

## **AN EXPLORATORY PATH ANALYSIS OF CLIMATE CHANGE EFFECTS ON TOURISM**

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### **Abstract**

*This study is an overview of the climate change effects on tourism. Paying particular attention to the eco-agri-tourism, conceptually approximating the terms, the aim of this study is to record both the direct and indirect effects of the de facto climate change in the Mediterranean and associate the outcomes with the situation in Greece. A structured review of the literature on the Driver-Pressure-State-Impact-Response framework principles was applied in order to conceptualize this complex problem. In addition, through analyzing certain outcomes this paper seeks to offer sustainable solutions towards addressing the implications arising.*

**Keywords:** *Climate Change, Tourism, Sustainable Development, Greece*

### **Introduction**

Climate change is internationally defined as the changes in the meteorological conditions relating to significant periods. Such changes may include notable -statistically-fluctuations or changes to climate levels. Climate change is mainly caused by human-induced disruption to natural balances. Under the United Nations Framework Convention on Climate Change (UNFCCC), climate change is the change in climate arising directly or indirectly from human activities, clarifying the notion of climate variability due to natural causes. In the areas surrounding the Mediterranean a particular type of climate is noted, also known as the “Mediterranean Climate”, that is generally characterized by mild and rainy winters and hot -or perhaps dry hot- summers. In Greece, a complex geomorphology is clearly visible, wherein depending on the prevailing weather conditions contributes to the development of particular climatic contrasts which are regarded as climate change (from Mediterranean to Alpine). In addition, Greece owns a long coastline, which combined with the particular geomorphology forms a patchwork of local climate characteristics that can be considered quite different from the ones of the Mediterranean. Thus, the average altitude in the mainland is circa six hundred (600) meters, while the total coastline measures a total of sixteen thousand and three hundred (16300) kilometers, i.e. one third (1/3) of the length of the earth periphery at the Ecuador. Hence, scientific research results arguing temperature increase of up to five (5) degrees Celsius by 2100, corroborate the foregoing considerations, especially when there are currently

scientific indications of a two degree Celsius temperature rise -average- during summer in state capital. At the same time, it is estimated that the sea level might rise by fifty (50) centimeters by 2100 with catastrophic effects on seaside areas, ecosystems, etc. A report published in 2005 by WWF and the Greek National Observatory, highlighted the effects of the broader Mediterranean region in the event of a global warming by just two (2) degrees Celsius. Particularly in Greece, according to this report, waves of heat and droughts, extensive fires, problems on drinking water sufficiency and damages to agricultural activities will occur frequently. In view of this worrying situation, tourism sector, would almost certainly be severely hit in the broader Mediterranean region with devastating economic side-effects (Giannakopoulos, Kostopoulou, Varotsos, Tziotziou, & Plitharas, 2011). Tourism, in terms of GDP, labor force and trade balance, is one of the most important economy sectors in Greece (Vardopoulos & Theodoropoulou, 2019). Moreover, as a climate-dependent sector (Michailidou, Vlachokostas, Moussiopoulos, & Moussiopoulos, 2016) it is subject to particular issues, mainly seasonality and geographic over-concentration. High temperatures, extreme weather events, water scarcity, etc., are just few of the effects expected to have particular impact on tourism in Greece. For example, studies performed by the German Central Bank and the World Trade Organization, project tourism demand re-distribution for the benefit of countries and regions with milder -summer- temperatures, such as those in the Nordic. In particular, rising temperatures in Europe are set to bring even harsher heat waves to Greece, especially during summer. The continuing weather conditions pressure in Greece along with the already temperate climate in central and northern Europe, as a result of climate change and global warming, will drastically reformulate the map of summer destinations across Europe. This is expected to significantly reduce tourist flows (Amelung, Nicholls, & Viner, 2007), with shocking effects for the Greek internal economy. It follows that is imperative to develop a strategic plan on tourism in Greece with two main objectives: a) reducing seasonality and b) combating mass tourism phenomena. These can be ensured by promoting specific aspects of different parts of Greece (Karytsas, 2009), attracting alternative forms of tourism (such as agritourism, ecotourism, winetourism, etc.) (Theodoropoulou, 2016), minimizing the environmental footprint, and all similar mechanisms subjected to the imperatives of sustainable development. Agri-tourism is defined as a form of soft tourism, where the visitors accommodate farm guesthouses and actively contribute to work related to the farm operation (Tsartas, Manologlou, & Markou, 2001). Core characteristic is the direct exposure in rural life, nature, cultivation, etc., an indeed surprising perspective for the modern man. According to the initial interpretation of the Greek Center of Rural Tourism, agri-tourism in Greece is the development of parallel activities, aimed at the economic and social regeneration of rural areas by supporting agricultural production and marketing and by promoting small-scale soft tourism services along with the cultural and natural wealth of each region. Ecotourism is another alternative form of tourism, mainly associated with a variety of tourism activities using all possible environmental resources (Harry Coccossis, Tsartas, & Gkrimpa, 2011). Mostly concerns ecologically sound and usually under protection environmental areas. Activities may be both of scientific related character and educational nature (Theodoropoulou, Vardopoulos, Sardanou, Mitoula, & Kavouras, 2019), contributing - by definition- to the protection of the environment.

At a time of transition and change, modern societies have been consuming for a considerable number of years, the future generation resources. The multilateral and multipolar organization of the world economy is heading towards a theoretical development in the name

of which earth resources are depleted in a way that the environment is taken to the extreme, damaging sensitive ecosystems and triggering unprecedented imbalances. The urban way of life is pushed to its limits (Santamouris, Cartalis, & Synnefa, 2015), while at the same time, tourism as a social phenomenon, is called to serve both the feeling of personal amusement and mind harmony. The potential tourist, standing before their will of making up for their lost time -due to work time-, makes use of tourism services as a step towards finding means of knowledge and experiences that will further contribute to their personal development (Maccannell, 2015). The type of tourism, that serves the above mentioned contemporary paradigm, can only be based on small-scale quality tourism establishments, directly interdependent with the local economy, the gastronomic traditions, the history, the culture and the environment. In Greece, the shift towards such a tourist formula is considered imperative (Svoronou & Holden, 2005) [=Response], firstly due to the sector relation with the GDP (Nannos, Bersimis, & Georgakellos, 2013; Tsartas, 1994) and secondly due to the -rather disappointing evidence on- human activities relating to tackling climate change (Dimitroulopoulou & Ziomas, 2011; Lespez et al., 2016; Sapountzaki, 2018). Greece is ranked 39st among 60 countries with regard to performance addressing climate change<sup>1</sup>. Greenhouse gas emissions could perhaps go beyond what is set by the competent bodies (UNFCCC<sup>2</sup>, IPCC<sup>3</sup>, UNEP<sup>4</sup>, EEA<sup>5</sup>). Energy from renewable sources goal seems to be lying so far in the future (Karytsas, Vardopoulos & Theodoropoulou, 2019; Karytsas, 2018; Karytsas & Choropanitis, 2017; Karytsas, Mitoula, Sdrali, & Theodoropoulou, 2010; Karytsas, Polyzou, & Karytsas, 2019; Karytsas & Theodoropoulou, 2014b, 2014a). The total energy consumption increases by about 2.1% per year (GESY, 2018). For every KWh produced [=Driving Force], 777 grams of CO<sub>2</sub> are released [=State] (UNFCCC, 2017). 12.5 tns of greenhouse gases per capita are produced. The most polluting power plants throughout Europe (Agios Dimitrios) [=State] are still operational [=Driving Force]. Lignite and coal, the most polluting fuels [=State], are currently exempted from taxation [=Driving Forces]. Incentives for home energy saving and shifting to RES remain inapplicable (Karytsas, Vardopoulos, & Theodoropoulou, 2019). Oil dependence remains the greatest in Europe, etc. So how does sustainable tourism can be ensured against climate change phenomena [=Impact], when in response to similar with the above facts, nature reacts [=Pressure]? This will be easier to clarify after understanding the direct and indirect climate change impacts.

## Climate Change

The debate about global warming and its effect on global temperatures began in the 19th century, but the questions about climate change came forcefully to the forefront much later, in the mid-1950s with the first high-precision measurements of the level of carbon dioxide in the atmosphere (Keeling, 1958). It was those measurements that sparked an intense discussion

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<sup>1</sup> Overall Results of the 2018 Climate Change Performance Index are defined by each country aggregated performance regarding fourteen indicators within four categories; GHG Emissions, Renewable Energy, Energy Use and Climate Policy.

<sup>2</sup> United Nations Framework Convention on Climate Change ([www.unfccc.int](http://www.unfccc.int))

<sup>3</sup> Intergovernmental Panel on Climate Change ([www.ipcc.ch](http://www.ipcc.ch))

<sup>4</sup> United Nations Environment Programme ([www.unenvironment.org](http://www.unenvironment.org))

<sup>5</sup> European Environment Agency ([www.eea.europa.eu](http://www.eea.europa.eu))

about increasing temperature of the planet and the causes which may be causing such an increase.

The historical course for the climate change negotiations and the main stations of the historical evolution of the issue are as follows:

- Stockholm Declaration, 1972. The United Nations Conference on the Human Environment was held in Stockholm, Sweden in June 1972. The meeting agreed upon the fundamental principles of laws relating to the environment. The United Nations Program for the environment launched (Baylis & Smith, 2001; Maurice, 2001). Some argue that this conference had a real impact on the environmental policies of the European Community (that later became the European Union), as in 1973 the European Union created the Environmental and Consumer Protection Directorate, and composed the first Environmental Action, therefore it is allowed to be said the such increased interest and research collaboration arguably paved the way for further understand of global warming which has led to extremely important agreements and also has given a foundation of modern environmentalism (Linnér & Selin, 2013).
- Brundtland Commission, 1987. Formally known as the World Commission on Environment and Development, based in Geneva and established in December 1983. In December 1987, commission officially dissolved after releasing “Our Common Future”, generally noted as the Brundtland Report, a paper which defined the meaning of the term Sustainable Development and reflected about ways to save the human environment and natural resources and prevent deterioration of economic and social development (Borowy, 2013).
- Formation of the United Nations Preparatory Committee (1989) for the World Conference convergence concerning the environment within the next three years (procedure '92).
- The United Nations Conference on Environment and Development also known as the Rio Summit, Rio Conference, and Earth Summit in 1992, resulting five International Conventions: The Rio Declaration on Environment and Development. The integrated action program Local Agenda 21. The declaration of principles for the forests management. The Biological Diversity agreement. The convention on Climate Change to take effect from March 1994, which had as its objectives: a) to reduce greenhouse gas emissions that increase the greenhouse effect, and b) varying the weight of responsibility for the production of gas between developed and developing countries. Finally the United Nations Convention to combat desertification.
- The EEA was established by the European Economic Community, and firstly operate in 1994. It is based in Copenhagen.
- Parties to the United Nations Framework Convention on Climate Change meet in Berlin (the 1st Conference of the Parties) to outline specific targets on emissions.
- The Kyoto Protocol, an international treaty adopted in 1997 which extends the United Nations Framework Convention on Climate Change negotiated at the United Nations

Conference on Environment and Development is defined by its objective to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system, and along with agreed politics slow the speed at which the climate of the earth changes. The parties of the United Nations Framework Convention on Climate Change have met annually from year 1995 in Conference of the Parties to assess progress in dealing with climate change (Change, 1992).

- In February 2001, the seven richest countries on the world met in Trieste and agreed the next conference should adopt all measures of Kyoto Protocol and be taken more measures to protect the environment. Indeed, despite the absence of the USA, for the first time most countries agreed in Marrakech 2001 into an effective package of measures capable of tackling climate change.
- The World Summit on Sustainable Development also known Johannesburg Summit from where it took place, in 2002, (Rio+10 years) when actually the Kyoto Protocol (2005) took effect. It was agreed by negotiators to restore the world's depleted fisheries for 2015 in the form of "partnership initiatives". Fundamental to achieve the Millennium Development Goals.
- Positive were the commitments taken in Brussels in March 2007, the 27 European Union leaders, to reduce the European Union emissions of gases causing the greenhouse effect by 20% by 2020 compared to the 1990 levels and to increase production of electricity from renewable energy systems by 20% of a total energy production.
- The climate and energy package, the European Union climate and energy targets for 2020 were set in March 2007, when it was committed to become a highly energy efficient, low carbon economy. These targets, known as the "20.20.20 targets", primarily was setting three main objectives: a) a 20% reduction in European Union greenhouse gas emissions from 1990 levels, b) raising the share of European Union energy consumption produced from renewable resources to 20%, and c) a 20% improvement in European Union's energy efficiency.
- Bali Action Plan or the 2007 United Nations Climate Change Conference. A total of 192 countries are signatories to the United Nations Framework Convention on Climate Change (13th Conference of the Parties) and agreed on a roadmap of negotiations which will determine the key issues that should be addressed in December 2009 in Copenhagen Conference. As part of the Conference all developed country Parties had agreed to quantified emission limitation and reduction objectives. Agreed to (nationally) appropriate mitigation actions (Nationally Appropriate Mitigation Actions).
- Copenhagen Accord otherwise known as the 2009 United Nations Climate Change Conference which included the 15th Conference of the Parties and the 5th Meeting of the Parties, recognized that deep cuts are required in global emissions according to science and specified voluntary commitments to reduce pollutants without though setting higher rates and time commitments. The Accord states that global warming should be limited below two

(2) Degrees Celsius. As part of the Accord the European Union -27 have submitted mitigation targets, and have noted the need for international support in their plans.

- Cancun Agreements, the 2010 United Nations Climate Change Conference, also referred to as the 16th Conference of the Parties and the 6th Conference of the Parties serving as the meeting of the Parties to Kyoto Protocol. Where the global community agreed on the following : a) that the increase in global temperature should be kept below 2 Degrees Celsius, b) the industrialised nations pledged to create financial support fund of the developing world over the next three years to poor economic countries to adapt in green technology, c) it was agreed funding of nations that have forests in order to protect them, and d) to maintain the effect of the Kyoto Protocol, which requires from strong economy nations mandatory restrictions on emissions and was about to expire on December 31, 2012. But, the two biggest polluters N. America and China were not committed reducing their emissions. Japan, even tried to include nuclear power in the Clean Development Mechanism, which would have allowed industrialized countries to increase their emission “rights” if they were financing poorest countries for the establishment of nuclear power plants.
- Durban Platform for Enhanced Action rather preferably the 2011 United Nations Climate Change Conference. Durban Platform is a protocol, or yet another agreement reached on the conference, where a renewed set of negotiations on greenhouse gas emissions and other matter launched. The new agreement is to be reached, including all Parties (especially USA, China and India) by the 21st Conference of the Parties, with is provisions being implemented and coming into effect from 2020 forward. Discussions are organized under the Ad-Hoc Working Group on the Durban Platform which is instructed to note with grave concern the gap between current efforts and a pathway consistent with holding global temperature below 2 Degrees Celsius above pre-industrial levels. It is considered a victory of the European Union which in the meantime prepared the 2010 Energy Initiative and the road map of the route for moving to a competitive low carbon economy in 2050.
- The Doha Conference held in Qatar as the 2012 United Nations Climate Change Conference and was the 18th yearly session of the Conference of the Parties and the 8th Conference of the Parties serving as the meeting of the Parties to Kyoto Protocol. Aim of this conference was to provide an extension to the Kyoto Protocol until 2020, when it is expected to sign a more ambitious environmental protection plan. For the first time it was adopted by the members the wording “loss and damage” and its concept. For the first time in Doha, people took a stand out in the streets demanding from world leaders to take action upon the circumstances created by the climate change.
- Warsaw Conference, the 2013 United Nations Climate Change Conference, 19th Conference of the Parties or 9th Conference of the Parties serving as the meeting of the Parties to Kyoto Protocol. The conference led to an agreement that all states would start cutting emissions as soon as possible, with a date looking at the first quarter of 2015. Furthermore the Warsaw Mechanism was proposed, a mechanism which would provide financial and/or not only aid to developing nations, to cope with loss and damage from natural extremities (Rausch & Karplus, 2014).

- The 2014 United Nations Climate Change Conference held in Lima, Peru, the 20th Conference of the Parties and the 10th Conference of the Parties serving as the meeting of the Parties to Kyoto Protocol, while a conference in the annual series, more attention was directed toward the upcoming conference in Paris. The only weak but hopeful message sent by agents, government officials and international organizations, is a short sentence, well hidden in the common final communiqué, the intention of the participants to lead to economies with zero net carbon dioxide emissions by 2015. The European Union aimed a legally binding 40% drop in emissions by 2013 against carbon output in 1990 as baseline.
- In 2015 the anticipated 21st Conference of the Parties took place in Paris. The 11<sup>th</sup> Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol negotiations led to the adoption of the so called Paris Agreement which included measures to reduce climate change from 2020 (Barston, 2019; Horowitz, 2016), and would become effective by 2016. The adoption of the Paris Agreement also brought to an end the work established on the Durban platform during the 17th Conference of the Parties. The adoption threshold was reached on 4 October 2016 with more than 55 countries accounting for more than 55% of the global greenhouse gas emissions.
- The first session of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, was held in Marrakech during the 2016 United Nations Climate Change Conference, with a focal issue on water scarcity, water cleanliness, and water-related sustainability, a major problem in the developing world. The need for greenhouse gas emissions reduction by the use of low-carbon or renewable sources of energy was also a focal issue of the 22<sup>nd</sup> Conference of the Parties, with the President of the United Nations General Assembly calling for a transformation of the global economy to a low-emission global economy in all sectors.
- The 2017 United Nations Climate Change Conference among political leaders, non-state actors and activists was held in Bonn, Germany incorporating the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change, the 13th meeting of the parties for the Kyoto Protocol, as well as the 2nd meeting of the parties for the Paris Agreement, and was the 1st meeting after the President of the United States of America announced that the States would withdraw from the Paris Agreement. The outcome of the meeting was the ‘Fiji Momentum for Implementation’, a technical document outlining the steps to be taken towards making the Paris Agreement operational. In addition the conference conducted launching the Talanoa Dialogue; a mechanism aiming to help nations to increase and deliver their Nationally Determined Contributions by 2020.
- The Katowice Climate Change Conference was the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change and was held in Poland. The 2018 United Nations Climate Change Conference agreed on rules to implement the 2015 Paris Agreement among others.
- The 25th yearly session of the Conference of the Parties to the 1992 United Nations Framework Convention on Climate Change, the 15th session of the Meeting of the Parties to

the 1997 Kyoto Protocol, and the 4th meeting of the parties for the Paris Agreement, will take place in Santiago, Chile during November-December 2019.

### **Cross-disciplinary perspectives on climate change negotiations**

Science is clear. Every year that passes, measures adversely against climate change and whenever the authorities idle to take measures, the risk for all mankind grows. Those recent decades the carbon dioxide, methane and other poisonous gases have increased. If this situation continues, the next generations will find themselves in a terrible state. The temperature of the planet will rise. With increasing temperature, large rural areas will fall in drought and people will be forced to move to other parts of the world to survive (mass migration). Sea water will rise dangerously which means that coastal areas will be at risk from flooding, and diseases and disabilities generated by the environmental contamination, haven't even mentioned.

The governments of the big polluters of the planet, is almost certain and constantly proven with their attitude, that they do not want to take steps towards drastic reductions of greenhouse gases, since they continue their dependence on fossil fuels.

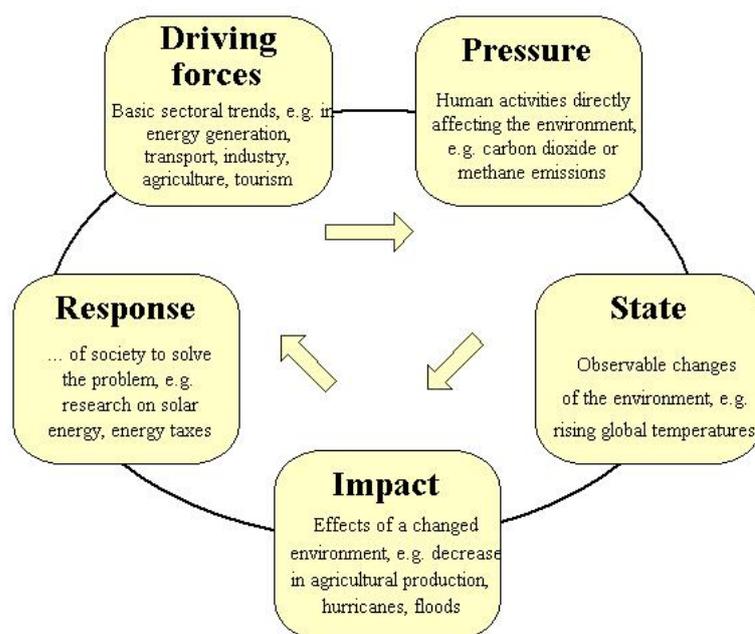
Over most of the history of negotiations, emissions mitigation commitments have been formulated in terms of economy -wide targets and timetables- or, in terms of quantified emission limitation and reduction objectives (QELROs). Resulting the turnover from the aim 'to set quantified limitation and reduction measures within specified time-frames for anthropogenic emissions, to where we are standing now on 'common but differentiated responsibilities' and 'voluntary goals' in whatever terms. We are here now, at this crucial times, obligated to focus on distinguishing, before proceeding in any form of agreement, on whether countries will be willing (or be able) to take actions or consider that they must (obligated). Actions that will, of course, be only one step in a continuing global effort to limit human influence on the climate. If the agreement reached in Paris 2015 is going into effect by 2020, the earliest review of performance along the way might not be before 2025. In this case, an effort to formulate the next agreement, would not start until 2025 or after, with new targets set for a decade or more after that, where then global emissions as far out as 2045 or 2050 will be heavily influenced by achievements in the negotiations over the next months.

The European Union international climate change policy consists of three building blocks, environmental integrity, multilateralism and a legally binding instrument, but lacks bargaining chips. European Union is often observed as a leader in global environmental politics, but its leadership role can nowadays also be questioned. Since 2009, the European Union has actively revamped the foreign policy architecture on climate action and has worked to refine the climate diplomacy strategy, though despite these efforts, European Union capacity for effective external climate action remains imperfect.

Nevertheless, first Parties have to present their Intended Nationally Determined Contributions for an ex-ante review process, clarifying and aggregating pledges to assess their implication for long-term goals. With the exception of the EU, Parties have not revealed their Intended Nationally Determined Contributions, thus uncertainty remains very great about the future of negotiations.

## Methodology

A structured review of the literature on the Driver-Pressure-State-Impact-Response (DPSIR) framework principles was applied in order to conceptualize the function, processes and components of this complex problem, to better understand and therefore to be in the best position to address sustainable development challenges. The DPSIR framework has considerable potential to bridge the gap between scientific disciplines and works towards the sustainable strategy development through simplifying the complexity of climate change effects (Vardopoulos, 2018).



**Figure 1** The DPSIR causal framework

The articles used represent all science disciplines concerned and were chosen from a broad array of international scientific journals. However, it should be noted, that this is not a full systematic literature review, as the scope of the current exploratory analysis does not include assessing the authors' chosen methodology.

## Results: Climate Change Effects

Climate change impacts on the aquatic ecosystem, and more particularly on groundwater include: a) the general decrease in supply and renewal of the groundwater due to the reduced precipitation and high annual rates of evapotranspiration, b) the increased salination in coastal, deep-water and increasingly to inland areas due to the reduced nature of the aquatic and associated terrestrial ecosystems potentials -element of the decreasing supply and water and groundwater over-abstraction-, c) the increasing concentration of pollution loads in coastal waters and the sea, d) the intensification of delta regions degradation, already affected by dam construction (by reducing basin districts and sediment discharges) and parallel dikes in the lowland of the delta regions, e) the pollution and desiccation of coastal wetlands and f) worsening desertification due to water deficit and territorial changes (condensation, soil sealing, etc.). In addition, an increasing number of studies have found that

alternation in water balances will have direct impact on crops, however in full correlation with the changes in the agricultural practices. (Doney et al., 2012; Green et al., 2011; Haddeland et al., 2014; Harley et al., 2006; Kløve et al., 2014; Kosmas et al., 2001; Koutroulis, Tsanis, Daliakopoulos, & Jacob, 2013; Mimikou, Baltas, Varanou, & Pantazis, 2000; Taylor et al., 2013). It is therefore clear that climate change impacts severely affect eco-agri-tourism.

The coastline in Greece, already faces severe erosion problems, stemming from two strong threats caused by climate change, namely the long-term and the short-term sea level rise (Doukakis, 2005; Papageorgiou, 2016; Poulos & Chronis, 2001; Xeidakis, Delimani, & Skias, 2007). The effects concern the population and the built environment, as well as the individual environmental systems (Economou, 2012). Whereas, given the coastal areas economic value -especially for Greece- (Martínez et al., 2007); proven by recent research results indicating that the coastal tourism contributes with rates reaching up to 20% of the GDP (Ciscar et al., 2011), combined with the various forecasts for the rise in sea levels ranging from 0.2 to 2 meters by 2100 (Nicholls & Cazenave, 2010), whether by gradual sea level rise or stormy meteorological tides and waves, and regardless of the land use (residential, agricultural, forestry, etc), a disorderly and uncoordinated territorial and spatial recede or retreat of all human activities is foreseen, with huge socio-economic impacts, if not addressed by planned adaptation policies (Doukakis, 2004; Latinopoulos, Konstantinou, & Krestenitis, 2012). Hence, a strong blow, with evidently disastrous effects on tourism and in particular eco-agri-tourism.

Regarding fisheries and aquaculture, the upcoming temperature rise combined with the atmospheric precipitations reduction, can be associated with the unexpected river fluctuations risks in Greece, as well as with the unspecified magnitude of ecological turbulence in ponds and estuaries. It is also quite clear that inland waterways will initially be affected on the availability, while the conflict of interest for other uses will grow. Similar effects are also foreseen in several lakes, mainly in times of long rainless seasons, which will lead to environmental degradation of fish fauna and, possibly, to reduction of the inland water collectors capacity (Allison et al., 2009; Badjeck, Allison, Halls, & Dulvy, 2010; Belias, Bikas, Dassenakis, & Scoullou, 2003; Bobori & Economidis, 2006; Brander, 2010; Konstantinou, Kombiadou, & Krestenitis, 2015). Finally, rising sea temperatures are likely to result in accelerating the growth rate of aquatic ectothermic organisms (Daufresne, Lengfellner, & Sommer, 2009; Narum, Campbell, Meyer, Miller, & Hardy, 2013). Therefore, the impact of tourism and in particular on the alternative forms of tourism is envisaged disastrous and fatal.

In agriculture, the increasingly positive effects concern the northern and eastern regions of the country. The most sensitive crop is wheat, followed by the cotton production. In the case of tree crops the effects may be considered neutral, for a period up to the middle of the current century, but this fact is totally reversed while approaching the end of the century, and mainly in southern and island Greece. Horticulture is moving to the northern parts of Greece and while the cultivation period gets longer due to the warmer spring seasons, with the (positive) effect of increased production. (Altieri & Nicholls, 2017; Chartzoulakis & Psarras, 2005; Georgopoulou et al., 2017; Howden et al., 2007; Karamesouti et al., 2015; Koufos, Mavromatis, Koundouras, Fyllas, & Jones, 2014; Nelson et al., 2014; Olesen et al., 2011; Papadopoulou, Charchousi, Tsoukala, Giannakopoulos, & Petrakis, 2015; Rickards & Howden, 2012; Vardopoulos, Falireas, Konstantopoulos, Kaliora, & Theodoropoulou, 2018; Voloudakis et al., 2015).

Looking at historical data, it is clear that due to climate change by 2100 there will be a total spatial re-distribution of forests in Greece, with significant extent reduction. Pine and evergreen broadleaf forests (Resco De Dios, Fischer, & Colinas, 2007) will expand by an average of 3% while forest stands dominated by spruce, fir, beech and black pine will shrink by approximately 6% (IPCC, 2014). In addition, coastal forests are threatened with desertification. Finally, following the re-distribution and the territorial reduction of the productive forests (estimated an average value of 250 thousand sq.m.), a of wood biomass production reduction (by 0.5% m<sup>3</sup>/ha/y) is anticipated (Allen et al., 2010; Chrysopolitou et al., 2013; Ellison et al., 2017; Fyllas & Troumbis, 2009; Kizos, Detsis, Iosifides, & Metaxakis, 2014; Lindner et al., 2010; Seidl et al., 2017; Venäläinen et al., 2014).

The Climate Change effects on biodiversity are complex. Biodiversity may be put under pressure by various factors correlating as follows: a) by direct effects on organisms; for example the temperature affects, the survival rates, the reproductive process, and the dissemination and behavior patterns, b) by affecting the biotic and c) the abiotic processes of the system (Bellard, Bertelsmeier, Leadley, Thuiller, & Courchamp, 2012; Kantzoura, Kouam, Theodoropoulou, Feidas, & Theodoropoulos, 2012; Omann, Stocker, & Jäger, 2009; Theodoropoulos, Peristeropoulou, Kouam, Kantzoura, & Theodoropoulou, 2010).

Moreover, Climate Change will radically alter the environmental and climate condition in the areas subjected to. In addition, changes to the environmental and the climate condition are expected to have direct impacts on data regarding the human existence and well-being. For example exposure of the constructed environment, increase of the production costs, business losses, cessation of services, etc. In many cases, Climate Change will also adversely affect human well-being by residential over-heating or deteriorating living and health conditions for example (Carter, 2011; Farrou, Kolokotroni, & Santamouris, 2016; Harlan & Ruddell, 2011; Hirst, 2013; Hunt & Watkiss, 2011; Masson et al., 2014; Roetzel & Tsangrassoulis, 2012; Younger, Morrow-Almeida, Vindigni, & Dannenberg, 2008). Furthermore, consequences of the Climate Change in transport are indicated by the following three subcomponents: a. impacts on infrastructure due to 1. Damages reconstruction caused by extreme natural disasters and 2. Preventative construction projects to protect the existing infrastructure, b. Impacts on infrastructure maintenance, and c. impacts of changing the system mode of operation and reliability due to for example delay or other changes in routes and services (Boarnet, 2010; Creutzig & He, 2009; Girod et al., 2013; Koetse & Rietveld, 2009; Love, Soares, & Püempel, 2010; Maibach, Steg, & Anable, 2009; Meyer & Weigel, 2011; Schmidt & Meyer, 2009; Vardopoulos, 2019a, 2019b).

Finally, the upcoming climate change is expected to set new epidemiological data globally (IPCC, 2014a). For example the International Health Organization highlights that climate change is responsible for 3% of the diarrhea cases worldwide, as well as for the 6% of the reported malaria cases in the developing countries (WHO, 2009). Given that climate change has an impact on human health (UNFCCC, 2012), a classification is indicatively attempted according to the following three parameters: a) direct effects; resulting from extreme weather events such as heat wave deaths, b) indirect effects; blooming due to certain environmental disturbances such as the growing threat of disease transmission by mosquitoes or rodents, and c) various effects; that are threatening populations affected by economic hardship and environmental degradation, such as nutritional issues or psychosomatics (Bezirtzoglou, Dekas, & Charvalos, 2011; De Blois et al., 2015; Harlan & Ruddell, 2011; Lindgren, Andersson, Suk, Sudre, & Semenza, 2012).

## Conclusions

In view of the above mentioned, and since the climate, the nature, the seas, the atmosphere; the natural environment in general, constitute an essential element of the tourist product in Greece, we safely reach to the conclusion that Climate Change has a direct impact on the tourism sector. In addition, climate change impacts on tourism in Greece fall into the indirect and the direct, with the latter affecting the Tourism Climate Index regarding tourism demand (Amelung & Viner, 2006; Hamilton, Maddison, & Tol, 2005; Rosselló-Nadal, 2014). Direct impacts include but are not limited to phenomena such as global warming, sea level rise, changes in humidity and air quality, increased droughts, rising pollution, increase of the visitors' discomfort index, increased risk of forest fires and desertification, rainfall shortages, increased intensity of extreme weather events, degradation of already fragile ecosystems, etc.

On the other hand, indirect impacts are related to coastal tourist infrastructure damages, or tourist infrastructure abandoning owing to the failure to meet the requirement of use (for example ski resort lack of snow), aquifer seawater infiltration whereby the danger of salination, reduced water availability, particularly drinking water, due to rainfall shortages, reduction and/or elimination of eco-agri-tourism activities and infrastructure (Bigano, Hamilton, & Tol, 2006; Elsasser & Bürki, 2002; Gössling, Scott, Hall, Ceron, & Dubois, 2012; Hein, Metzger, & Moreno, 2009; S. Nicholls, 2004; Peeters & Dubois, 2010; Perch-Nielsen, 2010; Scott, Gössling, & Hall, 2012) which is to be translated in economic terms through the decrease in the number of arriving tourists, the reduction in average stay time, the high degree of seasonality, the reduction in the GDP which relates to the reduction in the GDHI<sup>6</sup> both linked with tourism-related economic activities, pushing into a downward spiral, the increase in the average tourist services cost, the incalculable economic damages caused by the partial inability to provide tourist services due to extreme weather events (losses of profit arising directly or indirectly), the financing of projects to reduce environmental pollution or to deal with Climate Change direct impacts or to respond to extreme weather events, the research promotion and the development of innovative bioclimatic infrastructures, the expenditure on the infrastructure reinforce and maintenance, the degradation or possible destruction of cultural and historical monuments and sites, the need for training towards adapting to the new standards, etc (Bezirtzoglou et al., 2011; Coccossis & Mexa, 2004; Lemesios et al., 2016; Michailidou et al., 2016; Sarantakou, 2017).

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<sup>6</sup> Gross Disposable Household Income

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