WHITE PAPER FOR NSF WORKSHOP

Name: Mohd Raihan Taha
Affiliation: Universiti Kebangsaan Malaysia
E-mail: drmrt@eng.ukm.my
Webpage: http://pkukmweb.ukm.my/~jkas/
http://www.lestari.ukm.my/temporganisasi.htm

Geoenvironmental Research Experience (list projects in progress or completed within the past 5 years)**:**

1. Adsorption of contaminants on residuals/tropical soils
2. Fundamental aspects of bioremediation in residual soils
3. Characteristics of tropical residual soils for use as compacted clay liners
4. Stabilization and solidification of contaminated residual soils
5. Contaminant transport in residual soils
6. Electrokinetic processing in residual soils
7. Geotechnical-geoenvironmental characterization and modeling of residual soils.

Geoenvironmental Teaching Experience (list related courses, including short courses, taught within the past 5 years)**:**

1. Environmental Geotechnics (Undergraduate & Graduate elective course)
2. Groundwater Engineering (Undergraduate elective course)
3. Short course in "Landfill Geotechnics" (I was the course chairman organized by The Institution of Engineers, Malaysia).
4. Geotechnics I (Undergraduate)
5. Geotechnics II (Undergraduate)
6. Foundation Engineering (Undergraduate)
7. Soil Improvement (Undergraduate)
8. Engineering Geology (Undergraduate)

Geoenvironmental Consulting Experience (list major projects only)**:**

1. Ground contamination at PC Site (expert witness/consultant)
2. Site evaluation for contaminated ground
3. Evaluation of construction on dumpsites/unengineered landfills
4. Assessment of ground contamination around dumpsites/unengineered landfills
5. Environmental impact assessments
6. Assessments of Danish environmental projects assistance

7. **Appraisal of Geoenvironmental Research, Education and Practice** (limit to 1-2 pages)**:**

The field of geoenvironmental engineering has grown so much in the last 10-15 years and it is now a well-developed field of expertise. A subject related to geoenvironmental engineering is not uncommon in many universities and its expertise is much sought after by institutions.

In general geoenvironmental research topics may be grouped as below

i. Properties and behavior of contaminated and uncontaminated soils;
ii. Waste characterization and mechanics;
iii. Contaminant transport;
iv. Landfill geotechnics;
v. Remediation systems;
vi. Reuse of contaminated soil/waste.

Each of these research topics have been actively undertaken in the past and will continue to grow as number of researchers and concern for the geoenvironment (especially in the developing and underdeveloped countries) increases. The area is now truly multidisciplinary in nature drawing people from almost all fields of science and engineering.

Since much work has been done, it is also possible for each of the afomentioned topics to represent a standard course title in a geoenvironmental graduate/postgraduate programs. In addition, such program should include "Policy and Regulatory Aspects of Contaminated Land". Obviously this topic is not normally researched by geoenvironmental engineers but has recently gained much prospect for companies looking to hire engineers. Furthermore, in practice, it is not only the hard science and technology that rules. Law and economics are also imperative. The recommended program of studies will further streamline the geoenvironmental majors in their own field of expertise. This replaces the traditional one or two geoenviroenmental courses which provided a "touch n' go" coverage of most of the listed materials.

Geoenvironmental engineering is an emerging area in developing countries like Malaysia and much yet to be done. Specific law and related regulations concerning soil contamination are still not in place. Thus strategic, commercial and social interest in matters related to ground contamination is generally low. The number of academicians and practitioners working in this area are very small compared to the general interest on the conventional geotechnical engineering. The immediate danger in practice is the adoption of results, experience and products from "western" countries when the soil, state of waste/contamination, weather, etc. are significantly different.

Perspective on Emerging Geoenvironmental Issues and Technologies (limit to 1-2 pages)**:**

Geoenvironmental engineers, researchers, academicians, practitioners, etc. should try to learn and take the advantage offered by nanotechnology. As written by Masciangoli and Zhang (2003) "one prospective solution (nanotechnology) is diminutive in size but immensely powerful in capacity. Such strong introduction on the ability of nanomaterials and nanotechnology to revolutionize environmental systems should not be taken lightly". In addition, Taha (2003) wrote that geoengineers have long realized the importance of nanoscale phenomenon. The silica and gibbsite sheet models for various clay minerals such as kaolinite and montmorillonite have Angstrom or nm units. For example, each basic kaolinite layer (a silica tetrahedral and an aluminum/magnesium octahedral sheets) is about 0.7 nm. The importance of the potassium ions in the structure of an illite mineral that differentiates it from the montmorillonite/smectite has long been recognized. The reality offered by nanotechnology is that we can now have much more control on the potassium ions. It is possible to add or remove them at will through nanorobots. Another important nanoscale phenomenon is the Guoy Chapman double layer thickness relationship. This formula has helped geoengineers to explain the changes in macro characteristics of soil such as hydraulic conductivity, strength, compressibility, etc due to change in soil chemistry. Nanotechnology can help in the further manipulation of this phenomenon to understand better the soil behavior and to use it more efficiently.

Geoengineers have "traditionally" involved in the physico-chemical processes and technologies. It is recommended that geoengineers be more proactive and involved in the use of green technologies offered by biotech industries. In this aspect bioremediation and phytoremediation comes into mind as these technologies, together with nanotechnology, will result in the use of less physical and chemical materials. Currently, the environmental engineers are spearheading this area but geoengineers knew much better on the main subject matter, i.e. soils.

References

Marciangoli, T., and Zhang, W.X. 2003. Environmental technologies at the nanoscale, *Environmental Sci. & Tech.* , March, pp. 102A-108A.

Taha, M.R. 2003. Nanotechnology advances for infrastructure development and maintenance, *Intl Conf. Adv. In Strategic Tech-ICAST 2003*, Vol. II, Universiti Kebangsaan Malaysia, pp. 1071-1076.