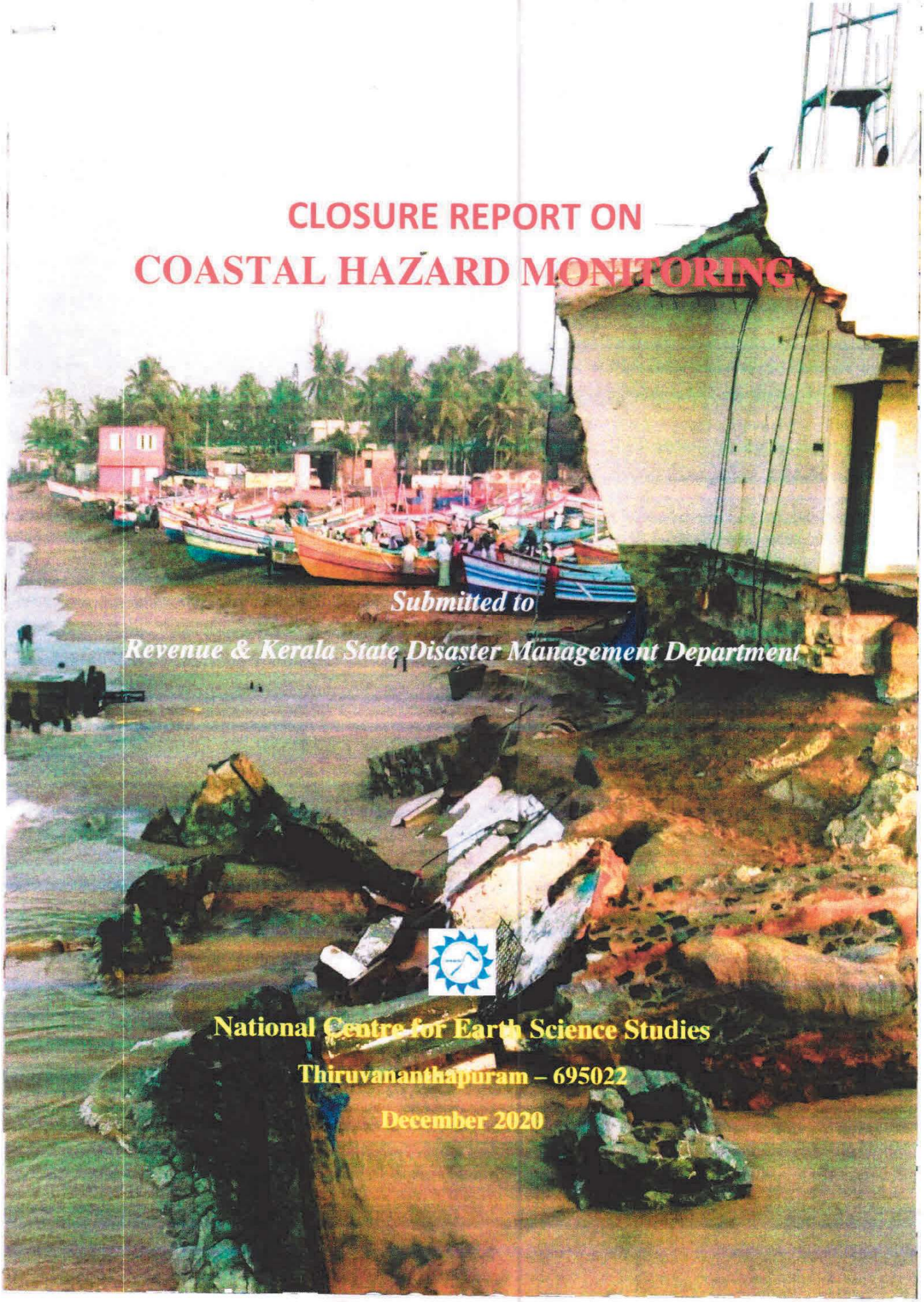
CLOSURE REPORT ON
COASTAL HAZARD MONITORING



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Thiruvananthapuram – 695022

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Closure Report on Coastal Hazard Monitoring and Early Warning Project

1. Introduction

In view of the increasing trend in coastal erosion hazard along the SW coast of India, a pilot project for continuous monitoring and understanding of the complex coastal processes that can lead to erosion along Kerala coast has been launched by the Coastal Processes Group of NCESS. As part of this initiative, in addition to the research component which is expected to provide valuable information on the coastal processes and other driving forces/factors that can lead to coastal flooding, particularly during the non-monsoon period, special attention was also given to societal development activities like providing timely alerts/warning to the coastal communities during adverse weather conditions. This programme has been conceived as a sub-component of the Natural Hazards Core Project of NCESS and it is being implemented by the Coastal Processes Group with funding from the Kerala State Department of Disaster Management. A pilot beach monitoring system through Video Observation and installation of Automatic Weather Station for obtaining continuous coastal data has been proposed as the key component of this project. This method of continuous coastal monitoring through video imaging technique though adopted in other parts of the world since 1990s, was introduced in India for the first time by NCESS in 2016. The data collected which is mostly site specific, is expected to provide continuous information on the beach and nearshore processes to the scientists and coastal engineers which are vital for understanding the stability of the coast and also for adopting appropriate measures which include both disaster mitigation and management. In addition, to take care of the societal commitment, installation of Electronic Display Board (EDB) at important locations along the Kerala coast is also proposed. This programme was initiated in April 2016 and taken up in July 2016 after the procurement of the necessary instruments/equipment and accessories for data collection. The first stage of implementation got underway during August-September 2016 with the installation of an Automatic Weather Station and a Video system for coastal monitoring at Valiathura in Trivandrum coast of Kerala. The site was selected as it represents a typical high energy coast located along the SW coast of India and the long-term coastal data (which includes nearshore, offshore and beach morphology) availability for such a location was limited to understand and unravel the complex coastal processes which triggers some of the rare events.

2. Study area

The study area, Valiathura beach in Thiruvananthapuram, Kerala, situated at 8°27′47″N 76°55′27″E is a high-energy coast located along the southwest coast of India. It is a typical high energy coast exhibiting seasonal changes in coastal dynamics and beach morphology. In addition to the seasonal changes in coastal morphology, it has been witnessing long-term changes and has been identified as one of the erosion hotspots along the Thiruvananthapuram coast (Noujas et al 2014). The location map of the study area with the camera station (inset) is shown in Figure 1.

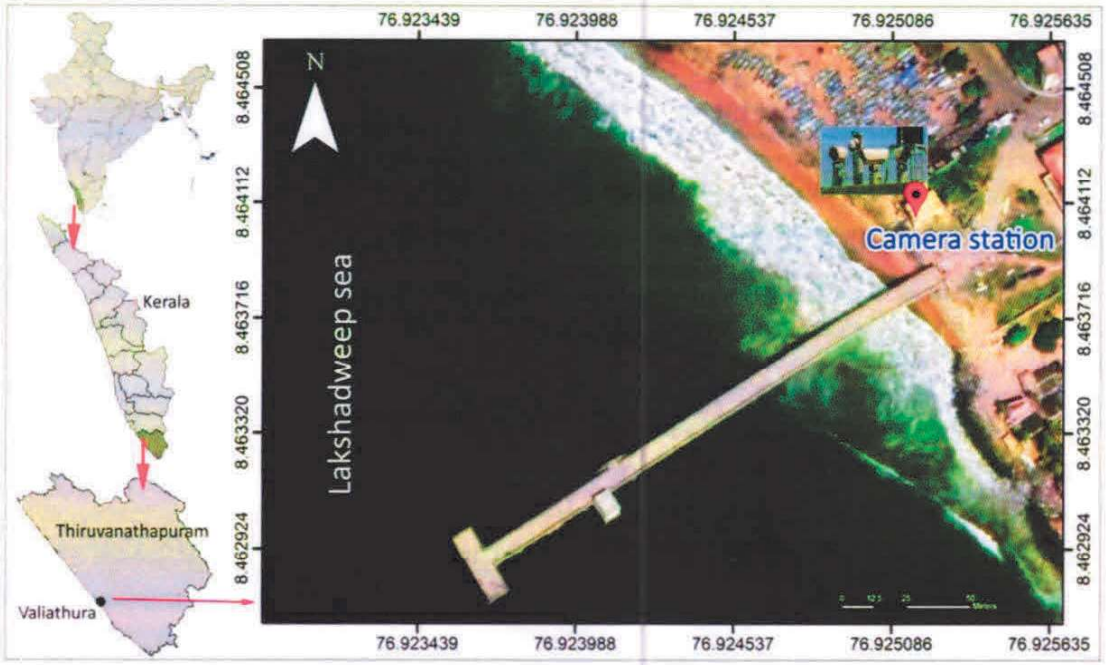

Figure1: Location map of the study area

3. Installation of VBMS, AWS and EDB

The first camera station, which is a Video based Beach Monitoring System (VBMS) comprising of four cameras was installed on the terrace of the Coastal Research Facility Lab (CRFL) of NCESS (Figure 2 (a)) at Valiathura. The main purpose of installing the VBMS is to continuously monitor the small pocket beach flanking either side of the 220m long Valiathura pier thereby collecting primary data related to surfzone dynamics of the Valiathura coast, which forms part of the Thiruvananthapuram coast which is considered as a typical high energy coast. The VBMS was mounted on a frame at a height of 10.3 meters above the Mean Sea Level such that it covers a coastal stretch of 200 meter in the alongshore direction and about 500 meter in the cross-shore direction. It consists of four cameras, out of which three are static Weather-Proof IR Bullet cameras, with a resolution of 2 MP (1080x1920), and the fourth one is a PTZ camera with 2MP resolution, facility for 360° continuous rotation and a zoom lens(20x Zoom). The three static cameras were fixed in such a way that they were able to capture the target area of interest, i.e. one camera is directed to the region immediate south of the pier and the remaining two are aligned to capture the region towards the north of the pier with proper overlap so that the combined view gives proper coverage of the target area. Provision was also made for data storage with a server at the CRF Lab (Valiathura) and also at NCESS campus through direct data transfer by establishing VPN connectivity with the support of BSNL. Along with the Camera Station (Figure 2(b)), an Automatic Weather Station (AWS) (Figure 2 (d)) to monitor the local weather conditions and an Electronic Display Board (EDB) (Figure 2 (e)) to provide timely information on the Sea State condition to the local user community were also installed at Valiathura during September 2016. After the initial trial tests, the VBMS started full-fledged operation in October 2016 and the sea state data as well as the

local coastal weather data were made available to the coastal community through the EDB mounted on the eastern side wall of the CRF Lab.

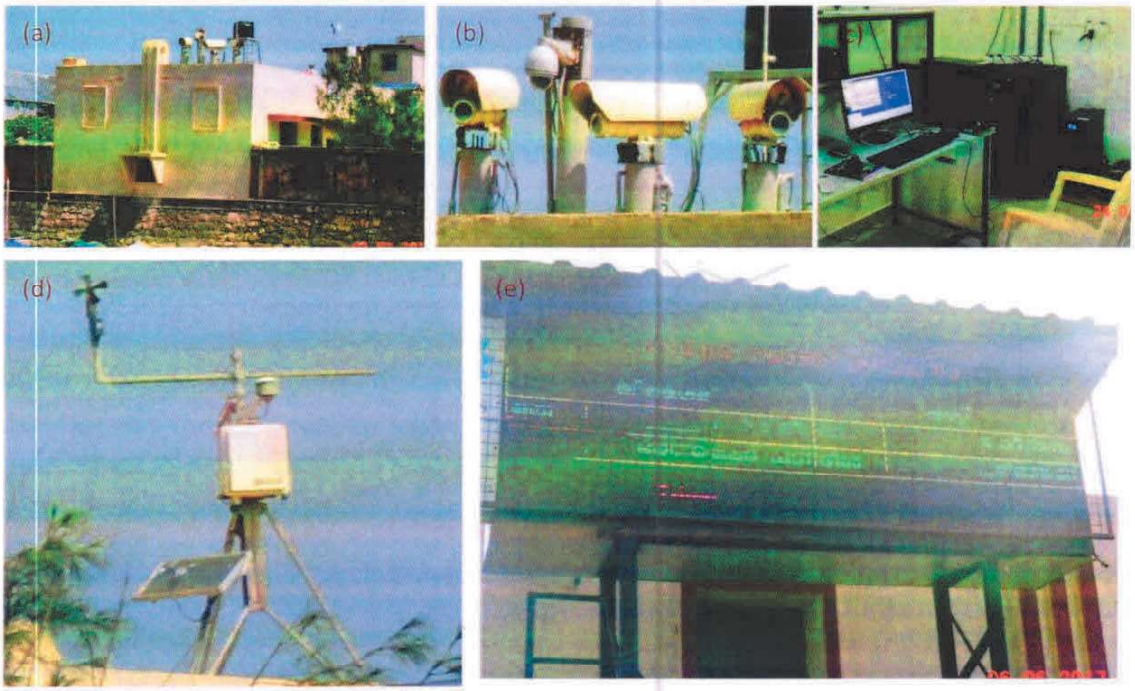

Figure2: (a) CRF Lab at Valiathura (b) Camera station (c) Storage and transfer setup (d) AWS and (e) EDB

4. Data Collection and Processing

The VBMS became operational in October 2016. The four cameras were used to record a video of one hour duration on daily basis so as to provide site specific information to understand the short-term changes in beach morphology under varying coastal processes which is dictated mainly by the offshore wave conditions and nearshore hydrodynamics which in turn are dependent on the coastal wave, wind and tidal conditions. The recorded video, which is essentially a time series collection of images, were processed further to extract useful statistical image products like snapshot (Figure3 (a)), timex (Figure3(b)), and variance (Figure3(c)), images. Further detailed analysis of these image products provides vital information regarding daily variations in beach width, surfzone and wave runup. Also attempts were made to extract information on temporal changes in wave characteristics from the recorded video, by generating time series products of a single pixel (Figure3(d)), and cross shore array (Figure3(e)). Camera calibration and rectification of image products which form part of the image processing techniques were carried out using algorithms that were developed in-house at NCESS.

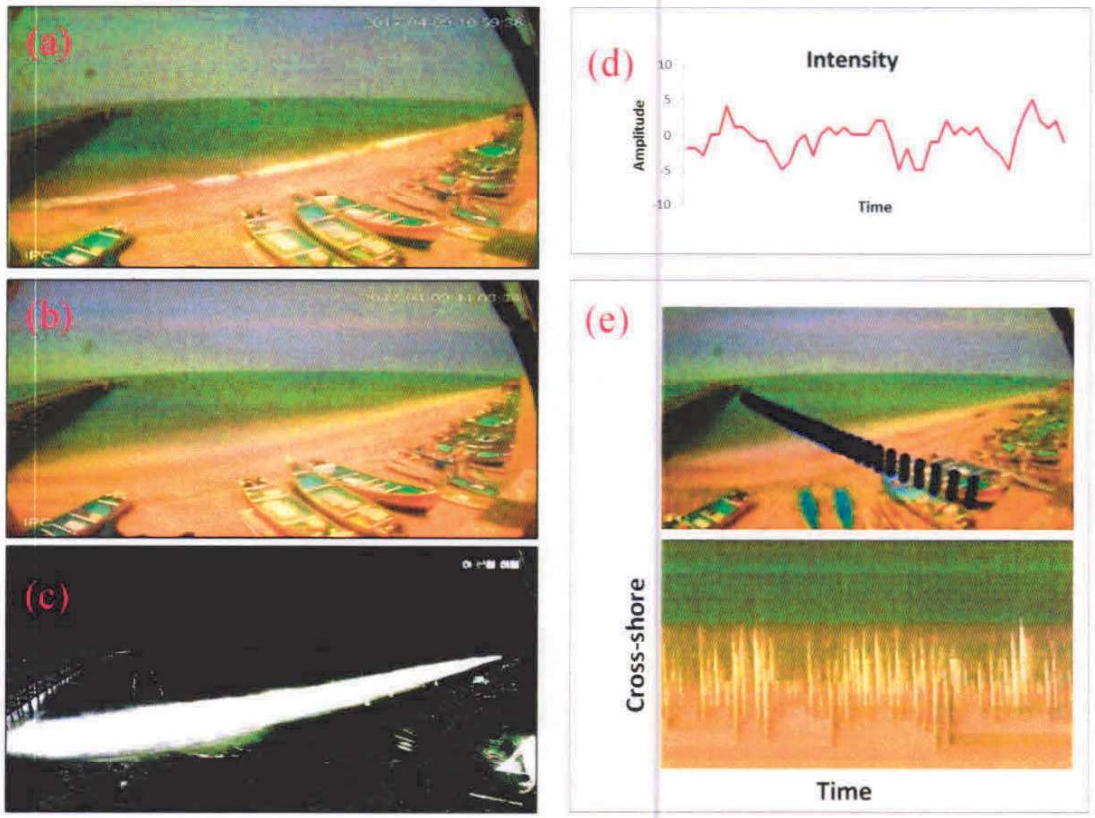

Figure3: Data products derived from the video images - (a) Snapshot (b) Timex (c) Variance (d) Single pixel timestack and (e) Cross-shore array

5. Results from VBMS System

a) Beach width

Beach width measurements give first-hand information on the stability of the beach. In this project, a MATLAB based tool was developed for obtaining the beach width from recorded video images of the beach. A fixed reference point on the beach (figure 4) is used as the reference point for the estimation of the beach width, which is calculated as the perpendicular distance from the reference point to the waterline. Using the MATLAB tool, the beach widths on either side of the pier were calculated daily from the recorded video images. The computed daily beach widths have been successfully validated by comparing with the measured values as shown in Figure 4 and they give a reasonably good comparison (correlation of 0.93).

b) Surf Zone

Surf zone is the region lying between the breaker zone and the shore. The breaker line is not a fixed line as the location of wave breaking varies depending on the wave height. Higher waves break further down the shore than smaller ones. The nearshore sediment transport is quite significant in this region and it is mainly responsible for the shoreline variations. Hence, it is imperative that site specific studies that aim to understand the surfzone dynamics are

carried out. As part of this study, timex images are used to compute the surfzone widths and the results are validated by comparing with the visual observations as well as physical measurements (made using the scale markings to facilitate easy measurements) (Figure 4).

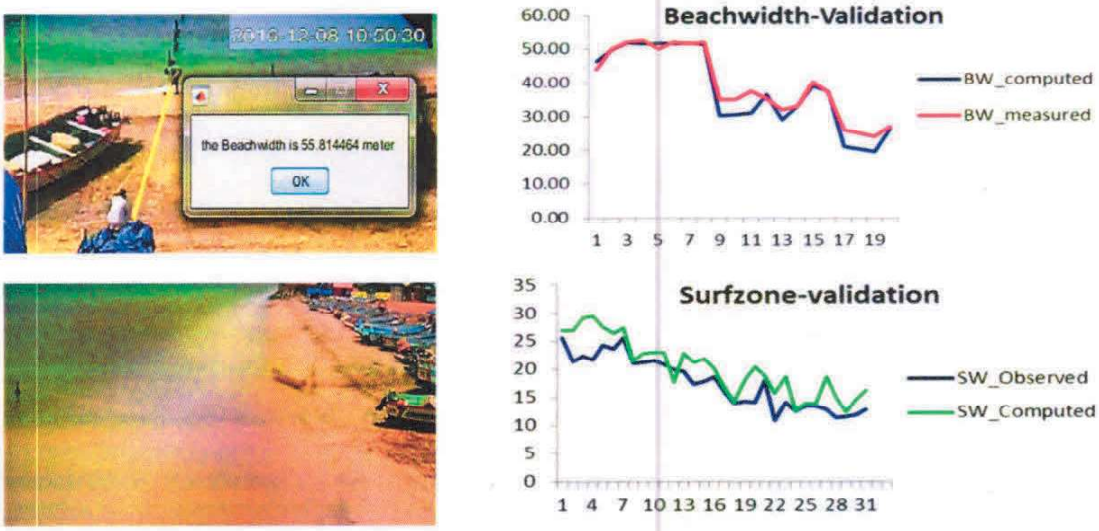

Figure 4: Beach width and surfzone width calculated from video images

c) Swash zone and wave runup

The turbulent motion of water that rush up the beach after a wave has broken is called swash. The swash zone forms the land-ocean boundary at the landward edge of the surf zone, where waves runup the beach face. In this study, the swash width is computed at one sec interval and the time series plots further analysed to study the wave runup behaviour. Wave runup is defined as the additional height that broken waves attain as they runup the shore before their energy gets dissipated due to friction and gravity.

As mentioned before the runup is computed from the swash width, which in turn is derived from the recorded video data and the field measured beach slope. A total of 900 individual run up events were obtained from the 15-minute video recording covering the northern stretch of the Valiathura beach. The computed wave runup during the recording period is presented in Figure 5. The measured wave runup varied between 0 and 1.8 m during this period. Reasonably good correlation is observed between the video derived results and the field measurements.

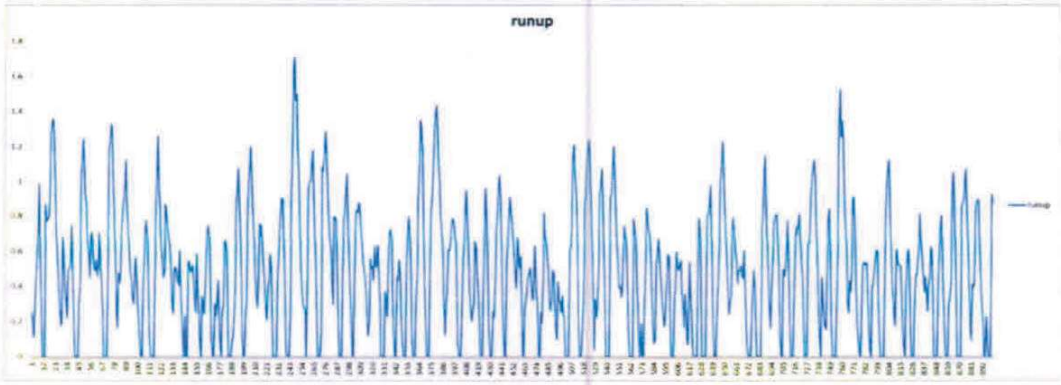

Figure 5: Time series of wave runup

d) Short-term Shoreline Change Analysis

Daily shorelines were extracted from rectified plan view images and further analyses were carried out using ArcGIS tools to study the short-term shoreline changes. According to the results of the study (Figure:6), about 50m reduction in beach width was observed during the period from December 2016 to June 2017.

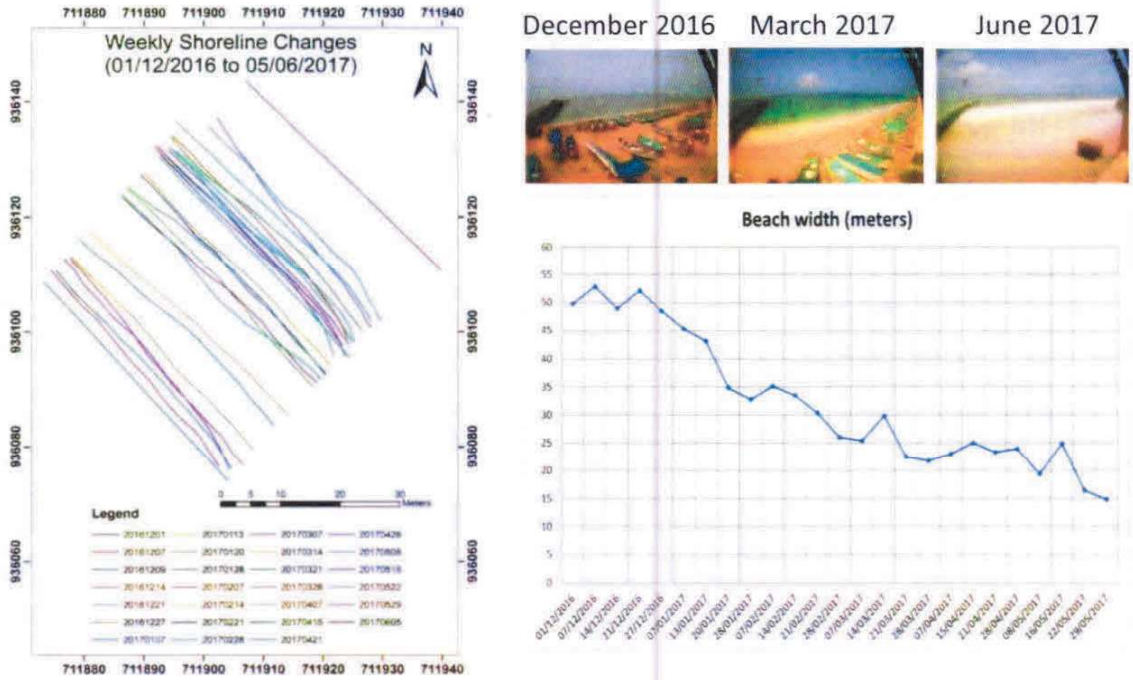

Figure 6: Computed short-term shoreline changes at Valiathura

6. Installation of EDB and display of Sea State Condition

The EDB, which was installed at Valiathura started functioning in September 2016 and remained operational till the collapse of CRF Lab. building in 2018. It was used to convey information on Sea State conditions like wave height, period and wave direction, and also parameters linked to coastal weather conditions (local) such as atmospheric pressure, humidity, wind speed, wind direction and rainfall to the coastal community. The data displayed

through EDB was updated twice in a day thereby providing timely warning/alerts to the coastal community particularly, during adverse weather conditions. It was useful for the local fishermen and coastal community of the area to plan their fishing activities.

7. Premature termination and closure of the project

The unusually high wave activity and subsequent erosion during the month of May 2017 and also early June, led to the partial collapse of the Coastal Research Lab. building at Valiathura (the sea facing room collapsed with sea water gushing into the building) on 7th June morning. Following this, NCESS was forced to suspend all the field activities at Valiathura (Figure 7). Even though NCESS attempted to reinstall the system and resumed the field data collection once again during March 2018 (Figure 8), it did not last long as the building was further damaged due to high wave activity later in the same month (Figure 9) and also during the subsequent monsoon season of 2018. The building which was in a dilapidated condition since September 2018 eventually collapsed in April 2019 (Figures 10 & 11) forcing NCESS to permanently stop all the field data collection activities related to this project.

Figure 7: View of the partially collapsed building of the NCESS Coastal Lab. Facility at Valiyathura (June 2017)

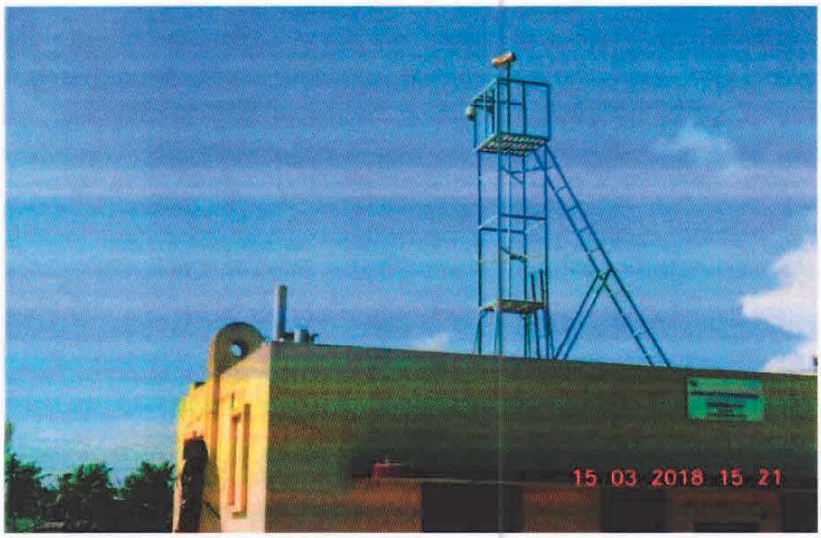

Figure 8: Attempt to reinstall the camera system by shifting the mounting frame to the middle portion of the terrace area

Figure 9: Increased coastal erosion at Valiathura in March 2018 due to high wave activity

Figure 10: Photograph showing the ruins of the NCESS CRF building at Valiathura after it was razed to ground due to erosion on 24th April 2019

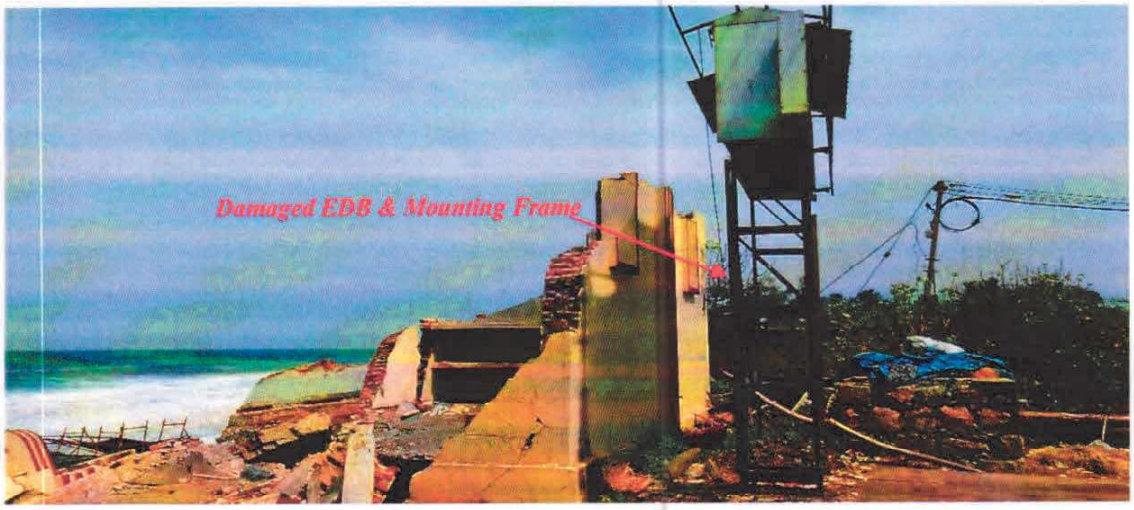

Figure 11: Photograph showing the damaged frame of the EDB after the building collapsed on 24th April 2019