

## Why is the future ready for environmental geotechnics?

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# 1 Why is the future ready for environmental geotechnics?

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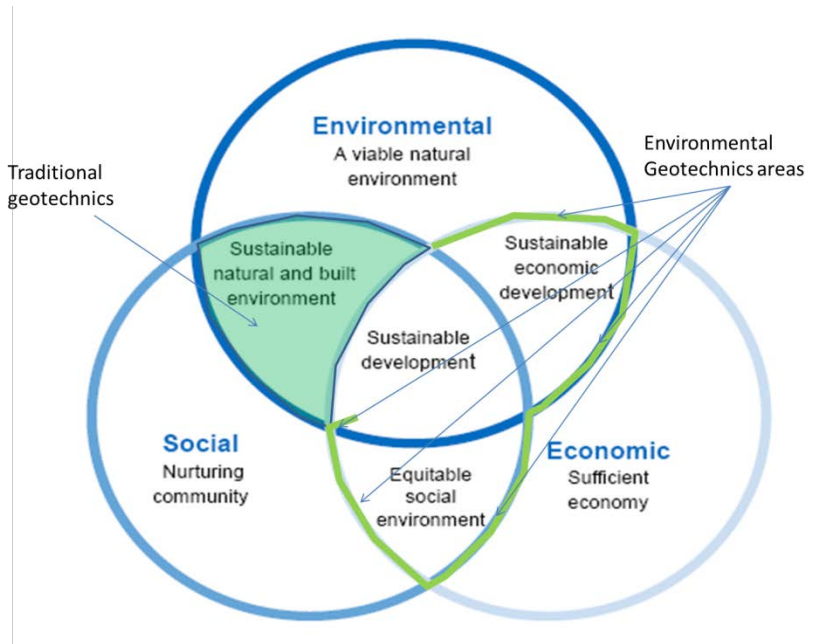
8 Working in and with the construction industry in the UK as a geotechnical engineer in the past 10  
9 years I had a chance to encounter a range of geotechnical problems and had the privilege to work on  
10 projects of varying scale each having its own peculiarities and significance. The problems each  
11 geotechnical engineer faces could roughly be classified in one or more of the following categories  
12 (Whitlow, 2000):

- 13 • Excavation and transportation of soils
- 14 • (Self-)Support of soil
- 15 • Flow of water into and within the soil
- 16 • Problems with shear strength of soil
- 17 • Problems with compressibility of soil
- 18 • Building with soils
- 19 • Contamination of soils

20 The challenge for me as a geotechnical engineer was to focus on the balance of the engineering  
21 solutions for the problem with the ground environment due not only to pressure from the clients  
22 and regulators but also to my increasing curiosity about the environment around the geotechnical  
23 solutions. I had to develop skills and knowledge to be aware and effectively consider the multiple  
24 layers of the environment affected by the geotechnical design and construction. Together with the  
25 traditional concerns over soil and geology, water and groundwater, financial aspects of the design  
26 and construction, the focus become shared with societal impacts, ecology, aesthetics, air quality,  
27 noise and vibration, energy and radiation, traffic and transportation, as well as preserving historical  
28 and archaeological treasures. Relatively early in my career I understood that only considering the  
29 above factors together can ensure a sustainable solution is reached – a solution which provides a  
30 balance in terms of the environment, society and financial aspects of the project. The balance is  
31 provided by the reliability, stability, durability of the solution from an engineering perspective but  
32 also its sustainability in terms of preserving and enhancing organic life, biodiversity, waste  
33 minimisation, resource preservation, etc.

34 This approach was adopted by many of our colleagues and not only put geotechnics in the heart of  
35 the sustainable development (Figure 1) but also gave rise to Environmental Geotechnics (EG), a  
36 subject area of civil engineering that deals with the phenomena in the interface between the nature  
37 and the man-made world. Civil and geotechnical engineers that had a chance to delve into this area  
38 on their continuous professional development paths and learned that EG provides a context where

39 the traditional civil engineering disciplines, including geotechnics, can enjoy revival and can develop  
40 further.



41  
42 Figure 1. Traditional and environmental geotechnics in relation to sustainable development.  
43 Adapted from United Nations, 1987.

44 Modern geotechnical engineers, who in the past would have considered the phenomena occurring  
45 in the (primarily soil) environment, today are faced with real development in environmental  
46 sciences which become more and more detailed and sophisticated with the natural phenomena and  
47 processes surrounding civil engineering infrastructure being modelled, monitored and assessed in a  
48 more scientific way. Planners and clients often specify environmental geotechnical performance of  
49 newbuilt projects but it is the duty of the geotechnical engineer to establish and justify the design  
50 with appropriate models, calculations based on assumptions and fact (ground investigations and soil  
51 mechanics principles).

52 The above concerns are usually taken into account during the option selection or analysis of  
53 alternatives where the technical feasibility based on geotechnical site characterisation and design  
54 principles should be juxtaposed against the environmental and societal concerns and the  
55 geotechnical engineer is faced with the following choice of solutions:

- 56 • No action
- 57 • Avoid site
- 58 • Design around the geo-environmental constraints

59 While I have found that a well-established 'no action' analysis can convince the client/public of the  
60 necessity of change, and the avoidance of the site can mean either total protection or 'passing the  
61 buck' to the next developer, the real challenges lie in the last solution in the list. The geotechnical  
62 engineer is faced with a choice of either introducing imported material to site which means  
63 exploitation of extra resources, environmental concerns with transport and production of the new  
64 material, etc. or mechanically/hydraulically/physically/chemically modifying the existing site

65 environment for a certain time period. Only by understanding and applying the environmental  
66 geotechnics principles can the choice be made to suit both geotechnical and environmental  
67 purposes.

68 In the past decade we witnessed the development and application of new plant/machinery and  
69 methods that came as a response to the environmental concerns of geotechnical engineers. Sonic  
70 drilling, intelligent compaction, geophysical methods have been developed to minimise the impact  
71 of geotechnical operations on the environment. New materials such as different polymers, fibres,  
72 foams, that provide sufficient strength while having standardised water retention properties,  
73 suitable durability, and are non-hazardous to the environment are constantly being developed. Re-  
74 use and re-cycling of waste materials such as pulverised fuel ash (PFA), crushed glass, construction  
75 rubble, used car tyres, is stipulated in the codes of practice and legislation often championed by the  
76 construction research bodies such as the Construction Industry Research and Information  
77 Association (CIRIA) , the Building Research Establishment (BRE), the Transport Research Laboratory  
78 (TRL). Through the International Conference on Soil Bio- and Eco-engineering, the International  
79 Network of ground bio- and eco-engineers ([www.inbe.cirad.fr](http://www.inbe.cirad.fr)) and the World Association for Soil  
80 and Water Conservation ([www.waswac.org](http://www.waswac.org)) promote geotechnical design with vegetation not only  
81 for erosion protection but also for slope stability and remediation based on a body of international  
82 research spanning engineering and biology (Norris et al. 2008). Similarly, the latest advances in the  
83 use of micro-organisms and chemical agents for soil stability which connects geotechnics with a  
84 number of natural and physical sciences serving the environment have been recently promoted  
85 through a “Bio- and Chemo- Mechanical processes in geotechnical engineering” symposium by the  
86 Institution of Civil Engineering (ICE).

87 Working with geotechnics graduates and young engineers I could see the change in attitude and  
88 scope the educational institutions instilled in recent years. The development of undergraduate and  
89 postgraduate courses such as Environmental Geotechnics and Environmental Civil Engineers  
90 contributed to shifting the geotechnical paradigm towards environmental sciences while  
91 accommodating the expanding interests of traditional geotechnical engineers. Further research in  
92 assessing the risks associated with EG and development of physical and numerical modelling of geo-  
93 environmental processes, including the integration of EG in the Building Information Modelling  
94 (BIM), are the current and latest challenges the education and research institutions are facing.  
95 Another challenge is providing a vehicle for the results of the new research to be implemented in  
96 practice to supplement the traditional continuous professional development (CPD) seminars and  
97 enable wider dissemination across different disciplines.

98 With the above challenges, among other personal and professional ones you are facing every day, I  
99 would like to share the passion for EG with you and also motivate to think outside the traditional  
100 boundaries of the mother discipline by never forgetting about the environment we all share.

101

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