

YID2209: Biogeophysical Systems
Semester 1 2017; M, Th, 2:30-4 pm; Classroom 12

Does evolution need disasters?



Original in: Museu da Cidade, Lisbon. Reproduced in: *O Terramoto de 1755, Testamunhos Britanicos = The Lisbon Earthquake of 1755, British Accounts. Lisbon: British Historical Society of Portugal, 1990*

*If it's the will of Heaven's Lord to give amnesty to this region,
Why doesn't He lash the dragons, force floods' withdrawal, and fashion us
fertile fields?*

Zhu Zhu, *Guochao shiduo*, 1869

*Will you say, "It is the effect of everlasting laws
Which necessitates this choice by a free and good God?
Will you say, seeing this heap of victims:
"God is avenged, their death is the payment of their crimes?"
What crimes, what bad things have been committed by these children,
Lying on the breasts of their mothers, flattened and bloody?
Lisbon, which is a city no longer, had it more vices
Than London, than Paris, given to doubtful delights?*

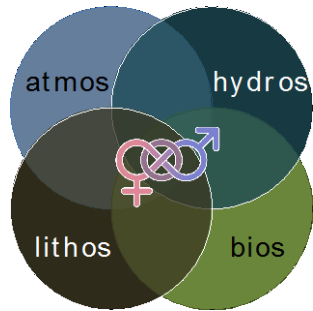
Voltaire, *Poème sur le désastre de Lisbonne*, 1756

Professor Brian G. McAdoo

Elm College Office

Office Hours: T, 10-11; W 2-3; or by appointment

brian.mcadoo@yale-nus.edu.sg



To understand the environment, it certainly helps to understand how Earth systems function to support our habitable planet. In this course, we will strive to understand how earthquakes, volcanoes, floods, landslides, tropical cyclones, and climate change, as well as iterant mass extinctions, each support evolution- evolution of life, ideas, art, political agendas and other changes that come with violent upheavals. To better understand the effects humans are having on the Earth, we will explore how the Earth functions as a complex system with a solid lithosphere interacting with an atmosphere and hydrosphere in a way that sustains a biosphere, and how diverse biota affects the others. We investigate how these different spheres interact, and how scientists measure the changes in these realms. During the course of this exploration, we will encounter the theory of plate tectonics, the dynamics of atmospheric circulation, and the fundamentals of biogeochemical cycling as the foundation of ecosystems. Students will engage in data collection and analysis, and compare their analyses to current knowledge as documented in the scientific literature, while placing these ideas firmly in the realm of understanding global change.

Required Texts

The Blue Planet: An introduction to Earth system science, Skinner and Murck, 3rd Edition

Thinking in Systems: A Primer, Meadows. Available on the Canvas site

The Little Ice Age: How climate made history, 1300-1850, Fagan

Learning Goals. By the end of this course, active participants will understand and be able to explain the following:

- Fundamentals of **Earth science**- plate tectonics, oceanic and atmospheric circulation, erosion and biogeochemical cycling;
- **Dynamic Systems Thinking** and the effects of periodic disturbances;
- The role of **feedback loops** and long-term equilibrium;
- **Scales** of Time and Space;
- **Observations** of environments, past and present, that we cannot see or sample;
- **Quantification** of the natural world;
- The singularity of **life** on Earth

Assignments. The breakdown below is deliberately planned so as to not put too much weight on any one type of assessment. For example, as a seminar-based class, each student is expected to bring a question to class based on the readings. Students will be evaluated (under class participation) on the quality, not the quantity, of the questions, along with the creativity and do-ability of your approach to addressing the question(s) posed. Highest marks will be given to those questions *least* easily answered. And remember, *there are no stupid questions!*

Breakdown-

- Assignments 30%
- Mid-term exam 20%
- Final exam 30%
- Class participation 20%

Late Policy. Class attendance is mandatory. If you miss more than 3 classes during the semester without a Vice Rector's note, your class participation grade will be impacted. Your assignment will be considered late if it misses the deadline without a Vice Rector's note or Medical Certificate from a Doctor. No points will be deducted if the assignment is turned in after the end of the class period that it was due, but it will be graded more critically. Assignments turned in after the end of the second class after it was due will be docked one letter grade, and one letter grade for each class period thereafter. Late work will be accepted until the end of the semester- it is always better to turn in something rather than nothing.

A note on etiquette.

- Come to each session **on time, awake and ready to participate**. I assume you will have done the readings, and have a **thoughtful, well-written question** that does not have an easy answer prepared to start that day's discussion. As these questions will be based on the readings, it will require a sufficient understanding of the readings to start considering answers/solutions that we can discuss- just make sure that it is cored in the readings!
- **Drinks are OK** in the classroom (coffee, water... *not* tequila.), but please **do not bring food**.
- Please feel free bring your **laptops** to class- I will let you know ahead of time if/when you will need a computer;
- If you send an **email** after hours or on weekends, please don't expect an immediate response. And be extremely cognizant of sending emails written while under **duress**- trust me on this one;
- **Do your own work**, unless specifically instructed to work in groups. Collaboration is a skill that I highly encourage you work to develop, and I also expect you to be able to handle this material if and when collaborators are not available. Help each other, but accept only enough help to get you over the hump and moving toward self-sufficiency.

Academic Integrity. We expect you to abide by the highest standards of academic integrity as a matter of personal honesty and communal responsibility. Acting with academic integrity requires that (a) you do your own work, (b) you not interfere with the work of others, (c) you accurately and honestly represent the content of your work, and (d) you properly attribute others' work. Violations of the College's academic integrity standards undermine both the community and your individual growth. Accordingly, they will be addressed with the utmost seriousness and sanctions ranging from grade penalties to expulsion. Examples of violations of academic integrity include plagiarism, copying or sharing homework answers, submitting work completed for one course as 'new' work for another course, or fabricating or falsifying research data. For more information please visit the Student Services website, Policies and Procedures section: <https://studentlife.yale-nus.edu.sg/policies/academic-integrity/>

The Yale-NUS Library provides resources on citations and plagiarism here: <http://library.yale-nus.edu.sg/plagiarism/>

Course Outline
(Subject to adjustment)

	Date	Topic	Readings	Assignments
Intros	14 Aug 17 Aug	Framing Disasters and Evolution Risk Theory - “There is no such thing as a natural disaster.” (<i>Tell that to the dinosaurs!</i>) Hazards, vulnerability, resilience	Kolbert, ch 4; Alvarez et al., 1980 Smith, 2006; Wisner, At Risk ch 1 & 2;	Essay - Choose a disaster- any disaster past or present- and describe the hazard, vulnerabilities and resiliences. Bonus points for choosing an area at risk of a future event! Due 21 Aug.
Time	21 Aug 24 Aug	Big Time and the End of the Dinosaurs (beginning of mammals) Thinking in Systems Systems- Triangles, Stop Disasters!	Janis, 1993; Waters et al., 2016; McPhee, <i>Basin and Range</i> ; Kolbert, <i>The Sixth Extinction</i> Skinner, ch 1; Meadows, <i>Whole Earth Models and Systems</i> ; www.stopdisastersgame.org	STELLA’s Bathtub. Due 28 Aug.
Lithos	28 Aug 31 Aug	Plate Tectonics I - Earth Structure. How do we know what we cannot see? Plate Tectonics II - The Geodynamic, Volcanoes, and Faults	Skinner, ch 5 & 6 Glatzmeier et al, 1998; Wei et al, 2014; The Core (2003)- optional	Plate tectonics and Earthquakes Due 11 Sept.
	4 Sept 7 Sept	Earthquakes I - 1755 Lisbon Earthquakes II - 1976 Tangshan	Zitellini et al, 2001; Poirier, 2006; Geller et al, 1997; “Heaven Cracks, Earth Shakes”, Palmer	
	11 Sept	Volcanoes I - Santorini/Thera and the Crash of the Minoans; 1815 Tambora	Nomikou et al, 2016; NYTimes, 1998	<i>Catch-up</i>
	14 Sept	Volcanoes II - 75K BCE Toba and the Human Genetic Bottleneck	Ambrose, 1996; Jackson et al, 2015; Williams et al, 2009	
	18 Sept 21 Sept	Review Midterm		
BREAK	23 Sept - 1 Oct		Please read <i>The Little Ice Age</i>, by Fagan; and/or <i>The Sixth Extinction</i>, Kolbert	
Week 7	2 Oct 6 Oct	NO CLASS (<i>McAdoo travelling</i>)		Essay - Review and summarize arguments surrounding the decline of the Minoans after Santorini/Thera OR the radiation of humans from East Africa following the Toba eruption. Correlation or causation? Due 9 Oct.

	Date	Topic	Readings	Assignments
Hydros	9 Oct	Biogeochemical Cycles: Nitrogen, Phosphorous, Potassium	Skinner, ch 15	
	12 Oct	The Carbon Cycle: Limestone, Coal and Oil and CO ₂	Non-Technical Guide, Cleal and Thomas, 2005; Freese ch 1-2	STELLA's Exponential Growth
	16 Oct	Water's Physics; Hydrologic	Skinner, ch 8,	
	19 Oct	Cycle , Isotopes and Climate, Dams	<i>Atchafalaya</i> , McPhee; Chen and Zong, 1998	
Atmos	23 Oct	Atmospheric Circulation and Climate (Evolution, Greenhouse Gases, Uneven Heating, Coriolis Effect)	Skinner, ch 11, 12	Big Mama STELLA- Creating a Climate System Model for the Earth
	26 Oct	Atmospheric Circulation and Weather (Wind, Monsoon, El Nino/IOD)	"The Barrel of the Gun", excerpt from <i>The Perfect Storm</i> , Junger.	Big Mama- Positive and Negative Feedbacks and Climate Change Mitigation
	30 Oct	Anthropogenic Climate Change I- How do we know what we know? (History, Proxies)	Fagan, The Little Ice Age; IPCC Synthesis, Paleoclimate; Climate Myths; Past temps from Ice Cores	Coring 101- Isotopes and gases in ice cores
	2 Nov	Anthropogenic Climate Change II- GCM		
	6 Nov	Tropical Cyclones	Knutson et al, 2010	<i>Catch-up</i>
	9 Nov	1970 Bhola, Bangladesh; 2010 Sandy, US	Sommer and Mosely, 1972	
	13 Nov	Drought, Rivers and Floods-	http://www.disasterhistory.org/central-china-flood-1931 ; Yu, 2008	Tropical Cyclones, floods and development
	16 Nov	1931 Yangtze/Huai Floods		
	18-24 Nov	READING WEEK		
	4 Dec	FINAL EXAM		<i>"How will systems evolve as human populations and climate change continue to impact the Earth?"</i>