Academic Year	AY2020/21	**Semester**	1
Course Coordinator	Assistant Professor Perrine Hamel		
Course Code	ES3202		
Course Title	Resilient Urban Systems		
Pre-requisites	ES2802: GIS and the Earth System		
No of AUs	3		
Contact Hours	Total hours – 39 (Lecture – 12; class activities – 24; visit: 3)		
Proposal Date	30/04/2020		

Course Aims

The urban population is growing globally, creating or exacerbating major global environmental issues such as climate change and biodiversity loss. To understand the role that cities can play in mitigating these issues, this course aims to equip students with the basic knowledge and tools to analyze urban landscapes using the frameworks of resilience and ecosystem services. We will cover the major challenges that cities face in the 21st century and the role that natural infrastructure –forests, parks, trees, green roofs– can play in addressing these challenges. Through a group project, students will apply this knowledge in practice by articulating the potential for natural infrastructure and presenting an urban ecosystem services assessment for a case study of their choice.

Intended Learning Outcomes (ILO)

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

1. Describe the major challenges and opportunities faced by cities in the Anthropocene
2. Explain how natural infrastructure can address urban challenges using the analytical frameworks of resilience and ecosystem services
3. Apply modelling tools to assess ecosystem services provided by natural infrastructure in cities
4. Collaborate with other students to produce and present an assessment of urban ecosystem services in a case study

Course Content

The course comprises two parts: i) a series of lectures aiming to provide the basic theoretical knowledge on urban challenges and natural infrastructure –what it is and how it benefits people; ii) practical activities aiming to consolidate this knowledge through discussions and hands-on modeling experience (see weekly schedule for details). If possible, a visit to a Government Agency in Singapore will complement the course by providing some local examples of the concepts studied in class.

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 1: In class quizzes and Discussions	1,2,3,4	Knowledge; intellectual flexibility and critical thinking; Formulating questions; values	20%	Individual	Appendix 1
2. Continuous assessment 2: Mid-term quizzes	1,2	Knowledge; intellectual flexibility and critical thinking;	20%	Individual	Appendix 2
3. Continuous assessment 3: Computer Modeling Project	2,3	Knowledge; intellectual flexibility and critical thinking; Problem solving; lifelong learning	25%	Individual	Appendix 3
4. Final project: Presentation and report	1,2,3,4	Knowledge; intellectual flexibility and critical thinking; Formulating questions; passion and communication; interdisciplinarity ; collaboration and leadership	35%	Individual/ Team	Appendix 4
Total			100%		

Formative feedback

You will receive informal feedback continuously throughout the course where appropriate, and formal feedback following every assignment. In addition, I will be available to answer questions regarding your research or assignments throughout this course.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Lectures effectively convey information on fundamental theories and key concepts and to bring all students up to similar levels of knowledge (ILO 1 and 2)
Interactive team-based activities	Various activities (discussion groups, presentation, etc) to help students analyse, formulate and communicate a deep understanding of topics that are fundamental to natural infrastructure management (ILO 1 and 2)
Computer modeling	Computer models allow students to gain technical skills and test their ability to apply concepts in practice (ILO 3)
Project-based learning	Project-based learning allows students to develop critical thinking, applying environmental knowledge in the real world, and hone communication and collaboration skills (ILO 4)

Reading and References

- 2016, Edward Elwar, Handbook on Green Infrastructure: Planning, Design and Implementation by Danielle Sinnett (Author, Editor), Nick Smith (Author, Editor), Sarah Burgess (Author, Editor); ISBN-13: 978-1783473991
- InVEST handbook: https://naturalcapitalproject.stanford.edu/software/invest

Course Policies and Student Responsibilities

(1) General

Students are expected to complete all assigned pre-class readings and activities on time, attend all lectures and class discussions, and submit all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements for seminar sessions they have missed. Students are expected to participate in all discussions and activities.

(2) Absenteeism

Absence from any part of the course without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate. There will be limited make-up opportunities. If you miss a lecture or discussion group exercise you must inform me via email (perrine.hamel@ntu.edu.sg) prior to the start of the class.

(3) Compulsory Assignments

You are required to submit compulsory assignments on due dates, unless a valid reason is provided. Valid reasons include falling sick supported by a medical certificate.

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.

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of thoughts, perspectives and experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:

- If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with one of the instructors or an ASE faculty member. We want to be a resource for you.
- Your classmates and instructors (like many people) are still in the process of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please talk to the instructors or an ASE faculty member about it.
- As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or an ASE faculty member.

Course Instructors

Instructor	Office Location	Phone	Email
Perrine Hamel	N2-01C-67	6791-1744	perrine.hamel@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction to course		*

2	Introduction to urban landscapes: challenges and opportunities	1	*
3	Urban resilience and ecosystem services analyses	1,2	*
4	Urban natural infrastructure (NI) for planetary health	1,2	*
5	Urban NI for water management	1,2	Tutorial: Urban NI for air quality and temperature regulation
6	Recap and quiz	1,2	
7	Modelling NI: InVEST 101	2,3,4	Tutorial: InVEST hands-on exercises
Recess week			
8	Tools to inform urban planning decisions	3,4	Tutorial: InVEST hands-on exercises
9	Informing urban planning decisions: case studies	1,2,3,4	Tutorial: project work
10	Modelling NI: Model evaluation	3,4	Tutorial: project work
11	Mid-project presentations	1,2,3,4	Tutorial: project work
12	Work on group project	3,4	Tutorial: class presentations
13	Feedback on class presentations	1,2,3,4	Tutorial: recap and feedback

*readings will be provided to students for certain weeks to prepare discussion and class activities

Appendix 1: Assessment Criteria for Participation in Tutorial and Forum 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 2: Assessment Criteria for Quizzes

Quizzes will be assessed as per NTU's standardized grade profile.

Appendix 3: Assessment Criteria for CA3: Computer Modeling project

Standards	**Criteria**
A+ (Exceptional) A (Excellent)	Successfully created model outputs for >90% of the tasks and interpreted them using clear, concise and thoughtful arguments.
A- (Very good) B+ to B (Good)	Successfully created model outputs for 75-89% of the tasks and interpreted them using clear, concise and relevant arguments.
B- to C (Average)	Successfully created model outputs for 65-74% of the tasks or interpreted them using sometimes unclear or irrelevant arguments.
C - (Bordering unsatisfactory)	Successfully created model outputs for 50-64% of the tasks or failed to interpret them correctly.
D, F	Replied correctly to <50% of the Multiple Choice Questions reflecting a rather poor understanding of the topic full mastery of the topic; F: did not take the test

Appendix 4: Assessment Criteria for the Final Project

Standards	Ability to meet project criteria (identify ecosystem services, recommendations)	Visuals (e.g. slides)	Oral presentation	Questions for others	Answering of questions
A+ (Exceptional) A (Excellent)	Excellent ability	Outstanding; Well-structured, focused and effective	Exceptionally well-prepared ; Convincing, well-structured and exciting;	Thought-provoking questions; Showing understanding and engagement	Correct with critical insight
A- (Very good) B+ (Good)	Very good ability	Very good; Reasonable structure and focus	Well-prepared ; Reasonably clear and well-structured	Asked; Showing understanding and engagement	Correctly
B (Average) B- (Satisfactory) C+ (Marginally satisfactory)	Satisfactory	Adequate; some capacity and focus	Prepared; Satisfactory	Some; Some understanding and engagement	Correctly
C (Bordering unsatisfactory) C- (Unsatisfactory)	Limited	Inadequate; limited capacity and focus	Ill-prepared (poor timing, off topic); Lackluster; Poorly organised	None	Mostly correctly
D, F* (Deeply unsatisfactory)	Not able	Poor quality, difficult to follow; Not addressing the topic	Inadequately prepared; Badly structured	None; Obvious lack of engagement	Not able

Your instructor has no way to assess the contribution of each student to the final project. Hence, each team needs to include a contribution statement at the end of the presentation to state the individual team members' contributions.

In addition, each student is required to rate the contribution of each of the other group members with a peer assessment score out of 10. Peer assessment should consider: attendance to group meetings (3 points), contributions to the project analyses (4 points), and preparation of final products (3 points). All peer evaluation scores will be kept strictly confidential and will not be revealed to the other group members. You are to evaluate other group members fairly and objectively, as your evaluation will affect other group members' grades (explained below). It is absolutely essential for you to submit your peer evaluation form to get marks for the final project. To account for peer evaluations, the final grades for the final project will be calculated as follows:

If, on average, a student receives a rating of 8 or more, that student receives 100% of the group's grade. If, on average, a student receives a rating of less than 8, that student receives a percentage of the group's grade as calculated by the formulae below:

- An average rating of 7 to <8 = 90% + (average rating - 7)*10
- An average rating of 6 to <7 = 80% + (average rating - 6)*10
- An average rating of 5 to <6 = 70% + (average rating - 5)*10
- An average rating of 4 to <5 = 60% + (average rating - 4)*10
- An average rating of 3 to <4 = 50% + (average rating - 3)*10
- An average rating of 2 to <3 = 40% + (average rating - 2)*10

Example:
Assume the maximum grade for the project is 30 marks. A student with an average rating of 8.90 gets 100% of 30 marks, i.e., 30 marks. An average rating of 6.29 means that a student gets 82.9% (or 80%+(6.29 - 6)*10) of 30 marks, i.e., 24.87 marks.

An average rating <2 will be investigated by your instructor, and the student may receive 0% of group grade.

Your instructor reserves the right to review the student ratings if in doubt, including if malice or discrimination are suspected. Similarly, if one student is not listed in the contribution statement and the instructor suspects that the student did not contribute at all, that student may receive 0% of the group grade regardless of the peer evaluation score.

Example of the peer evaluation score table:

Criteria	Yourself	Member 1	Member 2	Member 3	Member 4	Member 5
Contributed the fair share of work						
Attendance to group meetings (3 points).						
Contributions to the project analyses (4 points)						
Preparation of final products (3 points)						
TOTAL						
Comments, if any						

Appendix 5: ASE learning outcomes

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

1) Demonstrate intellectual flexibility and critical thinking in order to apply environmental knowledge in the real world

2) Communicate environmental concepts with enthusiasm to varied audiences both orally and in writing

3) Formulate scientific questions, and be able to access and analyse quantitative and qualitative information to address them

4) Exhibit the motivation, curiosity and skills for lifelong learning

5) Demonstrate ethical values and responsibility

6) Collaborate and lead by influence