Spanish Operational Group:

Software to improve land management in livestock cooperatives

April 13, 2018

UNIVERSIDADE DA CORUÑA

Participants

Association for Rural Development Mariñas-Betanzos is the entity that detected the needs of livestock farms, and promotes and coordinates the Operational Innovation Group.
The full list of participants is:

Group coordinator: Association for Rural Development Mariñas-Betanzos

Dairy cooperatives:
- Cusoviame
- Os Irmandiños

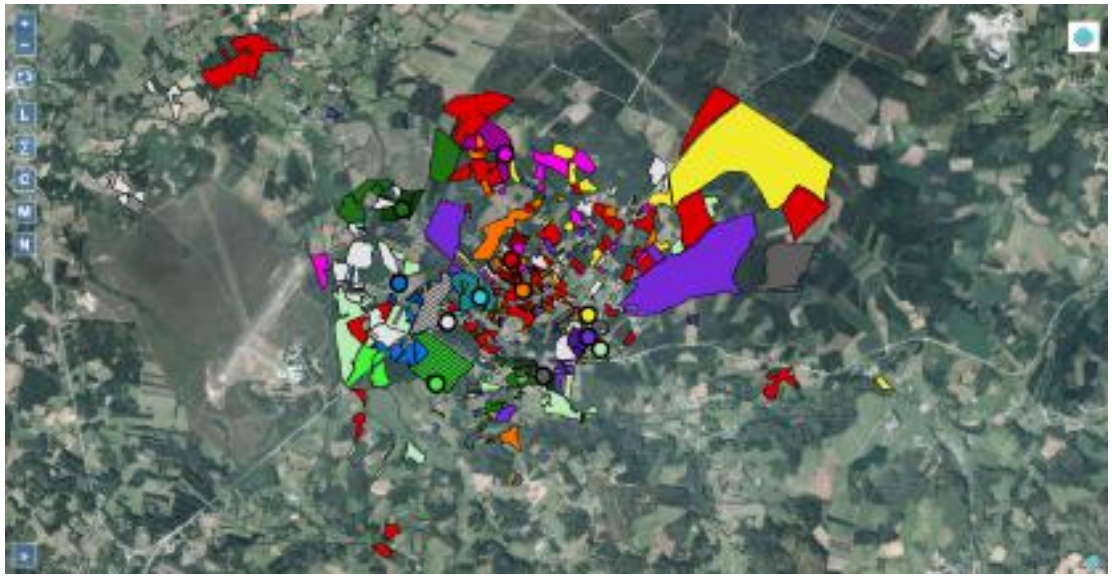
Research institutes:
- University of Santiago de Compostela, Laboratorio do Territorio
- University of A Coruña, Grupo de Arquitectura de Computadores

State organisation: Galician Institute of Food Quality (INGACAL). Mabegondo Agricultural Research Centre

Targetted problem

- Territorial structure of Galician livestock farms is very fragmented and their plots usually have small dimensions and a high dispersion.
- These circumstances hinder the economic efficiency and environmental sustainability of farms, requiring a higher amount of inputs to maintain them.
- Improving the territorial base of farms would facilitate:
  - Forage production as the basis of animal feed.
  - Reduce costs and dependence on imported feed for livestock.
  - Decreases the emission of greenhouse gases and favors a circular economy.
  - Ensure the technical and economic viability of livestock farms.

Targetted problem



Objectives

Main Objective

Improve the territorial base of farms and thus facilitate the production of fodder, as the basis for animal feed.

Achieved by

Developing a computer software that, depending on different initial situations, proposes the reorganization and grouping of the plots belonging to different farms.

- The creation and dissemination of the software will allow the reallocation of plots among farmers (swaps of land use), while their farms keep the same size and land ownership doesn't change.
- The plots that each farmer manages become closer to each other, reducing production costs and improving agricultural sustainability.

Project development

Project stages

1. Review the problematic of the territorial structure in the livestock farms.
2. Collection of information on the members of the cooperatives.
3. Interviews and questionnaires to the members, technicians and managers of the cooperatives.
4. Development of the software application.
5. Execution and test of the algorithm in the pilot zones.
6. Starting the tool.
7. Dissemination of results.

Algorithm

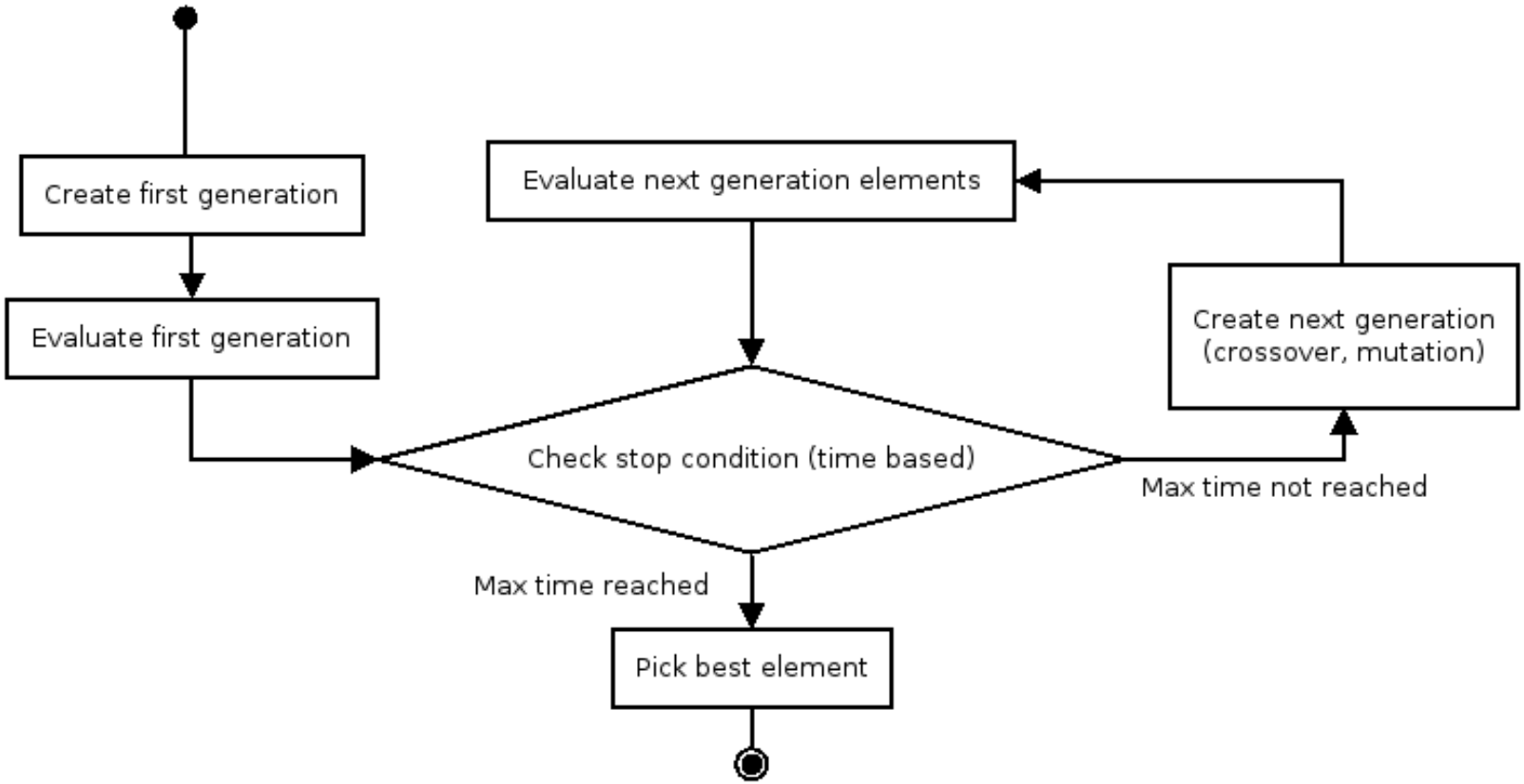
Genetic algorithm

A genetic algorithm is a particular kind of heuristics (optimization algorithms) that mimic the principles of natural evolution.
They are based on a *population* of *elements* that evolve and change.
In essence, the algorithm tries to achieve the lowest value of the heuristic, emulating the natural evolution.

Building blocks

- Crossover: Two elements (or more) combine to create one (or more) new elements.
- Mutation: One element changes independently of others (usually a random change).
- Evaluation: Compute the *value* of an element, the basis of the heuristic part of the algorithm.

Algorithm


Create first generation
Evaluate first generation
Evaluate next generation elements
Create next generation (crossover, mutation)
Check stop condition (time based)
Max time not reached
Max time reached
Pick best element

Custom features

Additions

- Generation step. Used for the first generation and in case of stagnation.
- Validation step. All elements in the population must be valid.
- Element improver. More costly than the mutation, but more thorough.

Features

- Customization: the application allows choosing from multiple options for each step, including the evaluation step, allowing focusing on different aspects of the problem.
- Performance: uses all available resources, with multiple parallel populations that share their best elements, using all resources to envolve one population faster, or a balance between the two.

Results

In the provisional results obtained in the pilot areas (4 areas with 43 farms analyzed in total), it was possible to verify the utility in the reduction of distances and the grouping of farm management plots.

- Average reduction of 32% in the number of parcels to be managed.
- Decrease of more than 37% on average in the distances between farms and plots.

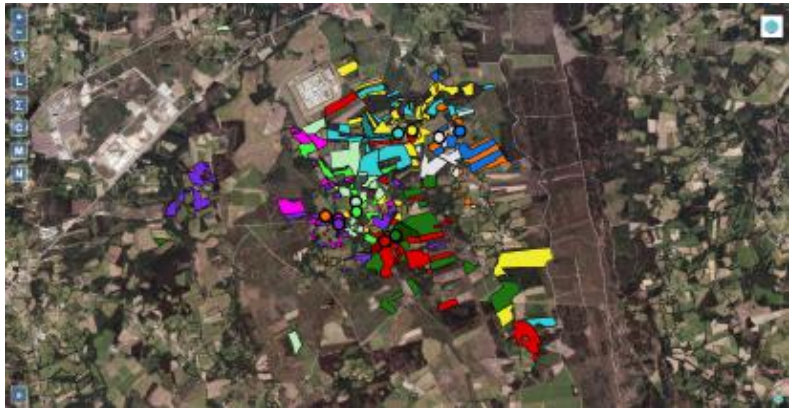
Results: Curtis

Before:

After:

Results: Curtis

Before:



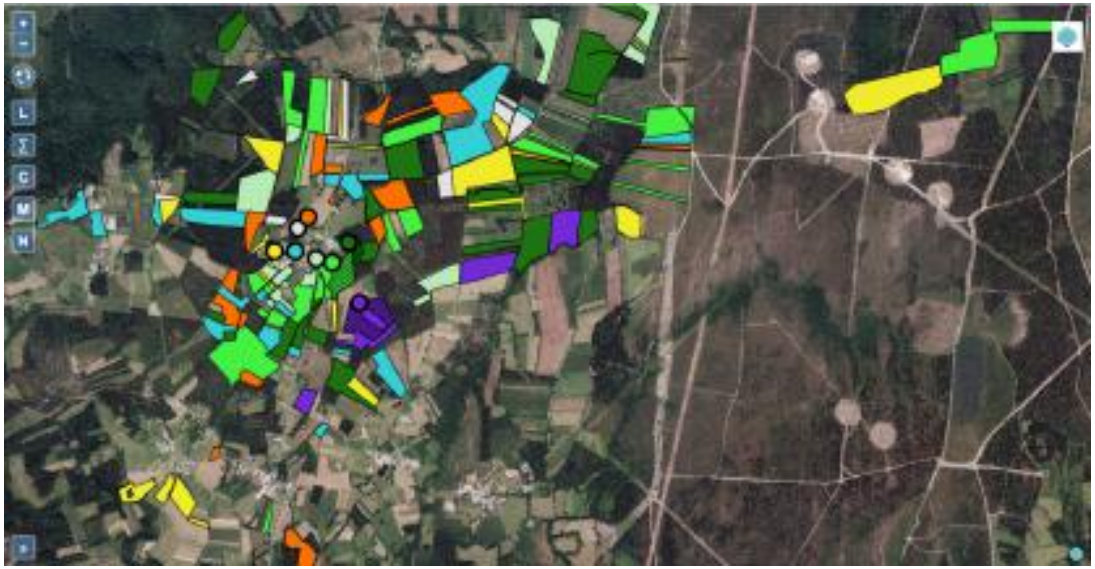
After:

Statistics

- Number of plots: 221 initial -> 151 final. **31.6% reduction.**
- Total distance to reference point: 15 773.17m initial -> 9 987.78m final. **37.2% reduction.**
- Average distance to reference point: 753.16m initial -> 701.27m final. **6.89% reduction.**
- Average distance between plots: 890.07m initial -> 688.27m final. **22.67% reduction.**

Results: Curtis

Before:



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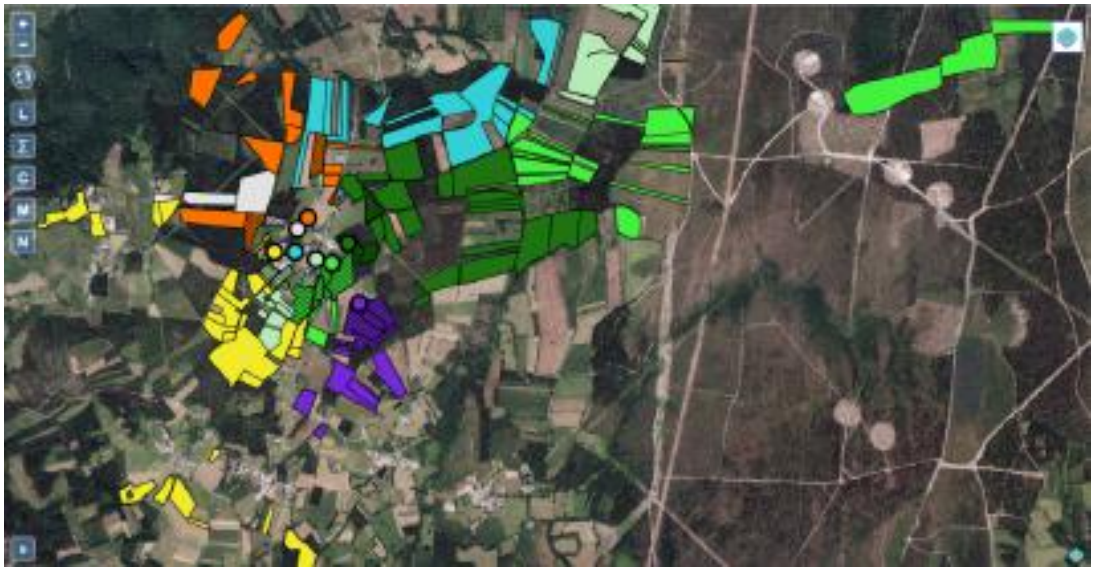
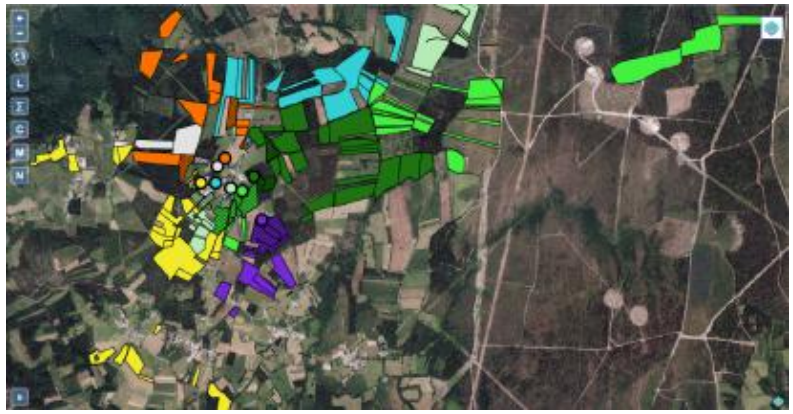


Results: Aranga

Before:

After:

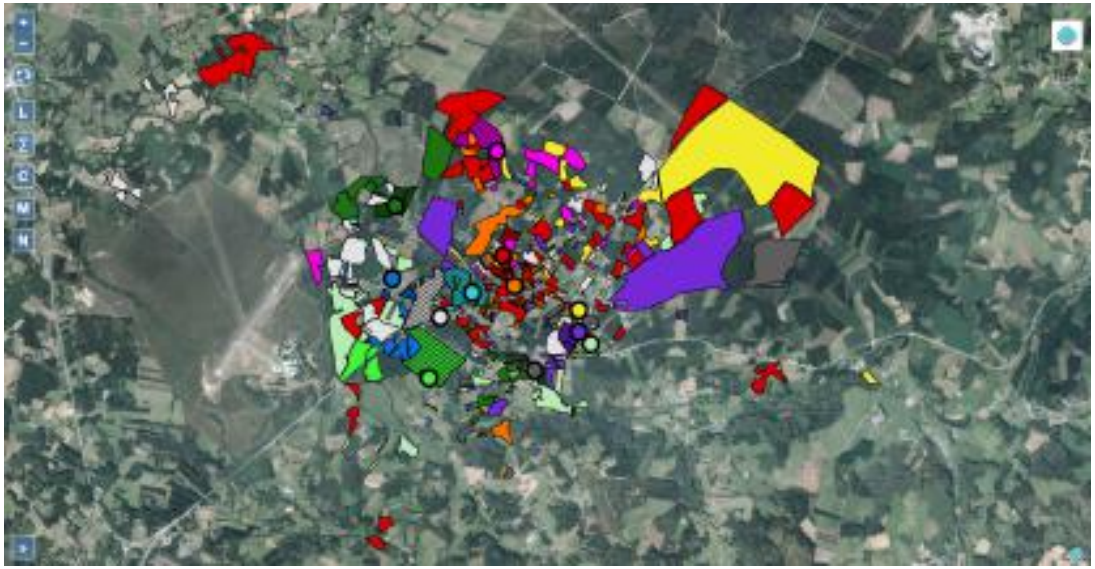


Statistics

- Number of plots: 151 initial -> 95 final. **37.09% reduction.**
- Total distance to reference point: 19 630.21m initial -> 13 975.23m final. **28.08% reduction.**
- Average distance to reference point: 886.47m initial -> 915.07m final. 3.23% increase.
- Average distance between plots: 1213.73m initial -> 882.33m final. **27.30% reduction.**

Results: Curtis

Before:



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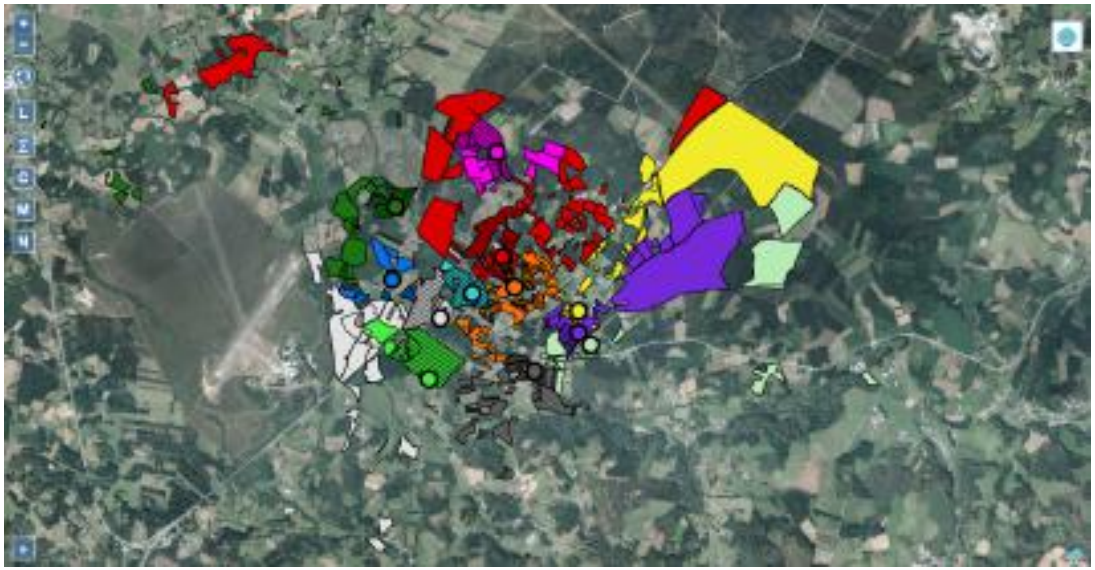
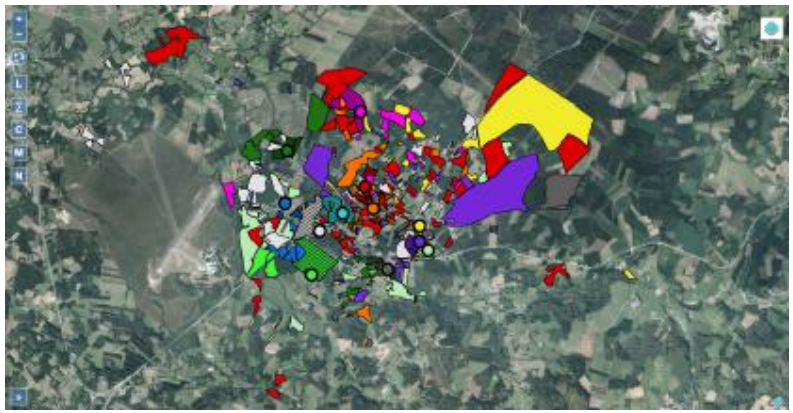
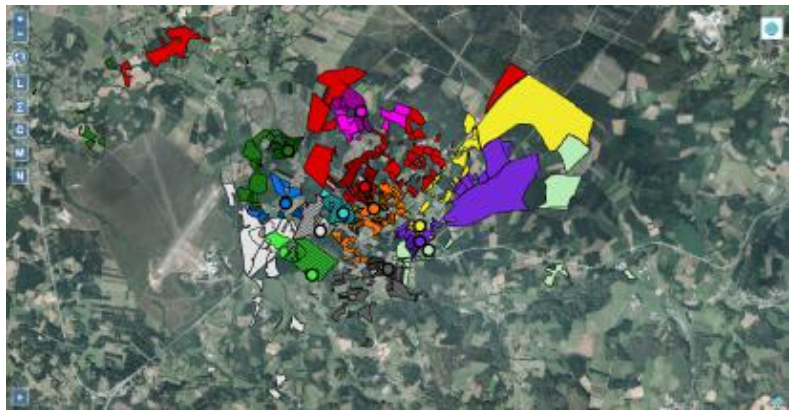


Results: Castro de Rei

Before:



After:



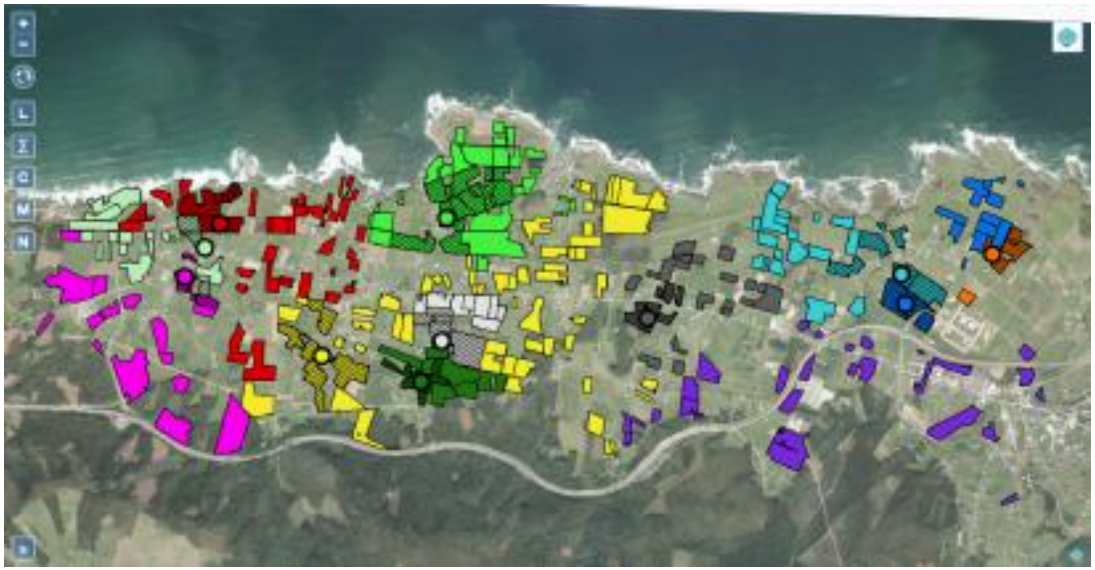
Statistics

- Number of plots: 335 initial -> 191 final. **42.98% reduction.**
- Total distance to reference point: 27 799.53m initial -> 12 557.19m final. **54.83% reduction.**
- Average distance to reference point: 846.17m initial -> 564.39m final. **33.30% reduction.**
- Average distance between plots: 1 044.01m initial -> 591.87m final. **43.31% reduction.**

Results: Curtis

Before:

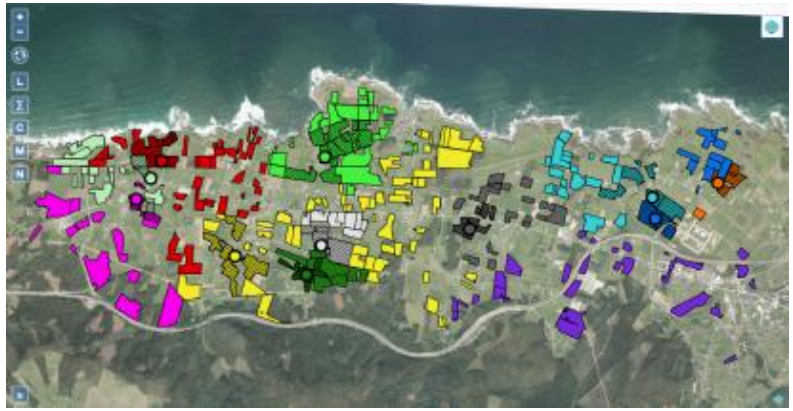
After:



Results: Ribadeo

Before:

After:



Statistics

- Number of plots: 320 initial -> 256 final. **20% reduction.**
- Total distance to reference point: 34 743.05m initial -> 24 723.16m final. **28.84% reduction.**
- Average distance to reference point: 1083.82m initial -> 777.82m final. **28.23% reduction.**
- Average distance between plots: 1 302.99m initial -> 683.23m final. **47.56% reduction.**

Funding

- One-time cost for each case of application, faced by promoting entity in each case (cooperative, local administration, etc)
  - Bureaucracy derived from the land use exchange, dependant on the way to realize it agreed by the owners.
  - Wages of field work for data collection, land value appreciation, etc; usually by cooperative technicians.
  - Potential adaptations or extensions to the software tool, if special needs arise.

Infrastructure requirements

The software tool has an online and offline version, so there is no specific requirements. The time needed to achieve good results decreases with the power of the computer used (number of cores and speed of the CPU, mainly).

Conclusions

- Higher acceptance than expected of the plot and/or use exchange by the landowners.
- Usefulness proved by tests on pilot areas.
- It is necessary the mediation of a technician of the cooperative, so that the proposal of reorganization does not have a negative reception.
- Farms, professionals in the sector, public administration and stakeholders in general could be beneficiaries of the application.
- There is still work to be done, to improve the benefits or reduce the rejection from landowners and farmers.

Future work

We are working on the application of the tool on other situations, with the support of the local administrations, and the research groups are looking to continue work on this or similar fields, or expanding the software tool.

Contact information

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  - LaboraTe (USC): http://laborate.usc.es
  - We are open for colaborations and future projects
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