Trees in agricultural landscapes: understanding past changes for a better management strategies

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Trees in agricultural landscapes: understanding past changes for a better management

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PROJET SOUTENU PAR FONDATION DE FRANCE

Study objectives

- In agricultural landscapes, rural forests - ie farm forests and trees oustside forests like hedgerows, scattered trees, small groves, ... - support key ecological functions and ecosystem services (ES), from firewood production to pest control, through cultural values.

- As both biodiversity and willingness of landowners to change their practices strongly depend on landscape history, we first traced back the history of rural forest from 1962 to 2010. Then we explored the causes of these changes and finally we evaluated how these changes could affect biodiversity.

Materials & Methods

The study site is an area of 140 km^2 in the LTSER ZA PYGAR in south-western France (43°16'29'' N; 0°51'51.24'' E). Rural forest managers are mainly farmers involved in crop-livestock farming: this results in landscapes with a mozaic of trees, grasslands and crop fields.

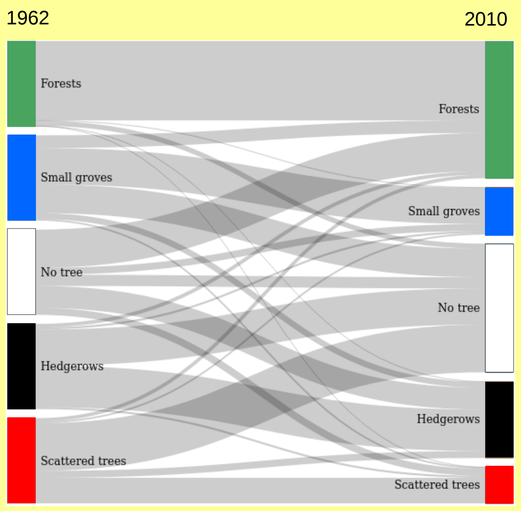
Over the last decades, the number of farms decreased, their size increased and tend o become more specialized in crop cultivation, which caused changes in landscapes composition and configuration.

We used retrospective photo-interpretation of airborne images (IGN) and Lidar data to trace back and quantify farm forest evolution (1962-2010) in the study area and in a subsample of 4 farms, coupled with face-to-face interviews with farmers.

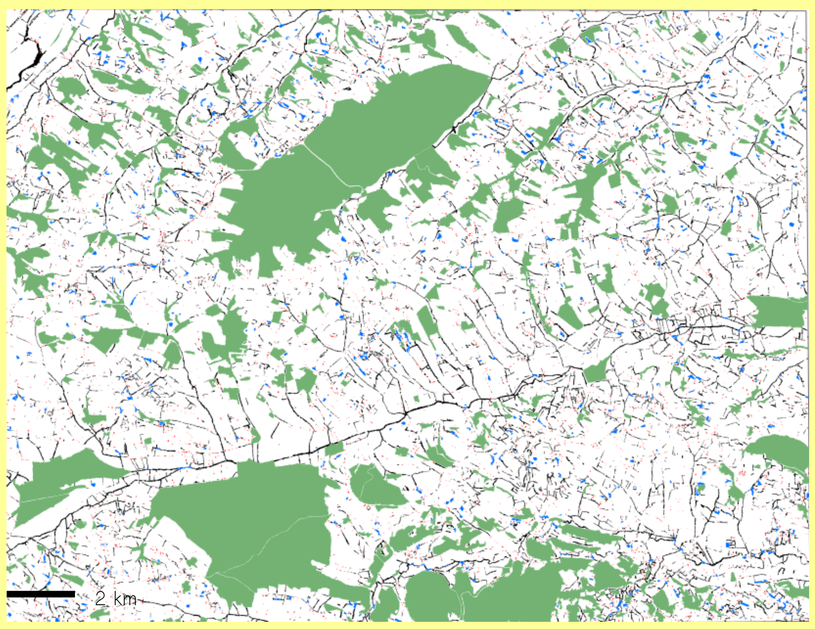
Farm forest evolution over the past decades

Scattered trees, hedgerows and small groves were widely removed between 1962 and 2010 (eg. hedgerows total length decreased from 657 km to 478 km). New rural forest elements appeared recently due to secondary succession consecutive to land abandonment, while some other increased in size and move to another type. For example the number of new scattered trees increased, probably before evolving into small groves and then new forests.

Forest area and number were relatively stable, due to the traditional self-reliance and autonomy principles that underpined farm strategies. These traditional uses still perpetuate and incitate farmers to maintain their forest estate [1,2].

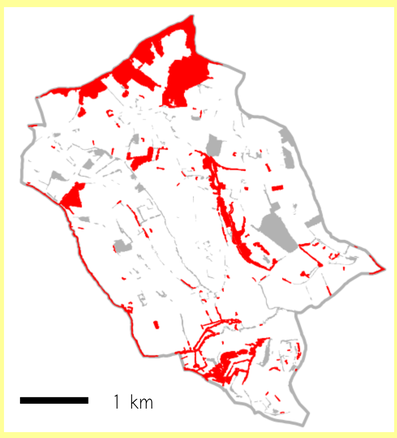


Rural forest evolution from 1962 to 2010, each grey path is proportional to the rate of surface area change between the two dates. Right: map of rural forest in 1979 in the study site.



green = forests, blue = small groves, black = hedgerows, red = scattered trees

Consequences for biodiversity



Relative importance of rural forest components in landscape connectivity, in a subsample of the study site. Areas in red have strong value for connectivity for two types of plant species differing in their dispersal capacity (anemochory and zoochory) (Dpc, Conefor, contribution of patch k as an intermediate stepping stone) .

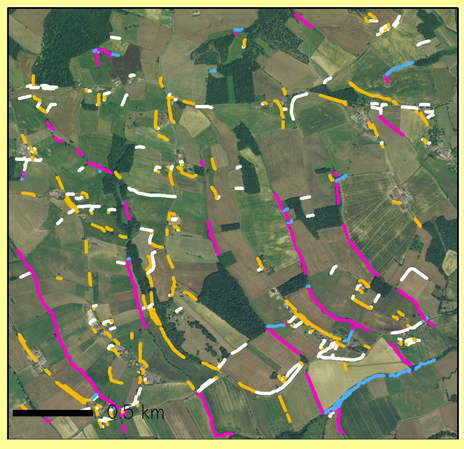
In agricultural landscapes, observed changes in rural forest composition, configuration, and age can affect biodiversity:

- removal of scattered trees, hedgerows and small groves that connect forest patches can alter fonctionnal connectivity depending on species dispersal capacities. It may also affect species depending on stable and diverse habitats for feeding ressources, nesting or overwintering. This is the case for beneficiary insects like crop pests predators and pollinators [3] that can affect ES in crops.
- as some species are associated with mature trees, they may be impacted by changes in age structure caused by the removal of old rural forest elements and the appearance of new ones. For example, some species depend on tree related microhabitats (e.g. cavities) that are mainly beared by veteran and regularly managed trees [4], and that are declining as these trees are removed.
- high forest stability is beneficial to ancient forests species, which are sensitive to extinction debth and colonization credit due to their low dispersal capacity.

Why maintain some hedgerows... but remove others ?

We did not detect any trend of differential hedgerow removal depending on their potential for winbreak (facing prevaling wind) or waterflow regulation (riparian), which are important ES for farmers.

Spatial configuration of these two ES supported by hedgerows:
blue = only water flow regulation potential
orange = only windbreaks
pink = both water and wind regulation potential
white = do not provide these ES) [5]



Fine spatial differences in hedgerow preservation seems to be the consequence of a balance between cultural, technical and ecological considerations [6]:

- hedgerows are positively associated with firewood production, services to agriculture and environmental benefits.
- they are negatively associated to labor constraints consecutive to intensification of agriculture and land consolidation
- there is a willingness of farmers to keep hedgerows as visual markers of properties (hedgerows located at the cadastral limits of the farms were more preserved than those in-farm one)

Examples of comments from interviewed farmers:

"When there is a hedgerow, or some trees, around the border of a plot, it has to be pruned to around 3 m to suit the machines used for the plot and the hedgerow [...]. All the same, that means a week and a half's work to manage all the borders. Each year. You've got to believe in it!"

"Hedgerows, we cut some down during the land consolidation but mainly inside the fields, the hedgerows around the boundary of the property, we try to keep them always, it marks the property."

"With a neighbor who's a breeder, you'd better have a hedge rather than a fence, in the end. Because a fence, the cattle can get through it, with a hedge they can't get through."

Conclusion

Rural forest patterns was driven both by social-cultural heritage (eg. practices and traditions), and socio-economical changes (e.g. intensification of agriculture, land abandonment). Current management of rural forest is made by farmers so as to balance ecosystem services and disservices, which vary according to individuals and site-specific factors. Our study demonstrate that a multidisciplinary approach, combining Ecology, Remote sensing and Social sciences, allows a clear understanding of landscape change drivers and then is essential to propose realistic and acceptable management recommandations.

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