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Degradation of Coastlines under the Pressure of Urbanization and Tourism: Evidence on the Change of Land Systems from Europe, Asia and Africa

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Abstract: The importance of studying coastal areas is justified by their resources, ecosystem services, and key role played in socio-economic development. Coastal landscapes are subject to increasing demands and pressures, requiring in-depth analyses for finding appropriate tools or policies for a sustainable landscape management. The present study addresses this issue globally, based on case studies from three continents: Romania (Europe), Algeria (Africa), and Vietnam (Asia), focusing on the anthropogenic pressure resulting from land use/land cover change or urban sprawl, taking into account the role of socioeconomic and political factors. The methodology consisted of producing maps and computing and analyzing indicators, correlating geospatial and socio-economic data in a synergistic manner to explore the changes of landscapes, and identify the specific driving forces. The findings show that the pressure of urbanization and tourism on coastal areas increased, while the drivers and impacts vary. Urbanization is due to derogatory planning in Romania and Algeria, and different national and local goals in Vietnam. The two drivers determine local exemptions from the national regulations, made for profit. In addition to the need for developing and enforcing policies for stopping the degradation and restoring the ecosystems, the findings underline the importance of international cooperation in policy development.

Keywords: land use/cover change; ecosystem services; anthropogenic impact; landscape planning; landscape analysis; driving forces; governance; ecological study; geospatial data

1. Introduction

1.1. Importance of the Coastal Areas

In their study, Martínez et al. [1] stated that "*Planet Earth is a coastal planet*", arguing by the fact that water accounts for 361.13 million km^2, i.e., 71% of total planet surface. In addition to their total size, coastal areas (CA) are important for their other roles. Ecologically, the CA are ecotone areas [2] and offer multiple ecosystem services [1,3]: provide food, habitat, and nurseries for 80–90% of the world's marine fish and shellfish [4–7], protect the biodiversity [2], provide the controversial "outwelling" service and help moderating the water quality [8], contribute to mitigating and adapting to climate changes [9], and reduce the vulnerability to rising seas and coastal hazards [10].

The ecosystem services provide essential resources for human well-being and economy [11,12], but the quality and quantity of these services are very vulnerable to anthropogenic factors [13]. The multiple economic, social and recreational opportunities have attracted humans to the CA since the beginning of the 20th century [14,15], and as a result they are generally more heavily populated than the inner continental areas; half of the world's population [6,16] with three times the average population density compared to the global average one [12,17], and 11 of the world's 15 largest cities are located on sea coasts or estuaries [18], and 50% of the world's population will live within 100 km of the coast by 2030 [19,20]. Coastal populations in many countries are growing at a rate doubling the national one. About 11% of the world population currently lives within 10 km of the coast [21,22] and, with a 65% urban share, coastal ecosystems are more urbanized than other ecosystems [23,24].

The CA are some of the main tourist areas of the world. Coastal tourism has pulled the numbers of tourists to visit and created essential revenue resources for locals. In addition, the integration of land and sea distributes natural resources such as water, beaches, landscapes, rich biodiversity and cultural heritage. These natural resources help to create spaces for diverse recreational activities that take place in all the CA and on water. The numerous infrastructures, including hotels, second homes, restaurants etc. were built to support these activities. The landscape is considered to be one of the most critical elements for coastal tourism and contributes to developing the economy of the countries, turning the CA into the main place where many extensive and diverse economic activities are developed [25].

1.2. The Human Pressure on the CA

Although many studies have revealed particular human impacts on the CA [6,26–28], Newton et al. [29] grouped all of them in nine "syndromes" (references integrate studies describing each one in particular): (1) sediment syndrome [5,8,15,28,30]; (2) water syndrome [8,31,32]; (3) eutrophication syndrome [5,8]; (4) coastal land-use syndrome [14,20,33–35]; (5) coastal urbanization syndrome [2,8,31,34–36]; (6) biodiversity syndrome [32,37]; (7) pollution and contamination syndrome [4,8,32,38]; (8) exploitation of non-renewable resources syndrome [1,4,39]; and (9) global change syndrome [1,40].

Several countries have experienced rapid development of their coastal regions in terms of population, economic growth and urbanization. The population growth in these areas is important since world trade has created numerous jobs and favored economic growth, for example in agriculture, fish farming, tourism, oil exploitation [41–43]. Currently, we witness a reduction in the number of beaches in the world. In the closer or distant future, the safety of equipment installed at the seaside is at stakes, and a reflection on the measures taken to protect the coast becomes necessary. Therefore, at the Rio 20 conference in Brazil, members agreed that adaptation to climate change is an urgent action worldwide and particularly noted that rising sea levels is one of the serious threats to many CA [44–47]. In these areas, the measurements should focus on coastal protection to reduce the risk today and in the future, as well as to adapt to rising sea levels. Currently, coastal protection efforts largely depend on structural measures, such as dikes, particularly in economic growth areas.

Although urbanization is a major driver of global changes, the process exhibits local differences. Defining and analyzing for the first time in the scientific literature a megalopolis, J. Gottmann [48] has appreciated in 1961 the role of huge urbanized CA of the world as intercontinental economic hinges. In that time he pinpointed mainly the positive role of such urban concentrations, but today the high pressure exerted by mega-cities shows the necessity to pay greater attention to the threats on their sustainability [49]. In Pacific Asia, regions outside the mega-cities have grown the fastest in population and land use changes. In Jakarta and Manila, land use controls are less stringent in the urban fringe areas, where developers can simply pave over farmland or forestland and easily install infrastructure [5]. In China, the coastal opening-up policy attracted a numerous foreign investment enterprises, and many economic development zones were generally built in cities and small towns [50], and most major cities have moved factories out to industrial zones on the urban edges, freeing up land for gentrification at the urban core [5]. In Europe the urbanization phases developed at different speeds and time between the north and the south [51], and the process is also more prominent in the east [52]. In developed countries, urbanization fragments large areas; in developing countries, growth is concentrated around urban cores, replacing adjacent land uses at a slower rate than developed countries [53]. Suburbanization is a seen in these countries as a relatively fine-scale residential development close to larger cities [54].

1.3. Importance and Aims of the Study

The literature review underlined the lack of holistic approaches, despite the fact that understanding the relationships between multiple human pressures and the status of ecosystems is crucial to develop spatial plans [55]. Although there are no common solutions, the human pressures and coastal ecosystems have a spatial component; this is why cartography is traditionally considered essential for the analysis and management of natural environments [55]. The literature review also emphasized the global importance of the CA. Furthermore, the global CA face common challenges due to the human pressure, especially because of the land use changes induced by urbanization and tourism. Despite the common problems, the political, economic, environmental, and social differences among the CA and the integrating regions and countries make impossible the identification of common solutions. Scientists can help manage the environment and protect the CA under pressure by providing scientifically sound technical information to decision-makers. In the recent years, the economic and social importance of the CA has grown, leading to major land use conflicts. In addition, these areas face common challenges due to economic development, including growing urbanization and tourism development. Nevertheless, comparative studies can bring important contributions to identifying common principles for the sustainable management of CA, contributing to tailored strategies for the management of the CA.

Coastal landscapes are subject to increasing demands and pressures; the present focus is on the anthropogenic pressure, especially that resulting from land use/land cover change, or urban sprawl, which leads to infrastructure development, taking into account the role played by the socioeconomic and political factors. Our goal is to produce maps and compute and analyze indicators in a synergistic manner in order to explore the changes of landscapes and identify the specific driving forces (urbanization, infrastructure development). The identification of changes is used to find appropriate tools or policies for a sustainable landscape management.

In more detail, this study aims to carry out analyses of long-term land cover/land use (LCLU) changes, focusing on the urbanization of Romanian, Vietnamese and Algerian coastlines (Figure 1) in an attempt to identify the drivers and mechanisms of the process in order to derive spatial planning lessons and phrase concrete planning recommendations that can be used in strategies for the CA of these countries, and also serve as an example to managers from other areas. The selection of these areas as case studies offers relevant insights for oceanic CA in Vietnam, which is one of the most populated low elevation coastal zones of the world [23], for narrow Mediterranean CA, which is one of the largest intercontinental seas, and for complex CA from the Black Sea, including the fluvial and maritime sector of the Danube Delta.

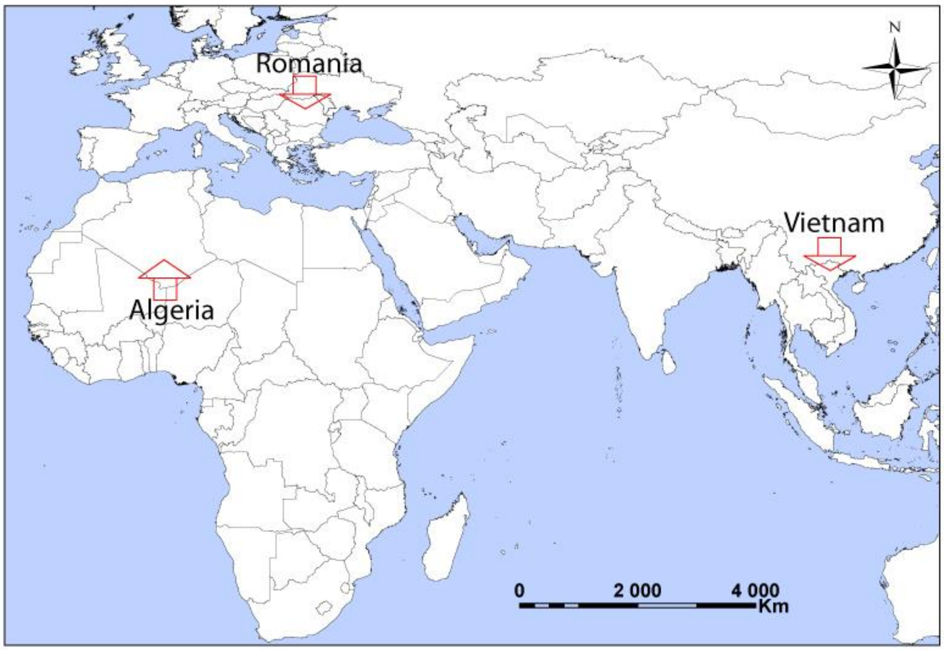


Figure 1. Location of the three case studies in the world. Source: made by A.-I.P. using ESRI ArcView data.

2. Materials and Methods

The present research is based on three case studies carried out in three countries situated on three continents: Romania (Europe), Vietnam (Asia), and Algeria (Africa) (Figure 1). Each study has attempted to employ an "ecological approach" (with local variations). The term is used in its epidemiological meaning [56]; it does not refer to the science of ecology, but to the ecological approach of looking at the entire system and not as individual organisms. In this framework, epidemiologists label "ecological" a study carried out at the population level (in this case, administrative units) instead of the individual ones, correlating the geo-spatial data on urbanization, available in GIS format (Romania) or derived from satellite imagery (Algeria and Vietnam), and ancillary data (e.g., statistical yearbook, population censuses, local master plans, specialized agencies) on tourism and the drivers of urbanization.

2.1. Geographical Settings

2.1.1. The Romanian Seashore

In Romania, the shoreline coincides with the coastline of the Black Sea and is located in the western part of the Black Sea (Figure 2). From a geographical viewpoint, it stretches from the north to the south over 243 km, with the northern limit situated at the border with Ukraine by Chilia arm of the Danube Delta (45°12′ N and 29°40′ E) and the southern limit situated at the border with Bulgaria by a conventional line, which passes south of Vama Veche (43°44′ N and 28°35′ E) [57]. The Romanian Black Sea shore is divided into two main parts. The northern one is the deltaic coast of the Danube River, consisting of deltas, lagoons and dikes, formed by marine-river accretions, bark of recent sands, arranged as beach and coastal belts with relatively low height, often less than 2 m [58,59]. The portion of the northern part situated between the mouths of the Chilia arm (North) and Midia Cape (South, 44°21′ N and 28°41′ E) of the Danube Delta, with a total length of 166 km, is part of the Danube Delta Biosphere Reserve [60]. The southern part is the part where most human settlements and a belt of tourism resorts are situated, including three port areas and tourist beaches. Since this area is developed, it represents the main focus of the study. However, in this study the limits of the coastline are defined based on the methodology used in a national project [61], coinciding with the boundaries of the territorial-administrative units situated at the seashore; the area spans over 3470.9 km^2 and has a maximum width of 50 km.

Figure 2. Location of the Romanian shoreline (blue) in Romania (purple) and Europe (gray). White areas correspond to the seas. Source: made by A.-I.P. using ESRI ArcView data.

The area described above was chosen because it is the only Romanian coastline; in addition, it is representative for a European country undergoing post-communist transition, and the different environmental impacts generated by it [62]. Moreover, the Romanian coast is an extremely dynamic system [63]. Within its limits, the groundwater and land adjacent to the marine areas exhibit specific processes and uses that affect directly the sea. The area includes the most productive part of the Black Sea (in the northern sector), which is strongly influenced by the Danube discharges, the climatic processes and the high temporal variability of the optimal plant growth conditions [64]. Overall, the study area is a very attractive environment [65], but it is increasingly affected by climate change (sea level, storms, floods, landslides and coastal erosion) [66], economic activities (agriculture, transport, tourism, fisheries, industry) and associated pollution [67].

Within this perimeter, the geospatial analyses were confined to the territory of administrative units adjacent to the shore line. The resulting study area, labeled in the article as 'Romanian shoreline', consists of 18 units with a broad variation of ranks (according to their national importance), areas (from about 10 to 800 km^2), and population (from less than 1000 to over 300,000) (Table 1).

Table 1. Administrative units of the Romanian shoreline and their population.

Type [1]	County	Name	Population (2000)	Population (2010)	Population (2020)	Area (km^2)
1	Tulcea	C. A. Rosetti	1,218	983	782	266.18
1	Tulcea	Murighiol	3654	3584	3428	776.95
1	Tulcea	Sfantu Gheorghe	1085	883	800	590.93
1	Tulcea	Jurilovca	5410	4987	4424	341.21
2	Tulcea	Sulina	5106	4501	3911	327.76
1	Constanta	Mihai Viteazu	3387	3702	3750	204.79
1	Constanta	Istria	2452	2624	2548	182.12
1	Constanta	Corbu	4671	6030	6337	166.19
1	Constanta	Agigea	4864	6880	8381	22.13
1	Constanta	23 August	5146	5556	5750	91.77
1	Constanta	Limanu	4239	5959	6749	97.48
1	Constanta	Costinesti	2515	2933	3301	24.14
1	Constanta	Tuzla	5687	6840	7210	50.36
2	Constanta	Navodari	35,687	39,698	42,360	45.62
2	Constanta	Techirghiol	7060	7727	8175	65.53
2	Constanta	Eforie	9354	10,726	11,071	13.64
3	Constanta	Mangalia	44,340	43,650	40,875	77.55
4	Constanta	Constanta	339,398	324,849	313,021	126.57

[1] Type (according to the national classification–Law no. 351 of 6 July 2001): 1—municipalities of national importance with potential European influence; 2—municipalities of regional importance, or role in balancing the settlement network; 3—cities; 4—villages serving as commune seats.

In general, Europe has been considered in 2007 part of the group of countries having CA with the largest percentage of altered and semi-altered ecosystems (up to 74%), moderate population density (a maximum of 8000 every 100 km^2) and population growth rate (−12% to 49%) [1].

According to Pranzini et al. [15], the first coastal settlements of the current Romanian territory appeared 26 centuries ago. The Greek cities represented a peak of development in the antiquity (8th century BC) [68], but modern development started at the end of the 19th century; it was interrupted during the communist regime, resulting into the decline of ports [69]. In order to address the most important environmental issue, i.e., the shortage of sediments, the protection relied on hard structures, with negative impacts. The centralized economy led to no maintenance investment, causing the decay of protective structures after the collapse of communism. The use and administration of beaches were "rented" to the private sector, but, in order to avoid fragmented development strategies, beaches had been under a centralized management, coordinated by the Ministry for Environment. Efforts are made to develop a master plan for coastal protection, and softer methods started to be adopted. There is a strong need for developing modern policies based on new concepts in conjunction with investments in soft techniques.

Previous studies have indicated that the Romanian seashore was affected by the increase of built-up area in two ways: (1) Urban development due to the construction of vacation homes and expansion of the existing cities against their hinterland, and (2) tourism, meaning the construction of tourism facilities [52]. Consequently, the analysis aimed to ascertain the influence of all drivers, measured by the correlation between the urbanized area per administrative unit and different statistical indicators for tourism and urban development.

2.1.2. The Littoral of Vietnam

In Vietnam, the seaward limit of the coastal zone is usually chosen at a depth of 30–50 m depending on the region; the continental limit is taken according to the administrative boundaries of coastal districts [70]. However, so far, no official computation of the surface of the coastal zone/area was made by the government, research institutions and scientists.

Vietnamese CA (Figure 3) are subject to many pressures, including those related to the climate, economy and society. The Vietnamese coastline expands over 3440 km from the Chinese border in the north to the frontier with Cambodia in the Gulf of Thailand. Currently, Vietnam has 63 provinces and municipalities, out of which 28 are coastal ones. The Vietnamese sea area is about 1 million square kilometers, which is three times larger than its land area. This includes part of the East Sea in the east, south, and west; the Gulf of Tonkin in the northeast; and part of Gulf of Thailand in the southwest. About 206,000 km^2 represent large CA less than 50 m deep [71].

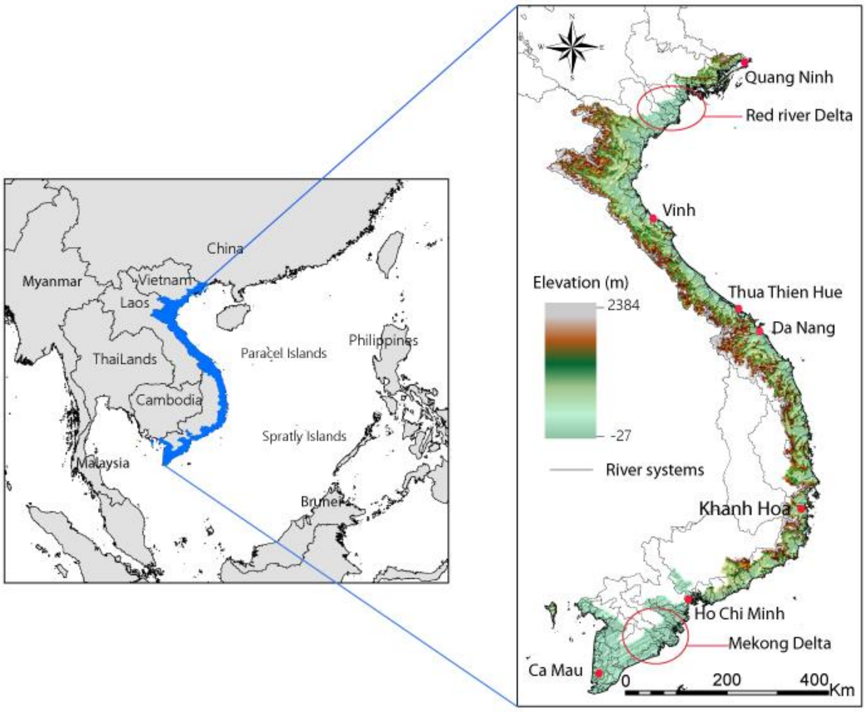


Figure 3. Location of the Vietnam shoreline (blue) in Vietnam and Asia (gray). White areas correspond to the seas. Source: made by H.D.N. using official data.

One of the great characteristics of Vietnam is its geographic diversity. This can be explained by its S-shape, since it stretches from its border with China to the mouth of the Gulf of Thailand. Three-fourths of its surfaces include mountains and plateaus and lesser populated beaches, clean and magnificent. Because of its geographical position, it provides the link between the Asian peninsula and sparse archipelagos in the South China Sea, and offers tourists a multitude of accesses by road, sea or air. The cultural heritage of this country and its physical particularities constitute a critical tourist potential, and in fact make it a very attractive eco-tourist destination with an exceptionally preserved nature. Vietnam is divided into three distinct regions: the North (formerly Tonkin), the center (e.g., Annam) and the south (e.g., Cochinchina). Similarly, we can distinguish three categories of links, the mountain area, the coast with the sea and the islands, and finally the plains.

Since 1986, economic development strategies have continued the economic liberalization in which Vietnam was engaged with the Đổi Mới (policy of Renovation). Urban growth can be seen as a concrete illustration of this economic dynamic. "The country has thus gone from a centralized and planned economy to a so-called socialist-oriented market economy (. . .). Economic development is accompanied by an intensification of urbanization" [72]. After more than thirty years of economic liberalization and the opening up of the country to international markets, land use patterns in the delta, especially in its CA, have undergone more changes. For example, urban expansion is most often due to industrial cores, the engines of economy. Tourism is another strong point of development. In a second step, a change of land management took place within the framework of the Đổi Mới policy, aimed at reducing the degradation of the environment.

The littoral region has a very important strategic position in geography, economy, politics, culture and national security [73]. This position is now much more territorial, with the two deltas united. In some areas, such as the east of Central Highlands and north of Red River Delta, the mountains extend directly into the sea. This area hosts numerous protected areas, including those of the port cities of Da Nang, Qui Nhon, and Nha Trang. In addition, port cities are essential and strategic communication nodes of the country. Much of the gross national product (GNP) comes from the fishing industry, shipping, tourism and other related industries. For this reason, currently urban, tourism and industrial projects are carried out intensively in this region.

With respect to population growth, the Vietnamese littoral region is one of the most densely populated areas of Southeast Asia [23]. Vietnam is a general example for the displacement of population from the hinterland to CA. The estimated total population of Vietnam was in 1999 nearly 76 millions in 1999, out of which nearly 25% (19 millions) were living in coastal districts or cities. According to the official data, presented in Table 2 [74], the population of Vietnam was close to 97 millions in 2019. Approximately 50% of it lived in the CA of the country; the two deltas of Red and Mekong Rivers were the most populated. Population densities in this region were up to ten times higher than in the rest of the country (994 inhabitants per km^2 in the Red River Delta and 103 inhabitants per km^2 in the Central Highlands in 2015) [75].

Table 2. Population of the Vietnam shoreline according to 2019 data [74].

Province/City	Population in 2000 (thousands)	Population in 2010 (thousands)	Population in 2019 (thousands)	Area (km^2)
Quang Ninh	1024	1159	1224	6177
Hai Phong	1691	1857	1980	1561
Thai Binh	1789	1786	1790	1586
Nam Dinh	1886	1830	1852	1668
Ninh Binh	886	900	953	1386
Thanh Hoa	3468	3406	3528	11,114
Nghe An	2871	2917	3105	16,481
Ha Tinh	1268	1228	1266	5990
Quang Binh	802	849	877	8000
Quang Tri	577	600	623	4621
Thua Thien Hue	1052	1090	1149	4902
Da Nang	706	926	1046	1284
Quang Nam	1382	1425	1487	10,575
Quang Ngai	1194	1218	1251	5152
Binh Dinh	1466	1489	1524	6066
Phu Yen	799	868	899	5023
Khanh Hoa	1049	1167	1213	5137
Ninh Thuan	516	570	601	3355
Binh Thuan	1063	1176	1222	7944
Ba Ria Vung Tau	829	1012	1092	1980
Ho Chi Minh	5274	7396	8297	2061
Tien Giang	1613	1677	1740	2510
Ben Tre	1297	1256	1265	2394
Tra Vinh	972	1005	1040	2358
Soc Trang	1193	1300	1312	3311
Bac Lieu	749	867	886	2669
Ca Mau	1133	1212	1222	5221
Kien Giang	1522	1703	1766	6348

The rapid growth of population along the sea can be seen as a rapid urbanization of the region, supported by the growth of industry and tourism. From 1990 to the present, the number of urban centers increased from 500 to 623. This growth took place especially along the coast, along with an increase of the urban population. The coastal region is easily accessible, and became the center of human activities; people live and find their livelihoods, parallel to the economic growth and rapid urbanization of Vietnam, especially after the renovation policies of the state. However, the centralized economy did not require any maintenance investment, leading to the deterioration of the protection structures. Thus, the CA had to cope with environmental problems such as the shortage of sediments. The protection was based on solid protection structures (e.g., dikes), with negative impacts on population growth, urban development and tourism.

In this context, it is appropriate and interesting to examine the country's development problems in relation to the characteristics of its population and the population programs carried out there, particularly in CA. Because of the beautiful beach, the coastal region is more comfortable to live, in parallel with its economic growth, urbanization and the development of tourism, especially after the country's renovation.

2.1.3. The Littoral of Algeria

The Algerian coast is located in the north of the country. It stretches from east to west for 1622 km (Figure 4). This Mediterranean maritime frontage is limited by Tunisia in the East (36°56′ N and 8°38′ E) and Morocco in the west (35°5′ N and 2°2′ W). This coastline is made up of 14 departments, has an area of 81,100 km^2, and an average width of 50 m starting from the seafront. It hosts many natural reserves which are the Habibas Islands (Oran), Anses de Kouali (Tipasa), Djurdura National Park (Tizi Ouzou), Gouraya National Park (Béjaia), Taza National Park (Jijel), and the Park National of El-Kala (Taref). In the background of the coastline, the landscape is dominated by the mountain chain of the Tell Atlas (Mont Chenoua, Blédien Atlas, Djurdura, Babors) with many forests.

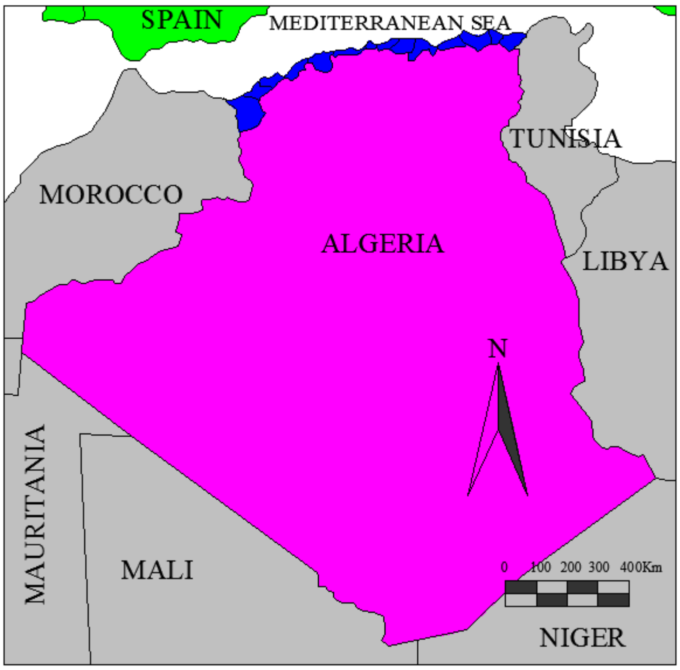


Figure 4. Location of the Algerian shoreline (blue) in Algeria (purple) and Africa (gray). White areas correspond to the seas. Source: made by W.H. using official data.

In 2008, the Algerian population was 34,080,030 inhabitants spread over the total area of the country, 2,381,741 km^2 [76–78]. 13,501,948 inhabitants (Table 3) are concentrated in the coastal departments (3941.94 km^2), or 39.61%. The explanation is that this region has a concentration of industries, fertile agricultural land and state institutions. The climate is more advantageous for agriculture and living and the area creates more job opportunities than the highlands and the Sahara, which cover all together 84% of the country's surface.

Table 3. Area and number of the population of the coastal departments. Source of data: National Statistics Office of Algeria. Data comes from the three national censuses in 1998, 2008, and 2020.

Department	No. of Municipalities	Population in 1998	Population in 2008	Populationin 2020	Marine Front (km)	Area (km^2)
Tlemcen	8	842,053	949,135	1,118,482	73.00	115.027
Ain Temouchent	9	327,331	384,565	427,658	80.00	212.45
Oran	14	1,213,839	1,454,078	1,625,863	124.00	363.65
Mostaganem	10	631,057	737,118	1,625,863	229.73	215.14
Chlef	6	858,695	1,002,088	1,185,580	129.00	165.82
Tipaza	14	506,053	591,010	675,232	145.81	203.73
Algiers	20	2,562,428	2,988,145	3,299,645	107.00	122.17
Boumerdes	10	647,389	802,083	864,726	80.33	116.65
Tizi Ouzou	5	1,108,708	1,127,608	1,433,501	61.43	103.33
Béjaia	8	856,840	912,577	1,128,030	110.83	532.02
Jijel	9	573,208	636,948	793,633	123.90	463.49
Skikda	14	786,154	898,680	1,059,808	250.19	451.23
Annaba	5	557,818	609,499	715,370	122.50	230.21
El Taref	10	352,588	408,414	491,938	90.00	647.03

The construction of ports in Algeria dates back to the Phoenician era (1250 BC), and then developed by the Romans from 25 BC. The Algerian navy was very powerful in the Ottoman era, during 1517–1830. Currently, Algeria has 51 ports spread over 14 Departments. The majority of the ports are used for fishing, 4 for oil, 2 are military and 9 commercial [79,80].

2.2. Data Analysis

In a nutshell, the analysis of data relies on different data sources for each country; the choice was influenced mainly by the availability of data for each country, but also on the characteristics and skills of the research teams. For Romania, the European CORINE land cover and use (CLC) data sets were used, and analyses were carried out using ArcView GIS 3.X (Environmental Systems Research Institute, Redlands, CA, USA); the data are derived from satellite imagery. For Vietnam, the data for the case study were derived directly from satellite imagery. For Algeria, official statistical data were used; again, the data rely on the analysis of satellite imagery, performed by the national responsible agencies. Although the sources of data differ, analyses are homogenous, because in all case studies we used quantitative data. Moreover, the differences in resolutions (e.g., 50 to 10 m for the satellite images used for deriving the CLC data, and 30 m for the LANDSAT images) lose their relevance in terms of possibly affecting the results at a broad scale of analysis, e.g., the area of each case study. An overall schematics of the study methodology is displayed in Figure 5.

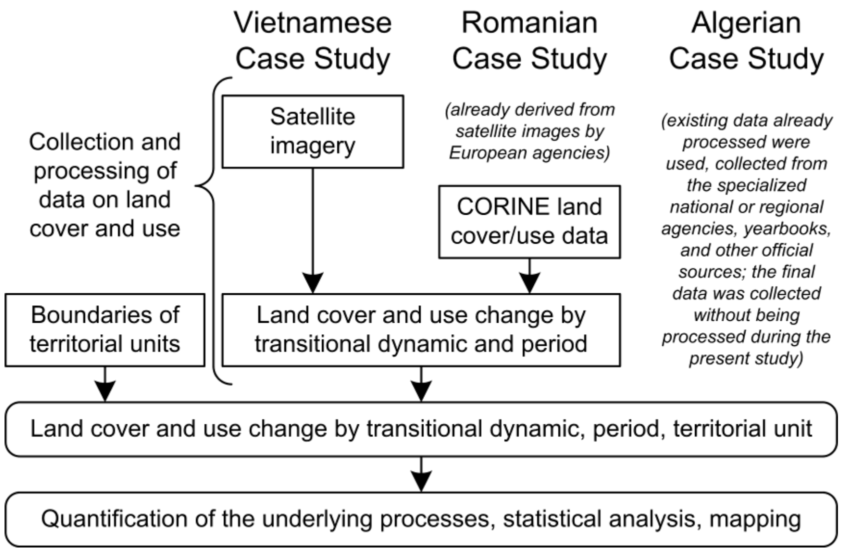


Figure 5. Schematics of the overall methodology of the study. The image focuses on the sources and level of processing data: satellite images in the Vietnamese case study, GIS data derived from satellite imagery in the Romanian case study, and already processed data from the national statistical office in Algeria, and also indicates the subsequent processing of data.

2.2.1. Analysis of the Urbanization of the Romanian Shoreline

The CLC dataset are the results of satellite images classification produced by the national teams of 39 participating countries, members of the European Environment Agency. CLC program was established in 1985 [81] by European Community and produced data available from 1990 to 2018 [82]. During the processing different satellite images such as LANDSAT 5 MSS/TM (for 1990 product), LANDSAT 7 ETM (for 2000 product), SPOT-4/5 and IRS P6 LISS III imagery (for 2006 product), IRS P6 LISS III and RapidEye (2012 product), and Sentinel 2 and LANDSAT 8 (for the 2018 product layer) [83] were used. The methodology for preparation [84] and creating [85] CLC has been discussed in different studies. The processing uses standard methodology and nomenclature with the following parameters: 44 classes in the hierarchical 3-level CLC nomenclature; the minimum mapping unit for status layers is 5 hectares, and the minimum width of linear elements is 100 meters [86,87].

The analysis of LCLU transformations relies on CLC datasets, freely available from the European Environment Agency [88] for the periods 1990–2000 and 2000–2006, and from the Copernicus Land Monitoring Service [89] for the periods 2006–2012 and 2012–2018 in a shape file format (projection: ETRS89 LAEA5210), usable by ArcView or ArcGIS. In order to perform spatial analyses within the Romanian administrative units, the data were re-projected unto the national projection system (Stereo 1970). In addition to them, CLC data for 2000 and 2006 (freely available from the same sources), and 2012 and 2018 (freely available from the Copernicus Land Monitoring Service) were used to identify the artificial surfaces at the end of each transition period.

Data were processed by identifying the transitional dynamics [90] characteristic to Romania associated with: (1) urbanization, defined as transformations within the cities indicating the urban growth (such as: “construction sites” to “urban fabric”), and transformation of agricultural, natural, wetland or water surfaces into artificial surfaces, (2) deforestation, consisting of the transformation of forests into other land cover classes, (3) reforestation, representing the opposite process of (2), (4) abandonment of agriculture, constituting the transformation of agricultural land into urban or natural land and inner transformations of the agricultural land classes indicating the abandonment (e.g., colonization by natural vegetation, loss of irrigations), and (5) development of agriculture, which is the opposite process of (4) [90–102].

Two types of spatial analyses were performed: (1) The spatial distribution of particular transitional dynamic was analyzed by reducing each parcel affected by it to its center, preserving its area as an attribute in the associated database using the X-Tools extension of ArcView GIS, and interpolating these centers via Inverse Distance Weighting in ArcGIS using this attribute as an indicator of the intensity of the process [100,101]; and (2) the parcels were clipped by the administrative units and their areas were summed up for each transitional dynamic by the administrative units using the Spatial Analyst extension of ArcView GIS. The second spatial analysis produced a database used to analyze the correlation between each transitional dynamic, the population and its density, computed using Microsoft Excel 2003.

The urbanization rate was computed as the ratio between the urban areas in 2000, 2006, and 2012, computed using CLC data, and the difference between it and the area attributable to urbanization, computed using CLC changes data, during each transition period. This formula was used based on the methodology developed by Petrişor [95], accounting for the fact that in Romania human settlements make up only a smart portion of the territory, and their growth is not visible unless the reference is made to the artificial surfaces only.

In order to ascertain the possible causes of urbanization, auxiliary data were obtained from the National Institute of Statistics. The tourism and urbanization data consisted of four indicators for each administrative unit: (1) The number of building permits issued by each administrative unit on an yearly basis during 2002–2018; (2) the number of tourism facilities, defined as any building or facility providing accommodation and other tourism-related services, counted by each administrative unit on an yearly basis during 1990–2018; (3) the existing tourism capacity, defined as the number of tourism accommodation seats, including the additional beds, counted by each administrative unit on an yearly basis during 1990–2018; and (4) the functional tourism capacity, defined as number of tourism accommodation seats computed accounting for the period when the facility is operational, counted by each administrative unit on an yearly basis during 2001–2018. The first indicator corresponds to the urban development, and the next three to tourism. The first indicator was computed adding the figures for hotels and other tourism facilities (data available only for 2002–2009), hotels only (data available only for 2009–2018), and residential units (data available for 2002–2018). The lack of availability for the first two indicators in some periods is explained by a changed counting methodology (the second indicator replaced the first). Correlations between the number of homes or hotels and the area affected by urbanization within each administrative unit were computed using Microsoft Excel 2003. The study used an "ecological approach", consisting of computing Bravais-Pearson's coefficient of linear correlation between the urbanization rate, derived from the CLC changes data, and its potential drivers ascertained using statistical yearbook data on the tourism and urban development for all administrative units and periods together, and for all changes occurred during 1990–2018 together. The computations were performed implementing computational formulae in Microsoft Excel 2003.

2.2.2. Analysis of the Vietnamese Shoreline

The development of land use change maps at different times plays a very important role in understanding trends in landscape change, population growth, growth and tertiarization of the economy, and history [103], but also their relationships. Maps allow for understanding the processes of deforestation, degradation, desertification and loss of biodiversity in a given region [104]. The maps produced for Vietnam rely on the geospatial database collected from Landsat for 2001 and 2018, and obtained from the United States Geological Survey (USGS). The images were geometrically rectified to the national UTM 48N coordinate system.

Geographic Information Systems were used in conjunction with remote sensing to determine the dynamic of land use [105–107]. This research used the supervised classification method, used to classify images obtained at two different moments [108]. The maximum likelihood algorithm was used for each image. All classes were determined in a pixel format, and converted to a vector format for reclassification and correction purposes. The results of image classification were compared class by class, to evaluate the changes on a pixel-by-pixel basis using a matrix of change [109]. After reclassification, misclassification was corrected at the pixel level. The approach relied on ancillary data, the digital elevation model (DEM) and visual interpretations. The DEM has a resolution of 30 m, and was derived from ASTER satellite-borne sensor images obtained from the NASA Earthdata [110]; after its downloading, data was grouped using the ArcGIS software with the Mosaic tool. Reclassification and correction were performed in a vector format by editing, assigning, changing name and code of polygons. Data on the urbanization and deforestation of the coastal region has been obtained from the General Department of Statistics and field-based surveys of the population.

In this study, satellite imagery from 1990, 2001, 2008, and 2018 were used to detect changes in the Vietnam CA (Table 4). In addition, data from the National Project on Coastal Trench Erosion in Vietnam [111] were used. The choice of periods is based on the availability of satellite images.

Table 4. Information on the satellite imagery used in the Vietnamese case study.

Acquisition Date	Platform/Source	Cloud Cover Percentage	Spatial Resolution/Scale
17/05/2018	Landsat 8	10%	30 m
06/10/2018	Landsat 8	10%	30 m
09/11/2018	Landsat 8	20%	30 m
25/08/2008	Landsat 5	10%	30 m
25/08/2008	Landsat 5	20%	30 m
29/09/2001	ETM+Pan	10%	30 m

To assess the impacts of tourist activities on the change in land use in general and the change in the coastline in particular, the land cover maps were build starting from the Landsat satellite images. These moments are selected linked to the period of the country's renewal policy in 1986 and the availability of data. These images were projected in the WGS84 coordinate system/UTM 48N area. The classification comparison method [108,112] was chosen to detect changes in land use. The principle of this method is based on the classification of two scenes acquired on different dates. It first assigns classes and then detects the change. In order to better separate objects and reduce confusion, the pseudo-oriented object-oriented classification (PCA, NDVI) approach was applied to the four Landsat images (from 1990, 2001, 2008 and 2018) using the Envi software. The results of the classification of satellite images were compared, class by class, to evaluate the changes. The assessment of change was done using a table of statistics using a matrix of change [109]. The detection of changes over the entire study period (from 1990 to 2018) was made by comparing the results from the classification of satellite images. Change detection matrices from comparing the areas of land cover units between two dates were produced. To this end, the average annual rate of spatial expansion, the transition matrix and the conversion rate were determined. The classifications were evaluated using confusion matrices, representing tables that describe the performance of a classification model on a test dataset with the true values [113], established by comparison between field data and those from the classifications of satellite images.

2.2.3. Analysis of the Algerian Shoreline

The study of the dynamics of transformation of the land use within the CA of Algeria was based on the collection of data from the reports cited in the text and other sources, in relationship to urbanization, abandonment of agriculture and its development, deforestation and reforestation. In all cases, data form the National Statistical Office were used; the national data are based on data collected by different specialized agencies. The analysis of the Algerian coast includes a description of its physical environment (geographic characteristics, morphology and length of the seafront) based on data from the National Coast Police. The dynamics of population in 1998, 2008, and 2020 is analyzed based on data from the National Statistics Office of Algeria. This analysis is aimed at understanding the pressure of population growth in the Algerian coastal cities.

The enumeration and classification of Algerian ports is based on an analysis performed by the Ministry of Transport and the Ministry of Maritime Fishing according to their function, used to pinpoint the areas affected by degradation due to over-fishing and marine pollution, in particular in the oil ports. The analysis is based on the following parameters: the total urbanized area (Ministry of Housing, the City and Urban Planning), urbanization, total agricultural surface, development of agriculture, rehabilitated agricultural area, the area used by the agricultural sector (Ministry of Agriculture), total area covered by forests, total forest area lost, deforestation (accidental and voluntary), and reforestation (General Forest Directorate and Global Forest Resources Assessment). All data sets were used for understanding the causes of change of the Algerian CA and compute the affected area and its share. This study was carried out for the periods 2003–2009 and 2009–2015. The parameters used in analyses were computed using the following mathematical formulae:

(1) Urbanized area 2009/2015 = Total surface urbanized in 2015 − Total surface urbanized in 2009;
(2) $\% \text{ of urbanization } 2009/2015 = 100 \times \frac{\text{Surface urbanized in } 2009/2015}{\text{Total surface urbanized in } 2015}$;
(3) Area affected by the development of agriculture = (2009/2015 rehabilitated agricultural area − Abandoned agricultural area) + (Total agricultural area in 2015 − Total agricultural area in 2009);
(4) $\begin{matrix}\% \text{ of agricultural} \\ \text{development } 2009/2015\end{matrix} = 100 \times \frac{\text{Surface of agricultural development } 2009/2015}{\text{Total agricultural surface } 2015}$;
(5) Total forest area lost 2009/2015 = (Deforested area 2009/2015 − Reforested area 2009/2015) + (Total forest area 2009 − Total forest area 2015);
(6) $\% \text{ of total forest area lost} = 100 \times \frac{\text{Total forest area lost } 2009/2015}{\text{Total forest area } 2009}$.

All statistics and data were grouped in tables. The digitization of satellite imagery from 2003 and 2015 was performed using the ArcGIS software. All the data sets were stored in a geo-database in which an entity class set has been created. The database allows for grouping all the feature classes that have been created and have the same projected coordinate system WGS84-UTM. Autocad 2011 was used to draw all maps against the background of scanned images. The administrative map was extracted from the report on the National strategy for the integrated management of Algerian CA, in particular its diagnostic part, drafted by the Ministry of Spatial Planning, Environment and the City.

3. Results

3.1. Degradation of the Romanian Shoreline

Land Cover/Land Use Changes

The analyses aimed to identify the main transitional dynamics affecting the Romanian shoreline. The results, presented in Table 5, indicate that the main transition dynamics are urbanization and deforestation; the latest one, as well as the abandonment of agriculture, can be also a precursor of the urbanization process [1]. However, the surface of forests on the Romanian shore is very small. The other transitional dynamics—abandonment and development of agriculture and regeneration of forests—characterize only the first period (1990–2000). Further computations of the intensity of LCLU changes and of the urbanization process, are presented in Table 6.

Table 5. Main transitional dynamics within the Romanian shoreline between 1990 and 2012. For each transitional dynamic, the area affected was computed as absolute size (column labeled "km^2"), and share of the total area of the shoreline (column labeled "%").

	Period	**1990–2000**		**2000–2006**		**2006–2012**		**Overall**	
	Area Affected	**km^2**	**%**	**km^2**	**%**	**km^2**	**%**	**km^2**	**%**
Transitional dynamics	Urbanization	12.07	42.71	4.83	82.24	5.20	77.30	22.10	54.09
	Deforestation	1.53	5.43	1.04	17.76	1.53	22.70	4.10	10.04
	Abandonment of agriculture	12.01	42.51	—	—	—	—	12.01	29.40
	Development of agriculture	1.63	5.78	—	—	—	—	1.63	4.00
	Regeneration of forests	0.74	2.63	—	—	—	—	0.74	1.82
	Other	0.27	0.95	—	—	—	—	0.27	0.65

Table 6. Indicators of the land cover/land use (LCLU) changes affecting the Romanian CA during 1990–2012.

Period	1990–2000	2000–2006	2006–2012	Overall
% of the artificial surfaces	4.45	4.72	4.86	—
% of the area affected by changes	0.81	0.17	0.19	1.18
Urbanization rate	8.47	3.04	3.18	16.69

The relationship between urbanization, population and its density was analyzed by computing the correlation coefficient and its significance. The results indicate a significant correlation between urbanization and population (r = 0.94, $p \leq 0.001$, n = 13) and between urbanization and the density of population (r = 0.90, $p \leq 0.001$, n = 13). The relationship between deforestation and population and its density suggests a negative correlation (r = −0.39 in both cases), but the results are not statistically significant (r = 0.52 in both cases) because of the lack of data (n = 5).

Because of the uneven distribution across transitional dynamics and periods, the spatial distribution was determined only for deforestation (overall) and for urbanization (for each of the three periods and overall). The results are presented in Figure 6, which includes in addition information on the population and density of the administrative units, in order to help visualizing the relationship.

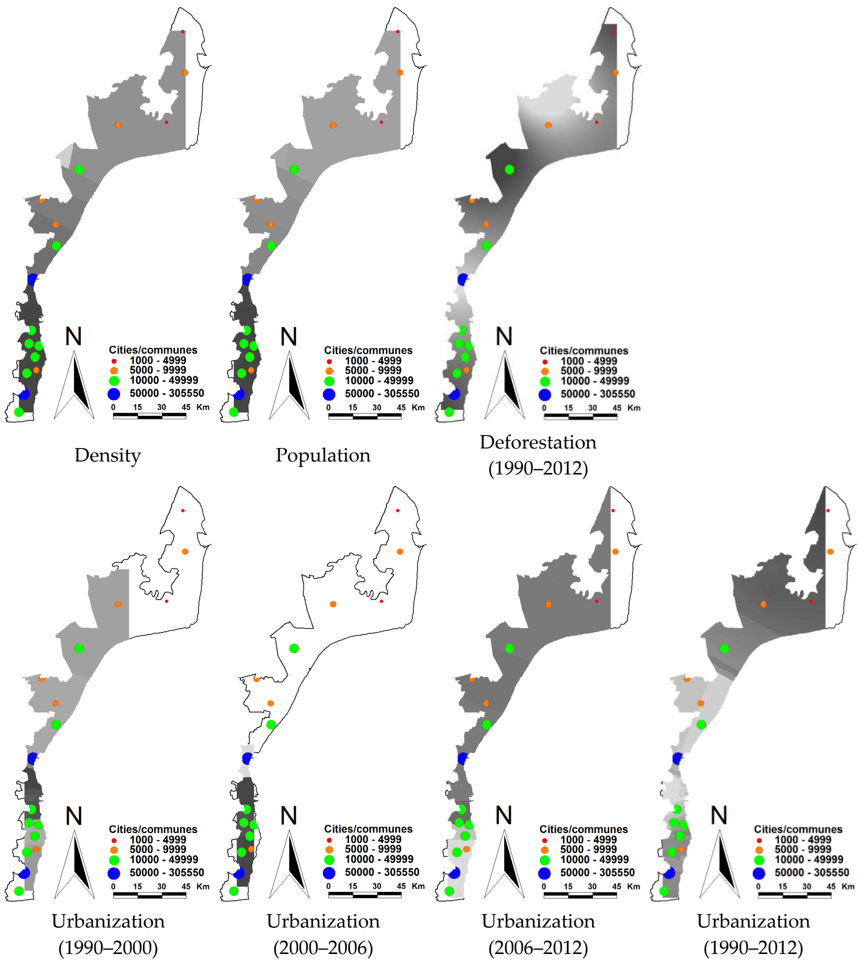


Figure 6. Urbanization and deforestation of the Romanian shoreline, in relationship with population and its density. The darker shades correspond to higher values. The red circles represent the centers of administrative units, with sizes proportional to the following population classes: (1) up to 999, (2) 1000–4999, (3) 5000–9999, (4) 10,000–49,999, and (5) 50,000 and over.

Although deforestation is an important transitional dynamic for Romania [90,114–117], the results indicate that within the CA it does not follow a consistent pattern with population or its density, which explains why their correlation was not statistically significant; this may happen because deforestation occurs on small isolated parcels [90,114–117], but also because of the fact that forests are scarce and unevenly distributed in the coastal area. Urbanization seems to occur most in the seaside resorts and less in the Danube Delta. The urbanization pattern seems to be consistent with the spatial distribution of population and its density, suggesting that urbanization is actually a sprawl of populated cities (especially Constanta) around the adjacent areas, a pattern common to Eastern Europe [54]. However, this pattern could also be due to the way of computing the population density and degree of urbanization, both dependent on the surface of territorial administrative units.

When looking at the urbanization of the Romanian seashore during 1990–2018, the findings indicate different trends during the four periods (1990–2000, 2000–2006, 2006–2012, and 2012–2018): a growth that slows down until 2012, followed by a dropdown after (Figure 7). This is most likely as an effect of the economic crisis started in 2008, but also due to new policies following the accession of Romania to the European Union in 2007, which changed through additional restrictions the way of functioning of many economic sectors, including tourism. In this particular case, the restrictions affected the "small scale" rental, i.e., locals renting one or few rooms to individuals or their families were no longer allowed to do this due to the taxation laws, imposing specific restrictions.

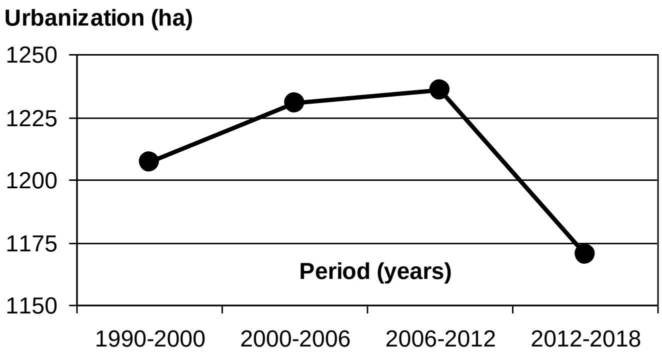


Figure 7. Dynamic of the urbanization of the Romanian seashore during 1990–2018. Figures reflect the urbanized area.

The results of the analysis ascertaining the influence of potential urban development and tourism related drivers using the correlation analysis are presented in Table 7. The table displays the values of Bravais-Pearson's coefficient of linear correlation, the sample size, and the p-value indicating the statistical significance of correlation; correlations are considered significant if $p \leq 0.05$, and marginally significant if $0.05 < p \leq 0.1$. In the last case, larger samples could yield significant results. The findings indicate a significant correlation between the urbanization rate and the number of building permits issued, and, with respect to the tourism indicators, only one marginally significant correlation between the urbanization rate and the existing tourism capacity.

Table 7. Correlation between the urbanization rate and its urban development and tourism-related drivers. Significant predictors ($p \leq 0.05$) are marked using **bold** font, and marginally significant predictors ($0.05 < p \leq 0.1$) using *italic* font.

Data for All Units and Periods (1990–2000, 2000–2006, 2006–2012, and 2012–2018)			
Correlation of the Urbanization Rate with:	**ρ (Coefficient of Correlation)**	**N (Sample Size)**	***p*-Value**
Number of tourism facilities	0.01	72	0.91
Existing tourism capacity	0.21	72	0.08
Functional tourism capacity	−0.09	72	0.48
Number of building permits	0.72	72	<0.05
Data for All Units and Overall Period (1990–2018)			
Correlation of the Urbanization Rate with:	**ρ (Coefficient of Correlation)**	**N (Sample Size)**	***p*-Value**
Number of tourism facilities	0.01	18	0.96
Existing tourism capacity	0.21	18	0.41
Functional tourism capacity	−0.21	18	0.39
Number of building permits	0.88	18	<0.05

The number of issued building permits is probably the best reflection of the actual urban development. In Romania each administrative unit must have an urban plan, which must be updated each 5–10 years [118]. However, this is rarely the case, and development occurs only by exceptions, i.e., by developments that to not comply with the rules, but are exempted from these. This pattern is called derogatory planning [119,120]. For example, in Constanţa, the largest city of the Romanian seashore, the Master Plan was not updated for 18 years, but the real development was documented by over 3000 plans for different areas of the city, representing exceptions from the regulations imposed by the Master Plan [121]. For this reason, the number of issued building permits reflects the process of drafting plans for new developments, but also of legalizing the spontaneous development process. It is also important to see that the number of building permits issued for residential units is far away greater than the number of tourism-related ones (Figure 8), suggesting that urban development was a more important driver than tourism for the Romanian seashore, although both were affected similarly by the economic crisis.

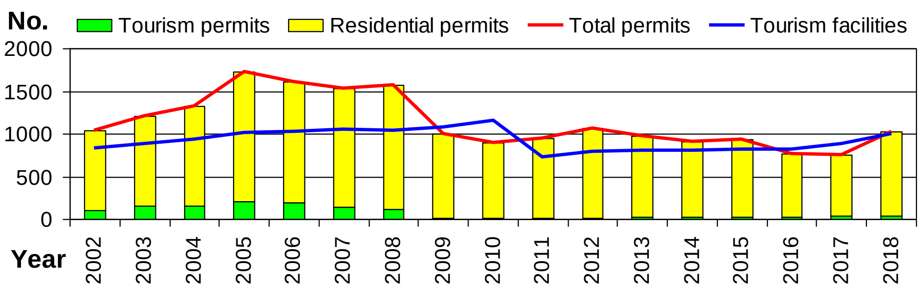


Figure 8. Dynamic of the number of tourism-related (green bars) and residential (yellow bars) building permits issued in the administrative units of the Romanian seaside during 2002–2018, in conjunction with the dynamic of the total number of permits (red line) and tourism facilities built up (blue line). Source of data: Romanian Statistical Yearbooks (National Institute for Statistics).

The fact that no correlation was found between the urbanization rate and the number of tourism facilities is explained by the particular dynamic of accommodation units on the Romanian seashore (Figure 9). Accommodation units existed in the area, built before 1989; the transition to an open-market economy resulted in their transition to private ownership. Therefore, tourism developed in a first phase by renovating existing units, and not necessarily by building new ones. Furthermore, the economic crisis made the construction of large facilities unlikely. Tourism developed by building small units; a large number of tourists occupied private houses, more or less legally, on a rental basis [122].

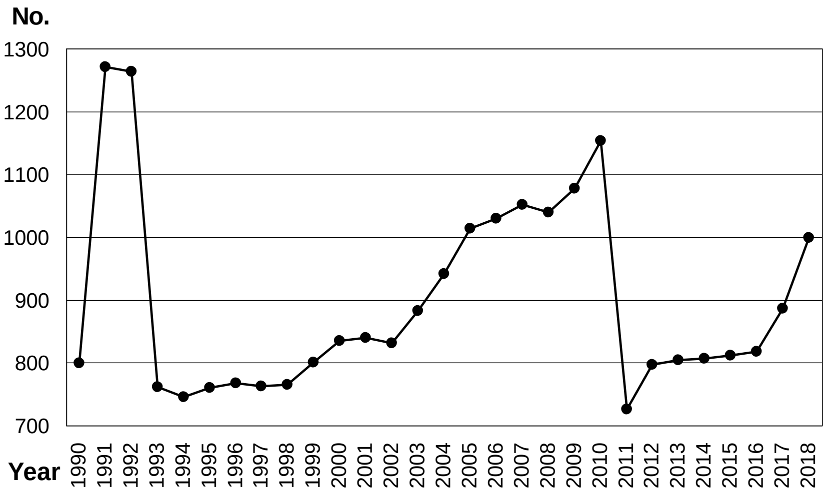
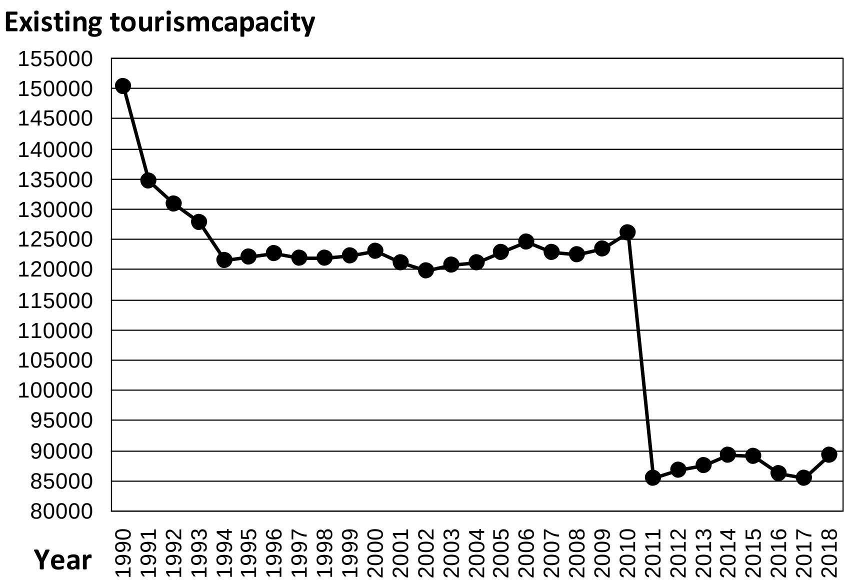


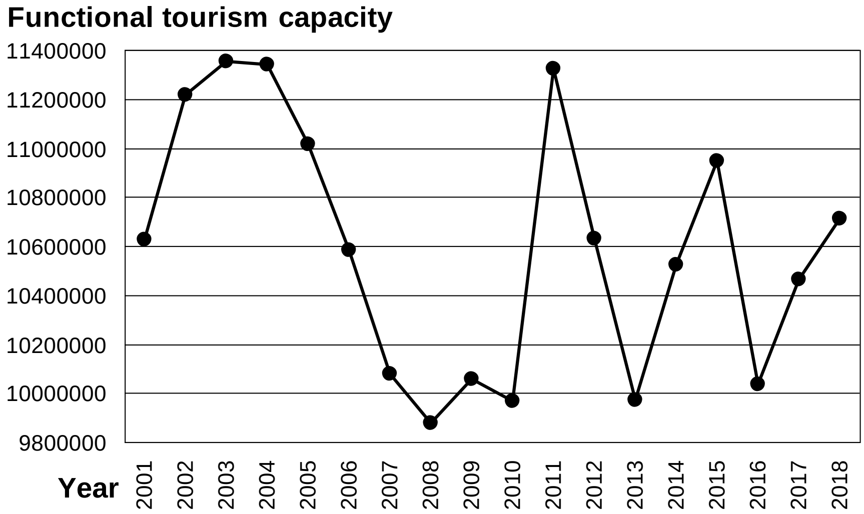
Figure 9. Dynamic of the number of tourism facilities on the Romanian seaside during 1990–2018. Source of data: Romanian Statistical Yearbooks (National Institute for Statistics).

The difference in the significance of two similar indicators, existing and functional tourism capacity, analyzed in Figure 10, consists of the fact that facilities were built regardless of their capacity being used or not. Furthermore, the two indicators had different dynamics. The existing capacity kept diminishing, most likely due to the fact that larger units lost their attraction and closed down especially during the economic crisis (top of Figure 10), while the functional capacity varied because of other factors, including weather etc. (bottom of Figure 10). This is why the existing tourism capacity, reflecting what was actually built up in addition to the large facilities, is the best tourism indicator for explaining the dynamic of urbanization.



(a)

Figure 10. *Cont.*



(**b**)

Figure 10. Dynamic of the existing (**a**) and functional (**b**) tourism capacity on the Romanian seaside during 1990–2018. The existing capacity represents the actual accommodation capacity as provided in the authorization of each tourism unit. The functional tourism capacity is computed as the product of the number of available seats and the number of days when the units are actually open. Source of data: Romanian Statistical Yearbooks (National Institute for Statistics). Data cover the existing capacity for 1990–2018 and functional capacity for 2001–2018.

The analysis of the major changes shows that at the same time with the positive consequences of applying the environmental legislation (declaring the Danube Delta as Biosphere Reservation, for example), the collapse of the totalitarian regime in Romania, touching the centralized economy, strongly affected some sectors from the Romania CA. In this case the most representative town of the Danube Delta, Sulina, lost the main industrial and transport activities, which are reflected by the decrease of its living standards [123].

3.2. Degradation of the Vietnam Shoreline

Land Cover/Land Use Changes of Vietnam CA

The economic development of Vietnam is accompanied by an intensification of urbanization, leading to numerous industrial activities and involving a recent transformation of land uses at a spectacular rate [71]. For example, during 2008–2016 the population increase was about 15% (170,000 inhabitants) in the Hai Phong Province in the north and Da Nang in the Center by, 25% in Ho Chi Minh City in the South, and 8–10% in Thanh Hoa Province, Nghe An Province, Thua Thien Hue and Ba Ria Vung Tau. However, the distribution of the population is uneven between municipalities in the province. Population is concentrated mainly in the coastal cities due to tourism industrial development.

Table 8 shows that the built surface increased by about 2049 km^2 during 2000–2008 and 1030 km^2 during 2008–2016. There is a relationship between the urbanization, population and economic development of the country. The results show that the dynamic of urbanization is also strongly linked to the growth of the population. Urban areas tend to expand when population grows, and are smaller when the population growth is low (Figure 11). For example, the population is growing more in Thanh Hoa province, Nghe An, Ha Tinh, Hue, Khanh Hoa, Ba Ria Vung Tau, Kien Giang and Ho Chi Minh city, causing more important changes of the urban areas.

Table 8. Increase of the built surfaces during 2000–2016 in Vietnam [124].

	2000–2008		2008–2016	
Area Affected	**km^2**	**% of Total**	**km^2**	**% of Total**
Urbanization	2049	2.1	1030	1.09

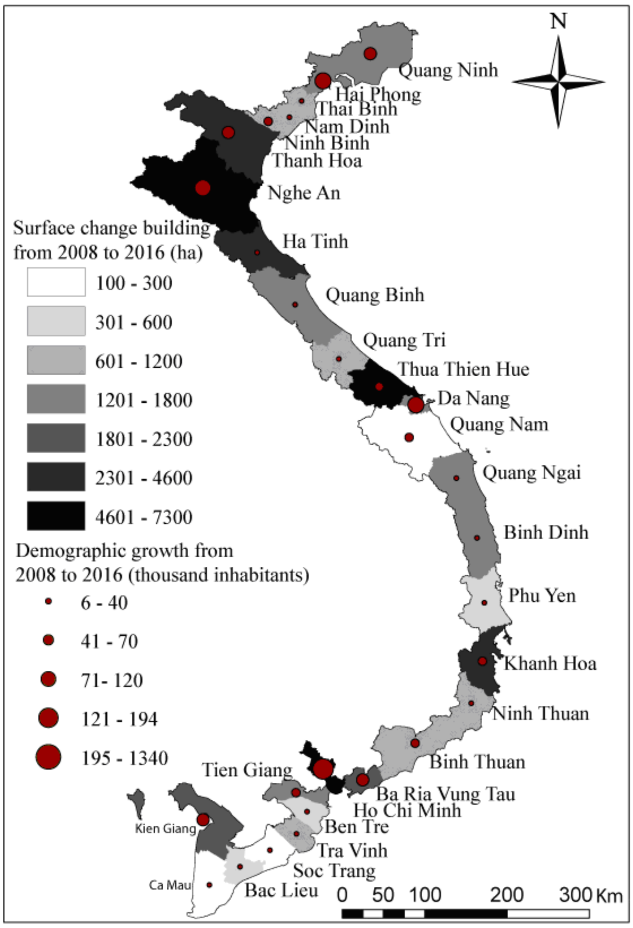


Figure 11. Changes of the built-up surface and increase of population during 2008–2016 in Vietnam.

The urban growth in the CA in Vietnam can be explained by the geographical position of the coastal region. First, the economic development strategy of the Vietnamese government envisaged that the recovery of the exchanges with China, Thailand etc. is possible because of the Eastern Sea. The objective of the strategy is to catch up with the second generation of new Asian industrial countries (coastal China, Thailand, Malaysia etc.), by concentrating investments on three economic areas: the North region i.e., the Hanoi-Haiphong-Halong triangle in the northern part of the Red River Delta; the Mid-Coastal Region (Nghe An, Ha Tinh, Quang Binh, Hue, Dang Nang, and Dung Quat); and the south along the Saigon River and Dongnai (Ho Chi Minh-Bien Hoa-Vung Tau). After 2010, they must be connected in order to balance the poles in the Middle Region west of the Red River Delta, around Can Tho in the Mekong Delta, and around Vinh and Nha Trang at both ends of the Center. Cities play an important role in this strategy through the development of industry and tourism, which will most likely generate many land use conflicts and environmental degradation through the erosion and accretion of the coastline.

According to these strategies, the rate of urbanization in these areas is also very different between settlements. Some provinces or cities have high rates of urbanization, especially in the coastal region, e.g., Quang Ninh (52%), Ho Chi Minh (83%), and Da Nang (77.6%). The urban population is concentrated mainly in large cities and coastal provinces.

Figures 12–14 show the examples of land use changes in Halong Bay in the north (Figure 12), Da Nang City in the Central Region (Figure 13), and Vung Tau in the South (Figure 14). The corresponding confusion matrices are presented in Tables 9 and 10. The coastal provinces are representative for the urbanization of Vietnam. The figures show that urban areas grow more on the coastline, replacing the forests. Artificial surfaces increased twice (from 33 km^2 to 77 km^2), three times (from 43 km^2 to 67 km^2) and up to 250% (from 87 km^2 to 214 km^2) during 2001–2018 in the cities Cam Pha (Quang Ninh province), Da Nang, and, respectively, Vung Tau. These changes are concentrated mainly along the coastline.

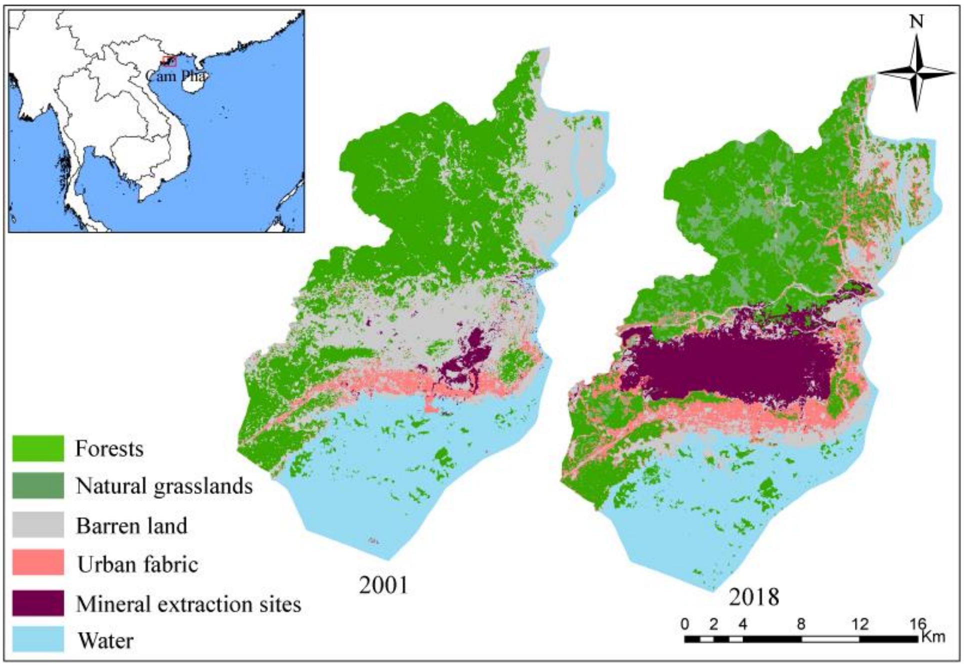


Figure 12. Land cover/land use patterns in the Cam Pha area, Vietnam during 2001–2018.

Other transformations were also identified. Starting in 2000, the Vietnamese government and the Vietnam Coal Corporation implemented a policy of increasing coal mining to meet domestic and export demands. In addition to mechanization, technology innovation and new machinery purchases, the coal mining area was also expanded both underground and on the ground. Specifically, according to the Ministry of Industry and Trade statistics, the total clean coal output of the whole industry increased from 8.35 million tons in 1995 to 32.6 million tons in 2005 (an average of 14.6%/year). From 1995 to 2003, Vietnam Coal Corporation invested 10 million USD for geological exploration, with 169,438 m. The Cam Pha (Figure 12) area is considered one of the regions with most coal production in the country. Coal production in this region accounts for nearly a quarter of the total coal production of the Vietnam Coal Corporation. These are the reasons for the increase in the mineral extraction area from 9.7 km^2 to 68.8 km^2.

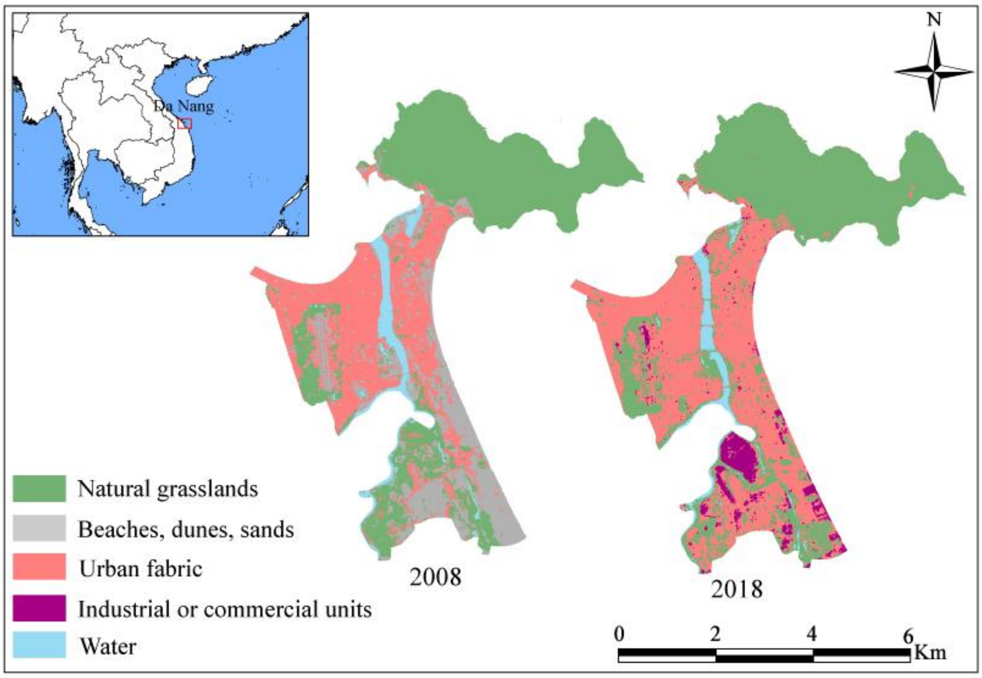


Figure 13. Land cover/land use patterns in Da Nang city area, Vietnam during 2008–2018.

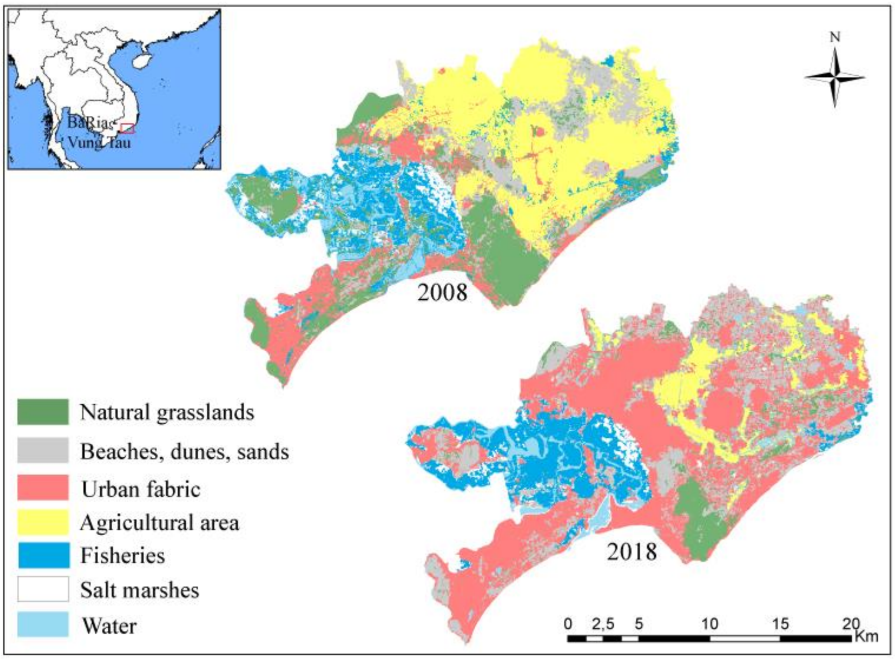


Figure 14. Land cover/land use patterns in Vung Tau Province, Vietnam during 2008–2018.

Table 9. Confusion matrices for the land cover/land use changes maps of Cam Pha area (Figure 12), Da Nang City area (Figure 13) and Vung Tau Province (Figure 14) in Vietnam.

Area	Campha Area		Da Nang City Area		Vung Tau Province	
Year	**2001**	**2018**	**2008**	**2018**	**2008**	**2018**
Overall Accuracy (%)	92	94	89	97	89	93
Kappa coefficient	0.87	0.92	0.85	0.95	0.86	0.89

Table 10. Example of a detail of the confusion matrix for ground truth in the DaNang city area, Vietnam (Figure 13) in 2018.

	Natural Grass Lands	Water	Industrial or Commercial	Urban Fabric
Natural grasslands	5355	0	0	53
Water	0	563	0	0
Industrial or commercial	0	0	666	288
Urban fabric	4	0	8	7507

Similarly, DaNang (Figure 13) with the advantage of its geographic location is considered to be the gateway to the Indochinese peninsula. Among the cities on the "east-west economic corridor of the Mekong River" which connects Vietnam, Laos, Thailand and Myanmar, Da Nang city has the largest international airport and port. So, it has the advantage of developing the industrial sector. Moreover, the 2010 Decision no. 393/QD-TTG of the Prime Minister on planning the socio-economic development of Da Nang city until 2020 included as one of the main objectives turning Da Nang into a significant socio-economic center of the country and Southeast Asia, focusing on the development of tourism, commerce, finance, and industry. As a result of this decision, several industrial centers were built. From the analyses of satellite data, industrial areas increased to 5.3 km^2 in 2018.

Ba Ria-Vung Tau Province (Figure 14), located in the southern economic zone, is one of the main economies and investment destinations in Vietnam. With a coastline of more than 300 km, this province has the advantage of developing seaside tourism. Many actions are carried out by the provincial authorities to consolidate this key sector. This is justified by the 2005 resolution no. 05-NQ/TU of the provincial people's committee on the development of tourism. The aim of this resolution was to develop the Ba Ria Vung Tau province, turning it into one of the tourism centers of the country, and making tourism a key economic sector of the province. This led to the rapid growth of the urban areas and infrastructure, while the agricultural area has been reduced from 162.7 km^2 in 2008 to 37.9 km^2 in 2018.

Given the advantage of its geographical position, the urbanization of the coastal corridor is due to tourism. This new sector is developing in the country, and will develop more in the future because of the position, large coastal front, and heritage. Urbanization and tourism accompany the natural demographic growth of urban population, migratory movements from the countryside to cities as a result of economic and industrial development, gradual transformation of rural towns into urban centers [71], and construction of hotels and residences. In addition, this growth leads to the need for building materials in Quang Ninh, Thanh Hoa, Nghe An, Ha Tinh, Hue, Da Nang and Phan Thiet provinces.

New buildings have been constructed on thousands of hectares along the coastline in Vietnam, destroying the protection forest. There are two distinct forms of villages: new buildings and traditional houses. The latter take the form of a house with a single floor or two floors. The vertical buildings serve seaside tourism. Resolution No. 36-NQ/TW of 22 October 2018 on the Sustainable Development Strategy of the Vietnam Maritime Economy to 2030, with a Vision for 2045 (Resolution 36), considers tourism one of the key economic sectors of the maritime economy. Therefore, it is expected to have more and more buildings along the coast, despite their negative impact on the littoral coastline.

In Vietnam, the development of tourism led to a change in land use described in the research of Hoang et al. [125], showing that tourism development brings a new source of income and livelihoods. In addition, the increase of tourist flows accompanies the demand for accommodation, which is accelerating the urbanization. The research by Hampton et al. [126] showed that the coastal region plays an essential role in the process of developing the economy through tourism. This study presents the relationship between tourism development and industrial growth, the change of land use in the coastal region, for example the province of Quang Ninh in Vietnam. Other authors consider that in Vietnam the growth of demography and tourism are the main drivers of urbanization, particularly in the coastal region [127]. However, this process causes the degradation of the coastline [128].

The importance of tourist activity in the coastal region of Vietnam can be assessed through the study of different parameters, including, first of all, the number of tourists each year. The tourist activity has prompted the municipality to carry out the improvements necessary for the proper development of tourism. Tourism policy has played an important role in the development of tourism. Tourism has become one of the main drivers of Vietnam's urban growth during the current period. The development of tourism contributes to the development of many other economic sectors; create more jobs for coastal society. With the advantage of the coastline, coastal cities have experienced many positive changes in the recent years due to coastal tourism.

Figure 15 shows that from 2005 to 2016, the number of tourists increased in proportion to the area of residential land, and which shows the close relationship between the two. When tourism increases rapidly, it leads to a demand for accommodation and services, increasing the pressure on infrastructure, transport, environment, etc. For example, the province of Quang Ninh in the northern region is considered one of the provinces with the most tourism development because of the long coastline. From 2005 to 2019, the number of tourists increased more than twice, from 4 million to over than 8 million.

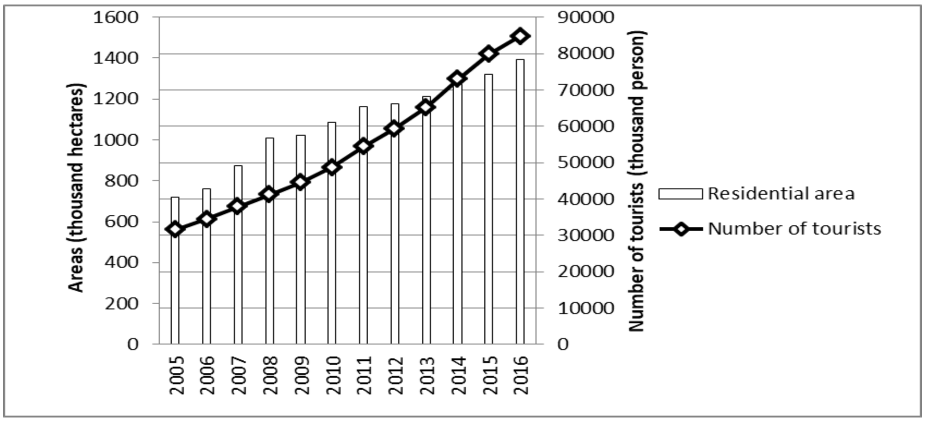


Figure 15. Dynamic of the number of tourists and residential area (vertical) in Vietnam [124].

This development accompanies urban growth. The urbanized surface increased by more than 100% in 11 years, from 2005 to 2016. Strong urban development took place in Da Nang in the 2000s, a period when Da Nang's economic interests shifted from the region inland and began to focus almost entirely on the coast. As a result, Da Nang is no longer a pure port city and has become one of the most sought-after tourist destinations in Vietnam and Asia. This change is dominated by the rapid urbanization of the coastal region, which began in the late 2000s and culminated in the 2010s. Or with the advantage of the climatic condition and the geographical situation, the province of Ba ria-Vung Tau is the development of faster tourism. The number of tourists increased from 453 thousand in 2005 to 1.3 million in 2016. This growth led to tourism investment to meet the demands of the tourism sector. From 2001 to 2014 there were 159 tourism investment projects with a total area of 6042 ha carried out in this province.

The development of integrated tourism in urban areas is not a new problem for many countries of the world because they consider urban regions and the factors that constitute the resources of urban tourism in terms of the tourism economy, some countries. Urban tourism has been considered a famous tourist attraction and very useful in terms of economic, social and environmental sustainability. However, tourist and urban growth lead to the CA degradation in Vietnam.

3.3. Degradation of the Algerian Shoreline

Main Drivers of Degradation

Table 11 shows that the main causes of the change in land use on the Algerian coast are urbanization and the development of agriculture. The latter caused significant deforestation. The process accelerated during the second period (2009–2015), in particular with the increase in revenues in state currency, especially with the soaring price of oil. This has multiplied the economic development of the country.

Table 11. Global indicators of land use change on the Algerian coast. Source: National Statistics Office of Algeria. The change is expressed as absolute value (column labeled "km^2"), and share of the coastal municipalities (column labeled "%").

Periods	**2003–2009**		**2009–2015**	
Affected Area	**%**	**km^2**	**%**	**km^2**
Total urbanized area	12.32	488.20	13.16	521.14
Urbanization	5.25	25.63	6.32	32.93
Overall agricultural area	47.38	1876.32	49.29	1952.06
Agriculture development	2.62	49.15	3.88	75.73
Rehabilitated agricultural area	3.30	61.90	4.52	88.25
Abandoned agricultural area	0.68	12.75	0.64	12.52
Overall forest area	40.30	1595.12	37.55	1486.44
Overall forest area lost	4.47	74.78	6.81	108.68
Deforestation	4.83	77.17	7.48	111.20
Regeneration of forests	0.15	2.39	0.17	2.52

Deforestation is not only due to the two causes mentioned above but also to forest fires. During 2001–2011, 94,754 ha of littoral forest were burnt, representing 48.53% of the total national area affected by fires (195 233 ha). Algerian forest fires are usually criminal or man-driven acts. Sometimes, people recuperate the charcoal for selling it further. Sometimes fires are set by the army during their fight against Islamic terrorists hiding in the area. Sometimes, spontaneous fires occur during the summer heat episodes. Wild deforestation by the land mafia plays an important role in the development of this phenomenon. Sometimes, fires are set to reclaim the land for agriculture or constructions. Constructions are authorized in the burnt areas after obtaining a building permit, using the regular procedure. Consequently, many illegal constructions are built on the recovered lands with generally the complicity or the silence of the local authorities. Algeria has not very many means to fight the fires, excepting for the tanker planes.

The allocation of land for agricultural purposes is important than that intended for construction with 75.23 km^2 against 32.93 km^2. Arboriculture (olives and fruit trees) is the main activity developed.

The cities of the Algerian coast most affected by the phenomenon of land use change in relation to the development of agriculture are Jijel (31.99 km^2), Taref (24.55 km^2), Skikda (14.33 km^2), and Béjaia (13.8 km^2) (Table 12). Some departments have seen their surface reduced, e.g., Tipaza (0.03 km^2), Tlemcen (0.52 km^2), Algiers (1.57 km^2), Ain Temouchent (1.61 km^2), and Oran (7.4 km^2), most of which are located in the west (Figure 16).

Table 12. Dynamics of land use in the departments of the Algerian coast. Source: National Statistics Office of Algeria.

Department	Area (km^2)	Period	Agricultural Area		Forest Area		Urbanized Area	
			%	km^2	%	km^2	%	km^2
Tlemcen	115.02	2003–2009	57.93	68.38	26.51	30.50	15.56	16.13
		2009–2015	59	67.86	25	28.75	16	18.41
		Change	0.76	0.52	6.08	1.75	12.38	2.28
Ain Temouchent	212.45	2003–2009	88.07	187.11	10.39	22.08	1.53	3.26
		2009–2015	85	185.50	10	21.24	5	5.70
		Change	0.86	1.61	3.95	0.84	42.80	2.44
Oran	363.65	2003–2009	49.03	178.31	16.81	61.13	34.13	124.21
		2009–2015	47	170.91	16	58.18	37	134.56
		Change	4.32	7.4	5.07	2.95	7.69	10.35
Mostaganem	215.14	2003–2009	77.52	166.78	16.17	34.80	6.30	13.56
		2009–2015	78	167.80	15	32.27	7	15.07
		Change	0.60	1.02	7.84	2.53	10.01	1.51
Chlef	165.82	2003–2009	63.65	105.55	16.39	27.19	19.96	33.08
		2009–2015	65	107.78	14	23.21	21	34.83
		Change	2.06	2.23	17.14	3.98	5.02	1.75
Tipaza	203.73	2003–2009	34.01	69.29	24.84	50.61	41.14	83.83
		2009–2015	34	69.26	24	48.89	42	85.58
		Change	0.04	0.03	3.51	1.72	2.04	1.75
Algiers	122.17	2003–2009	69.28	84.64	13.12	16.04	17.6	21.49
		2009–2015	68	83.07	12	14.66	20	24.44
		Change	1.88	1.57	9.41	1.38	12.07	2.95
Boumerdes	116.65	2003–2009	61.02	71.19	18.15	21.18	20.83	24.28
		2009–2015	62	72.32	16	18.66	22	25.67
		Change	1.56	1.13	13.50	2.52	5.41	1.39
Tizi Ouzou	103.33	2003–2009	30.44	31.46	43.43	44.88	24.68	26.99
		2009–2015	33	34.09	38	39.29	29	29.95
		Change	7.71	2.63	14.22	5.59	9.88	2.96
Béjaia	532.02	2003–2009	57.40	305.41	41.4	220.28	1.2	9.32
		2009–2015	60	319.21	38	202.16	2	10.64
		Change	4.32	13.8	8.96	18.12	12.40	1.32
Jijel	463.49	2003–2009	34.09	158.04	61	282.76	4.91	25.68
		2009–2015	41	190.03	53	264.18	6	27.02
		Change	16.83	31.99	7.03	18.58	4.95	1.34
Skikda	451.23	2003–2009	44.82	202.26	53.89	243.17	1.29	7.79
		2009–2015	48	216.59	50	225.61	2	9.02
		Change	6.61	14.33	7.78	17.56	13.63	1.23
Annaba	230.21	2003–2009	44.24	101.85	49.28	113.46	6.48	13.89
		2009–2015	46	105.89	47	108.19	7	16.13
		Change	3.81	4.04	4.87	5.27	13.88	2.24
El Taref	647.03	2003–2009	21.20	137.2	66	427.04	12.8	82.79
		2009–2015	25	161.75	62	401.15	13	84.12
		Change	15.17	24.55	6.45	25.89	1.58	1.33

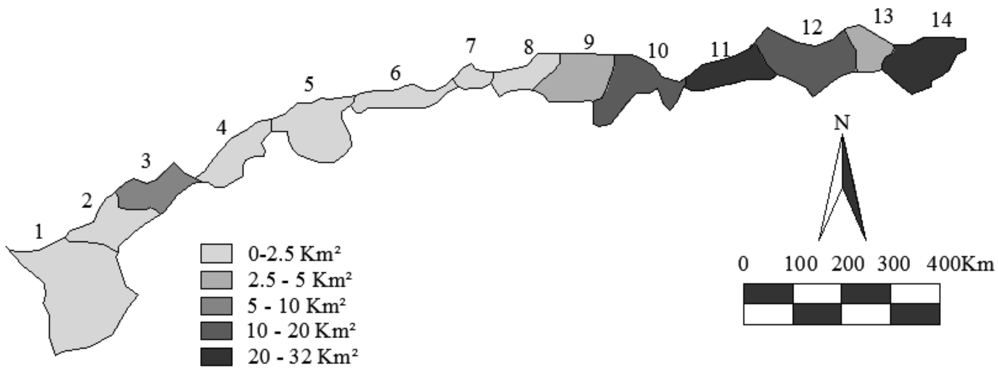


Figure 16. Development of the agriculture on the Algerian coast during 2009–2015 by department: 1—Tlemcen, 2—Ain Temouchent, 3—Oran, 4—Mostaganem, 5—Chlef, 6—Tipaza, 7—Alger, 8—Boumerdes, 9—Tizi Ouzou, 10—Béjaia, 11—Jijel, 12—Skikda, 13—Annaba, 14—El Taref. Source: made by W.H. using official data. The darker shading (in the Eastern part) indicates a better development of agriculture.

Deforestation has affected the departments of the East more than the ones in the West since they have a large forested area (Figure 17). The most affected cities are El Taref (25.89 km^2), Jijel (18.58 km^2), Béjaia (18.12 km^2), and Skikda (17.56 km^2). Despite reforestation, urbanization and forest fires during the summer season are more rapid and destructive.

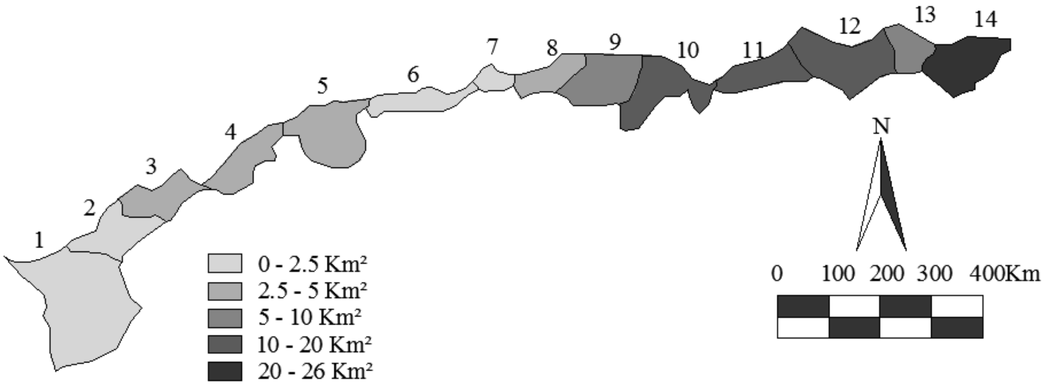


Figure 17. Deforestation of the Algerian coast during 2009–2015 by department: 1—Tlemcen, 2—Ain Temouchent, 3—Oran, 4—Mostaganem, 5—Chlef, 6—Tipaza, 7—Alger, 8—Boumerdes, 9—Tizi Ouzou, 10—Béjaia, 11—Jijel, 12—Skikda, 13—Annaba, 14—El Taref. Source: made by W.H. using official data. The darker shading (in the Eastern part) indicates that more deforestations occurred in the department.

Coastal urbanization is driven by the population explosive growth, as a direct relationship between migration and economic development [129], which explains the rural exodus and the internal migration of the population. The departments experiencing rapid urbanization with high land consumption are Oran (10.35 km^2), Tizi Ouzou (2.96 km^2), and Algiers (2.95 km^2). It must be stressed out that the second city of Algeria, which is Oran, exceeded the capital Algiers during 2009–2015 in terms of urbanization (Figure 18). The cause is that this city experienced the construction of an Olympic city (accommodation, sports halls, and stadium) to host the Mediterranean Games in 2022.

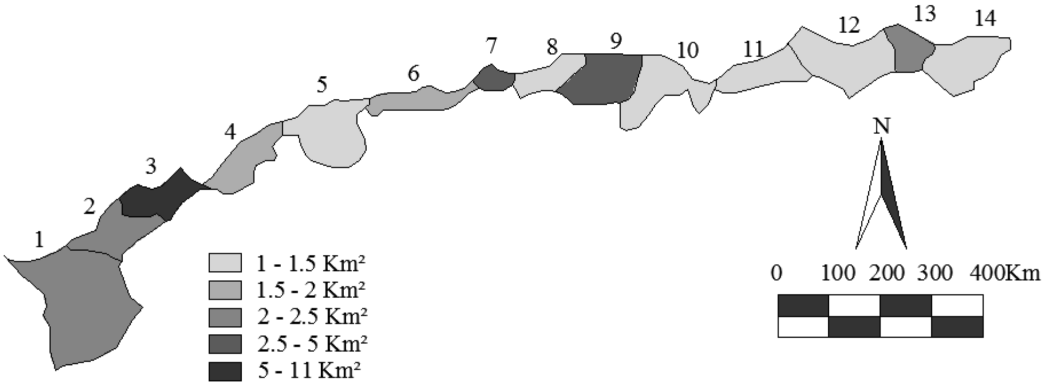


Figure 18. Urbanization of the Algerian coast during 2009-2015 by department: 1—Tlemcen, 2—Ain Temouchent, 3—Oran, 4—Mostaganem, 5—Chlef, 6—Tipaza, 7—Alger, 8—Boumerdes, 9—Tizi Ouzou, 10—Béjaia, 11—Jijel, 12—Skikda, 13—Annaba, 14—El Taref. Source: made by W.H. using official data. The darker shading (in the Western part) indicates a more intense urbanization.

4. Discussion

The literature review showed that coastal landscapes are subject to increasing demands and pressures; the present study explored the changes of landscapes in order to assess the anthropogenic pressure, especially that resulting from land use/land cover change, or urban sprawl, taking into account role played by the socioeconomic and political factors. In a nutshell, the results revealed that most changes are due to the "derogatory planning" [119,120], emphasizing the conflict between the local political factors, influenced by the local economy, and the national legislation. The study identified the specific driving forces (urbanization, including its mechanisms, and tourism), and provided additional evidence for the changes of coastline landscapes, which can be countered by policies for a sustainable landscape management.

4.1. Overall Importance and Significance of the Findings

In more details, the study attempted to look at the pressure of anthropization, focusing on urbanization and tourism, against the CA, including the adverse effects and possible solutions, by examining three countries situated on different continents, with different cultures and histories. The comparison aimed to assess both common elements, serving as grounds for understanding the mechanisms and acquire a global perspective, but also the differences, which are useful in assessing possible synergic effects. In a nutshell, the study revealed that the main drivers are in Romania the joint urbanization (e.g., development of vacation homes, to be used or rented) and tourism (larger facilities), in Vietnam a gap between the policies governing different sectors (e.g., developing tourism for helping the economy while spending money to diminish or counter the adverse effects), and in Algeria a difference between the national policies (unable to supply the infrastructure needed by tourists) and the illicit construction of small, but sparse residences to be rented out. In general, all these are attributable on the one hand to the race for profit (implying the sacrifice of long-term sustainability, including the environmental issues, for short-term economic benefits), and on the other hand to a general national planning strategy that is lacking, underdeveloped or not implemented in conjunction with the local often illicit urbanization; this second phenomenon is the "derogatory planning" [119,120]. This is by far the most important finding of the study, and applicable to all cases.

The local differences are minor, and sometimes change in the long run (for example, in Romania the economic crisis resulted in slowing down the process). Other differences are due to the extent; Africa and Asia have larger cities and the sprawl is far away more visible than in Europe. However, differences exist in Europe; the Western coast has evolved to almost a continuous built-up area, especially in the Mediterranean [130]; in Romania, where the built-up areas make up in general a smaller share of the entire territory, the figures are not equally striking, but if growth is analyzed in relationship to the built-up area [93], its true extent is unmasked, and the process shows to be as worrying as in the other CA analyzed.

Although the study was focused mainly on the LCLU changes induced by tourism and urbanization within the CA, previous studies [66,111,131] show that other environmental issues, such as pollution or loss of biodiversity, are inherent consequences of the two (e.g., Algeria and Vietnam). Furthermore, while accretion and beach erosion are direct or indirect consequences of urbanization and tourism, with a more severe extent in Algeria and Vietnam, they seem to be exacerbated by the climate changes [21], which influences their range and extent, and amplifies their consequences. The synergic effects in particular are important to show that the results of this comparative study represent a warning calling for immediate action. However, erosion can have other causes, including the decrease in river sediment inputs to the sea, as a result of their dam retention, or poorly designed or neglected developments such as harbor piers or breakwaters that interrupt the sedimentary transit by drift, and many others.

The remaining question of the study is whether the national long-term development goals and the planning system are really correlated to each other, or if development does not tend to be driven by the local and short term interests in the recent times, and planning has lost its importance [132–135]. This question is important since all the three countries analyzed in the study experienced the shift from a centralized system (including economy, planning, or management of environmental issues) to a form of "governance" where the local power seems to exceed the central regulations, creating derogations from them. In terms of the measures needed for controlling, stopping, and preventing the phenomenon, the findings suggest an immediate need for measures aimed at stopping the degradation and starting the restoration of the degraded systems. Such measures are represented, in a first step, by engineering works. A radical, but unlikely and controversial solution is the inclusion of CA in natural protected areas. In many countries coastal areas are natural protected areas; in the case of Romania entire coast has different status of protection ranging from national important natural protected areas to biosphere reserves and EU Natura 2000 sites. In Algeria, "non aedificandi" (i.e., "do not build up") areas can offer a partial protection from the development of constructions [136]. However, the protection status can generate additional conflicts [137–141].

Nevertheless, degradation cannot be stopped if its drivers are still acting. Therefore, the findings suggest an important need for giving course to the message sent by the European Environment Agency [130], according to which the importance of urban sprawl can no longer be ignored. Obviously, the task is not easy, especially during the economic crisis times, when long-term environmental interests tend to be sacrificed for short-term economic profit, in particular in cultures with low environmental awareness [142–145]. Furthermore, the planning system reform may be a harder to do task than simply enforcing the zoning provisions. Even its shift from a totally centralized system to local freedom is arguable. In addition, the main theoretical debate at stakes, with arguments favoring a compact city or sprawling, cannot easily find a global solution. It can be inferred that Africa and Asia still have some space reserves, whereas Europe has already exhausted them. In this context, it is worthy mentioning the role of planning in increasing the resilience to the hazards generated or aggravated by urbanization [146–149].

4.2. Lessons Learnt from the Case Studies for the Planning and Governance Processes

In the introduction, we have looked at the intrinsic mechanisms of land cover and use leading to urbanization, and indicated that one of the research goals was to analyze them in order to increase the understanding of the role of tourism and urban sprawl. Each of the case studies analyzed tells a rather different story, but overall their messages are convergent and make an important contribution to reaching the initial goal. In Romania, coastlines were urbanized by a mixture of the two, both resulting from the derogatory planning [119,120]; in tourism, the process led initially to building larger infrastructure than the one showed in the plan (e.g., higher, larger, denser constructions were built and accepted by derogation from the planning provisions) within the built-up area of seaside resorts, and occasionally in the close proximity. In parallel to this, and especially during the economic crisis, sprawl was the dominant form; secondary homes were built in order to be used or rented in the rural areas, through the process of including abandoned agricultural area in the surface that could be used for buildings. The Algerian case is similar, but lacks the first phase; the large tourism infrastructure is missing, and the pressure of tourism resulted into amplifying the construction of illegal properties for dwelling or rental purposes. Given the larger population of Algeria, the extent of this phenomenon is also more prominent. In Vietnam, local administrations have started large-scale projects, by converting other uses into built up surfaces. Entire extensions of the cities, true "floating cities", were built even on the water.

From the scientific perspective, the findings are consistent up to some point to those of Díaz-Palacios-Sisternes et al. [1]: agricultural land is turned into urban land, but through a different process. Agricultural land abandoned in the view of the next step (speculating its value for real estate) or due to the property restitution, is included by the local administrations in the land that can be used for building purposes; this is more consistent with the results of another study dealing with this issue [52]. However, during the entire period, other mechanisms are also present, including the development of built up areas due to tourism and urbanization. This suggests that the urbanization mechanisms described in the literature [1,52] apply to countries that experienced a centralized leadership and moved to an open-marker economy.

In a nutshell, the planning lessons can be resumed to the idea that wise planning, accounting for the environmental outcomes of the greed for short-term economic profit, result into welfare and sustainability, and poor planning, subordinated to local short-term interests, results into negative outcomes that turn against the dwellers, who suffer the consequences, or, in lesser words, planning can turn a vicious circle into a virtuous one. The same conclusion was drawn with respect to planning when looking at other issues, such as the green infrastructure [150]. In the current study, the vicious circle can be described as following: the favorable environmental conditions draw people to the CA, creating a reaction of the investors, which are able to see the potential profit; the resulting densification results into worsening the environmental and social conditions, and ultimately lowering the profits. Unfortunately, the results cannot be reverted. The Romanian CA is home to many abandoned large accommodation facilities, which had run bankrupted during the economic crisis, provided their increased competition. However, the land use has changed, and other negative impacts resulted from the process.

The uncontrolled urbanization, lack of integrated coastal planning, and chaotic human interventions increase the complexity of the entire Mediterranean coastal zone [151]. The North-African Mediterranean coast is very complex, having vulnerable natural ecosystems due to high desertification process, and rapid coastal urbanization especially in the narrow coast plain.

In more words, the main lessons learnt in terms of planning are: (1) Planning can reduce the environmental effects; its lack, or poor planning result in worsening the impact of environmental hazards on the human population. A large density of population means more people affected, but also higher costs to counter the effects, and more important damages. (2) The quality of urban life should not be neglected. by the planners. Cheaper seasonal housing is more exposed to amplified negative outcomes than the buildings designed as "permanent". (3) There is a strong need for a balanced distribution of the prevention costs. Prevention works should be part of the projects, even if they increase the overall costs. (4) Arguments can be brought for compact developments vs. sprawl, but the choice should also account for the local environmental and social conditions in addition to the economic evaluation of costs. (5) Controlling the process requires a joint approach to planning of different sectors, in tight correlation with the regulation system (centralized or governance-based). For example, the Algerian case study underlined a poor design of national tourism policies; therefore, there is a need to develop it in order to stop the proliferation of illegal constructions, resulted from the need to meet the actual demand of people. In summary, accounting for the scale, the underlying principle is that careful planning at the level of each administrative unit will improve the resilience of the entire CA.

In addition to the scale, planning should look at the long term outcomes, and in this case Strategic Environmental Assessments should be applied to all plans, accounting for the long-term effect of local interventions over the entire area.

Since our findings indicate the acceleration of urbanization, the implications tie to other issues, provided the impact of urbanization on biodiversity, but also on the life quality in the new urbanized areas, in connection to the higher exposure of CA to the effects of global changes. The protection of the high biodiversity of CA asks for new knowledge of the complex causal interactions between marine and terrestrial environments and a drastic reduction of the existing conflicts, by rethinking the current governance [152]. It is necessary to define an integrated and participatory governance of such interactions, applying the knowledge-based approach of the relationships between the local and global scales [153]. This is very important because the dynamics of the CA is characterized by high uncertainty (however, dominated by retreat processes) due to climate change, sea level rise, subsidence phenomena, influences of geomorphologic processes, and urbanization [154].

An important issue regarding the climate change risk and resilience of coastal urban planning (including, sometimes, informal settlements) is the participation of stakeholders in taking the fundamental decisions [155]. The accelerated urbanization and the spectacular population growth in the CA, associated with a high hazard risk, represent important challenges for the central and local governments. The main phenomena characteristic to these areas include the population migration: immigration in quiet periods and massive departures in case of disasters caused by sea level rise, typhoons, land subsidence or other natural events.

4.3. Limitations of the Study

The most important limitation of the study, assumed form the very beginning, was the inability to apply the same methodology for all the three case studies. The initial goal was to provide a long-term perspective. Starting from here, the long term had to be split into periods relevant for each country analyzed, given its recent history, and the social, economic, and administrative shits occurred during the overall period. For this purpose, the study was aimed more at detecting trends, and finding their relevant local drivers. Nevertheless, despite the fact that the lack of a common methodology for the three case studies is a limitation, the convergence of results indicates the added value brought by using a broad range of approaches and stresses out even more the global importance of findings, calling for urgent action. Moreover, the initial source of data was satellite imagery; it was used directly for the Vietnamese case study. The Romanian case study used CORINE data derived from the satellite imagery, and the Algerian case study used official data, which ultimately were derived from satellite imagery as well. The different resolutions of the satellite images were no longer likely to affect the results at the broad scale of the three case studies.

In addition to this limitation of the theoretical framework, additional limitations occurred due to the availability of data, which seems to be a major issue in Algeria and an important issue in Romania. Overall, the study revealed the need that authorities make data more easily available, and in larger amounts. Here, the availability of data does not mean simply whether data were available or not, but also implies the data quality. By "available data", this study meant trustworthy data from official sources. Elaborating over the data issue, the advantages of data are obvious. As part of the European Union, Romania benefits upon the CLC data, a large data set covering LCLU and their changes starting 1990. There are potential problems associated with CLC data, applicable to this study, due to the misclassification and differences in the classification schemes and resolutions from one period to another [90,92–101,156–158], but also due to the different resolutions (e.g., the CLC dataset has a minimum mapping unit for status layers of 25 hectares, while, minimum the mapping unit for CLC is 5 hectares). Nevertheless, CLC data have proved their usefulness in analyzing urban sprawl [159] and other LCLU changes in Europe [160,161] and even outside the European Union [162], and even in fostering local development [163]. Obviously, the existence of a GIS-ready data set is important in the research economy and could reduce other sources of errors, but does not make the case studies of Vietnam or Algeria less valuable, since they rely on satellite imagery. Ultimately, the CLC data set used for the Romanian case study is also derived from satellite imagery. Moreover, all together the three studies underline, from a methodological view point, the importance of geospatial data for investigating, but also for managing the urbanization of the CA.

It is also important to point out that Europe uses two different data sets for looking at the urban environment. The Urban Atlas LCLU data set has a resolution of 0.25 ha for the artificial surfaces and 1 ha for the other classes (2–5), and 10 m for the linear features [164,165]. These data would have been suitable for analyzing the urban sprawl if their time frame was correlated with the pace of changes [94,98], but unfortunately the data is collected each 6 years, a time that does not fit the alert pace of urban changes. However, CLC data offer satisfactory solutions for looking at the urban sprawl, if certain mathematical adjustments are performed [93,94,150,159].

Similarly, the study lacked the possibility of using similar indicators as ancillary data or predictors of the changes. Previous studies, even if carried out for different purposes (e.g., [166,167], have showed that even European countries, using a common set of the Eurostat indicators, compute each of them using different national methodologies, making the results hard to compare. It is obvious that a cross-continental comparison is almost impossible, especially when the availability of data becomes an issue.

A limitation in the study design was the heterogeneity of the research team in methodological terms, ranging from people able to work directly with remote sensing data (satellite imagery) to people able to work with GIS data, and to people able to correlate already processed information. However, this formula was preferred, because the aim of the study was not to yield a bird-eye common view of the phenomenon, but to explore deeply into its mechanisms, and provide fine-tuned interpretations. Overall, it can be considered that the heterogeneity of analyses is a positive feature of the current research, since overall the study was able to draw global lessons from local case studies.

The literature shows that an "ecological approach", as the one used in most case studies is, by its default design, subject to the "ecological fallacy", meaning that any conclusion obtained at the level of the entire population is not necessarily valid at the level one [168], because of the spurious correlations. That is, in our case: a large city is likely to have a larger area affected by urbanization, and at the same time issues more building permits, has more tourism facilities etc. The "ecological fallacy" was prevented by using the urbanization rate, expressed as the share of the urbanized area from the total area of each unit instead of the actual urbanized area. Furthermore, previous studies have found out that the urbanization rate is better correlated with population and its density than the raw area affected by urbanization [169].

4.4. Future Research Directions

The current study proved the usefulness of geo-spatial data. However, if a program designed for turning remote sensing data into GIS-ready information is costly and requires additional cooperation mechanisms to be implemented (the example of CLC in Europe), nowadays remote sensing data is available even free of charge for almost any location, at different spatial scales, and for previous periods. Nevertheless, its processing is subject to many individual decisions, resulting into a reduced comparability of different datasets. This is why the CLC data have the advantage of offering already processed data, obtained using the same methodology for an entire continent. An alternative is to develop a comparison based on a common dataset derived from satellite imagery, but preserving the country-specific interpretations, based on correlations with ancillary data. Overall, the findings are alarming and suggest the need for a program (and international funding) for continuously monitoring the dynamics of CA. Such a program can operate under many frameworks, such as the United Nations Convention on Biological Diversity. The program can provide a set of recommended policies for the countries with important CA. The analysis shows that such cooperation initiatives exist, e.g., the European Union Maritime Security Strategy, which includes provisions for the protection of CA, but also the European Maritime and Fisheries Fund. Similarly, with regard to Algeria, the National

Coastal Commissioner has the mission, among other things, to (1) preserve and enhance the coastline, coastal areas and their ecosystems; (2) implement the coastal and coastal protection measures; (3) provide local authorities with any assistance related to its areas of intervention; (4) maintain, restore and rehabilitate land and marine spaces that are remarkable or necessary to maintain natural balances for conservation; and (5) promote public awareness and information programs on the conservation and sustainable use of coastal areas and their biodiversity

At the global scale, the migration phenomenon is dominated by two main attractors: big cities and CA [170]. It is also worth noting that wars and famine are rare in these areas. Both attractive areas overlap frequently, because of the fact that the largest urban concentrations are located within the CA. However, the location of such cities exposes them to greater risks taking into account the new climate change trends (higher frequency of cyclones and flooding), sea level rise, and coastal erosion, which cause all together huge economic losses and human casualties [21,171].

This setting and the critical analysis of the existing theoretical framework require a new approach to land-sea interactions and coastal development, using a different viewpoint on governance [172]. The three case studies analyzed in this paper show the necessity to apply a governance model focused on co-evolution. In this context, the Evolutionary Governance Theory shifts the attention not only to the multi-level governance, but highlights new integrated policies which take into consideration the coastal conditions, including the uncertainty as key element crossing the historical interactions [173].

The current trends of concentrating population and economic activities in the urban areas, especially when they have a continuity alongside of the CA, in conjunction with the increase of extreme phenomena due to climate change and sea-level rise, ask researchers and planners to seek for new solutions for protecting the human beings, and their activities and investments. The Evolutionary Governance Theory applied to the CA around the world, together with a better dissemination of the best practices in building the coastal infrastructures, could be an important future research direction, supporting decision-makers for a better management of the CA.

This study has employed a data-driven approach; the implicit shortcoming is that data are able to pinpoint the relatively recent dynamic, ever since the remote sensing technology was in place. For an in-depth analysis, diachronic analyses are a possible future research direction able to pinpoint the phenomena at a different time scale [174,175]. Also, since our study did not focus directly on the erosion and accretion, these phenomena were only briefly discussed as a consequence of urbanization, since we did not have sufficient data to ascertain their direct relationship. Future studies should look at this relationship, eliminating other concurrent causes, presented in the discussions.

Last but not least, although this study was focused on the changes within urban areas, other phenomena, affecting the natural areas (e.g., deforestation) or agricultural ones were revealed. Their importance was not sustained by the statistical analyses (e.g., the deforestation within the Romanian CA), because forests were not covering large areas. However, future studies carried out in areas were forests and agricultural areas are present within the CA may reveal whether these changes are precursors of the urbanization and tie to the urban sprawl.

5. Conclusions

The article aimed to examine the urbanization of the Romanian, Vietnamese and Algerian coasts in order to drawing spatial planning principles which can be used for drafting the CA strategies in these countries and similar ones.

Although Romania has a very short coastline of the Black Sea, the complexity of land-sea interactions is very high because of the different natural and anthropic factors, and coastal condition. First of all, any territorial analyst can notice the opposition between the northern and southern parts of the Romanian Black Sea coast with respect to the urbanization and degradation of CA. The Northern part is dominated by natural dynamics, especially after 1991, when the Danube Delta became a Biosphere Reserve.

Each case study has yielded important lessons. In Vietnam, the CA play a very important role in the development of the country in terms of economy and tourism. 50% of the country's population lives in the CA, depending on their resources. This leads to the degradation of the CA. In order to protect the coastlines, it is necessary to assess the mechanisms of change in order to propose appropriate measures with regard to the economy of the country. The results show that urban sprawl and development of tourism are the main causes of coastal changes in Vietnam, especially in Quang Ninh, Da Nang city, and Ba Ria-Vung Tau province, which have underdeveloped land use planning strategies, and the urbanization does not account for the environmental protection. These findings indicate that perhaps in some provinces of Vietnam urbanization and tourism development are not correlated with the environmental protection. This is not only the case in Vietnam, but is also valid in other Asian developing countries like China.

In Algeria, the study demonstrated that the degradations of the CA are caused by urbanization and the development of agriculture. Urban and agricultural areas increase their surface area to the detriment of natural areas, especially to the forests. The processes are amplified by the demographic explosion, the rural exodus and the migration of the population from the inner cities.

The three case studies seem to be less significant at the global scale, but their comparative analysis offers the possibility to notice that land-sea interactions are shaped by the uncertainty of phenomena characteristic to the sea and adjacent terrestrial areas. The historical interactions between both environments have set their fingerprint on the landscape, which on the one hand is an expression of the particular resources and cumulative cultural experiences, and on the other hand shows the permanent adaptation to natural restrictions and historical and political distortions. The study provided in the end three detailed knowledge packages, integrating the relationships between urbanization and degradation of CA. All cases show a very old urbanization, which demonstrates that the CA were very attractive for an increasing population, who found enough resources and multiple conditions to thrive. Old civilizations had developed on the Vietnamese coast, with two important deltas and urban areas on the northern and southern part, on the narrow coast of Algeria, with some urban locations well known from the age of the Roman Empire, and on the North-Western area of Black Sea, where the Greeks and Romans founded ancient fortresses. However, the history drastically modified these areas. Their continuity indicates a sustainability potential that crosses the centuries. The current status of land-sea interactions revealed by the three case studies is characterized by demographic increasing, a rapid economic development, and a high degree of urbanization. Simultaneously, the "sea" started to change its characteristics under climate changes, questioning the usefulness of some investments made over time. In the meantime, the urban communities are becoming more cautious about developing new infrastructures in the coastal areas, even if the present technology seems to find always solutions. Sustainability is a priority for central and local governments, which implies a deeper knowledge of the land-sea interaction mechanisms that have changed their underlying rules.

This experience is useful for a transcontinental cooperation in research and higher education, because changing different ideas for a better analysis of the case studies allowed for the mutual discovery of a huge intellectual potential. This potential could be valorized to develop the methodology applied in the study, and continue the cooperation in other joint research projects. From theoretical and practical point of views, this experience shows that research can be continued by deep analyses to validate the Evolutionary Governance Theory, which offers a real tool for a coherent approach to the CA sustainability, taking into consideration the importance of connections between past, present and future management experiences. At same time, in methodological terms, the study indicated that remote sensing and GIS technologies can be effectively applied to identify the status and assess the CA changes. These methods are applicable to other countries with CA. Understanding the drivers of change—natural or human—is an important factor helping managers to design appropriate planning alternative plans for the CA, especially in the context of climate change and sea level rise [176,177]. Therefore, the establishment of a network of managers and scientific research is necessary to provide land use planning and coastal protection options in different regions around the world experiencing the same issues. The results of this study may also help scientists predicting shore shifts that can increase the risk of erosion or accretion. In addition, they can support planners proposing appropriate strategies for the development of CA at the regional and national levels.

In sustainability terms, most authors resume its essence to the well-known 1987 definition, focused on the inter-generational equity in terms of satisfying the needs [178]. However, a 2003 interview [179] with the author of the definition indicated that the focus should be reset on the equity of the traditional pillars (economy, society, and environment), and perhaps on the newly added cultural one [180]. Within this conceptual framework, the global comparative study of the urbanization of CA makes a crucial contribution to stressing out the importance of equally addressing all pillars in the development process, provided the strong negative outcomes of ignoring one of them, especially today, when the global changes affect the global earth systems, and aggravate the local conditions.

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