SUSC PS5130 Improving Health through Environmental Measurements in Water, Soil and Air
TBD
3 Credits

Instructors:  Lex van Geen, Lamont Research Professor in the Lamont-Doherty Earth Observatory, avangeen@ldeo.columbia.edu, (845) 365-8644

Office Hours:  TBD

Response Policy:  Students can expect a response within 24 hours, 7 days a week. Email is our preferred mode of communication.

Course Overview
Starting from a global perspective on the leading environmental contributors to the burden of disease, this course will lead participants through a series of case studies of environmental contaminations of natural or man-made origin. Airborne particulate matter from natural and anthropogenic sources, soil contamination with lead from mining and other industrial activities, and natural well-water contamination with arsenic are some of the topics to be covered. One of the goals of the course will be to develop the critical sense needed to distinguish indisputable harm from poorly substantiated claims and concerns by both reading the primary environmental and public health literature and analyzing existing data sets. The course will cover cases of egregious exposures in developing countries, as well as some environmental issues in and around New York City. The course will provide students with the opportunity to learn how to use and deploy several field kits and monitors for analyzing water, soil, and air, and assess the quality and implications of their own data. An emphasis on empowerment through measurement, mapping, and sharing of information will lead to a discussion of regulation, policies, and mitigation to reduce the burden of disease caused by environmental exposures in both industrialized and developing nations.

The course will provide students with the methods and tools to understand, monitor, and analyze current environmental health threats in water, soil, and air, and explore strategies for solving these at times complex challenges. Students will leave the course with a stronger sense of the power, and limitations, of environmental data and better equipped to evaluate and communicate the effectiveness of new interventions. After completing the course, students will more confidently apply core scientific concepts to evaluating and addressing public health challenges posed by, for instance, air, soil, and water contamination with lead.

This course is approved to satisfy the Area 4: Scientific Tools for Responding to Sustainability Challenges requirement for the M.S. in Sustainability Science Program.

Learning Objectives
Students will be expected to gain a quantitative understanding of the main processes that lead to contamination of water, soil, and air, based on the presented case-studies and their own measurements, as well as the ability to conduct back-of-the-envelope calculations and design a sampling campaign to gauge the new situations they may encounter in their career. Specific learning outcomes include:

L1. Identify and apply the tools and methods used to gauge the health impacts of environmental exposures.

L2. Collect, analyze and model scientific data to quantify environmental burdens on human health and address uncertainties that might lead to dispute.

L3. Use portable kits and instrumentation to quantify hazards in real-world environments.
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L4. Use environmental data to evaluate existing and new strategies for addressing public health challenges.

Readings

- Edwards, M. Fetal death and reduced birth rates associated with exposure to lead-contaminated drinking water. Environmental Science & Technology 48, 739-746 (2013). Pages 739-746
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- Peel, JL and Smith, KR. "Mind the Gap." Environmental Health Perspectives. 2010; 118 (12): 1643-1645. Pages 1643-1645

Resources

*Columbia University Library*

Columbia’s extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: [http://library.columbia.edu/](http://library.columbia.edu/).

*SPS Academic Resources*

The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: [http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources/](http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources).

Air monitors. Several air monitors that collect data in real-time will be available for student use, including black carbon monitors ([https://aethlabs.com/microaeth](https://aethlabs.com/microaeth)), particulate monitors for personal (RTI microPEMs [https://www.rti.org/sites/default/files/brochures/rti_micropem.pdf](https://www.rti.org/sites/default/files/brochures/rti_micropem.pdf)), Airbeams (Aircasting.org) or for fixed site indoor or outdoor use (PurpleAir.org).

Arsenic kit. Students will learn how to use a widely-used for measuring As in drinking water based on the 19th century Gutzeit method. Samples returned of well-water returned on regular basis from rural New Jersey through another project will provide an opportunity for using the kit and comparing the results to laboratory measurements (George et al., 2012)

Lead kit. Students will have the opportunity to use a qualitative (high, medium, low) kit for estimating bioaccessible lead in soil that is simplification of the standard EPA method (Drexel and Brattin, 2007). Results from this kit will also be compared to laboratory measurements.

Course Requirements (Assignments)

Three take-home quizzes on Water, Air, and Soil contaminants (L1, L2, L4)

The homework will gauge to which extent students are able to apply the material presented in class and the additional readings. The quizzes will each consist of 5 short problems requiring students to analyze and interpret data sets related to but not identical to the case-studies covered in class.

Final Group Project: Environmental Measurements (L1, L2, L3, L4)

The group reports will be derived from the environmental measurements conducted in the NYC area during the last two weeks of the course. The format of the presentations will follow the following format: 1) identify
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the problem, 2) quantify human health impact, 3) propose field measurements to inform the problem, 4) form
hypothesis on potential strategy to address the challenge, and 5) sample/measure locally and use appropriate
tools and methods. One example of a student project could be to conduct a soil survey for lead in some under-
sampled part of New York City. Students will use various instruments or kits to measure environmental
contamination in air, water, and/or soil and the importance of replication and calibration. The group will be
formed based on selected topics and individual interests. Starting on the third lecture (02/05), example topics
will be suggested in the class. On 04/02, details about the topics, requirement, and approach for designing the
study, collecting data, and data analysis will be discussed. The presentations will be given on 04/23 and
04/30. The presentation from each group will last about 30 minutes, followed by a 15 to 30 mins of
discussion. The final report will be about 15-20 pages in length with double line spacing, and should include
introduction, method, results, and discussion parts. The final report will be due on May 4.

Participation (L1, L2)

Class participation: students will come to class with readings completed and ready to participate in classroom
discussions.

Evaluation/Grading

Take-home problem sets/quizes: Air, Water, Soil (each 20%)
Problem sets will be scored on a scale of 0-100.
This problem set will be graded by the quality of the answers, including whether knowledge learned from
class and readings are used correctly, clearness of the answers, etc.

Final Group Project: Environmental Measurements (30%)
The final group presentation and report will be scored combined on a scale of 0-100.
Presentation will be graded based on a list of criteria, including whether the problem of hypothesis is clearly
stated, the study design, methods are data analysis are explained, and whether the results and interpretation
can be followed, as well as whether, the student(s) display knowledge during question and answering session.
Each group member must have a defined role. Final report will be graded on the depth of their understanding,
the merit of the writing, etc.

Participation (10%).
Participation in class discussions and the final group presentation will count towards 10% of final grade.
Students are expected to attend class and contribute at least one substantive comment every other week.
Substantive comments include answering questions, defending your point of view, and challenging the point
of view of others. Students must have contributed in the final group presentation.

The final grade will be calculated as described below:

**FINAL GRADING SCALE**

<table>
<thead>
<tr>
<th>Grade</th>
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<tbody>
<tr>
<td>A+</td>
<td>98–100 %</td>
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<td>A</td>
<td>93–97.9 %</td>
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<td>A-</td>
<td>90–92.9 %</td>
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<tr>
<th>ASSIGNMENT</th>
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<tr>
<td>Quiz 1: Air</td>
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<tr>
<td>Quiz 2: Soil</td>
<td>20</td>
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<tr>
<td>Quiz 3: Water</td>
<td>20</td>
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<tr>
<td>Environmental Measurements Group Project</td>
<td>30</td>
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<tr>
<td>Participation</td>
<td>10</td>
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**Course Policies**

*Participation and Attendance*
You are expected to complete all assigned readings, attend all class sessions, and engage with others in online discussions. Your participation will require that you answer questions, defend your point of view, and challenge the point of view of others. If you need to miss a class for any reason, please discuss the absence with the session’s lead instructor in advance.

*Late work*
There will be no credit granted to any written assignment that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor.

*Citation & Submission*
All written assignments must use [citation format], cite sources, and be submitted to the course website (not via email).

**School Policies**

*Copyright Policy*
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

*Academic Integrity*
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Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student’s disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.

Course Schedule/Course Calendar

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics and Activities</th>
<th>Readings (due on this day)</th>
<th>Assignments (due on this date)</th>
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<tbody>
<tr>
<td></td>
<td>1. Overview of where environmental exposures fall within top 20 causes</td>
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<td>2. Deaths and disability-adjusted life years (DALYS)</td>
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<td>3. Concentration and bioavailability</td>
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<td>Water and health.</td>
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<td>1. Microbial pathogens</td>
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<td>2. Geogenic and anthropogenic contaminants</td>
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<td></td>
<td>Air and health.</td>
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<td>1. Ambient PM2.5 and cardiovascular disease</td>
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<td>2. Indoor PM2.5 and cardiovascular health (mind the gap paper)</td>
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### Soils and health.

1. Flemming and the development of antibiotics from soil
2. Organic contaminants and inorganic contaminants.

### Statistics of sampling and measurements

1. Measurement accuracy
2. Measurement precision
3. Spatial and temporal variability
4. Hands on evaluation of data sets

**Ali Z, Bhaskar SB. Basic statistical tools in research and data analysis. Indian Journal of Anaesthesia 2016; Pages 662-669.**

### Overview of available hands-on tools for class projects

1. Water: Arsenic kit based on Gutzeit method
2. Air: light scattering nephelometer (PM2.5), light absorption for BC and ETS, Filter based measurements for chemical analysis.
3. Soil based: hand-held XRF, Pb extraction in glycine
4. SurveyCTO app for data collection

**George, CM, Y Zheng, JH Graziano, SB Rasul, JL Mey, A van Geen, Evaluation of an arsenic test kit for rapid well screening in Bangladesh, Environmental Science and Technology 46, Pages 11213-11219.**


### Laboratory

Class will be divided into smaller groups to measure and map (Google Earth) some form of contamination in the NY area e.g.:

- Air pollutant measurements of different types of restaurants or transportation modes using air monitors described above
- Well-water arsenic measurements in New Jersey
- Soil Pb measurements in playgrounds and parks
- Alternatively – analysis of large existing data set, or final summary push on global burden of disease (e.g. well-water arsenic in Bangladesh)

**Chillrud, SN, RF Bopp, HJ Simpson, J Ross, EL Shuster, DA Chaky, DC Walsh, CC Choy, LR Tolley and A. Yarme, Twentieth century metal fluxes into Central Park Lake, New York City, Environ. Sci. Technol. 33, 657-662, 1999.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>Description</th>
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</table>
| 2/26 | Water | 1. The hydrologic cycle  
2. Total Dissolved Solids in sea, surface, and groundwater  
3. Impact of redox conditions on natural waters  
Students submit group project ideas for approval |
| 3/5  | Water | 1. Global Burden of Disease- details on assumptions and calculations for Water  
2. Case Studies:  
   a. Microbial pathogens and sanitation  
   b. Arsenic in groundwater of the Bengal Basin  
   c. Lead in drinking water  
BGS/DPHE Executive Summary and Chapters 6 and 8. Pages xvii, 77-104, 151-160  
<table>
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<tr>
<th>Date</th>
<th>Topic</th>
<th>Authors/References</th>
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<tr>
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<td>Take-home 1: Water</td>
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<td>Peel, JL and Smith, KR. &quot;Mind the Gap.&quot; Environmental Health Perspectives. 2010; 118 (12): Pages 1643-1645.</td>
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1. Air circulation and mixing, physics of particle formation, primary and secondary pollutants
2. Natural and anthropogenic sources of airborne particles; Outdoor fine particulate matter (PM2.5) and cardiovascular disease

1. Global Burden of Disease- details on assumptions and calculations for Water
2. Case Studies:
   a. Improved cookstoves in developing countries
   b. Indoor VOCs and green solutions
   c. Atmospheric deposition of Pb and other contaminants in Central Park
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<tr>
<th>Date</th>
<th>Topic</th>
<th>Notes</th>
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<tr>
<td>4/2</td>
<td><strong>Proposal Presentations of Group Projects</strong></td>
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<td>1. Identify the problem</td>
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<td>3. Proposal of field measurement to inform the problem and</td>
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<td>4. Hypothesis on potential solution/policy change</td>
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<td>5. Local sampling/measurement plan using provided kits if appropriate</td>
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<td>Students present group project proposals to class</td>
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<td>1. What is a soil? Soil forming factors, processes, distribution of specific soils.</td>
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<td>2. Processes that affect soil contamination risk and dose.</td>
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<td>3. Role of speciation in controlling bioavailability.</td>
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<td>1. Global Burden of Disease- details on assumptions and calculations for Soil</td>
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<td>2. Case studies:</td>
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<td></td>
<td>a. Superfund sites.</td>
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<td>b. Soil lead (Peru mining, Brooklyn backyards)</td>
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<td>c. Acid mine drainage</td>
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<td>d. Parkinsonism and manganese.</td>
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<td>Take-home 3: Soil Group Project Presentations</td>
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<tr>
<td>4/23</td>
<td><strong>Presentations</strong></td>
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<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Details</th>
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<tbody>
<tr>
<td>4/30</td>
<td><strong>Presentations</strong></td>
<td>Group Project Presentations</td>
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<tr>
<td>5/4</td>
<td><strong>No Class Session - Assignment Due Date</strong></td>
<td>Group Final Report Due</td>
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