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Landscape and resilience

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Modern agroecosystems have weak resilience, they are very sensitive to disturbances as they are used with a single goal which is optimization of agricultural production. Depending on the areas and on the farming systems they are more or less fragile concerning salinization, pest outbreaks, soil erosion, water fluxes and water quality. The development of a sustainable agriculture requires an increase in agroecosystem resilience. This resilience will be obtained by sustaining/ restoring ecosystem services upon which agriculture will be more and more dependant.

During the period of "agriculture was solely an activity producing commodities", the dominant paradigm was that it was possible to achieve this goal by focusing on fields as independent units within which all processes could be controlled by external inputs. Nowadays this system is collapsing as soil deterioration, consumer health, loss of biodiversity are becoming central political issues. The objective now is to design systems high in sustainability which can be taken as those that aim to make the best use of environmental goods and services while not damaging these assets. This means to integrate biological and ecological processes into food production, to minimize use of non renewable inputs that cause harm to the environment and to make productive use of people's collective capacities to work together.

The design of novel agroecosystems relying on ecological services must consider not only practices at field level but also the landscape level. Many ecological processes are driven by factors operating at the landscape level, and depend on landscape patterns in space and time. Agricultural landscapes are characterized by two main types of habitats, the semi-natural habitats such as field margins or woodlots with a frequency and intensity of disturbances being relatively low, and the fields devoted to agricultural production with a high degree of disturbance. Spatial configuration of landscape elements (size and shape of fields and semi-natural habitats), and interaction between them are of importance for ecological processes. Heterogeneity and connectivity of the landscape mosaic are the two main parameters influencing fluxes of organisms and matter.

Because of their heterogeneity, landscapes can provide refuge in time and space to a wealth of species that cannot survive in a single field. Many beneficial insects use several types of landscape elements during their time life. Heterogeneous landscapes host a variety of wild bees that may ensure pollination services in the case of honey bees populations collapse. For many pests, landscape heterogeneity is a deterrent to movement. Spatial patterns of permanent cover in a watershed determine water quality and water runoff. Features such as grassy strips bordering streams, permanent grassland in the valleys, ensure soil protection and decrease the total load in nitrates. The role of semi-natural habitats has been underlined in many studies, woody elements affecting positively for example populations of beneficial insects. Remnant structures serve as refuge for many species and their potential services. Subsequently these refuges are sources of recolonization of novel elements, so that services can be widespread. The mosaic of farmed habitats plays also an important role determining the spatio-temporal dynamics of pests species and their natural enemies, protecting by their winter cover soils sensitive to erosion.

Landscape resilience is based on both heterogeneity and redundancy. The latter is important during landscape changes as redundancy permits to keep alternative pathways of changes. The figure shows the case of bocage landscapes; they are characterized by networks of hedgerows. Hedgerows have been planted and removed according to their fit to societal objectives in terms of land use. In the nineteenth century hedgerows were planted as fences to control cattle reproduction, among other goals. In the second part of the twentieth century, they were removed to enlarge fields to allow the use of large machinery. This led to environmental problems (erosion, loss of biodiversity etc.), so new

plantations were planned. All along this history, the maintenance of some landscapes with many hedgerows or parts of networks elsewhere has permitted: 1) to conduct research on the role of hedgerows and how to design novel landscapes and 2) to save species that can recolonize new hedgerows.

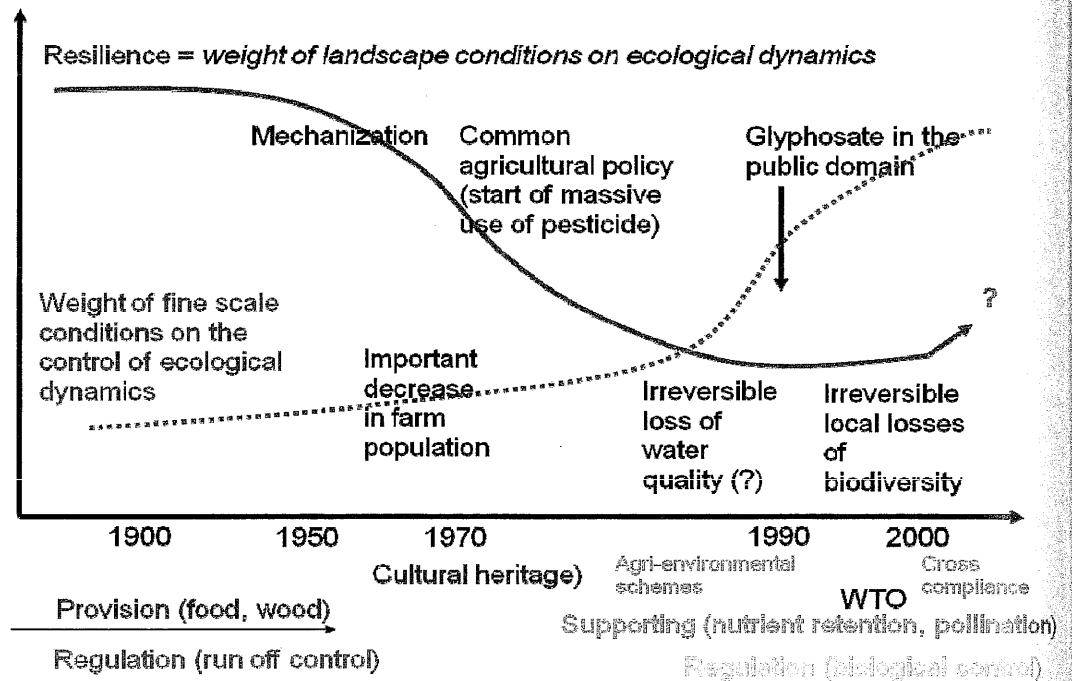


Figure 1: landscape dynamics and resilience, the case of bocages.

EU= European Union; WTO = World Trade Organization; agri-environment schemes = public policy to restore or enhance environmental goods in farmed areas; cross compliance = obligation for farmers to comply with certain practices that have positive effects on the environment to receive their premium as part of EU Common Agricultural Policy.

Some public policies aimed at improving sustainability in agriculture are based on the landscape level. To be efficient they need a collective input of the farmers in a given territory. This can be done on a compulsory basis as for cross compliance tools of the European common agricultural policy, or a voluntary basis as for agro-environment schemes. In this case a collective cooperation of people to work together is needed and social and economic barriers have to be dealt with in the future. The impact of these policies must be assessed through large spatial scale and long term ecological researches.