



# MAPPING OF CO<sub>2</sub> CAPTURE, STORAGE, AND MANAGEMENT (CCSM) IN GRADUATE PROGRAMS:

The Americas  
Europe  
Africa

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## Objective

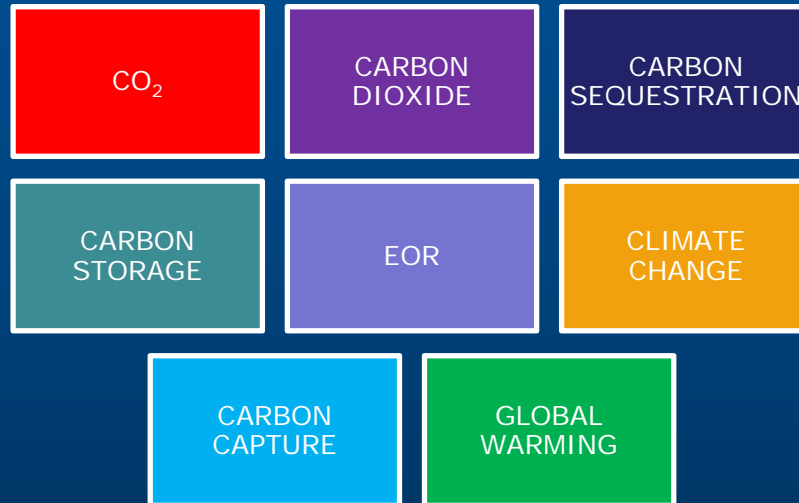
To identify **courses in the area of CCS and Climate Change** inside the academic programs currently available in universities worldwide

→ Until now: The Americas, Europe and Africa

# Methodology

The information presented in the report was obtained from [universities websites](#). For the United Kingdom → internet searches, email inquiries, and actual visits to discuss courses with universities

Key words:



For each University, all the offered courses were summarized on tables in accordance with four themes:

- (i) **Capture:** Subjects in engineering and science of CO<sub>2</sub> capture from flue gas stream, incorporating transportation;
- (ii) **Storage:** Subjects on geology and science of CO<sub>2</sub> storage and enhanced oil recovery;
- (iii) **Environment:** Subjects on climate change, environmental sciences and management, including modeling, geography and town planning;
- (iv) **Economy, Social, Political and Legal aspects:** Subjects on economical and legal issues related to CCS projects and/or environmental impacts.

# Surveyed Universities per country

THE AMERICAS (total: 35 universities)	
Argentina (5)	University of Buenos Aires University of Cordoba National University of Technology University of Salvador (Universidad del Salvador) <b>University of Palermo</b>
Brazil (6)	<b>Pontifical Catholic University of Rio Grande do Sul</b> <b>University of São Paulo</b> State University of Rio de Janeiro Federal University of Rio de Janeiro Pontifical Catholic University of Rio de Janeiro Federal University of Rio Grande do Sul
Canada (6)	<b>University of Alberta</b> <b>University of British Columbia</b> <b>University of Calgary</b> <b>University of Regina</b> <b>University of Saskatchewan</b> University of Waterloo
Chile (1)	<b>Pontifical Catholic University of Chile</b>
Colombia (2)	University of Andes National University of Colombia
Ecuador (2)	Pontifical Catholic University of Ecuador Central University of Ecuador
Mexico (2)	National Autonomous University of Mexico University of Guadalajara
United States of America (7)	University of Tennessee University of Chicago <b>University of Washington</b> <b>Princeton University</b> <b>University of California</b> <b>University of Delaware</b> Stanford University <b>Harvard University</b>
Uruguay (2)	Republic University University of Montevideo
Venezuela (1)	Central University of Venezuela

EUROPE (total: 33 universities)	
Italy (13)	University of Bari University of Bologna University of Brescia University of Cagliari University of Catania University of Florence University of Genoa University of Milan University of Milan - Bicocca University of Naples Federico II University of Palermo University of Parma University of Rome Tor Vergata
Netherlands (11)	<b>University of Amsterdam</b> <b>VU University Amsterdam</b> (Free University Amsterdam) <b>University of Groningen</b> Leiden University Maastricht University <b>University of Utrecht</b> Erasmus University Rotterdam Tilburg University <b>Delft University of Technology</b> Eindhoven University of Technology University of Twente
Portugal (9)	Catholic University of Portugal <b>New University of Lisbon</b> University of Algarve University of Aveiro <b>University of Coimbra</b> <b>University of Évora</b> <b>University of Lisbon</b> University of Minho <b>University of Porto</b>
Spain (1)	<b>University of Cordoba</b>

AFRICA (total: 3 universities)	
South Africa	University of South Africa <b>University of Cape Town</b> University of Pretoria

**Number of universities MAPPED :**

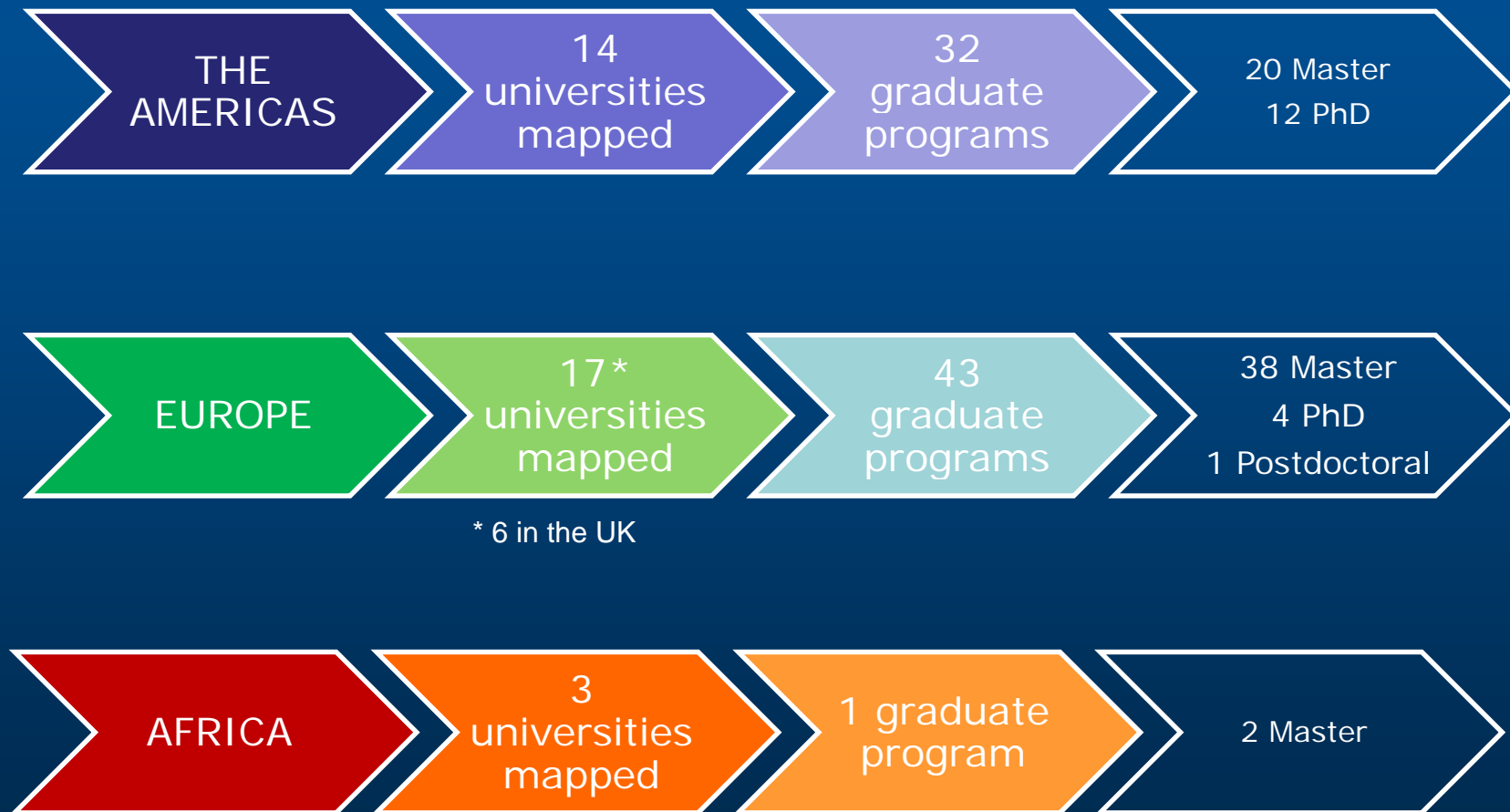
**14 in the Americas**

**17 in Europe (The Netherlands, Portugal, Spain, UK)**

**1 in Africa (South Africa)**



# Mapped Universities and Postgraduate Programs

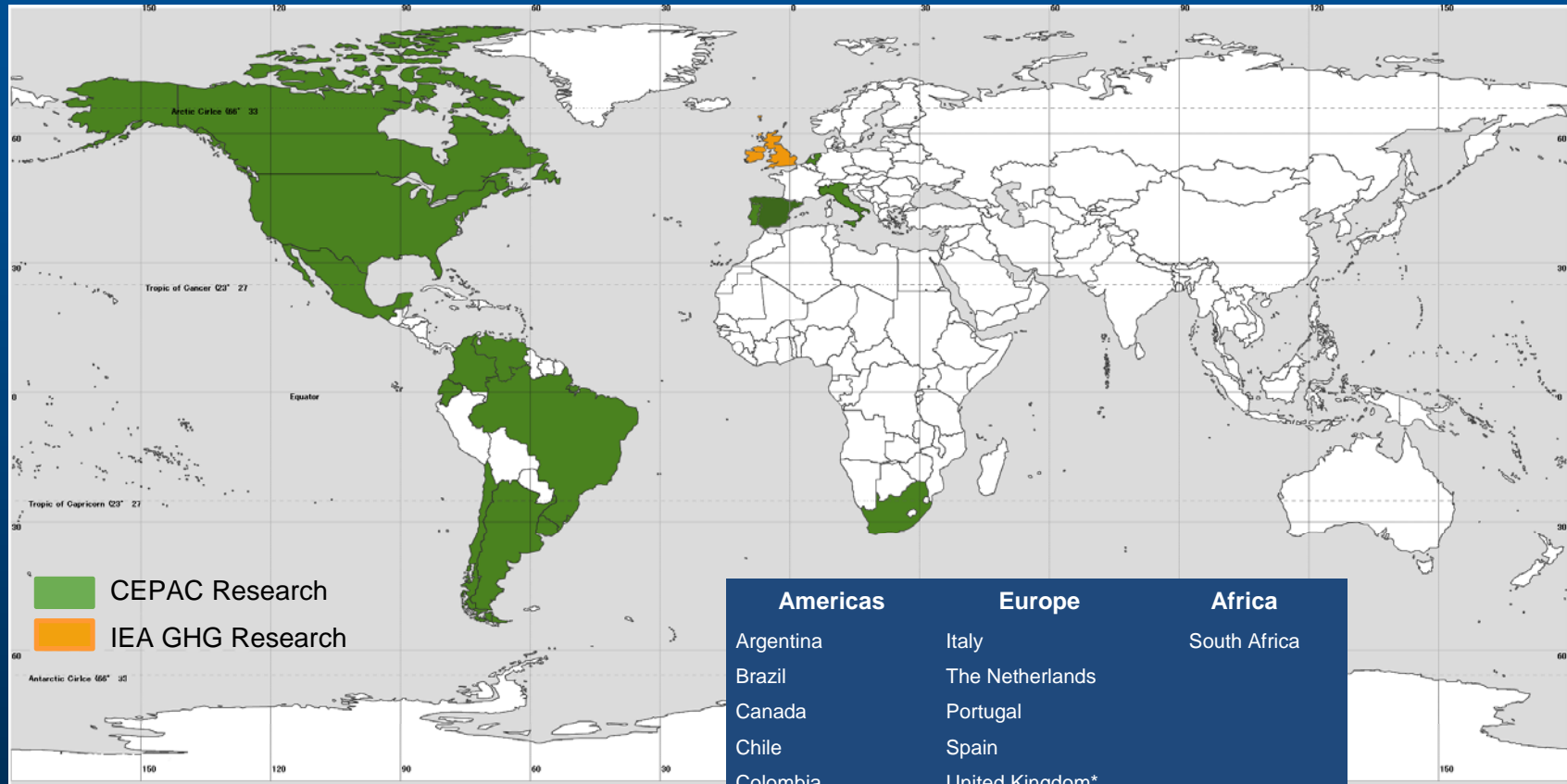


Surveyed countries in The Americas: Brasil, Argentina, Chile, Uruguai, Colômbia, Equador, Venezuela, USA, Canada, Mexico

Surveyed Countries in Europe: Italy, Portugal, The Netherlands, Spain, UK

Surveyed Counties in Africa: South Africa

# Surveyed Countries



# THE AMERICAS



## Argentina

### 1. University of Palermo

*MSc. in Environmental Law*

Offered Course:

Science and Environment (Elective)



## Chile

### 1. Pontifical Catholic University of Chile

*Master in Energy Engineering*

Offered Course:

Hydrogen Production and uses (elective)

# THE AMERICAS



## Brazil

### 1. Pontifical Catholic University of Rio Grande do Sul

*MSc. Engineering and Materials Technology*

*PhD. Engineering and Materials Technology*

**Offered Courses:**

Materials and Processes for Carbon Capture and Storage (elective)

Materials and Technologies for Mitigation of Environmental Impacts (elective)

### 2. University of São Paulo

*MSc Geosciences*

*PhD Geosciences*

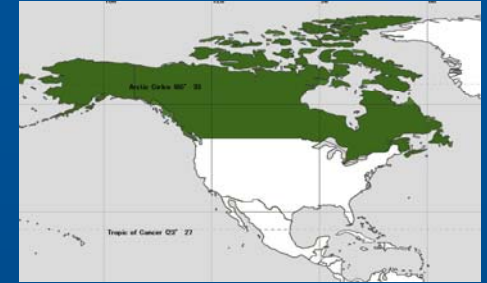
**Offered Courses:**

Climate Changes in Earth's present and past (elective)



# THE AMERICAS

## Canada



### 1. University of Alberta

*Master of Arts / Master of Science / PhD. in Earth and Atmospheric Sciences*

Offered Courses:

Global Change

Atmospheric Modelling

Human Dimensions of Environmental Change

Advanced Human Dimensions of Global Change

### 2. University of British Columbia (BC, Canada)

*M.Eng. on Clean Energy Engineering*

Offered Courses:

Energy and the Environment (compulsory)

Thermal Energy Systems (compulsory)

*Master of Art / Masters of Science in Resources Management and Environmental Studies*

Offered Course:

Climate Change in the 21st Century (elective)

# THE AMERICAS

## Canada

### 3. University of Calgary

#### *M.Sc. Geosciences – spec. on Reservoir Characterization*

##### Offered Course:

Flow in Porous Media (or Waterflooding and Enhanced Oil Recovery) - elective

#### *M.Eng. / M.Sc. / Ph. D (spec. in Chemical Engineering)*

#### *M.Eng. (spec. in Petroleum Exploration Engineering)*

##### Offered Courses:

Thermal Recovery Methods (elective / compulsory for spec. Petroleum Engineering)

Reservoir Simulation (elective / compulsory for spec. Petroleum Engineering)

Air Pollution Control Engineering (elective)

Thermal Recovery Methods (elective)

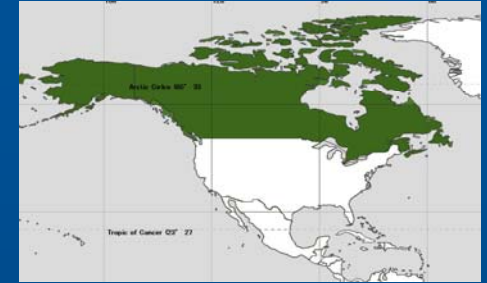
Secondary and Tertiary Recovery (elective / compulsory for spec. Petroleum Engineering)

#### *M.Eng / M.Sc / PhD in Electrical and Computer Engineering*

##### Offered Courses:

Renewable Energy and Solid State Lighting for Human Development

Renewable Energy and Solid State Lighting for the Developing World



# THE AMERICAS

## Canada

### 4. University of Regina

*Master of Applied Science / Master of Engineering / PhD.  
(Petroleum Systems Engineering)*

**Offered Course:**

Advanced Enhanced Oil Recovery (elective)

### 5. University of Saskatchewan

*Master in Sustainable Environmental Management (M.SEM.)*

**Offered Courses:**

Human Dimensions of Environmental Change (compulsory)

Current Issues in Land Reclamation and Remediation (restricted set of electives)

Environmental Economics and Policy Making (restricted set of electives)

Reservoir Mechanics (elective)

Petroleum Geology

*Master of Environment and Sustainability (M.E.S.)*

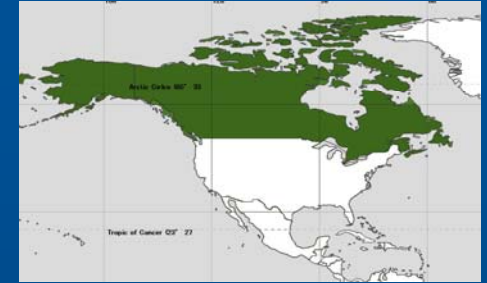
**Offered Courses:**

Human Dimensions of Environmental Change (compulsory)

Research in Environment and Sustainability (compulsory)

Reservoir Mechanics (elective)

Petroleum Geology (elective)



# THE AMERICAS

## United States

### 1. Harvard University

*PhD (Earth and Planetary Sciences)*

Offered Courses:

Introduction to Meteorology and Climate  
Global Warming Debates: The Reading Course

### 2. Princeton University

*M. Eng. / M.Sc. / PhD (Engineering and Water Resources)*

Offered Courses:

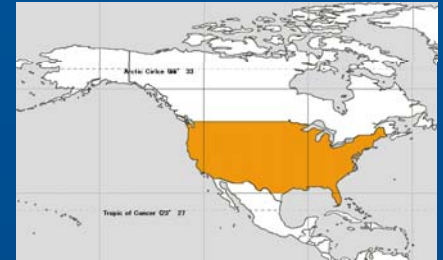
Environmental Engineering & Water Resources

### 3. University of California

*Master / Ph.D. (Atmospheric and Oceanic Sciences)*

Offered Courses:

Ocean Biogeochemical Dynamics and Climate (elective)



# THE AMERICAS

## United States

### 4. University of Delaware

*M.Sc. / PhD (Geography)*

**Offered Courses:**

Climate and Life

Conservation: Global Issues

Seminar in Climate Change

### 5. University of Washington

*M.S. / Ph.D. (geological sciences and geophysics)*

**Offered Courses:**

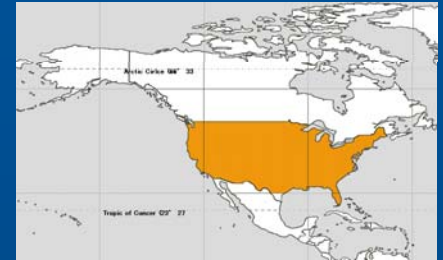
Climate Modeling (elective)

Climate Impacts on the Pacific Northwest (elective)

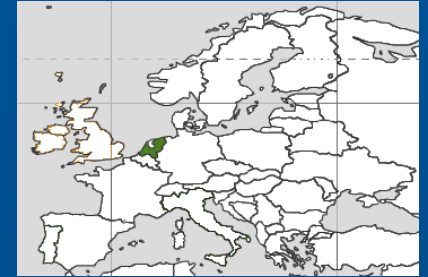
Current Research in Climate Change (elective)

Climate Dynamics (elective)

The Global Carbon Cycle and Climate (elective)



# EUROPE



## The Netherlands

### 1. Delft University of Technology (TUD)

*MSc Applied Earth Sciences – track Resource Engineering (Spec. Geotechnical and Environm. Engineering)*

**Offered Courses:**

Environmental Geology & Geophysics - Compulsory  
Underground Waste Management – Compulsory

*MSc Applied Earth Sciences - track Petroleum Engineering and Geosciences (specializations: Petroleum Engineering / Reservoir Geology)*

**Offered Courses:**

Applied Reservoir Engineering & Simulation, part I - Compulsory  
Applied Reservoir Engineering & Simulation, part II – Compulsory only for spec. Petroleum Engineering  
Special Topics Geotechnology and Sustainable Development – Elective for spec. Petroleum Engineering

### 2. University of Groningen

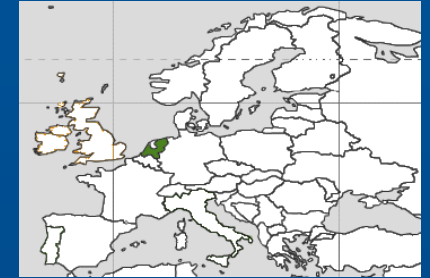
*LL.M in International Law and the Law of International Organizations*  
*LL.M in European Law*

**Offered Courses:**

International Environmental Law – Optional / elective  
Energy Law – Elective  
European Environmental Law – Elective for LLM European Law

# EUROPE

## The Netherlands



### 3. University of Amsterdam

*MSc. Earth Sciences – Environmental Management*

*MSc. Earth Sciences – Geo-Ecological Dynamics*

Offered Courses:

Climate Change – Optional from the “Optional compulsory courses list” for Environmental Management /  
Elective for Geo-Ecological Dynamics  
Paleo-ecology and Global Change - Optional

*LLM International and European Law - Public International Law*

Offered Courses:

M2420 - International Environmental Law – Elective

### 4. VU University Amsterdam

*MSc. Earth Sciences*

*MSc. Geosciences of Basins and Lithosphere*

*MSc. Hydrology*

Offered courses:

Modern Climate Systems

Modern Geo-ecosystems

From Source to Sink: Chemical and Physical Cycles

Practical: Palaeoclimate Change and Environmental Impacts

Sedimentary Environments and Climate Archives

Climate Modelling

Climate and Policy

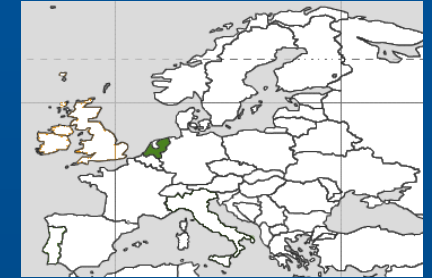
International Environmental Economics

Man and Climate: From Hominids to Modern Civilisation

Sedimentary Environments and Climate Archives

Spatial Ecology and Global Chang

# EUROPE



## The Netherlands

### 4. VU University Amsterdam

#### *MSc in Spatial, Transport and Environmental Economics*

##### Offered courses:

Environmental Economics - Optional

International Environmental Economics - Optional

#### *MSc in Economics (specialization Spatial Economics)*

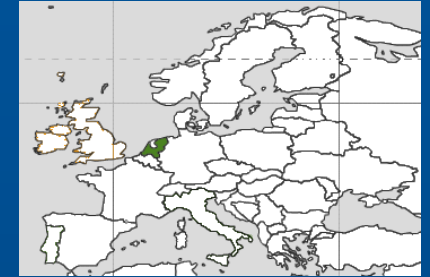
##### Offered courses:

Environmental Economics - Compulsory



# EUROPE

## The Netherlands



### 5. University of Utrecht

#### MSc. Earth Sciences - Geology (specialization Sedimentary Systems)

##### Offered Courses:

Paleo oceanography and climate variability – Compulsory (specialization in Sedimentary Systems)

Astronomical climate forcing & time scales – Compulsory (specialization in Sedimentary Systems)

Organic geochemistry - Elective

#### MSc. Earth Sciences – Geochemistry

#### MSc. Earth Sciences - Hydrology (spec. Earth Surface Hydrology)

##### Offered courses:

Paleo oceanography and climate variability - elective

Organic geochemistry – Compulsory (Geochemistry) / Elective (Hydrology -spec. on Earth Surface Hydrology)

Hydrology, climate change and fluvial systems – elective( Geochemistry) / Compulsory (spec. on Earth Surface Hydrology)

Astronomical climate forcing & time scales – Elective

#### MSc. Earth Sciences - Physical Geography (spec.: Coastal Dynamics and Fluvial Systems / Natural Hazards and Earth Observation / Quaternary Geology and Climate Change)

##### Offered courses:

Hydrology, climate change and fluvial systems

Advanced Course in Quaternary Geology and Climate Change

Paleo oceanography and climate variability

Organic geochemistry

# EUROPE

## The Netherlands

### 5. University of Utrecht

#### MSc. Energy Science

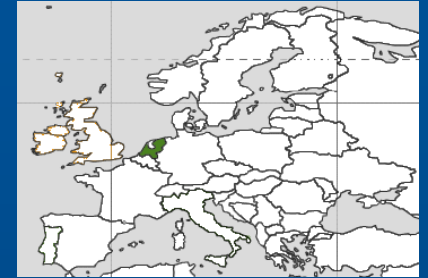
##### Offered courses:

Energy and Resources Policies - Compulsory  
Research Methods for Energy and Materials - Compulsory  
Simulation of Ocean, Atmosphere and Climate – Elective  
Topics in Climate Science - Elective

#### LLM (Master of Laws) Public International Law

##### Offered courses:

International Environmental Law - Compulsory  
International Law of the Sea – Optional



# EUROPE

## Portugal

### 1. New University of Lisbon + University of Lisbon

#### PhD in climate change and sustainable development policies

##### Offered courses:

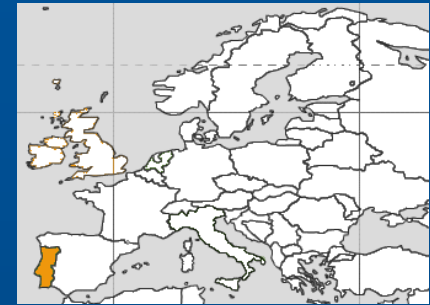
- Adaptation and Mitigation of Climate Change (compulsory)
- Science of Climate Change (compulsory)
- Economy and Market Regulation (compulsory)
- Ethics, Public Policy and Environmental Diplomacy (compulsory)
- History, Development and Environment (compulsory)
- Earth and Ocean Systems (compulsory)
- Sociology of Environment and Communication (compulsory)
- Seminar on Energy and Climate Change (compulsory)

### 2. University of Coimbra

#### Master in Environmental Engineering

##### Offered courses:

- Global changes and Climatology (compulsory)
- Risk Analysis (compulsory)

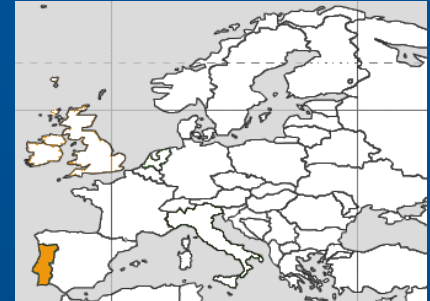


# EUROPE

## Portugal

### 3. University of Évora

*Master degree in Earth, Atmospheric and Space Science*  
*Spec.: Atmospheric Physics and Climate // Internal Geophysics*



#### Offered courses:

- FIS7922 - Seminar in Earth Sciences, Atmospheric and Space (compulsory spec. Internal Geophysics)
- FIS7931 - Atmosphere and Climate Physics (compulsory spec. Atm. Physics and Climate)
- FIS7757 - Resources, Energy and Environment (compulsory)
- FIS7924 - Atmosphere and Space Remote Sensing ECTS (compulsory)
- FIS7927 - Methods and observation techniques in Earth, Atmospheric and Space (compulsory)
- FIS7765 – Climate, Climate Modeling and Climate Change (compulsory)
- GEO7954 Geographic Information Systems in Earth, Atmospheric and Space I (elective)
- FIS7910 - Anthropogenic impacts on the Atmospheric Environment (elective)
- FIS7766 - Gases and Aerosols Dispersion in Atmosphere (elective)

### 4. University of Lisbon

*Master in Environmental Sciences and Technologies*

#### Offered courses:

- Environmental Law and International Relations (compulsory)
- Environmental Economy (compulsory)
- Conversion Technologies and Environmental Requalification (compulsory)
- Climate Change and Renewable Energy (compulsory)
- New Markets and Environmental Affairs (compulsory)
- Socio-Economic Impacts of Environmental Policies and Markets (compulsory)

# EUROPE

## Portugal

### 5. University of Porto

#### *Integrated Master Degree in Chemical Engineering*

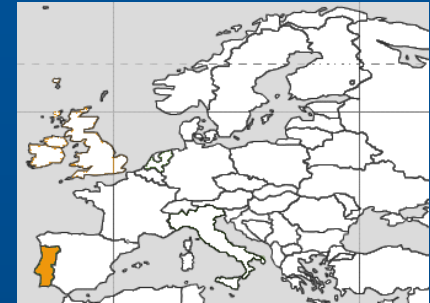
##### Offered courses:

EQ0108 - Gaseous Emissions Control and Management (compulsory)

#### *PhD in Sustainable Energy Systems*

##### Offered courses:

PDSSE0001 - Energy, Environment and Sustainability (compulsory)



## Spain

### 1. University of Coimbra

#### *Master in Climate Change: Natural resources and Sustainability*

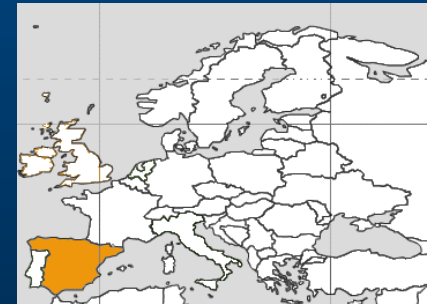
##### Offered courses:

100348 - CAMBIO GLOBAL: CONVENIOS E INICIATIVAS INTERNACIONALES (elective)

100359 - EFECTOS DEL CAMBIO GLOBAL EN LOS ECOSISTEMAS (elective)

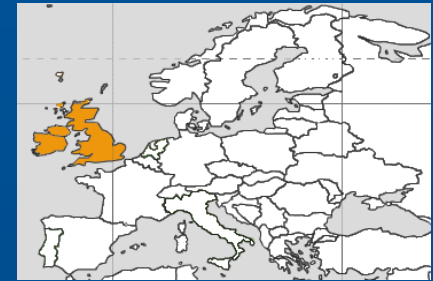
100350 - EVALUACIÓN Y MEDIDAS DE ADAPTACIÓN AL CAMBIO GLOBAL (elective)

100356 - SOCIEDAD Y CAMBIO GLOBAL (elective)



# EUROPE

## United Kingdom\*



Institution	Degree	Compulsories				Electives			
		C	S	E	X	C	S	E	X
U. of Edinburgh School of GeoSciences	Masters of Carbon Capture and Storage	█	█		█	█	█		█
U. of Edinburgh Business School	Masters of Carbon Management			█	█			█	█
EUROPEAN: U. of Edinburgh (UK), U. of Versailles St-Quentin (France), U. of Bergen (Norway)	PERICLES – Postdoctoral European Masters Formation on Interactions Between Climate, Environment and Society			█	█				
Imperial College Institute of Energy Futures	Masters in Sustainable Energy Futures	█			█	█		█	
U. of Nottingham, Birmingham and Loughborough Schools of Engineering	Engineering Doctorate (Industrial) and Masters in Carbon Capture	█			█	█			█
U. of Glasgow Crichton Carbon Centre	Masters of Carbon Management			█	█			█	█
U. of Lancaster School of Engineering	Masters of Low Carbon Emission			█				█	

\* IEA Greenhouse Gas R&D Programme (IEA GHG), "The Landscape of Carbon Dioxide Capture, Storage, and Management (CCSM) Education in the UK". 2009/TR5, August 2009.

# AFRICA

## South Africa

### 1. University of Cape Town

*MSc.in Engineering in Energy & Development Studies*

*MSc. in Engineering in Sustainable Energy Engineering*

Offered courses:

ENERGY & CLIMATE CHANGE (elective for MSc. Eng. Energy&Development Studies)

ENERGY MODELLING (elective)



# Preliminary Conclusions

## THE AMERICAS

→ topics on Carbon Capture and Storage and Climate Change are being discussed inside graduate programs, but currently there are no specific graduate programs on CCS in America

→ The number of **courses containing topics on CCS and climate change** in America's post graduate programs is **limited**, and the major existent **courses are not compulsory** in the academic programs

→ Compulsories courses in the surveyed universities are mostly related to environmental subjects (such as climate change) and they belong Environmental programs

→ **Canada, Unites States and Brazil** lead the graduate programs that have courses related to CCS and climate changes, with 9, 5 and 2 post graduate programs respectively

→ The Electrical Engineering graduate program (University of Calgary, Canada) is the only one that deals economical and political aspects related do CO<sub>2</sub>.



# Preliminary Conclusions

## EUROPE (surveyed countries: Italy, The Netherlands, Portugal, Spain, United Kingdom)

→ Topics on CCS/Climate Change are present in a considerable number of post graduate programs in the surveyed countries

→ Mostly of the courses of the academic institutions considered in this report are compulsory

→ **United Kingdom:** at least 5 graduate programs specifically in the area of CCS and Carbon management !!! (\*\*\*) Univ. of Edinburgh: MS degree in CCS)

the United Kingdom review was that the postgraduate programs in CCS that are presently available have *a lack of emphasis on both risk assessment and regulation, which are obviously very key areas (IEA GHG research)*

→ **Portugal, The Netherlands:** compulsory courses on the topics surveyed

# Preliminary Conclusions

## AFRICA (surveyed country: South Africa)

→ South Africa: University of Cape Town → Master degrees with courses regarding to Climate change and energy modelling

**THANK YOU!**

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