



**University of Pavia – Department of Electrical, Computer and Biomedical Engineering**

# **Social Networks and Computational Sustainability: Challenges and Proposals**

**Keynote speech**

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Sixth International Conference on Building and Exploring Web Based Environments - WEB 2018  
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# Outline

- ✓ An introduction to the University of Pavia
- ✓ Research/Development field: Computational Sustainability
  - ✓ Key definitions and concepts
- ✓ Our two applications
  - ✓ Land use metric: the Anthropoentropy Factor.
  - ✓ Social Networks in the Academic Environment, a Gamefication Based System
- ✓ Conclusions



# **INTRODUCTION**

# University of Pavia

- ✓ Officially established in 1361
- ✓ Notable professors:
  - ✓ Alessandro Volta (1745-1827)
  - ✓ Girolamo Cardano (1501-1576)
  - ✓ Antonio Scarpa (1752-1832)
  - ✓ Camillo Golgi (1843-1926)
- ✓ Today:
  - ✓ 24000 students, from Italy and from overseas.
  - ✓ Around 4500 graduations per year, with around 700 students obtaining a post-graduate qualification





# **COMPUTATIONAL SUSTAINABILITY**



# UniPV - CSU

Computational Sustainability Unit ([LINK](#)),

Department of Electrical, Computer and Biomedical Engineering

Director: prof. Maria Grazia Albanesi

- ✓ Multidisciplinary approach:
  - ✓ Department of Economics and Management
  - ✓ Department of Earth and Environmental Sciences



# Computational Sustainability

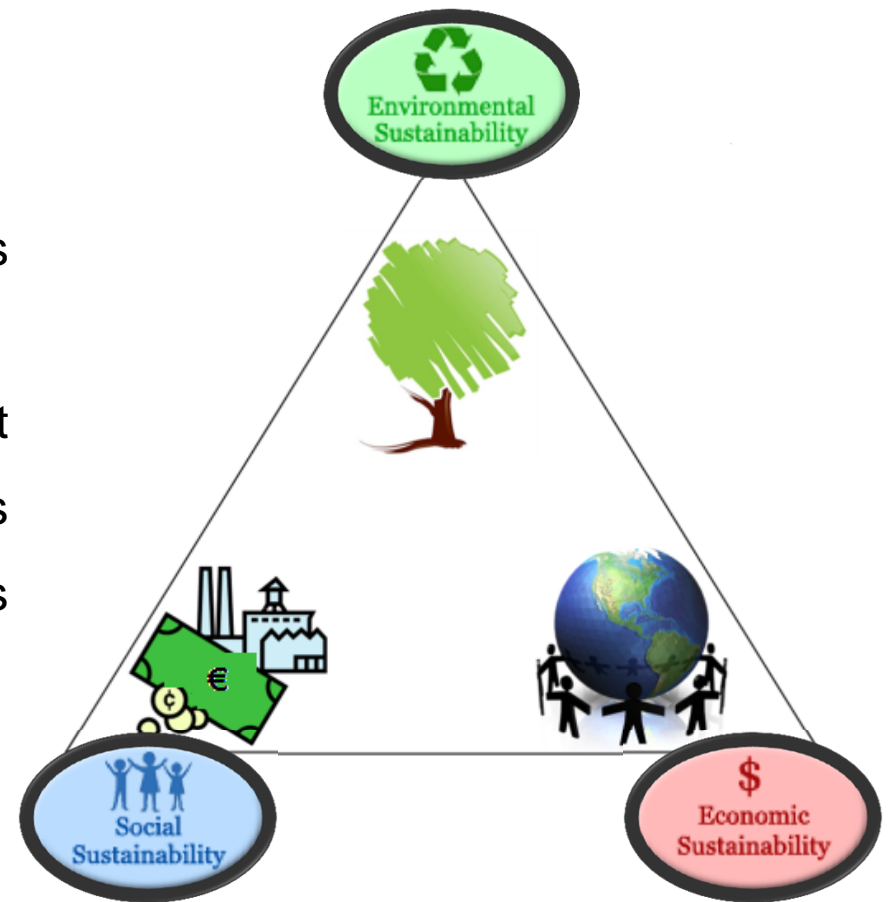
- ✓ First conference: 2009, USA.
- ✓ Most recent: <http://www.compsust.net/compsust-2017/>
- ✓ The Computational Sustainability Network: <http://www.compsust.net/>
- ✓ Definition(1987, [«Report of the World Commission on Environment and Development: Our Common Future»](#)):
  - «Sustainable development is development that meets the *needs of the present* without compromising *the ability of future generations to meet their own needs*»
- ✓ Two key concepts:
  - ✓ Present and future needs
  - ✓ Limitations to the ability to satisfy those needs.



# Sustainability

What is implicit in the definition:

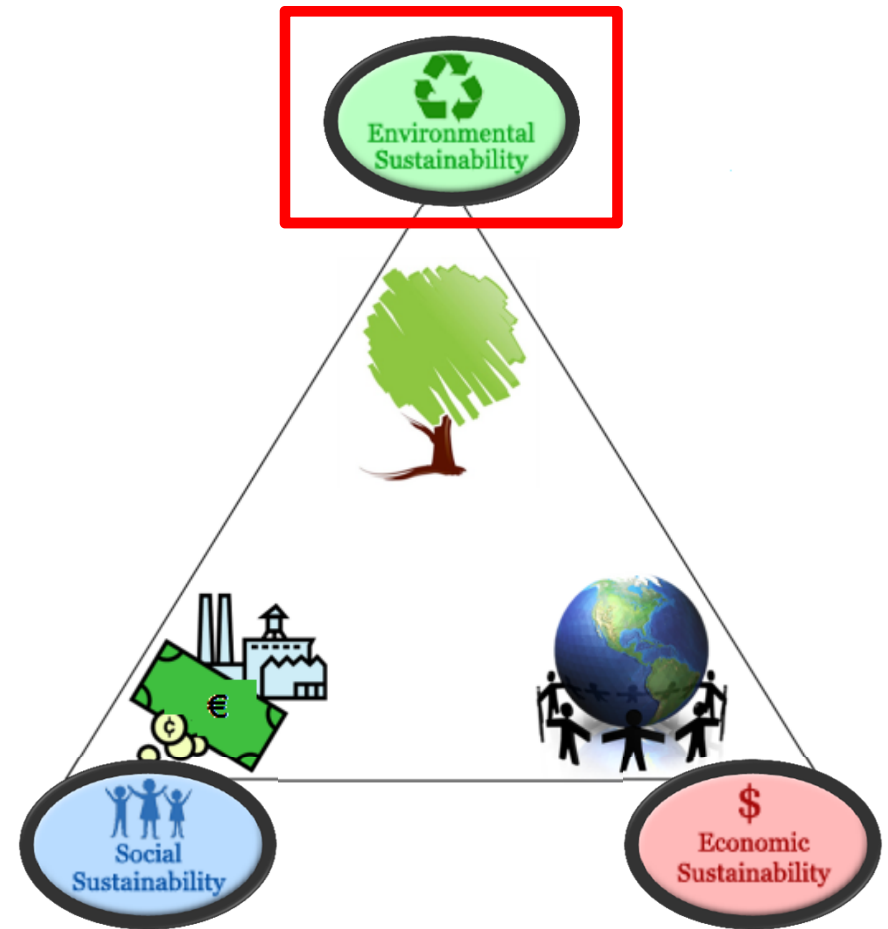
- ✓ Time.
- ✓ The need to measure the effects of human development.
- ✓ The existence of a contrast between the immediate needs (short-term) vs. the future needs (long-term).



# Sustainability

## Environmental Sustainability:

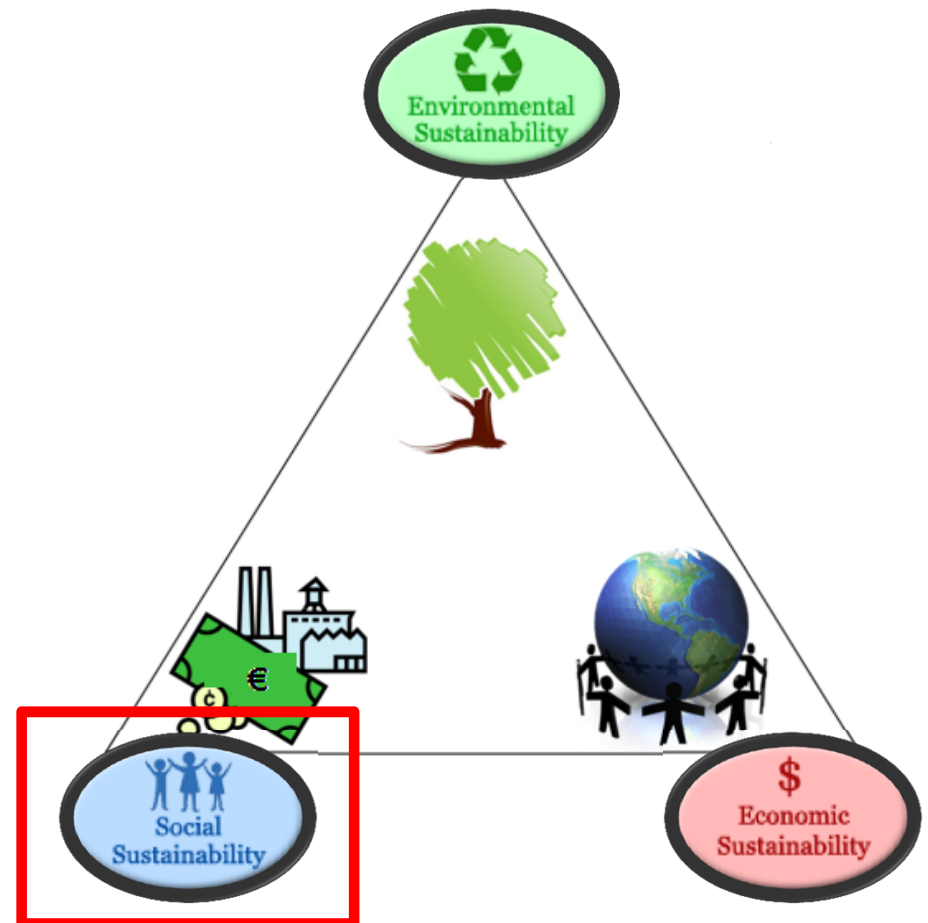
- ✓ Air quality metrics
- ✓ Food production optimization
- ✓ Land use
- ✓ Low impact oil drills



# Sustainability

## Social Sustainability

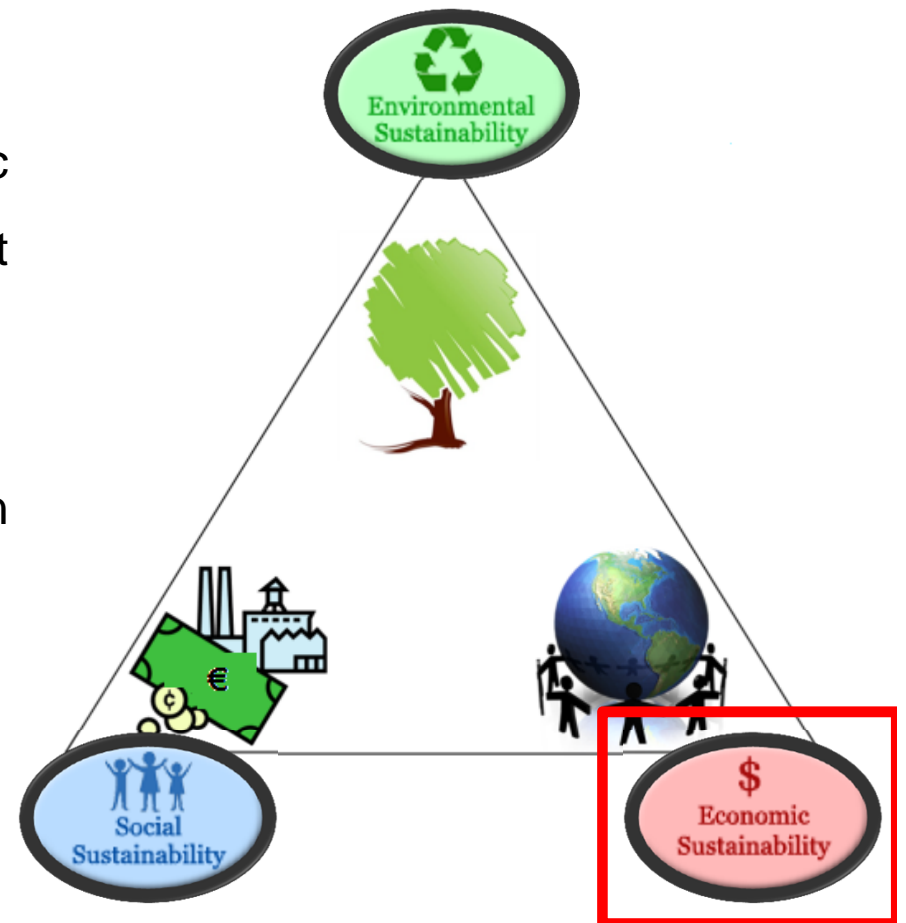
- ✓ Information Sharing.
- ✓ Gender and social based discrimination in the education/market.
- ✓ Knowledge management.



# Sustainability

## Economic Sustainability:

- ✓ Decoupling economic development from environment degradation
- ✓ Green IT and Green Economy
- ✓ Nature and nature preservation as an economic system





# Our Proposals

- Web Applications for...
  - Land use computation
  - Academic teaching
- Leverage the power of social networks to increase the engagement of people into activities that are either preliminary or central to Computational Sustainability



Social Networks for



# **LAND USE COMPUTATION**



# Land Use Computation

The percentage of land occupied by:

- ❖ Houses and buildings in general (firms, schools, hospitals etc.)
- ❖ Roads and Railways
- ❖ Intensive agricultural sites (i.e., plant nursery)

Has different negative effects on the environment around each of these structures.



# Land Use: Negative Effects

- Soil sealing
- Fragmentation and reduction of biodiversity
- Pollution

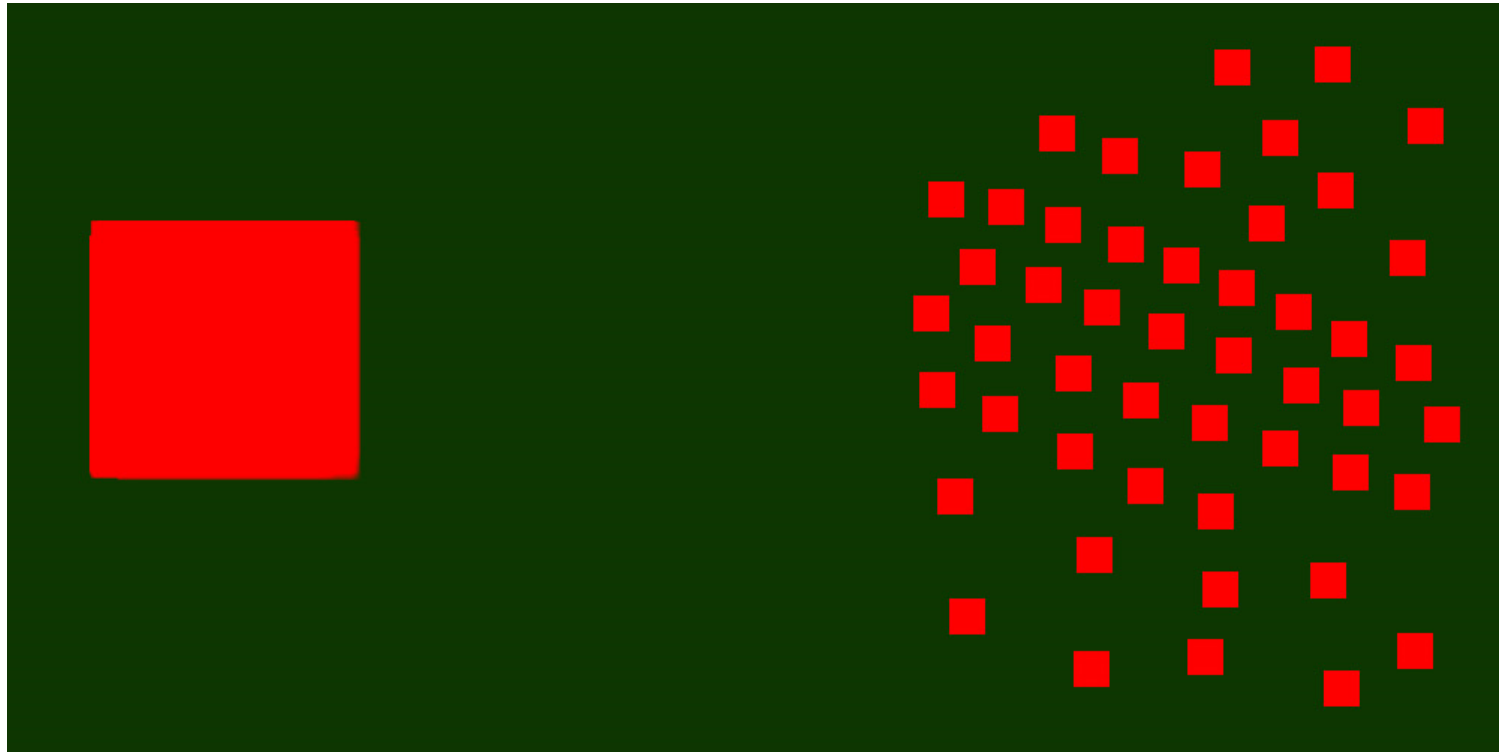
111 788 ha/year in EU\*

Land take in Italy: + 6.3%\*\* (1956-2006)

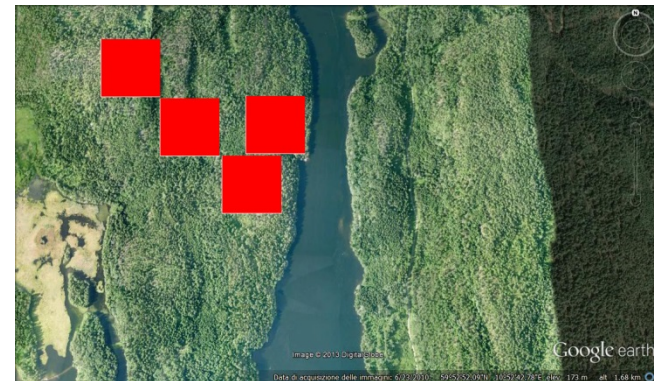
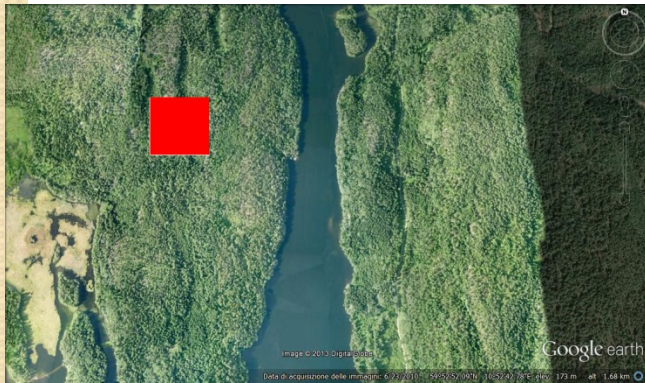
Sources: \* European Environment Agency, \*\*ISPRA



# An Example of Negative Effect: Fragmentation

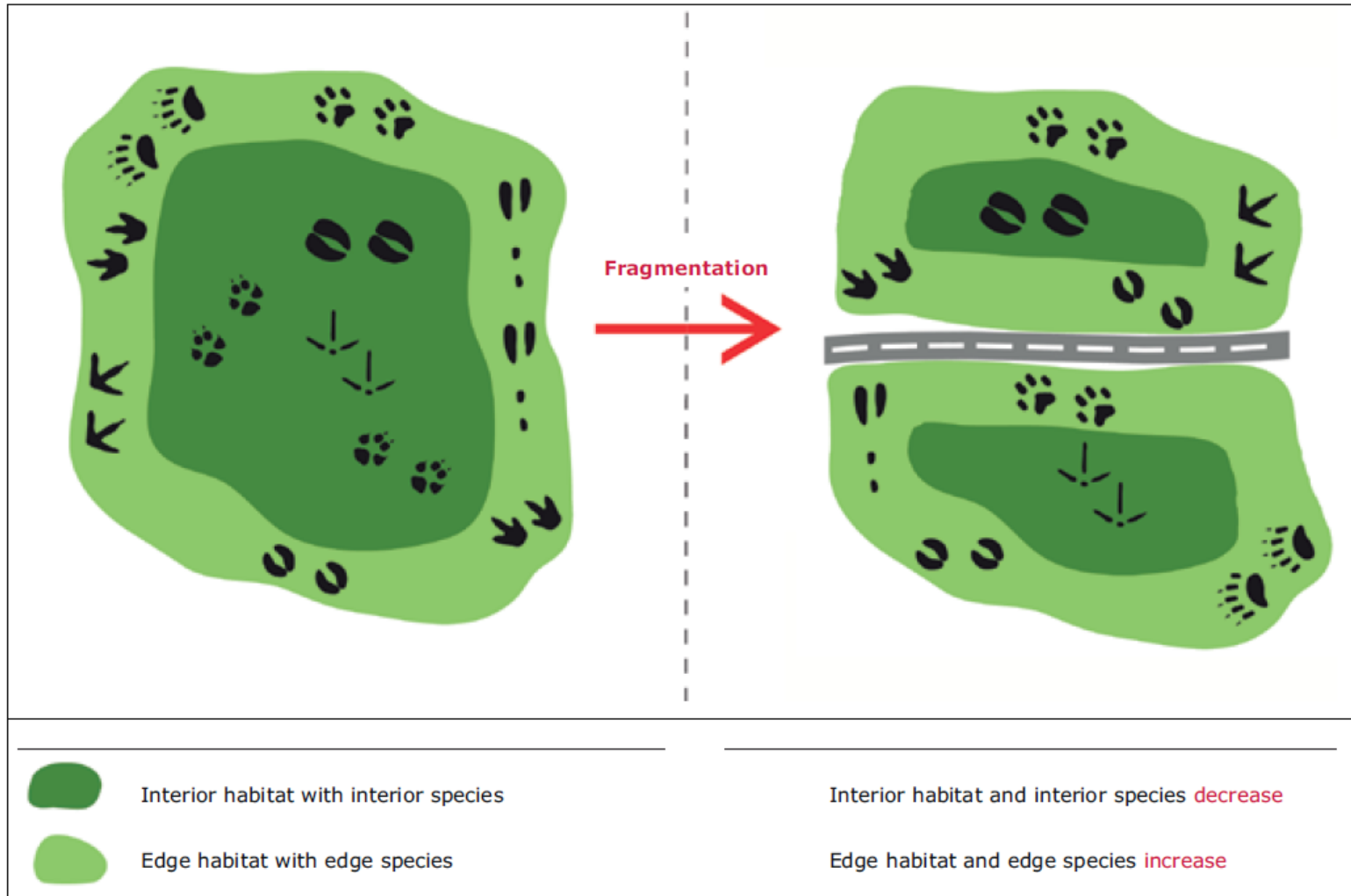


# An Example of Negative Effect: Fragmentation



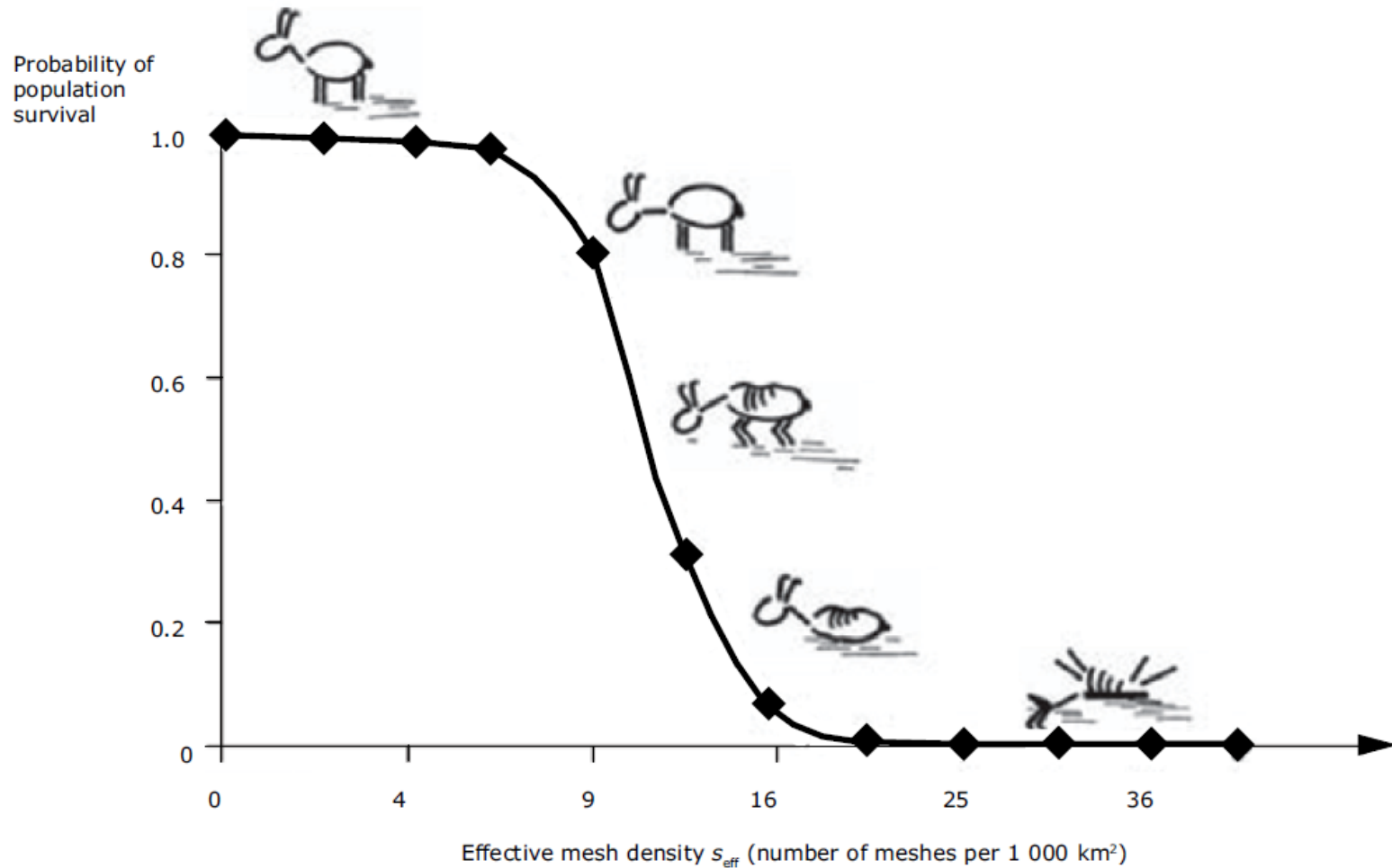
# An Example of Negative Effect: Fragmentation

Landscape Fragmentation in Europe, EEA –FOEN T.R n. 2/2011



# An example of negative effect: Fragmentation

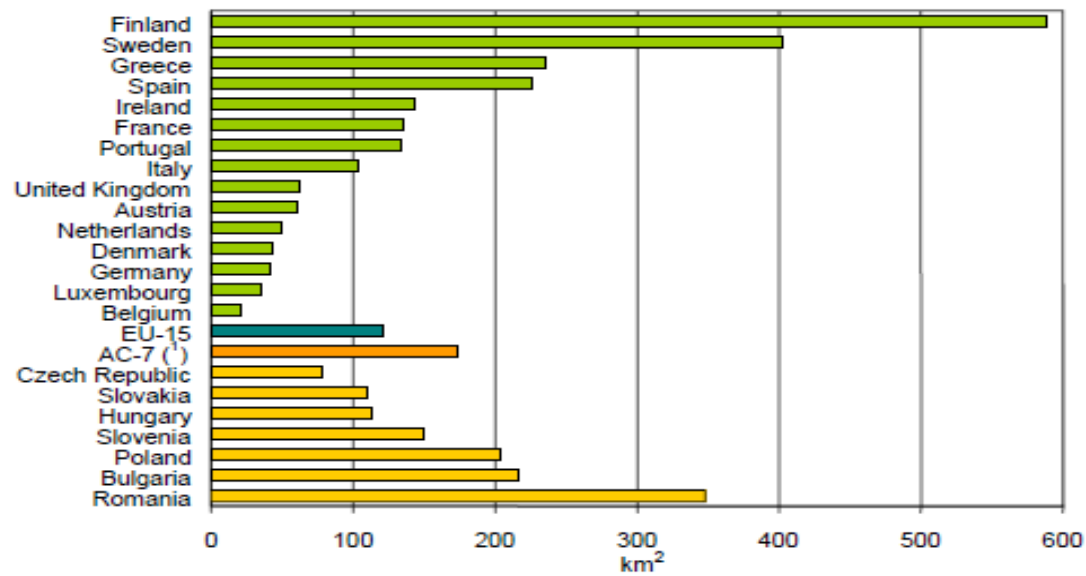
Landscape Fragmentation in Europe, EEA –FOEN T.R n. 2/2011



# Fragmentation

An example of suboptimal indicator:

**Figure 1: Average size of non-fragmented land parcels**



(<sup>1</sup>) AC-7 refers to the ACs shown in the graph.

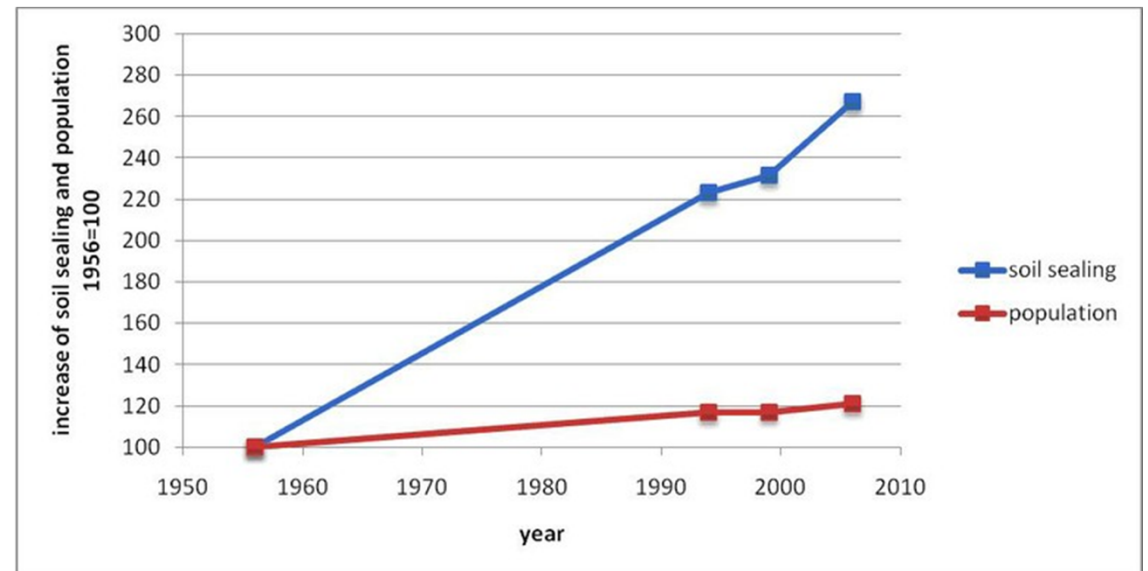
Data on EU and AC infrastructure refer to 1998.

Source: EEA-ETC/TE, 2002.

# Land Use – Common Indicators

## Classical approach

- ✓ Population based
- ✓ Area based



## Requested features

- ✓ Fragmentation and continuity
- ✓ Easy to be computed and updated
- ✓ Automatic or semi-automatic

# A New Indicator: Anthropentropy

*Anthropos* (ἄνθρωπος) = man

*Entropy* = disorder

***The anthropentropy of a territory***

$$AF = DA / (S - NA)$$

Where

S: Area of the territory

DA: Death Area

NA: Neutral area

# Neutral Area

*Neutral area* is the part of the territory containing:

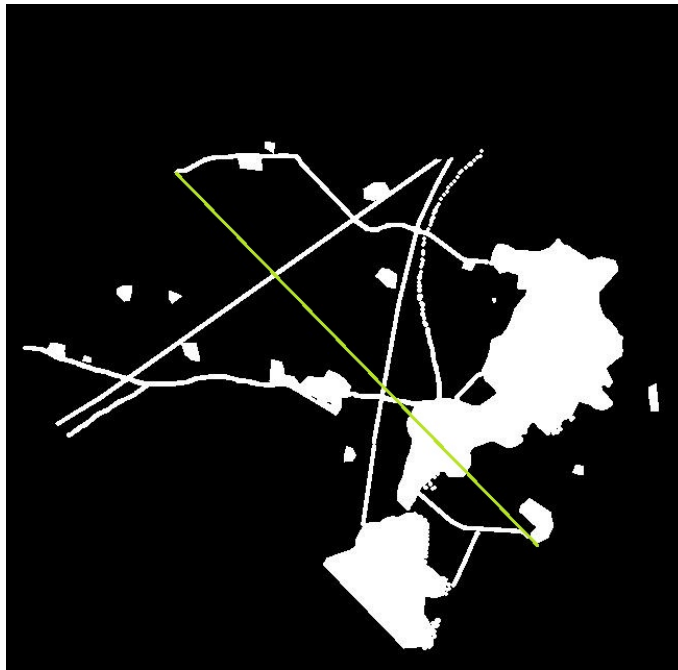
- ✓ inland water (lakes, lagoons etc.) larger than 2 km<sup>2</sup>
- ✓ lands located more than 3000 m above sea level.



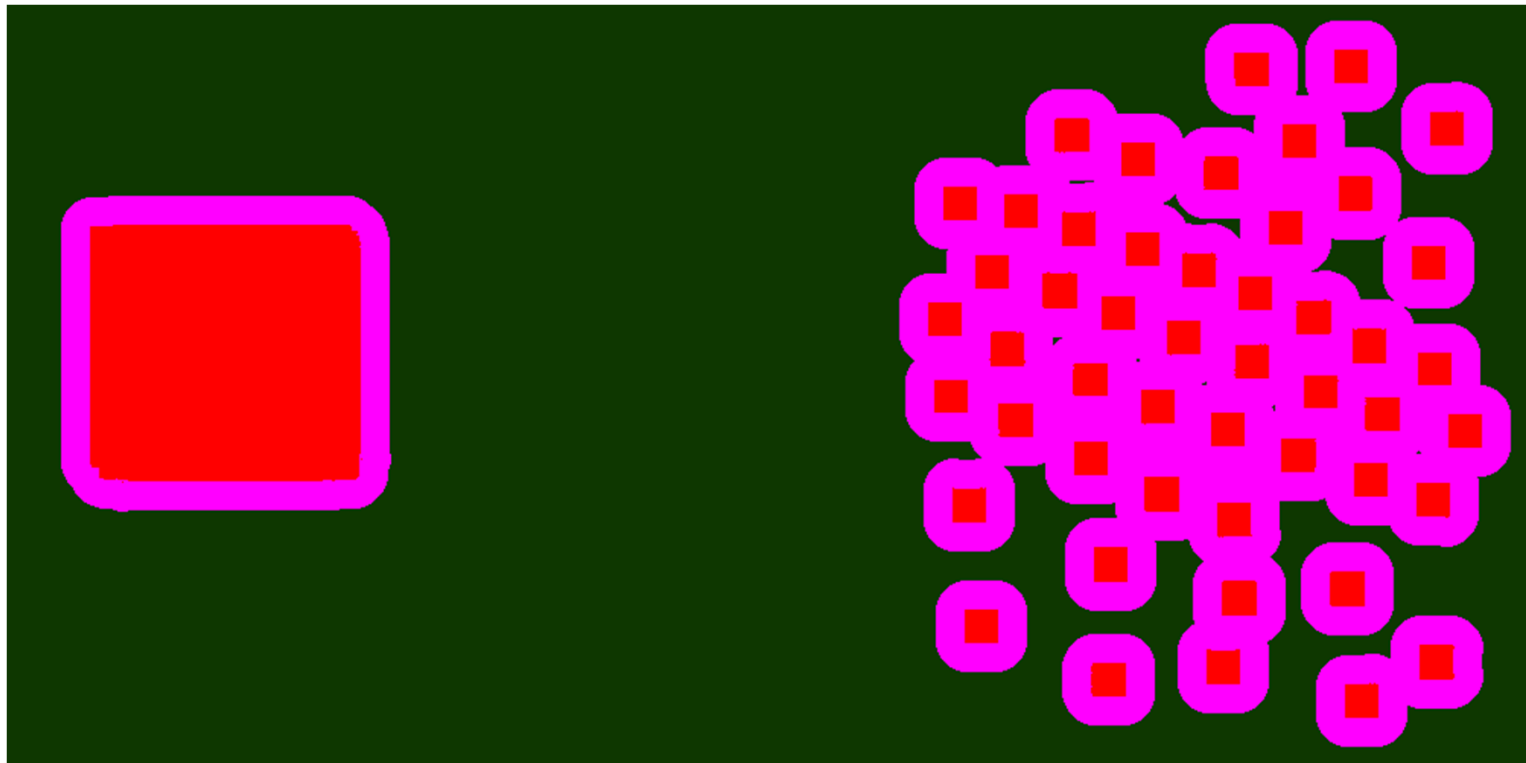


# Death Area

The anthropic area is increased by 50 m buffer in each direction (bidimensional metric).



# Death Area and Fragmentation



# The Metric

$0.0 < AF \leq 0.2$   
condition

OK optimal environment  
preservation for land use, ideal

$0.2 < AF \leq 0.4$

First worrying level

$0.4 < AF \leq 0.6$

Serious degradation

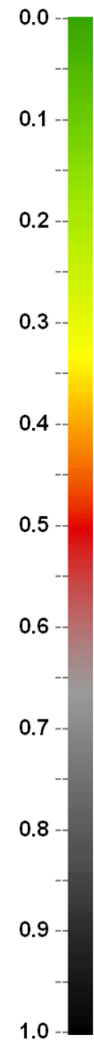
$0.6 < AF \leq 0.8$

Very serious degradation

$0.8 < AF \leq 1.0$

Irreversible situation

A possible application: to help local government in  
planning new urban expansions.





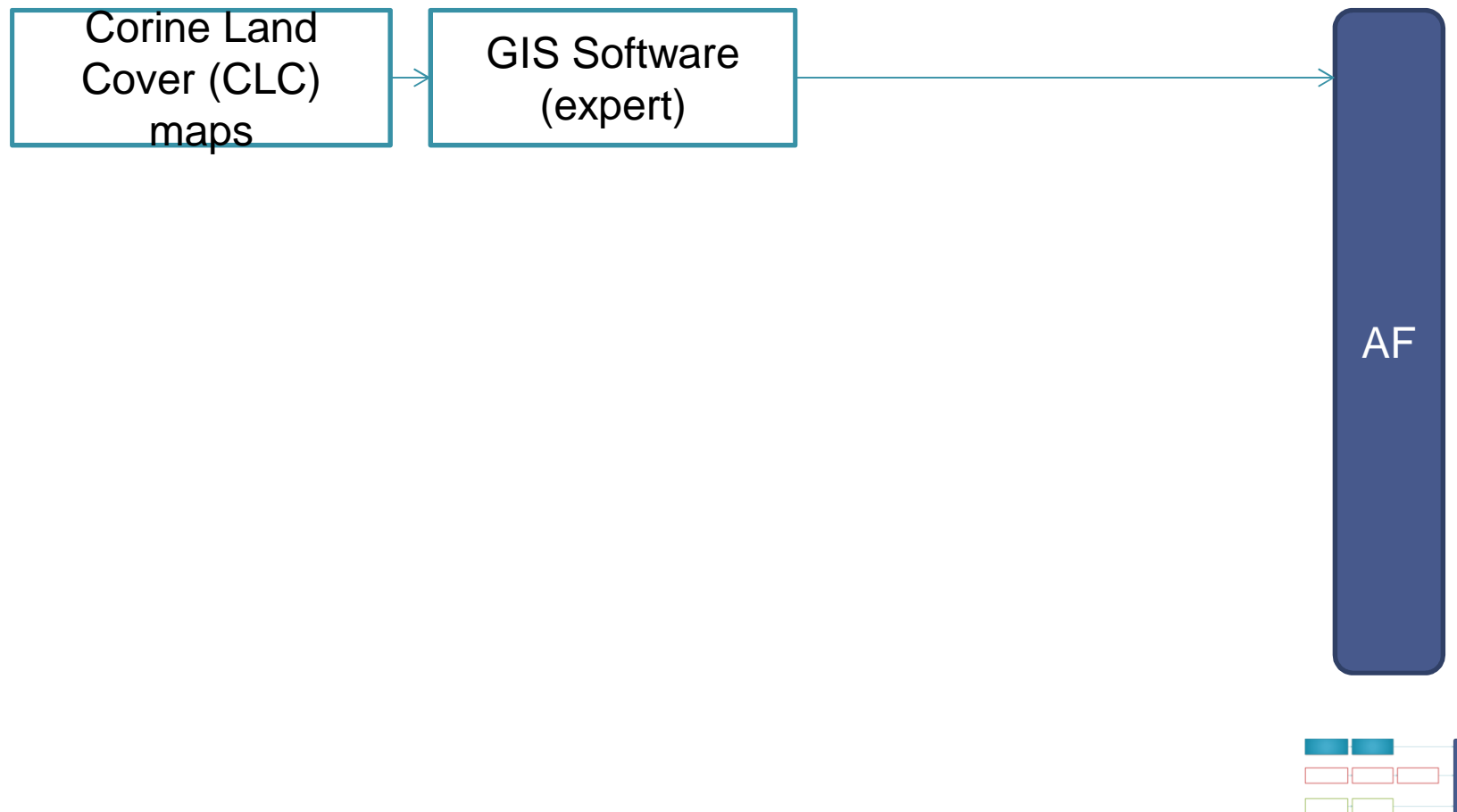
# Data Sources

Two main problems:

- ✓ Availability of annotated maps, where land use in terms of anthropic places is evident.
- ✓ Map scale accuracy: must be comparable with the size of the dilation chosen for the algorithm.

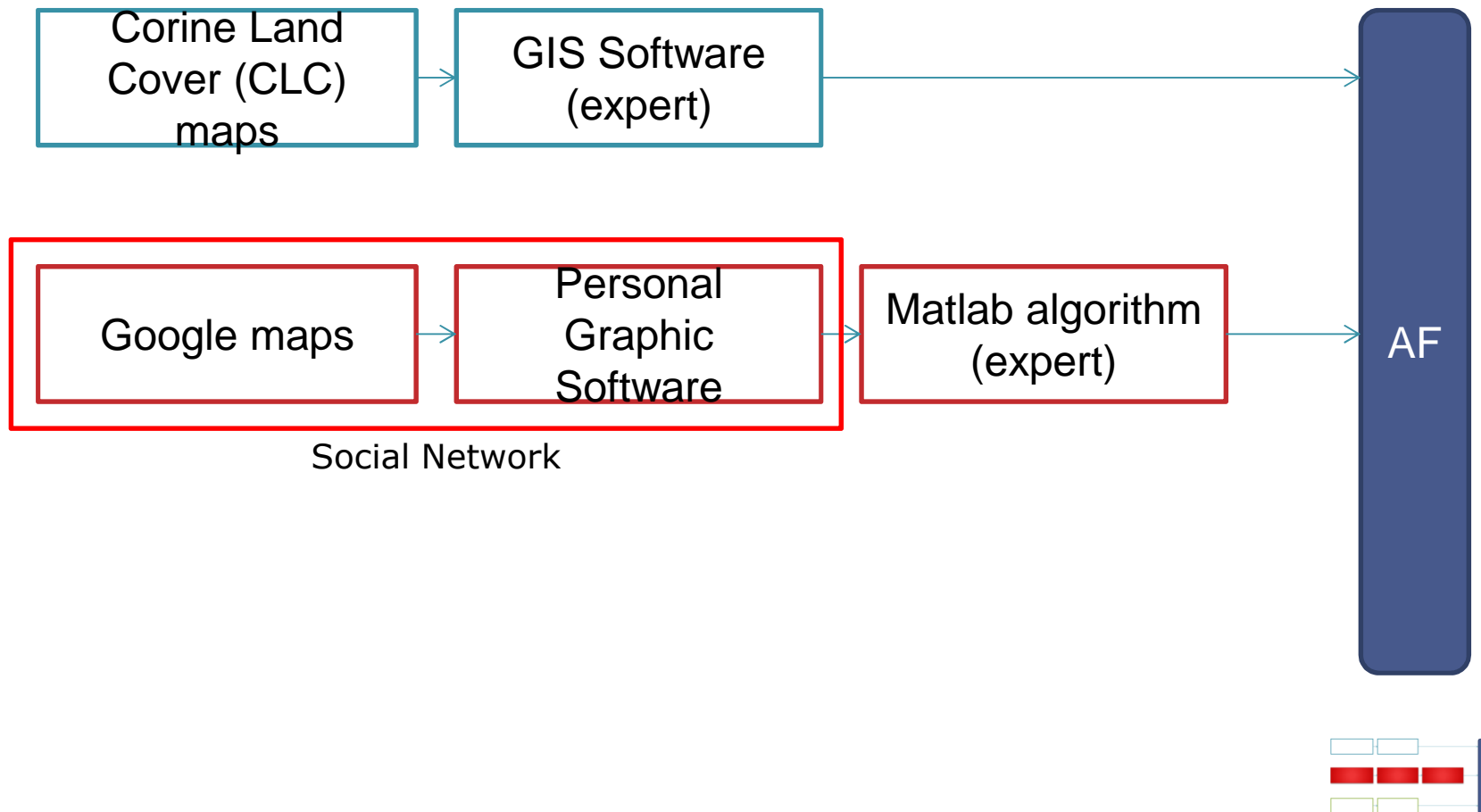
# Possible Solutions

Our project has been developed in different phases:



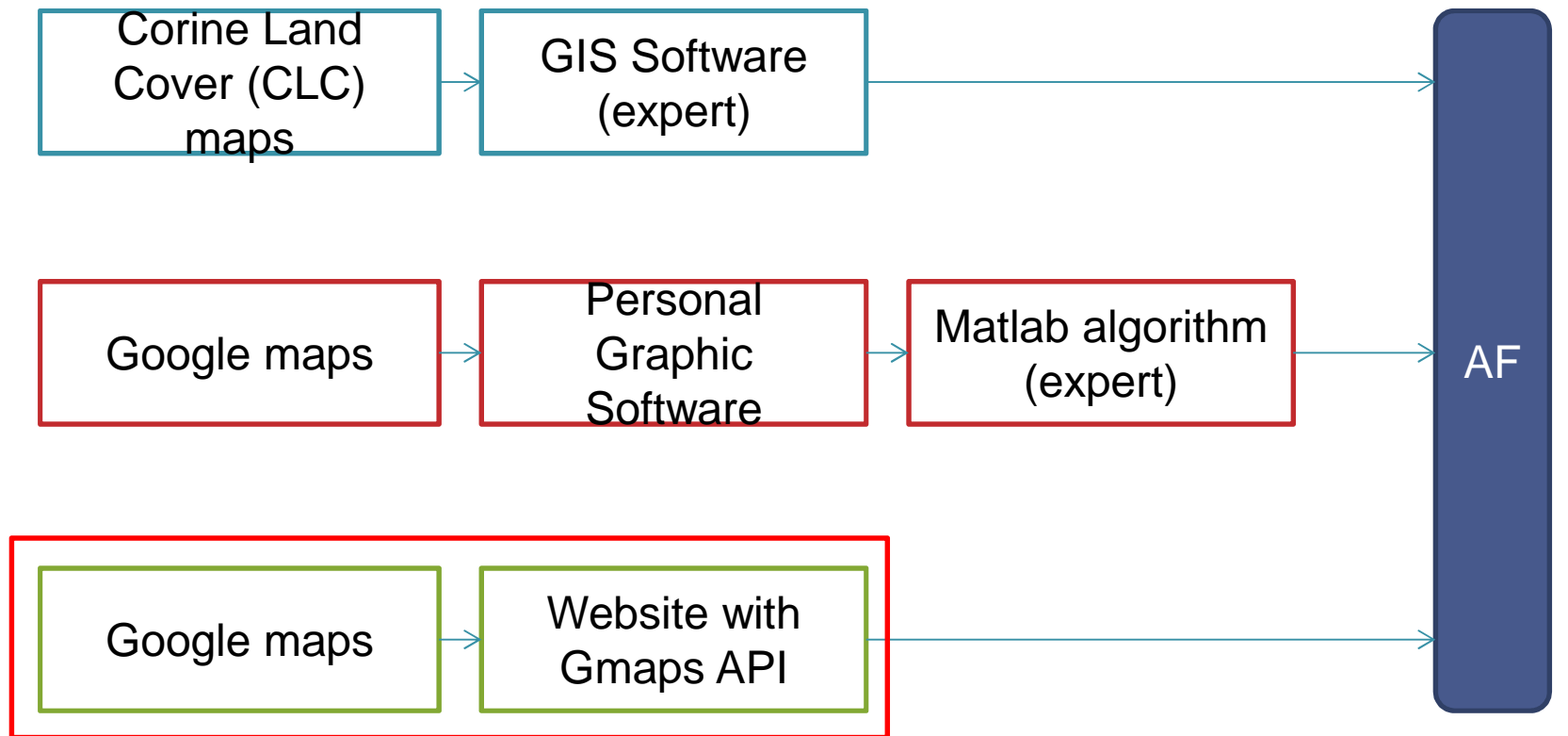
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






Dedicated website/app



# Legend of Corine Land Cover

## CLC types 2000

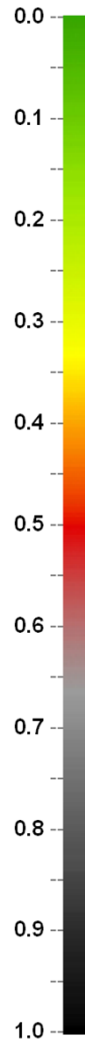
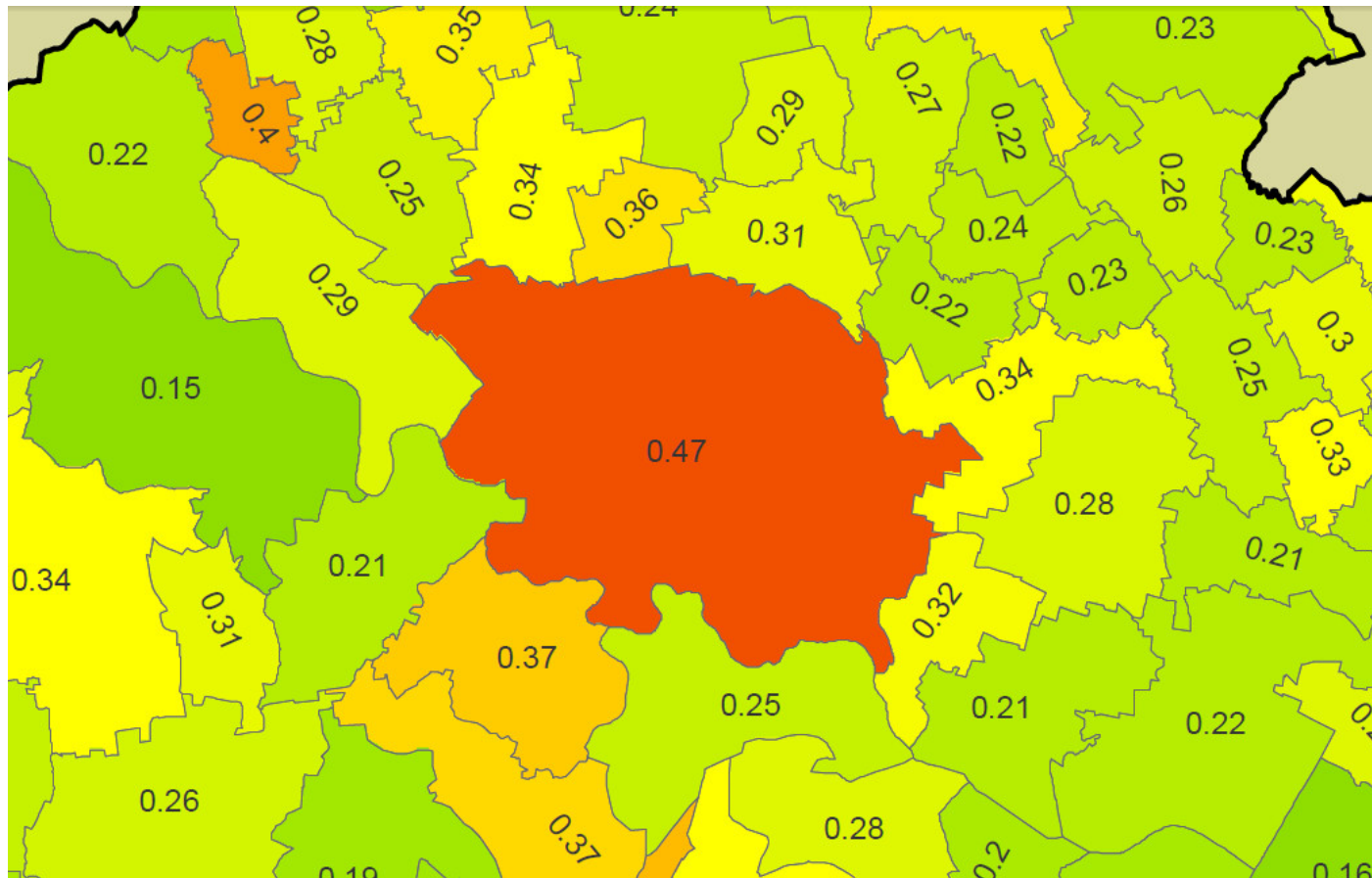
-  Artificial areas
-  Arable land and permanent crops
-  Pastures and mosaics
-  Forested land
-  Open spaces/bare soils
-  Wetlands
-  Water bodies
-  No data
-  Outside data coverage



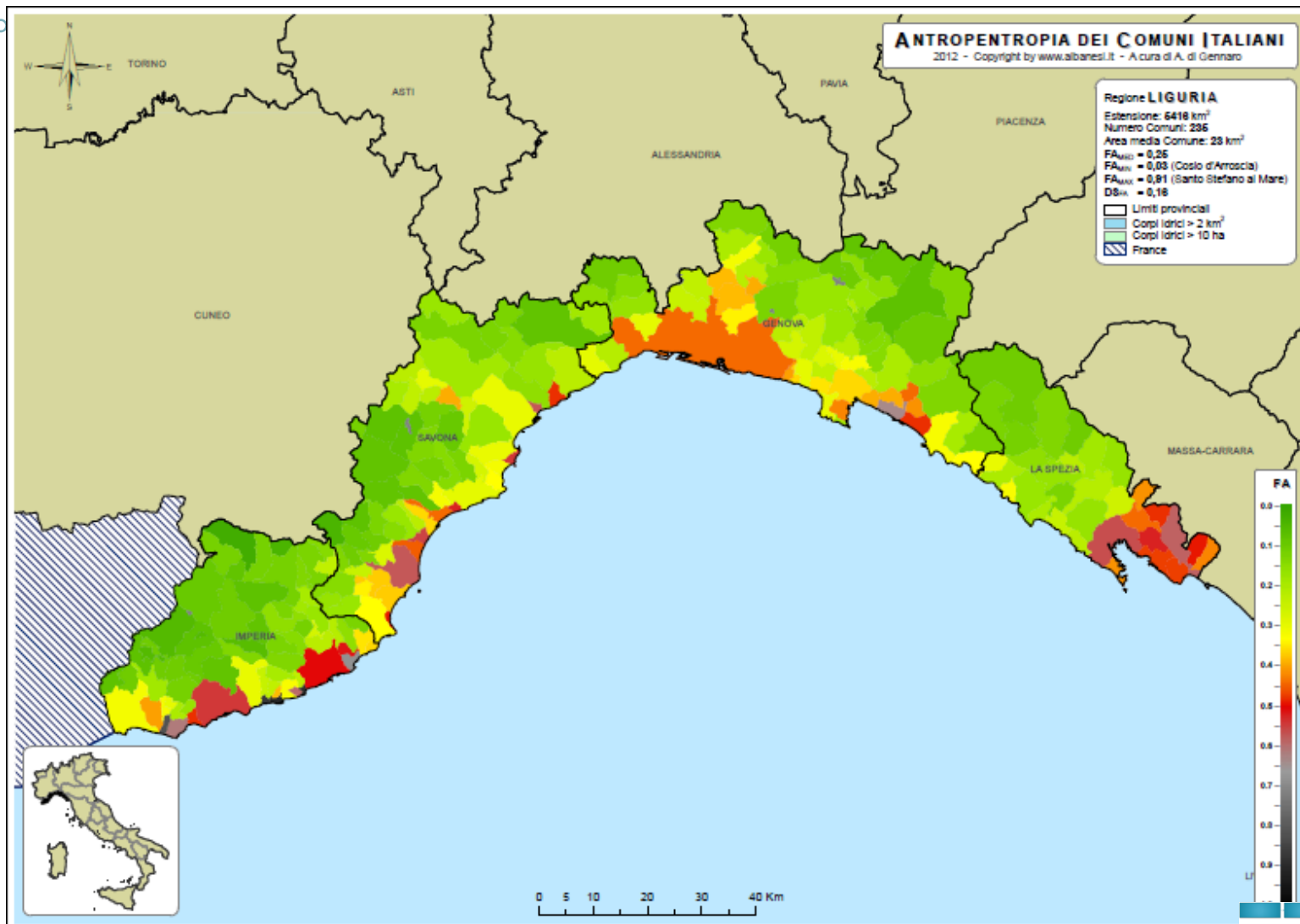


# Goal

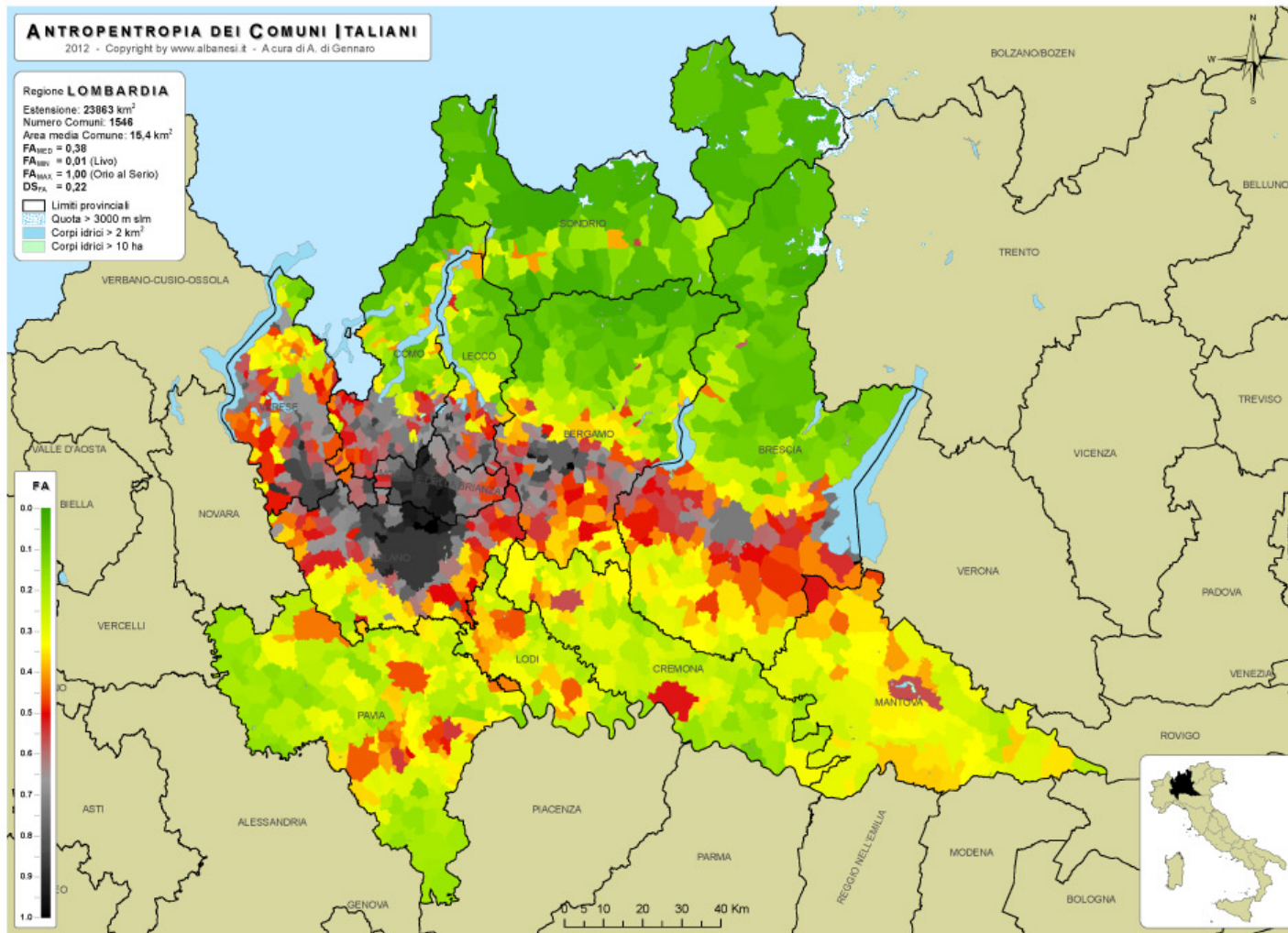
- Have each Italian municipality labelled with an AF value



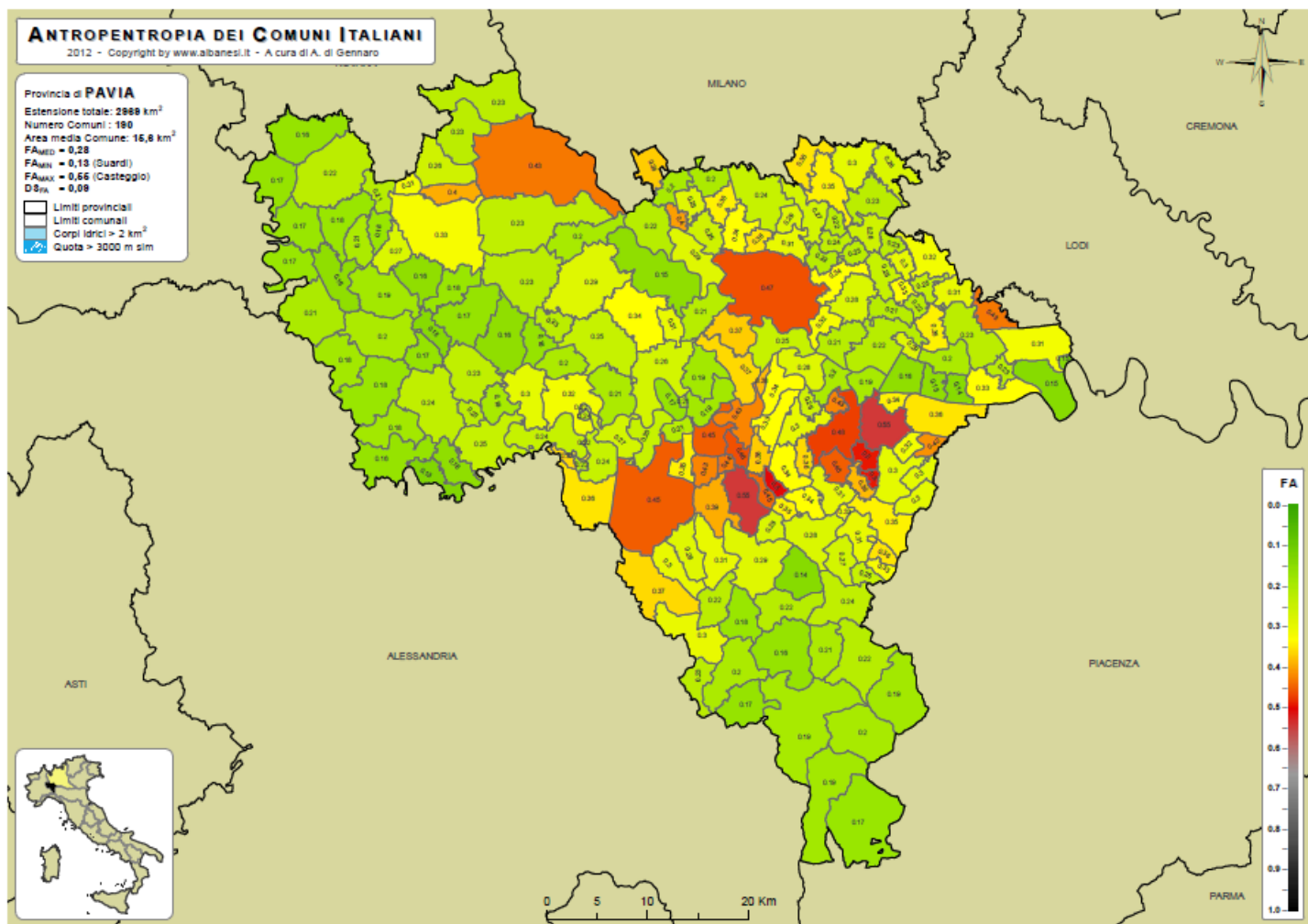
# Liguria



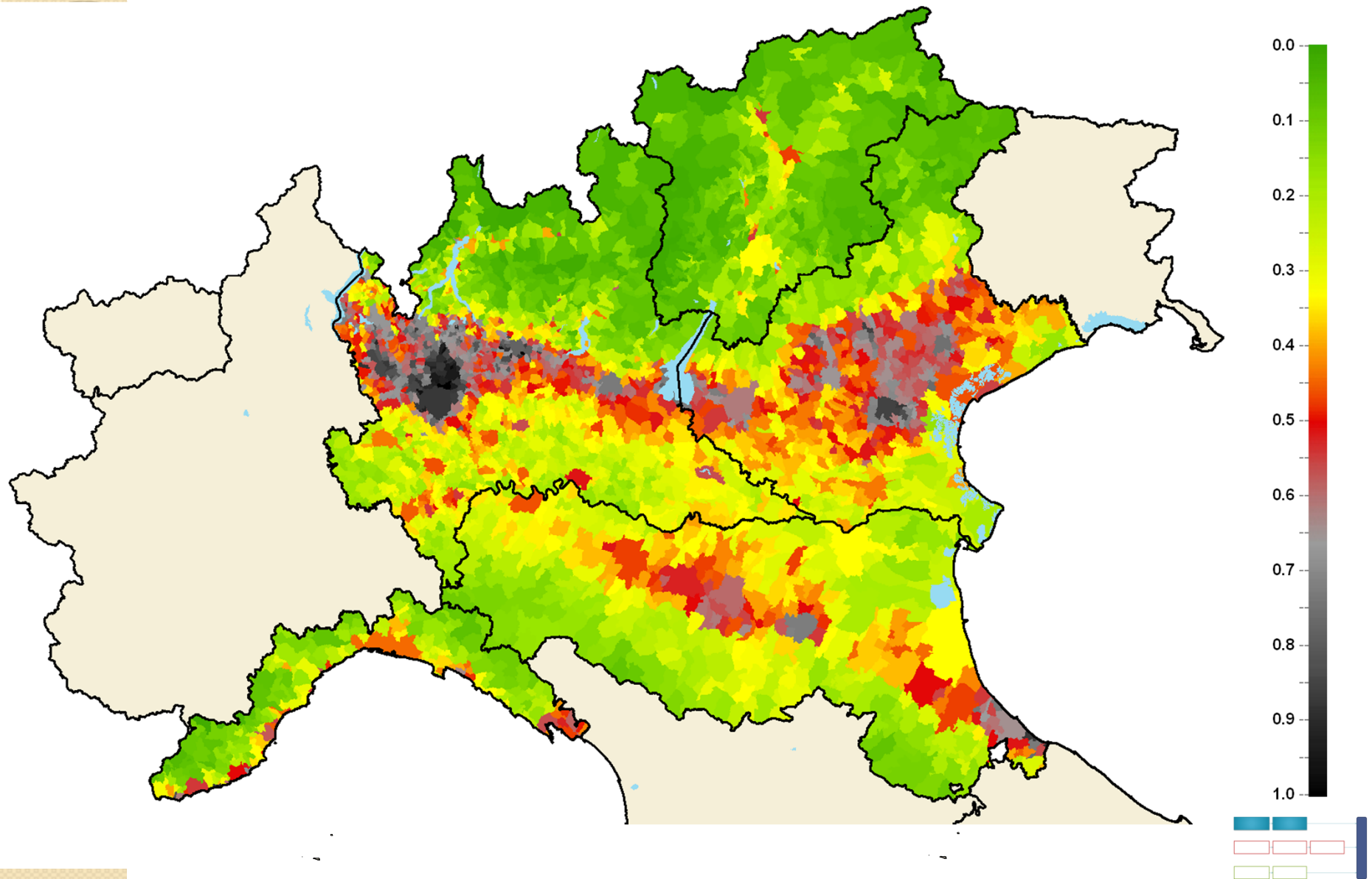
# Lombardia



# Pavia



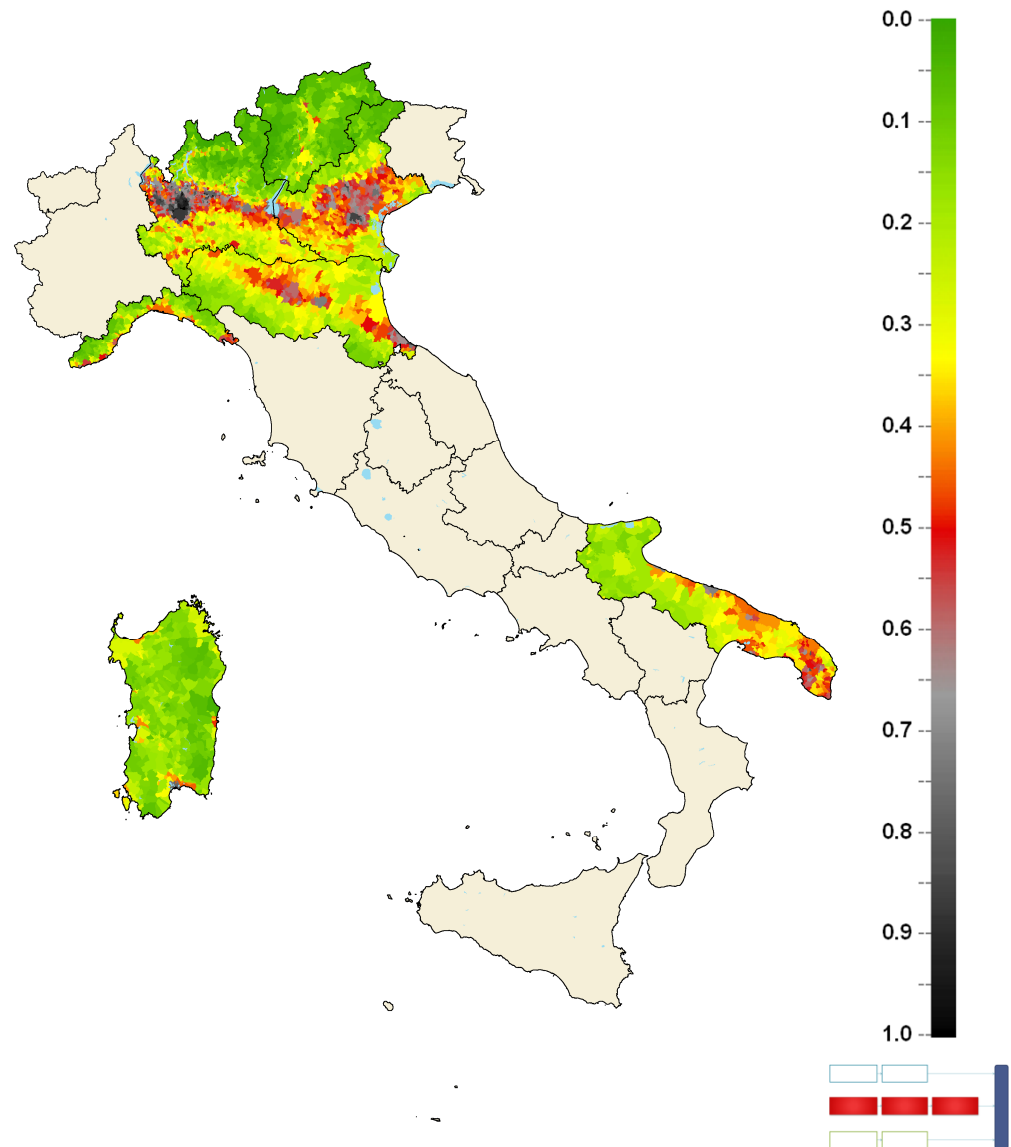
# Northern Italy



# The Complete Anthropentropy Map of Italy

○ Only a little part of Italy is covered with Corine Land Cover data

Facebook Users  
linked to  
[www.albanesi.it](http://www.albanesi.it)



# UGC Data and Crowdsourcing

A “bottom-up”, collaborative procedure generates, from Google Earth maps, a map with anthropic places and neutral zones.

Characteristics of the procedure:

“Bottom” side:

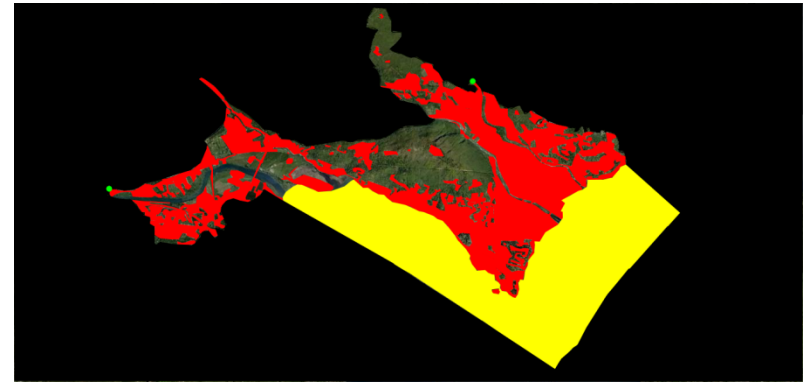
It requires a low level of computer skills  
Based on open software and open data  
(Google Earth maps and Gimp).

“Up” side:

Fully automated algorithm based on computer vision  
operators (Matlab)



# User Generated Maps





# Critical Issues

## Drawbacks:

- ✓ Precision and knowledge of the territory vary from map to map.
- ✓ Collaboration is fundamental – it could only work if enough person are willing to put effort in elaborating the maps.

## Advantages:

- ✓ It increase awareness of the territory and environment degradation by the citizen
- ✓ The calculation procedure of AF can be used in a scenario "What if?"
- ✓ It reacts more quickly to changes in the area (bottom - up knowledge)



# Some computed AF on UGC maps

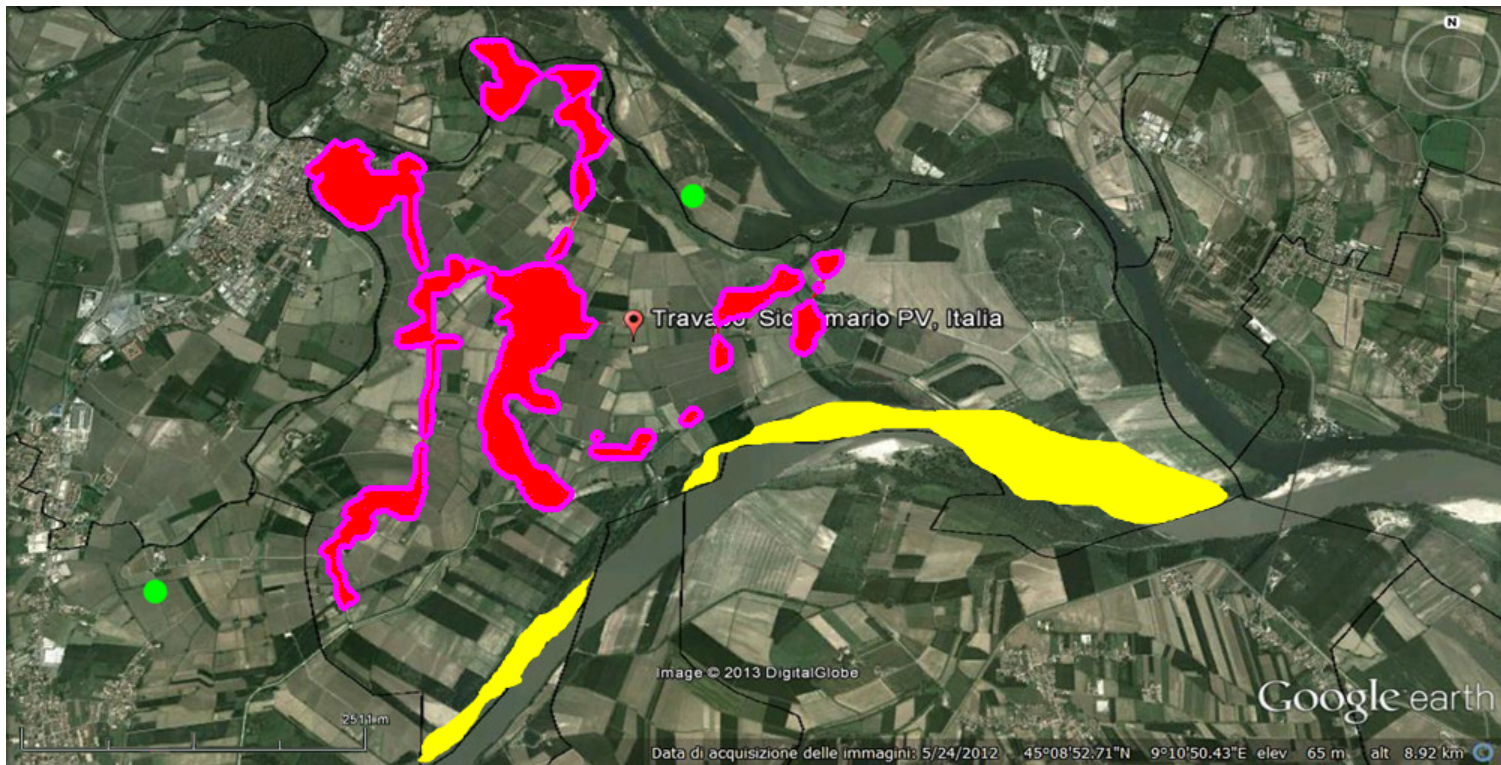
Municipality	S (Area in kmq)	Neutral Area	AF
Scarperia	79.3700	0.00	0.1637
Erice	47.3000	0.00	0.214
Verbania	37.6200	0.37	0.674
Pomigliano d'Arco	11.4400	0.00	0.98040
Praia a Mare	22.9100	0.00	0.4370



45 maps received and processed in the first 3 months (rejected percentage <1%)



# An example



# Adding Temporal Perspective: the DANTHE Project

How can you estimate the future land use? Hypothesis on new anthropic places (ap)

**DANTHE = Dynamic ANTHropentropy Expansion**

- A new ap is, in turn, capable of attracting new sites (anthropogenicity)
- Anthropic places are categorized
- New expansions
  - Uniform
  - Gravitational
  - Road



# Anthropogenicity

Class Number	Classes of Anthropic Places	
	Class Name	Some Examples
1	Slow-growing settlements	schools, hotels, cemeteries, recreational small settlements, small shopping centers, including small parking lots
2	Fast-growing settlements	Houses (villas, cottages, mansions, possibly including small parking lots)
3	Commercial centers	Medium-large shopping centers, trade centers, malls
4	Industrial areas	Factories, industrial warehouses, logistics centers
5	Slow-growing areas of service production, venues for sport and health.	Business hubs, sports, recreational and health centers, waste treatment sites, energy production plants
6	Fast-growing areas of service production, venues for sport and health.	Stadiums, sports arenas, zoos, campuses, touristic resorts.
7	Airports and heliports	
8	Exhibition grounds	Venues for shows and trade fairs
9	Fast-growing roads	Highways or provincial roads
10	Slow-growing roads	Ring roads, railway lines, underground
11	Highways	
12	Stations	Bus, train stations



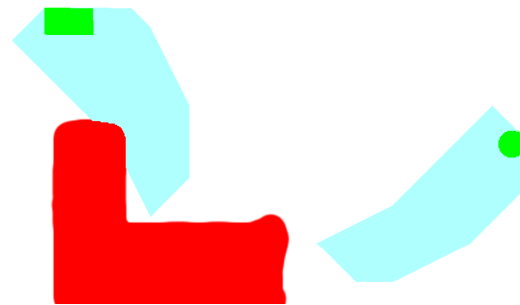
# DANTHE

New expansion models

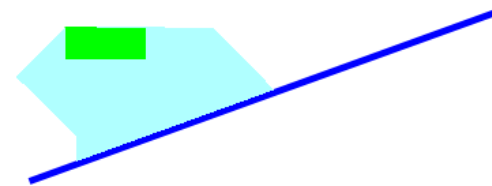
✓ Unlinked expansion



✓ Linked expansion



✓ Road based expansion



# A Web-Based, ad-hoc tool

We developed a new web based app with the aim of increasing the ease of use of the system, in order to attract more *trained* users:

Albanesi, M.G., Amadeo, R.: "A *Web-based Collaborative Tool for Land Use Computation on Satellite Images*" (WEB2)





Social networks for



# **ACADEMIC TEACHING**





# Introduction – Social Teaching

- Educational principles:
  - Consideration of the students' background.
  - Improving student's motivation
    - Lack of learning motivation in a student is mainly caused by his/her personality or by an underachieving teaching methodology (ineffective class presentation, lack of practical activities...)
  - Obtain precise students' feedback on their perception of the learning process
- We developed an *ad-hoc* social network to complement the usual structure and methodology of an Academic Course, to put emphasis on the previously described principles (Course Social Network – *CSN*)
- Final aim: to improve the learning process of students.



# Course Social Network – Objectives and Motivation

- Creation of a “virtual class” environment, in order to offer the students and alternative tool to get to know each other. Improving the sense on community of a numerous class is beneficial to encourage information sharing and direct interaction between peers.
- Stimulation of User Generated Content creation.
- Utilization of the crowdsourcing paradigm to keep the course topic up to date and, if possible, to steer the lessons towards what the students find more interesting.
- Encourage the creation of online subgroups of students, to let them study and analyze topics not strictly inherent to the course
- Reward the most productive or talented students using the *gamification* paradigm.





# Gamification

- Gamification: a motivational technique born with the aim of helping users to perform activities or to learn and/or share information.
- Base idea: add gaming characteristic (rewards, challenges, interaction, leagues..) to web-based systems, increasing students' involvement in its use.
- *Motivational affordances* are the foundation of every gamification implementation (points, leaderboards, achievements, levels, story/theme, clear goals, feedback, rewards, progress, challenge)<sup>1</sup>
- The *affordances* are combined with relevant topics of the course, in order to link the “fun and challenge” of the gamification approach to the learning process of the students.

<sup>1</sup>Hamari, J., Koivisto, J., & Harri, S. (2014). Does Gamification Work? —A Literature Review of Empirical Studies on Gamification. *47th Hawaii International Conference on System Science* (p. 3025 - 3034). Hilton Waikoloa, Big Island, Hawaii, USA: IEEE.

# Implementation

- Student's participation is voluntary: there is no penalty if a student decides not to subscribe
- Non uniform privileges: the Professor can create content (*posts*) to steer the discussion or the topics in a certain direction, while students can (Hybrid realization, Blog/Social Network)
- Students can comment each post or create new topics (*discussion groups*)
- Students can also share information through private messages, create links (*friendships*) between them

The image displays two screenshots of the MTCS Course Social Network v1.0 A.A. 13/14 website. The top screenshot shows the main page with a navigation menu, a 'Meta' sidebar, and a 'My Points' section. The bottom screenshot shows a 'Discussion Groups' section with several groups listed, including 'Keypod', 'Work Together!', 'WWT - KeyWordsTime', 'Keypod 2 - gruppo aperto', 'Qualità delle Innovazioni tecnologiche', 'Keypod Membership', 'Private Group / 5 members', 'Learn Group', 'Public Group / 194 members', 'Private Group / 21 members', and 'Private Group / 3 members'.

# Implementation

- Gamification awards points (*CSN points*) as a reward for every action taken (*group creation, comment, private message, daily log-in*) and creates a leaderboard. Moreover, the Professor can award points following someone contribution in class.
- At the end of the class, only the leaders of this leaderboard are awarded *prizes* (increased marks at the end of the tests, priority in case of thesis request...)

