Assessment of post-storm recovery of beach profiles using video imaging techniques

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Introduction

Since the early 1960s, beach profiles have been surveyed along the entire length of the Gold Coast, Queensland Australia following standard surveying methods applied around the world. These surveys have provided the basis for analysis of beach width and volume changes in support of beach protection works. In 1999 a new approach to monitoring changes in the beach width was adopted with the implementation of the ARGUS coastal imaging system (Holland et al. 1997; Aarninkhof and Holman 1999) to assess the effectiveness of beach protection strategies. The principal monitoring parameter was the position of the shoreline, although an assessment was also made of the changes in beach. More recently the video monitoring has been carried using CoastalCOMS technology developed by Griffith University and Coastalwatch Pty Ltd.

Remote Video Imaging System

Currently, Coastalwatch has cameras located throughout the Gold Coast including installations on Gold Coast City Council properties and Surf Life Saving Clubs. High mounted cameras are utilised to enable the data capture necessary for the beach monitoring system. Advances in camera and control technology by companies such as Sony Technology now allows robotic cameras to be controlled over data networks to high degrees of accuracy replacing the multiple camera technique used in other systems previously.

The calibration of the robotic camera system is achieved through a custom designed rig that attaches directly to the Sony designed robotic camera housings. This calibration rig allows for the positioning of the robotic camera in the housing exactly as previously installed thus eliminating any errors introduced for incorrect position and eliminating the need for time consuming and difficult calibrations. The CoastalCOMS Sony controlling software platform then gives the user the ability to pan, tilt and zoom to a fraction of degree to the previous preset positions being broadcast. The calibration rig therefore allows you to replace or service a robotic camera without loss of current preset sampling positions. In general, the cameras provide “sweeping” views over the coverage areas and record 3 to 5 days VHS video of information, which is then over-written on the recording system starting with the oldest recorded footage first.

The acquisition of video from each camera occurs every 1 hour from 6am to 6pm and once daily at mean sea level (MSL processed). The video capture at MSL is in five minute periods and data is stored simultaneously from both sites on the Coastalwatch servers located in the Equinix data centre. The video data is recorded in Windows Media 9 format in a beach monitoring archive website directory allowing easy and direct access to all archived video. The live archived data simultaneously allows for real time correlation of information with video data such as: weather stations; tide predictions; wave buoys; Wavewatch III swell forecast model; SWAN model; ANNA Forecasts; and Coastalwatch swell forecasts and surf observations

One of the core functions of the coastal monitoring cameras is to quantify changes in beach width. Shoreline pixel coordinates are determined at a number of fixed transects within the field of view based on hue saturation criteria between the dry sand beach and the water. Pixel coordinates are then translated into real world GPS coordinates through a rectification algorithm. Beach width is then calculated as the perpendicular distance from a fixed point to the shoreline. Along the Gold Coast, the A-line, or boulder wall that spans most of the coast, is used as a fixed geo-reference baseline for determining beach widths. From this, several key data assessments can be made, including:

- A time history of beach width at the various transects
- A plot of beach width variation along the study area at various times
- An envelope of maximum and minimum beach width variation along each beach

Data

Along the Gold Coast, camera stations are positioned to monitor two sections of coastline: the Northern Beaches, between Narrowneck and the Spit; and Palm Beach to the south. Daily shorelines are estimated along 12 km of coastline. The 6-month data set between April – December 2009 is used to analyse beach variability under natural forcing. Data is manually checked for accuracy and images where shoreline positions are inaccurate due to storm conditions (high run-up) or glare are discarded from the analysis. A total of 151 shoreline positions at the Northern Beaches and 157 shoreline positions at Palm Beach were kept. The data is then binned into weekly, monthly, and 6-month average shoreline positions for further analysis.

Hourly wave conditions are recorded by a wave measuring buoy located in a water depth of 18 m at Narrowneck. It is operated jointly by the Queensland Department of Environment and Natural Resources and the Gold Coast City Council. These included significant wave height (H_s), maximum wave height (H_{max}), peak wave period (T_p), mean wave period (T_z), and peak wave direction (D_p).

Over the monitoring period one major storm and two minor storms hit the Gold Coast. From May 18 - 25, 2009, an East Coast Low (ECL) caused significant erosion to the nearshore and dune face along the entire coast. Gale force winds, heavy rain, and dangerous surf closed the beaches during this period. The ECL had a maximum significant wave height of 6.1 m out of the ESE, with peak wave periods growing from 6 s to 13 s by the peak of the storm on May 23. One minor wave event, from June 16-25th, registered H_s in the 2-3 m range (H_{max} ~ 5 m). The beginning of the event registered wave periods of 15 s, dropping to 10 s at the peak of the storm (June 22). Waves were also out of the east during the wave event, exposing most of the coast. The third event was from July 8-14th and registered wave heights (H_s) upwards of 3 m and a maximum wave height of 5 m. Wave period also increased to 15 s during the event, making this event the second most powerful storm of the monitoring term. The inter-storm wave conditions were relatively mild and considered good for beach recovery.

Post-storm Recovery

The majority of the northern beaches underwent erosion during this monitoring period (Figure 1). The East Coast Low in May caused significant shoreline retreat and dune erosion in the area, while two minor storms in June and July prevented a full recovery. Despite this, the area between the Southport SLSC and the Sheraton Mirage recorded shoreline accretion between 5 – 10 m (Figure 1). The area just south; from the artificial surfing reef at Narrowneck to approximately Woodroffe Avenue underwent 10 - 30 m of erosion, suggesting that the May storm may have deposited sand from this area to its northern neighbour. The mean and 5% beach width are fairly uniform for the Northern Gold Coast beaches. The 95% beach width, displays a large variability along the coast (Figure 2). The largest variability between the mean and 95% beach width occurred between the Southport SLSC and the Sheraton Mirage where a large amount of sand was eroded during the May storm (Figure 2).

In April, the area north of the Sheraton Mirage had a very wide beach (95% beach width ~ 150 m) (Figure 2, top) that was subsequently eroded (Figure 2, 2nd panel) during the May event. The May event eroded most of the beach 10 - 50 m, with the exception of the area between Southport SLSC and just south of the Sheraton Mirage that experienced 10 – 20 m of accretion (Figure 2). In June, another event (H_{max} ~ 5 m) caused a further 10 – 15 m of erosion along most of the beach. The exception was an isolated area between Breaker St. and Woodroffe Ave. that experienced 5 - 10 m of accretion. The event effectively removed the sand deposited on the beach north of y ~ 700 m during May, pushing the shoreline back to roughly the previous and current 6 month mean shorelines. Analysis of the beach width envelope (Figure 2) shows the beach width varied throughout June by as much as 75 m and suggests the beach likely did recover somewhat from the May storm prior to the June event. The June beach width envelope also indicates that the area just south of Narrowneck reef (y = -400 m) was particularly sensitive to the June event. The July event had similar wave conditions to the June event, yet beach erosion along most of the beach was less pronounced. This agrees well with the idea that an equilibrium shoreline position relative to wave characteristics exists. The area just south of the reef continues to have a reduced beach width compared to the surrounding area (Figure 2). Mild wave conditions throughout August 2009 provided ideal beach rebuilding conditions. During August 2009, the beach eroded almost back to the A-line at one location, where the minimum beach width (5%) recorded was 15 m at y = -150 m. Continued mild wave conditions during September 2009 caused minimal shoreline change at the northern end of the beach. The area around the Southport SLSC (750 m < y < 1500 m), which underwent large accretion during the May event and mild accretion during August 2009, experienced ~ 10 m of erosion during September 2009, while the area to the south (500 m < y < - 500 m) experienced equivalent accretion. A mild wave event (H_s ~

1.5 m) out of the North may have caused this southerly shift in sand. The beach was fairly stable due to mild wave conditions for September and October 2009 (Figure 2).

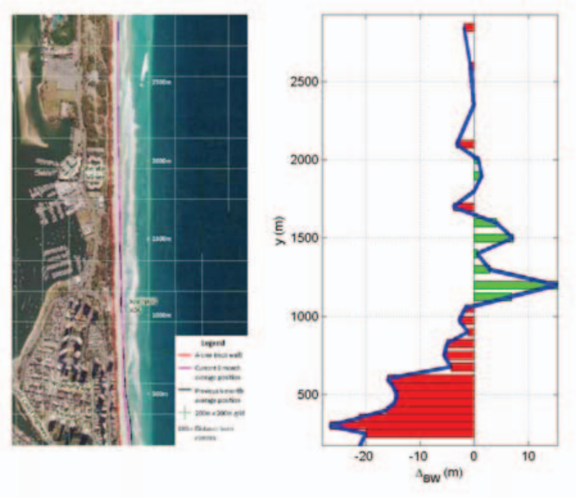

Figure 1. Shoreline and change in beach width for northern end of Northern Gold Coast Beaches. (left) Derived shoreline position. (right) Change in beach width, positive (green) indicates accretion.

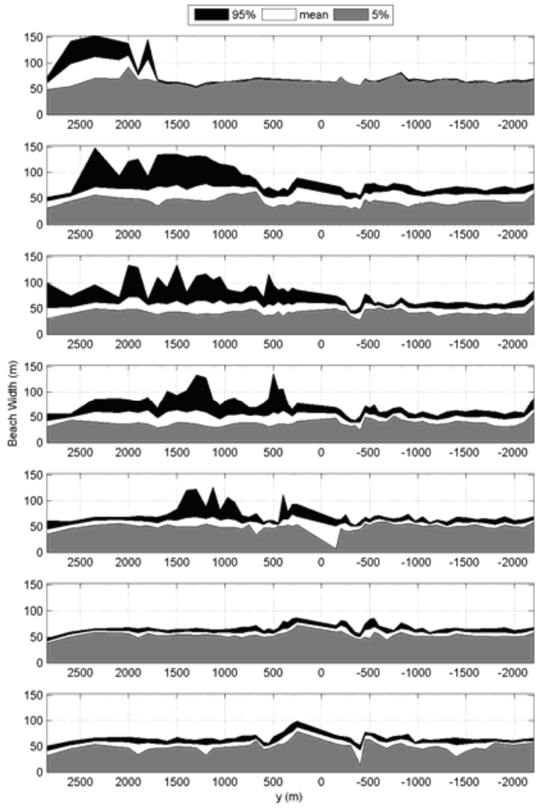

Figure 2. Monthly beach width envelope. Top to bottom: April, May, June, July, August, September, October 2009. April and October are partial month statistics.

Conclusions

The use of video cameras and remote sensing techniques allow for the near continuous monitoring of beach variability along a 12 km stretch of coast that would otherwise be prohibitive using classical survey methods. Shoreline data and derived beach width show large erosion during a May storm event. The subsequent storms exhibit less erosion and may indicate an equilibrium approach to shoreline position with respect to dominant short term wave forcing. The ensuing slow recovery of the beach over the proceeding 6 month period shows the general trend of shoreline position to longer scale wave climates.

References

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