

FIG WORKING WEEK 2012
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“Knowing to manage the territory, protect the environment, evaluate the cultural heritage.”

LandFragmentS*: A New Model for Measuring Land Fragmentation

Demetris Demetriou**, John Stillwell, Linda See
Centre for Spatial Analysis and Policy
School of Geography 
UNIVERSITY OF LEEDS

(LandFragmentS* = Land Fragmentation System)

 Demetris Demetriou**,
District Land Consolidation Officer of Larnaca and Famagusta, Cyprus
Dipl. (Eng.), MSc (Eng.), MSc, PhD (Cand.)

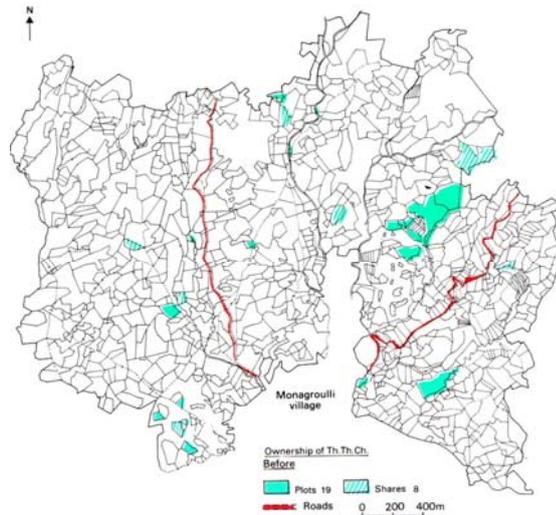
Contents

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- 2. LandFragmentS
- 3. Case study
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Part 1

What is land fragmentation ?

It is a situation in which land ownership consists of many, small, spatially dispersed, irregularly shaped, non accessible and sometimes with problematic legal rights parcels.



Is land fragmentation always a problem?

- Negatives
 - hinders mechanisation
 - inefficient production
 - large costs
 - reduction in income
 - land abandonment
 - conflicts between owners
- Positives
 - risk management
 - crop scheduling
 - ecological variety



Part 2 Existing land fragmentation indices

- Not comprehensive
 - take into account only a couple of factors
- Not flexible
 - factors involved are standard
- Not problem specific
 - factors involved have the same weight
- Non-spatial factors ignored
 - type of ownership (dual / shared) and the accessibility on a road

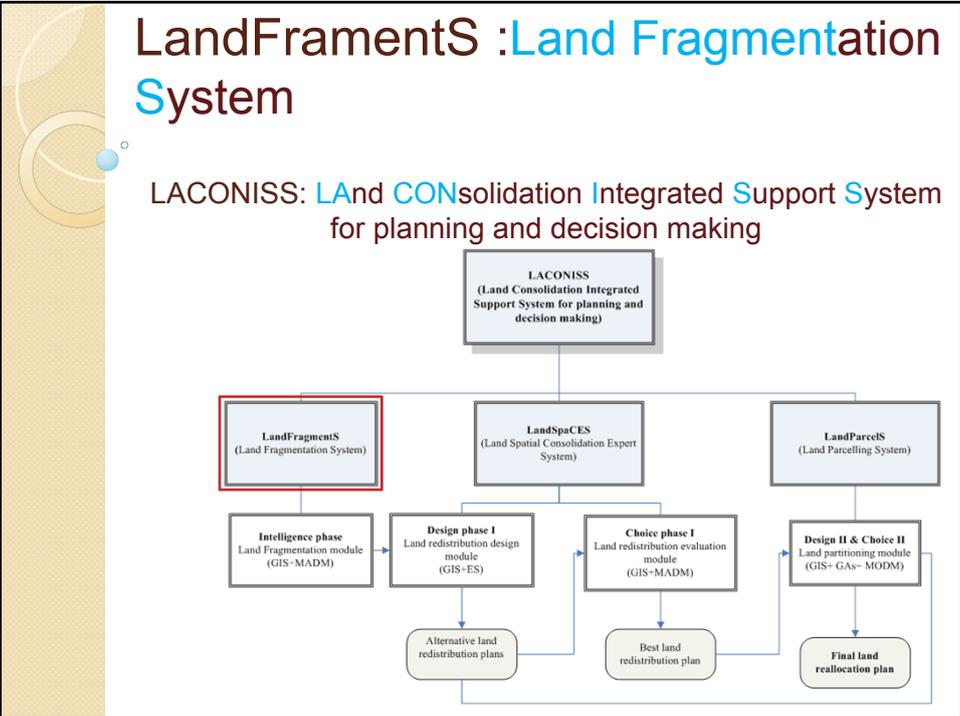
$$FI = \frac{\sum_{i=1}^n a^2}{A^2}$$

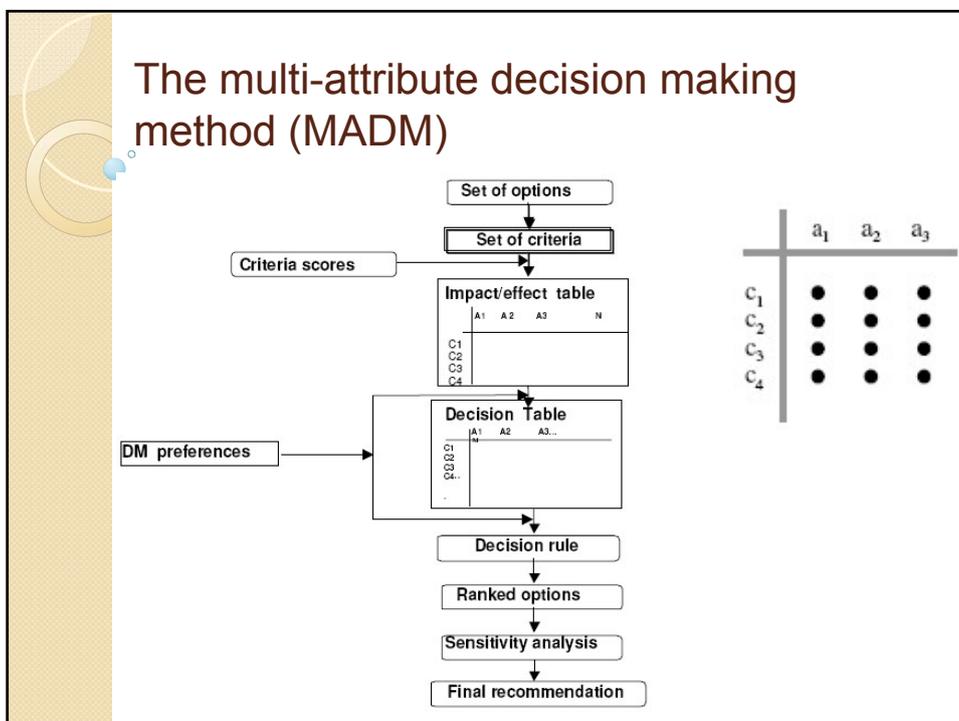
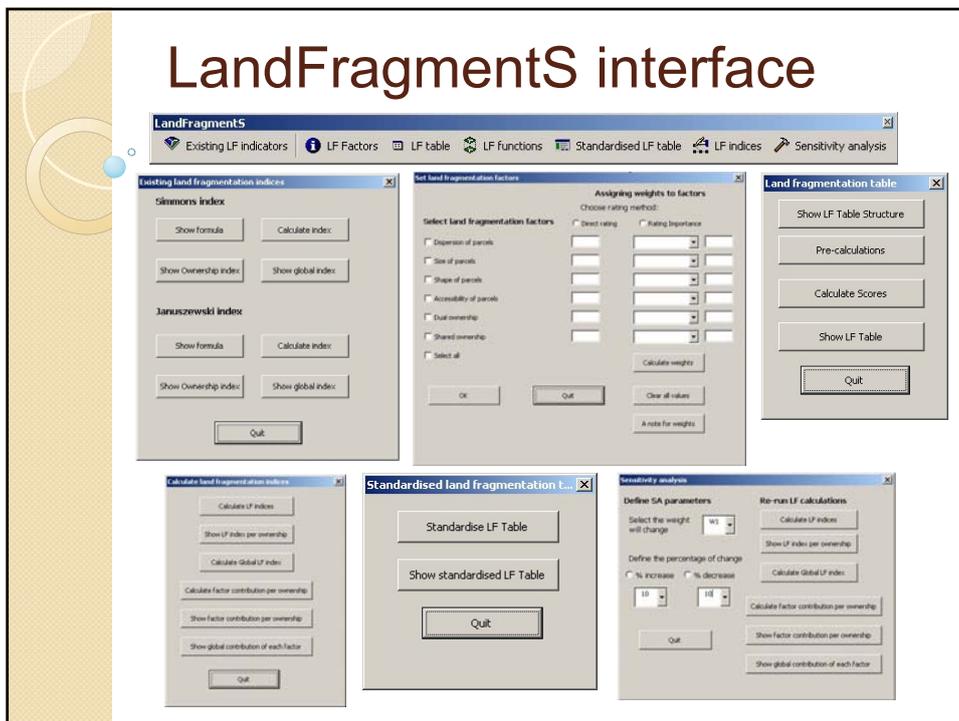
Simmons (1964)

$$K = \frac{\sqrt{\sum_{i=1}^n a}}{\sum_{i=1}^n \sqrt{a}}$$

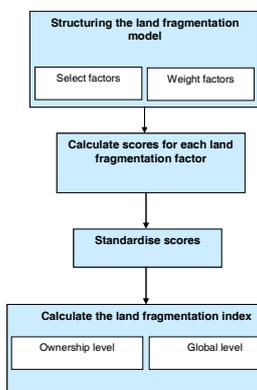
Januszewski (1968)

- α= size of a parcel
- A=size of a holding
- n=number of parcels belong in a holding





The new methodology: GIS+MADM



Ownership ID of holding	Land fragmentation factors (Weights)						Index	
	F ₁ (w ₁)	F ₂ (w ₂)	F ₃ (w ₃)	..	F _j (w _j)	..		F _m (w _m)
1	f ₁₁	f ₁₂	f ₁₃	..	f _{1j}	..	f _{1m}	LFI ₁
2	f ₂₁	f ₂₂	f ₂₃	..	f _{2j}	..	f _{2m}	LFI ₂
3	f ₃₁	f ₃₂	f ₃₃	..	f _{3j}	..	f _{3m}	LFI ₃
..
i	f _{i1}	f _{i2}	f _{i3}	..	f _{ij}	..	f _{im}	LFI _i
..
n	f _{n1}	f _{n2}	f _{n3}	..	f _{nj}	..	f _{nm}	LFI _n
								GLFI

$$LFI_i = \sum_{j=1}^m f_{ij} w_j \quad \begin{matrix} 0 = \text{worst LF} \\ 1 = \text{least LF} \end{matrix}$$

$$GLFI = \sum_{i=1}^n LFI_i / n$$

GLFI = f (Dispersion) + f (Size) + f (Shape) + f (Accessibility) + f (Dual ownerships) + f (Shared ownerships)

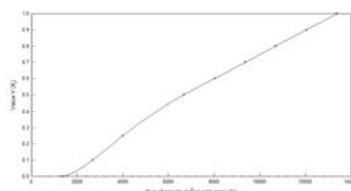
Land fragmentation factors

- Dispersion of parcels (F1)

$$DoP = \sqrt{\frac{\sum_{i=1}^n (x_i - x_{hmc})^2 + \sum_{i=1}^n (y_i - y_{hmc})^2}{n}}$$

where x_i and y_i are the co-ordinates of the centroid of parcel i and x_{hmc} and y_{hmc} are the coordinates of the holding's mean centre

- Size of parcels (F2)

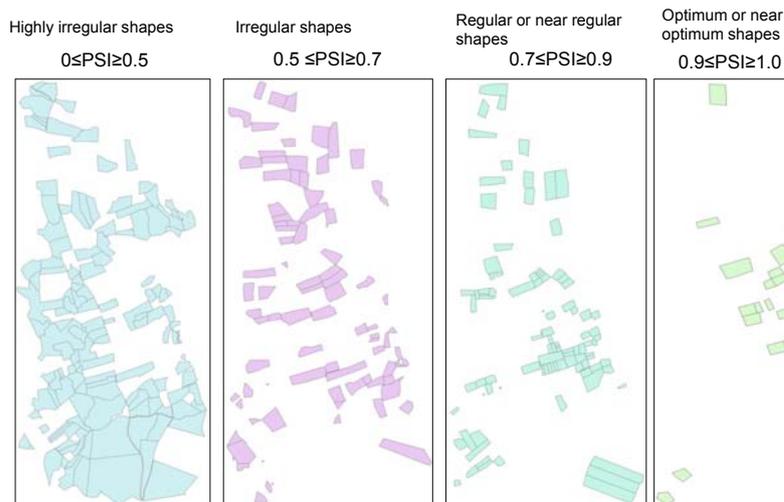


$$V(x_i) = -1.71(10^{-20} x_i^5) + 6.83(10^{-16} x_i^4) - 9.97(10^{-12} x_i^3) + 6.36(10^{-8} x_i^2) - 7.37(10^{-5} x_i) + 5.58(10^{-3})$$

Land fragmentation factors

- Shape of parcels (F3)

PSI = f (length of sides) + f (acute angles) + f (reflex angles) + f (boundary points) + f (compactness) + f (regularity)



Land fragmentation factors

- Accessibility of parcels (F4)

1 (parcel has access on a road) or 0 (parcel has no access on a road)

- Dual ownership (F5)

1 (parcel is a dual ownership) or 0 (parcel is not a dual ownership)

- Shared ownership (F6)

1 (parcel is a shared ownership) or 0 (parcel is not a shared ownership)

- The score of F4, F5 and F6 is calculated as the average value of the assigned 1s and/or 0s of all the parcels that belong to a holding

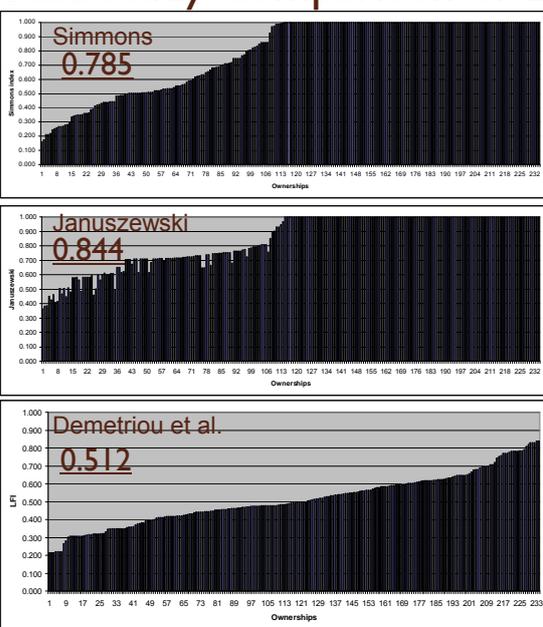
Part 3 Case study area




Land consolidation area
 Chlorakas village in the District of Pafos
 195 hectares
 253 holdings
 340 parcels/shares

Case study: comparison of distributions

0= worst LF
 1= least LF
 Min, Max, Mean
 0.160, 1.0, 0.785



0.364, 1.0, 0.844

0.216, 0.839, 0.512

Evaluate LandFragmentS

- | Existing indices | Vs LandFragmentS |
|---|--|
| <ul style="list-style-type: none"> ○ Not comprehensive <ul style="list-style-type: none"> ○ take into account only a couple of factors ○ Not flexible <ul style="list-style-type: none"> ○ factors involved are standard ○ Not problem specific <ul style="list-style-type: none"> ○ factors involved have the same weight ○ Non-spatial factors ignored <ul style="list-style-type: none"> ○ type of ownership and the accessibility on a road | <ul style="list-style-type: none"> ○ Comprehensive <ul style="list-style-type: none"> ○ takes into account six factors ○ Flexible <ul style="list-style-type: none"> ○ factors involved can be selected by the planner ○ Problem specific <ul style="list-style-type: none"> ○ factors involved may have a different weight defined by the planner ○ Non-spatial factors taken into account <ul style="list-style-type: none"> ○ type of ownership and the accessibility on a road |

Part 4

Conclusions

- Land fragmentation is often a serious rural spatial problem
- Existing land fragmentation indices are poor
- LandFragmentS is a flexible tool that integrates GIS and MADM and overcomes the weaknesses of existing indices
- GLFI outperforms existing land fragmentation indices
- MADM can be utilised for measuring the performance of an existing system



**Many thanks for your attention
and patience!**