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Local Assessment of Vulnerability to Climate Variability and Change for Šibenik-Knin County Coastal Zone

Integration of Climatic Variability and Change into National Strategies to Implement the ICZM Protocol in the Mediterranean

Technical report

September 2015

PAP/RAC

Report:

Local Assessment of Vulnerability to Climate Variability and Change for Šibenik-Knin County Coastal Zone

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Editors:

Daria Povh Škugor, PAP/RAC, Split, Croatia

Ivan Sekovski, PAP/RAC Associate, Split, Croatia

Authors:

Nick Dale, Metroeconomica, Bath, UK

Anil Markandya, BC3 Basque Centre for Climate Change, Bilbao, Spain

Data preparation:

Martina Baučić, Geodata, Split, Croatia

Marina Stenek, PAP/RAC Associate, Split, Croatia

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Bucavac Ltd. Public Utility Company Primošten;
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State Geodetic Administration;
Tourist Board of Šibenik-Knin County.

Proofreading and translation:

SPES Centre for tuition and interpretation, Zagreb, Croatia

Graphic design:

Studio Quarto, Split, Croatia

Slobodan Pavasović, PAP/RAC Associate, Split, Croatia

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Pavić, H. (2010)

Dolac of Šibenik flooded again, citizens desperate

24 sata, December 1, 2010

Šibenik, Croatia

Frequent flooding of the street, cellars and cafés in the Šibenik quarter of Dolac make the inhabitants and businesses owners desperate. Rain and high tide, combined with low-lying coast and poor drainage of storm waters and sewerage in general, have cut this quarter from the rest of the city. The ground floors of every house host cafés which can now only be reached in rubber boots.

- Last year we suffered floods for 42 days and 42 nights. We have to pump the water out of the cafés, while guests come in and out during short-lasting low tides. On several occasions during the day we manage to throw the sea and rain waters out, but reckless drivers make high waves with their cars which fill the premises with water in no time getting the feet of our rare guests wet. We plead with the drivers not to "surf", and have asked both the Port Authority and Maritime Police to place in the flooded areas signs limiting the speed to five knots for both boats and cars – says Vlado Kužina, the owner of the popular Dolac café "Domald".

In January last year, Zdravko Nuhić Špico (52), owner of the near-by café "Leut", died electrocuted while throwing water with a bucket out of his flooded café.

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List of Acronyms

ACI	Adriatic Croatia International club
AR	Assessment Report
BEF	Baltic Environmental Forum
CFP	Common Fisheries Policy
CVC	Climatic Variability and Change
DHMZ	*Državni hidrometeorološki zavod* (Meteorological and Hydrological Service of Croatia)
DIVA	Dynamic Interactive Vulnerability Assessment
EEA	European Environment Agency
EFFIS	European Forest Fire Information System
EMFF	European Maritime and Fisheries Fund
EU	European Union
FAO	Food and Agricultural Organisation
FINA	Financial Agency
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GVA	Gross Value Added
GWh	Gigawatt-hours
ha	hectar
HCPHS	*Hrvatski centar za poljoprivredu, hranu i selo* (Croatian Centre for Agriculture, Food and Rural Affairs)
HiRAM	High-Resolution Atmospheric Model (sometimes HIRHAM)
HRK	Hrvatska kuna (Croatian Kuna)
HTM	Hamburg Tourism Model
ICZM	Integrated Coastal Zone Management
IOC	International Olive Council
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IPCC AR4/AR5	IPCC Fourth/Fifth Assessment Report
km	kilometre
LTD.	Limited (for a company)
MENP	Ministry of Environment and Nature Protection
m	metre
mm	millimetre
MWh	Megawatt-hours
NCP	Nautical Centre Prgin
NUTS	Nomenclature for Territorial Units for Statistics
PAP/RAC	Priority Actions Programme Regional Activity Centre
pH	Hydrogen ion concentration
PE	Population Equivalent
PESETA	Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis
RAC	Regional Activity Centre
RC	Republic of Croatia
RCAO	Regional Coupled Atmosphere-Ocean Model
RCP	Representative Concentration Pathway
RCM	Regional Climate Model
RDA	Regional Development Agency

RERCPPP	Registry of Renewable Energy Resource and Cogeneration Projects and Privileged Producers
SEEFCCA	South East European Forum on Climate Change Adaptation
SKC	Šibenik-Knin County
SLR	Sea-Level Rise
SRES	Special Report on Emissions Scenarios
SSP	Shared Socioeconomic Pathways
SWOT	Strengths, Weaknesses, Opportunities and Threats
t	ton
TCI	Tourism Climate Index
TEF	The Factory for Electrodes and Ferroalloys
TLM	*Tvornica lakih metala* (Factory of Light Metals)
TSA	Tourist Satellite Accounts
UN	United Nations
UNDP	United Nations Development Programme
UNEP/MAP	United Nations Environment Programme / Mediterranean Action Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VAT	Value-added Tax
WSZ	Water Supplied Zone
WTTC	World Travel and Tourism Council
WWTP	Waste Water Treatment Plant
y	year

1 Introduction

This Local Vulnerability Assessment report of climatic variability and change (CVC) in Šibenik-Knin County in Croatia is part of the Global Environment Facility (GEF) project, "Integration of Climatic Variability and Change into National Strategies to Implement the ICZM Protocol in the Mediterranean" (the ClimVar & ICZM Project). The report falls under the project objective to "strengthen the understanding of the impacts of CVC on the coastal zones of the Mediterranean region, which aims to assess environmental and socio-economic impacts and evaluate response options in vulnerable sites."

To support this objective, this report will assess the economic impacts of CVC in Šibenik-Knin County and make conclusions and recommendations that will inform the preparation of the coastal zone management plans and national ICZM strategies.

The structure of the report includes an overview of the economy of Šibenik-Knin County and a summary of conclusions drawn from available climate change projections relevant to the County, which are presented in Sections 2 and 3.

Section 4 assesses local vulnerability to CVC for a number of key economic sectors in the County. It includes sections on those sectors that may be impacted by CVC, including tourism, agriculture, fisheries, water management, manufacturing, maritime transport, and energy. The selection of CVC issues to be covered in this report is based on discussions with the Priority Actions Programme Regional Activity Centre (PAP/RAC) and has taken into account the priority impacts of climate change in the coastal zone of Šibenik-Knin County raised by stakeholders in the Climagine participatory process (Lay, 2013). This section uses the results of the Economic and Social Assessment of the Croatian Marine and Coastal Zone (Institute of Economics, Zagreb and Faculty of Economics, Split, 2015) and water management-related inputs for the Coastal Plan (Margeta, 2014). The report does not comprehensively cover all possible CVC impacts on the local economy, but we believe it includes the key potential impacts.

This sector-based approach corresponds to several related reports on this subject for other areas in the region (such as Callaway et al., 2010 for Montenegro and Metroeconomica, 2011 for the Buna/Bojana Region of Montenegro and Albania). The range and complexity of different CVC impacts across different economic sectors and issues means that there is no common methodology for estimating these impacts between sectors. Therefore, this study uses a number of approaches to carry out the assessment and to quantify and monetize the various impacts as much as possible. Where appropriate, this bottom-up local-level assessment has been informed by the results of two other reports produced for the ClimVar & ICZM Project. These are the top-down assessment of sea-level rise impacts for Croatia by Hinkel et al. (2015), based on the Dynamic Integrated Vulnerability Assessment (DIVA) model, and a vulnerability analysis of coastal areas of Šibenik-Knin County by Baučić (2014). This is particularly the case in Section 5, which focuses on sea-level rise-related damages. For sectors where some or all CVC impacts are not directly related to coastal sea-level rise other data sources and methods have been used. Section 5 also covers other CVC impacts, such as forest fires, human health and cultural heritage.

Sections 6 and 7 draw conclusions and make recommendations based on the assessment. The diversity of methods used in the assessment for different sectors means that we do not make direct quantitative comparisons between the economic results for different sectors and issues. A second reason for caution against such comparisons is that the available research results that we have used in this report are sometimes based on different IPCC climate scenarios and pathways (both SRES emission scenarios in AR4 and RCPs in AR5). Nevertheless, in the final part of the report we provide general conclusions on the relative order of magnitude of impacts on different sectors. These conclusions feed into the recommendations for prioritisation in coastal zone management plans and inform the understanding of the adaptation deficit in the County.

The authors gratefully acknowledge the expert advice and data collection assistance provided by Daria Povh (Senior Programme Officer, PAP/RAC), Martina Baučić (University of Split), Ivan Sekovski and Marina Stenek.

2 Overview of the Economy of Šibenik-Knin County

Šibenik-Knin County is a coastal county in Croatia covering 2,984 km^2, equal to 5.27% of the country's land territory. It includes 242 islands that make up 19.2% of all Croatian islands. Its location is shown in Figure 2.1. The assessment of CVC impacts in this report focuses on the coastal zone and the zone of Krka River basin as shown in Figure 2.2.[1]

Demographic data for Šibenik-Knin County and the other counties of Croatia are provided in Table 2.1. The County's total population in 2011 was about 109,000, or 2.55% of the total population of Croatia. Croatia's population is among the fifteen oldest populations in the world, and the share of older persons is constantly growing. The median age is 42.4 years, which make Croatia the sixth oldest EU country. Šibenik-Knin County has an even older population, with a median age of 44.1 years. The share of older persons (age 65 or over) is more than 20%, while share of oldest (age 80 or over) is more than 5%. The share of older persons exceeded the share of young people (0 to 14 years old) by more than 50%. According to all population data, the situation in Šibenik-Knin County is the second most difficult of Croatia's 20 counties. In addition, net migration is the third highest of all counties, even though the other coastal counties have much fewer problems than the continental counties.[2] Between the censuses of 1991 and 2011 there was about a 12% decline in the population of the coastal zone of Šibenik-Knin County. During this period, the decline in urban population in the coastal zones of Šibenik-Knin County was about 19%, the highest of all of Croatia's coastal counties.

Figure 2.1: Location of Šibenik-Knin County

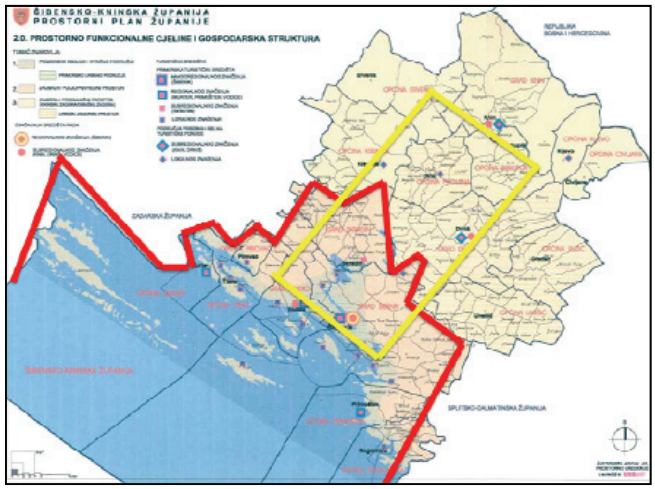

Figure 2.2: Map of the coastal zone of Šibenik-Knin County

Note: *The zone within the red line is the coastal zone as defined in the ICZM Protocol. The zone within the yellow line is the zone of Krka River Basin. Both zones are considered for the purpose of the Coastal Plan.*

[1] For some sectors and issues we are not able to define precisely the economic impacts of CVC inside and outside these boundaries (e.g. agriculture and some tourism expenditures). In such cases the assessment is based on data for SKC as a whole.

[2] Source: Faculty of Economics of Zagreb, Demography department. I. Čipin et al. Expert Input for the National Strategy for Spatial Development. 2014.

Table 2.1: Surface land area, population, density, number of towns and municipalities of Adriatic Croatia. Source: Fredotović et al. (2014), quoting the Statistical Yearbook of the Republic of Croatia (2013).

County	Surface land area (km^2)	Population	Population Density (persons /km)	Number of towns	Number of municipalities
Istria	2,813	208,055	74.0	10	31
Primorje-Gorski Kotar	3,588	296,195	82.6	14	22
Lika-Senj	5,53	50,927	9.5	4	8
Zadar	3,646	170,017	46.6	6	28
Šibenik-Knin	2,984	109,375	36.7	5	15
Split-Dalmatia	4,540	454,798	100.2	16	39
Dubrovnik-Neretva	1,781	122,568	68.8	5	17

The total GDP of Šibenik-Knin County in 2011 was 6.434 billion HRK or about 865 million Euros, which is about two percent of total national GDP. In 2011, Croatia was ranked 25th out of the 28 EU countries for *per capita* GDP. In 2011, *per capita* income in the county was 58,955 HRK (7,930 Euros), which was only about 77% of the Croatian average.[3] The economic structure of the county based on Gross Value Added (GVA) is shown in Figure 2.3. It indicates a mixed economy of mining, manufacturing, and wholesale and retail, with a small contribution from agriculture. However, tourism is not officially defined as a separate sector in the national accounting system (since it is a demand-defined rather than a supply-defined activity) and its value is spread across a number of subsectors, in particular food, accommodation, and transport (both wholesale and retail).

The Croatian government calculates a development index by counties and for towns and municipalities. The index is calculated on the basis of 5 variables: unemployment rate, income *per capita*, county budget revenues *per capita*, population change, and educational attainment rate.[4] In 2013, the development index in Šibenik-Knin County was 80.93% of the Croatian average. Although this is a rather low value for a coastal county, there has been some progress relative to the development index calculated in 2010, which was only 63% of the Croatian average.

Operational Income in 10 Coastal Municipalities of Šibenik-Knin County is shown in Table 2.2. This indicates the economic dominance of the Municipality of Šibenik, which accounts for about 79% of the total operational income for these municipalities. It also shows the importance of manufacturing (40% of the County's income), wholesale and retail trade (19%), food and accommodation (10%), and the very small contribution of agriculture (less than 1%)[5] in these municipalities. The construction sector and real estate services contribute about 10% to the total, indicating the level of building development (including on the coast).

Šibenik-Knin County suffered a significant decline in County GDP of about 12% during the economic downturn of 2008. Since that time, GDP has stabilised but has not recovered to its pre-2008 level (see Figure 2.4). This period of stagnation has also occurred in other Croatian counties, but it has been particularly severe in Šibenik-Knin County.

[3] Croatian Bureau of Statistics. http://www.dzs.hr/Hrv_Eng/publication/2014/12-01-02_01_2014.htm.

[4] Measured as ratio of population with secondary education and higher in population over 15 years.

[5] Operational income only includes commercial companies and therefore underestimates total income from agriculture in SKC which is to a large extent small family farms as described in Section 4.2. As shown in Figure 2.3, Gross Value Added of agricultural and fisheries is officially about 2% in SKC compared with around 3% for the Croatian Adriatic as a whole.

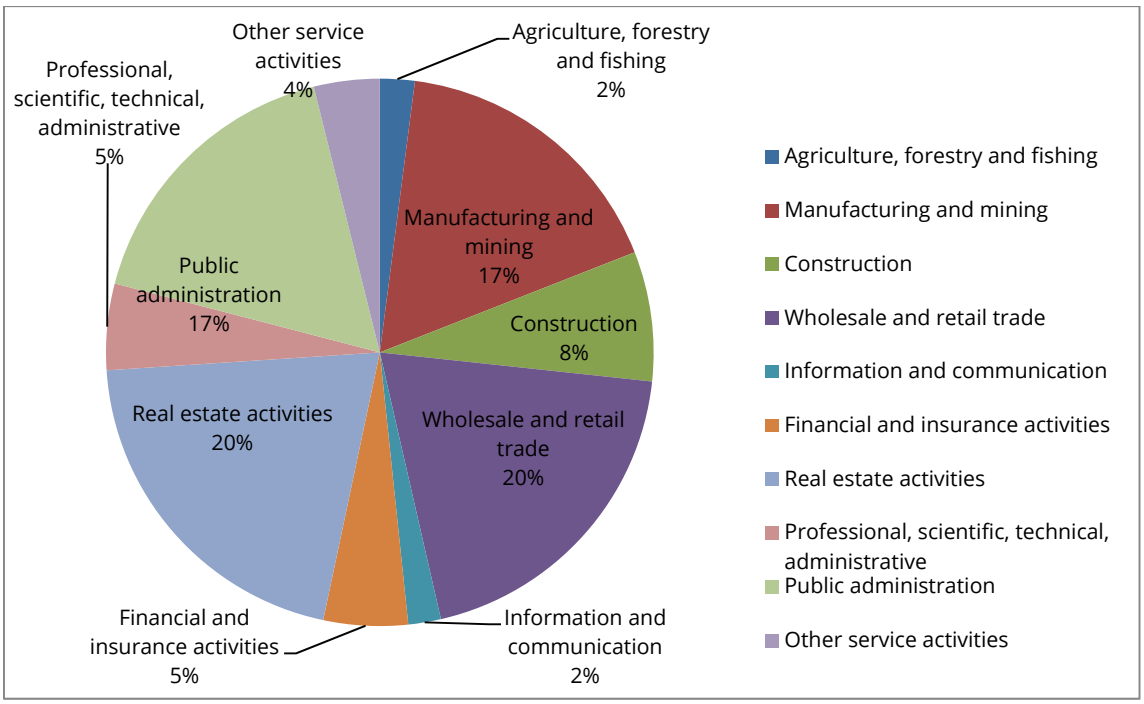

Figure 2.3: Economic Structure of Šibenik-Knin County 2011 (% of Gross Value Added).
Source: Based on Croatian Bureau of Statistics data.

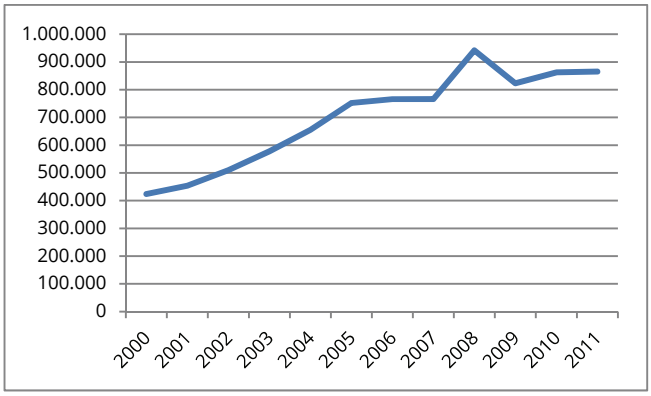

Figure 2.4: Trend in GDP of Šibenik-Knin County (millions €).
Source: Based on data from the Croatian Bureau of Statistics.

Figure 2.5 illustrates the overall trends in gross value added for different economic sectors in Šibenik-Knin County. While all sectors suffered declines in 2008, the sectors that have shown the strongest overall growth since 2000 are real estate, wholesale and retail trade (which includes transport, accommodation and food services and therefore also includes tourism-related activities), and manufacturing and mining. Construction showed strong growth to 2005, but it then crashed and has not recovered to its previous level. Agriculture, forests and fisheries have been in decline since 2001, when they represented 5.9% of total GVA. In 2011, they represented only 2.1%.

Tables 2.3 and 2.4 show the relative importance of different economic sectors in terms of revenues and employment in the coastal, mainland and island zones of the County. In each case the dominant sectors in the coastal and island zones are manufacturing, wholesale and retail, and accommodation and food services, with arts, entertainment and recreation featuring strongly in the Island Zone.

The Regional Development Strategy for Šibenik-Knin County from 2011 to 2013 focused on encouraging metalworking, processing mineral resources, tourism and environmentally-friendly manufacturing. The strategic goal (C1) was a "competitive economy based on foreign and domestic investment in tourism support services, traditional agriculture and industry based on innovation, and advanced technologies in the economy." Quantitative results in the Strategy for this goal that were expected by the end of 2013 included (i) GDP growth at a rate above the Croatian average, (ii) unemployment at the level of Croatia's Adriatic counties, (iii) an increase in the number of tourists by 5% per year and an increase in revenue of 10% per year, (iv) a 15% increase in exports over 2009, (v) an increase in wine production of 15% and olive oil of 20%, and (vi) new irrigation for perennial crops of 300 ha (RDA, 2011).

Table 2.2: Operational Income in 10 Coastal Municipalities in SKC (2011 or Latest Year Available).
Source: Financial Agency (FINA).

	Primošten	Skradin	Šibenik	Tisno	Vodice	Pirovac	Rogoznica	Murter	Bilice	Tribunj
Agriculture	106,802	1,478,055	7,671,940	242,248	2,502,515	329,134	-	7,806,360	-	5,012,624
Mining & Related	1,761,101		1,450,376							
Manufacturing	21,296,644	919,425	1,826,973,467	21,887,939	20,298,487	1,896,530	21,528,481	34,240,607	675,058	8,409,285
Electricity Gas	-	1,241,046	165,935,799	2,012,500			0		-	
Water Supply Sewage & Waste	6,843,025	2,973,240	198,768,481	2,012,500	12,387,756	643,356	3,148,529	2,777,271	-	811,182
Construction	456,706	53,677	251,997,651	4,185,467	77,077,146	588,857	3,503,995	3,639,720	12,642,129	38,808
Wholesale & Retail Trade	13,237,685	11,050,751	679,041,195	16,207,258	108,221,393	22,529,145	9,923,111	24,416,837	22,129,778	5,437,294
Transportation	293,891	649,488	150,719,234	2,864,335	12,663,023	152,784	528,500	4,102,914	-	956,478
Accommodation and Food	67,101,383	13,209,162	272,019,437	37,936,650	66,816,844	954,146	3,801,362	4,558,583	211,877	3,329,806
Information & Communication	379,047	182,926	19,665,106		6,486,803	116	0	290,836	520,737	
Real Estate Services	25,106	-	82,394,364	712,712	42,099,493	1	1,046,897	54,448	0	0
Professional & Technical	61,413	312,500	84,362,614	1,385,802	4,665,891	0	44,198	3,666,372	917,012	255,560
Administrative & Support	7,990,065	312,500	56,192,727	9,959,657	25,705,649	584,014	3,099,826	4,555,661	-	0
Education			14,781,668		688,380				312,783	
Health and Social Care	565,972	7,166,109	11,051,517		7,824,014	2,835,878	32,119		566,651	
Arts and Entertainment	37,199,475	0	17,642,038	706,186	650,574		41,803,007	36,869,378	23,627,403	13,475,591
Other Activities	9	0	9,679,322	693,084	4,401,120		56,243	2,703,139	0	
Total	**157,318,324**	**39,548,879**	**3,850,346,936**	**100,806,338**	**392,489,088**	**30,513,961**	**88,516,268**	**129,682,126**	**61,603,428**	**37,726,628**

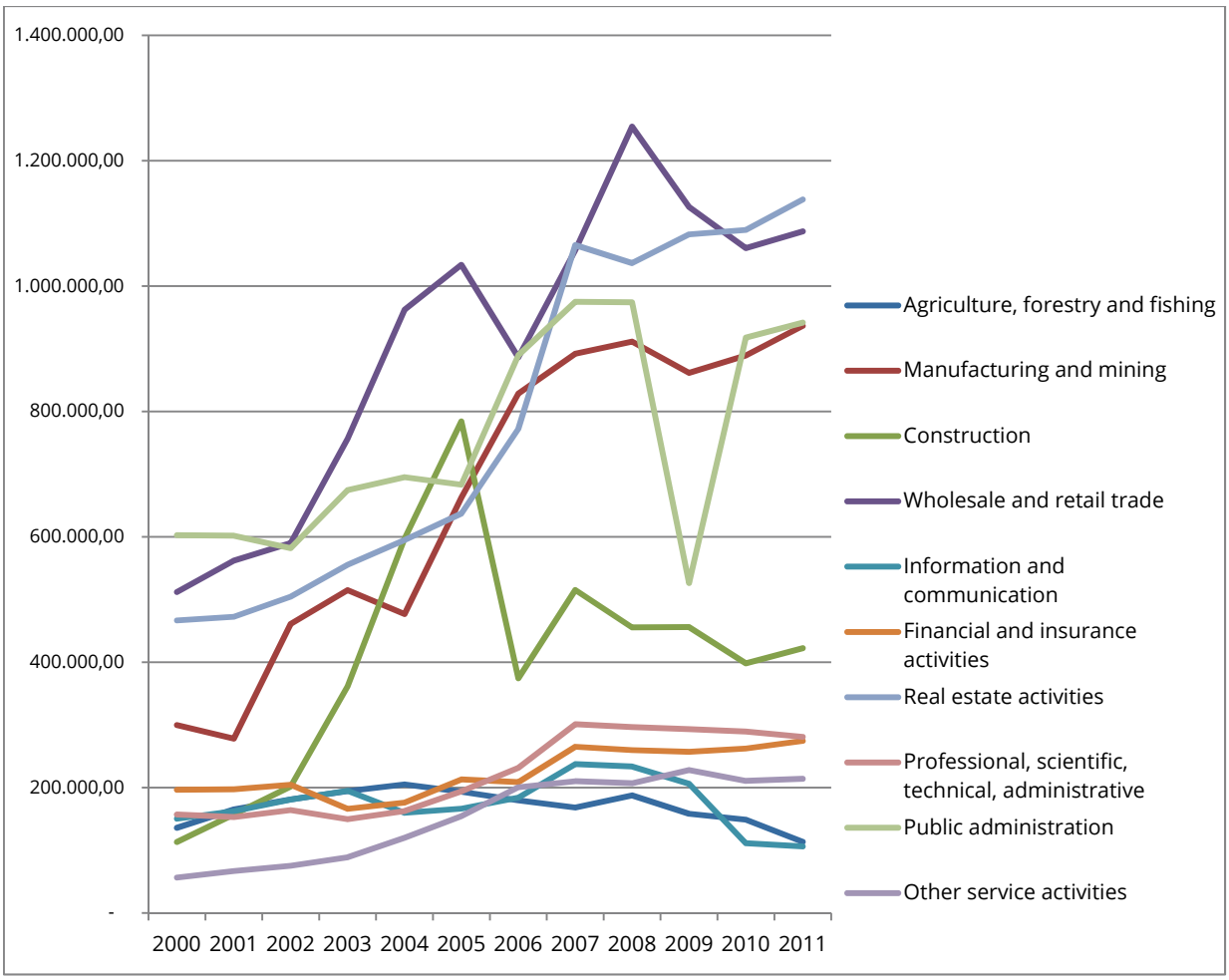

Figure 2.5: Trends in Gross Value Added of Šibenik-Knin County by Sector (in thousands HRK).
Source: Based on data from the Croatian Bureau of Statistics.

Table 2.3: Employment by sector in the coastal zone of the Šibenik-Knin County (%).[6] Source: Fredotović et al. (2014).

	Total Coastal Zone				Mainland Coast				Islands			
ACTIVITY	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011
Agriculture, forestry and fishing	-	-	-	-	-	-	-	-	6%	-	-	-
Manufacturing	29%	27%	27%	27%	30%	27%	27%	27%	17%	29%	26%	26%
Water supply; sewerage; waste management and remediation activities	-	5%	-	-	-	5%	-	-	-	7%	6%	5%
Construction	11%	11%	10%	9%	11%	12%	11%	9%	-	-	-	-
Wholesale and retail trade	16%	16%	17%	15%	16%	16%	16%	15%	15%	10%	23%	19%
Transporting and storage	6%	-	6%	7%	6%	-	6%	7%	-	-	-	-
Accommodation and food services	16%	15%	15%	16%	15%	15%	15%	16%	25%	8%	8%	9%
Arts, entertainment and recreation	-	-	-	-	-	-	-	-	21%	24%	23%	22%
Other activities	22%	26%	25%	25%	22%	25%	24%	25%	16%	22%	14%	19%
Total employment	**9.914**	**9.301**	**9.153**	**9.165**	**9.609**	**9.039**	**8.877**	**8.883**	**305**	**262**	**276**	**282**

Table 2.4: Business revenues by sector in the coastal zone of the Šibenik-Knin County (%). Source: Fredotović et al. (2014).

	Total Coastal Zone				Mainland Coast				Islands			
ACTIVITY	2008	2009	2010	2011	2008	2009	2010	2011	2008	2009	2010	2011
Agriculture, forestry and fishing	-	-	-	-	-	-	-	-	-	4%	6%	6%
Manufacturing	37%	34%	38%	40%	37%	33%	38%	41%	34%	41%	30%	26%
Water supply; sewerage; waste management and remediation activities	-	-	4%	5%	-	3%	4%	5%	-	-	-	-
Construction	11%	12%	9%	7%	11%	12%	9%	7%	-	-	-	-
Wholesale and retail trade	24%	21%	20%	19%	24%	22%	20%	19%	20%	11%	21%	19%
Transporting and storage	-	-	-	-	4%	-	-	-	-	-	-	-
Accommodation and food services	10%	11%	11%	10%	10%	11%	11%	10%	17%	-	-	4%
Professional, scientific and technical activities	-	-	-	-	-	-	-	-	-	-	3%	-
Administrative and support service activities	-	-	-	-	-	-	-	-	5%	5%	-	-
Arts, entertainment and recreation	4%	4%	-	-	-	-	-	-	17%	25%	26%	28%
Other activities	15%	18%	18%	20%	14%	18%	18%	19%	7%	13%	14%	17%
Total business revenues (millions HRK)	**4.951**	**4.156**	**4.468**	**4.877**	**4.798**	**4.030**	**4.339**	**4.748**	**153**	**126**	**128**	**130**

[6] It is Important to note that this table gives employment in legal entities. In the agriculture and fisheries sector employment is largely in crafts and family farms for which data are not available.

3 Overview of Climate Change Trends and Projections

Current trends and projections for climate change in the coastal area of Croatia that are relevant for Šibenik-Knin County are summarized here. They are based on MENP (2014) and EU (2014). Results from climate observations and modelling provide a number of clear conclusions for likely changes in annual and seasonal temperatures and sea-level rise. However, the results also indicate differences in some projections for different climate scenarios and models used.

3.1 Temperature

Observed climate trends:

- There was a statistically significant increase in the mean annual temperature from 1951 to 2010 of 0.07 to 0.22°C per decade for the Croatian coastal zone. This increase accelerated in between 1981 and 2010 to 0.28 to 0.71°C per decade.
- Temperature trends are positive in all seasons, but the greatest increases in the coastal region of Croatia are from summer temperatures. This trend differs from the continental part of Croatia, where the main increases are from winter temperatures.
- The magnitude and frequency of heat waves has increased significantly in Southern Europe between the 1960s and the 2000s.

Projections for climate change:

- Climate change projections based on the IPCC SRES A1B scenario show mean annual temperature increases for the period 2011–2100 of between 0.3 and 0.5°C per decade in Croatia. The projections show statistically significant warming in the eastern Adriatic region in all three 30-year periods of the 21st century. The greatest temperature increases are in the summer and early autumn along the Croatian Adriatic coast.
- Projections for Croatian Adriatic coast in the period 2011–2040 show that summer season temperature increases can be expected, although the extent of the increases varies between models and scenarios. According to the DHMZ RegCM results (A2 scenario), the greatest increase, about 1ºC, is expected in the northern Adriatic region, while the ENSEMBLES models (A1B scenario) show increases of 1.5–2°C in the central and southern Adriatic in this period (MENP, 2014).
- Increases in summer temperature of 4.5–5°C are projected in southern and central Dalmatia toward the end of the century by the ENSEMBLES regional climate models (RCMs). The number of days with maximum temperatures higher or equal to 30°C will double by the middle of this century in many areas of Croatia.

3.2 Precipitation

Observed climate trends:

- There was a decreasing trend in annual precipitation in all parts of Croatia during the 20th century, but it was more marked in the northern Adriatic and on the Dalmatian islands.
- There has been a positive trend in the annual number of dry days in the area of the Adriatic, but the number of wet days has remained unchanged.

Projections for climate change:

- In the first half of the century, projected precipitation change in Croatia is uncertain.
- Projections of precipitation changes in Croatia for 2041–2070 compared with 1961–1990 (A2 scenario) show total precipitation decrease in three seasons (spring, summer and autumn) in coastal Croatia. The decrease is generally less than 0.5 mm/day (or 45 mm in a season). The projected percentage decrease in total precipitation along the eastern Adriatic coast is greater in the summer (over 20%) than in spring and autumn (less than 15%). Precipitation increase in winter is not significant.

3.3 Sea-Level Rise

Three sea-level rise scenarios for the Croatia coastal region have been used in the DIVA modelling for this project (Hinkel et al., 2015). The values for sea-level rise in 2050 and 2100 are reproduced in Table 3.1 and are based on a low scenario (RCP 2.6 combined with the 5% quantile of ice-melting projections), a medium scenario (RCP 4.5 combined with the median), and a high scenario (RCP 8.5 combined with the 95% quantile).

Table 3.1: Sea-level rise scenarios in Croatia in 2050 and 2100. Source: Reproduced from Hinkel et al. (2015).

Scenario	Sea-level rise Croatia, 2050	Sea-level rise Croatia, 2100
Low SLR	0.15 m	0.28 m
Medium SLR	0.19 m	0.49 m
High SLR	0.31 m	1.08 m

4 Economic Sectors and Their Vulnerability to Impacts of Climate Change

This section discusses the potential impacts of climate change trends and projections on key sectors of the economy of Šibenik-Knin County. To estimate potential costs for the economic sectors, each sector is presented in terms of its contribution to County economy. For some sectors, such as agriculture, the key impacts will come from temperature and precipitation changes, while for other issues, such as asset damages from coastal flooding, sea-level rise is the key source of impacts. In some sectors, especially tourism, we can identify potential economic impacts from both temperature and sea-level rise.

4.1 Tourism

Overview of the Sector

Šibenik-Knin County has many features that make it an attractive tourist destination. They include the natural beauty of its coastline, two national parks, two nature parks, a rich cultural and historical heritage with several preserved sites, and traditional activities (the production of wine and olive oil). While improved highway infrastructure has made the County more accessible to tourists, access to most tourist destinations still relies on older, dilapidated secondary roads (RDA, 2011).

Tourist infrastructure is mainly concentrated in the coastal area. There is much less development further inland despite the great tourist potential. The islands of the Šibenik archipelago (except Murter) do not have well-developed tourist facilities. Zlarin and Prvić account for most of the island's overnight stays.

Accommodation facilities in the county make up about eight per cent of the Croatian total with about 66,000 beds in 2011. About 65% of these were in private accommodations, 13% in hotels and apartments and 21% in camp sites (RDA, 2011)[7]. Total tourist arrivals numbered about 650,000 in 2011, about 84% of which were foreign arrivals. The total number of tourist nights approached 4 million in 2011, about 87% of which were foreign tourists. Data on the number of tourists and tourist facilities is provided in the Annex for the period from 2007 to 2011. They show steady levels in the number of tourist nights for both domestic and foreign tourists, although there were slight declines in domestic and foreign arrivals and total beds available.

The latest tourist board data shows total arrivals of about 760,000 for 2014 and total nights in this period of about 4,802,000, numbers that indicate a steady increase since 2011. Detailed data are given in the Annex (Table A2). They show that over 60% of arrivals and over 70% of tourist nights occurred in July and August, while the period from June to September accounted for about 85% of arrivals and over 90% of tourist nights. The figures highlight the significant seasonal nature of tourist income and employment and the potential vulnerability of the local tourist sector to climate change, which is predicted under some models to result in decreases in summer coastal tourism in Southern Europe due to changes in climatic suitability (as outlined later in this section).

Contribution of Tourism to the Local Economy

The contribution of tourism to the economy of Šibenik-Knin County is significant although, as noted in Section 2, it is difficult to quantify because tourism is not defined as a separate sector in national accounting systems and included in a number of subsectors under the wholesale and retail trade definitions. Tourist Satellite Accounts (TSA), which estimates the contribution of travel & tourism to GDP, have been published for the national level, but they do not provide details for the county level (WTTC, 2014). We have estimated the direct contribution to GDP[8] in Šibenik-Knin

[7] There are slight differences in the proportions of different types of accommodation given in the Regional Development Strategy and the data in the Annex on the Number of Tourists.

[8] UN's Tourism Satellite Account methodology defines direct contribution to GDP as "GDP generated by industries that deal directly with tourists, including hotels, travel agents, airlines and other passenger transport services, as well as the activities of restaurant and leisure industries that deal directly

County to be about HRK 2.076 million (about € 270 million), or about 32% of the county's total GDP. This estimate should be treated with caution since it is based on the TSA national level estimates and assumes that the contribution to GDP is proportional to the County's share of national tourist nights. It probably overestimates tourist expenditures actually made in the country since it includes items like airlines, but it does illustrate the likely significance of this sector to the County. A lower estimate provided by the Regional Development Strategy (RDA, 2011) is that tourism and accommodation account for about 7.5% of total revenues from economic activities in Šibenik-Knin County.

Based on data on tourist overnights (from the Šibenik-Knin County Tourist Board) and estimates of average daily expenditure per person[9], we have calculated total expenditures by tourists in 2014 in the County of about € 317 million, which is used in the assessment on climate impacts given below. About 70% of this amount come in the peak season of July and August. Tourist resorts and marinas account for significant business revenues in the County. For example, Solaris Beach Resort, one of the top five companies in the County in 2009, generated an income of 180 million HRK, or about three percent of the total business income in the County.

Nautical Tourism

Nautical tourism is a key and developing part of the County's tourism sector. Šibenik-Knin County accounts for about two percent of Croatia's GDP and it has 2.55% of its population. It is remarkable then that its share of the number of moorings in Croatia in 2013 was more than 20%, while the profit realised by the County's nautical ports in 2013 was almost 28% of the total profit of nautical ports in Croatia. An analysis made during the preparation of the National Strategy on Nautical Tourism Development 2009-2019 found that the County is the most attractive one for nautical tourists in Croatia. Further details on the size of this subsector are included in the Annex.

It is interesting to note that yearly indices (2012–2013) for profit realised by nautical ports is 117 for the county, with the highest values for maintenance services (136) and other income (122). It may be that the number of berths for land storage has not yet quite followed this demonstrated demand. The numbers lead to the conclusion that this economic sector, with all its related supporting activities, has the potential for the specialisation of Šibenik-Knin County.

There are 13 existing and three planned marinas in the County. In 2013, there were 3,529 berths in nautical ports and an additional 938 dry berths, the total of which represented about 20% of the national total. Details are provided in the Annex.

Tourist overnight stays in nautical ports and marinas have been increasing in recent years. In 2014, the number of charter vessel guests in ports of the County was about 75,000 tourists and about 515,000 nights, or about 10% of total tourist nights in the county.

Tourist resorts and marinas account for significant business revenues in the County. For example, Primošten Marina was among the five most profitable companies in the county in 2009 (RDA, 2011). In recent years, foreign investment in tourist infrastructure has included that by Euro-Bridge Ltd., a Hungarian company that has invested € 15 million in Primošten Marina.

Since we do not have aggregate data on business revenues or operating income of the nautical tourism industry, we have estimated the expenditures of charter vessel tourists. Details are provided in the Annex and are based on tourist nights at each port and an average daily expenditure of charter vessel tourists of 169 Euros[10, 11] based on the figure in TOMAS (2012) and adjusting for inflation since then. This means that

with tourists. It is equivalent to total internal Travel & Tourism spending within a country less the purchases made by those industries".

[9] The average daily expenditure per person in destination of 66 Euros was used based on TOMAS estimates. This comprises accommodation, food in the accommodation, other expenditures on food and drink outside of the accommodation site and expenditures for all other services.

[10] There is data on berth prices per night for a selection of marinas. We tried to use this data to estimate revenues, but it required many assumptions. So, we decided we could make a rough estimate of expenditure per resort based on tourist nights per resort/marina.

[11] This average expenditure figure does not include travel expenditures to and from the port. It captures mooring fees paid to the marina and other daily expenditures for goods and services made in the locality.

we are assuming that the average daily expenditures of charter vessel tourists is the same in Šibenik-Knin County as the national average. Also, this figure does not include other nautical tourists who are not chartering and it will, therefore, be an underestimate. The total figure comes to € 87 million, which can be compared to a direct contribution of tourism to GDP estimated above in Šibenik-Knin County of about € 270 million, which also indicates the significance to the local economy of this subsector.

National Parks

Visitor and revenue information on the two national parks in Šibenik-Knin County, Krka and Kornati, are provided in Table 4.1. In both parks there is a great concentration of visitors during the peak season (July and August), with 50–60% of annual turnover in Krka and 70–85% in Kornati during that period. The total revenues from these two national parks were about 66 million HRK in 2012, or about € 8.7 million, which when compared with the estimate of total tourist expenditures of about € 300 million (2014) in Šibenik-Knin County indicates that this is a relatively small but still important part of total revenue because of the multiplier effect on the local economy from tourists visiting the parks.

Table 4.1: Number of visitors and revenues for national parks for 2011 and 2012.
Source: Communication with State Institute for Nature Protection, 2014.

National Parks	Size [ha]	Altitude	Number of Visitors		Revenues (HRK)*	
			2011	2012	2011	2012
Krka	14,200	0 – 253	683,739	732,999	56,687,591	58,034,774
Kornati	30,200	0 – 236	91,780	96,736	7,769,639	8,398,460

Impacts of Climate Change on Tourism

Table 4.2 summarises the type of impacts that climate change and variability can have on tourism. They include changes in overall and seasonal tourist numbers because of changes in temperature and rainfall, and indirect impacts on tourism due to changes in the attractiveness of the natural and built environment by the degradation of an ecosystem, an alteration in the appearance of landscapes, or changes in the prevalence of wildlife.

For example, the attractiveness of the Krka waterfalls might be vulnerable to reduced precipitation. Direct impacts on the coast also occur through the effect of sea-level rise, sea surges and coastal flooding on tourist infrastructure and access, and the attractiveness of coastal destinations. All these impacts have the potential to have a negative effect on tourism flows and activities, and local tourist expenditures and business revenues.

Current assessments of climate change project a northward shift in the latitudinal band of climate favourable to tourism over 21st century, improving the climate in northern and central Europe in most seasons (EEA, 2012). Several recent studies on climate and tourism have used the Tourist Climatic Index (TCI) for assessing the climate factors of greatest relevance to the quality of the tourism experience (for example see, Amelung and Moreno, 2009; Perch-Nielsen et al. 2010; Roson and Sartori, 2012). The TCI is a composite measure that uses a weighted aggregate of several climate variables (temperature, humidity, precipitation, sunshine and wind) to assess comfort for outdoor activities for the "average" summer tourist.

A number of studies using TCI have concluded that southern Europe's tourism suitability will drop sharply in the summer months in the medium and long term. Figure 4.1 shows the projected changes of TCI for four seasons between the present (1961–1990) and the future (2071–2100) reported in the study by Perch-Nielsen et al. (2010).[12] The future climate conditions in this figure are based on the SRES A2 scenario (divided world). The Figure shows

[12] These results are reproduced in the key EEA (2012) report summarising climate change, impacts and vulnerability in Europe.

a positive change in the TCI ensemble mean in this period for winter, spring and autumn in most Mediterranean countries and a corresponding negative change in winter.

The consequence of these changes in the suitability for tourism in the Mediterranean region is likely to be a seasonal summer decline in the flows of tourist number, in particular to areas where tourism is currently a key economic sector. Thus, the number may decline during summer months, but this drop may be partially or fully compensated for by increases in other seasons. In addition, some analyses suggest that only in the medium (2046–2065) and long term (2080–2099) would Mediterranean destinations gradually become "unacceptably hot" during the peak summer months (Rutty and Scott, 2010). Thus, the decline in number in the summer months will probably not occur for another three decades.

There is some uncertainty about the economic impact of changes on visitor number, depending on which economic model and climate projections are used. For example, the study by Roson and Sartori (2012) concluded that climate change could generate overall positive effects for tourism in most northern Mediterranean countries. For Croatia this study estimates an average future increase of 0.4% in tourist nights per year (2036–2065) with some shifts between seasons.

Table 4.2: Summary of Potential Impacts of Climate Change on Tourism. Adapted from the framework in Callaway et al. (2010).

Source of Impact	Type of Impact
General changes in climate and weather: ▪ Effects of changes in temperature and rainfall on tourism demand. ▪ Effects of changes in the frequency and magnitude of floods and droughts.	Changes in annual and seasonal tourist demand due to impacts on: ▪ the attractiveness of a location and its suitability for different forms of tourism. ▪ specific environmental characteristics of locations, including vegetation, animal populations, and scenic amenity values.
Precipitation and temperature-induced changes in the discharge of streams and lake levels.	Indirectly affects: ▪ the attractiveness of a location for tourists. ▪ structure and development of aquatic ecosystems and habitats that influence the supplies of environmental services enjoyed by tourists.
Precipitation and temperature-induced changes in water quality.	Indirectly affects: ▪ the attractiveness of a location for tourists. ▪ structure and development of aquatic ecosystems and habitats that influence the supplies of environmental services enjoyed by tourists.
Temperature-induced changes in water temperatures.	Indirectly affects: ▪ the attractiveness of a location for tourists. ▪ structure and development of aquatic ecosystems and habitats that influence the supplies of environmental services enjoyed by tourists.
Sea-level rise-induced changes in salt water levels, salt water quality and temperatures. Flooding/wave surge/SLR.	Impacts on coastal tourism opportunities, tourism infrastructure, coastal aquatic ecosystems and habitats that influence the supplies of environmental services enjoyed by tourists.

Other factors also affect the attractiveness of a destination. They include local natural environment, culture and history; economic considerations, such as flight, accommodation and daily living costs and currency exchange rates; security aspects, such as political stability; public health standards; and accessibility in terms of time and convenience in reaching the destination compared to competing destinations. Popular perceptions about the quality of the tourist experience in terms of standards of service and infrastructure, which themselves are influenced by marketing and media, are also important. The key point here is that while climate can be a significant factor that determines tourist choices in the Mediterranean region, many other local factors influence the popularity of any given tourist destination over time (Magnan et al., 2012).

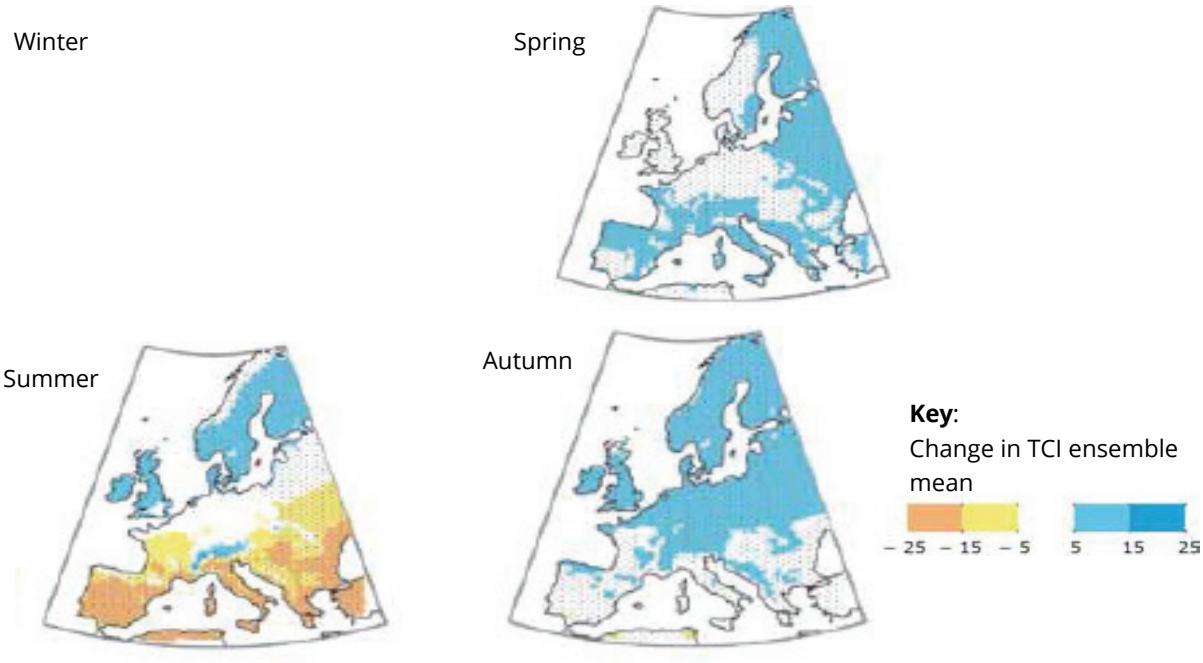

Figure 4.1: Projected Seasonal Changes in the Tourism Climatic Index between Present (1961-1990) and Future (2071–2100). Source: EEA, 2012.

Assessment of Economic Impacts of Climate Change on Tourism in Šibenik-Knin County

The economic impacts of climate change and sea-level rise on tourism in Šibenik-Knin County have been considered for the following areas:

- Changes in tourist visits, bed nights and expenditures as a result of climate change.
- Changes to expenditures and revenues from different tourism activities (such as nautical tourism and visits to national parks) as a result of climate change.
- Direct damages to tourism assets and infrastructure from sea-level rise related impacts.

Estimates of Impacts of Climate Change on Tourist Number and Expenditures in Šibenik-Knin County

This part of assessment for tourism has followed the approach taken in Callaway et al. (2010) and Metroeconomica (2011) to provide estimates of impacts of climate change scenarios for the total and seasonal tourist visits, overnights and expenditures in Šibenik-Knin County. The study also uses results from both the Hamburg Tourism Model (HTM) and PESETA EU studies.

Baseline Data and Projections

Baseline data from the Šibenik-Knin County Tourist Board on arrivals and overnights used in the assessment are shown in the Annex on tourism (Table A2). Expenditures were calculated from the number of tourist overnights and an average daily expenditure per person estimates for Croatia in TOMAS (2014) of € 66 in 2014. We are assuming that daily expenditure is the same in Šibenik-Knin County as the national average and that this average daily expenditure is the average for all foreign and domestic visitors.

To estimate the impact of climate change on future tourism, projections were made for tourism number and expenditures to 2025 as shown in Table 4.3. These numbers are based on 2014 data and assume an increase of five percent per year in tourist visits and nights to 2025 based on the strategic objectives in the Regional Development Strategy (RDA, 2011).

We recognize that it is very difficult to project tourist growth reliably using current tourism number because such a forecast depends on the tourist strategy and infrastructure of Šibenik-Knin County but also on the growth of tourist infrastructure in other destination countries offering similar opportunities and on the growth of incomes in the countries of origin of tourists.

Table 4.3: Šibenik-Knin County Seasonal Projections (2025).

	Arrivals	Nights	Arrivals%	Nights%	Expenditures (millions €)
January	2,940	13,515	0.2	0.2	1
February	2,942	12,503	0.2	0.2	1
March	9,935	30,795	0.8	0.4	2
April	43,215	138,284	3.3	1.7	9
May	72,063	267,507	5.6	3.3	18
June	172,874	907,090	13.3	11.0	60
July	366,563	2,646,704	28.2	32.2	175
August	434,531	3,104,760	33.5	37.8	205
September	135,021	878,222	10.4	10.7	58
October	45,765	172,838	3.5	2.1	11
November	7,517	22,996	0.6	0.3	2
December	4,933	18,904	0.4	0.2	1
Total	**1,298,300**	**8,214,119**	**100.0**	**100.0**	**542**

Estimates of Temperature Change Impacts on Tourism

The estimates of climate change impacts given here are derived from the models described below. They are tentative estimates because of the nature of the models and data that are available. Nevertheless, they give some indication of the order of magnitude of economic impacts that may occur under different temperature increase scenarios (in the absence of adaptation, such as a switch in seasonal tourism).

HTM Model

Estimates of percentage changes in tourist visits for a range of average annual temperature changes from the Base Case average annual temperature were used in the Hamburg Tourism Model to calculate potential changes in tourist visits, nights and expenditure.

Table 4.4 shows the percentage changes in tourism visits and overnights that the HTM predicts for temperature increases from 1–5°C (due to climate change) for average annual temperatures ranging from 14°C to 17°C. The climate-related temperature changes in the table reflect the range of changes in average annual temperatures for the A1B NF, A1B FF, and A2 FF climate change scenarios. The range of changes shows how sensitive the model is to average temperature. The current mean annual temperature in Šibenik is 15.1°C.[13] The warmest month is July with an average temperature of 24.5°C. Therefore, in calculating changes in tourist visits, overnight stays and expenditures under these scenarios using Šibenik-Knin County tourist data, we have focused on 15° and 17°C average annual temperature.

[13] http://www.sibenik.climatemps.com/temperatures.php

Table 4.4: Simulated Climate Impacts: Percent Changes in Annual Tourist Visits for Different Changes in Temperature. Source: Callaway et al. (2010).

Average Annual Temperature (°C)	Average Annual Temperature Increase per Climate Change scenario				
	A1BNF 1	A1BNF 2	A1BFF 3	A1BFF & A2 FF 4	A2 FF 5
14	–0.15	–0.3	–0.44	–0.59	–0.74
15	–1.73	–3.46	–5.19	–6.92	–8.65
16	–3.31	–6.62	–9.94	–13.25	–16.56
17	–4.89	–9.79	–14.68	–19.58	–24.47

Table 4.5 shows calculations of the impacts of the climate scenarios given in Table 4.4 on annual tourism visits, nights and expenditures in Šibenik-Knin County. The figures for changes in tourist nights assume that these change in proportion to tourist visits. The table shows that a potential temperature increase of around 1°C now would reduce visitors by between 13,000 and 37,000, depending on whether the 2014 average annual temperature in Šibenik-Knin County is taken as 15° or 17°C. The implied loss in income is between 1.7 and 4.9%. If that temperature increase occurred in 2025, the losses would be in the range of € 9–27 million. A higher temperature increase would imply a greater loss of visitors, but these are not likely in 2025 and would apply at a much later date, when the underlying visitor numbers would also be different.

Table 4.5: Simulated Climate Impacts: Changes in Annual Tourism Visits and Tourism Expenditures due to Climate Change Scenarios. Source: Model calculations.

Avg. Annual Temperature (°C)	Base Case 0	Average Annual Temperature Increase per Climate Change scenario				
		A1BNF 1	A1BNF 2	A1BFF 3	A1BFF & A2 FF 4	A2 FF 5
	Annual tourists	**Change in Annual Tourist Visits due to Climate Change**				
Current (2014)						
15	759,089	–13,132	–26,264	–39,397	–52,529	–65,661
17	759,089	–37,119	–74,315	–11,1434	–148,630	–185,749
Projected growth of tourism (to 2025)						
15	1,298,300	–22,461	–44,921	–67,382	–89,842	–112,303
17	1,29,8300	–63,487	–127,104	–190,590	–254,207	–317,694
	Annual tourist nights	**Change in Annual Tourist Nights due to Climate Change**				
Current (2014)						
15	4,802,625	–83,085	–166,171	–249,256	–332,342	–415,427
17	4,802,625	–234,848	–470,177	–705,025	–940,354	–117,5202
Projected growth of tourism (to 2025)						
15	8,214,119	–142104	–284209	–426,313	–568,417	–71,0521
17	8,214,119	–401,670	–804,162	–1205,833	–1,608,324	–2,009,995
	Annual tourist expenditures	**Change in Annual Tourist Expenditures due to Climate Change (millions of €/year)**				
Current (2014)						
15	317.0	–5.5	–11.0	–16.5	–21.9	–27.4
17	317.0	–15.5	–31.0	–46.5	–62.1	–77.6
Projected growth of tourism (to 2025)						
15	542	–9	–19	–28	–38	–47
17	542	–27	–53	–80	–106	–133

PESETA Model

A second set of estimates of the impact on tourism of temperature change was made applying the EU PESETA methodology to the base case visits and expenditure data in Tables A2 (Annex) and 4.3. The PESETA methodology involves estimating monthly values of the TCI (Tourism Climatic Index) for each country in the Eurostat data base for a Base Case and a number of alternative climate scenarios. Data from the NUTS2 tourism data base is then combined with information from the Eurostat data base to develop a monthly statistical relationship between tourism bed nights in a country and its TCI index, gross domestic product, and its consumer price index. Unfortunately, we do not have data from this study for Croatia. Therefore, the estimates given in Table 4.6 of the percentage change in visits associated with a small change in temperature in the Base Case average temperature are made assuming a value of the TCI for Croatia that is the same as that for Montenegro (Callaway et al., 2010).[14] These show estimates based on two IPCC climate scenarios (SRES A2 and B2) for two different regional climate models (HIRHAM and RCAO).

The estimates for percentage changes in annual and peak season tourist visits for the different models and climate scenarios are in Table 4.6. It is difficult to compare them with the HTM model since they make no predictions for small increases in temperature. Where there is an increase that is comparable across the two approaches the results are quite different. For an increase of 3°C the HTM model indicates a fall of between 10 and 15%. The PESETA model on the other hand shows a small increase in annual visitors of 2.8% for this kind of region with a temperature increase of 2.5°C and only a small decline in summer visitors.

The implications of the model projections for annual tourism in Šibenik-Knin County are shown in Table 4.7. As in the case of the HTM estimates, the figures for changes in tourist nights assume that these change in proportion to tourist visits. A key difference with the HTM estimates is that estimates for changes in visits for different climate scenarios are available on a monthly basis and not only on an average annual basis. Thus, we have calculated estimates for changes in visits, nights and expenditure for the current peak months of July and August, which together represented about 70% of annual nights and expenditure in 2014. Table 4.7 suggests that if an increase in temperature of 2.5°C were to occur now, it would result in around 21,000 more visitors to the County. If it were to occur in 2025, the number of visitors would increase relative to the baseline projection for that year by around 37,000. Of course, such a large increase in temperature will not occur until the end of this century (if at all), so the increases we are projecting are more relevant over a very long period of time.

In summary one can draw the following conclusions on the effects of temperature change on tourism:

- Models differ considerably regarding the consequences for tourist visits. One model (HTM) indicates significant declines with even small increases in temperature, while another (PESETA) points to a possible increase with gains in temperature of up to 3°C in terms of average annual visits but with a decline in visitors in July and August.
- It is likely that until 2025-2030, when temperature increase will not exceed 1°C, the effect on numbers will be small – perhaps negative (3–4%) – but it may even be positive over the whole year with a modest decline in the summer months.

Economic Impacts of Climate Change on Tourism Activities

In this section we discuss the extent of climate change impacts on some key specific types of tourism in the County, particularly with nautical tourism, national parks and protected sites. The general impacts of climate change on these specific tourist activities and locations will be included in the estimates for impacts of temperature changes on visitor number and expenditure given above. However, the infrastructure and built assets for specific types of tourism may also be impacted in other ways.

[14] We looked in the Peseta website and could not see any percentage change in the figures for visits for Croatia. We took the percentage change figures for Montenegro, which are likely to be very similar.

Table 4.6: Simulated Climate Impacts: Percent Changes in Annual and Peak Season Tourist Visits based on PESETA Study.

	Climate Change Scenarios by Regional Climate Model and Average Annual Temperature Increase (for Europe)			
	Hiram – A2	Hiram – B2	RCAO – A2	RCAO – B2
Time Period	+3.9°C	+2.5°C	+5.4°C	+4.1°C
Average Annual	2.69	2.86	–6.43	–6.49
July Average	–0.25	–0.03	–7.79	–7.87
August Average	–0.33	0.52	–11.29	–11.41

Table 4.7: Simulated Climate Impacts: Changes in Annual Tourism Visits and Tourism Expenditures due to Climate Change Scenarios Based on PESETA Study.

Simulated Climate Impacts: Changes in Annual and Peak Season Tourist Visits based on PESETA Study (%)					
	Climate Change Scenarios by Regional Climate Model and Average Annual Temperature Increase (for Europe)				
	Hiram – A2	Hiram – B2	RCAO – A2	RCAO – B2	
Time Period	+3.9 Deg C	+2.5 Deg	+5.4 Deg C	+4.1 Deg C	
Av Annual	2,69	2,86	-6,43	-6,49	
July Average	-0,25	-0,03	-7,79	-7,87	
August Average	-0,33	0,52	-11,29	-11,41	
Simulated Climate Impacts: Changes in Annual Tourism Visits and Tourism Expenditures Due to Climate Change Scenarios based on PESETA Study					
	Climate Change Scenarios by Regional Climate Model and Average Annual Temperature				
	Base Case	Hiram – A2	Hiram – B2	RCAO – A2	RCAO – B2
	+ 0 Deg C	+3.9 Deg C	+2.5 Deg	+5.4 Deg C	+4.1 Deg C
	Change in Annual Tourist Visits due to Climate Change (Total Annual Tourist Visits/year)				
Current (2014)					
Annual	759089	20419	21710	-48809	-49265
July	214322	-536	-64	-16696	-16867
August	254061	-838	1321	-28683	-28988
Projected growth of tourism (to 2025)					
Annual	1298300	34924	37131	-83481	-84260
July	366563	-916	-110	-28555	-28849
August	434531	-1434	2260	-49058	-49580
	Change in Annual Tourist Nights due to Climate Change (Total Annual Tourist Nights/year)				
Current (2014)					
Annual	4802625	129191	137355	-308809	-311690
July	1547473	-3869	-464	-120548	-121786
August	1815289	-5990	9440	-204946	-207124
Projected growth of tourism (to 2025)					
Annual	8214119	220960	234924	-528168	-533096
July	2646704	-6617	-794	-206178	-208296
August	3104760	-10246	16145	-350527	-354253
	Change in Annual Tourist Expenditures due to Climate Change (millions of €/year)				
Current (2014)					
Annual	317,0	8,5	9,1	-20,4	-20,6
July	102,1	-0,3	0,0	-8,0	-8,0
August	119,8	-0,4	0,6	-13,5	-13,7

Table 4.8: Vulnerability Assessment of Coast with Existing Tourism Land Use by Settlements. Source: Baučić (2014) except for expenditure column.

City/Municipality	Vulnerability (km)				Nautical Tourism Expenditure (Euros)
	Small	Medium	Large	Total	
Šibenik	0.48	1.16	2.48	4.12	29,170,159
Skradin					439,634
Vodice		0.72	2.01	2.73	4,565,469
Murter		0.92		0.92	12,624,668
Pirovac		0.31	0.19	0.50	4,251,420
Primošten	0.09	0.08		0.17	16,381,238
Rogoznica		0.02		0.02	9,107,075
Tisno	0.68	1.35	0.83	2.86	12,478,878
Tribunj					746,890
Total	**1.25**	**4.56**	**5.51**	**11.3**	**89,765,430**

Nautical Tourism

Nautical tourism is by definition more vulnerable to sea-level rise and extreme events that result in coastal flooding and increased threats for navigation. The exact nature and extent of damage to the infrastructure of nautical tourism from flooding and other sea-level rise-related impacts is impossible to predict, but we can highlight the locations of heightened risk. Vulnerability analysis of coastal areas (Baučić, 2014) indicates that the length of the coast of Šibenik-Knin County with existing tourism land use is 11.34 km (about two percent of the total) and the length of the coast with planned tourism land use is 15.60 km (three percent of the total). This data on land use is based on the County's physical plan and includes hotels, apartment complexes, camping sites and nautical ports.

Based on this analysis, Table 4.8 shows the length of coast for existing tourist land use per municipality and settlement with a summary vulnerability index based on an assessment of coastal type, maximum height of land in the coastal zone, wave heights, bays with probability of seiche[15] and historical settlement.

Damage from climate-related extreme events

The economic impact of damage to tourist assets on the coast may be measured in terms of (i) repair costs, (ii) loss of business revenue/tourist expenditures while damages are being repaired and (iii) reduced tourist visits due to the loss of attractiveness of the location. We are unable to make quantitative estimates of such economic impacts when the nature and extent of damages are unknown, not least because we do not have information on flood protection measures in place for each port and marina. However, we can inform our conclusions by looking at tourist expenditures that are at risk of being reduced or lost because they are generated in the vulnerable coastal areas given in Table 4.8. Based on our estimates of expenditure by charter vessel tourists alone (Annex, Table A4) the right hand column of Table 4.8 shows where this expenditure occurs by municipality.

National Parks

Vulnerability to climate change impacts of the two national parks in Šibenik-Knin County, Krka and Kornati, varies according to their specific features and location. We do not have an analysis of the specific vulnerability of the ecosystem of Krka National Park to climate change on which to base a quantitative estimate of the possible climate impacts, but we note that it has a rich and varied flora and fauna and some specific tourist attractions. In particular, the series of waterfalls, including Skradinski Buk, are a popular destination and their tourist value may be damaged by any significant changes in water flow according to climate change scenarios. It is also important to mention the existing conflict over the use of the area of Krka National Park. The Skradinski Buk

[15] A seiche may be initiated by a standing wave oscillating in a partially or fully enclosed body of water (UNESCO-IOC).

waterfalls are created with the calcareous sinter. Their continued existence depends on the availability of water. At present, there are three hydro power plants in the park and two more along the Krka River. Water intake becomes an important issue during the summer months. Since there is no legally established biological minimum, three institutions (the National Park, Croatian Electrical Power and Croatian Waters) have different views on the required biological minimum. Although the parties each have their arguments, the existence of calcareous sinter, the key feature of the National Park, depends on water flow. In the future, we might expect less water in the summer months, making the importance of agreement on the biological minimum even greater.

On the other hand, fast-flowing river water may also damage the calcareous sinter, which is very fragile. A short-term but intense increase in precipitation is expected in the winter months, leading to flooding and a consequent risk to the calcareous sinter and a risk of contamination or pollution of the river. Possible floods in Knin Field could transport contaminants or pollutants toward the Krka National Park, increasing its vulnerability. The importance of an agreement on the biological minimum and careful management of Krka River are essential to the future existence of Skradinski Buk.

Kornati National Park is an archipelago of 140 islands and therefore has very different specific vulnerabilities.

Conclusions on Tourism

Estimates of the impacts of climate change scenarios on total and seasonal tourist visits, overnights and expenditures in Šibenik-Knin County were somewhat inconclusive. One model (HTM) indicates significant declines in visits with even small increases in temperature, while the other model (PESETA) points to a possible increase in visitors with gains in temperature of up to 3°C in terms of average annual visits, but with a decline in visitors in July and August. However, it is likely that in the short and medium term up to 2025–2030 the effect of small changes in temperature on visitor number and expenditures will be small. It may even be positive over the entire year, although with a modest decline in the summer months. It is in the longer term (the second half of this century) when the impacts of temperature change may affect total tourism number more severely.

The overall economic effects of temperature change on tourism in the County also depend on whether the holiday season remains fixed in July and August or shifts to the spring and autumn tourism shoulder seasons.

It is possible that changes may result in an improved distribution of visitors, with an increase of visitor number in the shoulder seasons and a modest decline in the summer months. Adapting to climate variability and change means the authorities and tourist boards must already make plans to create offers in the shoulder seasons to attract more guests while the impacts of climate change on tourism still have not been demonstrated. The redistribution expected with the climate change would reduce the burden in July/August, so that the huge infrastructure used only in these two months all around the Mediterranean would be less loaded. However, in the meantime, increased needs for energy and for water in July/August are to be expected because of air conditioning in tourist facilities and greater demand for water in hotter weather. The authorities must take this into consideration in their local strategies and plans. The impacts of climate change on particularly vulnerable locations, especially on the coastline, are likely to be more important in terms of tourism value than general temperature changes, at least in the medium term. In particular, a significant amount of nautical tourism built infrastructure is in areas most vulnerable to coastal flooding and sea- level rise-related impacts, which is also the case for several protected sites. National parks also have some specific vulnerability to climate impacts that may impact revenues.

An important role could be played by international organisations that could encourage governments to establish favourable conditions for a redistribution of the holiday season. International organisations could also work on the development and promotion of economic instruments to support an extension of the tourist season in the Mediterranean countries.

4.2 Agriculture

Overview of the Sector

Agricultural lands in Šibenik-Knin County are summarized in Table 4.9. Arable land, vineyards and orchards cover about 44,000 ha of land while 134,875 ha are meadows and pastures.

The agricultural, fishery and forest sectors account for only about two percent of Gross Value Added (GVA) in the County, with this contribution declining in recent years (see Figure 2.4, p. 4). Farms in the County are small and fragmented, a situation that is not conducive to efficient production (RDA, 2011). Table 4.10 shows that most enterprises are family farms with very few commercial businesses engaged in agriculture. The sector is reliant on state subsidies, which totalled about HRK 32 million between 2008 and 2012.

The assessment given in the Regional Development Strategy is that there are very favourable conditions for agricultural production in the County but that potential is not being exploited because of the small, fragmented agricultural parcels, poor agricultural infrastructure (irrigation and roads), a lack of processing capacities for fruit and vegetables, and poor organization. For example, the RDA states that there is potential for raising six or seven times more sheep and goats, restoring around 300,000 olive trees, and developing fruit production, especially traditional crops such as cherries and figs, and vegetable production. Furthermore, less than one percent of those employed in the County are working in agriculture, including fisheries and forestry companies.

According to the census on agriculture from 2003, 11,197.62 ha of land are actually used for farming in Šibenik-Knin County. Of this amount, 10,820.62 ha (96.63%) are worked by agricultural households, while only 377 ha (3.37%) are used by businesses. Eurostat data for 2012 show that for the EU 28 family farms accounted for almost 97% of the farms in the EU, but their share of the cultivated agricultural land was 67%. The discrepancy between land designated as agricultural in the spatial plan and the land actually used for farming shows that there is some potential for the County.

Table 4.9: Area of agricultural land in Šibenik-Knin County (in hectares).
Source: Regional Development Strategy (2011), quoting the Spatial Plan of Šibenik-Knin County, County Bureau for Environmental Planning, July 2002.

	Arable land and Gardens	Orchards	Vineyards	Meadows	Pastures
Šibenik total	8,085	5,683	3,728	698	61,764
Knin total	12,474	136	270	2,318	54,314
Drniš total	12,154	66	1,415	419	15,362
Commercial	621	183	259	330	78,740
Total private	32,092	5,702	5154	3105	52,700
Overall	**32,713**	**5,885**	**5,413**	**3,435**	**131,440**

Table 4.10: Number of agricultural enterprises by type in Šibenik-Knin County.
Source: Paying agency for agriculture, fisheries and rural development.

	2007	2008	2009	2010	2011	2012
Family Farm	6,547	6,738	6,833	6,833	6,653	6,515
Crafts	39	38	38	37	36	39
Limited Company	23	26	33	34	38	39
Cooperative	33	40	40	44	44	44
Other	7	7	7	7	7	7
Total	**6,649**	**6,849**	**6,951**	**6,955**	**6,778**	**6,644**

Table 4.11: Number of grape and wine producers and wine production in the Šibenik-Knin County and Croatia
** Provisional results of the harvest of 2009.*
Source: Regional Development Strategy (2011), quoting HCPHS, Department of Viticulture, Wine and Fruit, 31 December 2009.

	2005	2006	2007	2008	2009*
Number of registered producers of grapes and wine in Šibenik-Knin County	1575	1665	1740	1810	2151
% of Croatia total number of producers in Šibenik-Knin County	10.72	10.68	10.54	10.64	12.13
Wine production (in tons) in Šibenik-Knin County	18,429	20,619	14,760	20,056	21,411
% of Croatia total wine production in Šibenik-Knin County	3.35	3.82	3.03	3.40	3.18

*Table 4.12: Olive Oil Production in Šibenik-Knin County. *Source: Regional Development Strategy (2011).*

	2007	2008	2009
Processed olives in the RC (t)	23,465	34,972	29,835
Processed olives in SKC (t)	4,362	5,401	4,619
The share of SKC production in total for Croatia (%)	18.6	15.4	15.5
The oil obtained in SKC (t)	615	783	647

Irrigated farming is only about 1.3% of the total, 21% of which uses groundwater, 49% of which uses water from rivers and streams, and 30% of which uses water from the water supply system. Because of Croatia's recent investments in water supply and treatment, in line with EU requirements, the price of water is expected to increase significantly in the coming years.

The age structure of family farm managers is rather unfavourable. Fifty-one percent of managers are 65 and older, which is the highest percentage of this age group among all Croatian counties. The EU average for this age group is 29.7%[16]. On the other hand, only 4.6% of family farm owners are younger than 40. In the EU 28 managers under 35 make up 7.5% of all managers.[16]

Types of agricultural production in the County include:

Grape production and winemaking has been expanding in recent years, with 2,151 registered manufacturers of grape and wine in 2009, as shown in Table 4.11. The main viticulture areas are Pirovac-Skradin, Šibenik-Knin, Drniš-Promina and Primošten.

Olive production is centred in the coastal area and on the islands. In recent years there has been a significant increase in the planting of new olive groves. The County has about 800,000 olive trees, nearly 600,000 of which are old. On average, they provide between 4,500 and 6,000 tons of olives per year, enough to process 700–850 tons of oil (Table 4.12). There are 16 registered producers of olive oil.

According to the International Olive Council (IOC), the top priority for this economic activity is standardization of the quality. Global demand for olive oil is growing, due to increasing awareness of its favourable effects on health. In 2014, a considerable increase in the production of olive oil has been noted in many countries, particularly Spain, which produces 50% of world's olive oil. The Regional Development Strategy recognises the lack of storage capacity, non-existent and unprotected brands, and a grey oil market as the biggest threats to the County's olive oil production.

Vegetables are also grown in the karst fields, much of which for personal use. There is unrealised potential for the production of vegetables (tomatoes, cabbages and other vegetable crops). Forage crops and cereals are also grown in the karst fields.

[16] Eurostat: http://ec.europa.eu/eurostat/statistics-explained_/index.php/Agriculture_statistics_-_family_farming_in_the_EU

Livestock holdings in the County are shown in Table 4.13. The large mountainous and karst areas in the County provide great potential for raising small livestock. The main products are lamb and goat, with the production of sheep and goat milk not meeting its full potential because of traditional milking practices. However, the County has the second most goat and sheep holdings in Croatia. Production of cow's milk actually declined over the 2006–2009 period. Pigs are bred mainly for personal consumption. Beekeeping is also present, but it is another undeveloped subsector.

Table 4.13: Livestock Holdings (number of head).
Source: Regional Development Strategy (2011), quoting the Croatian Agricultural Agency, Annual Report.

	2005	2006	2007	2008	2009
Sheep	69,387	72,013	70,207	74,610	72,095
Goats	5,753	5,851	5,264	6,385	5,400
Cattle (total)	1,756	2,303	2,321	2,698	3,206
Bee colonies	5,199	5,843	6,820	7,018	6,336

The Croatian Agricultural Agency carries out programmes and measures to improve agricultural production. In particular, they conduct activities related to quality standardization through breeding by selection control. Economic crises have also affected this activity, so that the numbers have been constantly falling. However, Šibenik-Knin County has the highest number of the sheep breeders under selection in Croatia. The situation is different for goat breeders under selection: their number is rather low, but it is still the highest among the coastal counties.

The number of sheep and goats under selection control from 2009 to 2013 are shown in Table 4.14.

According to the Regional Development Strategy, the problems that must be solved include the branding of products, better market promotion, and improving quantity and quality.

Table 4.14: Sheep and Goats under Selection Control.

	2009	2010	2011	2012	2013
Sheep	7,725	7,696	7,563	7,770	6,169
Goat	330	353	232	216	231

Organic agriculture is considered a niche where Croatia could achieve significant results. A particularly suitable area for organic agriculture is Croatia's karst region and the coastal counties. The share of agricultural land used for organic agriculture in the County grew from 140 ha in 2008 to 417 ha in 2011, or in other words, it makes up 3.72% of the total land used for agriculture. In the National Action Plan for the Development of Organic Agriculture the goal for 2016 is a share of 8%, which is consistent with the Action Plan for Dalmatia in which the goal for 2013 was of 5%. In 2011, the share of organic agriculture in Croatia was of 2.46%. So, the County's 3.72% was above average. When comparing the County with other coastal counties, its share is 9%, which, however, is still below the average. The number of ecological producers grew from 10 in 2008 to 21 in 2011 (1.4% Croatia, 7% Adriatic counties). The Action Plan for Dalmatia covered the period from 2009 to 2013 as a preliminary tool for a new round of financing through the Common Agricultural Policy of the EU. It would be interesting to assess how much of what was proposed has been realised.

Organic breeding in Šibenik-Knin County in 2011 existed only for cows and sheep. While the former made up 1.3% of Croatia's total and 11.7% of the Adriatic share, the latter made up 7.4% of the Croatian share and 33.9% of the Adriatic share.

The County's potential in organic agriculture, including organic cattle breeding, is high. One of the County's advantages is its land, which has not been used for decades and has not been polluted by agrochemicals. Integrating organic production with tourism can become a key priority for creating opportunities for rural development. To realise this potential, it will be necessary to establish better connections between the inland area and the coastal zone, both in terms of infrastructure and in cooperation between the two regions. Finally, since education is an important prerequisite for successful organic agriculture, a new Polytechnic with a department for Mediterranean karst agriculture represents an important potential for the region. However, the age structure of the farm owners/managers remains an obstacle to successful development of organic agriculture.

Official economic data on the agricultural sector reflect a low level of production with gross value

added of about HRK 113 million in 2011, only two percent of the total GVA in the County. Operational income from the agricultural sector in coastal municipalities is shown in Table 4.15. There is a lack of up-to-date data on agricultural production per product in the County. The most comprehensive dataset seems to be the 2003 census,[17] although this does not provide data on revenue and production values.

Table 4.15: Operational Income in HRK for the Agricultural Sector for Coastal Municipalities in Šibenik-Knin County (2008–2011). Source: Financial Agency (FINA).

Primošten	106,802
Skradin	1,478,055
Šibenik	7,671,940
Tisno	242,248
Vodice	2,502,515
Pirovac	329,134
Rogoznica	-
Murter	7,806,360
Bilice	-
Tribunj	5,012,624

The foreign exchange balance for Croatia is rather unfavourable, as shown in Figure 4.2. The data for unemployment and the data for the abandoned agricultural land speak for themselves (Figure 4.3).

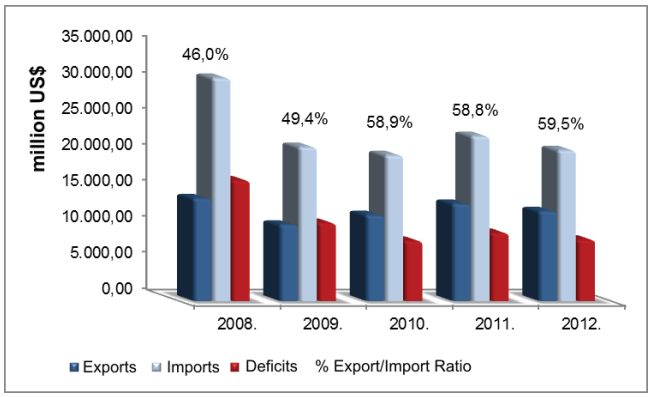

Figure 4.2: Foreign Exchange for the Republic of Croatia; 2008 – 2012. Source: National Bureau of Statistics and Ministry of Agriculture.

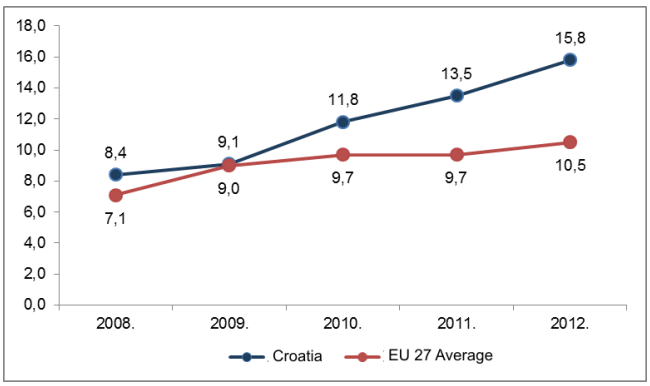

Figure 4.3: Unemployment Rates, a Comparison of the Croatian and EU averages, 2008 – 2012. Source: Eurostat, National Bureau of Statistics and Ministry of Agriculture.

Impacts of Climate Change on Agriculture

The agriculture sector is particularly vulnerable to climate change with temperature, precipitation, and weather extremes impacting production. In the coastal regions and on the islands reduced soil moisture during the summer is expected because of increased evapotranspiration and a decrease in precipitation.[18] Some climate-related impacts are already apparent, with extreme weather events, such as flooding and storms, and water shortages, resulting in average annual losses of 176 million euros from 2000 to 2007. The scale of damages might become worse in future (UNDP, 2008). On the other hand, warmer winter and spring seasons might benefit production by enabling earlier flowering and the growing of different varieties of grapes, olives and fruits (BEF, 2014).

There are few low-lying areas on the coastline of the County where agriculture is practiced, so crop damage due to sea-level rise, is not a significant issue. According to Baučić (2014), there are only 2.3 km of particularly valuable agricultural land (with a Vulnerability Index of 4), although we do not have details of the current production of crops or livestock on the land. Therefore, the main impacts of CVC on agriculture in the County are potentially from:

- changes in agricultural yields due to changing patterns of precipitation and temperature;
- damage from increased extreme weather events (river flooding, storms. Media evidence of

[17] Agricultural Census 2003: http://www.dzs.hr/App/PXWeb/PXWebHrv/Menu.aspx?px_type=PX&px_db=Popis+poljoprivrede+2003&px_language=hr&rxid=fc9d580f-2229-4982-a72c-cdd3e96307d3

[18] For an overview of impacts see: http://www.climateadaptation.eu/croatia/

episodes of coastal flooding is given in Baučić (2014) but we do not have any information on damage to agricultural production and revenue);

- increased incidence of disease. For example, the 2014 olive crop was affected by the rainy summer with lower than average temperatures. Production was damaged by the olive fruit fly, which thrives in these climatic conditions. However, we do not have quantitative evidence about the damage to agricultural production and revenue from such disease episodes; and
- impacts along the supply chain, especially on the wine and olive oil industry, due to the loss of supply of local grape and oil through extreme events or disease.

It has not been possible to make a detailed local estimate of the potential total loss of agricultural production caused by changes in yields due to future climate change scenarios because the data on production by crop in the County is out of date – it is from the 2003 agricultural census and we know that total production has declined since then – and because of the complex and differential nature of yield impacts on different crops. These estimates would be likely to show only small total impacts on agricultural production and value from climate change simply because production is now at such a low level compared to its potential. Furthermore, the amount of coastal agriculture is relatively small.

We focus here on the subsectors of wine and olive production since unlike other agricultural production, they have been developing in the County and have the potential for further expansion, including as part of the marketing of traditional produce for the tourist market.

Wine production

The key conclusion regarding wine production from the IPCC AR5 Fifth Assessment Report (Kovats et al., 2014) is that "climate change will alter the geographic distribution of wine grape varieties (*high confidence*) and this will reduce the value of wine products and the livelihoods of local wine communities in southern and continental Europe (*medium confidence*) and increase production in northern Europe (*low confidence*)."

In addition to impacts on grape yields, higher temperatures are also expected to affect wine quality in some regions and grape varieties. Some adaptation is possible through improved technologies, good practices and changing to grape varieties that are more suited to warmer climates. However, this may compromise some of the unique characteristics of wine production in a specific region.

There is evidence that the Croatian wine-growing sector has benefited from a trend of warmer winters and springs, which have led to better harvests and made it more possible to cultivate new varieties of grapes (Lange and Marković, 2014). Thus, there is a possibility that wine growing in the County might benefit with the appropriate adaptation practices, although it will require further research by local wineries. There have been some studies on climate impacts on grape varieties, but they have focused on individual species. We do not have enough information about local grape varieties and specific climate scenario impacts on yield and growing season to make a valid assessment of the likely economic impacts in the County.

Olive Production

Research suggests that there have already been some climate impacts on olive production in Croatia, with analyses of the trends of olive tree phenophases (growing phases) on the Adriatic coast and islands indicating a significantly earlier start to flowering (2–4 days/10 years) due to increases in the spring air temperature (MENP, 2014).

A study by Ponti et al. (2014) assessed the ecological and economic impact of a projected 1.8 °C climate warming (A1B scenario) on the olive and its pest, the olive fly, across the Mediterranean Basin and found varying impact on olive yields and fly infestation levels with some areas benefiting economically and others losing. Comparing the periods 1961 to 1970 and 2041 to 2050, the study predicted a minimal impact of climate warming on aggregate olive oil production with some decrease in risk across the region. The study gives results for Albania, Croatia, Cyprus, Greece and Turkey, as a whole. They indicate slight increases in average olive yield, from 2.2 to 2.38 tons per ha, and decreases in olive fly infestation from 57 to 45%, which translate into an increase in profit from about 2,234 €/ha to 2,491 €/ha. High economic losses were observed in some areas of Italy and Greece for small olive farms in marginal areas.

From these results we can see that the possibility that olive growing in the County may benefit from some climate change scenarios. However, a much more localised study would be necessary to understand more precisely the implications of climate change for olive growing and the specific needs for adaptation.

Conclusions on Agriculture

The contribution of the agricultural sector to the GDP of Šibenik-Knin County has been declining in the last several years. Many factors have contributed to that trend: farms are small and scattered, which is not conducive to efficient production; there is a high dependency on state subsidies; increased water prices; the age structure of farmers and farm managers; etc. Despite agriculture making up only 2.1% of the county's GDP (together with fisheries and forestry), some types of agricultural production (such as grape production and winemaking, olive and olive oil production, vegetables, livestock, and organic agriculture) have a high potential for development.

Detailed estimates of the impacts of climate change on the agricultural sector were not possible in this study because of outdated data and the complex nature of the impacts of climate change on the yields of different crops. However, the main impacts are expected to come from changes in agricultural yields due to changing trends of precipitation and temperature, damage from increased extreme weather events, such as river flooding and storms, increased incidence of disease (already affecting olive oil production), and the impacts along the supply chain, especially on the wine and olive oil industries. Much work is being undertaken in Europe on how to respond to such changes and to make agriculture more climate resilient in the future. The policies being developed include a shift to crops that are more resilient, the use of insurance to smooth the effects of events such as droughts and floods, and the expansion of irrigation where water supplies are likely to be sufficient to justify it (in Croatia's case the share of irrigated land is only 1.3%). Applying this research to Croatia is important and some centres, such as the Polytechnic of Knin, are contributing to it through a better understanding of the role of agriculture in the Mediterranean karst.

Two types of agricultural production were the focus of this study – wine production (expected to be affected by the impacts of high temperatures on grape yields, grape variety, and wine quality) and olive oil production. Both of them might benefit from climate change, at least in the medium term. However, this will require a more careful assessment of the impacts and the ways in which the changes can be best exploited in terms of production.

Finally, another way in which agriculture may thrive in spite of a changing climate is through the promotion of agro-tourism, which needs not be closely tied to peak coastal tourism.

4.3 Fisheries and Aquaculture

Overview of the Sector

Šibenik-Knin County has a historical tradition of fishing. There were about 400 fishing vessels in 2011, but fishing has been in a long decline, with only 312 licenses issued for commercial fishing, 1,044 for small-scale commercial fishing and 1,521 sport fishing in 2009. The Regional Development Strategy reported a total catch of 2,181 tons for "fish and other marine organisms" in 2009.

The key fishing ports are Murter, Primošten, Rogoznica, Šibenik and Tribunj. The Regional Development Strategy also reported shortcomings in the condition of fisheries infrastructure, a lack of processing facilities and an aging fishing fleet. In addition, it reported that some fish resources, particularly demersal fish, have been degraded by overfishing.

Another traditional activity is shellfish cultivation. Seven fish farms and shellfish producer concessions are listed in the regional development strategy. They are located around rivers and bays, such as the mouth of the Krka River. The strategy also noted that this subsector is currently operating at a low level – at only 25% of its potential (RDA, 2011). The main reasons for these poor results seem to be the unorganized market and other difficulties, such as absence of a purification centre.

Despite these obstacles, aquaculture is seen as a long-term solution for increasing the quantity and quality of fish and shellfish production in Šibenik-Knin County, which like Croatia's other coastal counties, has many of the prerequisites for the

future development of aquaculture, such as clean water in semi-enclosed areas optimal for the production and tourist markets (UNDP Project COAST, 2013). The importance of aquaculture development is high since it can create jobs even in areas where employment opportunities are limited (e.g. islands). The Integrated Shellfish Farming Development Plan of 2009 envisaged the development of production in the estuary of the Krka River by 2015. This includes a strategic goal for the production of 5,000 tons of mussels and 1,000,000 oysters through a number of management measures. Today, there are 30 mariculture concessionaires operating on 283,797 m^2, mainly in the area of the mouth of the Krka River. The majority of the concessions are for shellfish farms (with a maximum capacity of 50 tons), while four are for fish farms (with a maximum capacity of 100 tons)[19].

Finally, it is important to note that Croatia has developed an Operational Programme for Fisheries for 2014–2020. It is designed to achieve the goals set by the EU's Common Fisheries Policy (CFP) for 2014–2020, supported by its financial instrument, the European Maritime and Fisheries Fund (EMFF). The goals include ensuring environmentally, economically and socially sustainable fishing and aquaculture and promoting a balanced and inclusive territorial development of fishing and aquaculture areas.

Impacts of Climate Change on Fisheries and Aquaculture

Climate change can potentially impact the fishing industry in Croatia in a number of ways. Warmer sea temperatures may change the distribution of fish species and increase the number of invasive species, which may affect the catches in coastal counties and islands (Šimac and Vitale, 2012). While there is some evidence of a change in distribution of fish species around Europe, there are limited studies for the Mediterranean area (Cheung et al., 2009). More work is needed for the Mediterranean in order to estimate the impact of climate change on fisheries in the County. Our initial assessment is that the climate change impacts on the fish catch and its value within the economy will be small simply because the fishing industry is currently operating at such a low level.

Increasing salinity is also likely to have an impact on fish species. During the Climagine consultations, this issue was noted in terms of increased water salinity harming shellfish farming around the Krka River and the sea.

Conclusions on Fisheries and Aquaculture

Although Šibenik-Knin County has an historical tradition of sea fishing, some shortcomings are present today, including a lack of processing facilities, an aging fishing fleet, and overfished resources (demersal fish in particular). Apart from overfishing, an additional pressure for this sector is a change in the distribution of fish species and an increase in invasive species, mainly related to increasing temperatures.

The aquaculture sector could compensate for this uncertainty in future fish production. It has a great potential in this area. However, this sector could also be affected by climate change, especially the subsector of shellfish farming, through increasing salinity in Krka River estuary. Research on how to make aquaculture more climate resilient is active in many parts of the world. It is important for Croatia to participate in this programme and to apply the lessons learned.

4.4 Water Management

Overview of the Sector

The available water resources in Šibenik-Knin County are susceptible to large oscillations. In the winter the region may be characterised as rich in water resources, while the need for water is rather small. However, in August the region belongs to the category of poor regions in terms of available water resources. Although on a yearly basis water still represents a resource that may be a driver for the development in the County, in August the situation looks rather different, with a water exploitation index that reaches values that represent moderate pressure on the resource.[20] Table 4.16 summarises the main indicators of freshwater in the County.

[19] Source: J. Fržop. Regional Department for Maritime Affairs, Transportation, Islands and Regional Development. 2014.

[20] Source: J. Margeta. Input for the Coastal Plan for Šibenik-Knin County, 2014.

Industry and tourism use around 30% of water, while irrigated farming accounts for only about 1.3% of the total land used for agriculture. Therefore, this activity is not an important user of water at present. The biggest issue for the water supply systems are high losses, still higher than 50% of total abstracted water. In addition, Regional Development Strategy points out that establishment of the unique regional water supply system is expensive, due to the weak density and scattered development. Figure 4.4 gives the amounts abstracted per month.

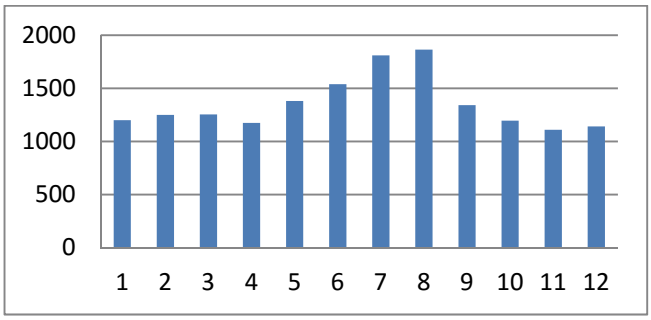

Figure 4.4: Water abstracted per month (10,000 m^3).

Waste water

The percentage of the County population connected to wastewater treatment is about 50% for primary and even less for secondary treatment. The exact percentages per agglomerations, and other relevant data including planned investments costs, are shown in Table 4.17.

These data show the pressure that waste waters are currently creating on the river and marine environment. However, the situation is slowly improving and is expected to improve considerably by 2023 (Margeta, 2014).

To demonstrate the size of the infrastructure required in August and the corresponding financial burden, the size of the population, the number of apartments and the number of tourists per nights per municipality are presented in the Table 4.18. The data on population and apartments are from the 2011 census, while tourist numbers are from August 2014, as noted by the Tourist Board of Šibenik-Knin County.

It may be noted that in some towns, for example Primošten, Rogoznica and Tisno, infrastructure needs based on human population pressure more than tripled compared to the size of the resident population, who ultimately bear the cost of the required infrastructure. For the coastal towns and municipalities we may see that in August the needs are almost double that of the population living in the coastal zone.

Impacts of Climate Change on Water Management

Climate change, combined with increased water use, will lead to severe pressures on water availability in the Krka River Basin.

According to a study by Margeta (2014), an increase in temperature and a decrease in precipitation will lead to decreased water availability in the summer months, meaning less water for all current and planned water use, such as irrigation, water supply, hydropower, rafting, and aquaculture. This negative impact is particularly significant because in these summer months the demand for water is the highest.

In the winter months a short but intense increase in precipitation is expected, leading to flood episodes and a consequent risk to people and their assets, and a risk of water contamination or pollution. Low-lying coastal areas in Šibenik-Knin County will be particularly affected. Floods in some other areas, such as Knin Field, could lead to the transport of contaminants or pollutants toward the Krka River National Park or even downstream to the river's mouth. For that reason, the vulnerability of the Krka National Park will increase.

Flash floods will be of particular concern, especially in urban areas where they represent a hazard to assets and urban infrastructure in general.

Table 4.16: Main indicators of the water supply zone for the County (2010). Source: Diagnostic Analysis, Coastal Plan for Šibenik-Knin County.

Water supply zone	Number of settlements	Population	Population with access to the water supply system	Rate of access to water supply system (2007)	Total investment in €
WSZ Knin	23	17.187	14,770	85.9%	4,515,000
WSZ Šibenik	173	95,704	82,980	86.7%	12,810,000
Total	**196**	**112,891**	**97,750**	**87.0%**	**17,325,000**

Table 4.17: Waste water treatment systems for agglomerations above 2.000 population equivalent. Source: Diagnostic Analysis, Coastal Plan for Šibenik-Knin County.

Coastal agglome-rations	Sensitivity of receiving waters	Construc-tion deadline	% of pop. connected	Actual total population equivalent (PE)	Total planned population equivalent (PE)	WWTP treatment level	WWTP actual capacity (PE)	WWTP planned treatment level	WWTP planned capacity (PE)	Network construction price (Eur)	WWTP construction price (Eur)	Total construction price (Eur)
Šibenik	Normal	2018	58%	79,606	100,000	1	50,000	2	100,000	14,408,000	5,442,000	19,850,000
Skradin	Sensitive	2023	34%	2,022	3,350	2	1,700	3	3,400	2,449,000	680,000	3,129,000
Vodice	Normal	2013	35%	12,792	44,000			2	44,000	26,677,000	5,254,000	31,931,000
Pirovac-Tisno Jezera	Normal	2020	0%	15,159	24,455			2	27,000	10,456,000	5,442,000	15,898,000
Primošten	Normal	2023	45%	9,261	15.000	P	1,000	1	15,000	4,082,000	2,721,000	6,803,000
Rogoznica	Normal	2023	53%	6,331	19,838	P	9,000	2	20,000	6,250,000	1,633,000	7,883,000
Bilice	Sensitive	2023	0%	2,179	3,000			2	3,000	1,633,000	408,000	2,041,000
Betina-Murter	Normal	2023	0%	11,545	17,300			2	17,300	8,435,000	4,762,000	13,197,000
Inland cities												
Knin	Sensitive	2020	32%	12,619	24,700			3	25,000	8,163,000	5,442,000	13,605,000
Drniš	Sensitive	2023	75%	3,332	9,558			3	10,000	3,887,000	3,088,000	6,925,000

Table 4.18: Pressure on Public Water Infrastructure in August.

Coastal towns and municipalities	Population	Tourist nights in August 2014	August tourists as population equivalent	August population equivalent	% of August population equivalent increase
Šibenik	46,332	437,866	16,950	63,282	37
Vodice	8,875	399,559	15,467	24,342	174
Skradin	3,825	11,078	429	4,254	11
Tisno	3,094	227,778	8,817	11,911	285
Murter	2.044	91,807	3,554	5,598	174
Pirovac	1,930	83,101	4,661	6,591	242
Rogoznica	2,345	65,551	8,006	10,351	341
Primošten	2,828	120,422	9,067	11,895	321
Tribunj	1,536	206,825	3,179	4,715	207
Bilice	2,307		0	2,307	0
TOTAL	**75,116**	**1,811,681**	**70,13**	**145,246**	**93**

Conclusions on Water Management

Water is a promising driver for development in the County. However, this potential is seriously impeded by water exploitation in summer months, mainly driven by increased demand by tourists but also by expected increases in irrigation needs. The supply of water for increased demand is in question, especially when considering the losses in water supply systems (more than 50%) and the scattered development that makes establishment of a regional water supply system rather expensive.

Climate change will worsen the situation with increasing temperature and reduced precipitation, leading to decreased water availability in summer months. In winter months, on the other hand, intensive precipitation, flash floods and increasing water levels in the coastal zone, can pose a risk to assets and infrastructure in urban areas. These negative impacts will result in increased living expenses because of the low efficiency and productivity of water supply infrastructure (Margeta, 2014).

Regardless of climate factors, the water management sector will have to adapt the demand for water to the available water capacity. There are a number of demand side measures that can be introduced to save water that should be considered. On the supply side the County can reduce losses in delivery systems, which would make a significant impact. If adaptation measures are not implemented, the County's productivity and profitability will be affected.

4.5 Other Sectors and relevant climate changes impacts

There are several other economic sectors operating in the Šibenik-Knin County. The ones that make a strong contribution to the local economy – manufacturing industries and maritime transport (with an emphasis on ports) will be discussed here.

Manufacturing

Šibenik-Knin County has a long heritage of manufacturing dating to the end of the 19th century. The main contributors to its development were the manufacture of electrodes and ferroalloys and the manufacture of aluminium. The Factory for Electrodes and Ferroalloys (TEF) was shut down in the 1990s, but the Factory of Light Metals (TLM), which was oriented primarily to aluminium-related products, still operates as the biggest industrial complex in the County. It employs more than 1,500 people. Today, manufacturing is important to the County since 15% of all people employed work in this sector,[21] which makes manufacturing the second most important sector after the wholesale-retail sector. There are many other manufacturing facilities in the County that develop products related to mineral resources, gypsum, lime, bolts, vehicle parts, etc. The role of manufacturing in local development is also reflected in the recent establishment of several economic and business

[21] 2011 Census, Croatian Bureau of Statistics http://www.dzs.hr/hrv_eng/publication/2011/09-02-04_01_2011.htm.

districts, such as Čista, Drniš, Kosa, Podi, Preparandija-Knin and Radonić. In regard to manufacturing in the coastal zone, the NCP Repair Shipyard Šibenik LTD. is especially important. It specializes in the repair and construction of different types of vessels and is one of the leading ship repair yards on the eastern coast of the Adriatic. In addition, it has promising new products – its aluminium boats for the fish farms have recently become very in demand in northern European countries.

The manufacturing sector is energy demanding. On a global level it responsible for 35% of electricity use.[22] The impact of climate change could therefore be felt indirectly, through impacts on electricity production. This possibility is particularly important for Šibenik-Knin County since energy production is highly reliant on hydropower. There are five hydropower plants in the county, all on the Krka River (RDA, 2011). Hydroelectric production is a subsector that is highly affected by climate change. In general, climate change influences changes in river flow (runoff) as a result of changes in temperature and precipitation in the catchment area. Changes in runoff volume, flow variability and seasonality will directly affect the potential for hydropower generation (Kumar et al., 2011), which, in turn, will affect industries that consumer large amounts of electricity, such as manufacturing.

Maritime transport (ports)

When discussing the maritime sector of Šibenik-Knin County, it is essential to focus on the port of Šibenik since it is by far the largest and most important port in the county. It is located on the Krka River estuary. There are several terminals in the port: one for bulk and general cargo (Rogač), one for the transhipment of phosphates (Dobrika), a terminal for wood, and a passenger terminal (Vrulje)[23].

In 2010, a total of 10,882 ships arrived in the port of Šibenik, which was an increase of 6.5% compared to 2009 but a decrease of 4% compared to 2006. Of the total ship arrivals in 2010, the major portion was comprised of passenger and cruise ships (83.1%) and general cargo ships (15.4%). The total number of passengers in 2010 was 553,000, which was a decrease of 1.4% compared to 2009. International traffic comprised 1.6% of total passenger traffic. The total traffic of goods in 2010 was 646,000 tons, which was an increase of 5.2% compared to 2009 but a decrease of 49.6% compared to 2006.[24]

The port of Šibenik's good railway connections were recognized as one of its strengths in a SWOT analysis in the RDA (2011). These connections are particularly important for cargo transport. Regarding passenger traffic, an increase to 873,000 is projected (RDA, 2011), and a new passenger terminal is under development. Croatia's Strategy for Transportation Development for 2014-2030[25] highlighted the importance of the port of Šibenik as an area of special (international) economic importance for the country. In the same strategy, and in Croatia's Strategy for Maritime Development and Integrated Maritime Policy for 2014–2020,[26] the future development of the port of Šibenik is aimed at a specialization in passenger traffic, in particular for exclusive sailing vessels of smaller capacity (so-called "boutique ships") and mega-yachts.

Apart from the port of Šibenik, which is the only port of special economic interest in Croatia, the Spatial Development Plan for Šibenik has highlighted Vodice as a port of importance to the County. There are 22 other ports of local importance or special purpose ports, such as those related to nautical tourism (covered in the chapter on tourism), fisheries (mentioned in chapter on fisheries), sports and three shipyards.

Because of their location, seaports are particularly vulnerable to weather events associated with climate change and variability, such as rising sea levels and storm activity (Becker et al., 2013). Although the port of Šibenik is considered to be well sheltered, cyclonic *jugo* (sirocco) winds can

[22] http://www.unep.org/climatechange/mitigation/Manufacturing/tabid/104340/Default.aspx

[23] Port Authority of Šibenik (http://www.portauthority-sibenik.hr/)

[24] Croatian Bureau of Statistics (2011): Traffic in Seaports 2006-2010, Zagreb 2011. http://www.dzs.hr/Hrv_Eng/Other/morske-luke_2006-2010.pdf

[25] Available in Croatian at http://hac.hr/UserDocsImages/strategija.pdf

[26] Available in Croatian at http://www.mppi.hr/UserDocsImages/POMORSKA%20STARTEGIJA%20VRH%202207201%20web%2026-7_14.pdf

raise the sea level up to one meter and create high and short waves.[27]

The possible direct impacts of CVC on seaports and maritime transport include damage to vessels and infrastructure, and disruption of maritime operations (ship movements, mooring, loading and unloading). It could also include increased impacts on human health and safety from weather-related events. The economic impacts would include the costs of damages and disruption to maritime operators, the port authority[28] and other operators along the supply chain (road and rail forwarding, etc.). A full assessment of the risks at specific ports is required to establish the range and likelihood of impacts from existing and future climate hazards as a basis for estimating the possible costs of CVC impacts and for making a decision on how and when to deal with these hazards. Such an approach is outlined in the *Climate Change Adaptation Guidelines for Ports* (Scott et al., 2013).

Energy

The potential impact of climate change on energy in the County will come from its effects on hydropower and on the distribution and transmission of electricity from extreme events.

Hydro Potential

The use of hydro potential for electricity generation has a long tradition in the County. Jaruga on the Krka River is one of the ten oldest hydroelectric power plants in the world. It went into operation in 1903. Today, there are five hydroelectric power plants in the County with a total installed capacity of 40.8 MW. They produced 173 GWh of electricity in 2008. With the onset of climate change, the climate and hydrological models show declines in both thermoelectric and hydroelectric power generating potential for most of Europe, except for the northernmost countries (Van Vliet et al., 2013). In the case of hydropower the declines are a result of the vulnerability of the European power sector to reduced water availability, while problems arise for thermoelectric power plants because they could be forced to reduce production due to environmental restrictions on cooling water use when water availability is low and legal temperature limits are exceeded. Van Vliet et al. (2013) considered the decline in hydropower potential in the period 2030–2060 in all countries of Europe under the B1-A2 scenario, which is a middle-of-the-road forecast for future emissions and temperature changes. They estimated that the fall for Croatia would be 15–20%. If the same figure applies for Šibenik-Knin County, the decline in capacity will be 6–8 MW and a potential loss of generation of 26–35 GWh. At prices of between 91 and 116 euros/MWh for industry and households (without VAT),[29] this would mean a loss of revenue between 2.4 million and 4.1 million euros. Furthermore, the same amount of electricity will have to be purchased from other sources.

Power Lines

Other impacts that the County may experience are damaged power lines, which are vulnerable to extreme weather, which is, in fact, the cause of most blackouts today.[30] The "weakest link" is not the transmission lines, which transport electricity across great distances to distribution points, but the distribution lines that link these points to neighbourhoods or individual households. Many customers outside the population centres are served a single distribution line, which may go through forests and thus be particularly vulnerable. This may appear to be a minor problem, since it affects only a few households in the countryside. Yet, in 2005 a devastating storm hit the west coast of southern Sweden. The combination of strong winds, falling trees and broken branches damaged several sections of the distribution grid. The result was that thousands of households were without electricity, some of them for up to 45 days. The storm had an especially serious impact on the rural population and the rural companies situated in major forest areas.

While distribution lines are the most vulnerable part of the grid, transmission lines are not resistant to damage from extreme weather either. In 2003, some parts of Switzerland and all of Italy were

[27] Port Authority of Šibenik (http://www.portauthority-sibenik.hr/

[28] To give an indication of existing costs, the Port Authority of Šibenik-Knin County had expenses of about 11 million Kuna in 2013 of which about 4.2 million Kuna was spent on maintenance.

[29] http://ec.europa.eu/energy/sites/ener/files/documents/2014_countryreports_croatia.pdf

[30] See: https://www.ethz.ch/en/news-and-events/eth-news/news/2014/06/adapting-the-electricity-grid-to-climate-change.html from which this section is taken.

blacked out for several hours, and for as much as 18 hours in parts of Italy. The trigger for this disruption was the failure of a transmission line in Switzerland. It became overloaded and then it overheated, causing it to sag too close to the ground and resulting in a flashover – a small lightning bolt – between the line and a tree. However, the consequences would have been the same if the line had been broken because of a flood, ice build-up, lightning, or falling branches caused by strong winds.

If the climate is changing and the weather is becoming more extreme, the electricity grid will be at an increased risk of damage. Precautionary measures, such as minimising the exposure (burying power lines) or maximising the robustness of grid components (reinforcing pylons and overhead lines), may be useful and efficient today, with the already known frequencies of weather extremes. However, these measures may not be sufficient or cost-efficient in a changing climate, with a greater frequency and intensity of extreme weather events. For example, if we design the power system to withstand a 100-year flood, it will not withstand a 200-year flood, which may become more frequent in the future.

The best adaptation measure for climate change is to increase the resilience of the electricity system by creating more interconnections, integrating national systems and voltage levels, and improving coordination among network operators. It is also crucial that transmission lines do not operate at or near full load during normal conditions, so that when one line goes down, the others can pick up the load and the transmission system remains intact. Electrical networks today operate under the "n-1" principle, ensuring a supply of electricity even after the failure of a component in the power system. However, if a major transmission line is shut down and a second one is shut down immediately after – as was the case in the Swiss and Italian blackout – then it is no longer possible to secure an uninterrupted supply of power. A power system designed under the "n-2" principle may be disrupted under extreme conditions, too, but a blackout is far less likely.

Wind Energy

In recent years there has been a significantly greater interest by investors in wind power projects in Croatia following the adoption of new regulations for renewable energy. A number of plants are currently operating, with installed capacities of about 20 MW, with plans for a further 90.5 MW. The demand for this development will partly depend on the demand for power and the position that Croatia negotiates with the EU on its target reduction in GHG emissions to 2030. According to "Hrvoje Požar" Croatian Institute of Energy[31], potential for wind energy production in Šibenik-Knin County is significant – around 250 MW, with three wind-power parks currently operating with total power of 33.8 MW.

Solar energy

Solar energy is used sporadically in the County as an additional power source in households, services, businesses, etc. It most common use is thermal solar collectors for domestic hot water. Their use as a source of heating is negligible. The use of photovoltaic panels for the production of electricity is also very limited. The current regional plan for the County does not include a location to accommodate solar power stations, although there is investor interest in this type of energy production. Renewable Energy Resource and Cogeneration Projects and Privileged Producers (RERCPPP) Registry in the County reported eleven projects which should be verified and realized through the relevant development studies and spatial planning documentation.

Gas pipelines and associated infrastructure

The gas transmission system of Lika and Dalmatia is a key facility of the second development-investment cycle in the plan for the development, construction and modernization of the gas transport system of the Republic of Croatia. Its construction will significantly increase the coverage of the gas pipeline system and will allow the use of natural gas in these two regions, whose population and economy have hitherto been dependent on oil, fuel oil, electricity and solid fuels.

[31] Energetski Institut Hrvoje Požar (2012) „Potencijal obnovljivih izvora energije: XV. Šibensko-Kninska županija", Zagreb.

5 Impacts of Sea-Level Rise, Sea Floods and Other Climate Change Impacts

This section summarises the conclusions on sea-level rise-related climate impacts relevant to Šibenik-Knin County. It draws on the study by Hinkel et al. (2015), which covered the full length of the Croatian coastline using the DIVA (Dynamic and Interactive Vulnerability Assessment) model. It then gives more detailed estimates of current and future damages from coastal flooding in the County based both on estimates of total damages to property for the county in the Hinkel et al. study and the vulnerability assessment of Šibenik-Knin County for floods and other sea-level rise-related climate impacts by Martina Baučić (2014). In addition to these impacts, the impact of climate change on the incidence of forest fires was covered, especially since they appear to be a significant issue in the County.

5.1 DIVA Study Conclusions for Šibenik-Knin County

The study by Hinkel et al. (2015) used a top-down methodology based on the DIVA model and database. The DIVA model is an integrated, global research model for assessing the biophysical and socio-economic consequences of sea-level rise and associated extreme water levels under different physical and socio-economic scenarios. The assessment for Croatia focused on the impacts of:

- increased coastal flood risk in terms of the expected annual damages of extreme sea-level events (storm surges), in terms of monetary damages to assets (buildings, infrastructure) and number of people affected, and
- dry land loss due to increased coastal erosion from sea-level rise and the resulting damages (forced migration).

According to the DIVA projections, the Šibenik and Vodice municipalities of Šibenik-Knin County are among the floodplain areas most impacted by sea floods for 2050 and 2100 (Hinkel et al., 2015). Šibenik is ranked second among Croatia's floodplain areas in terms of the value of assets below the 100-year flood and for total cost of sea floods under different shared socioeconomic pathways (SSPs)[32] for both 2050 and 2100. Vodice floodplain area is ranked fourth regarding assets below the 100-year flood and fifth regarding total cost of sea floods.

In addition, Murter-Kornati is the third most impacted Croatian floodplain area in terms of extent of potential flooded area, while Šibenik is sixth under the same category. In addition, Šibenik is fifth most impacted floodplain area in terms of people in the floodplain (i.e. living below the 100-year flood) and people flooded annually for all SSPs for both 2050 and 2100.

The values for all municipalities of Šibenik-Knin County for people at risk of flooding, the area below the 100-year flood, assets below the 100-year flood and the expected costs of sea floods are shown in Table 5.1 based on the example of an SSP2 scenario, Medium SLR, for 2100.

The results of DIVA study indicate that, although people at risk of flooding in the Šibenik-Knin County make up 7.8% of the total number of people at risk of flooding in Croatia, the costs of sea floods account for 18.75% of the total sea flood costs for the entire country. In addition, while the area below the 100-year flood in the Šibenik-Knin County makes up 10.6% of Croatia's total, the value of assets in the County is around 18.6% of the asset value for the entire floodplain of Croatia. The numbers are for a SSP2 Medium SLR scenario for 2100.

[32] SSPs are socio-economic scenarios with five population and gross domestic product (GDP) growth scenarios. Each SSP represents different assumptions about future global and national development. The highest GDP and lowest population numbers are represented by SSP1 (Sustainability), which reflects a world progressing towards sustainability with reduced resource intensity and fossil fuel dependency, and SSP 5 (Conventional Development), which reflects a world oriented toward equitable rapid fossil fuel dominated development. GDP is lowest and population highest under SSP 3 (Fragmentation), which reflects a world fragmented into poor regions with low resource intensity and moderately healthy regions with a high fossil fuel dependency. GDP and population under SSP 4 (Inequality), which is a highly unequal world both within and across countries, follow a similar but less extreme trend compared to SSP3. SSP 2 (Middle-of-the-Road) reflects a world with assumptions midway between the other four SSPs.

Table 5.1: DIVA study projections for Šibenik-Knin County for 2100 for SSP2 scenario, Medium SLR.

Municipality	People at risk of flooding*	Area below H100 (in ha)	Assets below H100 (in USD/yr)	Expected costs of sea floods (in USD/yr)
Murter-Kornati	469	12.12	99,708,687.50	16,611,265.90
Pirovac	325	0.59	54,982,739.75	8,653,903.61
Primošten	192	0.58	17,753,476.56	2,602,777.93
Rogoznica	296	0.99	139,884,892.80	21,750,228.74
Šibenik	2,948	11.53	1,110,806,537.82	187,332,463.67
Tisno	645	3.98	163,943,010.75	26,946,717.52
Tribunj	357	0.54	45,986,398.80	7,183,691.16
Vodice	1,256	4.01	733,780,408.00	124,332,711.95
Total	**6,488**	**34.34**	**2,366,846,151.98**	**395,413,760.48**

***** *Average number of people flooded per year by storm surge allowing for the effect of flood defences.*

5.2 Estimates of Damages Caused by Sea Floods in Šibenik-Knin County

Estimates have been made of the total damages to property for Šibenik-Knin County as part of the national assessment for Croatia carried out by Hinkel et al. (2015). At the same time, an assessment has been made of the vulnerability of Šibenik-Knin County to floods and climate change and variability by Baučić (2014). This section combines the two studies to derive a more detailed estimate of the current and future damages from coastal flooding in the County.

The method used is made up of the following steps:

- The vulnerability assessment gives the coastline in each of 38 settlements in the County. Their total coastline is 478 kilometres (including inhabited islands but excluding uninhabited ones). The overall vulnerability for coast of Šibenik-Knin County is presented by Figure 5.1. The settlements are listed in Table 5.3 with their respective coast length.
- The assessment also provides a vulnerability score for individual segments within these settlements using the following information for each settlement: the natural characteristics of the coast, the forces acting on the coast and its socio-economic characteristics. In each case the characteristics are rated from 1–5 in terms of the vulnerability that they represent for the settlement. Scores by land use are shown in Table 5.2.
- We are interested in the assets at risk in each settlement, so we focused on the socio-economic characteristics of the settlements. Each area in the settlement is classified under one of five categories as listed in Table 5.2. A score of 5 indicates the greatest vulnerability, while a score of 1 the lowest vulnerability.
- To calculate a socio-economic vulnerability value for each settlement, we have taken a weighted average of the areas within a settlement, using the coastal length as the weight. Hence, the value for settlement "i" is given by V_i where:

$$V_i = \sum_j S_j l_j$$

and where S_j is the score given to area j and l_j is the length of area j in terms of its coast.

- The total value of all the settlements in the country is the sum of the V_i and the share of damages as estimated by Hinkel et al. for Šibenik-Knin County are allocated to each settlement in proportion to its share of the vulnerability-based value. Thus, damages to settlement 'i' are D_i where:

$$D_i = \frac{V_i}{\sum_j V_j}.D$$

and where D is the total estimated damage from sea floods as estimated by Hinkel et al. (2015) under different scenarios. It is estimated today at USD 2.9 million (See Table 5.3).

- The results are given in Table 5.3. We have reported damages in millions of US$ per year, now and in the future for 2050 and 2100 under

three socio-economic scenarios and under a medium climate change sea-level rise scenario. The same can also be done for a low and high sea-level rise scenario. Damages are correlated with length of coastline but not entirely: some settlements such as Žirje have a long coastline but low damages, while some have a relatively short coastline but significant damages, an example being Žaborić.

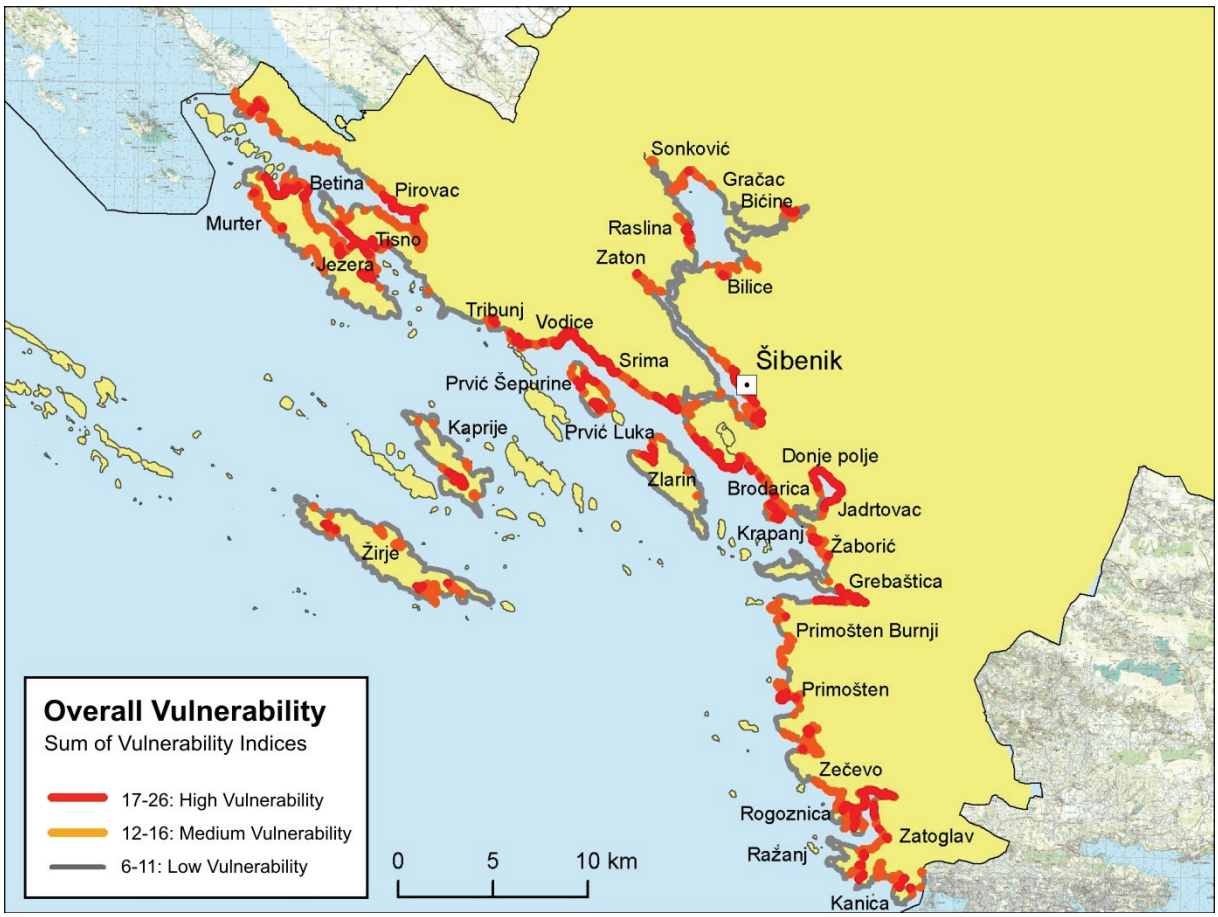

Figure 5.1: Map showing overall vulnerability for coast of Šibenik-Knin County. Source: Reproduced from Baučić (2014).

Table 5.2: Vulnerability Scores for different land areas in each settlement.

Type of Use of Land	Vulnerability Score
Mixed Built Area Tourist Built Area Business Built Area Special Built Area	5
Agricultural Land Sport and Recreation Built Area	4
Mixed Undeveloped Land Tourist Undeveloped Land Industrial Undeveloped Land	3
Sport and Recreation Undeveloped Land	2
All other land	1

Table 5.3: Estimates of Damages by Settlement Today and in the Future, USD millions/year.

				Medium SLR 2050			Medium SLR 2100		
Settlement Name	Coast Km.	Cost Share	Today	SSP2	SSP3	SSP5	SSP2	SSP3	SSP5
Betina	13.1	8.5%	0.25	2.64	2.38	3.15	5.45	5.02	6.64
Bilice	13.3	2.3%	0.07	0.73	0.66	0.87	1.50	1.38	1.83
Bićine	1.1	0.5%	0.01	0.16	0.14	0.19	0.33	0.30	0.40
Brodarica	2.8	2.8%	0.08	0.87	0.78	1.04	1.79	1.65	2.18
Donje Polje	3.6	0.4%	0.01	0.11	0.10	0.14	0.23	0.22	0.28
Gračac	6.4	0.5%	0.01	0.15	0.14	0.18	0.31	0.29	0.38
Grebaštica	17.5	1.1%	0.03	0.33	0.30	0.40	0.69	0.64	0.84
Jadrtovac	8.3	1.3%	0.04	0.41	0.37	0.49	0.84	0.78	1.03
Jezera	28.3	3.5%	0.10	1.09	0.99	1.30	2.25	2.08	2.75
Kanica	25.3	1.0%	0.03	0.31	0.28	0.37	0.65	0.60	0.79
Kaprije	1.9	4.0%	0.12	1.23	1.11	1.47	2.55	2.35	3.10
Krapanj	20.7	4.7%	0.14	1.45	1.31	1.73	3.00	2.76	3.65
Lozovac	1.2	0.2%	0.00	0.05	0.04	0.06	0.10	0.09	0.12
Murter	9.2	4.9%	0.14	1.53	1.39	1.83	3.17	2.92	3.86
Oglavci	2.7	0.3%	0.01	0.11	0.10	0.13	0.22	0.21	0.27
Šibenik	17.5	14.1%	0.41	4.37	3.94	5.21	9.02	8.31	10.99
Pirovac	6.5	2.4%	0.07	0.74	0.67	0.88	1.53	1.41	1.86
Podglavica	5.9	0.9%	0.03	0.29	0.26	0.35	0.60	0.56	0.73
Primošten	6.3	4.8%	0.14	1.50	1.35	1.79	3.09	2.85	3.77
Primošten Burnji	11.7	1.7%	0.05	0.52	0.47	0.62	1.07	0.98	1.30
Prvić Luka	7.6	1.5%	0.04	0.47	0.43	0.57	0.98	0.90	1.19
Prvić Šepurine	12.8	2.0%	0.06	0.64	0.57	0.76	1.31	1.21	1.60
Ražanj	4.3	1.3%	0.04	0.41	0.37	0.49	0.85	0.79	1.04
Raslina	5.9	1.8%	0.05	0.55	0.50	0.66	1.14	1.05	1.39
Rogoznica	6.1	2.6%	0.08	0.80	0.73	0.96	1.66	1.53	2.02
Skradin	8.0	1.0%	0.03	0.30	0.27	0.35	0.61	0.56	0.75
Sonković	56.0	1.8%	0.05	0.55	0.50	0.65	1.13	1.04	1.38
Srima	27.4	2.1%	0.06	0.64	0.57	0.76	1.31	1.21	1.60
Stivašnica	11.1	1.0%	0.03	0.31	0.28	0.37	0.65	0.60	0.79
Tisno	8.8	5.3%	0.15	1.64	1.48	1.96	3.39	3.13	4.13
Tribunj	4.5	3.3%	0.09	1.01	0.91	1.21	2.09	1.93	2.55
Vodice	7.5	3.4%	0.10	1.05	0.95	1.25	2.16	1.99	2.63
Zatoglav	8.5	1.1%	0.03	0.34	0.30	0.40	0.69	0.64	0.85
Zaton	21.7	1.2%	0.04	0.38	0.35	0.46	0.79	0.73	0.96
Zečevo Rogozničko	6.6	1.1%	0.03	0.35	0.32	0.42	0.73	0.67	0.89
Zlarin	42.3	2.9%	0.08	0.89	0.80	1.06	1.83	1.68	2.23
Žaborić	30.2	2.3%	0.07	0.71	0.64	0.85	1.47	1.35	1.79
Žirje	6.3	4.4%	0.13	1.36	1.23	1.63	2.81	2.59	3.43

Note:

1. Cost share is Vi/Sum (Vi) from the text.
2. The "today" figure is the average damages that are estimated at present from sea level rise and storm surges in the district.

5.3 Climate Change Impacts on Forest Fires

Factors influencing risk of forest fires include **meteorological** factors (temperature, precipitation/ drought, relative humidity, wind speed, and lightning), **human** factors (uncontrolled forest clearance, waste dumping and arson, land and fire management policy and resources), and **environmental** factors (forest ecosystem condition, differential fire risk of types of vegetation, topography).

The types of damage from wildfires are summarised in Table 5.4, which indicates the breadth of possible impacts and the value of fire prevention from an economic, environmental and health point of view. But there can also be benefits from wildfires since some forest ecosystems depend on them for regeneration. However, less than 10% of all forest fires are prescribed burning; the rest are classified as wildfires (FAO, 2010).

Table 5.4: Types of damages from wildfires.
Source: Based on P. Corona et al., Economic Valuation of Forest Fire Damages: Toward a common methodology at the European Level.

Types of damages	Examples
Financial losses	Wood, Forest Products.
Environmental/social costs	Soil erosion and water quality, biodiversity conservation, recreation, carbon sinks reduction.
Indirect costs	Firefighting, damages to infrastructures and mobility, damages to landscape and tourism.
Human health costs	Morbidity and mortality from air pollutants and burns.

A high proportion of forest fires in Europe occur in the Mediterranean region. In 2012, Croatia had the fifth highest number of forest fires and fourth highest amount of burnt area of the European countries in the EFFIS database.[33] Data on fires in Šibenik-Knin County are given in Figure 5.2., which shows a total of about 900 open-space fires in 2011 compared to total forest fires in Croatia of about 6,700 in 2011 and 7,870 in 2012. The total burnt area of about 5,000 ha in 2011 compares to burnt areas of about 50,000 ha in 2011 and 80,000 ha in 2012. From 2003 to 2012 the average number of recorded fires was 745 per year. Data for the period 1994–2012 show an increasing trend in the number of fires (Kević, 2013).

Preliminary cost estimates provided in Kević (2013) are around HRK 24 million for firefighting interventions in 2012, with an average cost per fire of approximately HRK 30,000. The trend in the country for the costs of these interventions from 2003 to 2011 was generally increasing.

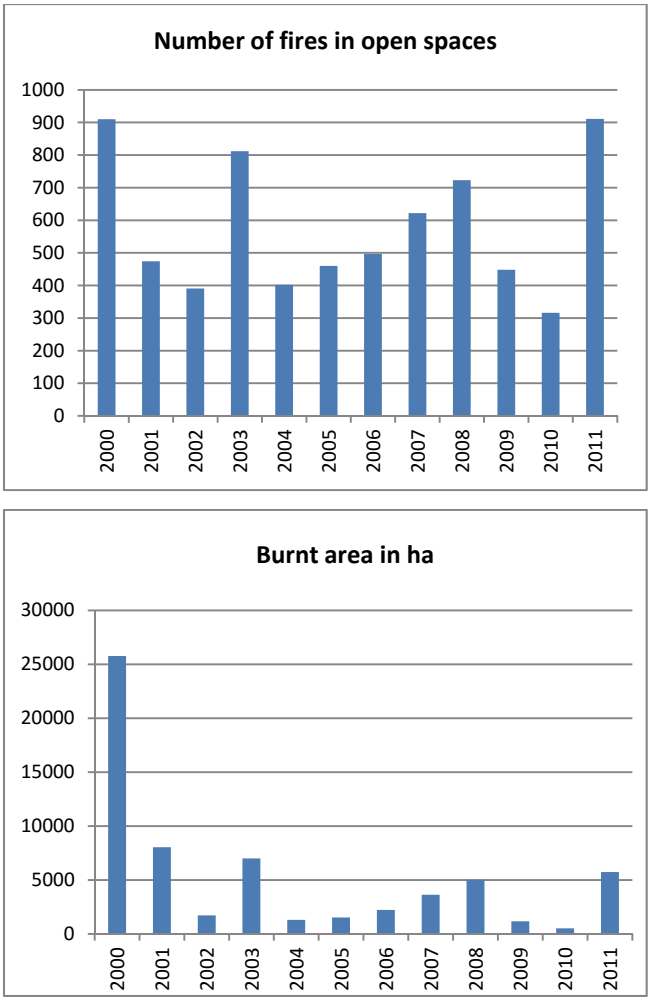

Figure 5.2: Fires in Šibenik-Knin County.
Source: Input for Coastal Plan for Šibenik-Knin County (Milovan Kević, 2013) Personal communication, National Protection and Rescue Directorate.

Table 5.5 shows the area of forest by fire risk level. These are areas under the jurisdiction of the Croatian Forest Administration and do not include national parks (such as Krka National Park, which has a large forested area) and protected landscapes.

Table 5.5: Area of forest according to fire risk level (ha).
Source: Reproduced from Milovan Kević (2013) based on the Annual Plan for the Protection of Forests against Fire (2013), Forest Administration Split.

Forest Office	Level 1	Level 2	Level 3	Level 4
Drniš		24,477.22	19,754.57	4,691.60
Knin		44,272.68	20,503.57	3,470.77
Šibenik	661	10,192.00	12,997.00	8,724.00
Šibenik-Knin County	661	78,941.90	53,225.14	16,886.37
Coastal	26,554.33	295,586.38	189,016.46	34,748.12

[33] Source: European Forest Fire Information System (EFFIS).

High temperatures and drought conditions raise the risk of wildfires. Thus, climate variability and change may impact the frequency and severity of wildfires. Some sources suggest that climate change is likely to increase the number of days with severe burning conditions, lengthen the fire season, and increase lightning activity, which might lead to increases in fire frequency and areas burned (IPCC, 2007). However, the evidence to date on the extent of the link between increased temperatures, droughts and forest fires is mixed.

Climate projections for southern Europe and the Mediterranean region are for decreased precipitation and an increased temperature variability, number of dry spells and droughts, and intensity of heat waves. Consequently, the length and severity of the fire season, areas at risk and the probability of large fires may also increase (ForestEurope, 2010).

The study by Caesar & Golding (2011) projects global increases in the fire danger index to 2100. Their figures show percentage change in the Forest Fire Danger Index for the period 2090–2099 relative to 1971–2000 for E1 and A1B SRES. The largest proportional increases in the index for the period 2090–2099 relative to 1971–2000 (under the A1B SRES[34]) include part of Mediterranean Europe. Increases in fire danger are lower under the mitigation scenario (E1[35]), but they generally affect the same regions as under the A1B scenarios.

Despite the availability of global projections for increases in Forest Fire Danger Index linked to climate change, and the detailed study by Kević (2013) that looks at the relationship between meteorological parameters (linked to forest fire risks) and trends in forest fires in Šibenik-Knin County, it is impossible at the moment to make reliable projections for the future incidence of forest fires and, therefore, estimates of the costs of future damage in the county (the related studies by Callaway et al., 2010).

The above data on the costs of recent interventions show that such cost might be significant in years with a high incidence of fires. Moreover, these costs do not include the financial costs of lost production, environmental costs, or the human costs of fires. The contribution of forestry to the total GDP and GVA in the County is reported only as part of Agriculture, Forestry and Fishery in official data. In 2010, it was only about five percent and has been decreasing in recent years. We can conclude from this data that income from forestry is a relatively small part of the County's total economy and the potential impact on this income from fire damage caused by climate change impacts will also be relatively low compared to the potential cost of climate change impacts on the larger sectors of the economy. It is difficult to estimate the contribution of forests to tourism, but it might be considered significant, since they are an important factor of attraction of the county. Finally, forests also make a part of the cultural identity of the locals. Estimating these values is beyond the scope of this study.

To summarize, high temperatures and drought conditions might raise the risk from wildfires by increasing their frequency and severity. Climate projections for southern Europe and the Mediterranean region suggest decreased precipitation and increased temperature variability, dry spells and droughts, and intensity of heat waves. These factors would result in the increased length and severity of the fire season, areas at risk and the probability of large fires. Therefore, building synergies with the rural and agricultural development policies, spatial planning, energy or environmental policy provides an opportunity to enhance prevention activities.

This eco-boat from Šibenik-Knin County, which has also been equipped for firemen, is an example of cooperation between sectors.

[34] The A1B scenario reflects a medium-to-high emission trajectory and leads to mid-range estimates of a global average temperature change of about 3.4°C by 2100 (IPCC, 2007) relative to pre-industrial levels.

[35] The E1 scenario is a mitigation scenario aimed at achieving the EU's two-degree goal (global warming relative to pre-industrial levels).

5.4 Climate Change Impacts on Health

A number of possible direct health impacts from climate change include heat-related mortality and morbidity, increased risks of food and vector-borne diseases, and deaths and injuries from flooding. In addition, indirect risks to health include impacts on water, waste water and energy infrastructure from extreme weather events. But there may also be possible benefits to health, such as reductions in cold-related morbidity and mortality (Callaway et al., 2010).

Increases in heat-related morbidity and mortality are associated with rising temperature and an increased incidence of heatwaves. The study by Kovats et al. (2011) on the impacts and economic costs on health in Europe estimated an additional 26,000 deaths per year from heat by the 2020s, rising to 89,000 per year by the 2050s and 127,000 per year by the 2080s. These are figures for the EU-27 countries and are geared to a medium to high emission (A1B) scenario with no mitigation or adaptation. While the study did not cover Croatia, we have estimated the possible order of magnitude of additional deaths in the country, assuming that such increases are in the same proportion to the total population as the EU average in the Kovats study, and assuming a stable population in the future. This calculation indicated an additional six deaths per year from heat by the 2020s, rising to 20 per year by the 2050s and 28 per year by the 2080s under the same high emission scenario and with no mitigation or adaptation.

However, there are two reasons to believe that impacts in Šibenik-Knin County may be higher than the *per capita* average in Europe that we have assumed here. First, the Kovats study concludes that there are higher relative risks to Mediterranean countries from heat-related health impacts. Second, the County has a larger than average older population, as described in Section 2, which is at greater risk from heat-related impacts. Nevertheless, our preliminary assessment is that heat mortality is likely to be a relatively small impact in the short and medium term, when the average summer temperature increases for the period 2011–2040 are projected to be around 1 to 2°C.

Health impacts from flooding and storm surges are not easy to predict in terms of the number of people affected and the severity of impacts. The Europe-wide analysis by Kovats projected the total number of additional deaths from coastal flooding resulting from climate change alone to be 29 per year by the 2020s, 105 by the 2050s and 621 by the 2080s under the A1B scenario without adaptation. We have not estimated impacts in Šibenik-Knin County by scaling down these figures because the risks from flooding are very location specific, but we note that in terms of additional deaths the numbers may be much lower than for heat-related impacts based on those results. Section 4.4 of this report on water management has also noted that the expected increased incidence of flooding will present a higher risk of water contamination/ pollution in particular in low-lying coastal areas and in some other areas, including increasing the vulnerability of Krka National Park.

An increase in extreme climate events may also cause greater maritime accidents that result in an increased threat to human safety. However, we do not have projections for increased risks to human health from such events in Šibenik-Knin County.

Climate-related impacts on the incidence of food and vector-borne diseases are also possible for those diseases sensitive to ambient temperature. For example, the Kovats study estimated that climate change could lead to an additional 7,000 cases per year of salmonellosis in the EU-27 under the A1B scenario by the 2020s, rising to 13,000 by the 2050s and to 17,000 by the 2080s if the baseline incidence remains at current levels. This study has not assessed the specific risks of these diseases in the county since they entail complex calculations and need more background data than is available.

This preliminary assessment suggests that the short- and medium-term health impacts of climate change in the County are likely to be relatively minor. The key impacts to consider are heat-related and flooding, although more County-specific research is needed to estimate the relative significance of these impacts and to investigate further other potential impacts, such as increases in food and vector-borne disease.

5.5 Climate Change Impacts on Cultural Heritage

The coast of Šibenik-Knin County has a number of protected historical and architectural sites. They are of particular interest to tourists, but they are also an important part of local and national cultural identity. These sites may include an entire district of a town or a village within which there may be separately protected ancient buildings.

Cultural heritage sites have already been affected by sea-level rise around the world. Even without a future temperature increase, 40 UNESCO World Heritage Sites have been impacted by SLR (Marzeion and Levermann, 2014). Šibenik-Knin County is no exception. Many protected historical and architectural sites are located in areas vulnerable to sea-level rise, as shown in Figure 5.3, which has a map of these sites and a vulnerability index number for the impacts of climate change and variability. This index is based on the assessment of vulnerability factors – with 1 being the least vulnerable and 5 being the most vulnerable – from Baučić (2014).

The total length of the coastline on which these sites are located is 17 km, or four percent of the coast (excluding uninhabited islands, islets and rocks). These areas contain some very valuable cultural heritage sites (for example, the historic centre of Šibenik with the UNESCO-protected Cathedral of St. James), which are also tourist attractions. Although we do not have information on the number of visitors or revenue that has been generated (from entrance fees to these sites) and there are no economic valuations of these sites, they are clearly important for tourism and local heritage. Indeed, in addition to the clean sea and beautiful natural surroundings, the rich historical heritage sites are a key attraction of the Croatian Adriatic. These can also be an important feature for extending the season, if they are smartly integrated into the tourist offer.

Figure 5.3: Distribution of protected historical and architectural sites and vulnerability index for Šibenik-Knin County. Source: Reproduced from Baučić (2014).

6 Conclusions

This section provides general conclusions on the key economic impacts of climate variability and change in Šibenik-Knin County based on the assessments in the preceding sections. Table 6 summarises the different types of impacts by sector and shows the likely relative order of magnitude of potential and existing CVC impacts on different sectors and issues. It does this by giving a simple rating of the likely significance of impacts without adaptation on (i) the sector itself and (ii) the total local economy (i.e. taking into account that sector's current relative contribution to GDP). The ratings are from –3 (most negative) to +3 (most positive) for both the medium and long term. We do not assign an overall rating for the long-term impact on the County's economy because there are too many unknown factors about how that economy will be structured by the end of the century.

The table shows that the greatest potential impacts of CVC on the Šibenik-Knin County will be reflected in the damage to coastal assets. This means that primary residents, owners of the secondary houses and tourism facilities located in the low-lying coastal zones will be particularly affected. This also includes the assets for nautical tourism and protected sites. Other impacts on tourism are likely to be smaller. Current analysis on potential impacts from changes in temperature and rainfall is rather inconclusive. The overall economic effects of temperature change on tourism in the county also depends on whether the summer holiday high season remains in July and August, or if it shifts even partly to the spring and autumn. Even without climate change considerations this shift may be a positive development for the tourist industry because it would even out demand and increase total tourism revenues. It may also have other benefits, such as reducing environmental impacts during the summer season.

The overall economic impact of CVC on agriculture is difficult to assess due to the range of different products and impacts on the sector, but it is likely that olive and wine grape production will benefit from climate change.

In addition to the sectors discussed in this report, the table also includes preliminary ratings for manufacturing industry, infrastructure and health. The manufacturing industry is a key sector in terms of its contribution to GDP and the number of activities that it includes. Most of the heavy industry in the County has closed down; manufacturing is represented mainly by light industries. Overall, we have concluded that the direct impact from climate change is likely to be small since most of these businesses are located on industrial parks that are not in areas threatened by sea-level rise and their production will not be greatly affected by changes in temperature and rainfall.

Health impacts refer to increases in morbidity and mortality associated with rising temperatures and the increased incidence of heat waves. Our preliminary assessment is that these impacts are likely to be a small in the short and medium term when the average summer temperature increases for the period 2011–2040 are projected to rise by 1 to 2°C. Other health impacts are possible due to extreme events (such as flash flooding), but this is not easily predicted in terms of the number of people affected and the severity of the impacts.

Table 6.1: Summary of CVC impacts in Šibenik-Knin County by sector and issue.

Priority Sector/Issue	Climate hazards	Potential Economic Impacts	Significance of impacts on sector in medium term (up to 2050)	Significance of impacts on sector in long term (up to 2100)	Significance of impacts on whole of local economy in medium term (up to 2050)
Tourism	Change in seasonal temperature	Changes in total tourist visits and expenditures	–1 to +1 (Results inconclusive and possibly positive)	0 to –3 (depending on climate scenario)	–1 to +1
	SLR	Damage to assets and infrastructure as well as nautical tourism	–2	–3	–2
	SLR	Damage to assets and infrastructure impacting tourist expenditures related to historic sites	–2	–3	–1
	Effect of CVC on ecosystems and water flows	Changes to attraction and expenditures for national parks	Unable to estimate		
Forest fires	Higher temperatures and droughts	Increase in frequency and severity of wildfires	–2		–1
Agriculture	Change in temperature, precipitation, and weather extremes	Change in agricultural yields and incidence of disease e.g. olives	0 to+1 (wine grape production) 0 to+1 (olive production)	0 to+1 (wine grape production) 0 to+1 (olive production)	0 to+1 (wine grape production) 0 to+1 (olive production)
	Changes in frequency and severity of extreme weather events	Damage to agricultural production	Unable to estimate	Unable to estimate	
Fisheries	Warmer sea temperatures	Change in the distribution of fish species and number of invasive species that may affect fishing catch	Unable to estimate		0 to –1
	Increasing salinity	Impact on shellfish farming, e.g. around the Krka River	Unable to estimate		0 to –1
Sea-Level Rise	Flooding and other SLR related effects	Damage to coastal assets caused by sea floods	2 to 3	3	2 to 3
Infrastructure (Transport water, waste)	Changes in rainfall. Total and seasonal distribution.	Water supply and summer demand management. Water availability for tourism, agriculture and energy production	–1	–2	–1
	Flooding/wave surge/SLR	Harbour damage. Loss to ferry services in storms and flooding.	–1	–1	–1
Energy	Change in supply potential due to change in climate conditions	Possible changes in potential for hydro, wind, solar. Increase of energy demand during hot periods.	–1	–1	–1
Manufacturing			0	0	0
Health	Increased temperature and incidence of heatwaves	Increases in morbidity and mortality	–1	–2	–1

7 Policy recommendations

Like the other coastal counties of Croatia Šibenik-Knin County has been faced with an economic decline, which has resulted in unemployment and an uncertain future. Understandably, its plans are focusing on ways to create sustainable development based on its comparative advantages, which clearly include a central role for tourism because of its natural coastal capital, but the plans also include the development of the County's potential in agriculture, fisheries (especially aquaculture) and possibly energy.

Any development plan must bear in mind the need to make the economic structure of the country more resilient to possible shocks, both natural and economic.[36] In this report we have focused on one important source of such shocks, climate variability and change. There is strong evidence that the climate will become warmer, with longer and possibly more intense floods and droughts. The models all point to an increase in the sea level and an increase in storm surges over the rest of this century.

What are the policy implications of these expected changes to the climate? First, the analysis shows that there is considerable uncertainty about the extent of the impacts. They depend in the medium to long term on how successful the global community will be in limiting greenhouse gas emissions. However, in the short term (i.e. the next two to three decades) the expected impacts will be more or less determined by the current stock of greenhouse gases and the expected increase in these gases in the next decade or so.

The second key factor relates to timing. The climate impacts described above will become more significant as this century progresses, with notable changes after 2050. For the next two to three decades we can work on the assumption of modest increases in current climate variability and increases in sea levels as detailed in the report.

These factors must be considered in the way that the various aspects of climate change are introduced into the planning process. As we have noted, the greatest economic impacts will be on coastal assets, particularly housing and tourism facilities. These assets must be addressed in two ways. First, protection should be provided for those locations with high-value assets. Second, plans for future development and land-use plans should take into account the increased risk of damage from storm surges and sea-level rise. The established setback zones should be adaptable, in a way to take into consideration the latest projections concerning CVC and the related vulnerability assessments. Table 5.3 provides estimates of damages by settlement if current levels of protection remain in force. These estimates can provide a basis for prioritizing the actions needed for protection. One should bear in mind that a strategic retreat might be less costly than hard structures. Other soft adaptation measures, such as early warning systems, insurance, building codes, creating natural buffers, etc. should be developed and applied. The sector most likely to be affected by climate change is tourism, but at this stage it is difficult to see what the implications will be. Some models indicate a decline in visitors with rising temperature, especially in July and August, while others indicate a small increase over the entire year. There is some indication that the peak visitor number in July and August could decline from 2030 onwards (when temperatures may be a degree above current levels) and there is some evidence to support an increase in tourism in the "shoulder" seasons of spring and autumn. Plans for a growth in tourism over the next two to three decades (which has to be part of a resilient County economy) should consider these possible changes in demand. A spread out tourist season may be environmentally and economically desirable by reducing pressure on natural resources and by creating employment over a longer period. The other area where this sector is vulnerable to climate change is nautical tourism. Here, it is important for existing marinas to be protected against sea-level rise and storm surges and for new ones to be built at locations where such protection is not needed or where it can be justified based on the potential revenues from development.

[36] For a further discussion of the notions of resilience in economic development see *https://www.um.edu.mt/__data/assets/pdf_file/0013/44122/resilience_ index.pdf*

Similar considerations apply to the development of fisheries, an area that has been in some decline. The prospects for raising the level of activity in this sector are positive, but they require investment in better equipment. The impact of climatic factors on this sector is difficult to predict at the local level and would need further research.

An important role could also be played by aquaculture. As fisheries provide significant feed and seed inputs, the impacts of climate change on them will, in turn, affect the productivity and profitability of aquaculture systems. The vulnerability of aquaculture-based communities will stem from their resource dependency and their exposure to extreme weather events. Important issues in evaluating long-term investments in this sector include possible reductions in dissolved oxygen with higher temperatures and increased acidity (lower pH). The overall impacts are complex, but they might even be positive for some species. Further careful analysis of the likely changes and species-specific assessments are required, but they are definitely worth making before making major investments.

Other areas on which climate change could have an impact are agriculture, forests, infrastructure, energy and manufacturing. Of these, perhaps the most affected by climate is agriculture, an especially increased potential from wine production and olive growing. The evidence is based on studies of the wider Mediterranean region, so further local research is needed on varieties, planting and harvesting times, etc. This should be part of a programme of expanding these activities as part of the development of a resilient economy. In the case of forests additional resources will be needed to manage fires and they should be incorporated in government budgets. We have not been able to assess the infrastructure and energy sectors (except for buildings in coastal locations); both of these sectors can be affected by damage to harbours and ferry services, flood damage to roads, water supply systems, etc. Such an assessment should be part of the national adaptation plans for Croatia, which are now being prepared.

In summary, this report contributes to the objective of creating a "platform for sustainable development in the Šibenik-Knin County coastal zone based on water as its fundamental resource, a blue economy and smart specialization" by identifying the risks and opportunities arising from climate change.

8 References

Amelung, B. and Viner, D. (2007) "The Vulnerability to Climate Change of the Mediterranean as a Tourist Destination", in Amelung B., Blazejczyk K., Matzarakis A.: *Climate Change and Tourism – Assessment and Coping Strategies*, Maastricht – Warsaw – Freiburg, 2007.

Amelung, B. and Moreno, A. (2009) *Impacts of climate change in tourism in Europe, PESETA-Tourism study* (JRC Scientific and Technical Reports). European Commission — Joint Research Centre, Institute for Prospective Technological Studies.

Baučić, M. (2014) *Vulnerability analysis of coastal areas of Šibenik-Knin County with a focus on climate change and variability*, Working Report as an Input to the ClimVar & ICZM Project.

Becker, A., Acciaro, M., Asariotis, R., Carera, E., Cretegny, L., Crist, P., Esteban, M., Mather, A., Messner, S., Naruse, S., Ng, A.K.Y., Rahmstorf, S., Savonis, M., Song, D., Stenek, V., Velegrakis, A.F. (2013) A Note on Climate change adaptation for seaports: A challenge for global ports, a challenge for global society. Climatic Change. doi: 10.1007/s10584-013-0843-z

BEF (2014) *Adaptation to Climate Change in Croatia: Country Brief*, Prepared by Baltic Environmental Forum for the project CroAdapt.

Caesar, J. and Golding, N. (2011) *Meteorological factors influencing forest fire risk under climate change mitigation*, report by Met Office Hadley Centre for AVOID research programme.

Callaway, J. M., Kašćelan, S. and Markovic, M. (2010) *The Economic Impacts of Climate Change in Montenegro: A First Look*, UNDP, Montenegro. Available at: http://www.adaptationlearning.net/sites/default/files/The%20Economic%20Impacts%20of%20CC%20in%20Montenegro%202009.pdf

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., et al. (2009) Projecting global marine biodiversity impacts under climate change scenarios. Fish Fish. 10, 235–251.

Corona, P. et al. (2008) Economic Valuation of Forest Fire Damages: Toward a common methodology at European level.

EEA (2012) Climate change, impacts and vulnerability in Europe 2012, EEA Report 12/2012.

EU (2014) "Europe in a Changing Climate" Initiative. http://www.climateadaptation.eu/croatia/climate-change/

FAO (2010) Global Forest Resources Assessment 2010. Main report. FAO Forestry Paper No. 163. Rome.

ForestEurope (2010) Assessment of Forest Fire Risks and Innovative Strategies for Fire Prevention, Ministerial Conference on the Protection of Forests in Europe, Oslo.

Fredotović, M., Golem, S., Kordej De Villa, Z., Markandya, A., Pavlinović, S., Rašić Bakarić, I, Slijepčević, S., Starc, N. (2014) Economic and Social Assessment of the Croatian Coastal Zone, July 2014.

Hinkel, J., Vafeidis, A. T., Lincke, D. and Wolf, C. (2015) Assessment of Costs of Sea-Level Rise in the Republic of Croatia Including Costs and Benefits of Adaptation – DRAFT. Integration of climatic variability and change into national strategies to implement the ICZM Protocol in the Mediterranean: National level assessments for Croatia, June 2015.

Institute of Economics, Zagreb and Faculty of Economics, Split (2015) Economic and Social Assessment of the Croatian Marine and Coastal Zone. UNEP MAP PAP/RAC, Split, Croatia.

IPCC (2007) IPCC Fourth Assessment Report: Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability.

Kovats, S., Lloyd, S., Hunt, A. and Watkiss, P. (2011) Technical Policy Briefing Note 5: The Impacts and Economic Costs on Health in Europe and the Costs and Benefits of Adaptation, Results of the EC RTD ClimateCost Project. In: Watkiss, P. (Editor), 2011. The ClimateCost Project. Final Report. Volume 1: Europe. Published by the Stockholm Environment Institute, Sweden, 2011. ISBN 978-91-86125-35-6.

Kević, M. (2013) Report on Forest Fires, for Plan of Integrated Coastal Zone Management Šibenik-Knin County.

Kovats, R.S., R. Valentini, L.M. Bouwer, E. Georgopoulou, D. Jacob, E. Martin, M. Rounsevell, and J.-F. Soussana, (2014): Europe chapter in: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects*, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1267-1326.

Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.-M. Devernay, M. Freitas, D. Hall, Å. Killingtveit, Z. Liu (2011): Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lange, M. & Marković, A. (2014) Climate Trends and Risks in Croatia http://www.kas.de/upload/dokumente/2014/12/Climate_Report/Croatia.pdf

Lay, V. (2013) *Report of the 2nd "Climagine" workshop, 8th November, 2013*, written by Vladimir Lay, consultant of the Blue Plan RAC.

Magnan, A., Hamilton, J., Rosselló, J., Bujosa, A. and Bille, R. (2012) Mediterranean tourism and climate change: identifying future demand and assessing destinations' vulnerability. In: *Regional Assessment of Climate Change in the Mediterranean (A. Navarra* and L. Tubiana, eds.). Springer, Dordrecht, the Netherlands (CIRCE Study).

Margeta, J. (2014) Vodni resursi i vodna infrastruktura (in Croatian). Input for the Coastal Plan for Šibenik-Knin County.

Marzeion, B. and Levermann, A. (2014) Loss of cultural world heritage and currently inhabited places to sea-level rise. *Environmental Research Letters*, 9, 034001, doi:10.1088/1748-9326/9/3/034001

MENP (2014) Sixth National Communication and First Biennial Report of the Republic of Croatia Under the United Nations Framework Convention on Climate Change, Republic of Croatia, Ministry of Environmental and Nature Protection, November 2014.

Metroeconomica (2011) Application of Methodology for Climate Change Risk Assessment for Integrated Coastal Zone Management in Buna/Bojana Region of Albania and Montenegro, report by Taylor and Anneboina under the supervision of Prof. A Markandya.

Ministry of Tourism (2013) Croatian Tourism Development Strategy until 2020. http://www.mint.hr/UserDocsImages/Strategy-tourism.present.pdf

Pascual, M. & Markandya, A. (2014) *Values of Fixed Assets in Croatia*, Working Report as an Input to the Climate Variability Project, Prepared by, BC3 and Metroeconomica.

Perch-Nielsen, S. L., Amelung, B. and Knutti, R. (2010) Future climate resources for tourism in Europe based on the daily Tourism Climatic Index. *Climatic Change* 103(3-4), 363–381.

Ponti, L., Gutierrez, A. P. and Dell'Aquila, A. (2014) "Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers", *PNAS*, vol. 111 no. 15.

RDA (2011) *Regional Development Strategy*: Šibenik-Knin County (2011-2013), Regional Development Agency of Šibenik-Knin County, March 2011.

Roson, R. and Sartori, M. (2012) *Climate Change Impacts on Tourism in the Mediterranean*, draft report. ecomod.net/system/files/tourimp.pdf

Rutty, M. and Scott, D. (2010) Will the Mediterranean become "too hot" for tourism? A reassessment. *Tourism and Hospitality Planning & Development 7(3),* 267–281.

Scott, H., D. McEvoy, P. Chhetri, F. Basic, and J. Mullett (2013) Climate change adaptation guidelines for ports. Enhancing the resilience of seaports to a changing climate report series. Gold Coast, Australia: National Climate Change Adaptation Research Facility.

Šimac, Z. and Vitale, K. (2012) *Climate Vulnerability Assessment: Croatia*, for the project "South East European Forum on Climate Change Adaptation" (SEEFCCA), May 2012.

TOMAS (2014) *Attitudes and expenditures of tourists in Croatia*, the Institute for Tourism, Zagreb.

TOMAS (2012) *Attitudes and spending of boaters in Croatia*, TOMAS NAUTIKA Yachting 2012, the Institute for Tourism, Zagreb.

UNDP (2008) A Climate for Change: climate change and its impacts on society and economy of Croatia. Human Development Report Croatia 2008. United Nations Development Programme.

UNDP Project COAST (2013) Nature and People Together: Guidelines for sustainable rural development in Dalmatia, April 2013.

van Vliet, M. T. H., Vogele, S. and Rubbelke, D. (2013) Water constraints on European power supply under climate change: impacts on electricity prices, Environmental Research Letters, 8, 035010, 10.1088/1748-9326/8/3/035010

WTTC (2014) Travel & Tourism: Economic Impact 2014, Croatia, World Travel & Tourism Council.

Annex: Data on Tourism

Table A1. Šibenik-Knin County: Number of tourists and tourist facilities (2007-2011).
Source: Croatian Bureau of Statistics, Statistical Reports (Annual).
** Since 2009, this data has been published in Nautical Tourism Capacity and Turnover of Ports (Annual).*

	2007	2008	2009	2010	2011	2012	2013
Rooms, apartments and camping sites	21,428	20,416	20,340	20,584	21,427	20,751	20,975
Moorings in nautical ports *	2,846	2,846	3,051	3,001	3,081	3,510	3,529
Total beds	78,587	75,617	74,047	64,961	65,763	63,567	73,696
Total tourist arrivals	820,312	822,879	746,532	634,614	650,059	657,371	716,849
Domestic tourist arrivals	132,498	137,149	107,787	99,901	106,646	96,406	109,856
Foreign tourist arrivals	687,814	685,730	638,745	534,713	543,413	560,965	606,993
Total nights	3,920,068	3,978,112	3,799,217	3,783,823	3,975,122	4,139,536	4,513,814
Domestic tourists nights	532,213	565,864	492,087	471,277	508,729	471,601	526,244
Foreign tourists nights	3,387,855	3,412,248	3,307,130	3,312,546	3,466,393	3,667,935	3,987,570

Table A2. Šibenik-Knin County Seasonal Tourist Arrivals and Nights (2014).
Source: Tourist Board of Šibenik-Knin County (except expenditure estimates).

	Arrivals	Nights	Arrivals%	Nights%	Expenditure (million €)[37]
Jan	1,719	7,902	0.2	0.2	0.5
Feb	1,720	7,310	0.2	0.2	0.5
March	5,809	18,005	0.8	0.4	1.2
April	25,267	80,852	3.3	1.7	5.3
May	42,134	156,406	5.6	3.3	10.3
June	101,076	530,357	13.3	11.0	35.0
July	214,322	1,547,473	28.2	32.2	102.1
Aug	254,061	1,815,289	33.5	37.8	119.8
Sept	78,944	513,478	10.4	10.7	33.9
Oct	26,758	101,055	3.5	2.1	6.7
Nov	4,395	13,445	0.6	0.3	0.9
Dec	2,884	11,053	0.4	0.2	0.7
Total	**759,089**	**4,802,625**	**100.0**	**100.0**	**317.0**

Table A3. The significance of nautical tourism for Šibenik-Knin County.

	Croatia	Šibenik-Knin County	Share of County
Population	4,284,889	109,375	2.55%
GDP in 2011 (million HRK)	328,737	6,434	1.96%
Share in the coastline length (km)	6,278	970	15.45%
Number of moorings in 2013	16,940	3,529	20.83%
Number of berths for land storage	5.473	938	17.14%
Number of vessels in nautical ports as on 31.12. 2013.	13,735	2,920	21.26%
Number of vessels in nautical ports, 2013	182,921	41,.963	22.94%
Profit realised by nautical ports in 2013 (thousand HRK)	686,660	191,807	27.93%

[37] Expenditure estimated using average daily expenditure of € 66 from Tomas 2014.

Table A4. Locations of Existing and Planned Marinas in Šibenik-Knin County.
Source: Šibenik-Knin County, Spatial Plan of Šibenik-Knin County, September, 2012.

Town/Municipality		Number	Settlement	Name of Port	Existing area of waters (ha)	Total max area of waters (ha)
Existing	District of Murter-Kornati	1.	Murter	Hramina	5.1	7.0
		2.	Kornati	Podražanj (Žut)	3.1	5.1
		3.	Kornati	Piškera (Kornati)	2.5	25
	District of Tisno	4.	Betina	Betina	1.39	1.39
		5.	Jezera	Jezera	3.25	3.25
	City of Vodice	6.	Vodice	Vodice	5.35	7.0
	District of Tribunj	7.	Tribunj	Tribunj	4.02	4.02
	City of Šibenik	8.	Šibenik	Solaris	2.99	10.0
		9.	Šibenik	Mandalina -Kulina	12.92	12.92
	City of Skradin	10.	Skradin	Skradin	3.06	5.0
	District of Primošten	11.	Primošten	Kremik	9.33	10.0
	City of Rogoznica	12.	Rogoznica	Frapa	14.13	14.13
	City of Pirovac	13.	Pirovac	Pirovac	3.25	3,25
Planned	City of Tisno	1.	Tisno	Luka	0	4.7
	City of Šibenik	2.	Šibenik	Crnica	0	10,0
		3.	Kaprije	Uvala Kaprije	0	3.5
Total					**70.39**	**103.76**

Table A5: Estimate of Expenditure by Charter Vessel Tourists (2014).

Tourist Zone	Port	Tourist Nights on Charter Vessels at ports	Expenditure (Euros)
Jezera	ACI Jezera	19,276	3,257,644
Jezera	ACI Skradin	1,834	309,946
Vodice	ACI Vodice	1,012	171,028
Jezera	ACI Žut	18	3,042
Betina	Betina	21,517	3,636,373
Šibenik	Municipal Port of Šibenik	5,601	946,569
Jezera	Jezera	7,707	1,302,483
Kornati	Kornati	15	2,535
Betina	Marina Betina	22,944	3,877,536
Rogoznica	Marina Frapa	33,552	5,670,288
Murter	Marina Hramina	71,112	12,017,928
Primošten	Marina Kremik	93,170	15,745,730
Tribunj	Marina Tribunj	121	20,449
Murter	Murter-Hramina	1,368	238,280
Pirovac	Pirovac	24,408	4,251,420
Primošten	Primošten	877	152,757
Šibenik	Raslina	119	20,111
Rogoznica	Rogoznica	18,733	3,262,940
Skradin	Skradin	690	116,610
Vodice/Šibenik	Solaris	24	4,056
Šibenik	Šibenik	158,385	26,767,065
Tisno	Tisno	199	33,631
Tribunj	Tribunj	4,167	704,223
Vodice	Vodice	25,199	4,258,631
Zaton-Šibenik	Zaton (Šibenik)	3,341	564,629
Total		**515,389**	**87,100,741**

Strategic Partnership for the Mediterranean Sea Large Marine Ecosystem

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