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Analysis of Visible Signs of Rip Currents in Arabian Sea at Calangute & Vagator Beach of Goa

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Abstract **Original Research Article**

Introduction: While on beaches even if you are only in knee-deep water, may be swept off your feet by strong ocean waves and rip currents. (large volume of water returning back out to sea after onshore wave action) Drowning due to Rip Currents is measure preventable cause of death. If caught in a Rip Current; swim towards the shore at an angle. Research question was to observe & analyze of Visible Signs & Characteristic of Rip Currents. ***Methods:*** Naturalistic Observational Cross Sectional Comparative study was carried out in Arabian sea in two groups at Calangute Beach & Vagator Beach at Goa India by observing prevalence of presence of following visible sign & characteristics by naked eyes out of simple random sampling done selected 100 Rip Currents, as given in Rip Current Wikipedia & Rip Current safety University of Delaware Sea Grant College Programme. In statistics Excel sheet, IBM SPSS windows version 20, Z-test & $p < 0.05$ were used. In this research no human subject was used so no ethical clearance was required. ***Results:*** Prevalence of Visible signs were [A] A channel of Churning Chopping water was observed at Calangute Beach in 36% & at Vagator Beach 80% of Rip Currents[B] A line of Sea Foam look almost like a road or a river running out to sea, away from the shore was observed at Calangute Beach in 99% & at Vagator Beach in 100% of Rip Currents [C] A Rip showing Different Coloured Sea water beyond the surf zone depending on the angle of the Sun was observed at Calangute Beach in 5% & at Vagator Beach in 27% of Rip currents [D] A break in the incoming Sea wave pattern as waves role into shore was observed at Calangute Beach in 90% & at Vagator Beach in 93% of Rip currents. While in comparison, at Vagator Beach; Rip showing; channel of Churning Chopping water & Different Coloured Sea water was significantly more than at Calangute Beach. ***Conclusion:*** A line of Sea Foam look almost like a road or a river running out to sea, away from the shore was the most frequently occurring identifying sign of observed Rip Currents. Rip's visible Sign like Chopping of water & Different Coloured Sea water was different at Calangute Beach & Vagator Beach. So during Rip Current presence; don't go inside sea, swim towards the shore at angle and save yourself and others.

Keywords: Rip Current Visible Sign: Sea Foam Running to Sea: Incoming Breaking Wave.

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INTRODUCTION

Rip currents (also referred to as rips) are narrow areas of seaward-flowing water and represent the greatest hazard at surf beaches worldwide [1]. It is important to remember that rip currents do not pull people under water; they pull people away from shore. Rip currents can occur at any beach where there are breaking waves: on oceans, seas, and large lakes. The location of rip currents can be unpredictable: while some tend to reoccur always in the same place, others can appear and disappear suddenly at various locations. Rip currents typically flow at 0.5 metres per second (1–2 feet per second), but they can be as fast as 2.5 metres per second (8 feet per second), which is faster than any human can swim. The rip is like a treadmill, which the swimmer needs to step off. Causes of rip currents are wind ,sandbar, piers, jetties radiation stress. wave shoals set down, wave trains. Varying underwater topography [2]. While on beaches, Swimming in the ocean is very different from swimming in a pool or lake. The strength and force of ocean waves and currents are surprising to those unfamiliar with the power of the sea. Many unsuspecting vacationers who venture into the surf, even if they're only in knee-deep water, may be swept off their feet by these strong ocean waves and currents. Drowning deaths usually occur when people are unable to keep themselves a float and swim back to shore. This may be due to fear, panic, exhaustion, a lack of swimming skills, or any combination of these factors [3]. Rip Current

consist of large volume of water returning back out to sea after on shore wave action [4]. Two forces produce increased external pressure (hyperbaria) in diving weight of column of water directly above the diver (hydrostatic pressure) & weight of the atmosphere (ata or bar) at the water's surface. Boyle's law applied to depth versus volume and pressure. At the depth of 1 meter the compressive force of water against chest cavity becomes so large that the inspiratory muscles cannot overcome external pressure and expand thoracic dimensions. This makes inspiration impossible without external air at sufficient pressure to counteract the compressive force of water at particular depth. This reality forms the basis of SCUBA [5]. Offshore directed currents formed in the surf zone due to breaking waves are called "rip currents" and essentially typical to the oceans. Being a nearly closed basin, the Black Sea is probably the only exception with frequent rip currents on its beaches. Particularly in countries with shores facing the oceans such as Australia and United States, numerous studies and articles are available regarding rip currents, their formation, and related drowning incidents [6]. The Black Sea is a body of water and marginal sea of the Atlantic Ocean between the Balkans, Eastern Europe, the Caucasus, and Western Asia. It is supplied by a number of major rivers, such as the Danube, Dnieper, Southern Bug, Dniester, Don, and the Rioni. Many countries drain into the Black Sea, including Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Hungary, Moldova, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Turkey and Ukraine [7]. The Israeli Mediterranean relative drowning number (RDN) is higher than that of other Mediterranean countries and probably of other beaches in the world. The high drowning figures in Israel seem to reflect both the meteorological and oceanographic conditions of Israel's Mediterranean coast and the beach-safety management (BSM) schemes that can be reduced by proper modern scientific and managerial approach [8]. Rip current-related fatalities in India are most common in the south-eastern India, with a non-uniform spatial distribution. August and October are identified as most favourable for rip current generation. In India, rip current-related drowning is estimated as 39 per year during the last decade. East coast of India (Bay of Bengal) averaged 30–40 drownings, and west coast of India (Arabian Sea) averaged 5–10 drownings per year. In coastal Andhra Pradesh, more than 350 people had been drowned due to rip currents and only 10 people were rescued. Visakhapatnam recorded highest drowning 293 in numbers [9]. The Bay of Bengal is the north-eastern part of the Indian Ocean, bounded on the west and northwest by India, on the north by Bangladesh, and on the east by Myanmar and the Andaman Islands of India and Myanmar and the Nicobar Islands of India. Its southern limit is a line between Sri Lanka and the northwesternmost point of Sumatra (Indonesia). It is the largest water region called a bay in the world. A number of large rivers flow into the Bay of Bengal: the Ganga–Hooghly, the Padma, the Brahmaputra–Jamuna, the Barak–Surma–Meghna, the Irrawaddy, the Godavari, the Mahanadi, the Brahmani, the Baitarani, the Krishna and the Kaveri [10]. The Arabian Sea is a region of the northern Indian Ocean bounded on the north by Pakistan and Iran, on the west by the Gulf of Aden, Guardafui Channel and the Arabian Peninsula, on the southeast by the Laccadive Sea, on the southwest by the Somali Sea, and on the east by India. The Gulf of Aden in the west connects the Arabian Sea to the Red Sea through the strait of Bab-el-Mandeb, and the Gulf of Oman is in the northwest, connecting it to the Persian Gulf. The biggest river flowing into the Arabian Sea is the Indus River [11]. Rivers flowing into the Arabian Sea from India are Indus River Basin Narmada River Basin Mahi River Basin Sabarmati River Basin Maharashtra Coastal Rivers Tapi River Basin Coastal rivers of Goa Karnataka Coastal Rivers Kerala Coastal Rivers [12] Drowning is measure preventable cause of death, most frequently in children and in developing countries. Aspiration (whether of salt or fresh water) is usual in drowning (submersion resulting in death) and near drowning (known as nonfatal or submersion injury) and leads cardiac arrest within few minutes. Death or severe neurological impairment occur after submersion for more than 5 to 10 minutes, but much longer durations may be tolerated in hypothermic conditions. Alcohol affects vision, balance, movement, and reasoning and is a major risk factor for drowning. Causes of drowning – people with little or no swimming ability, with head and neck injury, following cardiac and neurological emergency, As a result of alcohol and drugs, metabolic diseases including hypoglycaemia, and even child abuse and murder. Swimmers in difficulty may be able to shout for but, contrary to public opinion, those who are drowning do not (4). The world Congress of Drowning definition of drowning is "Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid "The term drowning does not imply the final outcome –death or survival, the outcome should be denoted as fatal or nonfatal drowning. The injury following drowning event is Hypoxia. Young children can struggle for only 10-20 seconds and adolescents for 30-60 seconds before final submersion [13]. Most common causes of drowning by age in Infants/ young children are Domestic baths, Garden Pools. In Adolescent are swimming pools, rivers, sea etc. In adults are water sports, boating, fishing, occupational, In older people are Domestic baths etc [14]. Near drowning describes a submersion event leading to injury may result in aspiration, laryngospasm, hypoxemia, and academia. Drowning describes submersion resulting in death symptoms and signs includes anxiety, dyspnoea, cough, wheezing, trismus, cyanosis, chest pain, dysrhythmia, hypotension, vomiting, diarrhoea, headache, altered level of consciousness, neurological deficit, and apnea. Hypothermia is highly likely with cold water or prolonged submersion. The patient's appearance may vary from deceptively asymptomatic

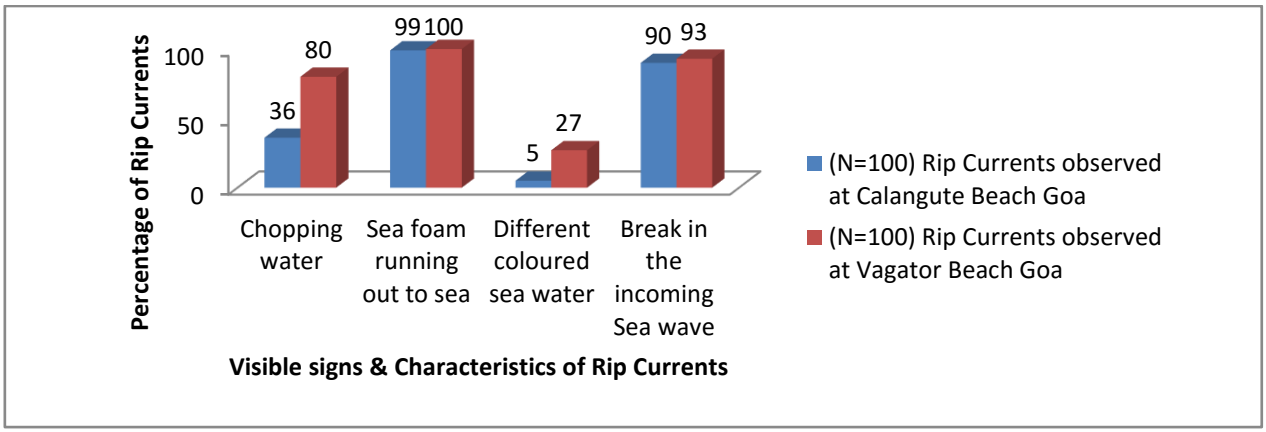
during initial recovery period only to deteriorate or die as a result of acute respiratory failure within the following 12-24 hr, to abnormal vitals signs [15]. In Clinical features; Patient must also be assessed for hypothermia ,hypoglycemia, concurrent injuries, and medical conditions, clinical manifestations are hypoxemic, pulmonary edema, and hypoventilation prognosis cannot be reliably predicted ,but cardiovascular status is a better prognostic indicator than neurological presentation. Patients who are neurologically responsive at the seen of immersion, in sinus rhythm and with reactive pupils, have good outcomes. Those who are asystole on arrival at hospital and remain comatose for more than 3 hours have poor prognosis unless they are hypothermic. Patients with a normal chest radiograph on admission usually survive (4).

METHODS

This naturalistic observational cross sectional comparative analytic study was carried out in Arabian sea in two groups at Calangute Beach & Vagator Beach at Goa India by direct observation of rip currents by naked eyes (1) on basis presence of following visible sign & characteristics as inclusion criteria to identify rip currents , out of simple Random sampling [16] done selected 100 Rip Currents, as given in Rip Current Wikipedia (2) & Rip Current safety University of Delaware Sea Grant College Programme (3) & "Rip Currents Safety". U.S. National Weather Service.US Dept. of Commerce National Oceanic & Atmospheric Administration [17] are [A] A channel of churning chopping water [B] A line of sea foam look almost like a road or a river running out to sea, away from the shore [C] A Rip showing different colored Sea water beyond the surf zone depending on the angle of the Sun [D] A break in the incoming sea wave pattern as waves role into shore beach . Data so collected was tabulated in an excel sheet. Data was analyzed using IBM SPSS. Statistics Windows, Version 20.0. The statistical significant difference among groups was determined by the Z-test. The level of significance was set at $p < 0.05$. In this research no human subject was used so no ethical clearance was required.

RESULTS

Visible Signs & Characteristics of Rip Currents	(N=100) Rip Currents observed at Calangute Beach Goa	(N=100) Rip Currents observed at Vagator Beach Goa	p value
A channel of Churning Chopping water	36%	80%	<0.001
A line of Sea Foam look almost like a road or a river running out to sea, away from the shore	99%	100%	0.317
A Rip showing Different coloured Sea water depending on the angle of the Sun	5%	27%	<0.001
A break in the incoming Sea wave pattern as waves role into shore	90%	93%	0.447



DISCUSSION

In Pathophysiology- Aspiration is usual in drowning. (Wet drowning) is due to aspiration of fluid or foreign material. Approximately 10 to 15% of victims of drowning had not aspirated water, in these cases death may result from laryngeal spasm and asphyxia or airway obstruction during submersion. (Dry drowning). Recent Chinese bronchoscopic studies in an anaesthetized dogs whose lungs were filled with sea water showed that bronchi filled with the bronchoalveolar fluid, causing increasing blood lactate dehydrogenase –L and alkaline phosphatase levels. Electron microscopy shows injury to type 2nd alveolar epithelial cells, thickened respiratory mucosa, and platelet adherence. (4) Following inhalation of water there is rapid onset of ventilation perfusion

imbalance with hypoxemia and the development of diffuse pulmonary oedema [14]. However, aspiration of large volumes of water hypertonic sea water draws fluid into the lung from circulation by osmosis, resulting in fluid filled, nonventilated, but perfused alveoli incapable of normal gas exchange whilst aspiration. However, aspiration of large amount of hypotonic freshwater may cause sufficient absorption of fluid into the circulation from alveoli to cause both acute hypervolumea and haemolysis. Within 1 hour, pulmonary oedema develops, resulting in a decrease in circulating blood volume. It has been estimated that about 10 % of body weight of may be absorbed from the lungs during freshwater drowning (4), which impairs surfactant function which lead to alveolar collapse right to left shunting of unoxygeneted blood [14]. Since the brain has a limited ability to maintain ATP anaerobically when cerebral blood flow is reduced, it suffers irreparable damage within 4 to 6 minutes. Death or severe neurological impairment occur after submersion of more than 5 to 10 minutes. However, in hypothermic conditions, brain activity may be restored after up to 60 minutes of submersion apnoea. By standers estimate of submersion time are usually inaccurate. (4) further in paediatric age group pathology remains anoxic–ischemic injury, pulmonary injury & cold-water injury [13]. In Management; If you get caught in a rip current – remain calm, and try to float or tread water. Don't swim against the current, as this is difficult for even experienced swimmers. Swim along the shoreline until you feel the current relax, or let the current carry you until it slows down. Then swim towards the shore at an angle. Since rip currents are narrow, it does not take much effort to swim along the shore out of danger's way. If you are unable to reach shore, wave your arms and yell for help. (2) First requirement of rescue is immediate basic life support includes sustain ventilation, oxygenation, and circulatory support and CPR is provided if pulse and respirations are absent, Patient must be assessed for hypothermia, hypoglycemia, trauma, and concurrent medical conditions. venomous stings or bites, decompression sickness, carbon monoxide exposure from boat motors should be considered. Rescuer should not attempt to drain water from the victim' lungs. The Heimlich maneuver (subdiaphragmatic pressure) should be used only if foreign material airway obstruction is suspected. Resuscitation and basic life support efforts must be continued until core until core temperature reaches 32 degee centigrade even for seemingly hopeless patients, nasogstric suctioning can decompress the stomach, subsequent management includes-ensure optimal ventilation and oxygenation- by giving oxygen, endotracheal intubation, mechanical ventilation, CPAP, PEEP, [15] Use of extra corporial membrane oxegenation and /or cardiopulmonary bypass in refractory cases. A central venous catheter or pulmonary artery catheter helps to assess the effective circulating blood volume to guide fluid therapy. Failure of response to intravascular replacement with 20 ml/kg of colloid is an indication for starting inotropes (4) Treatment of complications eg Adult respiratory distress syndrome secondary pneumonia. Cardiovascular support –Fluid replacement and vasopressures or diuretics, correction of blood ph and electrolyte abnormality (corrected through adequate ventilation, oxegenation and glycemic control). There is direct correlation between prognosis and the patient's age, submersion time, rapid prehospital resuscitation and transport to a medical facility, clinical status at time of arrival at hospital, Glasgow coma scale, pupilary reactivity, and overall health assessment (APACHE 2nd score) [15]. Inpatient monitoring for 24 hours following near drowning. This includes continuous monitoring of cardiorespiratory, neurological, renal and metabolic function. Pulmonary edema may not appear for 24 hours. General management of hypothermic casualty. The old adage that "you are never dead unless warm and dead" must be taken seriously. A variety of rewarming methods are available –Warm blankets, hot drinks, metalized space blankets, warmed intravenous fluids, peritoneal warm fluids, cardiac bypass, heated humidified air also permits core rewarming. Hot baths are effective but difficult to use safely since a paradoxical fall in core temperature can occur as blood flow is rapidly restored in cold limbs. In general, if cooling was prolonged in onset or duration, rewarming must be undertaken with extreme caution. In critical cases, where rapid rewarming is needed, full resuscitation facilities must be available, careful monitoring during, rewarming is vital. Blood volumes are often low due to early cold-induced diuresis, followed by the inability of hypothermic kidneys to retain salt and water. In immersion casualties, hydrostatic effect on the limbs may have promoted additional fluid loss and, if possible, these people must be kept recumbent throughout rescue and rewarming to minimize risks from extreme postural hypotension. Warming cell membranes are extremely unstable ,and uncontrollable fluxes in potassium and other electrolytes may occur, although care must be taken in interpreting biochemical results from cold peripheral blood sampling [18]. Rip current related research provides a better understanding of the physical and social aspects of rip currents in ocean areas that will lead to better forecasts, better governmental policies in beach areas, and ultimately to save lives. The primary factors associated with rip current formation on beaches are variations in the local beach bathymetry, wind-generated waves of significant wave height typically 1 m or higher, and lower tidal stages.[19] Further a new rip current hazard assessment method is proposed based on the beach state model. Using the measured morphodynamic parameters (wave parameters, tidal ranges and sediment grain size) of 51 South China beaches, a preliminary assessment of rip current hazards was carried out & results showed that 71% of South China beaches may develop rip currents. [20] Assessment of the effectiveness of rip current swimmer escape strategies was done by using Lagrangian measurements of rip flow using GPS drifters

were obtained. Participants with attached GPS were deployed in groups [21]. Stabilizing effect of random waves occurs on rip currents. The instability leading to the formation of rip currents; the mechanism is physically interpreted and is due to refraction and shoaling [22]. In the assessment of rip current using hydrodynamic modelling showed that this rip current events occurred during spring tide phase when the flow change from Flood to Ebb. [23]. The modelling of rip channel in creation of rip currents was done in research [24]. The energy in flowing river streams, tidal currents or other artificial water channels is being considered as viable source of renewable power. Hydrokinetic conversion systems, albeit mostly at its early stage of development, may appear suitable in harnessing energy from such renewable resources. Both in-land water resources and offshore ocean energy sector will benefit from this technology [25]. Rip currents present a severe hazard for water users on beaches and account for the greatest cause of lifeguard rescues worldwide. The physical dynamics of rip currents are well studied, and more recently, the social and behavioural science research surrounding human interaction of rip currents has been expanding, providing a social perspective and feeding into public education strategies. The aim of this study was to assess levels of public understanding of rip currents and beach safety on UK beaches. A questionnaire was undertaken during the summer of on four beaches. Beach users had a poor knowledge of rip currents, but those who have been caught in a rip before have a higher level of knowledge. Conversely, beach users had a good understanding of what the beach safety flags indicated, and most people complied with this flag system. In addition, those previously educated on rip currents had a higher knowledge, and lifeguards proved to be the most effective form of education. The study presents an insight into UK beach users' knowledge of rip currents and provides more evidence with which to pilot a rip current education scheme within the UK. [26] Most beachgoers were aware that swimming between flags indicating a patrolled section of beach was the safe swimming option, but a significant proportion chose not to swim there. Rural residents were more likely than the other two groups to make safe choices about where to swim in the presence of flags. The odds of international tourists making a safe swimming choice in the vicinity of a rip current were three times lower than usual beachgoers and rural inland residents. It Means improving beach safety will require more refined strategies for specific target groups rather than a series of one-size-fits-all approaches [27]. Internal and surface waves in the Black and Caspian Seas significantly contribute to the generation of rip currents. By altering coastal water levels and disrupting how waves break on the shore, these waves drive strong, seaward-flowing currents that pose major safety hazards to swimmers [28]. In a field experiments, conducted included current and wave monitoring and morphological mapping flow component in rip channels at the Herzliyya beach, Israel, on the South-eastern Mediterranean. Time series of instantaneous and smoothed shore-parallel current velocities and of the orbital components, were analysed, including statistical and spectral processing. The feeder and the neck demonstrated the highest longshore flow components, whereas the rip head, typically showed the lowest longshore velocities. The unsteadiness of the net longshore current was very high. Feeders typically showed a mean unidirectional longshore current. However, directional fluctuations gradually increased towards the rip head. The data suggest a clear spectral structure; most energy (46–67%) was in the gravity range with 13–35% subharmonic and minor (13–16%) in the infra-gravity band. Systematic cross-shore spatial trends of the energy spectra components were linked to bar morphology and to exposure to incident waves [29]. In China southern provinces feature higher rip current hazard than the north due to larger wave, lower tidal range, and more dynamic littoral morphology [30]. In a U.K. based study the results show male teenagers (aged 13-17 years) are the most likely demographic to be involved in a rip incident. In addition, people bodyboarding, and people in non-patrolled areas of the beach are at higher risk.[31] In an Australia based research results reflected that 407 rip current drowning deaths were identified (21 deaths/year); an exposure-based mortality rate of 0.11/1 million coastal visits. Incidents predominantly involved males (85%), 20–34 years (38%), occurred in regional/remote areas (59%) and in the presence of others (80%). For every rip current drowning death, an estimated 2449 people were rescued by someone else and 8171 individuals self-rescued.[32] World's Deadliest Beaches are Skeleton coast Namibia, Cape Tribulation – Australia, New Smyrna Beach – Florida, Fraser Island – Australia, Hanakapiai Beach – Hawaii, Utakleiv Beach – Norway, Boa Viagem Beach – Brazil, Bikini Atoll - U.S. Marshall Islands, Gansbaai - South Africa, Playa Zipolite – Mexico, Reunion Island – France, Kilauea Beaches – Hawaii, Staithes Beach – UK, Chowpatty Beach – India, Amazon River Beaches – Brazil, Dumas Beach – India, Second Beach - South Africa, North Sentinel Island Beach – India, Schitovaya Bukhta Beach – Russia, Darwin - Australia, Copacabana – Brazil, Red Triangle – California, Cairns – Australia, Mindanao Island - The Philippines, Cable Beach – Australia, Manaus Beaches – Brazil, Lamu Island Beach – Kenya, Tamarama Beach – Australia, West End Beach – Bahamas, Costa del Sol – Spain. [33] A rip current is a strong flow of water running from a beach back to the open ocean, sea, or lake. They can be more than 45 meters (150 feet) wide, but most are less than 9 meters (30 feet). They can move at 8 kilometers (5 miles) per hour. Rip currents are one of the most dangerous natural hazards in the world. The United States Lifesaving Association (USLA) estimates that 80 percent of its rescues are related to rip currents. In places like western Australia and the U.S. state of Florida, strong rip currents are one of the first signs of an approaching hurricane. Surfers often take advantage of rip currents for a ride out

to sea. Rather than using energy to paddle, they will find a rip current and coast along on their surfboard. Rip currents lose their power at the surf line, the area where waves begin to break. Surfers can coast out to the surf line on a rip current and wait for the perfect wave. A swimmer caught in a rip current can be in much more danger than a surfer. The United States Lifesaving Association (USLA) recommends that swimmers who find themselves in a rip current do not try to swim back to shore. Even strong swimmers are unlikely to be able to swim against the current. They are much more likely to find themselves exhausted, an even more dangerous position. The USLA advises swimmers caught in a rip current to swim parallel to shore. Rip currents are usually narrow enough to be escapable this way. Floating along the current past the surf line (where the rip current disappears) is also an option, but that can be a long way from shore. Swimming back might require a lot of energy. [34] Prevention of Rip Current Tragedies - Through public media education and campaigns, parental education and supervision, rescue efforts, personal flotation devices (life jackets), training in CPR, better safety standards, safety beach seasons, Know how to swim. Never swim alone. For maximum safety, swim near a lifeguard. Obey all devices such as fencing of swimming pools, Epileptic children & infants should be supervised while they are in bath. Fatalities from breath holding hypoxia during diving tend to occur in young male. Hyperventilation to increase breath hold time is dangerous practice that should be discouraged, Alcohol consumption should be discouraged (4) Don't become a victim while trying to help someone else! Many people have died in efforts to rescue rip current victims. Get help from a lifeguard. Emergency Call. Check the latest surf zone forecast on Weather Radio or online. During instructions and orders from lifeguards. Be cautious at all times. If in doubt, don't go out! Smooth water located between breaking waves could signal the presence of a rip current. Further, your body will cool quickly while in the water. Limit your time in the water and get out if you start to feel cold.(2) Indian National Centre for Ocean Information Services (INCOIS) is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focussed research [35]. The National Oceanic and Atmospheric Administration (NOAA) is an American scientific agency within the United States Department of Commerce that focuses on the conditions of the oceans, major waterways, and the atmosphere. NOAA warns of dangerous weather, charts seas, guides the use and protection of ocean and coastal resources, and conducts research to provide understanding and improve stewardship of the environment [36]. The following hazards in coastal areas are included in National Disaster Management Plan of Government of India includes Geological and shoreline changes, Rip currents, Cyclones, Sea level rise, Coastal flooding, Storm surges and flooding, Flooding from heavy rainfall events, Saline ingress and ,Tsunamis. [37] Guidelines for Disaster Management is given in practical manual of PGDHHM course of IGNOU Principles of a Hospital Disaster Plan consist of following variables - predictable, simple, flexible ,concise, comprehensive adaptable, anticipatory, part of a regional health plan in disasters, make provisions for vulnerable groups.[38] The Castelle and Scott typology, widely cited in the scientific literature, provides a functional classification grounded in the physical forcing mechanisms responsible for rip current formation. This scheme distinguishes three primary categories, bathymetrically controlled (focused rip & channel rip), hydrodynamically controlled (flashed rips & shear instability rips), & boundary-controlled (shadow rip & deflection rip), & other rip currents (mixed rip & embayed cellular rip) [39] In contrast, the Leatherman classification adopts a field-based, visually oriented approach, identifying five types of rip currents (bar-gap, structurally controlled, mega, cusped shore, and flash). For each type, the framework details their causes, means of detection, threat level, and recommended avoidance strategies. By emphasizing visual appearance and practical implications, the Leatherman classification offers a more accessible framework, particularly valuable for public education and beach safety initiatives [40]. In dye tracking method utilizing Rhodamine-B [41] or Fluorescein has been widely employed in coastal studies with notable success. This method involves dispersing dye along the shore, allowing currents to carry it and reveal flow structures [42]. Dye tracking provides a cost-effective approach to visualizing rip currents. [43] Rip currents exhibit distinct visual characteristics that can aid in their identification by observers with varying levels of experience. These indicators include: (A) absence of wave breaking, (B) areas of deep, intense blue, and (C) sediment dispersion. Although their prominence may vary depending on the specific type of rip current , at least one of these features is consistently present, enabling detection.[44] In India ; National Coastal Mission Scheme (NCM) is under the National Coastal Management Program is implemented with the following components: Management Action Plan on Conservation of Mangroves and Coral Reefs, Research & Development in Marine and Coastal ecosystem ,Sustainable Development of Beaches under Beach Environment & Aesthetic Management Service Capacity Building / Outreach Programme of Coastal States/UTs on conservation of marine and coastal ecosystem including beach cleaning drive. The implementing agencies of NCM are the State Governments of Coastal States and Union Territory (UT) Administrations. [45]. Rip currents are one of the most hazardous natural phenomena affecting beachgoers worldwide and pose a persistent challenge to coastal safety management. Significant methodological developments are highlighted, including the use of Lagrangian drifters, RPAS (Remotely Piloted Air Systems; Drones), fixed cameras, numerical models, and

dye tracing. Beyond technical evaluation, the paper critically examines how these detection methods can inform and enhance coastal management practices. The operational suitability of each method is assessed in terms of daily monitoring, early warning systems, beach zoning and contexts with limited resources. The analysis emphasizes the role of rip current detection in supporting marine spatial planning, beach carrying capacity regulations, infrastructure siting, public education campaigns and real-time risk communication tools. Furthermore, the study explores how rip detection data could be incorporated into national coastal governance frameworks, This work bridges the gap between technical research and actionable policy by offering evidence-based guidance for the sustainable and resilient management of coastal safety. Rip Current Governance Integration Framework that links detection, analysis, and predictive technologies directly to governance systems. This framework provides a structured, continuous pathway from hazard identification to actionable management and review, enabling countries to optimize resource use and enhance beach safety. The framework consists of six interconnected elements. (A) Hazard Identification: cameras, drones, and dye tracers & support lifeguards & municipal managers. (B) Dynamic Analysis: frequency, intensity, and spatial distribution resource allocation and emergency response planning. (C) Model Development and Validation: Numerical models, including Delft3D4, MIKE 21, and X Beach, Validating these models with in-situ data. (D) Standardization: Harmonized methods, comparable matrices & national hazard databases. (E) Adoption into Governance Systems: Early warning protocols, lifeguard deployment, safety regulations, and awareness campaigns. (F) Monitoring and Review: Forecast accuracy, operational response, public compliance, Feedback loops resilience & evaluation. Together, these elements provide a structured pathway for embedding rip current science into multi-level governance systems. By connecting detection, analysis, and prediction with concrete management actions, the framework enhances operational efficiency, expands the geographic reach of rip current safety practices, and contributes to international goals on disaster risk reduction and sustainable development. Integrating rip current detection into governance requires not only technological innovation but also institutional frameworks that enable data sharing, policy adoption, and public outreach. Expanding geographically diverse research, standardizing methods, and embedding detection within multi-level governance structures are urgent steps toward resilient coastal communities, consistent with the Sendai Framework and the Sustainable Development Goals.[46]

Conclusion

A line of Sea Foam looks almost like a road or a river running out to sea, away from the shore was the most frequently occurring identifying sign of observed Rip Currents. Rip's visible Sign like Chopping of water & Different Coloured Sea water was different at Calangute Beach & Vagator Beach. So save yourself and others from drowning by not going in side sea during rip current. One should know how to swim & if caught in rip current then swim towards the shore at an angle. The rip is like a treadmill, which the swimmer needs to step off. Rip Current Governance Integration Framework consists of six interconnected elements. Hazard Identification, Dynamic Analysis, Model Development and Validation, Standardization, Adoption into Governance Systems, Monitoring and Review & Evaluation.

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