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Sand dune restoration as sustainable natural architectural design for coastal protection along seasonal storm-prone beach

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Abstract
Monsoonal storms cause coastal erosion of worldwide sandy beaches, including coasts in Malaysia. Although hard engineering structures are effective in mitigating erosion, those constructions can create several environmental issues such as down-drift erosion. The Effective Sand Fence (also known as E-Fence) is considered one of the sustainable alternative structures to protect beach erosion. Therefore, the objective of the current study is to identify the effectiveness of E-Fence for dune restoration. In this study, we measured beach profile survey, grain size distribution, and wind speed. In addition, XBeach simulation was used to determine sediment accumulation under the E-Fence protection. Results of the beach profile survey (i.e., slope and dune volume) indicate dune restoration in protected areas of the E-Fence. Grain size distribution and wind speed suggest the decreasing of wind velocities from the swash zone to the backshore. Accordingly, the E-Fence acts as a barrier, and the reduction of energy leads to accumulate sediments by passing through gaps in the structure. The E-Fence is thus capable of sustaining against wave attack and can maintain stable coastal ecosystems. Consequently, this coastal protection structure assists in developing cheaper coastal erosion mitigation strategies in Malaysia and elsewhere. © 2024

Author Keywords
Beach profile; Dune restoration; Sand trapping fence; Seasonal monsoon; Sediment transport

Index Keywords
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References

- Muhammad, M., Idris, K., Ariffin, E.H., Shaffril, H.A.M., Samah, B.A., Suandi, T.
  The impact of climate change on small-scale fishermen in Malaysia
  (2016) *Soc. Sci.*, 11 (13), pp. 3352-3356.
- Eichmanns, C., Schüttrumpf, H.
  Investigating changes in aeolian sediment transport at coastal dunes and sand trapping fences: a field study on the German coast
  (2020) *J. Mar. Sci. Eng.*, 8 (12), p. 1012.
- Hamzah, M.L., Amir, A.A., Maulud, K.N.A., Sharma, S., Mohd, F.A., Selamat, S.N., Karim, O., Begum, R.A.
  Assessment of the mangrove forest changes along the pahang coast using remote sensing and gis technology
  (2020) *Journal of Sustainability Science and Management*, 15 (5), pp. 43-58.

- Shariful, F., Sedrati, M., Ariffin, E.H., Shubri, S.M., Akhir, M.F.
  Impact of 2019 tropical storm (Pabuk) on beach morphology, Terengganu coast (Malaysia)
  (2020) *J. Coast Res.*, 95 (sp1), pp. 346-350.

- Eichmanns, C., Schüttrumpf, H.
  Influence of sand trapping fences on dune toe growth and its relation with potential aeolian sediment transport
  (2021) *J. Mar. Sci. Eng.*, 9 (8), p. 850.

- Harman, B.P., Heyenga, S., Taylor, B.M., Fletcher, C.S.
  Global lessons for adapting coastal communities to protect against storm surge inundation
  (2015) *J. Coast Res.*, 31 (4), pp. 790-801.

- Itzkin, M., Moore, L.J., Ruggiero, P., Hacker, S.D.
  The effect of sand fencing on the morphology of natural dune systems
  (2020) *Geomorphology*, 352.

- Li, B., Sherman, D.J.
  Aerodynamics and morphodynamics of sand fences: a review
  (2015) *Aeolian Research*, 17, pp. 33-48.

- Grafals-Soto, R.
  Effects of sand fences on coastal dune vegetation distribution
  (2012) *Geomorphology*, 145, pp. 45-55.

- Lima, I.A., Araújo, A.D., Parteli, E.J., Andrade, J.S., Herrmann, H.J.
  Optimal array of sand fences
  (2017) *Sci. Rep.*, 7 (1), pp. 1-8.

- Harris, M.E., Ellis, J.T., Barrineau, P.
  Evaluating the geomorphic response from sand fences on dunes impacted by hurricanes
  (2020) *Ocean Coast Manag.*, 193.

- Liu, J., Wu, J., Kimura, R.
  Evaluating the sand-trapping efficiency of sand fences using a combination of wind-blown sand measurements and UAV photogrammetry at tottori sand dunes, Japan
  (2023) *Rem. Sens.*, 15 (4), p. 1098.

- Ariffin, E.H., Sedrati, M., Daud, N.R., Mathew, M.J., Akhir, M.F., Awang, N.A., Yaacob, R., Husain, M.L.
  Shoreline evolution under the influence of oceanographic and monsoon dynamics: the case of Terengganu, Malaysia
  (2018) *Coastal Zone Management*, pp. 113-130.
  Elsevier

- Yaacob, R., Shaari, H., Sapon, N., Ahmad, M.F., Arifin, E.H., Zakariya, R., Hussain, M.L.
  Annual changes of beach profile and nearshore sediment distribution off Dungun-Kemaman,Terengganu, Malaysia
  (2018) *Jurnal Teknologi*, 80 (5), pp. 57-66.

- Wan Talaat, W.I.A., Ghazali, F., Kaur, C.R., Rahman, M.A.A., Aziz, N., Muhammad, Z.
  Conceptualising Marine Spatial Planning for Coastal Development in Terengganu
  (2020),

- Perera, U.L.H.P., Ratnayake, A.S., Weerasingha, W.A.D.B., Subasinghe, H.C.S., Wijewardhana, T.D.U.

Grain size distribution of modern beach sediments in Sri Lanka
(2023) *Anthropocene Coasts*, 6, p. 10.

- Mustaffa, Z., van Gelder, P., Hashim, A.M.
  An insight in spatial corrosion prediction
  (2012) *Int. J. Pres. Ves. Pip.*, 95, pp. 16-23.

- El-Shafie, A.
  An application of artificial intelligence (AI) technique for wave prediction in Terengganu
  (2016) *Journal of Energy and Environment*, 8 (1).

- Shahirah-Ibrahim, N., Badli-Sham, B.H., Juliani, N.
  Species diversity of freshwater turtles and tortoises in Terengganu, Malaysia
  (2018) *Journal of Sustainability Science and Management*, pp. 1-27.

- Hashim, F.E., Peyre, O., Lapok, S.J., Yaakob, O., Din, A.H.M.
  Offshore wind energy resource assessment in Malaysia with satellite altimetry
  (2020) *Journal of Sustainability Science and Management*, 15 (6), pp. 111-124.

- McCall, R.T., Van Thiel de Vries, J.S.M., Plant, N.G., Van Dongeren, A.R., Roelvink, J.A., Thompson, D.M., Reniers, A.J.H.M.
  Two-dimensional time dependent hurricane overwash and erosion
  (2010),

- Berard, N.A., Mulligan, R.P., da Silva, A.M.F., Dibajnia, M.
  Evaluation of XBeach performance for the erosion of a laboratory sand dune
  (2017) *Coast Eng.*, 125, pp. 70-80.

- Reis, A.H., Gama, C.
  Sand size versus beachface slope - an explanation based on the constructal law
  (2010) *Geomorphol*, 114, pp. 276-283.

- Ariffin, E.H., Mathew, M.J., Yaacob, R., Akhir, M.F., Shaari, H., Zulfakar, M.S.Z., Sedrati, M., Awang, N.A.
  Beach morphodynamic classification in different monsoon seasons at Terengganu beaches, Malaysia
  (2018) *Journal of Sustainability Science and Management*, 13 (5), pp. 65-74.

- Ismail, N.I., Ariffin, E.H., Yaacob, R., Husain, M.L., Baharim, N.B.
  The impact of seasonal monsoons on the morphology of beaches protected by barrier islands in Setiu, Terengganu, Malaysia
  (2020) *Journal of Sustainability Science and Management*, 15 (4), pp. 120-129.

- Mathew, M.J., Sautter, B., Ariffin, E.H., Menier, D., Ramkumar, M., Siddiqui, N.A., Delanoe, H., Gensac, E.
  Total vulnerability of the littoral zone to climate change-driven natural hazards in north Brittany, France
  (2020) *Sci. Total Environ.*, 706.

- Ariffin, E.H., Zulfakar, M.S.Z., Redzuan, N.S., Mathew, M.J., Akhir, M.F., Baharim, N.B., Awang, N.A., Mokhtar, N.A.
  Evaluating the effects of beach nourishment on littoral morphodynamics at Kuala Nerus, Terengganu (Malaysia)
  (2020) *Journal of Sustainability Science and Management*, 15 (5), pp. 29-42.

- Hamsan, M.A.S., Ramli, M.Z.
  Monsoonal influences on rip current hazards at recreational beaches along Pahang coastline, Malaysia
  (2021) *Ocean Coast Manag.*, 209.

- Cheng, J.J., Lei, J.Q., Li, S.Y., Wang, H.F.
  Disturbance of the inclined inserting-type sand fence to wind–sand flow fields and its sand control characteristics
  (2016) *Aeolian Research*, 21, pp. 139-150.

- Eichmanns, C., Schüttrumpf, H.
  A nature-based solution for coastal protection: wind tunnel investigations on the influence of sand-trapping fences on sediment accretion
  (2022) *Frontiers in Built Environment*, 8, p. 58.

- Grafals-Soto, R., Nordstrom, K.
  Sand fences in the coastal zone: intended and unintended effects
  (2009) *Environ. Manag.*, 44 (3), pp. 420-429.

- Deabes, E.A.
  The impact of thermal power stations on coastline and benthic fauna: case study of El-Burullus power plant in Egypt
  (2020) *Results in Engineering*, 7.

- Takagi, H.
  “Adapted mangrove on hybrid platform”–coupling of ecological and engineering principles against coastal hazards
  (2019) *Results in Engineering*, 4.

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