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Mini Review

Reconfiguration of the Multifunctional Biodiversity Matrix. A Challenge in the Governance of the Food System

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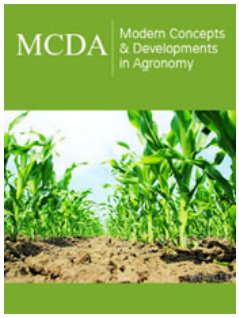
ISSN: 2637-7659



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Submission: March 19, 2024
Published: April 18, 2024

Volume 14 - Issue 2

How to cite this article: Luis L Vázquez*. Reconfiguration of the Multifunctional Biodiversity Matrix. A Challenge in the Governance of the Food System. Mod Concep Dev Agrono. 14(2). MCDA. 000832. 2024. DOI: 10.31031/MCDA.2024.14.000832

Abstract

To facilitate various ecosystem services, the agroecological transition for the construction of sustainable food systems requires the mainstreaming of biodiversity in territorial planning or bio-planning. The facilitation of functional interactions of biodiversity in and between Natural Ecosystems (NE), Agroecosystems (AE) and Urban Ecosystems (UE), must promote multifunction's that are determinants in the regeneration of the soil, crops, livestock and people microbiome, ecological self-regulation of agricultural pests, restoration of degraded soils, resilience to climate change, among other necessary functions.

Keywords: Functional biodiversity; Food system; Territorial bio-planning

Introduction

The territorialization of agroecology is putting pressure on the role of biodiversity in sustainable food and the need to have a holistic scientific basis to integrate it as a transversal component in territorial planning.

The term diversity encompasses multiple levels of biological organization. Although its definition has been associated mainly with the number of species in a community, landscape or region, it currently recognizes the variety of roles that species play in communities and ecosystems and the ways in which they transform the environment with their activity, which is known as functional diversity. The generation of scientific knowledge related to functional diversity is a key tool for the conservation and comprehensive management of ecosystem services [1].

Ecosystem services are defined as [2]: the benefits that people obtain from ecosystems and are grouped into four categories:

1. support (ecological structures and functions essential to offer ecosystem goods and services, such as example: the soil).

2. provision (the different plant and animal species that make up the biodiversity of an ecosystem provide direct goods for human consumption and direct or indirect services that benefit us).

3. regulation (certain natural processes that help maintain the balance of ecosystem interactions and conditions, such as climate and pest regulation).

4. cultural (cultural diversity, religious and spiritual values, recreation, aesthetic values, educational values).

However, the greatest attention has been concentrated on ecosystem services at the scale of natural ecosystems, very little on agroecosystems (primary agricultural, livestock

and forestry production) and urban ecosystems (towns and cities), where developmentalism has degraded natural resources and, consequently, the quality of life of human populations is affected.

The consideration of agrarian spaces as structuring systems of the territory has occurred in parallel with the recognition of the agri-food system as a strategic element in economic development, in the quality of life, and in the creation of urban-rural links, from the systems approach reterritorialized or locally based agri-food. This opens up multiple possibilities for connection and creation of intersectoral synergies in the organization of agricultural spaces, also considering their multifunctionality and the overlap of their economic, ecological and social dimensions [3].

Within all these proposals, local agroecological-based food systems stand out, understanding that, in them, spatial planning has the potential to contribute to overcoming the metabolic gap by closing material cycles and overcoming the current segregation between production and consumption. but also, between the productive and the reproductive, between society and nature [4].

Of course, current tropical landscapes in a general sense are fragments of natural habitat surrounded by a "sea" of agriculture, where the nature of these fragments is not as important for conservation as the nature of the agricultural matrix that surrounds them. for the ecological functions they favor [5].

In the prospective towards sustainable food, the management of functional biodiversity transcends the sectors of ecology and the environment, due to its contribution to the regeneration of biodiversity in socioecosystems, among other strategic objectives that demonstrate the need for an approach holistic in the governance of the territory, an aspect that is summarized in this article.

Multifunctions of Biodiversity in the Food System

Biological diversity is composed of three main attributes: composition, structure and function. Composition is the elements that constitute biodiversity, that is, the hierarchical levels of organization: genes, population/species, communities/ecosystems. The structure refers to the physical organization of the elements of each level of hierarchy: genetic and population structure, habitat, physiognomy, landscape patterns. Functionality refers to the diversity of processes that take place at each level of hierarchy: genetic, interactions, ecosystemic, disturbances, others [6-8].

At the territorial scale (Figure 1), the facilitation of functional interactions of biodiversity in and between Natural Ecosystems (NE), Agroecosystems (AE) and Urban Ecosystems (UE), is a determining factor in the regeneration of the soil, crops, livestock and people microbiome, ecological self-regulation of agricultural pests, restoration of degraded soils, resilience to climate change, among other functions necessary for the sustainability of the food system.

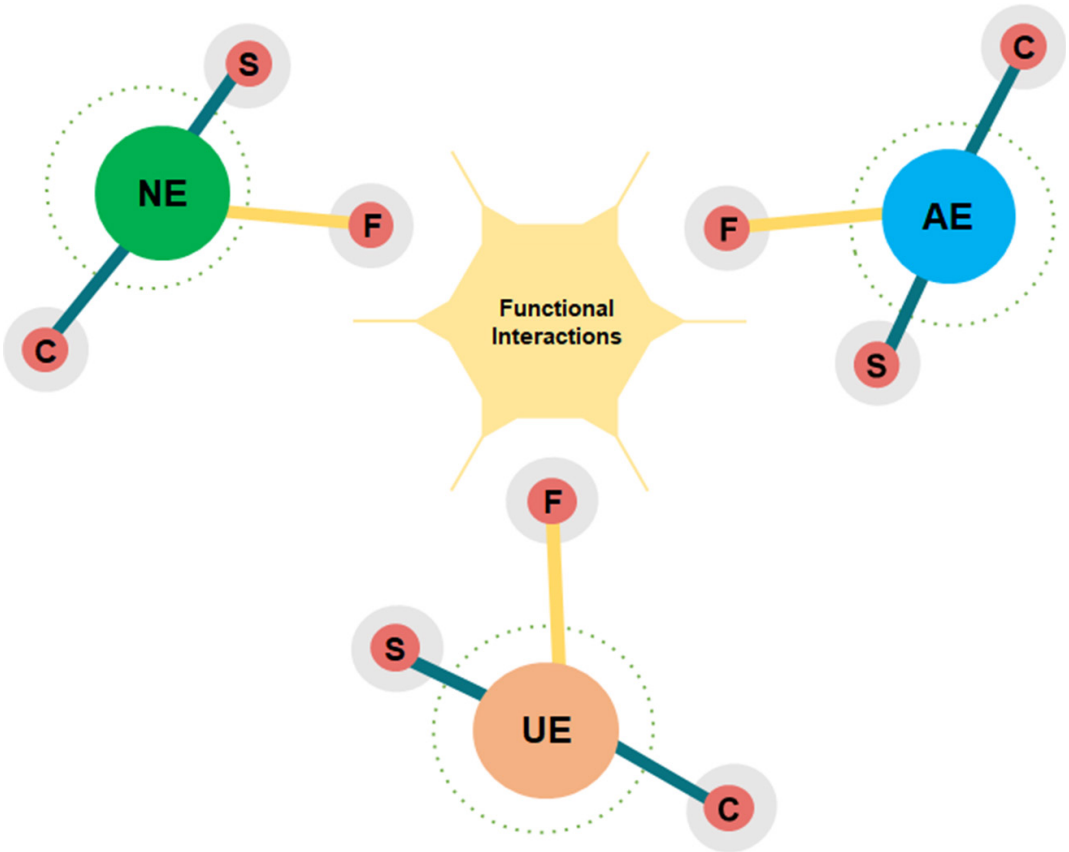

Figure 1: Facilitation of functional interactions of biodiversity between ecosystems at the territorial scale. Ecosystems: NE (Natural Ecosystems), AE (Agroecosystems), UE (Urban Ecosystems). Biodiversity: C (Compositional), S (Structural), F (Functional).

When these interactions are achieved in the design of farms and their management, then it can be said that the complexity of said system has been reached, since biodiversity functional is favoring the different organisms to act for the benefit of agricultural production, by having the mechanisms that allow increasing the regulation of populations of harmful organisms, pollination, nutrient recycling, crop nutrition, among other ecosystem services [9]. In the search for a healthy diet, the redesign of food production systems under the principles of Agroecology, facilitates the functional interactions of biodiversity that contribute to its capacity for ecological self-regulation and that of the intestinal ecosystem of the people who consume said foods [10].

In the study and practical application of functional biodiversity, emphasis is placed on the response of biological communities to environmental changes and their impact on ecosystem processes through functional traits, known as: response-effect [11], behavior is also observed in human settlements, when family and community nutrition and well-being are affected by extreme events (climate, epidemics, economic crisis, others), whose main response is to produce their own food around or in backyards. their homes and even at the community level [12].

In the same way that changes in land use, invasive species, overexploitation and climate change have generated great modifications in ecosystems, altering their functioning and reducing the capacity to offer ecosystem services [13], agriculture and livestock conventional farming has overexploited and degraded soil, water and biodiversity resources, including the human populations that work, live and feed on such productions.

In this sense, restoration ecology, defined as the science associated with intentional human intervention, which promotes the recovery of ecosystems after disturbance, acquires great relevance and functional ecology becomes a key input for the restoration of communities and ecosystems [14], so that they complement each other in the facilitation of ecosystem services.

As a result of the agroecological transition, transformative innovations are carried out in the redesign of production systems (agroforestry), cultivation (multiple crops or polycultures) and livestock (silvopasture) systems, agricultural and livestock production is diversified and vegetation auxiliar structures are integrated (groves, living fences, living barriers, windbreaks), among other changes that contribute to a different multifunctional matrix in rural, peri-urban and urban areas, which could well be considered as Functional Types of Agroecosystems (FTA).

In fact, a new ecological concept related to ecosystem functioning is the Functional Types of Ecosystems (FTEs), as groups of ecosystems with similar dynamics in the exchanges of matter and energy between the biota and the physical environment [15,16].

"Biozones", proposed to identify vegetation units that share characteristics of ecosystem functioning [17], are also used to refer to the aggregate components of ecosystems whose interactions with each other and with the environment produce differences in the patterns of the structure and dynamics of the ecosystem [18].

Bio-Planning of the Territory

Territorial planning, as a fundamental component in the governance of the food system, is demanding an agroecological transition towards the facilitation of functional interactions between natural ecosystems, agroecosystems and urban ecosystems, which could be considered as bio-planning of the territory.

In the last decade there have been considerable advances in the incorporation of agricultural spaces into territorial planning. We have gone from a situation in which practical examples were scarce [19], to a growing presence of this issue in theoretical debates on territorial planning, and to its gradual, still incipient, assimilation in professional practice [20].

The awareness of the dependence of the current food system and the negative impacts it has on the environment has driven new plans, whether strategic or spatial planning, which are formulated taking into account the functional and spatial needs that the reorganization of the system would entail. agri-food sector in a transition towards relocated models [20].

They assume that, in the reconstruction of resilient territories, linked to a bioeconomy adapted to local resources, it is essential to strengthen the relationships and links between production and food consumption, as well as working on rebuilding ties and communities. It is also important to recover food culture and traditional knowledge linked to local conditions, and improve ecosystem functioning, especially in inserted areas or in proximity to spaces of natural value [20].

Agriculture, being inserted in a landscape environment that includes conservation spaces such as biological corridors and protected areas, the permeability of the agricultural matrix is of vital importance to guarantee the efficiency of these spaces [21].

The interest in integrating agricultural spaces and food systems into green infrastructures is in turn transferred to the interior of cities and their peri-urban environments, combining their design with the principles of landscape ecology and agroecology until reaching infrastructures [22].

Until recently, urban planning barely paid attention to agricultural spaces and the food system. However, one of the great challenges of urban planning and territorial organization is to recover the "lost relationships between the city, agriculture and food. Mata Olmo [23] evolving towards territorialized food systems and counting on social participation [24].

This endorses the relevant role of agriculture as a model of the population dynamics of animal and plant species, and recognizes that, from the point of view of nature conservation, the abandonment of agriculture represents a threat similar to that of the intensification of agricultural uses [25].

Precisely, during the agroecological transition, in agricultural and livestock production systems, aquifer infrastructures, land communication routes and facilities, whether in rural, peri-urban and urban areas, designs must be promoted and integrated vegetation structures, which in their together express functional

characteristics, so that they contribute to the ecosystem services that, as a whole, facilitate sustainability.

Conclusion

Ecosystems have been formed naturally or according to human intervention; however, the agroecological transition implies the reconfiguration of the territory into local food systems. In this process, functional biodiversity is decisive for the generation of various ecosystem services that facilitate sustainable food. It is suggested that governance should integrate the bio-planning of the territory.

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