Journal of Civil & Environmental Engineering

Süme, J Civil Environ Eng 2014, 4:4
DOI: 10.4172/2165-784X.1000150

Research Article Open Access

Grain Size and Beach Formation Characteristic at the T-Head Groins System at Kiyicik, Turkey (Eastern Black Sea)

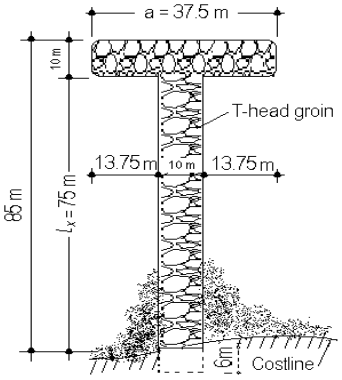
Veli Süme*

Recep Tayyip Erdoğan University, Civil Engineering Department, Rize, Turkey

Abstract

The construction of the Black sea motorway in northern Turkey started in 1998. The motorway is located along the shore line. To provide shoreline protection, T-head groins were placed along the coast at selected locations which may be prone to erosion. The objectives of this paper are to evaluate the performance of the 13 T-head groins built at Kiyicik, Turkey. The shore survey and sediment analyses were conducted and analyzed in relation to bathymetry assessments and sediment grain size characteristics (d25, d50, d65, d90). Effectiveness of the T-head groins was evaluated for shore line protection. Sediment accumulation profiles differed based on positions of the T-head groins along the shore line. The grain sizes of the sediments accumulating at theT-head groins were significantly different depending on their location.

Graphical abstract:



Highlights:

- Thirteen T-head groins were studied.
- Sediment accumulation profiles differed based on position of the T-head groins.
- Sediment particle sizes were significantly different depending on location.

Keywords: Coastal structures; T-head groins; Shore protection; Sediment size; Beach erosion; Sediment capture

Introduction

Coastal erosion affects coastal araes causing infrastructure damage. Retaining walls are constructed parallel to the shore. There are also structures that are perpendicular to the shore such as groins. Thus, approaching the breaking waves washes ashore attempted to mitigate the effects of coastal erosion [1]. Some researchers have worked on the the needs of society to identify solutions [2-6]. There are many studies on groins such as rock on the size and wave analysis, some groin of ranges; some have sought about the trunk size and height [7-11]. Some of them researchers have studied on the beach morphology and sedimentation [12-15] and their environmental aspects [16,17]. The experimental research shows that the length of theT-head groin cannot be greater than three times the groin gap. However, the groin trunk height above the sea level should be around +0.5 meters [18,19]. Numerical studies have also been onducted to estimate the performance of groins [20]. Additionally, along the shores of the United States west coast of Florida, coast of Naples, a flat T- or L-shaped groins, Japan, Britain, Israel and Argentina beaches of Miramar German Baltic shores, Spain [21], and Turkey Coast of Blacksea [22,23] the T-head groins was constructed.

In this study, T-head groins built along the shore of City of Of, Turkey were studied. The objective of this study was to evaluate the sediment depth changes during the 34 month period. The sediment depth measurement were conducted by sonar and analysed at the T-head groin system consisting of 13 individual groins. Grain size analyses were conducted to assess the charcatersitics of the sediments captured at each groin.

The wave anylyses in the eastern blacksea

The data used in wind estimates are obtained from the meteorological wind data or from the synoptic wind maps. The prominent wave

***Corresponding author:** Veli Süme, Recep Tayyip Erdoğan University, Civil Engineering Department, Rize, Turkey, Tel: (464) 223 7518; Fax: (464) 223 7514; E-mail: veli.sume@erdogan.edu.tr

Received June 04, 2014; **Accepted** July 26, 2014; **Published** August 02, 2014

Citation: Süme V (2014) Grain Size and Beach Formation Characteristic at the T-Head Groins System at Kiyicik, Turkey (Eastern Black Sea). J Civil Environ Eng 4: 150. doi:10.4172/2165-784X.1000150

Figure 1: Study area.

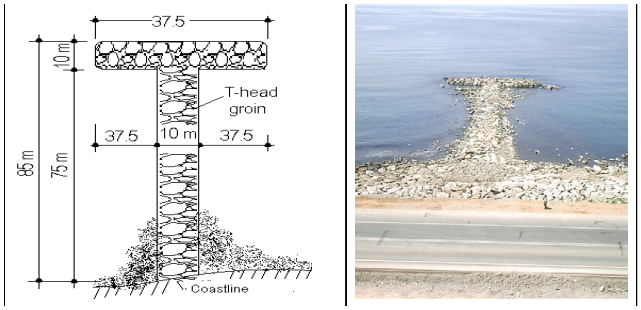


Figure 2: The shape and view of T-head groin. The shape and view of T-head groin.

directions of the area are north (N), north north-west (NNW), North West (NW) and west (W). Wave steepness is 0.041 and the wave heights range from 6.1 to 6.6 meters around the tudy area. The extreme values for the wave heights can be as much as 11.5 meters in Cayeli [24].

Sediment transportation on shores

Baltaci and Solaklı rivers the most significant sediment sources in the study area. The T-groins studies are located between the two rivers. The steep slope of these rivers and their higher speeds cause significant river-bed erosion resulting in deposition of the sediments at the discharge zone. Longshore sediment transport in the south west (SW), north east (NE) direction (i.e., in accordance with the coastal profile) [25]. According to the accumulating sediment and according to wave effects, shore profile is classified. When waves are small, they are in normal or summer profile, when waves are large (i.e, during storm events), they are in storm or winter profile. Moreover, sand and gravels taken randomly and without any methods from places near shoreline may change shore profile. Transportation in parallel to coast is one which currents along shoreline cause [26].

Study area

T-head groins have been built, with the aim of shore protection where they are essential according to project criteria and where the Blacksea double motorway still built in parallel to shore generally by filling sea passes [27,28]. The study area is 2050 meters long. The T-head groin system is located in the area of Kıyıcık. There are 13 T-head groins (e.g., T_1, T_2) along the coastline. The construction of the T-head groins was started in 2000 and finished in groups in the same year. The area also has The harbor of City of Of has a fishing shelter and small boat shelters as shown in Figure 1. The sediment accumulation characteristics as well as particle size distribution of the sediment accumulation at the groins were evaluated (Figure 1).

General Characteristics of T-head Groins

A series of T-head groin which function together to prevent shore erosion is called T-head groin system. In this system all of the T-head groins have been constructed a=37.5 meters lenght, l_x=75 meters long and l_g=150 meters gap (Figure 2). T-head groins trunks are 10 meters width and constructed with 500 kg to 10 ton rocks. About, the trunk height is changes +1 to +1.5 meters from sea level [29]. Groins are built with a strong connection with the coast (mainly water level MLW) will go into the shoreline constructed of about 6 meters inside from MLW to coast line and sediment transportation are built perpendicular to the shore to be kept, thus, prevention of coastal erosion is near the harbor and fishing shelter along with hindrance the filled (Figure 2).

Materials and Methods

Sediment depth survey

Around T-head groins and in the heels sediment deposition or losses were measured by a sonar system. The depth measurements were converted to contour lines using netCAD and AutoCAD. The depth measurements were performed by using 5m x 5m squares for an area of 60m x 80m inside each T-head groin as illustreted in (Figure 3). At this process, was made one by one according to plumb and sonar data 2009 and 2013 according to and the four-year change was compared. As a result, depending on sediment transportation, where there is a sediment depositing around the groins were evaluated functionally. The observation and evaluation were made from direction of the west-east for the T-head groins system on the coastline (Figure 4).

Sieve analyses

Sediment samples were collected from the left and right heels and weighted. The sand-gravel samples did not include grains that are greater than 30 mm. The samples were oven dried at 105 ± 5°C and then sieve analysis was conducted. Sieve analyses were done using standard sieves (SI) (9 sieves; sieve ranges 0.25, 0.5, 1, 2, 4, 8, 16, 31.5 and 63

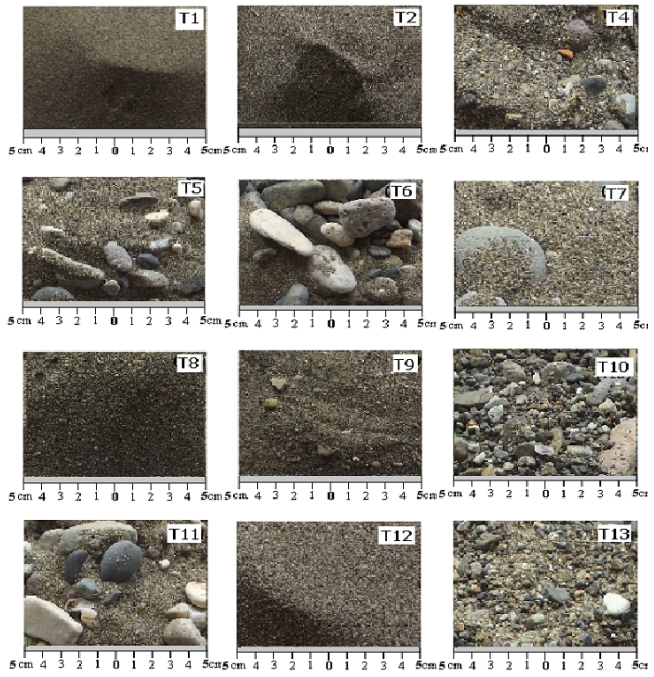


Figure 3: Comparision of sediments captured at the T-head groin system (T3 did not have any sediment accumulation).

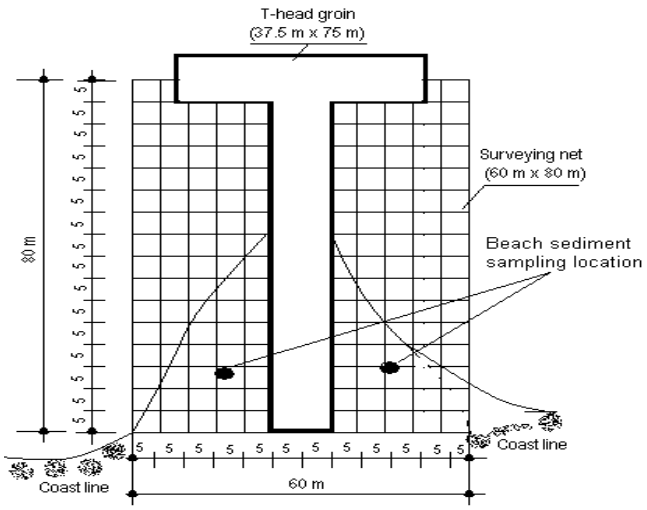


Figure 4: Sample grid for depth survey at the T-head groins.

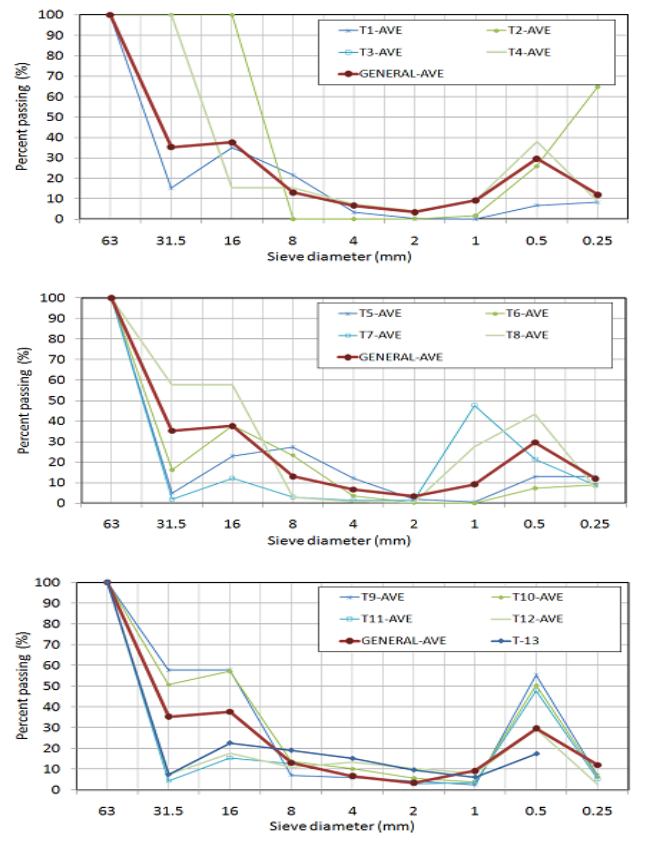


Figure 5: Grading curve of the sediments captures at the T-head groin system (T3 did not have any sediment accumulation).

mm). Then, the materials remaining on each sieve were weighed. The percentages of weights were calculated and grading graphs were developed. In the end, d_{25}, d_{50}, d_{65}, and d_{90} from these with graphs were obtained (Figures 4 and 5).

Results

As a result of the observation and research, the following results were obtained by making surveying and evaluating (fullness rates are according to the inside areas of T-head groins): the sediment transport from west to east is parallel to coast and. The majority of the sediment transport is in the west (W), north-northwest (NNW), north-west (NW) and north (N) direction which are the prominent wave directions.

In the groin system studies, the sediment data were collected during 2000 and 2009 to develop the isohip curves. At the heels of the groins T_1-T_5, there was no deposition. At T_6-T_8 there were sediments up to 35% of the length of the groin trunk at about +1.3 meter depth. At the heels of the T_9, there was no deposition and at T_{10} sediments accumulated up to 45% of the length of the groin trunk at about + 0.8 meter depth. At the heels of the T_{11} and T_{12}, there was about 30% length of the groin trunk deposition and T_{13}, 50% length of the groin trunk deposition are available between at about + 0.9 to + 1.3 meter depth, are full of sand and are used as a beach (Figure 6).

Figure 5 shows that, in the ever not stored sand in the T-head groin, on the contrary took place at the base scouring. T-head groin of the harbor breakwater to be very close, wave energy increases. This causes an increase in the transport of sand. For this reason, T-head groin the trunk has accumulated relatively large size gravel (Figure 6a).

Especially, from heels to increase in the amount of filling and the increased sediment depositing and the stored material is composed of gravels larger than 30 mm. Nevertheless, plays a significant role against coastal protection (Figure 6b). Increase the amount of accumulated material in the heel, although scouring took place in places far away from the seashore; therefore, sediments consisting of fine sand were deposited. As a result, the beach forming at this location is used as a public beach by the local people (Figure 6c).

Approximately, as much as half of the length of the T-head groin of the sediment had deposited in the (Figure 6d). Near-shore areas of accumulated sand, grading altered material and coarse material from the coast began to accumulate. The large volume sediment deposited in this area. To contribution against coastal protection are quite high, and is used as beach in summer months (Figure 6d).

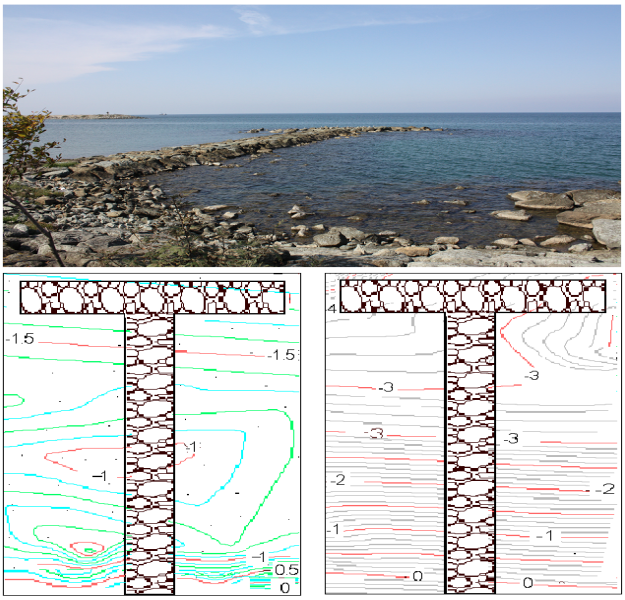


Figure 6a: (Kiyicik T_1). Isohips curve 2000-2009 and view 2013.

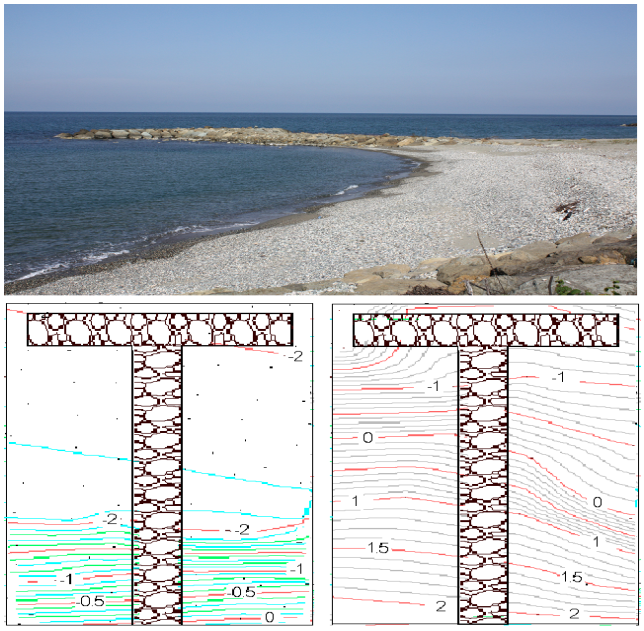


Figure 6b: (Kiyicik T_1). Isohips curve 2000-2009 and view 2013.

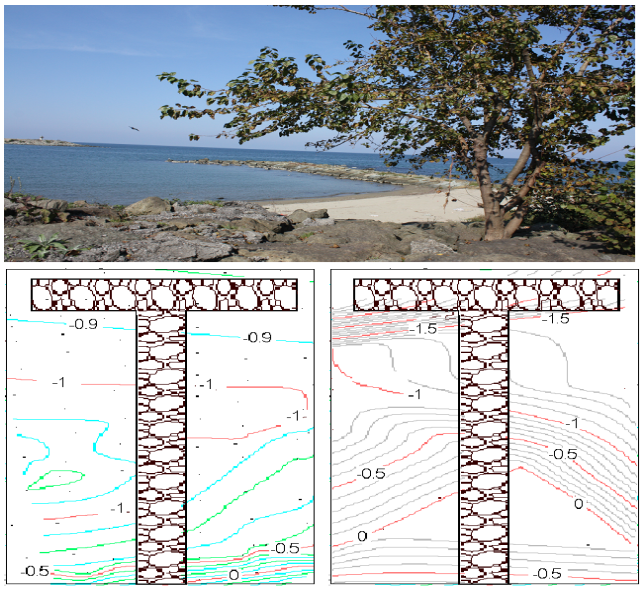


Figure 6c: (Kiyicik T_{10}). Isohips curve 2000-2009 and view 2013.

At the T_7-T_9 T-head groins large volume sediments were observed (d_{25}), respectively T_{12}-T_{13}, T_{10}-T_{11},T_1-T_2 and that followed by the T_5-T_6. The coarse material accumulated the T_7-T_9 T-head groins. Respectively that T_{12}-T_{13}, T_{10}-T_{11} and the T_1-T_2 and followed by T_{12}-T_{13}, T_7-T_9, T_{10}-T_{11}. T_5 and T_6 in the medium-sized (d_{50}-d_{65}) gravel sand can be said to accumulate. T_3 and T_4 is also, never is seen accumulated sand and gravel (Figure 7a and 7b).

In the heel according to average depth measurements, general evaluation if is made hasn't been storage of sediment at the T_3 T-head groin .

The T-head groins T_6-T_7-T_8-T_{10} at T_{13}, were evaluated have increased by about 0-1.10 meters, according to the sea surface and at the T_{11}-T_{12} groin heels very slight decreased compared to 2009 , it can be seen graphics is examined. This situation shows that continuing the process of depositing (Figure 8).

Conclusions

When the study area is examined, it is noted that the T-head groin sizes chosen are appropriate, but it can be said that choosing to the

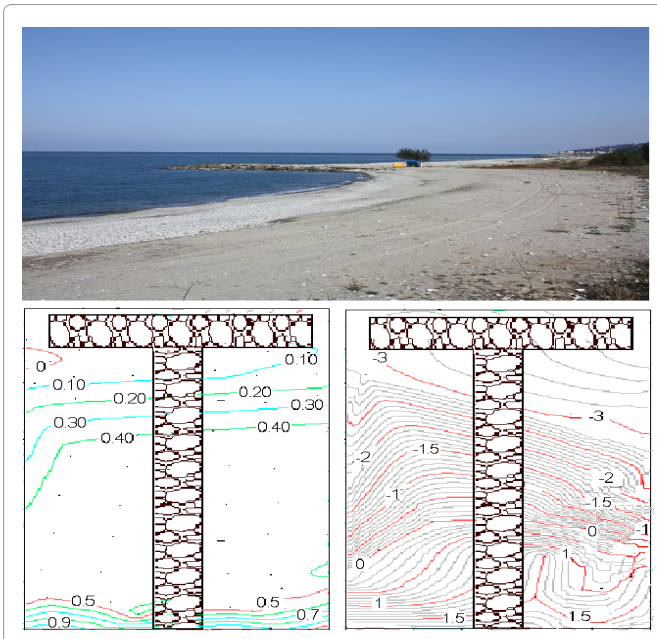


Figure 6d: (Kiyicik T_{13}). Isohips curve 2000-2009 and view 2013.

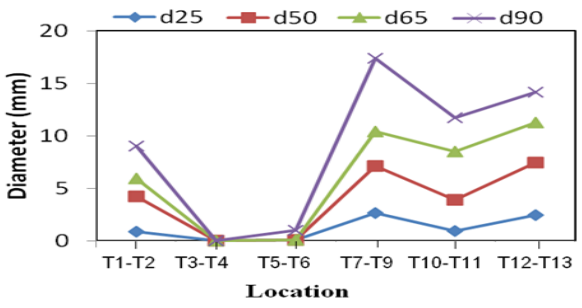


Figure 7a: Grain size 2009.

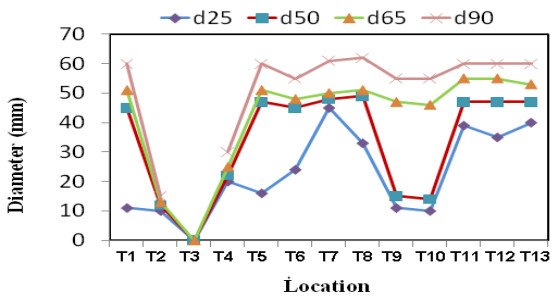


Figure 7b: Grain size 2013.

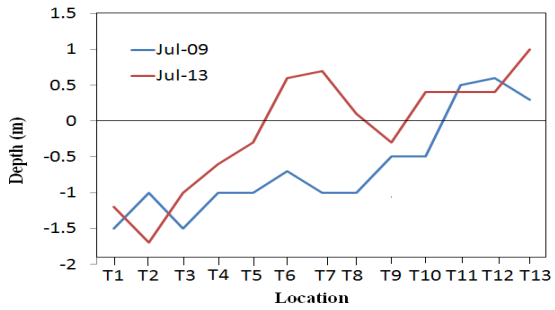


Figure 8: Historical chance at heels.

T-head groin locations was not the optimum. The geometry of the groins was not carefully selected. The T-head groin levels were very high from sea level (+1.5 to 2 meters). Because the T-head groins trunk was finished, it may not be suitable to say something today. However, for the motorway was finished, some extra T-head groins can be put on this area along the shoreline. If relevant institution the new T-head groin system will built, it must be three times T-head groin gap as long as the T-head groins length. That the fishing shelters near them, the small boat places and the harbours have the same function must be taken into consideration. It's suitable that, the structure height from sea level that mustn't be higher than +0.5 meter level. Therefore, incoming wave will pass over their trunks and reach the other T-head groins, and have to leave in the heel more materials. As a result, T-head groins deposition will accelerate. In the course of time, T-head groins will get lost by being covered fully with sand and like a natural beach will appear. In addition, modifications and restorations must be done in the studies. State officers and constructer have taken advises given into consideration and about that they are very pleased. Furthermore, in the course of time, shoreline change must be observed periodically, available damage must be restored, sand and gravels must be taken from T-head groins which are excessively full, and artifical deposition must be carried out in some groins which are necessary to be built or to be used as a beach. Especially, in this area extreme values wave are very high (at the Blacksea region). There aren't any wave data in such an area so, in this certain places shoreline new wave surveying stations has to found. The data reinforcement will be realised about the recycling to University as data, i.e., the recycling of the result of the area and observation. This approach results will be provided to increase the data and experimental studies will be evaluated together with the field data.

References

1. Saengsupavanich C (2012) Unwelcome environmental impact assessment for coastal protection along 7 km shoreline in Southern Thailand. Ocean & Coastal Management 61: 20-29.
2. Önsoy H, (1991) A Research for artifical beach and protection against sea erosion in the shores of Algeria in the western Mediterranean, State Harbour and Airport Magazine, Ankara, Turkey.
3. Gregory R, Keeney RL (1994) Creating policy alternatives using stakeholder values. Management Science 40: 1035-1048.
4. Sagoff M (1998) Aggregation and deliberation in valuing environmental public goods: a look beyond contingent pricing. Ecological Economics 24: 213-230.
5. Fischhoff B (2000) Value elicitation: is there anything in there? An Interdisciplinary Reader, CUP, Cambridge, 517-543.
6. Tompkins EL, Few R, Brown K (2008) Scenario-based stakeholder engagement: Incorporating stakeholders preferences into coastal planning for climate change. Journal of Environmental Management 88: 1580-1592.
7. Burcharth HF, Kramer M, Lamberti A, Zanuttigh B (2006) Structural stability of detach low crested breakwaters, Coastal Engineering 53: 381-394.
8. Özbahçeci BO, Ergin A (2008) Design weight armour stone considering the effect of extreme waves. Ocean Engineering 35: 393-399.
9. Sümer BM, Fredsoe J (2002) The mechanics of scour in the marine environment. In Advanced Series on Ocean Engineering, World Scientific, Singapore 17.
10. Vidal C, Medina R, Lomónaco P (2006) Wave height parameter for damage description rubble-mound of breakwaters. Coastal Engineering 53: 711-722.
11. Briganti R, Bellotti G, Franco L, Rouck JD, Geeraerts J (2005) Field measurements of wave overtopping at the rubble-mound breakwater of Rome-Ostia yacht harbor. Coastal Engineering 52: 1155-1174.
12. Iskender MM, Frihy OE, El Ansary AE, Abd El Mooty MM, Nagy HM (2007) Beach impacts of shore-parallel breakwaters backing offshore submerged ridges, Western Mediterranean Coast of Egypt. Journal of Environmental Management 85: 1109-1119.
13. Munari C, Corbau C, Simeoni U, Mistri M (2011) Coastal defence through low crested breakwater structures: jumping out of the frying pan into the fire. Marine Pollution Bulletin 62: 1641-1651.
14. Ranasinghe R, Turner IL (2006) Shoreline response to submerged structures: a review. Coastal Engineering 53: 65-79.
15. Sane M Yamagishi H Tateishim M Yamagishi T (2007) Environmental impacts of shore-parallel breakwaters along Nagahama and Ohgata, district of Joetsu, Japan. Journal of Environmental Management 82: 399-409.
16. Thomalla F Vincent CE (2003) Beach response to shore-parallel breakwaters at Sea Palling, Norfolk, UK, Estuarine, Coastal and Shelf Science 56: 203-212.
17. Birben AR, Özölçer IH, Karasu S, Kömürcü MI (2007) Investigation of the effects of offshore breakwater parameters sediment accumulation. Ocean Engineering 34: 284-302.
18. Özölçer IH, Kömürcü IK, Birben AR, Yüsek Ö, Karasu S (2006) Effects of T-shape groin parameters on beach accretion. Journal of Ocean Engineering 33: 382-403.
19. Van Rijn L (2006) Principles of sedimentation and erosion engineering in rivers, estuaries and coastal seas, Aqua publications, The Netherlands Coastal Erosion and Control, Delft, Netherlands.
20. Eslami Arab S (2009) A numerical study on design of normal and T-head groins. MSc-Report, Delft University of Technology, Delft, Netherlands.
21. Hanson H, Kraus NC (2002) Chronic beach erosion adjacent to inlets and remediation by composite T-head groins. US Army Corps of Engineers, ERDC/CHL CHETN-IV-36.
22. Süme V (2002) T-shaped groins of structured research on the coastal of Trabzon–Of and Rize–İyidere for shore protection in the eastern Blacksea. 4th National Coast and Port Engineering Symposium, Antalya, Turkey.
23. Süme V (2008) Book of surveying. Course Book, Section 8: 317-342, Rize, Turkey.
24. Kislakci AU (2008) Wave and wave climate in Turkey. Msc thesis, Middle East Technical University (Metu), Turkey.
25. Süme V (1992) Dynamic design and stability study of coastal structures, Msc thesis, Blacksea Technical University, Institute of Sciene, Trabzon, Turkey.
26. Zyserman JA, Johnson HK, Zanuttigh B, Martinelli L (2005) Analysis of far field erosion induced by low-crested rubble-mound structures. Coastal Engineering 52: 977-994.
27. Doğuş and Polat Constructer (2000) Application Projects and Data, Rize, Turkey.
28. Uysal K (1995) Design wave estimation by using wind data in the eastern Blacksea. Msc thesis, Blacksea Technical University, Institute of Sciene, Trabzon, Turkey.
29. Özölçer İH (1997) Research of groins effects in shore protection. PhD thesis, Blacksea Technical University, Institute of Sciene, Trabzon, Turkey.