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A New Video and Digital Camera System for Studies of the Dynamics of Microtopographic Features on Tidal Flats

LARS CHRESTEN LUND-HANSEN
EINER LARSEN
KURT THOMAS JENSEN
KIM N. MOURITSEN

Marine Ecology, Biological Institute
Aarhus University
Århus, Denmark

CHRISTIAN CHRISTIANSEN
THORBJØRN JOEST ANDERSEN
GUNNILD VØLUND

Institute of Geography
University of Copenhagen
Øster Copenhagen, Denmark

A newly developed video and camera system for tidal flat microtopographic studies is presented. It consists of a SONY handy cam placed in an underwater housing mounted on a frame about 70 cm above the sediment surface. A rectangular surface area of 30 × 40 cm is imaged by the camera. The camera records video sequences and/or digital images at predetermined time lapses. The total number of images is about 540, and a similar number of 10-second long video sequences can be recorded. The camera is programmed with a PC before deployment, and the total deployment time depends on the time lapse between recordings. The camera is connected to an external power supply (12 volt), and a halogen projector pointing towards the sediment surface ensures that the system is operable on a 24-hours scale. The system has been tested in the Danish Wadden Sea. It has proved to be a very useful tool in studies of topographic effects of erosion and deposition sequences, and for studies of benthic organisms-sediment interactions. The test site was further equipped with sensors for water and seabed measurements, which proved to be indispensable regarding the interpretation of recorded image time-series.

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Address correspondence to Lars Chresten Lund-Hansen, Marine Ecology, Biological Institute, Aarhus University, Finlandsgade 12, 8200 Århus N, Denmark. E-mail: lund-hansen@biology.au.dk

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The remote sensing system presented here comprises a method where digital images are recorded with a distance of only a few meters between camera and object; aerial photography (Jiménez et al. 1997) and satellite remote sensing (Jensen 1996) are excluded. This kind of digital imagery has been applied in coastal research for some years with the aim of studying changes in beach profiles and foreshore topography (e.g. Holman et al. 1991 and 1993, Holland and Holman 1997, Lippmann and Holman 1989), but there are few examples from intertidal flats (Ansell 1995, Røy et al. 2002, Sun et al. 1993). An intertidal flat is characterized by a recurrent change between inundations at high water and aerial exposure at low water once to twice per 24 hours depending on the tidal frequency (Andersen 2001). Erosion and deposition processes have been studied intensively on intertidal flats, where erosion and erosion rates, for instance, are complex functions of interrelated physical and biological parameters (e.g., Andersen and Pejrup 2001, Friend et al. 2003, Mouritsen et al. 1998, Paterson et al. 2000). The general approach used to gain more insight into these complex functions is intensive sampling and measurements at selected positions at low water or between tidal cycles (Friend et al. 2003). More extensive sampling and measurement may be made on a long-term or yearly basis (Andersen 2001, Christie et al. 1999). However, due to meteorological effects, mainly wind generated waves and biological activity, the time-scale for changes in microtopography on an intertidal flat is shorter than the tidal period. The present method was developed to monitor long-term changes in microtopography on an intertidal flat by recording digital images of the sediment surface at every low water.

Description

The system consists of a stainless steel underwater camera housing, containing a conventional video camera—SONY Hi 8 Digital Handy cam DCR-TR7000— which records analog video signals and digital still pictures. The camera is programmable through a microcomputer (Tattletale TFX-11), which controls time lapse between recordings, recording of video sequences and/or digital images, the time length of the video sequence, and the time between power up and start of the recording. The microcomputer is placed inside the housing where it is connected to the camera remote control through which the camera is operated. There is no electronic connection between microcomputer and camera. The underwater housing is equipped with two SUBCON© connecters at the upper end for power supply and programming, and a circular glass window with a diameter equal to that of the ocular is placed at the lower end. The camera is equipped with a 90-minutes tape, and digital images are stored on the tape in a digital format. The camera housing is mounted on a horizontal aluminum frame with the housing at the center of the frame, which is 150 cm long (Figures 1, 2, 3, and 4). The frame is, in fact a ladder where the upper and lower parts can be bent into legs. Each of the legs are locked on to unspruced wooden stakes, that are hammered into the sediment. The frame is secured with four wires connected to an additional four stakes in the sediment (Figures 1, 2, and 3). The housing to the right is the battery container which contains four 5 Ah 12-volt parallel connected and dry rechargeable batteries. The distance between camera and

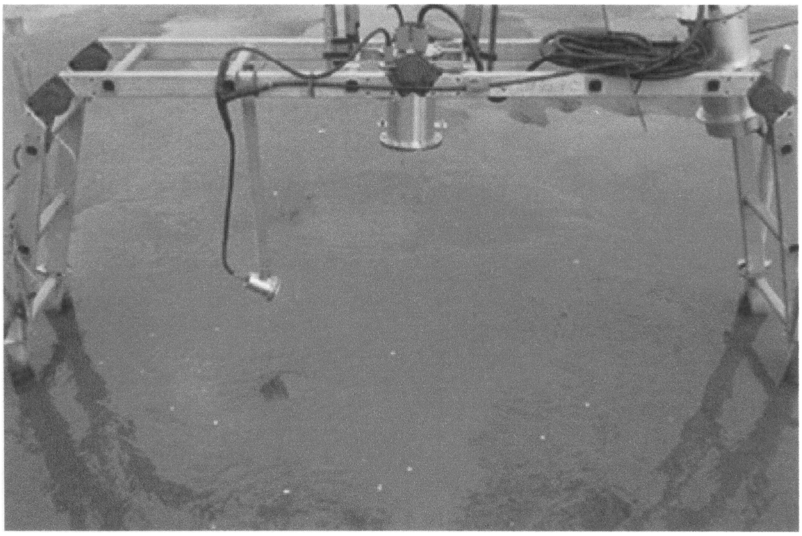

Figure 1. The frame equipped with camera (center) and battery housings (right). The halogen lamp is seen to the left.

sediment surface is about 70 cm. To the left, connected to a black cable (Figures 1, 2, and 3), is a halogen projector for night recordings whereby the camera system is operable on a 24-hour scale.

Operating Procedures

The camera housing is withdrawn after deployment, and recordings are downloaded to an external PC or video recording device. The tape is rewound for the next

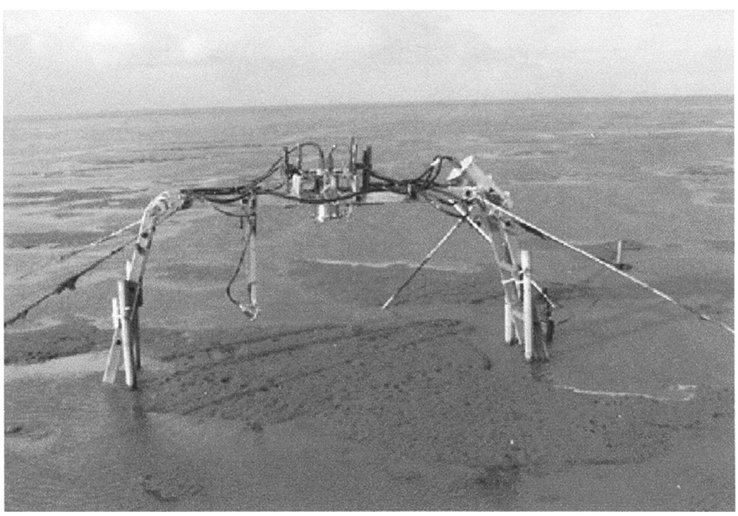

Figure 2. The frame placed on the intertidal flat with wires and the echo sounder behind the right leg of the frame.

Figure 3. An oblique view of the frame.

deployment, and the battery container is replaced with a new one. It is not necessary to open either camera house or battery container. The camera is programmed with possible new settings and camera battery are again mounted on the frame. One digital image takes up about 10 seconds on the tape, which gives a total of 540 records on a 90-minute tape. It would be straightforward to set the time lapse between recordings to 12.25 hours as the tide is semidiurnal in the Danish part of the Wadden Sea where test trails were carried out. This setting would equal one record per low tide. However, water level is controlled not solely by the tide producing forces but also by meteorological forcing as winds and waves. The period of high

Figure 4. A view of the frame from the side.

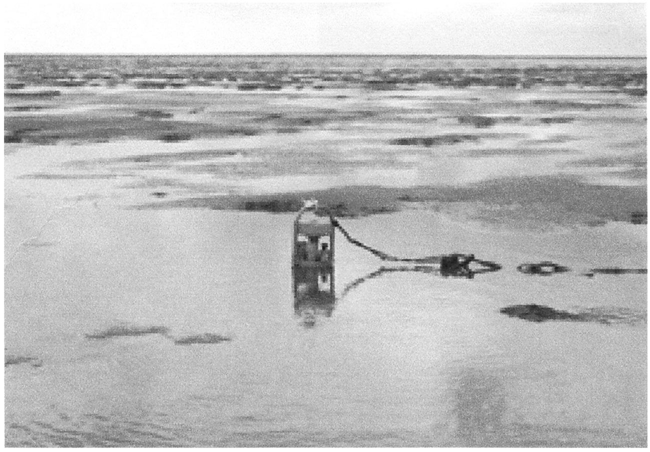

Figure 5. The Aanderaa current meter (RCM 9) placed about two meters from the frame.

water can be quite short at higher lying parts of a tidal flat in periods of offshore winds at the test site. Therefore, a time lapse of two hours was selected in the present case. This equals a total period of 45 days of deployment.

Additional Sensors

The site of investigation was further equipped with an Aanderaa current meter (RCM-9) (Figure 5), which measured salinity, temperature, water level (pressure), and current speed, direction and turbidity every 10 minutes. The current meter was placed about 2 meters from the frame during test trails. An automatically recording echo sounder was placed about 1.5 m from the frame. The echo sounder sensor was placed on a tripod about 50 cm above the sediment surface where it measured distance to the sediment surface with an accuracy of ± 2 mm (Jestin et al. 1998). Data from the echo sounder was stored internally. One of the legs of the echo sounder tripod can be recognized below left of the battery container (Figure 2).

Applications

Images recorded during a deployment in the Danish Wadden Sea are shown together with data on water and seabed level recorded between 25 October and 3 November 2001 in Figure 6. The images were recorded at low water and time of recording is shown as markers in the upper panel whereas the numbers below the images refer to dates of recording (Figure 6). The 26 October image recorded during daytime shows a very smooth and even surface and the 27 October night recording shows similarly a smooth surface. The distance from the echo sounder to the seabed decreased by about 0.5 cm between 25 and 26 October and the reduction in distance shows that deposition took place in accordance with the smooth surface. Small ripple marks and burrows are clearly seen in the upper right and left corners of the image 28 October, and these ripples probably developed as a result of erosion as revealed by the increase in distance to the seabed between 27 and 28 October (Figure 6). Two days of deposition (29 and 30 October) raises the seabed level, and the surface returns into a

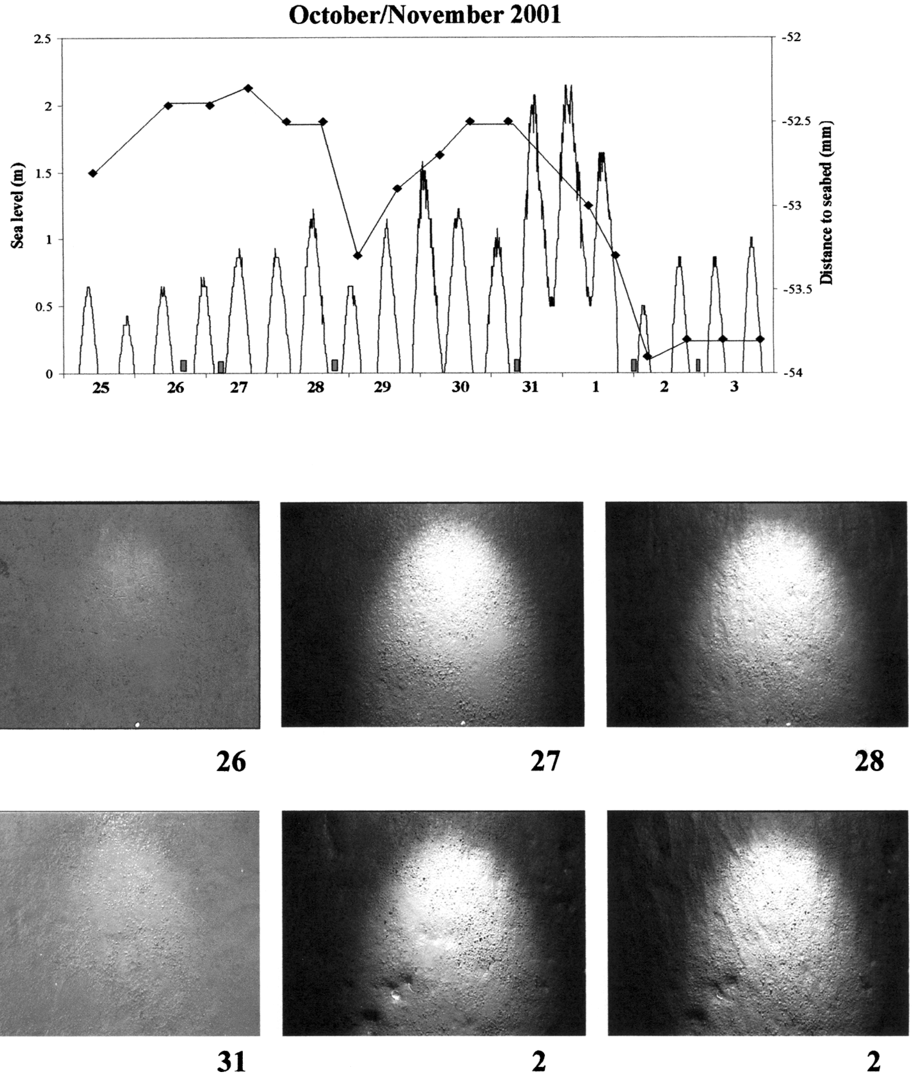

Figure 6. Upper panel shows sea level (m) and distance between echo sounder and sediment surface (mm) between 26 October and 3 November 2001. The six small marks in the figure show the time of recording and recorded images are shown above where the numbers refer to date of recording.

smooth state similar to 26 October without burrows and ripples. There is then a nearly continuous 24-hours period of inundation with high water levels (~2.0 m) related to a period of strong winds. Unfortunately, the current sensor was out of order during this period, but it is supposed that both currents and waves have caused the erosion of about 2 cm of seabed between 31 October and 2 November. The 2 November surface shows signs of strong erosion with ripple marks and several burrows. A white shell is clearly recognized in the lower left corner. The strong erosion event is followed by a period of small seabed level changes during 2 and 3 November. However, the two images from 2 October were recorded 00:06 and 22:06, intercepted by two high waters. A comparison of the two images suggests that sediment is deposited as evidenced by the filling of burrows and depressions with sediment, and the white shell is partly covered on the 22:06 image. This 2 and 3 November is a period where calm conditions prevail as indicated by the low high water levels. However, the test site is densely populated by *Corophium volutator*, and a structure of elevated plateaux and small pools are characteristics of such areas (Figures 3 and 4). The camera was focused on a plateau inhabited by a dense stock of the *Corophium volutator* and the small-scaled structures (holes and sediment piles) recognized on the sediment surface (Figure 6) are related to the burrowing activities of this amphipod. The importance of these activities regarding sediment structure and microtopography has recently been demonstrated by Mouritsen et al. (1998).

Conclusions

The new method presented here has proven to be a valuable tool by which sequences of erosion and deposition on the tidal flat and related effects on the microtopography can be studied. These changes can be studied on a longer-term basis depending on the time lapse between recordings. The interpretation of the images as a time-series will be more solid if water and seabed levels, current speed, and so on, are measured concurrently at the study site. The method can also be applied in research of the benthic fauna-sediment interactions.

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