CASE STUDY

Assessment of intertidal morphological changes using video monitoring

LOCATION:
Egmond, the Netherlands

KEYWORDS:
Tools and techniques for beach management

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EXECUTIVE SUMMARY

Coastal managers and engineers presently demand high-resolution monitoring information, which is not easily obtained from traditional survey techniques. With the advent of digital imaging technology, automated shore-based video stations provide enhanced opportunities to support cost-efficient coastal resource planning and impact assessment studies. Video monitoring was used to assess the intertidal morphological changes as well as the evolution of surf zone bathymetry after implementation of a shoreface nourishment at Egmond, the Netherlands, in July 1999.

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1. THE NEED

Coastal managers and engineers increasingly need coastal state information at small scales of days to weeks and meters to kilometres. This is due to the frequent use of local beach nourishments to ensure coastal safety and the demand for year-round exploitation of beaches, driven by the increasing recreational pressure on the coast. The design and evaluation of coastal policy measures and engineering interventions is hampered by the dynamics of the natural system. Beach nourishments adapt to an equilibrium profile in a matter of weeks to months, through phases that may be unexpected and could pose temporary problems. Rip currents may even develop within days, hence forming a serious threat for swimmer safety. Effective decision making and engineering design in this complex field thus demands the availability of detailed coastal state information at small scales of days to weeks and meters to kilometres. Remote sensing techniques offer the potential to provide this information against low costs.

2. THE APPROACH: THE ARGUS VIDEO TECHNIQUE

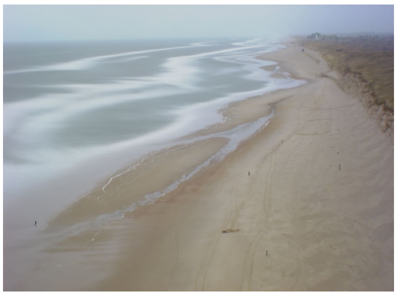
With the advent of digital imaging technology, shore-based remote video techniques like the advanced Argus system developed at Oregon State University (USA) have increasingly been used for the monitoring of coastal processes in support of coastal management and engineering. Unmanned, automated video stations (Fig. 1) guarantee the collection of video data at spatiotemporal scales of decimetres to kilometres and hours to years. Being continuously improved since 1992, the system nowadays features fully digital video technology which provides high image quality.

WL | Delft Hydraulics has been involved in Argus video monitoring since the installation of the first station in The Netherlands in 1995. In 1998, WL | Delft Hydraulics settled a license agreement with Oregon State University for the installation of Argus video stations and provision of Argus software worldwide outside the United States, Canada and Mexico. Since then, WL | Delft Hydraulics has been involved in the installation of more than fifteen video stations on three different continents and has contributed to the development of new user-friendly Argus software.

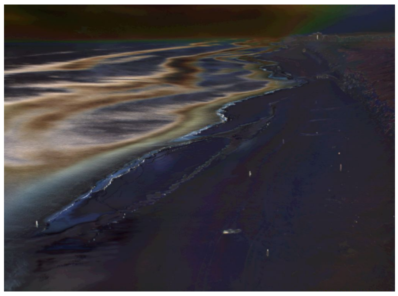
An Argus monitoring system typically consists of four to five video cameras, spanning a 180º view, and allowing full coverage of about three to six kilometres of beach. The cameras are mounted on a high location along the coast and connected to an ordinary PC on site, which in turn communicates to the outside world using broadband internet. Data sampling is usually hourly, although any schedule can be specified, and continues during rough weather conditions. As the process of data collection is fully automated, the marginal operating costs are virtually zero. For full flexibility, a self-contained system has been developed, with a low-power computer embedded in the camera housing.

Each standard hourly collection usually consists of three types of images. A snapshot image (Fig. 1a) serves as simple documentation of the ambient conditions but offers little quantitative information. Time exposure images (Fig. 1b) average out natural modulations in wave breaking to reveal a smooth pattern of bright image intensities, which are an excellent proxy for the underlying, submerged sand bar topography. Time exposures also 'remove' moving objects from the camera field of view, such as ships, vehicles and people. Variance images (Fig. 1c) help identify regions which are changing in time (like the sea surface), from those which may be bright, but are unchanging (like the dry beach). Panoramic (Fig. 1d) and plan view (Fig. 1e) merged images can be composed by geo-referencing the images from all the cameras of an Argus station. Plan view images enable the measurement of length scales of morphological features like breaker bars and the detection of rip currents. Besides time-averaged video data, data sampling schemes can be designed to collect time series of pixel intensities, typically at 2 Hz, with which wave and flow characteristics can be investigated.

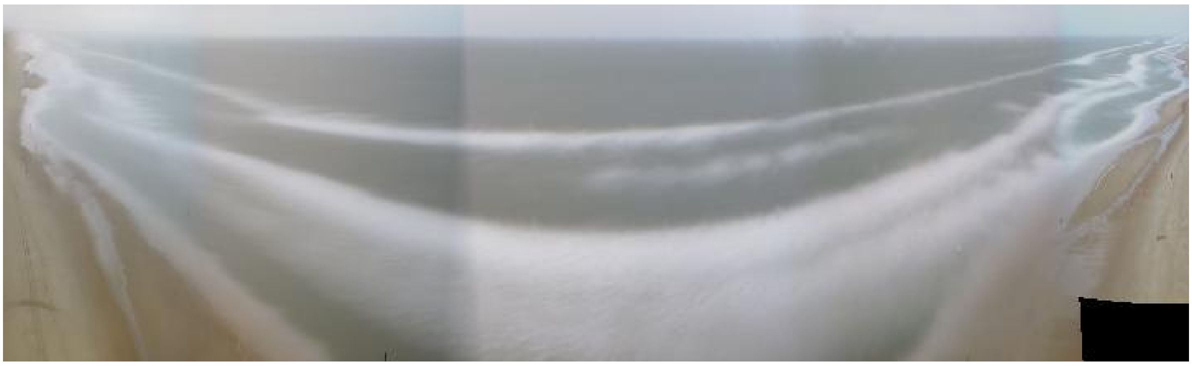
a: snapshot



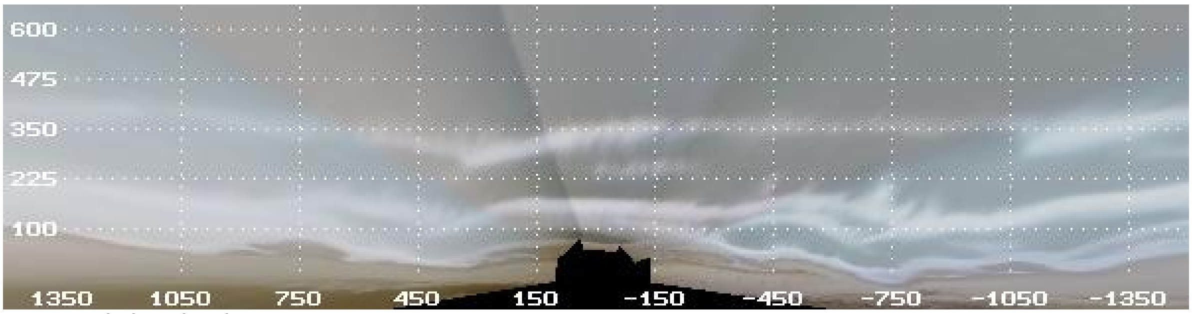
b: time exposure



c: variance



d: merged panoramic view



e: merged plan view image

Figure 1: Overview of standard Argus image types: (a) snapshot, (b) time exposure, (c) variance, (d) merged panoramic view and (e) merged plan view image. The images were taken February 2nd 2005 at Egmond, the Netherlands. The plan view image covers a coastal area of 600 m cross-shore by 2.800 m alongshore.

3. THE PRODUCT: COASTAL STATE INFORMATION DERIVED FROM VIDEO

Successful use of video monitoring techniques in support of coastal management and engineering involves the quantification of relevant coastal state information from video data. The Argus video monitoring technique was used to assess the intertidal morphological changes as well as the evolution of surf zone bathymetry after implementation of a shoreface nourishment at Egmond, the Netherlands, in July 1999.

Application 1: Intertidal morphological changes at a nourished beach

At Egmond, intertidal beach bathymetries were determined on a monthly basis by mapping a series of video-derived shorelines at different water levels throughout a tidal cycle. The mean vertical offset of this model is less than 15 cm along 85% of the 2 km wide study region. The resulting bathymetries (e.g., Fig. 2) were used to quantify patterns of erosion and accretion after a combined beach and shoreface nourishment. Example results are presented in the figures (1a and 1b), which show means of the monthly volume changes ΔV_{IB} per meter coastline (bars), as well as the cumulative morphological changes (lines). Negative values denote erosion. Figure (3a) presents the volume changes at a location 400 m to the south of the Argus station; Figure (3b) presents volume changes at a location 400 m to the north of the station. The analysis shows a tendency towards erosion during the first year. High-resolution video monitoring indicated that the additional beach nourishment implemented in the left-hand section (3a) in July 2000 disappears from the intertidal beach within a few months.

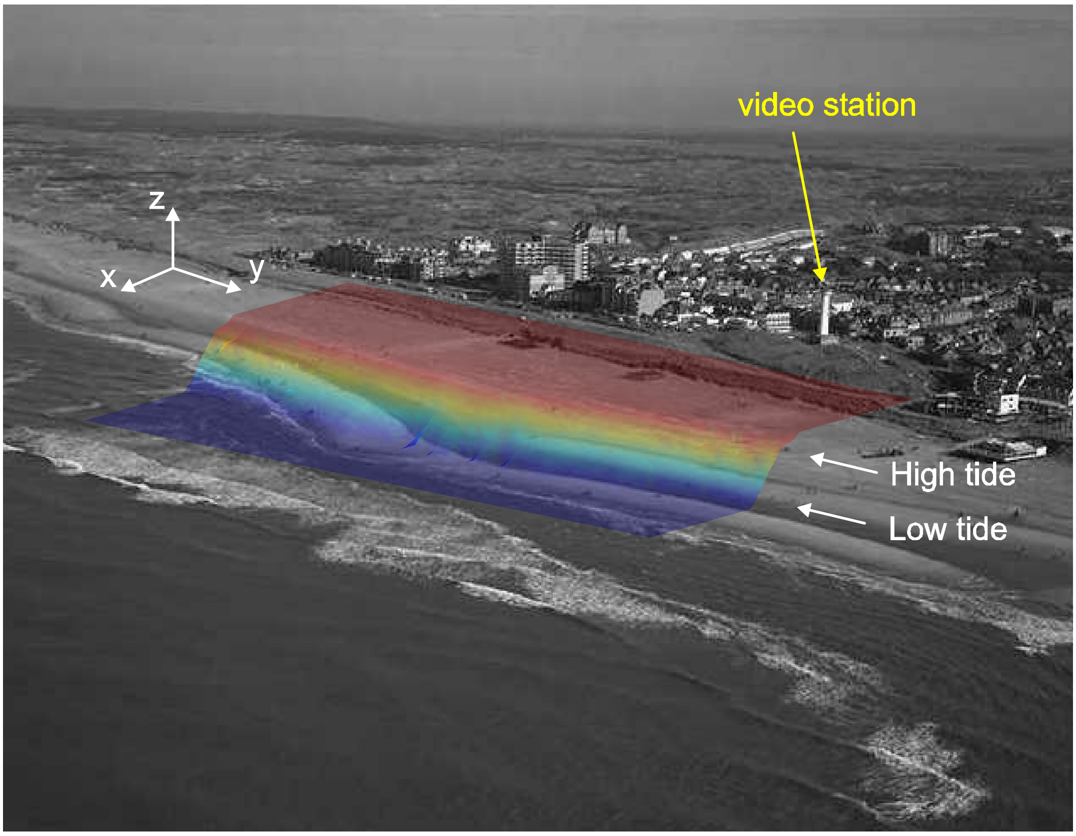
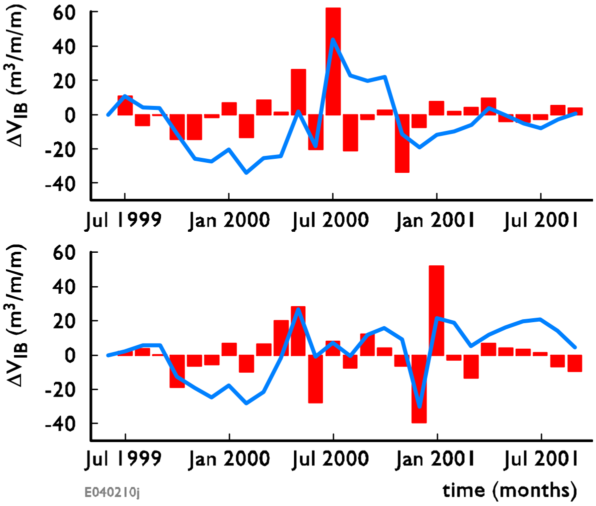


Figure 2: Intertidal beach bathymetry at Egmond derived from video.



Figures 3a and 3b: Monthly volume changes (bars) at 400 m south (a) and 400 m north (b) of the Argus station. Lines represent the cumulative morphological changes.

Application 2: Measurement of surf zone bathymetry

At Egmond, Argus video imagery has been used to monitor the evolution of surf zone bathymetry after implementation of a shoreface nourishment in July 1999. The bed elevation is continuously updated on the basis of a comparison of video-derived and model-computed patterns of wave dissipation (Aarninkhof et al., 2005). This approach yields marginal deviations in the order of 10 to 20 cm at the seaward face of the bars, which increase up to 20 to 40 cm near the bar crest. The results show a shoreward migration of the outer bar after deployment of the shoreface nourishment in combination with a net accretion of sediment along the shallow part of the beach profile above the -2 m depth contour, thus confirming the beneficial impact of the nourishment.

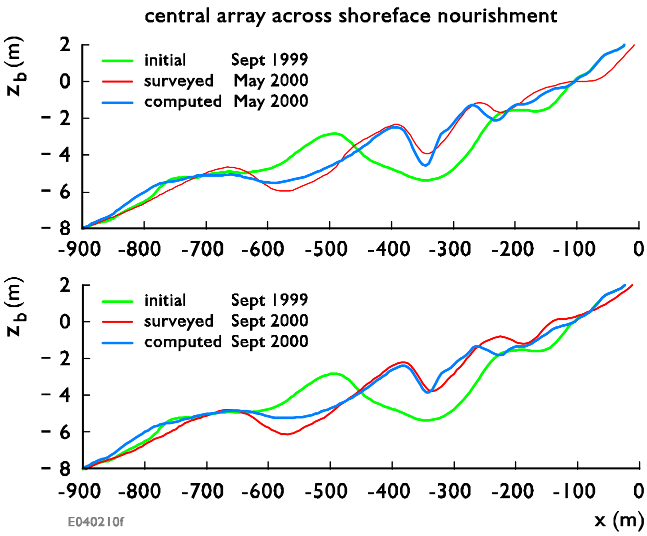


Figure 4: Initial, measured and computed bathymetries along two transects (130 and 1500 m north of the Argus station).

Reference:
Aarninkhof, S.G.J. (2003). Nearshore bathymetry derived from video imagery. PhD. Thesis, Delft University of Technology, 175 pp.

4. FURTHER READING

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