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LANO BEACH SHORELINE ANALYSIS

Aerial photographs were obtained for Lano from MNRE Technical Services for 1954 (1:18,000 scale) and 1999 (1:10,000 scale). Additional satellite imagery was obtained from DigitalGlobe for 2004, 2011 and 2015. This imagery was georeferenced to a consistent geographical location using geological and anthropogenic control such as rock outcrops, bridges and houses. Shorelines were then digitised using the vegetation-front as indicator, this being normal practice when using such data for shoreline analysis. Allowance was made for overhanging vegetation by interpolating between adjacent overhang-free locations. Other short-term irregularities were removed by shoreline smoothing across 50 m in the longshore direction. The detected shoreline accuracy (including georeferencing errors) is estimated to range between +/- 2 m and +/- 5 m. Historical imagery with superimposed digitised shorelines are overlaid upon the January 2015 satellite image in Figure 1. The measurement transects are marked 1 to 6, these sections being chosen to represent variation in coastal setting observed to occur within the area of interest. The shoreline time-series are depicted in the 6 graphs shown in Figure 2. Note these graphs all have the same horizontal and vertical scales enabling direct comparison when inspecting. The rate of change analysis (average annual change) for the 1954 to 2015 period, and also for the more recent 1999 to 2015 period, were determined using linear regression modelling. The derived values for each site, together with the corresponding net shoreline change distance for the two time spans, are listed in Table 1. The probability of the derived rates of change being statistically valid (80% likelihood) were calculated and are identified by the green highlighting in Table 1.

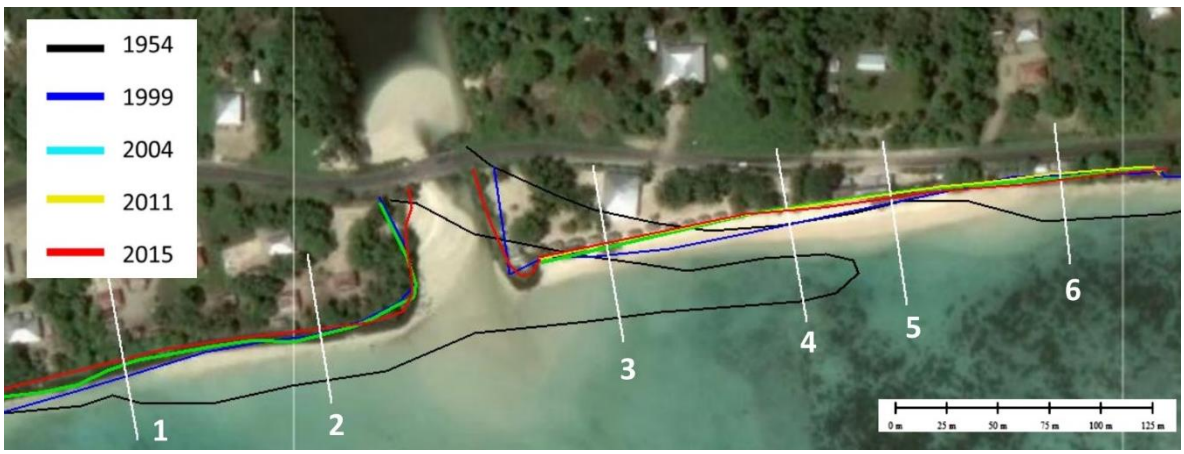

Figure 1 *Historical shorelines overlaid upon the January 2015 satellite image. White lines locate measurement transects for Sections 1 to 6.*

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The results in Table 1 and Figure 2 show longer term (1954 to 2015) shoreline erosion characterises the southern side of the inlet (Sections 1 and 2 which had 21.4 and 25.6 m of retreat respectively), and again at the far right of study area (Section 6 with 22 m of retreat). This contrasts with the central Sections (3 to 5) on the northern side of the inlet with Section 3 accreting 17.1 m and Sections 4 and 5 having smaller retreat values of 7.3 and 4.3 m respectively. The shorter term results (1999 to 2015) are generally characterised by erosion but only Sections 1 and 3 (7.2 and 5.6 m of erosion respectively) were statistically significant).

Lano's shorelines have undergone considerable, and contrasting, change and this warrants further comment. The area has been increasingly controlled by structures. Firstly, a river training wall evident in the 1999 aerial photo ensured the flow entered the sea at right angles rather than its previous northerly directed offset. The original inlet resulted in a spit with the southern shoreline being relatively further seaward (than after the inlet change) and the northern shoreline (on the landward side of the spit and stream) being forced landward through Sections 3 to 5 with this effect lessening at Section 6 (see Figure 1). Note that the original inlet configuration's effect on the southern shoreline appears to have ceased just beyond Section 1. After the outlet was controlled and forced directly seaward, the southern shoreline eroded and a seawall was constructed prior to 2011. On the northern side of the inlet, the old streambed infilled thus adjusting the shoreline at Section 3 seaward some 21 m. However, erosion then occurred (Figure 2) which lessen to the north, and this erosion has been controlled by seawalls, again being constructed prior to the time of the 2011 aerial photography.

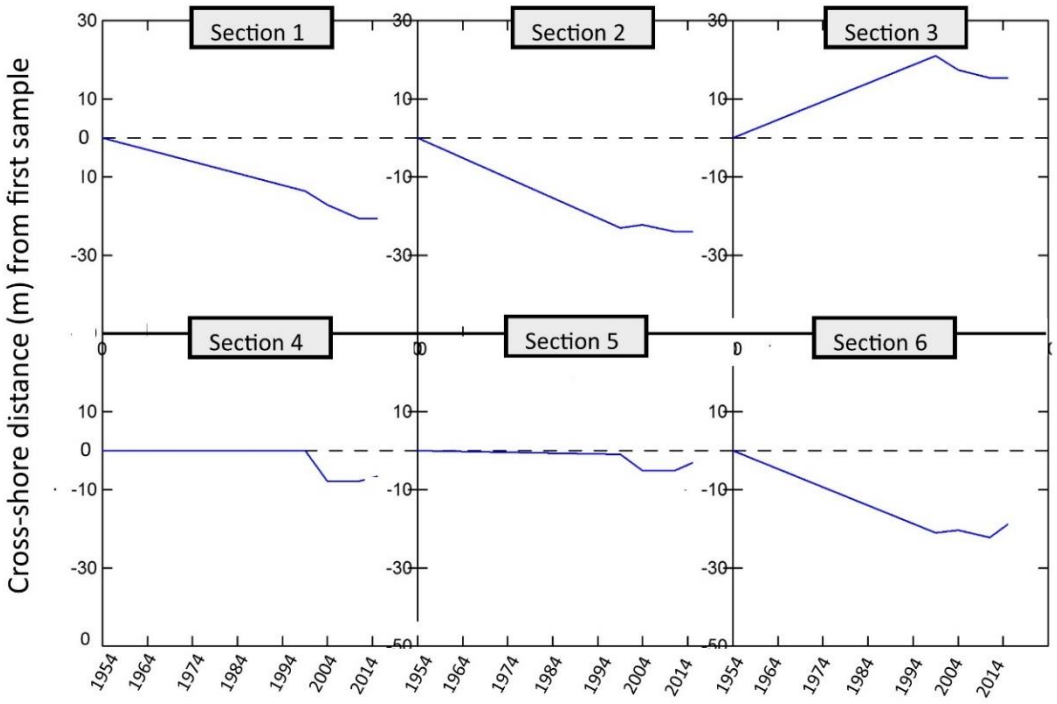

Figure 2 Shoreline time-series for the 6 sectional transects marked in Figure 1. The distance and time origins are from the first (1954) sample. Negative values relate to erosion (shoreline retreat) and positive to accretion (shoreline advance).

Table 1 Shoreline net change and average annual (rate of) change for the 6 measurement sites at Lano

Section	1954 to 2015		1999 to 2015	
	Net Change (m)	Rate (m/yr)	Net Change (m)	Rate (m/yr)
1	-21.4	-0.35	-7.2	-.045
2	-25.6	-0.42	-1.4	-0.09
3	17.1	+0.28	-5.6	-0.35
4	-7.3	-0.12	-5.8	-0.36
5	-4.3	-0.07	-1.9	-0.12
6	-22.0	-0.36	+1.0	+0.06

Note: Green highlighted values refer to statistically significant rates of change at the 80% level, i.e. $p < 0.2$.

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