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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Machine Learning Analysis of Lifeguard Flag Decisions and Recorded Rescues" *by* Chris Houser et al.

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We thank the reviewers for their helpful and insightful comments that have greatly improved the paper and ensured that we clarified our language about the predict and posted flags.

âĂć Line 25: Which differences? It is not clear

This sentence has been updated to: wrong flag colour was flown on ∼35% of days between 2004 and 2008 (n=396/1125). Days with the wrong flag colour represent only 17% of all rescue days but those days are associated with ∼60% of all rescues between 2004 and 2008.

âĂć Line 29: this seems strange to me; flag deployed over- estimating the risk and

more rescues or drownings present? It seems the beach user does not obey the flag command or, if the sea condition for the user didn't match the warning, then the flag warning was correct! Maybe I'll understand later on, but I can understand how an overestimation of risk leads to more rescues.

This is the interesting outcome of the study- the model underpredicting the hazard based solely on wind and wave data alone.

âĂć Line 32: So the largest number of rescues is due to people don't believing the criteria of lifeguards when choosing the colour of the flag?

We added some clarifying language here:

It is possible that the lifeguards were overly cautious, or they identified a rip forced by a transverse-bar and rip morphology common at the study site. Regardless, the results suggest that beach users may be discounting lifeguard warnings if the flag colour is not consistent with how they perceive the surf hazard or the regional forecast

âĂć Line 57: In Costa Rica just few beaches do so

We have clarified this statement: ". . ..(Brander et al., 2013; NWS, 2017), while rip-related drownings on a relatively small number of beaches in Costa Rica account for a disproportionately large number of violent deaths in the country (Arozarena et al., 2015). However, recent. . .."

âĂć Line 69: ". . .(called a transverse bar and rip morphology). . ." I suggest to write the reference for these classification of beaches which would be Wright and Short (1984).

Reference added:

Wright, L.D. and Short, A.D., 1984. Morphodynamic variability of surf zones and beaches: a synthesis. Marine geology, 56(1-4), pp.93-118.

âĂć Line 94: When the difference overestimates and underestimates the risk, or only in one of these cases?

We have clarified the hypothesis:

“. . ..difference between the predicted and posted flag colour. Specifically, it is hypothesized that a greater number of rescues will occur on days when the model underestimated the hazard level compared to the lifeguard who made their decision based on local observations including the presence of semi-permanent rip channels. In this scenario, the public may believe that the lifeguard is being overly cautious leading to people entering the water.”

âĂć Line 98: it would be convenient and illustrative the inclusion of a view from above of Pensacola beach. Google map shows a large rip current system along the beach.

Figure 1. Map of study site showing location of flagged section of beach and approximate location of the wave buoy used in the analysis and for regional rip forecasts. Also shown is the presence of transverse-bar and rip morphology of the innermost bar and the variable nature of the outermost bar for the flagged section of beach. The aerial image is from summer 2004 (before Hurricane Ivan) and is not necessarily representative of the nearshore morphology throughout the remainder of the study.

âĂć Line 100: the “worst” or the best for beach drowning?

The quote is to the worst, meaning that it has the greatest number of drownings.

âĂć Line 115: where is this number coming from? “The innermost bar varies alongshore at a scale of âĹij1000 m, consistent with the ridge and swale bathymetry, and tends to exhibit a transverse bar and rip morphology immediately landward of the deeper swales.” I would show a map of the study site, pointing the main access points and other important features. In addition, a bathymetry contour map would be really appreciated. This would be useful for the reader to really comprehend the beach morphology.

References have been added:

Barrett, G. and Houser, C., 2012. Identifying hotspots of rip current activity using

wavelet analysis at Pensacola Beach, Florida. Physical Geography, 33(1), pp.32-49.

Houser, C., Hapke, C. and Hamilton, S., 2008. Controls on coastal dune morphology, shoreline erosion and barrier island response to extreme storms. Geomorphology, 100(3-4), pp.223-240.

âĂć Line 120-128: I think that some pictures or bathymetric/topographic plots showing the evolution of the beach during the period described in this paragraph would really help the reader.

It is not possible to show adequately show the ridge and swale bathymetry and the nearshore morphology on the site map, and this level of detail alongshore does not match the rescue data which has no spatial information. We have, however, provided references to the inner shelf bathymetry and impact on nearshore morphology in the text:

“. . ..inner shelf. The innermost bar varies alongshore at a scale of $\sim$1000 m, consistent with the ridge and swale bathymetry (Houser et al., 2008), and tends to exhibit a transverse bar and rip morphology immediately landward of the deeper swales (Barrett and Houser, 2012). Historically, most drownings and rescues on this popular beach have occurred at these rip hotspots because they correspond to the main access points along the island (Houser et al., 2015; Trimble and Houser, 2018).”

âĂć Line 134: it would be nice to have on a map the location of these buoys

The buoy used in the study has been included in a new Figure (1):

Figure 1. Map of study site showing location of flagged section of beach and approximate location of the wave buoy used in the analysis and for regional rip forecasts. Also shown is the presence of transverse-bar and rip morphology of the innermost bar and the variable nature of the outermost bar for the flagged section of beach. The aerial image is from summer 2004 (before Hurricane Ivan) and is not necessarily representative of the nearshore morphology throughout the remainder of the study.

âĂć Line 130-153: Which exactly are the offshore wave conditions and wind ′ forcing functions used in the model?

The independent variables included in the model are now explicitly referenced in the model description:

"....The goal of CHAID analysis is to build a model that helps explain how independent variables (wind speed, wave height, wave period, wave direction, wind direction and water level) can be merged....."

âĂć Is the available data (wave height, period, direction) the same as the data used in the model?

That is correct.

âĂć Which exactly are the wave buoys ′ located near the study area? How far are exactly from the shore? How well correlated are the offshore wave parameters from the buoys to the nearshore wave climate?

We have revised the text to describe the location of the buoy to the field site, but also made note that this was the buoy used in the rip forecasts by the NWS during the study period, and has been used in several other studies to describe the wave field incident to Pensacola Beach:

"....$\sim$100 km southeast of the study area (buoy 42039; Figure 1). Between 2004 and 2008, this was the closest buoy to Pensacola Beach and had been previously used to estimate the incident wave field (Wang and Horwitz, 2007; Claudino-Sales et al., 2008; 2010; Houser et al., 2011) and was the basis for the rip hazard at Pensacola Beach until a new buoy was placed closer to the beach in 2009. The...."

We have also included a figure to show the location of the buoy:

Figure 1. Map of study site showing location of flagged section of beach and approximate location of the wave buoy used in the analysis and for regional rip forecasts. Also

shown is the presence of transverse-bar and rip morphology of the innermost bar and the variable nature of the outermost bar for the flagged section of beach. The aerial image is from summer 2004 (before Hurricane Ivan) and is not necessarily representative of the nearshore morphology throughout the remainder of the study.

âĂć I would enrich the description of the CHAID technique with references showing cases where this statistical tool has been applied.

We have included some examples of how CHAID has previously been used in natural hazard research with a focus on those that include perception and decision-making:

Previous use of CHAID analysis in hazard studies include landslide prediction (e.g. Althuwaynee et al., 2014), farmer perception of flooding hazard (Bielders et al., 2003; Tehrany et al., 2015), and property owner perception and decision making along an eroding coast (Smith et al., 2017).

âĂć Line 143: Which are exactly the variables the model uses? Only wave and wind forcing? It is not clear. Does the model use variables relate to nearshore morphology? If not, why does the model identifies situations related to morphology not detected by lifesavers? Or maybe is the lifesavers which identifies those situations and not the model? Those things are not clear here and in the discussion section.

The independent variables included in the model are now explicitly referenced in the model description:

"....The goal of CHAID analysis is to build a model that helps explain how independent variables (wind speed, wave height, wave period, wave direction, wind direction and water level) can be merged....."

We have also provided further clarification in the first part of the results section:

It is important to note that the CHAID Analysis does not incorporate nearshore morphology as an independent variable because changes in nearshore morphology were not tracked daily over the study period. In this respect, differences between the posted

and predicted flag colour may reflect lifeguard observations of nearshore morphology conducive to the development of rip currents despite winds and waves typical of green flag conditions.

âĂć Lines 159 “The annual number of rescues and rescue 159 days varied by year with a peak in both the total number of rescues and the number of rescue days” It would be good to better define the differences between number of rescues and the number of rescue days. It would be also necessary to properly define rescue day.

We have provided a definition of rescue day in the sentence:

The annual number of rescues and rescue days (ie. days with one or more rescues) varied by year, with a peak in both the total number of rescues and the number of rescue days in 2005.

âĂć L 227-229 “While rescues did not occur on a vast majority of the days when the posted and predicted flag were different, they accounted for a disproportionately large number of the rescues.” Perhaps the term “disproportionately large number” is exaggerated as the number it refers to is just the 60% of the rescues.

We have replaced “disproportionately large number” with “majority of”:

While rescues did not occur on a vast majority of the days when the posted and predicted flag colours were different, days when the predicted and posted flag colours were different accounted for a majority of the rescues.

âĂć L 230-232 “Rather, the results suggest that the difference between the posted and predicted flag colors is associated with the morphology of the innermost nearshore bar which is not captured by a model and forecast based on wind and wave forcing alone.” This is a very strong statement as it assumes that the decision made by the beach manager are 100% correct and thus the model is “bad” because it does not account for all the information that the manager have like the beach morphology. However, how accurate the beach managers can really discern beach morphology? Is there

any statistics available such as successful rates of discerning beach morphology by lifeguards?

We qualified the focus on nearshore morphology in this sentence and the remainder of the paragraph:

“Rather, the results suggest that the difference between the posted and predicted flag colour could be associated with the lifeguards noting that the nearshore had a transverse bar and rip morphology, which is common at this location. The morphology of the nearshore and other variables that could influence whether a beach user will enter the water or not (e.g. weather, number of beach users or presence of seaweed) are not captured by the current model, which is based on wind and wave forcing alone. The model developed in this study is similar to rip forecasts produced by the US National Weather Service (NWS), and does not include local variables known to the beach manager based on experience and years of careful observation. Discrepancies between the predicted and posted flag colours provide a basis for future model development and expansion. Incorporating more data into the model will it to evolve and better capture the variables that influence the colour of flag chosen by the lifeguards, while ensuring that the model remains computationally efficient. Introducing additional variables, such as nearshore morphology, to the model has the potential to better capture a lifeguard or beach manager’s understanding of what constitutes dangerous surf conditions at their beach. At the same time, it is also important to examine the accuracy of beach managers and lifeguards in assessing the nearshore morphology and potential for rip development.”

âĂć L 242 “to the model has the potential to better capture a lifeguard or beach manager’s intuition associated with dangerous surf conditions.” Again, it is assumed that the lifeguard “intuition” is beyond failure.

This is correct. We have changed the sentence to focus on understanding: “. . ..the potential to better capture a lifeguard or beach manager’s understanding of what con-

stitutes dangerous surf conditions at their beach."

âĂć L 258, 276, 283 In these lines phrases such as "erode confidence" are "thrust is eroded" are used. I would suggest to rewriting these phrases and replacing "erode" by other words like "lost" for example.

These have been changed to:

Whether this causes beach users to lose confidence in the lifeguards and other authorities managing the beach is an important question for future research.

the more trust in authority is lost - a beach

beach user, which can cause them to lose their confidence in the lifeguards.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-142/nhess-2019-142-AC2-supplement.pdf

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