Can Cross-Border Cooperation Drive Sustainable Land-Use and Land-Cover Planning in the Oresund Region?

ARIAN BEHRADFAR[1], RUI ALEXANDRE CASTANHO[1,2]
[1]VALORIZA, Research Center for Endogenous Resource Valorization, Instituto Politecnico de Portalegre (IPP),
PORTUGAL

[2]Advanced Research Centre, European University of Lefke,
Lefke, Northern Cyprus, TR-10 Mersin,
TURKEY

Abstract: - Cross-border Cooperation (CBC) represents common action plans between European cross-border regions. Land-Use and Land-Cover (LULC) changes are constantly one of the main themes in sustainable development and regional studies, particularly in cross-border territories. Therefore, we designed and implemented a comprehensive methodology of LULC analysis for the Oresund region, comprising the cities of Copenhagen and Malmo. Moreover, this study represents critically analyzed factors in CBC, LULC analysis, and policy recommendations. These guidelines could be used as the best practices among successful CBC in Europe. Besides, they offer capacity-building policies to develop visions and actions in CBC and LULC planning.

Key-Words: - cross-border cooperation; land-use and land-cover change; territorial planning; sustainable development; border regions; urban–rural dynamics; European Union

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1 Introduction

Increasing attention given to borderland studies and territorial-related issues in recent years reflects wide territorial transformations. Recent literature shows borderlands' prominent role within regional studies has been on the rise since the current century, [1], [2]. This specific field is now regarded as a crucial branch of regional studies, particularly in the European Union (EU), [3], [4]. Contribution to the territorial cooperation process validates using border communities to assess opportunities motivating CBC, [5]. Generally, the CBC is institutionalized cooperation between regional and local authorities in the borderlands of neighboring countries to support sustainable development, [6]. In fact, this transboundary cooperation fosters the creation of a global network of relationships among people and states, which enabled the achievement of political, economic, environmental, and socio-cultural benefits, [7].

Cooperation in natural resources and environmental conservation strategies in response to natural factors and human activities is a key concern in the European cross-border associations, [8]. In this regard, environmental and socio-economic developments drive LULC change with potentially negative impacts on human well-being. LULC changes are possibly the most persistent force-driving trend in the degradation of ecosystem services. Deforestation, agriculture, urban development, and other human activities have substantially altered the Earth's landscape, [9]. Administrative cooperation among municipalities is contributing to the management of LULC dynamics. Peripheral imbalance and development in these regions resulted in opposition and conflict of land policy and LULC planning, [10]. These inconsistencies could emerge in three ranges, including urban and rural areas, core and peripheral regions, and cross-boundary regions, [11]. Rapid population growth, urbanization, and industrialization that require substantial resource concentrations concerning land cause intensive LULC dynamics, [12], [13]. Regulations and various associations concerning governments led to a complicated CBC with both objective and subjective factors. Particularly, in the context of LULC changes, CBC may exacerbate socio-economic inequality, [14]. Imbalanced development of adjacent borderlands has also been accompanied by challenges, such as house prices and poor cross-

border transportation infrastructure. Furthermore, coordination of conflicting interests in local LULC planning in borderlands is another common struggle, [15].

Eventually, literature in CBC has mainly focused on socio-economic development at the national scale and paid little attention to transboundary LULC dynamics, [16].

CORINE is an inventory of European land-cover, which falls into 44 different classes. The status layers are available for the reference years of 2000, 2006, 2012, and 2018, distributed by Copernicus (CSL Copernicus), [17]. Moreover, we have considered other indicators and elements based on our previous studies to achieve a better understanding of LULC change drivers. Therefore, we have considered the LULC dynamics in the period of 2000 – 2018 for the Oresund Region, including the cities of Copenhagen and Malmo. Plus, we searched for environmental and socio-economic drivers of LULC changes.

2 Materials and Methods

To assess CBC efficiency in LULC changes analysis, this research includes direct and indirect methods and objectives. Contextually, based on previous research, [18], analysis of the 20 EU CBC cases. The analyzed CBC factors relate directly to LULC dynamics. Therefore, LULC analysis promotes CBC, sustainable planning, and land conflict resolution. The authors have specifically developed these theoretical insights and methodology for this research. The methodological framework has been divided into four main phases, including data acquisition, methodology, data analysis, and results and discussion. This study has been validated by in-depth informal interviews with a variety of CBC experts and stakeholders in the European borderlands. Additionally, expert validation confirmed indicator selection.

2.1 Case study

The Scandinavian borderlands share similar features, even if they can represent specific dissimilarities in comparison, [19]. Therefore, we have decided to assess the famous Scandinavian case of Copenhagen–Malmö among the Denmark–Sweden borderlands, as shown in Figure 1.

The Oresund region is located on both sides of the Oresund Strait. It covers the region of Skåne on the Swedish side and the Zealand region on the Danish side, [20]. It is also the most densely populated metropolitan region in the Nordic countries. The Oresund Bridge linking two cities since 2000, is a comprehensive freeway network that connects Scandinavia to Denmark/Western Europe, [21].

Fig. 1. location of the case study in the Oresund Region. Source: created by the authors.

The Oresund is one of the most well-known cases of the CBC in the EU, built in a metropolitan area, around Copenhagen, Malmö, Lund, and Helsingborg, [22]. Regional associations include both internal and external transport infrastructure, a high level of political agenda, and joint stages of development and economic profiles, [23].

The Oresund is a particular case that does not have as much peripheral nature as the other borderlands. In fact, special features, high magnitude, and velocity of regional enlargement processes make it different from the others. The existing challenges could not affect cooperation efficiency while adding various aspects of regional structures. In the context of LULC dynamics, the Oresund is a very interesting region due to urban sprawl interactions and consequent multi-functional activities. These accomplishments include protected areas on the islands and mainland, agricultural lands as the most concentrated area, and a great number of renewable energy and biomass constructions, [24].

2.2 LULC data sources

The input data of LULC analysis is the CORINE Land Cover (CLC), a Pan-European land-cover database. This dataset comprises European Environment Agency (EEA) member countries, associated countries, and members of the EU. It contains its own nomenclature with 3 hierarchical levels, including 5 distinguished LULC categories at level 1, 15 categories at level 2, and 44 categories at level 3. Level 3 has been selected for LULC granularity, validated, and provided to the Copernicus Land Monitoring Services. In particular,

it applies to the production of Very High-Resolution Land-use – Land-cover datasets for the reference years. In the mapping process, the ETRS98 Lambert Azimuthal Equal Area (LAEA) has been chosen as the map projection system. In the CLC dataset, a geometric resolution or equivalent scale has been set at 1: 10,000. Furthermore, this dataset provides a minimum cartographic unit of 0.5 ha and the minimum mapping width of 10 meters, [25] (Figure 2).

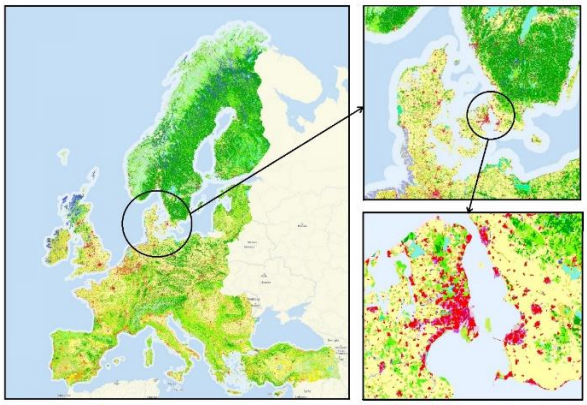

Fig. 2. the Oresund in Pan-European CLC. Source: created by the authors.

2.3 Analyzed factors of CBC and LULC

As we mentioned, the socio-economic elements in cross-border territories will be briefly explained to clarify their role and importance in efficient CBC.

2.3.1 Gross Domestic Product (GDP) per Capita

Gross domestic product is the total monetary or market value of all goods and services produced within a particular environment. It functions as a broad measure of overall domestic production and a comprehensive scorecard of a given country's economic health. In fact, it provides a snapshot used to estimate the scope of economic growth, [26], [27]. In order to break down a country's economic output into a per-person allocation, economists use GDP per capita to determine the prosperity of countries, [28]. GDP per capita highly depends on precise interactive relations with land. Economic growth, land administration, agricultural development, consumption preferences, and trade development are the main drivers of this factor. It also has close links with many more disaggregated indicators of sustainable development, [29], [30]. Therefore, it brings us to consider this crucial factor for the assessment of CBC and land dynamics.

2.3.2 Population density

Population density is the concentration of individuals within a specific geographic locale. It can be used to quantify demographic information and assess relationships with ecosystems, human health, and infrastructure. All human interventions take place to meet material needs, [31]. Population density growth is one of the main drivers of land development and alteration of landscape, whether compact inner-city growth or dispersed suburbanization on the urban fringes, [32]. From an urban-ecological point of view, population density growth would lead to progression in vegetation density to avoid the degradation of ecosystem services. Current trends in the degradation of urban vegetation and population density in urban areas are leading to a reduction in per capita ecosystem services. Therefore, monitoring vegetation trends in regional vegetation cover is necessary, as one of the main impacts of population trends, [33], [34].

2.3.3 Territorial strategies' strength

As we discussed, the most important objective of CBC is to improve the articulation of border regions. In this regard, various regional stakeholders have taken the initiative to establish a dialogue on cross-border development and share innovative solutions by elaborating territorial strategies on a cooperative basis. Therefore, by the quite unclear term of "territorial strategy", we specifically denote a comprehensive documentable detailed plan developed at the cross-border regional scale. This plan can successfully achieve the priorities shared by all the parties concerning territorial development and formulate policies in the field of regional planning, [35], [36], [37]. Yet, cross-border territorial strategies could not be perceived as spatial planning documents, while there could be no cross-border jurisdiction in this context. Additionally, the prevailing formal discourse and practical collaboration beyond borders could not positively cover existing obstacles. Therefore, the main aim of choosing this factor is the capability of assessing transboundary strategies in enhancing cross-border integration and bringing more cohesion to borderlands, [38].

2.3.4 Connectivity, mobility, and accessibility

The ability to access services, facilities, and other community sites is evidently an essential need in any area. Plus, this ability has a critical impact on common wealth's economy. Accessibility, mobility, transportation services, and modes of transport are

fairly extensive in the developed urban areas. Yet, based on natural and geopolitical elements, the borderlands always require more attention in this context. There is a crucial need to expand the reach of transit beyond borders toward cross-border connectivity, [39]. The combination of these concepts, in addition to the operative performance of region transport network, could be considered a substantial index in LULC dynamics.

2.3.5 Economic corridor strength

Borderlands face various persistent challenges and obstacles toward sustainability due to economic engagement. Therefore, CBC constantly works on numerous development schemes to accelerate economic growth. Many borderlands have been using economic corridors to stimulate economic circulation and flows that go beyond the international borders and obstacles in physical infrastructure, [40]. Economic corridors are an integrated infrastructures that link cross-border territories for economic resolution. They associate centers of production, such as manufacturing hubs, industrial clusters, supply chains, and economic zones, as well as the centers of demand for trade-off, [41].

The concept of economic corridor in the EU borderlands has become one of the most important initiatives of CBC since the 21st century, [42]. Nowadays, the initial vision of the economic corridors has remained consistent with the CBC program. They possess an economic rationale, including providing opportunities for economic development. They also facilitate physical infrastructure to be complemented by streamlined policies and procedures that enable easier cross-border flows, [43].

2.3.6 Euroregions marketing

Euroregions marketing is collectively associated with the nature of the CBC process. The institutional structure of CBC led to the establishment of a comprehensive international framework of Euroregions, [44]. Euroregions marketing is a cluster of institutions that harmonizes the extent of economic activities in CBC, [45]. Euroregions Marketing conducts marketing perspectives and activities to achieve desired objectives. However, structural organization and legal structures are dissimilar among the EU borderlands. Moreover, the level of integration process in distinct Euro-regional entities could be another substantial conflict, [46].

Euroregions marketing aims at performing duties to build favorable international environments for economic activities and interpret regional interests. Likewise, it follows the promotion of sustainable Euro-regional planning among local communities. Over time, this function was taken over by local administration at the communal level, [47]. Current Euroregions marketing has become a part of territorial marketing in the EU borderlands. Nowadays, it pursues the objective of influencing opinions and attitudes of external and internal stakeholders by developing an adequate set of instruments for stimulation of relations, [48], [49].

3 Results

This section presents visualized and statistical LULC dynamics in Oresund. The factors analyzed for precise interpretation, regarded as the analyzed factors in CBC and LULC change drivers has been taken into account to achieve an accurate analysis, discussion, and conclusion.

The LULC change data reflects the dynamics of the biophysical state of land. Urban area, forest, and arable land comprise the most covered land in this region. The lands occupied by industry, commerce, and transport are closely associated with urban areas. The highest percentage is located in the immediate vicinity of Copenhagen. Most arable land situated near the urban areas at a further distance is fixed at more than 50% of the area. The forest area is gradually increasing away from Copenhagen, covers 40% of the Oresund area. It is mainly associated with the dense forestation of Skåne, where the city of Malmö is located.

The LULC mappings for the reference years of 2000 (Figure 3), 2006 (Figure 4), 2012 (Figure 5), and 2018 (Figure 6) have been illustrated.

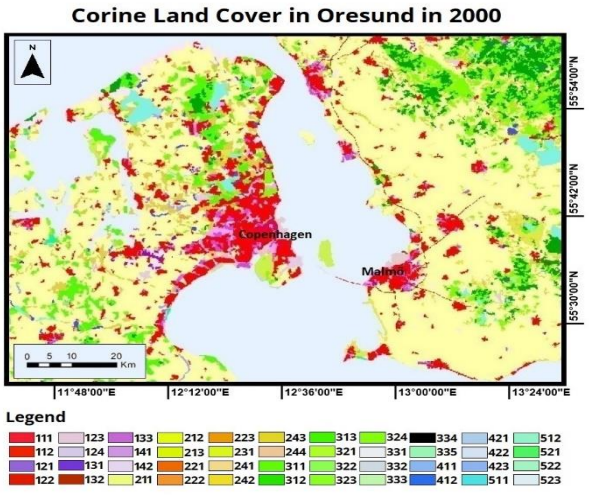

Fig. 3. Oresund LULC (2000). Source: created by the authors.

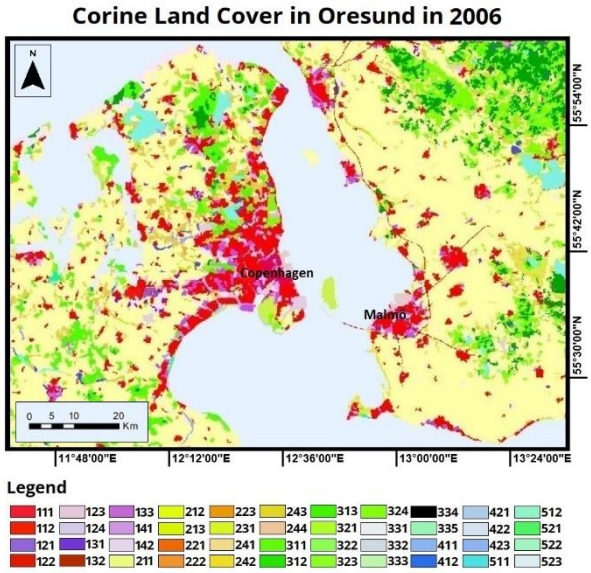

Fig. 4. Oresund LULC (2006). Source: created by the authors.

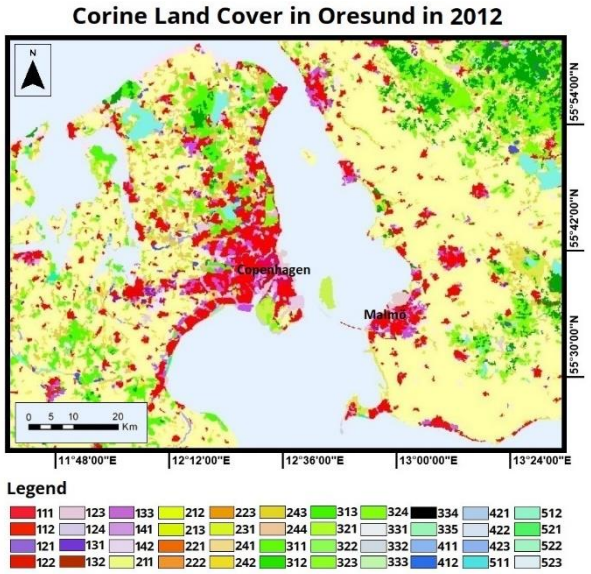

Fig. 5. Oresund LULC (2012). Source: created by the authors.

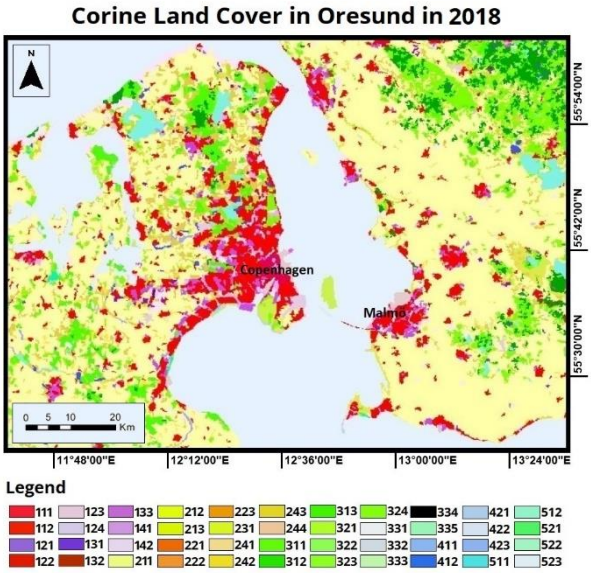

Fig. 6. Oresund LULC (2018). Source: created by the authors.

Consequently, the statistical data, including the percentage and extent of each LULC category, are represented in Table 1, Table 2, Table 3 and Table 4.

Table 1, Artificial Surfaces: % and Area Change 2000-2018 (km^2). Source: created by the authors.

Land-Cover Class		CLC 2000		CLC 2006		CLC 2012		CLC 2018	
Code	Label	%	Area	%	Area	%	Area	%	Area
111	Continuous Urban Fabric	4.9	259.7	5	265	5.2	275.6	5.2	275.6
112	Discontinuous Urban Fabric	3.4	180.2	3.6	190.8	3.9	206.7	3.9	206.7
121	Industrial or Commercial Units	0.65	34.45	0.74	39.22	0.79	41.87	0.83	43.99
122	Road and Rail Networks	0.58	30.74	0.6	31.8	0.63	33.39	0.74	39.22
123	Port Areas	0.82	43.46	0.78	41.34	0.7	37.1	0.66	34.98
124	Airports	0.5	26.5	0.5	26.5	0.5	26.5	0.5	26.5
132	Dump Sites	0.84	44.52	0.96	50.88	0.99	52.47	1.1	58.3

Table 2, Agricultural Land: % and Area Change 2000-2018 (km^2). Source: created by the authors.

Land-Cover Class		CLC 2000		CLC 2006		CLC 2012		CLC 2018	
Code	Label	%	Area	%	Area	%	Area	%	Area
211	Non-irrigated arable land	10.1	535.3	9.8	519.4	8	424	7.8	413.4
222	Fruit Trees and Berry Plantations	1.4	74.2	1.4	74.2	1.2	63.6	1.2	63.6
231	Pastures	1	53	0.85	45.05	0.74	39.22	0.58	30.74
241	Annual and Permanent Crops	22	1166	22.2	1176.6	22.5	1192.5	22.4	1187
244	Agro-forestry Areas	1.7	90.1	1.7	90.1	1.5	79.5	1.4	74.2

Table 3, Forest/Natural: % and Area Change 2000-2018 (km^2). Source: created by the authors.

Land-Cover Class		CLC 2000		CLC 2006		CLC 2012		CLC 2018	
Code	Label	%	Area	%	Area	%	Area	%	Area
311	Broad-leaved Forest	7	371	7.1	376.3	7.2	381.6	7.4	392.2
312	Coniferous Forest	3.3	174.9	3.4	180.2	3.4	180.2	3.4	180.2
313	Mixed Forest	0.63	33.39	0.71	37.63	0.73	38.69	0.82	43.46
321	Natural Grassland	1.7	90.1	1.7	90.1	1.9	100.7	2.1	111.3
323	Sclerophyllous Vegetation	0.97	51.41	1	53	1.1	58.3	1.3	68.9
331	Beaches, Dunes, Sands	19.5	1034	18.2	964.6	17.9	948.7	17.7	938.1

Table 4, Water Bodies: % and Area Change 2000-2018 (km^2). Source: created by the authors.

Land-Cover Class		CLC 2000		CLC 2006		CLC 2012		CLC 2018	
Code	Label	%	Area (KM^2)	%	Area (KM^2)	%	Area (KM^2)	%	Area (KM^2)
511	Water Courses	0.24	12.72	0.24	12.72	0.25	13.25	0.26	13.78
512	Water Bodies	2.58	136.7	2.59	137.3	2.59	137.3	2.61	138.3
523	Sea and Ocean	15.6	826.8	15.6	826.8	15.7	832.1	15.8	837.4

In terms of LULC distribution and structure, the Oresund region demonstrates diverse categories. There are three main regionally significant dynamics in transformed LULC functions, including urban areas, agricultural and recreational lands, and forestry. The transformed class of continuous and discontinuous urban areas, respectively facing an increase of 6.2% and 14.7 %, while industrial, commercial, and infrastructural units are associated with noteworthy growth as well.

These LULC dynamics follow transport/coastal corridors. Copenhagen's 5 Fingers Plan and Malmö's rapid growth are the main drivers of intensification in noteworthy urban development. These innovative national policies and prominent urban planning systems are the key guidelines and cores for successful CBC in this area, [50], [51].

Conversely, Arable land declined steadily due to high land prices. Moreover, coastal appeal accelerates the decline in arable land. Therefore, the reduction of agricultural land is much slower than any other LULC category. These changes don't significantly concern the landscape. Yet, the share of arable land declines moderately fast, while the Danish side declined faster, 0.9% vs 0.4% of Swedish side. This severe difference in arable land trends is principally subject to regional planning and regional developments.

4 Discussion

Socio-economic impacts on the LULC are increasingly studied globally, [52], [53]. However, the practices underlying these impacts require more attention for sustainable land management in borderlands. Therefore, we analyzed CBC factors to evaluate the relationships between the socio-economic trends and LULC changes for an accurate assessment of CBC.

Additionally, we present an overview of socio-economic data as the analyzed factors that characterize the settings of CBC evaluation in this region to discuss LULC dynamics (Figure 7).

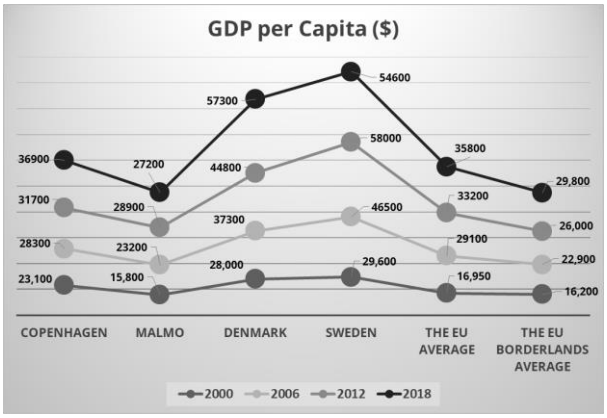

Fig. 7, GDP/capita, 2000-2018. Source: World Bank, [54].

There have been fundamental changes in the industrial and agricultural foundation of the Oresund at the beginning of the century. Both agriculture and industry encountered growing investments in

provisions, services, and facilities, renewable energy, electronics, and medical products. Adversely, this region faced the 2008 crisis with a high rate of unemployment and the emergence of public debt that reached 50% of GDP, [55].

Changes in LULC correlate with shifts in agricultural practices, urbanization, and industrialization that make a remarkable contribution to the GDP per capita. Moreover, this region confirmed a remarkable growth in employment rates. The Oresund Bridge built up cross-border flows between the two cities, [56]. Consequently, it boosted the employment in the private business sector, while the portion of occupations in agriculture and the manufacturing industry continues to reduce, [57].

In terms of urban area, no substantial changes in LULC could be monitored. However, most variations occurred in rural area which transformed into urban areas. These trends in urban areas have not been observed in the last years of the study period, as they mostly took place before 2012. The vast majority of urban land was established on former agricultural land. After 2006, the urban land-take was much higher than before. Approximately, no urban area has been transformed back into other categories. Consequently, once the land-use turned into an urban category, its function would not change in this region.

Agriculture has a large impact on the specificity of LULC in the Oresund. Arable land accounts for the dominant agricultural LULC in this region. Agriculture is the most significant form of LULC on the Danish side. The newest LULC dynamic is the conversion of agricultural land into an industrial area with highly developed transport infrastructure. Copenhagen has the highest rate of urban land development. In contrast, it comprises the highest agricultural land degradation.

The development in transport infrastructure and industry plays the chief role in economic growth, as measured in this study by the GDP per capita. The most observable disparities of LULC dynamics occurred among the configurations of industrial sectors in the most related lands. The key concentration of business services, financial operations, and transportation is in the urban areas. Consequently, the nature of peripheral cross-border territory resulted in less development in GDP per Capita than the overall rate at the national level. However, economic development in this region recorded a more accelerated pace than the other borderlands in the EU, [4] (Figure 8).

Yet, this area possesses an economic powerhouse that engenders the 26% of Sweden and Denmark's overall gross national products, [58]. Nowadays, this cluster of territories confirms more than 20% of the overall GDP of Denmark and Sweden combined, [59].

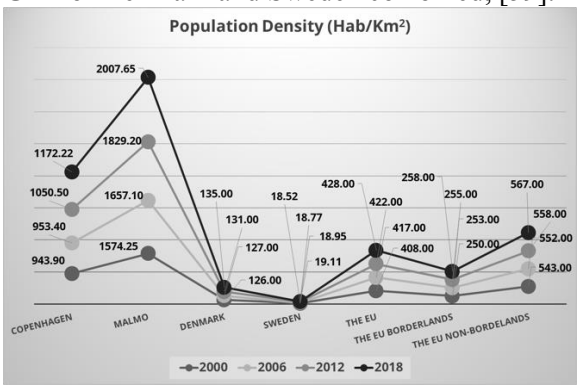

Fig. 8. Population density, 2000-2018. Source: World Bank, [54].

The Oresund region possesses the highest Nordic density, mostly concentrated on the Danish side. However, the immense majority of the population density is in the agglomeration of Malmo metropolitan area. The population in Copenhagen and Malmö experienced an increase of 23% and 26% between 2000 and 2018, respectively. Additionally, the population density in these cities has faced further growth with a surplus of immigrants.

Urban growth interactions across borders take place in dissimilar settings. These complex interactions are not destabilized when adding elements of urban configurations. Cross-border regional enlargement raises some core-periphery concerns in a binational sense, [60]. The Oresund region possesses a multifaceted landscape shaped by agglomeration elements, highlighting the trade-off between land market access and competitive forces. Also, there are other outcomes, such as urban sprawl or adverse propensity in the direction of a low rate of city density, as a result of urban development and a monocentric city. This phenomenon resulted in edge-city, the concentration of facilities outside the city center, based on LULC change monitoring. Furthermore, more details on the consequences could be picked up from the urban economic perspective.

In this regard, spatial LULC changes of the Oresund Metropolitan areas during the study period can be highlighted as a combination of population densification. The low-density outward expansion in continuous urban areas has outweighed in line with current dynamics of urban development. Discontinuous urban areas around the cities of Copenhagen and Malmö have largely faced urban growth. The outer-urban development has stabilized the densification and concentrated population density growth observed in the inner portions of the metropolitan area. These dynamics led to a more

transport-demanding environment and car-dependent flows in urban mobility. The courses of LULC trends in transportation networks development observed in this region are the consequences of investing in enhanced road capacity as well as improved public transport. There has also been a new trend of converting agricultural land into highly developed transport infrastructure.

As a result, both Copenhagen and Malmö metropolitan areas are becoming the region with new settlements and greater absorption of population. Plus, the high population density outflow led to some socio-economic challenges, including the ageing of the population and a relatively high unemployment rate. However, population density growth in the long-term perspective is more uncertain than spawning movement, as it depends on accessibility and economic structure (Figure 9).

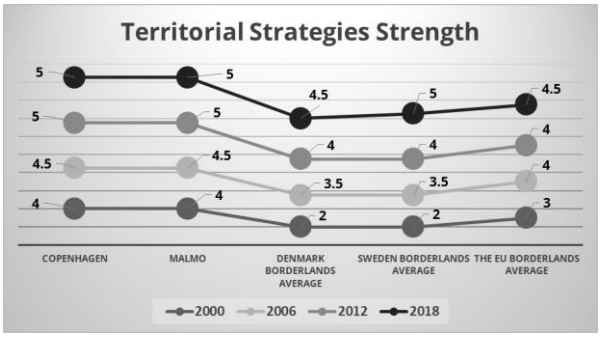

Fig. 9. territorial strategies strength (1 (lowest) to 5 (highest)). Source: created by the authors.

The Oresund region possesses a growth forum, regional councils, and research institutions for regional development and sustainability objectives. These units collectively design and implement holistic policies and action plans for strategic development by linking policy to business. In fact, they aim at searching for a relation between regional strategy and a specific operational policy for business development, [61]. We briefly present the summary of strengths and weaknesses of innovation policy and territorial strategies in this area in Table 5.

The results derived from LULC dynamics and the ability of travel and transit, summarized in connectivity, mobility, and accessibility, visibly imply that individuals deal with an expressive shift in tendency toward the Oresund region. In fact, this shift consists of growing possibilities for integration through sustainable cross-border accessibility and mobility, enhanced interactions, and a settled sense of belonging (Figure 10).

Table 5, LULC integration strengths and weaknesses of cross-border territorial strategies. Source: created by the authors.

Strengths	Extensive history and strong background of CBC
	Legitimacy, stability, and political endorsement from several regional committees
	Presence of cross-border policy intelligence tools (Orestat, Oresund Institute, etc.)
	More strategic use of European Territorial Cooperation (Interreg) funding than others
	Empowering internal and external accessibility and mobility by the Oresund Bridge
	Significant endowments in universities, academic capacities, and resources
	High level of innovation in life science and cleantech
Weaknesses	Regulatory obstacles for cross-border labour market integration
	Imbalance in the economic power of the two sides within the national context
	Growing regional imbalances between the core and periphery of the Oresund

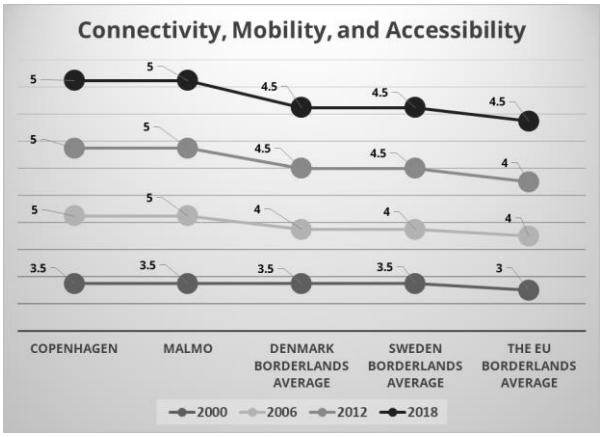

Fig. 10. connectivity, mobility, and accessibility (1 (lowest) to 5 (highest)). Source: created by the authors.

The Oresund Bridge, along with resourceful train and road networks and links guarantee strong internal accessibility between the two main cities of this territory. This claim has also confirmed by the expansion of transport infrastructure, roads, and rail networks in LULC. Moreover, external accessibility is strong with major international airports, which is plainly evident in LULC mapping. Over the last decade, the benefits of regional integration and cross-border dynamics have enabled the Oresund Region to stand out as one of the most sustainable cross-border territories with secure connectivity, mobility, and accessibility in the EU (Figure 11).

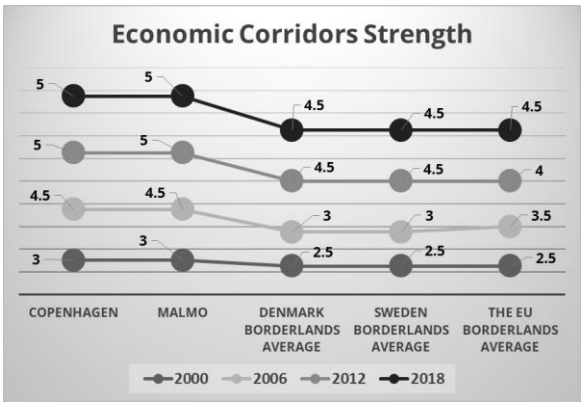

Fig. 11. Economic corridor strength with core-periphery focus (1 (lowest) to 5 (highest)). Source: created by the authors.

As we discussed, the opening of the Bridge between the cities delivered a strong boost to the integration process, economic development, and industry. This territory possesses a core-periphery configuration, with the most economic development and activities concentrated in the central area, in direct proximity to the Bridge near the two cities. As a result, regional resource endowments have considerably promoted regional communications of economic activities (Figure 12). Based on LULC dynamics, there has been significant growth in industrial and commercial units. In fact, the establishment of industrial areas is one of the key elements of CBC, considered a trustworthy scheme in fostering economic development and employability in an economy, [62].

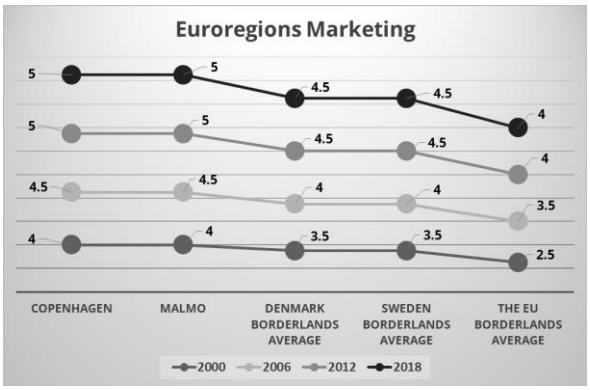

Fig. 12. Euroregions Marketing (1 (lowest) to 5 (highest)). Source: created by the authors.

Currently, more European cross-border territories are planning to market their own region by evolving innovative strategies in Euroregions marketing to boost competitiveness, [63]. In this regard, we intend to analyze these strategies and outcomes by reviewing relevant schemes and exploring practices. In the Oresund region, hypothetical models are associated with engagement in the process of territorial competition. However, the rise of similarities in regional hardware such as transport infrastructure, education, and leisure facilities, integration process in these territories is still competing to attract and retain individuals, [64]. The importance of Euroregions marketing for regional competitiveness has contributed to economic growth within the entire Oresund, selected as one of the best practices for CBC. To be sure, it is rare to find a region in the EU borderlands where government, education, and commerce have run so successfully in a united manner as in this territory. However, recent doubts have increased around the validity of the efficient performance. Definitely, this cross-border territory is currently performing better than ever before, but then it still does not match the sustainability perspective of an exciting and imperative innovative area in the EU, [65].

5 Conclusion

This study covers a range of methodological and statistical tools of LULC change analysis, along with data distribution, average, and correlations of the Oresund region. Additionally, it includes theories, procedures, and empirical data analysis for underlying indicators and attitudes regarding the efficiency of CBC. Indeed, we considered and analyzed factors of CBC within the EU borderlands derived from our previous studies to put them into the reality of these territories and link them with the practical measures of LULC dynamics.

CBC elaborates and acts on integrated territorial development strategies that set up three intervention packages. These three include conservation strategies of landscape and harmony, employability development and welfare, and preservation and strengthening of territorial identity, belonging, and marketing. Consequently, we tried to set the analyzed factors in a comprehensive way that fully covers these three topics. Besides, the designed analysis has been formulated with suggestions for responses and solutions to the challenges associated with LULC trends.

The core LULC changes in both cities have been recorded in the recreation and residential area growth. This trend in urban areas could be an effect of urban sprawl, suburbanization, seasonal house construction, and the transformation of rural areas. The spatial planning for protecting the environmental settings and natural areas has been relatively effective, with fewer agricultural and production

functions, and to a lesser extent of rural landscape in Copenhagen. Nevertheless, the urban sprawl and agglomeration pressure resulted in a gradual shift of agriculture to more peripheral areas near the borders. Contemporary, industrial, and infrastructure units faced a conversion to high-tech branches and more compact extent. This trend has a remarkable impact on a clean and healthy environment and well-organized landscape business as environmental benefits, specifically in agglomeration surroundings. The LULC changes indicate that the 2000s could be considered a period of transition for both cities, as this shift is reflected in these dynamics. In fact, this territory passed the traditional forms of agriculture, industry, and transport toward more corresponding to the modern challenges and economy. Peripheral urban areas (extents between urban settlement regions and rural surrounding areas) have to face the highest growth rates of urban development, regarded as the peripheral growth. In practice, these regions experienced high pressure in the degradation of natural landscapes near the cities as a result of rural housing. While most cross-border urban areas are currently developing at a slower rate (around 0.05-0.06% per year), housing development in peripheral rural regions is growing at many times this rate, [66]. In the case of the Oresund area, it can be predicted that LULC trends around the cities of Copenhagen and Malmo will have the fastest growth in artificial surface of urban areas compared to rural areas.

The transport infrastructure linked discontinuous urban fabrics with built-up extents and has expanded along the associated land. Moreover, the intensification of limited land resources took place in second-tier urban regions in both cities, typically in places situated within 20 to 40 kilometers of urban centers. This process is the central reason for the conversion of agricultural areas to artificial surfaces. Economic growth has led to internal variations in urban categories, typically over the emergence of new dwellings to the accommodation process. Consequently, the internal conversion of forest and semi-natural areas in conjunction with sport and leisure facilities happened in both cases, mostly in Danish side.

The empirical evidence presented in this study has confirmed a relevant relationship between land dynamics. This case highlights the dependency of CBC and integration processes on economic links, representing a formidable comparative advantage. Yet, existing gaps could act in disregard of developing territorial projects and the convergence of all the elements within interactions. Obviously, cross-border territories possess a transitional character. Communication with bordering territories is simplified thanks to the expansion of transportation networks. The development of accessibility, connectivity, and mobility has noticeably solved the commuting challenges and broadened the local to regional socio-economic potential. However, low business clusters and innovation are important challenges for both municipalities.

This territory is an attractive residential area, thanks to the countryside, natural environment, and extensive coastline. The empirical potential to develop the green industry and green energy production is the most important strength of this region. Within the Nordic CBC, a remarkable share of the regional planning events has been devoted to the role of transport networks going through all borderlands. Most municipalities of the Oresund region possess the highest commuting ratio in the EU borderlands. The LULC dynamics monitored and examined in this study are generally applicable recommendations for future CBC in Nordic borderlands. In fact, they are not constantly relevant due to the very large diversity of cross-border regions within the entire EU or all around the world.

The analyzed factors in this study are possibly essential priorities for CBC projects, especially by considering the next period of LULC change based on CLC and territorial cooperation states analysis. Therefore, the future priority for territorial cooperation could be particularly set on urban-rural LULC links in future CBCs. These regions are precisely linked with surrounding urban areas and play a key role in CBC. In fact, discouragement disparities in population density, unemployment rate, imbalanced economic development, and preservation strategies of natural and cultural heritage highly depend on rural-urban ties. Besides, the vision of sustainability in these regions brings about superior prominence on the strengthening ties between the rural and remote areas and nearby urban areas within a cross-border territory.

The ties between CBC and regional sustainability structure and development have become an interesting topic for further examination within the context of border studies. This subject mainly focuses on the more strategic aspects of spatial planning methods, such as the evaluation of the effectiveness of CBC. In fact, this growth-oriented method could be a starting point for determining the added-value of territorial sustainable development, particularly within the field of cross-border twin cities and Euroregions. The role of the twin cities and Euroregions in achieving territorial cohesion and balanced competitiveness in the EU borderlands is another captivating topic in CBC. Furthermore, more analyzed factors and indicators in the context of

sustainability concerns must be taken into account. Therefore, this study could be considered a starting point for sustainability analysis in the EU borderlands to inspire more research on this subject. Yet, limitations on the simultaneous collection of different data types are the main disadvantage in borderland studies.

Study limitations:

Data collection challenges in borderlands could be considered the main limitation of this research.

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Conflict of Interest

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