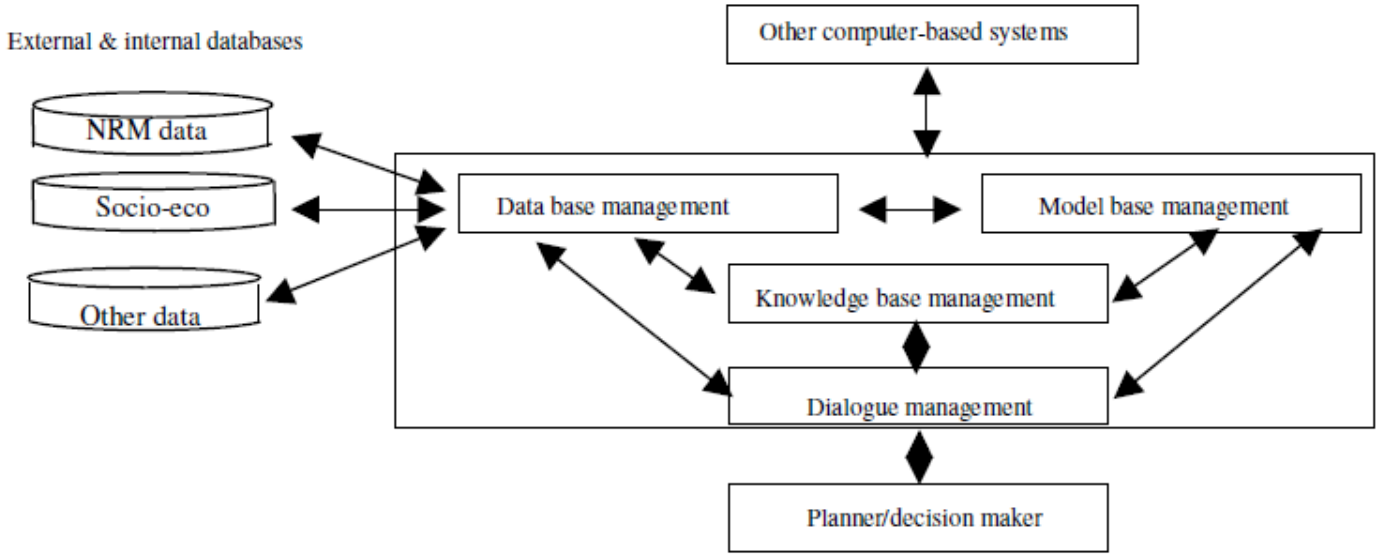
"Which line of action will return the most perceived benefits?"

3.4 Συστήματα ΣΛΑ: Βασικά στοιχεία

- Integrated Planning and Decision Support Systems
  - a database management system (DBMS)
  - a dialog generation and management system (DGMS)
  - a model base management system (MBMS)
  - *a knowledge based management subsystem (KBMS)*

GIS

iGIS



4.1 Σύγχρονες τάσεις: iGIS=Intelligent GIS

- What is intelligence?
  - Intelligence is *"the power of **learning**, **understanding** and **reasoning**"* Oxford Dictionary (1989)

- Μπορεί ένας υπολογιστής να έχει αυτές τις ικανότητες;

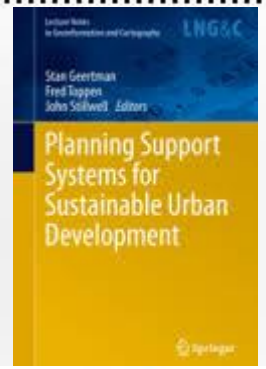
- **Artificial intelligence** (AI) is *"a science that has defined its goal as making machines do things that would require intelligence if done by humans"* (Negnevitsky, 2005)

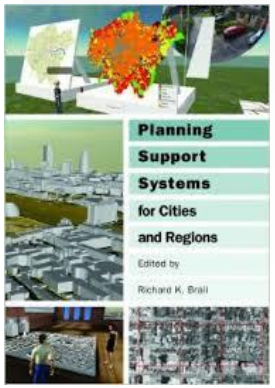
4.2 Σύγχρονες τάσεις: iGIS=Intelligent GIS

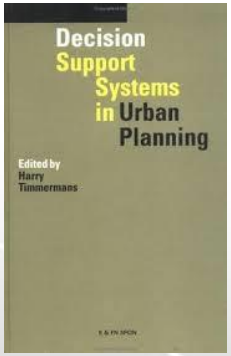
- Artificial intelligence techniques: **expert systems**, neural networks, **genetic algorithms**, genetic programming, fuzzy logic, ontologies...
- Computational methods: cellular automata, agent based modelling…
- GIS + AI + Computational methods + high performance computers = **Geocomputation** (Openshaw, 1990)

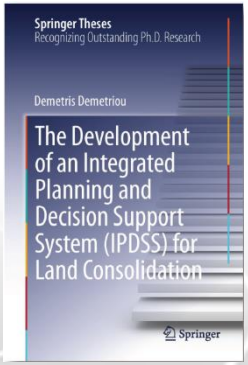
5.1 Παραδείγματα Συστημάτων ΣΛΑ

- **What if?**
- CommunityViz
- Index
- UrbanSim
- Mulino
- **LACONISS**



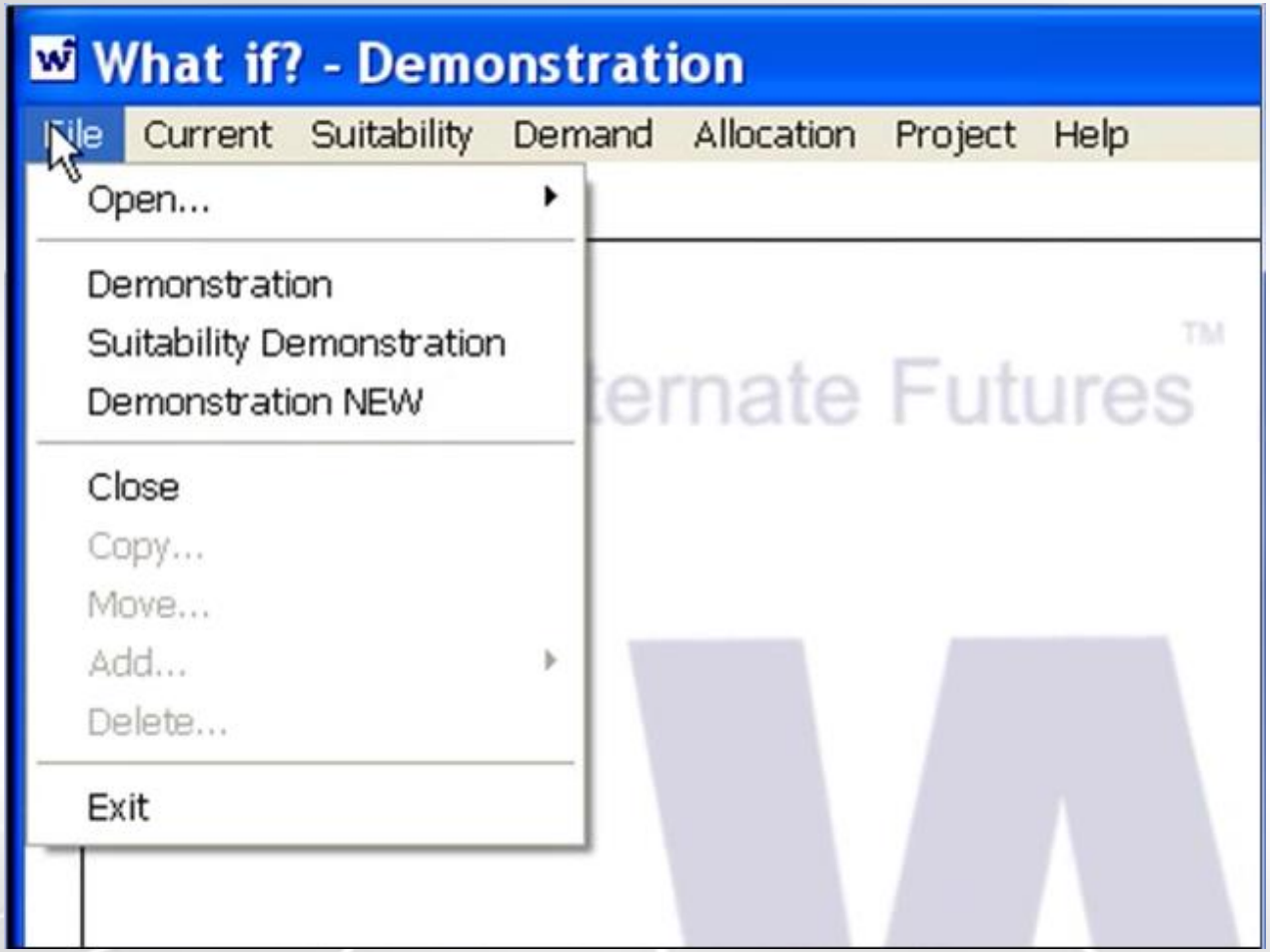






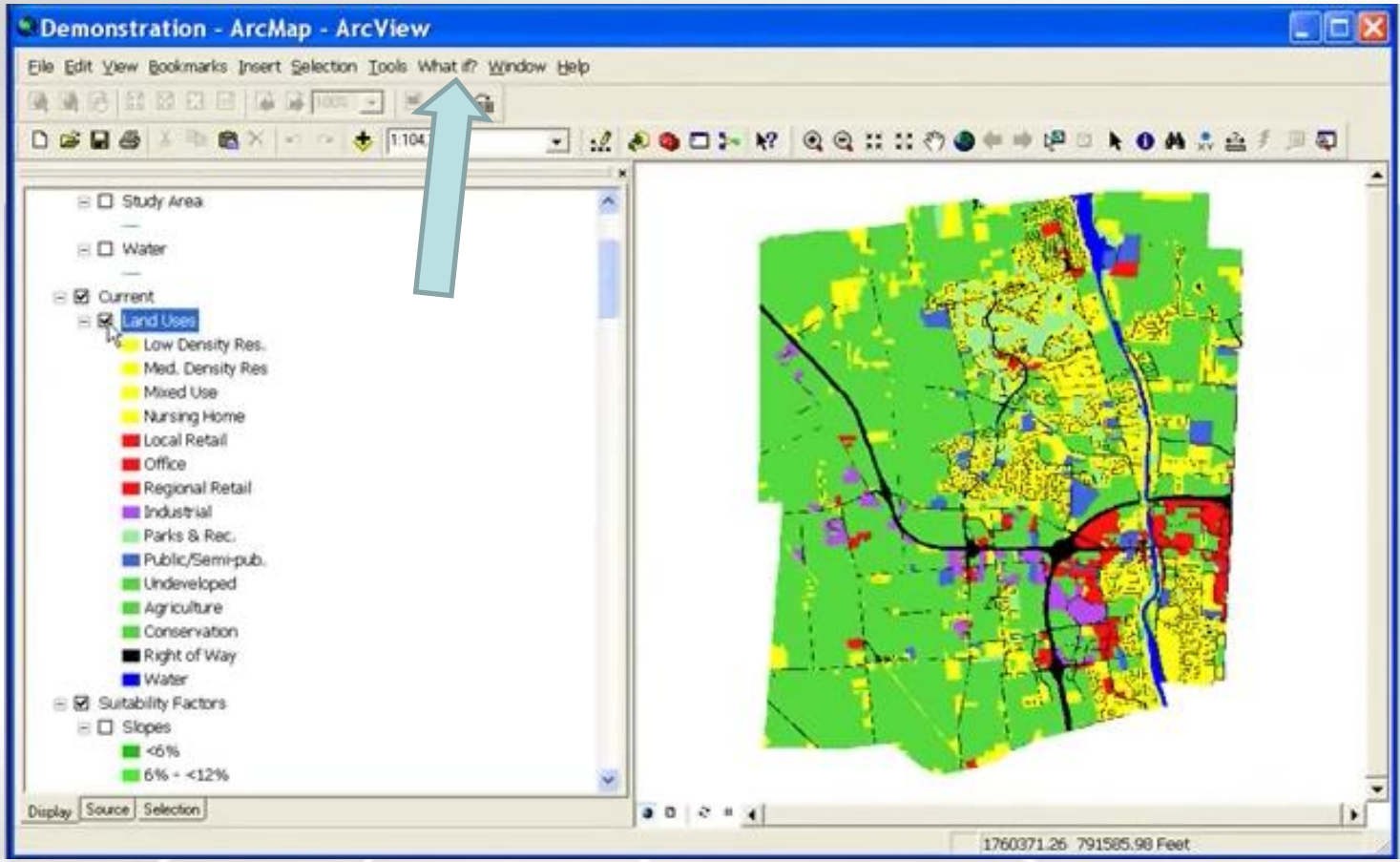
5.2 The What if? Planning Support System

- Σύστημα διερεύνησης εναλλακτικών σεναρίων ανάπτυξης μιας περιοχής

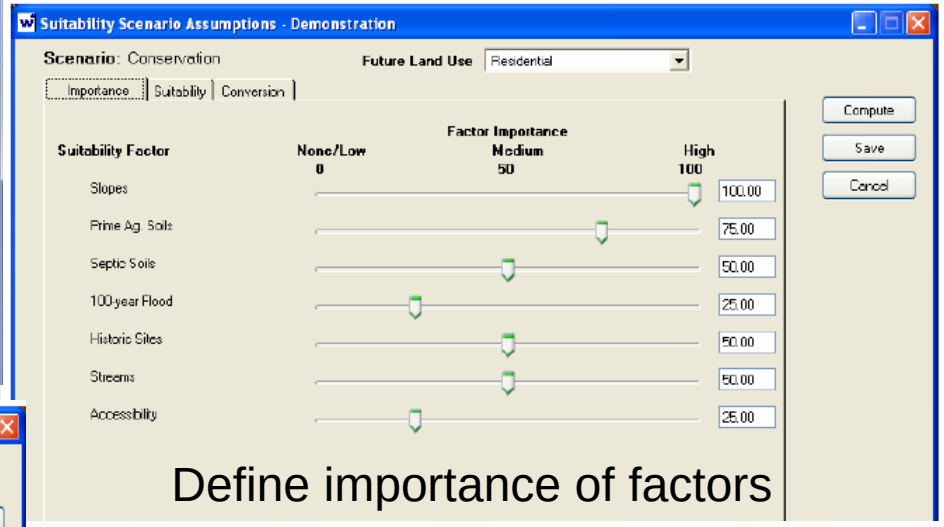


The What if? Within ArcGIS

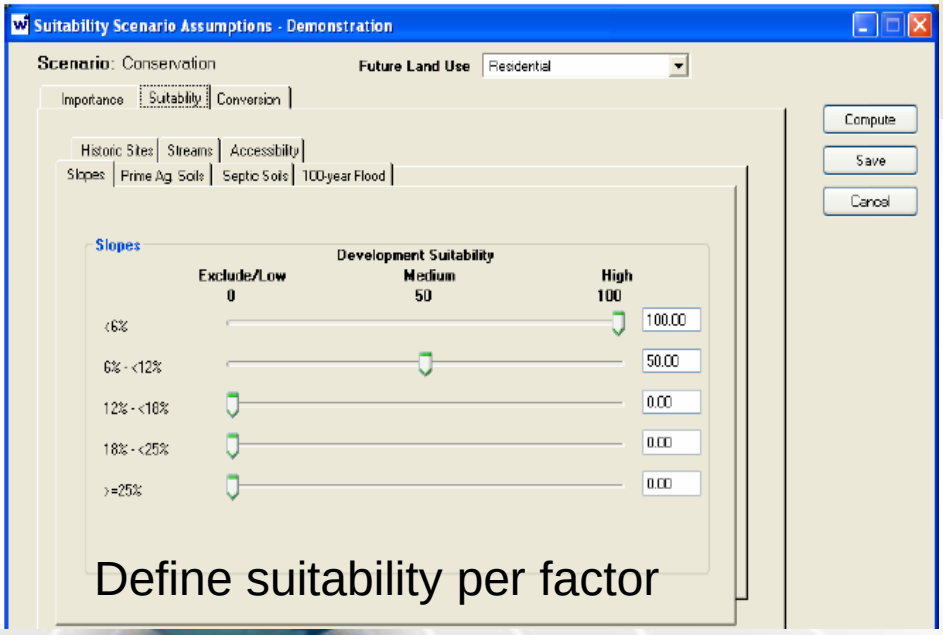
Δεδομένα: GIS χάρτης των υφιστάμενων χρήσεων γης
Εφαρμογή στην Edge City- μικρή πόλη στις ΗΠΑ



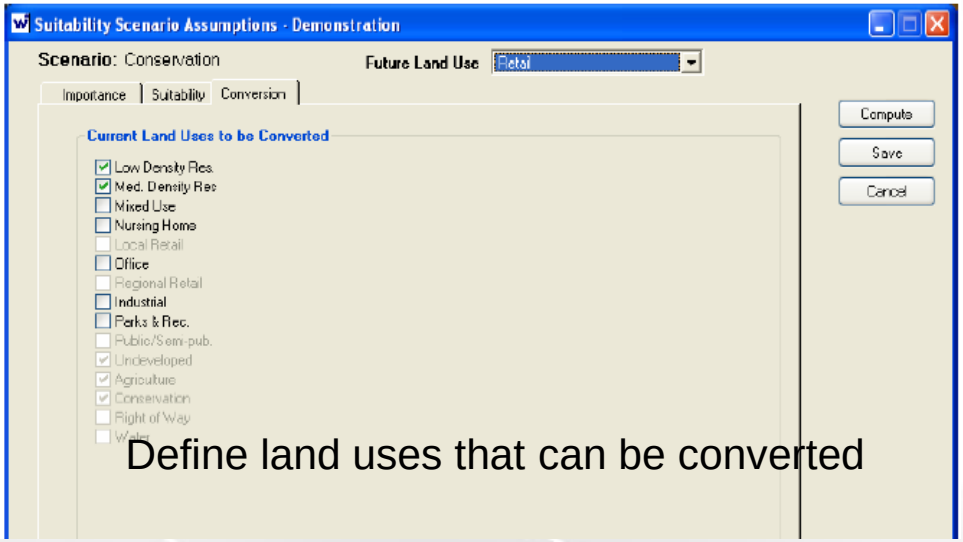
Ανάλυση καταλληλότητας της γης (Land suitability analysis)



Define importance of factors

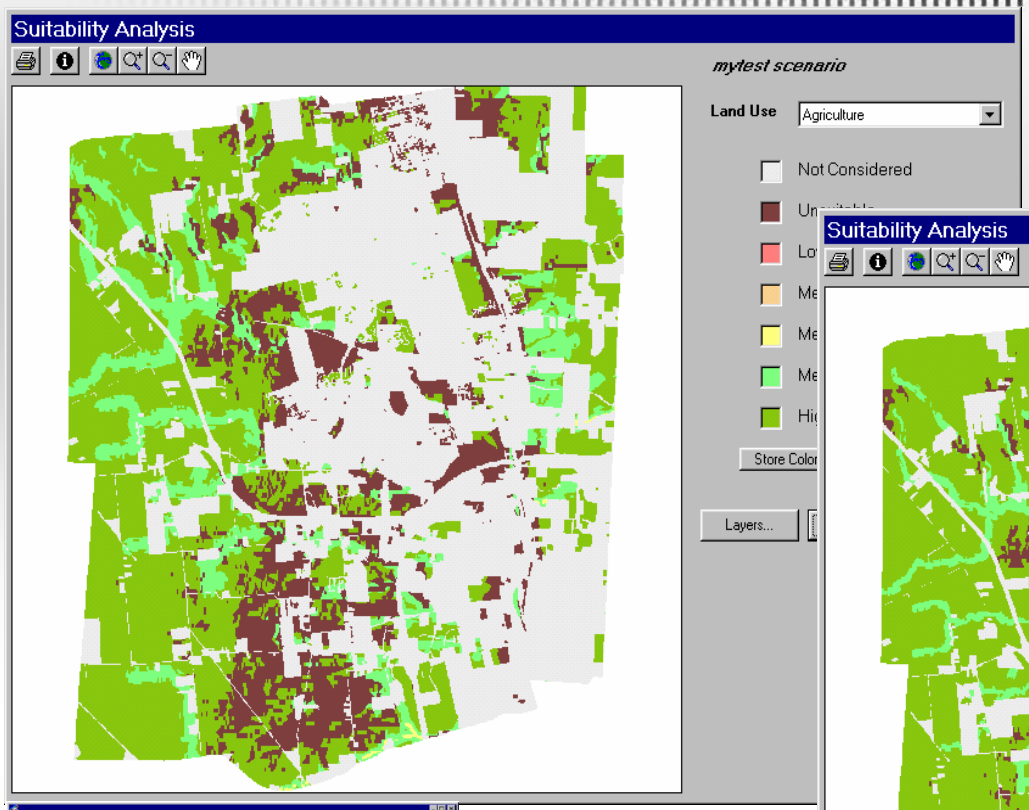


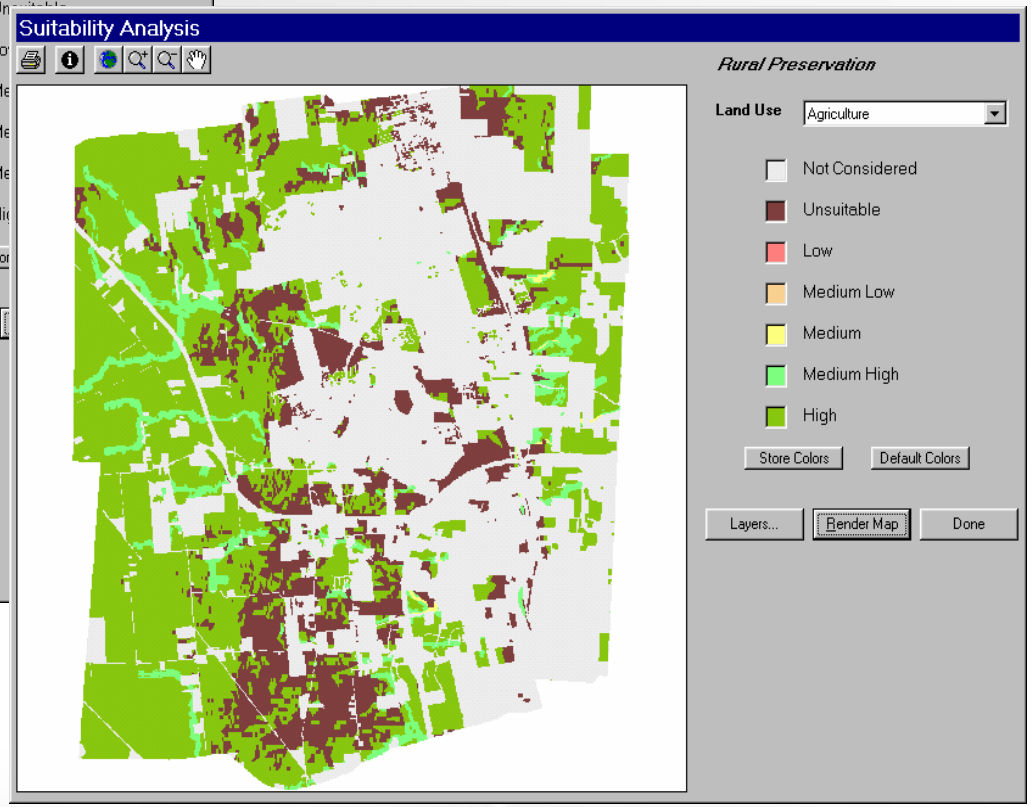
Define suitability per factor

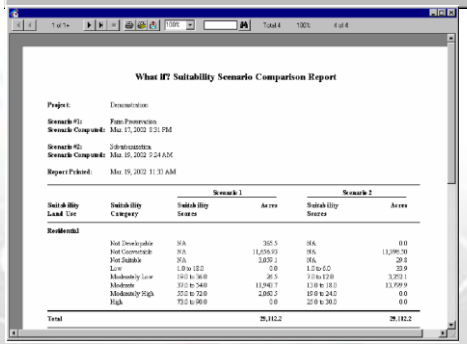


Define land uses that can be converted

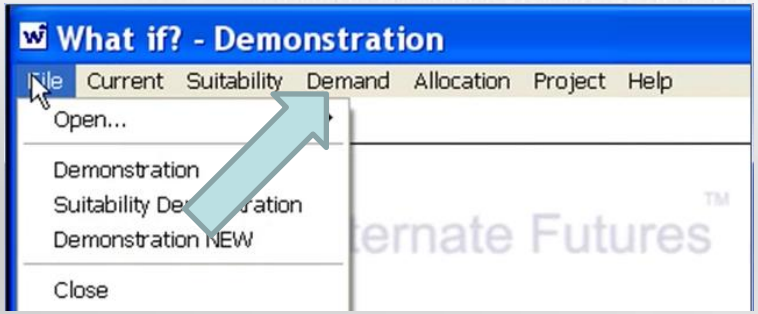
Χάρτες καταλληλότητας της γης

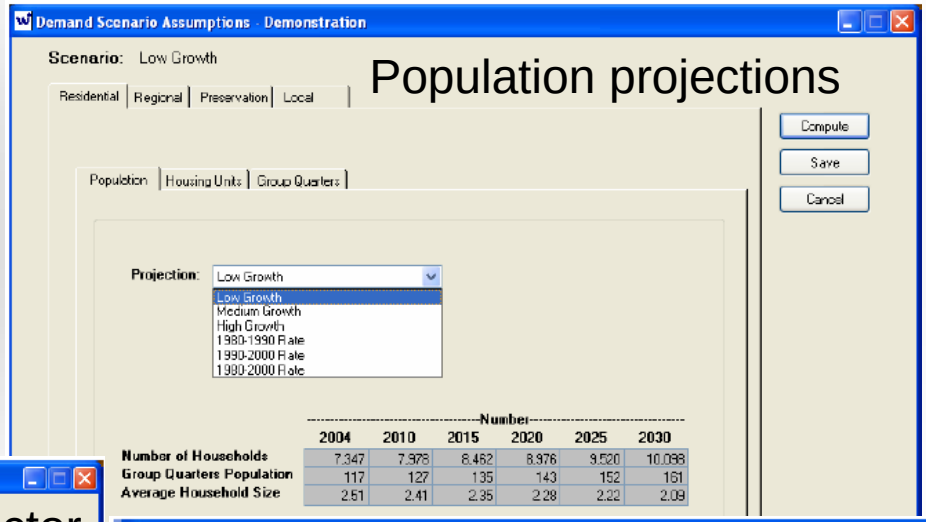


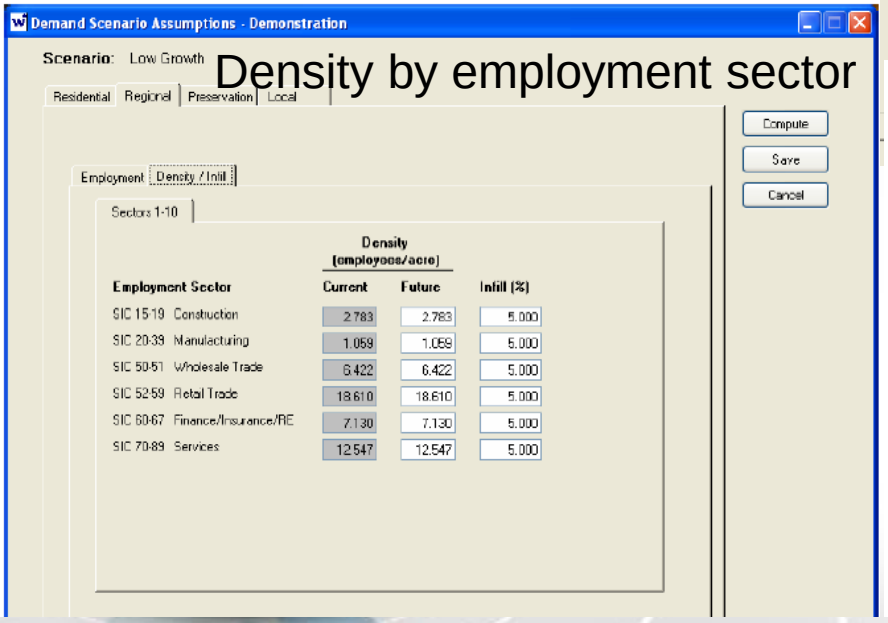


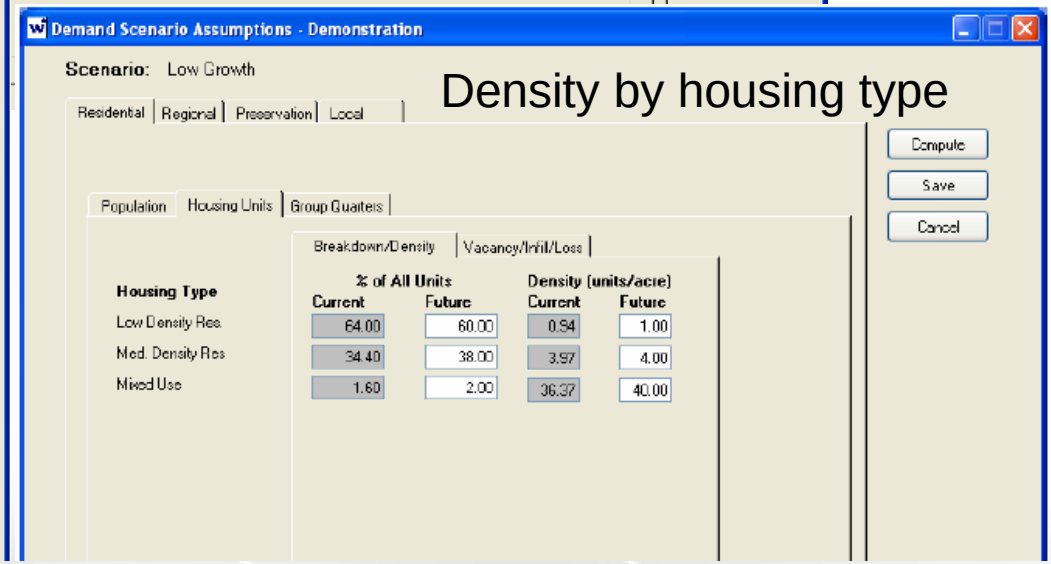


Υπολογισμός των αναγκών (Demand): Καθορισμός παραδοχών









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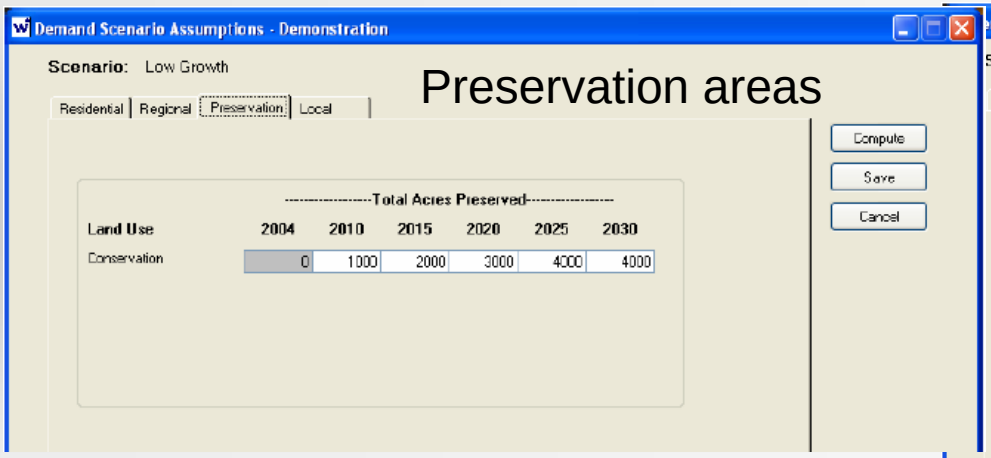
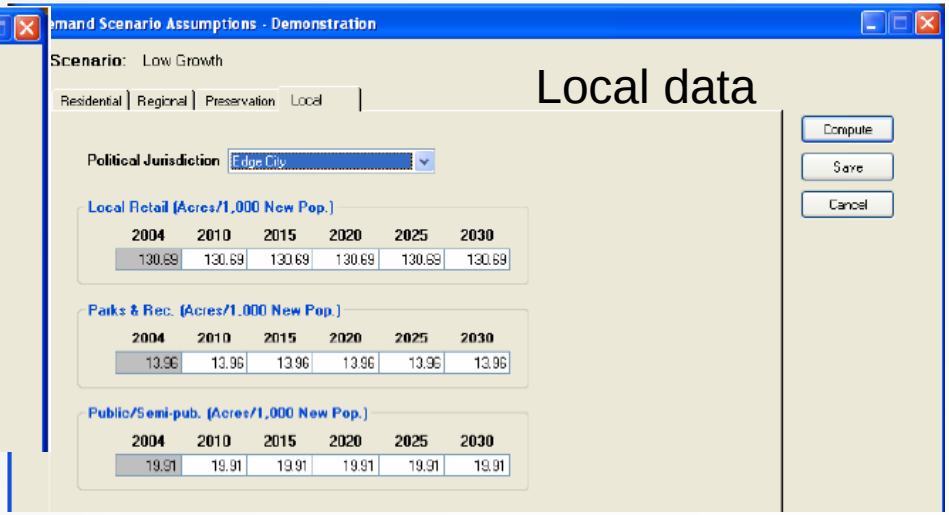
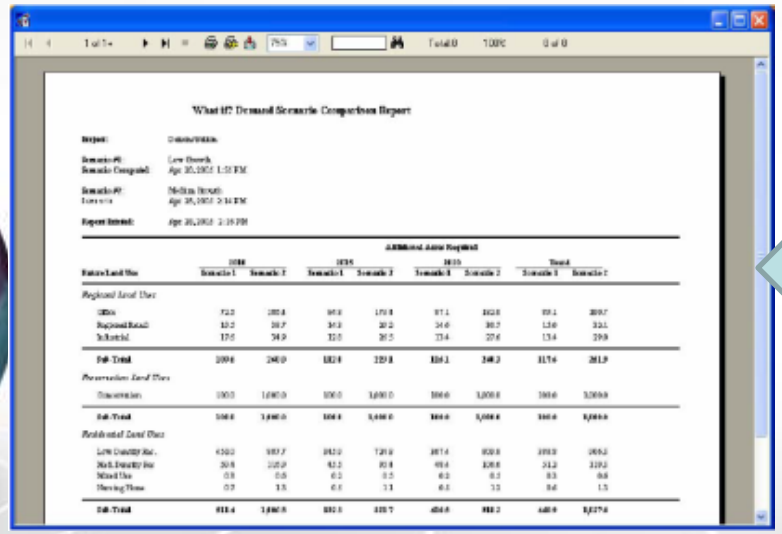
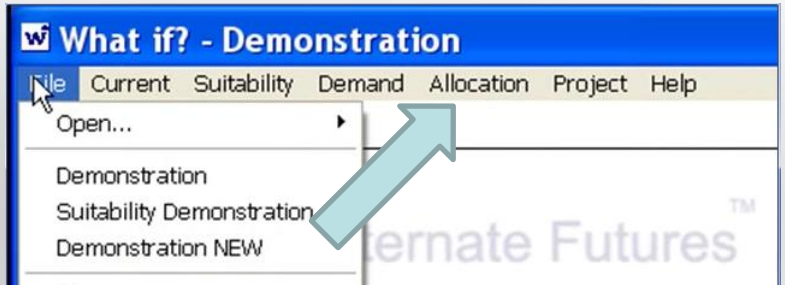


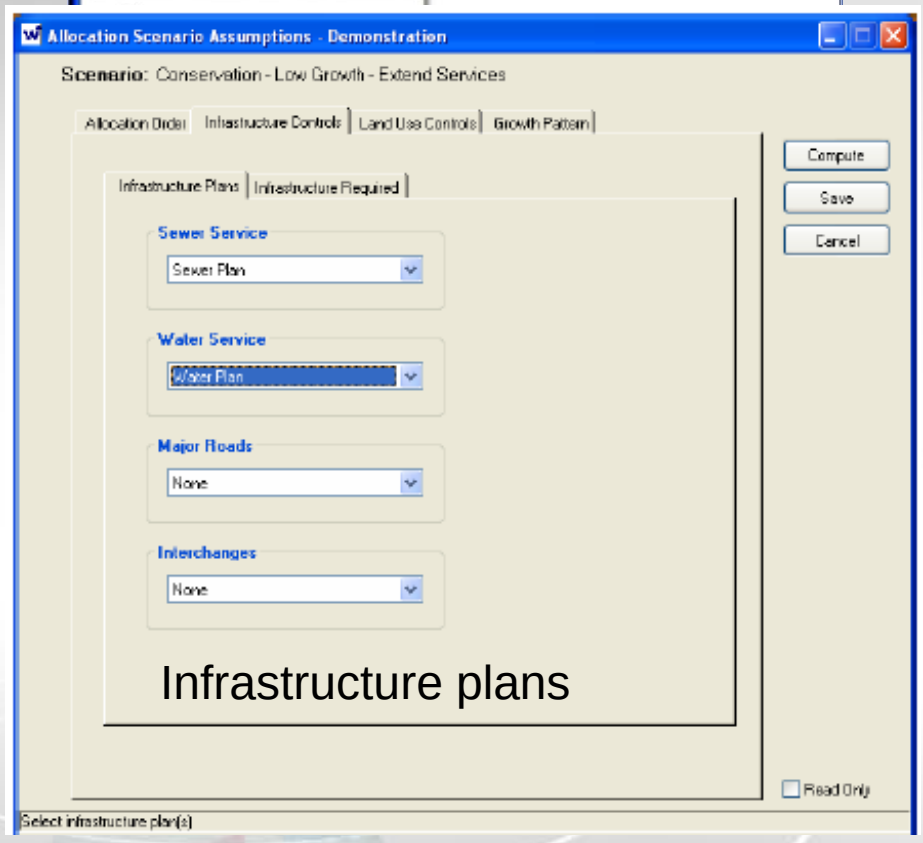


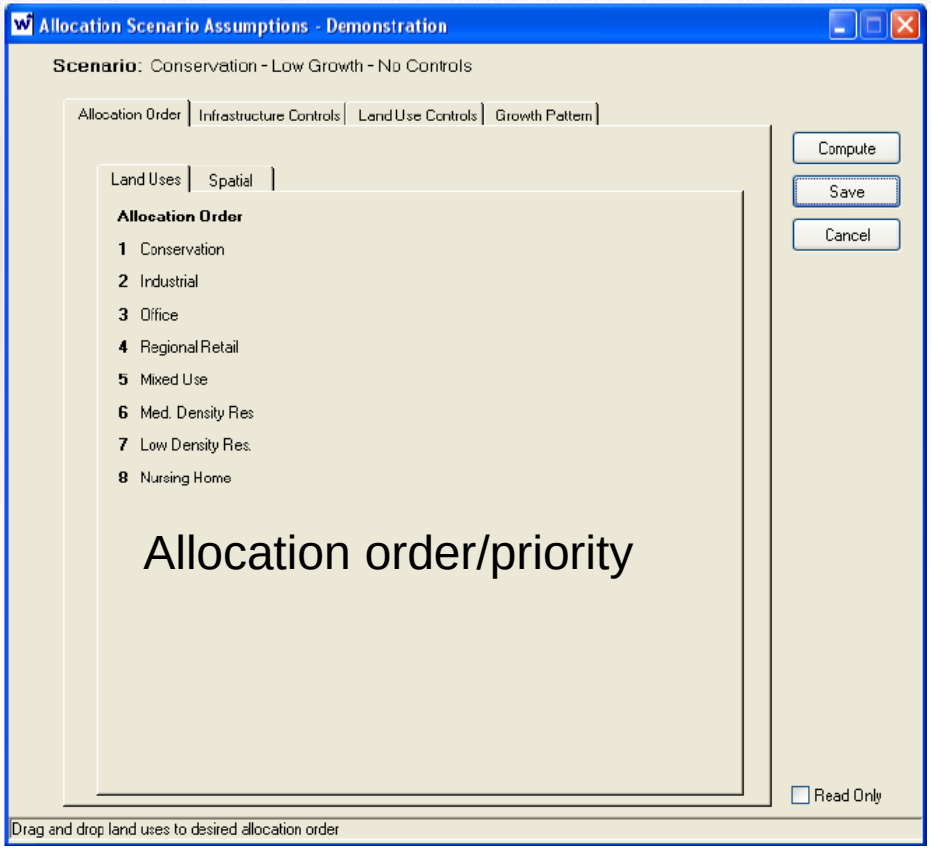


Demand comparison report
per land use/projected year/scenario

Διανομή της γης σε ζώνες (Land allocation)







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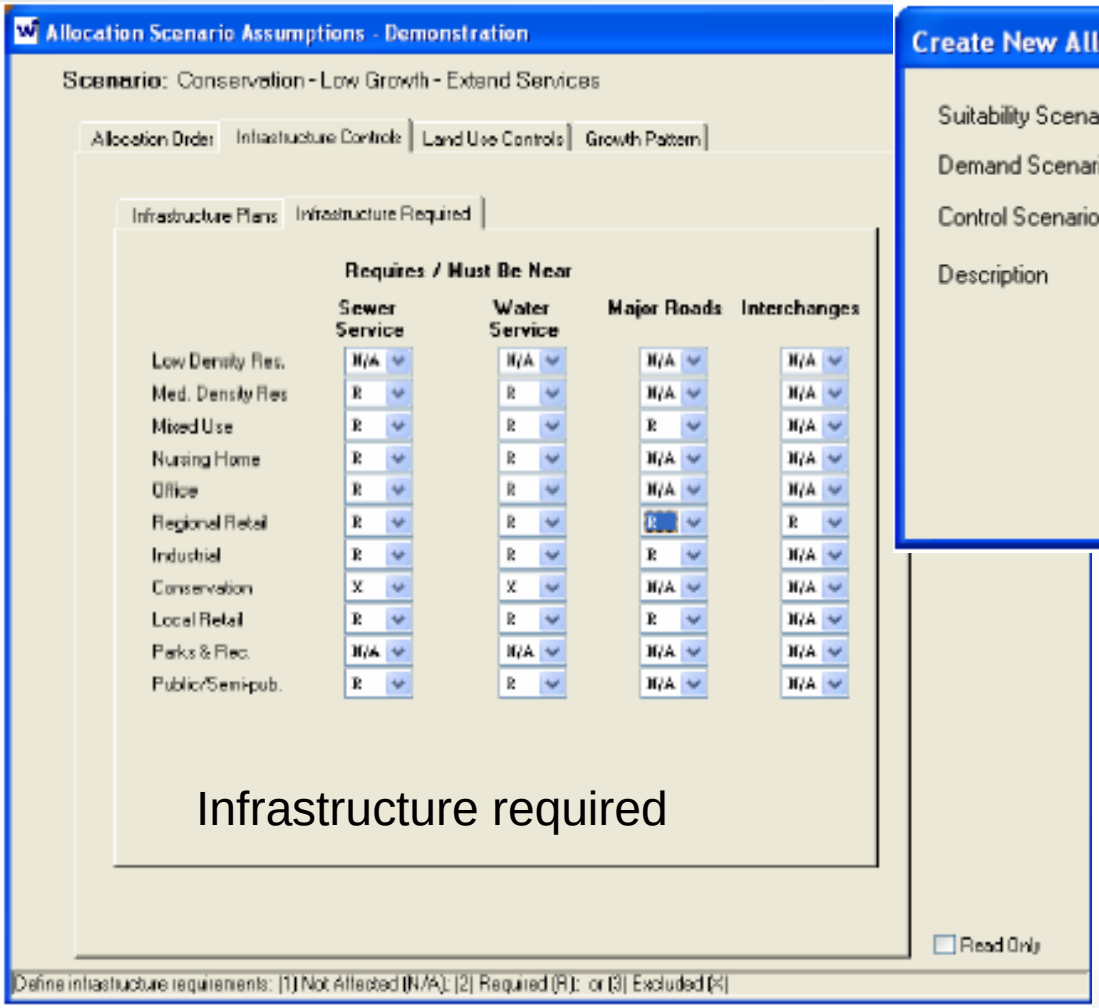
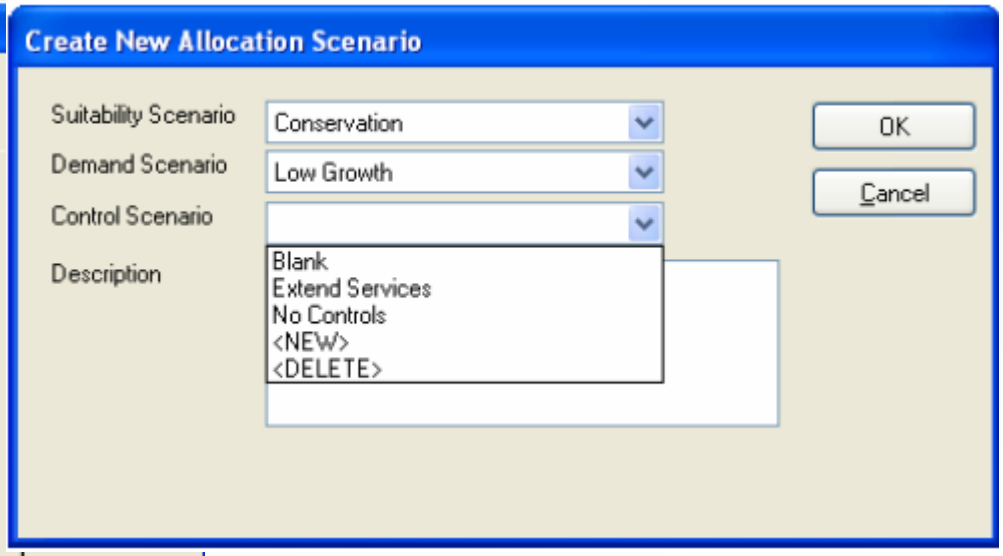
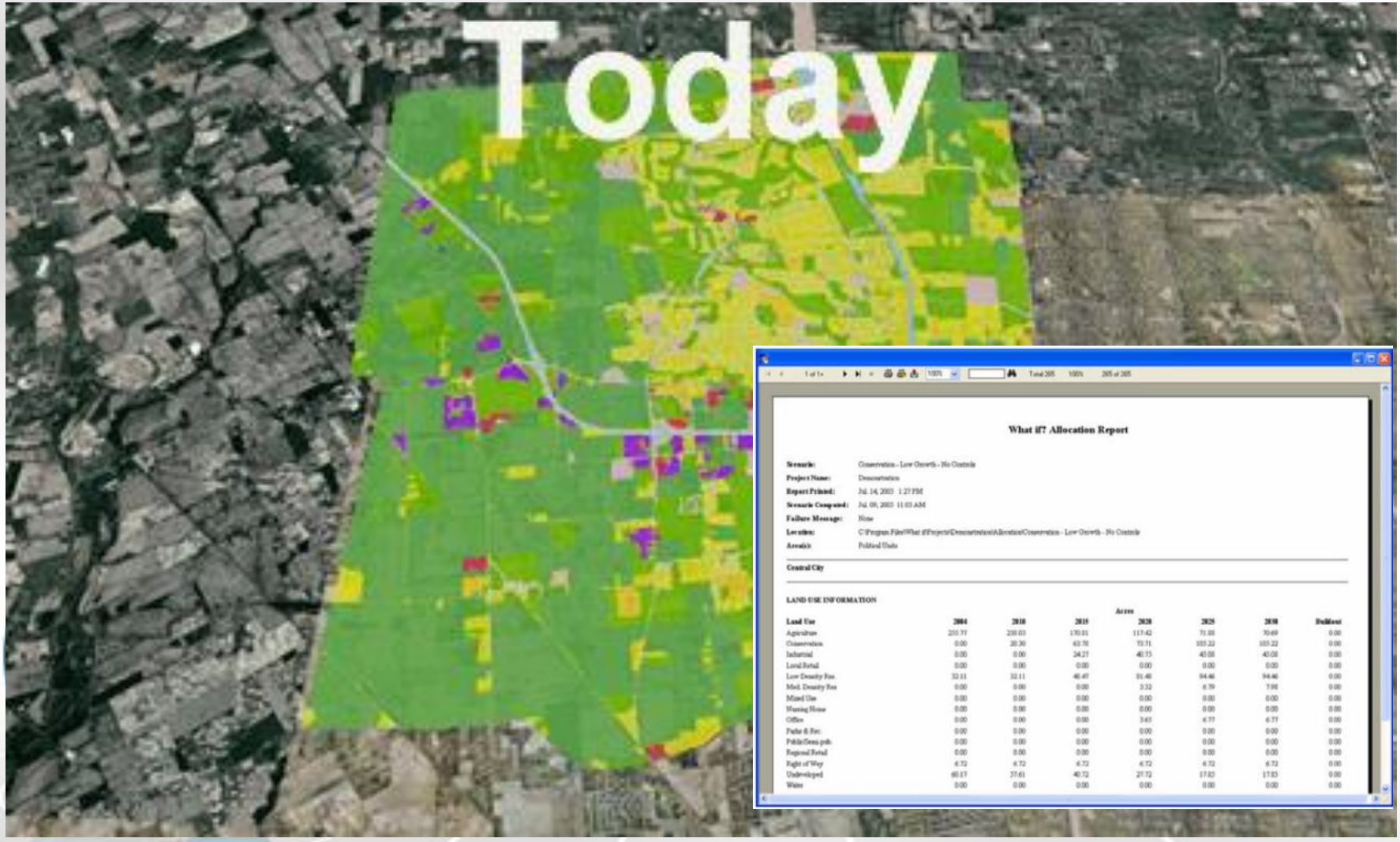


Infrastructure required

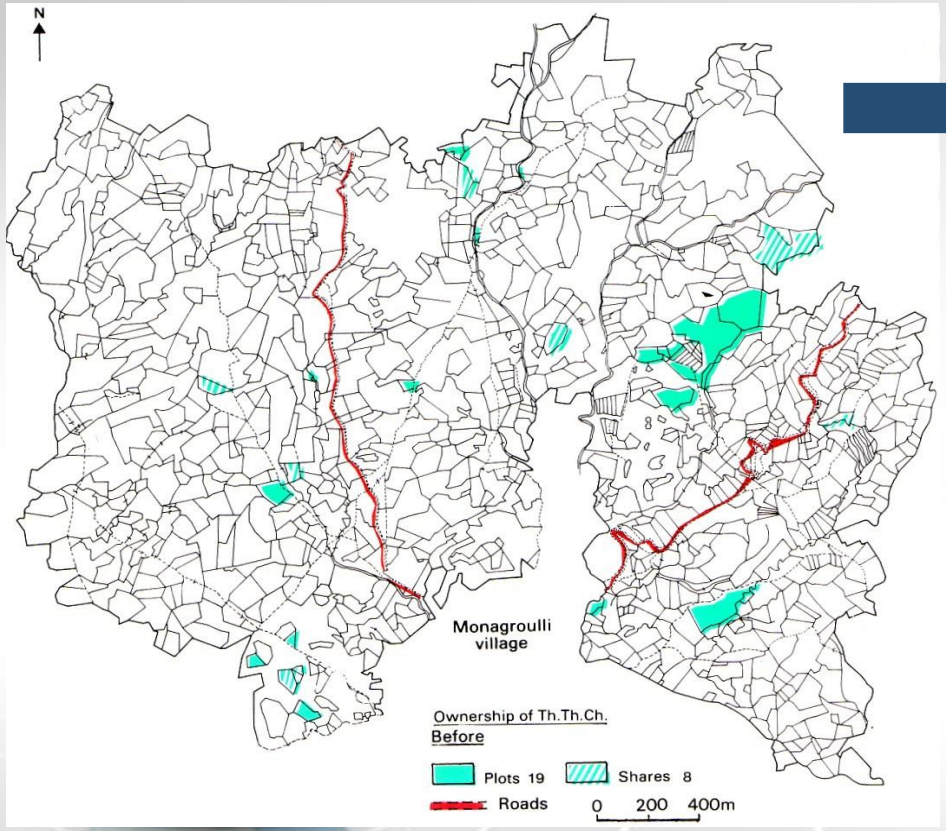


Χάρτες-σενάρια χρήσεων γης 2015-2035

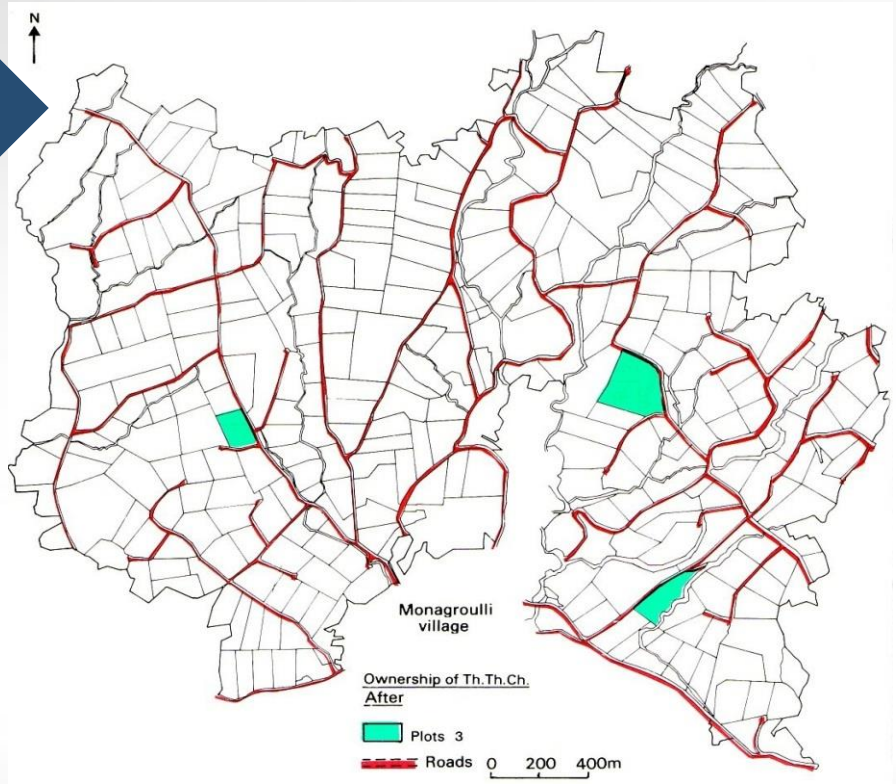


5.3 LACONISS: Υποστήριξη και αυτοματοποίηση της αναδιανομής γης

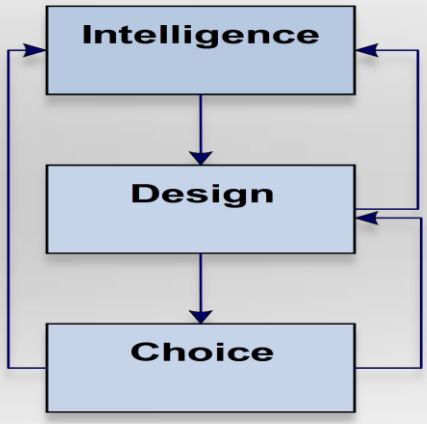
Πριν τον αναδασμό

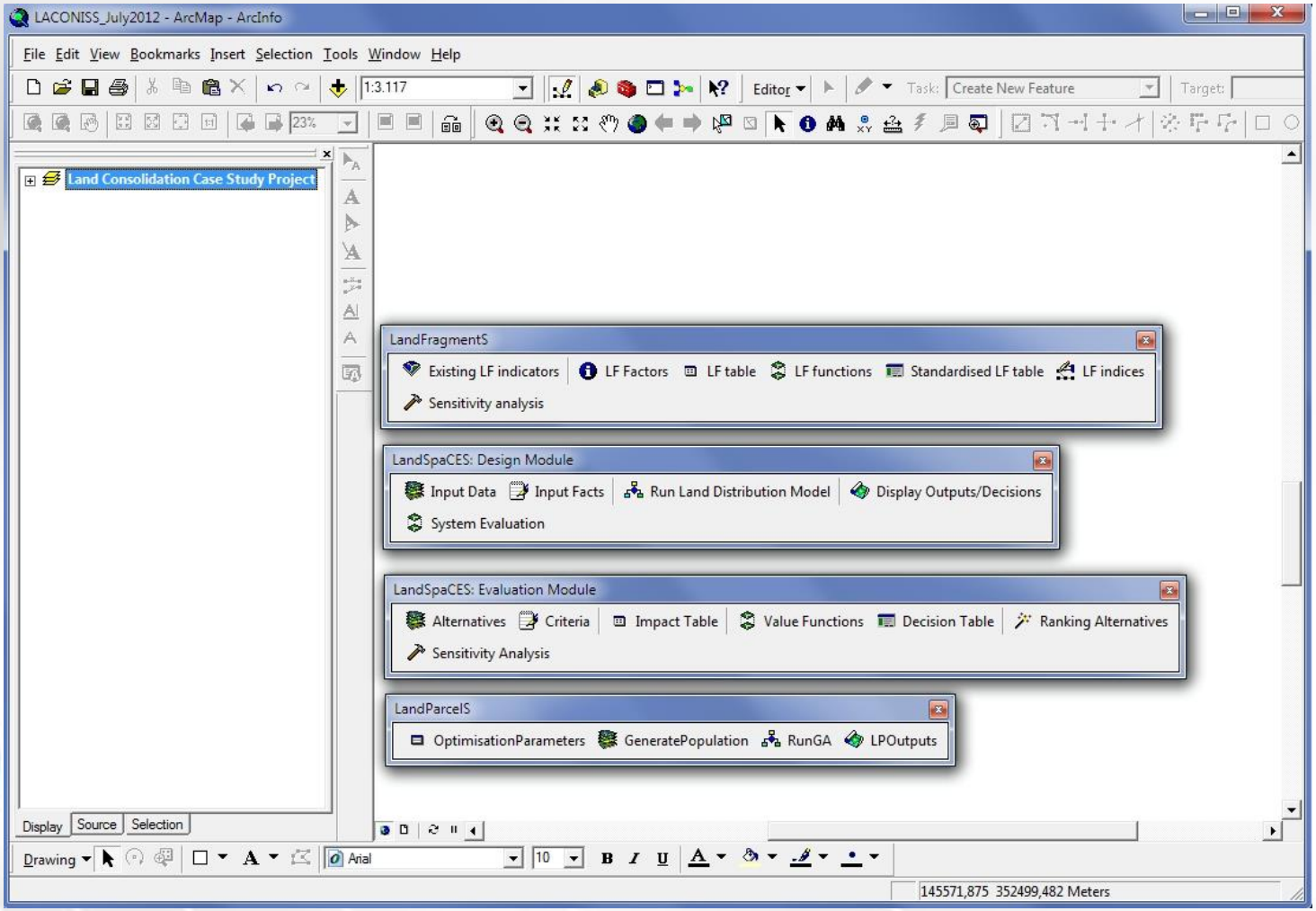


Μετά τον αναδασμό

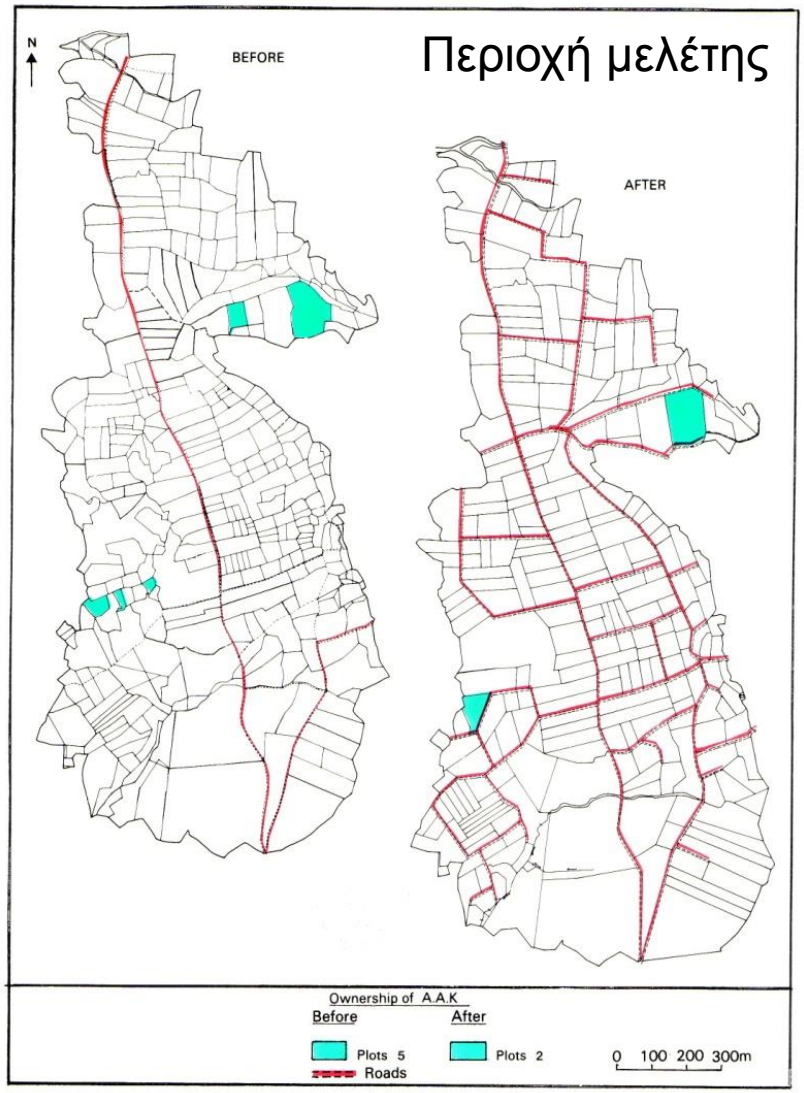


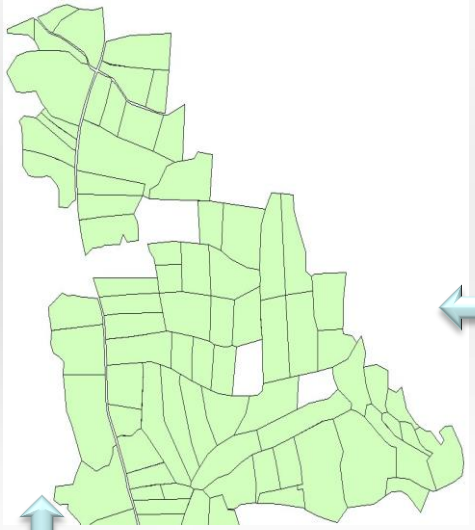
LACONISS: **LA**nd **CON**solidation **I**ntegrated **S**upport **S**ystem for planning and decision making

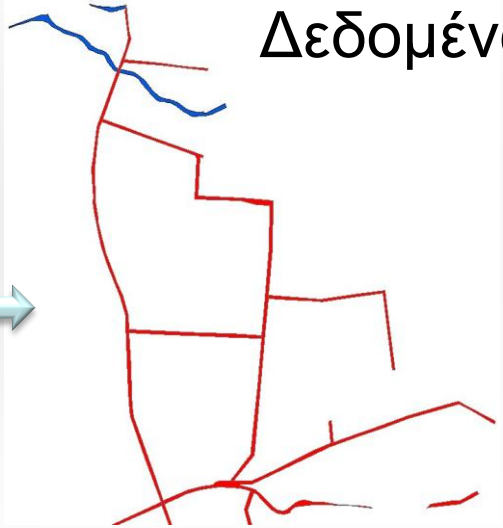


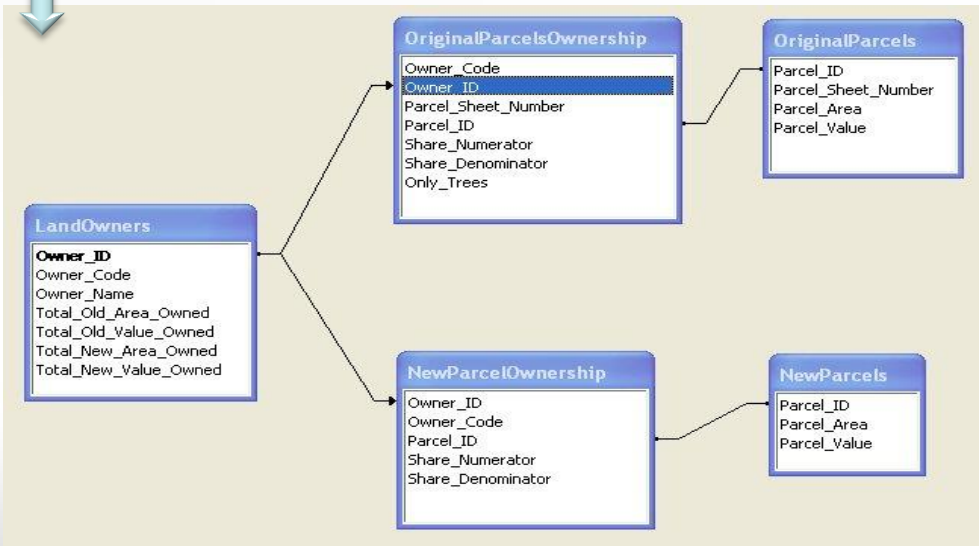


Εφαρμογή του συστήματος







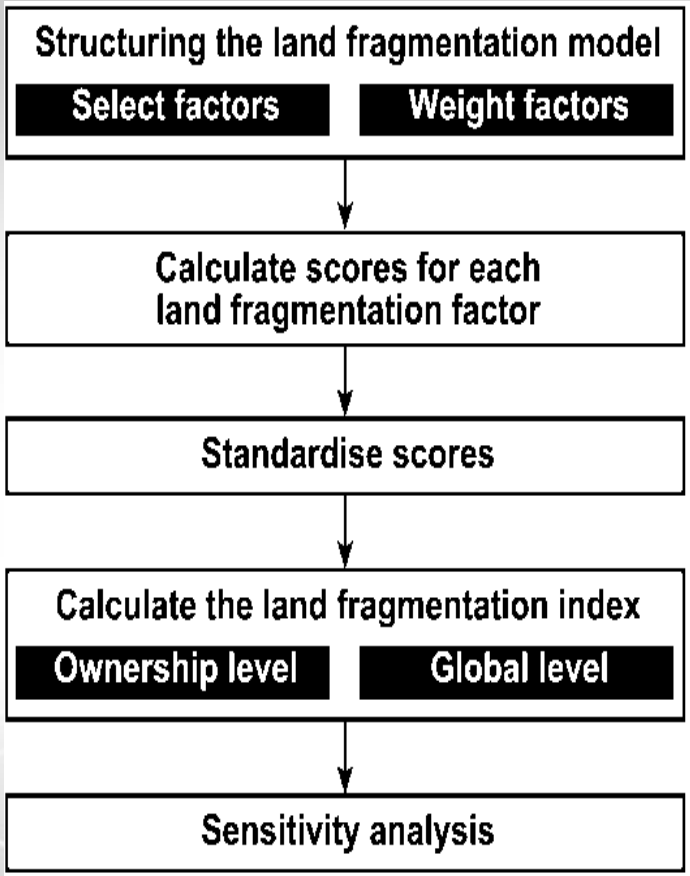


LandFragmentS: Land fragmentation system – Ποσοτικοποίηση προβλήματος

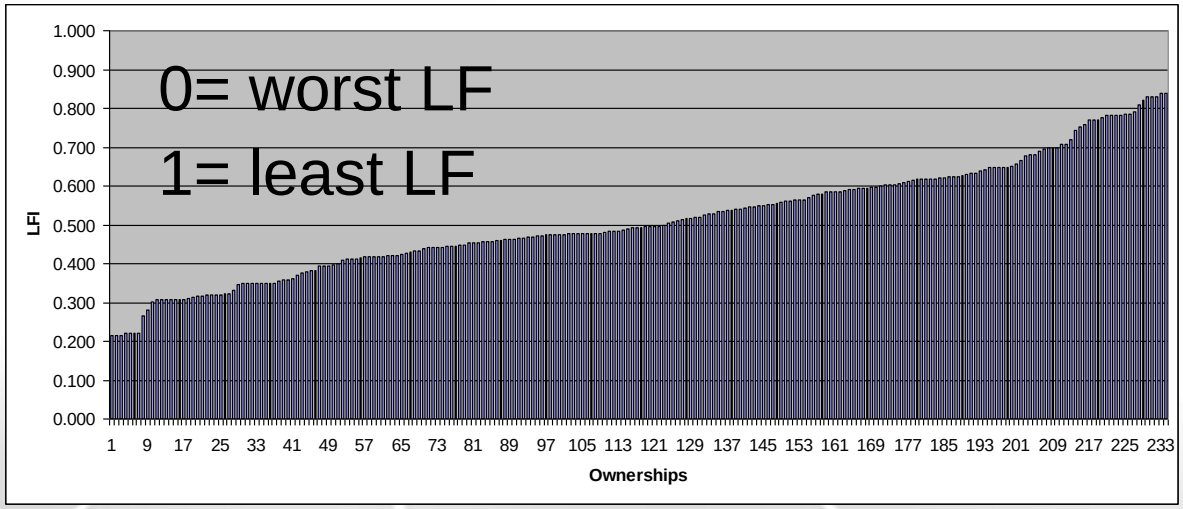
Παράγοντες πολυτεμαχισμού της γης:

- Διασπορά τεμαχίων
- Μέγεθος τεμαχίων
- Σχήμα τεμαχίων
- Προσβασιμότητα τεμαχίων
- Δυαδική μορφή ιδιοκτησίας
- Κατοχή ιδιοκτησίας σε μερίδια

Multi-criteria decision analysis

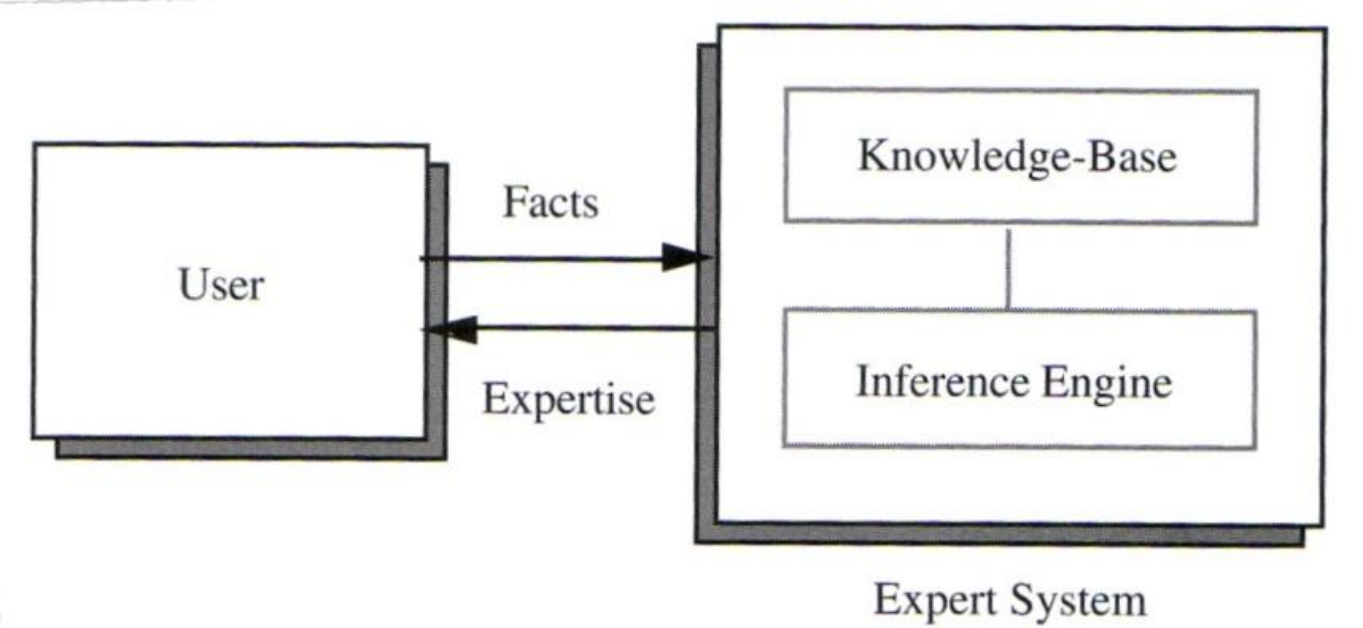


Υπολογισμός Δείκτη πολυτεμαχισμού της γης: (LFI)



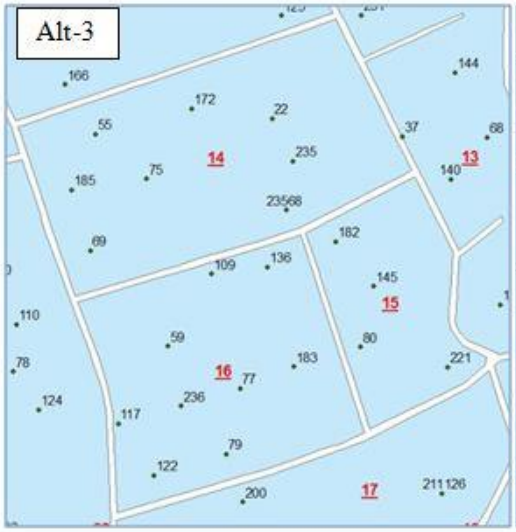
LandSpaCES: Land Spatial Consolidation Expert System (Design)- Αυτόματη δημιουργία εναλλακτικών λύσεων

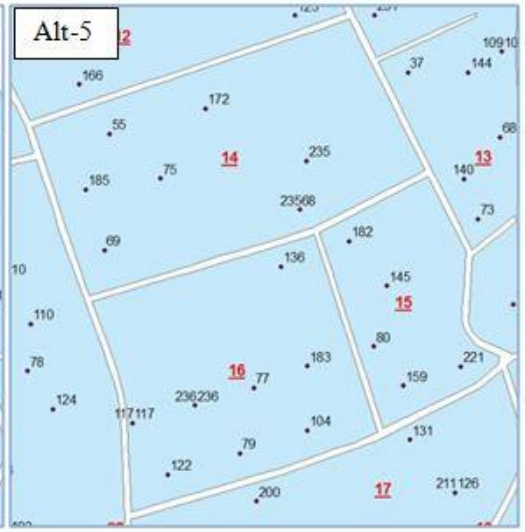
Βασικά μέρη του έμπειρου συστήματος (Expert System)

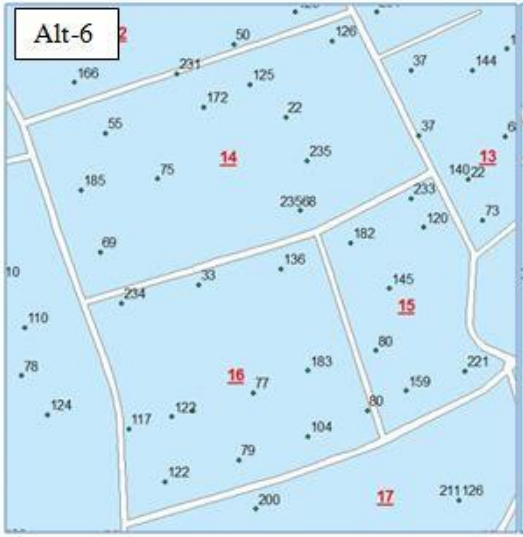


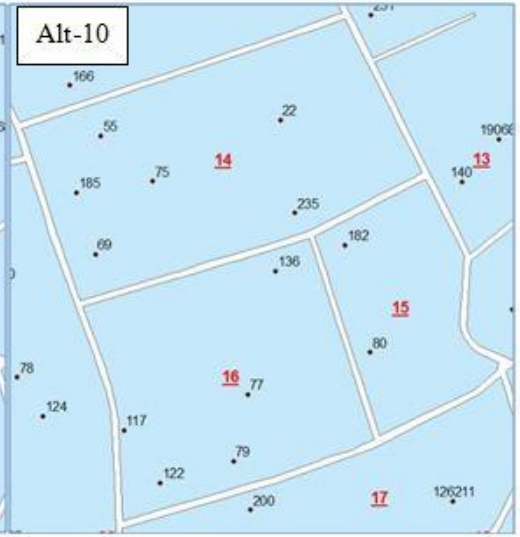
"IF this condition (or premise or antecedent) occurs THEN some action (or results or conclusion, or consequence) will or should occur". (74 such rules)

LandSpaCES Design: Εναλλακτικές λύσεις





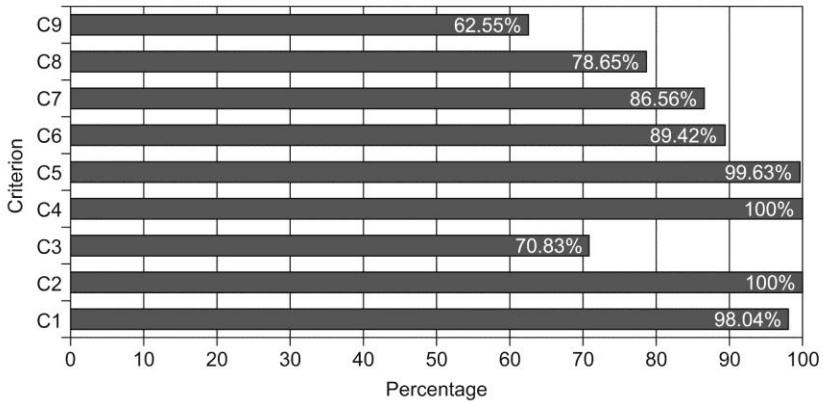




Attributes of NewParcelLS

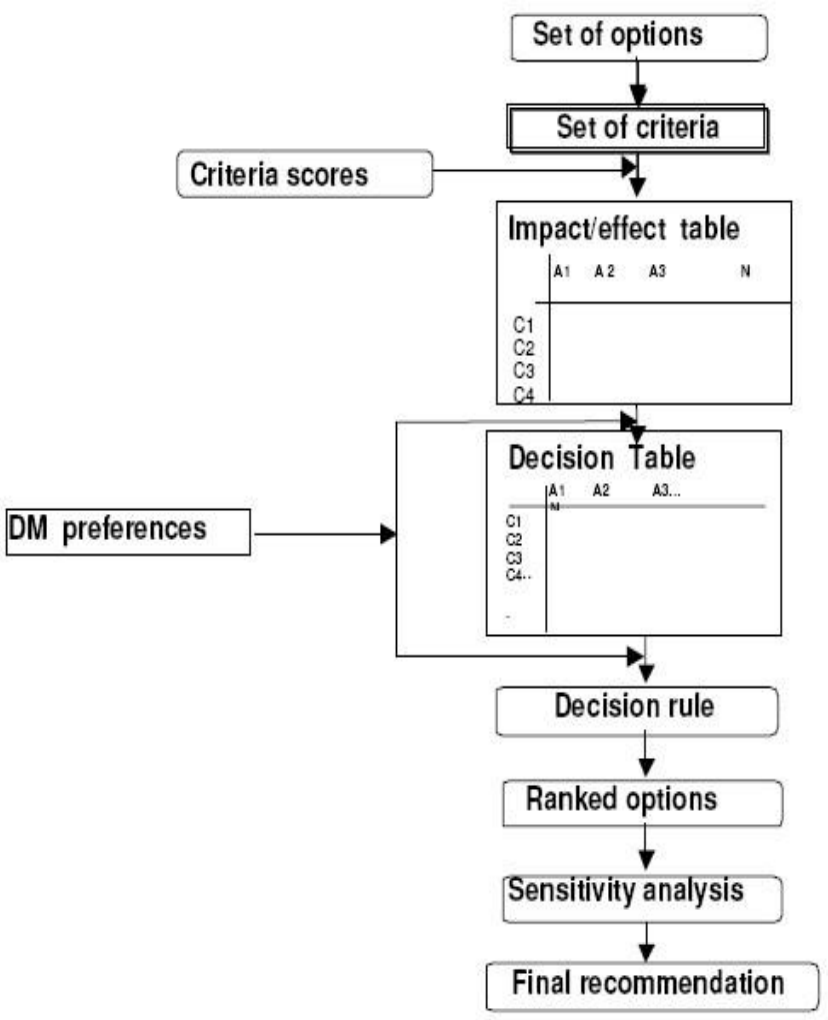
OID	Parcel_ID	Area	Value	X_Centroid	Y_Centroid	Block	PPI
0	1	3267.23	535.49	144928.16	352915.18	8	0.324893
1	2	6535.44	923.26	145424.05	351810.65	19	0.512819
2	3	8822.7	1377.6	144995.97	353021.67	8	0.546201
3	4	2940.9	415.47	145537.59	352893.32	7	0.270247
4	5	8822.7	1446.12	145009.81	352743.21	12	0.550143
5	6	4411.35	754.4	145201.49	353051.63	7	0.55375
6	7	7841.75	1107.91	144798.5	352601.23	10	0.527578
7	8	5554.49	1171.08	145235.75	351924.33	17	0.523973
8	9	3267.23	510.22	145453.67	351990.21	19	0.316531
9	10	3021.99	809.07	145237.53	352875.09	7	0.390352
10	11	9476.34	1129.78	144998.63	353476.69	4	0.53401
11	12	3920.87	102.04	145613.08	352933.42	7	0.324038
12	13	5228.16	816.36	145343.09	351967.56	17	0.491692
13	14	8822.7	1471.87	145540.78	351941.7	18	0.551625
14	15	5881.8	481.07	144866.67	351908.01	25	0.531603
15	16	9476.34	1479.65	145291.3	353023.41	7	0.554141

Record: 1 Show: All Selected Records (0 out of 259



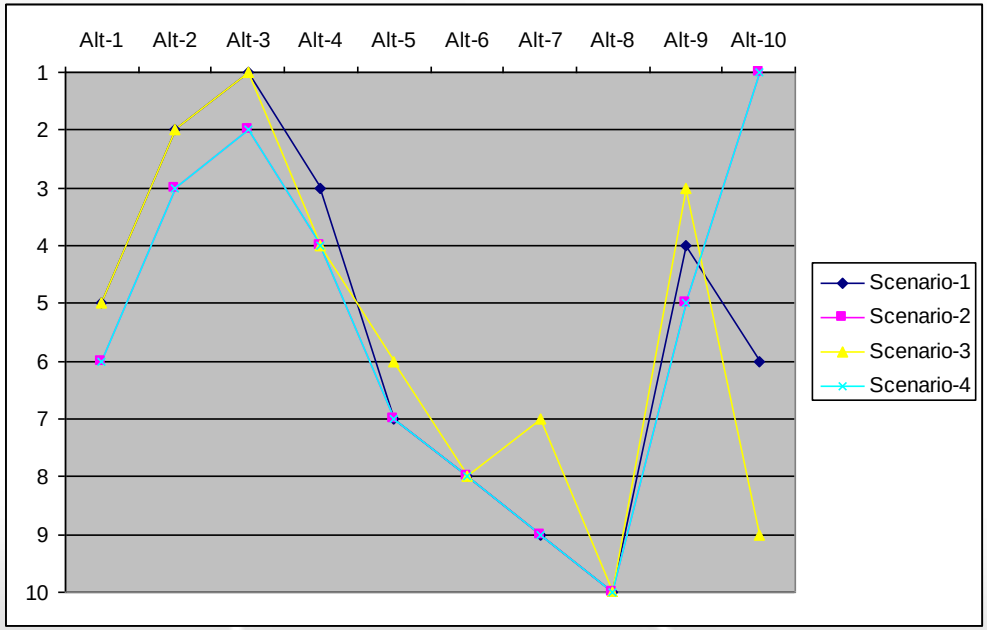
LandSpaCES: Land Spatial Consolidation Expert System (Choice) - Αξιολόγηση λύσεων

Multi-criteria decision analysis



Κριτήρια αξιολόγησης

- Μέγεθος νέων τεμαχίων
- Συγκέντρωση των τεμαχίων
- Αναλογία ιδιοκτητών πριν-μετά
- Βαθμός ικανοποίησης ιδιοκτητών
- Ιδιοκτησίες που συμπληρώθηκαν

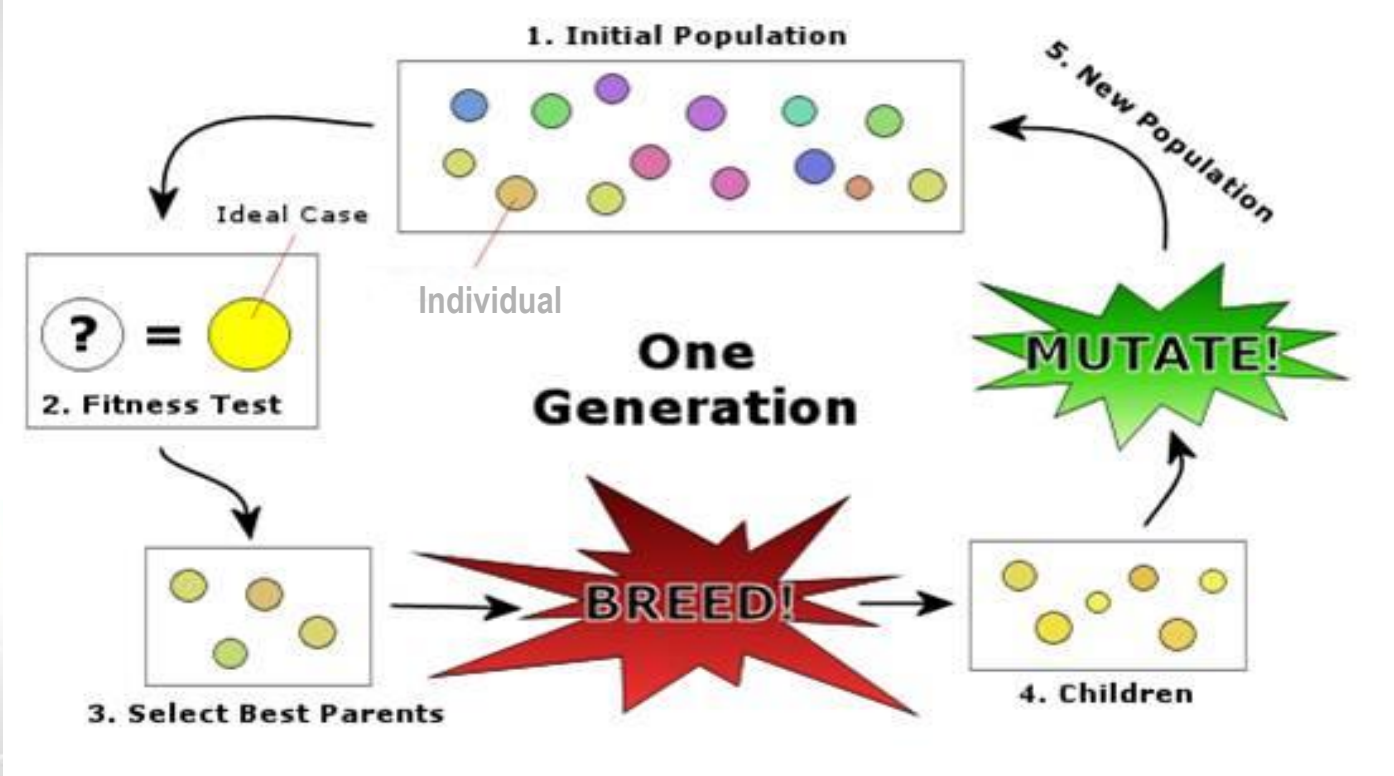


LandParcelS: Land Parcelling System

Multi-objective problem + genetic algorithm:
Βελτιστοποίηση σχήματος, μεγέθους και αξίας των τεμαχίων

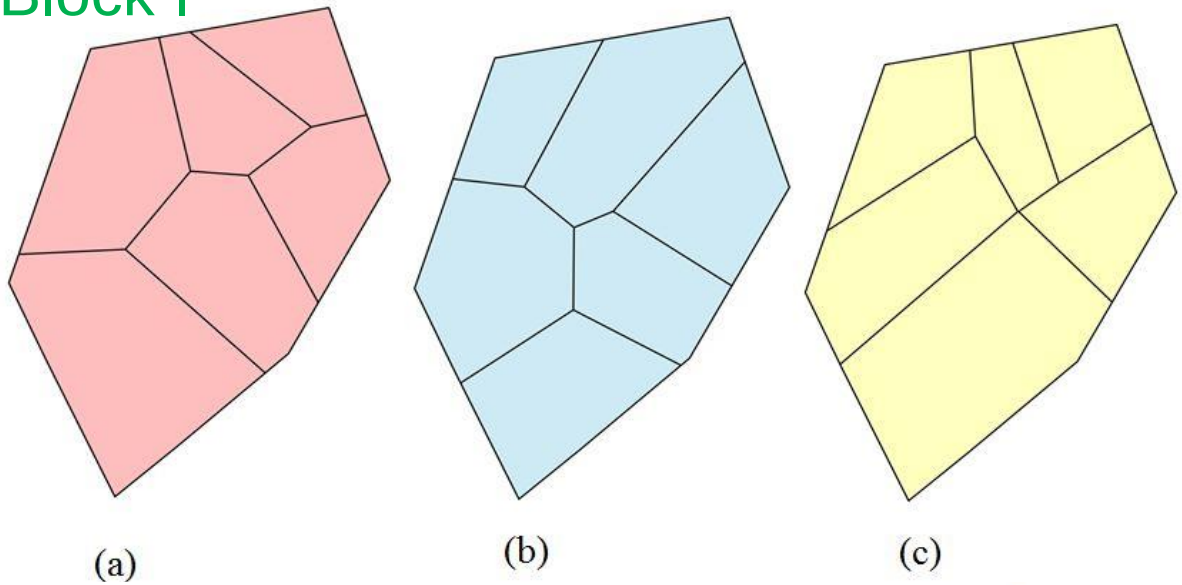
$$Fitness = \left(\sum_{i=1}^{N}(1 - PSI_i) * w_1 + \sum_{i=1}^{N}|dArea|_i * w_2 + \sum_{i=1}^{N}|dValue|_i * w_3\right) + \sum_{i}^{N} R_i$$

PSI= Parcel Shape Index
R=Road access



LandParcelS: Land Parcelling System- Αυτόματη δημιουργία των νέων τεμαχίων

Block I



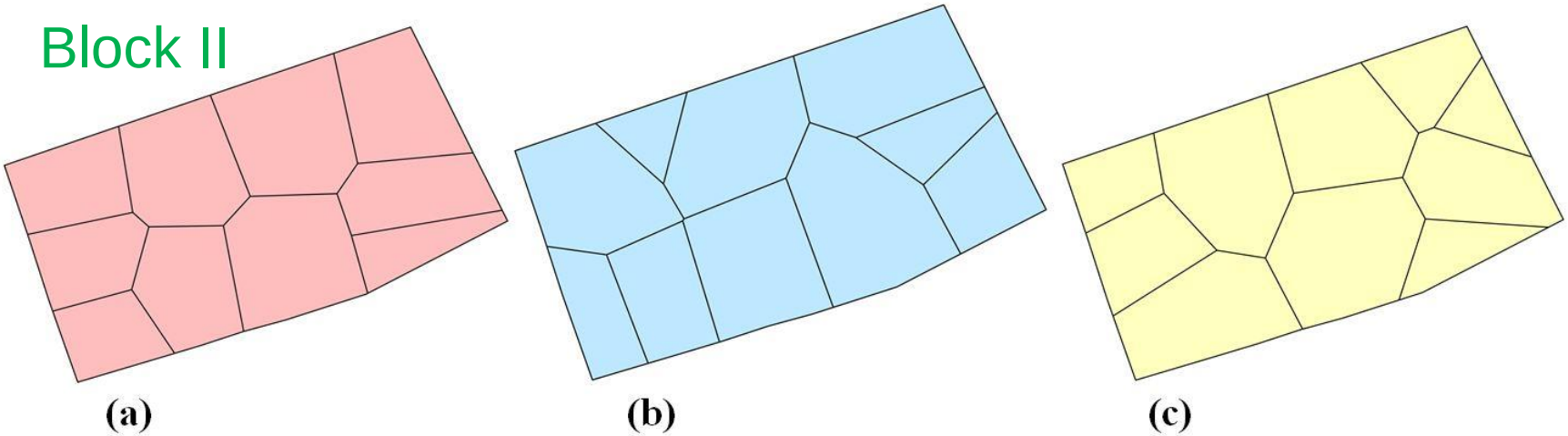
Βελτιστοποίηση:

(a) Σχήματος και μεγέθους

(b) Σχήματος και αξίας

(c) Σχήματος, μεγέθους και αξίας

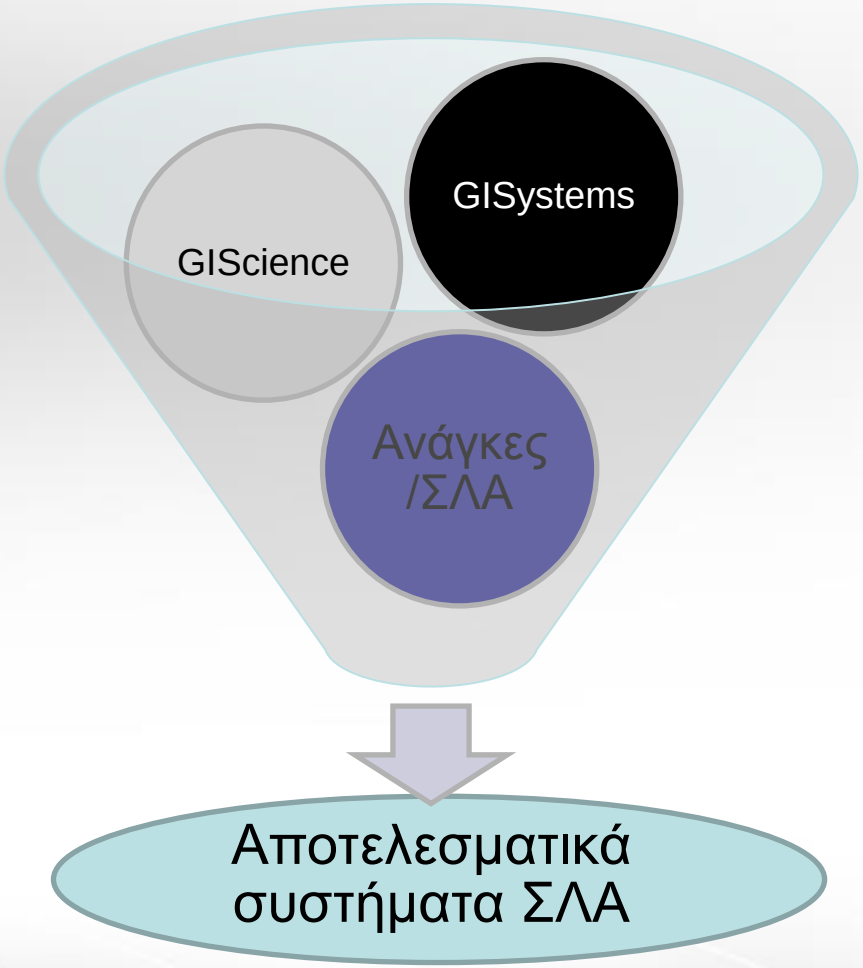
Block II



6.1 Συμπεράσματα

- Υπάρχει ανάγκη για:
  - εξειδικευμένα και προηγμένα συστήματα ΣΛΑ
  - ενσωμάτωση σε πλατφόρμες ΓΣΠ προχωρημένων μεθόδων ΣΛΑ όπως τεχνητής νοημοσύνης, υπολογιστικών μεθόδων, MCDA, 3D απεικόνισης
  - ευκολία ανάπτυξης τέτοιων συστημάτων και προσαρμογής τους σε κάθε συγκεκριμένο πρόβλημα σχεδιασμού

6.2 Συμπεράσματα



Σας ευχαριστώ για την προσοχή σας!