



## Climate Change Impacts on Coastal Tourism in the Baltic Sea Region

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### Abstract

Climate change impacts will have both positive and negative consequences for the tourism industry in the Baltic Sea region (BSR). Here we identify, based on existing knowledge and new knowledge obtained as part of the Baltadapt project, various aspects of climate change that may impact tourism industry in the BSR. Research findings on climate change impacts on tourist comfort and behaviour, tourism flows, destinations and activities are reviewed for the BSR. Coastal and cold-climate-dependent tourism are highly vulnerable to climate change-related risks. A future warmer climate can also bring new weather-related opportunities to the BSR. The regions' tourism industry has longstanding traditions and innovative enterprises; although tourism adaptive capacities with relation to climate change vary in different parts of the BSR. Most vulnerable will be low income regions, less populated coastal areas and those that depend on wildlife tourism. A review is also given of possible adaptation measures relevant for coastal and cold-climate tourism destinations. Finally, research and knowledge gaps are identified and discussed with the aim to support research, cooperation between science and industry in relation to climate change adaptation and tourism in the BSR.

## 1 Introduction

### 1.1 Scope of the coastal tourism review

This review has been prepared with the objective to compile and analyse existing knowledge on climate change impacts and adaptation relevant for coastal tourism and recreation in the Baltic Sea Region (BSR) (Figure 1). Coastal tourism and recreation are complex sectors that are vital contributors to the quality of life, employment and the economical wellbeing of the region. This review aims at demonstrating the diversity of challenges and opportunities that the coastal tourism in the BSR is facing as a consequence of climate change. The review focuses on tourist comfort and behaviour and changes to tourist flows, coastal tourism destinations and activities in the region (for coastal tourism infrastructure see Krämer et al. (pp. 55-90, this volume)). Only brief insight is given to climate change impacts with relevance to tourism supporting sectors, such as: public health, food, transport, insurance services, construction and indoor climate.

### 1.2 Relevance of climate change impacts and adaptation to tourism

Climate change is perhaps the most pressing environmental issue in the world today, although the tourism sector is a late comer to the discussion of challenges and opportunities due to climate impacts. While the Intergovernmental Panel on Climate Change (IPCC 2007) only mentions tourism in passing (in relation to transport, coastal systems and regional overviews), today studies and publications on climate change impact and adaptation relevant for tourism is growing rapidly in numbers.

Traditionally the seasonal contrast drives demand for summer vacations; and the climate and weather contrast between the source and destination countries of tourists creates major tourism flows at global, European, BSR and national scale (Viner 2006). Tourism has traditionally been considered to be a highly climate-sensitive economic sector (UNWTO and UNEP 2008); some tourism, e.g. beach and skiing, destinations are particularly climate-dependent; since climate is their principal resource (UNWTO 2009). Climate and weather are important factors that influence destination image and tourism resources, long-term tourism demand, the timing of travel, the length and quality of tourism seasons, tourist experience and satisfaction and tourism industry operations and profitability (Becken & Hay 2007, Bigano et al. 2008, Gössling & Hall 2006, Scott and Lemieux 2009, OECD and UNEP 2011, Gössling et al. 2012, Nicholls 2006). Tourist decision-making depends on the weather and climate conditions at the destination (see figure 1) and also at the point of origin. Characteristics of domestic and international travellers and their motivations for travel are diverse and changing with time. Thus tourists' adaptation capabilities to changing weather conditions differ depending from their information and experience. However, evidence shows that the decision to return to a destination is largely unaffected by past experiences of poor weather (Scott & Lemieux 2010).

At the same time tourists can be found in all types of climates and natural landscapes worldwide as tourism operators have adapted to provide tourism services in every climatic zone on the planet (Scott & Lemieux 2010). Each major global tourism market segments has specific needs, opportunities and constraints regarding climate and weather and thus adaptation measures should cover the most vulnerable aspects of tourism industry with reference to sustainability, cost-benefit and social justice principles.

### **1.3 Socio-economic trends of tourism**

When dealing with climate change adaptation in relation to tourism, it is crucial to consider the complexity of tourism industry development trends. Tourism industry is constantly changing and not only affected by the climate system such as its seasonality, inter-annual variability, extreme events and long-term changes, but also to macro-scale sectoral influencing factors such as economic growth or recession, transport access and cost, political stability or security, demographic, and technological, cultural and political change, currency exchange rates, border agreements (Scott and Lemieux 2010). Tourism is a phenomenon characterised also by a high level of dynamism, at least on the extremes. Forms of tourism have continued to multiply, e.g. increase in nature tourism, wellness and health tourism (Butler 2009). The temporal aspects of tourism is changing, e.g. gradual decline in relative importance of the summer holiday and the length of holidays, the increase of second and multiple holidays per year (Butler 2009). Fixed in space and in the usage of existing technical utilities the tourism destinations are transformed at slower speed to respond to tourism demand changes in the form of reinvestment, renovations and building new attractions (Butler 2009). Location of tourism depends on the technology and costs of transportation; particularly long-distance travel depends on energy prices and implications of climate change mitigation policies. The BSR tourism market does not dependent on long-haul travel as it is dominated by domestic tourists and tourists from neighbouring countries and overnight stays (Tables 1 and 2). Europeans are interested in "proximity" tourism, i.e. tourism to destinations/areas close to the usual place of residence (weekend trips); there are growing interest to travel independently, interest in low-cost offers, flexible travel schedules and tourism activities, desire for authentic experience of places and contact with nature and interest in adventure (EC and Eurostat 2008). Demographic change will change the characteristics of tourists; aging tourists will probably prefer convenience, safety, luxury and city trips and short breaks outside the peak seasons (ECORYS 2012a). Tourists will seek tailor-made products or will switch easily from one niche groups or specialized tourism product to another; loyalty towards one or a few destinations and repeat visits will decrease. Greater number and diversity of different destinations can have a better position in the tourism market. At the same time only more successful winter destinations will stay. An increasing number of first-time visitors will depend more on information resources and travel

product advertisements. Individualisation will limit to distinguish homogeneous target groups of tourists. ‘Connectivity’ trend refers to the growing demand for meaningful relations and experiences, e.g. demand for ecologically responsible consumerism where concerns about climate change, environmental pollution and sustainable resource management are integrated (ECORYS 2009). The future tourists that will be better educated will have more focus on their health, food, fitness, and wellness. In the future, anxiety society characteristics will dominate the tourism industry. This means that there will be consumers with two courses of action: fear leads to risk-minimisation and safety concerns; and at the same time complacency leads to risk-taking and the increase of participation in adventure or hazard tourism (Yeoman et al. 2009).

The fragmentation and geographically dispersed value chain of tourism industry contributes to the complex nature of the interactions between tourism, climate system, environment and society (Simpson et al. 2008). More than 90% of all enterprises in the tourism sector employ less than 10 persons that are mainly located in the tourist destination itself and this trend will continue. Due to changes in information technology the tourism industry is undergoing organisational changes and becoming a dynamic, interactive and demand-centred economical activity, where consumers can directly ‘assemble’ a ‘customised’ offer, while tour operators are losing their dominance and these tour operators which remain are becoming global and larger-size enterprises (ECORYS 2009 and 2012a). Coastline tourism and yachting will grow (ECORYS 2012a). Coastal tourism destinations are affected by complexity of changes - primary drivers are tourism itself, the expansion of the built environment, industrial development and trade, fisheries and aquaculture; and secondary drivers for the changes in coastal zone are as listed climate change, provision and supply of energy and agriculture (Vermaat et al. 2005). Maritime and coastal tourism is considered to be a catalyst for economic development of coastal areas. Previously these areas were depended extremely on fisheries and industries related to that, but this is now in decline (EC 2010).

Table 1: Economic dimension of tourism and tourist arrivals in 2011 (Bastis 2013)

Countries	Tourism direct contribution to GDP		Tourism total contribution to GDP	Tourism direct contribution to employment		Tourism total contribution to employment	Tourist arrivals	International tourist arrivals
	%	billion EUR	%	%	number	%	million	%
Russia	1.4	18.5	5.9	1.3	954,000	5.5	-	23.7 million
Sweden	1.8	7.1	5.5	1.7	110,000	5.6	24.0	21
Poland	1.9	6.9	4.8	1.9	306,000	4.7	21.5	20
Lithuania	1.6	0.5	4.2	1.6	22,500	4.0	1.6	60
Latvia	2.9	0.6	7.7	2.8	27,000	7.3	1.6	67
Germany	1.6	41.9	4.6	1.8	709,000	4.9	141.7	20
Finland	2.1	4.1	6.2	2.2	58,000	6.5	10.7	24
Estonia	3.3	0.5	12.7	3.4	18,000	12.4	2.7	67
Denmark	1.8	4.4	6.0	7.0	217,000	11.3	6.2	35

#### 1.4 Tourism system in the BSR

In 2011 the BSR’s tourism industry contributed to 267 billion EUR the total GDP and employed around 7.8 million people in the region (Bastis 2013). In 2011 the BSR had 72 million tourist arrivals (increase by 33% since 2002), 190 million overnight stays (increase by 20% since 2002) and 20,000 tourism establishments (increase by 5% since 2002) with 2.5 million beds (increase by 8% since 2002) (Eurostat data cited in Bastis 2013) (Table 1).

Tourism economic contribution among the BSR countries differs (Table 1). Most of the tourists in the BSR are domestic or from neighbouring countries (Table 2). In the BSR there are no mass tourism sites comparable to the Mediterranean area, but the concentrations of tourists in some areas is very

high, e.g. on the German coast. Large disparities in volumes and intensity of tourism development exist in the BSR. In the Baltic States, international tourists and overnight stays in hotels dominate; in other countries domestic tourists and overnight stays in campsites and other than hotel accommodations dominate, except Finland where hotel overnight stays dominate (Table 2). Tourism is an important economic sector for the southern coastal areas of the Baltic Sea, but also for urban regions located on the coast, islands and archipelagos. The increase in tourism over recent years, both within the Baltic Sea region and from elsewhere, demonstrates the attraction of resorts and their economic potential for the region.

Table 2: Tourist accommodation (Eurostat 2012) and total overnight stays (Bastis 2013)

Countries	Number of bed places, 2010 (1.000)	Change in the number of bed places, 2007–10 (%)	Share of hotels in the total number of bed places, 2010 (%)	Coastal region with the highest number of bed places, 2010	Total overnight stays, million, 2011	Total overnight stays by non-residents, total % and larger segments by country of origin in %, 2011	
EU-27	28 077.5	2.6	43.8	Venezia	-	-	-
Denmark	393.4	4.0	20.7	Sydjylland	28.2	34	25% Germany 18% Norway 16% Sweden 7% Netherlands
Germany	636.4	10.8	32.4	Ostholstein	339.0	19	17% Netherlands 7% Switzerland 7% USA 7% UK
Estonia	39.8	11.7	63.6	Pohja-Eesti	5.4	70	45% Finland 13% Russia 6% Germany
Latvia	27.3	32.0	80.5	Rīga	3.3	67	19% Russia 10% Germany 8% Finland 8% Lithuania 8% Norway
Lithuania	10.9	- 5.6	50.7	Klaipėdos apskritis	3.3	58	16% Russia 14% Poland 12% Germany
Poland	194.2	- 4.2	21.1	Koszaliński	57.2	18	38% Germany 7% UK
Finland	130.4	- 1.0	57.1	Uusimaa	20.0	21	23% Russia 10% Sweden 10% Germany
Sweden	591.9	6.3	30.2	Vastra Gotalands	48.7	24	27% Norway 16% Germany 8% Denmark
Russia	-	-	-	-	189.7	6	-

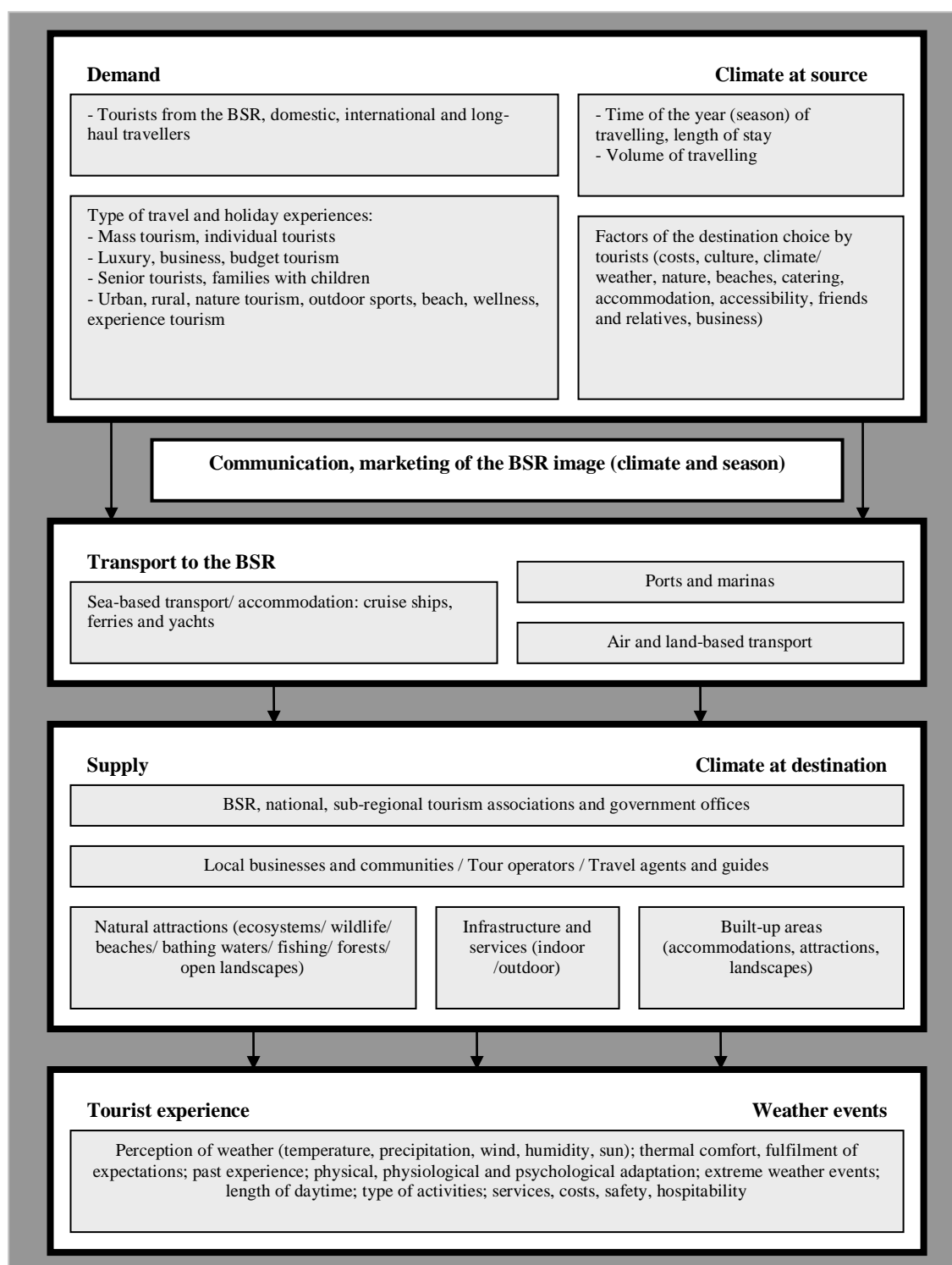


Figure 1: Structure of tourism sector in the BSR.

## 2 Environmental Consequences of Climate Change

Climate and weather as a motivator for travel and a component of the destination image have an impact on tourist demand which will affect destination choice, attraction to particular tourism activities and the timing and the duration of travel. Thus climate and weather can be both an asset for the destinations as well as a disruptor of tourism activities (Day et al. 2013). The impacts of climate change on tourism can be classified as either physical (e.g. the loss of biodiversity, damage to tourism infrastructure), economic (e.g. reduced tourism expenditure, reduced employment opportunities,

increased costs for businesses and society, increased costs for insurance), or social (e.g. health impacts, change of lifestyle, place identity and destination brand) (Buultjens et al. 2007).

## 2.1 Average air temperature rise

According to climate model projections, temperatures in the Baltic Sea area are expected to increase with a mean of 2.6°C by year 2100, and this increase is generally larger than the increase in global mean temperature. It is expected that North European summers will become ‘better’ and appear ‘more reliable’ (Mather et al. 2005). However expected temperature rise will not change the BSR’s core markets, the major change will be on high tourism season extension, the potential to increase the attractiveness of marine destinations and enhancing the BSR as all-year-round short break destination. Irrespective of improvements, the seasonality in the BSR will remain one of the main challenges for the tourism business. The physical “signals” of changes in temperature due to climate change are weak in value compared to variation in temperature due to daily, seasonal, and regional variations. This creates physiological barriers for climate change adaptation measures (Schott et al. 2010). Perception and experience of climate and weather do not depend only on temperature, but on ‘thermal comfort’ that is defined in combination with radiation, wind, humidity, precipitation and the appearance of the sky and quality of light of a location (de Freitas 1990). The BSR’s temperate climate will be more favourable for the family and senior citizen tourism, particularly during periods when other parts of Europe will have higher and intolerable temperatures. The tourist industry is mainly interested in daytime temperature and its changes, rather than in daily mean as nights are normally spent indoors (Førland et al. 2013). Warming can not only impact the ‘thermal comfort’ of tourists, but also their behaviour (Gössling et al. 2008) and the decisions concerning destinations or activities. Rise of temperature might increase the number of people switching from cars and public transport to bicycle and the visitation in national parks and taking part in nature tourism activities (OECD and UNEP 2011). However, the same process can change natural ecosystems and thus nature tourism resources. With milder winters the likelihood of road accidents might be reduced. With a possible increase of tourist numbers in summer months, railways, streets and airports could reach their maximum capacity in the peak season and coastal regions might require new and expanded traffic systems, as well as basic and supra-infrastructure for accommodation, catering, retail and tourism attractions need to be adjusted to increased tourism numbers.

## 2.2 Average water temperature rise and the shrinkage of sea ice

Different climate simulations predict a 2 - 2.5°C increase of the water temperature for the coming 90 years. The warming in the BSR will occur strongest in the northern regions in winter and in the southern regions during the summer months (Störmer 2011). The Baltic Sea surface temperature has large seasonal, interannual and regional variations. Water and air temperature rise combined with less rain in summer have positive impacts on beach tourism, due to a longer bathing and water sports season in the BSR. However, increased water temperatures in summer might also negatively impact tourism with the occurrence of and distribution of various water species like cyanobacterial blooms, jelly fish (Wenk & Janßen 2011), aliened species, and pathogens like vibrio-related diseases (e.g. Cholera) (Störmer 2011).

The maximum sea ice extent in the Baltic Sea has been decreasing since about 1800 and the extent of the maximal cover is projected to shrink further; water and air temperature rise will lead to a shorter period and lesser coverage of sea and coastal surface water ice, although predictions are made with uncertainty (EEA 2012a, Störmer 2011). The resulting changes in the freezing conditions of water bodies and the formation of snow cover are connected to several climatic factors that are hard to predict (Heikkinen et al. 2011). There will still be a large inter-annual variability spanning between almost ice free winters and severe ice winters. Ice-free conditions will be beneficial for water sports, cruise lines and water transport. Ice-fishing and other types of recreation and sports on ice, e.g. ice-yachting, can expect negative impacts from temperature rise (Järvinen et al. 2010, Ekelund 2007).

Milder winters are also likely to cause significant negative consequences in the operation of ice roads (Hudecz 2012).

### **2.3 Change in precipitation patterns**

On an annual mean basis the precipitation in all of the Baltic Sea run-off regions is projected to increase and there is a strong correlation with the increase in temperature. The projected increases are largest and most consistent during winter. In summer the scenarios generally show more precipitation in the north. In the south, with large uncertainty precipitation is projected to change only little, or even decrease. The volume and the type (rain, snow or fog) of precipitation are crucial for tourism attraction and tourist experiences and for the image and marketing of a tourism destination. Snow reliability in Scandinavia will remain higher than in many parts of the Alps, the region could “increase its market share in alpine and Nordic ski sports” (Ehmer & Heymann 2008). Large volumes of snow due to light reflection capability can create idyllic winter destination even in dark sky conditions, while ‘cloudy, windy and rainy winters would not have the same draw’ (Yeoman & McMahon-Beattie 2006). As a result of intensive precipitation landslides and flooding can affect not only tourism accommodation, but also cultural and natural heritage. More intense precipitation events, increased humidity, higher microbial activity, increased growth of fungus and mould can be cause of increased decay processes (e.g. in wood), decreased durability of materials, damaged or flooded buildings and structures (Penney 2012). Negative impacts expected for road maintenance in winter and thus road deterioration, particularly with gravel surfaces (Hudecz 2012). More precipitation, high humidity and fog events can cause lower visibility that will have negative impacts for sightseeing (Førland et al. 2013, Yeoman and McMahon-Beattie 2006), as well as for safe travel, particularly aviation. With less rain in summer, destinations get more attractive, since the risk of rainy holidays will be reduced. An increase in the duration of sunlight slightly increases a shift from car/public transport to cycling/walking (Inturri & Ignaccolo 2010).

### **2.4 Increase of extreme weather events and weather variability**

It is likely, that extreme weather events such as floods, droughts, heavy rains (snowfall) and storms will increase in a future climate. Extreme seasons (exceptionally hot, dry summers or mild winters) or short-duration weather hazards (windstorms, heavy precipitation leading to flooding or snowfall, fog or extreme heats or cold) are crucial for tourism and recreation, particularly to outdoor activities. Population health is sensitive to isolated extreme events (e.g. heavy rainfall and flooding, high and low temperatures, strong winds) through direct impact of through damage to the public health infrastructure, although inferring causal relationships from a single weather event is usually not possible due to lack of sufficient reliable data at relevant spatial and temporal resolution (Kovats and Bouma 2002). Increased occurrence of weather extremes could directly affect tourists, host communities and the tourism industry through basic infrastructure damage, additional emergency preparedness requirements, higher operating expenses (e.g. change of travel plans, increase of insurance costs, awareness campaigns, backup power and water systems, food supply and health care systems and evacuations), tourism business interruption (UNWTO and UNEP 2008) and to tourists to either shifting to other destinations or simply staying at home. It is also a reason for lowering visitor satisfaction (Pang et al. 2013).

There is reported shortcoming is the lack of applicable local wind and wave projections that is important for tourism development (Førland et al. 2013). Wind is used as an essential resource for surfing and kiting. Strong winds will negatively impact fishing, water skiing, motor boating, cruise and ferries. It may for instance impact the timetables of inter-island ferries (Yeoman & McMahon-Beattie 2006). In the BSR, climate change simulations reveal a large spread in changes in wind speed. Projected changes in wind extremes are quite uncertain, with a slight tendency to an increase in the south and a decrease in the north of the BSR. Estonian empirical research shows that storminess in winter has increased (Kont et al. 2011). The climate simulations indicate that the changes in storm

surge height in the scenarios can be consistently explained by an increase in mean sea level and variation in wind speed (Gräwe & Burchard 2012). The largest changes are expected in the extreme values in wind speed and in the increase of wave height and frequency. As a consequence, shallow areas can expect more severe erosion events, although additional studies are needed to understand the local effects of changes in wave conditions in the Baltic Sea now and in the future.

Coastline areas tend to be most vulnerable to storm surges, given that the majority of the tourists reside close to the coast and temporal variations in tourism can cause peak moments which make tourists extra vulnerable to flooding (Kellens et al. 2012). Rising sea levels, combined with storm surges and other extreme weather events have negative impact, particularly on safety aspects on walking, cycling and motoring activities, and cause weather-related traffic disruption and delays, damage to rail-bed support structures and to roadside infrastructure by high winds, flooding and erosion of roadways, as well as landslides and mudslides that damage roadways and tracks (Jaroszweski et al. 2010, Hudecz 2012, Inturri & Ignaccolo 2010). The most severe impacts might occur during peak hours and on already congested routes; adverse weather can also lead to less walking and cycling trips, and this can encourage a shift to motorised transport, although for short trips, particularly in urban areas, the impacts of extreme weather are expected to be rather low (Eichhorst et al. 2010). At the same time it is expected that the number of tourists that consume hazard events and their consequences (e.g. storm chasers and observers, canoeing in flooded rivers) is rising. Trees damaged by the storms and/or costal erosion and left undisturbed by human activities (often in national parks and other nature protection areas) create attractive landscape in coastal nature protection areas preferred by nature tourists. Extreme weather events and infrastructure failure can damage tourism destination image through negative press and feedback from visitors on their return (Yeoman & McMahon-Beattie 2006). Coastal tourism in the BSR are highly affected by seasonality, with summer having a high season, and thus the majority of tourists will not be affected directly by the increase of winter storms, but they may cause damage to coastal infrastructure and thus indirectly affect tourism. Also a smaller number of tourists in coastal resort towns or budget tourists using off-season price advantages might be affected by coastal storm and flood events in winter or spring.

With a projected rise of air temperature there will be an increased risk of long, frequent, and intense heat waves (>35°C daytime) and the occurrence of tropical nights (>20°C), and consequent risks of droughts in the BSR. The increase of the number of days with maximum temperatures above 25°C is another indicator used to measure regional climate extremes and has from territorial perspective relevance for the tourism sector as well as for human wellbeing (ESPON-IRPUD 2011). Heat waves have twofold role for coastal tourism, on the one hand destinations have to be well prepared for such weather events as they will have negative effects on human mortality (Beniston 2007); and on the other hand, warm weather will bring more tourist to the sea coast from nearby urban areas, as well as from more distant places. In periods of droughts and heat weaves the most vulnerable tourists seem to have been campers and caravanners. During extreme heat local people, especially those living in large cities, tended to abandon their cities whenever possible and retreat to the coasts and rural areas joining the normal tourist influx and increasing congestion on roads and beaches (Perry 2006). Foreign tourists do not receive advice or warning on extreme weather events before their departures, assistance is expected from tour operators and guides with little medical knowledge (Perry 2006). Droughts can create dangerous wildfire conditions (see below). Droughts can also have a negative impact on recreational fishing and the length of river-rafting season (Scott & Lemieux 2010), while heavy rains and even floods can have a positive impact on rafting.

## **2.5 Change of the length and characteristics of seasons**

Regional climate influence the characteristics of seasons. In the BSR global warming will result in longer summer tourism season versus shrinking winter tourism season. Seasonal tourism demand is comprised by the interplay of natural and institutional seasonality (Scott & Lemieux 2010, Koenig-Lewis & Bischoff 2005, Butler 2001). Tourism business is particularly dependent on the variability of



weather conditions in the most popular public and school holidays. Fluctuating tourism demand affects tourism flows and thus has an impact also on other sectors like construction, agriculture, and crafts (CM 2009). The variability of weather conditions affects also tourism infrastructure. Increased and more freeze-thaw cycles in cold winter climates, accompanied with higher temperatures can cause premature deterioration of road network, pavement and concrete, increased corrosion, accelerated deterioration of building facades, premature weathering, fractures and spalling (Penney 2012, Hudecz 2012). Uncertainties related to tourist climate preference and destination loyalty require attention if projections of the geographic and seasonal redistribution of visitor flows are being prepared (Simpson et al. 2008). Climate change is likely to alter tourism demand seasonal pattern and patterns of seasonal attractions (Hall & Higham 2005). Any changes in the length of the operating season will have considerable implications for the short- and long-term viability of tourism and recreation enterprises, and will allow quicker returns on investment with more intensive utilisation of facilities over a longer period (Perry 2006). Seasonality co-determines the suitability of locations for a wide range of tourist activities, and has an important influence on the profitability of tourism enterprises and their operating costs, such as heating-cooling, snowmaking, irrigation, food and water supply, and insurance costs (Simpson et al. 2008). Tourism stakeholders consider a shift of seasonality and the changes of seasons' characteristics and length such as belated and shorter winters or earlier summers as of high significance (Tervo-Kankare 2011). The combination of the length of the daytime, temperatures, precipitation and other climate parameters create seasons that have been traditionally important for public and school holidays and thus for tourism and recreation activities. According to climate model projections, the length and characteristics of seasons is expected to change. In Europe the volume of tourism in the future might be twice as high in the summer as in the winter season (ESPON-IRPUD 2011); increased air and sea temperatures and less precipitation in the summer are likely to encourage a longer season of outdoor activities, particularly will be beneficial for the northern part of the BSR. Although improvements of the relative conditions in the shoulder seasons will not change conditions for beach tourism at a large scale in Europe (Moreno & Amelung 2009).

## **2.6 Sea level rise**

Coastal areas have been identified as the most vulnerable when it comes to climate change (Nicholls & Kebede 2012, Moreno & Becken 2009, IPCC 2007, Kont et al. 2008, Kont et al. 2003). Sea level due to global warming is not rising uniformly at all locations. The Baltic, besides Mediterranean and Black Sea coasts are most vulnerable to sea-level rise due to their low tidal range (Vermaat et al. 2005). Coastal impacts also depend on the vertical movement of the land, which can either add (the south of the Baltic Sea) to or subtract from climate-induced sea-level change (the north of the Baltic Sea) (EEA 2012a). The consequences of rising sea levels will differ along the coastline, with lowland areas and densely populated regions being more affected. Other climate-influenced changes such as alterations of streaming patterns, wave and wind motions and extreme weather events can intensify the impact of sea level rise. The total rise will be much larger in the southern and south-eastern parts of the Baltic Sea (up to 60 cm) while the northern part will be less affected due to on-going land rise. Particularly low-laying and sandy seashores and coastal lagoons (Störmer 2011) will be affected. Large natural variability and lack of good quality long observational records makes detecting long-term changes in trends in extreme coastal sea levels difficult (EEA 2012a). The Baltic Sea on shorter time-scales is affected by the local meteorological conditions which may give rise to storm surges and floodings. The rise of sea-level will cause loss of land territory, e.g. beaches, nature and culture heritage and coastal constructions. In some cases the increase of water surface and water table can be used with the purpose of landscaping and nature restoration, e.g. creating green infrastructure. Tourism infrastructure, e.g. hotels, restaurants, access roads etc. and resources e.g. archaeological sites, cultural heritage sites, historic landscapes and coastal habitats, might be threatened or damaged by the rise of sea water level (Vermaat et al. 2005). The infrastructure of coastal protection can confine the attractiveness of coastal views. Infrastructure of ports and marinas, waterfront developments and coastal greenways are sensitive to sea-level rise that in combination with erosion can cause shrinking

of beaches and the relocation of tourist attractions inland. At the same time some coastal areas might experience an enlargement of beaches due to accumulation processes as a part of morpho-dynamic process (Lapinskis 2012). Rising sea levels can also cause salt-water intrusion into low-lying aquifers and endanger coastal ecosystems, wetlands and drinking water supply. Higher flood levels increase the risks to life and property, including sea dikes and other infrastructure, with possible follow-up effects on tourism, recreation and transportation functions. Damage associated with sea-level rise would frequently result from extreme events, such as storm surges, the frequency of which would increase as the mean sea-level rises (EEA 2012a).

## 2.7 Coastal and beach erosion

Several studies report that extreme erosion events caused by increased storminess in the eastern Baltic Sea and the decline in the occurrence of sea ice are observed more frequently (Ryabchuk et al. 2012, Žilinskas 2008, Kont et al. 2008, Lapinskis 2012). BSR-wide projections for coastal erosion are not available (EEA 2012a). There is an uncertainty whether climate change is the cause for increasing cliff erosion in the southern BSR (Wenk and Janßen 2011). The local effects of erosion in different parts of the Baltic Sea should be studied in detail as several factors are affecting coastal erosion (Swedish Government 2007):

- sea level relative to land elevation;
- wave conditions – height, frequency, direction, extreme conditions;
- wind and current conditions – direction, intensity;
- geology/soil types on land and seabed;
- topography and morphology – heights of dunes and areas behind the beach as well as the form of the shoreline; and
- bathymetry – seabed depth and gradient.

Coastal and beach erosion can be intensified by cleaning beaches from litter (and beach wrack) as well as dredging of marinas, that can cause the removal of sand, a highly valuable touristic resource. Some types of tourism and recreational infrastructure (such as restaurants, entertaining centers, yacht-clubs etc.) can cause an acceleration of erosion processes (Ryabchuk et al. 2012). The most extreme erosion events are observed when three hydro-meteorological factors act together: long-lasting westerly or south-westerly storms, high water levels, and the absence of stable sea ice. The coastal erosion processes have become more intensive as the frequency of these combinations has increased (Ryabchuk et al. 2012, Dailidienė et al. 2012). Most beaches have been eroded due to storms (Tonisson et al. 2008); in only a few places accumulation processes have been observed as thus recovery of beaches occurred (Kont et al. 2008). Beach and dune erosion, coastal damages and protection systems may lead to less attractive shoreline, negative impact on coastal destination image and tourism industry as tourists do not prefer artificial coastlines or groynes (Hamilton 2007, Jennings 2004, Buzinde et al. 2010, Kont et al. 2003). Coastal erosion might affect roads, railways, water supply and sewage systems, tourist facilities, valuable land, valuable natural environments and recreational areas. Several studies stress that the Curonian Spit National Park is particularly vulnerable to extreme storm events that might cause spit breaching as it has “weak points” where storm waves can break through the sand body (Ryabchuk et al. 2012, Armaitienė et al. 2007). Numerous studies classify the segments of the Baltic Sea coastline in accordance to vulnerability to erosion (Uscinowicz et al. 2004, Fenger et al. 2008), but a BSR-wide effort is missing to coordinate these studies.

## 2.8 Risk of salt water intrusion into ground water

Sea level rise and floods may cause this problem in coastal regions and on islands, leading to the intrusion of salt water into the fresh water supply system. Potentially most exposed here are the southern sandy shores and less so the rocky shores of the Baltic Sea. Salt water intrusion into ground

water will require investments in new fresh water supply system and maybe leading to limited capacity to accommodate tourists.

## **2.9 Increased risks of forest fires**

Longer fire seasons and the occurrence of dry and hot summers are expected to result in increased forest fire activity and wildfires have already impacted tourism destinations, particularly the eastern part of the BSR, Russia (Hall et al. 2011, Hall 2011). Wildfires have negative impacts on attractiveness and tourist perception, health effects of air pollution, and can cause the loss of recreation opportunities (access to certain areas, ban on open fires, damaged infrastructure, cancellation of nature walking, hunting, berry and mushrooms picking) and the loss of attractions (cultural heritage, landscape and wildlife) (Hall et al. 2011, Brown et al. 2008). Metropolitan, tourist and second-homes areas are more often affected by wildfires, and that can also negatively affect the air quality. Forest fires might threaten or actually destroy camp sites, making campers and caravanners most vulnerable to high risk of wildfire (Perry 2006).

## **2.10 Less fresh water input in summer and increased nutrient loads to the sea**

Changes in precipitation may lead to less fresh water influx during summer. Fresh water is needed for direct consumption in a variety of tourist infrastructure and services, including food production, bathrooms, for laundry and cleaning, swimming pools, spas, irrigated gardens or golf courses. Increased precipitation in winter in turn leads to more river discharge and there will be a risk of more nutrients leaching to the sea, leading at a later stage to more algae blooming during summer time and influence the quality of the sea bathing water (Wenk & Janßen 2011, Mossbauer et al. 2012, Swedish Government 2007).

## **2.11 Rise for prices of water and energy**

Tourism can make strong seasonal pressure on water use on coastal regions (EEA 2012b). Less fresh water in summer in combination with potential growth of demand could increase the price level of fresh water. In very dry summers it may even lead to water shortage and a limitation of water-intense touristic activities (i.e. golfing, indoor swimming or snow-making). There are large differences between countries of the BSR in current average availability of freshwater resources per capita. Latvia, Finland, Sweden and Estonia have the highest rate of freshwater availability. Lithuania and particularly Poland and Germany have comparably low availability of freshwater resources per capita, and thus can expect even more freshwater availability related problems in the future. However even in the countries with average high availability of water resources, warmer summers can create geographically and temporally problematic aspects with quality and quantity of water resources (Swedish Government 2007).

The need for cooling in hot summers in buildings and public transport can raise energy consumption and price. The BSR has experience with heating, while the need for cooling requires new knowledge; it can affect the costs of existing and new buildings. Higher energy prices can have a negatively influence on costs of long-haul travel and thus can decrease the number of long distance international tourists.

## **2.12 Changes in marine and coastal flora and fauna**

Climate is one of the key conditions for the regional biodiversity. With a change of climate new species will appear, others will disappear or move to other locations. Thus nature-based tourism especially in peripheral regions will be affected by species loss and ecosystem changes (Hall & Higham 2005; Gössling et al. 2008). Coastal tourism can be negatively affected by the eutrophication of the Baltic Sea that may worsen due to climate change (Marttila et al. 2005, Störmer 2011). While new and exotic interpreted species may attract tourists, e.g. in parks, gardens, agro-tourist farms, the viniculture at the Baltic Coast (Schernewski 2011), the propagation of other species may lead to direct

health risks (blue-green algae, ticks, mosquitoes) or to problems for coastal infrastructure (naval shipworm) and resources (increase of jellyfish). Recreational sea and coastal fishing might have negative impacts due to changes in species of fish; higher value game fish will be replaced by fish that are not perceived to be of the same value (Swedish Government 2007). Tourism might be affected by the loss of local fish species that are considered as the iconic emblems and used in tourism destination image building and branding such as wild salmon (Yeoman & McMahon-Beattie 2006).

Climate change can reformulate natural landscapes if species or biotopes are changed, and this can have a visual effect on vegetation and landscape that is important issue for scenery-based tourism industry (Yeoman & McMahon-Beattie 2006). Event-based tourism and recreational activities, e.g. in spring and autumn, depend on phenological phases of plants (blossoming or fall foliage seasons); and changes due to climate impacts might have negative implications for tourists and the tourism industry with reference to the timing of trips and their promotion (Scott & Lemieux 2010); studies with relevance to Europe or the BSR are missing. Coastal forests, particularly dry pine forests and high bogs, are well known as recreational resource with opportunities for walking, wild berry (Pouta et al. 2006) and mushroom picking. Bird-watching as an activity of nature tourism is widely developed in coastal areas, including saltwater meadows, wetlands and lagoons of the BSR. Negative climate change impacts might be expected for bird-watching due to the loss of the breeding grounds for birds (coastal meadows, flooded meadows and reed beds) (Kont et al. 2003), although more studies are needed. Change of biotopes and the distribution of species can have an impact on hunting that is a part of rural life style and tourists' activity, particularly in scarcely populated areas; however more studies are needed for assessment. A report by the Swedish Government (2007) suggests that opportunities for hunting should improve with climate change, due to greater production of forage. However, the elk may decline in southern Sweden, thus hunting opportunities will be reduced here. Warmer temperatures, insect (mosquitoes and ticks) disturbances (Epstein 2002) and drought in summer are documented negative impacts on reindeer herding (Keskitalo 2010, Swedish Government 2007) and thus can have an impact on wildlife and nature tourism in the northern parts of the BSR. Despite some reductions, relatively snow-rich winters in the BSR' northern part can offer various tourism activities combined with reindeer husbandry and thus in a European perspective, will become increasingly unique in line with the changes in climate (Swedish Government 2007).

With warmer and drier summers it is projected that tick-borne encephalitis will be driven into higher altitudes and latitudes (Semenza & Menne 2009, Epstein 2002). Tick-borne encephalitis has fluctuated considerably from year to year in many countries of the BSR, the increase in incidence are explained by a number of factors, including climate change, and increased travel and outdoor pursuits, placing people in increased contact with infected ticks (Petri et al. 2010). The distribution of tick, accelerate the spread of Lyme disease; still, higher temperatures are on balance with preferences for public health in northern Europe, "where sicknesses surrounding cold weather greatly outweigh any inconvenience of incidental heat peaks in the summer and tick bites" (Vries 2010).

### **3 Consequences of Climate Change on Coastal Tourism**

There is a limited understanding of how climate change impacts will interact with other long-term social and market trends influencing tourism demand and development (Scott & Becken 2010). Changing preferences and demands for tourism and recreation due to climate change can be studied at the macro level (which demands insights into climatic influences on patterns of mobility) and at the micro level (analysis of specific venues and settings taking into account geographical and climatic diversity) (Higham & Hall 2005). Despite of problems with assessing the relationships between climate change and tourism (Simpson et al. 2008) the only direction towards diminishing uncertainty is to contribute to new issue-relevant research and to review and discuss the existing research findings in order to design proper adaptation measures.

### 3.1 Climatic impacts on tourist comfort and behaviour

Weather stability is an important factor for tourism industry (Agarin et al. 2010); and there has been a longstanding interest to capture, assess or measure the climatic suitability of a potential or existing tourist destination (Becken 2010). Climate is a resource exploited by tourism; from tourism industry to individual tourist there is an interest in criteria for ideal, suitable, acceptable or unacceptable weather conditions that the selection of such criteria is admitted as one of the major problems. De Freitas (2005) summarizes that ideal atmospheric conditions for humans are those producing 'slightly warm' conditions in the presence of scattered cloud (0.3 cover) and with wind speeds of less than  $6 \text{ m s}^{-1}$ . Northern European tourists can have different preferences for ideal beach tourism weather (Morgan et al. 2000). Climate preferences may also change in time (e.g. through acclimatization to a warmer climate) (Moreno & Amelung 2009). For any human body physical, physiological and psychological factors will determinate the acceptable climatic range, while aesthetical, cultural, social and economical factors will play a role when choosing a tourism destination, product, activity or venue. Due to rise of adventure and alternative tourism, often weather parameters that may cause risks to the human body have high appeal and can thus be considered an asset (de Freitas 2003). Although due to technological, societal and environmental changes, suitability of different climates to different forms of tourism is becoming increasingly dynamic and thus will have implications on the future development of the tourism industry (Higham & Hall 2005). The relationship between weather and recreation is highly dependent on the kind of activity that is assessed, with beach recreation or walking requiring different weather conditions; this feature has been ignored in many previous assessments, which may have led to over- and under-estimations of the impact of climate change for specific tourism segments (Moreno & Amelung 2009). Indoor climate plays an important role versus time spent outdoors, e.g. people are spending around 10% of time outdoors in summer and about 4% in winter, according to an epidemiological survey conducted in the United States and Canada (Höppe 2002 in Shiue & Matzarakis 2011). Traditionally tour operators influenced greatly the choice of destinations. Today due to changes in information and communication technologies tourists can adjust their travel to particular destinations and participation in activities according to their individual preferences. Differences in preferences need to be taken into account when portraying climate for potential customers as tourists tend to be more vulnerable to climate than locals, although various segments of tourists have different characteristics with relevance to climate comfort, e.g. age, fitness, cultural background and previous experiences (de Freitas 2003).

Uncertainty on how precisely climate influences tourism will increase. Standard meteorological or climate station data are often not representative for the recreational area, a particular microclimate or location, e.g. valleys, hills, coast or a beach (de Freitas 2005). Incidence of unacceptable weather, extreme weather events and changing visitor perceptions and preferences will change the status of destinations once commonly associated with images of ideal climate (Higham & Hall 2005). Climate change is happening both on global and local scales (Matzarakis 2010) and tourists are acting upon actual weather conditions perceived as short-term events rather than climate. Averages of climate parameters have no physiological or psychological meaning, since tourists respond to the integrated effects of the atmospheric environment (de Freitas 2005). The thermal conditions experienced will vary depending on the relative influence of wind, humidity, solar radiation and level of a person's activity (de Freitas 2005). Although weather extremes are hard to predict, nevertheless they are highly relevant for tourism activity, perhaps even more important than the changes in mean conditions projected by climate models (Moreno and Amelung 2009). At the same time climate variables can play various roles when tourists choose their destinations: some climate variables are entirely physical (e.g. rain), some are physiological (e.g. air temperature), some are psychological (e.g. clear blue skies) and some are combinations of all three (de Freitas 2003) (see Table 3).

Since most physical and aesthetic factors are subjective, more often the thermal factor (Lin & Matzarakis 2011) is used for assessing changes in tourist flows. When tourists experience thermal conditions that are close to their thermal comfort zones, then tourism destinations are more visited in

relation to outdoor thermal condition opposite to conditions that cause thermal stress (Lin & Matzarakis 2011). Most studies are constrained by data availability thus use a single climate factor such as air temperature, relative humidity, or number of sunshine hours, heat waves or sea surface temperatures as a proxy for climate although combined effect remains unexamined (Eugenio-Martin & Campos-Soria 2010, Hamilton & Tol 2007). Several studies use tourism climate index (TCI) (Mieczkowski 1985) or beach climate index (Morgan et al. 2000) with main difference between them in the rating and weighting schemes. Critics note that neither the temperature, nor simplified indexes based on standard monthly and simple climatological elements provide a full account of individual preferences with regard to the choice of destination (Agarin et al. 2010). There is a need for regional tourism climate indexes that must not only relate to generally subjective and context-specific tourist weather perceptions and acceptances, but also might include customised tourism climate indexes attuned to regional visitors, including area-specific weather preferences, dislikes and acceptances, connecting to the commonly extensive range of visitor motives and activities (Førland et al. 2013).

Table 3: Climate and the potential impact on tourism (after de Freitas 2003, de Freitas 2005, Becken 2010, Becken & Hay 2007).

Facet of climate	Significance	Impact
<b>Aesthetic</b>		
Sunshine/cloudiness	Quality of experience, sports, tourism and leisure activities	Enjoyment, attractiveness of site
Visibility	Quality of experience, sports, tourism and leisure activities	Enjoyment, attractiveness of site
Day length	Quality of experience, convenience	Hours of daylight available, enjoyment, attractiveness of site
Snow/ice	Quality of experience, sports, tourism and leisure activities	Enjoyment, attractiveness of site, place image, personal injury, damage to property, hindered mobility
Wind and waves	Quality of experience, sports activities	Enjoyment, attractiveness of site, place image, personal injury, damage to property, hindered mobility
<b>Physical</b>		
Wind	Annoyance, charm, water sports and tourism activities	Blown belongings, sand and dust, waves, hindered mobility
Rain	Annoyance, charm	Wetting, reduced visibility and enjoyment, hindered mobility, slippery terrain
Snow	Annoyance, charm, winter sports and leisure activities	Participation in sports and leisure activities, hindered mobility
Ice	Danger, charm, winter sports and leisure activities	Personal injury, damage to property, hindered mobility
Severe weather	Annoyance, danger	Personal injury, damage to property, hindered mobility
Air quality	Annoyance, danger	Health, physical wellbeing, allergies
Ultraviolet radiation	Danger, attraction	Health, suntan, sunburn
Day length	Convenience	Hours of daylight available for outdoor activities
<b>Thermal</b>		
Integrated effects of air temperature, wind, solar radiation, humidity, long wave radiation, metabolic rate	Thermal comfort, therapeutic, restorative, tourism, sports, and leisure activities	Environmental stress, heat stress, physiological strain, hypothermia, hyperthermia, potential for recuperation

Contexts other than snow-based vacationing and sun and beach-oriented holidaymaking are rarely studied (Aaheim 2012). Research from Northern Scandinavia shows that most tourists considered weather conditions in summer as fairly good and satisfactory or acceptable and that weather aspects

have relatively small behavioural impacts in comparison with overall traveller motives and intentions in addition to aspects such as comfort or wellbeing (Denstadli et al. 2011). An empirical study on German tourist preferences indicates that bad weather can influence particularly the choice regarding shorter trips in local surroundings than long-distance trips as the choice of the destination is not determined by the weather image alone (Lohmann & Kaim 1999). It is combined with other beliefs about natural environment, natural attractions, scenery and beliefs about the built environment, culture and host communities (Nadeau et al. 2008, Dwyer & Kim 2003). Tourist perception, decision-making and behaviour depend on the climate and weather at the destination as well as at the trip origin, but also on the weather forecast and conditions anticipated by traveller (Perry 1972).

### 3.2 Climatic impacts on tourist flows

Studies on tourist flows and their geographical and temporal redistribution and their potential shifts in visitation patterns are built on studies which seek to identify ideal climate or 'comfortable' conditions for tourists, e.g. expressed as climate indices (Becken 2013) (see above). The question of tourist weather perceptions and sensitivities are thus having been actualized since climatic assets among tourism regions are likely to be redistributed with changing climates (Denstadli et al. 2011) by changing existing tourist flows. Amelung & Moreno (2012) argue that in Western countries due to high initial values for the number of bed nights and revenues, the positive results are likely to be an overestimation; as climate change no longer induces a growth in overall tourism volumes, but leads to a redistribution of visitation. The issue of possible climate change impacts on tourist flows also has raised interest for governmental and financial organizations. Finland's national adaptation strategy states that predictions on where the tourism will be directed are prone to several uncertainties, but there is a possibility that northern areas may benefit from increased tourism (Marttila et al. 2005).

Current models predicting future climate conditions for tourism (see Figure 2) and consequent generation of tourist flows are based on two quadratic relationships:

- 1) cool destinations become more attractive as they get warmer, and warm destinations become less attractive;
- 2) cool countries generate less international tourists as they get warmer, and warm countries generate more (Bigano et al. 2008).

The argument that colder countries will benefit and can expand their tourism sector is generally accepted due to its positive message in spite of critical remarks. Present predominant tourist flows from north to south (from northwest Europe to the Mediterranean in summer) and their timing might be changed; tourists in the future might prefer colder countries and places - higher latitudes (Simpson et al. 2008, Schott et al. 2010, Coombes et al. 2009) and altitudes (Bigano et al. 2008). Current models suggest that warmer regions will experience a decrease in tourism ranging from -8% to -20%, whereas regions of higher latitude will expect an increase ranging from 1.3% to 8% (Berrittella et al. 2006). Favourable conditions are suggested not only for the BSR but also for the North Sea and the northern Atlantic coast of Spain and the Canary Islands (Heymann & Ehmer 2009). Particularly senior tourists and nature tourists might prefer northern Europe (Carthy et al. 2001) and it is predicted that the proportion of overnight stays taken by foreign tourists will increase (Ehmer and Heymann 2008). The OECD and UNEP report (2011) criticise a postulate that climate change will lead to larger tourist flows to the Baltic and the Northern countries as a result of heat stress in the Mediterranean region. The report stresses that tourist flows is not affected only by temperature but many other factors, e.g. culture and nature resources and tourism services. It is highly uncertain that tourists currently preferring the Mediterranean region will move to other more northern destinations, e.g. the BSR (OECD and UNEP 2011).

The models suggest that total number of tourists is also reduced due to climate change, because international tourism that is dominated by the Germans and the British would prefer short-haul destinations in neighbouring countries. Tourists will stay closer to home and thus importance of

domestic destinations will increase (Bigano et al. 2008, Becken & Hay 2007). Domestic tourists have a greater consistency regarding destination preferences and a greater loyalty, at the same time regions with poorer climate show higher flexibility in terms of destination choice; and there is less variability in the probability of travelling domestically than abroad (Eugenio-Martin & Campos-Soria 2010). For Germans and Scandinavians their own countries are still their favourite holiday destinations. It is possible that these tourists will stay in their home country in larger numbers than they do now (Heymann & Ehmer 2009). No changes in the number of tourists are predicted for city tourism and for treatment at health resorts in the BSR due to climate change impacts (Heymann & Ehmer 2009). Currently longer-haul tourists (mainly from the USA) play a minor role for the BSR tourism industry. It is suggested that Northern American tourists will travel more to Northern Europe (Mather et al. 2005). At the same time an expected increase in travel prices will affect longer-haul holiday destinations more than closer ones (Heymann & Ehmer 2009).

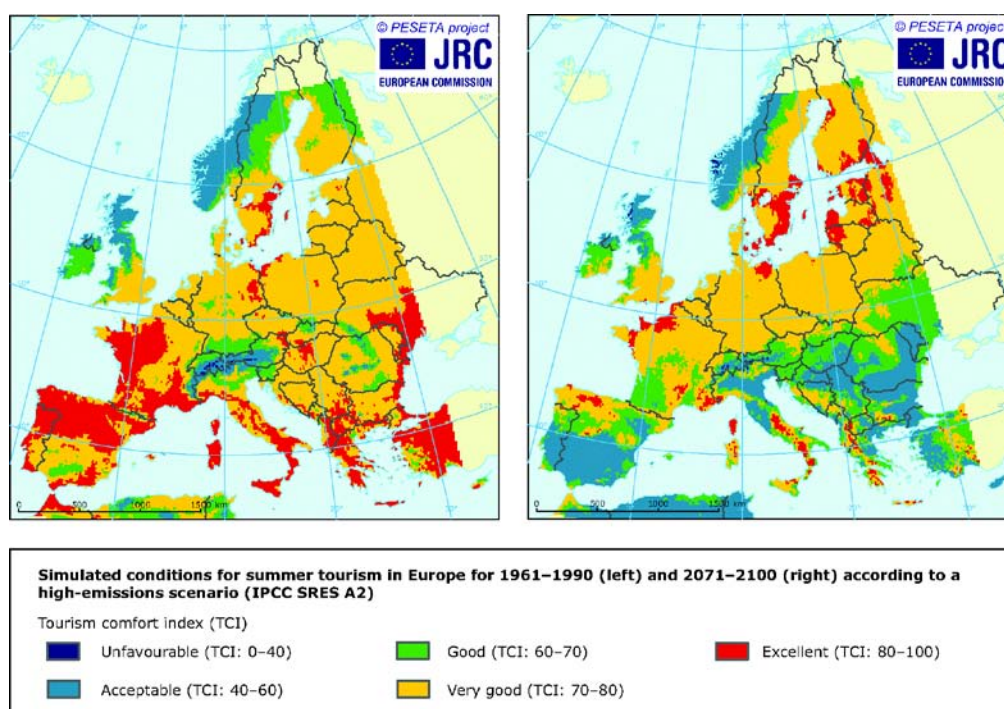


Figure 2: Modelled conditions for summer tourism in Europe for 1961 – 1990 and 2071 – 2100 (EEA 2010, Ciscar 2009, Amelung and Moreno 2009).

Several studies note the weaknesses of current models in predicting travel flows. Current models are not covering all global tourism flows, and mainly focusing on particular nationalities, e.g. German or British tourists; climate is mainly perceived as ‘pull’ factor for tourist motivation; ‘push’ factors that make tourism source areas unpleasant (hot, wet and cold weather) and the possibility of substitution between destinations are neglected. Mainly direct climate impacts on tourism destinations are considered. Uncertainties (Gössling & Hall 2005 and 2006, Goh 2012, Ciscar 2009, OECD and UNEP 2011) of current models are due to very few empirical studies, validity of databases, not adequate time-space resolution in climate data, largely unknown role of weather extremes and other weather parameters influencing thermal and perceived comfort, unclear role of information in decision-making and non-climatic parameters (cultural resources, costs of transport, personal disposable income (economic budget) and availability of leisure time (time budget) in the future, the existence of fuzzy-variables, e.g. terrorism, war, epidemics, natural disasters). Models perceive climate change as event with effects occurring suddenly in a given reference year, while in reality, climate change is phenomenon, which evolves over time, and thus there is time to adapt behaviour of tourists and tourism industry (Berritella et al. 2006).



### 3.3 Climatic impacts on tourism destinations

Competitive relationships between destinations and therefore the profitability of tourism enterprises will be affected by the changes in the length and quality of climate-dependent tourism seasons (Simpson et al. 2008). Indoor or weather independent facilities will not be able to compensate fully for a low attractiveness of the outdoor weather. Flexibility to respond to climate variability and change varies between the subsectors of the tourist industry. Tourist resorts and regions that are the most vulnerable to climate change are a function of (i) the likely magnitude and extent of the climate impact, (ii) the importance of tourism to the local economy and (iii) the capacity to adapt (Agnew & Viner 2001). Suppliers of tourism services and local managers have the least flexibility; and tourists, particularly short-haul, weekend and day tourists, have the greatest flexibility (Agnew and Palutikof 2001). Tourism destinations depend on tourist operators and businesses at the venues. Tourist operators are less affected by climate change impacts as they are often with greater geographical mobility and flexible to change destinations, venues or activities depending on the tourism demands and risks at the destination. Venue-based businesses are place and activity fixed; they tend to have climate change impacts at high priority, regardless of the area of operation (Brouder & Lundmark 2011). Venue-based businesses have over time invested more money in operations and has long-term payback period; they are more aware on place-based future prognosis. Urban tourism can be considered as less climate-sensitive, as it can rely on indoor activities, developed urban infrastructure and skilled-personnel; cities due to diversified activities are often less dependent on tourism-related businesses. Resilience to climate change impacts in urban areas are greatly depends on green infrastructure, flood protection and spatial planning (EEA 2012b), although cities are major gateways for international tourists and thus play a role for tourism development at regional scale.

### 3.4 Climatic impacts on tourism activities

#### Outdoor and nature-based tourism

Climate change may affect outdoor recreation through overall comfort and enjoyment of recreation activities; the quality of the recreation experience, altering the ecological systems of an area and longer summer seasons and shorter winter seasons that will change the availability of certain recreation opportunities (Richardson & Loomis 2005, Moen & Fredman 2007). These changes will produce both winners and losers of recreation activities, where skiing is being widely acknowledged as a potential loser (Moen & Fredman 2007). Interactions of positive and negative aspects for nature-based tourism in summer and winter seasons make it difficult to assess the accumulative impact from climate change (Forsius et al. 2013). Substantial benefits to beach recreation, fishing and boating as well as reservoir, beach, golf, and stream recreation are expected, which offset losses to downhill and cross-country skiing, camping, wildlife viewing, as well as to smaller decline of benefits in forest-based recreation (Richardson & Loomis 2005). Changes of forests due to natural hazards and global warming affect also its recreational value (Blennow et al. 2010), e.g. coastal pine forests are traditionally popular for walking, mushroom or berry picking and cross-country skiing. Overgrowth of forests due to climate change will reduce access for recreationists to favoured areas for activities, and also make some areas lesser suited for traditional outdoor activities (Fyhri et al. 2009). The future of forest-based tourism attractions and destinations, e.g. national parks, do not only depend on climate impacts but also on tourists' perceptions of landscape change (Hall et al. 2011).

For cool weather destinations such as the northern part of the BSR, days with rain are a potential downside of climate change for tourism and recreation. Rain can be an obstacle to landscape sightseeing, nature-based attractions and various types of outdoor recreation, both due to individuals' perceived discomfort of getting wet and feelings of reduced safety (e.g. hiking and trekking in slippery terrain) (Førland et al. 2013). Most of the climate impact studies focus on the tourism industry, however behaviour of tourists and recreationists differs in relation to adaptation to climate change - tourists would change the location, timing and activities of their holidays while recreationists would

adapt only timing and activities (Smith 1990). Heat stress and poor urban air quality in summer may push urban residents out from cities to rural and coastal tourism destinations, and outdoor recreation is likely to increase (Carthy et al. 2001). Statistics regarding levels of participation in outdoor recreation in Europe tend to be collected at the national level and thus create a barrier to prepare comparative studies (Nicholls 2006). Climate impacts on coastal tourism infrastructure might have implications for outdoor and nature-based tourism that not only depend on open access to countryside and sea coastline, but also highly values both nature and facilities (Fredman et al. 2012). Nature-based tourism operators in Finland are currently not aware of climate impacts and adaptation options (Saarinen & Tervo 2006). Increasing temperatures mean that destinations outside large urban areas will become more attractive, there will be greater demand for small-scale, rural, and nature-related tourism, e.g. Baltic States (Agarin et al. 2010). It is expected that with a future warmer climate destinations in northern Scandinavia might be more attractive for tourism, particularly recreational sea fishing, hiking, and outdoor recreation (Denstadli et al. 2011). Destinations that rely heavily upon climate as a touristic resource will be challenged to contend with changing perceptions of ideal times to visit (Higham & Hall 2005).

Weather and climate can determine the planning, implementation, financial success, visitor experience and quality of special events such as fairs, concerts, theatre, other art or sport related events that take place in outdoor venues (Scott & Lemieux 2010). Festivals or outdoor activities related to particular phenological phenomena such as flower blooming or autumn forest changes or harvesting, are more vulnerable to climate changes (Scott et al. 2005, Scott & Lemieux 2010). Also for golf industry the weather is a principal determinant of the length and quality of the season, the irrigation needs and pest management, which represent major operating costs (Scott & Lemieux 2010). Longer golf seasons in the northern countries could alter international and regional competition among major golf destinations (Scott & Jones 2007). The golfing areas might have negative impact from water shortages in summer and at the same time weather extreme events such as increased erosion; flooding and other surge damage can damage golf courses (Yeoman & McMahon-Beattie 2006).

### **Nautical tourism and water-based coastal tourism activities**

Nautical tourism destinations (ports and marinas) in higher latitudes are often seen as a potential winning segment of climate change. A study on Northern Europe stresses that no negative effects of climate change are expected for seaside holidays on Germany's North Sea and Baltic coasts - on the contrary - there could be positive effects resulting from the longer summer season, as better conditions for seaside holidays (higher temperatures, less precipitation in summer) will compensate the risks of climate change (extreme weather events (e.g. storm surges) or coastal erosion) (Ehmer & Heymann 2008, Heymann & Ehmer 2009). Authors argue that Baltic States could attract more seaside tourists and that the Polish and Russian coasts could also benefit to some extent.

The Baltic Sea's potential profitability of nautical tourism in a future climate is, however, expected to be second to that of the Mediterranean and Atlantic Seas (ECORYS 2012a). The density of tourism capacity is generally greater in the southern coastal regions, and climate conditions are an important explanation for this pattern. The Baltic Sea is becoming increasingly competitive in some niches such as aquatic sports and marinas, by promoting coherent strategies aimed at improving public services, infrastructures and adapting to the emerging climate conditions (ECORYS 2012a). Warming of both the atmosphere and the ocean will increase the length and quality of water sport season in the BSR (ECORYS 2012a). There are negative impacts related to water quality, sea-level rise, the erosion of beaches and threats to coastal infrastructure. Swimming, sailing, kayaking, canoeing, diving or fishing can be negatively affected by declining water quality, and there can be health risks in addition (Heggie 2010, Semenza & Menne 2009). Yachting, motor-boating, short distance coastal boating, canoeing, kayaking, sailing, rafting, surfing, kiting, and diving have specific requirements to wind and have low tolerance to precipitation, fog or storms, conditions which may change in a future climate. Yachting is expected to grow in the future with approximately 2–3% and this will also affect the development of

marinas. Ice-yachting activities might be affected negatively by climate change. More studies are needed to analyse climate change impacts on water-based recreational and sport activities in the BSR.

Diving is considered to be highly affected by climate change (Marshall et al. 2011). When making a decision on a destination, divers expect water of high transparency; high ecological and species diversity; and variety of underwater landscapes (e.g. shipwreck). Global warming might favour diving activities in the Baltic Sea that at the present are at lower scale in comparison with other European destinations, although with a tendency to grow (ECORYS 2012a). At the same time climate change is expected to decrease water transparency in the Baltic Sea as a result of eutrophication that affects particularly the coastal waters (von Storch et al. 2008). This can have negative impacts on diving. Surfing was originally a largely warm-water activity, but with improved technology of wet suits, the activity is now pursued in temperate areas (Davenport & Davenport 2006). It is expected that with higher temperatures and longer swimming season, the Baltic Sea beaches might attract more surfing, kiting activists and related wind-dependent beach-based sport activities. Increased storminess might facilitate this trend.

Studies on climate change impact on the Baltic Sea's recreational fishing (including both angling and river fishing) are scarce. Traditional local fish species might be suffering from climate change, and invasion of alien species may increase (Peltonen et al. 2012). Higher temperatures, reduction in sea ice cover, ice depth and ice coverage and increased storminess can reduce ice-fishing activities, but increase involvement in recreational fishing in ice-free waters.

The Baltic Sea is one of the fastest growing cruise markets in the world; it is the second largest area for cruise tourism in Europe, after the Mediterranean. The Baltic Sea with 95.3 million maritime passengers had 24.1% of all passengers in the EU in 2010 (Eurostat 2012). Over the past 10 years, the demand for cruising worldwide roughly doubled (ECORYS 2012b) however cruising remains a small segment in the overall global tourism industry and a fraction of all international tourists (Clancy 2008). A warmer climate and a decrease in sea ice extent might have a positive impact on the cruise and ferry industries. The warmer winter temperature will extend the cruise season, first of all in the Mediterranean (ECORYS 2012b). Increased inter-annual variability in sea-ice extent might be a barrier for extending the cruise tourism season in the BSR. Depth of the waters in ports of call set limits to the size of ships and thus sea-level rise might provide a positive impact if ports are adapted to new conditions (Krämer et al., pp. 55-90, this volume). Cruise tourism has developed as a relatively luxurious form of travel, however, with the building of more and larger ships; cruising is becoming affordable to more consumers, including families with children and senior tourists. The ship has become a destination in itself with amenities and attractions located on the ship, passengers need not venture ashore unless desired, and often time is limited to brief excursions (Hritz & Cecil 2008). Cruise tourism in the Baltic focus mainly on attractive cities with cultural heritage (offshore excursions), with little attention to the region's beaches or natural landscapes (ECORYS 2012b).

The price of fuel and climate change mitigation policies might have large impact on cruise industry (Adams 2010). Besides implementing more fuel efficient technologies, another strategy to save fuel is limiting the distances between ports during a voyage. Regions where destination ports are located close to each other, e.g. the southern and central part of the Baltic could experience a future growth in cruising while peripheries might have fewer cruises (ECORYS 2012b).

Destinations of the BSR largely rely on the potential of natural beaches. In the German Baltic coast the beach is the main reason for 70% of all tourists that have overnight stays (33 million) in 2009 (Haller et al. 2011). Prospective favourable weather conditions in summer might further increase the number of beach tourists. Research had identified that at present coastal communities concerns are on losses of sand caused by erosion and storm surges, and accumulations of beach wrack (Haller et al. 2011). Weather and climate are dominant imperative to travel motivation (Morgan et al. 2000, Denstadli et al. 2011, Gomez-Martin 2005). Beach tourist destinations thoroughly depend on favourable weather and climate conditions, e.g. sunshine, no precipitation, no wind, pleasant temperatures, clear waters and

low health risks (Scott et al. 2008a, Moscardo et al. 2001, de Freitas 1990). Beach tourism is a major factor for tourists travelling from Northern Europe to the Mediterranean. It is argued that temperature is the most influential component of climate change for beach tourism while modifications due to changes of precipitation and sea level rise will not have such impact (Coombes et al. 2009). Research proves that reductions in beach width appear to have little influence on visitor numbers and thus geologically soft and low-lying coastlines which are vulnerable to sea level rise may experience similar levels of growth in tourism to rocky coastlines (Coombes et al. 2009). Recent developments with man-made beaches, which are created in urban waterfronts, prove this. With climate change the distribution of visitors along the coastline and across the year might be transformed, the polarisation of the utilisation of coastal resources might increase; and the length of the peak tourist season at the beach tourism destinations might be extended. Improvements of the relative conditions in the shoulder seasons will not change conditions for beach tourism at large scale in Europe (Moreno & Amelung 2009). It is expected that excellent weather conditions for beach recreation and tourism in the summer may also be found in the southern part of the Baltic and Atlantic sea regions, while still the Mediterranean Sea will be dominating in European beach tourism as the adverse climate condition will limit beach tourism season to be extended beyond summer in other European regions (ECORYS 2012a). Beach tourism that has highly seasonal character is closely related to mass tourism development and thus with the provision of accommodations.

Beach tourism involves sun bathing, swimming, surfing, kiting, beach volleyball and football, running, walking, cycling, street gymnastics and other sports and activities in children playgrounds. Any increase in beach tourism will mean that new tourism infrastructure, such as upgraded transportation networks, the expanded provision of accommodation, catering and safety, is required to provide capacity for an increase of visitors in the region (Coombes et al. 2009). Several BSR coastal resorts use natural resources, e.g. mud and mineral water. Studies on possible climate change impact on natural resources relevant for spa development are missing. Countries around the Baltic Sea have a long history of coastal tourism, wellness and spa tourism that started in the first half of the 19<sup>th</sup> century while the origins of a seaside resort comes from the 1700s (Bacon 1997, Worthington 2003, Onofri & Nunes 2013). Currently coastal resorts in the post-socialist countries of the BSR are not fully utilising their capacity; also studies of climate change impacts are missing in general in these countries.

### **Snow- and ice-based tourism activities**

Snow-based tourism activities (downhill or Alpine, cross-country or Nordic skiing, snowboarding, snowmobiling, outdoor skating, dog-sledging, ice-fishing) and related businesses are being identified by numerous studies as tourism activities that are affected by climate change already or will be in near future (Landauer et al. 2012, Becken 2013, Fredman et al. 2012). Winter sports depend directly on climatic resources: without snow or low temperatures for the artificial production of snow, the development of winter tourism will not be possible (Gomez-Martin 2005). Snow- and ice-based outdoor activities are facing the prospect of higher temperatures, less natural snowfall, more thaw periods and shorter, more variable winter tourism seasons in the future (UNWTO and UNEP 2008). There are studies from Sweden (Moen & Fredman 2007, Brouder & Lundmark 2011, Baynes & Koivisto 2012) and Finland (Tervo 2008, Saarinen & Tervo 2006, Landauer et al. 2009, Landauer et al. 2012) that predict crucial negative impact on the economic viability of ski resorts and tourist operators acting in ski tourism. For the BSR countries skiing, skating, ice fishing and snowmobiling are favourite outdoor recreation activities and important for the regional identity, the quality of life and well-being of its inhabitants. Climate change can have an impact on tourism destination marketing and branding activities if the place image (the set of expectations and perceptions) relies on snow and ice (Landauer et al. 2012). Snow is not only a medium for winter sports but also a base for an important economic sector because of the links to tourism, winter cabins, producers of equipment, and local businesses (O'Brien 2009).

In southern Finland and Sweden, opportunities for snow-related activities are expected to decline; whereas the northern parts of Finland and Sweden could have a competitive advantage compared to winter tourism destinations in central Europe (Saarinen & Tervo 2006, Neuvonen et al. 2005, Swedish Government 2007). In Finland there is a projection that due to climate change cross-country skiing will reduce (Pouta et al. 2009; Neuvonen et al. 2005). In Baltic States regional differences observed, e.g. a considerable drop in snow-cover duration will take place on islands and in the coastal region of west Estonia (Jaagus 1997), while upland areas can still attract winter sport tourism. Winter thawing events lead to wetter snow which creates problems to skiing, snowmobiling and travel by sled (sled tours) (Keskitalo 2010). Climate change impacts will make skiers more flexible in time and space (Dawson & Scott 2010). Snow conditions are a key variable for skiers' decisions on destination choice; however other factors are also important such as skiing terrain, vertical drop and climatic conditions (temperature, precipitation and wind) are also important (Moen & Fredman 2007). The potential impact of climate change on winter tourism can be examined by the length of ski, snow-making and snowmobiling season, and the probability of being operational during the economically critical Christmas–New Year's holiday period (Tervo-Kankare et al. 2013). For the Baltic Sea climate requirements for cross-country skiing and ice-fishing, e.g. period and the depth of ice and ice-coverage of shallow coastal waters, coastal rivers and lagoons, might be as important as snowmobiling. High wind occurrence was found the most common reason for ski field closure in Finland, while snowmobiling and cross-country skiing was disturbed most by frosty conditions (Tervo 2008). The winter season can have twice as little tourism as in the summer (ESPON-IRPUD 2011) and thus the changes in the winter tourism flows can have less impact on the total annual number of tourists and the flows between countries and regions. In Finland skiing is the main purpose for about 10% of tourist trips made to participate in outdoor and nature activities, and cross-country skiing is not only a popular way to spend active holidays, but also an everyday sport and leisure activity in close proximity to residences (Landauer et al. 2009). With regards to climate change, the following research questions have been studied: the extent to which individuals change their participation habits by substituting skiing for another activity (activity substitution), participating less or more during a shortened ski season (temporal substitution), or travelling to other ski areas with better snow conditions (spatial substitution) (Dawson et al. 2011).

Climate change impacts in ski areas will likely vary greatly; low-lying ski areas are most sensitive and this will lead to a concentration of ski tourism on higher altitudes (EEA 2012a). Not the entire ski sector is at risk to climate change but rather certain individual ski areas that collectively make up a particular ski marketplace; the competition is likely to decline as individual operators of skiing become unable to afford the cost of adapting to future climatic conditions and this may actually advantage the ski areas that are able to remain operational (Dawson et al. 2011). Poorly adapted to climate change other ski resorts likely to close; skiers will travel to other remaining resorts (Dawson et al. 2011, Reynolds 2010, Scott & McBoyle 2007). Compared to alpine skiing, cross-country skiing is more vulnerable to climate change; it is predicted that air temperatures of winter days will rise; the snow depth will decrease as well as the number of days with snow cover, and thus will have direct negative influences on cross-country skiing, especially in southern Finland, where the majority of the Finnish population live (Landauer et al. 2009). Snow supplemented by snowmaking can increase snow cover and extend the season (Reynolds 2010). Artificial snow-making will increase costs and energy use and can have negative environmental impacts (increased water demand, pollution, etc), and there will be fewer days with suitable snow-making conditions (Boden 2007, Brouder & Lundmark 2011, Koponen & Pesonen 2012, Scott et al. 2008b). Finnish cross-country skiers expect the society to provide support for skiing activities and are not in general willing to pay for opportunities to ski (Landauer et al. 2009, Neuvonen et al. 2005, Landauer et al. 2012). Coastal tourism businesses in the northern Sweden have different perceptions on climate change than those in the inland – at the coast more variation than previously known is observed, and entrepreneurs are far more willing to accept one poor-snow winter as evidence of climate change and thus aware to begin to adapt new conditions (Brouder & Lundmark 2011). In Finland ski tourism destinations are smaller-scale and with less-

diversified tourism product and thus their capability might be lower to adapt new conditions (Landauer et al. 2012). The shortening of the winter season is perceived as a threat to well-being of employees in tourism (Heikkinen et al. 2011). Winter safaris in Finland have a major role attracting foreign visitors; due to their need for large amounts of snow, making artificial snow is not considered as realistic adaptation mechanism (Kaján & Saarinen 2013, Tervo 2008). Instead diversification and alternative products are suggested as an option. This option will make former winter safaris destinations less competitive, due to the fact that branching out into summer tourism and focusing on summer activities (i.e. rafting, mountain-biking or hiking) means that former niche of snow-dependent tourism (unique and attractive at European scale) is lost and a new position in the market of summer tourism should gain in competition with many other places in Europe having similar products (Kaján & Saarinen 2013). Studies are missing on development of downhill and cross-country skiing tracks, outdoor skating rings, bobsleigh, luge, and skeleton tracks with opportunities to use artificial snow and ice making in the BSR, for instance exploring upland areas or urban artificial terrain and artificial lighting.

#### 4 Adaptation Measures

Coastal tourism in the BSR is a spatially diverse, segmented, constantly changing and sensitive to climate-related risks, thus is requiring the need for complex adaptation measures (Filies & Schumacher 2013). The tourism industry has long experience in coping with climate variability and the ability to adjust to timing, places and activities. The sector is continuously adapting to be able to respond to changing demographic and economic conditions as well as to new demands and technologies (Perry 2006). Climate change requires to incorporate adaptation aspects into mainstream tourism planning, policies, information distribution and activity performance. Adaptation strategies need to cover three sides to adaptation:

- minimizing sensitivity or exposure to risk,
- developing a capacity to cope after damages have been experienced and
- acquiring the means to exploit new opportunities that arise (McCarthy et al. 2001).

Close cooperation of governments and relevant communities are needed to re-use existing tourism infrastructure and resources in affected places according to changed climate conditions. Governmental aid is needed particularly for tourism destinations, resorts and venues due to immobility of tourism-related fixed capital and infrastructure. While tourists and lesser degree, tour operators may respond immediately to unfavourable weather events; venue-based tourism business are less flexible to react to changing climate conditions, variability and extremes (Hall & Higham 2005, Perry 2006). Tourists are considered to have large adaptive capacity; however, their actual adaptive capacity and acceptable limits to change remains largely unexplored (Gössling et al. 2012, Scott et al. 2008a, Scott et al. 2012). Adaptive capacity for tourism destinations, enterprises and venues can be enhanced by creating the information and conditions (regulatory, institutional and managerial) that are required to support adaptation through public awareness, education, training, research, monitoring, and pilot and demonstration projects (Stern 2006). The BSR coastal tourism adaptive capacity is characterised by large spatial and industrial polarisation. Germany's coastal regions have medium overall capacity to adapt to climate change, the Baltic States have low capacity and Poland coastal regions are judged to have the lowest adaptive capacity in the EU. On the other hand Finland, Sweden and Denmark were assessed as having highest and high overall adaptive capacity to adapt to climate change in comparison with other regions in the EU (ESPON-IRPUD 2011). Countries that are wealthier and which have longer experiences in tourism industry might have larger adaptive capacities. Coastal cities and resort towns have larger capacity to cope with climate variability and possible changes than peripheries, e.g. countryside, former fishermen villages and nature areas. Micro and small and medium tourism enterprises may not have adequate human, social, technical and financial resources to cope

with climate challenges, while it is expected that large companies, like tour operators, hotel chains, and cruise and airline companies have larger adaptive capacity.

Various types of barriers have been identified that prevent climate change adaptation in the tourism sector (Schott et al. 2010). The wide spread denial of climate change by the tourism industry is explained by 'a lack of resources to implement long-term responses, uncertainty surrounding the manifestations of climate change, and the ineffectiveness of short-term responses to climate change' (Higham & Hall 2005, Hall & Higham 2005). Fragmentation of the sector, the dependence on other sectors and the dominance of micro and small and medium enterprises are crucial barriers for voluntary adaptation actions to be taken by the sector itself. Adaptation to climate change depends on various factors such as political, legal, economic, technological, social and cultural context, planning and management context, equity and awareness, information, education and skills level (Grothmann 2010, Becken & Hay 2007). Adaptation should be placed in a wider sustainable development context, recognising that it is an ongoing process and occurs at different levels in particular, at the local level; the tourism sector should build on current adaptive experiences to cope with future climate variability and climate hazards and should also consider impacts and adaptations in other sectors (Simpson et al. 2008).

As vulnerability to climate change is likely to be unequally distributed across different groups in society, nationally and internationally, regional vulnerability analysis (Brouder & Lundmark 2011, Moreno & Becken 2009, Fussel 2007) and policies are needed to provide resources (including capital, knowledge, technology and consent) that are not held by the adapting agents themselves (Berkhout 2005). Nature-based tourism activities and dependent communities are seen as being particularly sensitive to forecasted climate change impacts (Kaján & Saarinen 2013). Glavovic (2008) suggests principles and operational imperatives for building sustainable, hazard-resilient communities that can help to guide efforts in adapting the tourism sector to climate change impacts:

- put people first;
- develop responsive and participatory processes;
- prioritise empowerment;
- prioritise ecological sustainability; and
- adopt a proactive and strategic but precautionary approach by developing a long-term, visionary approach that is implemented in a risk averse manner.

The European Commission suggests to classify adaptation options into three broad categories (EC 2009) that can be used for coastal tourism industry:

- a grey infrastructure approach: focusing on engineering techniques and infrastructures, aimed at providing physical protection against climate impacts such as floods and sea level rise, and preventing the adverse effects of climate variability, through heat-resilient road pavements, air conditioning, etc.;
- a green infrastructure approach: based on strengthening the resilience of ecosystems, using trees and green spaces to enhance cooling capacity and lessen flood impacts, and
- a soft approach: based on the application of policies, procedures, information, communication, education, economic incentives and other price signals.

Examples of adaptation measures that are utilised by tourism stakeholders are shown in Table 4.

Transnational, national and sub-regional policies have a particular role for tourism and climate change adaptation as a framework for top-down measures as well as supporting bottom-up initiatives with knowledge, organizational and financial instruments.

Table 4: A portfolio of climate change adaptations utilised by coastal tourism stakeholders (modified Scott et al. 2008a, UNWTO and UNEP 2008, Simpson et al. 2008, Wong et al. 2012, Becken &amp; Hay 2007)

Type of Adaptation	Tourism Operators/ Businesses	Tourism Industry Associations	Governments and Communities	Financial Sector (investors/ insurance)
Technical	<ul style="list-style-type: none"> <li>- Involvement in beach cleaning, coastal protection and the community infrastructure</li> <li>- Weather-based infrastructure design</li> <li>- Weather-proof (rain, wind, heat) buildings and transport</li> <li>- Green infrastructure</li> <li>- Utilising extreme weather (storms)</li> <li>- Free access to drinking water and shading</li> <li>-Real-time webcams of weather conditions</li> </ul>	<ul style="list-style-type: none"> <li>- Enable access to early warning equipment to tourism operators</li> <li>- Develop websites with practical information on adaptation measures</li> <li>- Green infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>- Coastal protection</li> <li>- Ports, roads, and other transport infrastructure</li> <li>- Weather forecasting and early warning systems</li> <li>- Open public access to drinking water, bathing waters, shading</li> <li>- Green infrastructure</li> <li>- Water management</li> <li>- Drinking water supply</li> <li>- Increase sewer capacity/ enhance maintenance</li> </ul>	<ul style="list-style-type: none"> <li>- Building design or material (fire resistant) standards for insurance</li> <li>- Financing the developmental infrastructure projects</li> <li>- Insurance from various natural disasters</li> </ul>
Managerial	<ul style="list-style-type: none"> <li>- Contingency plans</li> <li>- Water conservation plans</li> <li>- Change of opening times / sales dates</li> <li>- Product and market diversification</li> <li>- Redirect clients</li> <li>- Weather sensitive marketing and branding</li> <li>- Selling the problem (e.g. storms)</li> <li>- Voluntary actions to preserve the environmental quality and nature resources</li> <li>- Staff adaptation and flexibility related to service quality and management</li> <li>- Communicate, and keep staff, customers and the media appraised</li> </ul>	<ul style="list-style-type: none"> <li>- Short-term seasonal forecasts and weather condition reports for marketing</li> <li>- Cooperate with media to improve destination image</li> <li>- Training on climate change adaptation</li> <li>- Encourage environmental management and preservation of nature resources</li> <li>- Cooperation amongst local stakeholders to reopen the destination and cross-selling among local businesses in case of weather hazards</li> <li>- Water conservation initiatives</li> </ul>	<ul style="list-style-type: none"> <li>- Impact management plans</li> <li>- Coastal zone management</li> <li>- Spatial planning</li> <li>- Natural disaster management planning</li> <li>- Business subsidies (insurance or energy)</li> <li>- Coordination of policy transfer / innovations in tourism</li> <li>- Coordinate improved destination branding</li> <li>- Ensuring the implementation of laws and policies</li> <li>- Replacement of vulnerable groups</li> <li>- Monitoring and inspections (food quality)</li> <li>- Marketing hazard recovery</li> </ul>	<ul style="list-style-type: none"> <li>- Provide information to customers (on weather variability)</li> <li>- Adjust insurance premiums or do not renew insurance policies</li> <li>- Restrict lending to high risk business operations</li> <li>- Banning approvals for high-risk jobs</li> </ul>
Policy	<ul style="list-style-type: none"> <li>- Natural hazards interruption guarantees by insurance and weather derivatives</li> <li>- Comply with regulation (e.g. building code)</li> <li>- Support innovations</li> </ul>	<ul style="list-style-type: none"> <li>-Coordinated political lobbying for climate change adaptation mainstreaming</li> <li>- Seek funding to implement adaptation projects</li> <li>- Support science and innovations</li> </ul>	<ul style="list-style-type: none"> <li>- Mainstream adaptation as an integral part of national and tourism planning</li> <li>- Boosting weather-proof tourism by providing economic incentives</li> </ul>	<ul style="list-style-type: none"> <li>- Consider climate change in credit risk and project finance assessments</li> <li>- Support investments to diversification of tourism activities and venues</li> </ul>



	<ul style="list-style-type: none"> <li>- Develop and have working emergency plan for severe weather events</li> <li>- Empower employees to make informed and realistic decisions</li> </ul>	<ul style="list-style-type: none"> <li>- Lobbying for weather-proof tourism</li> </ul>	<ul style="list-style-type: none"> <li>- Coastal management plans and set back policy, green infrastructure</li> <li>- Weather-proof building / urban design standards and location</li> <li>- Support education, training, science and strategic planning, innovations in tourism</li> </ul>	<ul style="list-style-type: none"> <li>- Finance developmental models in tourism sector</li> </ul>
Research	<ul style="list-style-type: none"> <li>- Site location</li> <li>- Green infrastructure</li> <li>- Water-proof design</li> <li>- Analysing tourism demand</li> </ul>	<ul style="list-style-type: none"> <li>- Assess awareness of businesses and tourists and knowledge gaps</li> <li>- Assess policies</li> </ul>	<ul style="list-style-type: none"> <li>- Climate change impacts / adaptation</li> <li>- Informing on changes in ecosystems</li> <li>- Monitoring programs</li> </ul>	<ul style="list-style-type: none"> <li>- Extreme event risk exposure (storms, floods, heat waves)</li> </ul>
Education	<ul style="list-style-type: none"> <li>- Water conservation education for employees / guests</li> <li>- Training of staff on emergency procedures and information campaigns in case of extreme weather</li> </ul>	<ul style="list-style-type: none"> <li>- Water conservation campaigns</li> <li>- Campaign on mitigation and adaptation to climate change</li> </ul>	<ul style="list-style-type: none"> <li>- Water conservation campaigns</li> <li>- Campaigns on risks of the UV radiation and extreme heat</li> <li>- Campaign on mitigation and adaptation to climate change</li> </ul>	<ul style="list-style-type: none"> <li>- Educate and inform potential and existing customers</li> </ul>
Behavioural	<ul style="list-style-type: none"> <li>- Tourists and tourism employees adjusting clothing and changing activities engaged in, timing, and places of visit</li> </ul>	<ul style="list-style-type: none"> <li>- Change of sector behaviour towards resource management and climate information and knowledge</li> </ul>	<ul style="list-style-type: none"> <li>- Politicians and civil servants changing attitude and decisions toward tourism and climate change adaptation</li> </ul>	<ul style="list-style-type: none"> <li>- Good practice in-house</li> </ul>

The knowledge gaps on weather and climate can be reduced by better collaboration of tourism authorities with the small and medium-sized enterprises, and strategic planning would be useful to reduce the tourism industry's dependence on weather-sensitive (seasonal) activities (Rauken & Kelman 2012). Better knowledge gained through strategic planning exercises can provide higher confidence, flexibility and minimize uncertainty for the tourism entrepreneurs when dealing with climate change and other global challenges and thus give a better position of the BSR as tourism destination in general. Coordinated marketing at the BSR or national, sub-regional, and cross-border level, as well as pooling resources and publicity through tourism authorities, could be advantageous.

Aspects suggested for climate change adaptation strategies are important also for tourism sector (Easterling et al. 2004), e.g. awareness of climate vulnerability (vulnerability assessment and management), awareness of adaptation options (the need to integrate climate risk into innovation processes), uncertainty and motivation (supported by tailored information, incentives to adapt), provision of adaptation spill-over and removing (capital, knowledge, technology, consent, market or infrastructural) constraints on adaptation. Particular attention should be paid to both the innovative and the vulnerable ones in tourism, e.g. places, segments and stakeholders and for that improvements of adaptive capacity play an important role (Easterling et al. 2004). It has to be checked whether tourism infrastructure, networks and services are robust with respect to current weather conditions, and for this, additional investment is needed. Linkages with other policy domains may yield opportunities for climate related measures in tourism sector, e.g. linking tourism development to spatial planning. By

strategically prioritising and implementing low cost adaptation measures first, large investments may be saved in the future in case climate effects in the tourism sector turn out to be severe (after Mark et al. 2012). The tourism industry's private sector relies on public investments and maintenance of public services and thus following public policy objectives related to climate change adaptation are relevant for it: to increase robustness of infrastructures; to inform the potentially vulnerable; to assist in the provision of early-warning and disaster relief; to facilitate, incentivize, guiding and enable adaptation and adaptive capacity; to regulate adaptation 'spillovers' and risk-shifting; increasing flexibility and adaptability of vulnerable managed systems; reversing trends that increase future vulnerability by spatial planning and regulating long-term and infrastructural assets and to improve awareness and preparedness, to regulate distributional consequences of adaptation, to provide information, knowledge and learning (Klein & Tol 1997, Easterling et al. 2004, Berkhout 2005). Maladaptation should be avoided (table 5), e.g. measures that potentially increase emissions of greenhouse gases (energy-intensive cooling), have high opportunity costs to alternatives, disproportionately burdens the most vulnerable, reduce incentive to adapt and avoid path dependency of infrastructural developments that are difficult to change in the future (Barnett & O'Neill 2010). Considering the fact that tourism and its infrastructure is a major influencing factor for the coastal landscape in the southern BSR there is a risk that adaptation measures are able to significantly change the appearance of the Baltic Sea coast (Gee et al. 2006).

Table 5: Integrating adaptation with mitigation (after Becken 2005, Milne 2004, Mills 2003).

Adaptation measure	Mitigation effects	Impact on environmental management	Economic aspect
Weather-proof tourist activities	Depends on the type of activities	Depends on the type of activities	High-yield alternative and income for local economy
Tourist education	Neutral	Increases awareness	Risk of deterring tourists
Green infrastructure	Reduces net carbon emissions through carbon sinks	Benefits water and flood management, biodiversity, reduces of fire vulnerability, health claims and deaths	Could be included in a carbon trading scheme
Water conservation	Reduces costs	Positive	Saves costs
Diversifying markets	Positive if new markets are more eco-efficient	Depends on the environmental impact	Positive if new markets are high yield
Insulated building envelopes; energy efficient construction	Reduced heat loss/gain, energy use and carbon emissions	Depends from technology used, reduced vulnerability to wind/ rainstorm damage; greater occupant comfort	Positive
Increasing air conditioning	Negative: increases carbon emissions	Depends from technology used	Expensive
Beach nourishment	Negative: energy use for mining and transportation	Disturbs ecosystems	Expensive
Reducing erosion with seawalls	Neutral	Disturbs natural currents, causes erosion elsewhere	Expensive, requires ongoing maintenance
Local renewable energy	Positive if reduced carbon emissions	Depends from energy source/technology used	Reduced business interruption

Potential evaluation criteria for adaptation options are suggested for the tourism sector (UNWTO and UNEP 2008): cost; effectiveness; ease of implementation; acceptability to local stakeholders; acceptability to financing agencies, ministries and/or donors; endorsement by experts; timeframe; institutional capacity; size of beneficiaries group; potential environmental or social impacts; and capacity to sustain over time. More detailed indicators relevant for coastal tourism industry are

suggested within the preparation of the German Strategy on Adaptation to Climate (Schönthaler et al. 2010). Indicators relevant for climate change mitigation and adaptation can also be included in eco-labelling certification schemes, e.g. Blue Flag certification, QualityCoast certification and in existing natural resources monitoring and management systems.

Currently not all countries in the BSR have national legislation or strategies for tourism sector; and not all have national or regional climate change adaptation strategies. The predicted impacts of climate changes for tourism business are diverse. Strategies to adapt to climate change will therefore have to be multidimensional and should cover from small-scale behavioural adaptation of tourists themselves to infrastructural adaptation measures. Development of long-term, local adaptation strategies for tourism destinations and climate impact management plans with reference to local vulnerability and risk assessments is suggested for the tourism industry. It is important that climate change adaptation relevant for tourism is mainstreamed in other policy areas. Climate change adaptation strategies for public health, food, transport, spatial planning, coastal and marine areas, biodiversity, forestry, construction and cultural heritage sector, if such are or will be adopted can have relevance for tourism and recreation. National strategies of Germany and Finland cover tourism sector (Swart et al. 2009), as well as the report from the Swedish Commission on Climate and Vulnerability has detailed analysis of tourism sector aspects (Swedish Government 2007). Each country focus on national particularities- Finland and Sweden address reindeer husbandry, Denmark focus on coastal management; Germany's national policy highlights longer summer seasons with positive effects for tourism (Swart et al. 2009). Positive aspects of climate change in terms of its potential for tourism and recreational use of the coasts are also noted by Finland's national adaptation strategy (Marttila et al. 2005), a study on the climate change impacts in the Helsinki metropolitan area (Järvinen et al. 2010), City of Stockholm's climate change adaptation strategy (Ekelund 2007) and a report on climate change adaptation in Åland (Anonymous 2011). The same findings are applicable to the rest of the Baltic Sea. Positive outcomes apply especially to summer time recreational opportunities that will improve due to a longer summer and ice-free season and due to increasing water temperature. In addition, Finland's national adaptation strategy anticipates that in the mid- and long-term climate conditions become unfavourable for tourism in Southern Europe. The report states that predictions on where the tourism will be directed are prone to several uncertainties, but there is a possibility that northern areas may benefit from increased tourism (Marttila et al. 2005). Swedish national report states that tourism is one of the vulnerable sectors dominated by small enterprises and thus should be offered proactive information campaigns, education and courses.

Coastal tourism adaptation options with relevance to the BSR have been prepared based on research publications (Jopp et al. 2013, Mossbauer et al. 2012, Wong et al. 2012, Chen & Graham 2010, Müller & Weber 2008, Becken & Hay 2007, Mather et al. 2005, Burton & Lim 2001). Tourists can easily adapt their behaviour in response to climate variability and poor weather conditions, extreme weather events, resort or venue closures or inability to participate in selected tourism activities, while tourism destinations and venue-based enterprises will experience more adaptation challenges due to difficulties and expenses involved in structural and management-based adaptations (Gössling et al. 2012).

It is important to re-position the BSR destinations in order to capitalise the benefits of climate change by investigating climate change impacts on competing destinations and by utilising new opportunities for domestic and the BSR tourism markets due to prolonged tourism season and the development of new activities, new products and new target markets. Destination images, marketing and branding should be improved by incorporating benefits from climate change; off-seasons and the prolongation of summer season need to be emphasised. Strategies should encourage innovation and diversification of tourism products (particularly in tourism destinations dependent from snow and ice- based activities) and consider public investments and tourism business subsidies. Year-round tourism activities and attractions should be supported. Measures are needed to adapt institutional (calendar) seasonality (events, holidays, opening times) to the shift of climate-dependent natural seasonality and changes in phenology of plants that are important for event tourism. Flexible regulation to outdoor

activities and climate-proof tourism infrastructure and services should be promoted (table 6); and measures are needed to respond to increasing demands and attractiveness of outdoor activities, beach and bathing tourism, water sports and cruise ships. Indoor attractions (e.g. with ventilation) need to be introduced to replace natural attractions if the appeal of the latter diminishes.

The tourism industry perceives climate change as a less urgent challenge and potentially even as beneficial for its business (Martinez et al. 2011); and tourism operators have a low awareness of climate change and there is little evidence of long-term strategic planning taking truly account of climate change (Simpson et al. 2008). Training programmes for tourism industry on climate change adaptation, as well as public education and practical information campaigns on climate change risks and adaptation measures are needed for host communities and tourists. Strengthen information network and research capacity of tourism destinations, e.g. protected area, staff with regards to climate change adaptation. Although increased temperatures might lead to more favourable tourism conditions in the BSR stakeholders need to take into consideration potential negative effects of a warmer Baltic Sea by including health risk analysis and early warning mechanisms. Unreliable coastal sea-ice conditions will increase safety risks and concerns and thus measures are needed to inform and protect tourists involved in ice fishing and walking along the coast. Access problems due to unreliable ice conditions inability to use temporary ice roads can be solve by using ferries or building safer crossings, bridges over water bodies and wetlands. There might be an increased need for outdoor lightening to compensate the loss of natural light reflection by snow. As for long-term adaptation tourism routes should be built on dry land; new routes should be planned for year-round use and to be exploitable in conditions of limited snow cover.

Table 6: Sectors in which climate change should already be taken into account during phases of planning, investments, design and construction of new infrastructure (Hallegatte 2009).

Sector	Time scale (years of operation) of new infrastructure if built today	Exposure to climate change
Water infrastructures (e.g. dams, reservoirs)	30–200	+++
Land-use planning (e.g. in flood plain or coastal areas)	>100	+++
Coastline and flood defences (e.g. dikes, sea walls)	>50	+++
Building and housing (e.g. insulation, windows)	30–150	++
Transportation infrastructure (e.g. port, bridges)	30–200	+
Urbanism (e.g. urban density, parks)	>100	+
Energy production (e.g. nuclear plant cooling system)	20–70	+

As the occurrence of extreme climate events will be exacerbated by climate change, there is a need to create a link between tourism and disaster risk reduction and management (Becken & Hughey 2013). In order to be prepared for heat waves, storms and floods and other extreme weather events improvements in early warning system, medical infrastructure and health services are needed to be sure that the specific needs of tourists will be considered. Measures should be planned and implemented against, e.g. the increase of mosquitoes and new threats to public health. Additional information and maps for tourists with safety provision during heat waves and storm and flood events (free access to shades/ wind screens/ shelters with emergency communication equipment, drinking water, changes of opening hours, and closed venues) can improve their capability to cope with extreme weather conditions. Emergency preparedness and increase of rescue service capacities (e.g. constructing of rescue centres, more harbours of refuge needed) are important and may be obtained through cooperation between tourism industry and host communities.

Wildfire proof settlements, including camping sites, second homes and caravan parking areas should be promoted. Relocation of vulnerable inhabitants and tourists if their health or accommodations are affected by direct impact of wildfire or smoke is needed. Restricted access to forest and nature areas

under wildfire risk; clean-up of littering in forests and meadows, reed and grass-cutting, natural grass management by herbivorous animals (e.g. cows, wild horses) are measures to be promoted. Maintenance of open green spaces and the promotion of green infrastructure and urban forestry in order to reduce urban heat and flood risks can also be utilised as tourism attractions, e.g. the path networks for cyclists and hikers and parking places can be adjusted to green areas. Recreational fishing community, outdoor recreants and nature tourists should be informed on changes in local species and biotopes and the risk of introduction and establishment of non-indigenous species. Beach users should be informed about beach wrack.

Greater public investment in infrastructure for new tourism developments (e.g. land preparation, coastal defences or supporting infrastructure investment) to meet climate change impacts can be considered. Jointly with tourism industry specific 'values' at risk to climate change and sea level rise should be identified. Intensification of coastal protection; protection schemes (e.g. levees, seawalls, dikes, infrastructure elevation) could be installed, foundations be strengthened to adapt to sea-level rise. Stronger and higher bridges and piers need to be constructed. Also for tourism purposes temporary constructions, water-friendly buildings, floating breakwater pontoons and piers can be used. Technical measures to protect sandy beaches (beach replenishment, flood barriers, dunes, dikes, groins) might be considered jointly with tourism industry. Increase of nature protection (coastal forests and seaside landscapes), ex situ conservation, and restrictions and limitations for new infrastructure developments are options to be considered for coasts that are sensitive to erosion. The potential impact on land-degradation should be taken into account when making decisions on investments and expansions of recreation areas and beaches. The importance of beaches and recreational areas around the coastline is highlighted by the Swedish municipality of Ystad who estimates that the benefits of protecting and conserving the coastline are three times greater than the costs.

Safety problems with second-home areas and tourism infrastructure in flooded areas should be solved through spatial planning and integrated flood management, e.g. flood proof settlements should be promoted. Use of temporary constructions, water-friendly buildings for tourism purposes can be considered. Adaptation of water policies is needed in cooperation with tourism industry, e.g. safeguarding water supply, water conservation campaigns organized jointly by governments, communities and tourism industry, improvement of rainwater management to solve overloaded sewage problem (e.g. rain and sewage reservoirs, sustainable urban drainage systems) and provision of green infrastructure and changes in watering practices (lawn, green roofs, parks, gardens).

Changes of insurance policy and use of innovative financial instruments, e.g. weather derivatives (Tang & Jang 2012, Pollard et al. 2008) can be promoted. It is necessary that climate-related information is taken into account when decisions on site selection and investments for development of new resorts, venues and accommodations are taken; observation show that climate information is utilised more extensively in engineering, construction planning, property design and maintenance (insurance, heating-cooling) (Scott & Lemieux 2010).

## **5 Knowledge Gaps**

Adaptation to climate change in the tourism sector has only been studied in recent years. Knowledge on adaptation approaches is thus cumulating fast. A number of academic papers have highlighted the limitations of existing knowledge and themes that are emerging otherwise studies are few (Kaján & Saarinen 2013, Becken 2013, Pang et al. 2013, Scott et al. 2012, Scott & Becken 2010, Burns & Bibbings 2009, Scott et al. 2005, Smith 1990). In 2001 the Commission on Climate, Tourism and Recreation of the International Society of Biometeorology listed research needs of government and industry (Higham & Hall 2005) e.g. climate as a resource and a limiting factor for tourism, the implications of climate variability and extreme weather events; methods for assessing relationships between climate and tourism; needs of the tourist and travel industries for climate and weather information; development of a Tourism Climate Index; advisory services for proper climatic

adaptation of travellers; and contribution of tourism to climate change. Future studies on climate change impacts on tourism are suggested (Dubois and Ceron 2006, Swedish Government 2007) that are also applicable to the BSR:

- Comparative research: linking tourism destinations with similar climate change impacts, exploring why some destinations are more sensitive to climate change than others (e.g. diversity of supply and demand factors, or the presence of built/cultural attractions), investigating what are the different methodologies used to assess the potential impact of climate change; and facilitating learning and policy transfer among the BSR tourism destinations,
- Studies of the impacts of extreme events and weather variability on tourism and capacity to cope with it, studies on vulnerability of particular tourism sites (resorts) and venues,
- Trans-disciplinary research that could facilitate networking and linking social, economic and climate change (natural sciences) researchers from different BSR countries,
- Activity-oriented and participatory action research, dealing with the impacts on activities and linking scientists and tourism entrepreneurs (including large tourism operator firms, cruise, ferry and other transport managers, and micro, small and medium size tourism entrepreneurs at destinations).

Most of the tourism climate change impact studies are performed for destinations (Hall and Higham 2005). The geographic concentration of research on tourism and climate change with focus on Western countries has been criticised (Scott 2011, Scott & Becken 2010). BSR-wide studies on climate change impacts and adaptation for tourism with focus on marine and coastal tourism is missing. Little attention has been given to the islands, peninsulas (narrow spits) and low-lying coastal meadows, wetlands, lagoons and dune landscapes of the Baltic Sea. Common understanding and studies on coastal ecosystems and species relevant for recreation and tourism in the region (e.g. fish, game, wild berries, and mushrooms) as well as climate change impacts studies for them are missing. Diversification of geographical and disciplinary perspectives, including intensified place-based research conducted by researchers that are appropriately equipped to understand these place-specific factors are needed to understand local responses and options how to adapt local tourism activities to the impacts of climate change (Schott et al. 2010). High uncertainties exist in forecasting flows and defining a character of future tourism as this depends not only from several environmental and social-economic factors but also influenced by tourists and tourism industry preferences, values and market trends. Climate impacts and adaptation for tourism cannot be analysed in isolation from trends in information, transportation, construction and indoor climate technologies, the quality of life, change of life style, and public health issues.

Another limitation is related to climate and tourism data availability, accessibility and compatibility (ECORYS 2012a, Scott & Becken 2010, Turton et al. 2010, Scott & Lemieux 2009, Swedish Government 2007). Standard meteorological data typically fails to capture the microclimatic characteristics of specific tourism destinations (e.g. coastal resorts) and recreational settings (e.g. littoral zones) (Higham & Hall 2005). More studies on tourist literature and the media's role regarding the change of perception and information distribution about climate, weather, its variables and extremes both at tourism destinations and the points of departures of tourists are needed (Scott et al. 2008b). New impact assessment studies of tourist comfort are necessary to reflect environmental quality and the diversity in activities to complement the traditional formula of "sun, sea, and sand" (Moreno & Amelung 2009, Denstadli et al. 2011). Studies on tourism behaviour change due to changed perceptions of climatic appeal and image of certain tourism destinations and activities can give better explanation of the change of associated tourism flows (Hall & Higham 2005, Bigano et al. 2006). Within the framework of preparing the German Strategy on Adaptation to Climate Change, indicators for actions targeted on the tourism industry have been proposed (Schönthaler et al. 2010). These indices may also be used at a BSR-level.

With relevance to the BSR research needs and topics relevant for climate change impacts and adaptation for tourism have been identified (Kaján & Saarinen 2013, Heikkinen et al. 2011, Turton et al. 2010, ESPON-IRPUD 2011, Førlund et al. 2013, ECORYS 2012a, Schott et al. 2010, Swedish Government 2007, Dubois & Ceron 2006). There is a need for better representation of the BSR in climate models and studies of climate variations and scenarios at the local level with relevance to tourist industry and tourists in different social segments. Better statistics on coastal tourism (activities and venues) and recreation (including second homes), improved indicators used and data availability in relation to climate and tourism can improve knowledge on climate change impacts and adaptation to tourism. As for the BSR seasonality will still continue to be a determinative factor affecting direction and motives of tourism related travel and tourism-dependent business activities, further research on seasonality changes, shifts of tourism flows and on vulnerability of various tourism activities to a changed climate are crucial for the tourism industry.

Systematic and interdisciplinary review process of climate change impacts and adaptation to tourism in the BSR should be supported by the networking of researchers representing all countries of the region; linkages between social and natural sciences and between tourism industry, spatial planning, architecture and construction, public health and climate change experts should be strengthened. Climate research communities could receive expert support on specific development issues of tourism destinations at the Baltic Sea region by closer cooperation with the Committee on Spatial Planning and Development leading intergovernmental co-operation of 11 Baltic Sea Region countries known as the Vision and Strategies around the Baltic Sea or VASAB. This spatial planning network of the BSR has experience dealing with region-wide spatial issues including coastal areas since 1992 and recently has actively participating in marine planning. Comparative institutional analyses of climate change adaptation processes and multi-level governance aspects in relation to tourism sector could support improved national and sectoral policies. Comparative studies on host communities' (small and medium-sized enterprises and venue-based tourism businesses), large tourism industry actors (tour operators, cruise, air-travel, etc.), and luxury tourism versus budget and mass tourism adaptive capacity to respond to changing tourism demand and opportunities are helpful for proposing adaptive measures.

Transnational research on climate change and adaptation aspects integration into strategic and environmental impact assessment with relevance to tourism site selection and development has to be promoted. Tourism destinations, as well as regions from where the tourists come from should be analysed in climate change impact assessments. Knowledge gaps still exist in the sphere of climate impacts on public health, food, and visitors' comfort and behaviour with relevance to the BSR. Analyses of behavioural changes due to climate change impacts and adaptation should embrace tourists, tourism entrepreneurs and host communities. Transnational research on innovations and professional education and learning in tourism sector with reference to climate change adaptation should be supported in the BSR taking account that the region is known globally as one of the forerunner of tourism innovations. Opportunities for "weather-proof" tourism product development and the diversification of tourism activities at the destination are suggested to be explored. Studies on ecological (climate change mitigation), cultural, social and economical impacts of switching outdoor activities to indoor places and switching for natural to artificially maintained settings are needed to ensure sustainable tourism development in changing climate conditions. Research on how to link mitigation and adaptation measures and to find synergies, particularly in transport, tourism infrastructure, accommodation and catering, and other tourism related activities in coastal areas are crucial in the context of global climate policy.

To utilise new opportunities, possible limitations and benefits for tourism in the BSR due to *rising average temperature* studies on changing climate conditions, better regulation for bathing, water sports and marinas are needed. Comparative studies on climate change impacts on ice and snow-dependent tourism venues and adaptation measures with relevance to the BSR should be conducted. Studies of the *extreme weather events* and climate variability impacts on human health and tourist

behaviour with relevance to the BSR are required. Trans-disciplinary studies on green infrastructure design, planning and utilisation as tourism asset should be performed. Furthermore trans-disciplinary research on *marine and coastal flora and fauna changes* and their impacts for tourism and recreation in the BSR should be undertaken. Information needs to be improved on depositional dynamic of floating algae accumulations along the Baltic coastlines; and socioeconomic analysis has to be performed whether biomass accumulations on beaches affect coastal attractiveness and local tourism revenue (Mossbauer et al. 2012). To cope with *impacts due to the sea level rise and erosion*, the improvement of coastal monitoring and methods is needed that is relevant for tourism industry. Transnational research might be supported to work out a common typology of the BSR coasts with relevance to coastal erosion and beach tourism and possible adaptation measures. Finding out tourists', host communities and tourism entrepreneurs' attitudes and perception of the sea level rise, coastal erosion and potential protection measures might be useful for proposing future adaptation strategies.

## 6 Summary and Conclusions

Climate change impacts will have both positive and negative consequences on tourism industry in the BSR. Coastal and cold-climate-dependent tourism are exposed to many climate change-related risks, while warmer climate can also bring new weather-related opportunities to the region. Variables of climate change and their impacts are identified based on existing reports as well as on new analyses carried out as part of the Baltadapt project. This report reviews existing research on climate change impacts with relevance to tourism destinations and activities, tourist behaviour and flows in the Baltic Sea Region. Possible adaptation measures are reconsidered with relevance to coastal and cold-climate tourism destinations. Finally, the research and knowledge gaps in relation to climate change adaptation and tourism are listed and discussed with the aim to support research and cooperation between science and industry.

Coastal tourism industry is an important contributor to regional and national economies and employments; it is the largest single maritime economic activity in Europe (ECORYS 2012a). Coastal destinations are the most popular destinations in Europe and the rest of the world (EC 2000). Coastal areas are important for the leisure and recreation to the local communities, and they are a part of regional identity, place image and branding. The BSR has a tourism industry with longstanding traditions and innovative enterprises; although tourism adaptive capacities with relation to climate change vary depending if the settings are in urban, densely or scarcely populated coastal areas or in wealthier or lower income regions. Nevertheless all coastal tourism destinations around the Baltic Sea are linked through climate change impacts relevant for the region. To create, share and distribute existing knowledge on climate impacts and to find the best and available adaptation options, joint activities are needed for the BSR tourism industry and governments. Fragmentation, polarisation and low capacity to research, innovation activities and long-term strategic planning of the tourism industry request joined support and intervention from the national and local governments, as well as coordinating action by trans-national regional organisations.

The most valuable resources for coastal tourism in the BSR are beaches and the water itself, and consequently the quality of these resources is of great significance for the decisions by tourists to spend their holidays in this area. Snow and ice in cool weather destinations, e.g. the northern part of the BSR, are equally important tourism resources. While climate change will bring many new opportunities due to the rise of average air and water temperature it also will make significant negative impacts on the quality of water and beaches and the shrinking of winter tourism season. Sea level rise and increased wind-speed, increased precipitation in winter and decreased in summer will affect natural and built-up environments and structures that are today located in a thin belt along the coast. Through increased precipitation the run-off of nutrients from cultivated land could increase the already existing problem of eutrophication which may affect, e.g. beach tourism.



There are certain barriers to climate change adaptation strategies for tourism sector (Turton et al. 2010) that makes it difficult for the stakeholders to act appropriately to the already arising impacts of climate change to the BSR:

- The scale and uncertainty surrounding climate change projections,
- Communication within and between regional, national and local actors,
- Concerns regarding the capacity of venue-based small and medium enterprises to adapt, relative to governments and larger/global tourism operators,
- Institutional, legal, community and resource limitations that inhibit, or are at least perceived to inhibit, the timely implementation of adaptation strategies.

To overcome uncertainties on climate change and its possible impacts, new knowledge and information distribution are needed not only for responsible governments at various levels, but also for tourism industry and tourists. Concerning climate change adaptation in tourism sector several key issues are identified and require the following (after Prideaux 2009, Turton et al. 2010):

- Confidence that climate is changing and this fact is recognized at wider society and acted upon,
- Common understanding that increased variability in climate is part of the climate change process,
- Overcoming communication problem among climate change experts, tourism industry and decision-makers,
- Comprehension that there are a number of drivers that underpin change and in the tourism context which are poorly understood,
- Recognition that climate change and adaptation is a moving target,
- To overcome uncertainty, the effective monitoring and evaluation of impacts and adaptation measures are needed that are relevant for tourism industry,
- Motivation from the tourism industry and destinations to avoid climate change risks or take up opportunities through adaptation actions,
- Resources from the government and private stakeholders,
- Innovation is a key strategy for tourism industry and destinations and that includes demonstration of new technologies and good practices,
- The tourism industry need to be self-organized on an industrial scale to ensure its voice is heard and concerns are accorded legitimacy; thus transitional support from the government at various levels is needed.

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