Academic Year	2018/19	**Semester**	1
Course Coordinator	Anna Lagerstroem		
Course Code	ES3306		
Course Title	Global Change Ecology		
Pre-requisites	ES2003 Biosphere ES2303 Introduction to Ecology		
No of AUs	3		
Contact Hours	Total of 39 hours (26 h lecture, 13 h tutorials). Lecture: 2 h per week. Tutorial: 1 hours per week.		
Proposal Date	March 15, 2018		

Course Aims

This course aims to let you apply knowledge from basic courses to appreciate the effects of various global change phenomena on real ecosystems, communities and organisms. It also aims to improve your ability to synthesise and present scientific information, formulating stable arguments based on this information and draw conclusions built on the consideration of different perspectives. The course aims to improve your skills and confidence through repeated exercises and continuous feedback.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. Apply basic ecological concepts and theory to real world ecosystems in a global change context.
2. Synthesise and interpret primary scientific literature, put it into context and communicate it in oral and written form.
3. Discuss the effects of different global change phenomena on various levels of ecosystems and its implications for ecosystem services that humans depend on.
4. Formulate well supported arguments and conclusions in controversial environmental issues, taking multiple perspectives into consideration.
5. Identify areas in global change ecology in need of more future study and suggest suitable approaches.

Course Content

The weekly arrangement for the course will be 2 h lectures and in-class problem solving + 1 h tutorials with short student presentations and literature discussions. Each week will cover a new topic or aspect of global change ecology. The main focus will be on how climate change effects ecological processes, in a wide range of different ecosystems, both terrestrial and aquatic. The effects of global change phenomena such as CO2 fertilization (e.g. effects on plant growth and interactions), N pollution (e.g. plant mineral nutrition, mycorrhizal interactions, soil nutrient availability), pollution of aquatic systems, ocean acidification, land use change (e.g. deforestation and habitat loss), and climate warming on ecological interactions both between different organisms and organisms and their environment. We end the course by looking at how multiple global change drivers can give a more realistic view of net ecosystem effects. Researchers methods for studying ecosystem effects of global change phenomena will be considered, as well as areas in need of further study. (Biodiversity loss and invasive species will not be covered in depth as they are major components of the course Current Issues in Ecology).

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment Rubrics
1. Continuous assessment: oral presentations	1, 2, 4.	1,2,3,6, 8	40%	Depends on the number of students taking the class.	Appendix 1
2. Continuous assessment: written assignments	1, 2, 3, 4, 5	1, 2, 3, 4, 6, 8, 9	40%	Individual.	Appendix 2
3. Contribution to tutorial discussions.	1, 2, 3, 4, 5	1, 2, 3, 6, 8, 9	20%	Team	Appendix 3
Total			100%		

Formative feedback

The format of the course, with continuous presentations and hand-in assignments, builds on weekly feedback to improve your performance. Your progress throughout the course, based on the given feedback, is part of the assessment criteria. Feedback on presentations and written assignments will be given weekly, aiming to improve performance bit by bit from week to week. Peer-feedback and self-feedback based on given rubrics will be encouraged.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lectures	Lectures will be used to outline context, background and basic concepts you are expected to be familiar with. (LO1).
Weekly tutorial: paper presentations and discussions.	On a rotating schedule, you will be expected to present a summary of the assigned reading material to the class, as a basis for further discussion. Doing this repeatedly with feedback will help improve your oral communication skills and confidence. In discussion exercises following the presentations, you will practice arguing different sides of an environmental problem and its solutions, with opportunities to demonstrate intellectual flexibility, question assumptions and search for creative solutions as a group.
Weekly discussion paper.	In the weekly discussion paper, you can use the discussion exercise as a base and get a chance to give your take on it. It should involve

	background, discussion and well based conclusions with suggested advice for environmental management and/or future research.

Reading and References

This course will be based on original research and review articles, mixing classical papers with the latest research and newly emerging topics. Papers will vary from year to year as new research is published. The subject of the course emerges from papers such as:
Vitousek, PM; Mooney, HA; Lubchenco, J and Melillo, JM. 1997. Human domination of Earth's ecosystems. Science, 277 (5325): 494-499.
Foley, JA; DeFries, R; Asner, GP; et al. 2005. Global consequences of land use. Science 309 (5734): 570-574.

Course Policies and Your Responsibilities

(1) General

You are expected to complete all assigned pre-class readings and activities, attend all seminar classes punctually and take all scheduled assignments and tests by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for seminar sessions you have missed. You are expected to participate in all seminar discussions and activities.

(2) Absenteeism

Discussions and team work is a crucial part of the course and a significant part of the assessment, therefore, students that miss a tutorial discussion seminar without a valid reason will need to compensate with additional assignments in order to avoid their grade being affected.
TBL requires you to be in class to contribute to team work. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be limited make-up opportunities for in-class activities. If you know you will be absent from a lecture or tutorial you should inform the teacher in advance via e-mail (alagerstroem@ntu.edu.sg).

(3) Compulsory Assignments

The course grade relies entirely on weekly compulsory assignments, with no final exam. Hence, submission of all assignments is necessary for a final grade and submission on time is necessary for the teacher to have time to provide feedback before the next assignment. Students who fall sick or for other reasons fail to meet expected deadlines should contact the teacher (a.lagerstroem@ntu.edu.sg).

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core

of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Anna Lagerstroem	N2-01c-65 (Room 11)	97724306	alagerstroem@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction, background and overview of major global change phenomena.	1, 2, 3	See note below.
2	CO2 fertilization and plant physiological response. Phase experiments.	1, 2, 3, 4, 5	See note below.
3	N pollution, critical load concept. Effects of increased N deposition on ecosystems. Interactive effects of N and C.	1, 2, 3, 4, 5	See note below.
4	Climate warming effect on terrestrial ecosystems.	1, 2, 3, 4, 5	See note below.
5	Climate warming effect on marine ecosystems.	1, 2, 3, 4, 5	See note below.
6	Ocean acidification and changed ocean currents etc., effects on organisms and ecosystems.	1, 2, 3, 4, 5	See note below.
7	Change in fire regimes. Fire suppression, increased fires as a result of warming.	1, 2, 3, 4, 5	See note below.
8	Mitigation of climate change – carbon sequestration.	1, 2, 3, 4, 5	See note below.
9	Land use change, soil degradation and food security.	1, 2, 3, 4, 5	See note below.
10	Fresh water systems and access to fresh water. Pollution of fresh water systems including plastic pollution and nanoparticles.	1, 2, 3, 4, 5	See note below.
11	Endocrine disrupters.	1, 2, 3, 4, 5	See note below.
12	Multiple global change drivers. Studying the effects of multiple factors on ecosystems.	1, 2, 3, 4, 5	See note below.

13	Synthesis	1, 2, 3, 4, 5	See note below.

Note: This is an advanced course and a key learning objective is to use scientific literature. Hence, the course literature will consist of original research and review papers that will be provided in advance of tutorials. Papers will vary from year to year as new research is published.

Appendix 1: Assessment Criteria for Oral Presentations

Standards	Criteria
A+ (Exceptional) A (Excellent)	- Exceptionally well prepared presentation, well timed and rehearsed. - Content is exceptionally well structured and presented in a clear and engaging way. - Content reflects the important aspects of the reading, highlighting key points and issues exceptionally well. -Team members exceptionally well-coordinated and interactive. All team members take active part and show interest in all parts of the presentation. -Introduces additional knowledge through secondary readings at appropriate times. - Any questions are answered knowledgably. - Shows engagement and understanding by asking thoughtful questions to the other presenters.
A- (Very good) B+ (Good)	- Well prepared presentation, well timed and rehearsed. - Content is well structured and presented in a clear and engaging way. - Content reflects the important aspects of the reading, highlighting key points and issues well. -Team members very well-coordinated and interactive. All team members take active part and show interest in all parts of the presentation. -Introduces some additional knowledge through secondary readings at appropriate times. - Any questions are answered correctly. - Shows engagement and understanding by asking questions to the other presenters.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	- Shows some preparation for presentation, reasonable timing and no reading from notes. - Content is adequately structured and presented. - Content reflects some important aspects of the reading, highlighting some key points and issues. -Team members adequately coordinated and interactive. All team members take some part and show some interest in all parts of the presentation. - Any questions are answered correctly. - Shows some engagement and understanding by sometimes asking questions to the other presenters.
C (Bordering unsatisfactory) C- (Unsatisfactory)	- Presentation preparation limited, timing not consistent with instructions. - Content has little structure and the presentation is difficult to follow. - Content reflects some aspects of the reading, failing to highlight one or two key points and issues. -Team members not well coordinated and with little evidence of interaction. Some team members are significantly more active than others. Team members show lack of interest when other members of the group are talking. - Any questions are answered mostly correctly. - Shows very little engagement and understanding. Not asking questions to the other presenters.
D, F (Deeply unsatisfactory)	- Presentation poorly prepared and carried out. - Content poorly structured and difficult to follow. - Content fails to reflect key aspects of assigned reading.

	-Team members uncoordinated and no group interaction. Work unevenly distributed. Group-members lacking engagement for the group and its work. - Cannot answer relevant questions. - Does engage or ask questions during other students' presentations. OR failure to deliver presentation.

Appendix 2: Assessment Criteria for Continuous Assessment – Written Assignments

Standards	**Criteria**
A+ (Exceptional) A (Excellent)	- Exceptionally good synthesis of assigned reading, well-structured, and including additional sources for better context. - Arguments exceptionally well based in theory and taking multiple perspectives into account. - Exceptionally thoughtful and solid conclusions. Clear evidence of original and lateral thinking. - Correct use of referencing throughout. - Excellent scientific style and language. - Provides excellent suggestions for future work.
A- (Very good) B+ (Good)	- Very good synthesis of assigned reading, well-structured, and including some additional sources for better context. - Arguments well based in theory and taking different perspectives into account. - Thoughtful and solid conclusions. Some evidence of original and lateral thinking. - Correct use of referencing throughout. - Very good scientific style and language. - Provides very good suggestions for future work.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	- Adequate synthesis of assigned reading, and structure of content. - Arguments have theoretical base and take different perspectives into account. - Conclusions are well motivated. - Adequate use of referencing throughout most of the paper. - Adequate scientific style and language throughout most of the paper. - Provides some suggestions for future work.
C (Bordering unsatisfactory) C- (Unsatisfactory)	- Some synthesis of assigned reading, limited structure, unclear. - Arguments have some theoretical base and sometimes take different perspectives into account. - Conclusions presented with limited support. - Adequate use of referencing throughout some of the paper. - Adequate scientific style and language throughout some of the paper. - Provides limited suggestions for future work.
D, F (Deeply unsatisfactory)	- Poor synthesis of assigned reading, unclear and difficult to follow. - Arguments lack theoretical base and/or fail to take different perspectives into account. - Limited or no basis for conclusions. - Inadequate use of referencing. - Lack of scientific style and language. - No suggestions for future work. OR failure to submit the proposal and/or article, and/or failure to deliver oral presentation.

Appendix 3: Assessment Criteria for Participation in Tutorial Discussions

Standards	Criteria
A+ (Exceptional) A (Excellent)	- Exceptionally good knowledge of the assigned reading material, related material and context. - Makes important contributions at appropriate times, covering all the required elements. - Articulates clear, concise and relevant arguments. - Knowledgeable, insightful and thoughtful answers to any questions. - Brings up new viewpoint to the discussion, evidence of thinking outside the box and creative solutions/suggestions. - Showing engagement by asking thoughtful questions to the presenters. - Forms exceptionally strong conclusions based on evidence and taking multiple perspectives into account.
A- (Very good) B+ (Good)	- Well prepared, has good knowledge of the assigned reading material and sometimes additional material. - Makes good contributions at appropriate times, covering all the required elements. - Articulates reasonable clear, concise and relevant arguments. - Knowledgeable and/or insightful answers to questions. - Sometimes brings up new viewpoint or other evidence of thinking outside the box. - Shows engagement by asking questions to the other presenters. - Forms strong conclusions based on evidence and taking multiple perspectives into account.
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	- Reasonably well prepared, has some knowledge of the assigned reading material. - Contributes to the discussion, covering some of the required elements. - Articulates somewhat reasonable clear, concise and relevant arguments. - Somewhat knowledgeable and/or insightful answers to questions. - Shows engagement by asking questions to the other presenters. - Forms conclusions based on evidence and sometimes taking different perspectives into account.
C (Bordering unsatisfactory) C- (Unsatisfactory)	- Somewhat prepared, has knowledge of some of the assigned reading material. - Contributes little to the discussion, covering all the required elements. - Articulates arguments that are not clear, or relevant. - Has trouble answering questions. - Asks few or no questions to the other presenters. - Forms conclusions that fail to either be based on evidence or take different perspectives into account.
D, F (Deeply unsatisfactory)	- Not familiar with the assigned reading material. - Minimal or no contribution to discussion. - Unable to answer questions. - Asks no questions to the other presenters. Unable to form conclusions on any relevant basis. Unexplained or unjustified absence.

Appendix 4. List of Programme Outcomes

OBTL Approved ASE learning outcomes

At the completion of your course of study in ASE, you will be able to:

1) Apply environmental knowledge and concepts to make sound decisions

- Interpret evidence to give sound environmental advice to stakeholders
- Give advice to industry regarding existing environmental legislation
- Synthesise the views of key stakeholders to make decisions involving environmental issues

2) Demonstrate intellectual flexibility and critical thinking

- Demonstrate intellectual flexibility to view environmental issues from multiple perspectives
- Question assumptions behind current ways of solving environmental problems
- Show willingness to adopt new ways of approaching environmental problems.

3) Demonstrate passion and use advanced communication skills to share that passion

- Learn independently and then share that knowledge with others
- Effectively communicate environmental concepts in writing
- Effectively communicate environmental concepts in speech
- Effectively communicate environmental concepts in various forms of media such as data visualisation, diagrams, animation, video, or podcasts

4) Formulate key scientific questions and develop hypotheses

- Research and formulate questions involving environmental issues
- Express and explain why these questions are important
- Create and evaluate hypotheses to research such questions

5) Conduct research

- Search for relevant scientific literature
- Interpret scientific literature
- Synthesize findings from scientific literature into current laboratory or field work
- Make first-hand observations in order to draw conclusions

6) Solve environmental problems

- Solve environmental problems systematically
- Solve environmental problems creatively
- Solve environmental problems reflexively
- Express and explain why the problems are important

7) Synthesize interdisciplinary approaches to solving problems

- Apply techniques from disciplines beyond your own field to solve environmental problems
- Express and explain how a problem solving approach may impact the environment
- Express and explain how an approach to solving an environmental problem may impact human society

8) Demonstrate the willingness and skills for lifelong learning

- Demonstrate good observation skills and a curiosity about the world
- Demonstrate critical thinking skills such as analysis, discrimination, logical reasoning, prediction and transforming knowledge

9) Demonstrate ethical values

- Use knowledge and skills to contribute to the world
- Debate the ethical implications of scientific processes and results
- Respect regulations involving plagiarism and copyright
- Respect requirements regarding confidentiality, data protection, conflict of interest, and falsification of data

10) Demonstrate collaboration and leadership skills

- Learn collaboratively and be willing to share expertise with peers
- Demonstrate leadership of small teams