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Best practices report

CC WATER

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- Screening within European and North American universities
- UN-Water and UN-Climate resources
- National Bodies

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2 Section 1: Teaching water-climate change relevant subjects

2.1 Teaching water-climate change relevant subjects

Prepared by Szymon Kobus, PL-UWM

The aim of this paper is to draw attention to the needs of education in the field of water management, with the simultaneous deepening of knowledge of water, environment and climate change, especially in the fields of study affecting the protection and shaping of water resources. In the face of progressing climate change, universal environmental and climate education of the society, including rational and balanced water management, is particularly important.

2.1.1 The importance of environmental and climate awareness

The International Decade "Water for Sustainable Development" 2018-2028, inaugurated by the UN General Assembly, is to bring together water stakeholders to develop cooperation and raise public awareness on sustainable water management. Availability of water determines the achievement of at least some of the 17 Sustainable Development Goals mentioned in the 2030 Agenda (not only Goal 6 - clean water and sanitation). Global water scarcity is increasing as populations grow and become wealthier, extreme climatic events intensify, cities expand, and the environment is exploited and polluted. Meanwhile, insufficient knowledge of a significant part of the population influences short-sighted decision-making and careless consumption choices, and perpetuates patterns of behavior that are harmful to the environment and water resources.

The results of a survey on environmental awareness of Polish citizens (conducted for the Ministry of Environment) reveal information gaps in Polish society regarding water management and climate change. Among other things, the research (2018) found that respondents recognize the need to modernize existing stormwater drainage (47.8%), strengthen emergency services (45.7%), and develop and modernize flood control facilities (39.9%), but underestimate the link between the development of blue-green infrastructure and water retention and mitigation of climate extremes. Only 1 in 10 Poles have taken action to reduce the effects of extreme weather events. The action indicated least often was participation in training on energy efficiency and water management, indicating a scarcity of opportunities or an aversion to environmental education. Findings from the Eurobarometer survey indicated that only one in four Poles (26%) were well informed on water management issues. Most respondents (69%) were of the opinion that not enough is said in the media about the issue of water saving.

In recent years, there has been an intensification of water education actions and programs conducted by Universities, State Water Holding Polish Waters, municipal water and sewage companies (pol. MPWiK) and pro-ecological associations and NGOs. However, it is necessary to support universal ecological and climate education at all levels of education: from kindergarten through primary, secondary and higher education. It is also very important to encourage the society to continuous education, including participation in trainings and programs of universities of the third age. The dissemination of water knowledge and exchange of best practices are essential factors of communication between scientists and politicians, local activists and the public.

2.1.2 Universal social education

In addition to the formal education system in disciplines related to water management, universal social education in this field is also important. Public awareness of water problems is as important as the professionalism of experts, especially in planning and designing activities in this area at various levels. Conscious social groups are able not only to cope with active support and solving some problems in water management, but what is extremely important, they are invaluable partners during all kinds of social consultations. Not only those directly related to water management, but also the living environment in the place of residence, e.g. local development strategies,

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environmental protection plans. Such education is a multi-faceted challenge that requires the efforts of various environments. Several key actions are driven by improving awareness of the ecological and climate challenges related to water:

- Access to information - is the basis of all education. Institute of Meteorology and Water Management (pol. IMGW) data resources have already been made available, and the flood hazard and flood risk maps are available on the so-called Hydroportal, but still a lot of information in the hands of administrative entities is not generally available without using the "access to public information" mode, which is burdensome for the average user. In addition, GIS (Geographic Information Systems) data in various spatial information systems requires synchronization and association with water information. It is also necessary to unify the standard of planning databases and improve the readability of the message. A good example is the activities of the Environment Agency of England, where flood hazard maps are made available in a simple, intuitive information system for residents and associated with consultancy in the issues of housing and flood safety.
- Access to guides and good practices - i.e. texts, videos, podcasts containing systematic advice on how to act in the event of threats or problems with water. The presence of easily accessible, professional guides is the key to independent activity of people in this field. In many countries, the number of guides addressed to residents, local governments and activists of non-governmental organizations (NGOs) is huge. The American Federal Emergency Management Agency (FEMA) provides several dozen of them, and the Australian ADR center (Australian Disaster Resilience) currently offers 45 guides only in the field of floods. Also, in Poland there are more and more guides and catalogs of good practices for municipalities and residents. However, their popularization requires the improvement of accessibility and systematization. Perhaps the right solution would be to create a large, publicly available water information platform, linked to Hydroportal and local geoinformation systems.
- Trainings and workshops - are usually conducted by organizations and associations for local authorities and residents, as part of environmental education programs financed, for example, by the provincial Funds for Environmental Protection and Water Management (pol. WFOŚiGW) or Municipal Water and Sewage Companies (pol. MPWiK). It is also worth considering financing public water education from fees for water services collected by State Water Holding Polish Waters (pol. PGW Wody Polskie) and allocating part of the fees for sealing the surface to prevent water problems at the place where they occur. The key topics of the training courses should include aspects related to the water cycle in nature, climate change, threats and possibilities of climate adaptation, retention and re-use of rainwater and gray water, rational and responsible use of water and sewage services, and the importance and protection of greenery in cities and in rural areas.
- Supporting the education of children and schoolchildren - is a form of transferring basic knowledge and facts about water and water management. This knowledge is partially transferred on various subjects, but requires updating and adaptation to the changing climatic and environmental conditions as well as Poland's water resources. An example is flood education. The manuals contain information on how to respond, but the importance of flood prevention and preparation is insufficiently emphasized. Educational programs also ignore the knowledge of natural retention, advantages and disadvantages of currently used solutions, the importance of the ecological condition of a river or water footprint. That is why it is important for professional circles to support teachers in their work. Systematized and easily accessible guides can also be good educational material.

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- Acquiring knowledge through action - includes collecting experiences through participation in various forms of activity, e.g. in social consultations of plans prepared at the national, regional and local level, or in voluntary networks monitoring the aquatic environment, water quality, weather parameters, etc. It is also participation in increasingly fashionable scientific activities carried out by citizens under the guidance of professionals (so-called citizen science). In the world, these are not marginal activities, e.g. in the USA, most of the continuous water quality measurements in rivers and lakes are performed by volunteers. Similar data can be cited from many countries around the world and concern water quality, air quality, meteorological parameters, plants, birds, etc. They are financed and managed by universities, government agencies and NGOs.

2.1.3 Integrating knowledge about water, environment and climate in higher education

The deepening of knowledge in various areas and fields of science leads to an increasing specialization of research and education programs and the separation of scientific disciplines. The result is a lack of a holistic perception of the environment and low awareness of the ecological and hydrological consequences of spatial decisions among planners, politicians and local authorities. The limited knowledge of spatial planners, town planners, architects and civil engineers in the field of water resources and environmental management results in the marginalization of these aspects in the planning and designing of investments, especially in the case of a shortage of economic and legal tools forcing natural and retention compensation. On the other hand, insufficient knowledge of spatial planning and environmental protection among graduates of engineering, water management and environmental engineering may limit the possibilities of interdisciplinary cooperation. It is recommended to restore the importance of water science in universities. Hydrologists and practitioners who know the latest scientific research and practical working methods as well as the most modern measurement techniques and models could play an important role.

2.1.4 Problems and needs of education in the field of water management

The research conducted in 2020 (by IG Polish Waterworks, Institute of Environmental Protection-National Research Institute, Polish Agency for Enterprise Development) on human capital in the water and sewage sector shows, among others, that students of Environmental Engineering have a limited awareness of the prospects future employment and the realities of the labor market, which may result from the lack of internships during education or their insufficient dimension, and from the lowering level of education in vocational and secondary schools. Employers are more likely to employ people aged 50+ than 20+ due to their greater technical skills and qualifications. Some employers who employ school and university graduates invest in employee training in parallel with working in a specific position, using the help of experienced professionals. Companies have an invaluable testing ground, which is their infrastructure. Therefore, cooperation of universities with the economic environment and the involvement of enterprises in the process of educating future employees is extremely important. It is also necessary to constantly update the knowledge and use in the education process the results of the latest research (e.g. in the field of new pollution, energy efficiency and circular economy, social communication, adaptation to climate change) and digital analytical and design tools. The transformation of the economy, accelerated by the COVID-19 pandemic, will require the retraining of large groups of employees or supplementing their competences with digital technologies.

In the face of the changing climate and the resulting disturbances, observed in individual elements of the hydrological cycle, it is necessary to consider a thorough reform of educational programs in hydrology, hydraulics and water management. For several years, the time devoted to teaching these subjects has been reduced (even at faculties with "environment" in the name). Currently, at the 1st

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degree engineering studies, in the fields of Engineering and Environmental Protection, the study of subjects related to water and hydrology in general is limited to a few (ten) hours of lectures throughout the entire teaching cycle. The shortage of auditorium or design exercises limits the students' ability to perform calculations or develop models. Even less than two decades ago, technical and agricultural universities offered future specialists - hydrologists and water engineers several subjects (fluid mechanics, hydrodynamics, hydrology, water management, water construction, etc.), each of which included lecture and auditorium and / or design parts and laboratory for much larger hours. The reduction of educational programs led to the degradation of knowledge about water in young engineers, misunderstanding of the processes governing the hydrosphere and, as a consequence, ignorance of climate change. The second dangerous effect is the increasingly visible generation gap among specialists in hydrology and water management, authorized hydraulic technicians, as well as among lecturers.

The education of modern-minded hydraulic engineers and builders is an extremely important and responsible task. A large group of senior specialists in hydraulic engineering and hydraulic engineering prefer hydrotechnical solutions based on significant interference in the river itself and river valleys. Additionally, the industry lacks high-class specialists with design and executive qualifications. There are also no modeling elements on physical models to verify data and design solutions. As a result, a significant proportion of projects are of poor quality and require additions or redesigns. Increasing the quality of education in the field of hydraulic engineering and hydraulic engineering with increasing emphasis on environmentally friendly solutions, the need to design compensating measures, interdisciplinary preparation, social communication skills, etc. it is a necessary condition for the training of a new generation of professionals in these specialties. Additionally, training programs should include courses on EU directives related to water management and the requirements related to their implementation in Poland. The lack of understanding of these legal regulations is a frequent cause of problems with obtaining construction permits for hydrotechnical facilities.

Water engineering should be combined with elements of environmental engineering and ecohydrology to make students aware of the importance of natural retention and restoration of small watercourses, irrigation drainage, nature based solutions (NBS) and biotechnology. It is also necessary to deepen and use the knowledge about the role of water management in spatial planning and urban design, as well as the impact of catchment development on water relations.

The decline in the interest in education in the field of Water Engineering and Management is largely due to the reduction in the number and scale of hydrotechnical investments, at which graduates could find a well-paid and interesting job. The lack of large investments does not preclude the possibility of education in various specialties in this field. However, it is necessary to define the vision of the development of water management in Poland and the nature of related investments, and then modify the content of the education programs.

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2.1.9 Universities and study programs in the field of CC and water management

Table 1: Universities and study programs in the field of CC and water management

University/ higher education	**Field of study**	**water-climate changerelated subjects** (if they were availableon the websites)
University of Life Sciences in Lublin	Management and adaptation to climate change	**- climatology and climate risk assessment ecology,** **- biology and protection of polar ecosystems,** **- air protection and emission modeling,** **- water resource management,** **- methods of increasing water retention,** **- protection of plants against weather phenomena,** **- adaptations of organisms to climate change,**

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		- green infrastructure and urban adaptation to climate change, **- adaptations to climate change in spatial management,** **- renewable energy sources**
Cracow University of Technology	Clean air engineering Water engineering and management Renewable energy sources and municipal infrastructure	- designing urban, water and green infrastructure to adapt cities to climate change - alternative energy sources, - sourcing, processing and distribution of energy from renewable sources
University of Agriculture in Krakow	water engineering and management	- aquatic ecology - hydrology
Ateneum University in Gdańsk	Natural aspects of climate change with English	- how to talk about climate change - environmental aspects of climate change
Nature University of Poznań	Ecoenergy Water engineering and management	- biomass energy - vegetable energy resources - ecology and protection of the biosphere - hydropower - wind energy and wind turbines - photovoltaics and solar collectors - technique and technology of biofuel production - renewable energy in construction - designing eco-energy systems - engineering and water management facilities, - facilities and systems for protection against flood and drought, - water supply and sewage networks, - complex facilities and water-drainage systems, - hydrotechnical facilities and watercourse regulation,

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		- systems for rational water management
Bialystok University of Technology	Ecoenergy	- renewable sources and conversion of electricity
Warsaw University of Life Sciences	Water engineering and management Renewable energy technologies Biology	- water engineering, water management -water and drainage engineering -water and sewage management in the enterprise - renewable and unconventional energy sources - legal conditions for energy management - assessment of the efficiency of renewable energy sources - design of renewable energy facilities - climat change
Collegium Civitas Warsaw	International and climate security	
European Social and Technical University of Servant of God Robert Schuman in Radom	Climate and ecology	- climate changes in the past causes and scenarios of climate change - the effects of climate change in poland and in the world - extreme phenomena - adaptations to climate change - air protection and emission modeling - methods of increasing water retention - renewable energy sources - financing pro-climate activities - climate risk management
Wrocław University	Geography Climate protection and air quality management	- climate change - causes and consequences - air quality management and environmental impact assessment - numerical modelling of atmospheric processes - protection and monitoring of the atmosphere

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University of Life Sciences in Wroclaw	Water engineering and management	- water law and administration - meteorology and climatology - hydrology
University of Warmia and Mazury in Olsztyn	renewable energy sources Ecological engineering Management of renewable and mineral resources environmental protection Landscape architecture	- passive, zero- and plus energy construction - wind energy - hydropower - harnessing of the sun energy - design of anthropogenic water reservoirs - hydrology and earth sciences - low emission systems of fuels applications - environmental effects of mining and energy generation secotrs - water resources management - hydrology - water management in river catchments - water engineering - water ecosystems - water management in the landscape - hydrology

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2.2 Water-climate change relevant subjects taught in leading universities outside the consortium

Summarized by SEUSL team

Table 2: Water-climate change relevant subjects taught in leading universities outside the consortium

University	Module name	Module content
Harvard university	The health effects of climate change	• Health — The Human Face of Climate Change • Heat & Air Quality • Infections • Nutrition • Migration • Research Methods • Responding to Climate Change
	Energy within environmental constraints	• Energy Overview • Estimating Costs • Environmental Impacts • Fossil Fuels • The Electric Grid • Solar Power • Nuclear Power • Demand Reduction and Efficiency
	Climate change policy: economics and politics	• Potential policies to reduce the emissions of the greenhouse gases that cause climate change • Why some governments might choose to address climate change more or less vigorously • How national governments cooperate to address climate-change – including an in-depth look at the Paris Agreement and its antecedents • How sub-national governments might complement action by national governments
Massachusetts Institute of Technology	Climate science, risk & solutions: a climate primer	• Evidence for human-caused climate change. • Uncertainty in our projections, engages in a discussion of risk and risk management, and concludes by presenting different options for taking action.

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	Climate action hands-on: harnessing science with communities to cut carbon	• How citizen science can support community actions to combat climate change. • Framing problems, design ways to gather data, gather some of their own field data, and consider how the results can enable action.
	Global climate change: economics, science, and policy	• Introduces scientific, economic, and ecological issues underlying the threat of global climate change, and the institutions engaged in negotiating an international response. • Develops an integrated approach to analysis of climate change processes, and assessment of proposed policy measures
	Global warming science	• Scientific foundation of anthropogenic climate change and an introduction to climate models. • Fundamental physical processes that shape climate (solar variability, orbital mechanics, greenhouse gases, atmospheric and oceanic circulation, and volcanic and soil aerosols) and on evidence for past and present climate change. • Discuss material consequences of climate change, including sea level change, variations in precipitation, vegetation, storminess, and the incidence of disease. • Examines the science behind mitigation and adaptation proposals.
	Land, water, food, and climate	• Examines land, water, food, and climate in a changing world, with an emphasis on key scientific questions about the connections between natural resources and food production.
	International politics and climate change	• Interconnections of international politics and climate change. • The politicization of the natural environment, the role of science in this process, and the gradual shifts in political concerns to incorporate "nature".

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		• Two general thrusts of climate-politics connections are pursued, namely those related to • Conflict – focusing on threats to security due to environmental dislocations and • Cooperation – focusing on the politics of international treaties that have contributed to emergent processes for global accord in response to evidence of climate change.
	D-lab: water, climate change, and health	• Vitally important interface of water, climate change, and health. • Mitigation and adaptation to climate change as it pertains to water and health. Water-borne illness, malnutrition, and vector-borne diseases represent the top three causes of morbidity and mortality in regions of our focus.
Columbia University	Regional climate and climate impacts	• Appreciate the range of climate information available and to grasp its underlying basis and the reasons for varying levels of certainty. This includes sub seasonal to seasonal climate forecasts for developing climate services for better adapting to climate stresses, and decadal and climate change projections for improved climate policy. • Build a sufficient understanding of the science behind the information, and analyze examples of how the information can and is being used.
	Managing & adapting to climate	• Exploration of the concepts, methods, and tools required to analyze climate-related problems and craft solutions for reducing vulnerability and building resilience to climate variability and change. • Examines and integrates risk assessment, risk perception, risk communication, and risk management. • Explores several forms of climate governance,

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		including market-based and policy responses and kinds of cultural and behavioral change that can be promoted by communication and education.
	Climate and empire	• Introduce students to the literature on climate change and its relationship to ontology, religion, violence, politics, and gender. • Explain climate change in its more recent incarnations in the Middle East and Asia. • Develop a mode of conceptualizing the present by rendering relevant geological time in addition to historical time, earth's history in addition to world's history
	Dynamics climate var & change	• An overview of how the climate system works on large scales of space and time, with particular attention to the science and methods underlying forecasts of climate variability and climate change.
	Climate & history: intersecting science,	• Examines the relationship between climate, scientific knowledge, and human societies. • First survey the role of climate as an historical actor of global history, rather than as the backdrop of political, social and economic events. • In the second part of the course, we will examine the history of weather and climate science, as well as climate change denialism.
	Between science fiction and climate fiction	• Explores the entanglement between traditional science fiction and the emerging genre of climate change fiction (popularly known as "cli-fi") in Latin American literature. • Explore how the history of colonialism makes Latin America a unique laboratory of experimentation that combines these two genres.
	Climate change: resilience & adaptation	•
	Global governance: climate change &	• Introduces the key notions, levels, and forms of

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	migration	global governance regimes. • The course goes beyond international relations theories to provide a variety of theoretical and practical perspectives on global public policy, multi-level governance and the interlinkages between global-level interventions and regional, national, and local activities and outcomes. • The course is divided into four parts. • Part 1 focuses on key institutions, actors and actor constellations, as well as the effectiveness, representativeness, and coherence of multilateral regimes • Part 2 focuses on various aspects of climate change governance • Part 3 on migration and refugees and the last part highlights conceptual links between mobility and climate and policy approaches to address them.
	Climate change: resilience & adaptation	• Focused study of climate change adaptation policy, exploring dimensions of adaptation across sectors and scales. • Learn about perspectives from the natural sciences, law, architecture, anthropology, humanitarian aid, and public policy.
	Food security, plant biology, climate change	• Overall, the course will have three main components. • Overview of interactions between the plant kingdom and human health, from food supply and nutrition to toxicology, contact dermatitis, aero-biology, inter alia. • In the second section, we segue to an overview of rising CO_2 and climate change, and how those impacts in turn, will influence all of the interactions related to plant biology and health with a merited focus on food security. • Finally, for the remainder of the course, our

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		emphasis will be on evaluating preventative strategies related to mitigation and adaptation to climate change impacts specific to potential transformations of plant biology's traditional role in human society.
	Climate change policy	• An understanding of the science, impacts, technological options, economics, and ethics of climate change policy. • An understanding of the politics, international law, and international relations aspects of climate change policy.
	Climate change and law	• Broad introduction to the field of climate law in the United States and at the international level. • Overview of the causes and effects of global climate change and the methods available to control and adapt to it. • Examine the negotiation, implementation and current status of the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Copenhagen Accord. • The focus then turns to the past and proposed actions of the U.S. Congress, the executive branch and the courts, as well as regional, state and municipal efforts. The Clean Air Act, the National Environmental Policy Act and the Endangered Species Act will receive special attention. • Evaluate the various legal tools that are available to address climate change, including cap-and-trade schemes; carbon taxation; command-and-control regulation; litigation; securities disclosures; and voluntary action. • The roles of energy efficiency, renewable energy sources, carbon capture and sequestration, and forestry and agriculture each receive close attention.

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	Climate change, disasters, and recovery:	• Introduce the avenues by which they can make an impact in combating the climate crisis, both personally in their communities and professionally in the future. We take a system approach in evaluating climate change, past disasters, the COVID-19 pandemic, and preparedness for future events.
	Global climate change and public policy	•
	Environmental justice and climate resilience	• Examine the intersections of race, equity, and the environment – focusing on the growing role and impact of the environmental justice movement. • Develop a deep understanding of climate, equity, and environmental justice in New York City. • Introduce students to the policies, stakeholders, research, and advocacy involved in the development and implementation of environmental laws, energy policies, nature-based solutions, and sustainable infrastructure. • Review the impact and implications of particular policies, as well assess case studies of particular communities.
	Anthropology of climate change	•
	Capstone workshop in climate and society	•
	Economic theory of climate change	• Examine the economics of climate change in a systematic fashion, with an emphasis on economic theory. Topics of coverage can include welfare economics, the theory of dynamic games, dynamic commons problems, club theory, hold up, and endogenous treaty emergence.
	Adaptation to climate change	• It familiarizes students with current approaches to projects and programs that promote adaptation, showing both the utility of the approaches and

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		some of their limits. The concepts of vulnerability, resilience and adaptive capacity are studied in detail; students learn to engage critically with these concepts.
	Religion and climate crisis: India	• Connections between dramatic climate assaults and religious practices and perspectives, taking Hindu India as an example: glaciers and floods, extreme weather, overpopulation, air and water pollution, deforestation. Hindu contexts, causes, and responses.
	Water resources and climate	•
	Seminar in race, climate change, and env	• Focus on placing race, gender, and class at the center of discussions of the environment, climate, and equity. • Create an academic space which enables collaborative dialogue, action, and insight for systemic change towards racial equity and understanding within a climate and environment context.
	The earth's climate system	•
	Pred effect climate change on glob forests	•
	Climate, technology, and society	•
	Climate adaptation in cities	•
	Cities and climate change	•
	Equitable climate action	•
	Energy decarbonization	• Understanding of the energy decarbonization pathways needed to address the risks of climate change and the economic, scientific, and political barriers that stand in the way. It will dig into the

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		technologies and strategies that can spur decarbonization in each of the major energy sectors. • It will highlight the most critical public policy alternatives to reduce emissions effectively and efficiently, including carbon pricing, support for innovation, and energy efficiency programs. • Describe historical failures, rare successes, and ongoing attempts to achieve energy decarbonization around the world.
University of Pennsylvania	Hydrology: Water and Climate	• Reconstruct the history and scales of climate changes • Learn basic atmospheric and ocean dynamics to understand fundamental climatic processes and future changes • Examine the mechanisms that act to drive climate change • Analyze long-term natural climate variability on a global and regional scale • Understand the importance of natural environmental change as a benchmark against which to assess human impacts, recent climate change, and future environmental change • Deepen insights into methods of scientific inquiry • Refine communication skills to effectively share an understanding of climate change, with a focus on both science and policy implications
Princeton University	Hydrology: Water and Climate	• Analysis of fundamental processes in the hydrologic cycle, including precipitation, evapotranspiration, infiltration, streamflow and groundwater flow
	Topics in Policy Analysis (Half-Term): Climate Change: Science, Policy and Mitigation	• Using case studies, real-world examples, and in-class exercises, in the areas of atmospheric and energy policy, the emphasis is on preparing both non-scientists and scientists to use, understand,

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		and critique science in environmental policy applications. Exercises are scaled to the student's background.
	Topics in STEP: Global Environmental Governance	• Examines international law and governance in the context of environmental problems. • Considers the need for regulation under conditions of scientific uncertainty in issues such as climate change, bovine growth hormones, gmos, fisheries management, biodiversity conservation, and ozone depletion. • Explores the efficacy of diverse regulatory approaches, mechanisms for scientific advice to policymakers and participation by business firms and ngos. • Considers intersections between environmental regulation (both domestic and international) with trade, investment, and multilateral development and aid programs.
	Energy for a Greenhouse-Constrained World	• Overview of fundamental physical mechanisms behind sustainable energy technologies, including solar thermal, solar photovoltaic, wind, nuclear, and hydroelectricity. Physics of the greenhouse effect, projected Earth's climate changes, as well as socio-economic impacts on energy uses and greenhouse-gas emissions are reviewed. • Variability, dispatchability, and a real power density of energy resources are discussed. Energy efficiency, energy storage, as well as transmission and distribution of electric power are touched upon.
	Climate Change: Impacts, Adaptation, Policy	• An exploration of the potential consequences of human-induced climate change and their implications for policy responses, focusing on risks to people, societies, and ecosystems. As one example: we examine the risk to coastal cities

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		from sea level rise, and measures being planned and implemented to enable adaptation. • Explore local, national and international policy initiatives to reduce greenhouse-gas emissions. The course assumes students have a basic background in the causes of human-induced climate change and the physical science of the climate system.
Cornell University	Climate Smart Communities: State and Local Climate Change Science and Policy	• Critically analyze the theory of multilevel governance and debate the importance of non-state (NGO) and sub-national (regional, state and local government) actors involved in climate change policy.
	Climate and Global Warming	• Familiarizes from a range of disciplines with such contemporary issues in climatology as global warming and El Niño. • Introduces the natural greenhouse effect, past climates, and observed and projected climate changes and impacts. Also covers natural climate variations (e.g., El Niño) and their consequences and predictability. Readings focus on recent scientific findings related to climate change.
	Global Climate Change Science and Policy	• Introduce students to climate change science and policy, with a focus on how science factors into the United Nations Framework Convention on Climate Change (UNFCCC) and how negotiations take place at the annual Conference of the Parties (COP). • Enable Cornell students to participate in global, engaged learning at the most significant annual meeting of the U.N. on climate change; and make a vital contribution to their academic studies and decisions about future work in international environmental affairs. • Analyze contemporary climate change science and

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		global environmental policy-making; develop and address pertinent research questions; engage with experts in the field and help them with policy-relevant research; and develop experience with communications and social media.
	Climate Change and Global Development: Living in the Anthropocene	• Investigates social, political, and economic life in the age of the “Anthropocene”: the current geological era in which humans have irrevocably altered the earth’s biophysical systems. • Analyze what political-economic dynamics have led to this, how climate change is known and predicted scientifically, and the impacts it has on politics, economies, environments, and societies across scales. • Drawing on case studies from around the world, we investigate topics including climate change impacts on land, oceans, animals, and forests; climate migrants and political instability; (un)natural disasters such as fires, floods, and hurricanes; and sea level rise and cities. • Investigate existing and potential political and economic responses to climate change ranging from international governance agreements and green markets to local climate justice movements.
	Controversies in Global Climate Change Science and Policy	• Introduce the interface between global climate change science and policy, with a focus on how science factors into the United Nations Framework Convention on Climate Change (UNFCCC) and how negotiations take place leading up to and at the annual Conference of the Parties (COP). • Critically analyze contemporary climate change science and global environmental policy-making; develop and addresses pertinent research questions; engage with experts in the field and

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		help them with policy-relevant research; and develop experience with communications and social media..
	Critical Theory and Climate Change	• Explores what German literature and thought, especially the tradition of Critical Theory, can teach us about living in the Anthropocene. • Re-explores these questions in light of climate change in the 21st century. Of particular interest is not only the rhetoric of climate change and a critique of its denial in word and deed, but also narration: how does one narrate the singularity of this catastrophe? Different narrative structures from trauma and tragedy to the 19th century novel and 20th century surrealism will be examined.
	Plant Responses to Environmental Stresses and Global Climate Change	• Explores the molecular, physiological, developmental and morphological characteristics that plants use to adapt to environmental stresses. Emphases are placed on stresses associated with global climate change including drought, flooding, extreme temperatures, salt, and environmental pollution. • Discuss strategies for improving stress tolerance in crops.
	Sustainable Water Resource Management in the Face of Climate Change	• In-depth analyses of those ecological and biological principles relevant to the sustainable management of global fresh and marine water resources. • Scientific literature with current management issues, including water supply, dams, irrigation, and groundwater overdraft, and coastal development. • Topics include linkages between hydrologic variability and communities, groundwater-surface connections, flow paths for dispersal, patchily

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		distributed water resources, and water quality controls on organisms, and adaptations to climate change.
	Plant Responses to Environmental Stresses and Global Climate Change	• Explores the molecular, physiological, developmental and morphological characteristics that plants use to adapt to environmental stresses. Emphases are placed on stresses associated with global climate change including drought, flooding, extreme temperatures, salt, and environmental pollution. • Discuss strategies for improving stress tolerance in crops.
	Climate and Energy: a 21st Century Earth Science Perspective	• This course asks how we humans, as a species, found our way in to the current bottleneck of climate and energy challenges, and how we, as a society, might find solutions that guarantee future generations can enjoy a stable climate, a secure and nutritious food supply, and access to clean energy.
	Perspectives on the Climate Change Challenge	• Critically important perspectives on the grand challenge of climate change. • Cover a range of topics including the science of climate change, implications for ecosystems, oceans, forests, agriculture and communities, the important ethical, philosophical and legal insights on the issue, and provide thoughts on societal responses through international mechanisms, economic drivers and communication tools. This seminar series counts towards the requirements of the climate change minor and the ESS minor and major.
	Communicating Climate Change	• This course will ask you to read, write and design many different forms and genres in order to experiment with the problem of communicating climate change, from pie-charts to science fiction

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		and from photography to TED Talks.
	Hydrologic Engineering in a Changing Climate	• Introduces methods in hydrologic engineering to assess and cope with climate variability and change. • Cover both statistical and physical approaches to analyzing and modeling hydrologic systems. • Learn the core concepts of traditional statistical analyses in hydrology, and will also learn the limitations of these approaches in a changing climate. • Become familiar with physical modeling approaches to understand hydrologic response under future climate projections and their limitations. • Recognize the rapidly changing nature of the field of hydrologic engineering as it tries to adapt to the impacts of climate change. • Topics include extreme event frequency analysis, trend detection, water balance modeling, and hydrologic simulations under projected climate change. Applications to stormwater and flood risk analyses
	Climate Change and the Gulf of Maine	•
	Climate Change Leadership	• Organizational decision makers • Managers • Risk and supply chain managers • Activists • Anyone interested in understanding the impacts of climate change and working towards solutions
Duke University	Our Changing Atmosphere	•
	Climate Change in the Marine Environment	• Exploration of climate change science focusing on marine ecosystems and inhabitants - specifically

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		ocean acidification, warming and sea level rise. • Factors causing climate change, and how those vary spatially, focusing on sensitive polar ecosystems and marine mammal populations. • Critical examination of climate change modeling using edgcm (research-grade Global Climate Model), focusing on how scientists use models, observations/theory to predict climate, and assumptions/uncertainty implicit in modeling. • Discussion of potential human impacts including consequences of sea level rise and potential increases in disease due to climate change.
	Global Warming	•
	Global Environmental Politics	• Examines the international community's responses to various global environmental problems. Because many environmental problems cross national borders, solutions require some form of global governance such as state-led mechanisms in the form of international environmental regimes. • Explore how and why states both succeed and fail to negotiate international governance mechanisms. • Examine why some international environmental regimes are more effective than others and why states choose to comply with environmental regimes.
	Energy and the Environment	• Overview of the challenges confronting humanity as a consequence of our reliance on energy. • Challenges include dwindling supplies, rising demand and environmental degradation. Realistic responses require an understanding of the complexity of the energy system, including energy resources, uses, and impacts, in the context of

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		social, political and economic imperatives.
	Energy Futures and Environmental Justice	• Comparative energy crises and natural resource management. • Uses case studies of fossil fuel, nuclear, and renewable energy resources drawn from anthropology, natural sciences, and even business economic readings.
	Introduction to Atmospheric Chemistry: From Air Pollution to Climate Change	• Integrated scientific background for the impact of humans on the natural environment. • Topics covered include greenhouse gases and climate, local and regional ozone pollution, long-range pollution transport, acid rain, atmospheric particulate matter pollution, and stratospheric ozone depletion.
	Climate Change and the Law	• Examine global climate change and the range of actual and potential responses by legal institutions, in the U.S. and internationally. • Explore fundamental questions about legal response to looming crises using climate change as the focal point of a broader discussion.
	Climate and Society	• Consequences, and future trajectory of climate change. • Cover physical observations of past climate change, role of human activities in driving climate change to date, and impacts of climate change on human and natural systems. • Analyze how socioeconomic choices affects future climate as well as factors influencing those choices, including risk analyses, geoengineering proposals, intergenerational equity, climate metrics and the media.
	Climate Change Economics and Policy	• Explores the economic characteristics of the climate change problem, assesses national and international policy design and implementation

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		issues, and surveys the economic tools necessary to evaluate climate change policies. • Course objectives are increased comprehension of economic aspects of climate change and ability to apply tools of economic analysis to climate policy and the responses of firms and households to it.
	Climate Change and Climate Modeling	• Provide knowledge and understanding of physics of climate system and Earth system modeling for scientists, engineers and policy students with physics and mathematics background. • Fundamental principles controlling physical and dynamic structure of climate system; discussion of relative roles of natural climate variability and external forces and anthropogenic influences. • Explore numerical methods, develop computing skills, and deal with data handing as a means to an end of quantifying climate system behavior.
	Global Environmental Change	•
University of Michigan	Climate Change and Sustainability: Environmental Challenges of the 21st Century	• Study the impacts of modern human society on land, ice, freshwater, ocean, atmosphere, ecosystems, resources, and human well-being. We will also consider practical, local, and every-day considerations relevant to a sustainable human future. • Discussions and analysis of spatial data, utilizing arcgis software, are used to investigate the role and impacts of change, toward developing mitigation and adaptation strategies.
	Our Changing Atmosphere	• The science of the greenhouse effect, stratospheric ozone depletion, polar ozone holes and urban smog. These phenomena and their possible consequences are discussed, along with the properties and behavior of the atmosphere and its interactions with other components of the

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		environment.
	Extreme Weather	• Provides an introduction to the physics of extreme weather events. • Uses examples of the thunderstorms, jet stream, floods, lake-effect snow storms, lightning, thunder, hail, hurricanes and tornadoes to illustrate the physical laws governing the atmosphere.
	Ice Sheets, Glaciers and Climate Change	• The dynamics and mass balance of ice sheets and glaciers introduced along with mathematical theories describing how ice sheets and glaciers flow and current methods of observation.
	Energy and Climate Change: Technology, Markets, and Policy	• Examine all aspects of energy: supply and demand, technical and social, with a concerted look at the natural place of social science (behavior, pricing, externalities, social norms) in the energy sphere.
	Environmental Ethics-Living Well with Nature	• Investigates a variety of proposed answers that claim to better situate humans with respect to nature. Such systems include variations on anthropocentrism, including a number of e-centric cousins (ecocentrism, biocentrism, zoocentrism, etc.) As well as movements such as deep ecology and ecofeminism.
	Topics in Culture and Environment	• Explore some of the many answers to that question. For example, over the past decade, artists from around the globe have used art to advocate and care for the natural world. In 2015, Icelandic art star Olafur Eliasson installed twelve blocks of melting glacial ice in Paris's Place du Panthéon to act as a ticking clock for the UN Climate Summit. The following year, Native Water Protectors gathered at Standing Rock in opposition to the Dakota Access oil pipeline.

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		• This course will also look beyond activism to ask what art can tell us about environmental history. • Explore foundational theories and examples of environmental art history from across time periods and geographies.
	Air Pollution Meteorology	• Extensive exploration of the important role that meteorology plays in the transport, dispersion, chemical conversion and deposition of pollutants in the atmosphere. • Sources emitting a wide range of potential pollutants are being built and retrofitted every year creating a demand to assess their potential impact on nearby (and even far-away) communities. • The need to understand and predict the transport and dispersion of pollutants has taken on an even greater importance.
	Global Warming	• Review of the science of global warming including global radiation balance, geochemistry of natural and anthropogenic greenhouse gases, climate feedbacks, and historical and geological records of climate change; summary of the impacts of climate change on natural and systems and society; and discussion of potential remediation methods and the politicization of global warming.
University of southern California	Global Environmental Changes and Health	
Yale University	Air Quality and Energy	
	Air Pollution Control	
Stanford University	Fundamentals of Renewable Power	
	Stanford Climate Ventures	
	Hard Earth: The Interconnected Impacts of	

	Global Climate Change	
	Scientific Basis of Climate Change	
	Poverty, Infrastructure and Climate	
	100% Clean, Renewable Energy and Storage for Everything	
	Energy Policy in California and the West	
UC Berkely	Climate Change Economics	
	Energy and Environmental Issues	
	Climate, Energy and Development	
	Environmental Science, Policy, and Management Colloquium	
Delft University of Technology	Introduction to Water and Climate	• Understand the different processes at play in the global water cycle. • Identify and describe the flows of water and sand in different riverine, coastal and ocean systems. • Identify mechanisms of climate change and explain the interplay between climate change, sea level, clouds, rainfall and future weather. • Explain why, when and which engineering interventions are needed in rivers, coastal and urban environments. • Explain why water for food and water for cities are the main challenges in water management and propose solutions. • Explain and confront the challenges in better understanding and adapting to the impact of

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		climate change on water over the coming 50 years.
University of Birmingham, UK	Climate Studies & Meteorology Degrees	• Large-scale climate and weather effects such as El Nino or global warming • Study about temperature, pressure, wind, humidity and rain • The changes in latitude, altitude or the interaction between Earth's atmosphere and the oceans
University of British Columbia	Climate Action 2020 - Climate Adaptation and Resilience - Climate and People - Climate Economics - Climate Justice - Climate Science	• Aims to reduce greenhouse gas emissions by 100 per cent by 2050, to use the university as a lab to develop climate change solutions and to take full account for the costs of its decisions on sustainability.
Vrije Universiteit Amsterdam, Netherland		• Included number of environmental areas such as water and climate risk, environmental economics and environmental policy analysis.
University of Victoria, Canada	Sustainability Action Plan	• Includes measures to reduce greenhouse gas emissions, reduce natural gas consumption and reduce waste
Asian Institute of Technology (AIT)	Climate Change and Water Resources	• The objective of this course is to provide the knowledge and understanding of climate change and its impact on water resources availability, use and demand. This course provides knowledge and skills on modeling tools and methods for climate change projections and impact assessment in water sectors, vulnerability assessment and adaptation strategies in managing water at regional, national and local level
University of Southampton	Climate Change, Energy and Settlements	• Climate Change, Energy and Settlements • An introduction to the Earth's climate system and climatic zones as basis for human activity and settlements. • The development of society in relation to the local

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		climatic and topographic conditions, resources availability (food, building material, energy), technical skills and the societal framework. • The conditions for development, evolution and collapse of civilizations. • The development and organization of human settlements addressing aspects of location, society, advantages to individuals, form, function, design and organization principles. • An assessment of population development and its implications on settlements, buildings and resource consumption with particular focus on energy consumption. • Discussion of how energy systems contribute to the shaping of society and the conditions that resulted in the agricultural and industrial revolution. • An introduction to climate science looking at historical and recent observations, climate modelling and climate change predictions. • The assessment of global and regional climate change implications and associated mitigation / adaptation strategies. • The concepts of sustainability, ecological and carbon foot printing.
National University of Singapore (NUS)	Climate Science for Engineers	• Introduction to the components of the Earth system – atmosphere, oceans, biosphere, cryosphere, pedosphere, humans, carbon cycle. History of climate • Principles of meteorology. Weather systems. Air masses. Winds. Thermodynamics of the dry and wet atmosphere. Vertical gradients, stability. • Cloud formation and physics. Precipitation formation, physics and types. • Stochastic rainfall generators. Alternating renewal

		process. Neyman-Scott rectangular pulse. Rainfall disaggregation. • Radiative transfer. Shortwave and longwave radiation. Surface energy fluxes. • Turbulence, aerodynamic resistance and PBL development. Land-atmosphere feedbacks. • Extreme weather phenomena. Thunderstorms, Tropical cyclones. • Numerical Weather Predictions. Meteorological and climate models. • Climate change and IPCC projections. CO2 emissions and future scenarios. Geoengineering • Climate downscaling and weather generators. • Carbon footprints and climate targets.
University of Dhaka (Bangladesh)	Climatology and Climate Change	• Concept of climate, classifications of climate, global, annual and seasonal distribution of surface climatic variables – MSL pressure, Sea Surface Temperature (SST), wind, air temperature, humidity and precipitation. Air-masses- Land and ocean air-masses – source regions and large-scale circulation. Climatology of natural disasters – tropical cyclones, nor westers, tornadoes, lightning, floods, droughts and their impacts. • Climate models: Nature and applications of climate models. Global warming and its causes- emission of enhanced Greenhouse Gases (ghgs) and sources and sinks of these emissions. Past and future climate change- global, regional & sub-regional. • Climate Change Impacts-Potential impacts of global, regional and sub-regional climate change. Physical/dynamical reasoning to explain variability and change in climate. • Climate information: products and services specific to application.

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East West University (Bangladesh)	Environmental Engineering, I	• Introduction to Environmental Engineering: water, health and sanitation, ecology and environment; climate change; biodiversity; contemporary environmental issues. • Water Supply Engineering: Water requirement in urban (water demand, population prediction, water demand for street fire hydrant and interior fire protection) and rural communities; the hydrologic cycle and water availability; water supply sources; ground water exploration: aquifer properties and ground water flow, well hydraulics, water well design, drilling, construction and maintenance; shallow hand tube wells, deep tube wells, deep set pumps, pond sand filter, rain water harvesting system and alternative water supplies for problem areas. Surface water collection and transportation; pumps and pumping machineries; water distribution systems; analysis and design of distribution network; fire hydrants; water meters; water loss control (auditing, unaccounted for water, leak detection and water conservation). • Water quality requirements; water treatment: plain sedimentation, coagulation, flocculation, filtration, disinfection; miscellaneous treatment methods; low cost treatment methods (arsenic/iron removal plants etc.) For rural communities; water safety plans.
National university in Seoul, South Korea	Environmental Engineering	• Basic elements of the environment and their interactions including human impacts are investigated. Numerous factors that cause deterioration of environ- mental quality such as the pollution of air, water, and soil as well as noise, vibration, solid wastes, and hazardous material are considered, and the effects on the human beings and the ecosystem as well as a

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		number of technologies to restore the environmental quality are studied. The environmental policies and socioeconomic system concerned with the prevention and abatement of environmental contamination and conservation of a healthy ecosystem are also major topics of the course work. Studies are not restricted to local or regional environmental problems spatially. Global issues such as climate change, ozone layer destruction, biodiversity and so on are discussed.
International Water Association (IWA)	Climate Change and Water in Mountains	• Introduction to climate change • Impacts of Climate Change on Water Resources • Impacts of Climate Change on Water uses • Recommendations for Adaptation and Water Governance Strategies • Risk management
UN CC	Climate change: From learning to action	• Module 1: What is climate change and how does it affect us? • Module 2: How to adapt to climate change? • Module 3: How to mitigate climate change? • Module 4: How to plan and finance action on climate change? • Module 5: How do climate change negotiations work? • Module 6: How to tackle climate change in practice?
University of Life Sciences in Lublin	Management and adaptation to climate change	• Climatology and climate risk assessment ecology, • Biology and protection of polar ecosystems, • Air protection and emission modeling, • Water resource management, • Methods of increasing water retention, • Protection of plants against weather phenomena, • Adaptations of organisms to climate change, • Green infrastructure and urban adaptation to

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		climate change, • Adaptations to climate change in spatial management, • Renewable energy sources
Cracow University of Technology	Clean air engineering	•
	Water engineering and management	• Designing urban, water and green infrastructure to adapt cities to climate change
	Renewable energy sources and municipal infrastructure	• Alternative energy sources, • Sourcing, processing and distribution of energy from renewable sources
University of Agriculture in Krakow	Water engineering and management	• Aquatic ecology • Hydrology
Ateneum University in Gdańsk	Natural aspects of climate change with English	• How to talk about climate change • Environmental aspects of climate change
Nature University of Poznań	Ecoenergy	• Biomass energy • Vegetable energy resources • Ecology and protection of the biosphere • Hydropower • Wind energy and wind turbines • Photovoltaics and solar collectors • Technique and technology of biofuel production • Renewable energy in construction • Designing eco-energy systems
	Water engineering and management	• Engineering and water management facilities, • Facilities and systems for protection against flood and drought, • Water supply and sewage networks, • Complex facilities and water-drainage systems, • Hydrotechnical facilities and watercourse regulation, • Systems for rational water management
Bialystok University of Technology	Eco energy	• Renewable sources and conversion of electricity

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Warsaw University of Life Sciences	Water engineering and management	• Water engineering, water management • water and drainage engineering
	Renewable energy technologies	• Water and sewage management in the enterprise • Renewable and unconventional energy sources • Legal conditions for energy management • Assessment of the efficiency of renewable energy sources • Design of renewable energy facilities • Climate change
Collegium Civitas Warsaw	International and climate security	•
European Social and Technical University of Servant of God Robert Schuman in Radom	Climate and ecology	• Climate changes in the past • Causes and scenarios of climate change • The effects of climate change in poland and in the world • Extreme phenomena • Adaptations to climate change • Air protection and emission modeling • Methods of increasing water retention • Renewable energy sources • Financing pro-climate activities • Climate risk management
Wrocław University	Geography Climate protection and air quality management	• Climate change - causes and consequences • Air quality management and environmental impact assessment • Numerical modelling of atmospheric processes • Protection and monitoring of the atmosphere
University of Life Sciences in Wroclaw	Water engineering and management	• Water law and administration • Meteorology and climatology • Hydrology
University of Warmia and Mazury in Olsztyn	Renewable energy sources	• Passive, zero- and plus energy construction • Wind energy • Hydropower • Harnessing of the sun energy

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	Ecological engineering	• Design of anthropogenic water reservoirs • Hydrology and earth sciences • Low emission systems of fuels applications
	Management of renewable and mineral resources	• Environmental effects of mining and energy generation secotrs • Water resources management
	Environmental protection	• Hydrology • Water management in river catchments • Water engineering • Water ecosystems • Water management in the landscape
	Landscape architecture	• Hydrology

Few more details collected via online literature search are summarized below:

1. Delft University of Technology

Online Course on Introduction to Water and Climate:
Water is essential for life on Earth and of crucial importance for society. Water also plays a major role in affecting climate. Its natural cycle, from ocean to atmosphere by evaporation, then by precipitation back to land returning via rivers and aquifers to the oceans, has a decisive impact on regional and global climate patterns.
Learning Outcomes of the module

- The different processes of the global water cycle
- The challenges in better understanding and adapting to the impact of climate change on water for the coming 50 years
- The flows of water and sand in different riverine, coastal and ocean systems
- How to identify mechanisms of climate change and explain the interplay of climate change, sea level, clouds, rainfall and future weather
- Why, when and which engineering interventions are needed in rivers, coasts and urban environments
- Why water for food and water for cities are the main challenges in water management and what the possibilities and limitations of reservoirs and groundwater are to improve water availability

(https://scholarship-positions.com/tu-delft-online-course-introduction-water-climate/2016/07/05/)

2. University of Birmingham, UK

Climate Studies & Meteorology Degrees
Climate studies and meteorology is an interdisciplinary study that focuses on the activity and changes of the atmosphere as well as weather patterns, on the other side. The sub-disciplines of these sciences lead to specializations in observation of the elements that comprise weather and the meteorological phenomena.
This module consists of

- Large-scale climate and weather effects such as El Nino or global warming
- Study about temperature, pressure, wind, humidity and rain

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- The changes in latitude, altitude or the interaction between Earth's atmosphere and the oceans

(https://www.mastersportal.com/disciplines/125/climate-studies-meteorology.html)

3. University of British Columbia

They have an action plan called "Climate Action 2020". It includes

- Aims to reduce greenhouse gas emissions by 100 per cent by 2050, to use the university as a lab to develop climate change solutions and to take full account for the costs of its decisions on sustainability.

The UBC experts have been finalized and include the following climate related contents to the UBC graduate curriculum.

- Climate Adaptation and Resilience
- Climate and People
- Climate Economics
- Climate Justice
- Climate Science

(https://www.timeshighereducation.com/student/best-universities/top-universities-climate-action)

4. Vrije Universiteit Amsterdam, Netherland

- Included number of environmental areas such as water and climate risk, environmental economics and environmental policy analysis.

(https://www.timeshighereducation.com/student/best-universities/top-universities-climate-action)

5. University of Victoria, Canada

- Created a Sustainability Action Plan, which includes measures to reduce greenhouse gas emissions, reduce natural gas consumption and reduce waste.

(https://www.timeshighereducation.com/student/best-universities/top-universities-climate-action)

6. Asian Institute of Technology (AIT)

Department: Water Engineering and Management

Module: CE74.18 Climate Change and Water Resources

Description: The objective of this course is to provide the knowledge and understanding of climate change and its impact on water resources availability, use and demand. This course provides knowledge and skills on modeling tools and methods for climate change projections and impact assessment in water sectors, vulnerability assessment and adaptation strategies in managing water at regional, national and local level.

https://www.ait.ac.th/admissions/eligibility/course-catalogue/set_main/set_wem/

7. University of Southampton

Module: CENV6147 Climate Change, Energy and Settlements

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Description: Sustainable development is a major international challenge and relates to historical, environmental and economic changes. This module focuses on the relationships between settlements, resources, climate and energy through history. It introduces students to the basics of human evolution, from the pre-industrial world to today's high fossil fuel society. Building on this knowledge, students will develop ideas and concepts towards sustainable lifestyles and resource and energy efficiency.
Only students enrolled on programme codes 3081MSc Energy and Sustainability, Pathway 3086 Energy Resources and Climate Change and 3081 MSc Energy and Sustainability, Pathway 3087 Energy Environment and Buildings will be permitted to register on this module.

Course Content: This module links the development of society to the surrounding climatic conditions and investigates its use of energy to achieve comfortable living and working conditions in its buildings and settlements. It will comprise the following:
1. An introduction to the Earth's climate system and climatic zones as basis for human activity and settlements.
2. The development of society in relation to the local climatic and topographic conditions, resources availability (food, building material, energy), technical skills and the societal framework.
3. The conditions for development, evolution and collapse of civilizations.
4. The development and organization of human settlements addressing aspects of location, society, advantages to individuals, form, function, design and organization principles.
5. An assessment of population development and its implications on settlements, buildings and resource consumption with particular focus on energy consumption.
6. Discussion of how energy systems contribute to the shaping of society and the conditions that resulted in the agricultural and industrial revolution.
7. An introduction to climate science looking at historical and recent observations, climate modelling and climate change predictions.
8. The assessment of global and regional climate change implications and associated mitigation / adaptation strategies.
9. The concepts of sustainability, ecological and carbon foot printing.

https://www.southampton.ac.uk/courses/modules/cenv6147#syllabus

8. National University of Singapore (NUS)

Postgrad modules: hydraulic engineering & water resources management

Module: CE5315 Climate Science for Engineers

Brief description: This module introduces fundamental mathematical and physical elements of the Earth climate with specific focus on clouds, precipitation, energy budget, planetary boundary layer and extreme weather phenomena. This knowledge is relevant for a better assessment of water and energy resources and impact assessments. Beyond introducing fundamental climatic processes, the module provides methods for the stochastic generation of climatic variables in a stationary and changing climate. It finally discusses broadly issues related to greenhouses gas emissions and future climate projections, outlining causes and potential solutions.

Course Content:

- Introduction to the components of the Earth system – atmosphere, oceans, biosphere, cryosphere, pedosphere, humans, carbon cycle. History of climate
- Principles of meteorology. Weather systems. Air masses. Winds. Thermodynamics of the dry and wet atmosphere. Vertical gradients, stability.
- Cloud formation and physics. Precipitation formation, physics and types.
- Stochastic rainfall generators. Alternating renewal process. Neyman-Scott rectangular pulse. Rainfall disaggregation.

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- Radiative transfer. Shortwave and longwave radiation. Surface energy fluxes.
- Turbulence, aerodynamic resistance and PBL development. Land-atmosphere feedbacks.
- Extreme weather phenomena. Thunderstorms, Tropical cyclones.
- Numerical Weather Predictions. Meteorological and climate models.
- Climate change and IPCC projections. CO2 emissions and future scenarios. Geoengineering
- Climate downscaling and weather generators.
- Carbon footprints and climate targets.

https://www.eng.nus.edu.sg/cee/graduate/coursework-based-programmes/msc-ce/

9. International Water Association (IWA)

Climate Change and Water in Mountains: A Global Concern
University of Geneva

Target Audience

Professionals and students who wish to go beyond basic notions of climate change and water management. Anyone who seeks to reinforce his or her knowledge in associated areas of climate change in mountain regions, such as adaptation and risk management.

Content

- Introduction to climate change
- Impacts of Climate Change on Water Resources
- Impacts of Climate Change on Water uses
- Recommendations for Adaptation and Water Governance Strategies
- Risk management

Learning Objectives

- By the end of this course, you will be able:
- to define the general concept of climate change in mountain regions
- to understand the concepts associated with climate change such as adaptation and water governance strategies
- to consider the impacts of climate change on water resources in mountain regions
- to identify the impacts of climate change on hydropower, agriculture, aquatic ecosystems and health
- To enumerate risks that can occur in mountain areas and lead to disruptions in water availability and use.

https://iwa-network.org/learn/climate-change-and-water-in-mountains-a-global-concern-2/

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2.3 Teaching water-climate change relevant subjects

Prepared by Munkhtsetseg

Table 3:Relevant subjects

	Institute, course	Course objectives	Why is it best practice ?
1	Delft University of Technology, the Netherlands Course on Introduction to Water and climate https://online-learning.tudelft.nl/courses/introduction-to-water-and-climate/	Understand the different processes at play in the global water cycle. Identify and describe the flows of water and sand in different riverine, coastal and ocean systems. Identify mechanisms of climate change and explain the interplay between climate change, sea level, clouds, rainfall and future weather. Explain why, when and which engineering interventions are needed in rivers, coastal and urban environments. Explain why water for food and water for cities are the main challenges in water management and propose solutions. Explain and confront the challenges in better understanding and adapting to the impact of climate change on water over the coming 50 years.	It is good teaching source of using the online forums to demonstrate the how climate change affecting to the water to students who has different background. - Video sessions (clips, movies)
2	UN CC:Learn Course on5 Climate change: From learning to action https://www.uncclear	**Module 1:** What is climate change and how does it affect us? **Module 2:** How to adapt to climate change? **Module 3:** How to mitigate climate change? **Module 4:** How to plan and finance	It is also good idea that participants will develop a concrete action plan or project to tackle climate change. - Work on real-life

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n.org/courses/climate-change-from-learning-to-action-coming-soon/	action on climate change? **Module 5:** How do climate change negotiations work? **Module 6:** How to tackle climate change in practice?	climate change issues

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2.4 Water quality monitoring

Prepared by Slwomir Kalinowski and Zakhar Maletzkyi.

The **pdf** file containing the details is attached separately.

water_monitoring.pdf

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3 Section 2: University – enterprise collaborations

3.1 University – Enterprise collaborations

Prepared by Katarzyna Glinska-Lewczuk

The integration of science, technology and innovation policies into water resources development strategies, as well as its combination with institutional and organizational changes, can valuably contribute to raising efficiency, improving resilience, and fostering the transition to sustainability within and beyond the water sector. Such achievements offer new opportunities and responses to support sound decision-making in the governance and management of water resources while minimizing the impact of climate change. Innovation provides more affordable and efficient technological tools, enables their implementation, and is indeed central to translating water-related scientific knowledge and technological know-how into useful processes, services and employment [UNESCO, UN-Water, 2020: United Nations World Water Development Report 2020: Water and Climate Change, Paris, UNESCO]

Science, technologies and innovation are rapidly evolving and continue to support a number of water resources management activities, including:

i. overall assessment and monitoring of water resources and hydrological processes;
ii. conservation, recovery and reuse of water resources;
iii. adaptation of infrastructures;
iv. cost reduction in treatment and distribution processes;
v. efficiency of water supply delivery and use; and
vi. access to safe drinking water and sanitation.

Several innovations in the water sector have over the past years deepened our understanding of climate-related challenges, and provided new ways to adapt in a flexible way to climate change and to mitigate greenhouse gas (GHG) emissions.

In 2003, a global initiative called the Dialogue on Water and Climates ought to bridge the knowledge and communication gaps between water managers and climate scientists, and to promote water-related adaption measures through a series of 18 multi-stakeholder dialogues at regional, national and basin levels, collectively highlighting the need to prepare for and adapt to the effects of climate variability and the likely implications of climate change.

Different sectors and stakeholders can face a variety of challenges with respect to both water management and climate change adaptation and mitigation. The often strong interlinkages across the water–climate–energy–food–environment 'nexus' can lead to synergies and cross-benefits in some cases, and in others impose difficult choices and trade-offs.

Interdisciplinary approaches are therefore required to ensure that the various perspectives and knowledge from different disciplines feed into the analyses and inform the decision-making process. The examples of conservation agriculture and sustainable land management clearly demonstrate how locally applied soil management techniques can have positive effects on water availability and flood control across a catchment (adaptation), while at the same time enhancing soil carbon storage (mitigation).

The need for greater cooperation between the water and climate communities exists well beyond the realm of scientific research. The disconnect remains abundantly clear at the policy level as well – most obviously in the fact that the term 'water' is completely absent from the Paris Agreement (UNFCCC, 2015). On the one hand, it is imperative that the climate change community, and climate negotiators in particular, give greater attention to the role of water and recognize its central

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importance in addressing the climate change crisis. On the other hand, it is equally (if not more) essential that the water community focuses its efforts to promote the importance of water in terms of both adaptation and mitigation, develop concrete water-related project proposals for inclusion in NDCs, and strengthen the means and capacities to plan, implement and monitor water-related activities in NDCs (prior to the 2020 NDC review and beyond)

Collaboration can achieve many beneficial outcomes for adaptation in areas such as stakeholder participation and buy-in, financing and information availability. Lack of collaboration may result in maladaptation as the scales of the response will not match the scales of the risk [*Burton, D. 2016: Collaboration and partnerships for adaptation. CoastAdapt, National Climate Change Adaptation Research Facility, Gold Coast.*].

- Collaboration occurs when several parties come together to work through and implement a collective solution to a multi-dimensional problem.
- Adaptation is well-suited to a collaborative approach because of the wide range of expertise required, the need for stakeholder engagement to ensure successful outcomes, and the wide spatial scales and long timeframes involved.
- Useful collaboration for adaptation can take place within organisations such as small businesses and local councils, between organisations, and between an organisation and its stakeholders.
- Collaboration can take place around financing, implementation, knowledge generation, monitoring and evaluation. It can help to realise any opportunities arising from climate change, as well as to address the risks.

There are shining examples of fruitful collaboration between universities, industry partners and start-ups. Many ideas from research in universities are put to use through collaboration between universities and firms. Others reach the market through licensing or start-up companies. A multistakeholder group of experts in technology transfer recently met in Tianjin, People's Republic of China, at the World Economic Forum's Annual Meeting of the New Champions, and identified a number of common challenges and opportunities that warrant further exploration and discussion (fig 1.)

<u>Nature Index</u>

Definition "Research collaboration" indicates a collaboration between two or more organizations (at least one university and one private enterprise) that has resulted in a co-authored scientific publication. Collaborations can be studied both at the level of the organizations involved (university-enterprise) and at the level of the scientific sector involved (SDS-enterprise). By university-enterprise collaboration we mean a research collaboration between a university and a private enterprise that has resulted in exactly one co-authored publication in the dataset under consideration. Research partnerships between industry and academia have more than doubled in five years. (based on Academic-Corporate co-authored publication growth 2015-2019)

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Figure 1: Industry and academia expectations about challenges and opportunities that warrant further exploration and discussion between universities, industry partners and start-ups

The tables show leading institutions ranked by their fractional count (FC) in Earth and environmental sciences from 2015 to 2017. Also listed are institutions' total number of Earth and environmental sciences articles in the Nature Index (AC 2015–2017) and the proportion of each institution's FC in Earth and environmental sciences relative to total FC from 2015 to 2017 (% E&E 2015–2017).

Table 4: Top 20 institutions in Earth & Environmental Sciences in Europe [source; https://www.natureindex.com/supplements/nature-index-2018-earth-and-environmental-sciences/tables/europe]

Rank	Institution	Country/Region	FC 2015–2017	AC 2015–2017	% E&E 2015–2017
1	Helmholtz Association of German Research Centres	Germany	**401.26**	1,135	25.8%
2	French National Centre for Scientific Research (CNRS)	France	**303.56**	2,026	13.5%
3	Swiss Federal Institute of Technology Zurich (ETH Zurich)	Switzerland	**245.26**	652	22.1%
4	Utrecht University (UU)	Netherlands	**102.05**	321	27.4%
5	University of Oxford	United Kingdom (UK)	**101.64**	347	7.7%
6	Max Planck Society	Germany	**93.19**	369	4.2%

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Rank	Institution	Country/Region	FC 2015-2017	AC 2015-2017	% E&E 2015-2017
7	National Institute of Geophysics and Volcanology (INGV)	Italy	**92.38**	203	99.4%
8	University of Leeds	United Kingdom (UK)	**87.97**	330	37.9%
9	University of Cambridge	United Kingdom (UK)	**84.17**	294	6.6%
10	University of Bristol (UoB)	United Kingdom (UK)	**83.15**	285	20.2%
11	Imperial College London (ICL)	United Kingdom (UK)	**80.75**	331	11.3%
12	Swiss Federal Institute of Aquatic Science and Technology (EAWAG)	Switzerland	**75.91**	228	86.6%
13	Leibniz Association	Germany	**75.61**	298	12.4%
14	Spanish National Research Council (CSIC)	Spain	**73.62**	302	11.6%
15	Technical University of Denmark (DTU)	Denmark	**67.78**	168	29.0%
16	Institute of Research for Development (IRD)	France	**63.02**	832	70.8%
17	University of Copenhagen (UCPH)	Denmark	**61.47**	230	14.3%
18	Stockholm University	Sweden	**59.47**	223	23.6%
19	Paris Diderot University (Paris 7)	France	**56.68**	334	33.2%
20	University of Oslo (UiO)	Norway	**53.31**	216	31.2%

The table shows the top collaborating partners ranked by their bilateral collaboration score (CS) in Earth and environmental sciences for the three-year period from 2015 to 2017. The CS sums the fractional count of collaborative papers from the two partnering institutions. Also shown is the article count (AC) of collaborative articles from the two partnering institutions over the same period.

Table 5: Top 40 (from 100) collaborations in Earth & Environmental Sciences

Rank	Institution	CS 2015-2017	Institution	CS 2015-2017	Bilateral CS 2015-2017	AC 2015-2017
1	Chinese Academy of Sciences (CAS), China	188.89	University of Chinese Academy of Sciences (UCAS), China	61.83	**250.72**	341
2	California Institute of	93.85	National Aeronautics	98.05	**191.91**	517

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Rank	Institution	CS 2015-2017	Institution	CS 2015-2017	Bilateral CS 2015-2017	AC 2015-2017
	Technology (Caltech), United States of America (USA)		and Space Administration (NASA), United States of America (USA)			
3	French National Centre for Scientific Research (CNRS), France	110.74	Institute of Research for Development (IRD), France	62.03	**172.77**	825
4	National Oceanic and Atmospheric Administration (NOAA), United States of America (USA)	83.62	University of Colorado Boulder (CU-Boulder), United States of America (USA)	64.06	**147.68**	354
5	Nanjing University (NJU), China	67.59	Tongji University, China	69.23	**136.82**	219
6	French National Centre for Scientific Research (CNRS), France	75.68	Paris Diderot University (Paris 7), France	56.15	**131.83**	331
7	French National Centre for Scientific Research (CNRS), France	63.90	Pierre and Marie Curie University (UPMC) - Paris 6, France	32.90	**96.80**	440
8	National Aeronautics and Space Administration (NASA), United States of America (USA)	58.37	University of Maryland, College Park (UMCP), United States of America (USA)	30.91	**89.28**	229
9	National Aeronautics and Space Administration (NASA), United States of America (USA)	46.63	University of Colorado Boulder (CU-Boulder), United States of America (USA)	42.38	**89.01**	249
10	Chinese Academy of Sciences (CAS), China	46.58	Peking University (PKU), China	37.33	**83.91**	233
11	Beijing Normal University (BNU), China	36.37	Chinese Academy of Sciences (CAS), China	41.14	**77.51**	184
12	Chinese Academy of Sciences (CAS), China	35.79	University of Science and Technology of China (USTC), China	36.25	**72.04**	120
13	National Aeronautics and Space Administration (NASA), United States of America (USA)	32.34	National Oceanic and Atmospheric Administration (NOAA), United States of America (USA)	39.47	**71.81**	194
14	Swiss Federal Institute of Aquatic Science and	47.14	Swiss Federal Institute of Technology Zurich (ETH	24.64	**71.78**	111

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Rank	Institution	CS 2015-2017	Institution	CS 2015-2017	Bilateral CS 2015-2017	AC 2015-2017
	Technology (EAWAG), Switzerland		Zurich), Switzerland			
15	National Aeronautics and Space Administration (NASA), United States of America (USA)	55.51	Universities Space Research Association (USRA), United States of America (USA)	9.44	**64.95**	154
16	Chinese Academy of Sciences (CAS), China	32.65	Tsinghua University (TH), China	30.97	**63.62**	164
17	National Aeronautics and Space Administration (NASA), United States of America (USA)	32.75	University of California Los Angeles (UCLA), United States of America (USA)	26.41	**59.16**	181
18	French National Centre for Scientific Research (CNRS), France	37.75	Grenoble Alpes University (UGA), France	21.23	**58.98**	240
19	Atomic Energy and Alternative Energies Commission (CEA), France	23.36	French National Centre for Scientific Research (CNRS), France	34.72	**58.08**	230
20	Johns Hopkins University (JHU), United States of America (USA)	17.98	National Aeronautics and Space Administration (NASA), United States of America (USA)	38.00	**55.98**	150
21	NERC National Oceanography Centre (NOC), United Kingdom (UK)	26.69	University of Southampton (Soton), United Kingdom (UK)	27.54	**54.24**	132
22	French National Centre for Scientific Research (CNRS), France	31.78	University of Lyon, France	21.65	**53.43**	179
23	France Ministry of Ecology, Sustainable Development and Energy, France	18.26	French National Centre for Scientific Research (CNRS), France	32.93	**51.19**	280
24	Lawrence Berkeley National Laboratory (LBNL), United States of America (USA)	24.00	University of California Berkeley (UC Berkeley), United States of America (USA)	24.02	**48.02**	77
25	National Aeronautics and Space Administration (NASA), United States of America (USA)	32.43	Science Systems and Applications, Inc. (SSAI), United States of America (USA)	15.41	**47.84**	85

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Rank	Institution	CS 2015-2017	Institution	CS 2015-2017	Bilateral CS 2015-2017	AC 2015-2017
26	École Normale Supérieure (ENS Paris), France	15.90	French National Centre for Scientific Research (CNRS), France	30.69	**46.59**	180
27	French National Centre for Scientific Research (CNRS), France	31.81	National Museum of Natural History (MNHN), France	13.96	**45.77**	184
28	National Aeronautics and Space Administration (NASA), United States of America (USA)	25.86	Southwest Research Institute (SwRI), United States of America (USA)	19.82	**45.69**	142
29	Centre National d'Etudes Spatiales (CNES), France	14.97	French National Centre for Scientific Research (CNRS), France	29.78	**44.75**	302
30	French National Centre for Scientific Research (CNRS), France	27.79	University of Toulouse, France	15.69	**43.48**	259
31	French National Centre for Scientific Research (CNRS), France	24.51	University of Lorraine (UL), France	18.76	**43.28**	116
32	Beijing Normal University (BNU), China	20.87	Tsinghua University (TH), China	22.26	**43.13**	129
33	Columbia University in the City of New York (CU), United States of America (USA)	24.96	National Aeronautics and Space Administration (NASA), United States of America (USA)	17.90	**42.86**	130
34	French National Centre for Scientific Research (CNRS), France	25.11	University of Versailles Saint-Quentin-en-Yvelines (UVSQ), France	16.31	**41.41**	226
35	French National Centre for Scientific Research (CNRS), France	26.24	University of Savoy, France	14.49	**40.73**	182
36	French National Centre for Scientific Research (CNRS), France	9.60	National Aeronautics and Space Administration (NASA), United States of America (USA)	30.27	**39.87**	197
37	Peking University (PKU), China	15.63	Tsinghua University (TH), China	24.08	**39.71**	135
38	Beijing Normal University (BNU), China	23.12	Peking University (PKU), China	16.57	**39.69**	134

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Rank	Institution	CS 2015-2017	Institution	CS 2015-2017	Bilateral CS 2015-2017	AC 2015-2017
39	National Aeronautics and Space Administration (NASA), United States of America (USA)	19.43	University of California Berkeley (UC Berkeley), United States of America (USA)	20.22	**39.65**	102
40	Chinese Academy of Sciences (CAS), China	19.56	Nanjing University (NJU), China	20.09	**39.65**	9

Example: lessons learnt from Italy

University-industry research collaborations in Italy (by Giovanni Abramo: University-industry research collaboration: a model to assess university capability [https://arxiv.org/ftp/arxiv/papers/1811/1811.01763.pdf])

The research collaborations for **the 2001-2003** by single university shows that of the 68 universities in Italy (considered in the survey) with research personnel in the hard sciences SDSs, 10 do not show any collaborations with the private sector. Half of the universities together produce only 13% of the total collaborations, while three universities (Bologna, Milan and Padua) produce 20% of the total, with over 100 collaborations each. These three universities represent 15% of the total research staff employed in Italian universities, for the 141 hard sciences SDSs under study. Five very small universities (Scuola Superiore Sant'Anna of Pisa, University of Reggio Calabria "Mediterranean", University of Benevento "Sannio", University of Teramo, University of Viterbo "Tuscia") bring up the rear for number of collaborations per university.

Only 2 of the top 10 universities for number of collaborations are located in southern Italy (Naples and Catania), while 3 are located in central Italy (Rome "La Sapienza", Pisa, Florence); the other 6 are located in the north. Aggregating the data by region we can get a better view of the correlation between university location and intensity of university collaboration with the private sector:

- more than half of the total of collaborations (55.9%) involve universities from northern Italy,
- with universities from central Italy following (26.5% of total collaborations)
- and the south having the smallest 9 share (15.8% of collaborations).

These empirical results show with certainty that:

i) the universities most active in collaborations with private enterprises are those situated in the northern Italy, which is historically more industrially developed than the remainder of the nation;

ii) number of collaborations is strongly correlated to size of the university.

Concluding remark:

The results support the hypothesis that size and geographic location of a university are the first determinants in its ability to establish collaborations with private research partners.

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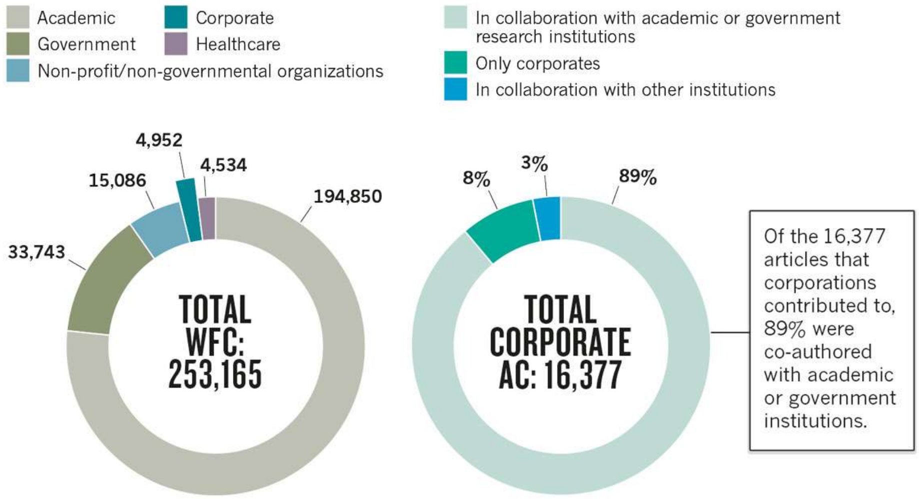
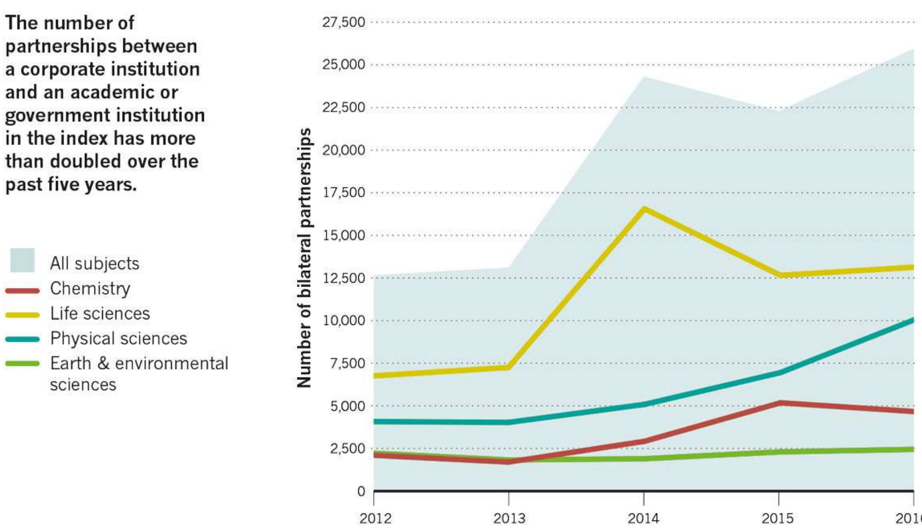
CORPORATE PARTNERS

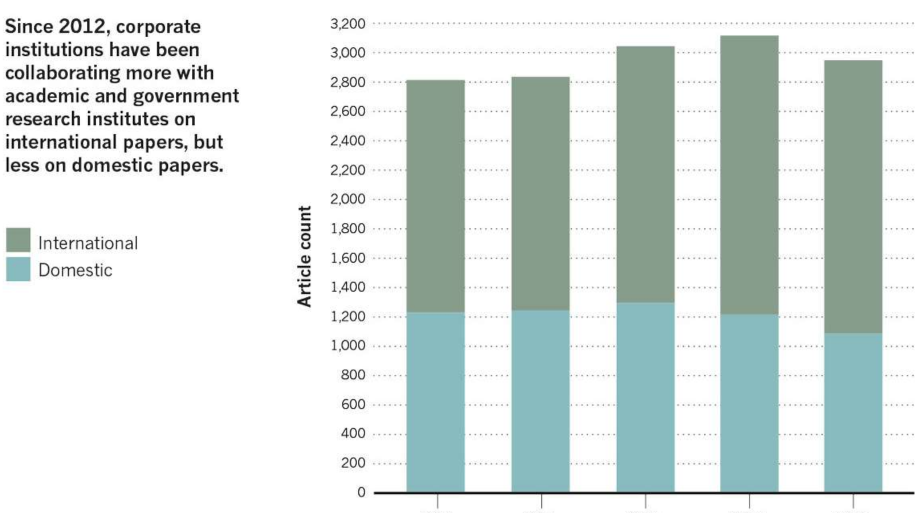
Corporations contributed only 2% to the authorship of papers in the Nature Index between 2012 and 2016, as measured by weighted fractional count (WFC). The majority of articles (AC) authored by corporations in the index were in collaboration with academic or government research institutes.



The number of partnerships between a corporate institution and an academic or government institution in the index has more than doubled over the past five years.



Since 2012, corporate institutions have been collaborating more with academic and government research institutes on international papers, but less on domestic papers.



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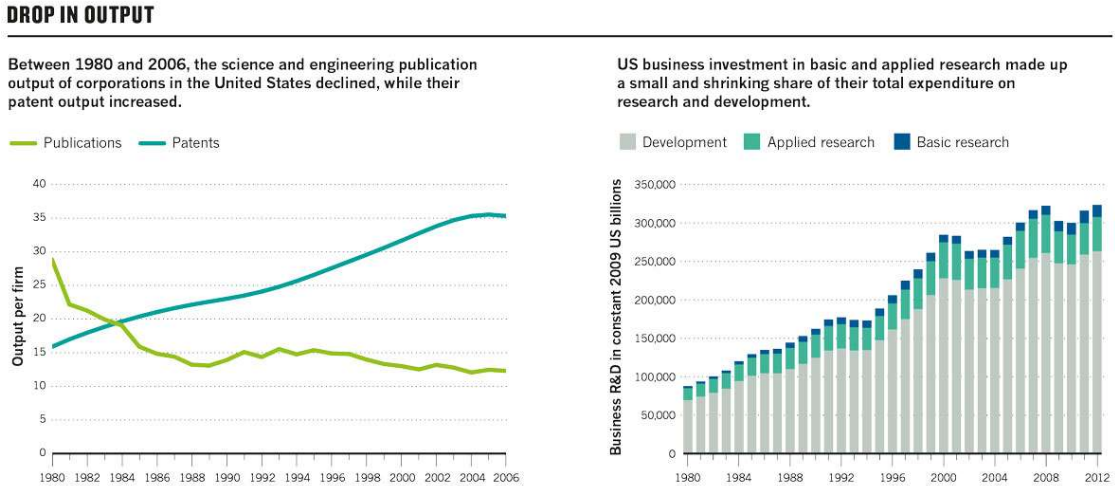

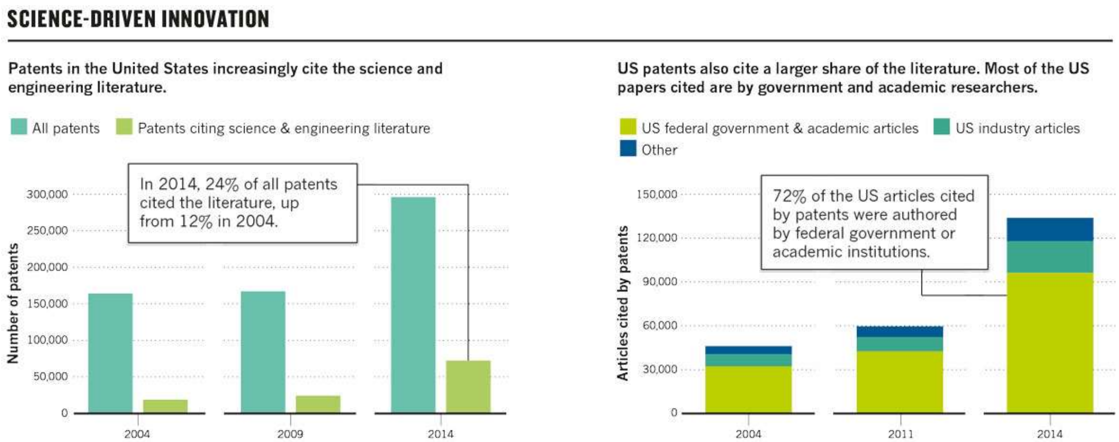

Each year, the Nature Index publishes tables based on counts of high-quality research outputs in the previous calendar year. Users please note:

1. The data behind the tables are based on a relatively small proportion of total research papers, they cover the natural sciences only and outputs are non-normalized (that is, they don’t reflect the size of the country or institution, or its overall research output).
2. The Nature Index is one indicator of institutional research performance. The metrics of Count and Share used to order Nature Index listings are based on an institution’s or country’s publication output in 82 natural-science journals, selected on reputation by an independent panel of leading scientists in their fields.
3. Nature Index recognizes that many other factors must be taken into account when considering research quality and institutional performance; Nature Index metrics alone should not be used to assess institutions or individuals.
4. Nature Index data and methods are transparent and available under a creative commons licence at **natureindex.com.**

The table shows the top 10 rising countries/territories in Earth and environmental sciences, ranked by change in adjusted Share* from 2015 to 2019. Also listed are the country's Share and Count in 2019, percentage change in adjusted Share from 2015 to 2019, and global rank in the 2020 annual tables.

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Table 6: Top 10 rising countries/territories in Earth and environmental sciences

Rank	Country / Territory	Share 2019	Count 2019	Change in Adjusted Share* 2015–2019	Change in Adjusted Share* 2015–2019 (%)	2020 Annual Tables Rank
1	China	1630.63	2331	**794.59**	95.0 %	2
2	Norway	98.84	261	**27.13**	37.8 %	13
3	South Korea	96.25	186	**11.77**	13.9 %	14
4	Czech Republic	29.55	86	**9.71**	48.9 %	27
5	Austria	39.53	150	**9.64**	32.3 %	22
6	Singapore	48.78	120	**8.39**	20.8 %	19
7	Brazil	37.20	104	**7.31**	24.5 %	23
8	Iran	8.30	23	**6.75**	437.1 %	36
9	Saudi Arabia	22.71	57	**6.16**	37.2 %	28
10	Colombia	9.08	33	**4.94**	119.2 %	35

Table 7: Top 40 Institutions in Europe in - Earth & environmental sciences

2019	Institution	Share 2018	Share 2019	Count 2019	Change in Adjusted Share 2018-2019 *
1	Helmholtz Association of German Research Centres, Germany	147.82	119.54	403	-21.6%
2	French National Centre for Scientific Research (CNRS), France	106.91	101.43	790	-8.0%
3	Swiss Federal Institute of Technology Zurich (ETH Zurich), Switzerland	92	90.13	236	-5.0%
4	University of Oxford, United Kingdom (UK)	36.71	42.52	158	12.3%
5	University of Cambridge, United Kingdom (UK)	42.15	36.89	140	-15.1%
6	Utrecht University (UU), Netherlands	35.17	36.67	130	1.1%
7	Max Planck Society, Germany	35.58	34.3	157	-6.6%
8	University of Leeds, United Kingdom (UK)	30.42	32.86	134	4.7%
9	Imperial College London (ICL), United Kingdom (UK)	32.94	32.24	121	-5.1%
10	Spanish National Research Council (CSIC), Spain	23.08	28.57	130	20.0%

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2019	Institution	Share 2018	Share 2019	Count 2019	Change in Adjusted Share 2018-2019 *
11	University of Bristol (UoB), United Kingdom (UK)	28.42	27.19	101	-7.3%
12	University of Oslo (UiO), Norway	20.98	26.44	90	22.2%
13	Leibniz Association, Germany	29.31	25.64	118	-15.2%
14	Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland	14.52	24.72	80	65.0%
15	Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Switzerland	24.4	24.2	74	-3.8%
16	University of Copenhagen (UCPH), Denmark	14.65	23.26	84	53.9%
17	Institute of Research for Development (IRD), France	21.35	21.75	363	-1.2%
18	University College London (UCL), United Kingdom (UK)	19.8	20.54	97	0.6%
19	University of Bergen (UIB), Norway	13.12	20.01	91	47.9%
20	Aarhus University (AU), Denmark	14.03	19.92	77	37.7%
21	University of Exeter, United Kingdom (UK)	21.44	19.16	71	-13.3%
22	Wageningen University & Research (WUR), Netherlands	20.73	18.83	70	-11.9%
23	University of Southampton (Soton), United Kingdom (UK)	18.17	18.72	86	-0.1%
24	Russian Academy of Sciences (RAS), Russia	17.86	18.72	78	1.6%
25	Delft University of Technology (TU Delft), Netherlands	21.56	17.88	61	-19.6%
26	National Institute of Geophysics and Volcanology (INGV), Italy	24.46	17.88	59	-29.1%
27	University of Reading, United Kingdom (UK)	10.8	17.54	77	57.6%
28	University of Liverpool, United Kingdom (UK)	12.7	17.27	54	31.9%
29	University of Bern (UniBE), Switzerland	15.8	17.2	71	5.5%
30	The University of Edinburgh, United Kingdom (UK)	19.97	16.84	67	-18.2%
31	Stockholm University, Sweden	14.81	16.73	79	9.5%
32	University of Bayreuth (UBT), Germany	14.75	16.52	39	8.6%
33	University of Paris, France	18.24	16.48	123	-12.4%
34	Technical University of Denmark (DTU), Denmark	21.47	14.97	60	-32.4%
35	Durham University, United Kingdom (UK)	13.65	14.68	74	4.3%

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2019	Institution	Share 2018	Share 2019	Count 2019	Change in Adjusted Share 2018-2019 *
36	University of Bremen (Uni Bremen), Germany	24.84	14.3	57	-44.2%
37	University of Münster (WWU), Germany	18.02	14.12	34	-24.1%
38	The University of Manchester (UoM), (UK)	18.7	14.02	57	-27.3%
39	NERC British Antarctic Survey (BAS), (UK)	10.85	13.63	47	21.8%
40	Ghent University (UGent), Belgium	16.61	13.39	42	-21.8%

Table 8: Top 10 Institutions in Poland in - Earth & environmental sciences

2019	Institution	Share 2018	Share 2019	Count 2019	Change in Adjusted Share 2018-2019 *
1	University of Warsaw (UW), Poland	2.5	2.65	6	2.7%
2	Polish Academy of Sciences (PAS), Poland	2.43	2.25	20	-10.2%
3	**University of Warmia and Mazury in Olsztyn (UWM), Poland**	–	1.29	3	N/A
4	University of Gdańsk (UG), Poland	1.35	1.22	2	-12.1%
5	University of Silesia (US), Poland	1.05	1.14	2	5.4%
6	Gdańsk University of Technology (GUT), Poland	1.17	0.83	1	-30.7%
7	Silesian University of Technology (SUT), Poland	0.05	0.8	1	1,451.3%
8	AGH University of Science and Technology (AGH UST), Poland	0.39	0.71	4	75.8%
9	Wrocław University of Environmental and Life Sciences, Poland	1.5	0.5	1	-67.7%
10	Medical University of Gdańsk (MUG), Poland	–	0.48	2	N/A

3.1.1 Financing CC and water projects in EU

Tackling the global CC and water challenges requires different forms of university-enterprise collaborations for maximising the types and number of partners involved. It allow for implementation of a larger range of types of actions from development of academic and applied research, innovative solutions, including collaboration with enterprises in projects, transfer of innovation to enterprises, addressing the science – policy interface, while having better access to research infrastructures and connections to implementation tools (financial, regulatory), demonstration and training.

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It provides the coverage of actions needed, the necessary long-term flexibility and the possibility for rapid integrating a larger range of activities devoted to the achievement of proposed targets, in close cooperation with ad-hoc stakeholders, who would be associated as partners for achieving specific proposed objectives and targets. If sufficiently flexible, it could allow a broader stakeholder engagement, by the use of different financial programmes (e.g. structural funds, regional specialization) and different collaboration agreement models designed explicitly for the different communities.

Europe boasts a wealth of experience in collaboration, innovation and the creation of proven solutions in addressing past and current CC and water challenges. The EU's has a leading role as a global actor by supporting regional and international cooperation, to address water as a path to achieving the UN SDGs. By placing the engagement of civil society at the centre of its action, the partnership expects to deliver true progress and leverage research and innovation to generate green growth. EUdelivers sustainable financing opportunities and create more impacts by accelerating the applicationof research results for policy implementation.

Table 9: Current EU partnership landscape following Horizon 2020 (EC, 2019)

	Public – Public Partnerships	Public – Private Partnerships	EIT instruments	Other Instruments
Currently active partnerships	Water JPI & its Eranet Cofunds (WaterWorks2014, 2015, 2017, AquaticPollutants) Articles 185 - PRIMA, BONUS	CPPP SPIRE (via Water Europe)	KIC Climate (water services component	EUREKA, COST Association

3.1.2 Example of project on University-Enterprise Collaboration (Erasmus +)

The Open Innovation Platform for University-Enterprise Collaboration is an collaborative educational project funded by the Erasmus+ Program of the European Union. OIPEC means to collect the best practices in European university-enterprise collaborations and transfer them to the Russian and Chinese beneficiaries.

The ultimate goals of the project are:

the creation of a platform that supports partnerships between universities and enterprises by providing easy access to universities' expertise for small and medium enterprises

the increase of the collaborative activities between universities and enterprises, with the aim of generating novel products/services or improving existing ones

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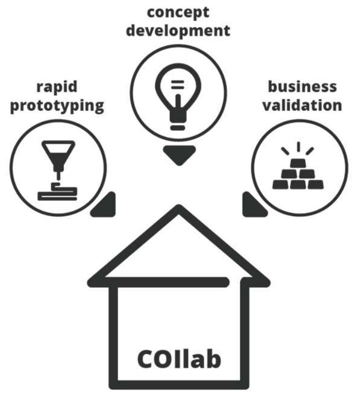

The platform consists of three main pillars:

1. arranging a training course and an executive program to improve competences of enterprises' staff in innovation management and new product/service development;

2. establishing and managing the "Collaborative Open Innovation laboratories" (COILabs), integrated facilities at partner universities with the following functional areas:

- Concept development area, centered on design thinking and raw prototyping
- Rapid prototyping area, providing both design and operational skills
- Entrepreneurial area, to support the development and validation of business concepts

3. sharing the expertise acquired among European, Russian and Chinese universities.

3.1.3 Best practices on CC water (source: Erasmus+)

Erasmus + collaboration projects on CC and water

Key word: 110 PROJECTS FOR KEYWORD: WATER CLIMATE CHANGE

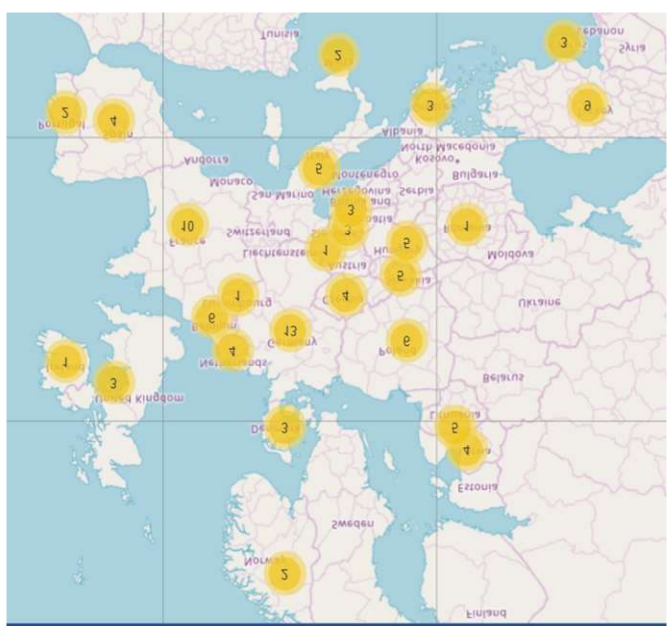

Figure 2: Number of Erasmus + projects related to "water and climate change " by European countries

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Table List of projects funded by ERASMUS+ FOR KEYWORD: WATER CLIMATE CHANGE. Category: Cooperation for innovation and the exchange of good practices Practical & reusable resources for the practitioners

[https://ec.europa.eu/programmes/erasmus-plus/projects_en#search/result/keyword=water%2520climate%2520change&categories[0]=Practical%2520%2526%2520reusable%2520resources%2520for%2520the%2520practitioners&categories[1]=Partnerships%2520and%2520cooperations]

Table 10: Projects founded by ERASMUS+ for KEYWORD: WATER CHANGE

	Project title **No**	Description	Type
1	**Water management and climate change** 2018-1-NL01-KA229-039027	Our most important objectives are raising awareness among our students about the challenges posed by climate change in the next few decades and teaching them the necessary skills to fully comprehend the issues and to think in terms of solutions. Dutch and French students of secondary schools aged 13/14 years, work closely together to get an idea of what climate change actually entails for their respective countries and the significance of water management. The students trips to Amsterdam (city on wooden poles), to the mills at Kinderdijk, to the dunes and beaches in both countries and to Mont Saint Michel (tidal island). This end product will be shared within the school (curriculum of other forms, profile papers) and outside the school (website, Facebook page school, vlog, school partnership). The information gathered within this project allows these students to have a better understanding of the problems concerning climate change, an inevitable issue for our teenagers' future. Example of an assignment	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **School Exchange Partnerships** Assignment Water and climate change in France and the Netherlands
2	**Citizen and**	The project aims to build and share the	Practical & reusable

	Public Expertise to Restore Water Cycles and Climate [2017-1-FR01-KA204-037471](2017-1-FR01-KA204-037471) https://www.waterways.world/cgcw/	knowledge of citizens in the field of common good water and climate risk. The project will establish a structured partnership between the French, Slovak and Great Britain citizens. It reinforces in the West and East of Europe the European network of citizens and public experts of the common good water initiated three years on sustainable development and social, economic and environmental water. It supports analyses and auditing systems of the national policies by the participating citizens, their pooling, local and European actions of training, reflections and exchanges. This project will lead to empowerment of citizens and local communities, encourage citizens and public powers to mobilize and act as professionals, citizens or elected representatives for a new paradigm of water and climate change. It will influence new water policies to prevent climate risk by engaging citizens of local communities, their communities and water managers together.	resources for the practitioners Results Restoring water to preserve our climate Manual Manual Obnova klimy Formation en ligne Eau et Climat – Fr Water and Climate on-line course - En Voda a klíma on-line kurz - Sl Référentiel Elu.es et Citoyen.nes
3	**Environmental Learning Illustrated** http://www.illustrated-climate.eu	"Environmental Learning Illustrated" developed an online interactive learning platform for participants to learn about the cause of climate change and potential solutions according to four main themes: energy and climate change, food, transport and consumption and waste. These four main themes also included related topics such as climate justice, water consumption and environmental refugees. The main result of this project was the creation of an e-learning platform that included an e-learning	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **Strategic Partnerships for adult education** Results **E-learning programme** E-learning module, online-

		programme with four modules, a graphic novel and 63 illustrations to convey the most important themes and make the learning easier and more fun for participants. The modules were: "Energy and Climate Change", "Food", "Transport" and "Lifestyle". The modules included subtopics such as "climate justice", "biodiversity" and "water conservation". The programme included an initial test for participants to understand their initial knowledge in the subject and a test at the end of each module for participants to understand their learning outcome. Each module also included practical actions that participants can take to reduce their impact on the environment such as saving energy and resources.	training, MOOC
4	**Adaptive learning environment for competence in economic and societal impacts of local weather, air quality and climate** **561975-EPP-1-2015-1-FI-EPPKA2-CBHE-JP** http://e-impact.net/	The project aims at building capacity at universities in Ukraine and Russia for improving the educational level of society in the area of local weather, air quality and climate change impacts on modern life towards more resilient social and economic development. Objectives:• To develop educational content for the learning environment on economic and societal impacts of local weather, air quality and climate targeted at university students, hydrometeorology professionals, and managers at weather-sensitive enterprises and public bodies• To develop hardware and software components of the learning environment and integrate them with educational content• To test the integrated learning environment in a university,	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **Capacity Building in higher education** Results Algorithm for building individual learning tracks Teaching aid “Methodological Recommendations on Practical Works for Students in Zoometeorology”, Monograph “Climatic Risks for Functioning of

		professional update, and sectoral settings• To design a commercialisation strategy for the adaptive integrated learning environment system. Impacts: • An adaptive learning environment will be developed allowing various types of learners to increase competence in the field of local weather, air quality and climate impacts on economy and society• The Ukrainian and Russian consortium universities will become in a position to commercialise the developed adaptive integrated learning environment and to further develop local weather, air quality and climate services on its basis for target groups rangring from whole sectors of economy to schools and private individuals. Such services will help building more resilient economic and social systems	Economic Sectors in Ukraine under the Climate Change", Teaching aid "Automated Monitoring and Assessment of Atmospheric Air Quality", Textbook "Methods for Applied Systems Analysis in Hydrometeorology", 701 p., 2017 Textbook "Practical training course in meteorology and climatology", 117 p., 2018 Textbook "Economic meteorology", 352 p., 2019 Teaching aid "School Weather Station", 15 p., 2019
5	**Promoting Green Skills through Games** **2017-1-IE01-KA201-025721** http://greenskillsgame.eu/	the Promoting Green Games project sought to develop an educational digital game & associated resources to innovate & support improvements in the area of sustainability education in schools, along with a toolkit for teachers to aid in the integration of this game in the classroom. The project achieved this primary goal by creating a game & associated resources to support the introduction, integration & support of sustainability (&/ or climate action) education & activity within schools for both students & for teachers. The developed project outputs have been subject to testing, feedback & re-development a number of times over the course of the project to align them as closely as possible to the needs of the target audience & education	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **Strategic Partnerships for school education** Results **Teaching & Learning Resources** **Digital Game** **Toolkit for Teachers Promoting Green Skills through Games - GBL Methodology**

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		sector & the main outputs (primarily the game & associated training material) are currently freely available on all major mobile formats & in public repositories such as the iOS store & Google play store. Feedback from pilot participants indicated an extremely positive opinion towards the use of the game for teaching & learning.	
6	**Green competencies: Europe safeguarding its natural heritage** **2018-1-PL01-KA202-050622** https://www.facebook.com/GENES-Green-competencies-Europe-safegurading-its-natural-heritage-293540064606568/	The project developed competency-based training that empowers the end-users with green skills and competencies about natural and cultural landscape preservation, identifying relevant concepts of "cultural landscape". The project involved stakeholders of different profiles and backgrounds from each country to support project activities, to disseminate and to realize follow-up activities. The primary goal was to allow organisations to develop and reinforce networks, increase their capacity to operate at transnational level, shared and confronted ideas and methods, exchanged the best practices. Results: - the development of entrepreneurial skills in planning cultural and environmental tourism, in the use of English language and ICT, Presentation of the best practice, the exchange of good practices in VET about preservation, management and valorisation of the local cultural and natural heritage. • Digital competencies improvement through the virtual maps creation. • Communication skills and competencies developing a new form of communication strategies on how to promote sustainable development and natural	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **Strategic Partnerships for vocational education and training** Results Power Point " Basic Knowledge About The Environment Power Point " Protection Of Biodiversity" Presentation " Dry Stones As Element Of Local Development In Mallorca Genes Map Catalogue E-Book " Natural And Cultural Heritage" - The Examples Of Good Practice Ppp Good Practice In Estonia Ppp Good Practice In France

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		heritage preservation, in particular, we would stimulate trainees to know own landscape characteristic and point to valorise. • Social and civic competencies promoting social cohesion and exchange between cultures. • Cultural expression improving awareness of European and national cultural landscape heritage. Impact: - increased EU cultural and natural heritage awareness - higher competencies about cultural landscape, national regulation and EU rules - increased knowledge of native culture - strong bonds with staff from partner organisations - digital skills development - English language skills development - experience of different teaching methods - social skills development - development of communication and intercultural skills (critical thinking, problem solving abilities, team working)	
7	LOVE EVERY DROP **2017-1-LT01-KA219-035229** http://www.drops.rapolioniogimnazija.lt/	The project provided an introduction to the importance of water locally and globally and raise awareness of how simple actions can substantially reduce water consumption. The focus was for students to carry out water audits in their schools and homes, as well as of local rivers and lakes. The aim was to make students understand the value of clean water in their local environment, to develop their knowledge about the importance of water by analyzing its role in the past, present and future, to enhance responsible attitudes and effective key competences towards the respect of water and our environment, to improve students' language and intercultural	Key Action: **Cooperation for innovation and the exchange of good practices** Action Type: **Strategic Partnerships for Schools Only** **Short films with a STOP MOTION technique about water** **Dissemination material** **The Importance of Water Conservation** **Love Every Drop**

		knowledge, to make the students from the target group and the community responsible about the problem of water management, to identify solutions concerning the responsible management of environmental problems in general and water in particular, to integrate students in the European society as active participants and potential future decision makers, to promote cooperation between young people from different European countries. Subjects and Problems: 1. water preservation. 2. providing European cooperation between students from different countries as active citizens in a common effort to resolve a general problem which affected Europe in the years to come. The major impact resided in the fact that the target group became aware of the necessity of a rational and sustained management of the water resources. In this way they became active participants in the process of environmental protection in general and water resources in particular. The development of the project determined the raising of awareness amongst the population when it comes to the responsible management of water. This led to the reduction of water consumption at home and at school, by rationally using the existing resources and by raising the quantity of recycled water.	**Others** **Water consumption measurements chart**

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3.2 University – enterprise collaborations – examples

Prepared by SEUSL team.

Table 11: University – enterprise collaborations – examples

Program	**Description**	Source
UN Climate Change and Universities Partnership Programme	The UN Climate Change and Universities Partnership Programme, coordinated by the NWP, is an opportunity for graduate students to work closely with local, national and regional partners to undertake a research project as a part of producing their master's thesis, while focusing on producing tangible outputs in response to the needs of targeted knowledge users in countries and subregions • Bridge adaptation knowledge gaps in various sub-regions, building on progress made to-date on the Lima Adaptation Knowledge Initiative; • Strengthen the research to practice interface by connecting graduate students with relevant international, regional, national and local institutions, who would provide technical support and guidance to the identified research project; • Produce relevant knowledge products to support the design and the subsequent implementation of the National Adaptation Plans (NAPs) in developing countries, particularly in least developed countries; • Produce useful knowledge products that feed into the UN Climate Change secretariat's key thematic areas (e.g. biodiversity and climate change adaptation, and oceans, coastal areas and ecosystems) to further support the knowledge needs of Parties.	https://unfccc.int/news/un-climate-change-works-with-universities-to-foster-resilience#:~:text=Launched%20at%20the%20recent%20United,remain%20a%20critical%20barrier%20to
Building Japan - UK Research Collaboration Climate Change,	The workshop enabled researchers to identify six themes in climate change to further develop research collaborations between the member universities. These themes are:	(https://www.britishcouncil.jp/en/programmes/higher-education/university-industry-

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Tokyo, 29-30 November 2018	• Low carbon societies and green infrastructure • Future risks and adaptation in floods and water shortage • Future risks and adaptation in food production and security • Managing future risks and building resilience in urban areas • Future risks and adaptation in ecosystems • Future risks and adaptation in human health	partnership/renkei/climate-change
Japan, Vietnam universities collaborate for climate change battle	Vietnam-Japan University and Ibaraki University in Japan have signed an MOU to offer a joint master's degree in climate change.	https://e.vnexpress.net/news/news/japan-vietnam-universities-collaborate-for-climate-change-battle-3812616.html
India-European commission partnership	Indian researchers, universities, research organizations and enterprises are able to team up with any European partners to participate in collaborative projects under Horizon 2020 and make the best use of Europe's scientific excellence.	https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020_localsupp_india_en.pdf
Government of Pakistan in collaborations with IUCN, International Union for Conservation and Natural Resources	This collaboration is based on the Climate Change and Vulnerability Challenges in Pakistan. This Collaboration organized a press brief on the sidelines of the Copenhagen Climate Change Conference. The focused ideas were, • increased variability of monsoon, • receding of Himalayan glacier's likely impact on Indus River system flows, • decreased capacity of water reservoirs • extreme events including floods and droughts • severe water stress, • face food insecurity due to decreasing agricultural production. • the degradation of ecosystems, biodiversity loss • saline water intrusion in the aquifers.	https://www.iucn.org/content/climate-change-and-vulnerability-challenges-pakistan

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The 2015 International Water & Climate Forum in San Diego, California.	IWA is partnering with water organizations from the U.S. and Australia for what will be a practical conversation among attendees and speakers to inform water utility climate action. ideas that will move communities and water systems to the next level in integrating climate resilience considerations in utility strategic planning and operations	https://iwa-network.org/how-communities-tackle-water-and-climate-realities/
World Water Camp	The International Water Association (IWA), VIA University College and Young Water Professionals Denmark (YWPDK) are collaborating to focus on climate change adaptation, wastewater and drinking water. Three main themes of the camp are, • Drinking water • Wastewater • Climate Adaption	https://en.via.dk/programmes/bachelor/climate-supply-engineering/watercamp
AWP and IWMI to collaborate on water management across the Asia-Pacific	IWMI and Australian Water Partnership (AWP) collaborate on programs related to the management of water for agriculture, integrated river basin planning and modelling, managing climate change impacts on water resources, and water management education.	https://waterpartnership.org.au/awp-and-iwmi-to-collaborate-across-the-asia-pacific/
The Australian Government UAE University have co-hosted a joint Conference on Water Resource Management and Sustainability for Arid Environments at the World	Conference sub-topics proposed by UAE University are: • Groundwater simulation and solute transport • Groundwater recharge and ASR systems • Innovative techniques for restoration and remediation of aquifers • Surface water harvesting • Mitigation of flood hazards in arid regions • Drainage systems in arid regions • Water treatment technologies • Water recycling and reuse of gray and treated wastewater • Improvements in desalination technology	https://waterpartnership.org.au/uae-university-seeks-partners-for-water-resource-management-and-sustainability-for-arid-environments-conference-at-dubai-expo/

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Exposition in Dubai	• Irrigation technology and water conservation in agriculture • Water-food-energy nexus • Renewable energy and water resources development • Applications of Geographic Information Systems (GIS) and Remote Sensing (RS) in water resources planning and management • Integrated management of water resources • Cloud seeding • Climate change and water resources in arid regions • Water policies and regulations • Risk management	
IWMI is contributing with University College London, Cardiff University, University of Sussex, and British Geological Survey & some African Universities.	A recent study sheds new light on the climate-groundwater relationship, finding that the 2015-2016 El Niño weather event replenished groundwater very differently in southern Africa and in East Africa just below the equator. Based on a combination of satellite and on-site data analysis, it is part of a growing body of research,	https://wle.cgiar.org/thrive/2019/08/19/it%E2%80%99s-time-look-underground-climate-resilience-sub-saharan-africa
ICAR-IWMI collaboration on managing floods and drought	Drought forecasting system and climate change (CC) impact evaluation would support decision-making, and in addition, strategies to manage and strengthen agriculture-water management, which could mitigate drought, risk	https://wle.cgiar.org/project/new-approaches-monitoring-and-managing-floods-and-droughts-india
The University of Amsterdam (UvA) in collaboration with IHE Delft,	The collaboration will focus on fresh in connection to food and climate change.	https://www.un-ihe.org/water-food-and-climate-conference

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VU Science for Sustainability Programme, the Amsterdam Business School, and Kennisactieprogramma Water.		
IHE Delft renew collaboration with Drainage Services Department of Hong Kong	To discuss the long-term climate resilience strategy for Hong Kong. As changing climate and economies are leading to increased levels of global uncertainty and risk, decision-makers across the world are reviewing their flood (disaster) risk management strategies. Singular, extreme events are becoming more common, while lead-in times needed for flood protection infrastructure remain long	https://www.un-ihe.org/news/ihe-delft-renew-collaboration-drainage-services-department-hong-kong
Furthering commitments to nature: Melanesian Spearhead Group and IUCN ink partnership	The collaboration has a lot of opportunities to offer in terms of strengthening our efforts in the areas of climate change, environment protection, conservation, and other sustainable development initiatives,	https://www.iucn.org/news/oceania/202004/furthering-commitments-nature-melanesian-spearhead-group-and-iucn-ink-partnership
MoU with UNFCCC establishes Adaptation Academy.	Partners in the Adaptation Academy are UNFCCC, IHE Delft, Asia Institute of Technology (AIT) and Oregon State University (OSU) with the Alliance for Global Water Adaptation (AGWA) playing a facilitation role. The purposed of this programme is to, • first develop and then offer a face-to-face 3–4-week training programme focused on imparting technical knowledge of the key components of the measurement and allow for the exchange of views, sharing of lessons learned and experiences, and internalizing and mainstreaming climate change activities.	https://www.un-ihe.org/news/mou-unfccc-establishes-adaptation-academy

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	• Next steps include the development of the course curriculum and thereafter the content of the modules	

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3.3 University – enterprise collaborations

Prepared by Munkhtsetseg.

Table 12: University – enterprise collaborations

	Institute, course	Objectives	Why is it best practice ?
1	UN climate change UN CC and Universities [partnership programme https://unfccc.int/news/un-climate-change-works-with-universities-to-foster-resilience	The UN Climate Change Secretariat is seeking to strengthen collaborations with universities and academic institutions, most especially those based in the global south, to: • Bridge adaptation knowledge gaps in various sub-regions, building on progress made to-date on the Lima Adaptation Knowledge Initiative; • Strengthen the research to practice interface by connecting graduate students with relevant international, regional, national and local institutions, who would provide technical support and guidance to the identified research project; • Produce relevant knowledge products to support the design and the subsequent implementation of the National Adaptation Plans (NAPs) in developing countries, particularly in least developed countries; • Produce useful knowledge products that feed into the UN Climate Change secretariat's key thematic areas (e.g. biodiversity and climate change	Students can work closely to local and regional partners to complete their thesis based on research project. - Collaboration with the research project

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	adaptation, and oceans, coastal areas and ecosystems) to further support the knowledge needs of Parties.

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4 Section 3: Quality assurance existing outside the universities

4.1 Quality assurance existing outside the universities

Prepared by Stanislawa Koronkiewicz, Slawomir Kalinowski, PL-UWM.

4.1.1 Polish legislation

Polish contemporary water legislation and management is following EU regulations:

1. Urban wastewater directive (1991)
2. Nitrates directive (1991)
3. Drinking water directive (1998)
4. Water framework directive (2000)
5. Groundwater directive (2006)
6. Bathing water directive (2006)
7. Drinking water directive (2006)
8. Floods directive (2007)
9. Environmental quality standards directive (2008)

Good practice – free and easy access to public information about legislation documents, government activity and realised projects concerning water management.

Example: project climate adapt.

4.1.2 Government activity

State water holding polish waters

2016 – establishing state water holding polish waters. It has been the main entity responsible for the national water management since january 1, 2018. Polish waters employs over 6,000 employees throughout poland, whose mission is to protect polish citizens from flood and drought, sustainable water management to protect our water resources and ensure good water quality for present and future generations. Polish waters exercise ownership rights in relation to waters owned by the state treasury, charge and collect fees for water services, and issue administrative decisions (water law approvals). Polish waters also acts as a regulatory body to protect residents against unjustified increases in the prices of water supply and sewage services. Directors of regional water management boards approve tariffs for collective water supply and collective sewage disposal, issue opinions on draft regulations for water supply and sewage disposal, and settle disputes between water and sewage companies and recipients of their services.

This holding has three main departments:

1. *Flood and drought protection department*

Tasks: planning, project preparation and investment implementation as well as maintenance and operation of hydrotechnical facilities. The division also handles matters related to the provision of water for agriculture as well as matters related to the monitoring of hydrological and meteorological situations and crisis situations.

2. *Water services department*

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Issues related to water users, primarily the issuance of water law permits, billing for water services, water management control, cooperation with various water users, incl. In matters relating to inland navigation, energy, industry, tourism and recreation.

3. *Water environment management department*

This division deals with matters related primarily to the implementation of eu directives, such as the so-called the water framework directive, the directive on the protection of marine waters, the directive on urban wastewater treatment or the nitrates directive. In addition, the division handles matters related to protected areas, such as natura 2000. This division also runs the water management it system.

4.1.3 Project klimada, adaptation to climate change

About the project (from the www page). The project “development and implementation of a strategic adaptation plan for the sectors and areas vulnerable to climate change” with the acronym klimada has been implemented in september 2011 and was completed by the end of 2013. The results of this project form the basis for the preparation of a strategic plan for adapting the country to climate change and was divided into two time scales – the period till 2030 and the period 2070-2100. The scope of work includes:

1. Assessment of expected climate changes in poland,
2. The assessment of climate change impacts and vulnerability of society and the economy to these changes,
3. Define the necessary of adaptation to the changes of climatic conditions of various economy and social life sectors and the estimation the necessary costs,
4. Mainstreaming the adaptation to climate change into socio-economic national policy,
5. Increasing the awareness of the different levels decision makers of risks related to climate impacts.

4.1.4 Enterprises activity

Water quality monitoring (tap water, surface water, groundwater, wastewater discharged from sewage treatment plants) is an important element in ensuring water quality and safety. Traditional physical and chemical methods as well as other unusual methods are used.

More about monitoring in attached file with presentation: water_monitoring.pptx (prepared for erasmus+ water harmony project.

An example of biomonitoring: application of clams to biomonitoring of water quality in warsaw waterworks (Poland).

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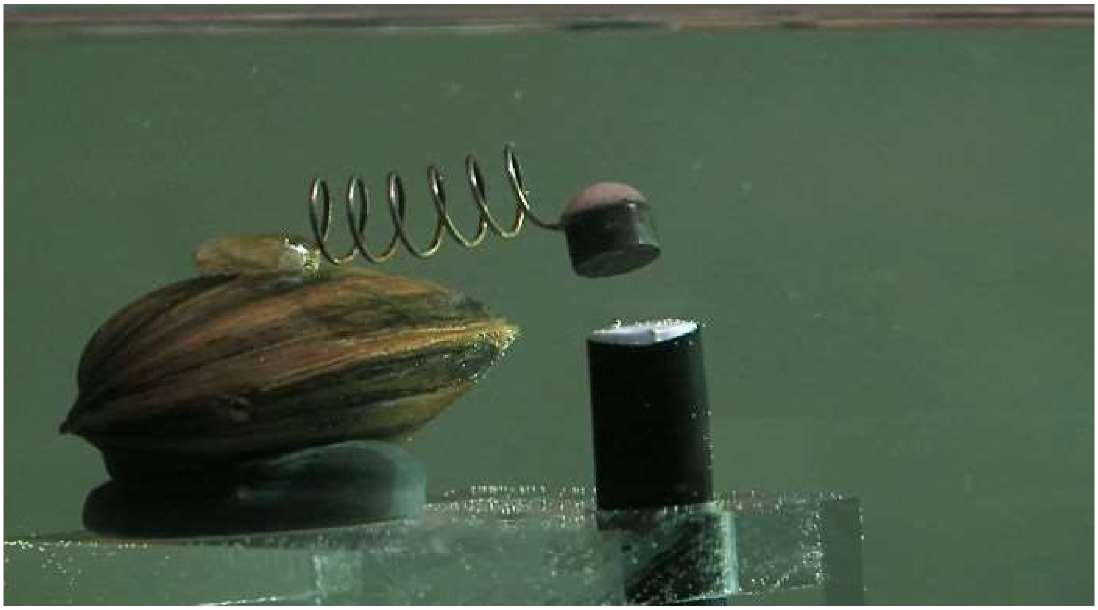

https://www.boredpanda.com/clams-measure-water-quality-poland-fat-kathy/?utm_source=google&utm_medium=organic&utm_campaign=organic

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4.2 Quality assurance – examples

Prepared by SEUSL team.

1. Assessment of the existing resourcing and quality assurance of current climate service by EU MACS European market for climate services.
   http://eu-macs.eu/wp-content/uploads/2017/07/EUMACS_D12_v2x.pdf

2. Quality Assurance for the Copernicus Climate Change Service
   https://climate.copernicus.eu/quality-assurance-copernicus-climate-change-service

3. The Intergovernmental Panel on Climate Change (IPCC) was established by the World Meteorological Organization and the United Nations Environment Programme for climate change assessments.
   https://www.ipcc.ch/

4. Verra's standards and programs
   https://verra.org/verra-standards-and-programs/
   Verra catalyzes measurable climate action and sustainable development outcomes by driving large-scale investment to activities that reduce emissions, improve livelihoods, and protect nature.

5. Quality Assurance, Control and Assessment, New found land Labrador Canada
   https://www.gov.nl.ca/eccm/waterres/rti/rtwq/qa/
   To ensure the effectiveness and reliability of the Real Time Water Quality (RTWQ) Monitoring Program, quality assurance, quality control and quality assessment procedures have been implemented.

6. Quality assurance framework development based on six new ECV data products to enhance user confidence for climate applications
   https://ec.europa.eu/jrc/en/publication/quality-assurance-framework-development-based-six-new-ecv-data-products-enhance-user-confidence

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