Dissemination and Testing of Rip current forecasting system with NavIC/GNSS enabled devices

Dr. Surisetty V V Arun Kumar
Indian Space Research Organisation (ISRO)

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ICG-17, Madrid (Virtual)

Motivation

- About 60% of world's population lives along the coast.
- "Rip Current" is a rare known fact but results in drowning around 40 people yearly along the Indian coast.
- Many drownings are underreported due to lack of awareness and less attention.
- No dedicated lifeguarding system exists in India to safeguard these innocent lives.
- No regular water quality checks in the beaches – risk of harmful pollutants to beachgoers.
- The existing methods are expensive and risky.

What are Rip Currents?

- They are strong, narrow, seaward flow of waters usually found in surfzone of many beaches worldwide.
- Typical speed range: 0.5-3 m/s
- Sometimes, speed can be >5 m/s
- It can drown even the strongest Olympic swimmers.
- Important for transport and cross-offshore mixing of heat, pollutants and nutrients.
- They are Silent killers

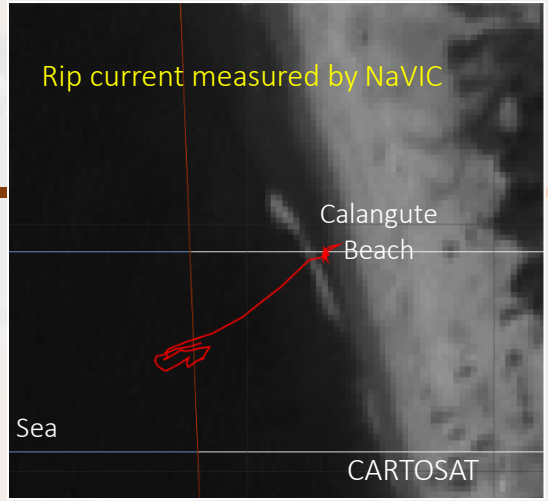
Rip Current Research @ SAC

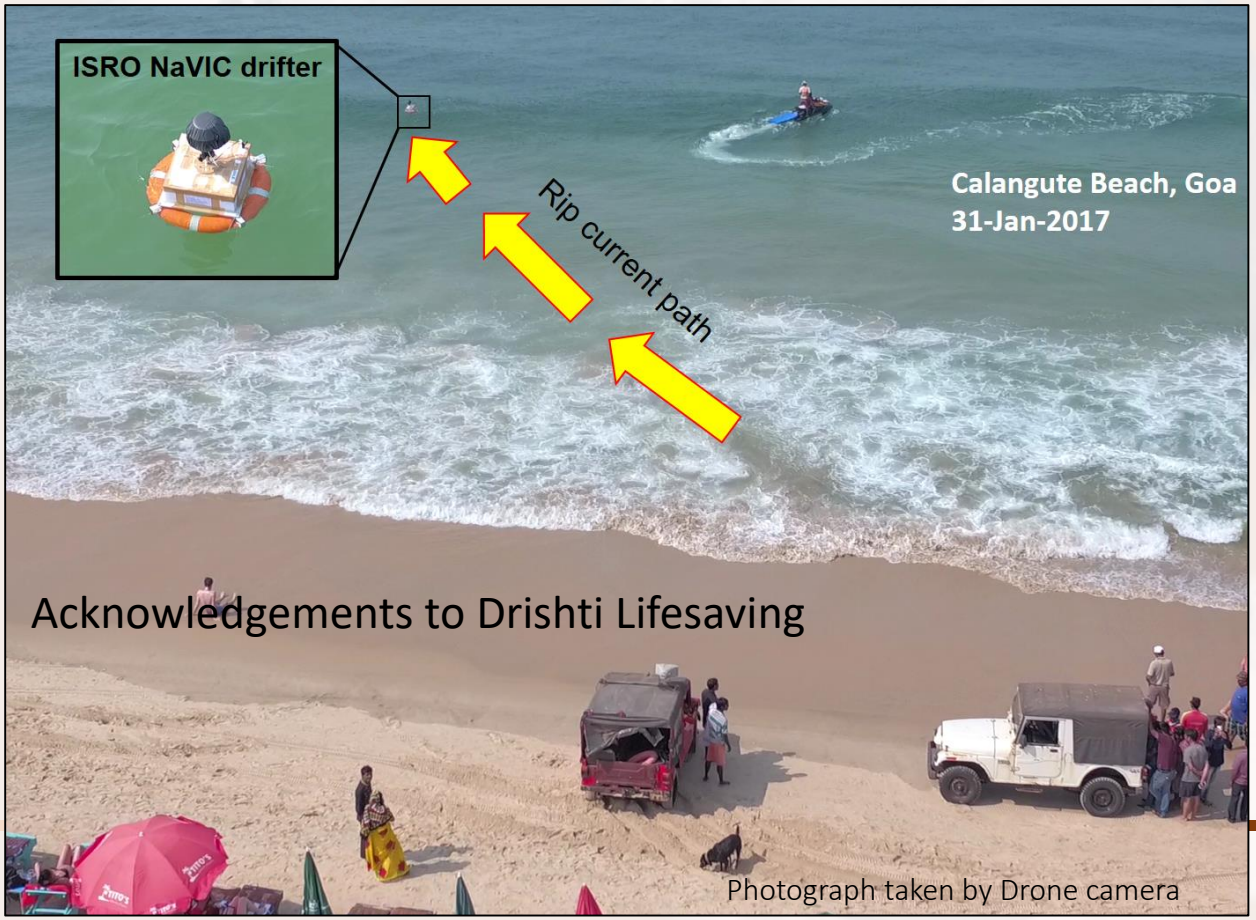
Major Activities include

- Monitoring using satellite RS & video
- Development of GNSS/NaVIC Drifters
- Safe Beach App/Web for Rip current reporting and dissemination.
- Rip current Forecasting & Dissemination System

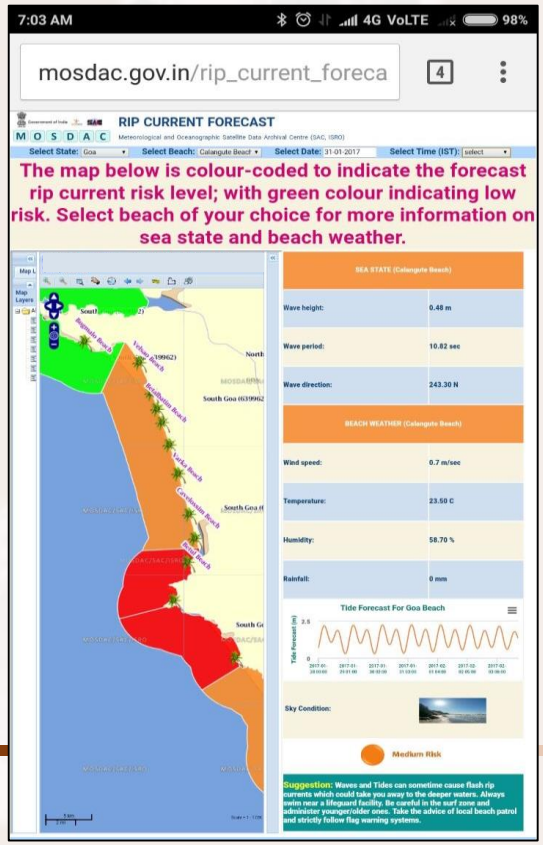
Testing NavIC drifter – v1

- SAC/ISRO has demonstrated the use of IRNSS: NaVIC receiver for the first time in India to measure the strength, direction and structure of rip current.
- The rip current forecast on MOSDAC has been validated with the in-situ data obtained from NaVIC receiver .



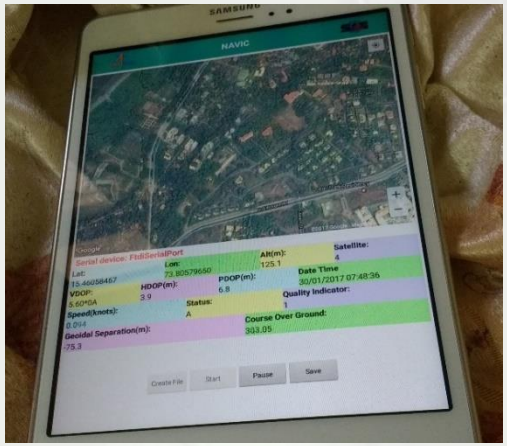


Rip current Forecast on 31-Jan-2017



EXPERIMENT

NaVIC Android App



Developed by SAC Team

Installation of NaVIC drifter

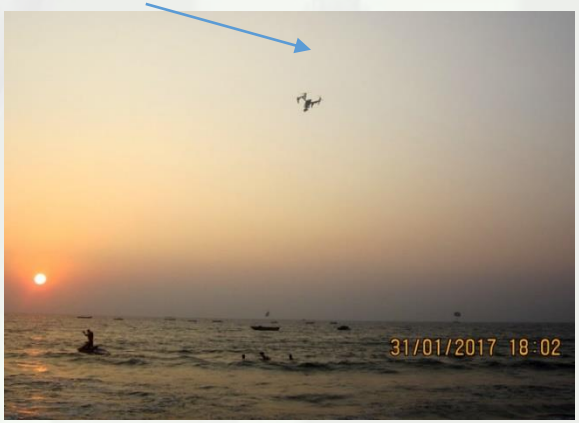
Deployment

Inside the drifter

Android mobiles are used to record the data

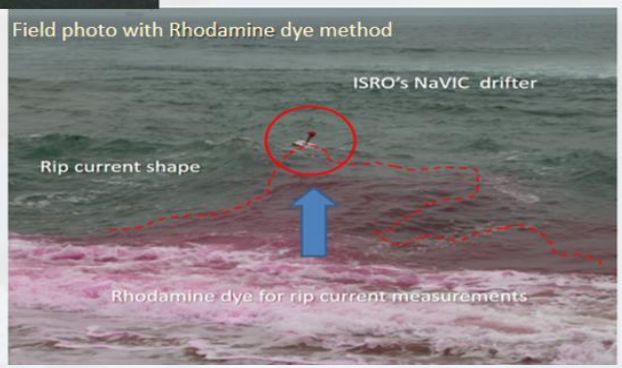
Red flag indicates Rip current zone

Drone shooting the experiment



ISRO NavIC Drifter Experiments conducted at RK Beach, Vizag

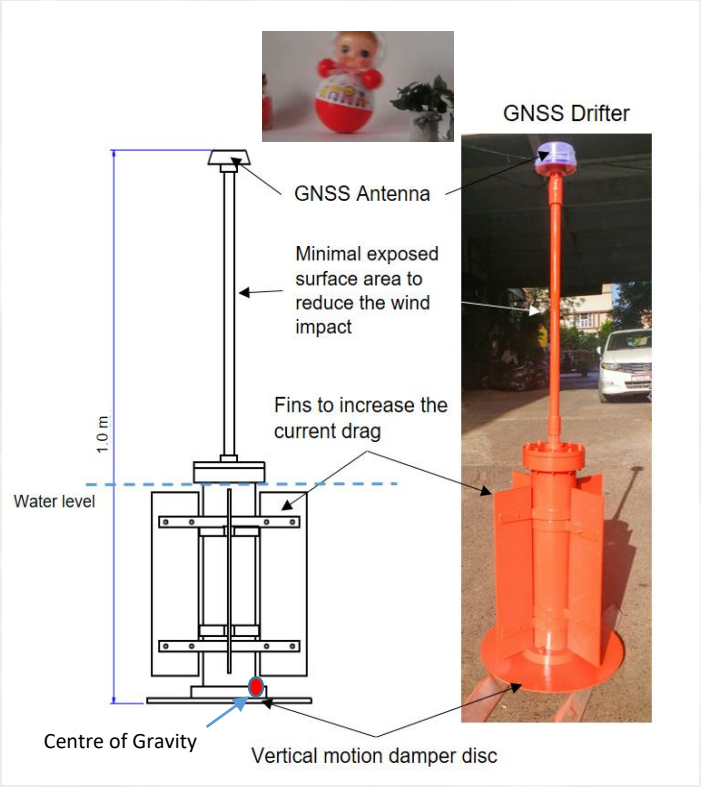
ISRO NaVIC drifter



GNSS drifter – V2

- ✓ Design was inspired from a **Roly-poly toy.**
- ✓ Drifter was made from off-the-shelf PVC parts and low-cost GNSS receiver (EMLID Reach®).
- ✓ GNSS receiver stores raw carrier phase and pseudo range internally from GPS, GLONASS, GALILEO, Beiduo, SBAS etc.
- ✓ Flanges were introduced to increase the current drag and bottom circular disc to reduce the wave impact.
- ✓ Minimum surface area above sea surface to reduce the wind impact.
- ✓ Very simple design but efficient at sea..!

Item	Price in US$
EMLID Reach L1 GNSS receiver module	$200
Tallysman Antenna	$60
PVC Pipe and other connectors	$30
20,000 mAh Power bank	$10
Manufacturing cost	$100
Total cost	**$400**



(Arun Kumar et al. 2019, Current Science)

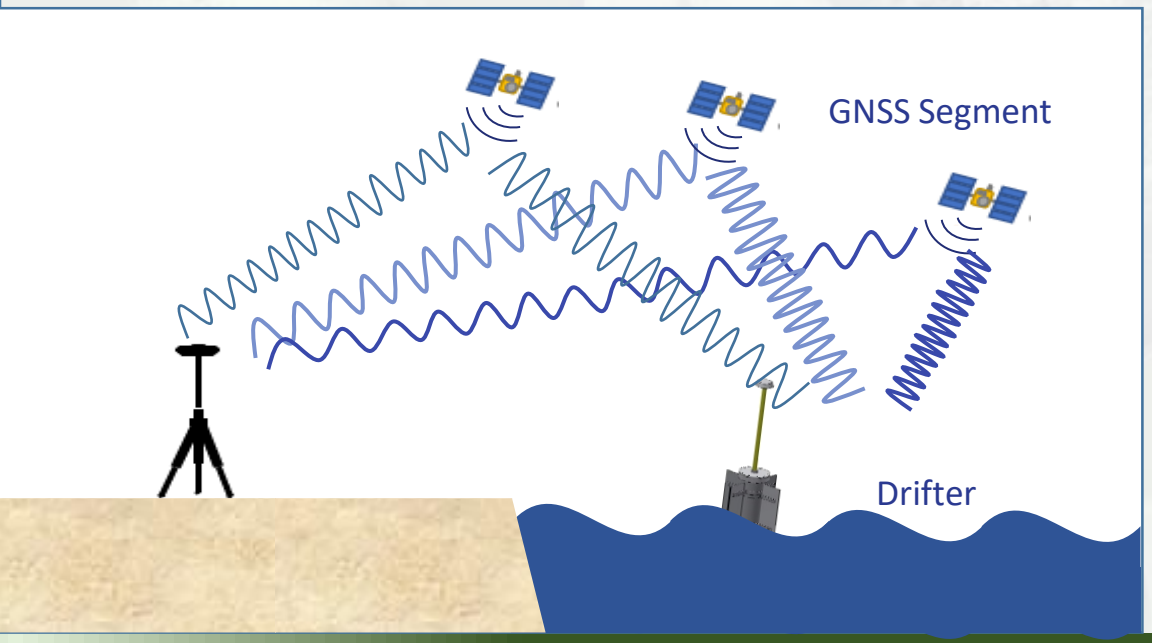
Multi-GNSS Antenna

Emlid Reach® M Module

4GB Memory
Intel Edison Processor
Ublox receiver
WiFi, Bluetooth
USB powered

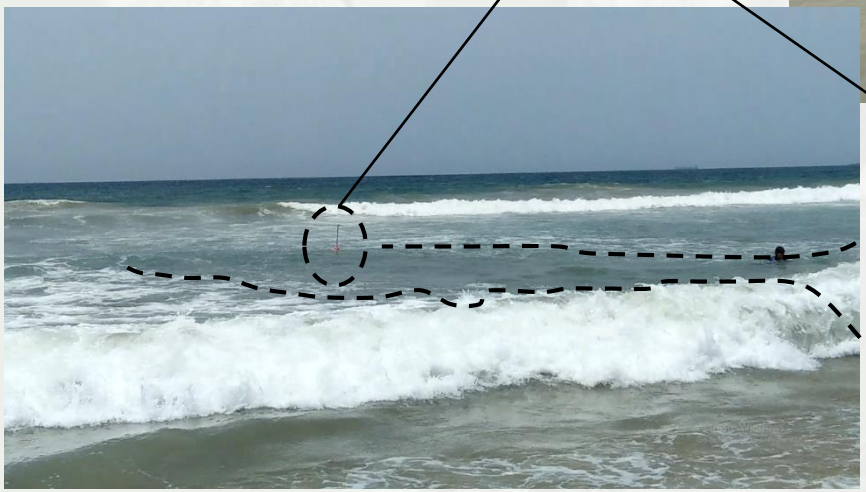
Data collection and operation

- In order to get precise position, we have used Reach RS ($700) as a base station (stationary) and recorded the raw logs.
- Drifter and base were simultaneously operated and both the datasets were post processed in RTKLib open source software to get a differential solution (PPK).



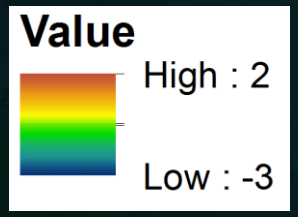
Drifter and Dye Experiments

Drifters



GNSS Bathymetry survey

- Surf zone bathymetry was measured using Jet ski along RK Beach.
- Southern section has gentle bathymetry, whereas northern section has natural discontinuities.
- Probability of Rips is high in an undulated beach topography.



Stretch: 2km

Danger region

Safe region

Ramakrishna Beach

HPCL Colony

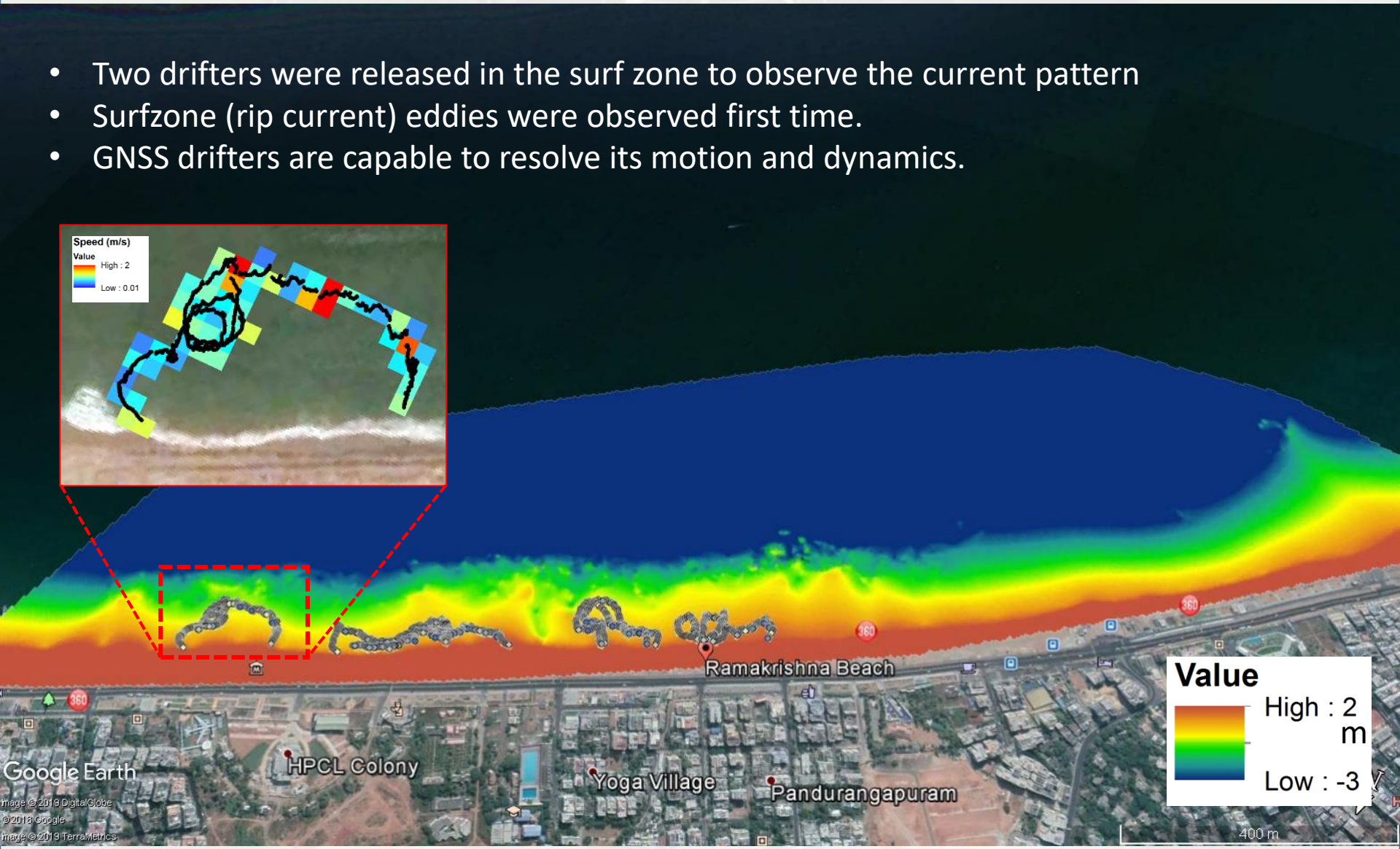
Yoga Village

Google Earth

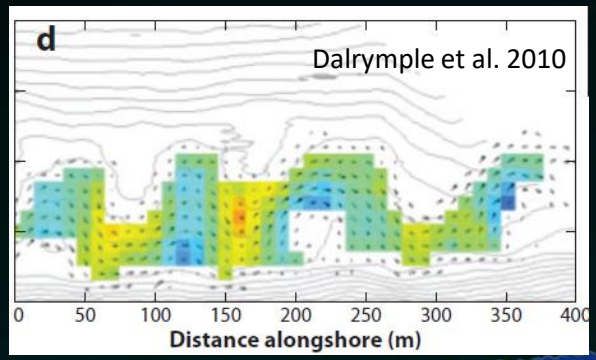
Fusion of Echo sounder data and GNSS rover data of beach

Rip current monitoring at RK Beach

- Two drifters were released in the surf zone to observe the current pattern
- Surfzone (rip current) eddies were observed first time.
- GNSS drifters are capable to resolve its motion and dynamics.

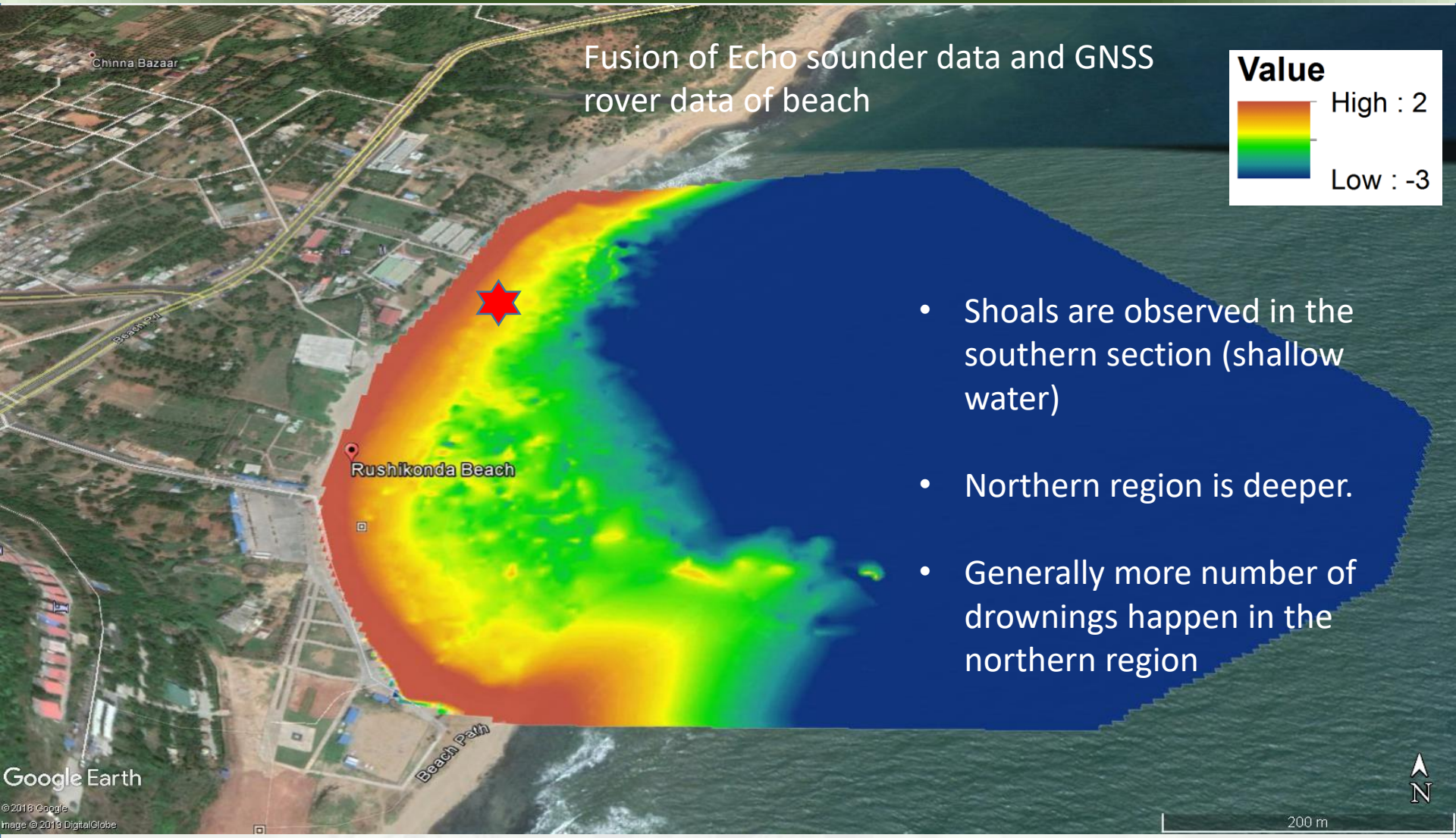


Rip Currents

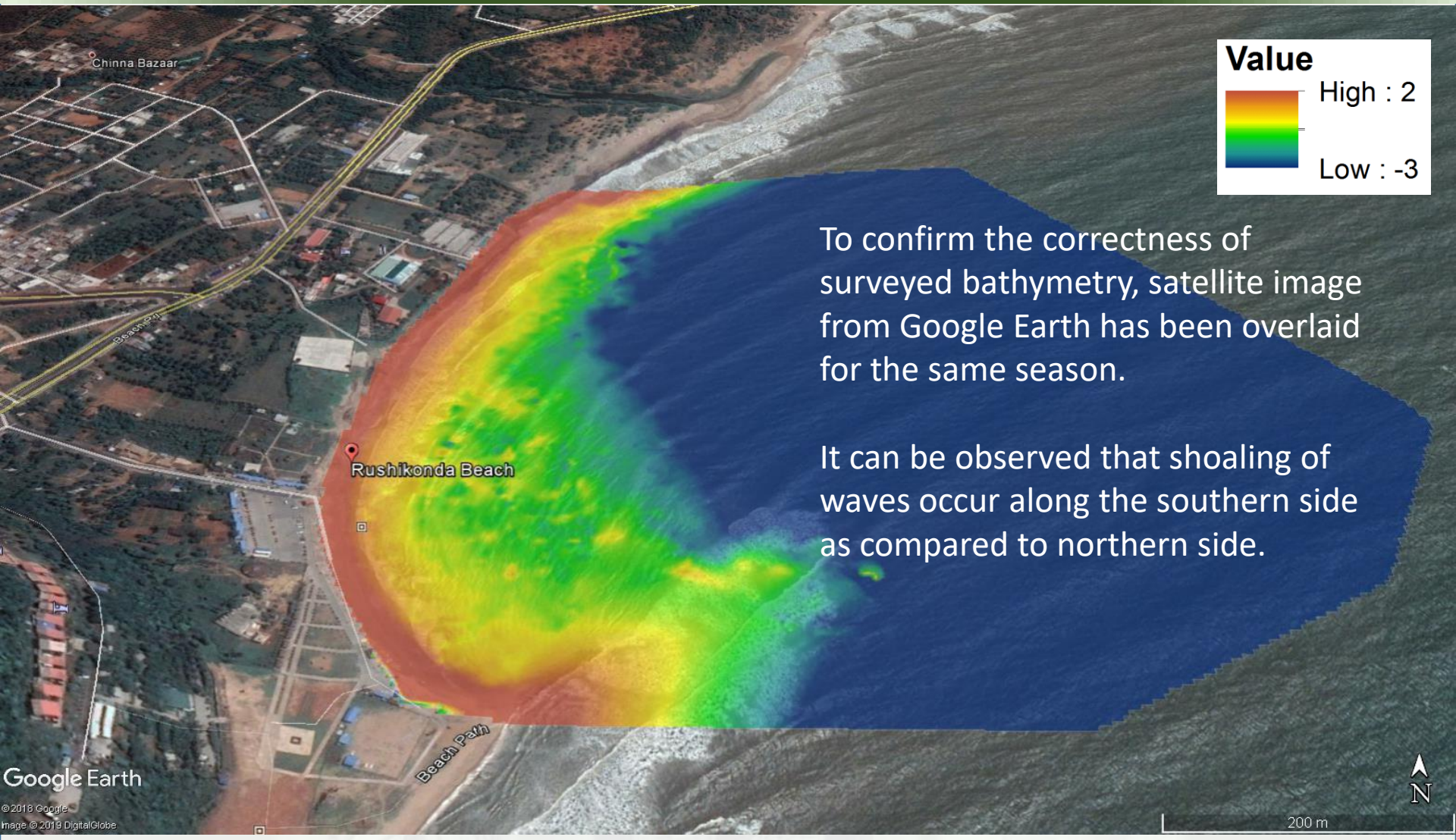


- Drifters (currents) followed bathymetric contours
- Unless they caught in the rip current, the current is almost parallel the shore

Rushikonda



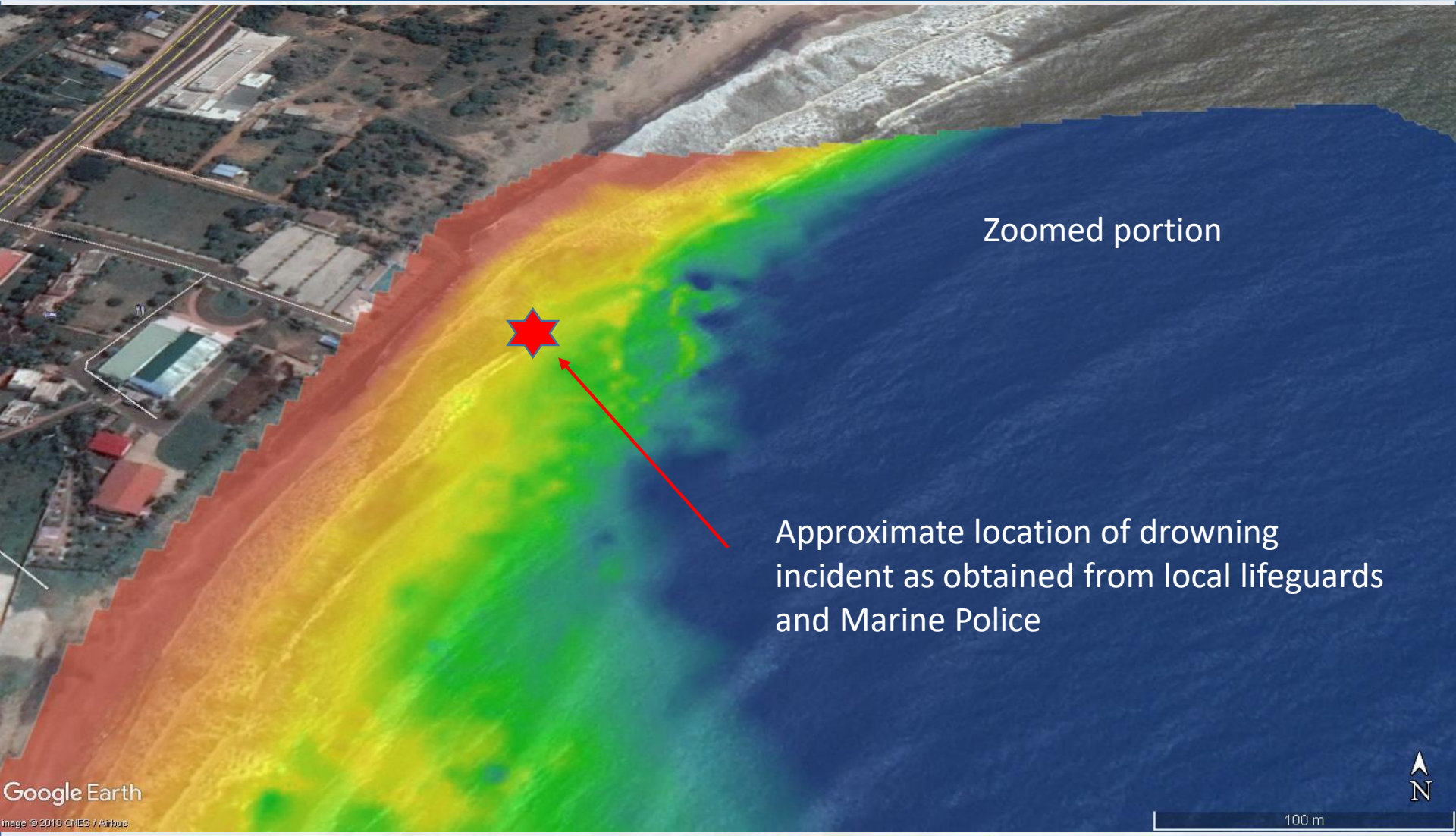
- Shoals are observed in the southern section (shallow water)
- Northern region is deeper.
- Generally more number of drownings happen in the northern region

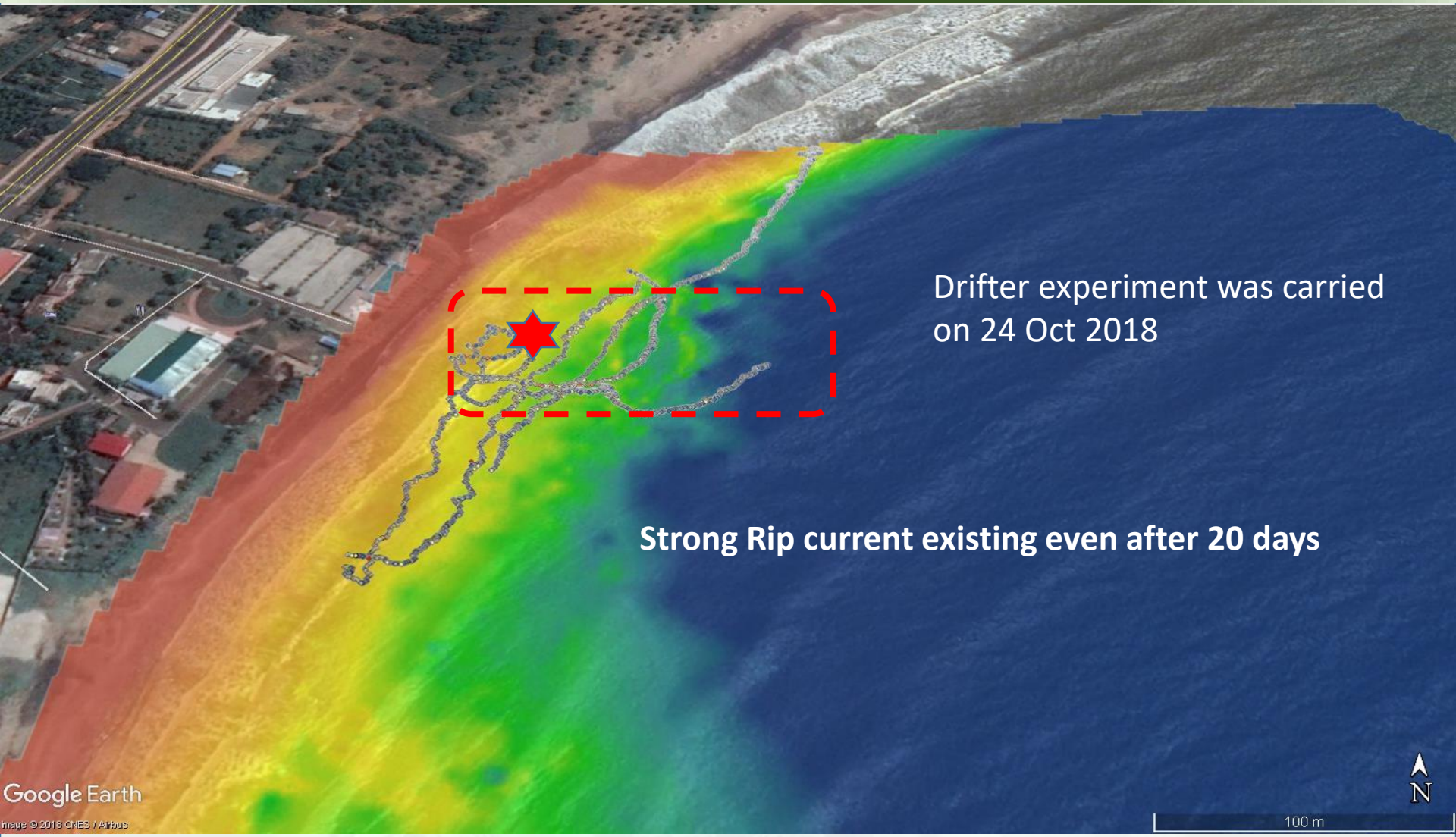


To confirm the correctness of surveyed bathymetry, satellite image from Google Earth has been overlaid for the same season.

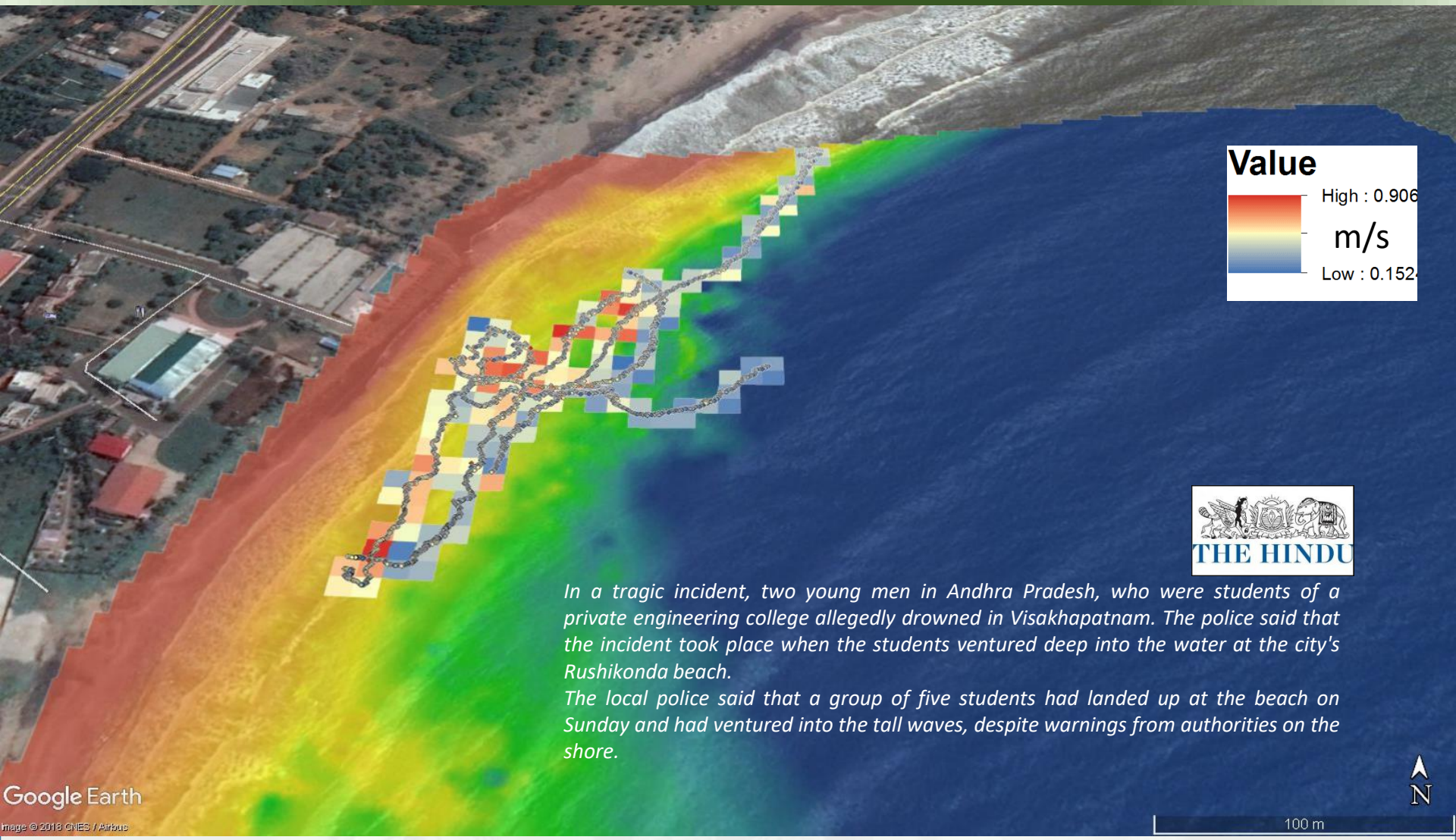
It can be observed that shoaling of waves occur along the southern side as compared to northern side.

Ground truth after drowning event




Drifter experiment was carried on 24 Oct 2018
Strong Rip current existing even after 20 days
Google Earth
Image © 2018 CNES / Airbus
N
100 m

Rip Current pattern



NEMO Drifter – v3

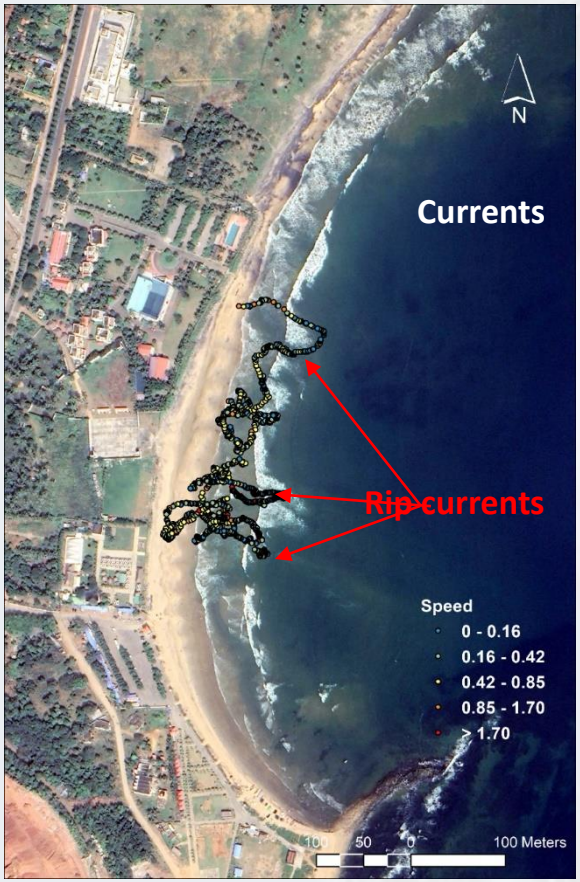
NEMo (NavIC based Environmental Monitoring) drifter

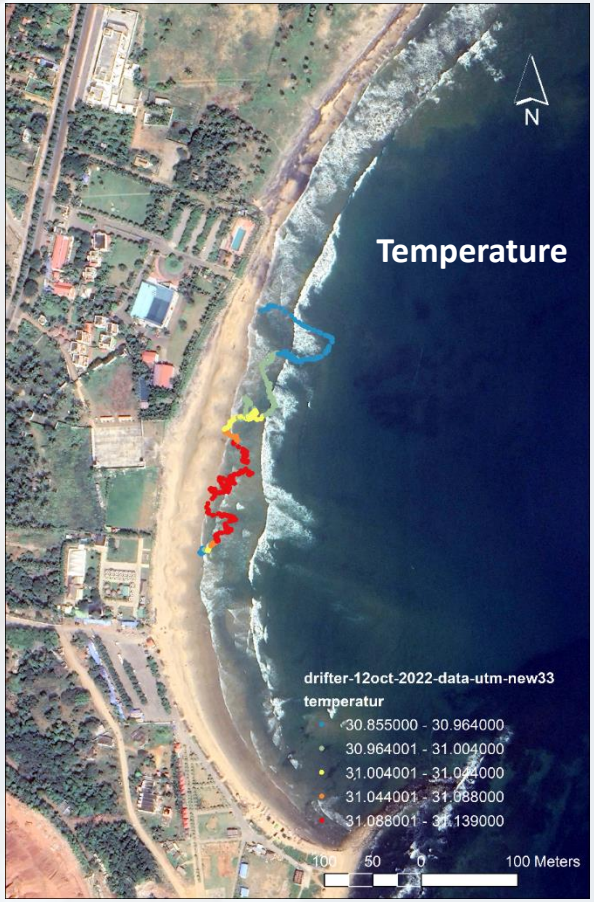
- Currents
- Temperature
- Salinity/Conductivity
- TDS
- Specific Gravity
- pH
- Dissolved Oxygen

Operated in the beaches at fortnightly interval

NEMO Drifter Observations

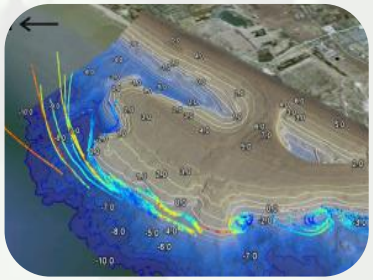
12, 13, 19 Oct 2022



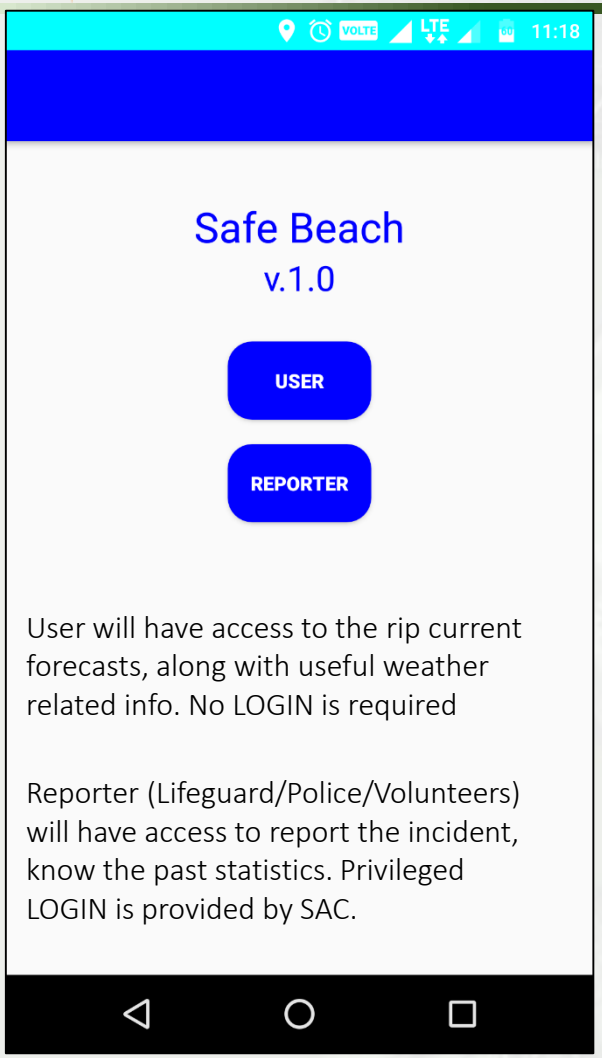


Other major applications of drifters

- ✓ Rip current dynamics (spatial & temporal structure)
- ✓ Search and Rescue
- ✓ Oil spill monitoring
- ✓ Bloom tracking
- ✓ Pollution dispersion monitoring in the surf zone
- ✓ Bathymetry mapping
- ✓ Nourishment effects
- ✓ River and estuarine flood monitoring
- ✓ Forensic investigation
- ✓ Military and Naval Coast Guard application

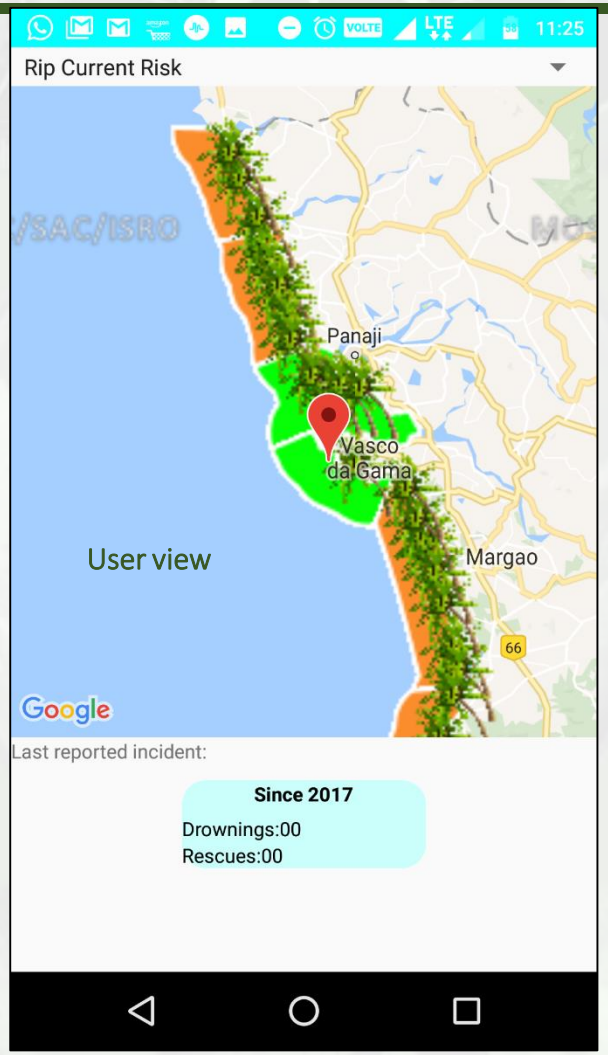


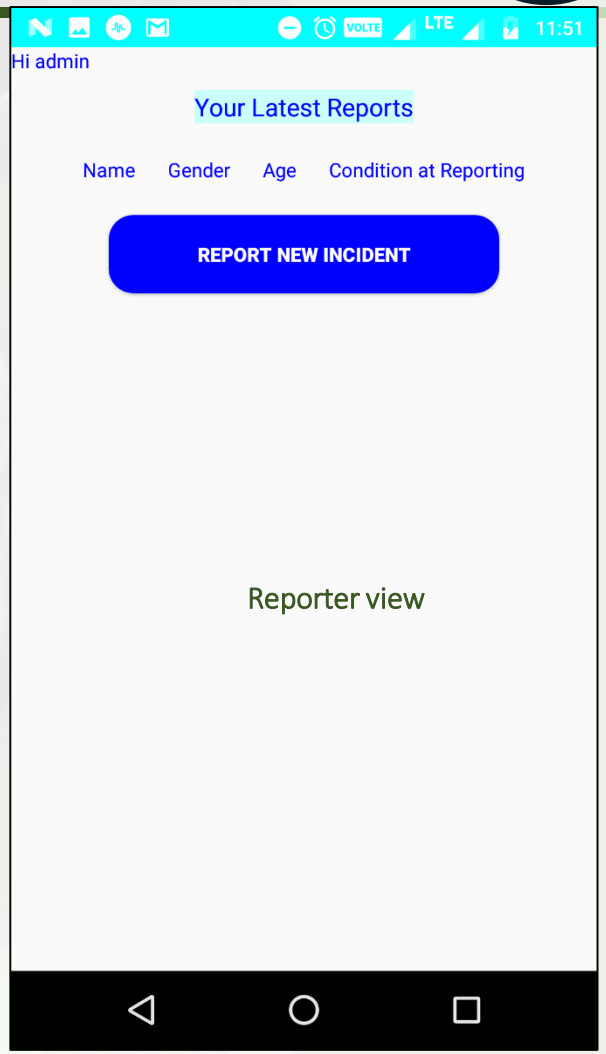
Safe Beach App



User will have access to the rip current forecasts, along with useful weather related info. No LOGIN is required

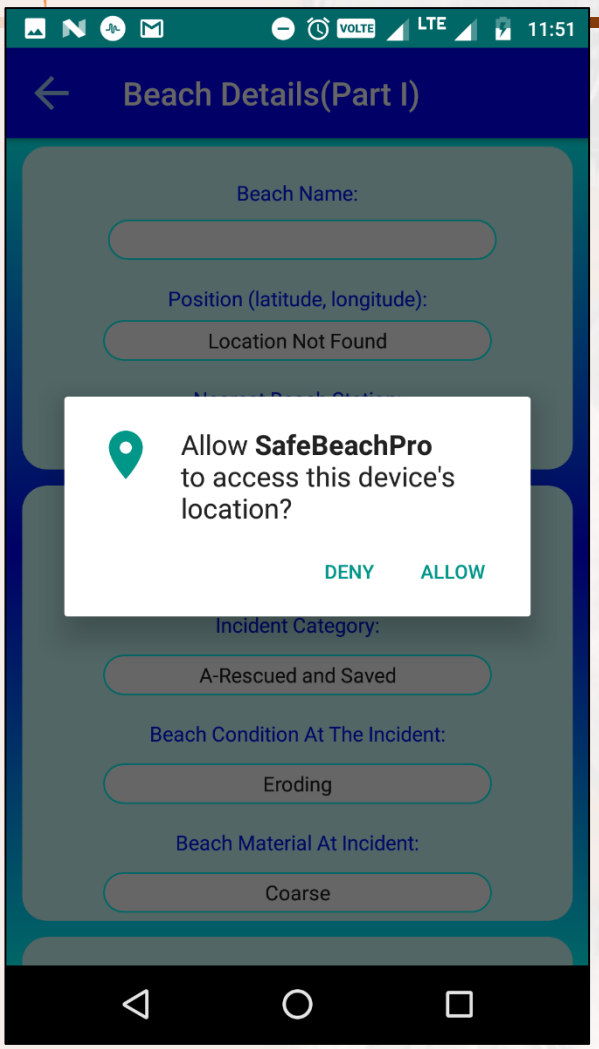
Reporter (Lifeguard/Police/Volunteers) will have access to report the incident, know the past statistics. Privileged LOGIN is provided by SAC.

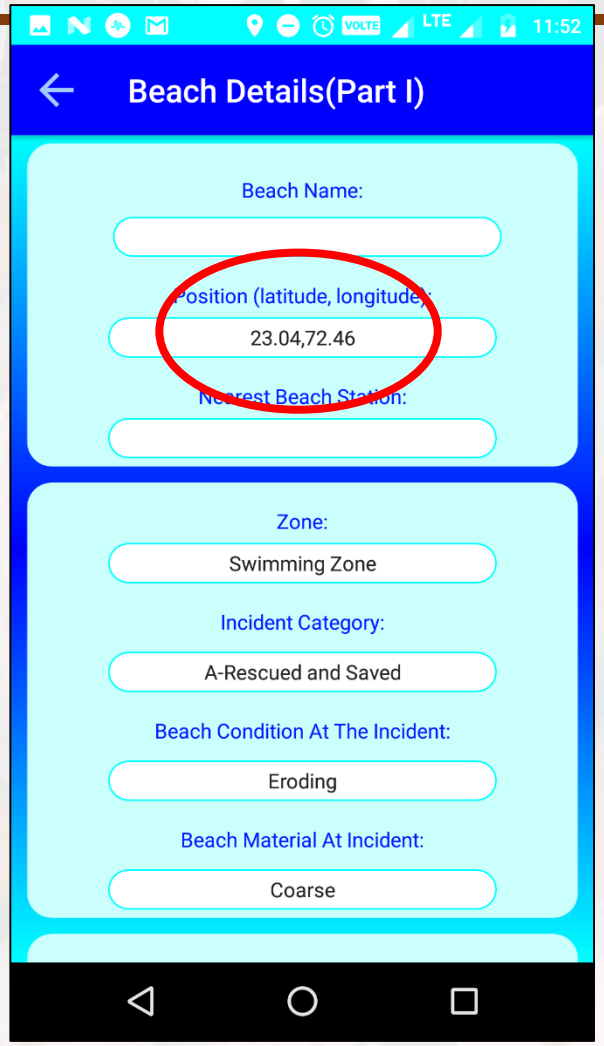


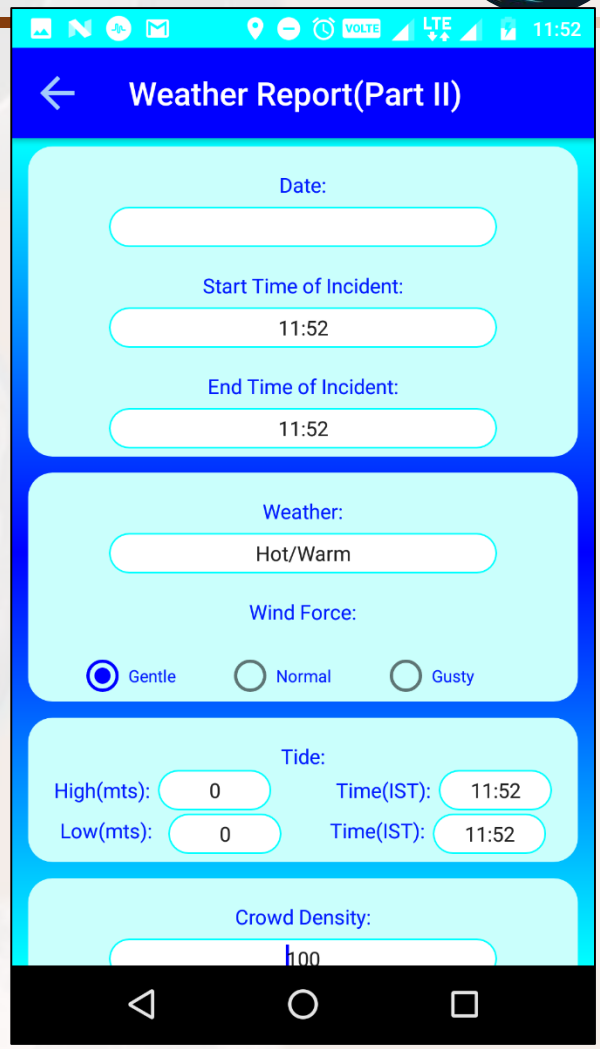


Safe Beach app is the India's first Rip current reporting app, primarily designed to know **a safe beach for recreation**. It has 2 modes: User and Reporter

Reporter View

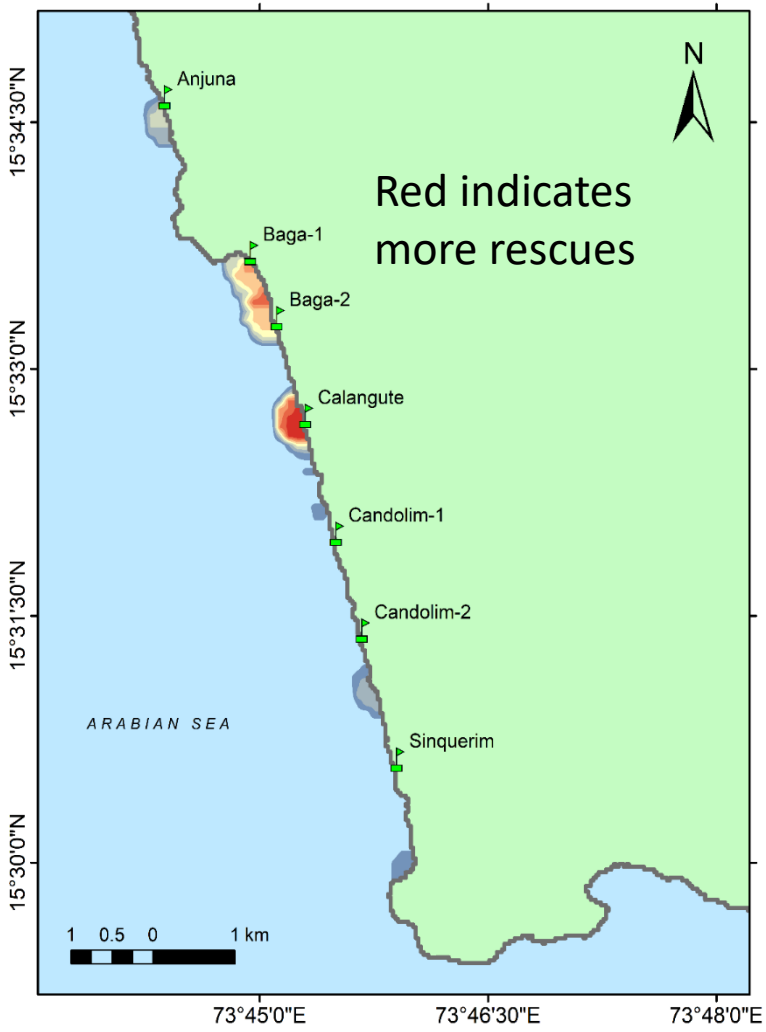






This data would be very helpful to validate our rip current forecast, to understand the factors (waves, beach, tide etc.) responsible for the cause of the event, to develop/fine tune our probabilistic models.

Heat map of Rip current rescues



Drishti Lifesaving Pvt. Ltd.

Doc. No- DLPL-OPS-007	
Incident Report No:	
Page 1 of 2	
Rev: 0	

Incident Report

Beach Name	Mobor	Nearest Beach Station	Mobor	Zone	Non swim zone
Incident Category	C	Tide status (incoming/outgoing)	Incoming	Whether under DLPL Jurisdiction /LG hours	Yes

TO BE COMPLETED ON ALL OCCASIONS AND RETURNED DIRECTLY TO ZONE INCHARGE

Date of Incident	23rd Jan 2018	Start time of Incident	1309 hrs	End time of Incident	1311 hrs

Conditions during Incident. Please delete item or tick box as appropriate

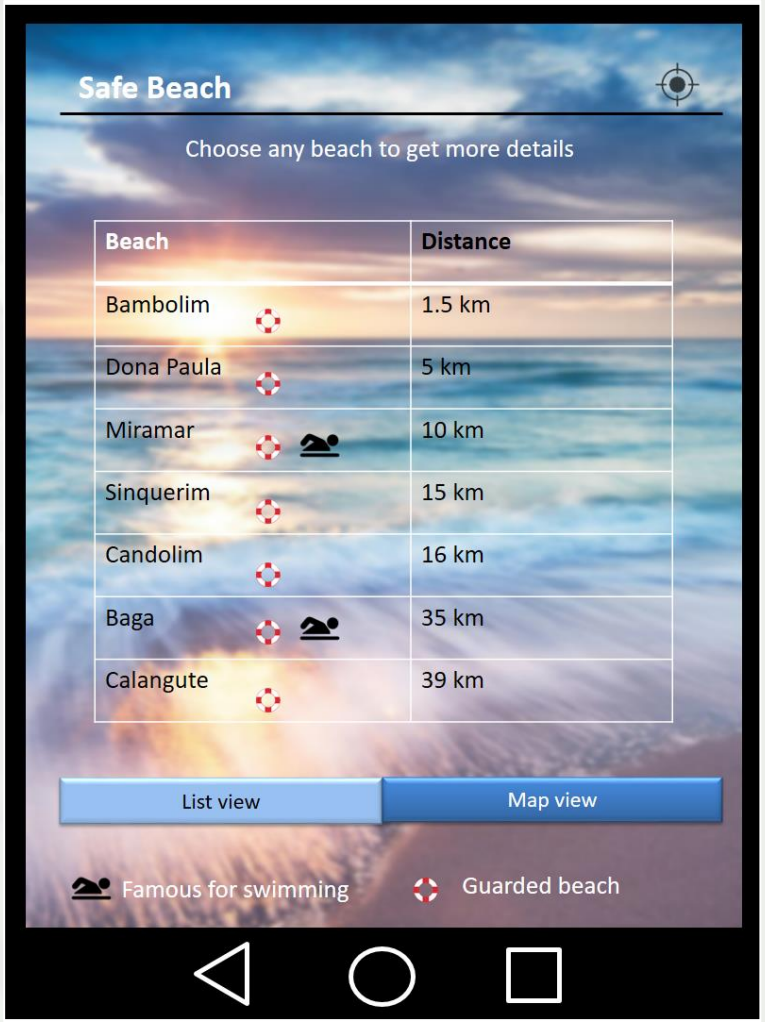
WEATHER	Hot	WI ND FORCE	Gentle	Tide: High	1.4 mtrs	Time	1445 hrs
				Low	0.5 mtrs	Time	0849 hrs
CROWD DENSITY	50-60	WIND Direction	NW to SE	SWELL / SURF	0.5 ft.		

Nature of Incident	Single rescue
Equipment Used	Rescue tube
First Aid & Outcome	Nil
Services Involved	DLPL

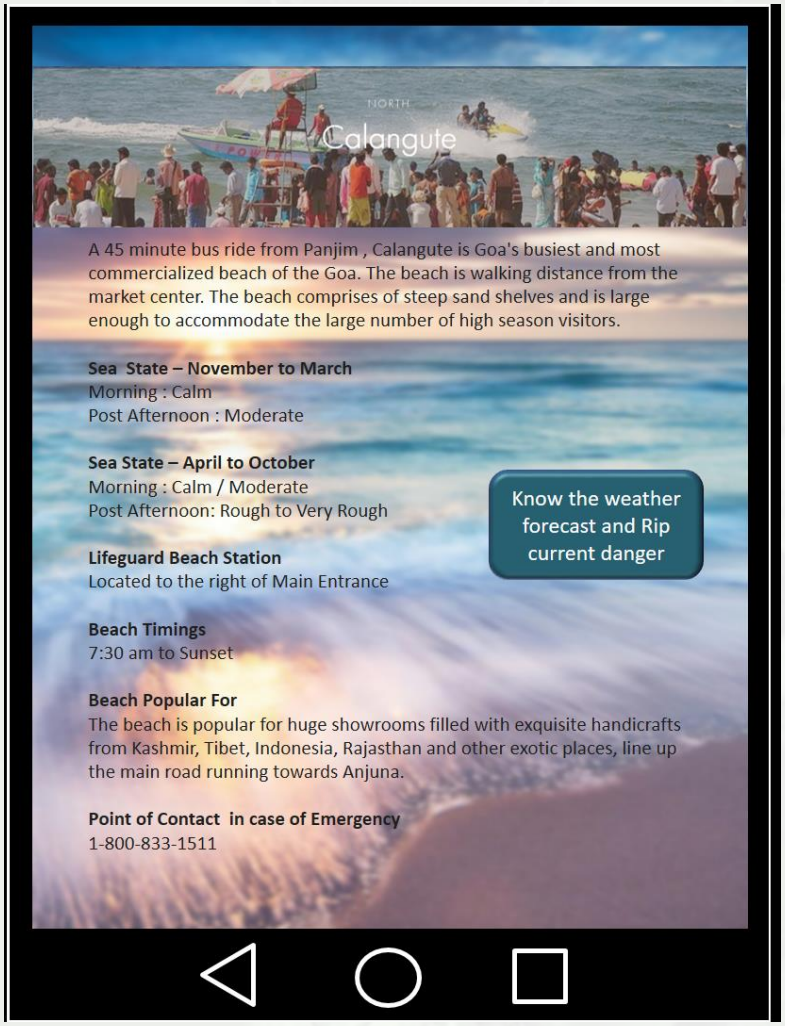
Details of Incident and Casualty Type:

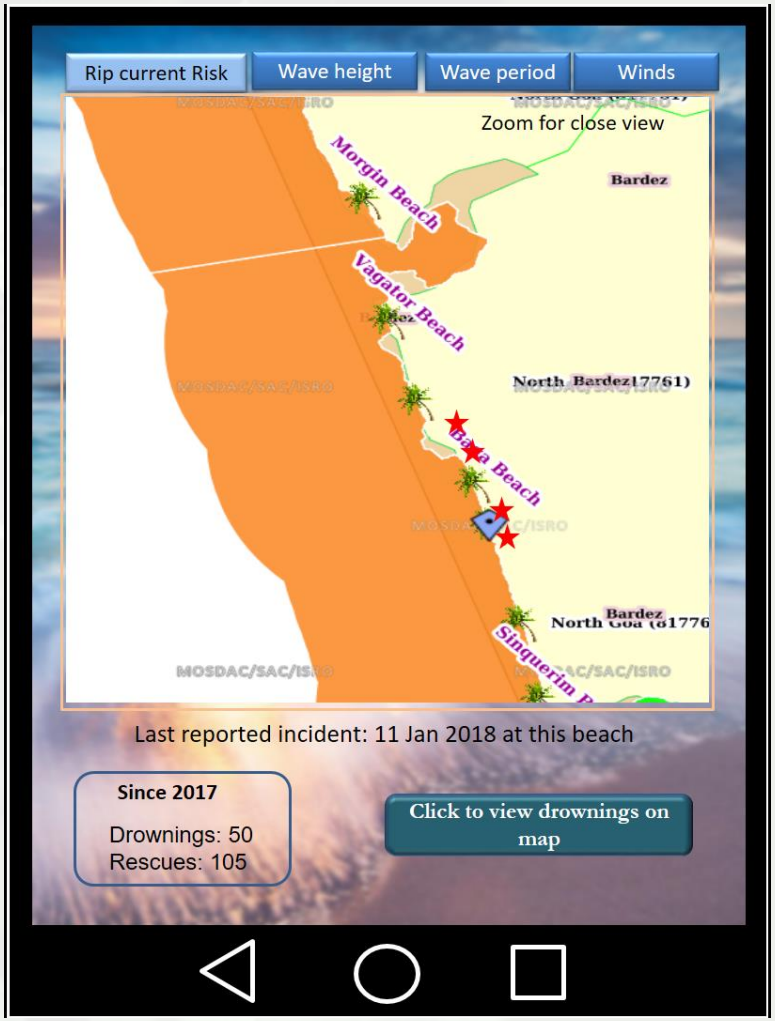
1. On 23rd Jan 2018 at about 1309 hrs approx 70-80 mtrs in front of Mobor tower lifeguard Govind Gaonkar was manning a crowd of 10-15 people enjoying in the water.
2. Lifeguard Nitesh noticed one group of 05 guest was trying to swim in the deeper level therefore he was whistling and was requesting them to stay closer and enjoy in the water. Suddenly of them, 30 yrs old male was caught into a rip current and drifted seawards.
3. Lifeguard spotted the same and rushed to his aid after relaying a rescue message to the tower. Victim was secured with rescue tube and brought ashore safely.
4. Upon recovery victim vitals were checked since all found to be normal he was released immediately.

Safe Beach Front page



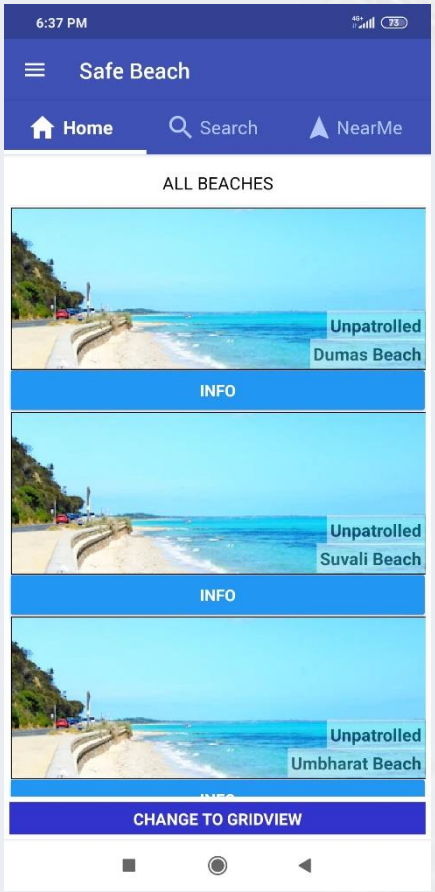
User view – Artistic view

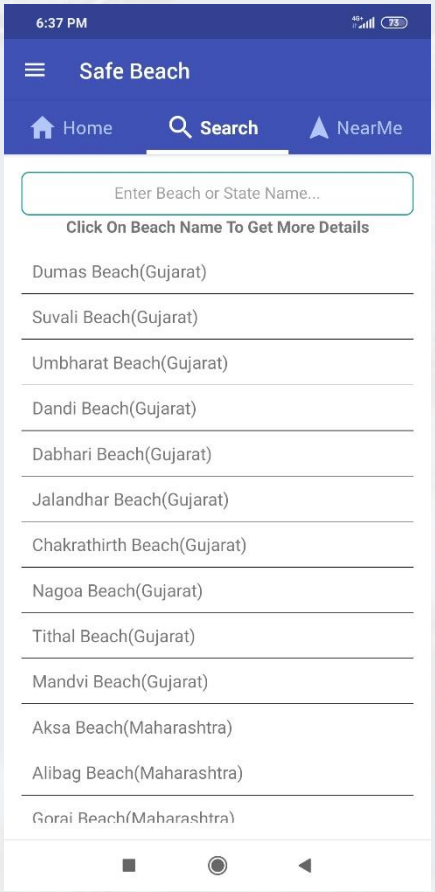


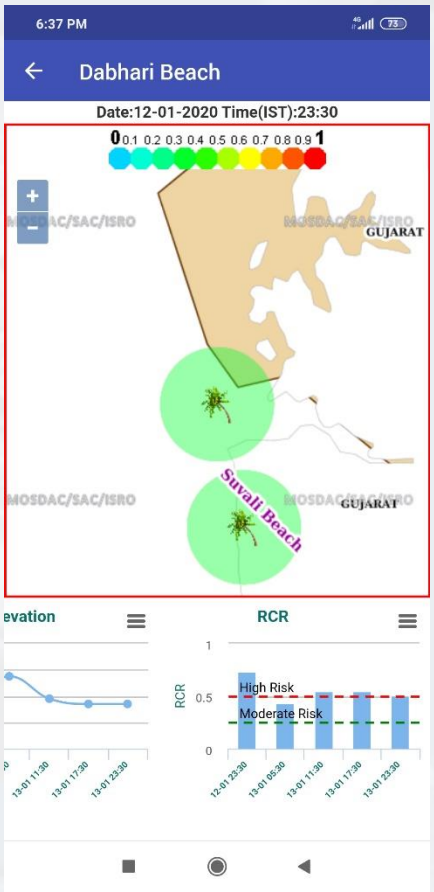


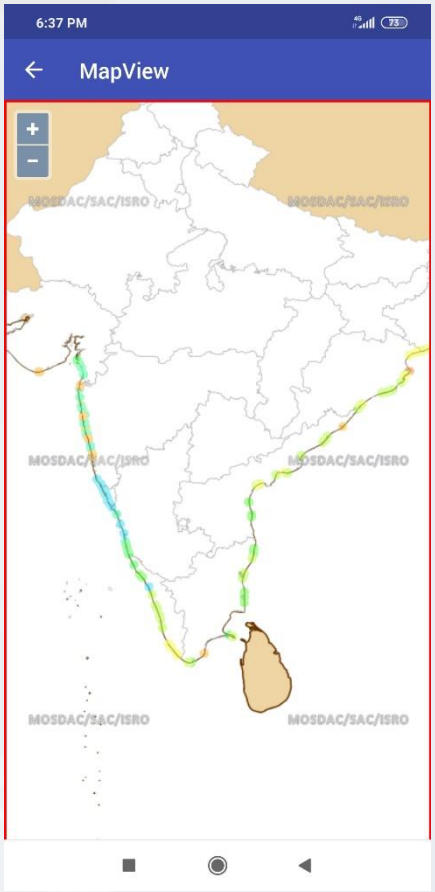
Experimental Safe Beach App

- Android version of **Safe Beach app** is designed with the help of MOSDAC Team.
- Available rip current likelihood forecasts for 175 beaches in India

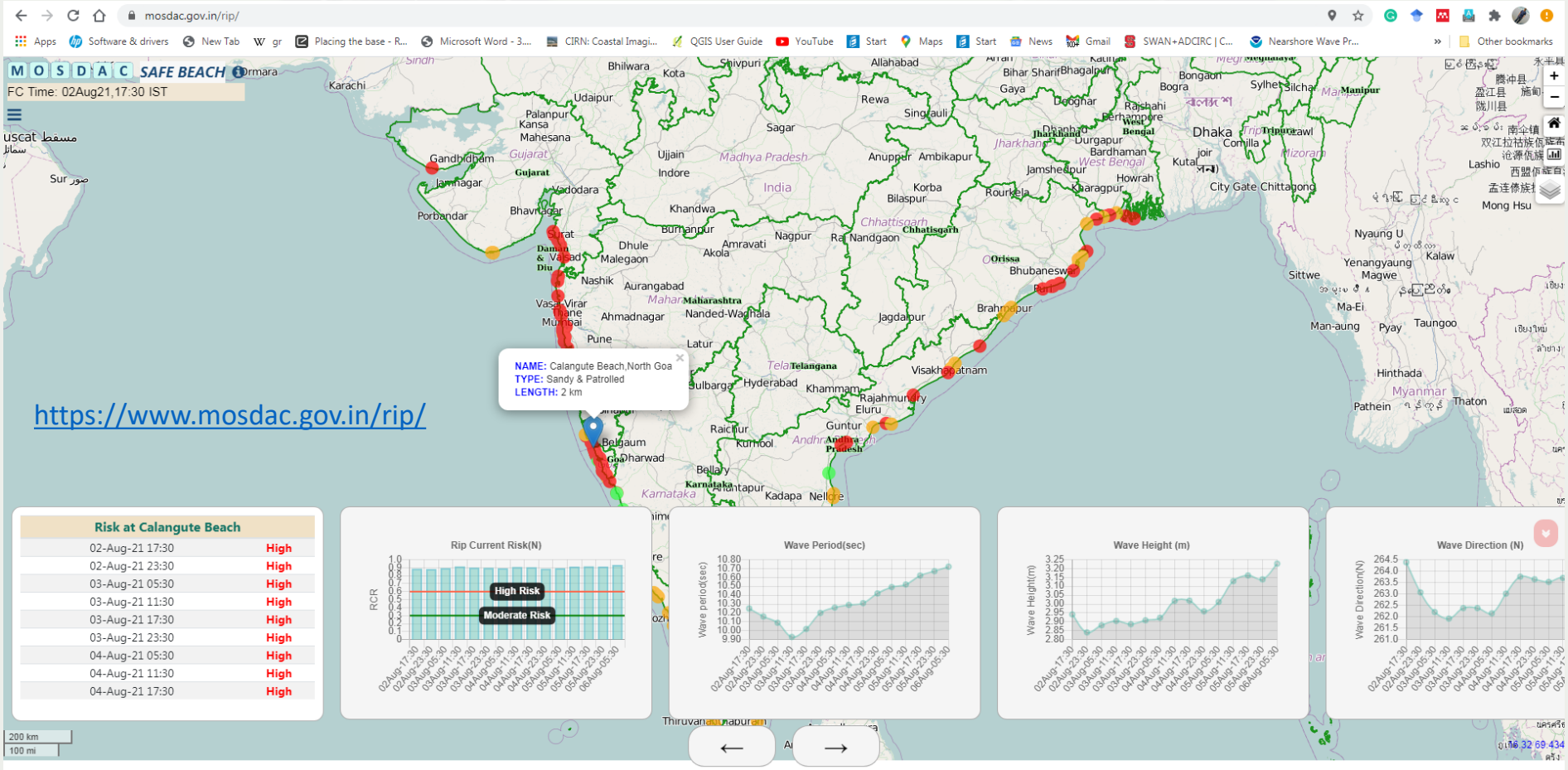




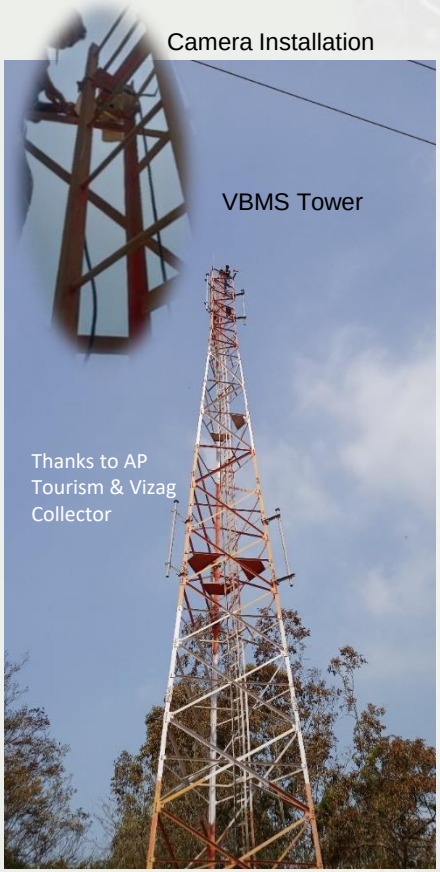




EXPERIMENTAL RIP CURRENT FORECASTING SYSTEM



Video Beach Monitoring System (VBMS)



Video Monitoring and Processing System

View of Beach from Tower

Salient features:

- ✓ First on east coast of India
- ✓ 24x7 monitoring
- ✓ 5MP Full HD video
- ✓ Night vision
- ✓ Enhances safety
- ✓ Multi-purpose research

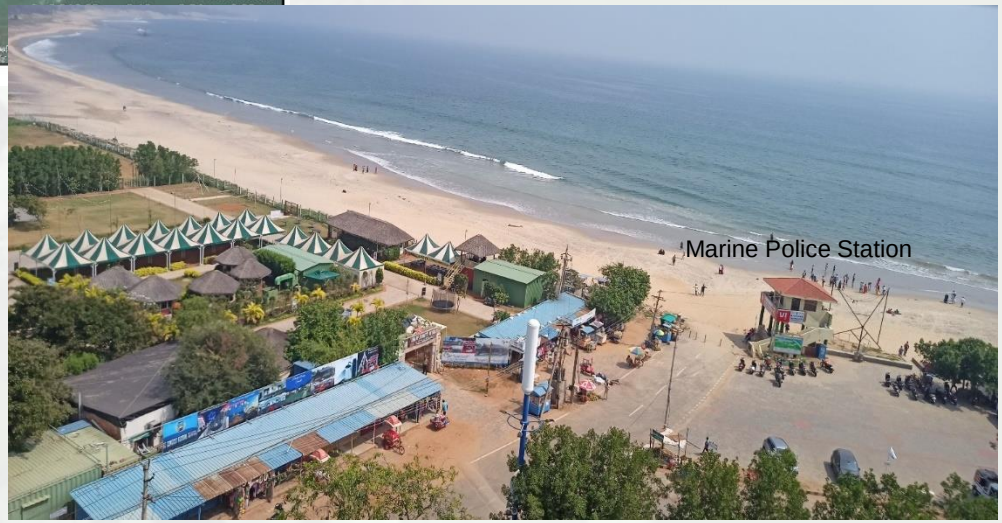
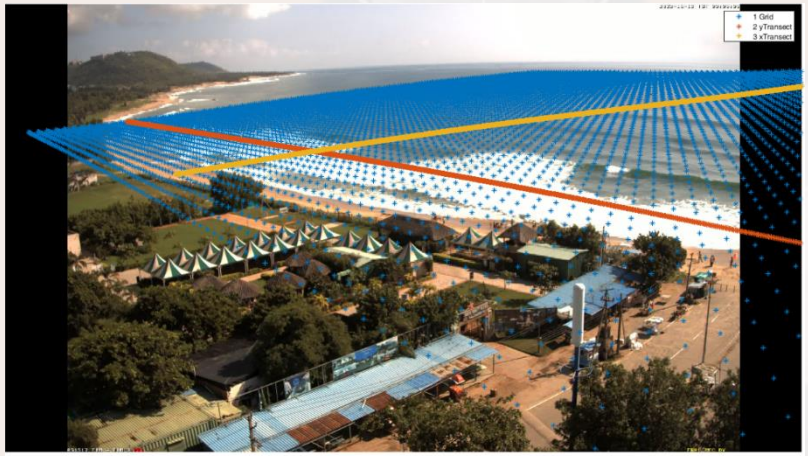
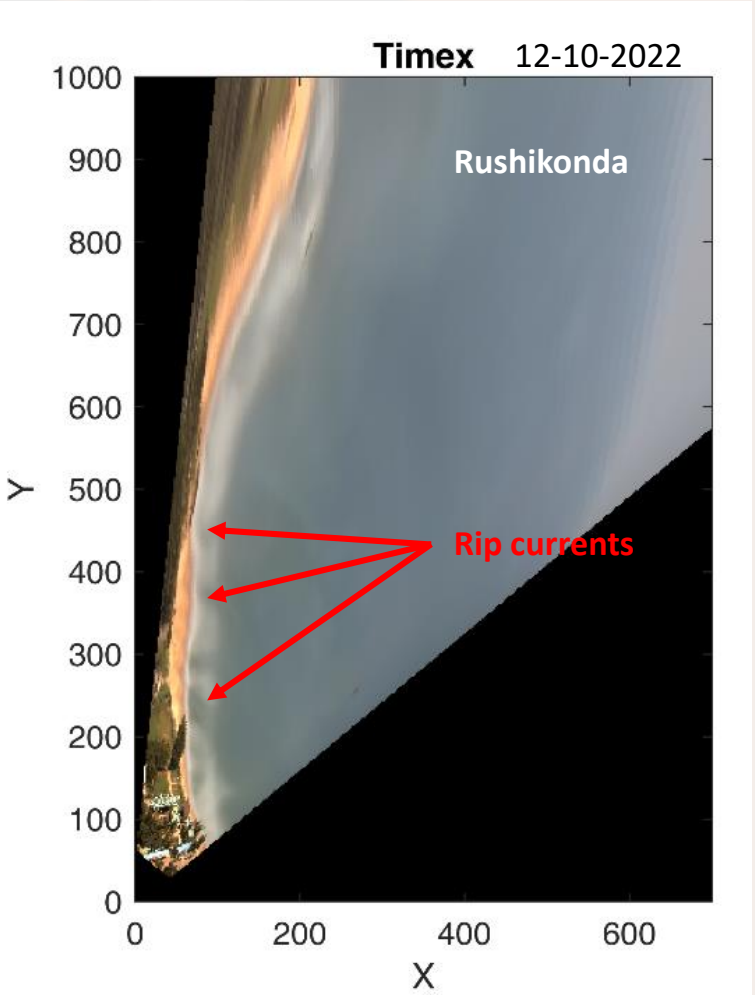
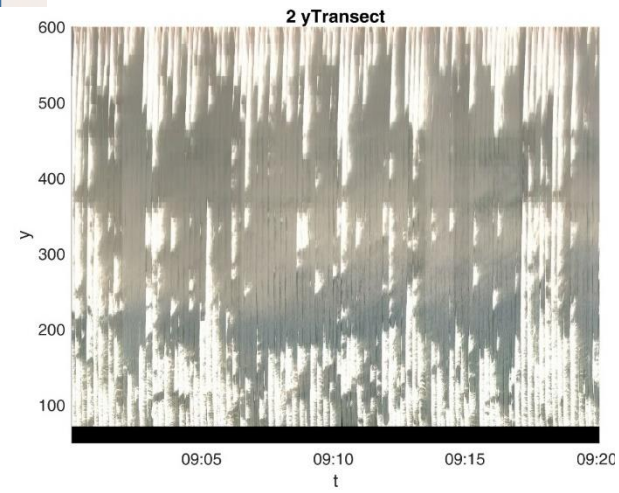


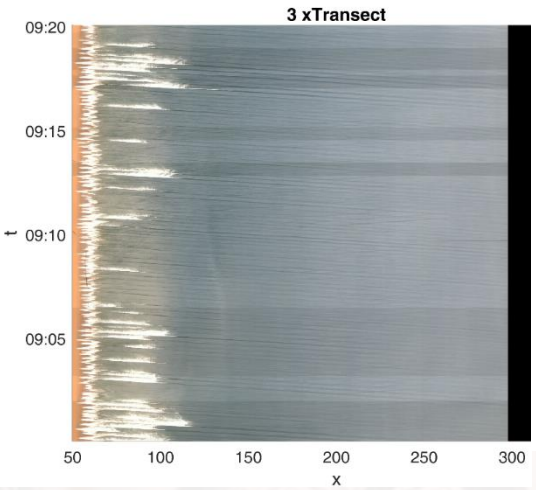
Image generation using GNSS survey



GCP collection



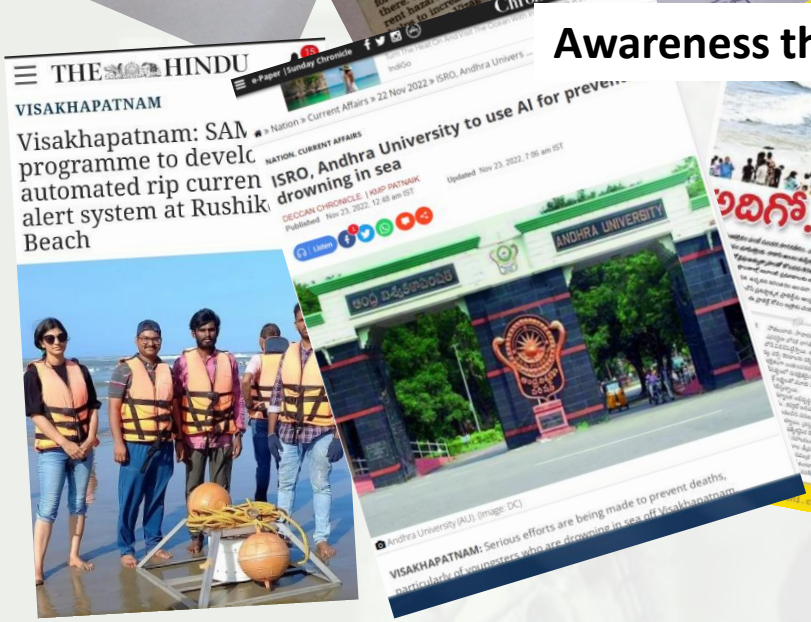


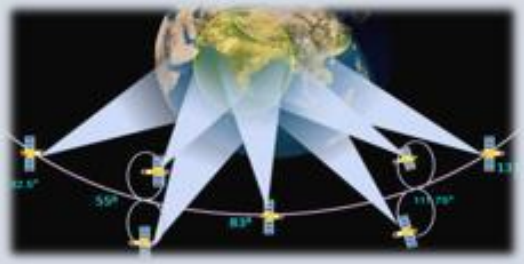


India's first Rip Current Warning Dissemination System

- Fully-automated Rip current warning (**High risk – Red**, **Moderate Risk – Orange** and **Low Risk – Green**)
- Installed at Rushikonda, AP (Blue Flag certified beach).
- Supported by Police Department, AP Tourism department, Govt. of AP.

Awareness through Press & Media





Thank You