

# ENVIRONMENTAL AND SOCIAL DECISION FACTORS OF BEACH SAFETY IN THE CENTRAL NORTHERN COAST OF SANTA CATARINA, BRAZIL.

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## ABSTRACT

Beach safety is an issue both of type/intensity of usage that a beach receives and of its physical characteristics (including morphodynamic state and local hazards). This paper shows the results of a survey conducted at oceanic beaches of the central northern coast of Santa Catarina, Brazil, in order to investigate the magnitude and nature of beach safety issue in these localities. The 137 registers obtained showed that: 64% of accident victims were male; 56% were habitual users of the beaches from which they were rescued; 70% were unable to swim; 77% of the accidents occurred in rip currents of moderate to strong intensity; 88% in under 0 to 1m wave breaker heights; 45% under spilling breakers and 30% under plunging breakers; 54% of the accidents occurred at longshore bar and trough beaches, 24% at dissipative beaches and 16% at rhythmic bar and beach beaches. Generally, results showed that social decision factors may be more important than the environmental ones in the issue of beach safety at the surveyed beaches.

**Key-words:** beach safety, coastal management; beaches of Santa Catarina coast.

## DETERMINANTES AMBIENTAIS E SOCIAIS DA SEGURANÇA NO BANHO EM PRAIAS DO LITORAL CENTRO-NORTE DE SANTA CATARINA

### RESUMO

Os determinantes dos níveis de risco público de uma praia são função da intensidade e tipo de uso que recebe e de suas características morfodinâmicas. Durante campanha de levantamento das condições de ocorrência de acidentes de banho no litoral centro-norte catarinense, realizada com o objetivo de identificar aqueles determinantes, os 137 registros recuperados demonstram que: 64% das vítimas são homens; 56% são veranistas habituais dos locais em que foram atendidos; 70% não sabiam nadar; 77% foram socorridas em correntes de retorno de intensidade moderada a forte; 88% dos acidentes ocorreram sob alturas de onda entre 0 e 1m, 45% em arrebentações deslizantes e 30% em arrebentações frontais; e 54% dos casos ocorreram em praias do tipo banco/cava longitudinais, 24%, do tipo dissipativo e 16%, do tipo banco e praia rítmicos. De um modo geral, os resultados obtidos demonstram a maior importância de determinantes sociais em relação aos ambientais para a questão da segurança no banho destas praias.

**Palavras-chave:** segurança nas praias, gerenciamento costeiro, praias de Santa Catarina.

### INTRODUCTION

Oceanic beaches are important recreational areas that are the focus many touristic and commercial activities, involving

significant numbers of people and high financial investments. The increasing human occupation and usage of beaches has been causing problems related to coastline stability and the maintenance of its esthetical and

environmental quality. Although many of the studies regarding oceanic beaches are issue oriented, those studies related directly to beach users and the beach safety issue are usually forgotten (Sheedy *et al.*, 1993).

Currently the beach safety issue is one of the most important issues concerning the coastal management of a region. Just as it affects beach users individually, threatening their welfare, it also has elevated socio-economic costs. Thus the establishment of a beach safety management program, based on knowledge of the magnitude and nature of the problem means minimizing socio-economic costs and maximizing public welfare and satisfaction. The absence of information concerning this subject in Brazil is prompting the carrying out of studies like those developed in Australia by Short & Hogan (1990, 1992) and Sheedy *et al.* (*op. cit.*).

According to the conceptual beach morphodynamics model suggested by Wright & Short (1984), the natural hazard of a beach increases with beach dissipativeness and with increasing wave breaker heights on a scale from one to ten (Figure 1). Particular physical characteristics of a beach, such as the presence of jetties, piers, submerged rocks,

river inlets or other obstacles, increase its local hazards (Short & Hogan, 1990). But it is only at the moment that a beach receives users that it becomes a public concern. In this case the beach hazard is identified by a "public beach risk" which is a result of the beach's natural characteristics (including morphodynamic state, incident wave height and other physical characteristics) and the intensity and type of usage it receives. By combining the number of users and the natural hazards of a beach (Figure 1), Short & Hogan (1993) proposed a classification of public beach risk at three levels (Figure 2), according to which the equipment and human resources to be used in a beach are defined.

In the context outlined above, the objectives of this work are (1) to present a historical evaluation of the beach safety issue in beaches of the central-northern coast of Santa Catarina (Figure 3) and (2) based on a pilot sampling, to identify the environmental and social decisive factors of public beach risk level in some of the beaches of this region, including Atalaia, Bombas and Dos Amores beaches.

*Morphodynamic Characteristics of Atalaia, Bombas and Dos Amores Beaches*

Atalaia beach belongs to the city of Itajaí and is located between a rocky headland that extends towards the sea, called Bico do Papagaio, in the south, and the Itajaí river jetty in the north (Figure 4a). It is 630m long and 21m wide (mean beach width). The shoreline is oriented north to south and due to the presence of the Bico do Papagaio headland and of the Itajaí river jetty, the beach is relatively protected from incident waves from north and south, being completely exposed to those incident from east. The modal beach morphodynamic state is dissipative and the occurrence of submerged bars of smooth contours are often noticed. The waves break relatively distant from the shore, plunging or spilling, trough a wide surf zone (about 60m).

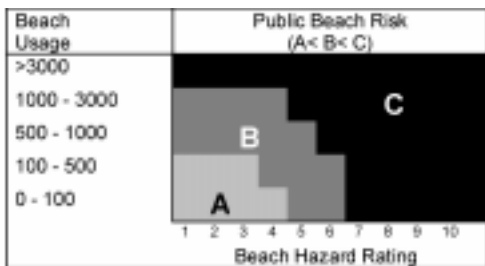
Beach State	Wave Breaker Height (m)									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
Dissipative	4	4	4	4	4	4	4	4	4	4
Longshore Bar - Trough	4	4	4	4	4	4	4	4	4	4
Rhythmic Bar and Beach	4	4	4	4	4	4	4	4	4	4
Transverse Bar and Rip	4	4	4	4	4	4	4	4	4	4
Ridge & Runnel	3	3*	4*	4	4	4	4	4	4	4
Low Tide Terrace	3	3*	4*	4	4	4	4	4	4	4
Reflective	2*	3*	4	4	4	4	4	4	4	4

Safety Rating		Key to Hazards	
Maximum	1-3		Water Depth
Moderate	4-6		Shoreline
Low	7-8		Rips and surf zone currents
Minimum	9-10		Rips, currents and large breakers

Note: All safety level ratings are based on a bather being in the surf zone and will decrease with increasing wave heights or with the presence of features such as inlets, headlands or reef (isolated) rips and currents. Rips also become stronger with falling tide.  
 \* signed numbers indicate the average wave height usually required to produce the beach type and its average hazard rating.  
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Figure 1. Beach hazard rating table presented by Short & Hogan (1992) (After Short & Hogan, 1992).



Note: Public risk levels may vary according to variations in: wave climate, beach users number, period of the year or week and climate.

Figure 2. Public beach risk levels classification proposed by Short & Hogan (1993) as a combination of beach usage and hazard rating (After Short & Hogan, 1993).

The beach face is composed by fine sand (0,180mm) and the slope is less than to 3°.

Rocky outcrops can be observed in the surf zone along the beach and some of them extend from the shore towards the sea. Permanent rip currents exist adjacent to these obstacles.

Bombas beach belongs to the city of Bombinhas and its limits are marked by two headlands, 2000m apart, between which the shoreline is oriented northwest to southeast, exposing the beach to waves incident from the northeast and east (Figure 4b). Ponta das Garoupas headland, in the south, protects the beach from south incoming waves. The mean beach width is 17m, the predominant morphodynamic state is dissipative and smooth bars are often observed too. The waves break plunging and spilling and the surf

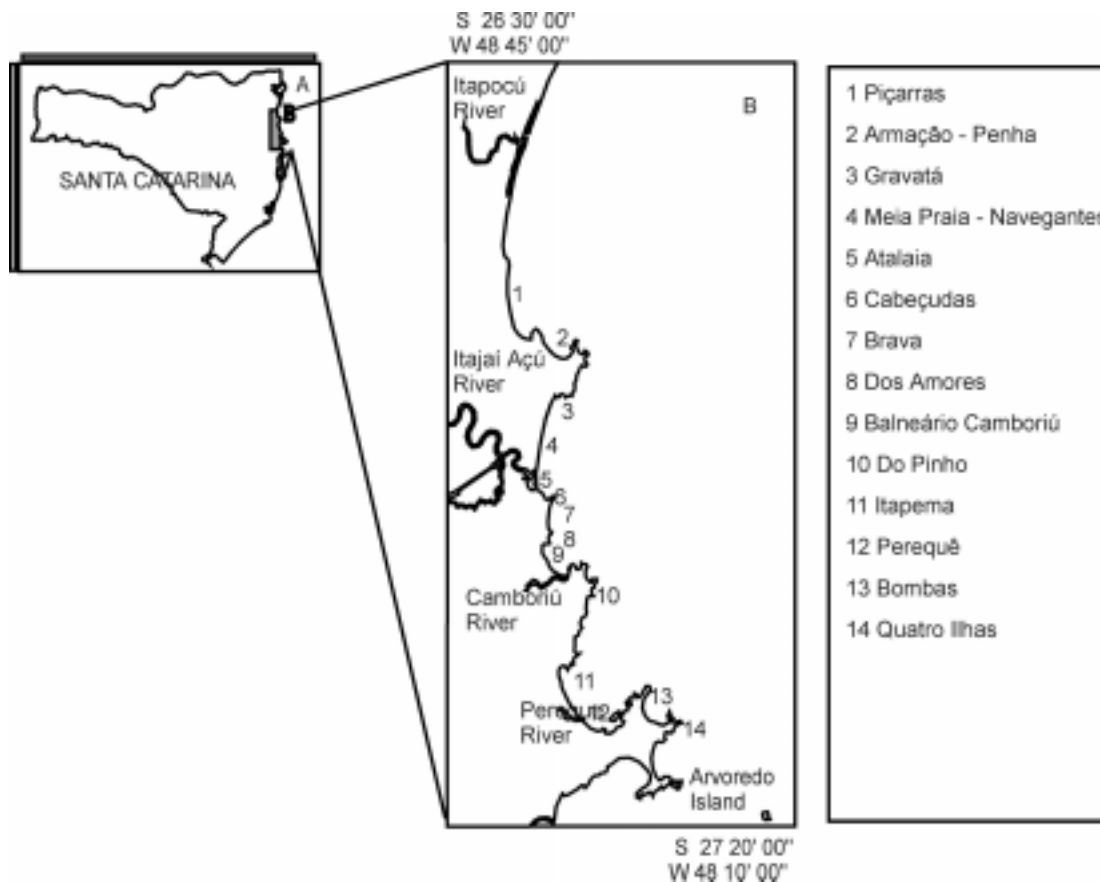


Figure 3. Map of the study area showing the location of central-northern coast of Santa Catarina beaches.

zone is about 35m wide. The beach face is composed of fine sand (0,177mm) and the slope varies between 2° and 3°.

Praia dos Amores beach also belongs to Itajaí city. In fact it is the southern portion (1100m) of a 3000m long beach arch whose limits are marked by two headlands, oriented from north to south (Figure 4c). Therefore the beach is completely exposed to incident waves but because of the medium to coarse sand that composes the beach face, it is an intermediate beach. The incident waves break in a spilling or plunging way over the continuous, rhythmic or transverse bars often observed. The bores that spread over the surf zone may break very close to the beach face in a collapsing or surging way. Morphologic features such as cusps and megacusps are frequently observed as well as rip currents. The beach face slope varies from 3° to 6° and the relatively coarse sand that composes the beach gives it a soft appearance.

## METHODOLOGY

The methodology used in this work is illustrated in Figure 5. To proceed to the historical evaluation of beach safety issue in the central northern coast of Santa Catarina, all past registers available at the Itajaí Fire station (3ª Companhia de Bombeiros Militar de Itajaí - 3ª CBM) and at the Legal Medical Institute of Itajaí (Instituto Médico Legal de Itajaí - IML) were collected. At the IML information was obtained regarding deaths due to drowning in salt water in patrolled beaches. The valuable data comprise locality and date of the occurrences. At the 3ª CBM all data regarding beach accidents assisted by life-savers were collected and the information gathered refers to: date and locality of occurrence of the accident; sex, age and survival of the victim. The absolute and percentage frequencies of these variables were calculated. The registers from IML were

used for comparison with those from the Fire station.

In order to identify the environmental and social decisive factors of public beach risk levels in the studied beaches of the region, a customized questionnaire was applied to register beach accidents assisted by life-savers during the summer of 1995/96. The questionnaire was divided in three parts comprising rescue data, victim data and environmental data (Table 1) and it was used in the 14 patrolled beaches of the region (Figure 3). At the beginning of the beach patrolling activities of summer of 1995/96, called Operação Veraneio (Operation Summer), the life-savers were trained to fill out the questionnaires and to identify the monitored variables. The absolute and percentual frequencies of those variables were calculated for the region as a whole and, individually, for each of the beaches. At the beaches of Atalaia, Bombas and Praia dos Amores visual estimations of the number of beach users were made so that the public beach risk level of these localities could be determined.

## RESULTS

### *Historical Evaluation*

At the 3ª CBM 133 registers of beach bathing accidents have been recovered covering a period of 8 years, from January 1987 to January 1995, and including 25 beaches. The majority part of the accidents, 68%, were registered in only five of those beaches: Atalaia (28%), Cabeçudas (12%), Balneário Camboriú (11%), Praia Brava (9%) and Navegantes (8%). More than half of the registers (55% or 73 cases) were of fatal accidents and 70% victims were male bathers. Most of the victims (35%) belonged to the 13 to 20 year old age group but a significant fraction, 24%, belonged to the 21 to 30 year old age group.

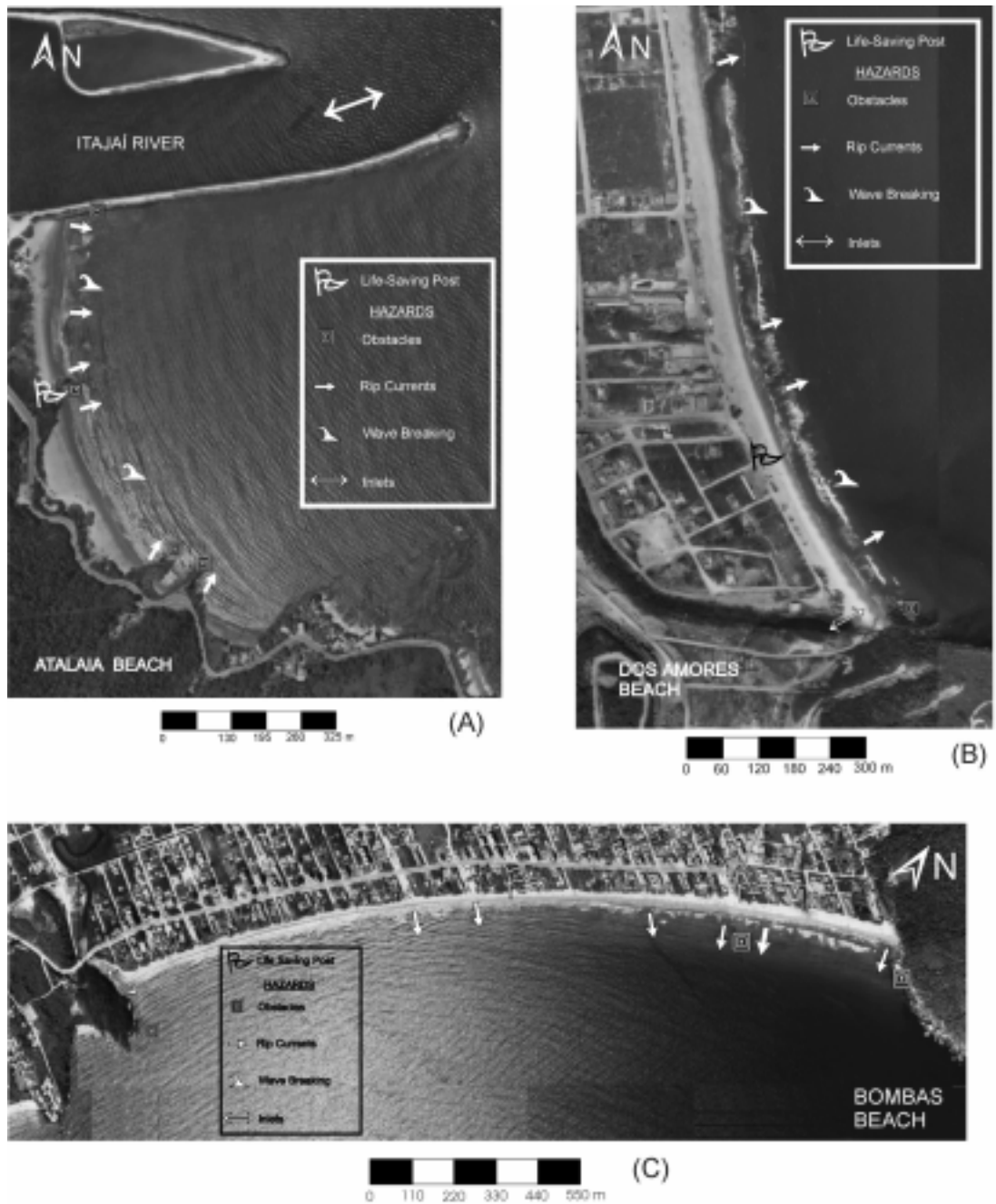


Figure 4. Aerial photographs of (a) Atalaia, (b) Bombas and (c) Dos Amores beaches. The main hazards that these beaches present are pointed out on the photos. Although rip currents may be variable in time and space, those mapped adjacent to obstacles tend to be permanent.

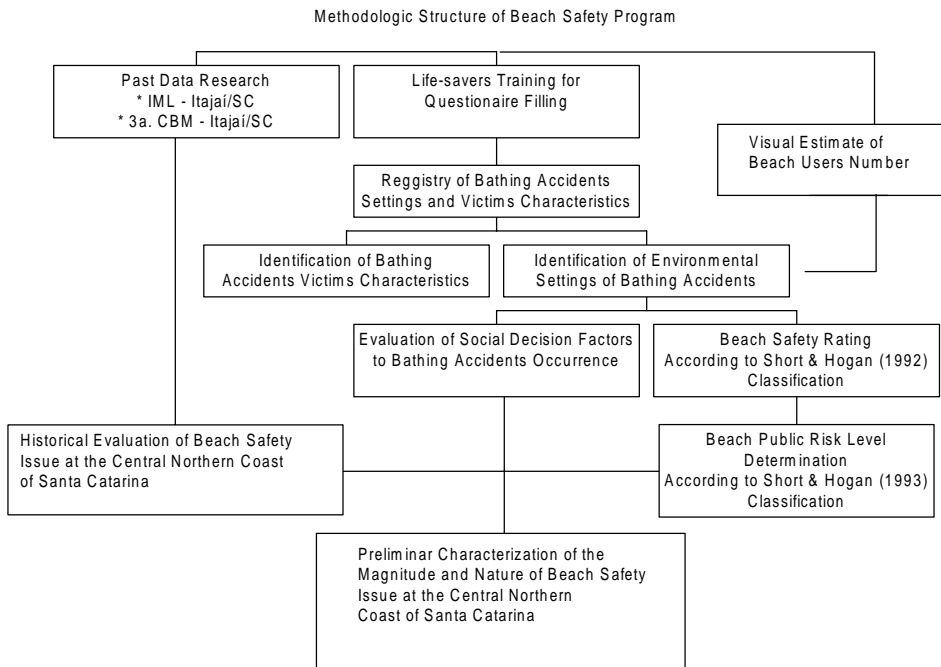


Figure 5. Illustrative diagram of the methodological structure applied in this study.

For the same period, 231 registers of drownings in salt water in the same 25 beaches referred to above have been recovered at IML (Table 2). Of these, 71% occurred in only six beaches of the region: Balneário Camboriú (25%); Navegantes (14%); Itapema (12%); Gravatá (7%); Praia Brava (7%) and Barra Velha (6%).

### *In Situ* Sampling

The monitoring of the occurrence conditions of accidents and characteristics of its victims conducted during summer of 1995/96 resulted in 137 registers of bathing accidents through questionnaires. Only two of these, or about 1%, refer to fatal accidents. As long as the totality of the accidents was not registered through questionnaires, it is not

possible to analyze quantitatively the data obtained, but important qualitative considerations can be depicted.

Among the 14 monitored beaches, Atalaia (26%), Bombas (32%) and Praia dos Amores (17%) are responsible for 66% of the 137 registers obtained. Hence the results presented in this study will focus on these localities. Itapema, Balneário Camboriú and Piçarras beaches did not accused the occurrence of accidents. In Table 2 the relative frequencies of the main variables controlled are shown for the central northern coast as a whole and to Atalaia, Bombas and Praia dos Amores beaches individually.

Generally, in the central northern coast of Santa Catarina 80% of the registered accidents occurred under clean sky or sparse cloud conditions. Moderate winds were

present in 84% of the cases. Strong to moderate intensity currents were associated with 74% of the accidents. Of all the cases, 86% occurred in rip currents and only 8% in longitudinal currents. Almost 80% of the accidents occurred under wave breaker heights less than 1m. Spilling breakers were noticed in 43% of the cases; collapsing breakers, in 29% and plunging breakers, in 19%. About 45% of the cases were registered at longshore bar and trough beaches; 20% at dissipative beaches and 13% at rhythmic bar and beach beaches. Approximately 80% of the cases were registered between 9:00a.m and 5:00p.m but no specific concentration of accidents was noticed during this period. Male victims were twice as numerous as female, representing 59% of the cases. The frequency of occurrence of accidents involving foreign, out of state and Santa Catarina resident victims was almost the same, about 28%. No predominant age group is observed among the victims either. In 55% of the questionnaires the inability of the victims to swim was registered and about 10% of the rescued victims were under the influence of alcohol.

### Case Studies

#### Atalaia Beach

The occurrence of accidents in Atalaia beach was concentrated on days with clear skies and moderate or weak winds. The accidents usually occurred in association with currents, mainly rip currents, of moderate to strong intensity and most of them also

occurred under spilling waves less than 1m in height. The most common morphodynamic state observed during accidents is longshore bar and trough. Almost all accidents occurred between 11:00a.m and 9:00p.m, but between 11:00a.m and 1:00p.m an isolated peak is clear. In the region as a whole, victims were mostly male but in Atalaia beach the victims were mainly Brazilians from states other than Santa Catarina, although local bathers made up an important fraction of the total. Most of the victims were below 20 years old and could not swim. The estimated user number of Atalaia beach was 1000 to 3000.

#### Bombas Beach

The majority of the accidents registered in Bombas also occurred on days with clean skies and moderate to weak winds and low waves (between 0,5 and 1,0m in height) of all breaking types. Waves between 1,0 and 2,0m height were associated with 10% of the accidents. Currents of moderate to weak intensity were observed in all the accidents and in Atalaia the number of accidents that occurred in longshore currents is greater. The longshore bar and trough and, secondarily, the dissipative states were the most frequently observed. The occurrence of the accidents was concentrated between 9:00a.m and 5:00p.m, with a large concentration between 9:00 and 11:00a.m and a smaller one between 11:00a.m and 13:00p.m. In Bombas it can be seen that there were 3 times more male victims than female. Foreign victims accounted for more than half of the accidents, followed by

Table 1. Structure of the questionnaire applied to register bathing accidents by life-savers.

Headline	Part A: Victim Data	Part B: Rescue Data	Part C: Beach Data
city beach post number life-saver date time	sex Place of residence familiarity and use of beach age hability to swim use of drugs associated lesions	type of rescue equipment used locality of rescue associated hazards fatality of the victim observations	morphology wave breaker height type of wave breaking sky condition wind intensity current intensity type of current

Table 2. Percentage frequencies of occurrence of the monitored variables per locality.

Obs: due to the incomplete filling of the questionnaire, many columns do not sum 100%	Central Northern Coast	Bombas	Praia dos Amores	Atalaia
• VICTIM SEX				
male	59%	66%	52%	67%
female	32%	22%	39%	28%
• TIME OF OCCURENCE OF THE ACCIDENT				
from 7:00a.m to 9:00p.m	1%	3%	0%	3%
from 9:00a.m to 11:00p.m	17%	38%	13%	6%
from 11:00a.m to 13:00p.m	23%	21%	22%	30%
from 13:00p.m to 15:00p.m	20%	13%	22%	25%
from 15:00p.m to 17:00p.m	21%	16%	39%	17%
from 17:00p.m to 21:00p.m	15%	9%	4%	19%
• AGE GROUP OF THE VICTIMS				
from 1 to 12 years old	25%	28%	9%	39%
from 12 to 20 years old	31%	28%	35%	36%
from 21 to 30 years old	21%	22%	26%	14%
from 31 to 40 years old	11%	9%	17%	8%
from 41 to 50 years old	8%	13%	13%	0%
more than 50 year old	1%	0%	0%	0%
• VICTIM PROVENANCE				
Foreigner	29%	53%	52%	6%
from state other than Santa Catarina	28%	25%	22%	31%
from Santa Catarina	27%	16%	17%	28%
from the beach where the rescue took place	8	0	9	14
• VICTIM FAMILIARITY OF THE VICTIM WITH THE BEACH				
ocasional visitor	40%	25%	30%	61
summer user	52%	66%	61%	36
• INFLUENCE OF ALCHHOOL				
alcoholized victim	10%	6%	17%	0%
sober victim	79%	85%	61%	94%
non detected	80%	9%	22%	3%
• SWIMMING ABILITY OF THE VICTIM				
positive	23%	16%	26%	28%
negative	56%	75%	48%	66%
• WIND INTENSITY				
very strong	1%	0%	0%	0%
strong	11%	13%	9%	14%
moderate	48%	46%	52%	39%
weak	27%	25%	8%	44%
absent	2%	0%	9%	0%
• CURRENT INTENSITY				
strong	36%	9%	57%	38%
moderate	38%	60%	17%	53%
weak	15%	22%	0%	6%
absent	2%	3%	0%	0%
• TYPE OF CURRENT OBSERVED				
longshore	8%	16%	0%	3%
rip	88%	81%	96%	94%
• WAVE BREAKER HEIGHT				
0,0 to 0,5m	42%	31%	48%	67%
0,5 to 1,0m	36%	59%	22%	31%
1,0 to 1,5m	15%	6%	22%	0%
1,5 to 2,0m	1%	3%	0%	0%
2,0 to 3,0m	0%	0%	0%	0%
more than 3,0m	0%	0%	0%	0%
• BREAKER TYPE				
spilling	43%	31%	26%	70%
plunging	19%	19%	45%	22%
collapsing	29%	37%	23%	5%
no waves	4%	10%	0%	0%
• MORPHODYNAMIC STATE OF THE BEACH				
dissipative	20%	28%	0%	8%
longshore bar trough	45%	57%	48%	75%
rythmic bar and beach	13%	3%	22%	0%
transverse bar and rip	1%	0%	4%	0%
ridge and runnel/low tide terrace	4%	0%	22%	0%
reflective	0%	0%	0%	0%



victims from other states of Brazil. Although victims were mostly below the age of 30, in Bombas the contribution of more victims of over 41 is noticeable, as well as victims under the influence of alcohol. The estimated beach user number was 1000 to 3000.

#### Dos Amores Beach

Like the other beaches, most of the accidents in Praia dos Amores occurred on days with clear skies and moderate to weak winds. All of the accidents registered reported the presence of rip currents of strong to moderate intensity and waves of less than 1,5m in height. In this beach both the breaking type and the morphodynamic state of the beach were very variable. The dissipative beach state was not observed in relation to accidents and, after the longshore and bar trough state, the highest frequency of accidents was observed in the rhythmic bar and beach and the ridge and runnel states. No time intervals of occurrence of accidents were clear. About 3 accidents with male victims were registered for each accident with female victims. Foreigners were by far the most frequent victims and in Bombas the high frequency of 31 to 50 year old victims in relation to children (below 12 years old) was also noticeable. The occurrence of accidents with victims under the influence of alcohol was the largest registered, 17%. The estimated number of users is 500 was 1000.

## DISCUSSION

### *Historical Evaluation*

Both the extremely low annual frequency of occurrence of accidents, 15 accidents per year, registered at the 3rd Fire station between 1987 and 1995, and the high occurrence of fatal accidents among these registers is evidence of the deficiency of the

historical data available in describing or characterizing the magnitude of the issue of beach safety in the beaches of the central northern coast of Santa Catarina. According to Lieutenant Ricardo Luis Dutra, of 3<sup>a</sup> CBM, the occurrence of 50 to 100 non-fatal bathing accidents for each fatal accident is observed annually. In the IML a 74% higher number of fatal accidents was registered for the same period and locations. This accentuated difference between the data from 3<sup>a</sup> CBM and from IML can be due to the fact that some victims are taken from the beach to the hospital while still alive and then die at the hospital, so the case is not registered by the life-savers as a casualty. There are also victims whose bodies just disappear and are found later, when they are brought directly to the IML, without having been registered by the life savers. Even taking into account these factors, the number of casualties registered by the IML is still much greater to that registered by the 3<sup>a</sup> CBM. Lieutenant Ricardo Luis Dutra also informed us that for various reasons the Fireman corps was not in the habit of registering accidents, being more concerned with attending to them. Considering the number of casualties registered at IML and the information given by Lieutenant Dutra, that 50 to 100 accidents occur to each fatality, it can be estimated that 11550 to 23100 accidents must have occurred between 1987 and 1995 at the 25 beaches of the central northern coast of Santa Catarina initially mentioned. This corresponds to an average of 1443 to 2880 accidents per year.

### *In Situ Sampling*

Although the information collected has no quantitative meaning, it has important value for qualitative considerations and for beach safety management as a whole.

Generally, the environmental conditions of bathing accidents registered coincide with the modal characteristics of the beaches studied. The high percentage of accidents

occurred on clear days or sparse cloud conditions and under low wave breaker heights (less than 1,0m height) also depict the most favorable conditions for bathing, encouraging users to go to the beach and consequently exposing them to the beaches natural hazards. Visual observations of wave breaker heights in the central northern coast of Santa Catarina point to a modal wave breaker height in the Summer of 1,0m for the monitored beaches, except Praia dos Amores and Navegantes, where higher waves are observed. This observations explain the relatively larger occurrence of accidents associated with waves of 1,5 m to 2,0 m in height at Praia dos Amores. The large frequency of accidents (74%) registered in moderate to strong intensity currents and also the high frequency of accidents in rip currents (86%) alert us to the importance of such currents as decision factors in the issue of beach safety in the region. While at Bombas currents are generally weaker, at Praia dos Amores they are stronger and 100% of the accidents occurred in association with currents. This can be explained by the modal beach state of these beaches.

According to the natural hazard rating of beaches presented by Short & Hogan (1990) for Australian beaches (Figure 1), waves of less than 0,5m in height for all morphodynamic states observed at the beaches of central northern coast of Santa Catarina can be considered equally safe (moderately safe rating = 4-5). As the wave breaker height increases there is a direct increase in the natural hazard rating of the beach, and the intermediate to dissipative beach states tend to be the most hazardous. 41% of the accidents occurred under wave breaker heights less than 0,5m; 37% occurred in wave heights of under 0,5 to 1,0m and 45% of the accidents were registered in longshore bar and trough beaches; 20% in dissipative beaches and 13% in rhythmic bar and beach beaches. Considering this, the analysis of the beach safety rating table given in Figure 1 indicates that approximately 80% of all bathing accidents occurred under moderate safety

rating situations (4-6). About 15% occurred under a low safety rating (7) and these accidents were associated with dissipative and longshore bar and trough beach stages.

The higher occurrence of accidents among male bathers possibly reflects the closer affinity of males to bathing activities and their more fearless attitude towards the sea. The large percentage of victims unable to swim shows up as a strong social decision factor to the beach safety issue in all surveyed localities, while other factors as such place of residence, age and influence of alcohol assume variable importance in Atalaia, Bombas and Praia dos Amores.

In Atalaia beach particularly, despite the fact that all accidents occurred under wave breaker heights less than 1,0m, the presence of rocky obstacles in the surf and breaker zones determines the formation of strong rip currents which decreases the local safety rating. In this beach , the high occurrence of accidents among bathers of under 20 years old, and particularly among bathers under 12, points to age as a decisive factor of local beach safety.

Bombas is more protected than the other beaches and also does not present any local hazards, so it is a naturally safer beach. On the other hand, its safe appearance make bathers feel more secure to bathe and momentarily forget beach natural hazards. This is why in Bombas it can be said that social factors are much more decisive than environmental factors in local beach safety.

In Dos Amores beach the intermediate beach characteristics, the presence of constant and strong rip currents and relatively higher wave breaker heights were associated with user characteristics such as older age, non-acquaintance with beach environment (as indicated by the fact that most of the accident victims were from other countries or states other than Santa Catarina) and occasional use of alcohol also determines the local beach safety.

Despite the differences of the relative importance of social and environmental factors as decisive to beach safety at the studied beaches, according to the Short & Hogan (1993) public beach risk level classification, all of them are classified as intermediate public risk beaches.

## CONCLUSION

The historical evaluation of the issue of beach safety in the beaches of the central northern coast of Santa Catarina reveals the absence of registers regarding the subject, stressing the importance and necessity of registering accidents and gathering data. Otherwise the efficiency of the patrolling activities conducted by the Fireman Corps cannot be demonstrated as well, as there will be no information to ensure an effective management of the issue. Rough calculations estimate that 11550 to 23100 bathing accidents might have occurred from 1987 to 1995.

The environmental conditions of accidents seem to represent the modal environmental conditions of the studied beaches. Clear skies, wave breakers of under 1,0m in height, rip currents and longshore bar and trough and rhythmic bar and beach states are the dominant parameters.

The use of the beach safety and public beach risk level classifications suggested by Short & Hogan (1992, 1993) indicates that the majority of accidents occurred in conditions of moderate safety. Atalaia, Bombas and Praia dos Amores show intermediate public beach risk level. The acquisition of more data will bring new insight to the issue, particularly quantitative aspects of it.

In Atalaia beach the presence of rocky obstacles in the surf and breaker zones increases the local hazard rate because of the strong rip currents those obstacles generate. The most decisive factors in local beach safety are victims of young age (less than 12 year

old) and inability to swim. In Bombas social factors are the most important while in Praia dos Amores environmental factors, such as strong rip currents and relatively higher waves, combined with social factors, such as place of residence of users, age and the use of alcohol, define local beach safety.

The information obtained regarding the environmental conditions of occurrence of bathing accidents and the characteristics of accidents victims indicate the variability of environmental and social factors as decisive to the issue of beach safety in the studied beaches. Future research concerning the characterization of beach users should be carried out for effective evaluation of the contribution of victims' characteristics to public beach risk levels. Only quantitative studies regarding the above mentioned topics will guarantee the correct evaluation of the magnitude and nature of the beach safety issue in the central northern coast of Santa Catarina.

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