

Module :	Global Environmental Changes and Health	
UE coordinators	Hélène Broutin, PhD, researcher MIVEGEC : Maladies Infectieuses et Vecteurs Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / UM1/UM2 helene.broutin@ird.fr	Benjamin Roche, PhD, researcher UMMISCO, Unité de Modélisation Mathématique et Informatique de Systèmes Complexes, Bondy benjamin.roche@ird.fr
Dates	Monday 24 th – Friday 28 th October 2016	
Credits/ECTS	3 ECTS	
Duration	Number of days: 5 Number of hours : 35	
UE description	<p>This module aims at</p> <p>1/ identifying different factors that drive the global environmental changes (GEC) and understanding their interactions and</p> <p>2/ understanding the impact of the GEC on health, focusing mainly on infectious diseases.</p> <p>3/ understanding how interactions between different GEC impact human health.</p> <p>The course is structured into 4 parts: After an overview of the global environmental changes and the impact on health (PART 1), the course will present the 3 main drivers of the GEC and their impact on health, namely, Climate, Biodiversity and Population Dynamics following by the exploration of the interaction between these drivers (PART 2). To illustrate the topics of the course with specific examples, 2 classes will focus on the impact on GEC on vector-borne diseases (e.g. malaria and dengue) and direct transmitted infectious diseases (e.g. cholera and meningitis) consecutively (PART 3). Finally, the course intends to emphasize the transfer of expertise between the research side and policy makers (e.g. WHO, Governments) through a session with specific situations of Public Health decision-making.</p>	
Prerequisites	none	
Course learning objectives	<p>At the end of the module, the students should be able to:</p> <ul style="list-style-type: none"> • Identify the major drivers involved in global environmental changes and their interaction • Illustrate those drivers with examples • Analyze how these drivers impact on human health (with examples); • Critically assess scientific studies and political decisions on the subject 	
UE Structure (details of sessions title/speaker/date/duration)	<ul style="list-style-type: none"> • Global Environmental changes and Health: Introduction (B Roche/ Oct, 24/ 3 Hrs) • Part I.a. Biodiversity evolution and Health (Roche / Oct, 24 / 3Hrs) • Part I.b Climate changes and Infectious Diseases (N. Martiny / Oct, 25/ 3Hrs) • Part I.c Population Dynamics changes and Health (B Roche / Oct, 25/ 3Hrs) • Synthesis part 1: How do the drivers interact? (H. Broutin / Oct, 26 / 2Hrs) • Interactions between urban environment and infectious disease transmission and control: the example of Dengue in Asia (B Lefebvre/Oct 26/3Hrs) • Part II.a Global Environmental Changes and direct/environmental transmitted diseases (J. Mueller / Oct, 27/ 3Hrs) • Part II.b Global Environmental Changes and vector-borne/zoonotic diseases (F. Simard / Oct 27/ 3Hrs) • Part III.a Evolutionary medicine: an introduction F Sicard/Oct 28/3Hrs • Part III.a.b Global Environmental change considerations and implications in Public Health (JF Guégan / Oct 28/ 3Hrs) 	
Course requirement	Students are asked for actively participating each session and share some experiences when relevant	

Grading and assessment	A two hour written examination scheduled in November 2016
Location	George Sand EHESP Campus in Paris
Readings	Articles to be read are provided below in each session

Session 1	Module 217
Session Title	Global Environmental changes and Health: an overview
Speakers	Hélène Broutin, PhD, reseracher MIVEGEC : Maladies Infectieuses et Vecteurs Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / UM1/UM2 helene.broutin@ird.fr Benjamin Roche, PhD, researcher UMMISCO, Unité de Modélisation Mathématique et Informatique de Systèmes Complexes, Bondy benjamin.roche@ird.fr
Session outline	<ul style="list-style-type: none"> • What are the Global environmental changes? • Three main drivers • Some basics concepts in Ecology and Evolution • Impact on Health • The Module presentation
Learning Objectives	<ul style="list-style-type: none"> • Define the global environmental changes • Identify the main drivers of global environment changes • Recognize importance of the interactions between drivers • Demonstrate the impact of the global environmental changes on health • Define the matter of spatial and temporal scales
Reading	McMichael, A.J. (2004). Environmental and social influences on emerging infectious diseases: past, present and future. <i>Philos Trans R Soc Lond B Biol Sci</i> , 359, 1049–1058 Cohen M.L. (2009) Changing patterns of infectious disease. <i>Nature</i> , 406, 762-767.
Duration	3 hours
Dates	Monday, October 24 th 9:00am-12:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 2	Module 217
Session Title	Biodiversity evolution and Health
Speaker	Benjamin Roche , IRD Researcher, PhD UMMISCO, Unité de Modélisation Mathématique et Informatique de Systèmes Complexes, Bondy benjamin.roche@ird.fr
Session outline	<ul style="list-style-type: none"> • Overview of the evolution of pathogens in response to global changes • The importance of the population scale in the understanding of the dynamics of resistance development

Learning Objectives	<ul style="list-style-type: none"> • Interpret changes in our changing world? • Define the key parameters governing pathogen evolution through example studies Focus on three key parameters: host density, homogeneity in host & host-pathogen contacts • Discuss climate changes: why some vector-borne diseases are not sensitive to that change • Discuss relationships between health structure with regard to pathogen evolution • Demonstrate the interest of population scale: a case study to understand the evolution of xenobiotic resistance Demonstrating • Assess pesticide resistance evolution to antibiotic resistance evolution
Reading	Cohen ML 2000 Changing patterns of infectious diseases. Nature 406 : 762-767 Roche, B., Guégan, J.F.J.-F.F., 2011. Ecosystem dynamics, biological diversity and emerging infectious diseases. Comptes Rendus - Biol. 334, 385–392.
Duration	3 hours
Dates	Monday, October 24 th 1:00pm-4:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 3	Module 217 “Global Environmental Changes and Health”
Session Title	Climate changes and Health
Speaker	Nadège MARTINY , Associate Researcher, PhD CRC : Centre de Recherches en Climatologie UMR 6282 CNRS / Université de Bourgogne, Dijon Contact : nadege.martiny@u-bourgogne.fr
Session outline	
Learning Objectives	<ul style="list-style-type: none"> • Define climate change • Distinguish between direct and indirect impact of climate change on health • Understand processes at different spatial and temporal scales.
Reading	Epstein, P.R., 2001. Climate change and emerging infectious diseases. Microbes Infect. 3, 747–54. Altizer, S., Ostfeld, R.S., Johnson, P.T.J., Kutz, S., Harvell, C.D., 2013. Climate change and infectious diseases: from evidence to a predictive framework. Science 341, 514–9.
Duration	3 hours
Dates	Tuesday October 25 th , 9:00am-12:00pm
Training methods	Lecture Active participation of the students

Validation	NA , written examination scheduled in November 2016
Session 4	Module 217
Session Title	Population Dynamics changes and Health
Speakers	<p>Hélène Broutin, PhD, reseracher MIVEGEC : Maladies Infectieuses et Vecteurs Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / UM1/UM2 helene.broutin@ird.fr</p> <p>Benjamin Roche, PhD, researcher UMMISCO, Unité de Modélisation Mathématique et Informatique de Systèmes Complexes, Bondy benjamin.roche@ird.fr</p>
Session outline	<ul style="list-style-type: none"> • Introduction • Population scale: Abundance of susceptible • Country wide scale: Migration between localities • Worldwide dissemination: First steps of pathogen spread • A summarizing example (with evolution): Influenza • Conclusion
Learning Objectives	<ul style="list-style-type: none"> • Define the role of population dynamics and infectious disease transmission • Identify population dynamics parameters at different spatial scales • Define pattern of contacts different from homogeneous structures: measures and important features • Identify change in epidemic threshold behavior induced by a heterogeneous pattern of contact; implications for public health measures • Determine why “space matters” for some diseases • Assess & discuss the importance of socio-economic factors
Reading	Anderson & May. Infectious Diseases of Humans, Oxford Univ. Press, 1992; Keeling & Rohani, Modeling Infectious Diseases (2008); Grenfell & Dobson. Ecology of Infectious Diseases in Natural Populations, Cambridge Univ. press, 1995.
Duration	3 hours
Dates	Tuesday October 25 th , 1:00pm-4:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 5	Module 217
Session Title	Synthesis Part I: How do the drivers interact? And situation games
Speakers	Hélène Broutin, PhD, researcher MIVEGEC : Maladies Infectieuses et Vecteurs Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / UM1/UM2 helene.broutin@ird.fr Benjamin Roche, PhD, researcher UMMISCO, Unité de Modélisation Mathématique et Informatique de Systèmes Complexes, Bondy benjamin.roche@ird.fr
Session outline	<ul style="list-style-type: none"> • Summary of the 3 main drivers of GEC • Examples of interactions • Conclusion
Learning Objectives	<ul style="list-style-type: none"> • Demonstrate the complexity of infectious diseases systems. • Identify examples of interactions • Assess & discuss the importance of interactions between drivers for a better control.
Reading	Roche et al (2014) "Control of Infectious diseases in Low-income Countries: prospects from ecology and evolutionary biology". <i>BMC infectious diseases</i> , in press.
Duration	3 hours
Dates	Wednesday, October 26 th , 9:00am-12:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 6	Module 217
Session Title	Urban environment, infectious disease transmission and control programmes: the example of dengue in Asian cities
Speakers	Bertrand Lefebvre, PhD, Associate Professor École des Hautes Études en Santé Publique bertrand.lefebvre@ehesp.fr
Session outline	<ul style="list-style-type: none"> • Introduction on dengue transmission and urban environment • The case of Delhi • The case of Bangkok • Rethinking dengue prevention and control programmes in urban settings • Conclusion
Learning Objectives	<ul style="list-style-type: none"> • Assess and discuss vector-borne disease transmission in complex urban environments • Demonstrate the importance of spatial scales in analyzing the interplay between environmental changes and infectious disease transmission

	<ul style="list-style-type: none"> Assess and discuss the role of local-scale human interventions in the transmission of dengue
Reading	<p>Reiner RC Jr, Achee N, Barrera R, Burkot TR, Chadee DD, Devine GJ, et al. (2016) Quantifying the Epidemiological Impact of Vector Control on Dengue. PLoS Negl Trop Dis 10(5): e0004588. doi:10.1371/journal.pntd.0004588</p> <p>Salje H. et al. (2012) Revealing the microscale spatial signature of dengue transmission and immunity in an urban population. Proc Natl Acad Sci; 109(24):9535-8. doi: 10.1073/pnas.1120621109</p> <p>Telle O, Vaguet A, Yadav NK, Lefebvre B, Cebeillac A, Nagpal BN, et al. (2016) The Spread of Dengue in an Endemic Urban Milieu–The Case of Delhi, India. PLoS ONE 11(1): e0146539. doi:10.1371/journal.pone.0146539</p>
Duration	3 hours
Dates	Wednesday, October 26 th , 1:00am-4:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 7	Module 217 “Global Environmental Changes and Health”
Session Title	Global environmental changes and direct/environmental transmitted diseases
Speaker	Judith Müller , MD, PhD Department of Epidemiology and Biostatistics, EHESP Emerging Disease Epidemiology Unit, Institut Pasteur de Paris. Contact: Judith.MUELLER@ehesp.fr
Session outline	<ul style="list-style-type: none"> How can environment impact health (transmittable diseases): mechanisms Examples for transmittable diseases <ul style="list-style-type: none"> a. Cholera b. Meningitis belt <ul style="list-style-type: none"> -> break -> exercise <p style="text-align: center;">Bacterial meningitis</p>
Learning Objectives	<ul style="list-style-type: none"> Identify mechanisms of environmental impact on transmittable diseases (other than vectors and population density) influenza to human pandemic Be familiar with the examples of cholera and the African meningitis belt (pneumonia, meningitis) Analyze the difficulties in studying the environmental impact on transmittable diseases
Reading	
Duration	3 hours
Dates	Thursday, October 27 th , 9:00am-12:00pm

Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 8	Module 217
Session Title	Global environmental changes and vector-borne/zoonotic diseases: Vector's adaptation in a changing world with a focus on malaria in Africa
Speaker	Frédéric SIMARD , Institut de Recherche pour le Développement (IRD) PhD, researcher, MIVEGEC : Maladies Infectieuses et Vecteurs : Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / Universités Montpellier 1 et 2 Contact : frederic.simard@ird.fr
Session outline	<ul style="list-style-type: none"> • Introduction to vector-borne diseases • Mosquitoes implicated in vector-borne diseases transmission • Vector competence / Vector's adaptation to the environment • Anopheles complex
Learning Objectives	<ul style="list-style-type: none"> • Identify vectors and understand vector competence • Define ecological niche • Ecology of vectors /Understand different mechanisms of adaptation to the environment
Reading	<p>Guis H., Caminade C., Calvete C., Morse A.P., Tran A., Baylis M. 2011. Modelling the effects of past and future climate on the risk of bluetongue emergence in Europe. Journal of the Royal Society Interface, published online.</p> <p>Ponçon N., Balenghien T., Toty C., Ferré J.B., Thomas C., Dervieux A., L'Ambert G., Schaffner F., Bardin O, Fontenille D. 2007. Effects of local anthropogenic changes on potential malaria vector <i>Anopheles hyrcanus</i> and West Nile virus vector <i>Culex modestus</i>, Camargue, France. Emerging Infectious Diseases 13(12): 1810-1815.</p> <p>Tran A., Ponçon N., Toty C., Linard C., Guis H., Ferré J.B., Lo Seen D., Roger F., De La Rocque S., Fontenille D., Baldet T. 2008. Using remote sensing to map larval and adult populations of <i>Anopheles hyrcanus</i> (Diptera : Culicidae) a potential malaria vector in Southern France. International journal of health geographics, 7 (9) : 1-12.</p>
Duration	3 hours
Dates	Thursday, October 27 th , 1:00 pm-4:00pm
Training methods	Lecture / Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 9	Module 217
Session Title	Part II.a. Evolutionary medicine : an introduction
Speaker	Frédéric THOMAS , PhD MIVEGEC : Maladies Infectieuses et Vecteurs : Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / Universités Montpellier 1 et 2 Contact : frederic.thomas2@ird.fr
Session outline	<ul style="list-style-type: none"> • Conceptual bases of medicine and evolutionary biology • Examination of different diseases with this approach • Future challenges of evolutionary medicine
Learning Objectives	<ul style="list-style-type: none"> • Observe the evolution by natural selection • Define evolutionary medicine • Analyze why our evolutionary heritage has left us vulnerable to disease
Reading	Why We Get Sick: The New Science of Darwinian Medicine. Nesse and William 1994 Evolution and Medicine. Perlman 2013
Duration	3 hours
Dates	Friday October 28 th , 9:00am – 12:00pm
Training methods	Lecture Active participation of the students
Validation	NA , written examination scheduled in November 2016

Session 10	Module 217 “Global Environmental Changes and Health”
Session Title	Global environmental changes consideration and implications in Public Health
Speaker	Jean-François Guégan , IRD, PhD, research Director MIVEGEC : Maladies Infectieuses et Vecteurs : Ecologie, Génétique, Evolution et Contrôle UMR 5290 CNRS / 224 IRD / Universités Montpellier 1 et 2 jean-francois.guegan@ird.fr
Session outline	<ul style="list-style-type: none"> • Globalisation, bird flu example • International research and assessment • The debate around climate change • International organizations and policy making
Learning Objectives	<ul style="list-style-type: none"> • Assess scientific result for policy making • Interpret complex problems in the simple way.
Reading	Millenium Ecosystem Assessment (2005) Ecosystem and human well-being. WHO The Interagency Working Group on Climate Change and Health (2009) A human health perspective on climate change. Environmental Health Perspective and the National Institute of Environmental Health Sciences Roche B & Guégan J.-F. (2011) Ecosystem dynamics, biological diversity and emerging

	<p>infectious diseases. <i>Comptes Rendus Biologies</i> 334: 385-392.</p> <p>Woolhouse M E J & Gowtage-Sequeria S (2005) Host Range and Emerging and Reemerging Pathogens. <i>Emerging Infectious Diseases</i>, 11 (12): 1842-1847.</p> <p>Lafferty K D (2009) The ecology of climate change and infectious diseases. <i>Ecology</i> 90 (4): 888–900.</p> <p>Greer A, Ng V, Fisman D (2008) Climate change and infectious diseases in North America: the road ahead <i>CMAJ</i> 178 (6): 715-722.</p>
Duration	3 hours
Dates	Friday, October 28 th , 1:00pm – 4:00pm
Training methods	Lecture + open discussion / Active participation of the students
Validation	NA , written examination scheduled in November 2016