09 January 2018

Syllabus (Subject to Change)
Anthropology 177/Human Biology 114/Earth Systems 114
Environmental Change and Emerging Infectious Disease
WMF 11:30-1:20 (Lecture MW, Sections F)
Winter 2018

Instructors:

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Teaching Assistant:

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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, Avian Flu, Malaria, Dengue Fever, Zika, Chagas disease, Lyme, Influenza, Cholera, Hantavirus, BSE/vCJD, and West Nile Virus. We'll use Monday and Wednesday class meetings for lectures; Fridays are reserved for sections, a required component of the class (section locations will be announced later).

Expectations:

Attendance at lecture and discussion sections is mandatory. There is an in-class midterm for both the 4- and 5-credit options. For the 4-unit option, there is also an in-class final. For the 5-unit option, there is a 15-page research paper and no final. The research paper may be on any course-related topic that is *approved by the instructors*. Paper proposals will be due during week 5 of the course (details TBA). Collaborative papers are welcome, subject to the requirement of roughly 15 pages per author. Please consult the paper guide available on Canvas.

Students registered for the graduate section of this class (Anthro 277, Earth Systems 214) must write a research paper, which is expected to be a more involved research paper than for the undergraduate class. While 277 enrollees are allowed to register for four credits to accommodate credit limits, you cannot receive graduate credit for this course without writing a full 15-page research paper. There will be a special graduate section for anyone enrolled in 277/214 in which more technical material relating to lectures/readings will be developed. The graduate section will, among other things, provides tools for developing more in-depth papers.

Prerequisites:

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

Sections:

Discussion sections will meet for one hour weekly starting the second week of the course. Locations TBA. *Sections are a required part of the class.*

Grading:

Grades for 5-unit enrollment will be based the midterm (40%), section (10%), and the 15-page paper (50%). Grades for 4-unit enrollment will be based on the midterm (40%), section (10%), and final (50%).

Readings:

Quammen, D. 2012. *Spillover: Animal Infections and the Next Human Pandemic*. New York: Random House.

In addition to this semi-popular book, we will use readings from the primary scientific literature throughout the quarter. Class reading assignments average between two and three journal articles per week. The reading load is thus quite light and the material in these readings is fair game for testing, so the prudent student will read all the assigned materials. All articles will be available on Canvas.

Course Outline (Provisional)

Lectures are on Monday and Wednesday from 11:30 – 1:20 in Dink G10. The one exception is a *lecture on Friday 02.23* following Presidents' Day: please make a note of this date

Topics, Order, and Readings All Subject to Change

Week 1. Introduction: EIDs and You

01.08 Ebola: The Future is Now (Jones)
Readings: Jones et al. (2008); Leendertz et al. (2016)

01.10 Epidemiology Meets Ecology: Some Tools (Jones)
Readings: Wilson (2001); Woolhouse et al. (2005); Arthur et al. (2017)

Week 2. Local Deforestation and Disease: Frontier Malaria in Rondônia

01.15 No class (celebrate Martin Luther King Jr.)

01.17 Colonization in Rondônia: How not to Change R_0 (Durham)
Readings: Charnley & Durham (2010); Paaijmans et al. (2009)

Week 3. Migration, Urbanization and Climate, Oh My

01.22 Vectors of Change and Vectorial Capacity (Durham)
Readings: Singer & Castro (2001); Souza-Santos et al. (2008)

01.24 Paper or Plastic? Climate Change, Human Migration, and Urban Refuse as Drivers of Epidemic Dengue Fever (Jones)
Readings: Stoddard et al. (2009); Scott & Morrison (2010); Smith et al. (2014)

Week 4. Bound by the Food Chain: Prions

01.29 Careful What You Eat: The Tragic Case of Kuru (Durham)
Readings: Collinge (2006); Alpers (2008), Durham (2008); Gajdusek (2008)

01.31 How Now Mad Cow: Environmental Influences on the TSE's (Durham)
Readings: Belay & Schonberger (2005); Mead et al. (2009)

Week 5. Devastatingly Slow Infections

02.05 The Origins of HIV: Primate Lentiviruses and Bushmeat Hunting (Jones)
Readings: Gao et al. (1999); Hahn et al. (2000); Keele et al. (2009)

02:07 Origins of HIV: Migration, Globalization, and How Local Infections Go Global (Jones)
Readings: Rudicell et al. (2010); Sousa et al. (2010)

Week 6. El Niño, Cascades, and Vortices: Hantavirus and Plague

02.12 Death in the Southwest: Hantavirus Pulmonary Syndrome (Jones)
Readings: Engelthaler et al. (1999); Yates et al. (2002)

02.14 Is Plague Caused by "Trophic Cascades"? and How Can Ecology Help? (Jones)
Readings: Duplantier et al. (2005); Osfeldt & Holt (2004); Collinge et al. (2005)

Week 7. Global Environmental Change: Climate and Cholera (with 1 Friday Lecture)

02.19 No class (Honoring some of our Presidents)

02.21 Environment and Endemism in South Asia: The Case of Cholera (Durham)
Readings: Faruque et al. (2005); Reiner at al. (2012)

02.23 **(NOTE: Friday lecture)** Coping with Copepods: Peruvian Cholera Epidemic (Durham)
Readings: Rodo et al (2002); Gil et al. (2004); Martinez-Urtaza et al. (2008)

Week 8. The Challenge of Chagas: Who's the Guinea Pig?

02.26 *In-class Midterm (4 and 5 unit students).* Covers material through 02.23

02.28 American Trypanosomiasis: Disease of Poverty (Durham)
Readings: Moncayo & Silveira (2009), Franco-Paredes et al. (2007); Cohen & Gürtler (2001); Rassi et al. (2010)

Week 9. Disruption of Community Processes and Disease Emergence

03.05 *Changes in the Land:* Deflected Succession and the Emergence of Lyme Disease in Eastern Woodlands (Jones)
Readings: LoGiudice et al. (2003); Keesing et al. (2006)

03.07 The Dilution Effect (Jones)
Readings: Ogden & Tsao (2009); Wood & Lafferty (2013); Salkeld et al. (2013)

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

03.12 The Future is Now, II: Zika and Friends, ZIKV, DENV, CHIKV (Durham)
Readings:

03.14 Wrap-Up

PAPER & FINAL

03.23 *Final Exam (for 4 units): 8:30 to 11:30 am*

Papers Due (for 5 units): 11:30 am, paper copy due in classroom; email copy to all Course staff

Readings (scroll over the citation for a link to the online source)

Alpers, M.P. 2008. The epidemiology of Kuru: monitoring the epidemic from its peak to its end. *Philosophical Transactions of the Royal Society B: Biological Sciences.* 363 (1510):3707-3713. (doi:10.1098/rstb.2008.0071)

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

Belay, E.D., and L.B. Schonberger. 2005. The Public Health Impact of Prion Diseases. *Annual Review of Public Health.* 26 (1):191-212. (doi:10.1146/annurev.publhealth.26.021304.144536)

Charnley, S., and W.H. Durham. 2010. Anthropology and Environmental Policy: What Counts? *American Anthropologist.* 112 (3):397-415. (doi:10.1111/j.1548-1433.2010.01248.x)

Cohen, J. E., and R. E. Gürtler. 2001. Modeling Household Transmission of American Trypanosomiasis. *Science*. 293:694-698.

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.

Collinge, J., J. Whitfield, E. McKintosh, J. Beck, S. Mead, D.J. Thomas, and M.P. Alpers. Kuru in the 21st century – an acquired human prion disease with very long incubation periods. *The Lancet.* 367 (9528):2068-2074. (doi:10.1016/S0140-6736(06)68930-7)

Duplantier, J.M., J.B. Duchemin, S. Chanteau, and E. Carniel. 2005. From the recent lessons of the Malagasy foci towards a global understanding of the factors involved in plague reemergence. *Veterinary Research.* 36 (3):437-453. (doi:10.1051/vetres:2005007)

Durham, w. 2008. When culture affects behavior: A new look at Kuru. In: M. Brown, ed. *Explaining Culture Scientifically.* Seattle: U. Washington Press. Pp. 139-161.

Engelthaler, D. M., D. G. Mosley, J. E. Cheek, C. E. Levy, K. K. Komatsu, P. Ettestad, T. Davis, D. T. Tanda, L. Miller, J. W. Frampton, R. Porter, and R. T. Bryan. 1999. Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. *Emerging Infectious Diseases*. 5 (1):87-94.

Faruque, S.M., M.J. Islam, Q.S. Ahmad, A.S.G. Faruque, D.A. Sack, G.B. Nair, and J.J. Mekalanos. 2005. Self-limiting nature of seasonal cholera epidemics: Role of host-mediated amplification of phage. *Proceedings of the National Academy of Sciences.* 102 (17):6119-6124. (doi:10.1073/pnas.0502069102)

Franco-Paredes, C., A. Von, A. Hidron, A.J. Rodríguez-Morales, I. Tellez, M. Barragán, D. Jones, C.G. Náquira, and J. Mendez. 2007. Chagas disease: an impediment in achieving

the Millennium Development Goals in Latin America. *BMC International Health and Human Rights.* 7 (1):7. (doi:10.1186/1472-698x-7-7)

Gajdusek, D.C. 2008. Early images of kuru and the people of Okapa. *Philosophical Transactions of the Royal Society B: Biological Sciences.* 363 (1510):3636-3643. (doi:10.1098/rstb.2008.4011)

Galvani, A. P. 2003. Epidemiology meets evolutionary ecology. *Trends in Ecology & Evolution*. 18 (3):132-139.

Gao, F., E. Bailes, D. L. Robertson, Y. L. Chen, C. M. Rodenburg, S. F. Michael, L. B. Cummins, L. O. Arthur, M. Peeters, G. M. Shaw, P. M. Sharp, and B. H. Hahn. 1999. Origin of HIV-1 in the chimpanzee Pan troglodytes troglodytes. *Nature*. 397 (6718):436-441.

Gil, A. I., Louis, V. R., Rivera, I. N. G., Lipp, E., Huq, A., Lanata, C. F., Taylor, D. N., Russek-Cohen, E., Choopun, N., Sack, R. B. and Colwell, R. R. (2004), Occurrence and distribution of *Vibrio cholerae* in the coastal environment of Peru. *Environmental Microbiology*, 6: 699–706.

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.

Janes, Craig R., K. K. Corbett, J. H. Jones, and J. Trostle. 2012. Emerging infectious diseases: the role of social sciences. *The Lancet.* 380 (9857):1884-1886.

Jones, K. E., N. G. Patel, M. A. Levy, A. Storeygard, D. Balk, J.L. Gittleman, and P. Daszak. 2008. Global trends in emerging infectious diseases. *Nature*. 451 (7181):990-993.

Keele, B. F., J. H. Jones, K. A. Terio, J. D. Estes, R. S. Rudicell, M. L. Wilson, Y. Li, G. H. Learn, T. M. Beasley, J. Schumacher-Stankey, E. Wroblewski, A. Mosser, J. Raphael, S. Kamenya, E. V. Lonsdorf, D. A. Travis, T. Mlengeya, M. J. Kinsel, J. G. Else, G. Silvestri, J. Goodall, P. M. Sharp, G. M. Shaw, A. E. Pusey, and B. H. Hahn. 2009. Increased mortality and AIDS-like immunopathology in wild chimpanzees infected with SIVcpz. *Nature.* 460 (7254):515-519.

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

Kilpatrick, A.M., P. Daszak, M.J. Jones, P.P. Marra, and L.D. Kramer. 2006. Host heterogeneity dominates West Nile virus transmission. *Proceedings of the Royal Society B-Biological Sciences.* 273 (1599):2327-2333. (doi:10.1098/rspb.2006.3575)

Kilpatrick, A. M. 2011. Globalization, Land Use, and the Invasion of West Nile Virus. *Science*. 334 (6054):323-327.

LaDeau, S.L., P.P. Marra, A.M. Kilpatrick, and C.A. Calder. 2008. West Nile Virus Revisited: Consequences for North American Ecology. *BioScience.* 58 (10):937-946. (doi:10.1641/B581007)

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)

LoGiudice, K., R. S. Ostfeld, K. A. Schmidt, and F. Keesing. 2003. The ecology of infectious disease: Effects of host diversity and community composition on Lyme disease risk. *Proceedings of the National Academy of Sciences, USA*. 100 (2):567-571.

Martinez-Urtaza, J., B. Huapaya, R.G. Gavilan, V. Blanco-Abad, J. Ansede-Bermejo, C. Cadarso-Suarez, A. Figueiras, and J. Trinanes. 2008. Emergence of Asiatic *Vibrio* Diseases in South America in Phase With El Niño. *Epidemiology.* 19 (6):829-837.

Mead , S., J. Whitfield , M. Poulter , P. Shah , J. Uphill , T. Campbell , H. Al-Dujaily , H. Hummerich , J. Beck , C.A. Mein , C. Verzilli , J. Whittaker , M.P. Alpers , and J. Collinge 2009. A Novel Protective Prion Protein Variant that Colocalizes with Kuru Exposure. *New England Journal of Medicine.* 361 (21):2056-2065. (doi:10.1056/NEJMoa0809716)

Moncayo, Á., and A.C. Silveira. 2009. Current epidemiological trends for Chagas disease in Latin America and future challenges in epidemiology, surveillance and health policy. *Memórias do Instituto Oswaldo Cruz*. 104:17-30.

Ogden, N. H., and J. I. Tsao. 2009. Biodiversity and Lyme disease: Dilution or amplification? *Epidemics.* 1 (3):196-206.

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.

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.

Rassi, A., A. Rassi, and J. A. Marin-Neto. 2010. Chagas disease. *The Lancet.* 375 (9723):1388-1402

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)

Reiter, P. 2008. Global warming and malaria: knowing the horse before hitching the cart. *Malaria Journal.* 7 (1):S3. (doi:10.1186/1475-2875-7-s1-s3)

Reiner, R.C., A.A. King, M. Emch, M. Yunus, A.S.G. Faruque, and M. Pascual. 2012. Highly localized sensitivity to climate forcing drives endemic cholera in a megacity. *Proceedings of the National Academy of Sciences.*

Rodó, X., M. Pascual, G. Fuchs, and A.S.G. Faruque. 2002. ENSO and cholera: A nonstationary link related to climate change? *Proceedings of the National Academy of Sciences.* 99 (20):12901-12906. (doi:10.1073/pnas.182203999)

Rudicell, R.S., J.H. Jones, E.E. Wroblewski, G.H. Learn, Y. Li, J.D. Robertson, E. Greengrass, F. Grossmann, S. Kamenya, L. Pintea, D.C. Mjungu, E.V. Lonsdorf, A. Mosser, C. Lehman, D.A. Collins, B.F. Keele, J. Goodall, B.H. Hahn, A.E. Pusey, and M.L. Wilson. 2010. Impact of Simian Immunodeficiency Virus Infection on Chimpanzee Population Dynamics*. PLoS Pathogens. 6 (9):e1001116. (doi:10.1371/journal.ppat.1001116)*

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)

Scott, T. W., and A. C. Morrison. 2010. Vector Dynamics and Transmission of Dengue Virus: Implications for Dengue Surveillance and Prevention Strategies Vector Dynamics and Dengue Prevention. In *Dengue Virus*, edited by A. L. Rothman, pp. 115-128. New York: Springer.

Singer, B. H., and M. C. De Castro. 2001. Agricultural colonization and malaria on the Amazon Frontier. *Annals of the New York Academy of Sciences*. 954:184-222.

Smith, D.L., T.A. Perkins, R.C. Reiner, C.M. Barker, T.C. Niu, L.F. Chaves, A.M. Ellis, D.B. George, A. Le Menach, J.R.C. Pulliam, D. Bisanzio, C. Buckee, C. Chiyaka, D.A.T. Cummings, A.J. Garcia, M.L. Gatton, P.W. Gething, D.M. Hartley, G. Johnston, E.Y. Klein, E. Michael, A.L. Lloyd, D.M. Pigott, W.K. Reisen, N. Ruktanonchai, B.K. Singh, J. Stoller, A.J. Tatem, U. Kitron, H.C.J. Godfray, J.M. Cohen, S.I. Hay, and T.W. Scott. 2014. Recasting the theory of mosquito-borne pathogen transmission dynamics and control. *Transactions of the Royal Society of Tropical Medicine and Hygiene.* 108 (4):185-197. (doi:10.1093/trstmh/tru026)

Sousa, J.D.d., V. Müllller, P. Lemey, and A.-M. Vandamme. 2010. High GUD Incidence in the Early 20th Century Created a Particularly Permissive Time Window for the Origin and Initial Spread of Epidemic HIV Strains. *PLoS ONE.* 5 (4):e9936. (doi:10.1371/journal.pone.0009936)

Souza-Santos, R., M.V. de Oliveira, A.L. Escobar, R.V. Santos, and C.E. Coimbra. 2008. Spatial heterogeneity of malaria in Indian reserves of Southwestern Amazonia, Brazil. *International Journal of Health Geographics.* 7 (1):55. (doi:10.1186/1476-072x-7-55)

Stoddard, S. T., A. C. Morrison, G. M. Vazquez-Prokopec, V. P. 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.

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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.

Woolhouse, M. E. J., D. T. Haydon, and R. Antia. 2005. Emerging Pathogens: The Epidemiology and Evolution of Species Jumps. *Trends in Ecology & Evolution.* 20 (5):238-244.

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.