Syllabus:
Earth Systems 114/Human Biology 114:
Global Change and Emerging Infectious Disease

WMF 11:30-1:20 (Lecture MW, Sections F)
Spring 2020

Instructors:

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Course Description:

This is a lecture course on the changing epidemiological environment, with particular attention to the ways in which anthropogenic environmental changes are altering the ecology of infectious disease transmission, thereby promoting their re-emergence as a public health threat. Organized by case studies of environmental change at (roughly) local to global scales, we focus on the role that environmental changes (such as deforestation and land-use conversion, urbanization, human migration, international commerce, and climate change) play in contemporary disease transmission. The diseases affected by these environmental changes include SARS CoV-1, SARS CoV-2 (COVID-19), Avian Flu, Malaria, Dengue Fever, Zika, Chagas disease, Lyme, Influenza, Cholera, Hantavirus, BSE/vCJD, and West Nile Virus.

We will focus on five broad global changes that have a substantial impact on the emergence, re-emergence, and persistence of infectious disease. These include: (1) Climate Change, (2) Migration/Mobility (both human and nonhuman), (3) Habitat/Biodiversity Destruction, (4) Social and Economic Inequality, and (5) Changing Selective Landscapes and Accelerated Evolution.

Given the ongoing disruption caused by the COVID-19 pandemic, the class will be taught remotely. In general, new lecture materials will be distributed on Mondays and Wednesdays. We will try to run synchronous lectures in general. However, John is a practicing infectious-disease physician in a time of pandemic crisis. This means that he may not always be able to give his lectures during the appointed class times. In this case, there will be pre-recorded videos available. All lectures will be saved for asynchronous viewing.

Throughout the quarter we will devote some class time to synchronous sessions, dedicated to updates and discussion of the COVID-19 outbreak. These will be recorded and uploaded.

Friday will be reserved for sections which will be led by the TAs and consist of journal article discussion.

Prerequisites:

One of the following: HUMBIO 2A & 2B, the Bio Core, the Earth Systems Core, or permission of the instructors.

Problem Sets:

There will be eight total problem sets (approximately 1 per week). The problem sets will reinforce skills discussed in lecture and call on the weekly readings. Problem sets will be made available on Canvas. If you are enrolled in the course for 5 units, you will need to do all of the problem sets. If you are enrolled in the course for 4 units, you will be expected to turn in 6 of the problem sets (you can skip two of your choice).

Sections:

Discussion sections will meet over Zoom starting the second week of the course. Sections function as journal clubs and discussion of general concepts in the class. In sections you will be discussing the required readings, so please come prepared! On weeks that we have COVID-19 discussions, there will be no sections. These are clearly marked on your syllabus.

For those of you enrolled in a graduate format of the class, there will be a graduate section led by the instructors -- this section will cover more advanced topics.

While we strongly encourage you to attend section, we understand the limitations due to time differences and technical difficulties, for this reason attendance will not be taken and section participation will not be a part of your grade.

Exams

Given the ongoing circumstances there will be no exams for this course.

Op-Ed Assignment
Students taking the course for 5 units will need to write a brief op-ed about an infectious disease topic. Full instructions for the assignment will be uploaded to Canvas. This assignment is due June 5, 2020.

Grading:

5- Unit Students		**4-Unit Students**	
Problem Sets:	80%	Problem Sets:	100%
Op-Ed:	20%		

Readings:

There is no text for this class. Instead, we will use readings from the primary scientific literature throughout the quarter. All papers are directly linked from the syllabus via their digital object identifier (doi). When a work is not available via doi, it will be available on Canvas.

You should do the required readings each week and come to section prepared to discuss them; other readings are listed as “optional” and are not required reading.

For a number of the lectures, there will be associated lecture notes. These will be made available on Canvas.

Lectures:

Each lecture below is marked by one of the following indicating how it will be given and when it will be made available.

> ***** = Lectures will be given live from 11:30 am to 1:20 pm via Zoom; following the live lecture, videos will be uploaded to Canvas
> **§** = The lecture will be pre-recorded and no live feed will be available; video files will be uploaded on Canvas on Mondays before 11:30 am.

A Final Note

Although disease ecology is a growing field, there are not many opportunities for its study at Stanford. This class is one of the few opportunities to do so. We recognize that the current pandemic and the necessary remote nature of the class make learning difficult; and some of you might not have the experience that you had hoped for. Usually the class has a lengthy research paper allowing students to look deeply into a subject of interest. If you are a student who has an interest in infectious diseases or disease ecology and are interested in pursuing more in-depth study, please reach out to the teaching team — we are happy to support you in developing an independent course of study allowing you to explore this subject more deeply based on your interests.

The Syllabus is subject to change, so make sure you're working from the most up-to-date version! We will note on Canvas any time the syllabus is updated.

Class Schedule (Subject to Change)
New lecture materials are posted on Monday and Wednesday.
Live sessions will be held 11:30 – 1:20 via Zoom.

Section 1 Introduction: Tools of the Trade

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6 April (M) **The Future is Now: Ebola Ecology and Politics (Jones)***

Readings:

Morens, D.M., P. Daszak, and J.K. Taubenberger. 2020. Escaping Pandora's Box: Another Novel Coronavirus. *New England Journal of Medicine*. (doi:10.1056/NEJMp2002106)

Farrar, J. 2019. Science, innovation and society: what we need to prepare for the health challenges of the twenty-first century? *International Health*. 11 (5):317-320. (doi:10.1093/inthealth/ihz047)

Chowell, G., and H. Nishiura. 2015. Characterizing the Transmission Dynamics and Control of Ebola Virus Disease. *PLoS Biology*. 13 (1):e1002057. (doi:10.1371/journal.pbio.1002057)

Optional:

Drake, J.M., I. Bakach, M.R. Just, S.M. O'Regan, M. Gambhir, and I.C.-H. Fung. 2015. Transmission Models of Historical Ebola Outbreaks. *Emerging Infectious Diseases*. 21 (8):1447-1450. (doi:10.3201/eid2108.141613)

Leendertz, S.A.J., J.F. Gogarten, A. Düx, S. Calvignac-Spencer, and F.H. Leendertz. 2016. Assessing the Evidence Supporting Fruit Bats as the Primary Reservoirs for Ebola Viruses. *EcoHealth*. 13 (1):18-25. (doi:10.1007/s10393-015-1053-0)

8 April (W) **The First Major Emerging Infectious Disease of the 21st Century and a Harbinger of Things to Come: SARS**

Readings:

Anonymous. Prevent and predict. *Nature Ecology & Evolution*. (doi:10.1038/s41559-020-1150-5)

10 April (F) **Measuring Outbreaks and Introduction to Complex Systems (Jones)***

Readings:

Arthur, R.F., E.S. Gurley, H. Salje, L.S.P. Bloomfield, and J.H. Jones. 2017. Contact structure, mobility, environmental impact and behaviour: the importance of social forces to infectious disease dynamics and disease ecology.

Philosophcical Transactions of the Royal Society B: Biological Sciences. 372 (1719). (doi:10.1098/rstb.2016.0454)

Optional:

Ngonghala, C.N., M.M. Pluciński, M.B. Murray, P.E. Farmer, C.B. Barrett, D.C. Keenan, and M.H. Bonds. 2014. Poverty, Disease, and the Ecology of Complex Systems. *PLoS Biology*. 12 (4):e1001827. (doi:10.1371/journal.pbio.1001827)

13 April (M) **Models of Infectious Disease and the Basic Reproduction Number (Jones)***

Readings:

Jones, J.H. Notes on R_0.

Optional:

Dietz, K. 1993. The estimation of the basic reproduction number for infectious diseases. *Statistical Methods in Medical Research*. 2 (1):23-41. (doi:10.1177/096228029300200103)

More Advanced:

Bjornstad, O.N. 2018. *Epidemics: Models and Data using R*. Cham, Switzerland: Springer, chapters 1-3. (doi:10.1007/978-3-319-97487-3)

15 April (W) **Ecology and Evolutionary Biology for Infectious Disease (Jones)***

Readings:

Johnson, P.T.J., J.C. de Roode, and A. Fenton. 2015. Why infectious disease research needs community ecology. *Science*. 349 (6252):1259504. (doi:10.1126/science.1259504)

Galvani, A.P. 2003. Epidemiology meets evolutionary ecology. *Trends in Ecology & Evolution*. 18 (3):132-139. (doi:10.1016/S0169-5347(02)00050-2)

Optional:

Dobson, A., I. Cattadori, R.D. Holt, R.S. Ostfeld, F. Keesing, K. Krichbaum, J.R. Rohr, S.E. Perkins, and P.J. Hudson. 2006. Sacred Cows and Sympathetic Squirrels: The Importance of Biological Diversity to Human Health. *PLoS Medicine*. 3 (6):714-718. (doi:10.1371/journal.pmed.0030231)

Palumbi, S.R. 2001. Humans as the World's Greatest Evolutionary Force. *Science*. 293 (5536):1786-1790. (doi:10.1126/science.293.5536.1786)

17 April (F) **Sections meet; Problem Set #1 Due**

Section 2: Climate Change

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20 April (M) **Vectors of Change: Climate and Shifts in Vector Behavior and Habitat (Openshaw)§**

Readings:

Patz, J., Frumkin, H., Holloway, T. (2014). Climate Change: Challenges and Opportunities for Global Health. *JAMA,* 312(15):1565-1580. doi:10.1001/jama.2014.13186

Mordecai EA, Caldwell JM, Grossman MK, et al. (2019). Thermal biology of mosquito-borne disease. *Ecology Letters*, 22(10):1690-1708. doi:10.1111/ele.13335

Optional:

Kraemer, M. U. G., Reiner, R. C., Brady, O. J., Messina, J. P., Gilbert, M., Pigott, D. M., et al. (2019). Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. *Nature Microbiology*, 1. (doi:10.1038/s41564-019-0376-y)

Paaijmans, K. P., A. F. Read, and M. B. Thomas. 2009. Understanding the link between malaria risk and climate. *Proceedings of the National Academy of Sciences, USA* . 106 (33):13844-13849. (doi:10.1073/pnas.0903423106)

Ogden, N. H., Radojevic, M., Wu, X., Duvvuri, V. R., Leighton, P. A., & Wu, J. (2014). Estimated Effects of Projected Climate Change on the Basic Reproductive Number of the Lyme Disease Vector Ixodes scapularis. Environmental Health Perspectives. (doi:10.1289/ehp.1307799)

22 April (W) **The Perfect Storm: Extreme Weather, Malnutrition, and Pathogens (Openshaw)§**

Readings:

Hulland, E., Subaiya, S., Pierre, K., Barthelemy, N., Pierre, J. S., Dismer, A., et al. (2019). Increase in Reported Cholera Cases in Haiti Following Hurricane Matthew: An Interrupted Time Series Model. *The American Journal of Tropical Medicine and Hygiene*, *100*(2), 368–373. (doi:10.4269/ajtmh.17-0964)

Rieckmann, A., Tamason, C., Gurley, ES., Rod, NH., Jensen, PKM. Exploring Droughts and Floods and Their Association with Cholera Outbreaks in

Sub-Saharan Africa: A Register-Based Ecological Study from 1990 to 2010. (2018). Am. J. Trop. Med. Hyg., 98(5), pp. 1269–1274 doi:10.4269/ajtmh.17-0778

Optional:

Reiner, R. C., King, A. A., Emch, M., Yunus, M., Faruque, A. S. G., & Pascual, M. (2012). Highly localized sensitivity to climate forcing drives endemic cholera in a megacity. *Proceedings of the National Academy of Sciences*, *109*(6), 2033–2036. (doi:10.1073/pnas.1108438109)

Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., et al. (2017). Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition. *Annual Review of Public Health*, *38*, 259–277. (doi:10.1146/annurev-publhealth-031816-044356)

24 April (F) **Sections meet; Problem Set #2 Due**

27 April (M) **Trophic Amplification in a More Variable World (Jones)***

Readings:

Yates, T.L., J.N. Mills, C.A. Parmenter, T.G. Ksiazek, R.R. Parmenter, J.R. Vande Castle, C.H. Calisher, S.T. Nichol, K.D. Abbott, J.C. Young, M.L. Morrison, B.J. Beaty, J.L. Dunnum, R.J. Baker, J. Salazar-Bravo, and C.J. Peters. 2002. The Ecology and Evolutionary History of an Emergent Disease: Hantavirus Pulmonary Syndrome. *Bioscience*. 52 (11):989-998. (doi:10.1641/0006-3568(2002)052[0989:teaeho]2.0.co;2)

Optional:

Ostfeld, R.S., and R.D. Holt. 2004. Are predators good for your health? Evaluating evidence for top-down regulation of zoonotic disease reservoirs. *Frontiers in Ecology and the Environment*. 2 (1):13-20. (doi:10.1890/1540-9295)

Collinge, S.K., W.C. Johnson, C. Ray, R. Matchett, J. Grensten, J.F. Cully, K.L. Gage, M.Y. Kosoy, J.E. Loye, and A.P. Martin. 2005. Testing the Generality of a Trophic-cascade Model for Plague. *EcoHealth*. 2 (2):102-112. (doi:10.1007/s10393-005-3877-5)

Section 3: Habitat Destruction and Loss of Biodiversity

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29 April (W) **Deflected Succession, the Dilution Effect, and the Emergence of Lyme Disease in the Eastern Woodlands (Jones)***

Readings:

Keesing, F., R.D. Holt, and R.S. Ostfeld. 2006. Effects of species diversity on disease risk. *Ecology Letters*. 9 (4):485-498. (doi:10.1111/j.1461-0248.2006.00885.x)

Optional:

Wood, C.L., and K.D. Lafferty. 2013. Biodiversity and disease: a synthesis of ecological perspectives on Lyme disease transmission. *Trends in Ecology & Evolution*. 28 (4):239-247. (doi:10.1016/j.tree.2012.10.011)

Salkeld, D.J., K.A. Padgett, and J.H. Jones. 2013. A meta-analysis suggesting that the relationship between biodiversity and risk of zoonotic pathogen transmission is idiosyncratic. *Ecology Letters*. 16 (5):679-686. (doi:10.1111/ele.12101)

1 May (F) **Sections meet; Problem Set #3 Due**

4 May (M) **COVID-19 Update and Discussion**

6 May (W) **Building New Ecologies: Case Studies in Urbanization and Infectious Diseases (Openshaw)§**

Readings:

de Castro, M. C., Monte-Mór, R. L., Sawyer, D. O., & Singer, B. H. (2006). Malaria risk on the Amazon frontier. *Proceedings of the National Academy of Sciences*, *103*(7), 2452–2457. (doi:10.1073/pnas.0510576103)

Optional:

Wilcos, B., Gubler, DJ., Pizer HF. (2008). Urbanization and the social ecology of emerging infectious diseases. In *The Social Ecology of Infectious Diseases* (pp. 113–137). Academic Press. http://doi.org/10.1016/B978-012370466-5.50009-1

Hassell JM., Begon, M., Ward, MJ., Fevre, EM. (2017). Urbanization and Disease Emergence: Dynamics at the Wildlife–Livestock–Human Interface. *Trends in Ecology & Evolution*, *32*(1), 55–67. (doi:10.1016/j.tree.2016.09.012)

8 May (F) **No sections, COVID-19 discussion on Monday, May 4; Problem Set #4 Due**

Section 4: Migration and Human Mobility

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11 May (M) **Livelihood-Based Mobility in a More Variable World (Jones)***

Readings:

Bharti, N., A.J. Tatem, M.J. Ferrari, R.F. Grais, A. Djibo, and B.T. Grenfell. 2011. Explaining Seasonal Fluctuations of Measles in Niger Using Nighttime Lights Imagery. *Science*. 334 (6061):1424-1427. (doi:10.1126/science.1210554)

Hazel, A., and J. H. Jones. 2018. Remoteness influences access to sexual partners and drives patterns of viral sexually transmitted infection prevalence among nomadic pastoralists. *PLoS ONE*. 13 (1):e0191168. (doi:10.1371/journal.pone.0191168)

13 May (W) **Mobility, Spatial Structure, and Demographic Change (Jones)***

Readings:

Wesolowski, A., N. Eagle, A.J. Tatem, D.L. Smith, A.M. Noor, R.W. Snow, and C.O. Buckee. 2012. Quantifying the Impact of Human Mobility on Malaria. *Science*. 338 (6104):267-270. (doi:10.1126/science.1223467)

Optional:

Stoddard, S.T., A.C. Morrison, G.M. Vazquez-Prokopec, V. Paz Soldan, T.J. Kochel, U. Kitron, J.P. Elder, and T.W. Scott. 2009. The Role of Human Movement in the Transmission of Vector-Borne Pathogens. *PLoS Neglected Tropical Diseases*. 3 (7):e481. (doi:10.1371/journal.pntd.0000481)

Wesolowski, A., T. Qureshi, M.F. Boni, P.R. Sundsoy, M.A. Johansson, S.B. Rasheed, K. Engo-Monsen, and C.O. Buckee. 2015. Impact of human mobility on the emergence of dengue epidemics in Pakistan. *Proceedings of the National Academy of Sciences of the United States of America*. 112 (38):11887-11892. (doi:10.1073/pnas.1504964112)

15 May (F) **Sections meet; Problem Set #5 Due**

18 May (M) **Forced Migration: Conflict and Refugees (Openshaw)§**

Readings:

Finger, F., Funk, S., White, K., Siddiqui, M. R., Edmunds, W. J., & Kucharski, A. J. (2019). Real-time analysis of the diphtheria outbreak in forcibly displaced Myanmar nationals in Bangladesh. *BMC Medicine*, *17*(1), 58. (doi:10.1186/s12916-019-1288-7)

Palacios, CF., Openshaw, JJ., Travassos, MA. Influenza in US Detention Centers — The Desperate Need for Immunization. (2020). N Engl J Med; 382:789-791. DOI: 10.1056/NEJMp1916894

Optional:

Gayer, M., Legros, D., Formenty, P., & Connolly, M. A. (2007). Conflict and emerging infectious diseases. *Emerging Infectious Diseases*, *13*(11), 1625–1631. (doi:10.3201/eid1311.061093)

Section 5: Inequality

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20 May (W) **The Legacies of Colonialism: the Emergence of HIV (Jones)***

Readings:

Moore, J. 2004. The puzzling origins of AIDS. *American Scientist*. 92 (6):540-547.

Optional:

Faria, N.R., A. Rambaut, M.A. Suchard, G. Baele, T. Bedford, M.J. Ward, A.J. Tatem, J.D. Sousa, N. Arinaminpathy, J. Pépin, D. Posada, M. Peeters, O.G. Pybus, and P. Lemey. 2014. The early spread and epidemic ignition of HIV-1 in human populations. *Science*. 346 (6205):56-61. (doi:10.1126/science.1256739)

Hahn, B.H., G.M. Shaw, K.M. De Cock, and P.M. Sharp. 2000. AIDS as a zoonosis: Scientific and public health implications. *Science*. 287 (5453):607-614. (doi:10.1126/science.287.5453.607)

22 May (F) **Sections meet; Problem Set #6 Due**

25 May (M) **A Tale of Two Cities: Informal Settlements (Openshaw)§**

Readings:

Marlow, M. A., Maciel, E. L. N., Sales, C. M. M., Gomes, T., Snyder, R. E., Daumas, R. P., & Riley, L. W. (2015). Tuberculosis DALY-Gap: Spatial and Quantitative Comparison of Disease Burden Across Urban Slum and Non-slum Census Tracts. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *92*(4), 622–634. (doi:10.1007/s11524-015-9957-0)

Optional:

Dovey, K., & King, R. (2011). Forms of Informality: Morphology and Visibility of Informal Settlements. *Built Environment*, 37 (1), 11-29.

Snyder, R. E., Jaimes, G., Riley, L. W., Faerstein, E., & Corburn, J. (2014). A comparison of social and spatial determinants of health between formal and informal settlements in a large metropolitan setting in Brazil. *Journal of Urban*

Health : Bulletin of the New York Academy of Medicine, *91*(3), 432–445. (doi:10.1007/s11524-013-9848-1)

Ngonghala, CN., Plucinski, MM., Murray, MB., Farmer, PE., Barrett, CB., Keenan, DC., Bonds, MH. Poverty, Disease, and the Ecology of Complex Systems. (2014). PLoS Biol. Apr;12(4):e1001827.

27 May (W) **HIV and the Evolution of Virulence (Jones)***

Readings:

Frank, S.A. 1996. Models of parasite virulence. *Quarterly Review of Biology*. 71 (1):37-78.

29 May (F) **Section meets; Problem Set #7 Due**

Section 6: Changing Selective Landscape and Accelerated Evolution

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1 June (M) **Socioeconomic Inequalities and Infectious Diseases in the United States (Openshaw)§**

Readings:

Pellowski, JA., Kalichman, SC., Matthews, KA., Adler, N. A pandemic of the poor: social disadvantage and the US HIV epidemic. (2013). Am Psychol; 68(4): 197–209. doi: 10.1037/a0032694

Optional:

Grief, S. N., & Miller, J. P. (2017). Infectious Disease Issues in Underserved Populations. *Primary Care*, *44*(1), 67–85. (doi:10.1016/j.pop.2016.09.011)

Ford, M. M., Desai, P. S., Maduro, G., & Laraque, F. (2017). Neighborhood Inequalities in Hepatitis C Mortality: Spatial and Temporal Patterns and Associated Factors. *Journal of Urban Health : Bulletin of the New York Academy of Medicine*, *94*(5), 746–755. (doi:10.1007/s11524-017-0174-x)

3 June (W) **Antimicrobial Resistance and Evolution-Proofing (Jones)***

Readings:

Williams, P.D. 2010. Darwinian interventions: taming pathogens through evolutionary ecology. *Trends in Parasitology*. 26 (2):83-92. (doi:10.1016/j.pt.2009.11.009)

Read, A.F., T. Day, and S. Huijben. 2011. The evolution of drug resistance and the curious orthodoxy of aggressive chemotherapy. Proceedings of the National Academy of Sciences. 108 (Supplement 2):10871-10877. (doi:10.1073/pnas.1100299108)

Read, A.F., P.A. Lynch, and M.B. Thomas. 2009. How to Make Evolution-Proof Insecticides for Malaria Control. *PLoS Biology.* 7 (4):e1000058. (doi:10.1371/journal.pbio.1000058)

5 June (F) **Sections Meet; Problem Set #8 Due; Op-Ed Due for 5 units students**

Week 10: Wrap-Up: Humanity's Changing Epidemiological Environments

8 June (M) **COVID-19 Update and Discussion**

10 June (W) **Putting everything together: Taking Action in a More Variable World (Openshaw & Jones)***