



UNSW Course Outline

GEOS2291 Earth's Systems and Sustainability - 2024

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General Course Information

Course Code : GEOS2291

Year : 2024

Term : Term 1

Teaching Period : T1

Is a multi-term course? : No

Faculty : Faculty of Science

Academic Unit : School of Biological, Earth and Environmental Sciences

Delivery Mode : In Person

Delivery Format : Standard

Delivery Location : Kensington

Campus : Sydney

Study Level : Undergraduate

Units of Credit : 6

Useful Links

[Handbook Class Timetable](#)

Course Details & Outcomes

Course Description

This course focuses on investigating changes in Earth's systems, with an emphasis on measuring the chemistry and modelling the movement of air and water.

To support the energy, food and material needs of modern societies humans have had an impact on almost all ecosystems on Earth. In this course students learn how to measure the impacts of past, current, and proposed human activities and how to collect the data required to determine how to sustainably manage our Earth. Students learn how to: measure greenhouse gas emissions and identify mitigation opportunities; measure water quality, determine its origin, and manage surface and ground water supplies; monitor the atmosphere and water resources using ground-, aircraft- and satellite-based analysers.

Each week consists of 3 hours of online learning material and a 3-hour laboratory.

There are no prerequisites for the course, but background knowledge of the Earth Sciences and chemistry would be helpful. This course provides the skills required to work for environmental consulting or carbon management companies or pursue research careers in environmental science.

The skills gained from this course contribute to the United Nations Sustainable Development Goals (SDGs) 3, 6, 11, 12, 13, 14 and 15.

Course Aims

This course aims to provide students with skills to quantify changes within and the connections between Earth's systems using advanced measurement techniques.

The aims of this course are to develop skills in:

- Collecting discrete air and water samples,
- Measuring the chemistry of air and water samples in the laboratory,
- Analysing discrete, spatial, and temporal data sets,
- Modelling the movement of air parcels and water,
- Using ground-, aircraft- and satellite-based measurements to track physical and chemical processes within Earth's systems,
- Tracking environmental management goals (e.g. soil health, water quality, and carbon pools),
- Scientific analyses, presentations, and writing.

This course aims to prepare students for careers in environmental sciences and carbon management.

Relationship to Other Courses

This course provides students with the skills required for careers in environmental science. GEOS2291 Earth's Systems and Sustainability builds on the course content from GEOS1111 Investigation Earth and Its Evolution and GEOS1211 Earth and Environmental Sciences.

Course Learning Outcomes

| Course Learning Outcomes |
|---|
| CLO1 : Measure and interpret water and air chemistry data, flow paths, and fluxes. |
| CLO2 : Create and analyse maps of greenhouse gas sources and sinks, particularly carbon dioxide and methane. |
| CLO3 : Analyse and interpret data used in environmental impact assessments. |
| CLO4 : Explain carbon accounting and carbon offsetting methods. |
| CLO5 : Communicate scientific information using verbal, written, and visual presentations. |
| CLO6 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques. |

| Course Learning Outcomes | Assessment Item |
|---|--|
| CLO1 : Measure and interpret water and air chemistry data, flow paths, and fluxes. | <ul style="list-style-type: none">• Analysis of Atmospheric Air Samples• Global Water Bottle Chemistry• Modeling Ground Water Recharge |
| CLO2 : Create and analyse maps of greenhouse gas sources and sinks, particularly carbon dioxide and methane. | <ul style="list-style-type: none">• Analysis of Atmospheric Air Samples |
| CLO3 : Analyse and interpret data used in environmental impact assessments. | <ul style="list-style-type: none">• Science Communication Video• Global Water Bottle Chemistry• Modeling Ground Water Recharge• Analysis of Atmospheric Air Samples |
| CLO4 : Explain carbon accounting and carbon offsetting methods. | <ul style="list-style-type: none">• Science Communication Video |
| CLO5 : Communicate scientific information using verbal, written, and visual presentations. | <ul style="list-style-type: none">• Science Communication Video• Global Water Bottle Chemistry• Modeling Ground Water Recharge• Analysis of Atmospheric Air Samples |
| CLO6 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques. | <ul style="list-style-type: none">• Science Communication Video• Global Water Bottle Chemistry• Modeling Ground Water Recharge• Analysis of Atmospheric Air Samples |

Learning and Teaching Technologies

Moodle - Learning Management System | Microsoft Teams

Learning and Teaching in this course

All lectures and additional reading have been uploaded into Moodle and the GEOS2291 MS Teams folders.

Assessments

Assessment Structure

| Assessment Item | Weight | Relevant Dates |
|--|--------|--|
| Science Communication Video Assessment Format: Individual | 20% | Start Date: 12/02/2024 09:00 AM Due Date: 01/03/2024 05:00 PM |
| Analysis of Atmospheric Air Samples Assessment Format: Individual | 40% | Start Date: 12/02/2024 12:00 AM Due Date: 28/03/2024 05:00 PM |
| Global Water Bottle Chemistry Assessment Format: Individual | 10% | Start Date: 05/04/2024 09:00 AM Due Date: 12/04/2024 05:00 PM |
| Modeling Ground Water Recharge Assessment Format: Individual | 30% | Start Date: 12/04/2024 09:00 AM Due Date: 22/04/2024 05:00 PM |

Assessment Details

Science Communication Video

Assessment Overview

For assignment 1 you will prepare a 3-to-5-minute video on:

- carbon accounting and its uncertainties, or
- a method to reduce greenhouse gas emissions or enhance the remove of carbon dioxide or methane from the atmosphere using biological or geological processes.

Preparing this video will enhance your knowledge of the carbon cycle and consolidate your understanding of the course material from weeks 1 to 3, with the video due for submission in Week 3. The assessment will also give you an appreciation of carbon accounting and management challenges.

Your submission will be assessed against the following criteria:

- background and introduction of the topic,
- scientific data presented to support the discussion,

- visuals used to help convey the physical and chemical processes discussed,
- the scientific rigor of the physical and chemical processes discussed,
- the quality of your Net Zero business case or proposed method to reduce the Tier 1 or 2 emission estimate uncertainty,
- transcript and supporting information.

Written feedback will be provided within two weeks.

Course Learning Outcomes

- CLO3 : Analyse and interpret data used in environmental impact assessments.
- CLO4 : Explain carbon accounting and carbon offsetting methods.
- CLO5 : Communicate scientific information using verbal, written, and visual presentations.
- CLO6 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques.

Assessment Length

5 minute PowerPoint video

Submission notes

Submit via your transcript via Moodle using the Assignment 1 Turnitin link and upload the presentation to MS Teams using the mp4 format.

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Analysis of Atmospheric Air Samples

Assessment Overview

For assignment 2 you will collect and analyse the chemistry of air samples near your home. You will also determine the origin of the air in your samples using atmospheric transport and dispersion modelling to locate the sources of the greenhouse gas in the air samples. The task involves preparing a written 10-page report, which is due in Week 7.

Your submission will be assessed against the following criteria:

- your background and aims descriptions,
- how you collected your air samples and recorded local climatic information (added as supplementary information to your mini paper),
- 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 of the air chemistry data,
- your discussion and conclusion links to State, Australian Government and United Nation policies and targets.

Written feedback will be provided within two weeks.

Course Learning Outcomes

- CLO1 : Measure and interpret water and air chemistry data, flow paths, and fluxes.
- CLO2 : Create and analyse maps of greenhouse gas sources and sinks, particularly carbon dioxide and methane.
- CLO3 : Analyse and interpret data used in environmental impact assessments.
- CLO5 : Communicate scientific information using verbal, written, and visual presentations.
- CLO6 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques.

Assessment Length

Approximately 3000 words or 10 pages

Submission notes

Submit via Moodle using the Assignment 2 Turnitin link

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Global Water Bottle Chemistry

Assessment Overview

For assignment 3 you will analyse the water chemistry of commercially available bottled water. This will test your understanding of the water chemistry lecture content. You will develop skills in database development, data visualisation and data analysis skills. A spreadsheet presenting your analyses is due in Week 8.

Marks are awarded for correct data analysis, the choice of solutes visualised, correct use of units, interpretation of data.

Written feedback will be provided within two weeks

Course Learning Outcomes

- CL01 : Measure and interpret water and air chemistry data, flow paths, and fluxes.
- CL03 : Analyse and interpret data used in environmental impact assessments.
- CL05 : Communicate scientific information using verbal, written, and visual presentations.
- CL06 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques.

Submission notes

Submit via Moodle using the Assignment 3 Turnitin link

Assignment submission Turnitin type

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Modeling Ground Water Recharge

Assessment Overview

Assignment 4 tests your understanding of the groundwater recharge lecture content. Building on skills learnt in Assessment 3, you will develop and apply spreadsheet and data analysis skills, including the use of equations and solver functions in a simple groundwater recharge model. A data analysis report is submitted for assessment in Week 11.

Marks are awarded for correct analysis of rainfall data to obtain rainfall recharge thresholds, correct use of a simple lumped parameter model to obtain groundwater, clarity of presentation of results (including visualisation), application of rainfall recharge and modelling results to understand past groundwater recharge.

Written feedback will be provided within two weeks.

Course Learning Outcomes

- CL01 : Measure and interpret water and air chemistry data, flow paths, and fluxes.
- CL03 : Analyse and interpret data used in environmental impact assessments.
- CL05 : Communicate scientific information using verbal, written, and visual presentations.
- CL06 : Quantify human impact on urban environments and natural ecosystems using advanced chemical measurement and modelling techniques.

General Assessment Information

Grading Basis

Standard

Requirements to pass course

A tally from assignments 1, 2, 3 and 4 greater than 49.

Course Schedule

| Teaching Week/Module | Activity Type | Content |
|------------------------------------|---------------|--|
| Week 1 : 12 February - 18 February | Blended | <p>Week 1</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Course Introduction • The Paris Agreement, Net Zero Goals, and Top-Down Atmospheric Measurements • Bottom-Up Carbon Accounting (IPCC Methods and Australia's GHG Inventory) • Carbon Offsetting – Emission Reduction Fund Methods <p>Friday Laboratory, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Staff Introductions and Course Overview • Assignment 1 – Carbon Management – Emission Reduction Fund Methods • Assignment 2 – Greenhouse Gas Measurements • How to Collect Air Samples. |
| Week 2 : 19 February - 25 February | Blended | <p>Week 2</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Air Pollution and Modelling Air Parcels • GHG Gas Measurements of Urban Emissions <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Laboratory Measurement of Air Samples (CH₄, CO₂ and CO) • Displaying Data in Google Earth • Assignment 2 Discussion |
| Week 3 : 26 February - 3 March | Blended | <p>Week 3</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Atmospheric Greenhouse Gas Measurements • Top Down Measurements using Aircraft <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Tracking Air Parcel Movement and Plume Dispersion – HYSPLIT Tutorial • Part of Assignment 2 – What was the source of my air? |
| Week 4 : 4 March - 10 March | Blended | <p>Week 4</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Satellite-based Greenhouse Gas Monitoring and Carbon Management <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • TROPOMI Satellite Analysis of Methane and Carbon Monoxide |
| Week 5 : 11 March - 17 March | Blended | <p>Week 5</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Water Chemistry • Water Chemistry Laboratory Tour <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Analysis of Bottled Water Chemistry (Assignment 3) |
| Week 6 : 18 March - 24 March | Other | Enjoy your break |
| Week 7 : 25 March - 31 March | Lecture | <p>Lectures to view and papers to read</p> <p>In week 7 there are two case study lectures to watch.</p> <p>The first lecture is a presentation about the UNEP Methane Science Studies in the Surat Basin. For more details on this study read Lu et al. (2021), Neiningner et al. (2021) and Kelly et al. (2022). These papers discuss the results of the top-down (airborne) vs bottom-up (inventory) methane emission estimates in the Surat Basin. The papers and lectures provide background knowledge for Assignment 2.</p> <p>The second case study is on cave hydrology. Are twelve years of hydrological monitoring at a SE Australian alpine cave enough to provide insights into the speleothem paleoenvironmental record?</p> |
| Week 8 : 1 April - 7 April | Blended | <p>Week 8</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Water Isotopes, Past, Present and Future <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Sydney region water isotopes |
| Week 9 : 8 April - 14 April | Blended | <p>Week 9</p> <p>Pre-recorded lectures</p> <p>Watch before the laboratory</p> <ul style="list-style-type: none"> • Caves as Observatories of Groundwater Recharge <p>Friday, 10:00am to 1:00pm, E26, Teaching Lab 02</p> <ul style="list-style-type: none"> • Groundwater Recharge – Assignment 4 |

| | | |
|-------------------------------|---------|--|
| | | • Understanding rainfall recharge at Wellington Caves, NSW (Parts 1, 2 and 4) |
| Week 10 : 15 April - 21 April | Blended | Week 10 Pre-recorded lectures Watch before the laboratory • Modelling Karst Hydrology - Cave Tour Friday, 10:00am to 1:00pm, E26, Teaching Lab 02 • Assignment 4 (continued) Part 3 |

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

All laboratories are face-to-face.

Course Resources

Prescribed Resources

Links to free software and other resources are provided in the lectures and laboratory notes.

Additional Costs

There are no additional costs.

Course Evaluation and Development

Each year this course uses the feedback from myExperience to refine the content.

Staff Details

| Position | Name | Email | Location | Phone | Availability | Equitable Learning Services Contact | Primary Contact |
|----------|-------------|-------|--|-------|----------------------------|-------------------------------------|-----------------|
| Convenor | Bryce Kelly | | Room 5115, Level 5 Biological Sciences South (E26) UNSW, Kensington 2052 | | Arrange meetings via email | Yes | Yes |
| Lecturer | Andy Baker | | Room 5114, Level 5 Biological Sciences South (E26) | | Arrange meetings via email | No | No |

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the [UNSW Student Code of Conduct Website](#).

Academic Honesty and Plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located at <https://student.unsw.edu.au/referencing>

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The [Current Students site](#),
- The [ELISE training site](#), and
- The [Use of AI for assessments](#) site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: <https://student.unsw.edu.au/conduct>

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,

- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: <https://student.unsw.edu.au/special-consideration>

Important note: UNSW has a “fit to sit/submit” rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- [The Current Students Gateway](#)
- [Student Support](#)
- [Academic Skills and Support](#)
- [Student Wellbeing, Health and Safety](#)
- [Equitable Learning Services](#)
- [UNSW IT Service Centre](#)
- Science EDI Student [Initiatives](#), [Offerings](#) and [Guidelines](#)