E-COURSE:
Soil contamination and remediation technology

Host institution	National University of Mongolia, School of Engineering and Applied Sciences
Credits	6 ECTS (optional course)
Lecturers	Davaasuren Davaadorj (National University of Mongolia)
Level	MSc and PhD course
Course duration	16 classes
Type	Research
OpenEDX link	http://online.num.edu.mn/courses/course-v1:NUM+ENVI+2021t3/about

Summary

This 3 ECTS course serves as an introduction to soil contamination assessment and its direct and indirect impact on environment, ecology and human health. It provides master and doctoral students coming from natural science backgrounds (and a limited exposure to multidisciplinary environmental studies) with a basic understanding of social aspects of environmental sciences, management and policy, in particular, those related to environment quality. The course includes background knowledge, data analysis, individual and group exercises, field work, seminar presentation and report writing.

Target student audiences

MSc and PhD students in environmental science,

Prerequisites

Required courses (or equivalents):

- Environmental science
- Soil quality assessment
- Environmental impact assessment

Aims and objectives

Main objective is to provide basic course provides students of environmental science and researchers with basic knowledge of geological structure, soil properties, ecology and soil pollutants assessment, soil cleaning processes and its limitations, prevention techniques, contaminants removal from soil by physical, chemical, biological, phyto-remediation etc. The soil contamination assessment and remediation course follows staged approaches which consists of three main concepts.

1. Concept 1: Soil chemical properties & CEC /Cation Exchange Capacity/
2. Concept 2: Pollution assessment and pollution source for soil contamination
3. Concept 3: Soil remediation technology

The Soil contamination and remediation knowledge consists divided over 4 main categories (Soil Cation Exchange Capacity, Soil contamination assessment, Contamination types and remediation technology). Finally, students will gain knowledge of soil contamination assessment and its impact and to select the remediation technology for cleaning the disturbed soils.

Concept 1 **Soil properties and Cation Exchange Capacity**
▪ Soil physical, chemical and biological properties ▪ Soil cation and Cation exchange capacity ▪ Soil pollution impact assessment
Concept 2 **Pollution assessment and pollution source for soil**
▪ Soil organic pollution ▪ Heavy metal pollution ▪ Soil fallout radionuclide contamination ▪ Urban soil degradation waste induced pollution
Stage 3 **Soil remediation technology**
▪ Soil remediation technology ▪ Phytoremediation

General learning outcomes:

By the end of the course, successful students will:

~ The knowledge of soil properties and CEC
~ Soil contamination resources and element extraction and transportation
~ Soil pollution types, pollution assessment
~ Negative impact from soil pollution and to estimate the pollution
~ Soil remediation technology

Applicable learning outcomes:

~ Soil pollution assessment: field sampling and laboratory analyses
~ Human health risk indices
~ To comparison of remediation technology and improve the remediate
~ To prepare the academic report and conduct the interview.

Overview of sessions and teaching methods

The teaching methodology will be based on class lectures and practical work classes. The lectures will consist of an expository session, which will serve to introduce the fundamental concepts associated with the syllabus. These classes will be followed by lectures and presentation lessons (8 lessons of 3 hours), aiming the preparation for lab classes, in which students will carry out the resolution of exercises using concepts covered in lectures, they will be explained the methodologies used in field work and practical classes, they will practice how to use legislation and quality standards for assessing the quality of soil, heavy metals and organic waste. Case studies will be studied. Practical classes (6 classes of 3 hours, interspersed in the other classes), are mainly targeting the implementation of practical classes for assessing soil quality, irrigation water and organic waste. Experimental and practical results will be analyzed and discussed. The aim of these practical classes is mainly to provide a more practical view of theoretical concepts as well as instigating the initiative and participation of students. The learning gained in classes will be measured by the elaboration of Reports, one for each laboratory work. This methodology allows the evaluation of learning objectives throughout the process, requires greater interaction between students and teacher, allowing constant assessment by the teacher of the knowledge acquired by the student, allowing you to make the necessary adjustments.

Course workload

The table below summarizes course workload distribution:

Activities	Learning outcomes	Assessment	Workload (hours)
In-class activities			
Lectures	Understanding theories, concepts, methodology and tools for contamination assessment and to select remediation technology	Class participation	30
Moderated in-class discussions	Understanding various policy and management contexts and common problems in communication in soil contamination and human induced soil pollution.	Class participation and preparedness for discussions	30
Independent work			
Paper review and discussion	Familiarity with and ability to critically and creatively discuss key concepts, tools and methods as presented in the literature	Class participation creative and active contribution to discussion	30
Practical research work	To use the contamination assessment of soil pollution and to collect data, data analyses, report writing and make presentation.	Class participation and preparedness for discussions	30
Total			120

Grading

The students' performance will be based on the following:

~ Level of preparedness for participation in class discussions and seminars (30% from 100% for active participation and demonstrated familiarity with the course readings to 0% for completely ignoring in-class discussions);
~ Contribution to group assignments and demonstration of individual work (30% from 100% for clearly demonstrated input to 0% for non-participation);
~ Quality of the approach application and reporting and presenting (40% from 100% for clearly shown the report and presentation to 0% for non-participation);
  - correct application of the approach +20%
  - write report +10%
  - make presentation +10%

Course schedule

Class	In class hours	Topics	Content	Class
1	4	Soil science and knowledge	Soil background and chemical, physical properties and soil pollution assessment	Lecture Seminar
2	4	Soil chemical properties and CEC	Soil pollution evaluation, and chemical reactions and pollution processes	Lecture Seminar
3	4	Soil contamination types	Soil contamination and contamination resources, soil polluted processes.	Lecture Seminar
4	4	Practical classes: to select study site, sampling method and evaluate the contamination assessment	Soil contamination assessment phases of study site selection, sampling methods, laboratory analyses, result and to prepare the report.	Seminar
5	4	Soil contamination assessment and estimation approaches	Soil contamination assessment and pollution indexes to estimate the contamination levels.	Lecture Seminar
6	4	Health risk assessment	Soil contamination impact on ecological and human health risks estimation. Carcinogen and non-carcigenic element and daily and annual	Lecture Seminar

			dose and life time cancer risk assessment.	
7	4	Soil organic pollution	Chemicals pollution in soils and chemical deposition, transportation and penetration of contamination resources.	Lecture Seminar
8	4	Heavy metal contamination	Heavy metal deposition, penetration and transportation, soil contamination assessment.	Lecture Seminar
9	4	Fallout radionuclide contamination and assessment	Fallout radionuclide of U, Th, Pb and K are deposition, direct, un-direct impact of contaminations	Lecture Seminar
10	4	Urban soil contamination and pollution resources	Soil contamination in different land uses of urban and to estimate the soil contamination of anthropogenic activity and resources.	Lecture Seminar
11	4	Soil remediation technology	Soil remediation technology of chemical, physical and biological technologies, to select remediation technology depending on pollution types.	Lecture Seminar
12	4	Phytoremediation technology	Phytoremediation technological phases, dominant plant types to use remediation and reduce the soil contamination processes	Lecture Seminar
13	4	Environmental degradation and soil contamination assessment of Mongolia	Land degradation, soil erosion and soil contamination rate in Mongolia and recent result studies.	Lecture Seminar
14	4	Soil pollution assessment and contamination rate studies: case study of big cities	The environment degradation and soil contamination assessment of biggest cities of Ulaanbaatar, Darkhan Erdenet etc.	Seminar
15	4	To estimate the human health risk assessment case	To use soil contamination result from landfill area of Nalaikh to assess the human health risk assessment	Seminar
16	4	The health risk assessment of fallout radionuclide contamination	To use fallout radionuclide results of ash basin of thermal power plant to assess the human health risks assessment	Seminar
Total	64			

Course assignments

Course assignments will constitute a multi-part project:

- Assignment No.1 – Soil contamination assessment paper reviewed based: Short report with make presentation in class 4
- Assignment No.2 – Urban soil contamination assessment and human induced land degradation of Mongolia: make a presentation with research report in class 14
- Assignment No.3 – The health risk assessment of soil contamination: make a presentation with research report in class 15-16.

Assignment No.1 The homework will require a to read previous study and literature cited work for students. This assignment will be focusing on the assessment methodology, application, detect a problem. There are need a at least 3 pages of the soil contamination assessment results need to prepare as a report and must submit their report and the result will be discussed during class 4.

Assignment No.2 The practical assignment will focusing soil contamination assessment and report in biggest cities of Mongolia for contamination impact on human health risks. It will help students to understand soil contamination resources, spatial distribution, types of soil contaminations in different land uses. This will include the review of research work and project reports related with biggest cities of sampling methodology, laboratory analyses, spatial and temporal changes. The assignment will be writing research report and make presentation. It's need a at least 3-5 pages of the assessment results

need to prepare as a report and to submit their report prior to class 14, and the result will be discussed during class 14.

Assignment No.3 the individual research will require a to estimate the soil pollution indices and human health risk assessment. Students will use the soil contamination data of landfill area and ash basins to estimate the pollution indices and health risk assessment and to prepare the research report and make a presentation. The individual report will require the research report of pollution indices and make presentation with human health risk assessment. The report will submit their report prior to class 15 and 16, and the result will be discussed during class 16.

Literature

Compulsory:

1. MNS5850:2018 Mongolian standard of Soil Quality. Permissible values of contamination
2. Jacques Oosthuizen. (2012) Environmental Health-Emerging Issues and Practices.

   Simone Morais, Fernando Garcia e Costa and Maria de Lourdes Pereire. **Chapter 10**. Heavy metals and human health. ISBN 978-953-307-854-0.
3. O. Batkhishig. (1996) Geochemical properties of Tuul river soils. PhD dissertation. Ulaanbaatar, Mongolia. Mongolian landuage.
4. G. Li, G.X. Sun, Y Ren, X, S Luo, Y, G Zhu. (2018). Urban soil and human health: a review. European Journal of Soil Science, 2018. doi: 10.1111/ejss.12518.
5. B. V. Tangahu, S. R Sheikh Abdullah, H. Basri, M. Idris, N. Anuar, M. Mukhlisin. (2011). A review on heavy metals (As, Pb & Hg) uptake by plants through phytoremediation. International Journal of Chemical Engineering/ Vol 2011. ID939361. doi:10.1155/2011/939161.
6. S. Khalid, M. Shahid, N, Khan Niazi, B. Murtaza, I. Bibi, C. Dumat. (2017). A comparison of technologies for remediation of heavy metal contaminated soils. Journal of Geochemical Exploration. 182 (2017) 247-268. http://dx.doi.org/10.1016/j.gexplo.2016.11.021
7. Y. G. Zhu and G. Shaw. (2000). Soil contamination with radionuclides and potential remediation. Chemosphere 41(2000) 121-128. PII: S 0 0 4 5 - 6 5 3 5 (9 9) 0 0 3 9 8 – 7.
8. K. H. Wedepohl (1995). The Composition of the continental crust. Geochimica et Cosmochimica Acta. Vol 59, No.7, pp-1217-1232.
9. Zheng N, Liu J, Wang Q *et al*., 2010. Health risk assessment of heavy metal exposure to street dust in the zinc smelting district, northeast of China. *Science of the Total Environment*, 408(4): 726–733.
10. Ferreira-Baptista L, De Miguel E (2005) Geochemistry and risk assessment of street dust in Luanda, Angola: A tropical urban environment. Atmospheric Environment 39(25):4501-4512.

Recommended:

11. Muhammad Aqeel Ashraf, Mohd. Jamil Maah and Ismal Yusoff. (2014). Environmental Risk Assessment of Soil Contamination. Chapter 1. Soil Contamination, Risk Assessment and Remediation. http://dx.doi.org/10.5772/57287.
12. U.S. EPA. 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Solid Waste and Emergency Response. Washington, DC. OSWER [20] - Directive No. 9355.4-24. December.
13. Risk Assessment Guidance for Superfund: Volume III - Part A, Process for Conducting Probabilistic Risk Assessment
14. United States Environmental Protection Agency (2002) Supplemental guidance for developing soil screening levels for superfund sites. Office of Emergency and Remedial Response, Washington
15. A.Kasassi, P.Rakimbei et.al, Soil contamination by heavy metals: measurements from a closed unlined landfill, Bioresour. Technol. 99 (2008) 8578-8584.
16. XW. Zhang, LS. Yang et.al, Impacts of lead/zinc mining and smelting on the environment and human health in China. Environ Monit Assess 2012, 184:2261-2273.