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Examining Climate Change, Tourism, and Sustainability in Small Islands, with Reference to the Balearic Islands, the Caribbean Islands, and the Pacific Islands

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Abstract

Tourism has become an important part of the social and economic development of small islands. The distinct differences and peculiarities of small islands have significantly raised awareness of sustainable tourism practices in small islands. In this case, the study seeks to determine the extent to which tourism sustainability on small islands is threatened by climate change. Small islands, and thus tourism, are vulnerable to rising average annual temperatures, changes in precipitation, sea-level rise, and extreme events such as El Nino-Southern Oscillation, hurricanes, and flooding. The Cayman Islands, Mallorca, and the Galápagos Islands were chosen as representatives of the Caribbean Archipelago, Balearic Archipelago, and Pacific Archipelago, respectively, as references to this issue. This study is based on secondary data and employs a qualitative approach. Based on previous research, the findings show that climate change has primarily affected small islands in these three case studies in terms of environmental sustainability, which then creates challenges in terms of economic and social sustainability. Thus, climate change and sustainable tourism can be viewed as interconnected issues that must be addressed in small islands.

Keywords: *Sustainable tourism development, tourism vulnerability, climate change, small islands, island tourism, the Cayman Islands, the Island of Mallorca, and the Galápagos Islands*

1. Background

Tourism in small islands has always been an important part of the destination life cycle. The remarkable transformation of tourism into the world's largest industry (WTTC, 2001) has restructured many small island economies from being reliant on traditional fishery and plantations to the tourism industry (McElroy, 2003). Small islands present notable differences and particularities in comparison to continental areas in terms of nature, biodiversity, economic development, culture, lifestyle, landscape, beaches, and human settlements (Coccossis, 2001). These characteristics tend to make small islands attractive as tourist destinations.

The need for sustainable development has been well-considered in small islands. The awareness of their small size, limited resources, remoteness from global markets, and environmental and economic vulnerability increase the importance of sustainable development (Hirano, 2008) including in the tourism sector. According to de Albuquerque & McElroy (1992), tourism has been increasingly dominant in small islands, which commonly have resource scarcity, limited market size, narrow domestic policy maneuverability, and lack of viable alternatives. Thus, sustainable tourism development has gradually emerged as the lead sector of sustainable community development in small islands.

Related with sustainable tourism development in small islands, climate change has become an important concern. Scott (2011) and Lew (2010) highlight the demands of sustainable tourism to address climate change as the greater reflection on the future of tourism development in a carbon-constrained global economy. In this case, as small islands depend more on tourism for their economic and community development, responses to climate change are significant to achieve sustainable tourism. Small islands have been considered as the least responsible for the emission of greenhouse emissions leading to climate change, but they are vulnerable to a range of associated adverse effects, including sea level rise, extreme weather events, and increased annual temperature (IPCC, 2012; UNEP, 2014; United Nations, 2010).

With this background, this research focuses on the impacts of climate change on such vulnerability within small islands and their tourism sustainability. Dolan & Walker (2006) argue that climate change impacts are unevenly distributed among the diverse geographical areas, so in presenting a wide-ranging discussion of the relationship of climate change and tourism in small islands, reference will be made in this research in particular to the Caribbean Archipelago, Balearic Archipelago, and Pacific Archipelago. This research then provides an evaluation of those three different archipelagos by identifying the implications of climate change towards tourism in three case studies of the Cayman Islands, the Island of Mallorca, and the Galápagos Islands. This research also examines the tourism sustainability challenges that may be caused by climate change in these small islands.

2. Theoretical Framework

2.1. Tourism in Small Islands

An island may be simply defined as a land area which is smaller than the continental area and surrounded by water (Sharpley, 2012) or terrain that was close to or isolated by water (Ratter, 2018; see also Royle, 2007). In the context of tourism studies, many researchers agree on the size of small islands as restricted to less than 10,000 km^2 land area surrounded by water (Hess, 1990; Sharpley, 2012; Benedicto, 2014; Balzan, *et al*; 2016; Petzold, 2017). UN-OHRLLS (2016) and Ioannides *et al* (2001) argue most small islands share similar sustainable development challenges, including small population, tiny domestic market, lack of resources, remoteness, susceptibility to natural disasters, poor accessibility, limited infrastructure, excessive dependence on international trade and vulnerability to global developments.

Small islands are disproportionately important as tourist destinations (Weaver, 2017). Small islands have been fascinating places associated with remoteness, separateness, difference and the exotic, which also provide the senses of romance, adventure, fantasy, escape, and 'otherness' (Sharpley, 2012). They usually offer authentic cultural and natural experiences in unique settings which are far from urbanized life and represent the notion of paradise (Carlsen & Butler, 2011). The attraction of small islands for tourists frequently lies in their 'islandness' (Sharpley, 2012), which means the qualities of being an island or like an island (Hall, 2012). However, the lack of resources, small size, and insularity; mean small islands generate a form of tourism (island tourism) that is overwhelmingly dependent on sun, sea, and sand (3S) (Pearce, 1987; see also Weaver, 2001). In this case, Wong (1993) argues that all island tourism is not precisely the same because the scale and character of it are dependent on the island's resources and tourism development policy adopted. Sharpley (2012), however, argues that the degree to which island tourism is distinct from other forms of tourism cannot be found specifically. The difference only lies in the location in which tourism activities occur in small islands, smaller places compared to continental states.

The robust growth of tourism development and dependency on small islands is the result of the competitive advantage that small islands tend to have in tourism-related activities, as experienced by small islands in the Caribbean, the Mediterranean, and Pacific (McElroy & de Albuquerque, 2002; Briguglio & Briguglio, 2002; Scheyvens & Momsen, 2008). The isolation of small islands is often considered a weakness for trade but makes small islands attractive, exotic and enticing as a tourism destination (Scheyvens & Momsen, 2008). The rapid growth of tourism accounts for around a half of the foreign exchange, employment, and Gross Domestic Product (GDP) in small islands

of the Caribbean, Mediterranean, and Pacific (Apostolopoulos & Gayle, 2002; McElroy & de Albuquerque, 2002). In many small islands, tourism becomes the only growing sector that gives real value and benefits in place of local communities' traditional primary occupations (Scheyvens & Momsen, 2008; Tsartas, 1992); though it can be an exploitative form of neocolonialism (Brohman, 1996), which capitalizing investment and resources (i.e. groundwater, human resources, and land) (Mowforth and Munt, 2003; Telfer, 2003; Harrison, 2003; Scheyvens & Momsen, 2008).

In the social dimension, tourism in small islands can be an effective tool for empowering the local community, especially women and young people (Tsartas, 1992) which also revitalizing local activities that have been in decline and improve creativeness of local community to reach tourists' satisfaction (Loukissas, 1982; Sinclair *et al*, 2005). However, Scheyvens & Momsen (2008) and Tsartas (1992) argue that inequalities between the rich and poor, acculturation, cultural erosion, the demonstration effect can be the result of tourism development in small islands, as these authors found on the Island of Ios, Greece. The power of foreign investors takes over the industry can lead to political disempowerment which may lead to fewer local benefits obtained. In addition, Macleod (2004) studying the Canary Islands shows that tourism has a great ability to change the culture which heightens issues of control, power, and personal identity, including the sense of pride, competition, and new social patterns.

The very nature of islands escalates some basic tourism-environment relationships which influence island tourism developments (Wong, 1993; Harrison, 2001). Economic benefits are likely to increase environmental costs (Harrison, 2001). Tourism developers mostly look at landscapes and beaches as products on sale (Altaba & Ponsell, 2000). Heavy investments in international hotel chains, resort developers, airlines, cruise lines, tour operators, and other tourism facilities promote high volume and density tourism, which tend to yield short-term benefits yet threaten the very natural amenity base that attracts the tourist in the first place (de Albuquerque & McElroy, 1995). Beach erosion, siltation of lagoons, and coral reef damage have been identified as the result of tourism-based construction (McElroy & Albuquerque, 2002).

On the other hand, tourism is indirectly involved in the conservation effort in small islands. The importance of the marine environment has triggered bigger investment in tourism and reduced the practices of harmful traditional and commercial fishing which can destroy the marine ecosystem in Gili islands, Indonesia (Harrison, 2001). Additionally, the increased environmental concern within tourism development may lead to sustainable tourism development. According to Altaba & Ponsell (2000), a conservation effort in small islands can be initiated from innovative governmental projects in tourism.

2.2. Implications of Climate Change for Tourism Industry in Small Islands

Climate change causes more vulnerability on small islands than in most continental regions (Petzold & Ratter, 2015). The features of small islands, their small-size, heavy socio-economic dependence on the coastline and limited resources, enhance their sensitivity to climate variability so that extreme events such as droughts, floods, and hurricanes pose a very real threat to regional development (Karmalkar *et al*, 2013). The observed impacts and projected threats of climate change in related to small islands have been substantially reported by Intergovernmental Panel on Climate Change (IPCC) since its First Assessment Report (FAR) in 1990 until the Fifth Assessment Report (AR5) in 2014. Given the inherent physical characteristics of small islands, the AR5 reconfirms the high level of vulnerability of small islands to climatic and non-climatic stressors, which cause serious negative effects on socioeconomic conditions and biophysical resources (Nurse *et al*, 2014), with many related studies in the Pacific Archipelago, Caribbean Archipelago and Balearic Archipelago.

IPCC (2007) & Nurse *et al* (2014) conclude that the consequences of average sea level and temperature rise worldwide and the rapid pace of melting of ice have been the most alarming impacts of climate change. Sea level rise has a severe impact on small islands, particularly the Maldives, which has an average elevation of only 1.5 meters above sea level (Gagain, 2012). In South Pacific Islands (Tonga, Fiji, Samoa, and Tuvalu), the sea level rise will likely create beach erosion, saltwater intrusion,

as well as negative impacts on the infrastructure and coastal society (Mimura, 1999).

The impacts of climate change on most small island economies have been found to be significant. According to Pulwarty *et al* (2010), the high climate-induced risk from flooding, sea-level rise, coastal erosion and storm surges in Caribbean coastal areas have destroyed important coastal infrastructures for tourism purposes. Under future climate change, Moore (2010) stimulates the regional tourism arrivals in Caribbean archipelagos and the results suggest that, in the worst-case scenarios, those of Bermuda, Jamaica, and Trinidad and Tobago Islands could fall by about 5% per year due the projected effects on all aspects.

From the social aspect, public health and water availability have become key concerns because of climate change in small islands. Hernandez-Delgado (2015) argues that climate change in tropical small islands has impacted public health (i.e., altered distribution and increased prevalence of allergies, as well as water-borne and vector-borne diseases). Extreme dry seasons have increased the community's vulnerability to health shocks and access to clean drinking water in Trinidad and Tobago Islands (Shah *et al*, 2013), and loss of water availability for basic household needs and feeding livestock in Funafuti, and Tuvalu (McCubbin *et al*, 2015). The projected changes in rainfall and temperature have resulted in critical water scarcity and drought problems in the Balearic Islands (Estrela et al, 2012).

Climate change is likely already creating changes in mean precipitation and increasing the annual variability of rainfall. As predicted by Hulme & Viner (1995, as cited by Loope & Giambelluca, 1998), these changes are the characteristics of a warmer world which could increase the frequency of drought. In the oceanic situation, for example, drought on Hawaii Islands would very likely involve increased incidence of fire, which generally promotes the spread of invasive introduced species at the expense of native species (Loope & Giambelluca, 1998). These invasive species may lead to displacement of the native species and create biodiversity changes.

There are several studies that have been conducted on tourism vulnerability to climate change issue. Csete *et al* (2013) conducted a vulnerability assessment in Hungary from a regional point of view and they results were presented on a map of the country showing the relative vulnerability of different tourism supply types, potential causes, and driving factors. In another case, Scott *et al* (2012) created a geo-referenced database of the major coastal resort in Caribbean Community countries to assess their potential risk to a scenario of one-meter sea level rise and it showed that this would result in losses of over 50% of coastal properties in the high-dependent tourism islands. Thus, it becomes clear that tourism industry is vulnerable to the global climate change in every aspect.

In order to ensure the long-term benefits of tourism, it is necessary to factor climate change and environmental issues into sustainable development initiatives (WTO, 2003; Scott, 2011). The reliance of tourism activities on weather and the environment necessitates the integration of tourism sustainability and climate change issues. Mycoo (2014) studied Barbados and shows that sustainable tourism there is unattainable if the most important coastal assets are greatly impacted by the changing climate and less-integrated tourism management. Hence, consideration of the public policy measures, adaptation and mitigation strategies of climate change, is significant to increase sustainable tourism (Scott, 2011).

3. Research Method

This research is based on secondary data with a qualitative analysis. The analysis of this research concentrated on three case studies. The data was taken from previous available research on the small islands under study, related to climate change and tourism, found in journal articles, books, research reports, and governmental databases. Various information sources, including bibliographic database, the University of Glasgow Library, and other Internet search engines were used to complete the research. This desk-based research strategy was considered important to cover the area of interest in tourism, its sustainability, and climate change. Most research on climate change is more concerned with the environmental impacts of tourism activity on destinations, but the relationship of climate change and tourism sustainability has rarely been examined, especially on small islands.

The three case studies – the Cayman Islands, the Island of Mallorca, and the Galápagos Islands – were selected as the representatives of the Caribbean Archipelago, Balearic Archipelago, and Pacific Archipelago, respectively, as these islands had been well-researched in climate change study areas. Research related to climate change and tourism has been conducted within these areas, but the relationship of climate change and tourism sustainability in small islands had not been previously evaluated. These selected islands thus have been considered to have differences in terms of geographical, ecological, and political conditions. However, they share some similarities: all of them are categorized as small islands, all are increasingly dependent on tourism and marine environment, all have limited range of resources, sensitive ecosystems and low carrying capacities, and all have been acknowledged as biodiversity hotspots.

4. Research Findings and Discussion

4.1. The Cayman Islands

The Cayman Islands are an island group and overseas territory of the United Kingdom in the Caribbean Sea. The Cayman Islands lie in a zone that is close to the boundary of the Caribbean and North American tectonic plates which is known as an earthquake generator. This means the Cayman Islands are seasonally affected by tropical depressions, tropical storms, and tropical cyclones or hurricanes (Tompkins *et al*, 2008).

The majority of direct losses in the islands from natural hazards are related to hurricane events (Gall *et al*, 2011). Hurricane Ivan, which occurred on September 12th, 2004, created an 8-foot storm surge on Grand Cayman (Taramelli *et al*, 2015), and was reported as the worst hurricane to hit the Cayman Islands, damaging 83% of the buildings with storm surges that flooded large portions of the coastal areas and deposited huge amounts of sand over roads, houses and infrastructure (Craig *et al*, 2006; Novelo-Casanova & Suárez, 2010; Taramelli *et al*, 2015). According to Young & Gibbs (2005, cited by Novelo-Casanova & Suárez, 2010), loss of electricity, water, and access to telecommunications for some period was experienced by the whole population which cut all economic activities off, including tourism, especially in the western part of Grand Cayman and along the southern coast. There were queues at the airport for residents and tourists who wished to depart the islands from 9th-30th September, during which time close to 10,500 people did leave (Craig *et al*, 2006).

Although the Cayman Islands have a great capability for recovering and rebuilding due to their high-level of insurances, the islands still faced a shortage of immediate resources which could have impacts on the government's budget and cash flow (Novelo-Casanova & Suárez, 2010). According to the IPCC (1990, as cited by Sear *et al*, 2001), the coastal defense cost in the Cayman Islands was around US$228 in 1990, which was 1% of the total GDP at that year.

As the Cayman Islands were previously known as 'malaria-free' islands in the Caribbean (Rawlins *et al*, 2008), the significant risk of the resumption of malaria transmission threatens the areas in many aspects. Data on malaria cases in the 21-CAREC (Caribbean Epidemiology Centre) shows that within 1980-2005, 12.5% malaria cases were from the Cayman Islands, which makes the country the fourth most greatly affected in the Caribbean (Rawlins *et al*, 2008). In this case, the warming temperature could result in the extension of the natural boundaries of some vectors and thus their transmission zones (Hay *et al*, 2002).

A significant bleaching of coral reefs surrounding Little Cayman Island began after extended thermal stress in 1998 and caused a decline of live coral cover in 2004, (Coelho & Manfrino, 2007; van Hooidonk *et al*, 2012). Additionally, in response to elevated temperatures throughout the Caribbean, up to 22% of corals off Little Cayman exhibited bleaching in 2003 and 2005 (Eakin *et al*, 2010), and in 2009, in which *Agaricia* spp., *Diploria* spp., *Montastraea* spp., *Porites* spp., and *Siderastrea* spp. showed significant signs of bleaching (van Hooidonk *et al*, 2012). Manfrino *et al* (2013) argue that the economic benefits in promoting reef-related tourism may disappear if the coral reefs are being continuously degraded through the years without efforts for their protection and recovery.

According to Tompkins & Hurlston (2003), the negative outcomes from climate change, especially after Hurricane Gilbert, have increased

environmental education and campaigns in schools, and boosted funding for nature-related tourism projects to remind the locals about the significance of nature in the tourism industry. There have been several changes in national policies for adapting and mitigating climate change, including conservation of natural features and submarine areas of historical or environmental importance, investment in better infrastructures and service in the airport, as well as preparedness for the coming natural hazards, and tourism-related building code (Tompkins & Hurlston, 2003).

4.2. The Island of Mallorca

The Island of Mallorca is an island in the Balearic Archipelago which has become one of the most famous island tourism destinations in the Mediterranean region, especially for tourists from colder climates, the typical 3S (sun, sea, and sand) market. According to IPCC AR5 (Hoegh-Guldberg *et al*, 2014), the new RCP4.5 scenario (a scenario that stabilizes radiative forcing at 4.5Wm^{-2} in the year 2100), suggests about 1.2° C to 2.3° C increase in sea surface temperature by 2100 compared to a 1986-2005 baseline and a decrease in precipitation of about 5% or 6% in the Mediterranean Sea which signals potential future problems for agriculture and water availability that is important in supporting local economic activities.

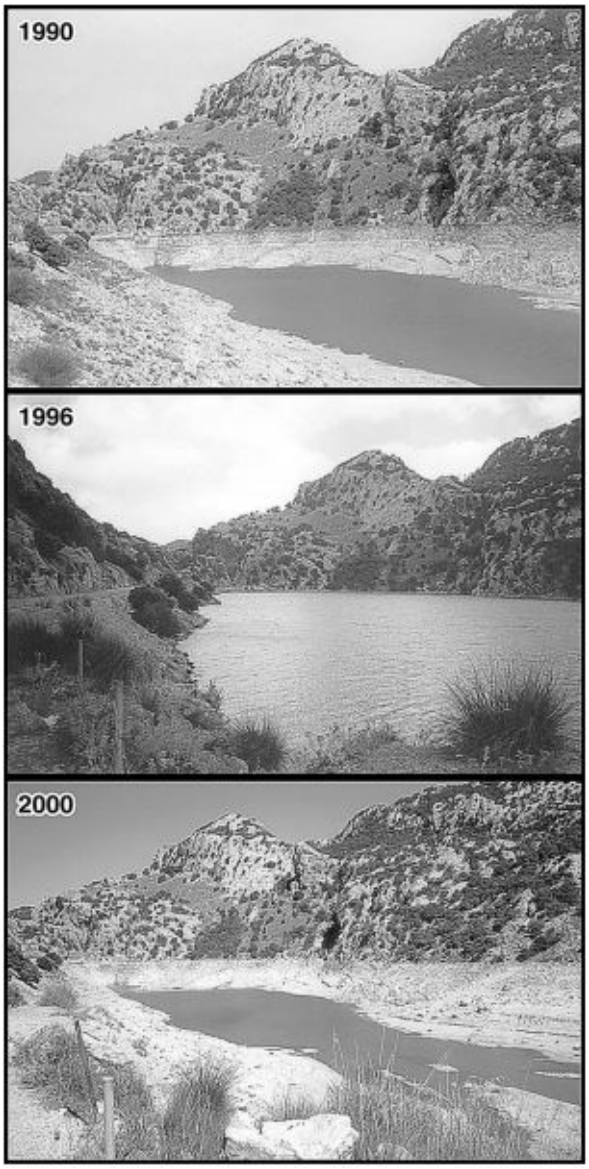
Extreme weather events create losses in tourism businesses and the damages will cause a rise in compensation from insurance companies, such as Consorcio de Compensacion de Seguros. The previous extreme events, flood and cyclonic storm, was in November 2001. The compensation reached €25.648.391 for covering losses in the Balearic Islands (Moreno *et al*, 2005). In this case, the projected changing climate resulting in more intense and frequent extreme events in the future will also increase the risk for insurance companies in covering the damage for tourism businesses in the Balearic Islands.

Climate change plays a significant role in decreasing the water availability on Mallorca. For 2060, an average global reduction of hydric resources is expected at 17% on the Iberian Peninsula, which is most severe in the Balearic Island river basins (Moreno *et al*, 2005). Decreased water reserves (see Figure 1) may lead to problems in economic functionality or feasibility in many current tourist sites. Most of the water on Mallorca comes from year-round rainwater storage and large reservoirs. Water shortages may occur more frequently as a consequence of changing temperature and precipitation (Hein *et al*, 2009) and soil moisture and groundwater levels on Mallorca will almost certainly decline during the 21st century (Kent *et al*, 2002). As the population and tourists on Mallorca also increased, the reservoir was not enough and thus several desalination plants were built in order to provide the months and periods of drought (Moià-Pol *et al*, 2017). However, the desalination energy price is high and climate change has been affecting the prices and amount of energy used. In 2002, there was a charge each night spent on the island (ecotax), ranging from €0.5 for campsites to €2 for a five-star hotel on Mallorca, an increase of £40-75 for a family of four with two children on a fortnight's holiday (Kent *et al*, 2002).

The decline in freshwater volumes caused by increased temperatures and decreased precipitations is coupled with an increased seawater intrusion which is expected to elevate the concentration of salt in waters with repercussions likely generating a loss in both plant and animal species (Candela *et al*, 2009). In Parc Natural de S'Albufera de Mallorca, the ecosystem is expected to experience a decrease in the number of 'specialist' bird species, purposively coming to the park for breeding or stopping over during winter (Faccioli *et al*, 2015). Changing in climatic conditions can also increase stress over migratory 'generalist' birds and force them to abandon the site. Thus, the drops in both bird species' abundance and diversity are expected to create welfare losses, since this natural park has attracted a lot of tourists from its natural assets and a wide range of nature-based tourism, including bird-watching (Faccioli *et al*, 2015).

The seasonality in Mallorca has become one of the major challenges, especially related to the changing climate. The temperatures during the warm season for the Mediterranean are likely to be too high for carrying out general tourism (beach tourism) in comfortable conditions (Amelung & Viner, 2006; Perch-Nielsen *et al*, 2010). In this case, local and regional policymakers and stakeholders have paid little attention to climate change mitigation and instead focused on new alternative

Figure 1. The water level in the reservoir at Gorg Blau in the Sierra de Tramuntana: (a) September 1990; (b) September 1996; (c) September 2000



Source: Kent et al, 2002

tourism in Bay of Palma, the most important beach-based destination in Mallorca. The implementation of alternative outdoor leisure activities, such as cycling, cultural tourism, football, golf, motor boating, sailing, and hiking have been projected to be more conveniently practiced in colder seasons and could alleviate the current strong seasonality in Bay of Palma (Bafaluy *et al*, 2014).

4.3. The Galápagos Islands

The Galápagos is an Ecuadorian province which is located approximately 600 miles to the west of the Ecuadorian mainland on the Eastern Tropical Pacific (Di Carlo *et al*, 2011; Pazmiño *et al*, 2018). The warming trend in the Galápagos area is not as significant as in other small islands areas with a 0.05°C increase per decade around the Pacific Ocean (Hoegh-Guldberg *et al*, 2014). However, despite the overall trend towards warmer sea surface temperature in the equatorial Pacific, decadal variability very likely will continue, as the result of El Niño-Southern Oscillation (ENSO) (Newman, 2003; Sachs & Ladd, 2011). During El Niño events, the surface ocean around the Galápagos warms substantially and rainfall is significantly increased than in normal years. These extreme events have occurred roughly every 2-7 years with no clear periodicity and are very likely to continue in the coming decades, modulating sea surface temperature, rainfall, and sea level changes in the Galápagos on inter-annual timescales (Sachs & Ladd, 2011). The changes in precipitation were believed to be the result of El Niño and La Niña in Galápagos.

The effects of El Niño during 1982-1983 and 1997-1998 on Galápagos giant tortoises (*Geochelone nigra*) were observed and resulted in increased mortality due to tortoises falling down ravines or drowning in floods and mass migration of a Santa Cruz Island population to lower elevations (Snell & Rea, 1999). Many seabirds and endemic bird species are at risk of massive migrations, die offs, and extinction due to decreased food availability and increased pathogens and disease vectors caused by increased precipitation in Galápagos, especially during El Niño events (Valle *et al*, 1987; Deem *et al*, 2008; Bataille *et al*, 2009; Jaksic, 2001; Trueman *et al*, 2011).

The Galápagos penguin (*Spheniscus mendiculus*) has been classified as an endangered species (Birdlife International, 2008) and its population has reduced by as much as 50% in El Niño events, as warmer waters disrupt the upwelling of nutrient-rich cold water (Vargas *et al*, 2006; Levin *et al*, 2009). The Galápagos Sea Lion (*Zalophus wollebaeki*) and Galápagos Fur Seal (*Arctocephalus galapagoensis*) populations have decreased by 60% and need very strong La Niña

events for recovery (Salazar & Denkinger, 2010). Warming events introduce infectious diseases and ocean acidification, both of which decrease their prey (Rosa *et al*, 2008) which leads to more pinniped mortality. Additionally, the population of green sea turtles and marine iguanas suffered 90% mortality caused by the reduction in the number of algae which are their main food and consumption of undigestible brown algae as food replacement (Palacios *et al*, 2011).

Total decline in live coral cover in the Galápagos was around 40% in 1997-98 ENSO year (Podestá & Glynn, 2001). Coral mortality due to bleaching was found in 13 sites in the central and southern Galápagos Islands, with *Pavona* Sp. and *Porites lobata* the dominant reduced massive corals (Banks *et al*, 2011). A cold shock of 11°C at 10m depth over just 6 days in February to March 2007, associated with La Niña-like upwelling, caused widespread bleaching in *Porites lobata* and *Pocillopora* Sp. (Banks *et al*, 2011). In addition, temperature changes also affect the associated abundance of burrowing mollusks (e.g. *Lithophagia* spp.) and sponges and cause local extinctions of dependent species as the coral habitat is further degraded by bioeroders (Banks *et al*, 2011).

The changes in sea temperature and salinity and a decrease in sea pH have decreased numbers of *churo* (marine snails), octopus, and *canchalagua* (Chitons) that are increasingly being consumed by tourists and local community (Quiroga *et al*, 2011), potentially reducing capability in providing tourists' needs and reducing the attractiveness of the islands. Furthermore, the decrease of sea cucumber, spiny lobster, coastal demersal fish, and large pelagic fish caused by El Niño events have forced fishermen in the Galápagos to change their employments to tourism and so increase competition in the tourism industry.

The decline of emblematic species due to climate change can create a loss in nature tourists (Quiroga *et al*, 2011), which lead to a big loss in the majority of international tourists as the higher spender. The collapse of generic nature tourism then leads to great losses of revenue and sources of employment, especially in Santa Cruz (Quiroga *et al*, 2011). Thus, a further consequence will be the decline in money for conservation efforts for the national park, in which 40% of the budget derives from the tourism sector (Quiroga *et al*, 2011).

5. Discussion

Tourism relies on a good climate, which makes this industry highly sensitive to climate change as the physical and ecological attributes of destinations are altered, compromising the levels of satisfaction, enjoyment, comfort, and safety of tourists (Becken & Hay, 2007) and potentially influencing the patterns of travel (Jiang *et al*, 2013). Small islands, considering their characteristics of environmental dimensions of vulnerability and exposure, are potentially vulnerable to change in natural systems (Cardona, 2012). The changes in climate, such as increased annual average temperature which leads to increased sea surface temperature and sea level rise, changing precipitation patterns, and more intense and frequent extreme events, have affected both natural and built assets of tourism and the sustainability of tourism in diverse ways.

As climate change is considered as a complex natural stressor (Mooney *et al*, 2009; Staudt *et al*, 2013), the environmental aspect of tourism sustainability is the most prominent aspect that will be affected in short and long-term changes. The changes in temperature, sea level rise, and precipitation in small islands have been researched causing significant alteration in the number of biodiversities and ecological stability (equilibrium). An increased temperature can cause stress to several species of birds on the Island of Mallorca (Faccioli *et al*, 2015) which leads to immediate migration that also results in the decline in biodiversity numbers. Extreme events in small islands have increased pathogens and diseases vectors and decreased food availability for endemic species, for example giant tortoises, endemic birds and seabirds, endangered penguins, sea lions, fur seals, green sea turtles, and marine iguanas on the Galápagos Islands (Salazar & Denkinger, 2010; Banks *et al*, 2011) all of which produce a high mortality level, slow recovery capacity, and increased endangerment of various species. As small islands are highly reliant on the marine environment, warming conditions have increased coral bleaching in all coral hotspots and damaged the marine environment which threatens the lives of underwater species. The damage of ecological conditions in small islands may be

associated with them becoming less attractive as pristine destinations and so lead to reduced arrivals in the future.

Small islands, with all their important sectors, especially in the tourism industry, are vulnerable to climatic changes. As the main attraction of small island tourism is the 3S (Pearce, 1987; Weaver, 2001), beach erosion is likely to happen and could disrupt tourism activities there. This could increase the possibility of welfare losses and reduced carrying capacity. The decrease of tourism revenue could be triggered by extreme events, such as hurricanes in the Cayman Islands (Sear *et al*, 2001; Taramelli *et al*, 2015), that damage buildings and infrastructure and create electricity and telecommunications losses. The extreme dry season has resulted in the loss of water availability on Mallorca (Kent *et al*, 2002) which creates associated problems for the local community and tourists. Although a rich region has some prepared adaptive capacities – e.g. the Cayman Islands (Novelo-Casanova & Suárez, 2010) – cutting economic activities is a considerable economic threat if the intensity and frequency of these events escalated in the future.

Challenges in the economic aspect of the local community could relate to the environmental issues created by climate change. Biodiversity loss has increased the need for conservation funding, which is mostly collected through tourism revenue, and decreases the appeal of the destinations. Coral bleaching makes the destination become less attractive. In addition, the increased average annual temperature has been associated with significant increase of malaria and other infectious disease cases in small islands through the vast spread of vector diseases. All of these could give negative effects on the destination images of small islands that can also affect tourism demand. The less desirable small islands would be less visited, and thus local community will experience a huge loss in their economy since it is highly dependent on this sector. These negative outcomes also can be strengthened by the raised price of any tourism products due to ecotax, as the result of water scarcity, and limited availability of foodstuffs.

Small islands could no longer accommodate nature-based tourists because of the damage in the natural environment and more undesirable climate. This issue, therefore, creates shifts in main tourism products and tourists' preferences. As part of their adaptive capacity, new tourism alternatives have emerged for small islands which have less dependency on nature and climate (Bafaluy *et al*, 2014). Although these alternatives could generate new tourist markets, the unmotivated nature-based tourists could create a big loss in small islands' tourism revenue and the new markets cannot be guaranteed as proportional substitution. However, some additional tourism activities with changes in climate trends throughout the year could be beneficial for reducing tourism seasonality which is usually high on small islands.

In the sociocultural context, climate change gives several benefits and challenges to the local community. The visible and perceived impacts of climate change on their environment and potential worse changes in the future have increased local awareness, improved environmental education, and increased local community participation in tourism planning and management. This could be a potential for local community empowerment in social and political aspects. However, there is a big chance of deculturation, in terms of loss of traditional livelihood (e.g. fishing in the Galápagos Islands and agriculture in the Cayman Islands and Mallorca), as climate change limits the sustainability of this livelihood. The shifts in local livelihood which tend to be towards the tourism industry could create higher tourism dependency, cause new competition between local communities, and reduce job opportunities, especially after employment reduction as the result of climate change.

On the other hand, climate change has encouraged tourism planners and the local community to develop tourism in small islands in a more sustainable way. The concern of environmental changes, the rapid development of tourism, and the climate change impacts that have been experienced in the destinations produce some mitigation and adaptation strategies which emphasize the environment, local community, culture, and conservation. These strategies should be engaged by all stakeholders in the tourism-climate system, which includes individual, site, destination, nation, region, and global persons.

On small islands, new tourism planning and implementation may involve diversification of tourism products. As the basis of island tourism

is the environment, this may potentially control the destinations' carrying capacity and reduce the anthropological stressors that have become as powerful as climate change in negatively affecting the natural environment. However, the products' diversification may create other challenges in the future. Under these circumstances, the islands intend to expand their markets and improve their competitive advantages which are associated with increasing tourists demand and higher number of visitors. Accordingly, this will increase the proportion of island tourism in response to increased radiative forcing in the future.

6. Conclusion

Globally, tourism is a crucial part of social and economic development, especially on small islands. Tourism has greatly contributed to the GDP on the small islands examined, and local communities have become highly dependent on this growing economic activity. It has provided employment opportunities, increased local welfare and national income, empowered the local community, and supported conservation of biodiversity; at the same time, it could lead to foreign capitalization, economic and power inequalities, cultural changes, and environmental destruction. The islandness, the unique characteristics, and images of small islands have all attracted many tourists and make small islands popular destinations. Island tourism, which tends to be dependent on the sun, sea, and sand, has been generated in small islands (3S) (Pearce, 1987). As the environment of small islands is a product of island tourism that is physically, biologically, culturally, socially, economically, and politically sensitive (Hills & Lundgren, 1977), sustainable tourism development has to be developed or it loses its attractiveness and usefulness.

As noted, tourism in small islands is fundamentally based on nature viewing opportunities. This alone makes the industry highly vulnerable to climate change and its local outcomes. Although tourism has also contributed to greenhouse gas emissions, the effects of climate change have the potential to significantly devastate the tourism industry and its sustainability in many aspects. Small islands and consequently tourism are prone to the increased average annual temperature, precipitation changes, sea-level rise, and the extreme events, such as El Niño-Southern Oscillation, hurricanes, and flooding. The impacts of these climatic changes are complex and related in all aspects.

As references to this issue, the Cayman Islands, the Island of Mallorca, and the Galápagos Islands were chosen as the representatives of the Caribbean Archipelago, Balearic Archipelago, and Pacific Archipelago, respectively. The findings, therefore, were varied and had different approaches, which leads to the limitation of this research. The findings showed some differences in the climatic changes between the case studies.

As reviewed from the findings, climate change has affected small islands in these three case studies primarily on the environmental aspect of tourism sustainability. This natural stressor has decreased biodiversity through increased mortality level, changed the breeding pattern, increased pathogens and diseases vectors, and coral bleaching. All tourist destinations along with their associated systems (natural resources, built resources, electricity, water, and telecommunications) have been damaged by sudden extreme events or long-term climatic changes. These environmental impacts create challenges for the islands' economy. The biodiversity loss and destinations' destruction have increased the probability of decreased revenue, as the islands become less attractive and have less competitive advantages. This could lead to shifts in tourism products and tourists' preferences. From the socio-cultural aspect, climate change, with all its environmental and economic problems, could be beneficial in empowering the local community, as these could increase local awareness, education, and participation, although it could cause a cultural degradation through livelihood changes.

Climate change and sustainable tourism can be considered as interrelated matters. Tourism in small islands may become less sustainable, environmentally, economically, and socially, as the result of climate change. This research thus supports the opinion of Scott (2011) on the mandatory need to address climate change in sustainable tourism development. Although the islands examined have different geographical conditions and climatic changes, the challenges created by global climate change are considered similar, as they all affect

biodiversity, local communities, and their activities. Nonetheless, climate change can be perceivable as a push factor for local community on small islands and their tourism developers to realize the importance of sustainable tourism initiatives. This natural issue can develop more awareness and better behaviors amongst tourism actors as an approach to making tourism on small islands more sustainable. Therefore, adaptation and mitigation of climate change on small islands by considering the triple bottom line of sustainability are prerequisites to sustain their tourism industry and its positive outcomes.

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