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Editorial

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Editorial

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The world is facing challenges in mitigating climate warming. A range of major countries have committed to carbon neutrality approximately by the middle of this century (Wallach, 2021). Sustainable development is the key to solve the climate problem, which requires novel and interdisciplinary efforts in science and technology. Environmental geotechnology plays an important role in this aspect and should grasp this chance to gain vitality.

This issue of *Environmental Geotechnics* reflects well the chance and importance of environmental geotechnology in aiding sustainable development and mitigating climate warming. The five papers demonstrate advanced carbon capture and storage solutions such as biochar technology and geological carbon sequestration, mine safety and tailing utilization, and sustainable remediation of landfill leachate-contaminated soil.

Biochar technology is one of the promising solutions for climate warming mitigation. It turns labile carbon in biomass to recalcitrant forms which can keep stable for hundreds to thousands of years (Lehmann, 2007). When adding biochar to soil, in addition of carbon storage, it can improve soil functionality and immobilize soil contaminants (Sohi, 2012). In the first paper, Wang et al. (2022) conduct a systematic review on the remediation of heavy metal contaminated soils by biochar. This is a timely review providing recent developments of biochar technology to the readers of *Environmental Geotechnics*. It is found that biochar has the advantages of low price, high efficiency, greenness and soil improvement. Modifications are actively used to improve biochar's performance in heavy metal immobilization. However, biochar may not be universally effective. Sometimes, it may not work or even mobilize heavy metals depending on soil conditions. Biochar can be applied with other solidifying materials (e.g. lime and cement) to enhance the strength of soil, and biochar plays a significant role in enhancing the solidifying performance. Before large-scale applications of biochar technology, we may need to solve a few challenges. Two most important issues may be lowering its production price and improving its long-term effectiveness in soil improvement and remediation.

In the second paper, Li *et al*. (2022) address another important issue for climate warming mitigation: geological carbon sequestration (GCS). One problem for GCS is the complicated thermo-hydro-geomechanical (THM)-coupled condition underground. Li *et al*. (2022) developed an in-house code (AEEA Coupler) to link two conventional industrial standard simulation software programs and aid THM simulation of large scale geological models. The accuracy and applicability of AEEA Coupler were verified via two benchmark validation models, and the reservoir pressure and displacement distribution obtained under different boundary conditions were within acceptable limits. The AEEA Coupler was applied to a real carbon dioxide injection process, and the pore pressure, displacement of the reservoir and vertical displacement of the wellbore were revealed to provide references for GCS engineering. Considering the relatively simple case in this study, the applicability of AEEA Coupler in complex conditions need further verification.

The management of mining sites are important for sustainable development. Mining provides important resources for a range of industries however it may also result in problems in foundation stability and the environment. The redevelopment and revitalization of abandoned mining sites are also challenging. In the third paper, Geniş and Aydan (2022) investigate the dynamic characteristics of ground and amplification of ground motions induced by earthquakes above abandoned mines where urbanization accelerated in recent years. They found that the ground amplifications may be three to five times that at the base and be particularly larger near steep cliffs. They suggest that earthquakes may significantly cause stability issues for abandoned mines. One possible solution may be the construction of a large circular tunnel on the abandoned mines above. Only with an accurate characterization of such abandoned mines, their successful redevelopment can be possible.

In the fourth paper, Correia *et al*. (2022) focus on the utilization of mine tailings. The use of mine tailings to produce cement-substitute binders is a low-carbon scenario with significant momentum. However, the reactivity of mine tailings themselves are relatively low. Therefore, alkaline activation is typically used to improve

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their reactivity and enhance their strength. Correia *et al*. (2022) statistically analyze the effects of curing conditions on the mechanical properties of alkaline activated Portuguese mine tailings. An optimal curing condition (60°C and 50% relative humidity) was observed. The findings are important for the utilization of mine wastes and the application of this low-carbon technique.

Electrokinetic treatment (EKT) of contaminated soil is regarded as a sustainable solution for land remediation (Reddy, 2010). Because when applied on site it does not disturb the soil, which benefits the redevelopment of the contaminated site. EKT is also regarded more cost-effective than soil flushing for the decontamination of clayey soil (Reddy, 2010). In the fifth paper, Gingine and Cardoso (2022) monitored the EKT of landfill leachate contaminated clay in laboratory. By monitoring the parameters such as the electrical conductivity and pH of the pore fluid, and changes in the electrical resistivity of the soil, as well as chemical analysis of soil metal concentration, it suggests the removal of metals from the soil by EKT. Operating conditions and monitoring provisions of EKT are important for an optimized performance in contaminant removal.

In conclusion, all the papers published in this issue are innovative and shed lights on what environmental geotechnics can do to help sustainable development and climate warming mitigation.

The International Society of Environmental Geotechnology (ISEG) seeks to promote scientific cooperation among countries, organizations and individuals on geoenvironmental issues (https://www.iseg.info/). I have been involved in environmental geotechnology and serving for ISEG for over 20 years (vice-president since 2000, and president since 2020). Quite a few of my projects are related to the work published in this issue. In 2000s, we aimed to provide sustainable solutions for the prevention of landfill leaching through cut-off walls using industrial by-products. In 2010s, we aimed to promote soil carbon storage by managing the land cover. We are now focusing on a range of topics aiming for sustainable development such as geological carbon storage, sustainable utilization of agricultural and industrial wastes, and management and utilization of shallow geothermal energy etc. In July 13–14 of 2021, the ISEG held a webinar themed 'New Challenges and Opportunities in Environmental Geotechnology' to address the new challenges in reaching carbon neutral targets, advancing sustainable infrastructure, and solving pollution problems for environmental geotechnics. The webinar revealed that a range of new research progress in environmental geotechnology has been achieved recently including:

1. the 'Carbon Target' is significantly influencing the research development
2. the protection of eco-system and the environment and the prevention of geohazard are becoming increasingly important
3. emerging technologies are aiding the development of environmental geotechnology.

Combining the findings from the five distinguished papers in this issue and the ISEG webinar, and my research experience, I suggest the following future research prospects in environmental geotechnology:

1. The development and application of low-carbon technologies
2. Green remediation of eco-system and the environment and high-efficient geohazard prevention
3. Deep interdisciplinary research based on the emerging technologies.

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