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Multifunctionality of cultural landscapes beyond diversity of crops, land-use patterns, and ecosystem services

Multifunktionalität von Kulturlandschaften: Mehr als nur die Vielfalt landwirtschaftlicher Kulturen, Landnutzungsmuster und Ökosystemleistungen

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Abstract

With the intensification of land-use and urbanization during the past decades, cultural landscapes throughout the world have considerably changed. Consequences on the global scale are the loss of biodiversity and ecosystem services. The concept of multifunctionality of landscapes has been introduced by science to qualitatively and quantitatively assess functions and services of cultural landscapes. It is implemented into environmental policy and landscape planning to promote sustainability on the landscape scale. However, diverse concepts and perceptions of "multifunctionality" developed which mainly focus on the multifunctionality of agriculture and patches of ecosystems and related services. Here, it is suggested to broaden the view of landscape multifunctionality towards a holistic perspective. This means that the multifunctionality of local communities with their economic diversification, functional settlement infrastructure, local educational systems, the variety of food processing, etc. are drivers for land-use multifunctionality. Accordingly, the economic, social, as well as ecological multifunctionality is reflecting the multifunctionality of the socio-ecological system of a cultural landscape. Today, traditional cultural landscapes often exhibit multifunctionality. Many initiatives on the regional, national, and international level focus on the preservation and restoration of those cultural landscapes. Biosphere reserves, for example, integrate the multifaceted interaction of people and nature for the sustainable use of the natural resources.

***Keywords**: Agrodiversity, biosphere reserves, landscape restoration, socio-ecological systems, traditional cultural landscape, village*

Zusammenfassung

Einhergehend mit der Landnutzungsintensivierung und Urbanisierung in den letzten Jahrzehnten haben sich die Kulturlandschaften in der ganzen Welt erheblich verändert, was zu einem globalen Verlust an biologischer Vielfalt und Ökosystemleistungen geführt hat. Das Konzept der Multifunktionalität von Landschaften wird in der Wissenschaft genutzt, um die Funktionen und Leistungen von Kulturlandschaften qualitativ und quantitativ zu bewerten. In die Umweltpolitik und Landschaftsplanung wurde es eingeführt, um die Nachhaltigkeit auf Landschaftsebene zu fördern. Es haben sich jedoch verschiedene Konzepte und Auffassungen von „Multifunktionalität" entwickelt, die sich hauptsächlich auf die Multifunktionalität der Landwirtschaft und von Ökosystemen und damit verbundenen Dienstleistungen konzentrieren. Hier wird vorgeschlagen, den Blick auf die Multifunktionalität von Landschaften zu erweitern und eine ganzheitliche Perspektive einzunehmen. Das bedeutet, dass die Multifunktionalität lokaler Gemeinschaften mit z. B. deren ökonomischer Diversifizierung, einer funktionsfähigen Siedlungsinfrastruktur, lokalen Bildungseinrichtungen, der Vielfalt der Produktverarbeitung die Triebkraft für die Multifunktionalität der Landnutzung ist und somit die Multifunktionalität des sozio-ökologischen Systems einer Kulturlandschaft widerspiegelt. Traditionelle Kulturlandschaften weisen heute häufig eine Multifunktionalität in dieser holistischen Perspektive auf. Viele Initiativen auf regionaler, nationaler und internationaler Ebene konzentrieren sich auf die Erhaltung und Wiederherstellung dieser Kulturlandschaften. Biosphärenreservate z. B. integrieren die vielfältigen Wechselwirkungen zwischen Mensch und Natur zur nachhaltigen Nutzung der natürlichen Ressourcen.

Schlüsselwörter: Agrodiversität, Biosphärenreservate, Dorf, Landschaftsrenaturierung, sozio-ökologische Systeme, traditionelle Kulturlandschaften

1 Introduction

The multifunctionality of cultural landscapes has been increasingly discussed since the 1970s (e.g., Manten 1975, Kostrowicki 1978, Niemann 1986, Van Buuren & Kerkstra 1993). This discussion was stimulated by the ongoing land-use intensification all over the world and the increasing monofunctionality (Brandt 2003, Waldhardt et al. 2010, Stürck & Verburg 2017), "monotonisation" (Brandt 2006: p. 188), and "simplification" (Laterra 2011, Mastrangelo et al. 2014) of cultural landscapes, with large patches of "single-function" land-use types (De Groot & Hein 2007). This global development strongly influences or causes the current environmental crises such as the loss of biodiversity and ecosystem services as well as climate change (MEA 2005, IPBES 2018, IPCC 2019). At least indirectly, the concept of differentiated soil and land use (in German: differenzierte Boden- und Landnutzung), introduced by the German landscape ecologist Haber (1971; 1989), is related to the multifunctionality of the cultural landscape. Today, the multifunctional use of landscapes is considered as an adaptive strategy for unknown future conditions, particularly against the background of climate change, food insecurity, and limited resources (Taylor Lovell & Taylor 2013).

Already in 1993, the European Council for Agricultural Law officially introduced the term "multifunctional agriculture" to provide legislative support for the development of agricultural sustainability (Wilson 2007). Meanwhile, the concept of landscape multifunctionality has been integrated into environmental policy, planning, and recommendations for sustainable land use (FAO 1999, Brandt & Vejre 2004, Selman 2009). Additionally, landscape multifunctionality became a part of several comprehensive spatial planning strategies during the last two decades (e.g., Dijst et al. 2005, Cairol et al. 2009). Initiatives for the development of multifunctional landscapes stretch all over the globe, thus for example in Europe (e.g., Tait 2001), the United States (Bills & Gross 2005), Australia (e.g., Cocklin et al. 2006), and Latin America (Estrada-Carmona et al. 2014).

Despite several attempts to broaden the concept of landscape multifunctionality beyond land-use patches and multifunctional agriculture towards socio-economic aspects (Naveh 2001, Renting et al. 2009, Selman 2009, Mastrangelo et al. 2013, Pinillos et al. 2020) it is still today mainly focused on agriculture and the production of agricultural products as well as ecosystem services (Yang et al. 2013). This is, for example, reflected in a recent policy paper by The Royal Society (2023: p. 12) stating that "a core element of driving up land productivity is to explore the use of land for simultaneously delivering more than one 'function' [and that it should consider] simultaneously the multiple products and services provided by the land".

Particularly for its implementation in environmental policy and sustainable rural development, however, it is necessary to fully integrate socio-economic multifunctionality in a holistic concept of landscape multifunctionality which addresses the spatial, functional as well as social dimension (Mastrangelo et al. 2014). Accordingly, environmental and ecological as well as socio-economic multifunctionality have to be taken into account. Thus, the concept of multifunctionality of cultural landscapes is strengthened as an objective for sustainable landscape development and for the implementation of several Sustainable Development Goals (DSDG 2020). With the words of Taylor Lovell & Lovell (2013: p. 1451), it can be stated that "landscape multifunctionality can serve as a framework for the co-transformation of the social and ecological dimensions of the system in ways that benefit humans". Since multifunctionality depends on the spatial scale and can be applied for the farm, landscape or regional level (McGranahan 2014), it is here referred to the scale of cultural landscapes.

Based on the concept of cultural landscapes, this paper firstly addresses the diversity of the landscape multifunctionality concept. Based on the ecological and socio-economic perspective of landscape multifunctionality, a holistic view on landscape multifunctionality is outlined which takes villages and small towns as drivers for land-use and landscape multifunctionality, respectively, into account. In conclusion, it is shown how a holistic approach of landscape multifunctionality is already or can be put into practice in cultural landscapes as real laboratories.

2 Materials and methods

Based on a short outline of the current understanding of cultural landscapes (see, Zerbe 2024), the diverse definitions and perceptions of the multifunctionality of cultural landscapes are reflected, showing the heterogeneity of the approaches in respective studies. Hereby, it could be built on the comprehensive literature review for the book "Restoration of Multifunctional Cultural Landscapes" from Zerbe (2022). Studies and articles, respectively, in peer-reviewed journals were considered which relate the concept of multifunctionality to the landscape level.

While ecological and environmental approaches to landscape multifunctionality are most abundant, a focus on socio-economic multifunctionality is laid on here. Criteria and indicators for multifunctionality are stated, emphasizing the role of villages or small towns in cultural landscapes.

Accordingly, the study presented here is a conceptual one, based on a review of literature and deriving conclusions for a holistic understanding of landscape multifunctionality. To this end, selected examples are presented how to put the findings into practice of sustainable land-use planning and the preservation of natural and cultural heritage.

3 Cultural landscapes

According to the European Landscape Convention (Council of Europe 2000), "landscape" means "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (for a comprehensive discussion, see Zerbe 2022). German geographers already used the term cultural landscape (Culturlandschaft) in the first half of the 19th century, first mentioned by C. Ritter in 1832 (Potthoff 2013). The term and concept of "cultural landscape" was brought to an international audience and defined by Sauer (1925) as "a landscape fashioned from a natural landscape by a cultural group. Culture is the agent, the natural area is the medium, the cultural landscape is the result". Later, the concept of cultural landscape was extended beyond its material-physical manifestations towards the intangible values, symbols, and shared identity and diversity of the local inhabitants (Groth & Bressi 1997, Antrop 2006, Stephenson 2008). Cultural landscapes, consequently, are

socio-ecological systems where social, economic, ecological, cultural, political, technological, and other components are strongly linked (Petrosillo et al. 2015).

Cultural landscapes encompass the whole range of human impact, ranging from parts where wilderness has re-appeared due to absent land use to parts that have been greatly transformed by growing settlements. Here, the concept of multifunctionality is discussed taking those cultural landscapes into focus which are characterized predominantly by agriculture, forestry and/or fishery. Thus, it is not referred to urban-industrial landscapes, although they have to be considered as cultural landscapes, too. However, urban-industrial landscapes have a unique character and are, to a great extent, very different from the above-mentioned types of cultural landscapes (e.g., Dennis et al. 2019, Stokes & Seto 2019).

4 Concepts of multifunctionality

Since the concepts of landscape multifunctionality entered the discussion in science and applied aspects of landscape and land-use development they were strongly focused on the multifunctional use of agricultural landscapes and the spatial patterns at the landscape scale. Accordingly, for example, Smith and Raitz (1974) refer to multifunctional agricultural estates in Kentucky's Bluegrass region, which produce various commodities, especially Burley tobacco, racehorses, and purebred beef cattle, and contribute to rural development and economy in numerous ways. The various forms of a diverse agriculture have coined the concept of "multifunctional agriculture", which means that "agriculture is considered multifunctional when it has other additional functions to food and fibre production" (Huang et al. 2015: p. 138, see also, Wiggering et al. 2006, Renting et al. 2009, Song et al. 2020).

According to Galler et al. (2015), diverse patterns of the cultural landscape are related to multiple landscape functions. Consequently, from a spatial point of view, Brandt and Vejre (2004; see also, Brandt 2003) define three different types of multifunctionality which are:

1. a spatial combination of different land units with different (mono)functions (spatial segregation),
2. different functions devoted to the same land unit, but separated in time (time segregation), and
3. the integration of different functions in the same unit of land (or overlapping units of land), at the same time (spatial integration or "real" multifunctionality).

This follows the paradigm that the spatial distribution of human activities influences important landscape processes and structures from which the services are derived (Jones et al. 2008). This is reflected in the long tradition of the analysis of landscape patterns and processes, and the assessment of landscape functionality as a precondition for land-use planning, particularly in Central and Eastern Europe (Buchwald & Engelhardt 1968).

In the further development of the concepts of multifunctional landscapes, several other concepts were interrelated, intermingled or merged to hybrid approaches (cp. Tab. 1). Multifunctionality has thus been interrelated, for example, with biodiversity (Byrnes et al. 2014, Butterfield et al. 2016, Meyer et al. 2018), the land-sparing vs. land-sharing debate (Grass et al. 2021), and green infrastructure (Taylor Lovell & Taylor 2013). Mander et al. (2007: p. 2), for example, stated that "ecological networks are the most important guarantees of landscape multifunctionality", thus integrating the concept of multifunctional landscapes and green infrastructure (e.g., Villard & Metzger 2014). By further stating (Mander et al. 2007: p. 1) that "many elements in cultural landscapes have a multifunctional character" and referring to examples such as hedgerows, forests, wetlands and their ecotones, multifunctionality is coupled with the concept of ecosystem services which these elements provide for humans.

Today, the concept of landscape multifunctionality is strongly interrelated with ecosystem services which have been framed and systematized by the Common International Classification of Ecosystem Services (CICES; Haines-Young & Potschin 2018). Following Hölting et al. (2019a: p. 1), "multifunctionality refers to the capacity of an area to supply multiple ecosystem functions or services". In fact, the idea of landscape ''functions" is hereby consistent with the ''ecosystem services" framework, where the provisioning, regulating, and cultural services are provided by different and various ecosystems or landscapes (Madureira et al. 2007). Assessment tools to quantify ecosystem services and to assess multifunctionality have been developed to determine current and future multifunctionality (e.g., Rodríguez-Loinaz et al. 2015, Stürck & Verburg 2017). The characterization and quantification of multifunctionality hereby is often based on metrics such as e.g., diversity indicators (Andersen et al. 2013, Crouzat et al. 2015, Queiroz et al. 2015) or indicators for sustainable land use (Wiggering et al. 2006). Cultural services such as well-being and health can be assessed by interview and participation approaches, respectively. Fagerholm et al. (2020), for example, investigated the relationship between multifunctional landscapes at European sites and well-being with an online survey integrating subjective perceptions of well-being with mapping perceived ecosystem service benefits.

As stated above, various aspects of multifunctionality have been discussed in scientific studies and implemented in environmental policy and planning during past decades. Manning et al. (2018: p. 435) even conclude that "multifunctionality is a simple but nebulous concept". It is not intended here to present a complete review on the understandings and definitions of "multifunctionality" in landscape ecology, physical and human geography, landscape and rural planning, and environmental policy. Although worthwhile, indeed, it is beyond the scope of this paper. Here, definitions and perceptions of multifunctionality in the context of cultural landscapes are emphasized, from which a selection is presented in Table 1. Given this, it becomes obvious that "multifunctionality" is perceived very differently, shedding light on a variety of aspects and parameters.

5 Ecological and environmental multifunctionality

Since many studies on the quality and the quantification of multifunctional landscapes focus on physical and ecological patches as well as the diversity or heterogeneity of ecosystems and land-use types, also taking into account different scales, environmental and ecological multifunctionality has been well investigated to date (e.g., Willemen et al. 2008, Stürck & Verburg 2017, Manning et al. 2018, van der Plas et

Tab. 1: A selection of definitions and perceptions of multifunctionality in the context of cultural landscapes, differentiated by the main focus (references in alphabetical order).

Tab. 1: *Auswahl an Definitionen und Interpretationen von Multifunktionalität im Kontext von Kulturlandschaften, differenziert nach der Schwerpunktsetzung (nach Erstautor*innen in alphabetischer Reihenfolge geordnet).*

References	Definitions and perceptions of landscape multifunctionality
Main focus: Ecosystem and landscape functions and services, landscape complexity, biodiversity	
Butterfield et al. (2016: p. 207f)	Balancing the joint production of multiple ecosystem services; maintaining or creating landscapes that provide many types of those
Byrnes et al. (2014: p. 112)	The simultaneous performance of multiple functions
Fagerholm et al. (2020: p. 217)	The ability of the landscape to provide multiple functions and uses
Galler et al. (2015: p. 243)	The range of multiple (beneficial) landscape functions provided by the landscape […], ranging from a specific site or within neighboring sites (local scale) or a region (regional scale)
O'Farrell & Anderson (2010: p. 59)	Landscapes created and managed to integrate human production and landscape use into the ecological fabric of a landscape maintaining critical ecosystem function, service flows and biodiversity retention
Selman (2009: p. 48)	Characterized by a high degree of complexity, particularly associated with the properties of simultaneity and inter-activity
Stürck & Verburg (2017: p. 481)	The diversity and abundance of different landscape functions and services within the same landscape
Van der Plas et al. (2018: p. 175)	The number of ecosystem services provided at high levels within at least one site in a landscape
Main focus: Ecological/environmental as well as socio-economic benefits and contributions	
Hölting et al. (2019a)	The capacity of a landscape to provide socio-economic and ecological benefits to society, including potential trade-offs and synergies between individual ecosystem functions and services
Holmes (2006: p. 143)	All modes of broadscale rural resource use and not solely an attribute of agricultural use
Oostindie et al. (2006: p. 47)	Sustainable farm management which builds upon a combination of functions in addition to food production also paying attention to the marketable contributions to environment, nature, culture, landscape, health and welfare
Renting et al. (2009: p. 112)	Agricultural activity beyond its role of producing food and fibre and having several other functions such as renewable natural resources management, landscape and biodiversity conservation and contributing to the socio-economic viability of rural areas
Reyers et al. (2012: p. 1122)	Landscapes which provide multiple environmental, social and economic functions and are able to achieve multiple societal needs including energy and food production, management of waste, conservation of biodiversity and the management of water quantity and quality across the landscape; the improvement of landscape heterogeneity and therefore resilience; and the provision of recreational opportunities
Taylor Lovell & Taylor (2013: p. 1448) Lovell et al. (2014)	The provision of a range of beneficial functions across production, ecological, and cultural dimensions, considering the needs and preferences of the owners and users

al. 2018, Pinillos et al., 2020). Multiple ecosystem services as indicators for the multifunctionality of a cultural landscape have been assessed and quantified. Hölting et al. (2019b 2020) provide an example with regard to environmental (regulating services such as e.g., climate regulation, water retention, pollination) and economic parameters (such as e.g., crop, timber, and dairy production) as well as cultural services (such as e.g., landscape aesthetics and recreation). Based on biodiversity and ecosystem services' assessment, Galler et al. (2015) investigated the efficiency of strategies in terms of environmental benefits (spatial efficiency) and in terms of the environmental benefits achieved for a given amount of funding (cost efficiency).

6 Socio-economic multifunctionality

Without human impact, cultural landscapes and multifunctional cultural landscapes, respectively, would not exist (cp. Ellenberg & Leuschner 2010), and so would not many ecosystem and landscape services, particularly the production of agricultural crops and cultural services (Fig. 1). Consequently, a precondition for multifunctional cultural landscapes are active multifunctional communities as drivers of landscape patterns and processes as well as a large part of ecosystem and landscape services (Fig. 2). Whereas the concept of ecosystem services has been well developed during past decades, having led to an increasing number of studies on basic and applied aspects, the concept of landscape services has been introduced by Termorshuizen and Opdam in 2009 "as a bridge between landscape ecology and sustainable development" (see also, Willemen et al. 2010, Gulickx et al. 2013, Keller et al. 2019).

That human impact and functioning local communities shape a multifunctional cultural landscape becomes most evident if land is partly or totally abandoned, often reflecting the decline and out-migration of village populations, respectively (Jaszczak et al. 2018, Wang et al. 2021, Zerbe 2022). With the decline of village and town functionality, land-use patterns and ecological processes change and thus, the ecosystem and landscape services provided for humans.

Apart from traditional transhumant (e.g., still today found in Central Asia) and nomadic populations (e.g., in Northern Africa), cultural landscapes with predominantly agriculture, forestry and/or fisheries are organized by small (villages) to medium-sized settlements (towns). Consequently, settlement structures including their infrastructure can be considered as "engines" for the management, maintenance, and the restoration of cultural landscapes (Fischer et al. 2012, Jung & Ryu 2015, Tu & Long 2017). Villages and towns are the drivers for the ecological and socio-economic development of the cultural landscape because they concentrate infrastructure, governance, and necessary social and economic services on the settlement area, as well as are "catalysts for rural development" (Jones 2017, p.1). What Servillo et al. (2014) compiled as three basic assets for towns holds also true for villages:

i. A compact built-up area with a certain concentration of population from a morphological perspective.

ii. A territorial unit of local governance from an administrative point of view.

iii. The core of a functional region, providing services for inhabitants, stakeholders, visitors, and tourists with regard to functionality, forming a socio-spatial system integrated by functional interrelations with its surrounding area, i.e., the cultural landscape.

Hence, these assets are aspects of the multifunctionality of cultural landscapes. The functionality of villages and towns can be operationalized by a set of indicators (e.g., Bhattacharyya & Ponnusamy 2017, Kalinka et al. 2020, Maja et al. 2020). Those are compiled in Table 2.

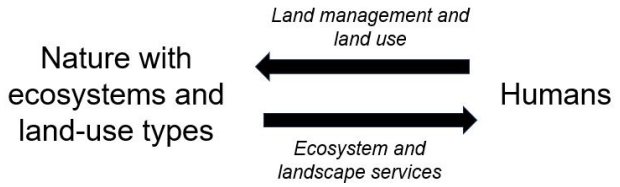

Fig. 1A: A cultural landscape as a product of the interaction of nature and humans: Humans manage the land which in turn provides the society with ecosystem and landscape services.

Abb. 1A: *Eine Kulturlandschaft als Produkt der Interaktion von Natur und Mensch: Der Mensch bewirtschaftet das Land, das seinerseits der Gesellschaft Ökosystem- und Landschaftsdienstleistungen zur Verfügung stellt.*

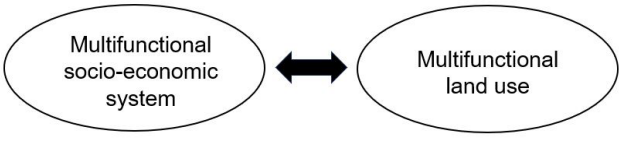

Fig. 2A: Multifunctionality of the socio-economic system as a precondition for multifunctional land use and its interrelation in a multifunctional cultural landscape.

Abb. 2A: *Multifunktionalität des sozioökonomischen Systems als Voraussetzung für eine multifunktionale Landnutzung und deren Wechselbeziehungen in einer multifunktionalen Kulturlandschaft.*

7 A holistic perspective of the multifunctionality of cultural landscapes

Naveh (2001: p. 269) claimed that multifunctional landscapes "should be conceived as tangible, mixed natural and cultural interacting systems". While sharing some common ground with agricultural multifunctionality, landscape multifunctionality addresses a broader socio-ecological system (Selman 2009). The concept of "strong multifunctionality" introduced by Wilson (2007), which is characterised by strong social, economic, cultural, moral, and environmental capital (see also, Wilson 2008) paves the way to a holistic view of landscape

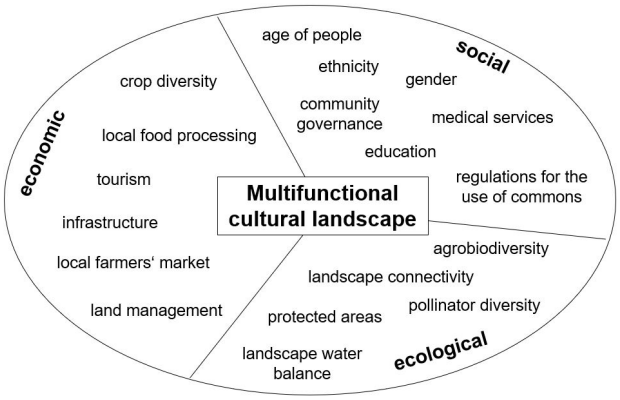

Fig. 3: Multifunctionality of a cultural landscape taking into account the complex socio-ecological system and its diversity.

Abb. 3: *Multifunktionalität einer Kulturlandschaft unter Berücksichtigung des komplexen sozioökologischen Systems und seiner Vielfalt.*

Tab. 2: Criteria and indicators for the functionality of villages or small towns (adapted from Zerbe 2022).

Tab. 2: *Kriterien und Indikatoren für die Funktionalität von Dörfern oder Kleinstädten (in Anlehnung an Zerbe 2022).*

Criteria	Indicators in villages and small towns
Residential building	Adequate housing with energy access, drinking water supply and sanitary facilities
Land use and fishery	
Agricultural land use and production	Farms, orchards, home gardens, common pasture, storage buildings, stables, agricultural machinery, local farmers' markets
Forestry	Farms, local or regional forest department, silvicultural machinery, sawmill
Fishery	Clean and productive water bodies (including fishponds in villages and towns), fishing boats, fishing equipment, storage buildings, local fish markets
Processing and provision of food and goods	
Processing of agricultural, forestry, and fishery products or businesses	Small and medium sized enterprises, milk/cheese dairy, manufacture (e.g., for wool products), local business, business for wood handicrafts
Food provision	Farm store, grocery, bakery, butcher, restaurant, bar
Provision of consumables and household goods	Local shop, small supermarket
Infrastructure	
Transport, connectivity, mobility	Path, street, railway, public transport, cycle path
Energy	Local and regional renewable energy sources and production, power grids
Water	Water supply system (for drinking and household water), pond (e.g., for fishery or fire extinction), drinking water safety measures
Governance	Municipality building, assembly room or place, farm association or cooperatives
Cultural services	
Social	Restaurant, bar, central square, clubs
Religious, spiritual	Church, temple, mosque, cemetery
Tourism	Tourist accommodation and other services
Education	School, workshops, excursions, seminars
Communication	Communication technology, internet access
Health care	Medical doctors, hospital, ambulance, pharmacy, access to medical specialists in the next city
Cultural identity	Monuments, historical buildings, historical information

multifunctionality, although very much focused on multifunctional agriculture and farming systems, respectively.

Accordingly, in a holistic perspective, a multifunctional cultural landscape depends on the diversity of the local community with its age, gender, and ethnics (e.g., Villamor et al. 2014; Jackson et al. 2021), land-use practice and agrodiversity, (traditional) local ecological knowledge (see for example, Berkes 2017, Gann et al. 2019) and land-use related knowledge (e.g., Parrotta & Trosper 2012), economic diversification (case studies from Evans 2000 and Ruiz-Ballesteros & del Campo Tejedor 2020), and governance (e.g., Salpina 2021). These components are all drivers for shaping the landscape with its land-use systems and near-natural ecosystems and, consequently ecosystem and landscape services (Fig. 3). In Table 3, objects for the operationalization of the multifunctionality of a cultural landscape are shown, following the 3-pillar paradigm of sustainability.

Tab. 3: Objects for the operationalization of multifunctionality of traditional cultural landscapes, following the three-pillar paradigm of sustainability and differentiating ecological/environmental, social, and economic multifunctionality, with a selection of parameters for their assessment and selected references as examples (adapted from Zerbe 2024).

Tab. 3: *Operationalisierung der Multifunktionalität traditioneller Kulturlandschaften, in Anlehnung an das Drei-Säulen-Paradigma der Nachhaltigkeit und der Unterscheidung von ökologischer, sozialer und ökonomischer Multifunktionalität, mit einer Auswahl von Parametern zu deren Bewertung und einigen Literaturhinweisen als Beispiele (in Anlehnung an Zerbe 2024).*

Criteria	Object for the operationalization of multifunctionality	Selected parameters for assessment	References (examples)
Ecological/ environmental multifunctionality	Biodiversity, agrobiodiversity (incl. specific groups of organisms such as e.g., pollinators; agricultural pest antagonists)	Species (numbers, diversity indices, Red-List species, etc.), habitats (number, quality, grade of degradation, threatened habitats, etc.)	Jones et al. (2021) Damiani et al. (2023)
	Agrodiversity	Crop diversity, diversity of farming practices, diversity of farm types	Houssni et al. (2023)
	Ecosystem services	Categories (provisioning, regulating, cultural) and variety within categories, thresholds, synergies and trade-offs	Hölting et al. (2019a)
	Protected areas	Number, area size, quality (e.g., naturalness, grade of degradation), management	Gohr et al. (2022) Chen et al. (2023)
	Landscape fragmentation and connectivity	Quantitative (e.g., number of patches in a given area) and qualitative (e.g., diversity of patches) indicators for fragmentation and connectivity (e.g., distance of certain patch types, presence of corridors)	Llausàs & Nogué (2012) Larrey-Lassalle et al. (2018) Spanowicz & Jaeger (2019)
Social multifunctionality	Medical and social services	Presence and number of physicians, accessibility to services, Health-Related Quality of Life (HrQol)	Makai et al. (2014) Coombs et al. (2022)
	Age, gender, ethnics of rural communities	Population census data with information on age, gender, ethnics, languages, and other population diversity indicators	European Union (2010) Fromentin (2023)
	Local communication and information technology	Internet access, Rural Communication Services (RCS), early warning systems against natural hazards	FAO (2017) Maja et al. (2020)
	Environmental education	Access to schools and/or the non-formal education sector, modern curricula, implementation of Education for Sustainable Development (ESD), access to online education resources	Zikargae et al. (2022) Silva et al. (2023)
	Governance and decision making	Implementation of participatory decision-making, rules for the use of commons, expansion of rights and opportunities for the rural community (empowerment)	Chirenje et al. (2013) Sisto et al. (2022)
Economic multifunctionality	Diversity of cropping and land-use systems (e.g., rotation systems, agroforestry systems, intercropping, forestry, fishery)	Crop diversity, diversity of farming practices, diversity of farm types	Jordan & Warner (2010) Hufnagel et al. (2020)
	Multipurpose crops	Use options for single crops such as e.g., food, fodder, building material, fertilization, ecosystem restoration, phytoremediation (e.g., coconut tree)	Allegrini et al. (2022), Pandey et al. (2022)

	Economic diversification such as agriculture, forestry, fishery, tourism, local handicraft, local food processing, local/regional farmers' markets, etc.	Range and functionality of profitable economic sectors, diversity of income sources, revenues from economic sectors	Merenkova et al. (2019), Abebe et al. (2021)
	Local and regional infrastructure	Facilities and structures to provide services such as transport, energy/ electricity, drinking water and sanitation, housing, ICT, health, and education, access to regional markets	Danneberg & Kulke (2016)

8 Multifunctional cultural landscapes put into practice

Many traditional cultural landscapes, having evolved during centuries or even millennia, have to be considered as multifunctional in its holistic perspective. Communities in these landscapes had to provide themselves with their daily needs, performed trade with other communities and urban settlements, and had to cope with environmental changes and uncertainties. This has been shown, for example, by E. Ostrom taking numerous examples of commons throughout the world into account (e.g., Ostrom 2015). Partly, unique landscape features have been developed such as e.g., terraced landscapes, seascapes, lakescapes or riverscapes (Zerbe 2024) or traditional cultural landscapes exhibit "everyday" cultural landscapes (Roe 2014: p. 240).

Today, it is widely accepted that these traditional cultural landscapes bear a high biodiversity, agrobiodiversity, and agrodiversity and can provide a broad range of various ecosystem and landscape services (Zerbe 2022). They often represent blueprints of "land sharing" which is the integration of land and water use, on the one hand, and nature conservation, on the other, within multifunctional landscapes (cp. Fischer et al. 2017). Given that a traditional cultural landscape is more heterogeneous than a modern monofunctional landscape which focuses on the intensive production of certain cash crops, a higher biodiversity can be expected (cp. Butterfield et al. 2016).

Particularly, those traditional cultural landscapes which have been designated as UNESCO World Heritage sites, national parks, and biosphere reserves, which are considered as High Nature Value (HNV) Farmland and Globally Important Agricultural Heritage Systems (GIAHS), and/or which are subject to landscape conservation initiatives on the national level can often be taken as examples or reference sites for multifunctional cultural landscapes and sustainable land use. In an exemplary way, this is reflected by the concept of biosphere reserves which aims at a sustainable relationship between people and their environments by safeguarding natural and managed ecosystems (UNESCO 2019). Participatory approaches and a close interaction with local communities and stakeholders are crucial (Těšitel & Kušová 2012, Elbakidze et al. 2013). With a participatory survey in the recently designated Nordhordland UNESCO Biosphere Reserve in Norway, Cusens et al. (2022) show that particularly biosphere reserves link cultural heritage, agricultural and biodiversity values in multifunctional landscapes.

9 Conclusion

Manifold efforts in science and environmental policy have been made to frame multifunctionality of cultural landscapes and put this into practice of rural and landscape development, respectively, in order to contribute to the achievement of the Sustainable Development Goals. However, it is necessary to unify its conceptual foundations. A holistic view on the multifunctionality of cultural landscapes would have several implications. Taking ecological/environmental, economic, and social multifunctionality into account, could promote approaches and tools for its comprehensive assessment (cp. Fig. 3 and Table 3). Traditional cultural landscapes (cp. Zerbe 2024) which still today exhibit a high degree of multifunctionality could serve as examples for the development and restoration of degraded cultural landscapes in order to reach the Sustainable Development Goals. Best practices could be identified worldwide and could serve as examples or blueprints for rural development policies.

Additionally to urbanization and land-use intensification, land abandonment is one of the mega-trends on the global scale, with the loss of natural and cultural heritage as a consequence (Zerbe 2022). A holistic perspective of multifunctionality could counteract this development. While revitalizing and strengthening economic and social multifunctionality of villages and towns in cultural landscapes, this could have a positive impact on land-use diversity as well as ecosystem and landscape services. Additionally, agrodiversity and biodiversity on the level of species (incl. crop varieties and animal breeds), ecosystem and land-use types as well as the landscape diversity could be promoted.

Multifunctional cultural landscapes will considerably increase resilience and improved service provision under scenarios of environmental (e.g., climate change) and socio-economic changes. Already in 1995, Hough stated that if creatively designed, multifunctional working landscapes can serve as a platform to integrate ecology, economy, and society. And, with Taylor Lovell & Taylor (2013: p. 1451) it can be added that "when applied to a landscape, the concept of multifunctionality is more tangible than "sustainability''.

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