Dangerous Rip Currents On Beaches

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Rip currents are a significant hazard at surf beaches. They run away from shore and can easily pull swimmers from shallow water away from shore. The United States Lifesaving Association (USLA) reports that rip currents are the primary source of distress in over 80% of swimmer rescues beaches where surf is present (e.g. ocean beaches and the Great Lakes). Rip currents are particularly powerful in larger surf conditions created by swells produced by distant storms, when there is little wind in the local beach environment. United States Lifesaving Association estimates that over 100 deaths can be attributed to rip currents in the United States in a typical year.

Originally called riptides, rip currents were first reported in the US media in the early 20th century. On May 5, 1918, at Ocean Beach, in San Diego, rip currents pulled many bathers off their feet and 13 men, including soldiers on leave, were swept offshore to their deaths. As a response, the City of San Diego appointed three municipal lifeguards. Notably, the ocean conditions and hazards in 1918 and today are essentially the same, but beach attendance is greatly increased (estimated at+18 million annually in San Diego beaches). Clearly, the number of drowning deaths could therefore be much greater without the presence of lifeguards. Similar circumstances exist elsewhere in the US.

Rip current deaths were been reported by local offices of National Weather Service as early as the 1960s, but Lushine (1991) first demonstrated that annual rip current drowning deaths are greater than from any other natural hazards in Florida. Gensini and Ashley (2009) examined records of rip fatalities from the National Storm Center for the entire U.S. coasts. While it is not comprehensive in nature, the top two states having higher rip current fatalities in the U.S. are Florida and California States.

Rip currents can turn a pleasant beach tour into a perilous trip. For example, in Panama City Beach, Florida on the 25th of July, 2008, a father attempted to save his son caught in a rip current, but both died. On June 5, 2005, two high school teens were missing separately on New Jersey and Long Island Beaches, just after their high school graduation examination. Two boys lost their lives in a swimming class at Indiana Dunes State Park Beach on Lake Michigan on August 4, 2008. And on June 29, 2009 a single mother tried to rescue her two daughters at Montara Beach (south of San Francisco), but the mother died and only one daughter survived. Tragedies of this sort are reported around the USA every year.

Lifeguards at surf beaches are skilled in identifying the subtle clues that indicated the rip currents, since they are the primary cause of distress and rescues to which lifeguards respond. Predicting the likelihood that rip currents will occur on the day has proven more challenging. Scientific studies of rip currents and operational tools are needed to reliably forecast rip current severity so that the public can be informed and rip current drowning can be minimized.

Spotting a rip current – A first step

There are some common signs to look out for to identify rip currents:

1. Seawater in brownish color or covered by white foam moving offshore;
2. isolated patches of water moving offshore or alongshore;
3. a break in the line of breaking waves where the waves are calm.

Rip currents take on many forms and are subject to many different influences, but always involve water moving away from shore in a concentrated manner. A schematic diagram is shown, but no two rip currents are identical. More pictures of rip currents are on the NOAA web page http://www.ripcurrents.noaa.gov

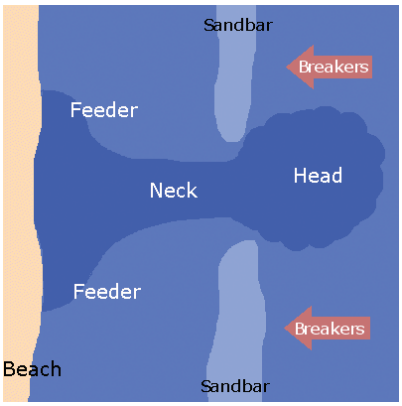

Figure 1: Rip currents on a sandy beach

Early surf zone research was conducted by Bascom and Isaacs of the University of California from 1945 to 1950. They conducted the "Waves" project using an amphibious truck, in the waters off Carmel, CA. They noted that when higher-than averaged waves would break in fast succession, they would raise the water level inside a bar, and a patch of water would rush back in a narrow channel.

Rip classification and Operation

Scientists and ocean engineers classified rips into various categories. The United States Lifesaving Association Manual (Brewster, 1995) defines four types of rip currents classified by lifeguards observing the sea surface on beaches:

Fixed Rip Currents –on sandy beaches as in *Figure 1.* A fixed rip may lie in a given spot for hours, days or months. It is characterized as "wave piling up" between the shore and offshore sandbars.

Permanent Rip Currents – these rips are present year round at a coastline with headland or jetty or a rock as illustrated in *Figure 2*.

Flash Rip Currents – or transient rips, often present during the low tides.

Traveling Rip Currents – these rips migrate along the beach and usually occur by long periods of strong swells. They can pull a large number of swimmers to half mile offshore.

A review of rip currents fundamental is summarized as training material for marine forecasters at http://deved.meted.ucar.edu/marine/ripcurrents/NSF/.

Beaches are an economic driver for coastal communities, attracting tourists and providing jobs. To help ensure that they can be safely enjoyed, in addition to providing lifeguards, it is valuable to provide sufficient information about risk levels that can be anticipated. In an effort to classify the likelihood and intensity of rip currents, the National Weather Service presently applies a Rip Current Outlook based on specific factors in three tiers: LOW, MODERATE and STRONG as seen on the NOAA web site. The threshold of each level can vary at different sites, since local human acclimation to conditions varies. The reliability of this product is evolving, in part utilizing observations of lifeguards and back-testing the prediction to the outcome.

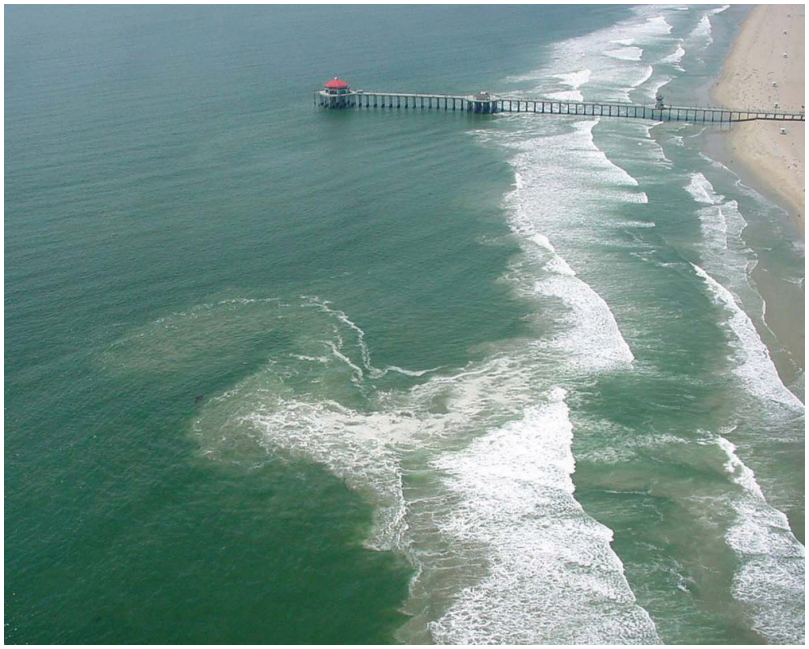

Figure 2: Rip currents taken by Huntington Marine Safety Division, California.

The greatest number of rescues from rip currents by lifeguards in the USA (+40,000/yr) is reported in Southern California. This may be due to a combination of consistently strong Pacific Ocean swells, causing strong rip currents, combined with high year-round beach attendance. Fewer, but consistent rip current rescues are reported along the coasts of the Atlantic Ocean and Gulf of Mexico.

Rips can be more prevalent and in some cases more intense during certain times of the year. On Southern California coasts, spring to summer is the most hazardous time when the prevailing swell changes directions from northerly to southerly and causes holes and channels that foster rip current formation. In Wu et al. (2011) rip current characteristics are given, and a lifeguard based series of observations are conducted with collaboration with local Weather Forecast Office to monitor daily surf and rip currents on beaches.

Tools for Prediction of Rip Currents and Data needed

Rip currents can occur under various marine weather conditions. A product of the National Weather Service is to issue Surf Zone Forecasts, in an effort to identify the risk level when rip currents are likely to be high and pose a threat to beachgoers. To ensure reliability in forecasting the threat of rip currents, there is a need to develop a roadmap as was done in wind wave forecasting: field observations direct theoretical analysis and then empirical formula is derived to apply to the field with proper tuning parameters.

In the beach reports, we have noted that the rescues activities can increase with when strong rip currents occur at lower tide levels. This suggests that rip current intensity may be influenced, in part, by tides. Observations also indicate strong correlation between rip current strength and incoming surf heights. Along the southeast coast of Florida, where seasonal surface winds create local wind waves, rip currents and alongshore currents are observed

at wind speeds higher than 10-15 kts for 3-5 hours. Rip currents can occur under various marine weather and geophysical conditions.

Although the incoming waves may come from hundreds or thousands of miles away, rip currents are considered to be determined by **local** parameters, which includes: water waves near shore, coastal water levels, *coastline* orientation variations, beach bottom condition, and promontories (both natural and human made). Local winds can affect waves at different time/spatial scales. A brief introduction of some tools is given below:

Tools	Data Used	Output Product
1. Marine weather charting	Surface wind system	Potential of rip occurrence
2. Empirical worksheet	Wind, swells, rescue record	Rip risk factors (Ref. 3)
3. Diagnostic analysis	Waves, beach sands and tides	Rip risk scale (Ref. 4)
4. Regression formula	Wind, waves and tides	Rip currents threat level (**)
5. Computer modeling	Coastal waves on a beach basin	Entire current field (Ref. 5)

** Personal communication and see papers in http://www.ripcurrents.fiu.edu

Method (1) reads the synoptic-scale winds and gives hints where rip currents might be occurring where the winds are on-shore toward coasts. Methods (2), (3), (4) make use of NDBC wave buoy data at different water depths or output data of wind wave models. Tide levels can be obtained from tide prediction or tide gauge observation. The beach properties include beach slope and beach sand size. Thus, the rip risk formula developed is expected site-specific for different beaches, except for the full scale numerical model. ⚓

Summary

In this note, dangerous rip currents on beaches are introduced. Recent efforts by the National Weather Service in partnership with the United States Lifesaving Association have greatly promoted the public awareness of the threat of rip hazards in the U.S. Local marine forecasters now have access to various online information to better understand rip current causes and to offer community outreach activities. Rip hazards need multiple efforts to mitigate its effect. Surf height appears to be the key variable, but there are many other marine influences.

Forecasting skill is in advancing as more and more remote sensing field data and numerical techniques are developed. At the 1st Symposium on Rip Current held in Miami in February 2010, scientists and engineers offered practical tools and empirical worksheets for use. Further research to better understand and predict rip currents is needed in the interest of reducing death and injury from this natural hazard.

Acknowledgments

Dr. C-S Wu is sponsored under the Storm-Scale Prediction of the Meteorological Development Laboratory of the Office of Science and Technology. He is indebted to the Los Angeles District of the US Army Corps of Engineers, for their beach data and the Weather Forecast Office at San Diego, CA with special thanks to Noel Isla for his earnest assistance. This note is dedicated to numerous marine forecasters in California and Florida coasts for their comments and motivations.

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