

Article

Planning and Preparation for Cruising Infrastructure: Cuba as a Case Study

John E. Nyberg ^{1,*}, Shachak Pe'eri ² , Susan L. Slocum ³ , Matthew Rice ¹, Maction Komwa ¹ and Donglian Sun ¹

¹ Department of Geography and Geoinformation Science, George Mason University, Fairfax, VA 22030, USA; mrice4@gmu.edu (M.R.); mkomwa@gmu.edu (M.K.); dsun@gmu.edu (D.S.)

² Office of Coast Survey, National Ocean Service, NOAA, Silver Spring, MD 20910, USA; Shachak.Peeri@noaa.gov

³ Tourism and Events Management, George Mason University, Fairfax, VA 22030, USA; sslocum@gmu.edu

* Correspondence: jnyberg@masonlive.gmu.edu

Abstract: The cruise line industry (CLI) provides an opportunity to rapidly improve national (and regional) economies in destinations. However, lack of planning and proper preparation by destination authorities and the cruise industry can have significant impacts on the local community, commerce, and environment. This paper identifies and quantifies near-shore challenges between the national authorities and the CLI that include port facility preparedness and the potential stresses on local infrastructure. These key parameters used to quantify the impact of the CLI on established destinations can potentially become part of the analysis, negotiation, and communication between all parties involved (government, business, and tourists) as part of the contribution to ensure sustainable CLI destinations. The Port of Havana, Cuba was selected as the study site and was compared against similar cruise line destinations around the Meso-American region (Philipsburg, Sint Maarten, Belize City, Belize, and Progreso, Mexico). The Port of Havana's natural infrastructure and the carriage available for the incoming ship (i.e., nautical charting) appear to be adequate for welcoming increased cruise ship traffic. The main concerns are the potential toll on local resources including the impact on port traffic and the local infrastructure required to support tourists once they depart the ship.

Keywords: cruise line industries; port of Havana; infrastructure; Meso-America; Cuba; Havana; tourism; nautical charting; hydrography



Citation: Nyberg, J.E.; Pe'eri, S.; Slocum, S.L.; Rice, M.; Komwa, M.; Sun, D. Planning and Preparation for Cruising Infrastructure: Cuba as a Case Study. *Sustainability* **2021**, *13*, 2951. <https://doi.org/10.3390/su13052951>

Academic Editor: Gianluca Scaccianoce

Received: 3 February 2021

Accepted: 5 March 2021

Published: 9 March 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Prior to 2019, cruise ships were steadily becoming an increasingly popular way for U.S. tourists to experience the Caribbean region [1,2]. In the 1920s and by the 1950s, American citizens started visiting Cuba mainly by plane. However, the flow of American tourists to Cuba stopped completely (except for a brief period in the late 1970s during the Carter administration) after the political turmoil in Cuba that included the military coup of General Fulgencio Batista in 1952, Fidel Castro's revolution in 1959, and the American embargo in 1960 [3]. After the Cuban revolution, tourists from Canada and Europe continued to visit the island nation, as the Port of Havana has already become an international CLI destination. The Mediterranean Shipping Company (MSC) Cruise Line became the most prevalent for tourism when it started visiting Cuba in 2015 [4]. It was predicted that President Obama's 2014 U.S. Presidential Memo normalizing relationships between the U.S. and Cuba would thaw the U.S./Cuba relationship and result in an increase in American tourism to the Island. Companies like MSC Cruises, Norwegian, and Carnival Corporation responded by both expanding existing services and creating new types of tourism packages that fit under the U.S. laws [5]. However, the thaw in the U.S./Cuba relationship was short-lived with U.S. President Trump's 2019 economic sanctions against Cuba that reversed the U.S. cruising trend by restricting U.S. cruise ships from calling on Cuban ports. This trend was further amplified by the COVID19 pandemic.

The pressure of this rapidly changing segment of the Cuban tourist industry has had dramatic impacts on the existing infrastructure in Cuba's ports of call, and in 2018 Cuba responded with a plan to modernize many of the components involved by hiring Global Ports Holding, the world's largest cruise port operator, to modernize and expand Havana's port infrastructure [6]. Once completed, port modernizations will include space for four additional ships and an incentive-based management plan that is paid for according to passenger growth. The additional space will allow more ships to take advantage of cold ironing, the practice of turning off their diesel engines to connect to local power, reducing the pollution generated by ships waiting for berthing space.

Vessel traffic information and nautical charts are critical data points for the future planning and development of port infrastructure, port and fisheries management, and future planning of the region. Though Cuba has a robust nautical charting program with a rich history, they currently have very limited access to data or software that is imperative for building complete nautical charts that meet international requirements for moving large (and growing) cruise ships, including accurate shoreline and modern hydrography [7]. Without proper investment in infrastructure, Cuba will not be able to accept ships larger than 270 m long, and in the worst case, may experience ship groundings or other accidents. Based on recent publications, it seems that the Global Ports modernization project aims to address these concerns [6].

Assessing impacts of the CLI, including environmental, cultural, and economic, can be an important step in ensuring the long-term sustainability of a destination. Cruise ship transportation can provide an opportunity to increase tourism and improve national (and regional) livelihoods as the result of some of the growth opportunities provided by the CLI. However, lack of planning and proper preparation by national authorities and the cruise industry can have significant adverse impacts on the local community, commerce, and environment. This paper identifies key parameters related to port and land infrastructure that will contribute toward quantifying the impact of the CLI on established destinations, such as the Port of Havana. These key parameters can also be used as standard negotiation terms between national authorities and the CLI in order to help differentiate between sustainable and unsustainable destination ports. The Port of Havana, Cuba was selected as the primary study site and will be compared and evaluated against neighboring destinations around the Caribbean and Meso-American region. The evaluation includes publicly available data that can be used to support decision-making and impact predictions on a destination. The datasets include charts, satellite imagery, Autonomous Identification System (AIS) for near-shore analysis, and UNESCO World Heritage Site data. The study identifies and quantifies challenges that include, port facility preparedness and potential stressors on local infrastructure.

2. Literature Review: Cruising as a Sustainable form of Tourism

Each destination port has unique characteristics that differentiates it from other ports, such as: urban vs. rural (possibly remote when considering the arctic or Pacific islands), warm versus cold, developing country versus developed country, and cultural versus natural tourist attractions. When considering a new destination port for cruise ship tourism, one needs to assess the potential for significant impacts that high volume, short burst, tourism would have on a new destination, including environmental, cultural, and economic challenges. The United Nations World Tourism Organization (UNWTO) says that sustainable tourism should make optimal use of environmental resources while conserving nature and biodiversity, respecting socio-cultural authenticity of host communities, and ensuring long-term economic operations that provide socio-economic benefits to all stakeholders [8]. Additionally, the UNWTO specifies that sustainable tourism should consider tourist satisfaction as part of the toolkit to promote sustainability awareness. When presented with the financial potential that cruise tourism offers, developing destinations often offer large concessions to lure new cruise business and can overlook the impacts on the local population.

Early work on CLI investigated the economic impacts of cruise tourism on a national and a sub-regional level, including the issues of the costs and benefits to the destination port [9,10]. In addition to economic impacts and cultural impacts on the local population at the destination port was also evaluated [11,12]. Namely, the risk of international influence on local of cultures, especially in the Caribbean, that has been observed with “globalization”. The economic impact continues to be a key issue in tourism management and policy, especially when cruise ship passengers travel during an excursion in and around the destination port [13–16].

In recent years, most of the published literature on the impact of CLI on port destinations and their approaches has been mainly focused on the impact to the environment from cruise ship pollution [17]. The CLI is regularly challenged by environmentalists on its record of taking advantage of the lack of pollution regulation in international waters, including claims that the cruise ship lobbyists have spent \$30 million over the past decade fighting environmental regulation [18,19]. In addition to commerce, one of the great aspirations of tourism in the modern era is to keep a low impact on destination environments and cultures [11,12,18]. However, the CLI’s business approach lives and dies according to profit. A reoccurring study commissioned by the Florida-Caribbean Cruise Association (FCCA) has captured the satisfaction rates of cruise tourists with regard to specific destinations [1]. As a long-term business, it is not economically beneficial to pollute the same destination site that is used to attract tourists. This type of impact will sour relationships with the local authorities and makes destinations undesirable. According to personal communication with a CLI official, site selections for new destinations by CLI are heavily influenced by the following considerations (Carnival Cruise personal communication, 2016): (1) easy and quick access for tourists to board and leave the ship; (2) proximity to land-based venues (such as, restaurants, museums, and heritage sites); (3) sustainability of tourist sites; and (4) appeal of sites to tourists.

There is relatively little published research concerning cruise destination sustainability. There is even less literature available on cruise destinations. Only a handful of papers discuss and compare factors that can be used to measure sustainability in cruise destinations and no studies were found on a repeatable measurement of cruise ship destinations with regard to sustainability. This paper reviews and analyzes studies that specifically focus on measuring sustainability (environment, culture, and economy) in CLI destinations in order to determine the key parameters that quantify the impact of the industry on establishing a new port destination, and existing port destination that have a potential to open new CLI markets (such as, American tourism). The literature review includes the prospect of long-term sustainability on those destination ports.

Brida & Zapata-Aguirre’s (2009) paper [20] is one of the most often cited works on sustainable cruise tourism. This qualitative study contains a significant trend analysis, mostly derived from Cruise Line International Association data. This paper offers valuable insight into the value and cost of cruise tourism to a destination from the perspective of sustainability through the economic impacts of direct spending, return visits and infrastructure investment; the environmental effects caused by modifications to the natural environment and use of resources; and social and cultural impacts, notably identifying the competition for space on small islands, crime, and fair labor conditions. A follow-up paper by Brida continues investigating the topic with a study on a cruise passenger homeport market analysis, analyzing passenger satisfaction in homeports [21]. MacNeill & Wozniak [22] published a study closely aligned to Brida’s publications (e.g., [21]) that focuses on the cruise destination complex of Roatan, Honduras, and its neighboring town, Truillo. The study compared Truillo before and after cruise tourism arrived and measures progress with regard to sustainability. The study also compares Truillo with other ports in the area, resulting in largely unfavorable findings that indicate the need for better regulations and use of cruise tax revenue [22].

Several qualitative studies focus on responsible cruise tourism and sustainability, taking specific aim at current practices in Belize while also touching on cruising in general.

Klein (2011) provides an overview of all three facets of sustainability and presents an opinion on port maturity, stating that the Caribbean is mature and that their ports have become homogeneous in the sense that they almost all exhibit similar shopping options [23]. Klein also presents information regarding sociocultural authenticity, through the opportunity to interact with local culture and how cruise tourism impacts historic cultural sites through its large number of visitors [23]. Two other studies on sustainable cruise ship tourism in Belize discuss the negative impacts of tourism and the strong desire of countries like Belize to abuse laws and offer unreasonable incentives to attract cruise business. The first study by Diedrich (2010) was based on surveys done with local populations and cruise tourists [24]. The study notes that not following established environmental regulations is just as bad as not having them at all. The study also mentions the restrictions on tourism needed to ensure sustainability, including limiting the number of tourists. Most importantly, the study notes that all forms of tourism, including cruise tourism, will likely continue to grow. As such, governments must determine how to let them progress in a sustainable way. The second study by Gould (2017) examines the political economy of cruise tourism and oil extraction in Belize [25]. The study points out that the mass tourism aspect of cruise ships is often disadvantageous to the host country. For example, Belize makes four times the amount of money from hotel guest than they do cruise visitors, and that tourists interested in environmental attractions are less attracted when destinations are impacted by mass tourism.

A recent quantitative study utilized a Multi-Criteria Decision Analysis (MCDA) method for applying a weighted sustainability analysis in comparing various routes for cruise ships entering Venice, Italy [26]. The study provides different route preferences, as the weights are adjusted to favor economic, environmental, or cultural interests. This is one of the few studies reviewed that considers issues like the hydrodynamics of large vessels in ports and the relative distances to tourist attractions in the comparison. Another quantitative study analyzes cruising activities and their effects on sustainable transport in the Mediterranean. The study uses indicators including shipping policy, port infrastructure, volume of passengers, and the infrastructure characteristics of the port city [27].

The CLI has also published several studies that provide the industry's perspective on corporate responsibility. An International Trade Forum study discusses the increased pressure on Pacific Island communities, as they are among the fastest growing cruise markets [28]. This industry-sponsored article discusses economic benefits and the ways in which the cruise industry is ensuring that the local community is benefiting through business opportunities. Another CLI paper provides an overview on the changes within CLI regarding port lifecycle development by testing tools for analyzing development [29]. A follow-up paper on the topic does note that "greenwashing" and complying with regulations will not be enough to solve the industry's environmental challenges [30].

Information regarding cruise tourism infrastructure (and, to a greater extent, local culture) on CLI destination ports is limited. This may be because a destination's rules and regulations in the territorial waters and on land of each port are defined by general tourism that typically arrives by air or land to a destination. These rules and regulations may not include details to specifically address the impact of CLI tourism on the local port destination. This makes it very challenging to define a universal policy to address impacts on communities, such as the economy, history, and cultural diversity. That may be the reason that many previous studies investigating impacts of CLI on the port destinations focus on environmental factors.

Marine pollution is heavily monitored by a variety of international, national, and local legislative bodies [17,31]. Cruise ships are required to follow the International Convention for the Prevention of Pollution from Ships, known as MARPOL 73/78 [32]. According to MARPOL, disposal of plastics into the ocean is prohibited, and there are severe restrictions on discharge of other solid garbage into coastal waters or special marine areas with heavy traffic or limited water circulation. Restrictions on liquid waste discharge varies with the liquid composition and distance from the shoreline (i.e., three nautical miles, four miles,

twelve miles, and two-hundred miles) [32]. In addition to water pollution, cruise ships contribute to air pollution. Providing passengers with entertainment (often lavish), lodging, and the additional expectations that are anticipated while on vacation increases the volume of fuel that a ship needs to operate, resulting in a larger cumulative carbon footprint per passenger [33]. The cruise industry is making attempts to improve their carbon footprint by working to use cleaner fuels like liquid natural gas. It is also important to note that this study considers sea wastewater disposition and the cumulative carbon footprint per passenger as secondary factors that impact port areas because ships do not typically release wastewater into the environment while in port. With that said, it is still recommended that each unique new destination make a point of spelling out how pollution will be addressed.

3. Materials and Methods

3.1. Study Sites

As discussed in the previous section, some of the impacts that CLI have on a destination are resource consumption and interference with local commerce, both in the port and on land. In order to predict the potential impact on Havana, data collected in destinations in neighboring nations will be used as a comparative reference. It is important to note that the number and size of cruise ships visiting a destination varies by company and geographic location. In this study, comparative sites were selected based on several characteristics: (1) regular cruise traffic; (2) not being a CLI headquarters (Miami, Fort Lauderdale, etc.); (3) offering shore-side excursions for passengers; and (4) accommodating a vessel length greater than 275 m (~900 feet). Similar to the CLI site selection for a new destination, the following study sites were considered comparative to the Port of Havana: Philipsburg, Sint Maarten, Belize City, Belize and Progreso, Mexico (Figure 1). Cruise Line statistics from 2018 and 2019 were used to define the passenger traffic to each destination site. UNESCO World Heritage Sites [34] were used as the primary shore-side attraction in all but one destination. A physical description of the destination sites for CLI tourists is as follows:



Figure 1. Overview map of the study site (green star) and the reference destination site (red stars).

Port of Havana—The cruise ship port in Havana, Cuba is located on the north side of the island in the historic district of Old Havana across the entrance channel from El Morro. Old Havana is a UNESCO World Heritage Site, and as soon as passengers leave the cruise terminal, they are in the heritage site.

Port of Belize City—Belize is located in Central America on the Caribbean Sea. There are two UNESCO World Heritage Sites for visitors to Belize City, Tikal National Park (Guatemala) and the Belize Barrier Reef Reserve System [34]. Cruise ships must anchor approximately 6.5 km from Belize City and ferry passengers into San Pedro Water Taxi terminal.

Port of Progreso—The port of Progreso, Mexico is located on the northern side of the Yucatan Peninsula and provides access white sandy beaches and to one UNESCO World Heritage Site, Chichen Itza. Progreso accommodates cruise ship docking at its 6.4 km-long pier that extends into the Gulf of Mexico.

Port of Sint Maarten—The cruise ship port in Sint Maarten is located on the Dutch side in the south-central part of the island. There are no UNESCO World Heritage Sites in Sint Maarten, but it has a port facility that is in very close proximity to the town of Philipsburg. Philipsburg is easily accessible to the cruise ship port and has many shops and restaurants that cater to tourists.

3.2. Destination Port Analysis

The analysis of the port of Havana and the reference sites was separated into marine near-shore analysis and land near-port analysis. This was done to support two focus areas: (1) getting the ship and its passengers safely and efficiently to shore, and the port's ability to support the projected growth in traffic; and (2) the proximity of the ship's debarkation area to points of interest for tourism and the impact that tourists have on the local infrastructure and economy. It is important to note that this destination analysis covers elements of sustainable seaport planning but needs to be expanded in order to include impacts like climate change, pollution, and sea level rise.

3.2.1. Marine Near-Shore Analysis

Data used for the marine near-shore analysis included nautical charts, satellite-derived bathymetry (SDB), automatic identification system data from (AIS), and several industry interviews with destination experts to verify assumptions regarding CLI priorities. A portion of the chart adequacy process outlined in the International Hydrographic Organization's GEBCO Cookbook was used to conduct an analysis of Havana Harbor [35]. The analysis included AIS data from 2011, 2012, and 2013 provided by the National Oceanic and Atmospheric Administration (NOAA), current Cuban nautical charts, and an examination of the current depths and shoreline extracted through the General Bathymetric Chart of the Oceans (GEBCO) process for satellite-derived bathymetry. For each destination port, vessel characteristics were analyzed based on searching the maritime mobile service number (MMSI) attribute from the AIS data through the United Nation's specialized agency for information and communication technologies [36]. Once the vessel traffic data was imported into ArcGIS as tracks, a geospatial filter was applied in order to analyze the traffic patterns for passenger vessels and then merged with the GEBCO analysis. Landsat 8 satellite imagery was downloaded from the U.S. Geological Survey's website [37]. Only imagery scenes that were cloud-free (less than 10%) with little or no water turbidity were processed using a satellite-derived bathymetry to generate an elevation grid [38,39].

3.2.2. Land Near-Port Analysis

The land near-port analysis included official reports, crowd sourcing websites, satellite imagery, and industry interviews. For the purpose of this study, near-port is defined as within the distance that a cruise ship passenger can travel during an excursion. Cultural sites must be offered as an excursion by the CLI in order to be included as a reference site. Excursions from the Port of Havana, Cuba, Belize City, Belize, and Progreso, Mexico include UNESCO World Heritage Sites. Philipsburg, Sint Maarten was also chosen because of the passenger traffic to the Island and the ports proximity to the main tourist zone in Philipsburg. GIS analysis, in conjunction with crowd sourced websites and satellite imagery, assessed travel times from ship to destinations. Assumptions were re-confirmed using Google transportation times for destinations that offered transportation by bus, Progreso,

Mexico for example. Statistical analysis on the number of ships and the maximum potential of passengers visiting a destination was conducted using 2019 information. The results of the statistical analysis were compared to ship and passenger information collected in 2018 and the FCCA's 2018 study of 36 destinations, 41,745 passengers, and 18,417 crew [1]. The FCCA study was chosen because it was the most extensive, reoccurring, survey that included Belize City, Progreso, and Sint Maarten.

4. Results

The marine impacts of CLI are considered immediate and can present themselves as water pollution or blocking passage for local commerce and fisheries. For the Marine Near-Shore Analysis, Nautical charts are considered a crucial part of a port's infrastructure. They are a mariner's roadmap for where to anchor and how to navigate while underway, and there are few places that are more difficult for mariners to maneuver than in a busy harbor. It is also important to note that many hydrographic offices around the world have been operating with limited resources, so maintaining charts to a standard that supports increasingly large ships is a challenge in Cuba, the U.S., and around the world. The stress of these challenges can be magnified when there are passengers, hazardous materials, heavy traffic, geographic choke points, shoal depths, dynamic seafloor, and/or poorly maintained charts. The cruise ship route corridor was identified based on the AIS with a 300-m buffer and was attributed as an impact area. The buffer distance was defined based on NOAA chart adequacy study and the corridor needed for a ship to safely navigate in and out of a port [39]. The underwater-keel clearance, which is a safe passage path for a cruise ship coming in along approach to port or the anchorage area, was evaluated by comparing the charted depths to SDB. Areas where the recent SDB results did not agree with the charted depth were marked and attributed.

Identifying the impact areas on land is a bit more challenging because the outcomes may not be immediate and may present themselves months or years later, depending on the fragility of the attractions and infrastructure in a destination. Based on the port location and the distance to an attraction, there may be more than one road (or path). Multiple paths to the excursion site might reduce the level of impact on infrastructure but expand the impact area. In addition, the number of potential passengers visiting an excursion site can increase the impact level. The daily surge of passengers impacts land infrastructure and may exhaust resources, such as clean water, sewage and garbage, increased traffic, and weathering of roads and sidewalks. When a cruise ship calls on a port, time is of the essence for everything and everyone [40,41]. Ships must adhere to strict schedules for a variety of reasons including birth space reservations for other ships, tourists' onward travel schedules, and the ability to include expected sightseeing for cruise ship customers. When off the ship in a given port, they must first clear customs, and then they need local currency, two things that can be made easy or difficult by a destination's managers and lessen immediate congestion in or around a port area.

4.1. Marine Near-Shore Analysis

A comparison between the charted depth areas to satellite-derived bathymetry show a good correlation at the Ports of Havana, Philipsburg, and Progreso (Figure 2). For example, the entrance to the port of Havana is about 350 m wide and is used mainly by commercial traffic (fishing) and cruise line ships. A December 2015 Landsat 8 image was used to determine bathymetry. Though absolute depths could not be determined accurately using the SDB method ($1\sigma \approx 1$ m), the data did indicate that the depth contours approximately matched the results from the imagery. Due to water turbidity, the SDB method was not able to derive bathymetry near the Terminal Sierra Maestra San Francisco pier face. Bottom characteristics from the chart indicate the sea bottom in Havana Harbor is not very dynamic and might explain the good correlation between the chart and the SDB. The Sint Maarten Port is an open port with a relatively deep bottom (~10.4 m) that is able to accommodate up to six cruise ships simultaneously. The Port of Progreso contains

a four-mile-long pier that can accommodate cruise ships with a draft of 9.7 m [42]. Port of Belize City is located behind a barrier reef that limits the vessel size that can enter and leave the port. The underwater geography of the approaches to Belize City are not deep enough to accommodate cruise ships, so passengers must spend valuable time ferrying to shore on smaller vessels. Passengers spend approximately 10% of their time (20 min each way) on the tender from the ship to shore [43].

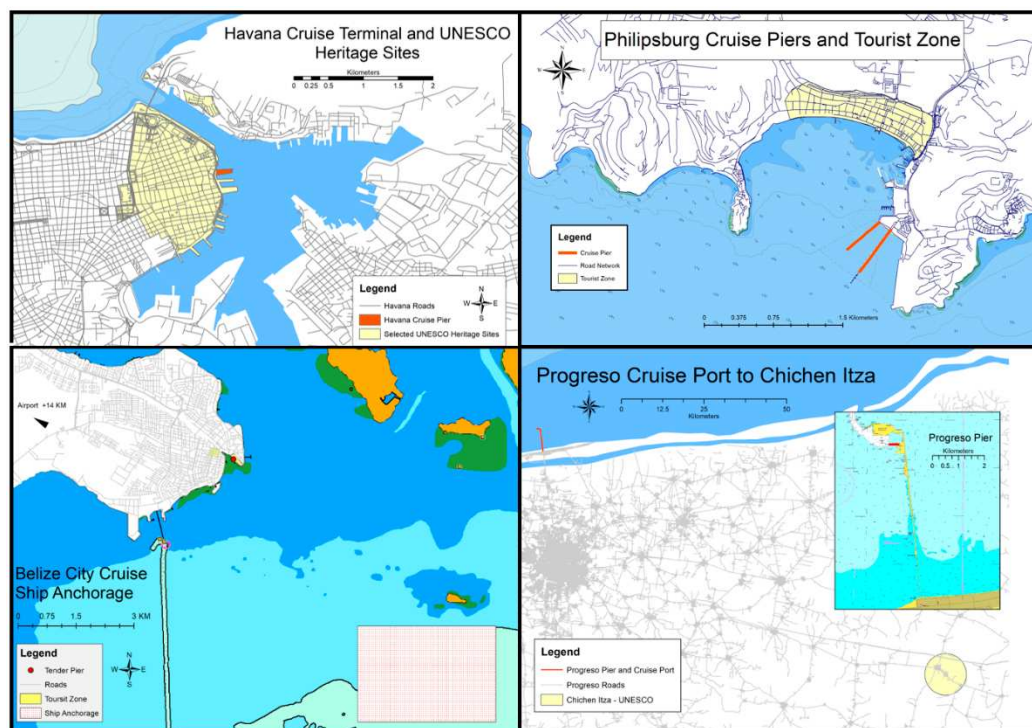


Figure 2. Land infrastructure for the destination study sites: (**top left**) Havana, (**top right**) Philipsburg, Sint Maarten, (**bottom left**) Belize City, Belize, and (**bottom right**) Progreso, Mexico. Road infrastructure was imported from OpenStreetMap.

Based on the AIS information, multiple cruise companies enter each of the study sites. The largest ship visiting Havana was the MSC Armonia (with a maximum capacity of 2679 passengers and 721 crew members). The 275-m length ship entered the port in 2018 with a maximum draft of 6.8 m and was tied up at the Terminal Sierra Maestra San Francisco in Havana Harbor. The Sint Maarten port can currently service five ships a day. The largest ship visiting Philipsburg was Symphony of the Seas (maximum capacity of 6780 passengers and 2390 crew members) operated by Royal Caribbean Lines with a maximum draft of 9.3 m. The chart indicates that there are about 10.5 meters of depth available where the ships are tied up at the pier. Port of Progreso contains a four-mile-long pier, but currently accommodates only one cruise ship at a time [42]. The largest ship visiting Progreso was Norwegian Getaway (maximum capacity of 3969 passengers and 1640 crew members) operated by Norwegian Cruise Lines with a maximum draft of 8.6 m. The anchorage areas near the Port of Belize City currently serves up to four cruise ships that anchor outside of the barrier reef. The largest ship reported to anchor in Belize is MSC Meraviglia (maximum capacity of 5400 passengers and 1500 crew members) operated by MSC Lines with a maximum draft of 8.7 m. The chart indicates that there about 10.3 to 12.5 m of depth available where the ships are anchored. In some of the Landsat imagery, turbidity plumes over the cruise ship anchorage are observed. Similar to the Terminal area in the Port of Havana, it was not possible to derive bathymetry over the cruise ship anchorage area and compare it to the charted depths.

4.2. Land Near-Port Analysis

Statistical analysis on the number of passengers visiting a destination in 2019 was conducted using information available in the AIS data (Table 1). The information included maximum potential passenger and crew numbers based on a ship's capacity in 2018 and 2019, annual change between the two years, monthly average, and minimum and maximum in 2019. It is interesting to note that the port of Havana had an 18% annual increase from 2018, whereas the reference sites showed a decrease of 3.0% to 5.1% in the number of passengers visiting a destination site. It is also interesting to see that the monthly cruise passenger trend for the Port of Havana is different than the three reference sites. While Philipsburg's, Belize City's, and Progreso's peak season is during the winter (December to February), the peak season for Havana is late spring to summer (May to August). A drop in the Havana's monthly passenger traffic is noticed in July (Figure 3). This drop is likely correlated to the two-month period that started on 4 June 2019 with the U.S. Administration announcement banning cruise ship visits from the U.S. to Cuba and ended when the last Americans with "grandfathered" travel plans visited. It is assumed that all of the passenger trends observed are correlated to origin country of the passenger visiting the destination. Before the renewed ban on U.S. cruise ships to Cuba, it seems that more Americans were interested in visiting Cuba over many other Caribbean and Meso-American destinations.

Table 1. Statistical analysis on the number of passengers visiting a destination spanning 2018–2019 was conducted using information available in the AIS data.

	Havana, Cuba	Philipsburg, Sint Maarten	Belize City, Belize	Progreso, Mexico
Destination population in 2019	2,138,000	41,500	61,500	~41,000
Maximum Capacity of passengers (+crew) in 2019	1,153,567 (1,561,230)	1,768,880 (2,391,492)	788,641 (1,075,399)	408,181 (570,027)
Maximum Capacity of passengers (+crew) in 2018	977,328 (1,308,500)	1,828,477 (2,475,526)	848,248 (1,167,381)	430,360 (598,256)
Annual Change	+18.0%	−3.3%	−3.0%	−5.1%
Monthly average in 2019	96,131	148,912	65,720	34,015
Monthly minimum in 2019 (month)	72,724 (September)	80,360 (September)	35,645 (October)	18,980 (May)

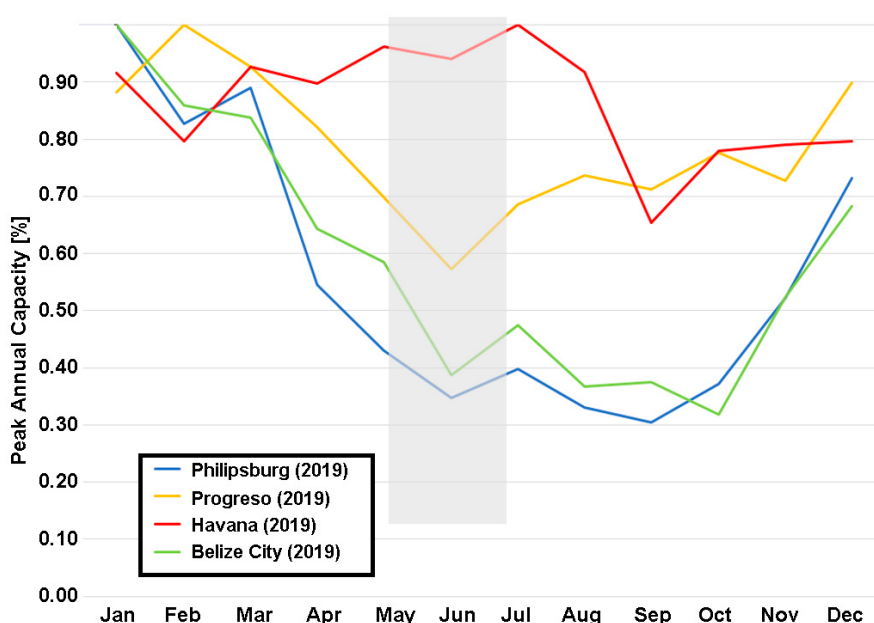


Figure 3. Normalized monthly cruise line passengers at the study site destinations (2019). The grey block represents the time period between the 4 June 2019 U.S. ban announcement and the two months after for American tourists had travel plans in hand and were allowed to travel to Cuba.

Based on UNESCO's World Heritage List, another interesting finding is the potential impact of the CLI passengers on the destination's land infrastructure and attractions. Though the potential impact of a large annual or monthly passenger traffic on the destination's land infrastructure is not clear from publicly available data, UNESCO does provide guidance on how to conduct heritage impact assessments [44]. UNESCO's World Heritage List (UNESCO, 2020) describes "Old Havana and its Fortification System" in a state of disrepair due to decay, chronic neglect, and the natural elements [34]. With that said, the UNESCO reports also state that there has been little impact on Old Havana from development and that there are numerous examples of the features that qualify it to be a heritage site partly due to its size. Similarly, UNESCO reports that the Mayan site Chichen-Itza, near Progreso Mexico, is in need of constant maintenance and attention in order to avoid deterioration of its pre-Hispanic fabric due to tourist traffic. The report states that the site lacks adequate implementation of its planning tools and allocation of resources to ensure the conservation of the "Outstanding Universal Value of the property in the long term." Belize City provides direct access to the Belize Barrier Reef Reserve System that is on the List of World Heritage in Danger [34]. In addition, it is possible to fly from Belize City into Guatemala's Tikal National Park. This Mayan site has reached a high volume of tourism and during seasonal peaks becomes a major management challenge, risking serious damage with visible impacts that include problems with solid waste and wastewater, as well as impacts on the archaeological remains from physical erosion and vandalism, all in need of careful assessments and management responses [44].

Good port infrastructure can mitigate land and marine impacts. For example, the cruise ship terminal in Havana has twelve immigration booths, and at the request of the cruise industry, has increased the number of money exchange booths from two to fourteen. The Port of Havana offers a pier to offload passengers in the old quarter of town, so tourists are immediately able to start their shore excursions. The geographic location of Havana's terminal in relation to its heritage site makes it a desirable destination for the CLI. The city has many accessible roads that reduce traffic congestion but expand the impact area. Philipsburg, Sint Maarten is also a desirable destination for the CLI. The cruise ship terminal is less than one and a half miles from the town of Philipsburg, 15 min if one chooses to walk, and water taxi transportation is available. The port realizes the importance of rapidly moving tourists from ship to shore by providing two passenger screening booths at pier two and over 100 taxi cabs to move people to shops and restaurants [45]. The port of Progreso, Mexico on the other hand, is not considered a desirable destination for the CLI because it has a four-mile-long pier that becomes an obstacle for tourists who are eager to start the two-hour-long journey to the famous Mayan ruins of Chichen Itza [42]. It should be noted that the Progreso pier facilitates cruise ships' ability to connect to shore power while in port that reduces the impact of local air quality. Similarly, the underwater geography of the approaches to Belize City are not deep enough to accommodate cruise ships. Passengers must spend valuable time ferrying to shore on smaller vessels, where excursions are up to an hour away from Belize City [43]. In addition, the commute from the San Pedro Water Taxi terminal to the Belize Municipal Airport is another 10 min drive. Based on the road infrastructure, there are multiple roads leading to the airport, possibly reducing traffic congestion on one main airport road and the traffic associated with the CLI.

5. Discussion

Based on Land Near-Port Analysis, tourism and the CLI have major impacts on destination ports and the infrastructure around them. In all of the cases discussed, the distance and means of transportation from the ship to the CLI attraction has the potential to impact the local population through increased wear on their roads, slower travel times for locals who may be forced to compete with CLI traffic, and increased pollution from cars, buses, and other forms of travel. Figure 2 shows that some destinations are better suited for CLI tourism as a result of their geography and their relationship to the local attractions.

Both Havana and Sint Maarten benefit from having their main attraction close to the cruise port. Progreso and Belize do not.

Table 2 shows a correlation between the amount of time and difficulty that a passenger must endure with that of satisfaction with a destination. Sint Maarten enjoys a high level of passenger satisfaction while Belize City's is much lower even though Sint Maarten does not offer a UNESCO recognized attraction. Time ashore is equal, but the time traveling from ship to main attraction varies significantly. The table suggests that attraction accessibility may have as much to do with satisfaction as the attraction itself.

Although the charting products that guide mariners in and out of the Port of Havana are up to date, an increase in marine traffic (correlated with the 17% increase of passengers from 2018 to 2019) would cause a stress on the commerce and local fishing industry that are using the port. The size of the cruise vessels and their slow speed may create traffic congestion around the entrance to the port of Havana that is only 350 m wide. Another impact that was also visible from satellite imagery was water pollution or stirred up sediment that was observed in the reference sites, particularly Belize (Figure 4). The impact of Donald Trump's economic sanctions, and now COVID-19, has put into question the viability of Cuba's dependence on U.S. tourism. As shown in Figure 3 by the post-July 2019 decline in cruise tourism as a result of U.S. policy change, Havana needs to expand its cruise tourism sources beyond the United States if it wants to achieve economic sustainability in the cruise sector. The port load (number of people per day as measured by ship capacity) totaled 84,616 in May of 2018, with only two days without a ship in port. In May of 2020, the schedule for Havana shows only one ship visiting with a passenger capacity of 490 as a result of the COVID-19 pandemic [46]. This is most likely because of the number of super spreader cases on cruise ships and lack of trust in the CLI to mitigate their impacts [47].



Figure 4. Examples of satellite imagery showing cruise line industry (CLI) impacts on the destination sites: **(top left)** Havana, **(top right)** Philipsburg, Sint Maarten, **(bottom left)** Belize City, Belize, and **(bottom right)** Progreso, Mexico. Road infrastructure (red polylines) was imported from OpenStreetMap.

Table 2. CLI Satisfaction surveys of passengers that visited the reference sites [1].

	Philipsburg, Sint Maarten	Belize City, Belize	Progreso, Mexico
Number of People Employed Locally	4867	1666	438
Local Income Earned (millions)	\$101.6	\$17.7	\$2.6
Number of Passenger Arrivals (thousands)	2827.6	1334.9	435.2
Number of Shore Excursions (thousands)	2232	956	330
Hours Spent Ashore (mean)	4.68	4.60	4.51
Satisfied Visitors	94%	86%	81%

6. Conclusions

When compared to complementary destinations, measurable factors that impact sustainable cruise tourism from the perspective of port and land infrastructure become apparent in Cuba. Over the past six years, the prospect of American cruising to Cuba has gone from a market of great potential to one that is non-existent. In just a few short years, companies like Carnival have gone from looking for creative ways to operate by offering voyages that focused on culture and education, to completely canceling service to Cuba along with large companies like Royal Caribbean and Norwegian. This clearly indicates how sensitive Havana is from an economic perspective. Royal Caribbean and Norwegian accounted for a combined passenger/crew maximum carrying capacity of over 500,000 people in 2019.

From a cultural perspective, the outlook is likely positive for Havana as a result of increased tourist traffic. If tourism planning is well implemented, tourists' receipts have the potential to bolster efforts to preserve and clean up the UNESCO world heritage area of Old Havana, and the return to the U.S. practice of allowing visits to Cuba to be of a cultural/research nature, might assist in preserving cultural awareness. There is evidence that even when U.S. policy is changed, should it be relaxed in the future, American tourists have a strong interest in Cuban culture as a forbidden fruit [48]. Should this happen, it is important for adequate protections in the form of planning and resource management be employed to protect both the UNESCO sites and Cuban natural resources.

Havana's shore-side infrastructure is ideal from a geographic perspective. The attractions are in very close proximity to the port allowing for most of the visitors to walk from the ship to the old town in Havana. The other primary destinations in Havana are short distances by bus or car. This paper has not examined the impact of tourism on the sites, nor has it accounted for the use of resources like food, water, fuel, or additional crowding in urban areas. Cuba should account for impacts like these in its future planning.

Havana's port infrastructure, specifically nautical charting, appears to be adequate for welcoming increased cruise ship traffic. Port facilities can currently accommodate at least one (probably two) large ship at a time, but if Cuba expects to have multiple lines visiting at the same time then they need to continue their plans to expand pier space that is dedicated to cruise ship dockage and should further take on measures aligned with sustainable seaport planning. Havana is fortunate to have a natural deep-water port that is ideal for this type of shipping that should limit the amount of dredging that would need to occur in other ports.

The most recent threat to the cruise line industry and its destinations has been the spread of COVID-19. It is important to consider preparations for future industry-wide threats that impact destinations. Such preparation will require clear policies to mitigate any risk for spreading the virus between passengers and crew, which also will increase the trust of passengers to visit sites and have a more enjoyable experience [47,49]

Author Contributions: Conceptualization, J.E.N., S.L.S., M.R., S.P.; Methodology, J.E.N.; S.L.S.; S.P.; Formal Analysis, J.E.N.; S.L.S.; S.P.; Software, J.E.N.; Writing—Original Draft Preparation, J.E.N., S.L.S., M.R., S.P., M.K.; D.S.; Writing—Review & Editing, J.E.N., S.L.S., M.R., S.P., M.K.; D.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Thank you very much to the many cruise line industry individuals, various hydrographic offices around the world and NOAA's Office of Coast Survey Development Laboratory for the fantastic insight, support, review and advice. Thank you also to Ian Ward for providing comments and guidance in the paper's early life.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the writing of the manuscript, or in the decision to publish the results.

References

1. Florida-Caribbean Cruise Association. *Economic Contribution of Cruise Tourism to the Destination Economies: A Survey-Based Analysis of the Impacts of Passenger, Crew and Cruise Line Spending*. Business Research & Economic Advisors (BREA) Report; BREA: Phillipsburg, NJ, USA, 2018.
2. Baker, D.M.A. The cruise industry: Past, present and future. *J. Tour. Res.* **2016**, *14*, 141–153.
3. Geiling, N. Before the Revolution: Socialites and Celebrities Flocked to Cuba in the 1950s. *Smithsonian Magazine*. 31 July 2007. Available online: <https://www.smithsonianmag.com/history/before-the-revolution-159682020/> (accessed on 23 January 2021).
4. Saul, J. MSC Will Be First Cruise Line in Cuba. *The Maritime Executive*. 14 December 2015. Available online: <http://www.maritime-executive.com/article/msc-will-be-first-cruise-line-in-cuba> (accessed on 23 January 2021).
5. U.S. Passports and International Travel. US Department of State—Bureau of Consular Affairs. 26 April 2016. Available online: <https://travel.state.gov/content/passports/en/country/cuba.html> (accessed on 23 January 2021).
6. Cruise Industry News. Global Ports Holding Wins Havana Port Deal; More Berths Announced. 22 May 2018. Available online: <https://www.cruiseindustrynews.com/cruise-news/19031-global-ports-holding-wins-havana-port-deal-more-berths-announced.html> (accessed on 23 January 2021).
7. International Hydrographic Organization (IHO). *S-66 Publication. Facts about Electronic Charts and Carriage Requirement*, 1.1.0 ed.; International Hydrographic Organization: Monte Carlo, Monaco, 2018.
8. United Nations Environment Programme (UNEP); World Tourism Organization (WTO). *Making Tourism More Sustainable—A Guide for Policy Makers, UNEP and WTO Report*; UNEP: Paris, France; WTO: Madrid, Spain, 2005.
9. Dwyer, L.; Peter Forsyth, F. Economic significance of cruise tourism. *Ann. Tour. Res.* **1998**, *25*, 393–415. [CrossRef]
10. Dwyer, L.; Douglas, N.; Livaic, Z. Estimating the economic contribution of a cruise ship visit. *Tour. Mar. Environ.* **2004**, *1*, 5–16. [CrossRef]
11. Wood, R. Caribbean cruise tourism: Globalization at sea. *Ann. Tour. Res.* **2000**, *27*, 345–370. [CrossRef]
12. Wood, R. *Tourism and Transport: Issues and Agenda for the New Millennium: Chapter 10—Cruise Ships: Deterritorialized Destinations, Advances in Tourism Research*; Les Lumsdon, L., Page, S., Eds.; Elsevier Ltd.: Amsterdam, The Netherlands, 2004; pp. 133–145.
13. De Grosbois, D. Corporate social responsibility reporting in the cruise tourism industry: A performance evaluation using a new institutional theory based model. *J. Sustain. Tour.* **2015**, *24*, 1–25. [CrossRef]
14. Weaver, D.B.; Lawton, L.J. The cruise shoreline as contested tourism space: Evidence from the warm-water pleasure periphery. *Tour. Manag. Perspect.* **2017**, *24*, 117–125. [CrossRef]
15. Fridriksson, J.; Wise, N.; Scott, P. Iceland's burgeoning cruise industry: An economic opportunity or a local threat? *Local Econ. J. Local Econ. Policy Unit* **2020**, *35*, 143–154. [CrossRef]
16. Casado-Díaz, A.; Navarro-Ruiz, S.; Nicolau, J.; Ivars-Baidal, J. Expanding our understanding of cruise visitors' expenditure at destinations: The role of spatial patterns, onshore visit choice and cruise category. *Tour. Manag.* **2021**, *83*, 104199. [CrossRef]
17. Paiano, A.; Crovella, T.; Lagioia, G. Managing sustainable practices in cruise tourism: The assessment of carbon foot-print and waste of water and beverage packaging. *Tour. Manag.* **2020**, *77*, 104016. [CrossRef]
18. Johnson, D. Environmentally sustainable cruise tourism: A reality check. *Mar. Policy* **2002**, *26*, 261–270. [CrossRef]
19. Bonmati, D.S. Sweatshop on the Highseas: Chapter 3: From Cruise Industry Investigations to Top Executives, Univision Noticias and Columbia Journalism School Online Publication. 2021. Available online: <http://huelladigital.univisionnoticias.com/cruceros-vacaciones-en-aguas-de-nadie/trabajo/index-lang=en.html> (accessed on 25 January 2021).
20. Brida, J.G.; Zapata-Aguirre, S. Cruise tourism: Economic, socio-cultural and environmental impacts. *Int. J. Leis. Tour. Mark.* **2009**, *1*, 205–226. [CrossRef]
21. Brida, J.G.; Pulina, M.; Riaño, E.; Aguirre, S.Z. Cruise Passengers in a Homeport: A Market Analysis. *Tour. Geogr.* **2013**, *15*, 68–87. [CrossRef]
22. MacNeill, T.; Wozniak, D. The economic, social, and environmental impacts of cruise tourism. *Tour. Manag.* **2018**, *66*, 387–404. [CrossRef]

23. Klein, R.A. Responsible Cruise Tourism: Issues of Cruise Tourism and Sustainability. *J. Hosp. Tour. Manag.* **2011**, *18*, 107–116. [CrossRef]
24. Diedrich, A. Cruise ship tourism in Belize: The implications of developing cruise ship tourism in an ecotourism destination. *Ocean Coast. Manag.* **2010**, *53*, 234–244. [CrossRef]
25. Gould, K.A. Ecotourism under pressure: The political economy of oil extraction and cruise ship tourism threats to sustainable development in Belize. *Environ. Sociol.* **2017**, *25*, 1–11. [CrossRef]
26. Pesce, M.; Terzi, S.; Al-Jawasreh, R.I.; Bommarito, C.; Calgaro, L.; Fogarin, S.; Russo, E.; Macromini, A.; Linkov, I. Selecting sustainable alternatives for cruise ships in Venice using multi-criteria decision analysis. *Sci. Total Environ.* **2018**, *642*, 668–678. [CrossRef]
27. Rosa-Jiménez, C.; Perea-Medina, B.; Andrade, M.J.; Nebot, N. An examination of the territorial imbalance of the cruising activity in the main Mediterranean port destinations: Effects on sustainable transport. *J. Transp. Geogr.* **2018**, *68*, 94–101. [CrossRef]
28. Sherry, A. Carnival Australia: Managing the Impact of Tourism. International Trade Center. 2011. Available online: <https://www.intracen.org/Carnival-Australia-Managing-the-impact-of-tourism/> (accessed on 23 January 2021).
29. Papathanassis, A.; Bundă, N.R. Action Research for Sustainable Cruise Tourism Development: The Black Sea Region Case Study. *Tour. Mar. Environ.* **2016**, *11*, 159–177. [CrossRef]
30. Papathanasis, A. Cruise tourism management: State of the art. *Tour. Rev.* **2017**, *72*, 104–119. [CrossRef]
31. Munsart, C.A. *A Cruise Ship Primer: History & Operations*, 1st ed.; Cornell Maritime Pr: Baltimore, MD, USA, 2015; 256p.
32. International Maritime Organization. Proceedings of the Final Act of the International Conference on Marine Pollution, London, UK, 8 October–2 November 1973; p. 166. Available online: <https://www.imo.org/en/KnowledgeCentre/ConferencesMeetings/Pages/Marpol.aspx> (accessed on 23 January 2021).
33. Rastogi, N. A Supposedly Green Thing I Might Do Again, Slate. Available online: <https://slate.com/technology/2009/09/how-bad-for-the-environment-are-cruise-ships.html> (accessed on 23 January 2021).
34. United Nations Educational Scientific and Cultural Organization (UNESCO). World Heritage List Portal. Available online: <https://whc.unesco.org/en/list/> (accessed on 23 January 2021).
35. International Hydrographic Organization (IHO). *The IHO-IOC GEBCO Cook Book*; IHO Publication B-11: Monte Carlo, Monaco, 2014; Available online: https://www.gebco.net/data_and_products/gebco_cook_book/ (accessed on 23 January 2021).
36. International Telecommunication Union (ITU). *List V—List of Ship Stations and Maritime Mobile Service Identity Assignments*, ITU Publication Notice 419-20. 24 April 2020; International Telecommunication Union (ITU): Geneva, Switzerland, 2020; p. 4. Available online: <https://www.itu.int/mmsapp/ShipStation/list> (accessed on 23 January 2021).
37. USGS. Earth Explorer. Available online: <https://earthexplorer.usgs.gov/> (accessed on 28 August 2016).
38. Pe’eri, S.; Keown, P.; Gonsalves, M. Reconnaissance Surveying Using Satellite-derived Bathymetry. *Hydro Int.* **2015**, *19*, 21–23.
39. Pe’Eri, S.; Parrish, C.; Azuiki, C.; Alexander, L.; Armstrong, A. Satellite Remote Sensing as a Reconnaissance Tool for Assessing Nautical Chart Adequacy and Completeness. *Mar. Geodesy* **2014**, *37*, 293–314. [CrossRef]
40. International Maritime Organization (IMO). *Guide Book, Reduction of GHG Emissions from Ships: Just in Time Arrival Guide—Barriers and Solutions*, Marine Environment Protection Committee (MEPC) Report, MEPC 75/INF.22; GloMEEP Project Coordination Unit, International Maritime Organization: London, UK, 2020.
41. International Harbour Master’s Association’s. *Port Information Manual (Version 3—August 2020)*, Industry Partners, Standards Partners and Endorsers of the ITPCO, IHMA, IAPH and UKHO; GloMEEP Project Coordination Unit, International Maritime Organization: London, UK, 2020; 74p.
42. Whats in Port: Progreso. Available online: <https://www.whatsinport.com/Progreso.htm> (accessed on 23 January 2021).
43. Cruise Port Insider Excursions. 2016. Available online: <http://www.cruiseportinsider.com/> (accessed on 23 January 2021).
44. United Nations Educational, Scientific and Cultural Organization (UNESCO). *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties*. International Council on Monuments and Sites; International Council on Monuments and Sites Publication: Paris, France, 2011; 26p.
45. Port of St. Maarten. Port of St. Maarten: Ship Schedule. Available online: <http://www.portofstmaarten.com/schedule.htm> (accessed on 23 January 2021).
46. Cruise Timetables. Cruise TT Website. Available online: <http://m.cruisett.com/> (accessed on 23 January 2021).
47. Pan, T.; Shu, F.; Kitterlin-Lynch, M.; Beckman, E. Perceptions of cruise travel during the COVID-19 pandemic: Market recovery strategies for cruise businesses in North America. *Tour. Manag.* **2021**, *85*, 104275. [CrossRef]
48. Wilson, J.; Látková, P. American tourists in Cuba: Is the communist country a forbidden or a tainted fruit? *Tour. Hosp. Res.* **2015**, *16*, 6–18. [CrossRef]
49. Choquet, A.; Sam-Lefebvre, A. Ports closed to cruise ships in the context of COVID-19: What choices are there for coastal states? *Ann. Tour. Res.* **2021**, *86*, 103066. [CrossRef] [PubMed]