Analysis of the impact of tourism flows on environmental degradation. Case study: Municipality of Naxos & Small Cyclades, Greece

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Abstract. From the 19th century until nowadays, tourism is an enormously evolving activity. In recent years, tourism has become the main economic activity in Greece that boosts the local economy of the country. The present study deals with the environmental impacts of tourism. The aim is to delve the correlation between tourism flows and environmental degradation, especially in the Municipality of Naxos & Small Cyclades in Greece which in recent years has become an attractive tourist destination. For the purpose of the study, appropriate monthly data on environmental degradation are collected and are correlated with monthly flows of tourism during the last years for the Municipality of Naxos & Small Cyclades. The collected data refer to the number of visitors (by plane and ship), their overnight stays in tourist accommodations, waste production, energy consumption, water consumption and quality of sea water for swimming. According to results, during the period of increased tourism flows in the Municipality of Naxos & Small Cyclades (almost triple the permanent population of the Municipality), indices of burden such as energy consumption and production, water consumption and amount of waste generated, are increasing. Also, the quality of sea water for swimming is marginally burdened.

1. Introduction
Tourism is considered one of the most evolving industries with various socioeconomic benefits for local economies, such as increasing currency flows, job opportunities, creation of infrastructure (hotel accommodation and other facilities related to tourism), assimilation of culture [1]. However, tourism has also potentially detrimental consequences on nature, societies and cultures [1]. Particular reference is made to the environmental impacts of tourism on water and local resources, land degradation and pollution in general (atmospheric, waste, aesthetics, climate change, ozone depletion).

For instance, water, and especially fresh water, is one of the most critical natural resources. The tourism industry generally uses water resources for hotels, swimming pools, golf courses (daily maintenance) and personal use by tourists. This can lead to water shortages and degraded water supplies, as well as to the production of more sewage. A research shows that tourists due to the hot climate and the tendency to consume more water during the holidays (than when they are at home) can use almost twice as much water per day (440 l / day) compared to residents with an average use in a city in Spain [2].
Tourism can put a lot of pressure on local resources such as energy [3], food and other raw materials which may already be scarce. Greater extraction and transfer of these resources exacerbates the natural effects associated with their exploitation. Due to the seasonal nature of tourism, in many destinations the tourism flows are ten times greater to the permanent population. Therefore, higher demand is placed above local resources to meet the higher needs that tourists often have (adequate heating, hot water, etc.) [2].

Tourism can cause the same forms of pollution as any other industry: air emissions, noise, solid waste and waste, sewage, oil and chemical emissions, and even architectural / visual pollution [2]. In particular, air, road and rail transport are constantly increasing as a result of the growing number of tourists and their need for greater mobility [2]. Almost 60% of air transport meets the needs of tourism implying that tourism is responsible for a significant share of emissions into the atmosphere. Emissions from transport, as well as from the production and use of energy for transport, are associated with acid rain, global warming and photochemical pollution. Air pollution from tourist transport has an impact worldwide. Some of these effects are quite specific to tourism activities. For example, especially in very hot or cold countries, tour buses often leave their engines running for hours while tourists go on an excursion because they want to return to a comfortably air-conditioned bus [2]. Noise from planes, cars and buses, as well as recreational vehicles such as snowmobiles and jet skis, is a problem of modern life. In addition to causing annoyance, stress, and even hearing loss to humans, it causes disturbance in the wild and especially in sensitive areas.

In areas with high concentrations of tourist activities and attractive natural attractions, waste disposal as well as their improper disposal is a serious problem that can have devastating consequences for the natural environment, rivers, picturesque areas and roadside sections. For example, cruise ships in the Caribbean are estimated to produce more than 70,000 tons of waste per year [2]. Solid waste and discharge can degrade the natural appearance of water and coastline and cause the death of marine animals [4]. In mountainous areas, hiking tourists generate a lot of waste. When they leave, they leave behind their rubbish, oxygen cylinders and even camping equipment. Such behaviors degrade the environment with all the remnants of a typically developed world, in remote areas where there are small waste collection or disposal facilities [2].

Therefore, concerns about responsible tourism practices should be equally focused on correcting past mistakes and preventing future ones. Thus, a clear preventive approach must be integrated into current tourism policies and strategies at all levels, if we consider tourism as a means for society to make progress through sustainability [5].

The purpose of this work is to investigate the hypothesis of whether the increase in tourist flows contributes over time to the environmental degradation. The study focuses in the Municipality of Naxos & Small Cyclades in Greece which in recent years has become an attractive tourist destination. The Municipality of Naxos & Small Cyclades includes five islands in total (Naxos, Koufonisia, Heraklia, Schinoussa and Donoussa). In particular, an attempt is made to investigate whether the tourist flows to a popular tourist destination - such as the Municipality of Naxos & Small Cyclades in Greece - seem to be related to environmental impacts in the region, in terms of waste generation, energy consumption, water consumption and seawater quality.

2. Methodology and data

In order to investigate the general contribution of tourism to the economic growth of the Greek economy, proper data concerning the value added of tourism to GDP are obtained. With respect to the Municipality of Naxos & Small Cyclades, it is sought to find appropriate data related to environmental degradation on a monthly basis, so that they can be correlated with the monthly flows of tourists during the last decade. The data collected relate to the number of visitors, their overnight stays in tourist accommodation, waste generation, energy consumption, water consumption, and seawater quality. However, the collection of monthly data for the last decade is not always possible due to limited availability of raw data. In several cases, it is required to convert the primary data into monthly data or to convert them so as to cover the whole Municipality.
The data is processed using the tools of descriptive statistics, creating appropriate graphs to detect the evolution of the corresponding indices over time.

In particular, data used in this study include:

2.1. National data, Greece
From the databank provided by World Bank [6] and, in particular, databases TCdata360 and World Development Indicators, proper data on the Gross Domestic Product (GDP) of Greece as well as on the percentage of contribution of tourism to total employment in Greece are obtained. GDP is expressed in constant 2010 $ prices to avoid the effect of inflation over time.

Data on the number of arrivals and overnight stays in tourist accommodation in Greece and in the Greek regions (northern and central Greece, Attica, Aegean islands and Crete) are obtained from Eurostat [7]. Data cover years from 1994 to 2018.

2.2. Data on Municipality of Naxos & Small Kyklades
As already mentioned, the Municipality of Naxos & Small Cyclades includes five islands in total (Naxos, Koufonisia, Heraklia, Schinoussa and Donoussa) which are located in the Aigaio Sea. Given that the last four islands are small in geographical terms and with a fairly low permanent population, data for them are not available in all cases, so, on a case-by-case basis, the investigation is limited to the island of Naxos.

2.2.1. Tourism Flows. From the bulletin of Air Traffic Statistics reported by the Hellenic Civil Aviation Authority [8], data on the number of passengers of domestic and international flights to Naxos State Airport on a monthly basis from 2010 to 2019 are obtained.

Data on the number of embarked and disembarked passengers in the port of Naxos from 2014 to 2019 per quarter are collected from the Hellenic Statistical Authority [9].

From the section of the available statistics of the INSETE website [10] for the South Aegean Region are obtained annual data of arrivals and overnight stays of foreigners and locals in Naxos & Small Cyclades for the years 2010 to 2018.

2.2.2. Environmental data. In the Municipality of Naxos & Small Cyclades there is a landfill which serves all five islands of the municipality. Its operation started on 1/12/2016 [11] and available data on municipal waste cover the years 2017, 2018 and 2019.

The water supply system of the island of Naxos is divided into 4 sections and the information gathered was provided by the Water Supply Department of the Municipality of Naxos & Small Cyclades [12].

The Network Users of the Hellenic Electricity Distribution Network Operator [13] collected the total electricity consumption for the Municipality of Naxos & Small Cyclades as well as separately for the island of Naxos for the years 2010 to 2019. Naxos from 13/03/2018 has been interconnected with the Interconnected Electricity Transmission System. Prior to the interconnection, it belonged to the electrical system of Paros which consisted of the complex of the islands of Paros, Naxos, Koufonisi, Heraklia, Sikinos, Folegandros, Antiparos, Schinoussa and Ios. From the page of the Administrator of Non-Interconnected Islands [13] are obtained the data of the settlements for the period before the interconnection (in total for the electrical system of Paros). The data are monthly and are analyzed in energy from Renewable Sources Energy - RES and from thermal power plants for the period from 1/1/2014 to 31/3/2018.

Finally, the quality of bathing water in Greece is systematically monitored by the Special Secretariat for Water of the Ministry of Environment. The water quality data used include measurements from 2013 to 2019 during the bathing season. The sampling takes place one day every month in 10 specific sampling points of the island of Naxos [14].
3. Results and Discussion

3.1. Tourism in Greece

Tourism in Greece has shown a remarkable upward trend after the Olympic Games in 2004. However, the global economic recession in late 2008 puts a severe pressure on the Greek economy which also affected tourism since the average income in Greece decreased. While international tourism recovered from mid-2010, tourism began to recover in 2013 in Greece.

Despite the negative effect of the economic crisis on Greek economy, the contribution of the economic activities of travel and tourism to the Greek domestic product (GDP) ranges from 3.77% (1997) to 8.23% (2019), showing over time an upward trend. Compared to the value added produced by the other economic sectors (primary, secondary) over the 1995-2019 period, it could be said that, travel and tourism, which are classified in the tertiary sector, boost the Greek domestic product (figure 1) from 2006. In 2019, the value added of travel and tourism in GDP is almost 80% higher compared to 1995 levels (figure 1).

![Figure 1. Value added (% of GDP) of economic sectors in Greece, 1995-2019. Base year 1995=100.](image)

Tourism has also contributed to total employment in Greece. According to figure 2, the contribution of tourism in total employment ranges from 10.43% in 1997 to 21.7% in 2019 showing an upward trend over time.

![Figure 2. Contribution (%) of tourism in total employment in Greece, 1995-2019.](image)

Concerning the number of arrivals (1994-2018) in tourist accommodation in Greece, there is an increasing trend from 1994 (figure 3). Considering the year 1994 as the base year, the relevant index
of arrivals in Greece reaches +145% in 2018 compared to 1994 levels. The increase is greater for the Aegean Sea islands and Crete (+230%) in 2018 compared to 1994 levels.

3.2. Tourism flows in the Municipality of Naxos & Small Cyclades

The highest number of arrivals is observed in July and the highest number of departures in August. The lowest number of arrivals and departures is observed in December and January. In general, arrivals and departures are almost at the same level. The highest number of boarding and disembarking passengers is observed in the third quarter of each year. In general, the total number of passengers has been increasing over time. For instance, the total number of passengers in 2019 was about 60% higher than in 2014.

Concerning foreign and local (Greek) tourists, the arrivals of foreign tourists in the Municipality of Naxos & Small Cyclades are higher than the arrivals of local tourists. Also, the overnight stays of foreigners in the Municipality are, on average, almost 50% higher than those of local tourists. After 2017, domestic tourism shows a declining trend in contrast to the ever-increasing number of foreign tourists.

Taking into account the total number of arrivals compared to the permanent population in the municipality in question, tourism flows exacerbate a high pressure in Naxos & Small Cyclades, since the total number of arrivals in 2015 and 2016 reaches 2.5 times the permanent population (figure 4).

![Figure 3](image-url)

**Figure 3.** Arrivals at tourist accommodation establishments, Greece and main Greek geographical domains, 1994-2018. Base year 1994=100.

![Figure 4](image-url)

**Figure 4.** Index of arrivals to permanent population in the Municipality of Naxos & Small Cyclades, 2010-2018.
3.3. Municipal waste
The smallest amount of municipal waste that ends up in the Naxos landfill is recorded in February of each year with an increasing trend reaching in July and August the largest amount, as shown in figure 5 which depicts the relevant data for year 2019. Although the data collected cover a three-year period, as the operation of landfill began in 2017, the annual amount of municipal waste shows an increasing trend, since in 2018 the increase is +5% compared to 2017, while in 2019 the increase is about +15% compared to 2017.

![Figure 5. Municipal waste in Naxos & Small Cyclades, 2019.](image)

3.4. Water consumption
Regarding water consumption in year 2019 (figure 6), the consumption of water during summer months (June, July and August) is twice as much as the consumption in all the other months of the year indicating a high pressure on local water resources.

![Figure 6. Water consumption in m³ in Naxos & Small Cyclades, 2019.](image)

3.5. Energy consumption
Energy consumption in the Municipality of Naxos & Small Cyclades is increasing annually, as shown in figure 7. Considering 2010 as the base year, energy consumption is +9% higher in year 2016 and +21% higher three years later, in 2019, indicating a high degree of increasing energy needs over a nine-year time period.
3.6. Quality of bathing water

The quality of bathing water in the island of Naxos during 2013 - 2019, is characterized as of exceptional quality since the concentration of enterococci and coliforms is much lower than the allowed limits.

4. Conclusions

The contribution of travel and tourism to the Greek economy is considered significant as it accounts for 8.23% of Greece's GDP in 2019 and contributes approximately 16% on average (1995-2019) to total employment. Therefore, the tourism sector contributes significantly to reducing unemployment, generating income and, consequently, to improving the living standards of the country's inhabitants.

The Municipality of Naxos & Small Cyclades has become an attractive touristic destination in Greece in recent years with increasing foreign tourism flows from 2017, especially during the summer months. While the Municipality in the years 2010 to 2013 accepted annually a number of tourists almost equal to the number of its permanent residents, the relevant number from 2015 onwards is almost 2.5 times higher than the number of permanent residents.

The increasing tourism flows exercise environmental pressure in the Municipality Naxos & Small Cyclades. Almost all indices of environmental pressure, such as municipal waste, water consumption, and energy consumption, show a remarkable increase in summer months over the last years. For instance, municipal waste peaks in August of each year reaching a quantity that ends up 3.5 to 4.5 times higher the quantity reported in February. The same happens with water consumption since the consumption in the summer months is twice as much the consumption in all the other months of each year. Regarding energy consumption, there is a steadily increasing rate over time.

Based on the above, we conclude that in the Municipality of Naxos & Small Cyclades, in recent years and in summer months, with increased tourist flows, there is a high environmental pressure on the local system. While such consequences appear in a relevant short time period, the ongoing development of tourism in the Municipality in question in the future, implies a long run environmental degradation.

References

[1] Archer B, Cooper C and Ruhanen L 2005 The positive and negative impacts of tourism Global Tourism, ed W F Theobald, 3d Edition (Massachusetts: Elsevier) pp 79-102

[2] Sunlu U 2003 Environmental impacts of tourism Local Resources and Global Trades: Environments and Agriculture in the Mediterranean Region, ed L Grassini and D Camarda (Bari : CIHEAM) pp 263-70

Figure 7. Energy consumption in the Municipality of Naxos & Small Cyclades, 2010-2019. Base year 2010=100.
[3] Kaika D and Zervas E 2011 Searching for an Environmental Kuznets Curve (EKC)-pattern for CO$_2$ emissions Proc. 7th Int. Conf. on Energy, Environment, Ecosystems and Sustainable Development (EEESD'11) (Angers: France/ November 17-19)

[4] PAP/RAC 1997 Guidelines for Carrying Capacity Assessment for Tourism in Mediterranean Coastal Areas. PAP 9/1997/G.1.Split, Priority Actions Programme Regional Activity Centre, pp viii+51

[5] Yfantidou G and Matarazzo M 2017 The Future of Sustainable Tourism in Developing Countries Sustainable Development 25 459–66 DOI: 10.1002/sd.1655

[6] WORLD BANK 2020 World Bank – Databases «tdata360» [accessed 12 Aug., 2020], available at: https://tdata360.worldbank.org/ and «World Development Indicators» [accessed 18 Aug., 2020], available at: https://databank.worldbank.org/home.aspx

[7] EUROSTAT 2020 web page, [accessed 15 Apr., 2020], available at: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=tour_occ_arn2&lang=en

[8] HCAA 2020 web page, [accessed 20 Jul., 2020], available at: http://www.hcaa.gr/profile/statistics/

[9] ELSTAT 2020 web page [accessed 29 Jul., 2020], available at: https://www.statistics.gr/

[10] INSETE 2020 web page, [accessed 27 Jul., 2020], available at: https://insete.gr/statistika-stoixeia-perifereion/

[11] M.T. A.T.E. 2020 MT Technical Limited Company, Data for municipal waste from Naxos Municipality landfill from 1/1/2017 to 31/12/2019, https://www.mtate.gr/el/

[12] MUNICIPALITY OF NAXOS 2020 Municipality of Naxos & Small Cyclades - Directorate of Technical Services and Environment - Water Supply Department, Water consumption data, https://e-naxos.eu/

[13] DEDDIE 2020 Hellenic Electricity Distribution Network Operator – Department of Network Users. Electricity consumption data for the Municipality of Naxos & Small Cyclades and Naxos for the years 2010 to 2019

[14] EGY 2020 web page, [accessed 7 Aug., 2020], available at: http://www.bathingwaterprofiles.gr/