coastline

Monitoring sand movements along the Adelaide coastline

SOUTH AUSTRALIAN COAST PROTECTION BOARD

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Cover photos show field surveying techniques. Source: SA Ports Corp.

INTRODUCTION

The Adelaide metropolitan beach system, which extends for 28 km from Kingston Park to Outer Harbor, is under continual change in response to natural processes and human impacts (Figure 1). The Coast Protection Board (the Board), through the Coast and Marine Section of the Department for Environment & Heritage (DEH), has monitored the changes that have taken place in beach and offshore sand levels since 1975.

The Adelaide foreshore is highly developed with only a small portion of the original dune system remaining. As a result, the natural movement of sand along the coast has been significantly altered. This, along with natural erosion, has left us with a beach system that needs to be artificially replenished to maintain sandy beaches. The amount of sand needed for beach replenishment is determined by surveying the level of sand on the beaches and calculating the volume needed to maintain the level of the beach.

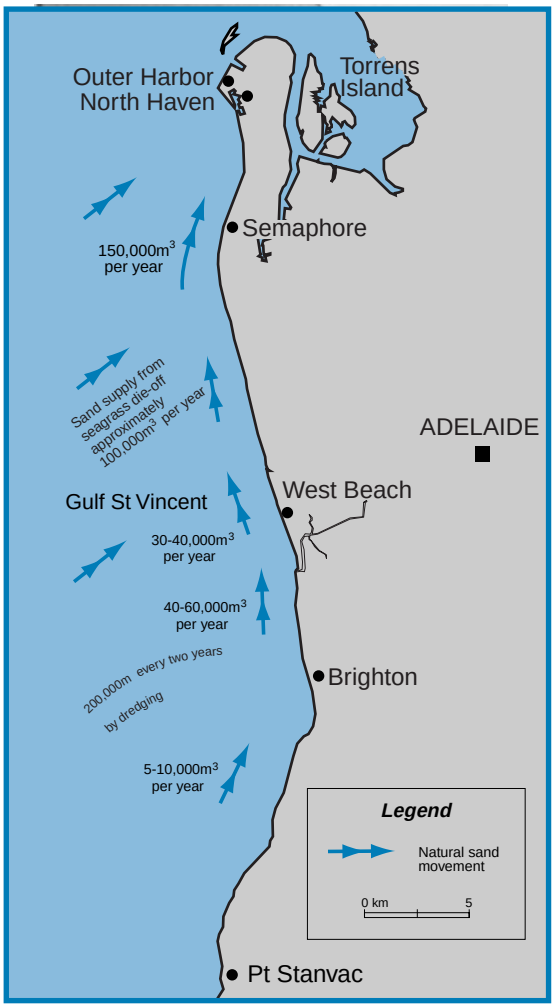

Figure 1 *Metropolitan Adelaide Beach System—sand movements along the coast.*

This issue of *Coastline* discusses the different methods used by the Board in monitoring these sand movements. The information gained from the program assists in identifying management issues and in making decisions on where, when and by how much the metropolitan beaches need to be replenished. The knowledge gained also assists the Board in measuring the effectiveness of replenishment programs and the performance of previous and current management strategies, as well as planning for the long term.

BEACH MONITORING PROGRAM

The Board employs a number of methods for monitoring Adelaide's beach levels including beach profiles, beach surface modelling and the use of sand level rods. Beach pole monitoring and photographic records are also used to complement the information gained from the major surveys.

The Board coordinates and funds the beach monitoring program, with a number of other agencies involved in collecting data, including SA Ports Corp and the Resource Information Group of the Department for Environment and Heritage. The Information and Data Analysis Branch of Planning SA, within the Department for Transport, Urban Planning and The Arts, plays a leading role in the use of Geographic Information Systems (GIS) for interpreting the beach level data and mapping sand movements. The Coast and Marine Section of DEH edits, stores and analyses the monitoring data, and conducts its own minor terrestrial and hydrographic surveys, as well as any monitoring involving scuba diving (Fotheringham, 1997).

BEACH PROFILING

The program to monitor beach profiles commenced in 1975 with a network of 39 profiles. Since then the program has been extended with additional profiles being maintained along the Adelaide beaches (see Figure 2). Profiles are currently resurveyed every two years. The profiles provide information on sand levels for the active beach system, which includes the dune, beach and offshore zones.

Generally, the profiles are spaced approximately one every 500 metres along the Adelaide coast, set at right angles to the beach and surveyed to a distance of approximately one km offshore. More recently, a number of lines have been extended to two and five km offshore with the increasing awareness that changes in offshore

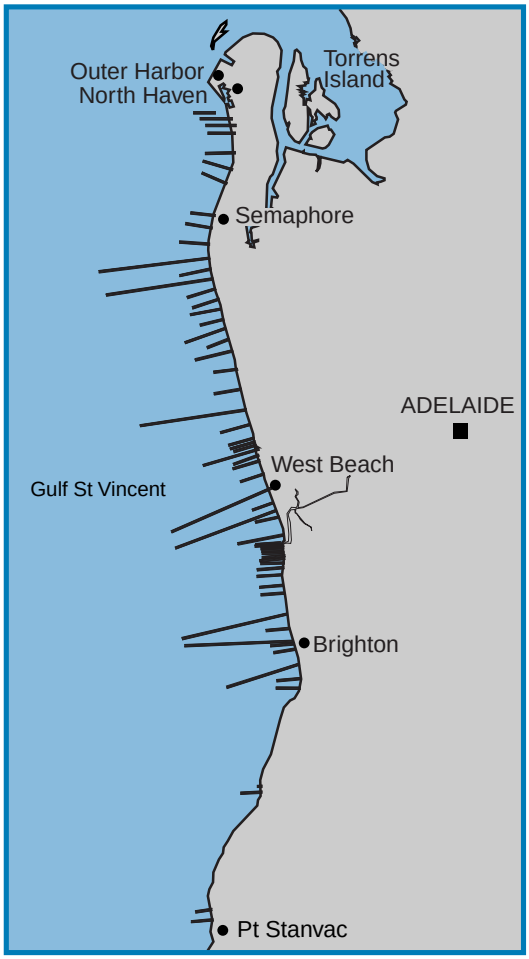

Figure 2 *Metropolitan Adelaide beach profile locations. Source: Information and Data Analysis Branch, Planning SA.*

areas can have a direct impact on sand management. Permanent survey markers (PMs) have been established at each site along the foreshore. These PMs are connected to

Figure 3 *Beach Profiling.*

the State survey grid with a record of their elevation and geographic position. The Australian Height Datum (AHD) is used for elevation measures and the Geocentric Datum of Australia for position.

The beach profile surveying methodology has remained largely unchanged, although new age electronic survey instruments and new technology have simplified measurements. Electronic distance measurers replaced optical theodolites and electronic data recorders replaced handwritten field books, as featured in Figure 3 (Fotheringham & Goodwins, 1990). When the monitoring program commenced, land detail and near shore areas were surveyed on foot and by wading shallower waters, using a level and measuring tapes; this progressed to the use of a prism with a known height and electronic instruments. The offshore areas were then measured by a single frequency echo sounder on a boat. Now, instead of a shore-based surveying instrument, a Global Positioning

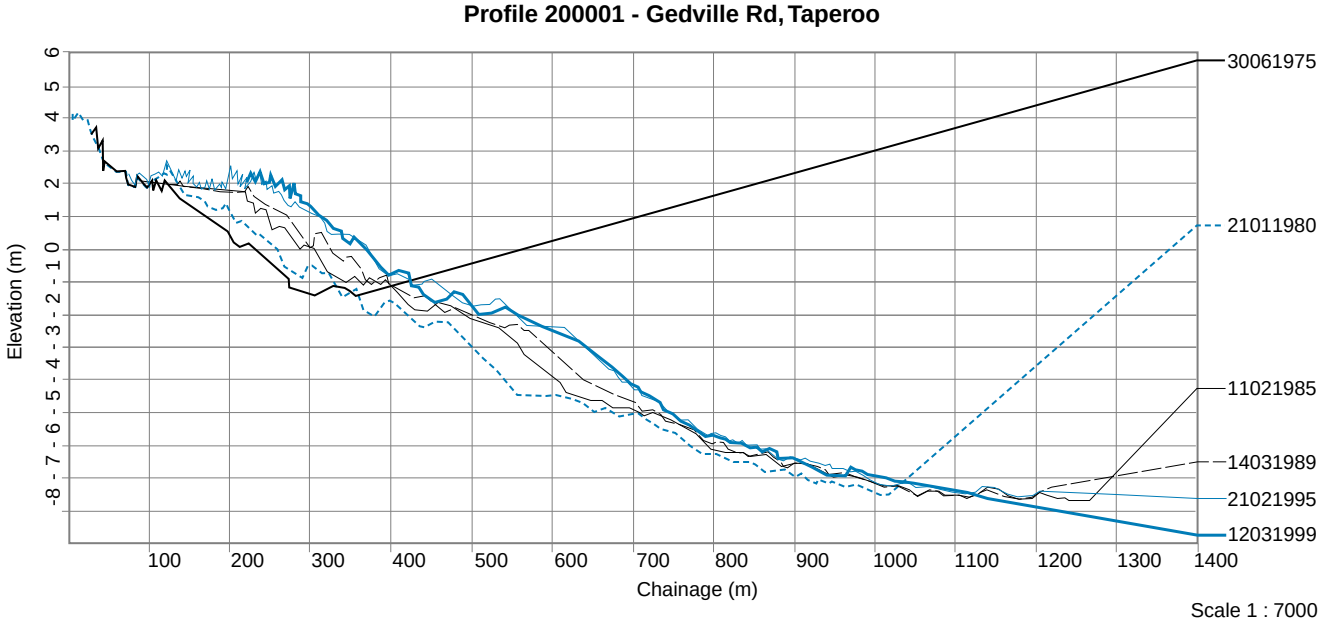

Figure 4 *Profile Plot*

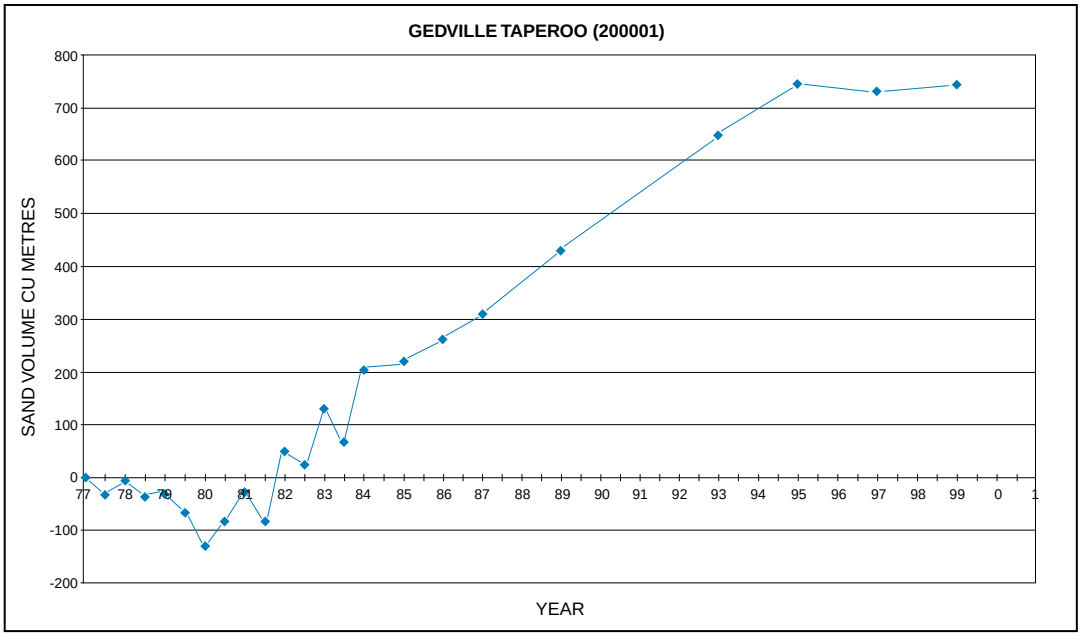

Figure 5 *Volume change at profile 200001 compared with 1977.*

System (GPS) is used to survey on-shore and to determine the boat position. Various checks and measures are incorporated into the surveys to take account of tidal movement and waves.

The beach profile surveys give an indication of trends in beach sand loss or gain for each profile over time. The beach shape is also plotted on a graph to show which section of the beach the sand moves in over the years of survey. Figure 4 shows an example of a plot of profile 200001 located at Gedville Road, Taperoo, where sand is accumulating. Elevations are in Australian Height Datum and measurements in metres. The graph highlights the zone of most active sand level change between 150 and 700 m chainage (distance) over the period from 1975 to 1999.

The sand volumes are calculated for each profile and then graphed over time to determine any trends. Figure 5 shows the substantial increase in sand volume that has occurred at profile 200001, since 1977.

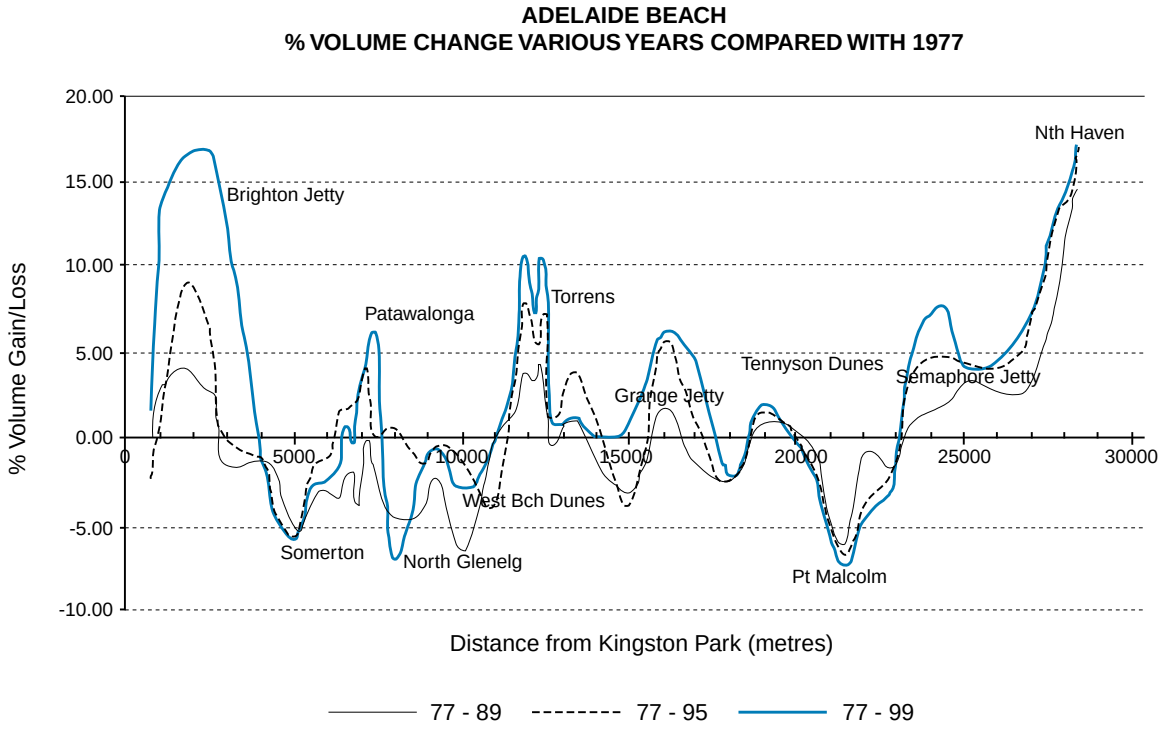

Figure 6 *State of the Adelaide Beach. Sand volume change (cubic metres) in 1989, 1995 and 1999 relative to 1977.*

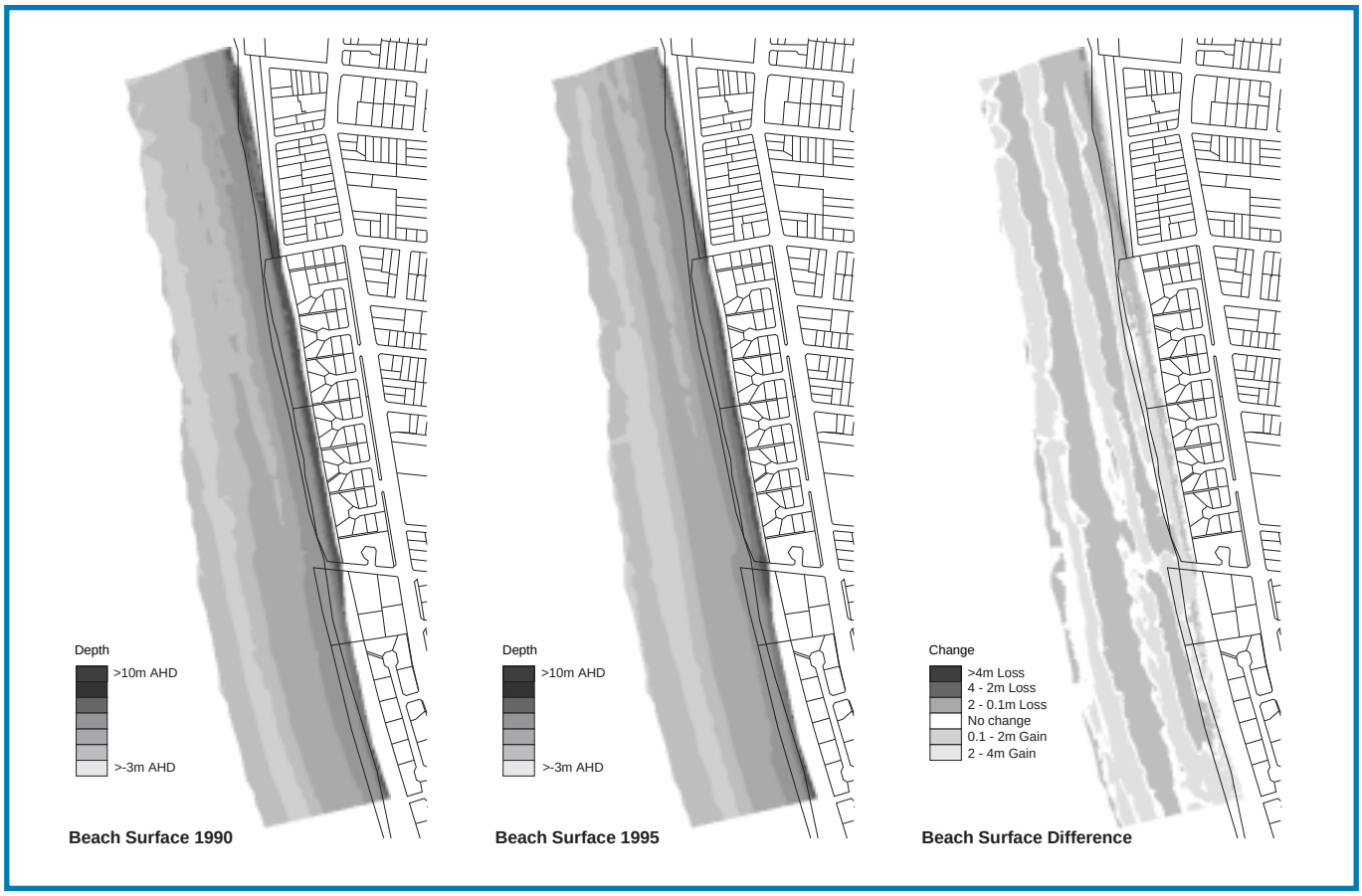

Figure 7 *Before, after and difference maps.*

Sand volume changes for all profile locations have been incorporated in a single chart to give an estimate of the general state of the Adelaide beach. Figure 6 shows a general increase in sand volume at Brighton Jetty, Patawalonga, Torrens Outlet, Grange Jetty and Semaphore Jetty and a decrease in sand volume at North Glenelg and at Pt Malcolm, since 1977.

BEACH SURFACE MODELLING

The profile network remains a useful management tool for indicating trends in sand movements at specific locations. However, advances in technology and data processing have provided the opportunity to explore new ways for monitoring the beach system more intensively. As a result, a method known as beach surface modelling was established in 1989. This method has become the major monitoring tool for beach protection and is used to closely monitor problem areas and major beach replenishment projects. The method is described by Fotheringham and Goodwins (1990), and Noyce and Fotheringham (1997). Refer to reference list for details.

To prepare the beach surface models, hydrographic, terrestrial and photogrammetry techniques are combined over the study area to create a dense grid of surface points, each with geographical position and elevation details. A GIS is then used to create a surface model. In 1990 the entire Adelaide beach system, from Kingston Park to Outer Harbour, was surveyed to a distance of three km offshore, providing the baseline data to which future surveys can be compared (Fotheringham, 1997).

When the model area is resurveyed, one surface model can be subtracted from the other to produce a surface difference contour map (see Figure 7). For example, the difference map highlights areas of sand loss or gain, both onshore and offshore, that have taken place between 1990 and 1995. Accretion and erosion areas are coded using a gradational shading scheme representing increasing levels of beach surface change in AHD metres. Calculation of volume changes is also improved using this method (Noyce & Fotheringham 1997).

Hard copy maps representing a complete time series for problem areas or specific replenishment sites are analysed by the Coast and Marine Section (DEH). This method is particularly useful in determining the requirements for beach replenishment, in tracking the movement of

replenished sand, and in monitoring the effects of dredging on sites where sand has been removed to replenish other areas of coastline.

Approximately 50% of the beach system is now regularly surveyed using this method. Changes in foreshore position can also be determined using this monitoring method, to highlight areas where there has been foreshore retreat (Noyce & Fotheringham, 1997).

As with beach profile monitoring, sand surface modelling survey techniques are becoming less field intensive and more refined as new technology arises. A GPS is now used to measure boat position and height, which helps to eliminate errors due to tidal movement. The terrestrial component is now surveyed with a GPS mounted on a four-wheel motor bike instead of the labour-intensive method carried out on foot (as shown by the front cover photo).

Figure 8 *Diver measuring sand level rod.*

SAND LEVEL RODS SURVEY PROGRAM

Brass sand level rods were installed in 1987 to monitor seabed changes in offshore areas. The top of the rod is used as a datum to measure seabed height changes. Rods have been installed along 16 profiles between 350 and 2000 metres offshore.

Rods are spaced 25 m apart, for the first 1000 m, then 50 m apart further offshore. The rods have a known position and are located using a GPS by boat. Divers then locate the rods underwater by compass and measure the rod heights as shown in Figure 8. These rod lines are measured annually and compared with data from other survey methods. Rod measurements have confirmed seabed deepening along parts of the Adelaide Beach. This has been attributed to the extensive loss of seagrass that has occurred as a result of long-term water quality changes, primarily due to effluent and storm water discharge. Although this trend is apparent from the beach profile data, sand level rods provide a more precise measure of seabed depth changes.

The loss of seagrass along the Adelaide beach is a major concern for the Board. The offshore seabed deepening affects nearshore wave climate and sand transport rates. With offshore areas deepening, the nearshore wave energy will increase, with the likelihood that storms will have a greater effect on the movement of sand along the coast. The loss of sand from offshore areas has also produced a supply of sand to the beach which will eventually dwindle, with consequences for beach management (Fotheringham, 1997).

BEACH POLE SURVEYS

Beach poles, consisting of galvanised metal poles with height calibrations, have been installed at several locations to enable community involvement in the monitoring of beach sand levels. They provide limited information, but

Figure 9 *Beach pole.*

are easily measured and have been valuable in detecting trends. Beach pole data is particularly useful when the poles are located on profile lines as they can be used to complement the profile data.

Figure 10a *Brighton beach 1982*

PHOTOGRAPHIC RECORD

The Board has maintained a photographic record of changes that have taken place along the Adelaide Beach over time. Aerial, ground and underwater photography provides a valuable tool for measuring coastal change. Photos are taken to supplement the beach profile, sand surface modelling and sand level rod surveys. Figures 10a and 10b show changes that have been taking place at Brighton, as a result of beach replenishment.

INTEGRATING BEACH MONITORING DATA

The data from the different monitoring methods can be integrated to improve the overall picture of the changes that are taking place along the Adelaide beach. As described earlier, beach profile data extend back to 1975, while modelling data have only been collected since 1989. The use of GIS has greatly assisted the integration of monitoring systems. For example, beach profile data can be overlayed on surface difference maps and used to check the accuracy of beach surface change mapping, and in determining whether certain trends have existed over long or short time periods (Fotheringham & Goodwins, 1990; and Noyce & Fotheringham, 1997).

As discussed previously, the loss of seagrass has resulted in a deepening of the seabed. Seagrass loss in shallow waters can be detected from aerial photographs. It is possible to compare sand volume losses with

Figure 10b *Brighton beach 2000*

corresponding areas of seagrass loss by overlaying surface model difference maps onto aerial photographs as shown in Figure 11. Profile lines and sand level rod locations are also shown. From this, it may be possible to anticipate where further sand depletion may occur in response to seagrass loss.

CONCLUSION

Effective management of the Adelaide beaches has been greatly assisted through monitoring sand movements along the coastline. In monitoring these changes, the response of the Adelaide beach system to seasonal weather patterns and storm events is well understood (Fotheringham & Goodwins, 1990). Furthermore, long-term trends have become evident, providing a basis for designing beach replenishment programs.

Advances in survey technology have greatly increased the efficiency of data capture, and advances in GIS technology have enabled greater integration of monitoring data, providing an increasingly important tool for monitoring the state of our beaches.

Monitoring will continue to play an essential role in maintaining beach levels, in providing for amenity,

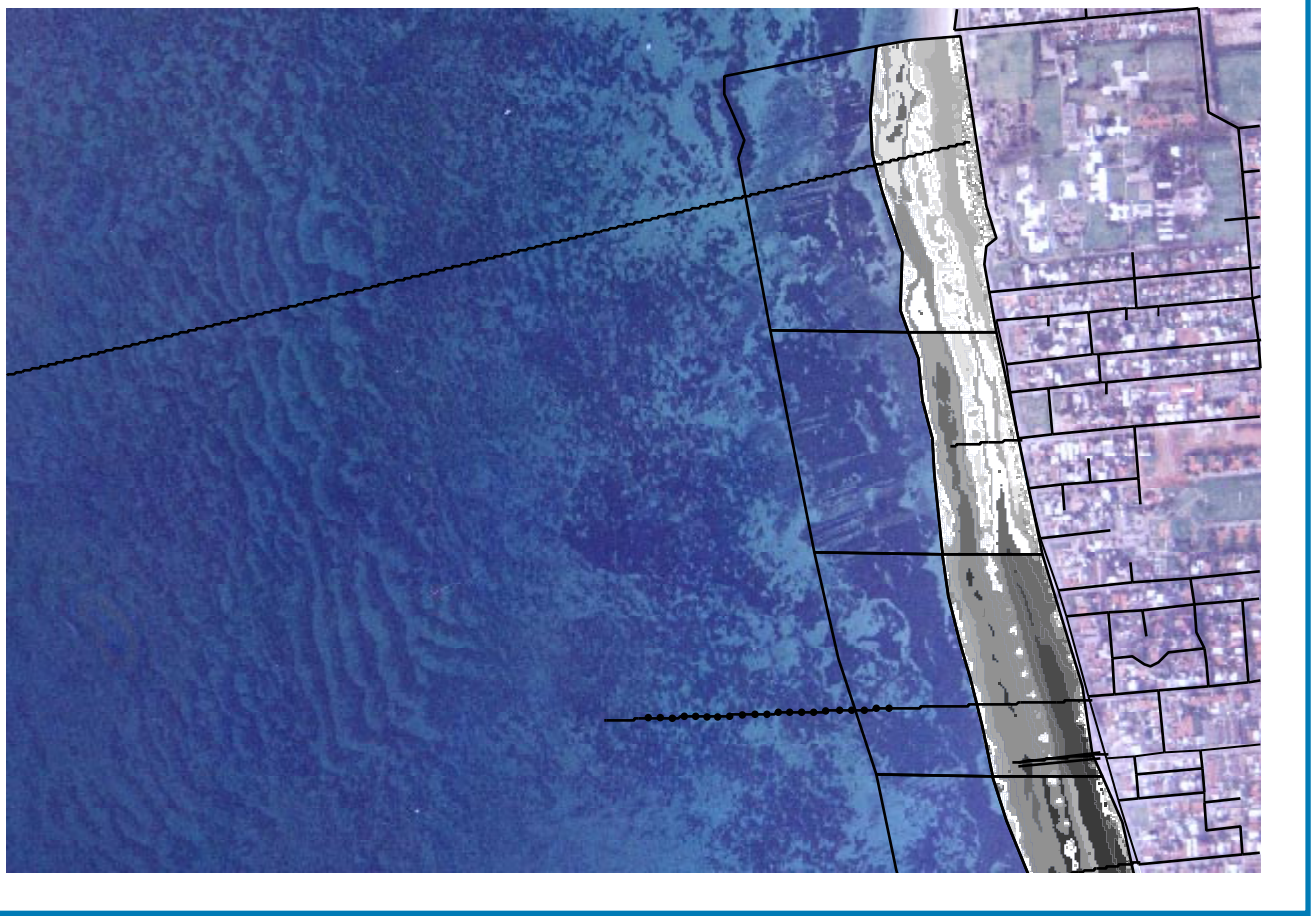

Figure 11 *Integrating modelling data using GIS.*
Source: Information and Data Analysis Branch, Planning SA.

recreation and the protection of the Adelaide foreshore, as well as in planning for the long-term management of our beaches.

For further information, contact the Coast and Marine Section, EPA, Department for Environment and Heritage. Ph 8204 2000; fax 8204 1806; or visit our web site: www.coasts.sa.gov.au

All photos/diagrams are courtesy of the Coast and Marine Section unless stated otherwise.

Environment Protection Agency
Government of South Australia
EPA

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