


Relationship between incidents occurred in the beach area and the presence of return current on beaches in the metropolitan region of São Luís, MA

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ABSTRACT

Rip currents are known to be the biggest cause of rescues and drownings within the surf zone. In Australia, about 90% of all rescues carried out in the surf zone and the majority of drownings are related to rip currents (Short, 1999). The objective of the work was to make a relationship between rip currents and the incidents that occurred in the great island of São Luís. For the research, a survey of the accident record was carried out, images were obtained and awareness and information work was carried out. The interpellation of the data was applied in a participatory way, seeking the knowledge of all those who were involved in the activities carried out on the beaches, through a direct approach to those who frequent this environment, in addition, it was using data from historical series provided by BBMAr (Fire Brigade Maritimes of Maranhão). Despite the adversities and all the obstacles faced during the execution of the research, it was possible to locate with some drone overflights the place where the rip currents appeared along the main beaches of the state, identifying the points that could represent a real risk of drowning. and incidents for visitors to these beaches. This work serves as a starting point for further research to be carried out, since there is not an expressive number of works with this approach in Maranhão, precisely on the large island of São Luís.

Keywords: Return currents, Beaches, Incidents.

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INTRODUCTION

Coastal environments are extremely dynamic and various terrestrial, oceanic and atmospheric processes converge in them, constantly changing their characteristics. The morphological changes are the result of variations in the incident energy regime (wave and wind climate), water level variation (storm events), and imbalances in the local sedimentary supply (SHORT, 1999, KLEIN, 2004). Of the various environments found in the coastal area, the beach environment stands out. Its morphological and sedimentary behavior is the result of the complex interaction between sediment source, wave energy and the characteristics of the adjacent internal shelf (KOMAR, 1998).

In this sense, beach environments represent the transition zone between the action of marine and continental processes, being subject to temporal variations in both sea level and sedimentary supply. The sedimentology of the beaches can be formed by grains of different compositions and granulometry, and the grain size in combination with the climate of incident waves, interact and condition the morphology of the beach profile (HOEFEL, 1998).

According to Dalrymple et al. (2011), MacMahan et al. (2006) rip currents can remove large volumes of sediment, resulting in a potential risk of erosion during extreme events. However, the greatest risk is related to bathers; hundreds of drowning deaths and tens of thousands of rip current-related rescues are recorded worldwide each year (BRIGHTON ETAL., 2013; AROZANERA ET AL., 2015).

The risk posed by rip currents to bathers is largely underestimated, which can have a negative effect when it comes to allocating funds to rescue services (BRIGTHON *et al.*, 2013). In the USA more than 100 people drown each year in rip currents (NOAA, 2016), in this country these currents are responsible for more deaths than: hurricanes, tornadoes, floods, lightning or sharks (LUSHINE, 1991, FLETEMEYER AND LEATHERMAN, 2010). Lushine (1991) published an article presenting the number of annual drownings in southeastern Florida attributed to these currents, as well as the relationship between these and certain meteorological and oceanographic factors.

The safety of bathing in the sea in the city of São Luís, Maranhão, as in any other large tropical coastal city, where the high frequency of bathers is always a concern. Conservative figures provided by the local lifeguard agency indicate that an average of 1,586 accidents are recorded per year on the Atlantic coast, and this total is expected to be about 20% higher, since not all occurrences are recorded, judging by the understanding of the lifeguards themselves.

The monitoring and collection of information to analyze the relationship between rip currents and incidents that occurred in the beach area, in addition to raising awareness among bathers and government authorities about the importance of these currents on the beaches of the large island; To monitor the variations of the beach features helping to identify erosive and/or depositional behaviors, understanding the morphodynamics of the place.



The mapping of rip currents and the identification of the location of dragging occurrences contributes to the safety of users, so that authorities obtain important information to assist in decision-making and prevention strategies.

In view of the above, this research assumes great importance since studies from this perspective are not found in expressive numbers for Brazilian beaches, especially for the northeast region and, more specifically, São Luís. The objective of this work was to make a relationship between rip currents and the incidents that occurred on the large island of São Luís.

MATERIAL AND METHODS

SURVEY OF ACCIDENT RECORDS

The data referring to incidents with bathers that occurred on the beaches served in the research were collected from a partnership with the Maritime Fire Battalion (BBMAr), which belongs to the Military Fire Department of Maranhão, and is in charge of the missions of attending to occurrences of prevention, search and rescue in aquatic environments, serving the metropolitan region of São Luís. Information on these accidents was collected between 2014 and 2019, in order to trace a relationship between drownings and the place of possible predominance of rip currents.

IMAGING

Visual record searches were made using images available in Google Earth® and Google Maps software. These images were used to identify the sites of formation of the Rip Currents and to classify them as fixed or mobile. In the field, a drone was used to obtain aerial images of the possible places where the rip currents appeared. These images were always taken at low tide, the best period for viewing this oceanographic phenomenon.

AWARENESS AND INFORMATION WORK

After locating the Rip Currents, a "*Blitz*" of presentation and information was made with the visitors of the analyzed beaches, and pamphlets were distributed with definitions and location of the rip currents, the most frequent places of appearance of the currents and especially the way to get out of them in case any bather accidentally falls into one of these currents. At this stage, the project had the support of the firefighters and members of the Oceanography and Aquatic Microbiology laboratory, going to the most frequented beaches and with the highest reports of drowning and visualization of currents to carry out information work and demonstrate the places of danger of drowning

RESULTS AND DISCUSSION

A total of 4 visits were made to collect data at the BBMAR (Maritime Fire Battalion) headquarters. The occurrences were divided into drownings with death and without death, since the meaning of drowning is asphyxiation by the replacement of air by water or some liquid. The following table shows the drowning data collected during the survey (Table 1).

BEACHES	DROWNING WITH	DROWNING
Pebble	6	8
One-eyed	1	0
Ponta da Areia	3	0
Araçagy	9	4
Dry Mangrove	7	4
Guia Beach	1	0
Water Eye	1	3
Fox	1	0
Tajaçuaba	1	0
Guarapiranga	1	0

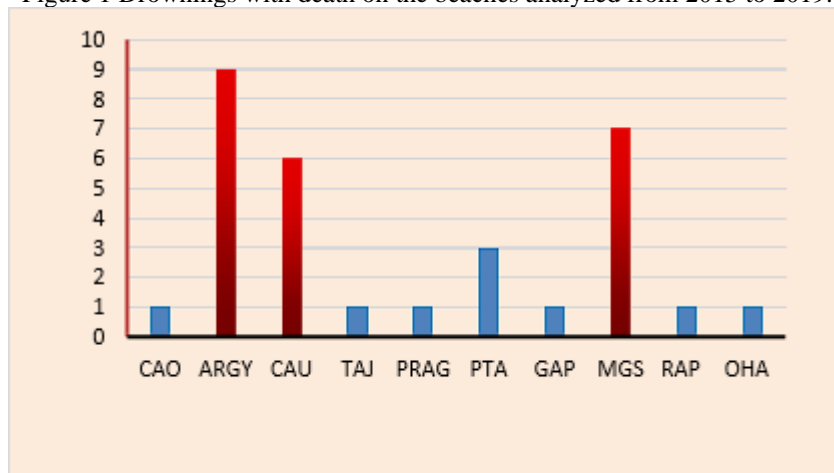
Source: Author

Analyzing the table, it is possible to verify that three (3) beaches have significant numbers of drowning cases: Mangue Seco, Calhau and Araçagy. These beaches are highly populated beaches on weekends due to their location, such as the pebble beach, which is one of the postcards of the capital.

Araçagy beach got its name from a fishing village that existed in the region; It was one of the first beaches on which bars and restaurants began to stabilize and it is believed that, because it is one of the few beaches that still allow cars to move freely on the strip of sand, it attracts more and more bathers, being one of the busiest beaches in the capital on weekends. Another factor that has been increasing this growing number of bathers on the beach is real estate speculation that has been growing in this region, attracting more and more people to live close to the beach (IBGE 2016).

Figure 1 shows several beaches that had only one case of drowning with a recorded death. Many of these beaches are far from areas with a high incidence of people, for example: PTAJ (Praia do Tajaçuaba); PRAG (Praia da Guia); PGAP (Guarapiranga Beach); PRAP (Praia da Raposa)

Figure 1 Drownings with death on the beaches analyzed from 2015 to 2019.



Araçagy beach is located at latitude 2° 27' 50"S, above the beaches of Olho d' Água, Calhau and Ponta da Areia. In the data collection, it was found that 1/3 of the victims who drowned on the beach of Araçagy were found on the beach of Olho d'Água, perhaps due to the presence of a rip current passing through these two beaches and carrying the bodies to the beach of Olho d'Água.

Despite the indications of the presence of rip currents, overflights were carried out with the drone to identify and punctuate the places where the currents appeared, the danger of these currents is extremely underestimated and their power is accentuated at low tide as it increases the surf zone generating greater pressure in the currents and consequently a higher speed

Rip currents or "*Rip currents*" as they are called around the world, produce a kind of funnel that is their great danger. According to Serrão Pedro (2019) and Berribili Marcos (2020), these funnels are very characteristic and are indicative that can be used to characterize the presence of rip currents in a given location, since these "funnels" are nothing more than places where there is no formation of waves that will end up forming this characteristic.

Mangue Seco beach, located in the municipality of Raposa, had a total of seven drownings with death. This beach, unlike those that have a high number of fatal drownings, was not so frequented between the years 2014 to 2016, but from 2017, it began to become popular for being an isolated beach in the metropolitan region and, for becoming known for being a clean beach, presenting beautiful landscapes, since it was not unsuitable for swimming.

With this gradual increase in bathers, the authorities began to observe an increase in the number of drownings with death and without death, which culminated in a considerable increase in cases. In addition, this beach is known for its fishing potential, where fishing families reside.

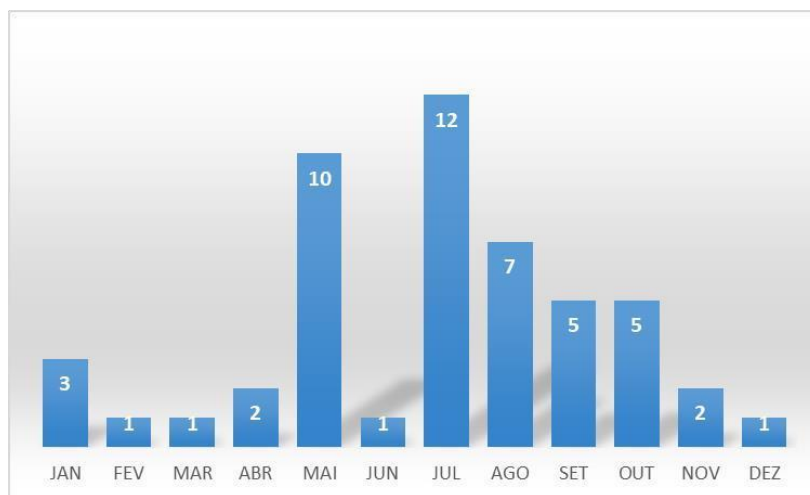
Mangue Seco beach, however, is also known to be a dangerous beach according to reports from the families of fishermen in that locality, as they claim that along the coast there are several "ditches". What fishermen call a ditch are actually natural erosive processes that occur due to the trajectory that the rip current makes once it stirs the bottom and ends up excavating the sand.

(SHORT, 2001; MACMAHAN et al., 2006).

Through documentary research of drowning records provided by BBMar, it was possible to conclude that most of the drownings recorded in the period from 2015 to 2019 were of fishermen who left to exercise their trade.

Regarding the months that had the most cases of drowning, we can analyze figure 2, which shows the graph with the number of drownings and the month in which they occurred; It is possible to observe that the month of July was the month with the highest number of drownings on the beaches evaluated, with a total of 12 drownings, it is worth mentioning that this total may be higher than we really know, since there is still an underreporting of cases.

Figure 2 - Total number of drownings recorded by BBMar in the months of January to December in the period from 2015 to 2019 by beach.



The month of July is the month of vacations in most Brazilian states, which corroborates the idea that there is a greater concentration of people in these leisure environments, thus increasing the possibility of drowning.

Many bathers end up venturing beyond the surf zone, through reports from the firefighters themselves, what happens is that many think they are good swimmers, but according to Criado Sudaú (2016), the rip currents can reach speeds higher than 2 m/s. The men's world swimming record (César Cielo/BRA/2009) for 100 m freestyle is 46.91 sec., which is equivalent to a speed of 2.13 m/s.

In the case of non-professional swimmers, good swimmers are those who maintain an average speed of 0.9 m/s for 12 minutes. This explains the risk that rip currents pose for all bathers, including those who are good swimmers.

The discrepancy between the estimates of deaths and drownings caused by rip currents is explained by the lack of reliability in this information (CRIADO SUDAU 2016). Another uncertainty regarding the number of rip-current related redemptions is due to the fact that 83% of survivors of these currents escape without the help of lifeguards, so they are not recorded in official statistics

(DROZDEWKI et al., 2012).

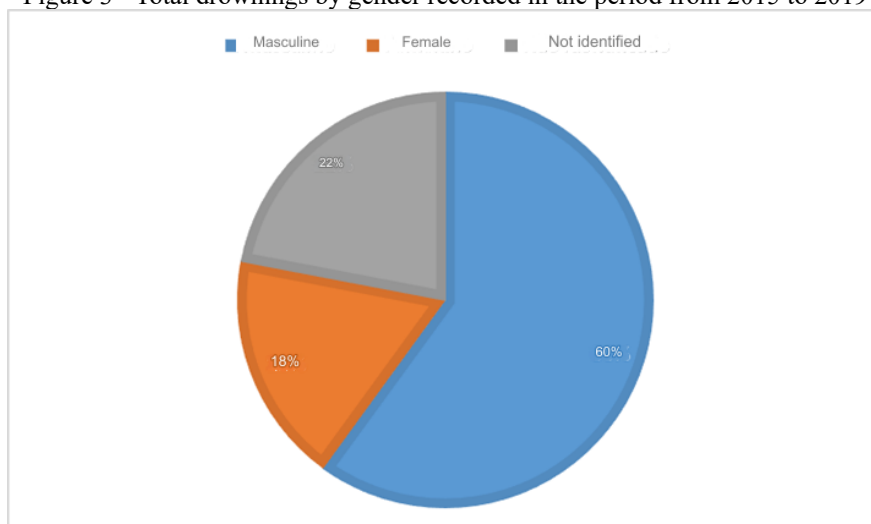
Brihgtton et al. (2013) after analyzing drownings and rescues in Australia between 2004-2011, indicated that rip currents were responsible for 57.4% of rescues. Although this is a considerably lower percentage than what has been used to date, there is no doubt that rip currents are the main causes of drownings and rescues on ocean beaches around the world.

In their work, Vanz and Fernandes (2014) showed that the main causes of drowning in Rio Grande do Sul and Santa Catarina are rip currents, which were responsible for 42% of cases, followed by falls from rocky shores with 10% of cases. People who have suffered sudden illness come next with 9%. Albuquerque et al. (2010) concluded that the main type of hazard associated with Praia do Futuro (CE) is rip currents, with 86% of the occurrences

The risk posed by rip currents to bathers is largely underestimated, which can have a negative effect when it comes to allocating funds to rescue services (BRIGTHON et al., 2013). Drownings with no fatalities are also reported and serve as a parameter to classify beaches as dangerous or not. Calhau beach is a place frequented daily by people doing leisure activities, unlike Araçagy, which is usually more frequented during weekends, which can cause a difference in the number of cases verified on these beaches.

The gender of drowning victims was also analyzed. Figure 3 shows the drowning relationship between men and women and the number of people who drown and does not record their age and gender, indicated in the figure as unidentified.

Figure 3 - Total drownings by gender recorded in the period from 2015 to 2019



The graph above shows that 60% (30) of the drownings that occur, whether with or without death, are male, and 18% (9) correspond to females. According to the firefighters, many of them enter the sea after having ingested some type of alcoholic beverage, causing them to quickly be pulled by a current without offering any effort.



The cases of drowning whose gender was not reported correspond to 22% (11) of the total. This information, which is often suppressed from the records drawn up during data collection, makes it difficult to draw a more concise profile of this variant, which would help to set up prevention strategies, in addition to assisting in searches and statistics.

Regarding the age of the people who drowned, the data show that 50% of the victims did not have their age reported, evidencing the failure to collect data on these types of accidents. The known age group with the highest rate of drownings is between 10 and 20 years old, according to firefighters, usually because they are young they end up not caring about the dangers that the sea has and ignore the calls of lifeguards and guidelines.

Deaths from drowning on the beaches of Santa Catarina and Rio Grande do Sul are concentrated in the age group under thirty years, 66% of the total. This percentage rises to 84% when deaths up to forty years of age are counted, and according to Albuquerque et al., (2010) the majority of victims in Praia do Futuro (CE) are male (59%), aged between 21 and 28 years, as we can relate along with the data above, where it shows that 60% of the incidents are linked to male victims (VANZ. A AND FERNADES, L.G, 2014).

After collecting data from the fire department and taking aerial images, information *blitzes* were carried out in the places with the highest incidences of drowning incidents and in the places, which coincided with the drowning sites, where rip currents were seen. These actions took place on weekends when the density of bathers in the strip of sand was higher, and the teams were divided along the beaches observed in this study, in order to cover a larger area and provide information to a greater number of people.

On the occasion, educational and preventive brochures were distributed and explanations were made on the subject. At this time, questionnaires were not applied, because the main objective of the action was to identify the degree of knowledge of bathers about the subject addressed, however, it was evidenced that it is necessary to carry out a more in-depth work in this sense, addressing more visual communication and information strategies

CONCLUSIONS

Despite the adversities and all the obstacles faced throughout the execution of the research, it was possible to locate with some drone overflights the place where the rip currents appeared along the main beaches of the state, identifying there the points that may represent a real risk of drowning and incidents for the visitors of these beaches.

Even in the face of easy visualization, these currents are little known by bathers, and are often underestimated as a danger for drowning, as stated by Mocellin (2006), 80% of the cases are due to rip currents, which increases their degree of danger and thus increases the cases of drowning caused



by these currents.

For these reasons, it was quite evident the need for the authorities to carry out more visual marketing actions, in addition to the need for a coastal management plan, in order to mark the points already known as dangerous for bathing in the coastal strip and invest more in the dissemination of information about rip currents, their dangers, how to avoid them and how to get out of them, because a simple action can save lives.

This work serves as a starting point for other researches to be carried out, since there is not a significant number of studies with this approach in Maranhão anymore, precisely on the large island of São Luís.



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