COMPARISON OF OBSERVED AND PREDICTED COASTLINE CHANGES AT THE GOLD COAST ARTIFICIAL (SURFING) REEF

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1. INTRODUCTION

The Gold Coast attracts local, national and international visitors to the beaches of southern Queensland, Australia. The Surfers Paradise beachfront is a focus of development, supporting a range of accommodation, recreational and business infrastructure.

Figure 1. Surfers Paradise, Australia.

Beaches of the eastern Australia coast are typically high energy and dynamic. The Gold Coast beaches experience a net rate of northward littoral drift of approximately 500,000 m^3 of sand per year and regularly experience episodic storm erosion. The management and maintenance of beaches is a high priority for the Gold Coast City Council.

In 1997 the '*Northern Gold Coast Beach Protection Strategy*' was initiated by Gold Coast City Council to maintain and enhance (*i.e.*, widen) the beaches at Surfers Paradise (ICM, 1997). The major engineering components of the Strategy include an initial 1.1 Mm^3 of sand nourishment, additional ongoing sand nourishment of approximately 80,000 m^3 per year, and the construction of a submerged artificial reef structure. Sand nourishment commenced in February 1999 and construction of the reef commenced in August 1999.

This paper presents a comparison and critical assessment of coastline changes that were predicted for the northern Gold Coast during project design, and prototype coastline changes that have been observed to date.

2. GOLD COAST REEF

The principal function of the Gold Coast Reef is to provide a 'control point' to stabilise up-drift sand nourishment and to promote salient growth within its lee. Moderate beach widening is desirable as this will both increase beach amenity and provide a buffer to future storm erosion events.

The Reef is constructed of approximately five hundred 150 – 300 tonne sand-filled geotextile containers stacked in a two-layer configuration. The completed reef extends approximately 350 m alongshore and 600 m offshore, in water depths ranging from 2 m to approximately 11 m.

A pioneering feature of the reef is that its shape and configuration has also been designed to produce a world-class surfing break. In summary, the purpose of the reef is twofold: (1) to stabalise and enhance the beach by promoting beach widening through the maintenance of a shoreline salient; and (2) to enhance local surfing conditions.

3. SALIENT OR TOMBOLO?

Prior to commencement of the sand nourishment and reef construction engineering works, one-line numerical shoreline modelling (Turner et al., 1998a) and a 3-D scale physical model study (Turner et al., 1998b) were completed to assess the likely extent of beach widening that could be anticipated in the lee of the reef. Concurrent to these studies, the final design for the reef and detailed investigations of sedimentation around the reef were also completed (Black et al., 1998; Black, 1998).

Of primary concern was the possibility that the shoreline salient expected to develop in the lee of the reef, may over-widen and connect to the reef, to create a tombolo. On the high littoral drift coastline, the formation of a tombolo could be anticipated to cause extensive down-drift erosion.

4. ONE-LINE NUMERICAL MODELLING

While the reef design was still in the conceptual stage, regional-scale one-line shoreline numerical modelling was completed for a 20 km long stretch of coastline, centred around the proposed location of the reef. The GENESIS model (Hanson and Kraus, 1991) was used to assess the regional-scale impacts of nourishment and reef construction for a range of scenarios.

The northern Gold Coast is a relatively complex stretch of coastline. The engineering features that were included in the simulations included: nourishment along 2 km of the coastline; the submerged reef structure (modelled as an offshore structure exhibiting partial wave transmission); a buried seawall; a major river entrance; an existing sand-bypassing plant at this river entrance; and possible back-passing of sediment from the river entrance to the beach immediately down-drift of the reef (Figure 2).

From the results of multiple simulations and sensitivity analyses, it was concluded that moderate beach widening (30 – 50 m) could be achieved within the lee of the reef, at the cost of relatively limited down-drift erosion, which could be effectively managed by annual nourishment. It was also concluded that the salient that would form in the lee of the reef could be anticipated to assist in extending the design life of sand nourishment of the up-drift beaches (Turner et al., 1998a).

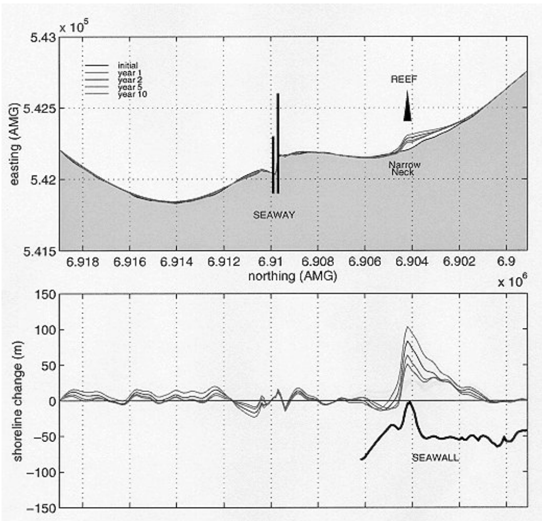

Figure 2. GENESIS simulation of Gold Coast Reef.

5. 3-D SCALE PHYSICAL MODEL

A 1:50 scale physical model of the reef and 800 m of the adjacent coastline was constructed to further investigate the anticipated extent of shoreline adjustment in the lee and immediate vicinity of the reef. A hybrid fixed-bed/sediment-tracer technique was employed, using a light-weight pvc material to examine the new equilibrium shore alignment (Turner et al., 1999).

Following extensive model testing, it was concluded that the formation of a tombolo was not anticipated due to the high degree of wave energy penetration into the lee of the reef. The high transmission of the submerged structure, and strong diffraction and refraction around both the northern and southern flanks of the structure, account for such high penetration of wave energy. Current patterns that developed around the model reef also assisted to limit the potential for over-widening of the beach.

6. COASTAL VIDEO IMAGING

To monitor and quantify the adjustment of the Gold Coast shoreline to the construction of the prototype reef and sand nourishment, a multi-camera ARGUS coastal imaging system (Holman et al., 1993) was installed at an elevation of approximately 100 m above sea level on the 33rd floor of a beach-front apartment building. This automated system is providing hourly-updated images of an approximately 5 km length of coastline. Images from the site are automatically posted to the world-wide web (*www.wrl.unsw.edu.au/coastalimaging*). The images from each of the 4 cameras are merged and geometrical rectified, to provide a 5 km long plan view of the coastline adjacent to the reef (Figure 3). Using digital image processing techniques, the evolving shoreline is mapped on a weekly basis as it adjusts to the reef and sand nourishment. Ongoing analysis is following the progressive adjustment and growth of the shoreline, and it is anticipated this monitoring will continue for an initial period of three years.

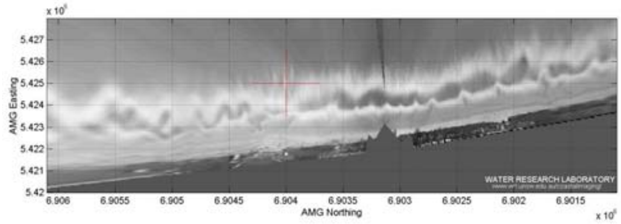

Figure 3. Merged (4 cameras) and rectified image used to map the shoreline along 5 km of the Gold Coast.

7. REFERENCES

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