



# A Global View on the Environmental Consequences of Antarctic Tourism

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## Abstract

Antarctica tourism evidently harms its ecosystem in direct and indirect ways. Ecosystems are dynamic and complex systems, which simultaneously depend on various humanity and natural factors. The nature of tourist activities continuously changes, which needs improved policies and protection standards. If the varied tourism activities and the diverse consequent impacts are not adequately addressed, they may not be thoroughly considered by international treaties. This can pose unacceptable environmental risks supposedly legally safeguarded by these treaties. Hence, this study studied Antarctic tourism impacts in five major groups from a global view. The results are useful for future legislations and implementations.

Keywords: Antarctic tourism, environmental impact; categorisation, global perspective

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## **1.0 Introduction**

International treaties e.g. the UN Framework Convention on Climate Change have asked for anticipation, prevention or minimisation of the causes of global climate change and mitigation of its adverse effects (FCCC, 1992). This is more critical on the less known destinations such as Antarctica with fragile and pristine nature. The ways in which these activities impact the environment are the most important step of the related assessment and management processes. The individual influences of tourism on local ecosystems have caught research interest, however; due to the interaction relations, environmental degradation aspects should be studied integrally and from a global perspective. Moreover, the role of tourism on environmental stress is not limited to the physical aspect only, but extends to the intangibles such as the tourists' perceptions of the environment (Nicoletta & Servidio, 2012).

The Antarctic Treaty System consists of international instruments such as 1959 Antarctic Treaty; 1964 Agreed Measures for the Conservation of Antarctic Fauna and Flora; 1972 Convention on the Conservation of Antarctic Seals, 1980 Convention for the conservation of Antarctic Marine Living Resources; 1991 Protocol on Environmental Protection to the Antarctic Treaty (Madrid Protocol 1991) and other special meetings that made decisions and formed measures and instruments.

As the most significant instrument, Madrid Protocol 1991 bound a number of environmental protection instruments. The five annexes, namely Environmental Impact Assessment, Antarctic Fauna and Flora, Waste Disposal Management, Marine Pollution and Area Protection provided a comprehensive measure on the Antarctic region protection (Kariminia et al., 2013). Nevertheless, an increasing number of academics and parties have raised concern on the Antarctic environment degradations (Bastmeijer & Roura, 2004; Shah & Husin, 2013).

## **2. Literature Review**

The tourism environmental impacts have occurred locally but added up to a global dimension (Shah, 2013). From a wider view, these impacts can be categorized into direct and indirect (Gössling, 2002), polluted and non-polluted (Kariminia, Ahmad, & Hashim, 2012) and physical and non-physical groups (Nicoletta & Servidio, 2012). Due to the pristine and vulnerable ecosystems in Antarctica, environmental changes presented by tourism linked to extensive factors, namely land use, energy consumption, waste generation, biotic diseases and psychological aspects.

## **3.0 Methodology**

This paper aspires to comprehensively address the environmental impacts of Antarctic tourism on ecosystems from both local and global, and physical and psychological perspectives. In addition, it aims to estimate the scale of these impacts and theoretically assess the role of each for the environmental sustainability. Hence, the Antarctic environmental changes, in both local and global, are firstly reviewed. In the next step, the

study concentrated on impacts to which tourism contributes. Both laboratory and field studies were reviewed in these stages. Some parts of the data were presented by previous studies and some parts were reported for other environmental situations or non-systematically explained. The further review, comparison and evaluation shed light on the most critical aspects of the impacts which should be noted in forming the new international treaties.

## **4.0 Results and Discussion**

### **4.1 Changes in land cover and land use**

Tourist facilities and infrastructures promote the proportion of impervious surfaces, which in turn, caused more runoff (nutrients, suspended particles, oil and gas) to water bodies (Davies & Cahill, 2000). In Antarctic continent, the ice-free surface consists only 2% of the total surface (Figure 1). Furthermore, expeditions were mostly ship-based, and the land adventures generally included short-term visits ashore. Tourism-related constructions in Antarctica are mostly provided for the air base stations and supports. Thus, infrastructure development still remained low (Lu et al., 2011). Direct local land alterations are categorised into accommodation establishments (limited), land for traffic infrastructures and tourist activities and a wider area indirectly affected by the conversions.

The accommodation facilities are allocated to the tour operators and the scientific programmes. In terms of traffic infrastructures, airports, marinas, roads and parking contributed to the land conversions. As the only non-governmental permanent tourism air-based facility, the E-base was founded by an NGO in King George Island (Kariminia et al., 2012). It aimed to enhance the public awareness on protecting the Antarctic ecosystem. Furthermore, a Canadian company established a semi-permanent camp at Patriot Hills in 1987, which provided logistic support and organized flights for airborne tourism operations and private expeditions. Despite the proportion of covered surface by infrastructures in Antarctica was not considerable, policymakers are concerned with the involved construction and demolition. In addition, land alterations had indirect impacts such as loss of lands, coastal erosion and sedimentations (Liggett, McIntosh, Thompson, Gilbert, & Storey, 2011).

### **4.2 Energy and material use**

The Antarctic tourism industry utilised energy for two purposes; transport and destination related. The greater proportion is in transportation as cruise-based is the most common expedition. Seven different types of ships are used to ferry tourists: dive boats, expedition ships, icebreakers, motor yachts, Russian ships, sailing vessels and small ships (IAATO, 2013). The fuel consumptions from these vessels resulted in emissions of GHGs such as carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), which in turn contribute to harm biogeochemical cycles and impact the composition of the atmosphere and biosphere. The most important degradation outcome of these emissions is global warming. Elevated CO<sub>2</sub> and warmer temperatures negatively affect the climate through expansion of higher ecosystems' productivity into the regions (Tape, Sturm, & Racine, 2006). In fact, terrestrial ecosystems are feedbacks of changing climate as a function of surface energy balance and

patterns of sources as well as sinks of atmospheric CO<sub>2</sub>. Furthermore, energy use also contributed to changes in other areas of the global environment; for instance, it increases the possibilities for the exchange and dispersion of diseases (Gössling, 2002).

As the most vital resources to humanity, water crisis is expected to exacerbate in the future with regards to climate change and growing human population. As individuals generally use more water while travelling rather than at home (CEED, 1994; Gössling, 2001), tourism development could result in the increase in overall water use in Antarctica.

### **4.3 Waste production and environmental pollution and disturbance**

In general, the role of tourism in environmental pollution and disturbance included travel- and destination-related aspects. The destination-related degradations are categorised into accommodation and activities and involve a wide range of activities, namely construction and maintenance of facilities. The construction and maintenance of facilities generate waste material and energy, which affected the surrounding ecosystem. Although construction in Antarctica is limited, due to the pristine environment, the effect is considerably higher compared to urban areas. The environment pollution could be immediate, such as engine fallout; sewage disposal or gradual such as eutrophication and depleting dissolved oxygen supplies through leaching of nutrients from septic systems into the water body.

### **4.4 Travel**

Travel agencies are defined as all the facilities and individuals involved in providing services for tourists. In terms of facilities, large vessels are the highest potential risk as they may have a crash or accident, ground on uncharted rocks, break the ice lands or pollute the water. Operators preferred to use large vessels as small vessels were not economical enough. Liggett et al. (2011) reported twenty-nine accidents and incidents such as damage, aircraft crash; ship grounding and oil spill recorded in Antarctic area between 1967 and 2003. Surprisingly, almost half of all accidents are accrued during the last 12 years. Although IAATO has provided a swift accessible precautions and assistance, the sinking of MS Explorer in 2007 demonstrated the potential risk of vessels crash.

In addition, the cruise vessels generally pollute the air through engine emissions. It is due to used residual fuels, which have higher contaminants. The annual sulfur emissions by ships are higher than that from land. Waste oil is normally generated through leaks from engines, generators and hydraulic systems, and from the fuel filters while conducting maintenance work. Furthermore, toxic chemicals, dry-cleaning wastes, used batteries and paint waste from brush cleaning are possible to occur (Davies & Cahill, 2000). Animals could be exposed to contaminants and discharged bilges. Although the International Convention has prohibited the use and carriage of heavy and intermediate fuel oils for ships in the Antarctic treaty area for the Prevention of Pollution from Ship since 2009, the concern on the environmental contamination still remains.

The amount of garbage (dry garbage, food waste and disposes) produced by a cruise ship carrying 2700 passengers exceeded a tonne per day (Davies & Cahill, 2000). Illegal dumping of solid waste has been witnessed. For instance, in 1999, Royal Caribbean, the world's second largest cruise line, pled guilty to twenty-one felony counts for dumping oil and

chemicals from its cruise ships. Thus, the possibility of both shipboard waste and land generated waste once onshore should be taken into consideration. Furthermore, airborne travelling could lead to the possibility of air crash, air pollution and wildlife disturbance. However, after a growth between 1950s and 1970s, the number of tourists frequenting this area via flight seemed to have steadily declined during past few years.

#### **4.5 Destination**

Tourists inherently tend to visit the most picturesque and wildlife-rich areas with vulnerable ecosystems. According to IAATO (2011), Antarctic tourism currently comprised of eight activities: ship borne expeditions, small boat landing, kayaking, extended walk, station visit, scuba diving, science support and camping (Figure 2). Site degradation, disposal generation and littering, discharging sewage wildlife disturbance and damage to the ice layers may occur with these activities.

Sewage contains pathogens, which can contaminate water and affect its quality. The marine debris, on the other hand, could harm the ecosystems. It aesthetically impacts the coastal areas and ecologically damages the water through gas exchanges between different water surfaces. Moreover, opportunistic organisms may choose debris as its habitat, which could cause changes to the compositions of ecosystem. Meanwhile, the new generation of Antarctic tourists who travel individually or in small parties also have a high potential of environmental risk (Figure 3).

#### **4.6 Fauna and flora exchanges**

Tourists can transport non-human microbes through their bodies, clothes, animals, goods, food, seeds, etc., which could increase the risk of flora and fauna diseases (Figure 4). In addition, the facilities related to the tourists' travel and accommodation could lead to the exchange of biota. The accommodation-related facilities, for instance, import plant species alien to the environment. Vessels such as cruise ships are known to transport organism over the long distance of travel to Antarctica. Due to the isolation from other landmasses, Antarctic terrestrial ecosystems currently contain few non-native species.

Nevertheless, its indigenous biota is vulnerable to human mediated introductions on non-native species. Hughes, Convey, Maslen, and Smith (2010) reported an incident of the transportation of contaminated soil containing non-native organic materials through four construction vehicles imported in 2005 by contractors working for the Rothera Research Station (Antarctic peninsula).

There are also rising concerns on the chance of genetic exchange of microbes and evolution of viruses in new environments which in turn may increase diseases (Goldsmith, 1998). In isolated areas such as Antarctica, tourists could cause stress on animals while interacting with them. This could reduce the breeding success or threaten them with human pathogens.

Antarctic expeditions are usually offered in the austral summer (November to March) as the critical time for the wildlife to breed. For instance, this period is the courting season for penguins, seals are visible on fast ice, seals establish their breeding territory and penguin chicks start to fledge (IAATO, 2013). The animals may scrounge for the food given by tourists.

It could make them accustomed to human food, which could affect their behaviours. Changes in the seal and krill population were one of the results of the marine environment degradation in Antarctic (Wiedenmann, 2010). Penguins showed both behavioural and physiological response to visitors which could change their breeding and survival pattern (Bertellotti, D'Amico, & Cejuela, 2013).

#### 4.7 Psychological aspects

The environmental effects of Antarctic tourism are not only limited to the physical aspects. Travelling to a pristine area also altered the visitors' perception and understanding of the environment as a complex system of relations between individual, society and nature (Steiner, 1993). Indeed, there are two paradoxical situations; in one hand, Antarctic tourism would promote the visitors' environmental consciousness on its ecosystem while in the other hand, the proximity to the biota and consumption of the natural resources would characterise the personal behaviours of the tourists.

Thus, from a psychological perspective, travel to Antarctica would alter the travellers' perception of its environment in two ways: Environment proximity (adjacently to isolated environment diminish the visitors' image of its vulnerability) and environmental awareness (exposing to the new representations of the pristine nature fosters the visitors' environmental awareness).

Figure 5 depicts the Antarctic ecological tourism impacts in the addressed major categories as well as the defined sub-categories. The severity of the impacts relatively increases from the first to last impact group. Meanwhile, the third group of degradations demonstrates the highest level of direct pollution.



Figure 1: Map of Antarctica  
(Scentofpine.org)

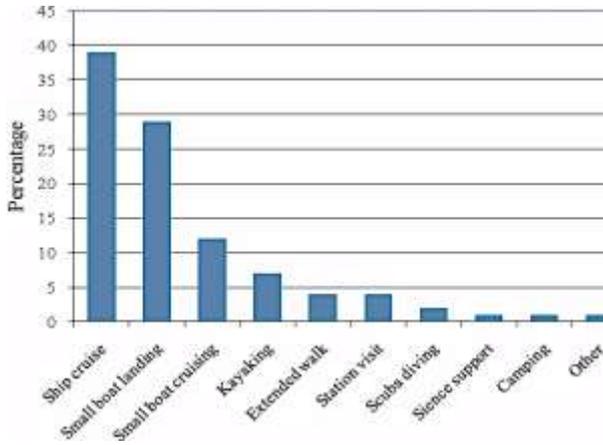


Figure 2: Distribution of Antarctic tourism activities (IAATO, 2011)



Figure 3: Individual travellers to Antarctica (IAATO, 2011)



Figure 4: Tourists may transport non-native species to the Antarctic (IAATO, 2013)

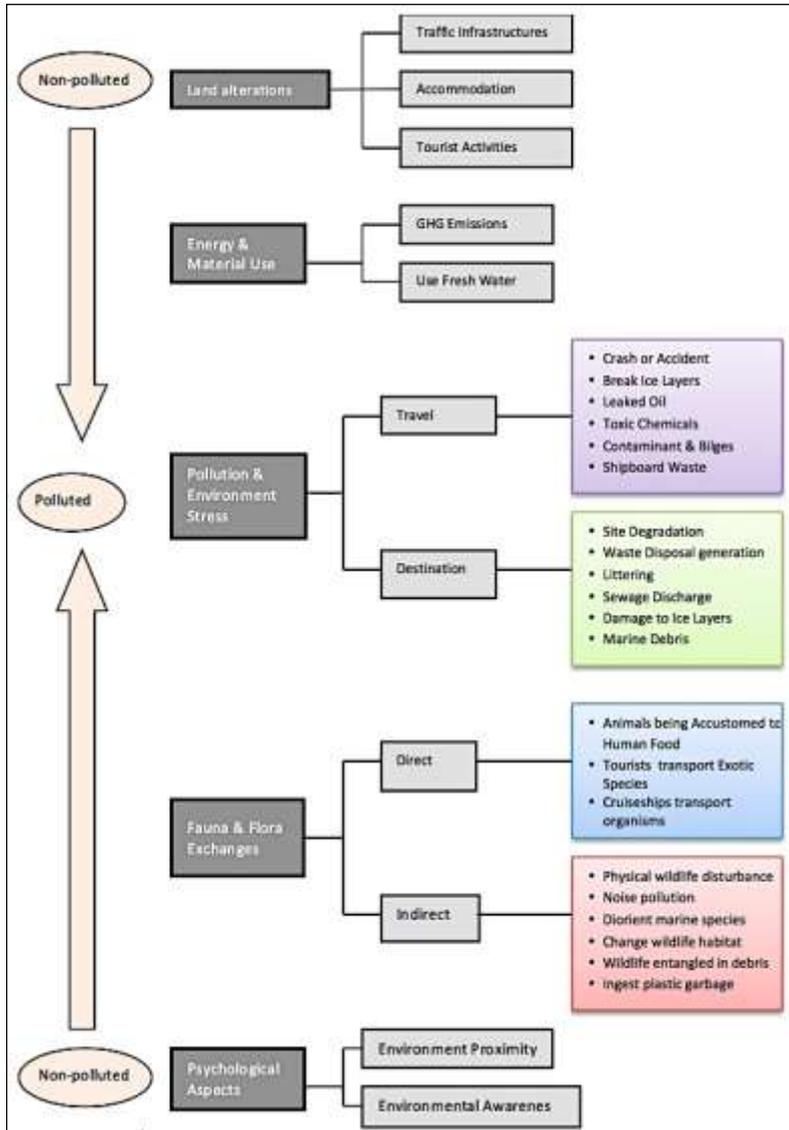


Figure 5: Local and global environmental impacts of Antarctic tourism

## 5.0 Conclusion

This study aims to shed light on the tourism impacts in Antarctica at local scale and global perspective. The psychological dimensions were also taken into consideration. The five major

impacts were land alteration, energy and material use, pollution, biotic exchange and change of perception towards the environment.

Land alteration was mostly for traffic infrastructures rather than for accommodations. The fuel consumption in the transport section caused GHG emissions and impacted the environment. Tourism development also increased fresh water usage. The environmental pollutions were categorised into travel and destination related dimensions. In addition to noise disturbance to wildlife, cruise ships risked crashing, breaking the ice layers, polluting the water and generated wastes. Land tourist would generate waste, sewage discharge, damage the ice layers and the disturb the wildlife.

Besides the direct disturbances, visitors unwittingly disturbed the ecosystem by transporting non-native species through their clothes and belongings. The Antarctic expeditions' season is a critical time for the wildlife due to unsuitable feeding by the tourists. Although sustainable tourism promoted environment-responsible behaviours, the tourist could not fully adhere to this.

The study demonstrated that the substantial environmental consequences of tourism in Antarctica. It is essential to deepen the debate on Antarctic ecosystem protection in the context of climate change.

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