Water, Sanitation, Hygiene and Global Health

ENVR 682

Every spring on Tue/Thur 3:30-4:45.

Spring 2017 in 2304 MC

Instructors:

Jamie Bartram jbartram@unc.edu Office: Rosenau 162b Tel: 966 3934 Office hours: after class or by apt.	Mark D Sobsey sobsey@email.unc.edu Office: 149C Rosenau Hall Tel: 966 7303 Office hours: by apt.	Mike Fisher fishermb@email.unc.edu Office: 4114 Rosenau Hall Tel: 966 3843 Office hours: M/W 1-2 PM or by apt.

Course Context

Inadequate access to safe water, sanitation and hygiene ('WaSH') is a major cause of preventable morbidity and mortality, and accounts for a substantive portion of the global burden of disease. Inadequate WaSH services contribute to over one million deaths each year, and disproportionately impact children under the age of 5 in developing countries, with important implications for child survival, development, and human rights.

Improving WaSH services in these settings is therefore the target of major national and international policy efforts. While the disease burden related to WaSH is far less in developed countries, background and outbreaks of disease continue, and emerging contaminants continue to present new challenges, making WaSH the target of continued regulatory and policy action.

Dr. Jamie Bartram and Dr. Mark Sobsey are among the world's leading experts on global WaSH science, technology, and policy, with over 50 years of collective experience, and have both made substantive contributions to shaping international WaSH science and policy. This course is a unique opportunity to learn about a subject of considerable global health and human rights significance from two of its foremost figures.

It is hoped that this course will attract students with diverse backgrounds and enrolled in different programmes; and that this diversity will lead to a rewarding learning experience. Some students will already be familiar with subjects covered in some sessions and will be expected to contribute accordingly.

Course Scope (content)

This course builds on prior understanding of infectious and toxic hazards, disease causation and environmental transmission covered in ENVR 401 (Unifying Concepts), ENVR 430 (Health Effects of Environmental Agents) and elsewhere. Early units deal with hazard and disease classification; 'safety', 'risk' and vulnerability. Subsequent units consider interventions in WaSH and their impact on health; and approaches to their application in different settings. Distal factors influencing disease burden and control (such as climate change and population shifts) are considered, as are the underlying approaches to study of WaSH-related disease and intervention impact, and the policy measures deployed in order to advance disease prevention and control. Throughout, the course focuses both on the subject matter and on developing the methodological tools and fundamental critical thinking skills needed to effectively address future WaSH challenges.

Learning objectives

Students successfully completing this course will *understand*:

- The hazards causing WaSH-associated diseases; the scale and distribution of the associated disease burden across and within population groups; and underlying determinants and their distributions; (Contributes to MSEE/MS/MSPH/MPH department competencies: "Obtain broad exposure to contemporary issues in environmental sciences, environmental health and environmental engineering")
- The nature of the interventions available to assist control of this disease burden and the factors determining their efficacy and effectiveness (as well as the difference between the two), and the approaches taken and measures employed to ensure effective deployment of WaSH interventions in real-world settings; (Contributes to MSEE department competency "Evaluate the success of environmental engineering designs and assess the uncertainty involved")
- The policy implications of the above at the national and global levels; (Contributes to MSPH/MPH department competency: "Explain the relationships between scientific knowledge, exposure, risk assessment, environmental management and environmental policy." Contributes to CEPH cross-cutting competency: "Apply evidence-based concepts in public health decision-making.")
- The principal analytical tools and methodological approaches that are used in exploring the above, including epidemiological methods, risk assessments, standard setting, burden of disease calculations, cost-benefit analyses, water safety plans, and others;

Will have increased their *skills* and achieved a significant level of ability in:

- Interpreting and constructively criticizing associated evidence (literature);
- Assessing quality of evidence, synthesizing evidence and distilling 'state of the art';
- Working effectively in teams to address complex challenges (Contributes to CEPH cross-cutting competency: "Demonstrate basic team building, negotiation, and conflict management skills.")
- Communicating science effectively (Contributes to MESS department competency: "Demonstrate written and oral communication skills related to environmental engineering." Contributes to CEPH cross-cutting competency: "Demonstrate effective written and oral health communication skills appropriately adapted to professional and lay audiences with varying knowledge and skills in interpreting health information.")

Eligibility and pre-requisites

This course is designed to be accessible to graduate students and upper- level undergraduate students with background in engineering or public health. Core knowledge of chemistry, biology, epidemiology and statistics are required and would be satisfied by undergraduate or entry-level graduate courses in, for example, chemistry, biochemistry, microbiology, cell biology and epidemiology. Core knowledge of risk assessment is beneficial (and is addressed in ENVR 430 for example).

Student numbers will be limited to approximately 25 in order to enable adequate discussion and group interaction. If numbers of applicants exceed this limit then selection will take account of early sign-up and the benefits of diversity of backgrounds within the group in accepting students.

Course Presentation

The flow of the course will generally follow that summarized in 'course scope' (above) and more specifically Table 1, below. Preparatory readings for each session are identified on the accompanying reading list. Any amendments will be posted at least one week in advance.

Most sessions will take one of four formats:

- *Faculty instructor-presentation*-led: in which, for example more than half of the time available is allocated to a presentation by one of the faculty instructors and the remainder is for resulting discussion. Such sessions may have associated prior reading assignments.
- *Discussion based on prior reading with identified questions*: in which, for example, all students undertake prior assigned reading which is supported by instructor identified questions for discussion. Discussion then focuses on the identified questions, and will occupy more than half of the time. A brief instructor-led introductory presentation may precede the discussion.
- *Student-led discussion*: in which, for example, all students undertake prior assigned reading and two or more students (or groups of students) undertake wider reading on the issue and make 5-minute presentations. Discussion then focuses on the presentations. A brief instructor-led introductory presentation may precede the discussion.
- *Invited speaker*: in which, for example more than half of the time available is allocated to the invited speaker and the remainder is for resulting discussion. Such sessions may have associated prior reading assignments.

This course will include a substantive component of discussion and applying students should be aware of this and be prepared to contribute and learn. Every student will be expected to demonstrate knowledge of the underlying science, key concepts and principles and quantitative elements covered in the course by making presentations, participating in discussion and completing written assignments.

Table 1: Course Summary and section coverage

Section title	Learning objectives	Department Competency
Week 1 **Section 1: Introduction**	***Content ('need to know')*** Understanding of course flow and structure, grading and deadlines Understanding of scope of course and of underlying theme. ***Skill development ('need to be able to do')*** n/a	
Weeks 2-4 **Section 2: Hazards, exposure, impacts relationship to WaSH**	The purpose of Section 2 is to consolidate learning achieved in ENVR 401 and ENVR 430 (or equivalent) and their application to major WaSH-global health concerns. ***Content ('need to know')*** The types of hazard associated with the water environment and with sanitation and their classification. The routes of exposure from WaSH-related sources to humans. Examples of adverse health outcomes associated with inadequate WaSH	(Contributes to MSEE/MS/MSPH/MPH department competencies: "Obtain broad exposure to contemporary issues in environmental sciences, environmental health and environmental engineering")

	The concept of causality and examples of criteria used in assessing causality as applied to both outbreak and endemic WaSH-related disease. The types of information (eg epidemiology, animal studies, quantitative risk assessment) used in studying wash- health. ***Skill development ('need to be able to do')*** To apply established criteria to assess the quality of evidence for causality of a WaSH-health interactions.	
Weeks 5 - 6 **Section 3: What is 'safe' and how is safety regulated?** *and* **Section 4: Monitoring and managing hazards**: introduction to application of risk assessment and epidemiology in study of WaSH-related disease **Midterm EXAM**	The purpose of Section 3 is to relate prior learning to the concept of "safety" and to technical approaches to standard-setting and regulation, including quantitative derivation of criteria, guidelines and standards. Section 3 also considers the use of epidemiology and quantitative risk assessment in standard-setting and regulation. Section 4 considers methods for monitoring and managing chemical and microbial hazards as they relate to water and sanitation. The overall purpose of sections 3 & 4 includes exploring processes in developing standards and regulation that are fit-for-purpose, including associated monitoring. ***Content ('need to know')*** Technical approaches taken to quantitative derivation of microbial and chemical criteria, guidelines and standards (using examples from WHO and USA) How epidemiological evidence is used in these approaches (NB quality and critique of epidemiological evidence are not covered) How data from studies on animals is used in these approaches (NB quality and critique of animal evidence are not covered) Concepts of tolerable/acceptable disease burden and composite measures (example of DALYs). Risk assessment and its roles in derivation of criteria, guidelines and standards Risk perception and "outrage factors" Relationship of regulations and standards to monitoring.	(Contributes to MSPH/MPH department competency: "Explain the relationships between scientific knowledge, exposure, risk assessment, environmental management and environmental policy." Contributes to CEPH cross-cutting competency: "Apply evidence-based concepts in public health decision-making.")

	Processes of developing guidelines and criteria (eg public participation, inter-sectoral consultation) ***Skill development ('need to be able to do')*** Undertake DALY calculations (e.g., estimate relative disease burdens) Undertake simple QMRA calculations (e.g, quantitatively characterize the risk from the data on exposure (e.g., agent concentration and volume ingested) and health effects (e.g., dose-response data). Consider and address the quality of QMRA evidence based on quality and quantity of available data.	
Weeks 7 - 9 **Section 5: Interventions – how do we prevent harm/achieve requirements of safety?**	The purpose of section 5 is to ensure understanding of the state of knowledge concerning the range of tools available to directly improve the WaSH situation in various settings, major issues in their application and of the state of knowledge regarding their impacts on public health including factors influencing those impacts. ***Content (need to know)*** Understanding/appreciation of the role of technology, behavior (socio-cultural aspects), economics, and context, including government, policy/regulation and market forces in implementation. State of knowledge on comparative study of intervention impact. Scope of managerial interventions, understanding of Water Safety Plans as an example Scope of technical/engineering interventions, understanding of point-of-use and community water treatment and sanitation systems (excreta management) as examples. Concept of settings-based approaches, using WaSH in Schools and health care settings as examples. Scope of behavioral interventions, understanding of signage, CLTS, HWTS, and hand hygiene as examples. Concept of intervention sustainability and issues in its assessment and impact, using small community drinking-water supply as an example ***Skill development ('need to be able to do')***	(Contributes to MSEE department competency "Evaluate the success of environmental engineering designs and assess the uncertainty involved")

	Understand, know and calculate log_{10} microbial reductions by water and waste treatment unit processes as part of risk management. Understand and know the steps for developing and using a Water Safety Plan or a Sanitation Safety Plan	
Weeks 10-12 **Section 6: Organizing prevention**	The purpose of section 6 is to ensure understanding of the ways in which interventions are deployed through approaches at setting, local, national and international levels; and the state of knowledge regarding good practice at each of these three levels. Note that economic aspects are not addressed and are covered in PLAN 685 (Prof Whittington) ***Content (need to know)*** The importance of local, state, and international water, sanitation, and/or hygiene policies as frameworks through which interventions and preventative measures may be deployed to mitigate risks from hazards associated with water and human excreta. The principal components of a national 'enabling environment', using the examples of climate change adaptation and promotion of household water treatment and safe storage. International policy using as examples: the Millennium Development Goals and subsequent Sustainable Development Goals, and associated international targets for water and sanitation; the human rights to drinking-water and sanitation; and approaches to monitoring of international/global progress. ***Skill development ('need to be able to do')*** Examine and understand prevention initiatives and sources of evidence on their success, with a critical view of their successes, deficiencies and failures Examine and understand monitoring and evaluation of WaSH measures and the creation and use of M&E as a basis for tracking coverage and effectiveness Be able to take a critical view of prevention efforts and identify flaws or gaps (e.g., the "improved" water versus "safe" water conundrum of the water access MDG target, and subsequent attemtps to address this through the SDGs; appreciate and discern the deficiencies in HWWS	(Contributes to MSPH/MPH department competency: "Explain the relationships between scientific knowledge, exposure, risk assessment, environmental management and environmental policy." Contributes to CEPH cross-cutting competency: "Apply evidence-based concepts in public health decision-making.")

	prevention campaigns and the ways in which their "success" is tracked.	
Week 13 **Section 7: Distal determinants**	The purpose of Section 7 is to ensure understanding of the wide array of determinants, often outside of the direct control of national and international water, sanitation, and hygiene policies, that determine both WaSH status and progress. ***Content (need to know)*** The principal distal determinants and their influence on maintaining and advancing WaSH and thereby health. WaSH policy and programming responses to distal determinants using the examples of population and migration, as well as climate change; the impacts of disasters on health through WaSH and the disaster preparedness cycle. ***Skill development ('need to be able to do')*** Assess and interpret likely impacts of distal determinants on WaSH status; propose and prioritize potential mitigating measures.	(Contributes to MSEE/MS/MSPH/MPH department competencies: "Obtain broad exposure to contemporary issues in environmental sciences, environmental health and environmental engineering")
Weeks 14 and 15 **Section 8: Role of scientific evidence in decision-making (policy-making and practice)**	The purpose of this section is to draw together learning achieved through previous sections and, based on this, to explore: the global burden of WaSH-related disease and its distribution among population groups; the overall sustainability and thereby net impact/benefit of interventions; the use of scientific evidence in decision-making, through the example of wastewater reuse. Note this section includes a 'public debate' student exercise. ***Content (need to know)*** Approaches taken in assessing and enhancing the sustainability of water and sanitation systems, including technical and management aspects. Benefits and risks of wastewater reuse, technologies for treating and reusing wastewater, and polity considerations. Layers of influence on WaSH and health outcomesleading to understanding of state-of-the-science and its adequacy to support decision-making Science as one of several interacting influences in policy making and decision-taking on WaSH and global health. ***Skill development ('need to be able to do')***	(Contributes to MSPH/MPH department competency: "Explain the relationships between scientific knowledge, exposure, risk assessment, environmental management and environmental policy." Contributes to CEPH cross-cutting competency: "Apply evidence-based concepts in public health decision-making.")

	Assess strength of evidence for impact and sustainability of WaSH interventions Critically review evidence regarding the safety and cost/benefit ratio of wastewater reuse; synthesize the evidence; defend conclusions	
NB Course-long skill development	Ability to interpret and constructively criticize associated evidence (literature). Ability to assess quality of evidence, synthesize evidence and distil 'state of the art'. Ability to work in teams Communicate science effectively.	(Contributes to CEPH cross-cutting competencies: Demonstrate effective written and oral health communication skills appropriately adapted to professional and lay audiences with varying knowledge and skills in interpreting health information; demonstrate basic team building, negotiation, and conflict management skills.)

Course materials

The textbook for this course is:

Bartram, Jamie, ed. *Routledge Handbook of Water and Health*. Routledge, 2015. Individual chapters can be read online through the UNC library website: http://search.lib.unc.edu/search?R=UNCb8385388.

Additional required and recommended preparatory readings will be identified for most sessions and assignments will also require additional literature search and further unspecified reading (on the student's own initiative).

Course web site: (Sakai)

Student Evaluation

Summary:

- Written assignments: 40% (one term paper: 25%; two presentation summary reports: 7.5% each, 15% collectively).
- Class participation: 30% (presentations: 15% and discussion: 15%)
- Written exams: 20% (mid-semester)
- Teamwork exercise ('public debate') 10%.

Explanation:

Each student is expected to make brief (5 minute) individual or group presentations (in groups of no more than 3) based on preparatory readings and to lead discussion and respond to questions and comments for a number of sessions (student-led discussion sessions) during the course.

- Quality of preparation and delivery of presentations (including timing, organization, clarity, appropriate use of visual aids and delivery [including maintaining audience interest]) will account for 15% of final grade (2 x 7.5%).

- Students are expected to have prepared presentation materials (for example a PowerPoint and/or presentation plan notes) and to submit a hard copy of these to the instructors before making the presentation (immediately before making the presentation is accepted). Students should also upload all presentation materials to the "Student Presentations" folder on Sakai prior to making the presentation. Where student presentations are made in groups, one presentation per group is sufficient; this presentation should reflect the work of all group members.
- Each student is expected to submit a written summary report, not exceeding 500 words, (excluding any references and up to one figure/illustration) to the instructor at the time of making the presentation. Students should also upload these reports to the "Student Summary Reports" folder on Sakai prior to making the presentation. The quality of these written summaries will account for 15% of final grade (2 x 7.5%).

  Students should be aware that preparing an effective 500-word summary is typically more time-consuming than preparing a longer report on the same theme. The word limit for these summaries is intended to encourage clarity, insight and synthesis and the style sought is that of a briefing note e.g., to deal with the scope of the issue, state of understanding science and key knowledge gaps and the quality of underlying evidence.

The quality of participation in discussion during all session types will account for a further 15% of final grade. Each student should be prepared to make at least one comment, question, or intervention that substantively advances the discussion during each week of the course. Such participation will be tracked and scored each week. Students who struggle to engage may wish to consider planning some options for remarks and questions in advance.

Each student will be expected to prepare one term paper (i.e. a substantive written assignment) from possible assignment descriptions that will be announced. Students are encouraged to collaborate and work in groups on these papers, and covering the breadth of literature required will be greatly facilitated by such cooperation. However, written submissions must be the original work of the individual student. Reports should be not greater than 4000 words, to be submitted double-spaced, plus typically 15–40 references, of which at least 50% should typically be peer-reviewed articles. Text may be supplemented by up to five illustrative tables and/or figures. The style of presentation sought is typically that of an 'expert review' in a reputable scientific journal. In grading these papers, account will be taken of: clarity and precision; effective communication (to the reader); understanding of the assignment and insights into its scope, dimensions or components; synthesis of the state of knowledge; and quality and appropriateness of response(s) identified/proposed.

There will be one written examination. Grading will take account of the criteria applied to term papers, described above.

Course attendees will design, develop and implement a 'public debate' on an issue of contemporary relevance in WaSH and global health. The purposes of this exercise include: detailed reflection on an issue, development of teamwork skills, development of presentational and discussion skills; as well as reflection on how science is deployed in complex decision-making affecting WaSH and health. A 'public debate scenario' will be agreed in discussion with course participants around week 9 of the course. Attendees will agree the roles that are required and their distribution among individuals. The actual 'debate' may require additional time in attendance towards the end of the course. Students wishing to take this course should ensure their ability to participate in this activity.

General comments on evaluation

In all grading it is understood that it is the responsibility of the student to communicate effectively, clearly and precisely to the reader. Where a word limit is set it will be adhered to strictly (i.e., no account will be taken of any text beyond the word limit). Where a deadline is set for submission of work it will be adhered to strictly (zero grading for late-submitted work).

Pre- or co-requisite Courses.

In order to benefit fully from the course, ENVR students will normally be expected to have successfully completed or to take in parallel the courses below. For non-ENVR students, comparable background will be accepted at the discretion of the instructors

ENVR 401 Unifying Concepts

Unifying concepts of environmental systems, including conservation principles, modeling, economics, and policy with applications from throughout natural, engineered, and human systems. Interfaces among scientific, engineering, and policy aspects of the field

ENVR 430 Health Effects of Environmental Agents

Interactions of environmental agents (chemicals, infectious organisms, radiation) with biological systems including humans, with particular attention to routes of entry, distribution, metabolism, elimination, and mechanisms of adverse effects.