ENV H 593 A Wi 18: Current Topics In Risk Assessment

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SYLLABUS:

Life Cycle Analysis in Nanoparticle Risk Assessment

Winter Quarter 2018

ENVH 593 (Journal Club)

Credits: 1

Current Quarter Topic: Life Cycle Analysis in Nanoparticle Risk Assessment

Instructor:

Elaine M. Faustman, PhD, DABT

Professor, Department of Environmental and Occupational Health Sciences and Director, Institute for Risk Analysis and Risk Communication (IRARC)

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Office hours: By appointment

Course Times and Locations:

Tuesdays from 4:00-5:30pm

Sessions will be held on: 1/9,1/30, 2/13, 2/20, 2/27

Class will be held in 4225 Roosevelt Way NE, Suite 100 in Roosevelt 2228/212

Course Website: https://canvas.uw.edu/courses/1128941

- The Syllabus is posted on the website
- Within the files tab you will find folders containing the readings for each session.
- Please post your selection in the discussion section of canvas by 12pm the Monday before class.

Course Description:

New and emerging technologies, such as engineered nanoparticles, are rapidly being incorporated into consumer products, medical supplies, pharmaceuticals and the food supply. In risk assessment, we are concerned with exposures from directly using or consuming these products as well as exposures that occur throughout the life cycle of the product. Life cycle analysis can assess the environmental and public health impacts associated with a product beginning with the raw materials all the way through disposal or recycling. Understanding these factors is critical to a complete risk assessment.

Course Learning Objectives:

Upon completion of this journal club, students shall be able to:

- Understand the rationale and need for life cycle analysis in risk assessment
- Review reports and procedures from life cycle analysis from State, Federal and International agencies
- Discuss how nanomaterials from consumer products can be released in the environment and the implications for exposure and risk assessment

In general:

1. Think critically about risk assessment by completing reading assignments and participating in class discussions.
2. Communicate the concept of integrated risk assessment and risk communication.
3. Explain the risk assessment framework as it relates specifically to the current quarter topic.
4. Analyze assigned readings and interpret their relevance to not only the quarter topic but also their applicability and generalizability to risk assessment topics at large.
5. Summarize key points from assigned journal articles or other required readings.
6. Prepare and deliver an oral presentation(s) discussing the required reading.
7. Critique risk assessment applications as they relate to the current quarter topic.
8. Identify risk assessment strengths and challenges, as well as the role of uncertainty.
9. Develop skills to think critically about the methods and tools used for assessment, management, and communication of risk.

Academic Integrity Statement:

Students at the University of Washington (UW) are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity.
The UW School of Public Health (SPH) is committed to upholding standards of academic integrity consistent with the academic and professional communities of which it is a part. Plagiarism, cheating, and other misconduct are serious violations of the University of Washington Student Conduct Code (WAC 478-120). We expect you to know and follow the university's policies on cheating and plagiarism, and the SPH Academic Integrity Policy. Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington Community Standards and Student Conduct website.

UW Disability Statement (Links to an external site.) (http://depts.washington.edu/uwdrs/faculty-resources/syllabus-statement/)

Access and Accommodations: Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at206-543-8924 or **uwdrs@uw.edu** (mailto:uwdrs@uw.edu) or **disability.uw.edu** (http://disability.uw.edu/). DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Multi-cultural Inclusion Commitment from Environmental Health

The UW School of Public Health seeks to ensure all students are fully included in each course. We strive to create an environment that reflects community and mutual caring. We encourage students with concerns about classroom climate to talk to your instructor, your advisor, a member of the departmental or SPH Diversity Committee and/or the program director. DCinfo@uw.edu is a resource for students with classroom climate concerns.

We have the privilege of learning together and we have a responsibility to engage in dialogue in a way that supports learning for all of us. Many of the issues we will discuss in this course may concern issues of disproportionate risks, sensitivities, and impacts due to age, gender, race, and/or social inequalities. This is what public health hopes to address, however we know that these can be difficult topics to address, hence we thus feel it is even more important to be sensitive to our colleagues' experiences and ideas. Here are some practices we as learning community members can strive to use in our learning process:

- My own viewpoint is important—share it. It will enrich others.
- My students' and colleagues' viewpoints are important—listen to them. Do not judge them.
- Extend the same listening respect to others I would wish them to extend to me. We all have room to grow to become better listeners in non-judgmental ways.
- Recognize that I might miss things others see and see things others might miss.
- Raise my views in such a way that I encourage others to raise theirs.
- Inquire into others' views while inviting them to inquire into mine.
- Ask questions when I don't understand something.
- Surface my feelings in such a way that we make it easier for others to surface theirs.
- Test my assumptions about how and why people say or do things.
- Challenge what was said or done, rather than make assumptions about the individual.
- Beware of either-or thinking.

- Be willing to take risks in moving outside my comfort zones.
- Affirm others

<u>Course Session Schedule and Readings</u>:

Session 1: Introduction to Lifecycle Analysis and Engineered Nanoparticles

- Introductions- All

- Overall goals of the course and introduction to the topic- Elaine Faustman

Session 2: Existing frameworks for risk assessment and prioritization of EMNs (January 30th)

- Introduction- Elaine Faustman

-Presentation of Key Points from Readings- Students

*Please read **one review article** or sections of longer reports and **one example article** and be prepared to share the key points*

Session 2 Readings:

Review articles of frameworks for risk assessment and prioritization

Hristozov D, Gottardo S, Semenzin E, Oomen A, Bos P, Peijnenburg W, van Tongeren M, Nowack B, Hunt N, Brunelli A, et al. 2016. Frameworks and tools for risk assessment of manufactured nanomaterials. Environ Int. 95:36–53.

Boyes William, Thornton BLM, Souhail RAA, Andersen CP, Bouchard DC, Burgess RM, Cohen Hubal EA, Ho KT, Hughes MF, Kitchin K, Reichman JR, Robers RK, Ross JA, Rygiewicz PT, Scheckel KG, Thai SF, Zepp RG and Sucker RM. 2017. A Comprehensive framework for evaluating the environmental health and safety implication of engineered nanomaterials. Critical Reviews in Toxicology. 47:9, 767-810

Nanomaterials Technical Report: ISO/TR 13121:2011

Example frameworks for risk assessment and prioritization of ENMs

Arts JHE, Hadi M, Keene AM, Kreiling R, Lyon D, Maier M, Michel K, Petry T, Sauer UG, Warheit D, et al. 2014. A critical appraisal of existing concepts for the grouping of nanomaterials. Regul Toxicol Pharmacol. 70:492–506.

Bos PM, Gottardo S, Scott-Fordsmand JJ, van Tongeren M, Semenzin E, Fernandes TF, Hristozov D, Hund-Rinke K, Hunt N, Irfan MA, Landsiedel R. 2015. The MARINA risk assessment strategy: a flexible strategy for efficient information collection and risk assessment of nanomaterials. Int J Environ Res Public Health. 12(12):15007-21.

Cohen Y, Rallo R, Liu R, Liu HH. 2012. In silico analysis of nanomaterials hazard and risk. Acc Chem Res.

46(3):802-12.

Godwin H, Nameth C, Avery D, Bergeson LL, Bernard D, Beryt E, Boyes W, Brown S, Clippinger AJ, Cohen Y, et al. 2015. Nanomaterial categorization for assessing risk potential to facilitate regulatory decision-making. ACS Nano. 9:3409–3417

Hansen S, Jensen K, Baun A. 2013. NanoRiskCat: a conceptual tool for categorization and communication of exposure potentials and hazards of nanomaterials in consumer products. J Nanopart Res. 16:1–25.

Oomen AG, Bos PMJ, Fernandes TF, Hund-Rinke K, Boraschi D, Byrne HJ, Aschberger K, Gottardo S, von der Kammer F, Kühnel D, et al. 2014. Concern-driven integrated approaches to nanomaterial testing and assessment – report of the NanoSafety Cluster Working Group 10. Nanotoxicology. 8:334–348.

Som C, Nowack B, Krug HF, Wick P. 2012. Toward the development of decision supporting tools that can be used for safe production and use of nanomaterials. Acc Chem Res. 46:863–872.

Stone V, Pozzi-Mucelli S, Tran L, Aschberger K, Sabella S, Vogel U, Poland C, Balharry D, Fernandes T, Gottardo S, et al. 2014. ITS-NANO-prioritising nanosafety research to develop a stakeholder driven intelligent testing strategy. Part Fibre Toxicol. 11:9.

Session 3: Background on Lifecycle Assessment

- Introduction- Elaine Faustman

- Presentation of Key Points from Readings- Students

Please read two articles or sections of longer reports and be prepared to share the key points

Session 3 Readings:

Al-Abed SR, Virkutyte J, Ortenzio JNR, McCarrick RM, Degn LL, Zucker R, Coates NH, Childs K, Ma H, Diamond S, et al. 2016. Environmental aging alters Al(OH)3 coating of TiO2 nanoparticles enhancing their photocatalytic and phototoxic activities. Environ Sci: Nano. 2016;3:593–601.

Bare JC, Gloria TP. 2008. Environmental impact assessment taxonomy providing comprehensive coverage of midpoints, endpoints, damages, and areas of protection. J Clean Prod. 16(10):1021-35.

Bare, J.C., and Gloria, T.P., Critical Analysis of the Mathematical Relationships and Comprehensiveness of Life Cycle Impact Assessment Approaches, Environmental Science and Technology, 40, 4, 2006, pp. 1104 – 1113.

Jørgensen A, Le Bocq A, Nazarkina L, Hauschild M. 2008. Methodologies for social life cycle assessment. Int J Life Cycle Assess. 13(2):96.

Bare JC, Gloria TP, Norris G. 2006. Development of the method and U.S. normalization database for Life Cycle Impact Assessment and sustainability metrics. Environ Sci Technol. 40(16): 5108-15.

Murphy CJ, Vartanian AM, Geiger FM, Hamers RJ, Pedersen J, Cui Q, Haynes CL, Carlson EE, Hernandez R, Klaper RD, et al. 2015. Biological responses to engineered nanomaterials: needs for the next decade. ACS Cent Sci. 1:117–123.

Chapter 10 from National Research Council. 2014. A Framework to Guide Selection of Chemical Alternatives. Washington, DC: The National Academies Press. doi:https://doi.org/10.17226/18872.

Praetorius A, Scheringer M, Hungerbühler K. 2012. Development of Environmental Fate Models for Engineered Nanoparticles: A Case Study of TiO2 Nanoparticles in the Rhine River. Environ Sci Technol. 46(12):6705-13.

Session 4: Application of Lifecycle Assessment for ENMs

Session 4 Readings:

Bergamaschi E, Murphy F, Poland CA, Mullins M, Costa AL, McAlea E, Tran L, Tofail SA. 2015. Impact and effectiveness of risk mitigation strategies on the insurability of nanomaterial production: evidences from industrial case studies. Wiley Interdiscip Rev Nanomed Nanobiotechnol. 7(6):839-55.

Gao Y, Yang T, Jin J. 2015. Nanoparticle pollution and associated increasing potential risks on environment and human health: a case study of China. Environ Sci Pollut Res Int. 22(23):19297-306.

Gilbertson LM, Busnaina AA, Isaacs JA, Zimmerman JB, Eckelman MJ. 2014. Life cycle impacts and benefits of a carbon nanotube-enabled chemical gas sensor. Environ Sci Technol. 48(19):11360-8.

Lee J, Mahendra S, Alvarez PJ. 2010. Nanomaterials in the construction industry: a review of their applications and environmental health and safety considerations. ACS Nano. 4(7):3580-90.

Tolaymat TM, El Badawy AM, Genaidy A, Scheckel KG, Luxton TP, Suidan M. 2010. An evidence-based environmental perspective of manufactured silver nanoparticle in syntheses and applications: a systematic review and critical appraisal of peer-reviewed scientific papers. Sci Total Environ. 408(5):999-1006.

Wohlleben W, Brill S, Meier MW, Mertler M, Cox G, Hirth S, von Vacano B, Strauss V, Treumann S, Wiench K, Ma-Hock L. 2011. On the Lifecycle of Nanocomposites: Comparing Released Fragments and their In-Vivo Hazards from Three Release Mechanisms and Four Nanocomposites. Small. 7(16):2384-95.

Tulve NS, Stefaniak AB, Vance ME, Rogers K, Mwilu S, LeBouf RF, Schwegler-Berry D, Willis R, Thomas TA, Marr LC. 2015. Characterization of silver nanoparticles in selected consumer products and its relevance for predicting children's potential exposures. Int J Hyg Environ Health. 218(3):345-57.

Gottschalk F, Sonderer T, Scholz RW, Nowack B. 2009. Modeled environmental concentrations of engineered nanomaterials (TiO2, ZnO, Ag, CNT, fullerenes) for different regions. Environ Sci Technol 43: 9216-9222

Auffan M, Rose J, Bottero JY, Lowry GV, Jolivet JP, Wiesner MR. 2009. Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective. Nature nanotechnology. 4(10):634-41.

Nowack B, Ranville JF, Diamond S, Gallego-Urrea JA, Metcalfe C, Rose J, Horne N, Koelmans AA, Klaine SJ. 2012. Potential scenarios for nanomaterial release and subsequent alteration in the environment. Environmental Toxicology and Chemistry. 31(1):50-9.

De Volder MF, Tawfick SH, Baughman RH, Hart AJ. 2013. Carbon nanotubes: present and future commercial applications. Science. 339(6119):535-9.

Session 5: Lifecycle Assessment Activity

GaBi Life cycle assessment software (30 free trial): **http://www.gabi-software.com/international/solutions/life-cycle-assessment/** (http://www.gabi-software.com/international/solutions/life-cycle-assessment/)

Session 6: LCA Case Studies

Garrett, P.E., Klein, M. and Collins, M., 2009. Life Cycle Assessment (LCA) of Product Stewardship Options for Mercury-Containing Lamps in New Zealand. **http://www.mfe.govt.nz/publications/waste/life-cycle-assessment-product-stewardship-options-mercury-containing-lamps-new-4** (http://www.mfe.govt.nz/publications/waste/life-cycle-assessment-product-stewardship-options-mercury-containing-lamps-new-4)

- refer to chapter 3 (scope of the LCA), whole report on canvas files

Saouter, E. and Van Hoof, G., 2002. A database for the life-cycle assessment of Procter & Gamble laundry detergents. *The International Journal of Life Cycle Assessment*, *7*(2), pp.103-114.

Life-cycle assessment of energy and environmental impacts of LED lighting products Part 1: Review of the Life-Cycle Energy Consumption of Incandescent, Compact Fluorescent, and LED Lamps. 2012 February

OSRAM. Life cycle assessment of illuminants—A comparison of light bulbs, compact fluorescent lamps and LED lamps. OsramOpto Semiconductors GmbH. 2009.

Ramroth L. Comparison of life-cycle analyses of compact fluorescent and incandescent lamps based on rated life of compact fluorescent lamp. Rocky Mountain Institute. 2008 Feb:11-2.

Course Summary:

Date	Details