# Pilot Operational Rip Risk Warning System

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Rip currents are important for the physical, chemical and biological circulation processes they influence in the nearshore environment (Castelle et al., 2016, Cervantes et al., 2015). However, these fast-flowing offshore currents (Figure 1) have the potential to carry unsuspecting beachgoers into deeper water (Castelle et al., 2014). The combination of exhaustion and fear causes hundreds of drownings and beach rescues (~70-80%) globally each year (Castelle et al., 2016). In the City of Cape Town, during the 2017/2018 and 2018/2019 beach-going seasons a total of 30 fatal drownings were recorded, many of which were rip current related (News24, 19 December 2019). Rip currents are currently not being operationally forecast and warned for in South Africa.

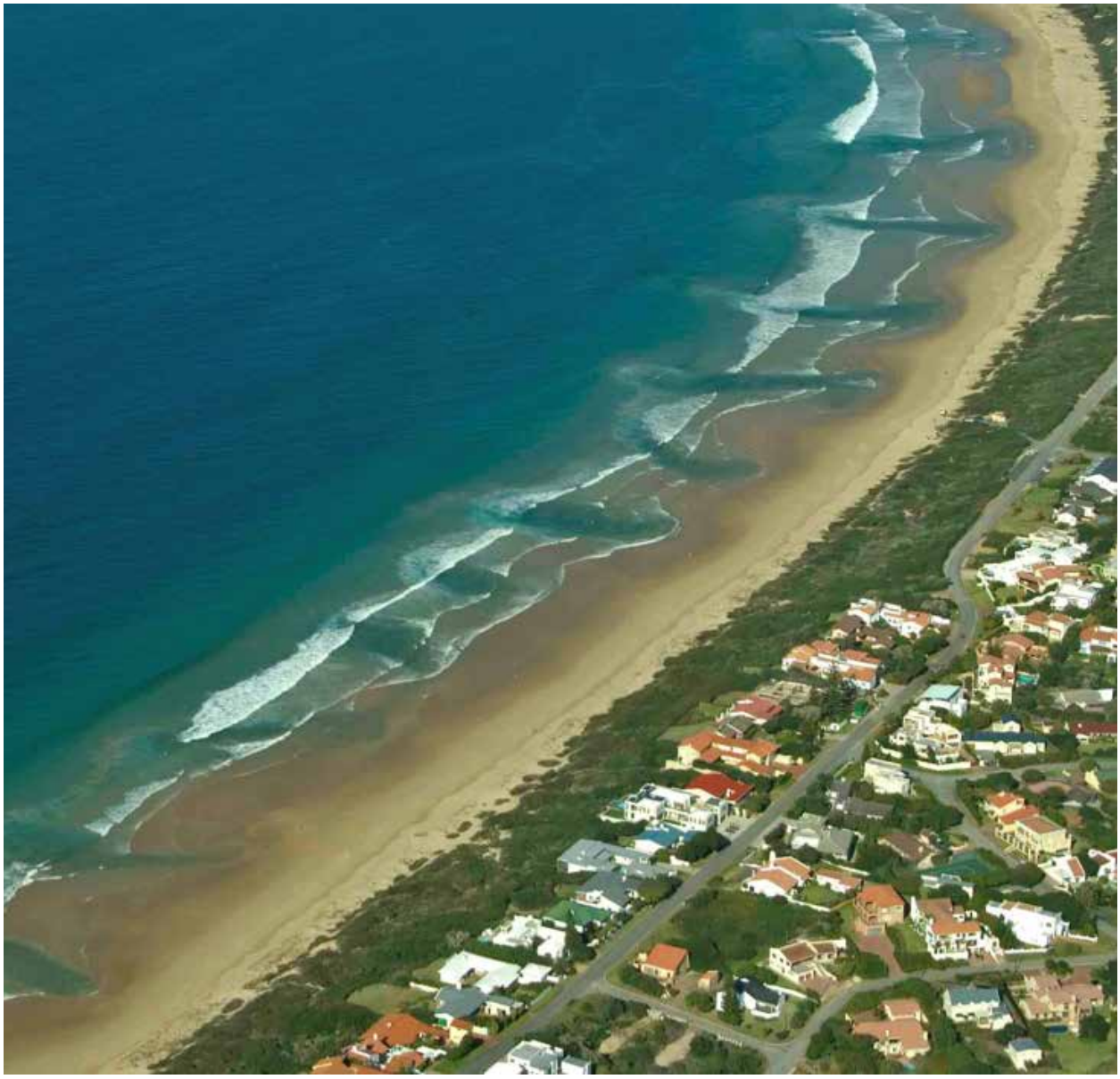

**Figure 1: Rip currents indicated by the darker green water, seen at a beach near Plettenberg Bay. Source: https://www.nsri.org.za/2020/01/beware-of-rip-currents/**

## What are rip currents?

Rip currents are strong, narrow currents that extend seaward from close to the shoreline into and beyond the surf zone (MacMahan et al., 2011, Brander et al., 2016, Castelle et al., 2016). Castelle et al. (2016) identifies differentiating rip current types based on their response to varying forcing conditions, i.e. the different causes of the alongshore variations in breaking waves that are fundamental in the formation of rip currents (Figure 2). For the purpose of building an operational rip current forecast model for the South African coastline, only bathymetrically-controlled rip current types are focused on. Bathymetrically-controlled rip currents are the most common type found on open beaches and are better understood and studied, therefore much more predictable (Scott et al., 2014, Castelle et al., 2016). Hydrodynamic processes are strongly influenced by the natural variability of beach morphology. They are the driving forces behind the relatively fixed locations of bathymetrically-controlled rip currents (Castelle et al., 2016). Under a given wave climate and tidal regime, bathymetrically-controlled rip currents vary over timescales, but importantly, are relatively persistent in space and time (Scott et al., 2014, Castelle et al., 2016).

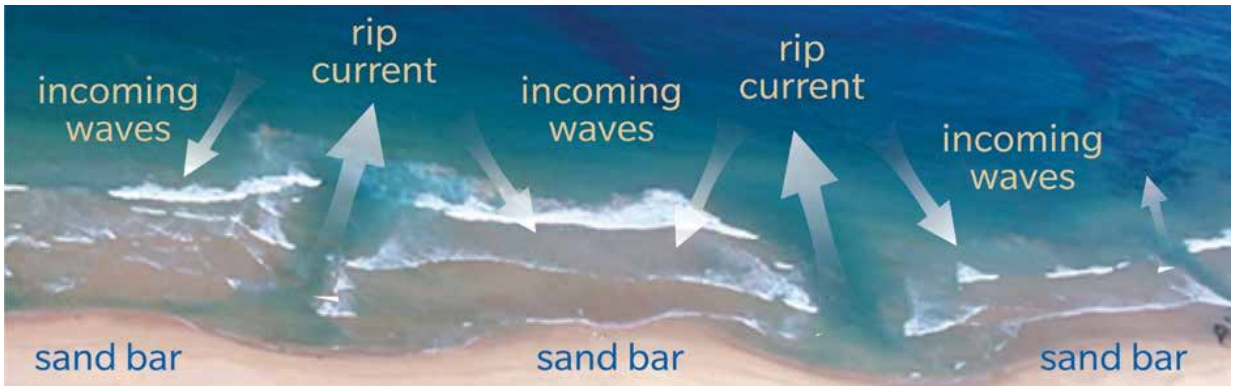


**Figure 2: A schematic showing the formation and how to identify rip currents. Source: https://beachsafe.org.au/surf-safety/ripcurrents**

## The pilot operational rip risk forecast model

The Weather and Climate Science for Service Partners (WCSSPA) fund provided an exciting platform for various project partners in South Africa and the United Kingdom to build an operational rip current forecast model for the South African coastline. A collaboration between the SAWS Marine Unit and researchers from the Coastal Marine Applied Research (CMAR) group produced a pilot operational rip current risk forecast model for the Cape Peninsula. Many different components were needed to build the operational rip forecast model. These were assembled via the input and expertise of many different project partners in South Africa. Modelled inshore wave and water-level data were derived using SAWS established Wave and Storm Surge operational Table-False Bay hydrodynamic models (SWaSS and SWaSS-TM) to understand the wave and water-level conditions and identify hydrodynamic thresholds at which rips are likely to occur. Using the SWaSS forecast model, the conditions (wave and tide) under which rip incidents have occurred were ascertained by means of a 3.5-year hindcast of waves and water-levels around the Cape Peninsula (CMAR, 2021). The high-resolution nearshore hindcast data allowed for the extraction of the wave conditions along relatively shallow depths allowing for the calculation of the theoretical significant breaking wave height required to link wave height to rip incidents (CMAR, 2021). Correlating times and dates of numerous rip incidents (data collected from beaches around the Cape Peninsula) with specific beach locations and the hydrodynamic forces occurring at that time, emerging patterns in the frequency and occurrence can be identified (CMAR, 2021). From the analysis, three levels of rip risk and an additional level for large waves were proposed (Table 1). These thresholds are a basis on which local knowledge and experience (such as those of lifeguards) can be built (CMAR, 2021).

Table 1: Table of risk levels and associated rip risk

| RISK LEVEL | RIP RISK |
|---|---|
| Level 1: Low Risk | Rips Unlikely |
| Level 2: Medium Risk | Rips likely |
| Level 3: High Risk | Rips Strong |
| Level 4: High Wave Warning | High Waves and Strong Currents |

The pilot site model is currently in the testing phase to properly ensure sufficient performance. Every day, routine hydrodynamic conditions for a 3-day forecast period are assessed against the pre-determined thresholds, generating warning flags at six different locations across the Cape Peninsula coastline (Figure 3). Numerous other outputs (Figure 4) are generated and can be neatly presented in a PDF, that will assist many different stakeholders in providing a rip risk forecast and potentially aid in beach awareness and safety.

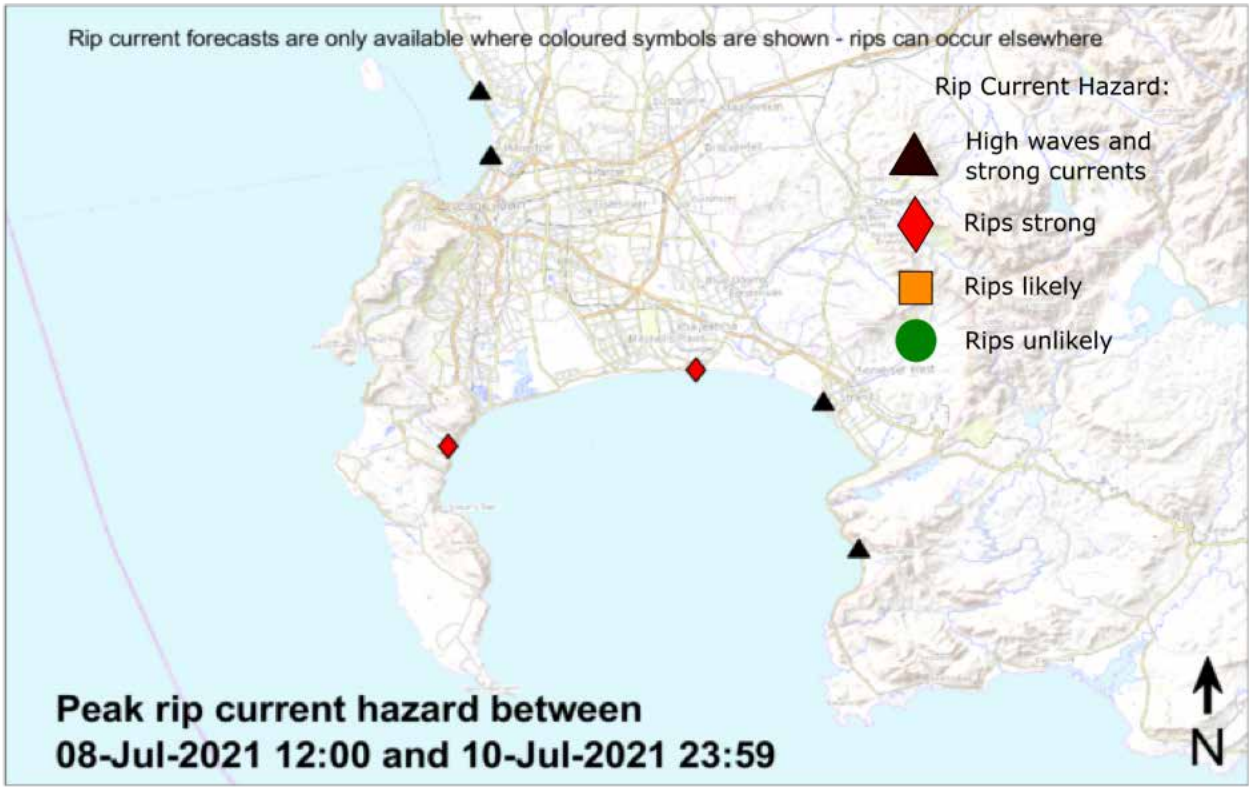


Figure 3: The rip risk forecast for 8 – 10 July 2021, for the six locations around the Cape Peninsula.

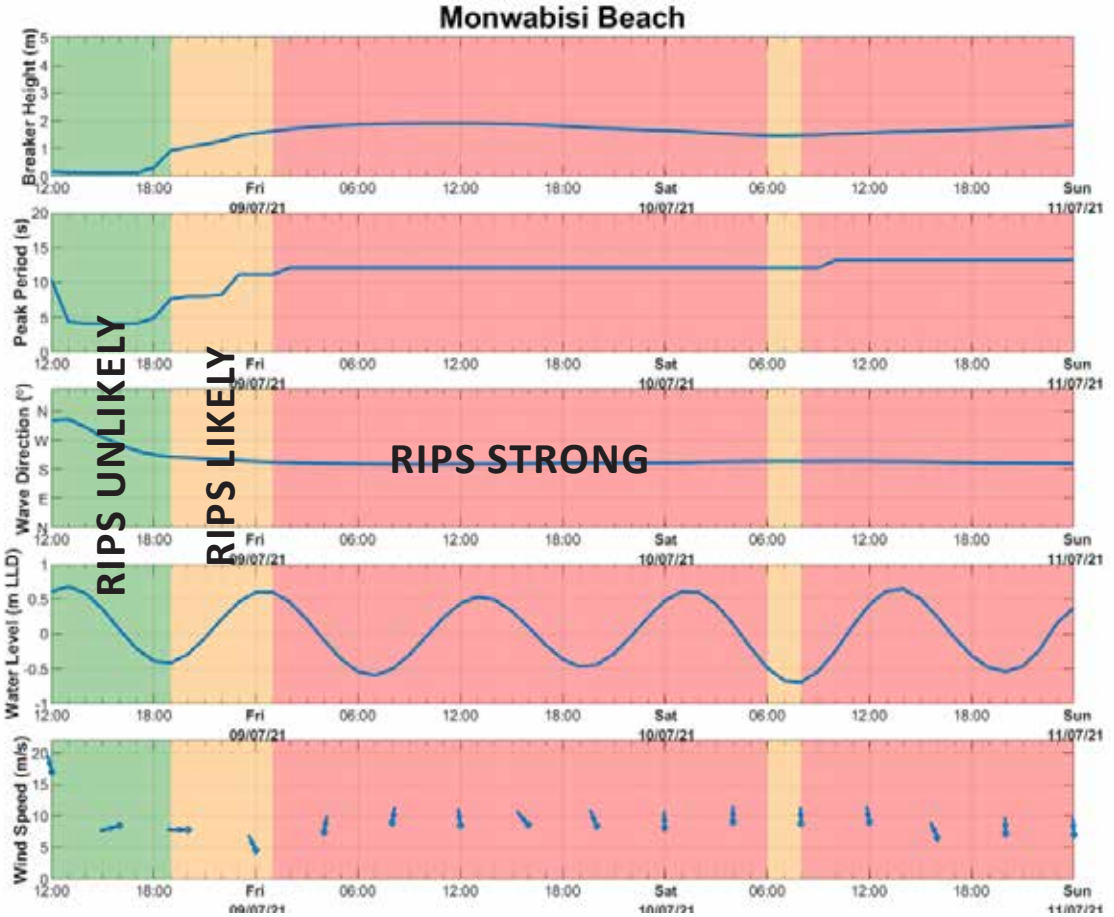


**Figure 4: Time series of Monwabisi beach illustrating associated wave conditions for the forecast period 8-10 July 2021. The time series is colour-coded based on the rip risk thresholds. Rips strongly is a higher weighted rip risk level and therefore indicated as the maximum rip risk on the regional map (Figure 3).**

Recently, an addendum to the standard SAWS marine IBF warning for waves was issued and re-shared by the National Sea Rescue Institute (NSRI), at their request, for the sake of public safety. The addendum mentioned that the experimental rip forecast system indicated the likelihood of strong rip currents at all six study site beaches along the Cape Peninsula. The information was received with great interest by the public and media houses, with numerous requests for more information. This bodes well for user uptake, and the reputation of SAWS in assisting to safeguard South Africans from marine weather hazards.

**Figure 5: GPS drifter and dye used to study and identify rip currents in the field. Source: Rip current CMAR, presentation 2020.**

## Future research

The original scope of the project included the collection of in-situ field data measurements to further refine the hydrodynamic thresholds. Unfortunately, the impact of COVID-19 on this project meant that not all objectives could be met, with some being postponed. The inclusion of in-situ data will allow for the model to be better calibrated and validated. Together with the project partners, we aim to collect field measurements using GPS drifters and the release of harmless dye (Figure 5) into the rip currents, to observe their evolution. Subject to the availability of the required input data (beach profiles, incident data etc.), we aim to extend the system further around the South African coastline. A forecasting system such as this enables public safety personnel to better prepare for hazardous beach conditions (via strategic allocation of personnel and equipment, for example) and inform the public of potential danger before they head out to the beach.

## Acknowledgements

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*Figures:*

Photograph of rip currents at a beach near Plettenberg Bay. 2020. [Photograph]. At: Plettenberg Bay: NSRI Website, News Archive.

Schematic of rip currents at a beach. Unknown. [Schematic]. At: Unknown: Surf Life Saving Website, Beach safe.

Photograph of GPS drifters. Unknown. [Photograph]. At: Unknown: CMAR 2020 Rip current presentation.

Photograph of dye released at the beach showing the rip current. Unknown. [Photograph]. At: Unknown: CMAR 2020 Rip current presentation.