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Technical Note

The ecological potential of geotextiles in hydraulic engineering

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ABSTRACT

Geotextile materials find increasing use in coastal protection as an alternative material to natural stone, slag, and concrete. In this environment geotextiles, like all surfaces of technical objects immersed in seawater, are subject to accumulation of organisms on their surfaces, a process usually called biofouling. In a 2-year experiment we investigated the colonization of benthic organisms on two different geotextile materials (woven fabric and non-woven fabric) in the Elbe estuary, Germany, and compared it with the colonization on unglazed ceramic tiles as reference representing the nearest compromise to natural hard substrates. Then, non-woven fabric was colonized by significantly less species, fewer individuals, and lower biomass values than the woven fabric and the ceramic tiles (one-factor ANOVA, $p < 0.05$); no such significant differences were noted between woven fabric and ceramic tiles. Over time, the numbers of species and numbers of individuals did not show significant increases between the first and the second year (Student's *t*-test, $p \geq 0.05$), while the biomass was still increasing significantly on all materials (*t*-test, $p < 0.05$). However, biomass was almost two orders of magnitude lower on non-woven geotextiles than on woven material. Exposure to seawater and fouling organisms had no adverse effect upon the stability of the geotextiles (wide-width tensile test results; *t*-test $p \geq 0.05$). Geotextile materials therefore offer a unique choice in coastal and hydraulic engineering: depending on the application, engineers can choose between a material that is easily colonized by benthic species, or one that minimizes such colonization where it is undesired.

1. Introduction

Geotextile containers find increasing use as an alternative material in aquatic engineering where they can replace natural stone, slag or concrete material. In some cases, like coastal protection, geotextile containers even outplay traditional solutions and can be considered as preferential solutions where traditional materials are not acceptable or available (e.g., Restall et al., 2002; Heerten et al., 2000a,b; Black, 1999; Tomlinson et al., 2003; Jackson and Hornsey, 2002). Geotextile sand containers facilitate flexible coastal structures, thus providing versatile applications (Heerten et al., 2000a; Restall et al., 2002) including special stakeholders interests such as artificial reefs which are especially designed to meet the needs of the surfing community (Jackson et al., 2007; Jackson and Corbett, 2007; Jackson and Hornsey, 2002).

Hard-surface substrate is in many coastal environments a rare habitat and is therefore very attractive to many organisms which rely on it to complete their life cycles. Moreover, natural hard substrates are among the most diverse and biomass-rich marine habitats, because they offer stability of the substrate that is required by many sessile and hemisessile organisms. Many marine algae and invertebrates depend on hard substrates to adhere to. Human-made structures, also termed artificial or secondary hard substrates, therefore provide habitable space for many benthic organisms and are colonized very rapidly (e.g. Peters et al., 2005, 2007). In some cases, even endangered species can be found in higher numbers on artificial hard substrates. The colonization of hard surfaces depends to a large extent on the texture of the surface itself; rough material can support a completely different benthic community than a smooth surface; surface structure plays an important role in affecting the character of epibenthic communities on underwater surfaces (e.g. Berntsson et al., 2000; Herbert and Hawkins, 2006; de Nys and Steinberg, 2002; Commito and Rusignuolo, 2000; Mullineaux and Garland, 1993; Anderson and Underwood, 1994; Glasby, 1999). This phenomenon is also of high economic interest, because biofouling represents a large problem to the merchant fleets worldwide. Barnacles, for example, are the most notorious foulers, and their settlement can be inhibited by microstructures (e.g. Berntsson et al., 2000).

The surface structure of certain geotextiles (woven and non-woven fabrics) has a unique texture that is unlike any of those found on natural hard substrates. Despite the fact that geotextile

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