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GAMBLING WITH LIABILITY FOR ACCIDENTS ON BEACHES

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Public and private owners of beach property take calculated risks when they allow the public to use their beaches. In essense they gamble that the one in a million chance of an accident doesn't cost them a million. Accidents can and do happen everywhere--on the sand, in the surf, in the bathhouse, at the concession stand---but the mere fact that a beach user is injured doesn't mean the beach owner is liable for damages. It is only when the beach owner's breach a legal duty of care causes a visitor injury that legal liability risks arise. This paper describes a beach owners liability for visitor accidents and injuries caused by defective conditions or hidden hazards on the beach and in the water. It is based on a review of court cases and state statutes. In essence, the legal mistakes and misfortunes of others provide the basis for this discussion.

In legal parlance, the risk most beach owners face falls in a category called negligence. The law of negligence requires beach owners to exercise the degree of care of a reasonable and prudent person to prevent unreasonable risks of harm.[1] As the risk of harm increases the owner must adjust management practices to prevent the risk from becoming unreasonable. The owners degree of control over the beach and the water is essential in defining this legal duty. Other controlling factors include the visitors status, state recreation use statutes and tort claims statutes.

STATUS OF BEACH USER

In most states, the beach owners legal duty of care is determined by the status given to the visitor. Beach users are categorized as **invitees, licensees** or **trespassers** with each receiving varying degrees of legal protection. Basically, invitees receive the greatest protection, licencees moderate protection and trespassers scant protection.

Invitees are persons who are expressly or impliedly invited on a beach for some purpose connected with the beach owners business or for the mutual interest of both parties. Thus a user of a publicly owned beach, or a user who pays a fee to use a privately owned beach, is an invitee. The owner is not an insurer of an invitees safety. An owner has a duty to inspect the beach, water and related facilities to discover hidden hazards, remove those hazards or warn the invitee of their existance and to take reasonable precautions for the safety of the invitee.

A licensee is a visitor who is privileged to enter the beach by the owners consent and is generally referred to as a social guest. Visitors using a private beach with permission, but without paying a fee, would be considered licensees. Owners have a duty to warn licensees of known hidden hazards but they do not have a duty to inspect the beach and surf to discover hidden defects. If a hidden defect, such as a submerged pipe, causes an injury and the beach owner was unaware of its existence there is no liability.

Trespassers receive scant legal protection under the law. They are users who are on the beach without the owners permission or consent. As a general rule, beach owners do not have a duty to warn trespassers of any hidden dangers nor to protect them from such dangers.

A few states do not follow this tripartite system for establishing liability but hold the owner to a single duty of care for all users, except trespassers. The coastal states of Alaska, California, Hawaii, Louisiana, Maine, Massachusetts, New Hampshire, New York, and Rhode Island have abolish the licensee and invitee distinctions for establishing a owners duty of care.[2]

RECREATION USE STATUTES

In the absense of state statutes, the invitee, licensee, and trespasser rules apply to an owner who allows the public to use the beach for recreation purposes. Recently, there has been a statutory trend to changes those rules of law. Recreation use statutes in all states,except Alaska, Mississippi, Rhode Island and Utah, have altered the owners duty of care to the gratuitous beach user. Typical of the wording of these recreation use statutes is the Maryland Act providing that the landowner who invites or permits, without charge, persons to use their property for recreational purposes:

> "Owes no duty of care to keep the premises safe for entry or use... or to give warning of a dangerous condition, use, structure or activity on the premises to any person who enters the land for these purposes" or "Confer upon the person the legal status of an invitee or licensee to whom a duty of care is owed."[3]

A reading of these two sections suggests that the recreation beach user is downgraded to the status of trespasser. Thus, the beach owner is only liable for wilful or wanton misconduct which injures the beach user. In effect, recreation use statutes offer a statutory promise that an owners consent to free use of the beach will not subject the owner to liability for user injuries.

GOVERNMENTAL IMMUNITY

A beach users ability to recover for an injury caused by a hidden hazard is often based on the ownership of the beach. While the aforementioned standards of care have been applied to both public and private beach owners, the doctrine of governmental immunity must be considered. All the coastal states, except possibly Georgia, have judicially or statutorily abolished or modified the doctrine of governmental immunity thereby allowing lawsuits against public agencies for user injuries on their beaches. [4] Specific reference must be made to each statute to determine the exact basis for recovery.

HAZARDOUS CONDITIONS

In analyzing beach owners liability for accidents, specific types of forseeable risks presented by hazardous conditions must be assessed. The risks associated with beach usage depend on the physical characteristics of the beach, authorized recreation activities, beach user characteristics and water conditions. A beach owners duty of care is governed, in great part, by the risks associated with these conditons. A number of cases have arisen wherein the courts have considered liability of the beach owner for an injury or death which allegedly resulted from a condition in a bathhouse, deck, pier or other area in the vicinity of the water. In those cases where the owner was liable for injuries to the invitee, the courts found that the hidden defect presented an unreasonable risk of harm and the beach user acting in a reasonable and prudent manner was not aware of the condition. Illustrative of this line of cases is **Bilbao v. Pacific Power and Light Co.**, 479 P. 2d 226 (Oregon 1971) wherein the court found the owner of the beach liable for an injury sustained by a visitor who tripped and fell on an anchoring cable. Observing that the cable was rusty in color and blended in with the sand, that it extended 4 inches above the sand in an area heavily used by beach visitors, that at least one other person fell over the cable on the day of the accident, and that no attempt was made to mark the cable or warn of the danger, the court concluded that the cable was a hidden defect.

Contrary results have been reached in a number of cases where the injured party was aware of the hazard and continued the activity. Indicative is **Friedrich v. Dept. of Transportation**, 586 P. 2d 1037 (Hawaii, 1979), where a pedestrian, who was rendered a quadrapalegic as a result of a fall off a state owned pier, brought action against the state seeking recovery of damages. The Supreme Court held that evidence, including testimony of the plaintiff, supported findings that the danger of entering the damaged pier was obvious and that the plaintiff was fully aware when he chose his path, both of the conditions which created the accident and of risk that he might slip and fall and thus the state did not breach its duty of care to warn of hidden defects.

These cases illustrate that a owner who extends an invitation to the public to use the beach has a duty to inspect the premises to discover hidden hazards. After discovering hidden hazards that pose unreasonable risks of harm to beach users the owner has an obligation to remove the hazard or warn the user of its existance. A failure to issue an adequate warning constitutes an unreasonable bet in gambling with an injury and a lawsuit.

A second type of associated risk for the beach owner is presented by hidden hazards in the water where an injury results from the owner's failure to warn against deep water, objects floating or submerged in the water, diving in shallow water, or a condition of the water. In cases involving these risks, the courts have frequently held the beach owner liable. Thus in **Buchanan v. City of Newport Beach**, 123 Cal. Rptr. 338 (Calif. 1975) the court held that there was sufficient evidence to support a finding that the city's failure to warn of a dangerous surf condition was the cause of the plaintiffs injury. The facts in this case show that while the plaintiff was "body surfing" at a beach called the "Wedge," he was thrust down into the sand by the action of the wave he was riding, thereby breaking his neck. This beach was created by a construction of a jetty to protect the harbor entrance and from the depositing of dredged sand on the beach. The man-made condition of the beach, plus the interaction of the ocean swells against the jetty caused a refraction of the waves and at times produced a dangerous surfing condition. No warning signs were posted advising surfers of this dangerous condition even though the city had actual knowledge of the danger.

A related line of case holds that if a reasonable inspection would not reveal a hidden defect, or if a beach owner provided an adequate warning of hidden hazards and the user voluntarily encountered the danger the beach owner has no liability. Thus in **Wamser v. City of St. Petersburg**, 339 So.2d 244 (Florida, 1976) the city was not liable for an injury sustained when a swimmer was attacked by a shark at a city beach. The evidence disclosed that the plaintiff was swimming 25 feet from shore and about 15 feet from the lifeguard when the attack occurred. Prior to the attack there were no sightings of sharks in the area nor had there been any previous shark attacks at this beach in its 24 year history. The court concluded that in the absence of a reasonable forseeability of the danger, there was no duty on the part of the city to guard against an attack or to warn of such an occurrence.

SUMMARY

Accidents, injuries and liability present triple concerns for public and private beach owners. When accidents and injuries are caused by the owner's breach of a legal duty of care, liability may be imposed. The law is replete with case examples of owner liability based on the failure to protect beach users from unreasonable risks of harm. Several guidelines can be drawn from the legal misfortunes of others to formulate beach management practices.

When a owner invites the public to use a beach for recreation purposes a legal obligation is recognized by the courts. That obligation translates into a legal duty of care. The owner is not the guarantor of the users safety but must act with that degree of prudence and foresight of a reasonable man to prevent unreasonable risks of harm. Translated into a management practices the owner has a duty to:

(1) Inspect the premises to discover hidden hazards,

(2) Remove those hazards or warn the user of their existence, and

(3) Conduct operations on the beach with reasonable care for the safety of the visitor.

While the duty may be modified by state recreation use statutes, or tort claims statutes, the beach owner would be well advised to consider these management practices to minimize unreasonable legal risks.

REFERENCES

1. Prosser, William and Page Keeton, Law of Torts, 5th Ed., (St. Paul: West Publishing Co; 1984) p.164

2. Ibid, p.433

3. Maryland Annotated Code §§ 5-1103-1104

4. See Restatement (Second) of Torts, § 895 B for a status of governmental immunity.

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RISK MANAGEMENT AND COASTAL STORMS OF 1982-1983

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Living in California eminently qualifies me to talk about risks, since most of us in that state live with the threat of every natural calamity known to man; earthquakes, flooding, mudslides, brush and forest fires, carbon monoxide poisioning, you name it! We have adapted to the risk quite well with little thought given to the consequences, until immediately following a major event, and at that our awareness only lasts for a short time before we are back to business as usual.

Prior to 1983, one type of natural disaster we had not come to expect was major coastal events. And that is what I want to share with you today . . . California's experiences with its coastal storms of 1982-1983.

The California Coastal Storms of 1983 are grim reminders of the risk associated with development of coastal areas. Prior to the occurrence of those storms it was difficult if not impossible to articulate the adverse consequences that could someday result from major coastal disturbances.

It was difficult to envision storm waves powerful enough to crush concrete, splinter piers, and perhaps most incredible of all, sweep away the top eight feet of many of our reach areas. It was difficult to imagine tornados in Southern California--twisters strong enough to uproot trees and cause major damage to businesses and residences.

Yet, those were exactly the unusual weather phenomena that occurred in California throughout the storms of 1982-1983. Pacific storms pounded the California coastline with awe-inspiring 15-25 foot breakers that caused massive damages up and down the coast to numerous structures built of heavily reinforced concrete or protected by stonework.

Many questions remain unanswered in the wake of these devastating storms. Questions such as--how rare are storms, waves, and tides of this magnitude? Could a future storm be even more severe than the storms of 1982-1983? How can we best prepare our coastline to withstand repeated battering and severe erosion? Or even more dramatically--should we abandon existing coastal development and let nature take its course?

While only the passage of time can answer these questions adequately, we need to form attitudes about risks today in order to prepare for future coastal storms. These are attitudes which can take years to form, based on the ocean's cumulative effects on our coast. In addition we must have better coastal data on which to base important decisions. The development and refinement of design criteria, construction methods and use of good judgement in selecting building sites are keys to successfully minimizing the destruction of a major coastal storm. However, only a change in attitudes will prompt us to be more cautious.

I would like to focus my comments on two issues: first, a description of the devastating California coastal storms of 1982-83 and second, a discussion of how our coastal community must reassess risks in light of these storms.

The storms were primarily the result of the little-understood phenomena known as "El Nino". El Nino is a rare atmospheric and oceanic anomaly that is associated with the warming of ocean temperatures above the normal ranges. This warm current derives its name, the Christ child, because of its usual appearance off Peru around Christmas time. There have been eight significant El Ninos since World War II. They occur on an average of every four to five years, but irregularly.

The 1983 El Nino physically was the longest and most intense in recorded history. When it arrived it was awesome. Repercussions were felt throughout the world. It spread a swath of devastation, floods, fires, and starvation that left more than 1,100 dead, damage estimated at $8.7 billion, and human suffering beyond comprehension.

El Nino caused major climatic changes in three areas--temperature, pressure and current.

1. The temperature of the eastern equatorial Pacific Ocean was unusually warm and for a longer than normal period of time. Warmer than normal water covered the entire eastern equatorial Pacific Ocean. Instead of lasting 1-2 weeks as it has in the past, it lasted over one year.

2. There was a seesaw effect as the normal low pressure zone in the western Pacific switched places with the usual high pressure in the eastern Pacific.

3. The perennial winds and currents died and reversed direction.

Normally winds blow from east to west or from the South American coast westward toward Australia and Indonesia. This reversal in the wind patterns and warmer than normal ocean temperatures pushed ocean waters against the Pacific Coast of North and South America, and in California brought the storm from farther south than normal. These shifts brought torrential rains, winds, and high waves to the Southern California coastal region. A factor which significantly increased the destructive power of the storms was their occurrence during high tides. It happened that the highest waves during three of our storms arrived at the same time as the highest or second highest tides of the month.

In addition to all of this, the accumulated beach erosion that had resulted from previous 1982-83 storms (and there were about 7 distinguishable events from November through March) left many piers, homes, and other structures unprotected from the onslaught of the heavy breakers. Thus, damages from the March storm exceeded those of any of the other earlier storms of the 1983 winter.

The 1983 storms were far more harmful to our coast than storms we have known in the past 30 to 40 years. Although we probably will never be able to prepare completely for major events such as those we experienced, it's easy to see how attitudes can become relaxed during a time of unusually calm weather.

There simply was not time to repair the beaches after the January storm, and so the protection they might normally have afforded was gone when the even more severe storm came in March. Beaches along Los Angeles County eroded an estimated 50-100' inland.

Every coastal county in California experienced damage as a result of these storms. Total damages to coastal areas are estimated at $115 million.

Southern California's piers also provide an example of how structures were attacked by these waves. While pilings are always being pounded by storms, the waves don't normally reach the decking, but they did in 1983. Damage to decking weakened the overall pier structure, causing reinforced concrete to fall.

The effect of the storms on the 80-year-old breakwater at Los Angeles Harbor sums up the experience at many harbors along the coast. The breakwater, constructed over a 14 year period, from 1899 to 1912, had never suffered major damages before this series of storms. Built pyramid-like out of rectangular granite, with capstones weighing 10 to 20 tons, only minor repairs have been required in the past--such as single capstone replacement. In the January storm the breakwater held, although there were some damages. The March storm, however, did severe damage. The breakwater held for the first day, but finally sustained damages when the wave heights reached 15 to 25 feet, considerably above the design wave of 17 to 19 feet that is currently used for harbors on the Southern California coast. The result was the creation of a 350-foot gap in the middle of the breakwater and several small gaps 40 to 50 feet wide.

While damage at the LA Harbor Breakwater was most dramatic, publicly maintained harbors required repairs totalling $25 million. In overview, the storms of 1982-83 devastated many coastal facilities, both public and private. Clearly, the risks of serious storm damage were far greater than we realized and for which we were prepared. The challenge for the future will be to revise our attitudes about risk and adjust our efforts accordingly.

Just looking at the history of development along our coast may help us to understand attitudes about risk in our local coastal communities which have developed over time. As long as sea bluffs and coastal areas were left undeveloped, erosion did not present major economic or public safety problems. However, the pressures of land speculation and development at the ocean's edge and along the bluffs have encouraged people to build more densely. As this process has accelerated over the past two decades, expensive residential structures have been built in high-risk locations. Much of this construction has, in fact, taken place during the last thirty years--years which until 1982 have been unusually mild. Clearly, the storms of 1983 were so much more severe than other storms in recent history, they tested the coastal community's assumptions about risk.

Some of the adjustments we need to make relate directly to coastal design practices. But before we can make such adjustments we must have better coastal data. That is why the Corps of Engineers has embarked on a state-wide effort to gain a better understanding of what specifically makes our shoreline change, and how human activities influence those changes--that effort is known as our Coast of California Storm and Tidal Wave Study. Hopefully this effort will be a model for similar studies throughout the United States. From this type of data perhaps we can do a better job of articulating risks.

We know that these storms were rare events, but just how rare, we can't say. Some oceanographers and meterologists suggest that our good weather of the past 40 years is not going to be repeated. They predict worse storms, and more extreme high tides during storm seasons in the next ten years. Larger waves may be expected in future storms, and Pacific hurricanes may again reach the California coast as they have in the distant past.

A second adjustment which can be made is to discourage irresponsible and dangerous coastal building practices. We know that even some of the newest and best-designed structures suffered damages during the storms, but many structures built dangerously close to the water were completely destroyed. With proper education of our coastal community, we can minimize construction of unsafe structures by those who do not comprehend the risks of building along the coast. By making an effort to educate our coastal community through conferences such as this, we can encourage an awareness of the risks.

Ideas about risk are attitudes. The severity of these storms requires attitude adjustments--we must learn from our mistakes. In this way we can adjust our agency and public attitudes. While our agency's attitudes about risks may be significantly more conservative, our actions are guided by our responsibility to protect the significant economic benefits associated with a safe and secure coast.

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PHYSICAL CONSTRAINTS AND HAZARDS VERSUS COASTAL RESOURCE USE AND DEVELOPMENT

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I - Introduction

The theme of the meeting concerns the risks that are inherent in coastal resource use. This paper focusses particularly on a number of risk-related problems in the U.K., and elsewhere, with reference to several recent hazard situations.

In a forthcoming book on coastal zone management (Jolliffe & Patman, 1985), it is argued that coastal resource use and development are influenced by a broad array of physical constraints that serve to prevent certain activities and inhibit the levels of others. In the more extreme cases, use is severely inhibited because of the risks (or hazards) involved. Physical constraints are either imposed by the natural environment or represent deliberately-earned risks emanating from man's activities. Thus, for example, the 'normal' erosion anticipated from storm wave action may be exacerbated by ill-conceived coast protection works. In general, risk levels have increased, and will continue to increase, if only because of man's increased presence in a generally dynamic environment - for with the rapid and often uncontrolled, expansion of coastal zone activities, there are often too many people in the wrong place at the wrong time!

In Britain, before enactment of the 1947 Town & Country Planning Act, coastal zone development had already spread rapidly beyond the fringes of the traditional resort areas. The nature of the demands then being made on the coastal zone, and the principal factors that led to this expansionist activity, are generally well-known and need no discussion here. However, from a risk standpoint, it is important to emphasise that many constructional developments, people and their activities now occupy risk zones, some (as in the case of some U.S. East Coast barrier islands) in high-risk situations. Coastal zone planners and managers, faced with this dilemma, need sensible, operable guidelines; it is timely for them to heed the sometimes painful lessons learned by their predecessors, and from the on-going experience of other maritime countries.

II - Some of the Kinds of Physical Constraints and Hazards that have to be Managed

A broad array of physical constraints both emanate from, and in turn affect the whole of, the coastal zone. Problems of coastal zone definition left aside, it is convenient here to make a simple tripartite division of the coastal zone into the hinterland, littoral and offshore zones. Within each of these three zones, one can distinguish between so-called endogenous or 'locally imposed' and exogenous or 'externally imposed', constraints - or what some geomorphologists describe as systematic variability components (SVCs) and asystematic variability components (AVCs). It raises the question of planning scale, since it is rare that the 'boundaries' of geomorphological systems closely conform to existing administrative boundaries. Thus, the deafforested catchment basin, the upstream barrage, the along-coast marina, or the offshore dredging operation may all have serious (hazard related) ramifications for a given administrative area at the coast; environmental impacts may be imposed from distance, and temporal delays may complicate a given situation. Then it is a strong case for bringing formal and functional systems more into line.

A core issue is that of magnitude, frequency and duration. A continuously-running tide race imposes fairly predictable controls on coastal zone resource use; the sporadic hurricane poses greater problems; while the comparatively short-lived effects of a single substantial oil spill will be seriously compounded by a close-running series of substantial oil spills in the same area. Magnitude, frequency and duration combine to produce a multiplicity of environmental situations.

Littoral zones characterised by fast-running tides or frequent rip-currents are largely self-deterministic in respect of the resource uses they permit. But what of the stretch of coastline that experiences only occasional serious storm surges and consequent flooding? To what extent does one sterilise coastal resource use, or create a moratorium on further development along that coastline? What precise part does (or should) the magnitude, duration and frequency factors in hazard situations play in coastal zone planning and management?

What kind of physical constraints operate? In general terms, these are comprised of:- aspects of river regime (particularly river levels and fluvial flow conditions); the nature of coastal land strip topography, geology and substrate conditions; sea level fluctuations including sea surface geometry and motion; nearshore and offshore flow conditions; sea-floor topography and substrate conditions; coastal pollution; and scenic quality (an aesthetic factor). The activities of Man, and their environmental impact, are highly relevant also. Such constraints and hazards may operate independently, and on other occasions in conjunction as when storm-wave activity is superimposed on abnormally high water levels. Some operate continuously; others, and often the most damaging, occur only very sporadically.

Below are a random selection of typical coastal zone constraints. In the hinterland zone, many areas are affected by occasional river flooding. At Christchurch in New Zealand, for example, the Heathcote and Avon Rivers have subjected the city to serious flooding during periods of prolonged heavy rainfall or high spring tides. Unstable substrates may present difficult, expensive and sometimes intractable foundation problems; in the case of a sand dune area near Dunkirk in northern France, a new steelworks called for special adjustable jacks, which were deemed to be justified on the grounds of the general importance of the project.

In the littoral zone, problems of coastal erosion abound, ranging from small scale weathering losses to major losses of coastal land. Erosion may be highly beneficial in terms of coastal sediment budget and the feed-back processes that operate to remove storm wave energy. The problem arises with man's presence in erosion-liable areas, with resultant loss of valuable land and the threat to buildings, highways and even human life. The nature of the beach surface and substrate may both favour and inhibit resource use: steep, loose gravel beaches may render boat-launching extremely difficult, yet greatly favour shore fishing. Gently-sloping firm sand beaches may (in macro-tidal areas) greatly inhibit reasonable water-space use at low tide, yet afford excellent areas for sand-yacht racing, etc.

Littoral zone pollution, somewhat ironically, tends to be most constraining at peak tourist times; however,for the tourists themselves it is usually a question of 'ignorance is bliss', since people bathing in sewage-contaminated water are usually unaware of the risks of contracting hepatitis, gastro-enteritis, etc. Sterilisation of beach/water space resources is increasingly commonplace, such as the recent closure of some of the Metro Toronto public bathing beaches on the northern shore of Lake Ontario. In the summer of 1984, the government in Lisbon, Portugal, had cause to seek to impose a ban on beach use at Estoril.

Offshore zone constraints stem very much from the fact that this is a naturally hostile environment capable of wrecking all of man's structural efforts. Man's very presence in the offshore zone involves an element of risk; in Britain, statistics suggest that offshore divers are at greater risk than miners working underground. In high-activity zones like the Dover Straits or the Malacca Strait, risk-levels, e.g. because of ship collisions or groundings, increase significantly. Accidents at sea may arise from fairly subtle circumstances, such as the settling en-route of bulk cargoes like sand and gravel, or because of centre-of-gravity shifts as lobster-pots are filled onboard. Such risks involve virtually every laden voyage; in contrast, risks to water-space users in the Bay of Genoa, Italy, in July 1984 due to thousands of poisonous jellyfish was unpredictable and a fairly rare occurrence. On the other hand, in the Gulf of Mexico, at least ten categories of marine fauna are poisonous; presumably, they are there for most of the average year, pose a threat to water-space users, and focus attention on the importance of suitable 'public education' in such matters. Foundations problems are commonplace: those of rig stability on shallow substrates, and the exhumation of, and structural stresses on, undersea pipes and cables, are cases in point.

These, then, are but a very few isolated examples taken from a veritable welter of physical constraints and hazards, spatially and temporally variable in their magnitude, frequency and duration - and, for numerous coastal areas, superimposed and even misunderstood. Constraints imposed by the natural environment are increasingly being reinforced by deliberately-earned problems (that often involve risk) that stem from man-made structures and man-induced practices.

That risks are constantly being encountered and that new risks are being generated in the coastal zone has been highlighted by a flurry of quite recent events. In September 1984, Hurricane "Diana" stalked the Carolina coastline, U.S.A.; while in October 1984, Hurricane "Josephine" travelled some 200 miles out from the same coastline, fortunately tracking oceanwards; we experienced the accidental discharge of radioactive waste from the Sellafield nuclear plant, leading to water, beach and estuarine contamination and the closure of many areas to the public while governmental checks were carried out. In the English Channel, the collision of the French freighter 'Mont Louis' with a car ferry 'Olau Brittania' led to total loss of a large cargo of hexafluore uranium en-route between Canada and the Soviet Union. The potential hazards of such shipments are abundantly obvious, and extremely lethal.

III - Some of the Relationships between Constraints/Hazards and Uses of Coastal Zone

With regard to the degree of constraint on use levels, and the levels of risk involved in particular coastal zone uses, a line spectrum exists. At one end of the spectrum, probably all normal use of the coast itself is precluded - notably in high-energy zones and particularly where access to the coast from the hinterland or from seaward is extremely difficult; somewhat ironically, wildlife interests are best served in these coastal zones though the public at large benefits little from this. At the other end of the spectrum, one can argue that highly permissive environments exist, in which (in theory at least) virtually all legitimate uses of the coastal zone are possible. In between these extremes, a broad array of environmental possibilities exist, advantaging some uses here, constraining other uses there; thus presenting planners and managers with a range of options to establish optimal use patterns according to local, regional, national, and even international requirements. Whether the choice of an optimal use pattern is ever actually achieved in this spatially variable supply, and highly volatile demand, situation is quite another matter.

Because of both spatial and temporal variations in the operation of physical constraints and hazards, planners and managers are faced with a fairly limited range of 'broad' options to deal with them. Do nothing - live with the environment and take what comes? Vacate hazard zones and create a moratorium on any further development there? Remain in the hazard zone, and try to adapt to hazard situations in order to minimise the impacts?

Even more fundamental is the question whether planners 'sterilize' use of coastal zones subject to risk; or whether they 'de-sterilize' other zones (that are also subject to risk) in the face of limited resource supply or underused resources and increasing resource demands? Resource trade-offs are an important facet of risk management, e.g. the use of marginal agricultural land for trailer-parks in areas of manifest flood and erosion risk. A distinct problem arises if such trade-offs lead to substantial resource transfers, e.g. where the private sector benefits from coastal resource use and development and the public sector is disbenefitted because of, say, massive sea defence and coast protection expenditures.

A problem arises from the fact that in many maritime countries, coastal zone hazards have not been properly or fully identified and mapped. However, for many types of risk, this would raise almost insuperable difficulties anyway - such as the sporadic dispersion of radioactive waste, or the stochastic variables inherent in the conveyance of hazardous substances at sea.

IV - Some Important Aspects of Coastal Risk Management

What seem to be some of the fundamental problems in the coastal risk field? The following discussion embodies some of the principal points to emerge from a recent Economic & Social Research Council meeting (Macgill, 1983):

(1) Risks to life and property in the coastal zone call for an improved knowledge-base. In Britain, the risk research field is a relatively immature one and throws up many challenges for geomorphologists, decision-makers and others.

Physical descriptions, allied with relevant societal issues, that estimate risk are badly needed: to enable us to identify the sources of, or factors leading to, potential harm, the nature of the 'injury' it may occasion, the population at risk, the likely frequency of the hazard, any time lag, the potential for early-warning, whether the problem is increasing (fast or slow) or diminishing, and areas in which knowledge is uncertain or incomplete (Macgill, 1983).

(2) Risk perception ranges from the rational to the irrational; and often disagrees markedly with the physical specification of a risk situation. Even in cases of manifest risk, coastal users may choose to ignore warnings or simply fail to appreciate the potential risk situation. For example, it is not an uncommon occurrence for people to be stranded by a rapidly-rising tide, as happened fairly recently on the extensive mudflats of the Bristol Channel, U.K. - almost with loss of life. A perception study conducted among bluff-top property-owners at Scarborough, Ontario, revealed a generally poor appreciation of a manifestly obvious erosion threat. Absence of manifest risk, on the other hand, may be due to 'ignorance' - people at risk being blissfully unaware of the potential hazard they face. In the summer of 1984, for instance, bathers at Santa Eulalia, Ibiza, in the Mediterranean, were happily committed to a water-space grossly and obviously contaminated with only partially-treated sewage effluent! In this context, it seems that risk management is often reactive rather than anticipatory; that lack of appropriate concern is often accompanied by administrative uncertainty, apathy and complacency. We should, perhaps, be taking a more positive stance in the anticipatory approach to risk evaluation, and to the amelioration of anticipated problems.

Societal acceptance or absorption of risk is yet another 'grey area' involving such factors as risk-benefit trade-offs and compensation. In the U.K., the thorny question of compensation as a possible mechanism for ameliorating risk situations, is an idea winning increasing support - but in reality needs research into whether risks are perceived, residual, uncertain or reducible. Compensation in coastal zone matters is obviously a political minefield, but one we can't sweep under the carpet! What do you say, for instance, to a coastal landowner who offers 'selfhelp' (dumped car-bodies or rip-rap, say), is refused permission, and is then refused compensation!

(3) Public participation in risk decisions, in Britain, finds its most celebrated mechanism in the Public Inquiry - but although conspicuous, has it would seem a relatively limited applicability in the context of a full range of coastal zone issues, being restricted generally to those that come under the heading "new development to land" (Macgill, 1983). Nor does one have enormous faith in the outcome of a public inquiry; in one research study, I had occasion to analyse the papers pertaining to two beach mining inquiries and was most unimpressed by the quality of the evidence put forward by both the appellant and the antagonists, and by the reasoning that followed this evidence. Notwithstanding such reservations, public inquiries at least partially ventilate what are often highly emotive environmental issues.

(4) On information matters, there has been much criticism by antagonists in risk debates of the absence of anything approaching a 'freedom of information' act in the U.K. However, the lack of information disclosure (i.e. information that in principle is available), there is the problem of information that still has not been collected. In fact, serious gaps are evident, as appeared to be the case in the recent Sellafield incident in the U.K. when a number of thorny issues concerning the dispercion of radioactive waste were raised at public level. Acceptable assurances were slow in forthcoming. Gaps are occasionally evident in the technical assessment of a realized hazard. How the U.K. fares on the information issue in relation to other maritime countries is questionable - but without doubt, it opens up a barrel-of-worms in respect to rights, democracy, and the like!

One prescriptive goal might be the establishment of information guidelines (something along the lines of the EIA procedures, perhaps), since 'reliable and trusted information is a crucial factor in the resolution of environmental conflict' (Macgill, 1983). This argues for interagency trust, and for public trust in those agencies; Macgill contending that one point that strongly emerges from perception studies is that the lack of faith in institutions is not merely a symptom but can be an important catalyst in risk-related concerns. This appears to be true, for instance, of nuclear waste disposal in Britain. The media must take a rap-on-the-knuckles in all this, for they have on occasions blown issues up out of all reasonable proportion. Perspective in risk issues is badly needed.

One recalls the Sellafield, Cumbria, U.K., incident in November 1983, referred to above. British Nuclear Fuels Limited (BNFL) discharge radioactive waste into the Irish Sea and, as in previous years, this has given rise to the highest exposures - though levels are said to be decreasing. The problem that arose in 1983 was because "plant washings" were accidentally transferred to a sea-tank. Human error in this case has given rise to a great deal of public disquiet, notably a lack of confidence in BNFL. Thus it seems that what the nuclear community should worry about is not a lack of technical knowledge but the mistrust in which it is apparently held by large sections of the public. This mistrust has been fed by a long history of false statements by both the proponents and opponents of nuclear power (Macgill, 1983). New standards of objectivity are needed; the need to bridge the gap between so-called 'scientific arrogance' and public perception of coastal zone issues.

(5) Risk management raises the problem of the mismatch between technological development and our ability to control potentially adverse effects. Remedial measures may lag behind technological development, and be either too generous or too weak in their response. Hard evidence of the mis-match is found in near-misses and realised incidents involving the handling and transportation of hazardous substances at sea. As mentioned earlier, in the English Channel, the collision in early 1984 between the French freighter "Mont Louis" with a car ferry "Olau Brittania" led to the total loss of a cargo of packaged hexafluore uranium en-route between Canada and the Soviet Union. Despite that fact that all of the containers were eventually retrieved intact, it could have been a very different story. It rightly raises the question whether the gap between our capacity to control hazards and the magnitude of hazard problems is widening or narrowing? There is, in fact, an enormous variability between coastal zone agencies in the extent to which risk reduction opportunities are exploited and risk-benefit trade-offs are approached (Macgill, 1983).

(6) There are serious questions to be asked about our predictive capability in Britain. This problem was sorely exposed when in February 1979 serious flooding occurred at Chesilton in Dorset - and in spite of serious flooding there in December 1978. A seemingly innocuous depression in the western Atlantic tracked fairly predictably across as far as the mid-Atlantic before filling in - but not before it had bequeathed a lethal package of exceptionally long wave energy and excessive wave heights, destined in course of time to hit South Wales, virtually the whole of the south coast of England, the Channel Islands, and the coasts of Spain and Portugal. As the energy package passed each monitoring station, there was no hint that it was targetted on the Chesil Bank, Dorset, U.K., in particular; rather like an Exocet missile homing in on H.M.S. Sheffield in the Falkland Islands incident! The price we are still paying for this particular coastal hazard is high indeed.

The same could be said in September 1984 of "Hurricane Diana", blowing off the U.S. East Coast. Winds of up to 150 m.p.h. led to widespread flooding of the North Carolina coast. The British media reported that in this traumatic situation a state of emergency was called; 100,000 people were said to have moved inland as "Diana" approached, clogging state highways and turning the port city of Wilmington into a "ghost city". More importantly in a sense, it appears that the eye of the hurricane was several miles offshore 'with no sense of direction' according to the National Hurricane Center in Coral Gables, Florida. It is interesting to speculate to what extent disruption could have been reduced had predictive capability enabled "Diana's" direction to be more certainly determined.

(7) There are very real problems with respect to risk management set against economic stringency. For example, at West Bay in Dorset, U.K., one family business (representing the private sector) has, for a long period of time, profited from beach mining operations carried out on one side of the harbour. The profits are derived from the removal of a wave-sorted pea gravel that has numerous industrial applications.

The beach on the other side of

the harbour represents all mayhem - there is very little of it left, and this has had to be defended with yet another coast protection scheme. The total public investment to date, in capital and recurrent expenditure on sea defence and coast protection has been enormous. This amounts to a massive resource transfer between the public and private sector; and now at a time of economic stringency.

At the seaside resort of Weymouth, a few miles along the coast, the local authority (subsidised up to 75% of the total cost by the Department of Environment) have recently spent a figure approach £0.4M to protect one public-house and three cottages. The erosion problem has been transferred to the end of the extended seawall, where it will continue to remove land of significant amenity value!

There are also impending U-turns in risk-abatement policy. In September 1984, while "Hurricane Diana" was trying to make up its mind in the western Atlantic, considerable concern was being expressed around southern Britain about the possibility of a repeat of the disastrous coastal flooding (and accompanying erosion) caused by a tidal surge in 1953. That particular incident killed 307 people in the U.K. alone, not to mention > 30,000 animals. In September 1984, we experienced the highest (equinoctial) tides for four years, and around East Anglia tides were actually running higher than in 1953. According to "The Times", the Chief Engineer of the Anglian Water Authority was "within 15 minutes of pulling the plug and evacuating the town of Harwich". The situation is, it seems, that although the authority currently enjoy a budget of some £1.5M/yr for sea defence maintenance, they are going to need at least £5.5M/yr guaranteed for the next 20 years if the status-quo is to be maintained. In the present economic situation, this is highly unlikely - so crumbling sea defences can only face a general policy of abandonment, particularly in areas of low population density and agricultural quality. However, it would be surprising if more heavily-populated areas and higher quality agricultural land does not continue to enjoy proper protection. It is an interesting environmental sum, in an area of manifest flood and erosion risks. Somewhat ironically, the 'abandonment' strategy is much in accord with the notion of 'feeder bluffs' in areas experiencing significant erosion.

(8) A fundamental problem arises ouf of the mismatch between formal and functional systems. The coastal zone is a system that functions in its own right; the various sub-systems that make up its constitutent parts often display (in the absence of human interference) a state of dynamic equilibrium. A recurrent theme in this conference will be the fact that man is a disruptive influence, promoting short-term changes within a framework of longer term (geologic) swings-and-roundabouts. This sad mismatch between the operation of natural systems and anthropogenic impact is no better exemplified than at East Head, West Sussex. The National Trust, who own East Head sand spit, face a serious terminal scour problem at the critically thin neck of the spit - already, about one-third of this narrow portion has been lost. A total breach into Chichester Harbour would have far-reaching ramifications that would be difficult to assess but cannot reasonably be ignored. This is, in fact, a classic example of fragmented jurisdictions, blinkered local authorities a lack of suitable communication channels, and a paucity of background information. As things stand, there are four local authorities all doing their own thing, all creating erosion and flood risk for adjoining auth-

ority sectors, and barely willing (with the exception of the National Trust) to get together to discuss the problem!

Concluding Comment

It has been said that research into coastal risk management in Britain is relatively immature. This is manifest also in our risk management infrastructure. Even at the time when this paper is being despatched to the U.S. Coastal Society for inclusion in the conference proceedings, one reads in "The Sunday Times" of 18/11/84 that Britain's beaches are increasingly threatened by dangerous chemicals washed ashore. Between September 1982 and September 1983, 130 containers (that included 41 different hazardous chemicals), some of them highly dangerous, were washed up along the shores of England and Wales. The Department of Transport, which has overall responsibility for chemical cargoes, admits it has no central register. This may indicate the 'tip of the iceberg' as far as risk management in general, in Britain's coastal zone, is concerned. It needs a thorough overview as a matter of some urgency, so that coordinated and effective action can be taken.

Acknowledgements

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THE IMPORTANCE OF DATA IN COASTAL MANAGEMENT MURRELLS INLET, SOUTH CAROLINA

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Introduction

Management decisions concerning the coast require a comprehensive understanding of the coastal processes. Data from the specific coastline and general models of coastal processes are needed. This paper discusses a coastal data collection program used in the management of Murrells Inlet, South Carolina.

Murrells Inlet is a tidal inlet about 10 miles south of Myrtle Beach, SC and 80 miles northeast of Charleston, SC (Figure 1). The inlet serves private recreation craft and a small commercial fishing industry. North of the inlet is Garden City Beach, a rapidly developing coastal town with many boat docks and ramps. South of the inlet are Huntington Beach State Park and North Litchfield Beach, SC.

Congress authorized navigation improvements for Murrells Inlet in 1971 under provisions of Section 201 of the Flood Control Act of 1965. Construction began in late 1977 and was completed in 1980. Major features of the project are two jetties, a navigation channel, a weir section in the north jetty, and a sand deposition basin (Figure 2). The weir section was built at a low elevation to allow sand to pass over it into the deposition basin during periods of southerly sand transport. A dredge can periodically remove sand from the sheltered deposition basin and pump it to nearby beaches.

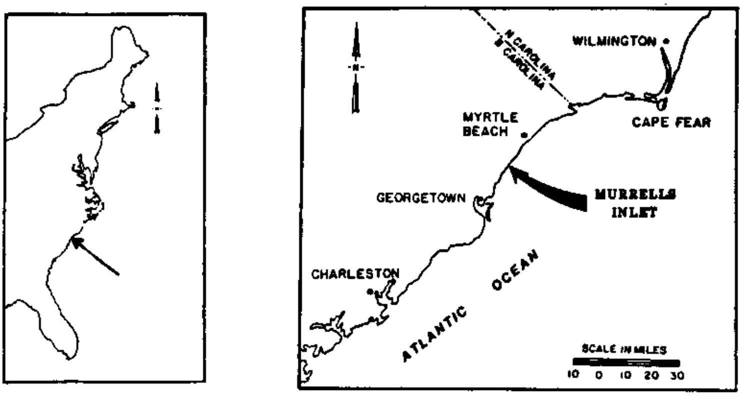

Figure 1. Location map

The jetties are over a half-mile long and are of typical rubble, quarrystone construction. The crest of the weir is at the mean water level (+2.2 MLW). The rest of the north jetty and all of the south jetty are built to an elevation of nine feet above mean low water (+9 MLW). The south jetty is capped with an asphalt recreation walkway. As part of the project, the navigation channel was dredged to a depth of -10 MLW and the deposition basin to a depth of -20 MLW. More than a million cubic yards of sand from these two dredging projects was pumped to beaches at Garden City Beach and Huntington Beach State Park. Shortly after construction began, the Corps of Engineers started monitoring the effect of the navigation project on the inlet and nearby beaches.

This paper briefly describes data collected in the monitoring program, presents some analysis of that data to form a picture of coastal processes at the inlet, and discusses the importance of this for management decisions.

The Data - The Monitoring Program

An extensive set of coastal data has been collected at Murrells Inlet under the monitoring program. The purpose of this program is twofold;

(1) to provide site-specific information for management of the Murrells Inlet project, and
(2) to provide general research data documenting coastal response to a jetty project.

Both the beach response to the new jetties and the wave climate forcing the response were measured.

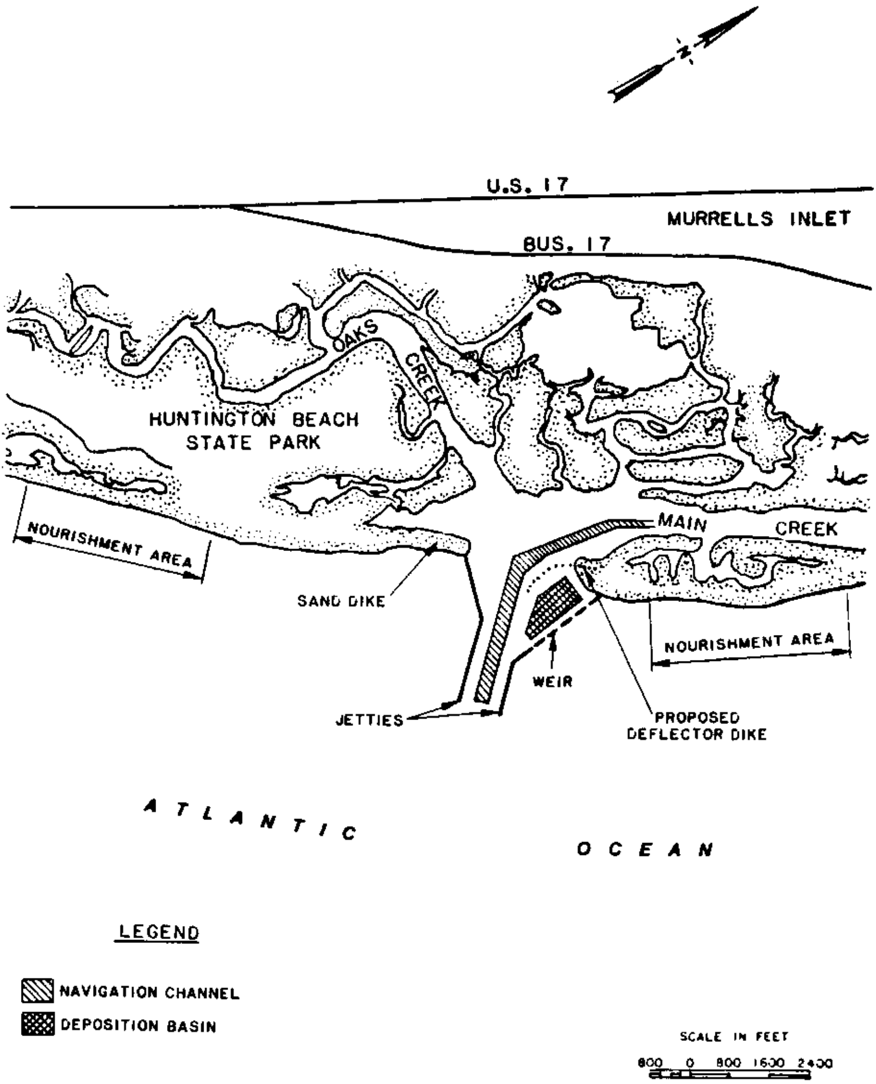

Figure 2. Murrells Inlet navigation improvement project.

Waves

Visual observations of the surf were taken daily for five years. The Corps of Engineers visual wave observation program is called LEO (Littoral Environment Observation). Daily visual observations of the wave, wind, and beach conditions are made at the same location by the same observer. Specifically, the following were estimatied daily at the four sites shown in Figure 3; breaking wave height, angle of breaking wave to shoreline, wave period, longshore current speed and direction, type of breaker, width of surf zone, beach slope, and wind speed. The four stations were set up to see the variation of the wave climate at different locations along the coast. There are limitations to the accuracy and usefulness of LEO data since it is taken visually. The primary value of LEO data lies in relative comparisons more than in absolute numbers.

Beaches

A primary goal of the Murrells Inlet monitoring program is to quantify beach response to the jetty project. The most dramatic change has been formation of a large, emerged sand bar and a lagoon on the south side of the inlet. Beach changes have been measured by beach surveying and aerial photography.

The largest part of the monitoring program is surveying of the beaches. Elevations along 43 profile lines were surveyed quarterly for the first four years after construction began. The profiles are located as shown on Figure 3 to cover much of the coastline while focusing on the inlet. In the immediate vicinity of the jetties, profiles are spaced at 500 foot intervals along the beach. Between roughly 3/4 mile and 2 miles on both sides of the jetties, profiles are spaced 1000 feet apart. Profiles continue at 5000 foot intervals to Midway Inlet to the south and beyond Kingfisher Pier to the north. Overall, the profiles cover 14 miles of coastline centered at the inlet. The profiles spaced at 500 foot intervals are aligned with the jetties. The other profiles are perpendicular to the 1977 coastline.

The landward portion of the profile is measured with level and rod at low tide in order to wade as far out on the profile as possible. The underwater portion of the profile is surveyed with a fathometer at high tide to overlap some of the beach which was surveyed by wading. The profiles are surveyed from behind the crest of the sand dunes to a depth of -18 ft MLW to cover the bulk of the active portion of the profile. Profiles far from the inlet are less than a half mile long. Some of the profiles near the inlet are almost 2 miles long.

Beach changes have also been monitored with aerial photography. Aerial photos of 14 miles of beach, centered on

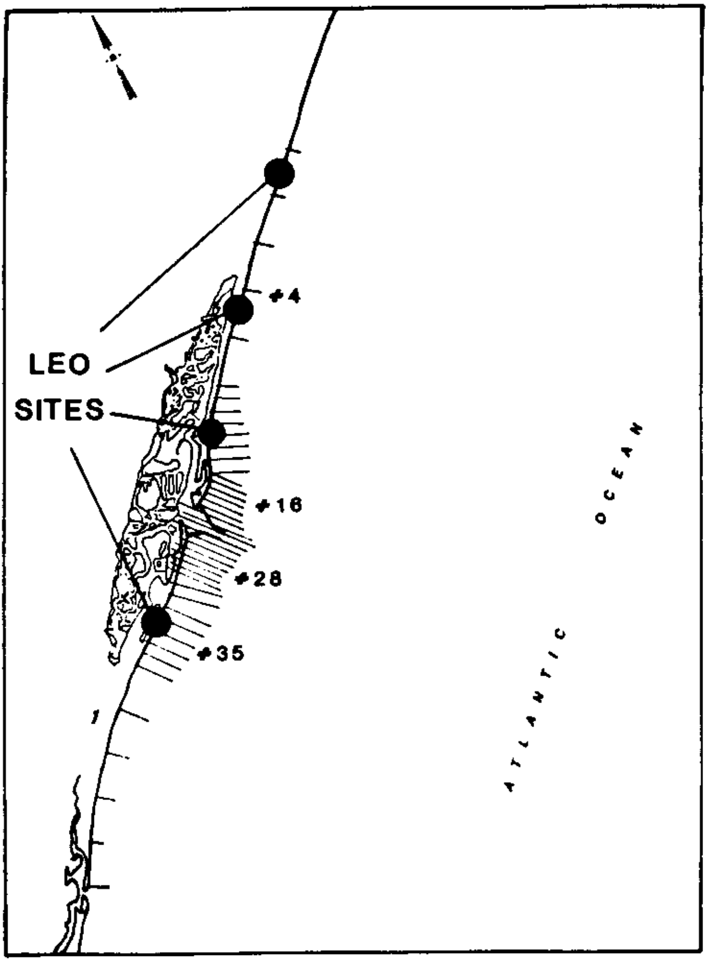

Figure 3. Location of beach profile lines and LEO sites.

the inlet, were taken monthly until October 1982, then quarterly. The flights were scheduled to coincide with low tide. The photos are an excellent qualitative history of the jetty construction and beach and inlet changes. They can also be used for quantitative analysis since ground control was included.

Inlet

The Charleston District of the Corps has closely monitored the inlet area since construction of the project. Quarterly site inspections by District engineers supplement survey trips and aerial photos. In addition to the beach profiles which include the inlet area (Figure 3), seperate surveys of the deposition basin, navigation channel, shoals, and the jetty stones have been made periodically.

What The Data Show - Analysis of the Data

Estimates of littoral drift

Longshore sand transport rates have been calculated from the LEO data. Results indicate that much sand has moved in both directions and that the net direction of transport varies with time and location. Sand transport estimates from LEO wave data are extremely sensitive to observer biases. Since different LEO observers were used, the averaging of results through time was avoided. However, trends in the direction of net transport at the four sites are clear (Figure 4). During 1979, the direction of net transport was north at all four sites. However, for 1980-1982, the direction of net transport was toward the inlet from both sides. This result could either be due to a local reversal in transport caused by the shoals and jetties at the inlet, or the inlet was a nodal point for sand transport along the South Carolina coast from 1980-1982.

Beach changes

Beach changes will be summarized considering the four profiles numbered on Figure 3. Each of these four profiles is characteristic of a stretch of the beach. Figure 5 shows the changes on each profile during the first four years of monitoring.

Profile #4 is characteristic of the beaches far away from the inlet on both sides. These beaches have not changed significantly.

Profile #16 is in the north nourishment area, the area where sand was placed during dredging of the inlet channel and deposition basin. The quarterly surveys indicate that the beaches in the nourishment area had come to a new equilibrium profile by April 1982, over a year after beach nourishment. The beach is much wider than before nourishment. It should be noted that profile #16 is close enough to the north jetty to be sheltered.

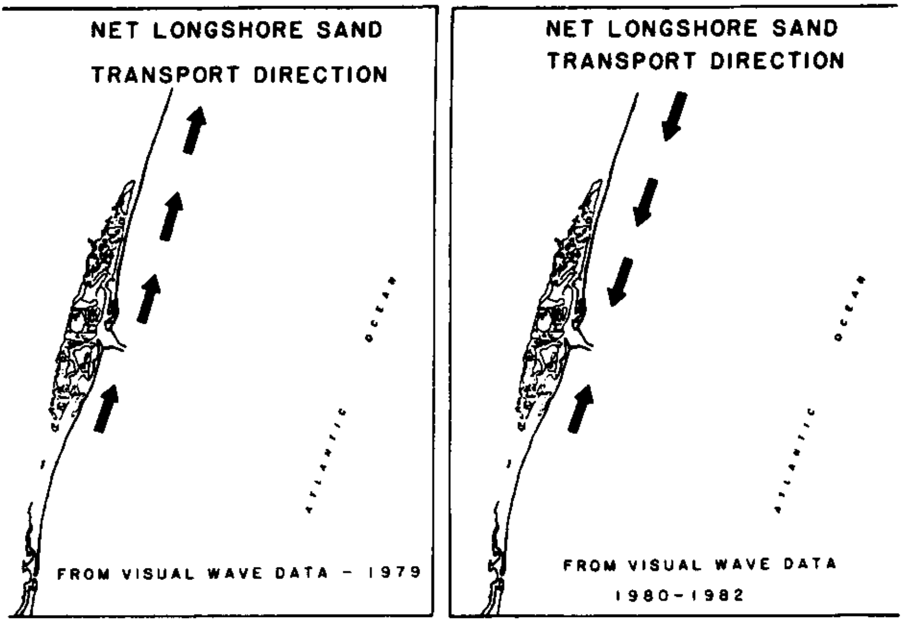

Figure 4. Net longshore sand transport direction

Profile #28 crosses the location of the old ebb-tidal shoal. Before jetty construction, a large ebb-tidal shoal was south of the tip of the present jetties. Construction of the south jetty closed the main ebb channel and directed the ebb flow out through the navigation channel. The beach profiles and aerial photos show that the sand in the shoal began moving onshore shortly thereafter. As the sand moved landward, it formed a high, shore-parallel sand bar which connected to the south jetty on the north and the state park beach a mile south of the jetty. A several acre body of water was trapped between the original beach and the emerged sand bar. This high sand bar has now become the new beach face and is several hundred feet seaward of the old beach face.

Profile #35 is in the south nourishment area. This area has behaved like the north nourishment area. After sand was placed on the beach, there was a period of profile readjustment. After about a year, the beaches had reached a new equilibrium profile. The beaches are several hundred feet wider than they were in 1977.

Between roughly three and four miles south of the jetties, a stretch of beach showed dune and beach recession.

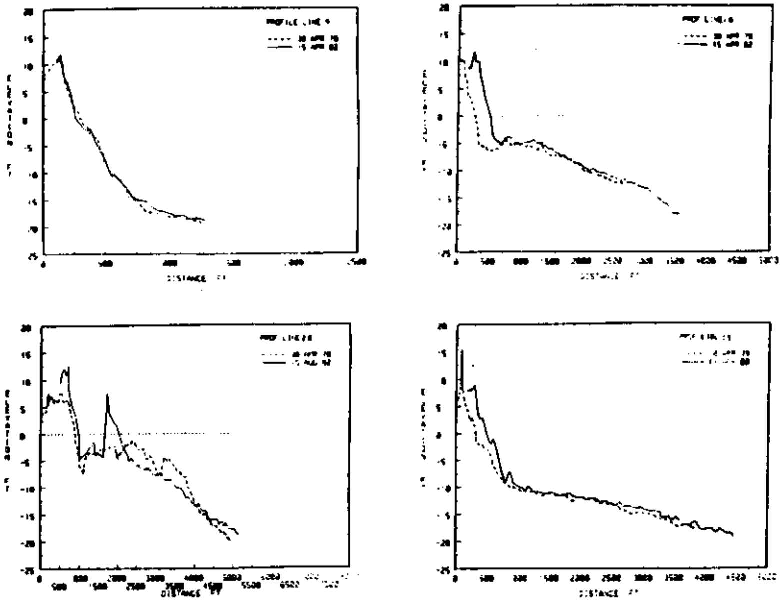

Figure 5. Beach profile changes - 4/78 to 4/82

Since profiles in this area are spaced at 5000 foot intervals, the recession only appears on one profile. Aerial photography shows that at the south end of the state park the dune and beach receded up to 50 ft. between 1978 and 1982. More recent surveys and observations indicate that this recession has stopped.

Summary of the Coastal Processes

Three processes mentioned above have combined to help nearby beaches form a new equilibrium planform with the jetties. When construction of the south jetty crossed the main ebb channel, much of the sand in the old ebb shoal moved to the state park beach. During dredging of the inlet, a million cubic yards of sand was placed on the beaches to the north and south. LEO analysis shows that much sand moved in both directions along the beach.

Aerial photos and beach surveys show that sand has filled in the angle between the south jetty and the state park beach (Figure 6). This sand fillet is common at shore-perpendicular structures. Sand which moves north into the area is trapped in the lee of the jetty when the longshore sand transport direction reverses. Such a build-up on the north jetty has been prevented by the weir. Shortly after the weir was constructed, the shoreline moved out to the beginning of the weir section and has stayed near there since.

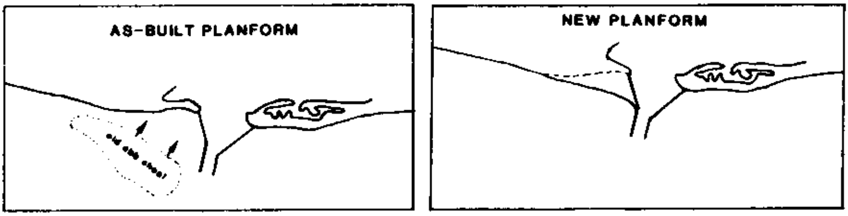

Figure 6. Schematic of beach planform change

Analysis of the coastal monitoring program data leads to an understanding of what has happened on the beaches near Murrells Inlet since jetty construction. This understanding is based on existing data and, therefore, may be modified by further analysis as more data become available. Without the monitoring program, the data base would be much smaller and the analysis much more speculative. Future political and management decisions about the Murrells Inlet area can be made with a better understanding of coastal processes of the area as a direct result of data collected in this monitoring program.

Acknowledgement

Profile survey data were collected by the U.S. Army Engineer District, Charleston. The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted under the Coastal Structure Evaluation and Design Program of the United States Army Corps of Engineers by the United States Army Engineer Waterways Experiment Station. Permission was granted by the Chief of Engineers to publish this information.

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ATTITUDES TOWARD HURRICANE EVACUATION IN ATLANTIC CITY, NEW JERSEY

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Abstract

When a hurricane threatens densely developed resort barrier islands, vertical evacuation is a controversial alternative to the conventional form of horizontal evacuation. In order to plan proper emergency management procedures, an understanding of the attitudes of potential users can be useful. This study has explored the extent to which residents prefer to remain on a barrier island, given a storm evacuation advisory. Atlantic City, a densely developed resort barrier island community located on the New Jersey shore, was chosen as the study site. This pilot study suggests that there are distinct groups that prefer to remain or leave a barrier island when a hurricane evacuation warning is given. The majority of those who would remain on the island chose their residence as a refuge rather than hotels or city institutions. The location of a vertical shelter in an area of perceived vulnerability, such as a beach block, may deter a resident from choosing that shelter. This may pose a problem for emergency management since casinos are located on the beach block and are the only shelters with vertical evacuation plans.

Background

When a hurricane threatens to strike a low-lying barrier island community, the area can suffer damage from high storm surge, onshore winds and coastal flooding. An informal partial evacuation off the barrier island to the mainland often occurs; a formal evacuation order may be given by emergency management personnel depending on: 1) the expected location of the hurricane; 2) maximum wind speeds; and 3) storm surge heights. Evacuation from a barrier island to the mainland during a hurricane can be difficult or impossible due to a number of emergency management problems, such as: 1) the flooding of bridges before complete evacuation can take place; and 2) traffic congestion.

An additional problem is the enhancement of hurricane warnings so as to convince residents of the hazard and possible need to evacuate (Ruch, 1981; Ruch and Christensen, 1981). A simulation of hurricane evacuation of Galveston Island, a developed barrier island on the Texas coast, showed that 30.5 hours were required for all people to leave the island during a hurricane with 120 mile per hour winds. Due to flooding in advance of the hurricane's arrival, the single bridge connecting Galveston with the mainland would be flooded 7.5 hours in advance of the hurricane's arrival (Ruch, 1981). In the coastal area of New Jersey, 24 hours are required for safe evacuation if the population at risk responds optimally (Mitchell, 1984a).

Leaving the barrier island for a safe mainland location is termed horizontal evacuation. In addition to this conventional evacuation technique, a controversial form of evacuation--termed vertical evacuation--is being seriously considered in many locations. With vertical evacuation, people seek a location on the barrier island, in buildings which would safely shelter them from storm surge, onshore winds and coastal flooding. This adjustment has been suggested as a possible alternative by Burton, Kates and White (1978), and Mitchell (1984a). An ongoing study is being conducted by Ruch (1983), in which he evaluates: 1)the structural feasibility of vertical evacuation; 2)the social and economic aspects of vertical evacuation, including the attitudes of managers and users; and 3)the legal and political aspects of vertical evacuation.

The pros and cons of vertical evacuation and the necessary infrastructures and managerial cooperation have been considered by Baker (1983, 1984). Vertical evacuation is viewed as a viable alternative for the following reasons: 1) large numbers of people would not have to leave an area as much as 300 miles wide well in advance of the hurricane's arrival; and 2) if people remain in area through vertical evacuation, the threat of predisaster looting may be diminished. Horizontal evacuation is considered prone to problems for the following reasons: 1) the intensity of a hurricane can change before its landfall so that the numbers needed to be evacuated may change; 2) there is difficulty convincing residents to leave early enough to make a conventional evacuation successful; 3) most of the residents evacuating from a 300 mile area will have left unnecessarily making them more difficult to evacuate next time; 4) the economic cost of a horizontal evacuation is enormous; 5) a horizontal evacuation increases the opportunities for traffic accidents; (Baker, 1983).

Baker (1983) has suggested the following disadvantages to vertical evacuation: 1) a building used for vertical evacuation could fail; 2) there is no way to guarantee the safety of a building despite its safe design; 3) interior walls could fail if windows fail; occupants would be subject to missiles if windows failed; 4) if more high-rise structures are built to serve as vertical shelters, the population at risk in the hazardous area will increase and conventional evacuation will become more difficult; 5) legal and equity questions such as liability for injuries, deaths and structural damages have not been answered; 6) a crowded vertical shelter might result in panic behavior. After the hurricane, the barrier island may be cut off from the mainland due to a breakdown in utilities and essential services while there are people on the island requiring medical attention.

Study Need

Because of the difficulty involved with horizontal evacuation from a barrier island, residents may prefer to remain on the island after receiving a storm evacuation advisory. If people prefer to remain on a barrier island when given a storm evacuation advisory, then vertical evacuation may be viewed by residents as a viable alternative to horizontal evacuation. The percentage of the resident population which prefers to remain on the island may indicate the potential for vertical evacuation. Cutter and Barnes (1982) examined the attitudes of evacuees following a technological hazard; an understanding of the attitudes of potential users was considered useful in order to plan proper emergency management procedures. Baker (1975) looked at the attitudes of residents toward land use policy following a hurricane. Ruch's (1983) research on vertical evacuation will include attitudes of managers and potential users. However, the preferences of potential users to hurricane evacuation have not been thoroughly examined thus far (Mitchell, 1984b).

Hypothesis

This study explores the extent to which residents prefer to remain on a barrier island, upon receiving a storm evacuation advisory.

Setting

Atlantic City is a densely developed resort barrier island community located on Absecon Island on the New Jersey shore. It was chosen as the study area because it has a number of high-rise buildings which Mitchell (1984a) has suggested could be used for vertical evacuation. Atlantic County has the largest single group of potentially storm resistant high-rise buildings because of design constraints. However, only the casinos in Atlantic City have evolved formal evacuation plans. With the increased redevelopment of Atlantic City due to casino industry growth, and the problems associated with horizontal evacuation, there is an increasing need to consider alternative evacuation techniques.

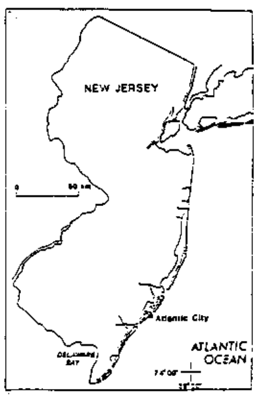

Figure 1: Location Map

Methodology

Sampling Procedures

This study consisted of presenting a storm scenario and questionnaire to 39 respondents who were residents of Atlantic City or the neighboring towns of Ventnor and Margate. Eriksen (1975) summarized the advantages of a scenario methodology for natural hazards research; using scenarios permits the consideration of more than one response option to a hazard. This survey was conducted in November, 1984, which is near the end of the June-November hurricane season.

Respondents were approached at four locations in Atlantic City and Ventnor. These locations were chosen in an attempt to obtain responses from local residents rather than tourists. If the respondents indicated that they were residents of Atlantic City, Ventnor, Margate or Longport, they were asked to read a paragraph describing a storm scenario and to answer a series of questions pertaining to their behavior in response to this scenario. Residents were asked to supply the information on the spot rather than reply by mail in order to increase the response rate. At each of these four locations responses were sought for approximately one hour. In order to avoid a sampling bias, every passerby was approached where ever possible.

Data Reduction Techniques

Responses were summarized by percentage of the total sample. Evacuation responses were related to: 1) land ownership characteristics--homeowners vs. renters; 2) period of residence--seasonal vs. permanent; 3) general location of residence--closer to the beach, to the bay or to the middle of the island; and 4)experience with and memory of previous hurricanes and storms. Where residents prefer to go during a hurricane emergency and why were divided into island and mainland evacuation choices.

Results

Renters, regardless of the location of residence, people who live near the bay or in the middle of the island, and those residents who had bad experience with hurricanes preferred to remain on the island during a hurricane evacuation advisory. Homeowners, seasonal residents, people who live closest to the beach and those with no experience with hurricanes preferred to leave the island (Table 1).

Table 1: Evacuation Responses (n=39)

	% of responses	remain	leave
overall	100%	39.8	60.2
homeowners	46.2	22.2	77.8
renters	48.7	63.2	36.8
seasonal residents	20.5	12.5	87.5
permanent residents	79.5	50.0	50.0
residence located closer to			
beach	51.2	30.0	70.0
bay	33.3	61.5	38.4
middle island	15.4	57.1	42.9

	% of responses	remain	leave
no experience with hurricane	35.9	14.3	85.7
experience with hurricane	64.1	58.3	41.7
memory of '62 and '44 storms	20.5	62.5	37.5
memory of '62 storm only	30.8	58.3	41.7

Respondents were asked two questions regarding where they would go during a storm (see Appendix, questions 5 and 6). If they gave an answer to question 5, they could select the same or a different answer to question 6. The first was an open-ended question; the second sought their responses to specific options, including several vertical evacuation alternatives. As a result of this questioning format, respondents may have provided the same response more than once.

The majority of those who chose to remain on the island chose to remain at home. The majority of those who chose to leave the island indicated that they would travel to Philadelphia, 60 miles away. Approximately 30% of all respondents mentioned that they would seek refuge on high ground. Some people mentioned apartment high-rises in which they live as a vertical refuge option (Table 2).

Table 2: Where residents prefer to go during a hurricane emergency*

island	open-ended response	specific choice
residence	30.8%	33%
boardwalk	2.6	
boat	2.6	
mainland		
not specific	17.9	
within 20 miles	10.3	20.6
Philadelphia (60 miles)	23.1	33.1
would not go to Atlantic City that weekend	2.6	
vertical refuge		
% of all respondents who mentioned high ground or floor they lived on as safe refuge	30.8	
% of those who preferred to remain on island who mentioned vertical refuge	74.8	
places mentioned as vertical refuge		
high floor of residence	5.1	15.4
Convention Hall	2.6	10.3
Atlantis Hotel		5.1

*may have answered more than once.

Over 80% of the responses to remain on the island or to leave indicated a concern for personal or property safety. Safety reasons related to staying on the island included too much traffic and securing one's own property. Safety reasons related to leaving included escaping floodwaters (Table 3).

Table 3: Reasons for evacuation decision*

To stay	
safety	
ok in past	30.8%
too much traffic	2.6
to secure property	2.6
employment	2.6
to experience a hurricane	5.1
To leave	
safety	51.3%
to escape flooding	5.1
because there is an alternative	2.6

*may have answered more than once.

Discussion

The data suggest but do not confirm that there are two distinct groups, one which prefers to remain on the island and one which prefers to leave. Some respondents perceived the island and high elevations there to be safer while others perceived a mainland evacuation to be safer. Ownership may be a characteristic distinguishing these two groups. Renters preferred to remain on the island, while homeowners preferred to leave. Property and flood insurance may influence a homeowner's decision to leave his or her property although one might think that a homeowner would be inclined to stay to prevent the looting of his or her investments. Willingness to depart might also be attributed to the fact that for some of these people, the Atlantic City residences are second homes. Seasonal residents have an established alternative and therefore are more inclined to leave. Those with second homes in Atlantic City perceived themselves as having a viable alternative to remaining in the hazardous area. However, there are more year-round homeowners than seasonal residents.

Public vs. private transportation may influence evacuation decisions. Without an independent means of transportation, residents may perceive themselves as having limited evacuation options. Automobile owners may be reluctant to leave because of the traffic congestion caused by mass evacuation.

Experience with hurricanes is another characteristic distinguishing those who prefer to stay from those who prefer to leave the island. Having survived previous hurricanes may be an incentive for some residents to stay. Experience may tell them that riding out storms is possible and more desirable due to the costs of evacuating and the looting that may occur during a horizontal evacuation.

An attempt was made to address the question of vertical evacuation by giving respondents specific choices of where to go (Appendix, question 6). Half mentioned vertical evacuation in hotels and public buildings like Convention Hall; half mentioned their residences as places for vertical evacuation. The responses to this question indicated that a total of 15.4% of respondents would evacuate to Convention Hall (10.3%) or the Atlantis Hotel (5.1%) (Table 2).The majority of those who would remain on the island prefer their homes for refuge. Some of these people would use the upper floors of their homes as vertical shelters. In addition, some residents who live on high floors of multi-story buildings would remain in their apartments during a hurricane emergency. 15.4% of the total respondents or 37.5% of those who chose to stay would seek vertical refuge in their homes. 30.8% of the total sample mentioned vertical evacuation as an option; this constitutes approximately 75% of those who prefer to stay on the island. This preference for one's residence as a vertical shelter suggests that casinos may not be the preferred vertical shelter even though the casinos are the only multi-story buildings equipped with evacuation plans. Vertical evacuation may be a viable alternative, however; most respondents did not mention the casinos as shelters. Evacuation plans for the casinos are predominantly concerned with sheltering hotel guests for the duration of the emergency. Provisions for hurricane emergencies by the casinos state that their businesses will remain open until the last possible minute. It is not clear whether residents are aware of the casinos as a viable emergency shelter option.

Another factor which distinguishes those who prefer to remain from those who prefer to leave is the section of the island on which respondents live. Residents of the middle island and bay areas preferred to stay on the island. This preference may reflect their perception of diminished vulnerability to storm surge and onshore winds. Residents of beach blocks may leave because they perceive a greater vulnerability to these elements. However, most vertical shelters are located on beach blocks. The desire of beach block residents to leave may indicate that residents who remain may not feel safe enough to evacuate to beach blocks even if that is where vertical shelters are located. The presence of high-rise buildings--whether they are casinos or apartment houses--may not be sufficient to encourage the cooperation of residents in a vertical evacuation. The location of vertical shelters on the island may be significant. Emergency response planners need to consider these attitudes towards the location of vertical shelters in order to encourage the cooperation of potential users.

Where people prefer to go during a hurricane is based primarily on their perceptions of safety. While casinos and public buildings may function as vertical evacuation sites, the respondents preferred residences over these buildings as safe refuges. Only one respondent mentioned Convention Hall as an evacuation alternative in an open-ended question. This respondent was a police officer who was familiar with the City's emergency management plan.

The greatest percentage of those preferring to leave the island during a hurricane emergency (33.1%) would go to Philadelphia, which is 60 miles away. In contrast, 20.6% prefer to remain within 20 miles of Atlantic City, on the mainland. Remaining closeby may be related to their concern for their property. Residents can return to the island more quickly if they have taken refuge less than an hour away.

Future Study

Additional work on evacuation attitudes is needed before conclusive statements can be made. Methodology should be improved to address directly the question of attitudes toward vertical evacuation. This study did not ascertain thoroughly enough how the residents who prefer to remain on the island viewed vertical evacuation. It is unclear whether vertical evacuation is not a preferred alternative or whether a more effective methodology would generate a different response. A more effective methodology would also include a more systematic sampling flow, spatially and temporally, including visits to casinos (Mitchell, 1984b).

The scenario methodology was useful in securing responses to a hypothetical situation. However, it may be more useful if a series of scenarios could establish the threshold conditions which would cause potential evacuees to horizontally or vertically evacuate. A future study could address issues such as: 1) whether a preference for vertical evacuation would exist due to traffic congestion; and 2) how hurricane intensity affects preference for vertical evacuation The following factors may have influenced responses and need to be investigated further: 1) transportation, 2) flood insurance, and 3) residents' familiarity with Atlantic City's Emergency Management Plan.

Conclusions

This pilot study suggests that there are distinct groups which prefer to remain or leave a barrier island when a hurricane evacuation warning is given. Property ownership, location of residence and previous experience with hurricanes are possible parameters for these groups. Perception of safety is the primary motivating factor for those who preferred to stay as well as those who preferred to leave. The majority of those who would remain on the island chose their residence as a refuge, rather than hotels or city institutions like Convention Hall. The location of a vertical shelter in an area of perceived vulnerability, such as a beach block, may deter a resident from choosing that shelter. This may pose a problem for emergency management since casinos are located on the beach block and are the only vertical shelters with evacuation plans.

Study results do not overwhelmingly confirm the hypothesis that residents prefer to remain on the island. However the results do indicate that approximately 40% of the population prefers to remain on the island during a hurricane evacuation advisory. Therefore, vertical evacuation may be an adequately viable alternative to make it a desirable component of emergency management planning for an urbanized barrier island.

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Appendix: Questionnaire

1) Are you a resident of Atlantic City--that is a homeowner or renter?
   yes no
2) How long have you lived here?______________________

   Read paragraph scenario.

3) Given the preceding information, would you stay on the island?
   yes no
4) Why?____
5) Where would you go?________________________________
6) Given the following choice, to which of these places would you prefer to go?
   remain in house
   Convention Hall (on the beach)
   Atlantis Hotel (on the beach)
   Harrah's Marina Hotel (on the bay)
   mainland closeby (within 20 miles)

mainland 60 miles away (Phila.)

7) Are you a permanent resident or a seasonal resident?

8) Is your home closer to the beach
to the bay
in the middle

9)Have you ever experienced a major storm or hurricane? yes no
When ____

10)Do you remember the Ash Wednesday Storm of March 1962? yes no
Do you remember the Hurricane of 1944? yes no

Misc. 11) Male Female

12) Age
18-25______
26-40______
41-60_____
over 60

13) Occupation____________________