This is an Accepted Manuscript of an article published by Elsevier in Journal of Cleaner Production on 4 September 2017, available online: <http://www.sciencedirect.com/science/article/pii/S0959652617320334>

An embargo period of 24 months applies to this Journal.

This paper has received funding from the European Union (EU)'s H2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 643712 to the project Green Bubbles RISE for sustainable diving (Green Bubbles). This paper reflects only the authors' view. The Research Executive Agency is not responsible for any use that may be made of the information it contains.

© 2017. This manuscript version is made available under the CC-BY-NC-ND 4.0 license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

Accepted Manuscript

Sustainable scuba diving tourism and resource use: Perspectives and experiences of operators in Mozambique and Italy

Serena Lucrezi, Melville Saayman

PII: S0959-6526(17)32033-4

DOI: [10.1016/j.jclepro.2017.09.041](https://doi.org/10.1016/j.jclepro.2017.09.041)

Reference: JCLP 10542

To appear in: *Journal of Cleaner Production*

Received Date: 2 February 2017

Revised Date: 28 July 2017

Accepted Date: 4 September 2017

Please cite this article as: Lucrezi S, Saayman M, Sustainable scuba diving tourism and resource use: Perspectives and experiences of operators in Mozambique and Italy, *Journal of Cleaner Production* (2017), doi: 10.1016/j.jclepro.2017.09.041.

This is a file of an unedited manuscript that has been accepted for publication. The manuscript has further undergone copyediting, typesetting, and review of the resulting proof before it was published in its final form. Please note that during the production process errors may have been discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Sustainable scuba diving tourism and resource use: Perspectives and experiences of operators in Mozambique and Italy

Serena Lucrezi *, Melville Saayman

TREES – Tourism Research in Economic Environs and Society, North-West University, 11 Hoffman Street, Potchefstroom 2520, South Africa

*Corresponding author. TREES, North-West University, Private Bag X6001, Potchefstroom, 2531, North-West, South Africa. Tel: +27 18 299 4140; fax: +27 18 299 4140. E-mail address: 23952997@nwu.ac.za

ACKNOWLEDGEMENTS

The authors extend their gratitude to the participants in the interviews, which are included in the list reported here: <http://www.greenbubbles.eu/?cat=70>. Special thanks go to Van Dao Truong, Murat Egi, Martina Milanese, Carlo Cerrano, Marco Palma, Waldo Krugell, Miguel Gonçalves, Armand Viljoen, the Peace Parks Foundation, and the management board of Portofino MPA. This study was funded by the Green Bubbles RISE project, H2020-MSCA-RISE-2014. The project has received funding from the European Union Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 643712. This paper reflects only the authors' view. The Research Executive Agency is not responsible for any use that may be made of the information it contains.

ABSTRACT

Scuba diving has attracted increased numbers of tourists on a global scale. While the beneficial as well as detrimental impacts of scuba diving tourism have been well documented, limited research attention is given to the perspectives of dive operators with respect to sustainable development. This study examined the perspectives and experiences of dive operators in relation to sustainable resource use in Mozambique and Italy, two countries that are home to popular coastal destinations and offshore marine parks. Interviews suggested that overall operators have positive attitudes towards sustainable resource use, engaging in actions such as deploying four-stroke engines, recycling equipment and waste, and favouring electric- over fuel-powered vehicles. Yet, they do not promote sustainable resource use at the dive centre, with reasons including limited time, lack of government incentives, and absence of rebate systems. Implications were discussed for sustainable diving operations in the study areas and generally.

KEYWORDS

Dive centre; sustainable; resource; scuba diving; renewable energy; operator

HIGHLIGHTS

- Scuba diving attracts increased tourism globally, with detrimental impacts
- Perspectives of scuba operators on sustainable resource use were investigated
- Operators had positive attitudes towards sustainable resource use
- Operators did not promote sustainable resource use at the dive centre
- Implications were discussed for sustainable scuba diving operations

Introduction

Tourism's contribution to global environmental change is increasingly significant (Gössling Peeters, 2015). This is often focussed on climate change (Scott et al., 2016), but also includes biodiversity loss, land use change, water use, and invasive species (Rutty et al., 2015). Given growth in tourist numbers, the detrimental impacts of tourism on the environment will only increase if tourism follows a business-as-usual path (Scott et al., 2016). In the business-as-usual scenarios to 2050, the projected growth of tourism is likely to increase levels of energy consumption by 154%, greenhouse gas emissions by 131%, water consumption by 152%, and solid waste disposal by 251% (UNEP, 2015).

Industry advocates have argued for technological and management solutions that focus on increased efficiency rather than any limits on tourism's growth to tackle resource use. However, while such measures may reduce, for example, emissions per passenger kilometre or guest night, the absolute amount of emissions continue to increase (Gössling & Peeters, 2015). The use of green- and eco-labels that aim to encourage greater consideration of the environment in consumption practices also presents significant issues (Gössling & Buckley, 2016), often raising scepticism among consumers who may not think of holidays as an environmental harm or may be deterred by the cost of eco-friendlier holidays (Villarino & Font, 2015; Wongthong & Harvey, 2014). In the absence of legal mechanisms to reduce tourism's environmental effects, increased attention has turned towards encouraging voluntary behavioural change by consumers (Cohen et al., 2014) and businesses (Truong & Hall, 2016) with respect to sustainable resource use. Such research has largely focussed upon the hotel sector (Lee & Oh, 2014), while limited attention is given to tour businesses (Frey & George, 2010) including those operating in marine and coastal environments such as scuba diving operators (Wongthong & Harvey, 2014).

Recreational scuba diving has become an important component of marine and coastal tourism, where about one million people are certified annually (Dimmock & Musa, 2015; PADI, 2016). Growing demand fuelled by advances in technology, training, education, and equipment has led to the establishment of dive centres, charters, resorts, and schools; the development of extensive retail networks; the support of local economies (Townsend, 2008); the branding of many locations as scuba diving hotspots; and a sense of pride among the scuba diving community and host communities (Dimmock et al., 2013; Lucrezi et al., 2017).

Many prior studies have documented the economic values of scuba diving tourism for destinations and countries (Barker & Roberts, 2004; Musa & Dimmock, 2013), the profile and motivations of scuba divers (Lucrezi et al., 2013), and diver satisfaction (Musa & Dimmock, 2013; Musa et al., 2006). Others have documented the positive environmental impacts of scuba diving tourism, such as conservation efforts (Biggs et al., 2012a), increased environmental awareness (Biggs et al., 2012b), and participation in Citizen Science and monitoring activities (Cerrano et al., 2016). Others yet have reported the negative environmental impacts of this sector, including direct damage to underwater ecosystems through physical contact with habitats and organisms (Barker & Roberts, 2004; Rouphael & Inglis, 2001; Worachananant et al., 2008); and indirect harm through urban development of coastal zones and land degradation (Wongthong and Harvey, 2014), sewage pollution (Lamb et al., 2014), food waste disposal (Hunt et al., 2013), eutrophication (Musa, 2002) and carbon emissions (Lindgren et al., 2008). The literature counts numerous works making particular reference to the direct harm caused by scuba divers to the environment. Many such works are summarised in books by Garrod and Gössling, (2008) and Musa and Dimmock (2013); and in the *Tourism in Marine Environments* journal (e.g. Vol. 8). More recent works include research articles by Hammerton and Bucher (2015), Roche et al. (2016), and Terrón-Sigler et al. (2016) among others. In contrast with this growing body of literature, the resource-intensive nature of the scuba diving tourism sector remains somewhat neglected, with research examining the use of resources and its associated impacts being scarce (Lindgren et al., 2008).

Based on what is available, it is assumed that scuba diving being a non-consumptive form of marine tourism, depending on the quality of the marine environment, operations would pay attention to environmental issues including waste management, carbon emissions, and water use through actions such as recycling, education, renewable energy use, and responsible travelling (Byrnes et al., 2016; Haddock-Fraser & Hampton, 2012; Hunt et al., 2013). Approaches proposed to promote sustainable resource use by scuba diving operations include self-regulatory (Byrnes et

al., 2016), third-party controlled (De Groot & Bush, 2010), meta-governance controlled (De Groot and Bush, 2010; Project AWARE, 2016), government and policy controlled (Hunt et al., 2013), and a mixture of these (Hunt et al., 2013). These approaches enable the implementation, oversight and monitoring of environmental standards, such as the consumption of water and energy, ensuring compliance with environmental goals (De Groot & Bush, 2010; Hunt et al., 2013).

An example of self-regulatory action is reported by Byrnes et al. (2016), who conducted a study on the environmental impacts of boating in Australia. The authors showed that scuba diving operators individually take self-regulatory actions like controlling sewage disposal from vessels by using standard domestic toilets. De Groot and Bush (2010) exemplified 'third-party' certification initiatives using the Green Globe tourism standards. These standards, which are applied by the tourism sector in Curacao through the Curacao Hotel and Tourism Association (CHATA), ensure that adhering scuba diving centres monitor their consumption of water and energy. While having been designed for the hospitality sector, the standards appear to be applicable to the local scuba diving industry, ensuring compliance with environmental goals. Blue Certified (Bluecertified.org) is another example of 'third-party' certification scheme catering specifically for the diving industry. The scheme, launched by the Ocean First Institute, aims to provide scuba diving businesses with 30 best management guidelines to reduce environmental impacts and costs. Some of them deal with waste treatment, energy consumption, water use and carbon emissions.

Certifying agencies such as PADI have launched campaigns including the Go Eco Operator and the current 10 Tips for Divers to Protect the Ocean Planet through Project AWARE (De Groot and Bush, 2010; Project AWARE, 2016). These invite operators and divers to seek ways to reduce the carbon footprint and to use recycled products, among other actions. These recommendations tend to be generic, without detailed step-by-step operational guidelines. The Green Fins management approach (Hunt et al., 2013), a UNEP initiative implemented by the Reef-World Foundation, provides an example of procedural programme which in part reflects positive attitudes of scuba diving operations towards sustainable resource use. The approach, which is adopted in some Asian countries, requires the application of a code of conduct by scuba diving operations comprising a series of standards. Some are aimed at encouraging more sustainable use of environmental resources, and include: adequate waste disposal on the vessels and at the dive centres; minimum discharge policy; abiding to all environmental laws imposed locally or nationally; clean-up events (both in the water and on land); and engaging the staff and clientele in environmental awareness through education and setting a good example. For each of these standards, the Green Fins approach provides a list of criteria, which are assessed during external audit sessions, so as to monitor the success and effects of the implementation of the management approach.

Thus, the scuba diving tourism sector is able to recognise its responsibility in generating impacts, from development to unsustainable energy use and waste generation, and to show good intentions to reduce its environmental footprint. However, the sector has voiced a number of challenges associated with the approaches outlined above. For example, while certain issues would be manageable through self-regulatory mechanisms, others such as waste disposal and wastewater discharge would be too difficult to address without the assistance of local policy and education. Main barriers to achieving sustainable goals of resource use include: generic or inaccessible information; limited government support; ineffective policy and education measures; low environmental awareness and knowledge among local people and the diving industry; and the poor influence of environmental performance on the market (Byrnes et al., 2016; Haddock-Fraser & Hampton, 2012; Wongthong & Harvey, 2014). Such findings highlight the importance of taking into account views and concerns of dive operators to ensure the sustainable development of scuba diving tourism. Additional research is required to understand the behaviour of scuba diving operators towards sustainable resource use, and key influences to such behaviour. This need concerns the scuba diving tourism industry in both developing and developed realities.

This study examined the perspectives and experiences of dive operators in relation to sustainable resource use in Mozambique and Italy, two countries that represent two different levels of development (developing vs. developed) but are home to well-known coastal destinations and offshore marine parks. In this study, the term "resource" is broadly defined as anything that can be transmitted from one person to another (Foa & Foa, 2012), embracing not only energy such as water, light, electricity, and fuel, but also available infrastructure and services (Rutty et al., 2015;

Scott et al., 2016). Thus, this research looks at the views and self-reported actions by the scuba diving tourism sector at the case studies from an environmental footprint point of view, limiting the scope of the discussion to the environmental pillar of sustainability, although some economic and social elements are also discussed.

The contribution of this study is three -fold. First, the research data were collected from main role players in the scuba diving tourism sector at the case studies. These data provided important bottom-up information able to correctly identify obstacles faced by this sector in embracing a philosophy of low environmental footprint and supporting the blue economy. Second, the results were used to provide recommendations including the implementation of simple and realistic plans of proper resource use, to promote environmental stewardship by scuba diving tourism firms for the benefit of sustainable growth of the scuba diving tourism sector at the case studies. Such recommendations are also applicable to the broader scuba diving tourism industry. Last, the results from this study allowed the researchers to look beyond simple actions, and envisage more complex and solid approaches engaging role players aside from the scuba diving tourism sector, from governance bodies to local and national authorities, meta-governance bodies, scientists, and organisations. The paper is structured as follows. It contains a description of the case studies under investigation. The method section illustrates the qualitative research method of data collection (the measuring instrument is provided as Appendix 1), the data collection process, and the thematic analysis of the collected data. The results section outlines the main findings for each of the two case studies, according to the main themes emerged from the data analysis, with some of the relevant data reported in the participants' own words. The discussion section interprets the main findings of the research, comparing the case studies to highlight both positive and negative attitudes by the scuba diving tourism sector towards sustainable resource use, identifying possible causes for such attitudes, and proposing solutions to overcome the problems identified by the research. The conclusion section recaps on the main findings of the research and on its contribution to science, policy and practice.

Case studies

Scuba diving operations revolving around two Marine Protected Areas (MPAs), one in Mozambique and one in Italy, were selected for this study (Figure 1). Past and present environmental and ecological issues associated with the marine and coastal environments at the case studies are outlined by Lucrezi et al. (2017) and briefly described below. The relevant policies affecting scuba diving tourism operations at the case studies are listed in Table 1.

FIG. 1

The Mozambique case study involves scuba diving centres operating in the Ponta do Ouro Partial Marine Reserve (PPMR) and based in the small and remote village of Ponta do Ouro. With an area of 678 km², the PPMR is a popular scuba diving destination among South African and international visitors. About 30,000 dives are logged from the launching site annually (Gonçalves, 2015). The location of Ponta do Ouro has been suffering from a series of stressors related to overfishing, abusive development on coastal dunes, pollution, and littering (particularly plastic). Prior to the establishment of the PPMR, scuba diving tourism was recognised as an important threat to marine ecosystems, due to the uncontrolled crowding of dive sites. Current policies regulate scuba diving activities in Ponta do Ouro by limiting the number of commercial operations to eight, and by banning the use of anchors and of underwater propulsion vehicles. Although private land ownership is prohibited, the right of use and tenure in Ponta do Ouro makes it virtually possible for people to develop and implement renewable energy infrastructure. Critical issues in the village remain ordinary power outages, the dependence upon electricity for water extraction (boreholes), the poor quality of the septic tanks system, and littering.

The Italian case study involves diving operations in the Portofino MPA (area 3.74 km²), in a small and relatively populated zone of the region Liguria. Scuba diving centres here are principally based in the locality of Santa Margherita Ligure. The diving industry in this region has existed for over 50 years, being characterised by tourism-centred operations and manufacturing of scuba diving gear. An average of 40,500 dives has been logged annually in Portofino MPA between 2000 and 2010 (Cappanera et al., 2012). Relevant environmental and ecological issues for the Portofino MPA have originated from the degradation of seawater in ports, land-based and water-based source pollution, dumping, anchoring, discarded fishing equipment, and the impact of scuba diving

activities, both direct like contact and indirect like pollution. Scuba diving activities in the MPA are regulated through the banning of anchors in the general reserve of the MPA and the establishment of fixed buoys; banning of underwater fishing; banning of underwater propulsion vehicles in the general reserve; limiting the number of boats (two) and divers (24) per buoy at a given time; and demanding that information on MPA regulations be provided during pre-dive briefings. On land, scuba diving firms of the Portofino MPA face a number of challenges to sustainable resource use due to the conformation of the territory (old buildings and infrastructure, small spaces and roads, rented spaces for the dive centre). In addition, recent changes at the municipal scale regarding waste disposal and recycling may require some time before local businesses, including the scuba diving operations, can adjust.

Method

A qualitative method approach was adopted in this research because it allows members of the study communities to “voice” their opinions and experiences (Yin, 2011). Data collection was from February to September 2016. As part of Green Bubbles RISE, an EU-funded project on sustainable scuba diving, all licenced dive centres in Ponta do Ouro (approximately ten), and in Portofino (approximately 20) were invited to participate in an interview on resource use.

Seven operators from Ponta do Ouro and eight working in Portofino agreed to participate in the interview, which was structured into 17 questions (see Appendix 1). The interview was conducted in English in Ponta do Ouro and in Italian in Portofino, lasting between 40 and 60 minutes. The interviews were transcribed verbatim. Those undertaken in Italian were translated into English and translations were cross-checked. The transcripts underwent thematic analysis identifying key patterns within the data set. Being considered a qualitative analytic method independent of theory and epistemology, thematic analysis becomes a flexible tool capable of producing a thorough account of research data (Braun & Clarke, 2006). Although the interview was structured, answers to each question were not kept separate from each other for the purpose of thematic analysis. The questions, however, were important in the process of open coding the data before generating the final themes from the data set. A theme was identified as such when capturing something relevant concerning the research questions and characterising a patterned response, and themes were identified inductively following the six phases outlined by Braun and Clarke (2006). Themes emerged from the data set include (1) scuba diving operators’ understanding of resources, (2) basic structure of the scuba diving operations, (3) waste and equipment disposal practices, (4) energy use and related costs, and (5) promotion of sustainable resource use.

Results

Interviewees’ profiles

Basic differences in the profiles of the interviewees and the firm size of the dive centres between the case studies are outlined in Table 2. Most of the interviewees in Ponta do Ouro were South African, four males and three females, 37 years old on average. Those in Portofino were Italian, six males and two females in their 40s. All of them reported having completed high school or higher. Those in Ponta do Ouro had worked in the scuba diving industry for about 10 years, and their businesses had been established between 6-22 years. Dive operators in Portofino were seemingly more experienced, having been in the industry for 18.5 years on average. Their business lifespan ranged from one to 21 years.

Dive operators’ understanding of resources

The interviewees defined a resource as an indispensable and usable asset that they need on a daily basis. They recognised the importance of resources for survival, for financial gain and for the benefit of human beings. For example, operators in Ponta do Ouro stated:

I think a resource is any type of asset that we need on a daily basis.

Something you can use to gain financial benefits and also for the customer to enjoy.

Operators in Portofino MPA perceived a resource as being “at the base of everything without which nothing can be done” or “something which allows us to concretise an idea and do a job”. Some understood a resource as something exploitable and associated it with people’s capacity to

achieve a goal. For instance, one dive operator stated, “in my opinion, a resource means the capacity of people to use an object, a material, or a person to achieve a goal”, while another defined a resource as “an opportunity if it is well deployed”.

When asked what specific resources are the most important, operators in Mozambique stated that the ocean and tourism are on top of the list:

The most important resources are the dolphins and the marine environment.

To me, the ocean is the most important resource. We need more clients and more infrastructures for tourism development.

Those in Portofino MPA stated that their most important resources were qualified operators and staff, good logistics, and infrastructure. The marine environment and tourism tended to be secondary. In many cases, the marine environment was not mentioned:

The most important resources in our business are information, the capacity to market our business to reach the customer, the working atmosphere, and the logistical resources that you offer to the client.

Our staff, vessels, equipment, the dive centre, and I are the most important resources.

Scuba diving operations' basic structure

The basic structure of the various firms assessed for this study is represented in Table 3. In Ponta do Ouro, relevant infrastructure and services of the dive centres included the vessels (one to three), trailers, off-road vehicles (ORVs), tractors, air compressors, laptops, printers, credit card machines, cell phones, GPS, radios, bathrooms, washing stations, fridges, kettles, and DVD players for educational purposes. The vessels are rubber ducks or zodiacs about 8 m in length, with double four-stroke, 85-100 horsepower Yamaha or Suzuki engines, between one and two years old and consuming about 0.75-1.5 l km⁻¹ in fuel. Two operators were still using two-stroke engines, which are nearly two times more fuel-consuming than four-stroke ones. The boat was normally maintained by the operators and staff on a daily (washing, flushing the motors, and changing oil and spark plug), monthly (painting, fiberglass, motor inspection, greasing and trailer bearings), and yearly basis (general inspection by government officials). This helped prevent potential risks, such as oil and fuel leakages. Most of the maintenance cost was attributed to the annual government inspection. An annual fee of up to US\$ 477 was due for the inspection and the boat licence alone.

We have annual fees to pay for the boat and its annual inspection. Eight officials come and we have to cover their costs during the inspection. Last year we paid US\$ 561. Then every centre paid the officials US\$ 56 during inspection. If you do not pass the inspection, you have two weeks to fix problems, and after that they release the annual licence to launch. The annual licence fee is US\$ 421 per boat.

Operators were concerned about the inspection cost and the lack of a local agency for the maintenance of boat motors, blaming these issues on the government's disinterest in the development of the local diving tourism industry:

I pay the inspection fee to the government, and then I need to pay for liability insurance, for mariner and myself as skipper for being on the boat, then annual licence fee, about US\$ 1,192 in total. This is not a sustainable business.

There is no agency for the motors. They are bought in South Africa at US\$ 81 for one horsepower. My boat is 115 horsepower. It costs 40% more to bring the motors to Mozambique. It would be easier to run the business in South Africa. We make enough to live. The paperwork required by the Mozambican government is the biggest challenge. The Mozambican government does not care about the development of tourism here.

The operators reported three to seven vessel launches per week during the quiet season and seven to 56 during the peak season (December to April). The average distance to reach a dive site

was 4-15km. Popular dive sites included Doodles reef (1km trip), Pinnacles reef for shark diving (10km trip), and Techobanine reef (20km trip). Each boat accommodated no more than eight clients, with operators not necessarily launching full boats.

Most agreed to inter-charter if needed. Two operators did not want to give their clients away while they would happily receive other operators' clients.

In Portofino, infrastructure and services relevant to diving operations included the rented space of the dive centre, the vessels (one to three), three-wheel motorbikes ("ape") or electric trolley-pulling bikes, air compressors (up to two), laptops, printers, card machines, telephones, radios, bathrooms, changing rooms, lockers, washing stations, boilers, fridges, microwave ovens, air conditioners or fans, and DVD players. The vessels were either rubber ducks (6-10 m in length) or boats in fiberglass or aluminium (10 m in length). The engines, of various brands, were outboard, inboard, or inboard-outboard. Each vessel normally had a single engine running on diesel or petrol, had 160-370 horsepower, and was 2-13 years old. Most engines were about six years old. Those running on diesel consumed about 30 litres of fuel per hour (1-1.2 l km⁻¹), while those running on petrol consumed 40-60 litres per hour (1.3-2.4 l km⁻¹). Maintenance was normally performed by the operators, staff, and service stations at ports. It included oil, water and fuel check daily, and hull, zincs, tubular structure, filter change and engines up to twice a year. Most operators did not encounter problems with the vessels during operations, although some reported incidents such as internal oil leakages. Maintenance costs ranged between US\$ 2,383-32,497.

We spend US\$ 32,497 per year I would say. We recently had engine problems because they are forced daily; we had the collapse of a motor shaft, broke the changeover switch costing us US\$ 5,416. We had internal oil leaks, breakage of straps, struck bilge pumps. If in winter the repairs are done properly there should be no problems. We clean the boats and check the oil daily. Every month the boss does what he can.

The operators launched the vessels about 5 times per week during the quiet season and up to 45 times during the peak season (June to September). On average, a boat accommodated eight to nine divers. In the peak season, a full boat accommodated up to 12 divers. The average distance to reach a dive site was 9-10km. Operators generally went as far as San Fruttuoso Bay, just over half way along the promontory of Portofino. However, popular sites such as Faro are only 5 km away from most dive centres. Operators were willing to launch a boat for a minimum of two clients if necessary, as this would improve customer loyalty. Some of them tried to inter-charter in the quiet season and on weekdays, although inter-chartering was seen as difficult and potentially damaging to the image of the dive centre.

Waste and equipment disposal practices

A breakdown of the waste and equipment disposal practices by the different firms at the case studies is reported in Table 3. Many operators in Ponta do Ouro stated that recyclable materials were sorted at the garbage dump and sold to Maputo, while others claimed that there was no system in place for waste to be recycled. Most of them declared to compost. They were concerned about the impacts of the government's urban development plan on waste generation and the lack of environmental education, although these issues may not discourage international tourism:

No, there is no system in place for recycling. There was some attempt but it did not work. I try to compost. With the road connecting Maputo to Ponta do Ouro coming that may get better. But the government is not taking any action. They are just saying they are building the road. There is also a problem with ground water. Once we get the road, there will be too many people and this system of septic tanks is not going to work. The tourists should just bring along their plastic. There needs to be education from when the children are small, but right now this is not working.

More Maputo people will come in the weekends, so there will be litter. But our market will go up because foreigners know Africa is dirty, while South Africans will not come and it will be difficult for other operators relying on this market segment.

The interviewees stated that there was no proper way to manage toxic waste and flooded electronic equipment and batteries. The former was buried at the dump while the latter were either sent to South Africa or taken away by divers. Engine oil was sent to Maputo for recycling.

Equipment needing maintenance included life jackets, fins, masks, wetsuits, O-rings, hoses, BCDs, regulators, cylinders, and compressors. Maintenance was done locally or in South Africa. One operator used pieces of old wetsuits as patching material, while another donated some of the old soft gear to schools. One respondent stated that he has a garage full of old equipment and did not know what to do with it. If not repairable, the broken equipment was thrown away.

Most operators in Portofino MPA reported having disposal bins for regular waste and for plastic at the dive centre, with some having separate bins also for paper and glass. Toxic waste was discarded in different ways: oil was sent to the main bunkering area at the port or to the fishing vessels while used batteries were sent back to wholesalers, suppliers or mechanics. Flooded electronic equipment was taken away by divers; otherwise it was sent back to production homes for replacement or disposal. Pieces of equipment needing repair or discarding included plastic parts and wetsuits. Wetsuits were thrown away at the rate of 1-2 per year or one every 2-3 years. There was uncertainty whether neoprene can be recycled as plastic. Operators did their best to save broken equipment by sending it to wholesalers for repair and inspection or by fixing it by themselves. Old equipment was mainly sold.

Energy use and related costs

Details on the behaviours and costs related to energy use among the scuba diving operations at the case studies are listed in Table 3. In Ponta do Ouro, fuel and electricity were the most used and expensive energy types. A boat launch required US\$ 23 of fuel or higher, depending on the travel distance and sea conditions. One operator claimed that a single boat launch could cost up to US\$ 92. The cost of electricity ranged between US\$ 25-189 per month. Although water is drawn from a borehole, the pump uses electricity to function. This is an issue because the area suffers from frequent power outages, and not everyone possesses a power generator. Most operators were not using renewable energy, although the problem of the power outages increased their interest in it. One respondent stated that “it is crazy not to use the sun”. Some operators reported using roof hoses to heat water and installing solar panels at home. The main barrier to using solar energy was financial and logistical.

Likewise, the most expensive energy type for operators in Portofino was fuel, with costs ranging between US\$ 22-30 per boat launch. Other notable costs included electricity, telephone, waste disposal and water, with annual expenses reaching up to US\$ 7,000. Most of them did not use renewable energy at the dive centre due to resistance at the condominium and municipal levels. Yet some respondents reported deploying electric vehicles to move diving equipment to and from the port or marina. One respondent reported using thermostatic valves at the dive centre.

Promoting sustainable resource use at the dive centres

Table 3 provides information on the extent to which scuba diving operators at the case studies promoted sustainable resource use. Some operators in Ponta do Ouro did not promote sustainable resource use and sustainable initiatives at the dive centre because they felt no real need to do it, while others reported having no time for it. Those who did encouraged clients not to litter, to recycle, to reduce the use of plastic, and to eat sustainably caught fish and seafood; and taught staff not to spill oil during oil changes and not to waste water. Regarding water saving, varying attitudes were identified. One operator justified the importance of teaching others not to waste it using expressions like “water is very important to us”; while another claimed that he did not promote sustainable water use because “there is no shortage of water really”. The character and origin of the client influenced the need for and success in promoting sustainable resource use:

International tourists are disciplined with litter because of where they come from. The South African market is not so disciplined and you need to remind them about rubbish bins and sweet papers on the boat.

I do not really see any possibility to encourage customers to use renewable resources. About 10% of our customers are “normal” while the rest come here to enjoy a cheap holiday.

In Ponta do Ouro, the greatest barriers to promoting sustainable resource use were the lack of a system in place, infrastructure, and government support. There was some willingness to use solar energy, although this would be expensive due to import taxes from South Africa. Furthermore, environmental education was needed to raise local residents’ awareness of sustainable resource

use. Enablers to promoting sustainable resource use included government support in the form of import tax reductions and the introduction of subsidies and rebate systems. Yet, interviewees stated that such measures may not work due to cultural issues, the fact that Mozambique is a Third World country, and that the devices needed to exploit renewable energy come from outside, calling for import taxes. Cultural and financial issues were described as follows:

Change must start from the bottom. Local people should complain and ask for infrastructure and services and then the government will follow. People should be educated about these things so that they can ask for them, use them and maintain them. We need a mind change of people. Older generations do not teach the younger generations the right things. Culture is a problem.

It is all about money in the end. Eco-friendly operations cost more money. Also if we buy things we need to import it. A solar geyser costs ZAR 7,500 (US\$ 526) and at the border we need to pay for import tax. There are no discounts for sustainability.

Also in Portofino operators did not engage in the promotion of sustainable resource use, except for the promotion of the code of conduct in the MPA, carpooling, and recycling plastic. One operator stated:

Talking about sustainability when we are the first who cannot embrace this philosophy is difficult.

Barriers included lack of incentives from the government; lack of interest at the municipal level; lack of public interest in the environment; no available technology for the nautical sector in comparison with other sectors; economically inaccessible renewable energy; the configuration of the territory and limited space available; old infrastructure in the local area; and the spaces of the dive centre being rented and not owned. The operators wished to receive incentives from the state in the form of rebate systems, lower taxation, and contributions; municipal support; shorter bureaucratic processes; and that renewable energy was made more available and at a cheaper cost. One operator voiced these wishes as follows:

We need incentives, subsidies and someone who will propose them. The existence of some technologies is not even known, and there are no investments on behalf of the state.

Discussion

Scuba diving operators from both case studies provided fair definitions of resources, recognising their indispensability for the success of their business and for survival in general. However, there was confusion in Ponta do Ouro over the exhaustibility of water, the supply of which is a serious issue in the area (Jury et al., 2011). Operators from Portofino viewed resources under a more opportunistic light, with some neglecting the importance of the marine environment as a primary resource. Due to struggles in obtaining resources such as water and the remoteness of the area, operators in Ponta do Ouro may feel their dependence on natural resources more strongly in comparison with those in the more developed Portofino, who placed the marine environment as second to infrastructure and services.

Scuba diving operators' perceptions of resources can be sensitive to the surrounding reality in a given Scuba Diving Tourism System or SDTS (Dimmock & Musa, 2015). Regardless, their environmental awareness is crucial to support sustainable actions (Lindgren et al., 2008). This can be enhanced through meta-governance mechanisms including informative sessions led by certifying agencies, MPAs, and municipal councils. These can focus on local issues close to the heart of operators while promoting synergy and cooperation amongst members in the SDTS.

The basic structure of the scuba diving operations was similar between case studies. Vessel size, fleet size and MPA regulations can control daily diving operations, helping establish limits of maximum carrying capacity (here referring to the number of boats and the number of divers at a given time) of dive sites. By consequence, the deployment of resources for the diving operations is also limited. The PPMR poses restrictions to the number of scuba diving operations allowed to use the marine reserve. Although Portofino has more scuba diving centres compared with the PPMR, three dive centres merged into one in December 2016 (S. Lucrezi pers. comm.). This may lower consumption of resources compared with the past (Leslie, 2015), due to a single management board controlling resource use, translating into efforts to reduce consumption and costs. One issue

was the shared difficulty of inter-chartering and a general reluctance to do it. While logistical and working philosophy issues make inter-chartering challenging, this practice possesses the potential to reduce resource use by sharing fuel consumption, and promote collaborations among dive centres.

The deployment of motor vehicles for diving operations at the case studies may be seen as energy-consuming and damaging to the environment. In Ponta do Ouro, ORVs are needed due to the lack of tar roads and the distance between dive centres and the launching site. Operators located close to the launching site request their divers to walk, and most leave their vessels on the beach when launching them several times a day. These small steps reduce fuel consumption and save money, although recommendations such as the use of diesel over petrol can still be made. In Portofino, some operators deploy electric vehicles to transport equipment, asking the scuba divers to walk to the marina. Some ask scuba divers to manually push trolleys with equipment to the marinas. In Portofino, electric vehicles are becoming increasingly popular (Rossellini, 2016). While operators based at a short distance from their vessels could deploy electric vehicles to transport equipment, for many it remains financially, functionally, and logistically challenging (Speranza, 2016).

Vessel engines in Ponta do Ouro were new four-stroke, thus eco-friendlier than those in Portofino, which were older models with an average greater consumption. The former undergo great physical stress, and operators cannot afford to have serious engine-related issues, which would require trips across the border to South Africa and considerable costs. These factors call for constant small maintenance and possibly frequent engine turnover, indirectly minimising environmental impacts. This outcome is not necessarily economically sustainable. The operators complained about the cost of the boat inspections and the lack of a local agency for the motors. The establishment of a local motor agency seems unlikely; however, the new road connecting the capital of Mozambique to Ponta do Ouro may allow operators to have easier access to engine maintenance. The annual boat inspections may also become cheaper due to easier access to the area by government officials. At any rate, the alleviation of the boat inspection costs could stimulate greater efforts by scuba diving operators to reduce their environmental footprint. Operators in Portofino may think that a limited financial capacity justifies postponing vessel engine upgrades; however, in the long term they may spend more money on the maintenance of current engines. These operators are exposed to advances in scuba diving and boating through events like the Genova Boat Show and the Boot Show in Germany (M. Kruger pers. comm.), making it possible for them to look into ways to upgrade vessel engines to something eco-friendlier.

The diving operators at both case studies made an effort to save damaged diving equipment before having to discard it and replace it, and disposed of certain types of waste (e.g. engine oil, batteries) the best way possible. Sending flooded equipment back to the production houses may reflect trust in the latter's ability to properly deal with it. These actions, however, may be merely based on the need to save money, or on convenient deals between diving operators and production houses. Clients had to take care of their own special waste (e.g. torches, computers) and the operators were not interested in knowing its fate. Dive centres should promote ways to properly discard special waste and offer a service to the clients, including the repair and/or collection of equipment including torches, batteries, computers, soft gear, and regulators (Hunt et al., 2013). If unable to do so, they could provide information on places and initiatives to recycle scuba diving equipment (Denny, 2014; Morton, 2014; Richardson, 2009). Certifying agencies and the broader scuba diving industry should make a greater effort to dispense information on the origin of materials such as neoprene, how equipment made of special materials can be disposed of, and the current advances in the production and availability of eco-friendlier scuba diving products (GlobeNewswire Inc., 2016).

Ponta do Ouro is difficult to accommodate in terms of waste disposal and recycling. Diving operators make an effort to save, reuse and recycle equipment, by sending it to South Africa. While South Africa has no system in place to cater for special scuba diving waste (D. Schlebusch pers. comm.), it has launched a strong and efficient campaign to recycle tyre rubber (e.g. REDISA, Innovative Recycling). This could expand to include the bulk collection and recycling of neoprene and rubber (e.g. from fins), although dive centres, dive shops, dive schools and manufacturers collectively need to look into this possibility. The Portofino case study should exploit relations with local production homes and the steady flow of divers to implement a system of equipment repair,

recycling and turnover. This system could operate at a small expense on behalf of clients, with results including better control of waste; direct economic advantage for clients, dive centres and production houses; and improving the image of the dive centre and the production company (Richardson, 2009).

Scuba diving operators may still be unsure how to dispose of neoprene, which is a synthetic rubber. The recycling initiative in Portofino is recent (2016-2017) and while there are dedicated websites (Santagreen.it) describing waste disposal and recycling regulations in the area, operators may still be adjusting. The reuse of materials such as fins and wetsuits is not accommodated, as rubber belongs to regular waste. This is yet another reason why dive centres should exploit relations with production houses so as to minimize environmental harm, gain some benefit, and sensitise clients.

Scuba diving operators listed fuel as the top and most expensive resource used for their business. Scuba diving operations are likely to remain at the mercy of fluctuating fuel prices, due to the influences of the global economy. However, scuba diving operations at both case studies are based on local diving, not taking place beyond a certain range. This operational framework can somehow control fuel consumptions. Meanwhile, switching to four-stroke engines and to diesel would result in long-term savings, although initially coming at a cost. Recent technological advances are promising reductions in carbon emissions by the combustion of biodiesels such as waste cooking oil, although with some uncertainties (Piloto-Rodríguez et al., 2017). The cost of biodiesels is considered competitive with regular diesel, and the nautical sector including developing countries is already making use of them, with tangible benefits including community development and cohesion amongst stakeholder groups (Moecke et al., 2016).

Scuba diving operators listed electricity as second top and most expensive resource used for their business. Some operators used roof hoses (Ponta do Ouro) and thermostatic valves (Portofino) as ways to save energy at the dive centre. The successful local implementation of renewable energy is characterised by a bottom-up assessment of renewable/reusable energy potential, followed by the implementation according to the needs of the community, with minimal environmental impact (Moecke et al., 2016; Winkler et al., 2016). This process can be hampered by limited knowledge of renewable energy among stakeholders, poor dissemination of information, and top-down approaches; all issues which were lamented in various forms by operators of both case studies.

In Ponta do Ouro, the use of roof hoses by some operators is relevant considering that Sub-Saharan Africa countries accommodate a negligible proportion of solar thermal systems compared with the rest of the world (Joubert et al., 2016). Operators also correctly perceived the potential and importance of exploiting solar energy in their area, especially in light of unstable electricity supply coupled with increasing costs (Joubert et al., 2016; Macau Daily Times, 2017). Nevertheless, the reluctance to switch to solar energy remains fuelled by the distrust in an initially expensive investment and by the import taxes from South Africa. The perceived necessity to import infrastructure from South Africa can be contested, and recent deals by the Mozambican government are leaning towards the support of large-scale solar power generation and supply (Migiro, 2016). However, rural areas in Mozambique such as Ponta do Ouro may continue to suffer the effects of a colonial energy access geography, regardless of tourism income potential (Power et al., 2016). Further, a complex political economy of energy use both in Mozambique and South Africa implies longer times for energy transitions (Power et al., 2016). Investments by the scuba diving industry in Ponta do Ouro would eventually result in a stable and low-maintenance source of energy, although issues including poor funding for subsidies and limited knowledgeable expertise on installation remain (Joubert et al., 2016).

In Portofino, thermostatic valves represent a basic and common method to control the consumption of heat, thus efforts to reduce energy consumption and embrace renewable energy solutions are arguable. Liguria promotes sustainable development including the use of renewable energy with some installations being eligible for incentives. Information on the region's strategy and actions is provided in a dedicated website (Ambienteliguria.it). The region is working with a plan to speed up bureaucratic processes for potential investors in renewable energy (Tigullio News, 2013). Recently, the region offered over Euro 400,000 of contributions to applying municipal councils for the installation of previously confiscated solar panels, although the money was allocated to public structures (Levante News, 2016). Thus, the competitive nature of available

subsidies, the cost of investment, the cost of installation, and dive centres being leased and not owned, may be true obstacles to implementing renewable energy. On the one hand, operators can continue (or begin) to negotiate with landlords and coops for investments in renewable energy. On the other hand, municipal councils and the region need to continue to push for sustainable development strategies.

Operators from both case studies did not promote sustainable resource use. It is understandable if scuba diving centres unable to embrace a certain business philosophy refrain from promoting a similar philosophy to their clients. Nevertheless, actions including water saving and recycling can be implemented and promoted without significant effort. Pre-dive briefings and check-in/check-out periods allow operators and staff to mention key issues to the customers. Operators are in frequent contact with staff, with opportunities to ensure compliance with some standards of resource use. Visual aids, including small posters in public restrooms requesting clients not to waste water, or colourful recycling bins for different types of waste, can be used. If the dive centre is adopting a particular programme, this should be made known to the clientele, with the potential to improve the image of the business and affect the clients' behaviour (Dimmock et al., 2013; Lindgren et al., 2008).

In Ponta do Ouro, some operators felt there was no need to promote sustainable resource use. According to them, international visitors are more knowledgeable of environmental responsibility and tolerant of environmental issues, such as littering, in African countries. Meanwhile, South African tourists are less disciplined with regards to the same issues. While this may be true (Lucrezi & van der Walt, 2016), this perception should be changed, as problems such as littering remain sensitive to various tourist types (Petrosillo et al., 2007). Further, the issue of increased waste generation as a result of urban development remains a daunting prospect to scuba diving operators. Local authorities' action, coupled with initiatives of corporate social responsibility on behalf of the scuba diving industry, can be important steps in educating the resident community and outsiders. However, an infrastructural and urban plan to catch up with urban developments is still required to address the limited capacity of the village to accommodate a larger flow of tourism and increased waste generation (Jury et al., 2011).

Portofino may be perceived as a case where the promotion of sustainable resource uses is not required, thanks to a variety of resources already made available to clients and staff by local municipalities. Nevertheless, scuba divers visiting the area often do so exclusively to dive, thus only coming into contact with the scuba diving operations during their stay (Lucrezi et al., 2017). Actions like throwing a cigarette butt into the sea and disposing of plastic and cans in the regular waste were observed at dive centres which, during this study, supported the importance of sustainability (S. Lucrezi pers. obs.). These actions can easily become impressed in the minds of scuba divers, as demonstrated by experimental research (Dearden et al., 2007). In the case of Portofino, the dive centre, the vessels and the dive sites represent the main theatres for the promotion of sustainable resource use, where operators and staff have to pay attention to their communications and actions.

In summary, scuba diving tourism operations at the case studies face challenges to achieve environmental sustainability goals, to ensure that ecosystem services their business depends on can be delivered. Some challenges can be addressed rapidly and easily by decisions on behalf of operators, while others would need the support of the greater scuba diving industry, of local and national authorities, of governance bodies such as MPAs, and of technological advances. Policy remains probably the strongest tool to ensure compliance with eco-friendlier resource use (Buckley, 2012). However, the industry is able to take initiative to sensibly use resources and minimise environmental harm, by means of cooperative self-regulation. A mixture of policy and bottom-up initiatives would represent the best recipe for more sustainable resource use by the scuba diving industry. However, their weight and impact will depend on the circumstances locally. Further, external elements such as scientific groups, technological groups, and organisations need to be engaged.

Scuba diving operations have justified difficulties in implementing environmental management guidelines with the unavailability of information, also expressing a desire to have access to such information. While codes of conduct and best practice are obtainable through the internet and meta-governance bodies, their successful implementation may be hampered by factors such as

content lacunae and incomprehensibility. These should be developed with the support of local, regional and national authorities, and be promoted, implemented and monitored by experienced intermediaries. Simple yet comprehensive plans of proper resource use can represent a step forward in environmental stewardship by scuba diving tourism operations. Such plans need to conform to local realities, avoiding standardisation and generalisation. They need to take into account the concerns of the local scuba diving tourism industry, perhaps by allowing its representatives to set reasonable and adjustable goals over specific time periods. This method can improve the chances of healthy collaborations between the scuba diving industry and external bodies with a mandate to ensure that environmental management plans are implemented.

Conclusions

Scuba diving tourism represents an important component of marine and coastal tourism. While many of its impacts have been identified and assessed for the purpose of promoting the sustainable growth of this sector, the resource-intensive nature of scuba diving tourism has somehow been neglected, particularly in reference to a stakeholder analysis of the challenges faced by the scuba diving industry in minimising its environmental footprint and promoting awareness among scuba divers. Based on the available literature, it is understood that the scuba diving tourism sector recognises its responsibilities in causing harmful environmental impacts on the environment due to the use of resources such as electricity and water, and the generation of waste and pollution. While intentions to reduce these impacts are reflected in a number of actions and initiatives, the sector continues to face challenges associated with self-regulation, local policies, lack of accessible information, and lack of awareness among the sector itself and the general public.

This study shed light on these challenges by voicing the opinions, attitudes and self-reported actions of the scuba diving tourism sector concerning the sustainable use of resource for scuba diving operations. Two case studies, Ponta do Ouro in the PPMR, Mozambique and Portofino MPA, Italy, were considered for this research. The data collected from local scuba diving operators at the case studies show that, on the one hand, the scuba diving tourism sector acknowledges the indispensability of resources for its survival. The structure of scuba diving operations and firm size are able to act as regulatory tools in controlling resource exploitation and reducing environmental harm. Finally, scuba diving operators embrace a philosophy of reuse and recycling at the dive centre to some extent. On the other hand, lack of awareness, local policies, logistical problems and competitive costs hamper initiatives like the use of renewable energy and proper waste management. Scuba diving centres tend not to promote sustainable resource use as they could, possibly as a result of the inability to embrace an eco-friendly business philosophy. Through a discussion of the results from this research, a series of recommendations were advanced. Some of these can simply be followed by the local scuba diving tourism sector, while others require efforts on behalf of local policy makers, scientists, meta-governance bodies, organisations, and national authorities, to work together with the scuba diving tourism sector to enhance its environmental sustainability. Future research may look into testing the implementation of various actions at the case studies or at other locations, in order to assess the efficacy of these actions, and establish monitoring criteria to ensure their success in assisting the scuba diving tourism industry reduce its environmental footprint and promote environmental stewardship.

References

- Barker, N.H.L., Roberts, C.M. (2004). Scuba diver behaviour and the management of diving impacts on coral reefs. *Biological Conservation*, 120, 481–489.
- Biggs, D., Ban, N.C., Hall, C.M. (2012a). Lifestyle values, resilience, and nature-based tourism's contribution to conservation on Australia's Great Barrier Reef. *Environmental Conservation*, 39, 370–379.
- Biggs, D., Hall, C.M., Stoeckl, N. (2012b). The resilience of formal and informal tourism enterprises to disasters: Reef tourism in Phuket, Thailand. *Journal of Sustainable Tourism*, 20, 645–665.
- Braun, V., Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77–101.

- Buckley, R. (2012). Sustainable tourism: Research and reality. *Annals of Tourism Research*, 39(2), 528–546.
- Byrnes, T., Buckley, R., Howes, M., Arthur, J.M. (2016). Environmental management of boating related impacts by commercial fishing, sailing and diving tour boat operators in Australia. *Journal of Cleaner Production*, 111(B), 383–398.
- Cappanera, V., Venturini, S., Campodonico, P., Blini, V., Ortenzi, C. (2012). Valutazione dell'impatto antropico legato alle attività svolte nell'Area Marina Protetta Portofino. Le attività di fruizione 2010-2011 . Portofino: Portofino AMP.
- Cerrano, C., Milanese, M., Ponti, M. (2016). Diving for science – science for diving: Volunteer scuba divers support science and conservation in the Mediterranean Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 27(2), 303–323.
- Cohen, S., Higham, J., Peeters, P., Gössling, S. (Eds.). (2014). *Understanding and governing sustainable tourism mobility: Psychological and behavioural approaches*. Oxon: Routledge.
- De Groot, J., Bush, S.R. (2010). The potential for dive tourism led entrepreneurial marine protected areas in Curacao. *Marine Policy*, 34, 1051–1059.
- Dearden, P., Bennett, M., Rollins, R. (2007). Perceptions of diving impacts and implications for reef conservation. *Coastal Management*, 35, 305–317.
- Denny, M. (2014, October 8). Reuse, recycle used scuba diving gear. Retrieved 10 January 2017 from <http://www2.padi.com/blog/2014/10/08/reuse-recycle-used-scuba-diving-gear/>
- Dimmock, K., Cummins, T., Musa, G. (2013). The business of scuba diving tourism. In G. Musa, K. Dimmock (Eds.), *Scuba diving tourism* (pp. 161–174). Oxon: Routledge.
- Dimmock, K., Musa, G. (2015). Scuba diving tourism system: A framework for collaborative management and sustainability. *Marine Policy*, 54, 52–58.
- Foa, E.B., Foa, U.G. (2012). Resource theory of social exchange. In K. Törnblom, A. Kazemi (Eds.), *Handbook of Social Resource Theory* (pp. 161–174). New York: Springer.
- Frey, N., George, R. (2010). Responsible tourism management: The missing link between business owners' attitudes and behaviour in the Cape Town tourism industry. *Tourism Management*, 31(5), 621–628.
- Garrod, B., Gössling, S. (Eds.). (2008). *New frontiers in marine tourism: Diving experiences, sustainability, management*. Amsterdam: Elsevier.
- GlobeNewswire Inc. (2016, July 7). Global scuba diving equipment market 2016-2020 with American Underwater Products, Aqua Lung International, Johnson Outdoors, Mares Sherwood Scuba dominating. Retrieved 11 January 2017 from <https://globenewswire.com/news-release/2016/07/07/854233/0/en/Global-Scuba-Diving-Equipment-Market-2016-2020-with-American-Underwater-Products-Aqua-Lung-International-Johnson-Outdoors-Mares-Sherwood-Scuba-Dominating.html>
- Gonçalves, P.M.B. (2015). Communication N/ref: 0019/RMPPO/2015, 11 May 2015. República de Moçambique: Ministério do Turismo, Administração Nacional das Áreas de Conservação, Reserva Marinha Parcial da Ponta Do Ouro.
- Gössling, S., Buckley, R. (2016). Carbon labels in tourism: Persuasive communication? *Journal of Cleaner Production*, 111, 358–369.

- Gössling, S., Peeters, P. (2015). Assessing tourism 's global environmental impact 1900-2050. *Journal of Sustainable Tourism*, 23(5), 639–659.
- Haddock-Fraser, J., Hampton, M.P. (2012). Multistakeholder values on the sustainability of dive tourism: Case studies of Sipadan and Perhentian islands, Malaysia. *Tourism Analysis*, 17, 27–41.
- Hammerton, Z., Bucher, D. (2015). Levels of intervention – reducing SCUBA-diver impact within subtropical marine protected areas. *Journal of Ecotourism*, 14, 3–20.
- Hunt, C.V., Harvey, J.J., Miller, A., Johnson, V., Phongsuwan, N. (2013). The Green Fins approach for monitoring and promoting environmentally sustainable scuba diving operations in South East Asia. *Ocean and Coastal Management*, 78, 35–44.
- Joubert, E. C., Hess, S., Van Niekerk, J.L. (2016). Large-scale solar heating in South Africa: Status, barriers and recommendations. *Renewable Energy*, 97, 809–822.
- Jury, M.R., Cuamba, P., Rubuluza, P. (2011). Development strategies for a coastal resort in Southern Mozambique. *African Journal of Business Management*, 5(2), 481–504.
- Lamb, J.B., True, J.D., Piromvaragorn, S., Willis, B.L. (2014). Scuba diving damage and intensity of tourist activities increases coral disease prevalence. *Biological Conservation*, 178, 88–96.
- Lee, S., Oh, H. (2014). Effective communication strategies for hotel guests' green behavior. *Cornell Hospitality Quarterly*, 55(1), 52–63.
- Leslie, D. (2015). Resource management and operational practices – Environmental management systems. In D. Leslie (Ed.), *Tourism enterprise: Developments, management and sustainability* (p. 85). Wallingford: CABI.
- Levante News. (2016, October 7). Pannelli solari: Contributi della Regione a 8 Comuni levantini. Retrieved 13 January 2017 from <http://www.levantenews.it/index.php/2016/10/07/pannelli-solari-contributi-della-regione-8-comuni-levantini/>
- Lindgren, A., Palmlund, J., Wate, I., Gössling, S. (2008). Environmental management and education: The case study of PADI. In B. Garrod, S. Gössling (Eds.), *New frontiers in marine tourism: Diving experiences, sustainability, management* (115–138). Amsterdam: Elsevier.
- Lucrezi, S., Milanese, M., Markantonatou, V., Cerrano, C., Sarà, A., Palma, M., Saayman, M. (2017). Scuba diving tourism systems and sustainability: Perceptions by the scuba diving industry in two Marine Protected Areas. *Tourism Management*, 59, 385–403.
- Lucrezi, S., Saayman, M., Van der Merwe, P. (2013). Managing diving impacts on reef ecosystems: Analysis of putative influences of motivations, marine life preferences and experience on divers' environmental perceptions . *Ocean and Coastal Management*, 76, 52–63.
- Lucrezi, S., van der Walt, M.F. (2016). Beachgoers' perceptions of sandy beach conditions: Demographic and attitudinal influences, and the implications for beach ecosystem management. *Journal of Coastal Conservation*, 20, 81–96.
- Macau Daily Times (2017, January 11). Mozambique – Prices one quarter higher in 2016. Retrieved 12 January 2017 from <http://macaudailytimes.com.mo/mozambique-prices-one-quarter-higher-2016.html>
- Migiro, K. (2016, November 1). Drought-hit Mozambique signs first major solar power deal. Reuters. Retrieved 20 January 2017 from <http://www.reuters.com/article/us-mozambique-power-idUSKBN12X01G>
- Moecke, E.H.S., Feller, R., dos Santos, H.A., de Madeiros Machado, M., Cubas, A.L.V., de Aguiar Dutra, A.R., Santos, L.L.V., Soares, S.R. (2016). Biodiesel production from waste cooking oil for

- use as fuel in artisanal fishing boats: Integrating environmental, economic and social aspects. *Journal of Cleaner Production*, 135, 679–688.
- Morton, B. (2014, January 15). Neoprene reborn: Five ways to recycle your wetsuit. *SportDiver*. Retrieved 10 January 2017 from <http://www.sportdiver.com/article/news/neoprene-reborn-five-ways-to-recycle-your-wetsuit>
- Musa, G. (2002). Sipadan: A SCUBA-diving paradise: an analysis of tourism impact, diver satisfaction and tourism management. *Tourism Geographies*, 4(2), 195–209.
- Musa, G., Dimmock, K. (Eds.). (2013). *Scuba diving tourism*. Oxon: Routledge.
- Musa, G., Kadir, S.L.S.A., Lee, L. (2006). Layang Layang: An empirical study on scuba divers' satisfaction. *Tourism in Marine Environments*, 2, 89–102.
- PADI. (2016). *Worldwide Corporate Statistics 2016*. Data for 2010–2015. Retrieved 20 November 2016 from [https://www.padi.com/sites/default/files/documents/about-padi/statistics/PADI](https://www.padi.com/sites/default/files/documents/about-padi/statistics/PADI%2016%20WW%20Statistics.pdf) 2016 WW Statistics.pdf
- Petrosillo, I., Zurlini, G., Corlianò, M.E., Zaccar elli, N., Dadamo, M. (2007). Tourist perception of recreational environment and management in a marine protected area. *Landscape and Urban Planning*, 79, 29–37.
- Piloto-Rodríguez, R., Sánchez-Borroto, Y., Melo-Espinosa, E.A., Verhelst, S. (2017). Assessment of diesel engine performance when fueled with biodiesel from algae and microalgae: An overview. *Renewable and Sustainable Energy Reviews*, 69, 833–842.
- Power, M., Newell, P., Baker, L., Bulkeley, H., Kirshner, J., Smith, A. (2016). The political economy of energy transitions in Mozambique and South Africa: The role of the Rising Powers. *Energy Research and Social Science*, 17, 10–19.
- Project AWARE. (2016). Pledge to follow Project AWARE's 10 Tips to Divers to Protect the Ocean Planet. Retrieved 25 January 2017 from <http://www.projectaware.org/action/pledge-follow-project-awares-10-tips-divers-protect-ocean-planet>
- Richardson, V. (2009). Recycling your old dive equipment: For divers with worn-out gear, it's not easy being green. *Undercurrent*, 24(8), 9–10. Retrieved 10 January 2017 from <http://www.undercurrent.org/UCnow/issues/y2009/UC0809/undercurrent200908.pdf>
- Roche, R.C., Harvey, C.V., Harvey, J.J., Kavanagh, A.P., McDonald, M., Stein-Rostaing, V.R., Turner, J.R. (2016). Recreational diving impacts on coral reefs and the adoption of environmentally responsible practices within the SCUBA diving industry. *Environmental Management*, 58(1), 107–116.
- Rossellini, S. (2016, July 2). Santa Margherita nuovo paradiso delle auto elettriche. *Il Secolo XIX*. Retrieved 16 January 2017 from [http://www.ilsecoloxix.it/p/levante/2016/07/02/AScqGyLD-paradiso margherita elettriche.shtml](http://www.ilsecoloxix.it/p/levante/2016/07/02/AScqGyLD-paradiso%20margherita%20elettriche.shtml)
- Rouphael, A.B., Inglis, G.J. (2001). Take only photographs and leave only footprints? An experimental study of the impacts of underwater photographers on coral reef dive sites. *Biological Conservation*, 100, 281–287.
- Rutty, M., Gössling, S., Scott, D., Hall, C.M. (2015). The global effects of tourism: An overview. In C.M. Hall, S. Gössling, D. Scott (Eds.), *The Routledge Handbook of Tourism and Sustainability* (36–64). Oxon, New York: Routledge.
- Scott, D., Gössling, S., Hall, C.M., Peeters, P. (2016). Can tourism be part of the decarbonized global economy? The costs and risks of alternate carbon reduction policy pathways. *Journal of Sustainable Tourism*, 24(1), 52–72.

- Speranza, R. (2016). Auto elettriche, pro e contro: Prezzi alti, ma il problema è sempre l'autonomia. AllaGuida. Retrieved 16 January 2017 from <http://www.allaguida.it/articolo/auto-elettriche-pro-e-contro-prezzi-alti-ma-il-problema-e-sempre-l-autonomia/122395/>
- Terrón-Sigler, A., León-Muez, D., Peñalver-Duque, P. (2016). The effects of SCUBA diving on the endemic Mediterranean coral *Astroides calycularis*. *Ocean and Coastal Management*, 122, 1–8.
- Tigullio News. (2013, February 22). Impianti fotovoltaici ed energie rinnovabili: Procedure più snelle. Retrieved 13 January 2017 from <http://www.tigullionews.com/impianti-fotovoltaici-ed-energie-rinnovabili-procedure-piu-snelle-in-liguria/>
- Townsend, C. (2008). Dive tourism, sustainable tourism and social responsibility: A growing agenda. In B. Garrod, S. Gössling (Eds.), *New frontiers in marine tourism: Diving experiences, sustainability, management* (139–152). Amsterdam: Elsevier.
- Truong, V.D., Hall, C.M. (2016). Corporate social marketing in tourism: To sleep or not to sleep with the enemy? *Journal of Sustainable Tourism*, doi:10.1080/09669582.2016.1201093
- United Nations Environment Programme (UNEP) (2015). The 10YFP Programme on Sustainable Tourism. Retrieved 31 January 2017 from <http://web.unep.org/10yfp/programmes/sustainable-tourism-programme>
- Villarino, J., Font, X. (2015). Sustainability marketing myopia: The lack of sustainability communication persuasiveness. *Journal of Vacation Marketing*, 21(4), 326–335.
- Winkler, B., Lemke, S., Ritter, S., Lewandowski, I. (2016). Integrated assessment of renewable energy potential: Approach and application in rural South Africa. *Environmental Innovation and Societal Transitions*, in press. doi:10.1016/j.eist.2016.10.002
- Wongthong, P., Harvey, N. (2014). Integrated coastal management and sustainable tourism: A case study of the reef-based SCUBA dive industry from Thailand. *Ocean and Coastal Management*, 95, 138–146.
- Worachananant, S., Carter, R.W., Hockings, M., Reopanichkul, P. (2008). Managing the impacts of SCUBA divers on Thailand's coral reefs. *Journal of Sustainable Tourism*, 16, 645–663.
- Yin, R. (2011). *Qualitative research from start to finish*. New York: The Guilford Press.

Figure 1. Map of the study areas, including Ponta do Ouro (PPMR, Mozambique) and Portofino MPA, Italy. Credits: M. Palma.

Basemap: OpenStreetMap contributors and the GIS user community

ENERGY AND RESOURCES A THE DIVE CENTRE

1. How would you define a resource?
2. What are to you the key resources necessary for the survival of your business?
3. How many boat launches per week do you count on average during the busy season and the quiet season?
4. Are your boats normally full when you launch, and do you help/get help from other dive centres to fill up boats?
5. What is the average distance you cover in km to travel to a dive site on a dive trip?
6. Describe/list the infrastructures (e.g. showers), motorised vehicles (e.g. van, vessel) and motorised/electric appliances (e.g. fridge, air compressor) that you own and/or use for your dive centre.
7. Can you describe in detail your vessels, with particular reference to the engine type, consumption (fuel), maintenance (e.g. painting, how often it is services), where they are normally kept, costs related to keeping them (e.g. council taxes), and problems normally encountered when using them (e.g. leakages).
8. How much do you normally pay, on average, in electricity, water, gas, fuel, and garbage/waste disposal per month for your dive centre during the busy season and during the quiet season?
9. Do you make use of renewable energy at the dive centre and/or at home? If so, how?
10. Do you recycle at the dive centre and/or at home? If so, how?
11. How do you dispose of toxic waste (e.g. torch batteries, electronic waste such as dive computers) and what do you do with flooded electronic equipment?
12. What is the type and amount of scuba equipment that you normally discard and/or recycle?
13. How do you normally get to and from work (e.g. by car, scooter) and how far do you travel (km)?
14. Do you promote sustainable resource use among your staff and clients, whether or not your dive centre can embrace this philosophy? Please elaborate on your response.
15. What makes it difficult for you to run a dive centre that implements and promotes sustainable resource use?
16. What would encourage you to run your dive centre using resources in a more sustainable manner?
17. Do you have any comments and/or recommendations regarding this interview? Anything we have not considered and that is important to you?

Table 1

Relevant policies and plans in relation to the use of resources and to the general operations by the scuba diving tourism sector at the case studies.

Category	Ponta do Ouro, PPMR	Source	Portofino MPA	Source
Marine Protected Area	Management Plan and policies therein	http://www.pontainfo.com/Resource_centre.html	Management Plan and policies therein	http://www.portofinoamp.it/it/chi-siamo/statuto.html
National, Tourism	Mozambique Tourism Policy	http://www.acismoz.com/lib/services/translations/Trans%20Tourism%20policy%202003.pdf	Strategic Plan for Tourism Development in Italy 2017-2022	https://www.senato.it/service/PDF/PDFServer/BGT/01000578.pdf
National, Tourism	Mozambique Tourism Law	http://www.acismoz.com/lib/services/translations/Trans%20Tourism%20Law%204-04%20of%2017%20July.pdf		
National, Conservation	Conservation and Development in Mozambique	http://pubdocs.worldbank.org/en/199741449520242770/Conservation-and-Development-in-Mozambique-TFCA-2015.pdf	ISPRA Report on Sustainable and Renewable Energy	http://www.isprambiente.gov.it/content/00003400/3498-gravina.zip/at_download/file
National, Energy	Mozambique Energy Sector Policy Note	http://documents.worldbank.org/curated/en/135711468180536987/ACS17091-REVISED-PUBLIC-Mozambique-Energy-Sector-Policy-Note.pdf		

Regional, Environment			Environment and Energy	http:// www.comune.genov a.it/sites/def ault/files/DEF/1_DF/ 1_02_doc.pdf
Municipal, Waste	Review Municipal Solid Waste Sector Mozambique	http:// www.associacao- mocambicana- reciclagem.org/ sites/default/files /resources/ A%20Comprehens iv e%20Review%20o f%20the%20 Waste%20Sector% 20in%20Mo zambique.pdf	Santa Green	https://santagreen.it/

Table 2

Profile of the interviewees and basic characteristics of firm sizes of the dive centres at the case study locations.

	Ponta do Ouro, PPMR	Portofino MPA
Nationality	Mostly South African	Mostly Italian
Gender	Male and female in similar proportion	Mostly male
Marital status	Married / single	Single / divorced
Age	30s (25-50)	40s (33-65)
Education	High school diploma or equivalent (two graduates)	High school diploma or equivalent (one graduate and one PhD)
Status in business	Owner / manager / CEO / instructor / guide	Owner / manager / CEO / instructor / guide
Years in industry	7-19 (average = 11)	4-43 (average = 18.5)
Business lifespan	6-22 years (average = 12)	1-21 years (average = 11)
Fleet (vessels)	1-2	1-3
Staff in season	5-17 (average = 10)	3-6 (average = 5)
Peak diving season	Dec, Jan, Mar, Apr	Jun-Sep
Additional activities	Accommodation, food, beverage, repairs, research, volunteering, retail	Repairs, research, informatics, school teaching, marketing, retail
Productivity 2010-2014 (dives)	Low in 2010-2011; growth by 50% in 2012-2013, decline by 20% in 2014-2015, growth by 10% in 2016	General decline until 2014, then growth starting from 2014

Summary of key differences in firm characteristics of the dive centres with respect to resource use at the case study locations.

Ponta do Ouro,
PPMR

1	177-439 (fuel not specified)	N	N, fins, masks, flooded electronic equipment to South Africa	Car 2 km, staff walk	N	No availability / better prices
2	--	N	Compost, reusing plastic containers for food, fins donates	Car 2 km	Sustainable seafood, recycling, reusing plastic bags among clients	No availability / availability, subsidies
3	91 (fuel not specified)	N	Compost, home recycling, toxic waste buried, neoprene used as patching material	Car or quad bike 1 km, staff walk	Marine reserve, collecting lollipop papers after dive among clients	No government support / better prices, better logistics at the border
4	--	Roof hoses, water filter	Compost, batteries to South Africa	Live at centre	Conservative water use among staff	No local awareness, no system in place / education
5	108-346 (fuel 23-92 per launch)	Roof hoses	Compost	Live at centre	Buying local food products among clients	Costs / fair trade
6	139 (fuel 25-48 per launch)	N	N	Car, quad bike or walk 60 m	Collecting lollipop papers after dive among clients	Costs / better prices
7		N (solar panels at home)			Preventing oil spills among staff, collecting lollipop papers after dive among clients	Logistics, costs / better logistics
Portofino MPA	460-2,770 (including fuel)***	10%	N, flooded electronic equipment to South Africa, oil sent to Maputo, old equipment kept in storage	Car 0.8 km		
1				Scooter 4 km		
2	623 (fuel 22 per launch)	N	At home, toxic waste to collection centre	Foot or scooter 4 km		
3	Fuel 20 per launch	N	Paper, glass, plastic grinder, oil to fishing vessels, batteries back to wholesalers	Car 6 km	Car pooling	No availability, costs / better prices, better logistics
	350 (fuel 20 per		Paper, plastic, home		--	
					Marine reserve	

	launch)		recycling, flooded electronic equipment back to wholesalers			incentives, dissemination on technology
4	175-290 (fuel 30 per launch)	N	Plastic	Foot or scooter 2 km	Marine reserve	Logistics / better logistics, incentives
5	234-585 (fuel not specified)	N	Plastic, home recycling, flooded electronic equipment and batteries back to wholesalers or	Scooter 2 km	N	No incentives, logistics / lower taxation, subsidies
6	150 (fuel not specified)	Electric vehicle, thermostatic valves	mechanics, oil to the docks Plastic, paper, glass, flooded electronic equipment to collection centre	Foot or motorbike 1 km	Bottle recycling	Logistics, no government support / support from council
7	450-820	N	Plastic, paper, glass, batteries recycled, oil to the docks	Foot 0.2 km	Marine reserve	No incentives / funding allocation
8	--	Electric vehicle	Plastic, paper, glass, toxic waste to collection centre at the port	Scooter or electric vehicle 6.5 km, train 15 km	N	No technology, logistics / initiative

*Some accommodation utilities included

** Electric vehicle or trolley replacing vehicle

*** May have included costs related to fishing charters