

*Social and recreational value of waves: application of the
Zonal Travel Cost Method with surfers from Icaraí beach
(Caucaia, Ceará, Brazil)*

*Valor social e recreativo das ondas: aplicação do Método
Custo de Viagem Zonal com surfistas da praia do Icaraí
(Caucaia, Ceará, Brasil)*

*Valor social y recreativo de las olas: aplicación del Método
Costo de Viaje Zonal con surfistas de la playa de Icaraí
(Caucaia, Ceará, Brasil)*

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Abstract

This article presents the results of an analysis of the social and recreational value of waves at Icaraí Beach, located in Caucaia municipality, Ceará, Northeast Brazil. The evaluation of the wave resource followed the Zonal Travel Cost Method, a fundamental tool for obtaining economic estimates of ecosystem services that are not subject to market forces. The method provides a valuation of unique abiotic resources that underpin tourism, sporting and recreational economies. For data collection, 50 questionnaires with open and closed questions were administered from February to July 2019 to a specific audience, the local surfers. The social value of Icaraí's surf break is strongly related to the surfers' familiarity with the beach, as well as in the perception of the wave resource as a profitable attraction for the local economy. It is estimated that the economic benefit of the surf break at Icaraí Beach is US\$ 288,364 per annum, which is spent by 1,185 surfers, averaging US\$ 1.37 for each surf trip. In summary, the values reflect economic benefits for the municipality of Caucaia and can assist decision-making processes, contributing to the protection and maintenance of the beach by incorporating wave resources into an effective coastal management strategy.

Keywords: Value of waves. Surfers. Surfing. Cost of Travel Method. Coastal Management.

Resumo

Este artigo apresenta os resultados de uma análise do valor social e recreativo das ondas da Praia de Icaraí, localizada no município de Caucaia, Ceará, Nordeste do Brasil. A avaliação do recurso das ondas seguiu o Método do Custo de Viagem Zonal, uma ferramenta fundamental para obter estimativas econômicas de serviços ecossistêmicos que não estão sujeitos às forças de mercado. O método fornece uma avaliação de recursos abióticos únicos que sustentam as economias de turismo, esporte e recreação. Para a coleta de dados, 50 questionários com questões abertas e fechadas foram aplicados de fevereiro a julho de 2019 a um público específico, os surfistas locais. O valor social do pico de Surf de Icaraí está fortemente relacionado à familiaridade dos surfistas com a praia, bem como na percepção do recurso das ondas como atrativo lucrativo para a economia local. Estima-se que o benefício econômico do surf na Praia de Icaraí seja de US\$ 288.364 por ano, gasto por 1.185 surfistas, com uma média de US\$ 1,37 para cada viagem de surf. Em síntese, os valores refletem benefícios econômicos para o município de Caucaia e podem auxiliar nos processos de tomada de decisão, contribuindo para a proteção e manutenção da praia ao incorporar os recursos das ondas em uma estratégia eficaz de gestão costeira.

Palavras-chave: Valor das ondas. Surfistas. Surf. Método de Custo de Viagem. Gerenciamento Costeiro.

Resumen

Este artículo presenta los resultados de un análisis del valor social y recreativo de las olas en la playa Icaraí, ubicada en el municipio de Caucaia, Ceará, noreste de Brasil. La evaluación del recurso de las olas siguió el Método de Costo de Viaje Zonal, una herramienta fundamental para obtener estimaciones económicas de los servicios ecossistémicos que no están sujetos a las fuerzas del mercado. El método proporciona una valoración de recursos abióticos únicos que sustentan las economías turísticas, deportivas y recreativas. Para la recolección de datos, se administraron 50 cuestionarios con preguntas abiertas y cerradas de febrero a julio de 2019 a una audiencia específica, los navegantes locales. El valor social del pico surf Icaraí está fuertemente relacionado con la familiaridad de los surfistas con la playa, así como con la percepción del recurso de las olas como un atractivo rentable para la economía local. Se estima que el beneficio económico del surf en la playa de Icaraí es de US\$ 288,364 por año, el cual es gastado por 1,185 surfistas, con un promedio de US\$ 1,37 por cada viaje de surf. En resumen, los valores reflejan beneficios económicos para el municipio de Caucaia y pueden ayudar en los procesos de toma de decisiones, contribuyendo a la protección y mantenimiento de la playa al incorporar los recursos de las olas en una estrategia efectiva de manejo costero.

Palabras clave: Valor de las olas. Surfistas. Surf. Método de costo de viaje. Manejo costero.

Introduction

The biosphere is formed by a set of ecosystems that directly or indirectly provide various ecosystem services that are reflected in the well-being of society. Some of these services can be valued with ease, when they are in directly or indirectly related to the market system (e.g., fossil fuels, minerals and food production). However, other services, because they do not carry a market price, are extremely difficult to measure monetarily, especially when taking traditional economic theory into account (PEARCE, 1993).

According to Coffman and Burnett (2009), the difficulties encountered in the valuation of some ecosystem services and environmental amenities stem from the fact that the markets are notoriously limited in their scope and fail to adequately value the environments. Randall (1987) argues that the difficulty is linked to the market's incapacity to deal with environmental resources that constitute a public good, with free access and undefined property rights. Such characteristics mean that the market is inefficient and operates with failures, especially when it comes to the economic benefits generated by the environment.

With the absence of a real market that serves as a parameter, the determination of a "value" or "price" for certain services is complex. The values of environmental resources need to be quantified using methods other than those used in the conventional market. These methods, more specifically, seek to measure individual preferences for a resource, or environmental service. In this way, it is not an environmental asset that is assigned a value, but rather, people's preferences when the quality or quantity of the environmental resource changes. The economic value of environmental amenities is assessed based on the observation of their attributes by individuals (Abreu et al., 2006). In fact, the benefits arising from natural, cultural, historical and recreational resources create an awareness among their users of the cost that they have to bear to maintain and conserve them in an equitable way (PORTUGAL JÚNIOR, PORTUGAL and ABREU, 2012).

Thus, the moment an ecosystem benefit or service contributes to the goals and/or satisfaction of an individual or group (economic agent), it starts to gain value (GUEDES and SEEHUSEN, 2012). With regard to environmental economic theory, the value of a resource is classified into use value (UV) and non-use value (NUV), so that the use value is divided into direct use value, indirect use value and option value (ABREU et al., 2006; TURPIE et al, 2014; EMERTO, 2016).

Direct use values are those that agents directly benefit from, such as logging, fishing or scenic beauty services for tourist and recreational activities. Indirect use value, on the other hand, is associated with ecological functions that indirectly benefit society, for example, climate regulation, carbon storage and the hydrological cycle. Option value is associated with the values that individuals are willing to pay for the preservation of certain resources, with a view to future use, such as forests.

Non-use (or existence) values are those that are measured by the satisfaction of individuals when they know that certain environmental resources are available, but with no intention of benefiting from their use. For example, international support for projects and NGOs that aim to preserve animal species in danger of extinction (MOTTA, 1998; LEWIS and TIETENBERG, 2019). Numerous ecosystems are endowed with high economic value, as is the case of the coastal zone and its set of natural systems (e.g., beaches, dunes and cliffs), which attracts entrepreneurs and developers to invest in coastal development, particularly tourism.

Defeo et al. (2009) state that beaches are among the coastal systems of greatest value to society, given their intense and sustained use for recreational and leisure purposes. In this environment, numerous activities have developed around particular coastal processes, as is the case of surfing. Surf breaks constitute a wave abiotic resource that has value for those who use it. Waves are disturbances created, in most cases, by the action of the winds on the sea surface (LOSASA et al., 1992; BUTT, 2010), however their origin can also be associated with meteorological events, as in the case storms and hurricanes, and seismic events (geophysical and geological) that cause vertical displacement of water in coastal and oceanic regions (ANTUNES DO CARMO, 2005; OLEINIK et al., 2016). The waves are, therefore, a complex mixture of meteorological and geological variables (SILVA and FERREIRA, 2014).

The physical origin of the waves is important, but this only partially determines the type of wave that develops in a given place. The type of surf break that a beach presents, and the experience that this will provide the surfer gliding over its face, is defined by the wave's surfability (PATTIARATCHI et al., 1999). Studies by Hutt et al., (2001), Bancroft (1999), and Dafferner (2002) indicate that the conditions for recreational surfing in a region are influenced by factors such as the length of the wave break, the surfer's speed, the variability of the shelf angle and the distribution of wave height. Therefore, there are a set of factors that determine the value of waves for surfers.

The value of the waves goes beyond its physical characteristics, being a provider of environmental, social and economic services. Many recreational activities have developed around waves as a source of impetus, as is the case of surfing, which was once widely criticized by society but in recent decades has become popular and commercially profitable for large corporations (LANAGAN, 2002; BOOTH, 2005; MOURA, 2017). Thus, the waves are the main driver of the economic activity associated with surfing, while the surfer and supporters of this leisure activity are consumers of a culture that involves various economic sectors.

Regular surfers, in addition to being part of the public that frequents the beaches widely, perceive the natural physical environment differently from other users and, in doing so, add value to wave resources. Diehm and Armatas (2004) show that the existence of a surfable waves attracts a surfing community who actively promote local development, adding social and economic value. Thus, this study aims to measure the socioeconomic value of the abiotic resource of waves at Icaraí Beach (Ceará, Brazil) for practitioners of leisure surfing. Few previous studies have attempted to estimate the value of surfing in Brazil, constituting a knowledge gap in socio-economic research. Icaraí Beach is a favourite surf spot in Ceará, with good waves all year and proximity to the city of Fortaleza, which facilitates its access by surfers.

Data sources and methods

Study area

The perception of surfers of the coast of Caucaia, specifically Icaraí Beach, was evaluated as an initial landmark for understanding the affective and monetary pricing associated with surfable waves. Icaraí Beach, in the municipality of Caucaia-CE, sits within the metropolitan area of Fortaleza - RMF (Figure 1) and is located approximately 20 km from the center of the capital. The Icaraí shoreline is approximately 4 km long, with cliff areas, coastal dunes and coastal containment works along its coastal stretch and is characterized by its highly urbanized coastal front. Since the middle of the 20th century, the beaches of the municipality of Caucaia, mainly Icaraí, have been directly influenced by the urban and economic growth of the capital, which has resulted in significant seaside resort facilities for the leisure and recreation (including surfing) of residents of Fortaleza and the municipality itself. Paula (2015) documented the intense evolution of the coastal stretch of Icaraí over the past four decades, with major changes related to tourism development (developed between the 1970s and 1980s), and coastal erosion that has continually destroyed property and infrastructure between the 1990s and 2000s.

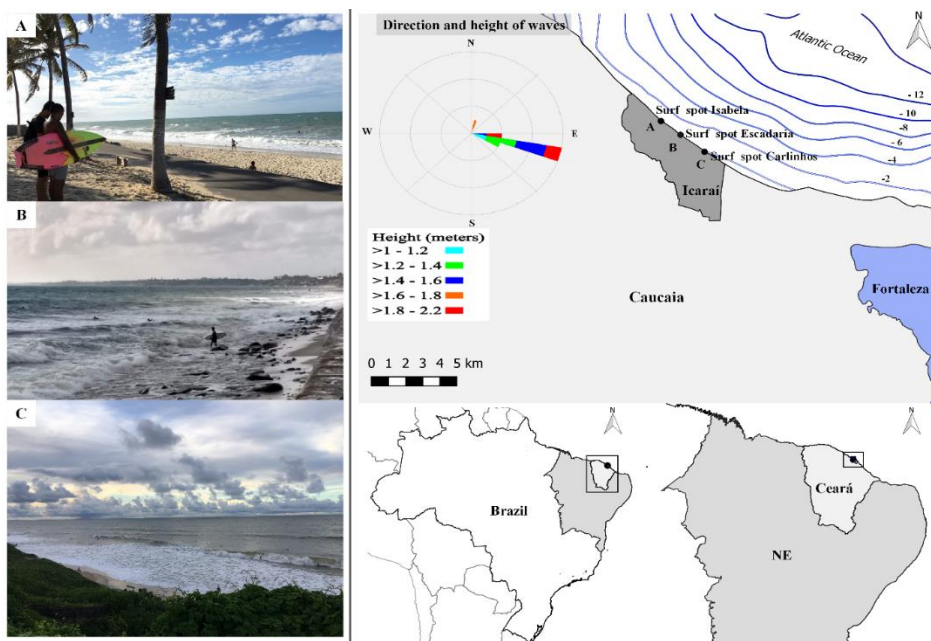


Figure 1: Location map of Icaraí beach, Caucaia – CE, NE Brazil.

From a recreational point of view, Icaraí Beach has great potential. With its strategic position, tourists, visitors, and industry workers (mainly from the Pecém port complex) find the Caucaia coast amenable to housing and tourist activities, recreation and water sports (DANTAS et al., 2008). However, active erosive processes have resulted in

an intense loss of environmental quality. Farias and Maia (2010) found a reduction of 300 meters of beach strip with the retreat of the coastline at a rate of -3.3 m/year. They characterise this beach as an area of high vulnerability to marine erosion (FARIAS and MAIA, 2010). This loss of beach strip coupled with the degradation of neighboring infrastructure, places additional pressure on the beach from recreational activities (promenades, sea bathing) and the development of surf.

Perception of the social value of waves

The methodology used to assess the social value of waves was based on the application of a questionnaire-based data collection instrument. Fernandes et al. (2004) highlight that questionnaires are powerful instruments for the social investigation of a fact or phenomenon. The elaborated form was of the mixed type, with open and closed questions, as this procedure allows a combination of quantitative and qualitative techniques, which, according to Creswell and Plano Clark (2011), provide better analytical combinations. The collection instrument was divided into four thematic sections (1 - Surfer profile, 2 - Use and knowledge of the surfing site, 3 - Understanding coastal impacts, and 4 - Social and economic value of the waves) and organized with the aid of a word processor. Printed forms were used because of the environmental conditions of the application site (at the beach) and the security risk surrounding technological tools (e.g., tablets, smartphones and others).

Before the actual application of the instrument, in January 2019, there were two pre-test rounds, with 20 questionnaires administered to surfers from the region. The pre-test was important to ensure the adequacy of the instrument and to observe time required for completion. After this phase, the instrument underwent modifications and was consolidated with four thematic sections and 38 questions distributed among these. The questions on the form are intended to determine the profile of the surfers, their knowledge of the conditions of the environment in which they practice the surf and any expenses incurred.

In the post-test application of the instrument, which occurred during the best season for surfing (February and July) 2019, 50 forms were administered. All forms were filled out by the researchers, as the survey took place right after the surfer left the sea, thus avoiding contaminating the sample population with another type of beach user. The instrument application team was composed of four researchers who worked at different times, as the peak of surfability varies based on the conditions of sea agitation (e.g., waves, tides and wind).

The determination of the sample universe of this research is complex, as there are different users of the beach, such as bathers and kitesurfers. However, our target audience is specific, composed exclusively of surfers who practice their recreational activity on the beach of Icaraí (Caucaia), resulting in a case study. The number of respondents is essentially random, since there are no data on total surfer numbers to determine a representative sample. To mitigate any temporal inconsistency, 10 visits were made at alternate periods and times over the 6 months of research to apply the data collection

instrument. After receiving the forms answered by the surfers, the information was organized and tabulated in electronic spreadsheets. Descriptive statistics were performed in R programming language (R Core Team, 2020), allowing a simple or multivariate analysis depending on the question under analysis. As for calculations of more complex equations and analyses, the Repl.it platform was used, in Python language (Python Software Foundation, 2020).

Economic value of the waves

The economic value of the waves abiotic resource, submitted to market logic, was calculated using the zonal travel cost method (ZTCM). This has been one of the most widely used methodologies in economic valuation studies based on ecosystem services, particularly recreation related to the natural environment (COFFMAN and BURNETT, 2009). According to King et al. (2000), the method estimates the economic values of direct and indirect use, having as a basic premise the cost of time and travel that an individual spends to enjoy, for example, a non-material benefit. In the case of this study, the target natural resource is the waves for surfing. The waves can be represented economically by the “price” or “value” that it costs to access this non-material good.

The ZTCM has been widely used to measure the economic value of access to different recreational forms. Its application in determining the social and economic value of the waves has already appeared in some studies, notably those carried out by Murphy and Bernal (2008) for Mundaka - Spain; Coffman and Burnett, (2009) in California - USA; Silva and Ferreira (2014) for Costa da Caparica - Portugal; Eberlein on the beaches of Matosinhos - Portugal; Zhang et al. (2015) on the Gold Coast - Australia.

The economic value associated with natural wave resources was estimated based on the surfer's willingness to pay to practice the surf. Distance, direction and travel time are variables that directly affect recreational activity spending. Thus, based on the number of visits to the beach, it is possible to determine the demand curve and the cost of direct use. This information is important to build the demand function of the wave resource, providing an estimate of the consumer surplus and the economic benefits generated by the recreational services from the waves of Icaraí Beach (Figure 2). The demand function relates price (y) to quantity of visits (x), providing information on how many units of a good/service are purchased at different prices. In general, the highest prices are those that will be purchased least, which makes the function a graphical representation with a negative slope (SEBOLD and SILVA, 2004).

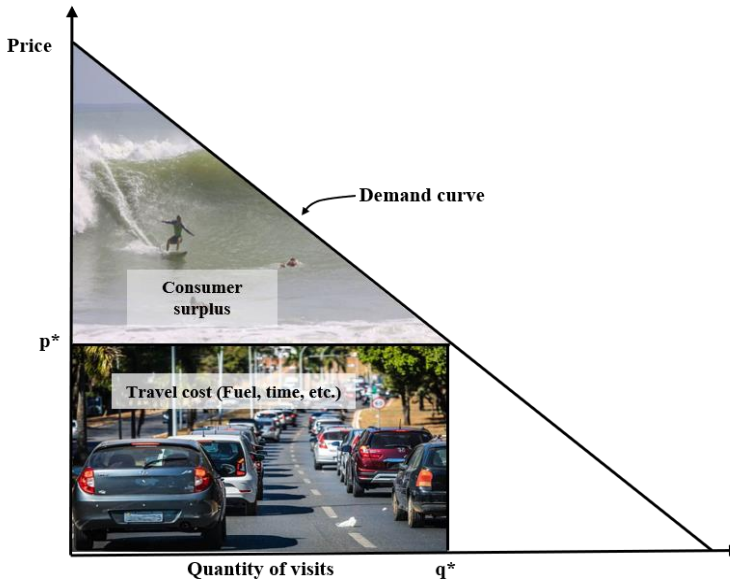


Figure 2: Demand function for wave resources.

The economic value of waves was determined by adapting the methods of Coffman and Burnett (2009) and Silva and Ferreira (2014). The first step consists of identifying the residential address of the interviewees and the frequency of visits, allowing the construction of a database in a GIS environment (Geographic Information System) and spatializing the information in a georeferenced cartographic base in Quantum GIS (QGIS). In this way, it is possible to establish zones and axes of displacement, establishing the distances and the time spent accessing the beach to practice surfing. Zones in this study refer to the surfers' neighborhoods.

The second stage calculates visitation rates per 1000 inhabitants in each area. According to King et al. (2000), the visitation rate by zone is the relationship between the number of respondents in the form and the total population by zone sampled. Population data by zone (or neighborhood) were obtained for the year 2019 from the online survey platform *Cidades* of the Brazilian Institute of Geography and Statistics (IBGE). The total economic value for each surf trip, was established based on the equation proposed by Coffman and Burnett (2009) and modified by Silva and Ferreira (2014). Equation (1), modified for the reality of Icaraí Beach, is composed of five variables, while the equation proposed by the above authors considers 6 variables. The variable not used concerns the costs of air travel, which was not applicable in our case.

$$TTC = TC_{PT} + TC_{PV} + tC * tT_{PT} + tC * tT_{PV} \quad (1)$$

Where: TTC is the total travel cost; TCPT – travel cost using public transport; TCPV - travel cost using private motorized vehicle; tC – time cost spent on the trip; tT_{PT}

- travel time using public transport; t_{TPV} - travel time using private motorized vehicle. Travel related to the cycling and pedestrian mode were not included in the equation, as no financial cost is associated with their use (SILVA and FERREIRA, 2014). Yet the municipality of Caucaia does not have a shared bicycle system, and bicycle rental is non-existent. It is important to note that the result of the equation represents costs associated with a one-way trip. Therefore, the results were doubled to obtain the round-trip cost.

The amount spent on public transport (PT) was determined from the price of the intercity public transport ticket that circulates in the Metropolitan Region of Fortaleza. According to the table of fares for metropolitan buses regulated by ARCE (Ceará State Regulatory Agency), the fare was US\$ 0.90 in April 2020. Spending on private motor vehicles (PV), depends on key variables that affect fuel consumption, such as the year of manufacture, model, weight, engine, type of technology and type of fuel, among others. Other key influences include direct expense, the distance to be covered, the type of ground cover, road traffic, the time of travel and the number of traffic lights, among others.

We adopted the compact category in our functions based on field surveys, which found a predominance of this type of vehicle, with engine size ranging from 1.0 liter (6 valve) to 1.8 liter (16 valve), either manual or automatic and running on gasoline. The average gasoline consumption/efficiency of light and compact motor vehicles is 12.2 km/l, according to the National Institute of Metrology, Quality and Technology (INMETRO). For motorcycle use, the reference calculation was based on the consumption of a motorcycle up to 160 ccs, with an average consumption of 37.1 km/l, according to the main manufacturers operating in the Brazilian market. The price of a liter of gasoline (US\$ 0.87) was based on National Petroleum Agency (ANP) values for February 2020 prior to the Coronavirus pandemic.

Distances traveled between origin and destination were calculated on the Google Maps platform, which allows to trace the fastest route to travel to the beach. The calculation of surfing's cost/hour was based on the minimum wage in Brazil in 2020 (US\$ 202.33). According to the rules of the CLT (Consolidation of Labor Laws) and maximum working day (220 hours/month), the daily rate is US\$ 6.74, and the hourly rate is US\$ 0.92.

The relationship between the visit rate and the total cost of travel was obtained through a linear regression analysis, in which the demand function is estimated. In this phase, it is also possible to insert other variables, such as age, demographics, income, sex and levels of education. However, we opted for a simplified analysis obtained by equation 2 (COFFMAN and BURNETT, 2009).

$$\text{Rate of visitors} = k_1 - \alpha * TTC \quad (2)$$

Where: k_1 corresponds to the constant derived from the regression analysis, also known as the y-intercept, since it represents the value of the adjusted line when crossing the y-axis; the second variable (α) sets up the regression coefficient of the analysis, in which it translates the average change in the dependent variable (y-axis) to a unit of change in the independent variable (x-axis); TTC is the total travel cost.

Having obtained these results, the next step consists of building a demand function for wave resources. According to Coffman and Burnett (2009), King et al. (2000) and Wright (2014), it must be assumed that the first point of the demand curve corresponds to the total annual visits to the resource, correlating with the current local access costs. In the case of our research, the number of annual visits among the 50 respondents were adopted. Other points of the demand curve are determined from estimated visitor numbers at different (hypothetical) visitation rates added to the calculation of the regression equation. Such increased amounts ranged between US\$ 0.97 and US\$ 3.88.

In estimating the total population of surfers who visit Icarai Beach annually, we adapted the equation proposed by Coffman and Burnett (2009), which calculated the population of visitors to the beach in Mavericks, California (USA). For the present research, other beach users were removed from the equation, the target audience being restricted to surfers.

Equation 3 was populated as indicated by Coffman and Burnett (2009), so that the calculation of the total surfer population (TS) was based on counting the number of surfers at all the surf spots on Icarai Beach. There was only one count per day, lasting two minutes and taking into account both surfers in the water and on the beach. The time variables incorporate 365 days (1 year) and 12 hours a day, since surfing at Icarai Beach is possible during all days of the year depending on wave conditions.

$$TS = \sum_{i=1\dots d} C/d * t_i * \sum_{i=1\dots d} \frac{S_i}{C/d} * days/year * hours/day \quad (3)$$

Where: TS = the total number of surfers; i is the counting day (the days when questionnaires were administered); d is the total number of counting days; t is the time spent counting in a day (in hours); C is the number of counts made per day and S is the number of surfers counted per day. Calculations were made using an online development platform through the browser, Repl.it. This tool is based on online IDE (integrated development environment) and supports more than 50 programming languages. Repl.it made it possible to write, using a Python programming language (Figure 3), an equation that calculates the total number of surfers, automating the process, without the need to install more complex software.

```

1      qtde_surfistas.append(int(input()))
2      print("Insira a quantidade de contagens por dia")
3      qtde_contagens = int(input())
4
5      print("Insira a quantidade total de dias de contagem:")
6      total_dias = int(input())
7
8      print("Insira o tempo de contagem por dia (em minutos):")
9      tempo_contagem = int(input()) / 60
10
11     print("")
12
13     qtde_surfistas = [ ]
14     for dia in range(total_dias):
15         print("insira o número de surfistas contados no dia",
16             dia + 1, ",")
17         qtde_surfistas.append(int(input()))
18
19     somatorio1 = 0
20     somatorio2 = 0
21     for dia in reange(total_dias):
22         somatorio1 += qtde_contagens / (total_dias *
23             tempo_contagem)
24         somatorio2 += qtde_surfistas[dia] / qtde_contagens /
25             total_dias
26
27     resultado = somatorio1 * somatorio2 * 365 / 365 * 12 / 24
28     print("")
29     print("o resultado final é:", resultado)
30
31
32

```

Figure 3: Python language equation for total surfers.

Results and Discussion

Surfer profile at Icarai Beach

Our study provides important insights into the profile of surfers at Icarai Beach. Of the 50 surfers interviewed, there was a predominance of male surfers (90%), confirming the results of Steinman (2000) for surfers all over Brazil, in which 95.3% of them were male. Pontes (2012), when researching the profile of surfers at Itamambuca Beach, São Paulo, observed that only 18.57% of the interviewees were female. The low percentage of female practitioners may be associated with social prejudices inherent in the practice of surfing in the first half of the 20th century, reflecting the late adherence of women to this leisure and recreation activity, along with gender bias in the early adoption of most sports (PONTES, 2012). In addition, the universe of surfing is commonly imagined as a masculine practice, linked to stereotypes of virility and courage that are conventionally attributed to men (CRUZ, 2012). This contributes to prejudices and a lack of support for the female public, as highlighted in an article published by the Convergent Journalism Laboratory through the Jornalismonic portal.

In Brazil, changes in social paradigms around surfing, especially of concepts and moral values, only emerged after the World Surfing Circuit came to Rio de Janeiro in 1976. This generated media visibility for the practice of the sport. Even among professional surfers, men outnumber women ten to one, according to the Brazilian Association of Professional Surfing (ABRASP).

Surfing is a sport, but for many recreational practitioners, it is also a lifestyle in which age is not a limiting factor. Thus, the average age of practitioners at Icarai Beach was 33 years, with a standard deviation of 8.34, showing a high degree of dispersion of practitioners by age. With regard to origin, exactly half of the interviewees were from the city of Fortaleza, while the rest were residents of Caucaia (Table 1). This high number of surfers from the neighboring city indicates how important the Icarai Beach is for surfing, given the considerable traffic barriers that exist between Fortaleza and the surf beach.

Casein terms of income, most practitioners were earning between the minimum wage (32% /US\$ 202.33) and 2 minimum wages (34%/US\$ 388.98). Only a small proportion (8%) reported earning more than US\$ 1214.00, and less than 4% reported having no declared income. It is important to note that surfing is also a major consumer market, attracting surfers and supporters. the Brazilian surfing market (e.g., clothing, accessories and boards) generates US\$ 2.5 billion a year and directly and indirectly employs around 140,000 people, according to an article published by Forbes Magazine, on September 29, 2019 (ZUCCO et al., 2002).

Table 1: Characteristics of the population of surfers surveyed in this study.

Variable	n	%
Sex		
Male	45	90%
Female	5	10%
Age		
20 – 24	10	20%
25 – 29	7	14%
30 – 34	9	18%
35 – 39	14	28%
40 – 44	7	14%
45 – 49	1	2%
50 – 54	1	2%
60 – 64	1	2%
Origin		
Icarai District	14	28%
Caucaia	11	22%
Fortaleza	25	50%

Source: Data collected from the forms applied between the months of February to July 2019.

The education level of the surfers in Icarai falls into two main groups: those who completed high school as the highest qualification constituting the highest proportion (52%), followed by those with incomplete higher education (32%). The remaining 16% either completed higher education (10%), did not complete high school (4%) and completed elementary school (2%). The results show a very different profile from that observed in the first half of the 20th century, as pointed out by Kampion (2003), in which the interviewees generally had a high level of education and income, as they were among the few able to acquire expensive surf equipment at the time. The current surfing population is a new audience formed from the 1990s and consolidated in the 2000s, and contrasts with the stereotypes of surfers in the late 20th century, which tend to portray surfers as young, happy romantics and outsiders in search of adventure and living on the beach without money (KAMPION, 2003). Our data suggest, in fact, that surfers are usually well educated and in active professional employment.

Another important variable is the frequency with which practitioner engages in recreational activity (MURPHY, 2008; PONTES, 2012). In the case of surfing at Icarai beach, 46% of the practitioners said they surfed at least three times a week, 28% at least once a week and 10% once a month. In the sample, 16% of the practitioners surfed every day of the week. This group is mostly local practitioners, for whom the trip to the beach

is quite straightforward, facilitating daily participation in this recreational practice. Excluding surfers who practice daily, Saturday and Sunday were the preferred days for 46% of surfers. However, this scenario may change depending on the state of the sea. For example, when swell waves occur, the opportunity to surf bigger waves causes the frequency of visits and preferred days to change. Frequency is an essential parameter to determine the social and economic value of the waves for surfers.

Social value of the waves

It is evident that, today, watersports idealize a new aesthetic standard, based not only on ideas of healthy, slim and tanned people, but also intrinsically linked to nature (PEREIRA et al., 2019). Mafessoli (2006) defines surfers as post-modern tribes, part of a group, possibly global, non-hierarchical and unorganized, which defines itself through shared lifestyles and values, based on love of sport, a strong relationship with nature, a healthy lifestyle and a common language.

Social value is strongly associated with individual and collective experiences of situations of pleasure and human well-being in a social practice of leisure and recreation. In the case of surfing, Silva and Ferreira (2014) indicate that non-economic values are decisive in the development of surfing practice, being linked to an ideology of freedom and respect for nature. These values are not monetary, but social, built on ties and relations with the beach and the waves, the natural elements essential for surfing.

For any sports and recreational practice, social familiarity with the environment is essential to strengthen the bonds of respect for the environment. In the case of Icaraí Beach, 92% of the practitioners claimed to have known the surf spot through a friend or family member, showing a strong community bond between people and place. Only 2% of the interviewees stated that they had known it through some form of informative media, while the others knew it for the surf itself or through song lyrics that speak of the Icaraí Beach as a good place to catch waves.

The length of time over which a surfer attends the same beach is another important aspect of the practitioner's identification with the place, which denotes an affective bond (SILVA and FERREIRA, 2012). In our case, this identity is reinforced by the observation that 16% of surfers have frequented this beach for over 20 years (Figure 4). One interviewee has surfed at this beach for 30 years. The majority (62%) of practitioners have been surfing this beach for at least 6 years and a maximum of 20 years. These practitioners already know the environment of Icaraí Beach and its waves well. Their social identity is intimately linked to the place, a form of social capital that cannot be estimated monetarily.

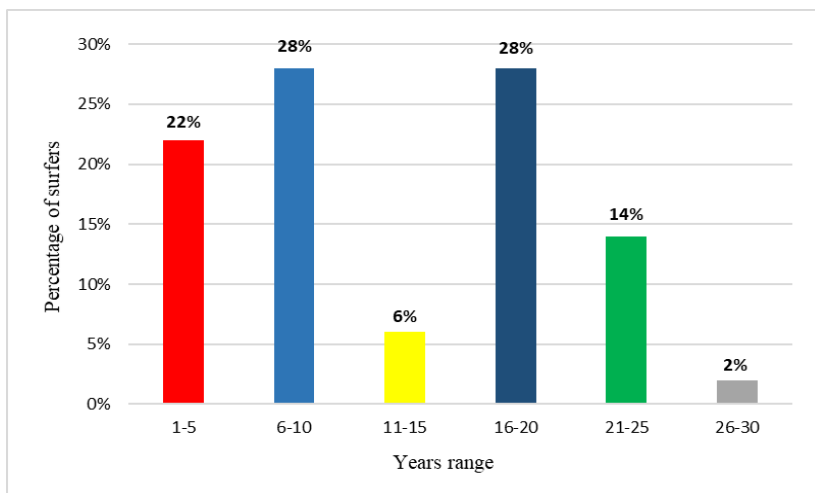


Figure 4: Duration of surfing activity at Icarai Beach (years/surfer).

Surfing practitioners were asked about the abiotic wave resource as a recreational attraction that can provide social and economic benefits. In this case, 92% of respondents recognized the waves as a recreational resource that brings social and economic benefits to Icarai Beach, so this resource is one of the main attractions of this beach. Their conclusion is supported by the concentration of surf shops along the Icarai foreshore, which place Icarai as a major surfing centre in Brazil. In another issue that involves the social and environmental value of this beach, practitioners were hypothetically asked about the issue of building a coastal protection work (e.g., sea walls) that would mitigate the problems of marine erosion at Icarai Beach, while reducing the conditions of waves for the practice of surf. The responses showed that there is no consensus on the issue, as 52% were in favor of construction, even though the surfability would be reduced, while 48% are not in favor of building any work that reduces local surfability. Those favorable to the construction justified their response by suggesting the environmental value of the beach and the protection of properties at risk of collapse should be prioritized in the coastal management plan. Those who disagreed with construction said that surfing is an activity that mobilizes investments and stimulates the local economy. They were in favor of coastal management work that solves the problems of erosion but does not harm the practice of surfing on Icarai Beach.

Economic value of the waves

Regarding the economic value of the waves, our analyses converged on an estimate of demand for the wave resource, making it possible to gauge the consumer surplus, that is, the net benefit that surfers obtain, directly or indirectly, when they consume the ecosystem service that supports the practice of surfing (SILVA and FERREIRA, 2014; ZHANG et al., 2015).

The first results concern travel costs estimated using the ZTCM. A total of 24 zones sit within the municipalities of Caucaia (6 zones) and Fortaleza (18 zones). Zone 0 (zero) was located in the neighborhood of Icarai, where the wave resource is located. The price paid to

visit the beach is directly related to the area of origin of the practitioner, i.e. his/her neighborhood. Consequently, the population of the neighborhood and the number of annual visits to Icarai Beach are key variables for the calculation of the ZTCM (Table 2).

Table 2: Visitation rate and cost per trip for Icarai Beach surf trips.

City	Zones	Total Visits/year	Number of Surfers	Population of the zone	Visits/ 1000	Distance (km)	TTC (US\$/Surfer)	
CAUCAIA	Icarai	0	2409	14	10974	219,52	0	0
	Iparana	1	475	3	5986	79,35	14	1,57
	Lagoa do Banana	2	110	1	1986	55,39	30,8	2,98
	Cumbuco	3	37	1	2298	16,1	20	2,00
	Araturi	4	256	3	20343	12,58	25,4	1,33
	Parque Potira	5	329	3	20231	16,26	34,4	2,05
	Jardim Guanabara	6	37	1	14919	2,48	27,4	2,64
FORTALEZA	Presidente Kennedy	7	37	1	23004	1,61	31	3,00
	Carlito Pamplona	8	9	1	29076	0,31	29	2,88
	Vila Velha	9	9	1	61617	0,15	24,6	1,22
	Alvaro Weyne	10	73	2	23690	3,08	26,6	1,24
	Pirambu	11	45	2	17775	2,53	28	2,04
	Barra do Ceara	12	219	2	72423	3,02	23,2	1,63
	Jardim Iracema	13	37	1	23184	1,6	26,6	1,18
	Aldeota	14	37	1	42361	0,87	42,6	4,00
	Praia do Futuro	15	110	1	11957	9,2	50,8	4,73
	Damas	16	110	1	10719	10,26	45	4,15
	Bairro de Fátima	17	9	1	23309	0,39	43,4	4,35
	Granja Lisboa	18	110	1	52042	2,11	41,8	3,92
	Granja Portugal	19	110	1	39651	2,77	42,6	3,68
	Antônio Bezerra	20	37	1	25846	1,43	32,4	2,73
	Conjunto Ceara	21	365	4	42894	8,51	37,4	1,67
	João XXIII	22	9	1	18398	0,49	39,2	3,58
	Bom Jardim	23	110	1	37758	2,91	44,6	2,06
Montese	24	37	1	25970	1,42	44,6	4,37	

Source: Data obtained in field research (February to July 2019) and through the application of the Zonal Travel Cost Method (ZTCM).

Total travel costs per surfer in each zone (Table 2) were obtained using equation 1. The results show varying values by location of the surfer, with a decrease in costs when the number of surfers and the number of visits per zone are higher. This made it necessary to evaluate the average, maximum and minimum values per set of zones, whether they are located in the same municipality or contiguous to each other, in order to understand the other factors that influence travel costs.

As expected, the largest number of surfers come from zone 0, the beach neighborhood. This situation results in a high visitation rate, but without associated travel expenses. Travel costs in other areas can be influenced by distance, for example, surfers who come from Praia do Futuro (zone 15), the most distant, to Icarai Beach spend around US\$ 4.73 per visit. Surfers who travel within the municipality (zones 1 to 6) spend an average of US\$ 2.10. For travel between the cities of Fortaleza and Caucaia, areas that are located in the extreme west of Fortaleza (zones 7 to 13) close to Caucaia, average expenditure is US\$ 1.90. Travel costs from these zones are significantly reduced by the abundance of transport modes (car, motorbike, bus, bicycle) and the ease of access to Icarai Beach. On the other hand, journeys from the central-east neighborhoods of Fortaleza (zones 14, 15, 16 and 17), the furthest from the beach, have an average travel cost of US\$ 4.30. For intermediate distances, the average cost is US\$ 3.15.

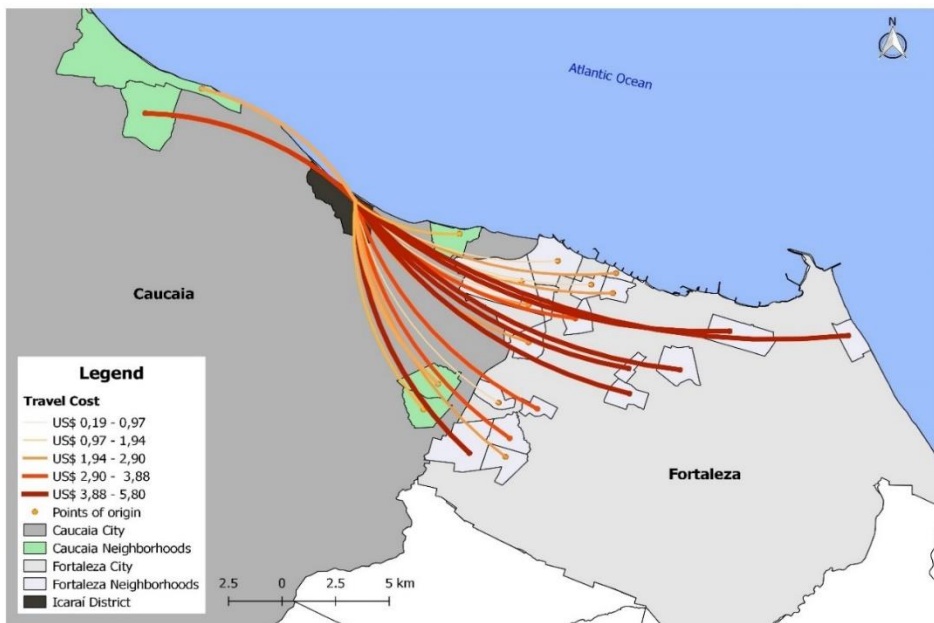


Figure 5: Flow map and travel cost for surfing at Icarai Beach.

Figure 5 maps all the surveyed journeys towards Icarai Beach for surfing. The map shows a direct relationship between the greatest distances and greatest expenses in commuting, though there are exceptions due to the transport modes available. Another

factor may also be related to the easier access between these areas and Icaraí Beach, as the capital Fortaleza is directly linked to Icaraí Beach, via a bridge over the Ceará River and the CE-090 highway.

The linear regression shows the relationship between total annual visits and total travel costs of each zone. The estimated regression equation (equation 2) provides a calculation of the rate of visitation = $62.38 - 3.29 * TTC$ (total travel cost) and the construction of the demand function for the average visitor. The first part of the demand function (Figure 6) points to approximately 7300 visits, with an annual cost of US\$ 6,098.90 for the 50 surfers interviewed. However, the intention of the function is to estimate the amount of demand at different prices of a good, that is, at different travel costs, to reveal the consumer surplus (CASIMIRO FILHO, 1998; SEBOLD and SILVA, 2004). Thus, when the amount of US\$ 0.97 was added to travel costs, the number of visits decreased to 6765, the same occurred at US\$ 1.94 and US\$ 3.88 resulting in a decrease from 1595 visits to 27 visits.

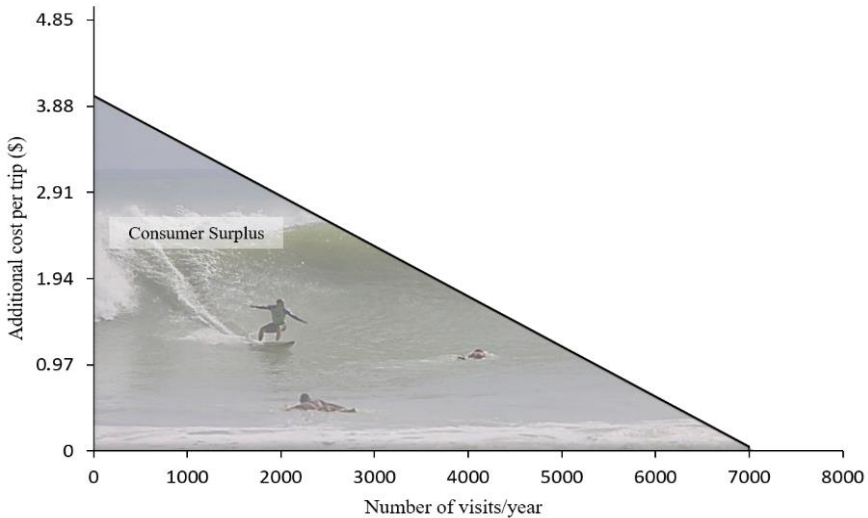


Figure 6: Zonal travel cost demand relationship for surfing at Icaraí Beach.

The consumer surplus is calculated from the area under the demand function graph (KING et al., 2000). Therefore, the total economic benefit of the abiotic wave resource at Icaraí Beach is US\$ 10,058 per year, or an average of US\$ 1.37 per visit. Comparing the economic benefit per visit with that of other studies, our results indicate a low visitation cost per surfer (Table 3). However, when taking into account the overall number of visits made by the 50 interviewed surfers (7307), the practice of surfing at Icaraí has a very considerable value. It is noteworthy that this low cost is related to the local surfers base in Icaraí Beach compared to the surf breaks where surfing national or international tourism is common.

Table 3: Comparison of consumer surplus from available studies. TTC – total travel cost.

Author	Surf Spots	Year of evaluation	Method	Consumer Surplus (TTC/Research year)
Kostald and Deacon (ano)	Huntington Beach (American Trader - USA)	2000	Travel Cost Method (value of environmental amenities)	US\$ 19.75
Coffman and Burnett (ano)	Mavericks (USA)	2009	Travel Cost Method (economic value)	US\$ 56.00
Silva and Ferreira (ano)	Caparica Coast (Portugal)	2014	Travel Cost Method (economic value)	US\$ 65.07
Lazarow (ano)	Gold Coast (Australia)	2009	Travel Cost Method (economic value)	US\$ 18.67
This study (Leisner and Paula)	Icaraí Beach (Brazil)	2020	Travel Cost Method (economic value)	US\$ 1.37

Source: Data obtained through literary review. Note: The amounts were converted into United States dollars, based on the Central Bank of Brazil quotation, on 23/07/2020.

It should be noted that the economic benefit of \$ 10,058 corresponds to the 50 surfers who responded to the survey form. Equation 3, which estimates the population of local surfers, determined 1185 surfers visit Icaraí annually, with cases of more than 100 surfers in a single daily surf session. These data are also corroborated from observations made in the field. Based on the measurement of the surfer population provided by equation 3, the economic benefit of the wave resource resulted in an amount of US\$ 288.363,79 annually, constituting an important economic benefit for the municipalities of Caucaia and Fortaleza. It should be noted that there are no data on the total annual number of surfers visiting Icaraí Beach and that equation 3 results in an estimate, using a simple scaling process. In addition, the calculation does not take into account surf carnivals in the locality and the high season period (occurrences of swell waves), when the number of surfers is much higher than the rest of the year.

Conclusions

We present an analysis of the costs associated with surf trips to a popular surf break in Brazil. The Zonal Travel Cost Method (ZTCM) and the questionnaire forms proved to be quite effective, generating important results for understanding the social and

economic value of the abiotic wave resource for recreational surfers in Icaraí Beach (Ceará, NE Brazil). This study provides baseline information about the profile of surfers at the beach, as well as the social and economic values associated with the ecosystem service provided by the waves. The Zonal Travel Cost Method (ZTCM) is an important tool for assessing the development of modern economies, as is the case of coastal economies, where the value of non-market resources can be difficult to assess using traditional economic methods. Such environmental valuations make it possible to adopt public policies that combine economic development with the maintenance of environmental quality.

The sample audience for this study was 50 respondents. This may appear to be a limitation in terms of representativeness, but because it is a very specific sample, with unique characteristics and time restrictions for answering questions, the value of the “n” sample can be considered satisfactory as a first approach for the method and the target audience. As the study continues, there will be an increase in the number of respondents and beaches visited. Our analysis focusses only on transportation costs, not taking into account the consumption of food and other expenses related to surfing (e.g., surfboards, wetsuits). These costs will also be analyzed in future research, based on an expansion of the study area and sample.

Beaches, and more specifically surf breaks, have been shown to be identity resources (HILL and ABBOTT, 2009), with social identity and economic value, making it absolutely important to value them in an integrated management of the coast. Several studies like this one show that beach visitors, bathers, surfers, managers and diverse stakeholders in this environment are keenly interested in the management, maintenance and improvement of recreational amenity. Beaches are places where valuation environmental research (non-market values) that identify the consumer surplus can be applied to reflect more truthfully the value of a beach or the waves associated with surfing for the individual or community.

Surf trips to Icaraí Beach are also a strong indicator of the attractiveness and local potential for a more robust development of a beach economy based on wave resources. Local surfers identify strongly with the beach, which makes social affective ties and economic values important vectors for the development of Icaraí Beach. Management is critical to preserving these ties, given that Icaraí is one of the stretches of the coast of Ceará with the highest rates of coastal erosion.

Assigning a monetary value to the waves abiotic resource is a complex action, as it involves cultural, landscape, territorial and economic elements. However, valuation studies can provide important baseline information related to decision making, which is often based on economic contributions. Therefore, valuing surfing and other related activities, such as landscape observation and tourism, is fundamental in guiding appropriate environmental conservation and sustainable growth in the locations where wave resources are present.

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Acknowledgements

The authors would like to thank the National Council for Scientific and Technological Development-CNPQ (Scholarship PQ 310246 / 2019-9 and Master's Scholarship) and the Post-Graduate Program in Geography (PROPGEO / UECE) for their support. This study was supported by the Cearense Foundation for Support for Scientific and Technological Development (FUNCAP) through FCT AAC No. 02 / SAICT / 2017 (Project Holistic Approach to the simulation of long-term evolution of the coast) and the Laboratory of Coastal Geology and Geomorphology and Oceanic of the UECE. Finally, we thank Professor Simon Connor for reviewing the English language for this article.

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Received for publication October 2020
Approved for publication December 2020