Antalya Kemer Sarioren Stream, Longshore Transport Model

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Abstract

Whether natural occurrence of a beach takes thousands of years, it takes a few years to totally erode it by mismanaged use of humanbeing. Beaches are important for tourism and human settlements. In this study, a part of Çamyuva Beach located on the south of Kemer district of Antalya Province has been modelled to forecast of coastal line change after construction of a groin structure for prevention of closure of stream mouth. Çamyuva beach is 5 km in length. The model results show that, the closure can be prevented by construction of a 30 m groin.

1. Introduction

The coastal zones are dynamic places that host many sectors and uses. Beaches, as a precious part of coastal zones, are critical habitats and highly demanded. Tourism is an important sector for Antalya, and for the study area, Çamyuva. Antalya is a popular tourist destination. Between years 2012 to 2015, an average of 10 million foreigner per year visited Antalya region, while domestic visitor counts are around 450000 [1]. Almost one quarter of the tourists of Antalya accommodate in Kemer Region [2]. In 1991, Çamyuva takes place on 1/25.000 scale of South West Antalya Tourism Development Plan and reported as one of the "Tourism Development Sites" [3]. According to Onur et al. [4] between years 1975 to 2006, population of Kemer was increased from 6000 to 83000. In the same study, the change of urban settlements increased from 1 ha in 1975 to 462 ha in 1987. The highway opened in 1980s increased the urban growth and tourism settlements in Kemer. The urban settlement increased between 1987 to 1995 and 1995 to 2003 is given as 159 % and 44% respectively [4]. All these changes show that, the stresses on beaches, where all these settlements are somehow related with tourism and coast, are increased every year by many times.

The protection of hinterland of coasts is highly dependent on beaches and their sustainable uses. There are many example of coastal destruction and erosion related to traditional management efforts not integrated with science and knowledge.

Çamyuva is a sandy beach given in Figure 1. The sediment particle size of the study area is gravel (~30%) and sand (70%). The D_{60} and D_{10} particle size is 1.8 and 0.6 mm respectively. The width of the beach is between 45-70 m. The width of the southern parts is around 25 m.

Major climate type is Mediterranean climate, having hot, dry summers and cool, wet winters.
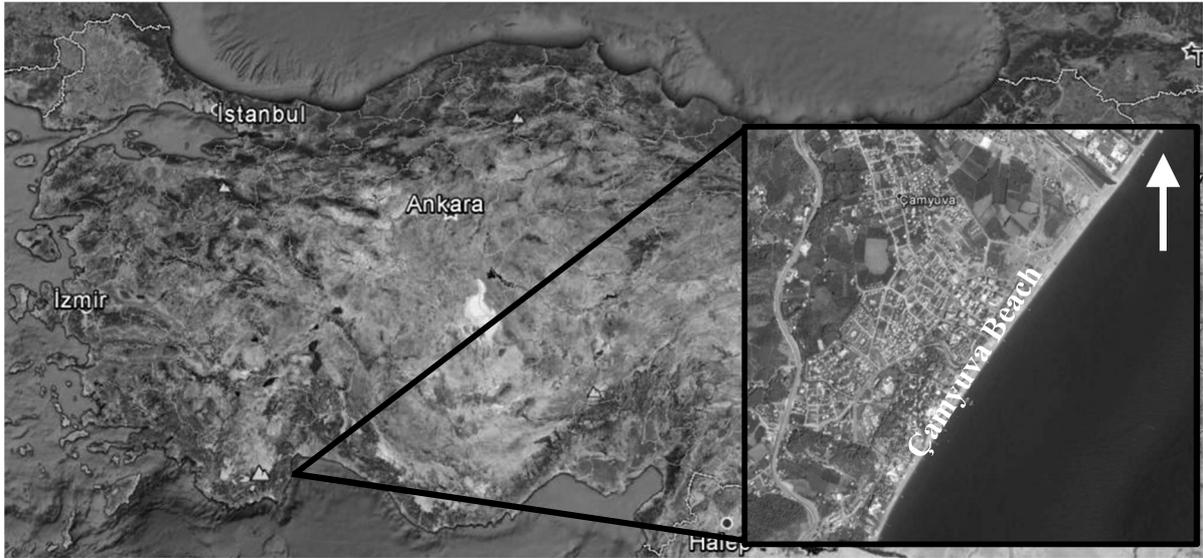
Fig. 1. Study area

2. Methodology

In this study, first of all, the regional wave climate was studied and wave parameters were prepared. After climatic parameters, the bathymetry of the region was prepared.

2.1 Determination of Wave Climate

The representative station given by "Coast Wind and Deep Water Wave Atlas, 1999" [5] of NATO TU-WAVES Project is 36.50^{o} N, 30.70^{o} E. The wind rose of the region is given in Figure 2. The dominant wave direction considering coast layout lead to erosion is between south and east. By using wave rose, the wave frequencies are calculated. The frequencies are used in calculation of wave hours. According to the Atlas [5], averages of the monthly maximums are in between 1m and 3 m (Figure 3). The relation between wave heights and wave periods of the region is given in Figure 4.
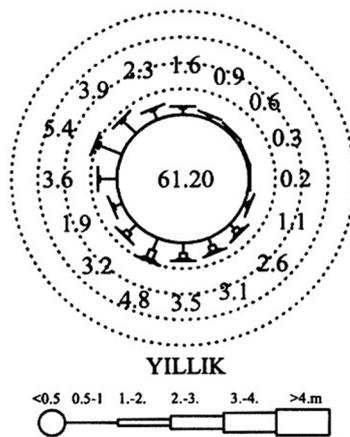
Fig. 2. Yearly wave rose at 36.50^{o} N, 30.70^{o} E coordinates of the Atlas (Özhan ve Abdalla, 1999)
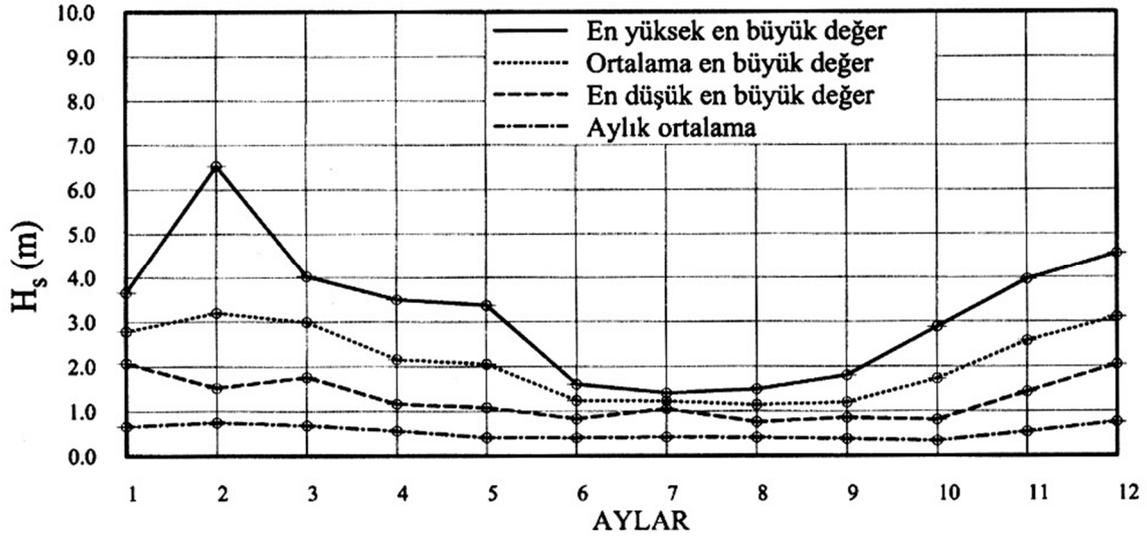
Fig. 3: Monthly average and maximum wave heights of 36.50^o N, 30.70^o E coordinates of the Atlas [5]
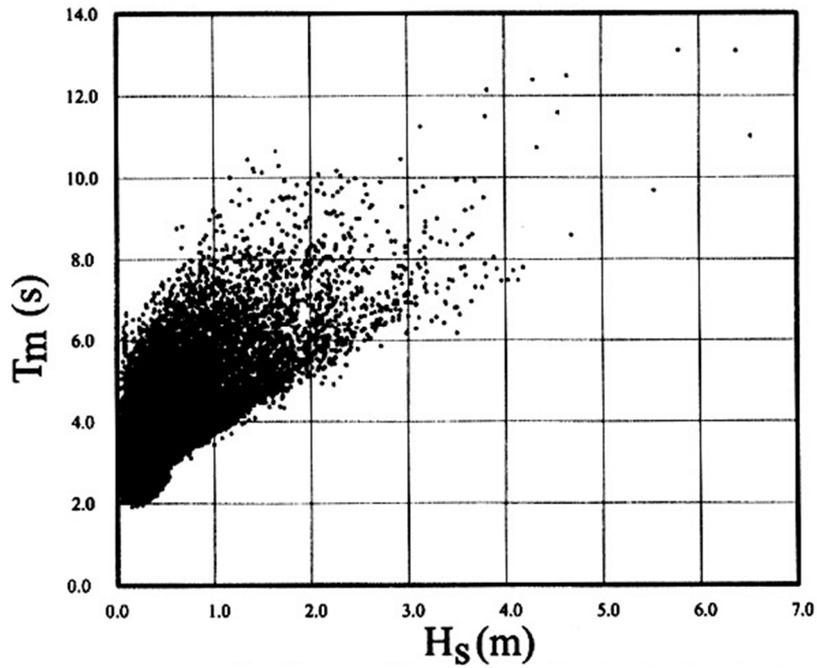
Fig. 4. Relation between wave height and wave period of 36.50^o N, 30.70^o E coordinates of the Atlas [5]

2.2. Numerical Modelling

The coastal change after construction of the groins are examined with the model. In the study, "one dimensional shoreline change model" GENESIS is used [6, 7, 8, 9, 10, 11].

For every time step ΔT and individual grid ΔX, the longshore currents driven by broken waves are calculated. The current velocity of the next time step is determined by using the boundary conditions and calculated former step current velocities. Simulation is executed for all time steps. After simulation completed, the transported sediment volume can be obtained.

3. Model application

In order to model the study area, the bathymetry of the region is digitized by using the maps of Office of Navigation, Hydrography and Oceanography [12]. The bathymetry is given in Figure 5. Bathymetry data is used for obtaining mesh (Figure 6). The bathymetry is also used for wave transformation which carry wave from deeper water to an arbitrary shallower water depth. Wave lead to sediment transport is between south and east. The transformed wave data is given in Figure 7.

Fig. 5. Bathymetry of the study area [12]

Fig. 6. Model mesh

Fig. 7. Wave direction vs wave height, number of occurrences.

3.1. One Dimensional Sediment Transport Model

Initial shoreline, bathymetry and wave data is used in one dimensional model (Figure 6).Calculated yearly wave hours are applied to the model. Yearly shoreline changes are obtained by model. Simulation is performed for six years. The effective grain size is taken from sieve analysis of the region, and D_{10} value is used in the model. The berm height and closure depth is taken as 2m and 8m respectively. K_1 and K_2 constants are taken as 0.4 and 0.2 respectively. The groin settlement is given in Figure 8. The sea depth of groin are ~0.65 meter. The initial shoreline and groin settlement of model is given in Figure 9.
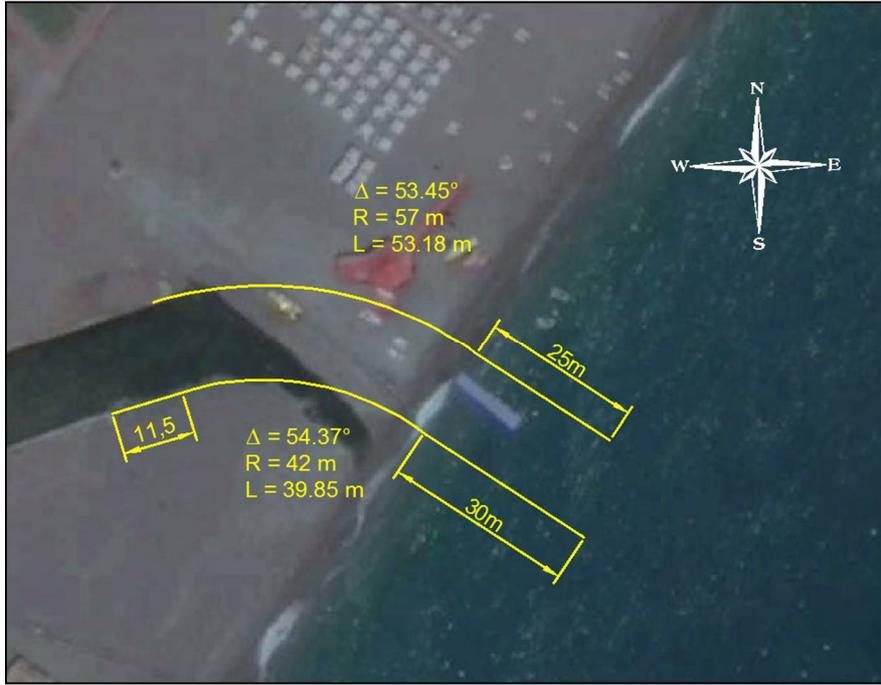
Fig. 8. Groin settlements of the Sarioren Stream mouth [13]
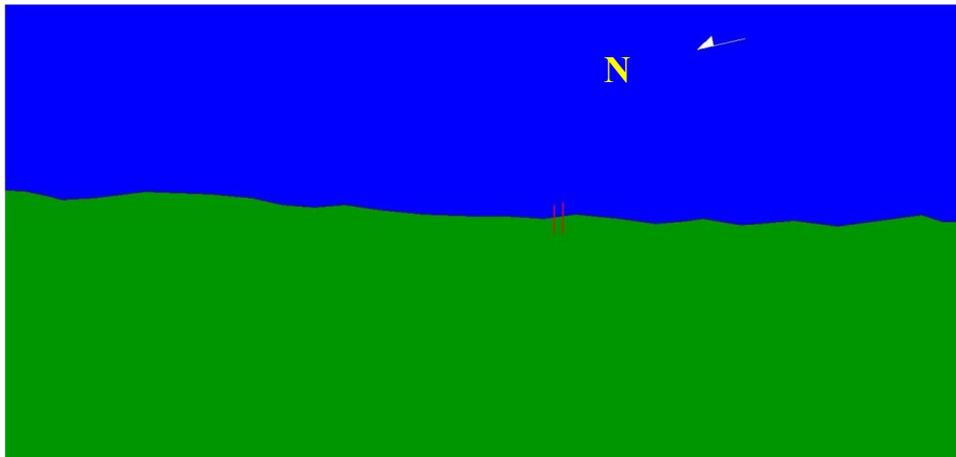
Fig. 9. Groin settlements and initial shoreline of the model

The net sediment transport direction is approximately south to north. The forecasted shoreline after 1st year of construction show that (Figure 10) the northerly waves are resulted in slight sediment deposition (7-10m) in the north site of the groin structures. The south side of the structures show 10 to 13 m erosion under the influence of northerly waves. The influence of southerly waves show that (Figure 11) there will be 8 m and 10m deposition and erosion in south and north of groins respectively. At the end of whole year period, there will be no significant shoreline change (Figure 12). After 2nd year simulation, the changes over shoreline are the same as first year (Figure 13 and Figure 14). The 6 year simulation shows that the groin structures are not resulted in deposition of the stream mouth (Figure 15 to Figure 19).

The sediment transport rates are given in Figure 20. The longshore sediment transport of the region is 186,836 m^3/year from SSW to NNE, and 54,889 m^3/year from NNE to SSW. The net transport direction is from SSW to NNE.

Fig. 10. Forecasted shoreline under the influence of northerly waves (1st Year)
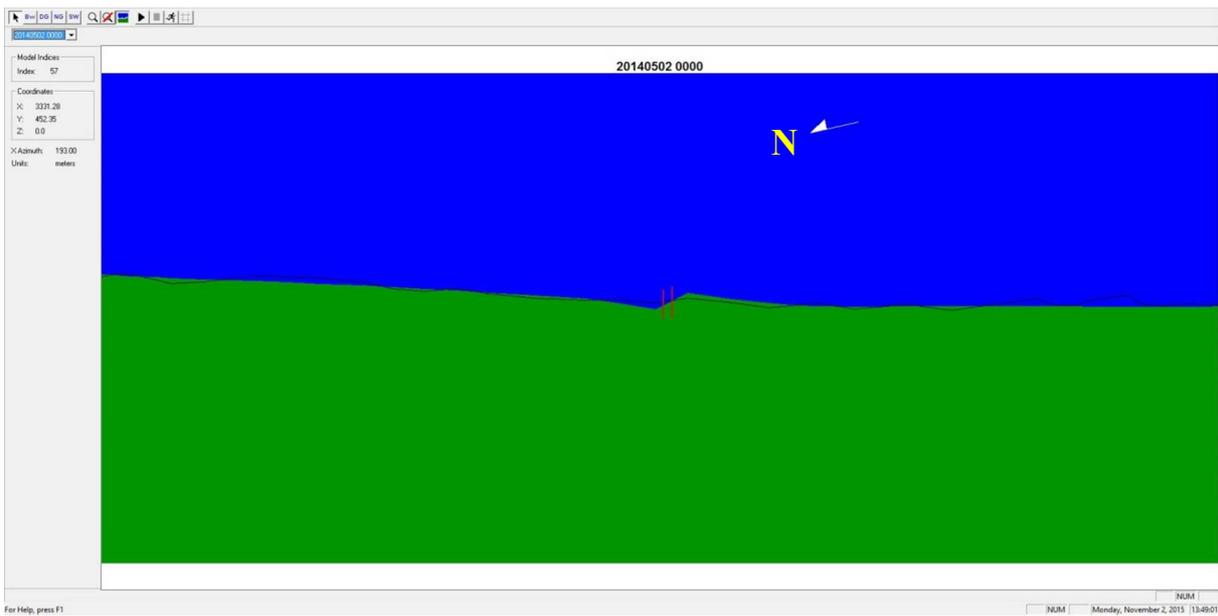
Fig. 11. Forecasted shoreline under the influence of southerly waves (1st Year)

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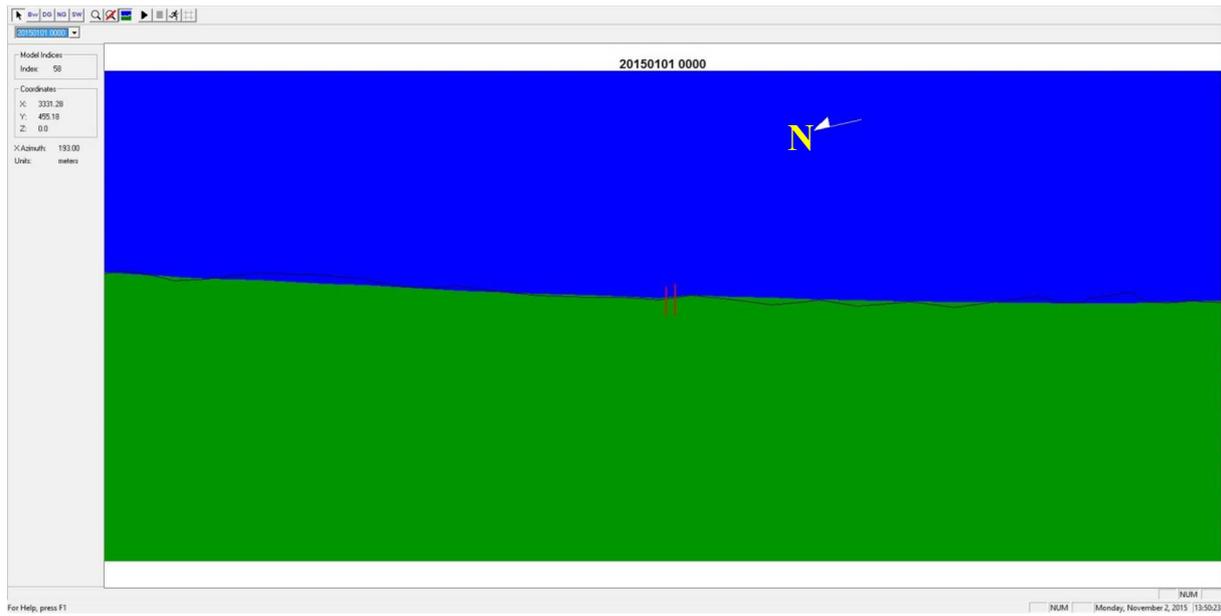
Fig. 12. 1st Year shoreline change forecast
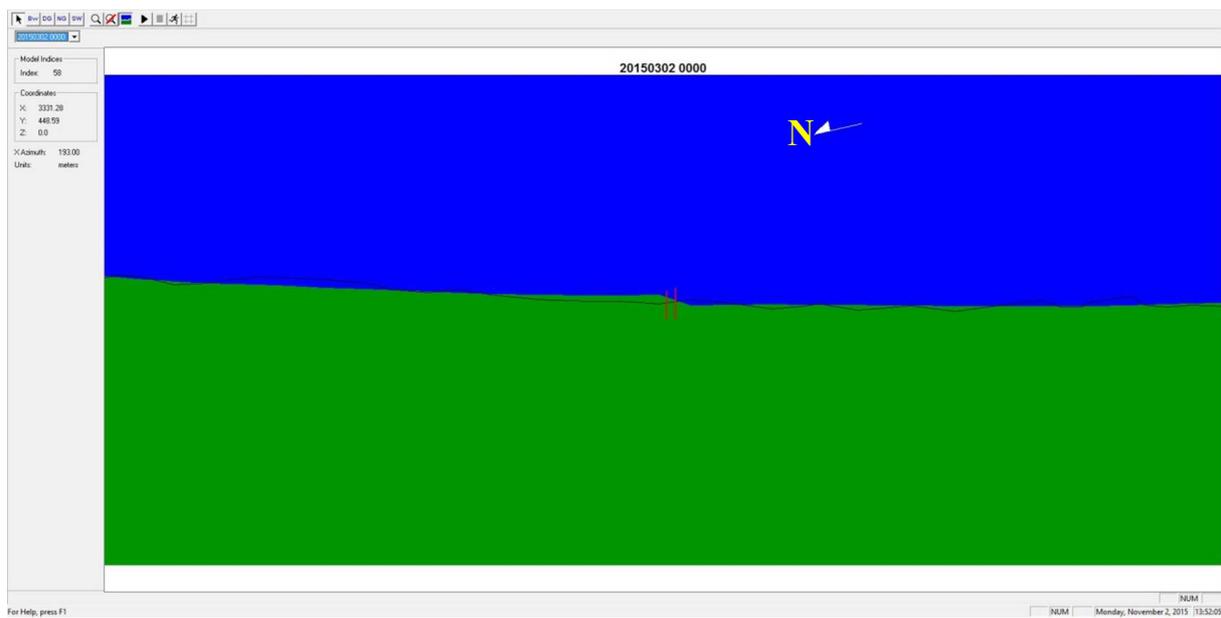
Fig. 13. Forecasted shoreline under the influence of northerly waves (2nd Year)
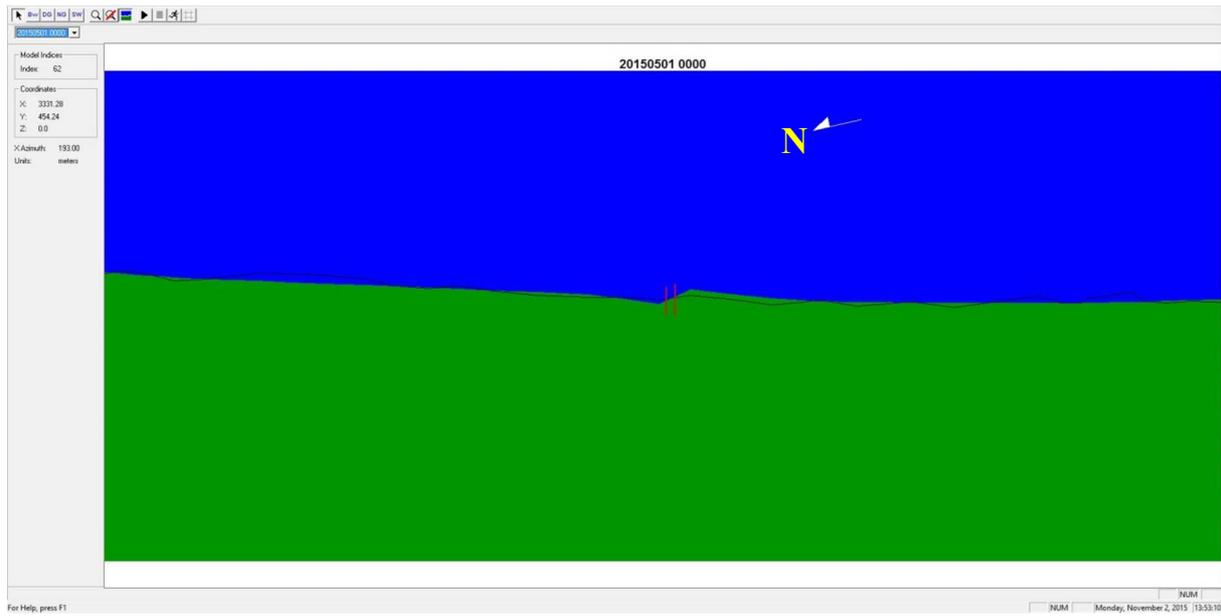
Fig. 14. Forecasted shoreline under the influence of southerly waves (2nd Year)
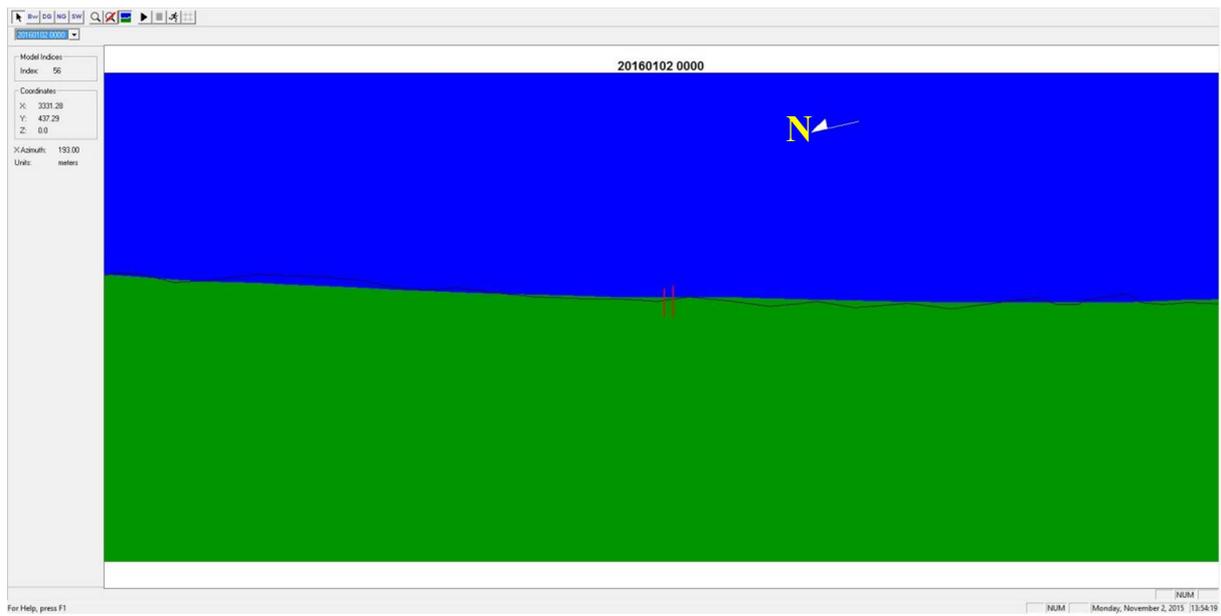
Fig. 15. 2nd Year shoreline change forecast
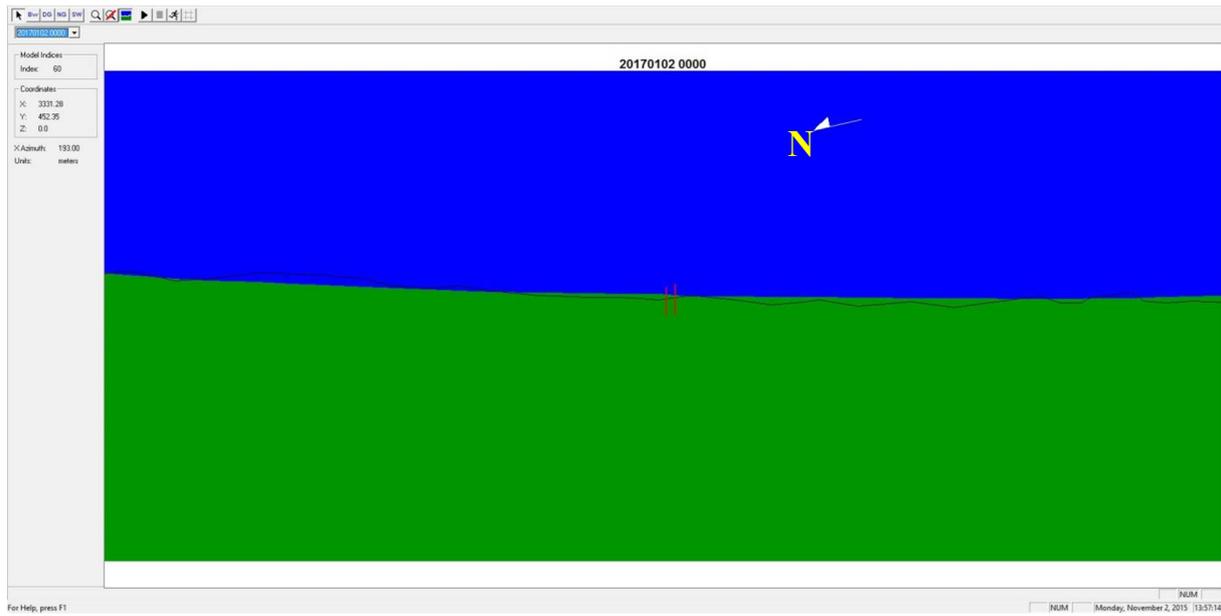
Fig. 16. 3rd Year shoreline change forecast
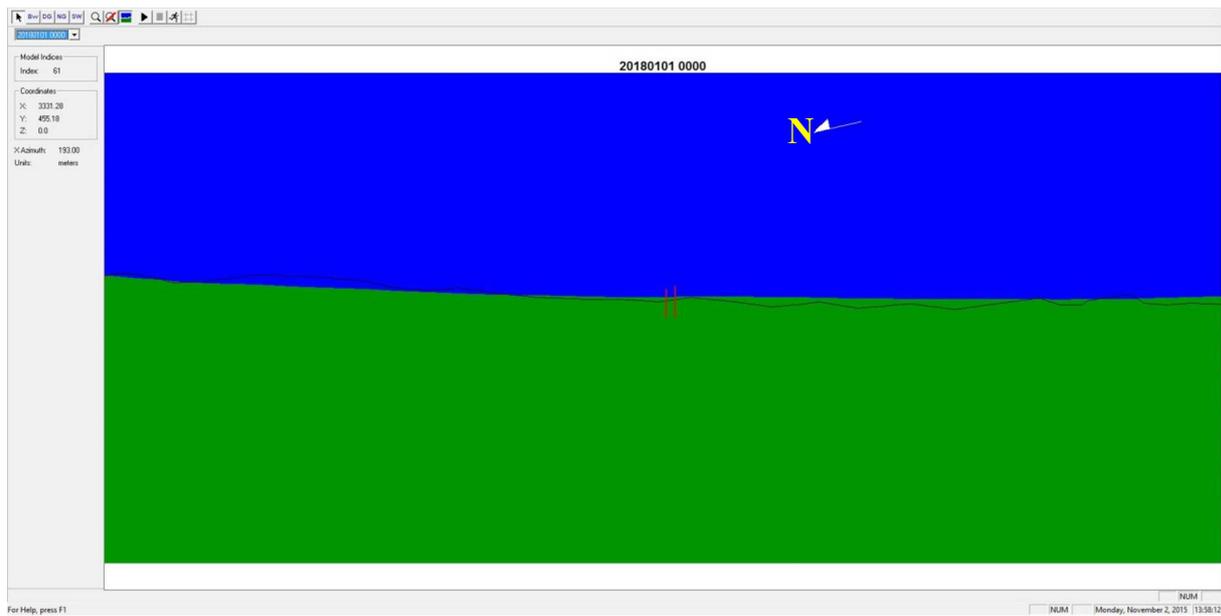
Figure 17: 4th Year shoreline change forecast
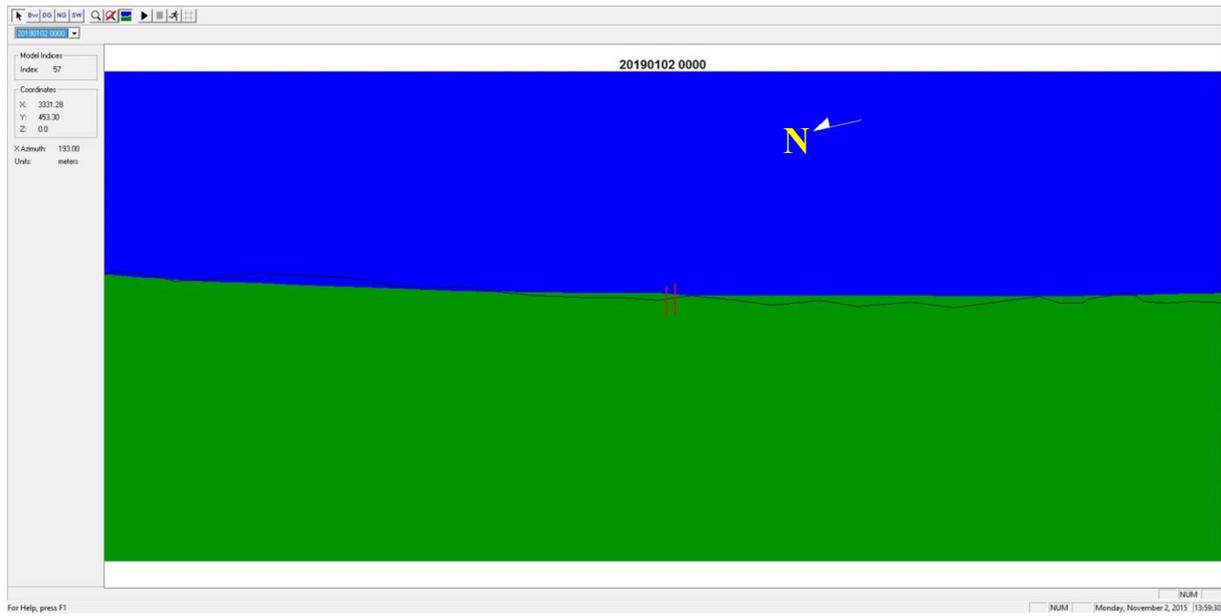
Fig. 18. 5th Year shoreline change forecast
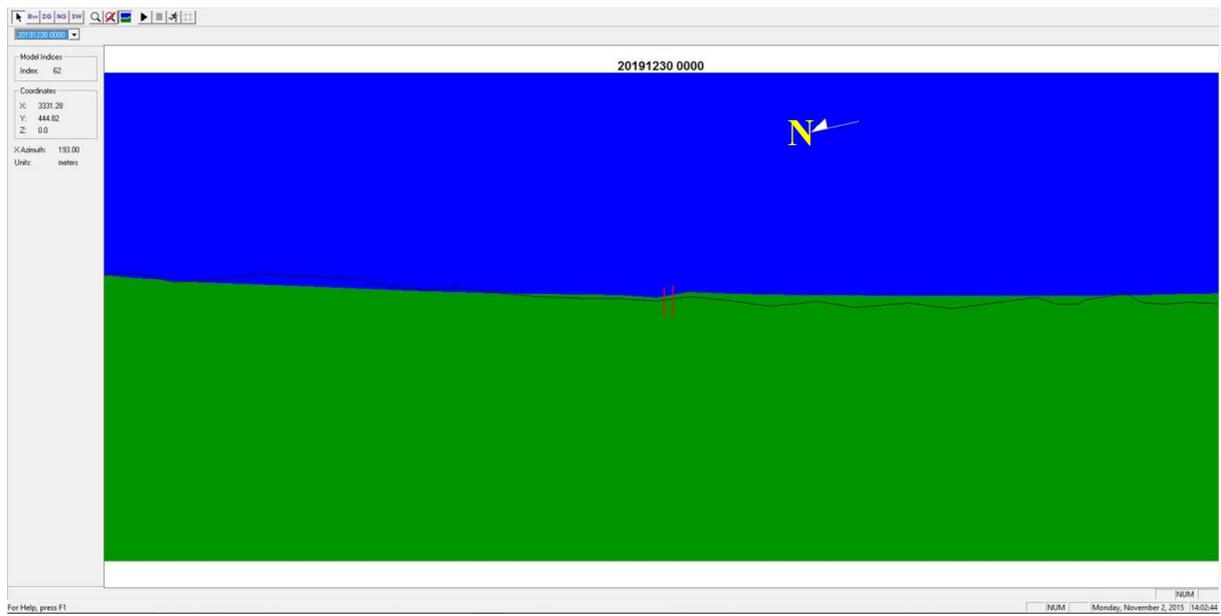
Fig. 19. 6th Year shoreline change forecast
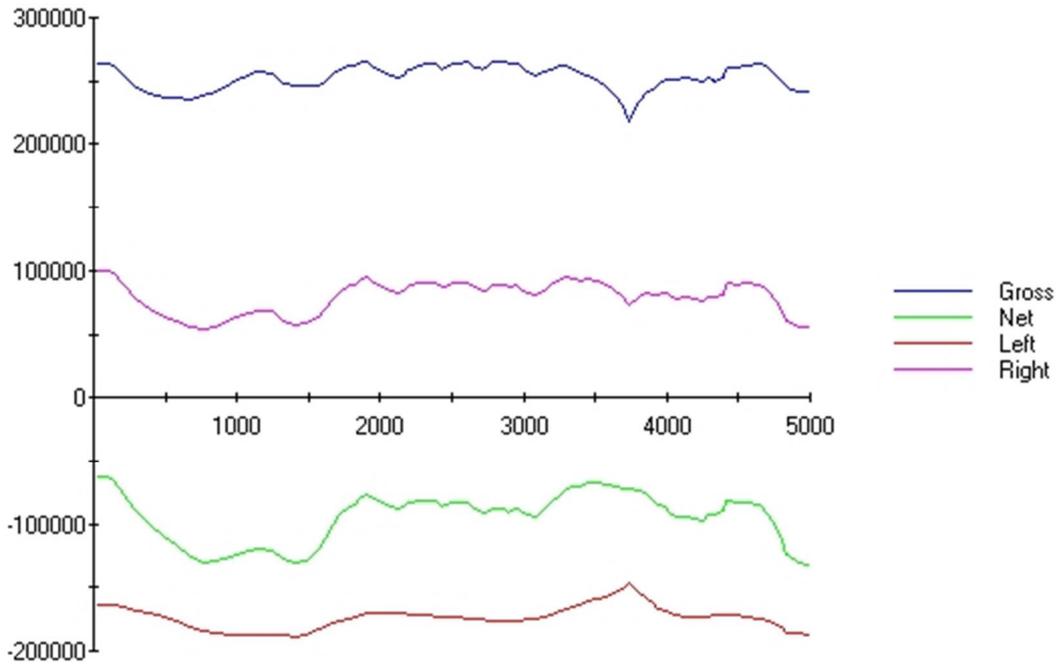
Fig. 20. Sediment Transport Rates

4. Conclusions

In this study, a part of Çamyuva Beach located on the south of Kemer district of Antalya Province has been modelled to forecast of coastal line change after construction of a groin structure for prevention of closure of stream mouth. Model has been processed for 6 years. Model results show that the net sediment transport direction is approximately south to north and there will be no significant shoreline change at the loaction.

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