**Cite this article**
Dean ETR (2021)
Editorial.
*Environmental Geotechnics* **8(6)**: 365–366,
https://doi.org/10.1680/jenge.2021.8.6.365

**Editorial**



Environmental Geotechnics

ice Publishing

# Editorial

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## IPCC Report

Geotechnical structures and processes straddle the interface between natural and built environments, and are likely to feel important effects of climate change and global warming. They are part of a building and construction industry that contributes almost 40% of global carbon production (UN, 2017). The latest report by the Intergovernmental Panel on Climate Change is currently available on the IPCC website. The full report (IPCC, 2021a) is around 1800 pages plus notes. At the date of writing the version available on the website is mostly still subject to copy-editing. There is a 42-page Statement for Policymakers (SPM), and a separate 150-page Technical Summary. Data used in the report are available in Excel form from the website. An interactive atlas is available (IPCC, 2021b), and the UN provides a brief and accessible summary (United Nations, 2021).

Figure 1 of this Editorial shows data from part of the information plotted in Figure SPM.1 of the IPCC report. The two curves show changes of average global temperature, referenced to the year 1855. Also shown is an average for the years 5 to 1000, based on reconstructed values. There seems to be an almost linear increase in the observed global temperature since about 1970, estimated by the present writer to be about 1°C every 60 years. Was 1970 a tipping point? Has something started we can no longer control? In the Cretaceous Period, from about 144–142 million years ago to the demise of the dinosaurs 65 million years ago, a hothouse equilibrium persisted over the globe, with luxurious forests where there is now Arctic tundra, and global sea levels that reached up to 200 meters higher at times than today (Skelton *et al*., 2002).

The IPCC's interactive map shows that small average global changes can lead to larger regional changes, with more extreme changes locally. The UN Summary notes that global warming of 2°C will likely be exceeded this century, and that there is now stronger evidence to expect increasing heatwaves, heavy precipitation, droughts, and cyclones.

These predicted changes, together with desertification, flooding, reduced ice cover, rising sea levels, and chemical changes including of seawater pH, seem likely to have profound effects on groundwater levels, and so on groundwater flows and the stability of foundations and earthworks. Effects will not be limited to coastal areas, and peats and other soils may in fact help to mitigate climate effects (Gewin, 2020). Design specifications may need to change, such as for environmental loading. In some regions more extreme changes may include collapse of permafrost (Wilkerson, 2021), affecting pipelines and utility lines, and release of methane hydrates and other gases from gassy soils offshore (Rogers, 2015).

## This issue of Environmental Geotechnics

In the first paper of this issue, Soliman *et al*. (2021) investigate stresses associated with sinkholes on karst ground, focussing on the brittle failure model of cover collapse, which relates to modes for tunnels, and the ductile failure mode of cover subsidence, which has similarities with the 'trap door problem' (e.g. Koutsabeloulis and Grifliths, 1989). Global warming will surely affect the frequency of occurrence of both modes, through effects on rates of processes described by the authors including chemical dissolution of carbonate rocks and soil ravelling. Numerical results presented by the Authors broadly support previous empirical approaches. This topic would seem ideal for future validation by geotechnical centrifuge modelling (Schofield, 1980).

In the second paper, Chen *et al*. (2021) describe an experimental and numerical investigation of the use of a biopolymer to control dust production from the surface of mine tailings pools. Airborne dust is an environmental problem in its own right, and mine tailings can also include toxic substances that one does not want to spread beyond their deposited location. This work may also be relevant to dust production in deserts and elsewhere. The authors describe saltation, which is a key process for dust production. Their experimental and numerical results confirm the effectiveness of the biopolymer which operates by coating particles, sticking particles down to other particles on the surface, and increasing the weight of a particle group to make it less likely to move.

The third paper, by Hata (2021), looks at a method of controlling sand permeability using yeast-enhanced microbe-assisted calcite precipitation to clog void passages, and sodium hypochlorite to unclog them. One aim is to reduce the need for cutoff walls and chemical grouting that use artificial materials such as cement and sodium silicate, and to avoid the need for dismantling associated temporary works. The author's experiments confirm the potential of the proposed method, which include processes that generate $CO_2$ and processes that change groundwater acidity. The author includes a recommendation for further investigation of the environmental impacts.

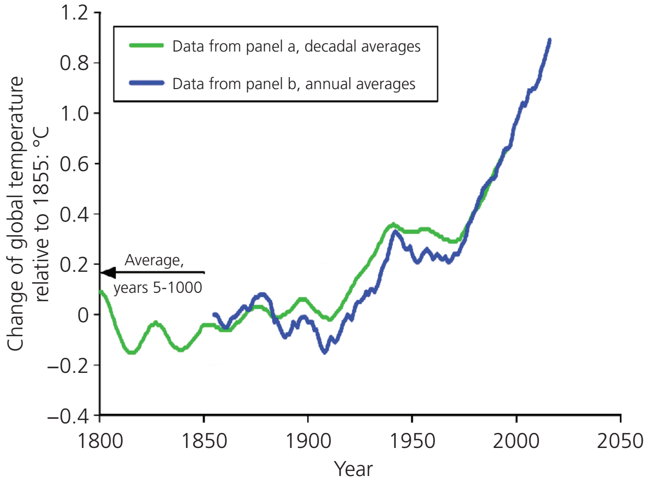


**Figure 1.** Historical data 1855-now and reconstructed changes of average global temperatures over previous centuries. Data originally part of Figure SPM-1 of IPCC (2021), downloaded from the IPCC website and used under Creative Commons Attribution 4.0 International License from the following CEDA catalogue page: http://creativecommons.org/licenses/by/4.0/ and http://catalogue.ceda.ac.uk/uuid/76cad0b4f6f141ada1c44a4ce9e7d4bd (Note: the downloaded data plotted here are slighted smoothed compared to the data of Figure SPM-1)

In the fourth paper, Cheng and Tang (2021) explore effects of changes of matric suction and temperature on the isotropic compression responses of loess. They note that loess is ‘a typical collapsible soil, … widely distributed in many parts of the world’. They found that a 100 kPa decrease in matric suction can cause a reduction in pre-consolidation pressure by factors of 3 (intact loess) to 4 (compacted loess) or more. 100 kPa would possibly be at the upper end of the reduction expected from local changes of rainfall and temperature resulting from global warming, but nevertheless indicates a major reduction in critical state strength of foundations and earthworks involving this material. They also confirmed the well-established thermal softening effect, indicating that significant softening may accompany global climate change.

The fifth paper, by Wang *et al*. (2021), starts with a review of hydraulic conductivity data in previous studies of municipal soil waste, and continues by presenting new data for samples prepared on the basis of the contents of an existing landfill in China. Geotechnical and environmental issues associated with landfills are described by Scott *et al*. (2019) and others, including problems of methane production and leachate. The authors’ test samples were formed from a mixture of textiles, bones, plastic, rubber, gravel, ceramics, soil, glass, paper, pak choi, cabbage, celery, apple, banana, wood and metal. They found that the logarithm of permeability decreased linearly with increasing pressure, density and age. These results will be of great benefit in understanding hydraulic issues in landfills and in the design of leachate collection systems.

The sixth paper, by Amaya *et al*. (2021), presents a thorough investigation of the possible use of lime to stabilize a very soft lacustrine soil in Mexico. An interesting feature of the technical work is that the soil changed from a clay to a silt as a result of chemical and electrical changes from adding sufficient lime. In addition to the technical aspects of the study, the authors make a preliminary assessment of the environmental impact of using lime. Benefits include the use of natural minerals, a reduced need for borrow pits far from the site, reduced transport impacts, and reduced impacts on ecosystems and local archaeological sites.

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