experts
PT-Outline

Environmental impact of geosynthetics in aquatic systems (EI-GEO)

RUS_ST2017-212

Final Report (R3)

The objective of the final report (R3) is to monitor the outcome after the project is finished.

Short project description *
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The project Environmental Impact of Geosynthetics in Aquatic Systems EI-GEO aimed at the investigation whether geosynthetics in hydraulic engineering applications could be a source of microplastic or other contaminants to the aquatic environment. Whereas the behavior of geosynthetics in landfill engineering is well studied and documented since decades, little is known on application such as coastal protection or scour protection for off-shore wind energy plants. However, due to the rapid expansion of offshore wind energy, rising water levels and more extreme weather conditions as a result of climate change more and more hydraulic engineering projects will be realized in the future.

Construction with geosynthetics boasts various advantages but it has to be ensured that there is no negative environmental impact from the application of geosynthetics in hydraulic engineering. It is expected that any effect will be visible only on the long-term because the virgin raw material used for the production of geosynthetics has almost no release of particles or substance relevant to the environment. Partly from improper material selection and partly from non-professional handling and debris from geosynthetic material can be found on the shore today.

- The following main tasks were executed within the project:
- Accelerated ageing of geotextiles using autoclave tests
- Dynamic surface leaching tests (DSLT) with geotextiles
- Ecotoxicological testing of leachates from DSLT
- Field studies with sampling and monitoring at Baltic shore

Description of results / use of results *

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During the surveys of the beaches of the Kaliningrad Oblast in 2018, a large amount of remnants of geosynthetic materials that are used in coastal protection structures were found. In addition, there is extensive contamination from other building support materials, e.g. geotextile FIBC (Flexible Intermediate Bulk Container) bags, the remains of fishing nets, ropes, and car tires.

The occurrence of geosynthetic remnants varies greatly along the entire shore of the Kaliningrad Oblast. The northern shore of the Sambia Peninsula accounts for 66 % of the remains found, 31 % - for the beaches of the Curonian Spit National Park, and only 3 % was found on the beaches of the western shore of the Sambia Peninsula and the Vistula Spit. Among the remains of geosynthetic materials found, the largest number were braid from gabions (44 %) and geocontainers (43 %), pieces of geotextile accounts for only 12 %, the remaining 1 % was made up of remnants of geocells and geogrids.

The performed primary statistical analysis on the occurrence of the number of pieces per 1 kilometer for various morphodynamic segments of the coast of the Kaliningrad Oblast showed that the main pollution occurs on the northern shore. Considering the average size of the one piece of geotextile (0.9 m2), the gabion coating (7,4 cm), the big-bag (0.3 m2), the geocell (0.06 m2), it is obvious that remnants of geotextile and big-bags were the mostly visible litter on the beach.

This fact that the northern shore of the Sambian Peninsula is mostly littered correlates well with the location of engineering structures using geosynthetic materials, most of which are located on the northern shore of the Sambian Peninsula. In addition, the main accumulation of residues of geosynthetic materials is observed in the areas adjacent to these engineering structures. The occurrence of residues on the Vistula Spit (south from the Sambian Peninsula) and on the western coast of the Sambia Peninsula is low due to currents structure in the eastern part of the Gulf of Gdansk.

The geotextile samples from autoclave ageing were examined with tensile tests to measure residual mechanical properties of the material. With the results the estimation of a service lifetime of the geotextile is possible. The half-life t at 298 K and 0.21 bar oxygen pressure, i.e. the time were 50 % of the mechanical properties are lost under ambient conditions, was estimated to be 330 years. Fitted pressure factor C was 146 J mol-1 bar-1 so that the activation energy Ea in the exponential Arrhenius equation is reduced by 7300 J mol-1 (<10 %) at 50 bar oxygen pressure in the autoclave experiment. It came out that temperature has the strongest influence on the accelerated ageing in the autoclaves, even at highest possible pressure of 50 bar.

To evaluate geosynthetic leachate ecotoxicity a combination of bioassays was applied - both acute and chronic tests and organisms representing two trophic levels were used. Such an approach has advantages over individual component analysis and testing because it can disclose mixture effects. The algae grow inhibition test were conducted at five volume/volume percent concentrations. Inhibition is evaluated by the reduction in specific growth rate relative to the cultures of the control. The samples did not indicate algae growth inhibition even at higher test concentrations. Results of acute Daphnia magna test showed toxicity of Fraction 1+2 only at 100% concentration, causing 7.1 % daphnia mortality after 24 hours and 54 % of cladocera mortality after 48-hour exposure. However, there was no toxic effect observed when ADaM media microelements were added to the highest concentration. The Fraction 7 did not cause any effects to Daphnia survival during the test.

The project gained international recognition by being cited by a Chinese research group in a review (H. Wu, et al., Review of Application and Innovation of Geotextiles in Geotechnical Engineering, Materials 13(7) (2020))

Have all partners received their initially allocated funding budget? *

Yes

Have the goals of your project been achieved? *

mostly

Have you encountered significant non-scientific obstacles within the project consortium and/or among the project partners? *

Yes

If yes, which

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The COVID-19 pandemic made personal project meetings from 2020 on impossible. The meeting in September 2020 was planned to take place in Berlin, but was then organized as virtual meeting. Due to the corona pandemic experimental work in in the participating laboratories (as well as data processing and modelling in Kaliningrad) was delayed because home-office was encouraged by the management.

Number of joint publications (peer-reviewed): *

2

Esiukova, E.E., Chubarenko, B. and Simon, F.-G., Debris of geosynthetic materials on the shore of the South-Eastern Baltic (Kaliningrad Oblast, the Russian Federation), *2018 IEEE/OES Baltic International Symposium (BALTIC)* **2018** 1-6, doi: 10.1109/BALTIC.2018.8634842.

Scholz, P., Putna-Nimane, I., Barda, I., Liepina-Leimane, I., Strode, E., Kileso, A., Esiukova, E., Chubarenko, B., Purina, I. and Simon, F.-G., Environmental Impact of Geosynthetics in Coastal Protection, *Materials* **2021** 14(3) 634, doi: 10.3390/ma14030634.

Number of other joint publications (not peer-reviewed): *

2

Number of conference contributions (oral/poster presentation): *

6

Has your consortium already prepared further joint proposals to continue the cooperation or is it planning to do so? *

Yes

If yes: which (national or bilateral programs/thematic ERA-NETs/Horizon 2020, other)

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It is intended to submit proposal to thematic calls with ERA-Net or H2020.

Have any BSc/MSc diplomas or PhD theses been finished within the context of your project? *

yes

If yes, how many

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1

address of project website

http://ei-geo.com

lessons learnt?

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The field study performed at the shore of Kaliningrad Oblast (Russia) demonstrated that debris from plastic and geotextile materials is found in the environment. Some of the found objects could be attributed to unsuitable material selection (gabion coating) or improper waste management. Proper stabilized geotextiles are not a source of microplastic in the oceans.

feedback on the ERA-NET Initiative: what worked well/what needs improvement

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It was a good experience to work together with research organisations from Russia, Latvia and Germany. Reporting task were clearly defined and communication with the funding agencies was

without any difficulty. The exchange with other projects in the call could be improved, e.g. by a common status conference.

added-value of international cooperation

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Research becomes more and more international. In this case it was special because Russia is not a member state of the European Union. So, for a travel to Russia and for the Russian colleagues travel to the partners in the EU visa were necessary. Nevertheless, for the EI-GEO project it was the ideal project consortium: BAM from Germany as certifying agencies for geotextiles in waste management, LHEI from Latvia with experience in ecotoxicity topics related to oceans and SIO-RAS from Russia with broad knowledge in oceanography.

upload of a photo / illustration / logos

Logo and photos can be seen on the project's internet page http://ei-geo.com