



## MSc in Global Management of Natural Resources

The industry needs talented individuals with sufficient knowledge of energy resources (including shale gas, minerals, conventional and unconventional oil, nuclear), process engineering, policy concerns, and financial managerial capabilities.

This post-graduate taught MSc responds to this need. The programme builds on existing strengths within UCL, London Campus (Earth Sciences, School of Management, and Chemical Engineering) and UCL Australia (International Energy Policy Institute), on a large proposal on shale gas recently funded by the European Commission (<http://shalexenvironment.org>), and on the minerals processing and environmental remediation expertise within the Future Industries Institute at the University of South Australia, UniSA, in Adelaide, Australia.

The objective of this multi-disciplinary MSc is to prepare students for highly skilled, multi-disciplinary managerial jobs in the natural resources sector. The successful graduate will be well versed in all aspects of the energy and natural resources industries, will be an effective communicator, will have a strong background on Earth Science and Engineering, will be aware of social responsibilities, will operate within international constraints and opportunities, and will have strong managerial skills. The programme is one of the first, if not the first, trans-continental teaching-research combination.

The students enrolled in the MSc in 'Global Management of Natural Resources' will spend the first two terms in London, where the research project will be initiated; they will spend the third term and the summer in Adelaide, where the research project will be completed. The students who will opt out of the research project could qualify to obtain a Graduate Diploma.

The programme includes one field trip to explore sedimentary formations similar to shale plays, and one field trip to one copper / gold / uranium mine in South Australia. The students will have the opportunity of enrolling in evening language courses at UCL, London campus. Career facilitation will be offered throughout the entire programme of studies and transferable skills will be fostered within the highly multi-disciplinary environment formed by many related publicly funded research programmes.

To ensure the quality of the research projects conducted as integral part of the MSc in 'Global Management of Natural Resources' the students will be supervised by a team within the nascent Future Industries Institute at UniSA. UCL staff members in Adelaide will coordinate the research projects. As the projects will use the material presented during the taught courses, there will be formal teleconferences set up between Adelaide and London to allow the students to clarify the material, as needed for preparing for the examinations and for completing the research projects.

UCL personnel, including the program director, will be present *at least intermittently* in Adelaide to both provide pastoral support to the students enrolled to the MSc in 'Global Management of Natural Resources' and to monitor the quality of research and supervision during the research projects.

The students enrolled in the MSc in 'Global Management of Natural Resources' will effectively be UCL Exchange Students and fully enrolled at UniSA during Term 3. This will provide them with institutional support and access to all University facilities in Adelaide.

## **Synergism with Societal Needs and Institutional Goals**

This MSc programme responds to the current societal need for managing energy and natural resources both economically and in a socially acceptable manner. In Europe and in the UK, a new class of managers are needed, if shale gas will become a commercial reality. Because oil and gas exploration and production is relatively new in the mainland EU, and because of strong vocal objections from environmental groups, these managers will have to be able to both respond to and address competently public concerns and to communicate effectively with the industry. Similar problematic will be faced by the future managers of other natural resources, including those involved with the nuclear energy sector, the mining industry, etc.

The professional figure we will prepare will be able to converse with, and therefore manage Earth Scientists (currently the dominant figures in exploration and production) and Chemical Engineering (traditionally expert in utilizing energy and natural resources). The fast development of energy and natural resources in Africa, South America and Asia will also require the professional figure we seek to develop with the present programme.

Within UCL, the present MSc fits well with the Grand Challenges of Sustainable City, because of its emphasis on energy and natural resources. In addition, it is also consistent with Intercultural Interactions because of its policy component and Human Wellbeing because it will promote the career development of the students enrolled.

## Programme of Studies

*Students Presence.* In Term1 and Term 2 (from mid September to end of March) the students will be physically present at the UCL campus in London; from April to mid September, starting in Term 3 the students will be Exchange Students and will be immersed in the UniSA campus in Adelaide, South Australia, where they will be fully supported. UCL personnel will be available for providing pastoral care and for monitoring the research projects supervision.

*Field Trips.* One field trip to Spain and/or UK, to explore sedimentary formations similar to shale plays; one field trip to one copper / gold / uranium mine in South Australia.

*Transferable Skills.* The students will have the opportunity of enrolling in evening language courses at UCL, London campus, in Term 1 and Term 2. As Exchange Students at UniSA, the students will benefit from transferable skills available in Adelaide. Career facilitation will be offered throughout the entire program of studies and transferable skills will be fostered within the highly multi-disciplinary environment formed by many related publicly funded research programmes.

Term 1	Term 2	Term 3 & Summer
<b>Geology for Global Managers and Engineers New Module</b>	<b>Earth Resources and Sustainability GEOLM043</b>	<b>Social Licensing SERAG011</b>
<b>Minerals Usage, Extraction and Processing New Module</b>	<b>Prevention and Remediation of Environmental Contaminations New Module</b>	<b>Dissertation Research Project</b>
<b>Natural Gas Processing New Module</b>	<b>Decision and Risk Analysis MSING014B</b>	<b>Dissertation Research Project</b>
<b>Dissertation – Skills for a Successful Research Project</b>	<b>Business Sustainability BENVGED8</b>	<b>Dissertation Research Project</b>

### Brief Modules Description (Subject to Change)

#### Existing modules from the UCL School of Management

1) MSING014B - Decision and Risk Analysis  
<https://www.msi.ucl.ac.uk/modules/msing014b-decision-risk-analysis>

2) BENVGED8 - Business Sustainability  
<https://www.msi.ucl.ac.uk/modules/benvged8-business-and-sustainability>

#### Natural Gas Processing

This module has the goal of providing an overview on the chemical processes typically implemented to transform the natural gas extracted from the ground into a valuable commodity. The module includes elements of project management, economics analysis, optimization, process control, and the description of a few unit operations that are essential for the implementation of natural gas processing plants.

**Reference textbook:** Handbook of Natural Gas Transmission & Processing, by Mokhatab, Poe, Mak

## Minerals Usage, Extraction and Processing

This module has the goal of providing an overview on the impact of minerals on our society, their extraction processes, and some of the unit operations typically adopted for the refining and commercialization of the raw materials. The module includes elements of historical usage, international dependencies of natural resources extractions and utilization, economics analysis, the typologies of mining operations, the description of a few unit operations essential for the mining industry, the economical analysis of chemical processes involved, in particular with the production of aluminum, and the relation between minerals and energy, with emphasis on coal and nuclear.

**Reference textbook:** Earth Resources and the Environment, 4<sup>th</sup> Edition, J.R. Craig, D.J. Vaughan, B.J. Skinner, Prentice Hall, 2011

Needs additional material to quantify various aspects of the discussion

## Prevention and Remediation of Environmental Contamination

This module has the goal of illustrating possible environmental consequences related to the extraction of natural resources. Focus will be on acid drainage and sulfide oxidation, as related to the mining industry, and on water usage. The module will touch upon the processes of environmental contaminations, the measurements of such contamination, prediction and methods to prevent the contamination, regulatory examples on how to manage mining in a responsible manner, and processes that could be implemented to remediate contaminated areas.

**Reference textbook:** Acid Mine Drainage, Rock Drainage and Acid Sulfate Soils: Causes, Assessment, Prediction, Prevention and Remediation, J.A. Jacobs, J.H. Lehr, and S.M. Testa, Editors, John Wiley and Sons, 2014.

## Social Licensing

Over the last 20 years industry has often adopted principles of sustainable and equitable development to help build and maintain its 'Social Licence to Operate' within the community. In reality, however, industry now faces more challenges to its operations than ever. Understanding who their stakeholders are and their concerns is an obvious first step in engagement. However, rapid changes in communication and social media are changing how the community organises and interacts with business and government, often at a rate that industry cannot keep up with. Stakeholders may have very different perspectives or belief systems and the ground rules which they operate from may not be those which industry is familiar. Not only is the information delivered to stakeholders important, but also the delivery and how feedback is received and acted upon. Perhaps the hardest thing for industry to deal with is that a 'Social Licence' can change rapidly and is very hard to measure. Over the course of this module students will learn how to identify key stakeholders, define roles, establish commitment to the project, align and prioritise stakeholder requirements to organisational objectives, and gain 'buy-in'. The module will also cover communication techniques, including dealing with organisational politics, resolving conflict and managing expectations.

**Reference textbook:** Zandvilet, L & Anderson, M.B. (2009) *Getting it right: Making corporate-community relations work*, Greenleaf publishing. Additionally, students will be required to read selected research papers, as outlined in class.

### **Earth Resources and Sustainability, GEOLM043**

This module explores the nature and critical issues of major types of Earth resources - energy, metallic, non-metallic, water, soil - and the impacts that resource usage has on the Earth environment. The concept of sustainability for Earth materials will be approached through discussion of thematic position topics, to encourage students to reach their own conclusions. Students will learn timescales and how geological processes control formation and distribution of resource materials, and the scope for environmental and climatic change at the Earth's surface. Key is the identification and characterisation of materials and the tools for exploration and planning for the consequences of exploitation as practised by the resource industries. The intended learning outcome is to demonstrate that Earth materials, which provide the foundations of modern society, are finite in abundance and non-equally distributed yet can be appreciated and profoundly informed from a geological perspective.

**Reference textbook:** Earth Resources and the Environment, 4<sup>th</sup> Edition, J.R. Craig, D.J. Vaughan, B.J. Skinner, Prentice Hall, 2011

### **Geology for Global Managers and Engineers**

This module will provide the students with a background regarding the basics of the geological sciences. Different types of rocks will be introduced, with emphasis on formations that are expected to bear natural resources, for example carbonate deposits, shale formations, sedimentary basins, etc. Geological expertise is critical to all types of civil engineering projects and chemical engineering solutions related to the environment, from human-scale urban construction, sustainable energy, resource extraction and natural hazards to long-term climate change, sea level rise and radioactive waste disposal. How we quantify natural resources will be delivered through lectures, practical classes and fieldtrips. How soils, rocks and minerals mapped at the surface, are quantified in 3D at depth using boreholes and geophysics quantified experimentally in the laboratory. Practicals will work with geological specimens, maps and structures, and use commercial software to model hydrocarbon reservoir formation, such as shale gas.

This module includes a field trip in UK and/or Spain to examine geological structures and the formation of hydrocarbon reservoirs

### **Dissertation**

The goal of the dissertation is to bring to fruition the material learned by the students during the programme. The students will also learn how to plan and execute research projects, as well as to report the results, discuss them openly, compare them to the literature, and defend their conclusions. The students will also learn to work in groups and to manage their time towards a satisfactory completion of the dissertation.

The module will include several parts, described below:

#### **A - Research Skills for a Successful Research Project**

This portion of the dissertation has the goal of preparing the students towards being able to complete their research. The goals of this section, planned for the 1<sup>st</sup> term of the MSc in Global Management of Natural Resources, include: (a) explaining what is the rationale for the research projects; (b) what are the project items offered; (c) what are the expectations and the resources available to the students. The students will be presented with an expected timeline, will choose the research projects of their preference, and will be paired with the research advisors.

**Reference textbook:** Dissertations and Project Reports: A Step By Step Guide, Stella Cottrell, Palgrave MacMillan, 2014.

## B- Research Project

During the third term the students will conduct their independent research. The students are expected to gather the information developed during most of the taught classes. The students will be divided in groups, and each group will face one 'scenario'. Typical scenario descriptions could be:

- In the north east corner of Scotland a deposit of uranium has been discovered. The formation is located at 1.5 km depth, inland, and it is estimated to contain 50 gigatons of uranium of a given purity. It is of interest to assess whether it would be practical to deploy this deposit for the production of electrical power to energize London. Your group is tasked with recommending what to do.
- A large amount of aluminum has been discovered in the center of Congo, near a wide national park. It is estimated that this reserve contains large amounts of aluminum, near the surface. It is of interest to assess whether the exploitation of this resource is practical, and if so, within which conditions. Your group is tasked with recommending how to proceed.
- A large reserve of shale gas has been discovered in the outskirts of Paris. This unconventional reservoir is located at 3 km underground, and it is estimated that the gas in place can be as high as 3 tcf. The reservoir extends over 10 km<sup>2</sup> on the surface, and it is estimated that 5 pads with 10 horizontally drilled wells are necessary to exploit the reservoir. It is of interest to quantify whether it is practical to produce this shale gas to produce electricity in France. Your group is tasked with providing a recommendation.

Each group of students will function as a consultancy team, with the goal of providing recommendations, in the form of a dissertation. However, within these scenarios, each student is expected to analyze in depth one individual aspect of the scenario, which will set the basis for the individual assessment, and which will be complementary to the ones explored by the other students. Within a scenario each student will be expected to be aware of the development of all the projects. The projects are intended to be open-ended and to allow the students to develop their own critical thinking. Within a scenario, one individual student will investigate in details, e.g.:

- fundamental research in mineral processing / environmental remediation
- geological survey – detailed analysis of the natural resource source
- investment strategy – economic case for the exploitation of such resource
- plant design – with fundamental engineering aspects
- project management, from extraction to production
- social licensing
- environmental impacts
- risk assessment, both from financial and environmental/safety points of view
- others, depending on supervision expertise.

These individual parts of the dissertation will be completed during Term 3 and summer, while the students will be at the University of South Australia. The projects on fundamental research will be conducted by the students embedded in the research programs at the Future Industries Institute at the University of South Australia, where significant expertise in minerals processing and environmental remediation has been developed. Some students will, for example, investigate new methods for mineral flotation, new processes for environmental remediation, etc. The students will be closely supervised, with particular attention to safeguard their health and safety.

Typical social licensing projects could address quests such as those listed in the list below, adapted to the specific project.

- What does a social license look like offshore?
- What is the outlook for the Australian coal industry following the 2015 UN Conference on climate change?
- What is the likely impact of fossil fuel divestment strategies in Australia?
- Marine mining: how much do we currently mine underwater and is this likely to increase as ore grades on land decrease?
- What are the potential impacts of gas developments on the Great Artesian Basin and how should risk be managed?
- Key links for the extractive industries: how vulnerable are ports and rail to climate change?
- What role will desalination play in meeting Australia's future water needs for mining?
- Shifting sands: how much sand & aggregate is mined worldwide?
- Is deep ocean energy (OTEC) production ever likely?
- Is iron fertilization of the ocean an effective means of CO<sub>2</sub> mitigation?
- How safe is deep water tailings disposal?
- What does China's dominance of rare earth minerals mean for their development in Australia?
- How to evaluate the environmental risks of Carbon Capture and Geosequestration?

These individual projects will be combined within the scenarios discussed above, and they will need to be integrated with the rest of the projects conducted by a team. Hence the students involved in these projects will need to be aware of the projects conducted by their peers on the other aspects listed above.

### **C - Presentation skills**

One learning objective is for the students to be able to present critically their results both via oral presentation and in a written form. The Oral Examination is designed to test this ability as well as to test the fundamental understanding they have achieved, both within the boundaries of their specific research projects, and in a wider boundary within the subject matter of the MSc in Global Management of Natural Resources. The students are also expected to be able to work in groups and to relate each individual results to the results of the other students within each group. This is the reason beyond the requirements of their group presentation and group dissertation, which will be within well-defined page limits.

### **D - Field Trip to a Mine Site**

The students will also be required to experience, first hand, a mining site. During their residence in South Australia, the students will visit one copper / gold / uranium mine. The scope is to see the physical aspects of such an operation, as well as to appreciate the scales of mining.