Institution: University of Plymouth

Unit of Assessment: UoA7

Title of case study: Informing on beach hazards to improve beach safety and help save lives

Period when the underpinning research was undertaken: 2006-2017

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Gerd Masselink	Professor of Coastal Geomorphology	2004-present
Tim Scott	Associate Professor of Ocean Exploration	2006-present
Paul Russell	Professor of Coastal Dynamics	1992-present
Christopher Stokes	Senior Research Fellow (Impact)	2015-present

Period when the claimed impact occurred: 2014 – Nov 20

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact (indicative maximum 100 words)

The Coastal Processes Research Group (CPRG) have significantly impacted beach lifeguarding risk assessment, training, and policy in the UK, South Africa (SA) and New Zealand (NZ). Rip current are dangerous flows that can take bathers from the shallows out to sea and cause hundreds of drownings and tens of thousands of beach rescues (70-80% of all incidents) globally each year.

CPRG's rip forecasts are used in the UK and NZ, informing daily lifeguard resourcing and ultimately reducing risk to life from rip currents. CPRG's research underpins annual Royal National Lifeboat Institution (RNLI) risk assessments at all UK bathing waters, has changed risk management policy at beaches in the UK and SA, has informed public rip current safety advice globally, and has contributed to a reduction in drownings across the world.

2. Underpinning research (indicative maximum 500 words)

The Coastal Processes Research Group (CPRG) at the University of Plymouth (UoP) have been researching beach hazards for 15 years. In 2006, CPRG academics Dr Tim Scott, Prof. Gerd Masselink and Prof. Paul Russell undertook research co-designed and funded by the Royal National Lifeboat Institution (RNLI). Their research involved a UK-wide classification of beach types and associated beach hazards. The resulting United Kingdom Beach Safety Assessment Model (UKBSAM) was based on a combination of hydrodynamic forcing factors (waves and tides), beach sediment, beach morphology, and over 100 other site-specific parameters gathered for 640 UK beaches (3.1). This research highlighted that rip currents represent a major beach hazard, especially in southwest England where they were found to be

responsible for over 70% of all beach rescues, and only occur on beaches featuring sandbars interspersed by channels, termed 'bar-rip' morphology.
Rip currents were further investigated through a 3-year NERC Partnership grant with the RNLI awarded to Prof. Gerd Masselink, titled 'Dynamics of Rips and Implications for Bather Safety' (herein, DRIBS; 2010 – 2012), conducted by Drs Martin Austin and Tim Scott. CPRG made the first successful measurements of rip currents under a variety of wave and tide conditions in the UK during two 6-week field experiments on Perranporth beach, a high rip-hazard beach on the north coast of Cornwall. The measurements revealed that rip currents turn on and off as the wave and tide conditions change, and provided unprecedented insights into the key role played by movement of the tide over the beach morphology through controlling the location of wave breaker patterns (3.2 & 3.3). This research made it possible to predict when and where rip currents would cause a danger to bathers, based on forecasted wave and tide conditions (3.4). The data also demonstrated that rip currents often do not just flow out to sea, but may represent large circulating eddies in the surf zone. Further fieldwork and numerical modelling was conducted by the same team of researchers through a research consultancy project with the RNLI in 2012 ('TOPORIP'), which demonstrated that surprisingly hazardous currents can occur on sheltered beaches not usually associated with rip currents if a groyne or other topographic obstruction is present (3.5). The strength and potential hazard of such 'topographic' rips was previously unknown.

From 2014 to 2017, CPRG conducted a study commissioned by RNLI titled 'Quantification of Beach Risk' (herein QOBR) aimed at developing a statistical model to predict bathing risk on all beaches in the UK and Ireland to inform resourcing decisions (3.6). A two-component statistical model was developed: one to predict beach hazard level and the other to predict beach-user numbers. It was found that bar-rip morphology is the most crucial contributor to water-user life risk, as it was linked to both higher hazard and higher water-user numbers.

CPRG's research on beach hazards combined novel measurement and modelling techniques and was the first time that rip currents had been studied on beaches with large tides anywhere in the world.

3. References to the research (indicative maximum of six references)

CPRG's research has been presented at key international conferences (International Conference on Coastal Engineering, Conference on Drowning Prevention, International Coastal Symposium) and published in the most prestigious journals in coastal science, each demanding the highest levels of rigour and originality. For example, Coastal Engineering, Marine Geology, Geomorphology, and Continental Shelf Research have annual acceptance rates of 32%, 32%, 32%, and 38%, and 5-year Impact Factors of 4.3, 3.8, 3.9 and 2.5, respectively.

NERC and RNLI joint funded grant *Dynamics of Rip Currents and Implications for Beach Safety (DRIBS)* (PI **Prof. Gerd Masselink**, CI Prof. **Paul Russell** and Post-Doctoral Researchers **Drs Tim Scott** and **Martin Austin**) (£396,192) (NE/H004262/1) 2010-2012:

3.1 **Scott, T., Masselink, G.** and **Russell, P.E.,** 2011. Morphodynamic characteristics and classification of beaches in England and Wales. *Marine Geology*, 286, 1-20. [http://dx.doi.org/10.1016/j.margeo.2011.04.004]

3.2 Austin, M. J., **Masselink, G., Scott, T. M.** and **Russell, P. E**., 2014. Water-level controls

on macro-tidal rip currents. *Continental Shelf Research*, 75, 28-40. [http://dx.doi.org/10.1016/j.csr.2013.12.004]

3.3 **Scott, T., Masselink, G**., **Austin, M.J**. and **Russell, P.E**., 2014. Controls on macrotidal rip current circulation and hazard. *Geomorphology*, 214, 198-215. [http://dx.doi.org/10.1016/j.geomorph.2014.02.005]

3.4 **Austin, M.J**., **Scott, T.M., Russell, P.E**. and **Masselink, G**., 2012. Rip current prediction: development, validation, and evaluation of an operational tool. *Journal of Coastal Research*, 29, 283-300. [http://dx.doi.org/10.2112/JCOASTRES-D-12-00093.1]

RNLI and Met Office joint funded project *Topographic rip currents TOPORIP* (PI Prof. Gerd Masselink, CI Prof. **Paul Russell** and CI **Dr Tim Scott**) (£99,000) 2012-2014:

3.5 **Scott, T**., **Austin, M**., **Masselink, G.** and **Russell, P.E**., 2016. Dynamics of rip currents associated with groynes – field measurements, modelling and implications for beach safety. *Coastal Engineering*, 107, 53-69. http://dx.doi.org/10.1016/j.coastaleng.2015.09.013]

RNLI funded project *Quantification of Beach Risk (QOBR)* (PI **Prof. Gerd Masselink**, CI **Dr Tim Scott**, and Post-Doctoral Researcher Christopher Stokes) (£101,533) 2014-2018:

3.6 **Stokes, C.**, **Masselink, G.**, **Revie, M**., **Scott, T**., Purves, D., Walters, T., 2017. Application of multiple linear regression and Bayesian belief network approaches to model life risk to beach users in the UK. Ocean and Coastal Management, 139, 12-23. [http://dx.doi.org/10.1016/j.ocecoaman.2017.01.025]

4. Details of the impact (indicative maximum 750 words)

CPRG's beach hazards research identified a variety of causes for beach incidents and drownings, but the single biggest hazard identified was rip currents. Rip currents are dangerous flows that can take bathers from the shallows out to sea and cause hundreds of drownings and tens of thousands of beach rescues (70-80% of all incidents) globally each year. In the UK, they cause >500 incidents per year and are the single biggest cause of lifeguard rescues.

Our research has fundamentally changed training of beach lifeguards in the UK and NZ, and public education on rip currents globally. It has engendered cultural shifts in safety management and has influenced beach safety strategy on UK and SA beaches and continues to inform annual RNLI beach risk assessments on all UK beaches. Ultimately, these impacts are contributing to a reduction in drownings on the world's beaches. Our research, 'as part of a suite of research and interventions, is having an impact. We can state this with confidence through evidencing the continuing trend of decline in accidental fatalities around our coastlines' Steve Instance, Lifesaving Manager, RNLI (5.1).

Improved lifeguard training and public education campaigns

CPRG's research enabled the RNLI to develop bespoke lifeguard training material on rip currents (5.1& 5.2) which are used annually for training of all RNLI lifeguards and supervisors (2012 – present) (5.3). Those lifeguards go on to provide beach safety on 249 UK beaches during the summer season (> 1/3rd of UK bathing waters). CPRG research has also fed into RNLI rip awareness campaigns (5.4) targeted at school children (lower secondary, age 11-14) prior to reaching the most at-risk age group (16-21) identified through CPRG's collaborative research with RNLI, where rip current speeds, behaviour, and escape strategies are directly quoted from CPRG's research. In NZ, CPRG's consultancy work on beach hazards for Surf Life Saving New Zealand (SLSNZ) has led to "the rewriting of the ... Surf Lifeguard Award Manual in 2019, which is used as a tool to educate over 1,000 new Surf Lifeguards annually" and

informed the development of their national rip current public education campaign in 2019 (5.5). Subsequently, SLSNZ disseminated the research findings to Surf Life Saving Australia (SLSA). This led to the development of an Australasian rip current public education campaign in 2019 (5.5). On a global scale, our research heavily influenced the official 'rip current safety advice' statement (Jan 2020) by the International Life Saving Federation (5.6), which underpins the safety advice offered to bathers in 139 countries around the world.

Improved daily beach lifeguard operations

CPRG's rip current forecasts have enabled a strategic shift within the RNLI and SLSNZ towards using data-driven evidence to make daily lifeguard resourcing and beach management decisions, as well as to communicate and justify those decisions (5.3).

Collaborating with the RNLI and the Meteorological Office (Met Office), our research was operationalised into a new Met Office service in 2013 delivering a localised weather, swell and rip hazard forecast for RNLI patrolled beaches (5.7). This is delivered daily to all of the 249 RNLI lifeguard units in the UK (>1/3rd of UK bathing waters). The forecast has significantly enhanced lifeguard capacity and preparedness, with RNLI teams making resourcing decisions proactively based on the forecast conditions (5.3). Information is provided directly to lifeguard managers at each beach on a 5-day forecast and is "actively used for rostering and the deployment of casual staff to address peak demand/risk" (5.3). This incorporates the UK's patrolled 'bar-rip' type beaches, which experienced 4,813 reported rip incidents between 2008 and 2016, including the five most hazardous beaches in the UK which contributed 1,463 of the total rip incidents. Additionally, the forecast informs RNLI communication to the public, which are delivered in local and national press ahead of days when beach risk will be high (5.1 & 5.3). The rip forecast has become a communication tool amongst RNLI staff to explain and defend why resourcing decisions have been made and/or why lifeguards have issued a 'red flag' (5.3).

Our impact has been extended to the international stage through the development of a beach hazard forecast for beaches in NZ in 2019 and SA in 2020. The NZ forecast is used to inform lifeguard resourcing and management decisions (5.5). For Auckland's lifeguards and Surf Life Saving clubs the forecast has "created greater operational awareness and response to when hazardous conditions are most likely to occur" and has subsequently enabled more informed usage of lifeguards and costly assets such as utility vehicles and jet skis (5.5).

Influencing beach safety strategy and coroner enquiries

Our research has significantly influenced strategy and policy at the RNLI regarding lifeguard resourcing, and funding of lifeguard units across the whole of the UK and Northern Ireland (NI). We created, for the first time, a ranked list of beaches according to the modelled likelihood of fatalities or serious incidents. This analysis strongly influenced the RNLI's 2017 Lifesaving Strategy (5.3), which commits to prioritising their resources to beaches that most need a lifeguard service. This in turn has influenced their approach to funding the lifeguard service, in that they now consider sole RNLI funding for the highest risk beaches, whereas their default approach previously was joint financing with the local authority (LA) (5.3). This ensures that all high-risk beaches which were previously unmanned due to lack of LA funding are now patrolled.

Our research has directly influenced coroners' inquiries. Dr Tim Scott provided an expert witness report for a coroner's inquiry into two drownings in SA in December 2014 (5.8), which

led to the coroner issuing a regulation 28 report in June 2015 (5.8). This put a legal obligation on the holiday provider in question to take significant steps to safeguard holidaymakers from subsequent risk of drowning at Woody Cape, and therefore fundamentally changed the safety policy at that beach. Subsequently, following six tragic drownings in 2015/2016 in East Sussex, Rother District Council asked CPRG to provide a beach hazard assessment, which contributed to a coroner's inquiry into the fatalities (5.3 & 5.9). This resulted in the implementation of an RNLI lifeguard service at the beach in 2017, with the local council stating that "the report added to our knowledge of the beach tides and, along with other reports, led to the addition of lifeguards on the beach" (5.9).

Underpinning beach risk assessment

RNLI policy and practice regarding beach risk assessments has fundamentally changed as a direct result of CPRG's research. The RNLI beach risk assessment form has been pre-populated with our UKBSAM and QOBR data since 2018, including the predicted rip current risk and predicted number of visitors and incidents at the beach, which directly influences every annual RNLI beach risk assessment made in the UK and Northern Ireland. RNLI's own research in 2015 confirmed that beaches classified in CPRG's UKBSAM as 'high risk' have rescue rates around 2.5 times higher than other beaches (5.10). In 2017 RNLI staff conducting beach risk assessments were redirected to visit those beaches that had the highest QOBR risk predictions. This has streamlined the RNLI risk assessment process and "created considerable time savings in their work to conduct assessments" (5.3)

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1 Impact statement from Steve Instance, RNLI Community Safety Partner (South West) ('S Instance_RNLI_REF_headedAndSigned.pdf').
5.2 RNLI rip current hazard assessment training cards ('RNLI_Rip_Assessment_Cards.pdf')
5.3 Impact statement from Tom Walters, former head of Operations Research at RNLI ('T Walters_RNLI_REF_headedAndSigned.pdf').
5.4 RNLI rip current awareness campaign material 'The Pull of a Rip' (The pull of a rip – workshop)
5.5 Impact statement from Adam Wooler, head of Surf Life Saving New Zealand (A Wooler_SLSNZ_REF_HeadedAndSigned.pdf).
5.6 International Life Saving Federation 'rip current safety advice'
5.7 Example RNLI rip current forecast ('MO Rip Forecast sample.JPG')
5.8 Woody Cape expert witness coroner's report and regulation 28 report
5.9 Impact statement from Tony Leonard, Executive Director of Rother District Council ('T Leonard_Rother Council_headedAndSigned.pdf').
5.10 RNLI research report: Exploring the effect of lifeguard preventative actions on beach safety ('15864-lifeguard-preventative-action-report.pdf')