UNSW
THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE

School of Biological, Earth and Environmental Sciences

GEOS2291

Earth's Systems and Sustainability

Term 1
2022

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Faculty of Science - Course Outline

1. Information about the Course
NB: Additional course information can be found in the UNSW Handbook: https://www.handbook.unsw.edu.au

Year of Delivery	2022
Course Code	GEOS2291
Course Name	Earth's Systems and Sustainability
Academic Unit	Biological, Earth and Environmental Science
Level of Course	UG
Units of Credit	6UOC
Term(s) Offered	T1
Assumed Knowledge, Prerequisites or Co-requisites	*No set prerequisites.* *BIOS1301, GEOS1211, GEOS1701 recommended but not required.* *No co-requisites*
Hours per Week	Up to 7 hours per week
Number of Weeks	Weeks 1 to 5 and 7 to 10
Commencement Date	T1 Week 1, Monday

Summary of Course Structure (for details see 'Course Schedule')

Component	HPW	Time	Day	Location
Lectures Pre-recorded	3	See Timetable	See Timetable	See Timetable
Laboratories/Tutorials Face-to-face and simultaneous online All labs will be recorded	4	See Timetable	See Timetable	See Timetable
Field Trip (no travel costs) Air sampling around UNSW campus or near your home Online alternative available One tutorial timeslot		See Timetable	See Timetable	
TOTAL	7			

Special Details	

2. Staff Involved in the Course

Staff	Role	Name	Contact Details	Consultation Times
Course Convenor		A/Prof. Bryce Kelly	bryce.kelly@unsw.edu.au	Arrange via email
Additional Teaching Staff	Lecturer	Prof. Andy Baker	a.baker@unsw.edu.au	Arrange via email
	Lecturer	Dr. Heather Haines	h.haines@unsw.edu.au	Arrange via email

3. Course Details

Course Description[1] (Handbook Entry)	Earth's Systems and Sustainability (GEOS2291) provides students with core background knowledge on how the atmosphere, hydrosphere, biosphere and geosphere (Earth's Systems) are interconnected. During this course, you will learn how to measure the chemistry of air and water, and quantify how the fluid chemistry changes as they flow through the landscape. These skills are needed to improve our knowledge about the interconnections between Earth's systems, and to quantify the impact of human developments. To support the energy, food and material needs of modern societies humans have had an impact on almost all ecosystems on Earth. We have altered the flow of rivers, cleared vast areas of land for agriculture, mined coal, extracted oil and gas, and mined many minerals to build our cities and support our lifestyles. Humans have extensively altered the chemistry of the atmosphere. This course teaches you how to measure the impacts of current and proposed human activities and how to collect the data required to sustainably manage our Earth.
Course Aims[2]	GEOS2291 provides you with a broad background to the interconnections between the hydrological cycle, biogeochemical cycles, and ecosystem response. You will gain an understanding of the influence of human activities on air and water quality and quantity. You will be taught how to analyse data that relate to air and water and how to interpret the patterns and trends hidden within the data. From case studies, tutorial problems and field trip observations, you will gain an appreciation of why management decisions that relate to air and water cannot be made in isolation and that decisions need to be based on scientific analysis of data.
Student Learning Outcomes[3]	The course develops your skills in the following areas: 1. Understanding Earth Systems (atmosphere, hydrosphere, biosphere and geosphere) 2. Measuring water chemistry, flow paths and fluxes 3. Measuring air chemistry, flow paths and fluxes 4. Mapping greenhouse gases' sources and sinks (carbon dioxide, methane and nitrous oxide) 5. Analysing spatial and temporal data for environmental impact assessments 6. Quantifying human impacts on urban environments and natural ecosystems 7. Understanding carbon accounting and carbon offsetting 8. Communicating sciences; writing science journal articles and producing science communication videos.

Graduate Attributes Developed in this Course[4]		
Graduate Attribute	**Select the level of FOCUS** *0 = NO FOCUS* *1 = MINIMAL* *2 = MINOR* *3 = MAJOR*	**Activities / Assessment**
Research, inquiry and analytical thinking abilities	***3***	• Air sampling and analyses • Interpreting water chemistry data • Analysing data, and modelling the movement of water and air • Producing a science communication video • Writing a scientific paper
Capability and motivation for intellectual development	**3**	• Lectures and Tutorials
Ethical, social and professional understanding	**3**	• Lectures and Tutorials
Communication	**2**	• Group MS Team meetings to discuss pooled data sets • Making a science communication video
Teamwork, collaborative and management skills	**2**	• Group MS Team Meetings and Assignments • For assignment 2 you will analyse the air chemistry data set collected by all students in the course.
Information literacy	**3**	• Lectures, Tutorials and Assignments

4. Rationale and Strategies Underpinning the Course

Teaching Strategies	Interactive lectures – engaging discussion forums that place the learning goals and presented information in the context of scientific analysis, societal goals and environmental management. Observations and measurements, report writing. Computer laboratories – problem-based learning (a toolbox of methods for data analysis).
Rationale for learning and teaching in this course.	Environmental careers are often multidisciplinary and require knowledge from many fields of study including atmospheric science, geology, hydrogeology, chemistry, biology, microbiology, and ecology. Professionals need a comprehensive knowledge of natural environmental processes and the impacts humans have on Earth's systems. Environmental consultants' and scientists' careers focus on measuring environmental conditions and processes, quantifying the impact of human activities and developing solutions to enable sustainable societies and ecosystems. This course will prepare you for careers in: • Environmental Consulting • Land and Water Management • Agriculture • Contaminated Land Remediation • Greenhouse Gas Monitoring • Carbon Accounting and Carbon Offsetting • Environmental Research GEOS2291 graduates work for consulting companies, State and Federal Government departments, and in research careers in universities worldwide.

5. Course Timetable

Some of this information is available on the Virtual Handbook and the UNSW Timetable.

UNSW Virtual Handbook: https://ww.handbook.unsw.edu.au

UNSW Timetable: http://www.timetable.unsw.edu.au/

Refer to the timetable spreadsheet at the end of this outline.

6. Assessment Tasks and Feedback

Assignment 1 - worth 20% - Due Friday Week 2, 5pm – A/Prof. Bryce Kelly

Topic: Science Communication Video

Description: You are to prepare a short video (3 minutes) on a topic related to biogeochemical cycling, carbon accounting and offsetting, or sustainability.

Grading: You will be graded considering:

- background and introduction of the topic
- scientific data presented to support the discussion
- visuals used to help convey insights about the physical and chemical processes discussed
- the scientific rigor of the physical and chemical processes discussed
- continuity of the storyline throughout the video
- transcript and supporting information

Student Learning Outcomes: 1, 3, 5, 6, 7, 8

Feedback: Written feedback will be provided within two weeks (provided all students have submitted in a timely manner).

Assignment 2 - worth 40% - Due Friday Week 5, 5pm – A/Prof. Bryce Kelly

Topic: Analysing the isotopic composition of methane in air samples, modelling the movement of air with HYSPLIT, and carbon accounting.

Description: You will either:

1) Analyse the air samples collected in the Surat Basin, Queensland, Australia coal seam gas fields and agricultural districts.
2) Analyse air samples collected around UNSW campus.

You will analyse the chemistry of the air sample and model the backwards trajectory of the air-parcel at your point of sampling using HYSPLIT. You will then summarise the results as a short scientific paper in the form submitted to Atmospheric Chemistry and Physics (https://www.atmospheric-chemistry-and-physics.net).

Grading: You will be graded considering:

- quality of data analysis (appropriate method, handling of units and errors)
- adherence to the scientific method: background, aims, method, results, discussion, and conclusion
- adherence to the style guide for the journal
- your interpretation of spatial and temporal variability or the air chemistry data
- your discussion and conclusion links to State, Australian Government and United Nation policies and targets

Student Learning Outcomes: 1, 3, 5, 6, 7, 8

Feedback: Written feedback will be provided within two weeks (provided all students have submitted in a timely manner).

Assignment 3 - worth 10% - Due Friday Week 8, 5pm – Prof. Andy Baker

Topic: Global water bottle label major ion chemistry and source rocks

Description: Tests understanding of the water chemistry lecture content. Students develop and apply database, graphics and data analysis skills. Your spreadsheet is submitted for assessment.

Grading: Marks are awarded for graph details, correct use of units, interpretation of data

Student Learning Outcomes: 1, 2, 5, 6, 8

Feedback: Written feedback will be provided within two weeks (provided all students have submitted in a timely manner).

Assignment 4 - worth 30% - Due Friday Week 10, 5pm – Prof. Andy Baker

Topic: Modelling groundwater recharge

Description: Tests understanding the groundwater recharge lecture content. Building on Assessment 1, students develop and apply spreadsheet and data analysis skills, including the use of equations and solver functions. A data analysis report is submitted for assessment.

Grading: Marks are awarded for correct use of units, correct use of model, results (including visualisation), interpretation, and conclusions.

Student Learning Outcomes: 1, 2, 5, 6, 8

Feedback: Written feedback will be provided within two weeks (provided all students have submitted in a timely manner).

Late Assignment Penalty

UNSW has a standard late submission penalty of:

- 5% per day
- for all assessments where a penalty applies
- capped at five days (120 hours), after which a student cannot submit an assessment, and
- no permitted variation

7. Additional Resources and Support

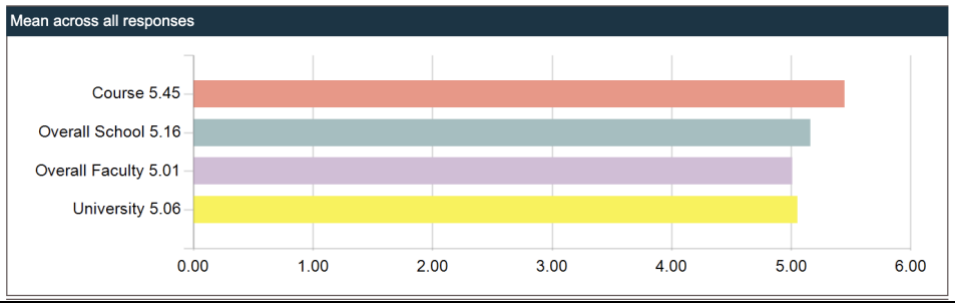
Recommended Reading and Viewing	The reading material at the links below provide useful background knowledge, and provide context about the content taught in the course: • Cohen, A. and Ray, I. 2018. The global risks of increasing reliance on bottled water. Nature Sustainability, 1, 327-329. https://www.nature.com/articles/s41893-018-0098-9 • Al Atawneh, D. et al 2021. Climate change and its impact on the projected values of groundwater recharge: A review. Journal of Hydrology, 601, 126602 https://www.sciencedirect.com/science/article/pii/S0022169421006508 • Bladon, K.D. et al 2014. Wildfire and the Future of Water Supply. Environmental Science and Technology, 48, 8936-8943. https://pubs.acs.org/doi/full/10.1021/es500130g • Groundwater https://iah.org/wp-content/uploads/2017/04/IAH-Groundwater-SDG-6-Mar-2017.pdf • Air Quality https://www.euro.who.int/__data/assets/pdf_file/0012/385959/fs-sdg-3-9-air-eng.pdf • Soil https://www.youtube.com/watch?v=AY9YVwJZDvw • William Schlesinger - "New Perspectives on Biogeochemical Cycles" https://www.youtube.com/watch?v=lU8DjoRlug0
	In Moodle there is a link to all lectures on MS Stream.
Required Readings	Web links to required reading will be provided at the end of each set of lecture slides.
Additional Readings	Web links to additional reading will be given on the lecture slides.
Recommended Internet Sites	Links to internet sites will be provided in the lecture slides.
Societies	- International Association of Hydrogeology (IAH; http://www.iah.org.au) - American Geophysical Union (AGU; http://sites.agu.org) - European Geosciences Union (EGU; https://www.egu.eu)
Computer Laboratories or Study Spaces	Computer Laboratory will be run online in MS Teams. Much of the data analysis will be done in Excel. There are comprehensive introductory tutorials on Excel here: https://support.microsoft.com/en-us/office/excel-video-training-9bc05390-e94c-46af-a5b3-d7c22f6990bb You will also be using HYSPLIT, which runs in most web browsers. https://www.ready.noaa.gov/HYSPLIT.php All software used in the course is freely available.

8. Required Equipment, Training and Enabling Skills

Equipment Required	If on-campus access is allowed Local students are to collect their air sampling kits in week 1 (UNSW Kensington Campus). International and distance mode students will be provided with a data set collected by UNSW staff. Please select a safe location to do the air sampling near your home. Sample well away from any buildings and trees. Check that all is clear overhead before collecting your air samples. If COVID restrictions do not allow on-campus access An alternative exercise for assignment 2 has been designed to accommodate COVID restrictions. There are no changes required for assignments 1,3, and 4.
Enabling Skills Training Required to Complete this Course	Any first-year science course. A background in chemistry, physics, biology or the environmental sciences is helpful.

9. Course Evaluation and Development

Student feedback is gathered periodically by various means. Such feedback is considered carefully with a view to acting on it constructively wherever possible. This course outline conveys how feedback has helped to shape and develop this course.

Mechanisms of Review	Last Review Date	Comments or Changes Resulting from Reviews
Major Course Review	*2020*	This course was adapted in 2020 for online teaching. We have moved the course online to overcome many of the challenges being experienced by all during the COVID period. The core content is the same as the face-to-face experience. We have adapted the assessments to align with the course goals and skills required for a career in environmental science and writing environmental impact statements. We have added content on carbon accounting and carbon offsetting, a topic of growing concern and career opportunities. We have extended the content on Earth's Systems incorporating the latest research insights, equipment advancements and policies developments.
myExperience	*2021*	
Student Comments	*2021*	**Student Comments -** What were the best things about this course? 2021 "I really liked the authenticity of the assignments, given that we were provided real data from Wellington Cave and Surat Basin to analyse. The feedback provided for each assignment component was also very specific and helpful. The laboratory sessions were designed to scaffold our learning and fulfilment of the assignment requirements, with the lecturers available to answer our queries, which really facilitated the learning process. The lecturers were all kind and approachable, and very knowledgeable in their field of expertise. "I love how this module was centered around the real–life analysis and how things are done in the industries now. Very topical and current." 2020 "Overall, I really enjoyed taking GEOS2291. I thought that the course covered a wide range of interesting topics, exploring them in the right amount of detail for the majority and then providing extensive on material for those who would like to dive in deeper which I believe is great way of teaching the content." "Physically taking air samples, ability to ask questions during an open lab time, working at own rates, variety of lecturers, lectures broken into smaller parts" **Student Concerns 2021** "Online delivery was great, but students like me would really benefit from doing this in person" "Maybe a group task to let people in the course actually engage with each other" How we adapted • In 2022 we will hold face-to-face labs and do on-campus air sampling in teams.

10. Administrative Matters

Expectations of Students	Attendance at 80% of lectures and laboratories is expected. Both Moodle and MS Teams keep a log of student access.	
Assignment Submissions	Assignments will need to be submitted via Moodle, MS Teams or email as directed on the assignment handout.	
Occupational Health and Safety[5]	The School of BEES recognises its obligations to provide a safe working environment for all persons involved in School-related activities. To achieve this goal with regards to teaching and learning, the School adopts the UNSW Occupational Health and Safety Policy (2001) and the UNSW OH&S Responsibility and Accountability Document (2001). These documents stipulate that everyone attending a UNSW workplace must ensure their actions do not adversely affect the health and safety of others. This outcome is achieved through the establishment of a documented chain of responsibility and accountability for all persons in the workplace, extending from the Head of School through to the students undertaking courses offered by the School of BEES. As part of this chain of responsibility and accountability, the Course Authority is responsible for ensuring all activities associated with this course are safe. The Course Authority has undertaken detailed risk assessments of all course activities and identified all associated potential hazards. These hazards have been minimised and appropriate steps taken to ensure your health and safety. For each activity, clear written instructions are given, and appropriate hazard warnings or risk minimisation procedures included for your protection. It is the student's responsibility to prepare for all practical work. Students should be familiar with the written procedures scheduled for the practical class and identify all personal protection requirements needed to complete the exercise in a safe manner. Students must comply with all safety instructions given by the Course Authority and/or Laboratory / Field Demonstrator, and observe the Safety Information located outside or within teaching rooms. If you are unsure of any safe operating procedures or written instruction regarding safety, you should seek further information from the Course Authority and/or Laboratory / Field Demonstrator before attempting the task. **NOTE: Students should discuss OHS matters in Labs and Field work as part of their research with their supervisor. These activities do not fall under the OH&S requirements of BEES 4511/4521/9011** Failure to comply with safety instructions may, in the first instance, be considered as a form of academic misconduct. If the outcome of a student's failure to comply with safety instructions results in personal injury, or endangers the health and safety of others, then the matter may be dealt with by WorkCover as a breach of the NSW OH&S Act (2000). For more information on OHS and Safety at UNSW visit the following site: www.ohs.unsw.edu.au/ or the relevant pages on the BEES website at: https://www.bees.unsw.edu.au/health-and-safety	
Assessment Procedures	*Please Read the UNSW Assessment Policy* *https://my.unsw.edu.au/student/academiclife/assessment/AssessmentPolicyNew.html*	
Equity and Diversity	Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course Convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (phone: 9385 4734) https://www.edi.unsw.edu.au Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made. Information on designing courses and course outlines that take into account the needs of students with disabilities can be found at: https://www.hr.unsw.edu.au/diversity/uploads/unsw-disability-inclusion-action-plan.pdf	
Grievance Policy	In all cases you should first try to resolve any issues with the course convener. If this is unsatisfactory, you should contact the Director of Teaching in BEES (A/Prof Stephen Bonser s.bonser@unsw.edu.au) or the Head of School, School of BEES (Prof Alistair Poore, a.poore@unsw.edu.au). UNSW has formal policies about the resolution of grievances that can be reviewed in myUNSW A to Z Guide (see https://student.unsw.edu.au/complaints).	**BEES Student Advisor** Faye Mo Tel: +61 (2) 9385 2961 https://www.bees.unsw.edu.au/biosciences-student-office

11. UNSW Academic Honesty and Plagiarism

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.
*Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

https://student.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne

Term 1 Week	Day/Time	Where	Lecturer	Topic	Assignments and Due Date
Week 1	Pre-recorded lectures	Watch on MS Stream before the laboratory	A/Prof. Bryce Kelly Dr. Heather Haines	• Staff Introductions and Course Aims • Introduction to the Atmosphere and Hydrosphere • Vegetation and the Carbon Cycle • Soils and the Carbon Cycle; Carbon Offsetting • Air Pollution and Monitoring	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face, meet outside the Biological Science Building (E26)	A/Prof. Bryce Kelly Prof. Andy Baker Dr. Heather Haines	• MS Teams Chat, Meet the Staff • Assignment 1 - Science Communication • Air Sampling for On Campus Students	
Week 2	Pre-recorded lectures	Watch on MS Stream before the laboratory	A/Prof. Bryce Kelly	• Greenhouse Gas Measurements – Airborne and Ground Sampling • Surat Basin – Methane Emissions Case Study	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face Biosci G29	A/Prof. Bryce Kelly	• Background for Assignment 2 • Laboratory Measurement of Air Samples • Assignment 1 Preparation Time	Assignment 1 Worth 20% Science Communication Video Due Friday week 2, 5 pm
Week 3	Pre-recorded lectures	Watch on MS Stream before the laboratory	A/Prof. Bryce Kelly	• Urban Greenhouse Gases • Using Isotopes for Source Attribution and Quantifying Mixing	
	Tuesday 2pm to 6pm	• Online in MS Teams	A/Prof. Bryce Kelly	• Analysis of Air Samples; Keeling Plots and Isotope Mixing Models • Help with Assignment 2	
Week 4	Pre-recorded lectures	Watch on MS Stream before the laboratory	A/Prof. Bryce Kelly	• Bottom-Up Carbon Accounting	
	Tuesday 2pm to 6pm	• Online in MS Teams	A/Prof. Bryce Kelly	• Writing a Scientific Paper • Tracking Air Parcel Movement and Plume Dispersion – HYSPLIT Tutorial • Help with Assignment 2	
Week 5	Pre-recorded lectures	Watch on MS Stream before the laboratory	A/Prof. Bryce Kelly	• Satellite Observations and Carbon Management	
	Tuesday 2pm to 6pm	• Online in MS Teams	A/Prof. Bryce Kelly	• Environmental & Sustainability Science Careers • Assignment 2 Writing Time • Help with Assignment 2 available either face-to-face or via MS Teams	Assignment 2 Worth 40% Isotopic chemistry of carbon sources, mixing models and HYSPLIT modelling Due Friday week 5, 5 pm
Week 6	UNSW Study Week			UNSW Study Week	
	UNSW Study Week			UNSW Study Week	
Week 7	Pre-recorded lectures	Watch on MS Stream before the laboratory	Prof. Andy Baker	• Water Chemistry	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face Biosci G29	Prof. Andy Baker	• Water Chemistry	
Week 8	Pre-recorded lectures	Watch on MS Stream before the laboratory	Prof. Andy Baker	• Water Isotopes, Past, Present and Future	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face Biosci G29	Prof. Andy Baker	• Water Isotopes, Past, Present and Future	Assignment 3 Worth 10% Bottled Water Chemistry - source rock identification. Due Friday Week 8, 5 pm
Week 9	Pre-recorded lectures	Watch on MS Stream before the laboratory	Prof. Andy Baker	• Caves as Observatories of Groundwater Recharge	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face Biosci G29	Prof. Andy Baker	• Modelling Groundwater Recharge	
Week 10	Pre-recorded lectures	Watch on MS Stream before the laboratory	Prof. Andy Baker	• Interconnections Between Fire and Water	
	Tuesday 2pm to 6pm	• Online in MS Teams • Face-to-face Biosci G29	Prof. Andy Baker	• Modelling Groundwater Recharge	Assignment 4 Worth 30% Modelling Groundwater Recharge Due Friday week 10, 5 pm