

RESOLUTION TO APPROVE MASTER OF PROFESSIONAL STUDIES IN CLIMATE LEADERSHIP IN COLLEGE OF NATURAL RESOURCES AND ENVIRONMENT

Summary Information – Master of Professional Studies in Climate Leadership

Master of Professional Studies in Climate Leadership (CIP Code: 03.0103)
College of Natural Resources and Environment
Requested initiation: Fall 2024

The establishment of the Master of Professional Studies in Climate Leadership will serve to provide a professional degree specifically designed for full-time working individuals interested in advancing or expanding their career in fields related to climate leadership. The proposed degree program will prepare individuals who can lead organizations and coalitions in the recognition of and response to the current and future threats that climate change poses. Students will learn how to interpret and communicate complex climate data and conduct comprehensive risk assessment to develop appropriate adaptation (e.g., seawalls, rainwater harvesting drought resistant crops) and mitigation (e.g., renewable energies, improving energy efficiency, carbon sequestration) strategies for various organizations, levels of government, and communities. The program will focus on developing climate professionals with the leadership skills to deconstruct conflicts (e.g., personal, political, cultural) concerning climate change and thus engage stakeholders and decision-makers in ways that create shared understanding and promote significant climate action. Graduates of the proposed program will be able to engage and lead stakeholders to create organizations and communities that are adaptable and resilient to the current climate changes and can develop solutions to stabilize the climate and ensure sustainability into the future.

RECOMMENDATION:

That the resolution to establish the Master of Professional Studies in Climate Leadership in the College of Natural Resources and Environment be approved.

June 6, 2023

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Description of the Proposed Program

Program Background

Virginia Polytechnic Institute and State University (Virginia Tech) requests approval for a Master of Professional Studies (M.P.S.) degree program in Climate Leadership to initiate in the fall of 2024. The proposed degree program will be located in the College of Natural Resources and Environment.

The M.P.S. degree program in Climate Leadership is a professional degree specifically designed for full-time working individuals interested in advancing or expanding their career in fields related to climate leadership. Throughout the curriculum, projects and case study topics are tailored to meet student's individual career goals. The program is offered part-time in a fully online format so students can continue working full-time while obtaining their degree.

The purpose of the proposed degree program is to prepare individuals who can lead organizations and coalitions in the recognition of and response to the current and future threats that climate change poses. Students will learn how to interpret and communicate complex climate data and conduct comprehensive risk assessment to develop appropriate adaptation (e.g., seawalls, rainwater harvesting drought resistant crops) and mitigation (e.g., renewable energies, improving energy efficiency, carbon sequestration) strategies for various organizations, levels of government, and communities. The program will focus on developing climate professionals with the leadership skills to deconstruct conflicts (e.g., personal, political, cultural) concerning climate change and thus engage stakeholders and decision-makers in ways that create shared understanding and promote significant climate action. Students will learn how to coordinate stakeholders in developing adaptation strategies to current climate change impacts and reduce greenhouse emissions to prevent future climate change. The core curriculum teaches students how to develop climate action plans that manage uncertainty and consider stakeholders' cultural values and ethics. Students will recognize the complex, multi-sectoral, and embedded nature of climate change and be able to communicate the importance of adaptation and mitigation to supporters and detractors alike. Graduates of the proposed program will be able to engage and lead stakeholders to create organizations and communities that are adaptable and resilient to the current climate changes and can develop solutions to stabilize the climate and ensure sustainability into the future.

In October of 2021, the World Health Organization declared climate change to be the biggest health threat facing humanity, citing, in part, its impacts on clean air, drinking water, food supply, and shelter.¹ The threat to human health and well-being is relevant from local to international levels.² However, addressing climate change is complex requiring the coordination of stakeholders representing local and national governments, business and industry, and the public. Furthermore, there is no agreed upon formula for engaging stakeholders in collaborative

¹ World Health Organization. (2021, October 30). *Climate change and health*. <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

² The AAAS Climate Science Panel. (n.d.). *What we know: The reality, risk, and response to climate change*. https://whatwewknow.aaas.org/wp-content/uploads/2014/07/whatwewknow_website.pdf

science-based climate action.³ Professionals must assess individual situations and collaborate with stakeholders to respond in ways that are ethical and just.⁴ The proposed M.P.S degree program will respond to these needs by preparing individuals with a foundational understanding of the causes of climate change, the competencies needed to engage critical stakeholders to create adaptation and mitigation plans that manage risk and promote sustainability, and the ability to communicate those plans in a way that promotes engagement and action.

The proposed M.P.S. degree program in Climate Leadership responds to vital societal needs and needs in the Commonwealth of Virginia. In Virginia, there is a need for collaborative adaptation strategies to respond to sea level rise and changing rainfall patterns already impacting fisheries, agriculture, and infrastructure; and coordinated mitigation plans to address coastal erosion and the impending effects of a warmer climate on agriculture.⁵ Graduates of the proposed degree program will be able to apply climate science and policy knowledge in the development of climate action strategies that engages key stakeholders to build sustainable organizations and resilient communities.

Institutional Mission

As stated in its mission, “Inspired by our land-grant identity and guided by our motto, *Ut Prosim* (That I May Serve), Virginia Tech is an inclusive community of knowledge, discovery, and creativity dedicated to improving the quality of life and the human condition within the Commonwealth of Virginia and throughout the world.”

The proposed new degree program aligns with the institution’s mission. The proposed program will prepare students to serve in leadership roles that are committed to helping communities respond to climate change and “[improve] the quality of life and the human condition.” The proposed program will provide climate science and policy “knowledge” and provide “discovery” opportunities for students to apply climate leadership skills “within the Commonwealth of Virginia and throughout the world.”

Delivery Format

The proposed program will be offered online only. All courses will only be offered online. Virginia Tech possesses the resources, support, and technology necessary for quality and rigorous online degree programs. Online courses and degree programs are supported by Technology-enhanced Learning and Online Strategies. The university’s primary learning management system is Canvas. Canvas is centrally supported by Technology- enhanced

³ Conde, C., Lonsdale, K., Nyong, A., & Aguilar, I. (2005). Engaging stakeholders in the adaptation process. In B. Lim & E. Spanger-Siegreid (Eds.), *Adaptation policy frameworks for climate change: Developing strategies, policies and measures* (pp. 47-66). Cambridge University Press.

⁴ Mahendra, A., King, R., Du, J., & Hart, M. (2019, October). *How to tackle climate change and inequality jointly in cities*. WRI. <https://wri.org/cities/research/publication/how-tackle-climate-change-and-inequality-jointly-cities>

⁵ Steinfeldt, T., Coil, C., & Plag, H. (n.d.) *Understanding Virginia’s vulnerability to climate change*. Georgetown Climate Center & Mitigation and Adaptation Research Institute at Old Dominion University. <https://www.georgetownclimate.org/files/report/understanding-virginias-vulnerability-to-climate-change.pdf>

Learning and Online Systems, which provides technical assistance, training, and system administration. Technology-enhanced Learning and Online Strategies also supports a portfolio of academic technology applications for use in online courses. Some examples include plagiarism and academic dishonesty prevention tools Turnitin and iThenticate, student engagement systems iClicker and TopHat, and video capture solutions Kaltura and Echo360. Videoconferencing tools used in synchronous courses (Zoom and Webex) are also supported by Technology-enhanced Learning and Online Strategies.

All faculty members providing online instruction may participate in professional development options (e.g., online instruction certification program, course development with instructional design staff, online course template) offered by Technology-enhanced Learning and Online Strategies. In addition to training on specific hardware and service applications (Zoom, WebEx, and/or Echo360 lecture capture), Technology-enhanced Learning and Online Strategies ensures that any instructional design, course development, and assessment needs are supported by the appropriate distance education teams.

Admission Criteria

Admission to the proposed M.P.S in Climate Security degree program will require additional requirements beyond those of the admissions policies of Virginia Tech. Applicants will be required to also meet the following requirements. In order to be admitted to the proposed Climate Leadership degree program, students must:

- Have a minimum of three years of professional work experience in an area related to climate, environmental, or sustainable science or policy.

Curriculum

The proposed M.P.S. in Climate Leadership degree program will require 30 credit hours. The curriculum includes 15 credit hours of core coursework and 15 credit hours of restricted elective coursework. The degree program is a non-thesis program only and does not offer a thesis option.

The core curriculum will provide students with a solid foundation in climate science and policy to be able to develop appropriate climate adaptation and mitigation strategies for various organizations and levels of government. Students will learn how to implement comprehensive risk assessment that incorporates uncertainties and is scientifically and ethically informed. The core curriculum instills fundamental knowledge and skills of leadership and communication strategies needed to engage critical stakeholders to develop substantial and wide-reaching transformations to create sustainable organizations that reduce greenhouse emissions and increase carbon sequestration.

All students are required to complete an experiential learning component as part of the NR 5114: Global Issues in Environmental Sustainability core course. Students who are unable to participate in the study abroad component of the Global Issues in Environmental Sustainability course (e.g., for reasons that include medical issues, physical limitations, active military service, and security clearances) will have the option to complete an 80 clock-hour, in-person learning experience in their primary location. During the first semester of the enrollment, the “Program

Lead” will assist all students in selecting an experiential learning pathway that best meets their needs. The course and the experiential learning component are designed to help students develop competencies needed to globally address climate change challenges. As part of the course, students situate their own professional work in a global context and practice collaborative project management and problem-solving skills that will be relevant to advancing their career in the climate change field. The course also helps students develop cultural competencies that will allow them to engage effectively and appropriately with culturally diverse stakeholders. The experiential learning component expands on what is learned throughout the course by allowing students to observe professionals addressing climate change in a real-world context that aligns with their personal or professional interests and schedule.

Students will work with a faculty advisor to select courses from a list of restricted electives to design a personalized program of study. Students will be able to choose courses that build upon their educational background and work experience as well as align with future career and/or academic goals.

Thirty-nine (39) new courses were developed for the proposed degree program. All new courses are denoted with an asterisk (*).

Program Requirements

Core Courses: 15 credit hours

- *CL 5004: Climate Science and Policy for Leaders (3 credits)
- *CL 5024: Climate Leadership (3 credits)
- *CL 5034: Risk and Rationality in Climate (3 credits)
- NR 5114: Global Issues in Environmental Sustainability (3 credits)
- NR 5544: Climate Adaptation and Mitigation Planning (3 credits)

Restricted Elective Courses: 15 credit hours

Students will select 15 credit hours from the following list of courses

Human Dimensions of Climate Change

- *CL 5104: Climate and the Human Experience (3 credits)
- *CL 5114: Environmental and Climate Decision Science in the Anthropocene (3 credits)
- *CL 5124: Climate One Health (3 credits)
- *ES 5774: Environmental Justice and Human Security (3 credits)
- *ES 5704: Climate Justice (3 credits)

Economics, Finance, and Corporate Risk and Resilience

- *CL 5204: Greenhouse Gas Accounting and Climate Solutions Design (3 credits)
- *CL 5214: Dynamic Integrated Climate-Economy Modeling (3 credits)
- *CL 5224: Financing Climate Adaptation and Mitigation (3 credits)
- *CL 5323: Energy, Economy, and Climate (3 credits)
- *ES 5564: Environmental Security, Finance, and Governance (3 credits)
- *ES 5574: Climate Risk and Corporate Resilience (3 credits)
- *ES 5794: Environmental Justice and Global Capitalism (3 credits)

Environmental Security

- *ES 5004: Environmental Security Fundamentals (3 credits)
- *ES 5104: Environmental Security Causes and Trends (3 credits)
- *ES 5114: ES Resolution Strategies (3 credits)
- *ES 5664: International Institutions and Agreements (3 credits)
- *ES 5674: Legal Frameworks for Environmental Security (3 credits)
- *ES 5694 Climate and Security Policy (3 credits)

Quantitative Tools and Analytics

- *CL 5304: Climate Models for Decision-making (3 credits)
- *CL 5314: Ecological Models for Climate Decision-making (3 credits)
- *CL 5334: Climate Information and Visualization Tools (3 credits)
- *ES 5034: Environmental Security Analytics (3 credits)
- *ES 5334: Geospatial Tools for Environmental Security (3 credits)
- *ES 5344: Modeling and Forecasting for Environmental Security (3 credits)
- *ES 5364: Strategic Environmental Assessment (3 credits)

Leadership and Policy

- *CL 5414: Leadership in Climate Advocacy and Coalition Building (3 credits)
- *CL 5424: Climate Communications: Politics, People, and Connection (3 credits)
- *CL 5444: Scenario Planning for Climate Change (3 credits)
- *ES 5684: Ethics, Governance, and Emergency Response to Environmental Security (3 credits)
- *ES 5694: Climate and Security Policy (3 credits)
- *NR 5534: Climate Change Policy (3 credits)

Military Operations and Implications

- *CL 5444: Scenario Planning for Climate Change (3 credits)
- *ES 5444: National Security Impacts of Climate (3 credits)
- *ES 5454: Environmental Implications of Military Operations (3 credits)
- *ES 5464: Civil/Military Disaster and Humanitarian Response (3 credits)
- *ES 5474: Military and Community Climate Security (3 credits)

Total: 30 credit hours

See Appendix A for a sample plan of study.

See Appendix B for course descriptions.

Faculty Resources

Virginia Tech's proposed M.P.S. in Climate Leadership degree program will be administered by the Dean's Office in the College of Natural Resources and Environment. The College has 82 full-time faculty members, across four departments. A total of five (5) full-time faculty members and three (3) adjunct faculty members will be dedicated to the proposed degree program. Three (3) existing full-time faculty from the college, two (2) new full-time faculty members, and three (3) existing adjunct faculty members will teach the Climate Leadership core requirements of the proposed degree program

Collectively, the three (3) existing full-time faculty members offer over 75 years of combined teaching and research experience in the field, and have published numerous papers and books, while also engaging with conferences and as strategic advisors to partner organizations.

Two (2) faculty members will be hired in the first year to teach core coursework in the proposed program.

Three (3) existing adjunct faculty members with the title of Professor of Practice will teach core coursework in the 4th year of the proposed degree program. The adjunct faculty members contributing to the core courses will be current, full-time working professionals in the climate field.

See Appendix C for faculty curriculum vitae (abbreviated).

Student Learning Assessment

Students who complete the proposed M.P.S. in Climate Leadership will possess the appropriate knowledge and skills needed to conduct comprehensive climate risk assessment and develop adaptation and mitigation strategies for various organizations and communities.

Student learning will be assessed throughout the proposed program via a variety of formative and summative mechanisms. Measures will include but are not limited to quizzes, group projects, group and individual papers and presentations, individual course assignments, course exams, case studies, and simulations.

Students will participate in an experiential learning component. The purpose of the experience is to help students develop the competencies needed to address global climate change challenges and understand specific country challenges within larger global trends. During the experience, students will work on projects local to the area. Students will be evaluated throughout the experience via group discussions, reflections, oral presentations, and a final group project.

Learning Outcomes

Students will be able to:

- Examine factors, including human factors, contributing to climate change using fundamental knowledge of earth, atmospheric, and ecological science.
- Analyze current and emerging climate policies designed to reduce climate vulnerabilities and influence climate change trajectory.
- Conduct comprehensive climate impact risk assessment using appropriate risk assessment strategies and incorporating scientific and ethical dimensions.
- Develop climate adaptation, mitigation, and resilience plans at varying geographic and temporal levels and including ethical, emotional, and cultural considerations.
- Communicate to government, businesses, and the public the hazards and risks posed by climate change.

- Apply leadership strategies to coordinate efforts and collaborate with stakeholders across programs and sectors to solve complex climate challenges.
- Interpret key demographic, economic, and environmental trends related to climate change in countries and regions around the world.
- Evaluate how local and global culture affects and shapes response to climate-related challenges.

Curriculum Map for M.P.S. in Climate Change

Learning Outcomes	Core Courses	Assessment Methods
Examine factors contributing to climate change, including human factors, using fundamental knowledge of earth, atmospheric, and ecological science.	CL 5004: Climate Science and Policy for Leaders CL 5034: Risk and Rationality of Climate Change NR 5544: Climate Adaptation and Mitigation Planning	Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, compose a report documenting the human and natural factors contributing to climate change and the possible effects on current and future climate trajectory), tests and written assignments.
Analyze current and emerging climate policies designed to reduce climate vulnerabilities and influence climate change trajectory.	CL 5004: Climate Science and Policy for Leaders	Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, examine the effectiveness of the Paris Agreement on reaching net zero emissions by the second half of the century), case studies, tests, and written assignments.
Conduct comprehensive climate impact risk assessment using appropriate risk assessment strategies and incorporating scientific and ethical dimensions.	CL 5034: Risk and Rationality of Climate Change	Formative: quizzes; written assignments, reflection, class discussion, data analysis Summative: Class assignments (for example, conduct a climate risk assessment, and develop a corresponding communication plan for a specific municipality such as Urbana, VA.), case studies,

		simulations, tests, and written assignments.
Develop climate adaptation, mitigation, and resilience plans at varying geographic and temporal levels and including ethical, emotional, and cultural considerations.	NR 5544: Climate Adaptation and Mitigation Planning	Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, develop a climate adaptation, mitigation, and resilience plan from a comprehensive risk assessment for a specific municipality, such as Tangier Island, VA, considering the cultural, ethical, and emotional state of the population), case studies, simulations, tests, and written assignments.
Apply leadership strategies to coordinate efforts and collaborate with stakeholders across programs and sectors to solve complex climate challenges.	CL 5024: Climate Leadership NR 5114: Global Issues in Environmental Sustainability NR 5544: Climate Adaptation and Mitigation Planning	Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, utilize simulation and role play to apply leadership strategies to reach consensus among residents, business owners, government officials, and scientists that is climate-adapted and sustainable for a contentious climate challenge, such as sea level rise in Matthews County, Middle Neck, VA), case studies, group projects, tests, and written assignments.

<p>Communicate to government, businesses, and the public the hazards and risks posed by climate change.</p>	<p>CL 5024: Climate Leadership CL 5034: Risk and Rationality of Climate Change NR 5114: Global Issues in Environmental Sustainability NR 5544: Climate Adaptation and Mitigation Planning</p>	<p>Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments, (for example, compose a press release that communicates the hazards and risks of a particular climate challenge, such as recurrent flooding in Old Town Alexandria, to local businesses and residents), group projects, simulations, tests, and written assignments.</p>
<p>Interpret key demographic, economic, and environmental trends related to climate change in countries and regions around the world.</p>	<p>CL 5024: Climate Leadership NR 5114: Global Issues in Environmental Sustainability</p>	<p>Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, analyze the key demographic, economic, and environmental trends relevant to solving water scarcity that is exacerbated by climate change in South Africa.), case studies, tests and written assignments.</p>
<p>Evaluate how local and global culture affects and shapes response to climate-related challenges.</p>	<p>CL 5024: Climate Leadership CL 5034: Risk and Rationality of Climate Change NR 5114: Global Issues in Environmental Sustainability NR 5544: Climate Adaptation and Mitigation Planning</p>	<p>Formative: quizzes; written assignments, reflection, class discussion Summative: Class assignments (for example, conduct a stakeholder cultural assessment to evaluate the impact of migration on villagers in Dhye, Nepal as a result of accelerated glacial melt that threatens water supply), case studies, decision-making simulations, tests, and written assignments.</p>

Employment Skills

Graduate of the proposed M.P.S. in Climate Leadership degree program will be able to:

- Interpret global trends in climate change evidenced in specific situations in the United States and countries around the world.
- Develop adaptation and mitigation plans to reduce climate vulnerabilities and influence climate trajectories.
- Evaluate carbon management and policies and compare the role of different sectors in society for their contributions to greenhouse gas emissions.
- Evaluate the effectiveness of current law, policy, and international agreements in facilitating climate responses.
- Analyze data to identify hazards and risks posed by climate change to inform and guide stakeholders.
- Contrast differences in risk perceptions across different groups of people and design methods to incorporate diversity, equity, and inclusion in climate-related risk governance.
- Create alignment between organizational values and climate-related sustainability goals.

Relation to Existing VT Programs

Virginia Tech offers one degree program that is related to the proposed program: the Master of Natural Resources (M.N.R.) in Natural Resources. The M.N.R. in Natural Resources degree program focuses on the interconnection of social science and natural resource management with the purpose of preparing students for work in the broad field of natural resources. It aims to equip students with an understanding of the social, economic, and environmental aspects of social-environmental problems such as those related to water scarcity, food security, poverty, urbanization, material flows, and biodiversity. Students learn social science theory and develop system thinking competencies that prove useful in intervening in and solving these problems. Students also develop the communication skills needed to engage with content experts and stakeholders across a variety of disciplines. Graduates are prepared for a wide variety of jobs in the public and private sectors such as those related to resource management and conservation; urban and environmental planning; and environmental, corporate, and social governance.

The proposed Master of Professional Studies (M.P.S.) in Climate Leadership will provide students with a foundation in climate science and policy that is necessary to help governments, corporations, non-governmental organizations, and communities reduce their vulnerability to climate change and decrease their carbon emissions. Students will learn how to assess the risks posed by climate change and how to communicate and use that information in the development of climate adaptation and mitigation plans. Coursework will also help students develop the leadership strategies and skills needed to coordinate and facilitate efforts to address climate change across programmatic missions and sectors. Students will be prepared for leadership roles in the public and private sector as climate officers, managers, and consultants.

The two programs share only one required course: NR 5114: Global Issues in Environmental Sustainability. This course is designed to help students develop competencies needed to globally address climate sustainability challenges, including climate change. While the foundational content of the course is the same, the problems students will address in their projects and

deliverables will be different depending on which program they are enrolled. In the M.N.R. in Natural Resources program, the students explore social-ecological challenges of development, such as urbanization or water scarcity. Whereas students in the M.P.S. in Climate Leadership will focus on existing and potential mitigation and adaptation strategies to respond to the impacts of climate change such as sea level rise and increased risk of natural disasters (e.g., hurricanes, fires).

Justification for the Proposed Program

Response to Current Needs (Specific Demand)

Climate change adversely impacts air quality, drinking water, food supply, and shelter around the globe.⁶ These impacts threaten human health and well-being and have consequences that are realized locally, regionally, and internationally.⁷ However, despite a warning by President Johnson's Science Advisory Committee in 1965 of the threats of abated climate change,⁸ little progress to take significant action has been made.⁹ This is because addressing climate change is incredibly complex. The factors contributing to climate change are multifaceted, both natural, but primarily, man-made, with the latter coming from a number of human activities (e.g., agriculture, transportation, industry, land use and forestry, electric power) that produce greenhouse gases that accumulate in the atmosphere.¹⁰ Mitigating greenhouse gas emissions and adapting to the climate change that has and will continue to occur requires the engagement and collaboration of all levels of governments, business and industry, including those that produce greenhouse gases, and the public.¹¹ Unfortunately, many of these stakeholders lack the knowledge or competencies to respond to climate change impacts or their expertise and skills span only one field (e.g., environmental science, climate policy, computer modeling, etc.).¹² As a result, there is a current need for professionals with knowledge of climate science and policy, who know how to interpret climate data, how to engage stakeholders in adaptation and

⁶ World Health Organization. (2021, October 30). *Climate change and health*. <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>

⁷ The AAAS Climate Science Panel. (n.d.). *What we know: The reality, risk, and response to climate change*. https://whatwewknow.aaas.org/wp-content/uploads/2014/07/whatwewknow_website.pdf

⁸ Climate Files. (2023). 1965 President's science advisory committee report on atmospheric carbon dioxide. <https://www.climatefiles.com/climate-change-evidence/presidents-report-atmospher-carbon-dioxide/>

⁹ Stoddard, I., Anderson, K., Capstick, S., Carton, W., Depledge, J., Facer, K., Gough, C., Hache, F., Hoolohan, C., Hultman, M., Hallstrom, N., Karth, S., Klinsky, S., Kuchler, M., Lovbran, E., Nasiritousi, N., Newell, P., Peters, G., Sokona, Y.,... Williams, M. (2021). Three decades of climate mitigation: Why haven't we bent the global emissions curve? *Annual Review of Environment and Resources*, 46(1), 653–689. <https://doi.org/10.1146/annurev-environ-012220-011104>

¹⁰ NASA. (n.d.). *The causes of climate change*. <https://climate.nasa.gov/causes/>

¹¹ Stoddard, I., Anderson, K., Capstick, S., Carton, W., Depledge, J., Facer, K., Gough, C., Hache, F., Hoolohan, C., Hultman, M., Hallstrom, N., Karth, S., Klinsky, S., Kuchler, M., Lovbran, E., Nasiritousi, N., Newell, P., Peters, G., Sokona, Y.,... Williams, M. (2021). Three decades of climate mitigation: Why haven't we bent the global emissions curve? *Annual Review of Environment and Resources*, 46(1), 653–689. <https://doi.org/10.1146/annurev-environ-012220-011104>

¹² Cloutier, G., Joerin, F., Dubois, C., Labarthe, M., Legay, C., & Viens, D. (2015). Planning adaptation based on local actors' knowledge and participation: a climate governance experiment. *Climate Policy*, 15:4, 458-474. <http://dx.doi.org/10.1080/14693062.2014.937388>

mitigation actions, and communicate information about climate change in an ethically and culturally sensitive way to a variety of audiences.¹³

The proposed M.P.S. in Climate Leadership degree program will respond to current needs by preparing, at its core, a person who has a foundational understanding of the causes of climate change, the competencies needed to engage critical stakeholders to create adaptation and mitigation plans that manage risk and promote sustainability, and the ability to communicate those plans in a way that promotes engagement and action. The current needs in Virginia and nationally include: 1) demand for professionals with foundational knowledge and skills in climate science who can evaluate climate policy and interpret and communicate climate data to develop adaptation and mitigation strategies for local, national, and international governments and organizations, and 2) demand for climate leaders with knowledge and skills to engage and lead organizations to create sustainability through clear communication and climate informed decision making.

Climate Change Impacts

From a scientific perspective, climate change is essentially about the production of greenhouse gases, mainly carbon dioxide, released into the atmosphere.¹⁴ Since the Industrial Revolution, industrial activities have been releasing increasing amounts of greenhouse gases far greater than the amount that can be captured by the natural carbon cycle.¹⁵ This leads to an increase in the concentration of carbon in the atmosphere, which in turn enhances the greenhouse effect, retaining a larger share of the solar energy received on Earth.¹⁶ To mitigate climate change, humans need to significantly reduce the amount of greenhouse gases released and, if possible, draw down the amount of greenhouse gas in the atmosphere; a complex challenge.¹⁷ Once greenhouse gases are released into the atmosphere, they become a global problem, irrespective of the country or sector the emissions. Furthermore, all countries around the world, regardless of their size or wealth, have limited resources they can use to reduce carbon emissions, let alone reduce atmospheric carbon levels, and one or a few countries alone cannot solve this problem¹⁸.

There are two broad categories of responses necessary to address climate change: adaptation and mitigation.¹⁹ Although climate adaptation strategies are responsive to the climate change that is expected, climate mitigation is necessary to stabilize the climate long term and knowledge of

¹³ Behl, Mona. (2016, November 9). Ethical Communication to Guide Climate Policy Decision in the Arctic. *Polar Record*. <https://www.cambridge.org/core/journals/polar-record/article/ethical-communication-to-guide-climate-policy-decisions-in-the-arctic/A582D7599D103A8B842A6C8EB25A46DE>

¹⁴ Environmental Protection Agency. (n.d.). *Causes of climate change*. <https://www.epa.gov/climatechange-science/causes-climate-change#:~:text=Since%20the%20Industrial%20Revolution%2C%20human,also%20affect%20the%20earth's%20climate>

¹⁵ European Environment Agency. (2018, September 17). *Understanding and acting on the complexity of climate change*. <https://www.eea.europa.eu/articles/understanding-and-acting-on-the-complexity>

¹⁶ European Environment Agency. (2018, September 17). *Understanding and acting on the complexity of climate change*. <https://www.eea.europa.eu/articles/understanding-and-acting-on-the-complexity>

¹⁷ Ibid.

¹⁸ European Environment Agency. (2018, September 17). *Understanding and acting on the complexity of climate change*. <https://www.eea.europa.eu/articles/understanding-and-acting-on-the-complexity>

¹⁹ NASA. (2022, August 29). *Responding to climate change*. <https://climate.nasa.gov/solutions/adaptation-mitigation/>

both adaptation and mitigation are key to tackling climate challenge.²⁰ Adaptation is the process of adjustment to actual or expected climate and its effects.²¹ Because the temperature of the earth has already warmed, it is critical to assess current and future vulnerabilities of cities, infrastructure, supply chains, and environment so communities can take appropriate action to reduce those vulnerabilities. For example, in Virginia, sea-level rise, heat waves, and changing rainfall patterns are already impacting fisheries, agriculture, and forestry industries and putting the food and water supply, and health and safety of the community at risk.²² In the western U.S., drought, intense heat waves, and wildfires threaten food supply chains, drinking water, infrastructure, and human health.²³ In the Northern Triangle of Central America, severe food and water insecurity and impacts from floods, hurricanes, and landslides are causing pronounced human migration.²⁴ Adaptation must occur now in order to protect human health and well-being from current and future impacts of climate change.

Mitigation is defined as “human intervention to reduce the sources or enhance the sinks of greenhouse gases.”²⁵ These include replacing green-house gas emitting fuels with renewable energy, retrofitting older buildings to increase their energy efficiency, or adopting agricultural practices that store atmospheric carbon in soils. These are actions that we must take now to avoid and reduce greenhouse gas emissions that will contribute to additional climate change in the future. “Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation and mitigation to other societal objectives.”²⁶ The proposed degree program will provide students with the knowledge and skills to develop both adaptation and mitigation strategies at local and national scales.

Successful adaptation and mitigation will require governments and organizations to coordinate actions that prepare for and minimize the impact to human health and well-being while also addressing the root causes of the problem, greenhouse gas emissions.²⁷ In Virginia, the Department of Defense, the U.S. Navy, and other federal, state, and municipal agencies are working together to improve resilience to climate change impacts in the Hampton Roads region,

²⁰ Qi, J. & Terton, A. (2022). Addressing climate change through integrated responses: Linking adaptation and mitigation. International Institute for Sustainable Development. <https://www.iisd.org/system/files/2022-03/climate-change-linking-adaptation-mitigation.pdf>

²¹ NASA. (2022, August 29). *Responding to climate change*. <https://climate.nasa.gov/solutions/adaptation-mitigation/>

²² Steinfeldt, T., Coil, C., & Plag, H. (n.d.) *Understanding Virginia's vulnerability to climate change*. Georgetown Climate Center & Mitigation and Adaptation Research Institute at Old Dominion University. <https://www.georgetownclimate.org/files/report/understanding-virginias-vulnerability-to-climate-change.pdf>

²³ Union of Concerned Scientists. (2018, June 25). *Global warming in the western United States*. <https://www.ucsusa.org/resources/global-warming-western-united-states>

²⁴ Sigelmann, L. (2019). *The hidden driver: Climate change and migration in Central America's Northern Triangle*. *American Security Project*. <https://www.americansecurityproject.org/wp-content/uploads/2019/09/Ref-0229-Climate-Change-Migration-Northern-Triangle.pdf>

²⁵ The Climate Reality Project. (2019, November 7). *Climate adaptation vs. mitigation: What's the difference and why does it matter?* <https://www.climateRealityproject.org/blog/climate-adaptation-vs-mitigation-why-does-it-matter>

²⁶ Intergovernmental Panel on Climate Change (2022). *Climate change 2013 synthesis report: Fifth assessment report*. https://ar5-syr.ipcc.ch/topic_adaptation.php

²⁷ Chidambaram, R. & Khanna, P. (2022, August 1). *It's time to invest in climate adaptation*. Harvard Business Review. <https://hbr.org/2022/08/its-time-to-invest-in-climate-adaptation>

home to the largest U.S. Naval facility in the world, and threatened by sea level rise and more frequent and intense hurricanes.²⁸ This requires a collaborative effort that must include individuals with an understanding of climate change science; mitigation and adaptation planning; risk assessment; and collaboration and communication. The proposed program will provide students with the knowledge and skills to analyze and interpret data to identify and assess climate risk and to recognize and manage uncertainty in risk responses. Students will also learn how to consider stakeholders' ethics, values, and emotions in climate-related risk management and decision making.

The Need for Leadership

Corporations and the public sector have been promoting climate action and sustainability for several decades, but actions have been primarily speculative and framed in a distant future.²⁹ We are now in an era of such tangible and corporeal climate change that the impacts are no longer in the distant future, they are currently exacerbating all sustainability challenges. Climate change poses the most significant challenges to sustainability, as it exacerbates all sustainability challenges.³⁰ "Shifting biodiversity and shifting climate conditions affect our food sources, rising sea levels, the way we design our cities, and more."³¹ Many sustainability challenges both affect and are affected by the climate: for instance, a warming Earth will make it harder to grow enough food, and the activities associated with food production contribute to climate change.³² The 2014 Quadrennial Defense Review describes climate change as "threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions – conditions that can enable terrorist activity and other forms of violence."³³ Hurricanes, tornadoes, flooding, heatwaves, and wildfires, exacerbated by climate change, increasingly threaten supply chains, impacting inventory, revenue, and availability and costs of goods.³⁴ To address these types of complex, globally dispersed challenges it is important to have "experts onboard who can critically interpret incoming climate data and provide actionable guidance in real time" and executives will need to intensify efforts to assess and mitigate risks.³⁵

²⁸ Lopez, T. (2021, July 21). *DoD, Navy confront climate change challenges in Southern Virginia*. U.S. Department of Defense. <https://www.defense.gov/News/News-Stories/Article/Article/2703096/dod-navy-confront-climate-change-challenges-in-southern-virginia/>

²⁹ Markman, Art. (2018, October 11). *Why people aren't motivated to address climate change*. Harvard Business Review. <https://hbr.org/2018/10/why-people-arent-motivated-to-address-climate-change>

³⁰ Lee, Hoesung. (2019, July 16). *Climate action and sustainable development are inseparable*. International Institute for Sustainable Development. <https://sdg.iisd.org/commentary/guest-articles/climate-action-and-sustainable-development-are-inseparable/>

³¹ Tso, K. (2021, March 30). *What is "sustainability"? Is it the same thing as taking action on climate change?* MIT Climate Portal. <https://climate.mit.edu/ask-mit/what-sustainability-it-same-thing-taking-action-climate-change#:~:text=A%20warming%20planet%20is%20a,sustainable%20solutions%20to%20other%20problems>

³² Sixt G. (2020, September 14). *Food systems and agriculture*. MIT Climate Portal. <https://climate.mit.edu/explainers/food-systems-and-agriculture>

³³ U.S. Department of Defense. (2014). *Quadrennial defense review*. <https://history.defense.gov/Portals/70/Documents/quadrennial/QDR2014.pdf?ver=tXH94SVvSQLVw-ENZ-a2pQ%3d%3d>

³⁴ Swanson, A. & Bradsher, K. (2022, September 8). *Climate change could worsen supply chain turmoil*. *The New York Times*. <https://www.nytimes.com/2022/09/08/business/economy/climate-change-supply-chain.html>

³⁵ Boyson, S., Gerst, M., Guntuka, L., Linton, T., Muraski, G., Vakil, B., & Vakil, S. (2022, May 2). *How exposed is your supply chain to climate risks?* Harvard Business Review. <https://hbr.org/2022/05/how-exposed-is-your-supply-chain-to-climate-risks>

Current climate change is unprecedented in human history and global temperatures will soon be greater than any human has ever experienced.³⁶ What's more, it is unclear how fast and how much the climate will continue to change. As a result, there are plenty of irreducible uncertainties in the field of climate change.³⁷ These uncertainties can be planned for, but they are often unframeable in traditional probabilistic risk management approaches. More importantly, humans have difficulty thinking about distant risks that are hard to characterize numerically and evoke dread and despair.³⁸ What often results are dismissal or hyperbolic discounting of the threat climate change poses paired with inaction or inadequate action that doesn't align with the magnitude of the threat.³⁹ Furthermore, climate policy is complex, rapidly evolving, and lacks guidance regarding implementation, which leads to further inaction. Individuals are needed who can clearly interpret and communicate the current and future risks of climate change, along with the uncertainties, that doesn't lead to withdrawal. Individuals that can and will bring stakeholders together to develop substantial and wide-reaching transformations to create sustainable organizations that reduce greenhouse emissions and increase carbon sequestration. The proposed degree program will teach students how to interpret and communicate climate data, analyses, and policy in a way that is clear and objective and promotes stakeholder engagement around solutions to create sustainable organizations.

Employment Demand

As the largest single employer in the U.S., the federal government and associated agencies are inventorying, cataloging, and developing climate education and training programs to help build sufficient climate literacy and climate leadership capability in the current workforce.⁴⁰ They have already recognized that the need to hire incoming professionals with these skills as soon as universities and the private sector are able to produce professionals with such capacities. In recognition of this need, the Obama Administration issued section 11 of Executive Order 13693 that called for training senior executives in climate and sustainability and also called for a climate and sustainability job series.⁴¹ The proposed program will respond directly to this need by training individuals in leadership strategies to develop and lead sustainable organizations. Students will learn how to develop immediate and long-term responses to climate change that can ensure sustainability and help organizations anticipate existing but unrecognized climate vulnerabilities in the business or work section.

³⁶ Lieberman, Benjamin David, and Elizabeth Gordon. (2022). *Climate change in human history: Prehistory to the present*. Bloomsbury Academic. <https://ia803402.us.archive.org/2/items/climate-change-and-air-pollution/Climate%20Change%20in%20Human%20History%20Prehistory%20to%20the%20Present.pdf>

³⁷ Markman, Art. (2018, October 11). *Why people aren't motivated to address climate change*. Harvard Business Review. <https://hbr.org/2018/10/why-people-arent-motivated-to-address-climate-change>

³⁸ Ibid.

³⁹ Nordhaus, W. (2019). Climate change: The ultimate challenge for economics. *American Economic Review*, 109(6), 1991-2014. <https://doi.org/10.1257/aer.109.6.1991>

⁴⁰ U.S. Office of Personnel Management. (2021). *Climate action plan*. <https://www.sustainability.gov/pdfs/opm-2021-cap.pdf>

⁴¹ Executive Order 13693 (2015, March 19). *Planning for federal sustainability in the next decade*. <https://www.govinfo.gov/content/pkg/DCPD-201500184/pdf/DCPD-201500184.pdf>

Graduates of the proposed M.P.S. degree in Climate Leadership will be qualified to work as a climate leader or officer employed with government agencies, non-profit organizations, and in the private sector. The U.S. Bureau of Labor Statistics (BLS) does not currently have a separate category for climate leadership. Nonetheless, other relevant employment categories in the BLS are appropriate for graduates from this degree program and show substantial positive projections over the next ten years. The most relevant employment categories include environmental scientists and specialists, natural science managers, emergency management directors, and conservation scientists. Given the current and future impacts of climate change, governments, non-profit organizations, and the private sector will face increasing need to prepare for how climate change impacts their ability to achieve their mission and generate profits. Graduates of the proposed M.P.S. in Climate Leadership will be prepared to lead engagement with environmental scientists and specialists, natural scientists, emergency management directors, and conservation scientists, among others, to help these organizations identify vulnerabilities and implement solutions that ensure long term sustainability.

According to the Bureau of Labor Statistics, overall “employment of environmental scientists and specialists is projected to grow 5 percent from 2021 to 2031, as fast as the average for all occupations”.⁴² Heightened public interest in the hazards facing the environment and increasing demand placed on the environment by population growth, are projected to spur demand for scientists and specialists.⁴³ While environmental scientists and specialists typically need a bachelor’s degree in environmental science or a related natural resource field, the BLS notes “a master’s degree may be needed for advancement.”⁴⁴ The proposed M.P.S. in Climate Leadership degree program will target working professionals and is intended to help them progress in their careers by providing advanced knowledge related to climate mitigation and adaptation.

Employment of natural sciences managers is projected to grow 6 percent from 2021 to 2031 as fast as the average for all occupations.⁴⁵ According to the Bureau of Labor Statistics, “Natural sciences managers supervise the work of scientists, including chemists, physicists, and biologists.”⁴⁶ Job growth for managers is projected to increase at roughly the same rate as those for life scientists and physical scientists. Businesses and government hiring more life and physical scientists also may need to hire more natural sciences managers to oversee them, although managers often are flexible in the number of workers they supervise.⁴⁷

According to the Bureau of Labor Statistics, “employment of emergency management directors is projected to grow 6 percent from 2021 to 2031 about as fast as the average for all occupations.”⁴⁸ Emergency management directors prepare plans and procedures for responding

⁴² U.S. Bureau of Labor Statistics. Environmental scientists and specialists. In *Occupational outlook handbook*. <https://www.bls.gov/ooh/life-physical-and-social-science/environmental-scientists-and-specialists.htm#tab-6>

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ U.S. Bureau of Labor Statistics. Natural sciences managers. In *Occupational outlook handbook*. <https://www.bls.gov/ooh/management/natural-sciences-managers.htm>

⁴⁶ Ibid.

⁴⁷ U.S. Bureau of Labor Statistics. Natural sciences managers. In *Occupational outlook handbook*. <https://www.bls.gov/ooh/management/natural-sciences-managers.htm#tab-6>

⁴⁸ U.S. Bureau of Labor Statistics. Emergency Management Directors. In *Occupational outlook handbook*. <https://www.bls.gov/ooh/management/emergency-management-directors.htm>

to natural disasters or other emergencies. They also help lead the response during and after emergencies, often in coordination with public safety officials, elected officials, nonprofit organizations, and government agencies.⁴⁹ The importance of preparing for and minimizing the risks from emergencies will help sustain demand and employment opportunities for emergency management directors. These workers will be needed to help businesses and organizations continue to provide essential services during and after emergencies. The outlook for public-sector employment of these managers is often related to budget constraints.⁵⁰

Conservation scientists manage the overall quality of natural resources. They work for governments, on privately owned lands, or in social advocacy organizations. “Employment is projected to grow 5 percent from 2021 to 2031, about as fast as average for all occupations.”⁵¹ Both changing weather conditions and the development of previously unused lands have contributed to increasingly devastating and costly fires. In recent years, prevention and suppression of wildfires have become the primary concern for managing forests and rangelands. With increasing numbers of forest fires and as more people live on or near forest lands, foresters and conservation scientists will be needed to mitigate growing humanitarian and environmental impacts of forest fires.⁵² Many conservation scientists and foresters advance to take on managerial duties. They also may conduct research or work on policy issues, often after getting an advanced degree. Foresters in management usually leave fieldwork behind, spending more of their time in an office, working with teams to develop management plans and supervising others.⁵³

Virginia Employment Commission, Labor Market Information 2020-2030 (10-Yr)

Occupation	Base Year Employment	Projected Employment	Total Projected Difference	Total Percent Change	Annual Change	Education
Environmental Scientists and Specialists ⁵⁴	3,484	3,687	203	5.827	20	Bachelor’s Degree
Natural Sciences Managers ⁵⁵	1,413	1,447	34	2.406	3	Bachelor’s Degree

⁴⁹ Ibid.

⁵⁰ Ibid.

⁵¹ Bureau of Labor Statistics, U.S. Department of Labor. Conservation scientists and foresters. In *Occupational outlook handbook*. <https://www.bls.gov/ooh/life-physical-and-social-science/conservation-scientists.htm>

⁵² Ibid.

⁵³ Ibid.

⁵⁴ Virginia Employment Commission. Long-term occupational Virginia 2020-2030 Projections, Environmental Scientists and Specialists. In *Long- and short-term occupational projections*. <https://virginiaworks.com/occupational-projections?page79862=1&size79862=12&page80257=1&size80257=12&page81630=1&size81630=12&search79862=192041>

⁵⁵ Virginia Employment Commission. Long-term occupational Virginia 2020-2030 Projections, Natural Sciences Managers. In *Long- and short-term occupational projections*. <https://virginiaworks.com/occupational-projections?page79862=1&size79862=12&page80257=1&size80257=12&page81630=1&size81630=12&search79862=119121>

Emergency Management Directors ⁵⁶	274	289	15	5.475	2	Bachelor's Degree
Conservation Scientists ⁵⁷	520	568	48	9.231	5	Bachelor's Degree

Duplication

Four (4) public institutions in Virginia, Christopher Newport University, George Mason University, the University of Virginia, and Virginia Commonwealth University, offer a degree program similar or related to the proposed M.P.S. degree program in Climate Leadership.

Christopher Newport University (CNU)

Christopher Newport University offers a Master of Science (M.S.) in Environmental Science degree program that is related to the proposed degree program. The program is designed to “enhance the understanding of ecosystem ecology, the conservation of organisms and their environment, and environmental chemistry.”⁵⁸ CNU’s program is primarily focused on providing students with an understanding of the field of environmental monitoring and conservation and provides a “solid background in ecological and environmental conservation theory.”⁵⁹ The degree program requires students to complete 30-33 credit hours. Students are required to complete 6 credits of core coursework, 21 credits of concentration coursework if they select a thesis, or 27 credits of concentration coursework if they select a final project.

Similarities

CNU’s elective in Geographic Information Systems & Spatial Analysis Techniques and Virginia Tech’s elective, Geospatial Tools for Environmental Security both include content related to Geographic Information Systems.

Differences

CNU’s M.S. in Environmental Science degree program requires students to take Biometry (3 credits) and Technical and Scientific Writing (3 credits). Virginia Tech’s degree program does not require courses with similar content. Virginia Tech’s proposed program includes core coursework in Climate Science and Policy for Leaders, Climate Leadership, Risk and Rationality

⁵⁶ Virginia Employment Commission. Long-term occupational Virginia 2020-2030 Projections, Emergency Management Directors. In *Long- and short-term occupational projections*.

<https://virginiaworks.com/occupational-projections?page79862=1&size79862=12&page80257=1&size80257=12&page81630=1&size81630=12&search79862=119161>

⁵⁷ Virginia Employment Commission. Long-term occupational Virginia 2020-2030 Projections, Conservation Scientists. In *Long- and short-term occupational projections*.

<https://virginiaworks.com/occupational-projections?page79862=1&size79862=12&page80257=1&size80257=12&page81630=1&size81630=12&search79862=191031>

⁵⁸ Christopher Newport University. *Department of Organismal and Environmental Biology, Graduate catalog*. <https://cnu.edu/academics/departments/oenb/graduateprograms/>

⁵⁹ Christopher Newport University. *Department of Organismal and Environmental Biology, Graduate catalog*. <https://cnu.edu/academics/departments/oenb/graduateprograms/>

in Climate, Global Issues in Environmental Sustainability, Climate Adaptation and Mitigation Planning (all 3 credits). CNU's M.S. in Environmental Science degree program does not require students to take courses with similar content.

Virginia Tech's proposed program includes a core course, Global Issues in Environmental Sustainability. The Global Study course is designed to provide students with a global perspective on climate challenges. As part of the course, students complete the Intercultural Development Inventory assessment, engage in discussion and work designed to develop their intercultural competence, and a 10-day study abroad experience. GMU's program does not require an international experience as part of their program.

Students in CNU's M.S. in Environmental Science degree program are required to complete a thesis or a project. Virginia Tech's proposed degree program does not require a thesis or final project.

CNU requires students to have college-level mathematics or statistics and an introductory sequence in biology and upper-level coursework in Chemistry, or vice versa. Virginia Tech's proposed program will not require students to have any particular prior coursework for admission.

CNU does not require students to have prior professional work experience for admission. Virginia Tech's proposed program will require students to have at least 3 years of professional experience for admission.

George Mason University

George Mason University (GMU) offers a Master of Science (M.S.) in Environmental Science and Policy degree that is similar to the proposed program. The goal of the program is to "meet the increasing need for trained environmental professionals who can address the problems of land and water management, land use and urbanization, wetland loss, microbial ecology, bioremediation, conservation biology, and ecosystem preservation" and to develop students who can "contribute to the analysis and resolution of global problems."⁶⁰ The degree program requires students to complete 33 credit hours. Students must complete 12 credit hours of core coursework by selecting one course from lists of courses in the following categories: science, statistics, policy, science, and policy. A Master's Seminar in Environmental Science and Public Policy course (1 credit hour) that explores topics in environmental science and public policy and an Advanced Seminar in Environmental Science (2 credit hours) that addresses topics at the interface of environmental science and public policy are also required. The program requires the completion of a research project or a thesis project (3-6 credits). Students select one of the following concentrations to align with their research project or thesis: Aquatic Ecology, Conservation Science and Policy, Environmental Science and Policy, Communication for Environmental Science, Policy, and Human Behavior, Environment and Management, Energy and Sustainability Policy and Science, and Conservation Medicine & Planetary Health (12-15 credit hours).

⁶⁰ George Mason University. *University catalog 2022-2022, Master of Science in Environmental Science and Policy*. <https://catalog.gmu.edu/colleges-schools/science/environmental-policy/environmental-science-policy-ms/#text>

Similarities

GMU's program offers two elective courses, Environmental Policy and Development of U.S. Environmental Policies, which may include content that is also included in Virginia Tech's elective course, Climate Policy. GMU's program also offers three elective courses (Geographic Information Systems (GIS), GIS Analysis and Application, and Land-use Modeling Techniques and Applications) which may include content and develop skills that are similar to a Virginia Tech core course (Environmental Security Analytics) and two elective courses (Geospatial Tools for Environmental Security and Modeling and Forecasting for Environmental Security). GMU's program offers the elective courses, Climate Change and Sustainability Communication, Corporate Environmental Management and Policy, and Emergency Planning and Preparedness that may include content similar to Virginia Tech's elective courses, Climate Communications: Politics, People, and Connection, Climate Risk and Corporate Resilience, Ethics, Governance, and Emergency Response to Environmental Insecurity, respectively.

Differences

GMU's M.S. in Environmental Science and Policy degree requires students to select a course from a list of science courses (e.g., Conservation Biology, Fundamentals of Ecology, and Population Ecology) and a course from a list of statistics courses (e.g., Qualitative Research Method for Environmental Sciences, Multivariate Data Analysis for Ecology and Environmental Science, Methods and Logic of Social Inquiry, Applied Statistics I). Virginia Tech's proposed program does not require courses with this content.

Virginia Tech's program requires students to take Climate Science and Policy for Leaders (3 credits), Climate Leadership (3 credits), Risk and Rationality in Climate Change (3 credits), Climate Mitigation and Adaptation Planning (3 credits), and Global Issues (3 credits). This content is not required in GMU's program.

Virginia Tech's proposed program includes a core course, Global Issues in Environmental Sustainability. The Global Study course is designed to provide students with a global perspective on climate challenges. As part of the course, students complete the Intercultural Development Inventory assessment, engage in discussion and work designed to develop their intercultural competence, and a 10-day study abroad experience. GMU's program does not require an international experience as part of their program.

GMU's program requires a research project or thesis. Virginia Tech's proposed program has no such requirement.

GMU requires students to have a bachelor's degree in "Earth sciences, engineering, resource planning, environmental studies, or a field that leads to an environmental focus."⁶¹ In addition, "applicants should have taken at least two semesters of chemistry and three of biology, including a course in ecology."⁶² Virginia Tech's proposed program will not require students to have any particular degree or prior coursework for admission.

⁶¹ George Mason University. *University catalog 2022-2022, Master of Science in Environmental Science and Policy*. <https://catalog.gmu.edu/colleges-schools/science/environmental-policy/environmental-science-policy-ms/#admissionspoliciestext>

⁶² Ibid.

GMU does not require students to have prior professional work experience for admission. Virginia Tech's proposed program will require students to have at least 3 years of professional experience for admission.

University of Virginia (UVA)

The University of Virginia offers a Master of Arts (M.A.) and a Master of Science (M.S.) in Environmental Sciences degree program that is related to the proposed program. The programs are "designed to provide students with an advanced, graduate-level background in the disciplines that comprise the environmental sciences, so that the knowledge gained could be applied by the student in areas such as environmental applications, law, teaching, public policy, etc."⁶³ The degree programs require students to complete 30 credit hours, which includes 24 hours of graded coursework. M.S. students must also complete 6 hours of research credits (e.g., Non-Topical Research or Research Problems). Students in both programs are required to take at least one course from each of the four core areas of the department (ecology, hydrology, geosciences, and atmospheric sciences). Students in the M.A. program must also complete at least one 3- or 4-credit applications related course, in a topic such as Geographical Information Systems (GIS), Remote Sensing, or Environmental Statistics. The M.A. and M.S. degree programs require completion of a thesis project.

Similarities

The proposed M.P.S. in Climate Leadership degree program requires all students to complete coursework in Climate Science and Policy for Leaders (3 credits). Students in UVA's degree programs are able to select Climate Change: Science, Markets & Policy (3 credits) which may include similar content with the proposed program's required core course.

Differences

Students in the UVA M.A. in Environmental Sciences degree programs are required to complete at least one 3- or 4-credit applications related course, in a topic such as Geographical Information Systems (GIS), Remote Sensing, or Environmental Statistics. Students in Virginia Tech's proposed degree program may select courses with similar content as electives.

Students in UVA's M.A. and M.S. degree programs are also required to take at least one course from each of the four core areas of the department (ecology, hydrology, geosciences, and atmospheric sciences). The proposed program does not have a similar requirement.

Virginia Tech's proposed program includes a core course, Global Issues in Environmental Sustainability. The Global Study course is designed to provide students with a global perspective on climate challenges. As part of the course, students complete the Intercultural Development Inventory assessment, engage in discussion and work designed to develop their intercultural competence, and a 10-day study abroad experience. GMU's program does not require an international experience as part of their program.

⁶³ University of Virginia. *Graduate degree requirements for the M.A.* Department of Environmental Sciences. https://evsc.as.virginia.edu/sites/evsc.as.virginia.edu/files/requirements_ma_8-2016.pdf

UVA requires M.A. and M.S. students to complete a thesis project. Virginia Tech’s proposed program has no such requirement.

UVA requires that students be registered for a minimum of 12 hours of graduate credit during each semester that a student is officially registered at UVA. Virginia Tech’s proposed program will have no such requirement regarding how many credit hours must be completed each semester.

UVA requires that applicants show a “determination to further their studies in the environmental sciences with an emphasis on original scientific research.”⁶⁴ In addition, “although not specifically required for admission, a firm background in mathematics, statistics, physics, chemistry, geology, and biology will be to the student’s advantage.”⁶⁵ Virginia Tech’s proposed program will not require students to have any particular degree, experience, or prior coursework for admission.

UVA does not require students to have prior professional work experience for admission. Virginia Tech’s proposed program will require students to have at least 3 years of professional experience for admission.

University of Virginia (UVA)

The University of Virginia offers a Master of Landscape Architecture (M.L.A.) in Landscape Architecture which is related to the proposed degree program. The degree program requires 61-97 credits. The purpose of the degree program is to train nationally accredited landscape architects.⁶⁶

Similarities

There are no similarities between UVA’s Master of Landscape Architecture in Landscape Architecture degree program and Virginia Tech’s proposed program. UVA’s program requires courses related to design, landscape architecture theory, history of landscape design, ecology and technology, and design computation. Students are required to spend at 29-59 credit hours in studio courses.

Differences

Students in UVA’s Master of Landscape Architecture in Landscape Architecture degree program are required to take Foundation Studio I-IV (24 credits total), EcoTech I-IV (16 credits total), History of Landscape Design I and II (6 credits total), Design Computation I and I (6 credits total), Theorizing Landscape Architecture (3 credits), and Design Research Seminar (3 credits). Students in Virginia Tech’s proposed program are not required to take courses with similar content.

Virginia Commonwealth University (VCU)

⁶⁴ University of Virginia. *Prospective graduate students*. Department of Environmental Sciences. <https://evsc.as.virginia.edu/prospective-graduate-students>

⁶⁵ Ibid.

⁶⁶ University of Virginia. *Landscape architecture*. School of Architecture. <https://www.arch.virginia.edu/programs/landscape-architecture>

Virginia Commonwealth University offers a Master of Science (M.S.) in Environmental Studies and Master of Environmental Studies (M.Envs.) that are similar to the proposed degree program. The programs are designed to provide an interdisciplinary degree in environmental studies that emphasizes the critical links between environmental life sciences and public policy.⁶⁷ The M.S. program requires 33 credit hours and includes 13 credit hours of core course work and the M.Envs. program requires 9 credit hours of core coursework and 3 credit hours of practical experience. Students in the M.S. degree program must also complete and defend a research thesis whereas students in the M.Envs. degree program are required to complete a comprehensive oral examination.

Similarities

VCU's programs require one course, Survey in Environmental Studies, which provides the theoretical and scientific basis of issues central to environmental studies, including global climate change. This course is similar to Virginia Tech's core course, Climate Science and Policy, which includes fundamentals of climate change science as well as climate law, policy, and international agreements.

Differences

Students who select the M.S. degree program are required to complete Introduction to Geographic Information Systems (3 credits), Environmental Data Literacy (3 credits), Environmental Research Methods (3 credits), and Scientific Integrity (1 credit) courses. Students who select the M.Envs. degree program are required to complete Survey in Environmental Studies (3 credits), Environmental Research Methods (3 credits) and Statistical Methods I (3 credits) courses. Virginia Tech's program does not require coursework with similar content. Virginia Tech's proposed program requires students to take coursework in Climate Science and Policy for Leaders, Climate Leadership, Risk and Rationality in Climate, Global Issues in Environmental Sustainability, Climate Adaptation and Mitigation Planning (all 3 credits). VCU's program does not require coursework with similar content.

Virginia Tech's proposed program includes a core course, Global Issues in Environmental Sustainability. The Global Study course is designed to provide students with a global perspective on climate challenges. As part of the course, students complete the Intercultural Development Inventory assessment, engage in discussion and work designed to develop their intercultural competence, and a 10-day study abroad experience. GMU's program does not require an international experience as part of their program.

VCU's programs require students to complete a thesis (M.S.) or a comprehensive oral exam (M.Envs.). Virginia Tech's proposed program has no such requirements.

Enrollment and Degrees Awarded at Comparable Programs in Virginia

⁶⁷ Virginia Commonwealth University. *Environmental Studies, Master of Science (M.S.)*. VCU Bulletin, 2022-2023 Edition. <http://bulletin.vcu.edu/graduate/vcu-life-sciences/center-environmental-studies/environmental-studies-ms/>

Enrollments⁶⁸	Fall 2017	Fall 2018	Fall 2019	Fall 2020	Fall 2021
Christopher Newport University	26	16	17	22	27
George Mason University	51	60	61	55	56
University of Virginia	11	14	18	15	20
University of Virginia	NA	0	98	88	87
Virginia Commonwealth University	24	27	28	25	23
Degrees Awarded⁶⁹	2018	2019	2020	2021	2022
George Mason University	12	14	22	14	9
Christopher Newport University	12	7	1	8	14
University of Virginia	6	7	3	7	7
University of Virginia		15	29	35	27
Virginia Commonwealth University	18	5	12	13	10

Student Demand

Virginia Tech evaluated student demand for the proposed M.P.S. in Climate Leadership degree program via a student survey

Student Survey

In April and May of 2022, the Virginia Tech Center for Leadership in Global Sustainability (CLiGS) in the College of Natural Resources and the Environment sent an online survey to full-time working professionals with at least 3 years of professional experience to determine interest in the proposed program. There were 124 responses. Prompts most relevant to student interest in the proposed degree are listed below, followed by the percent of survey respondents who answered: “extremely interested” or “very interested.”

- How interested are you in earning a graduate degree focused on climate issues in the next five years? 82% extremely or very interested.
- How interested are you in enrolling in a master’s in climate leadership program [as described], offered through VT CLiGS? 81% extremely or very interested.

⁶⁸ State Council of Higher Education for Virginia (SCHEV). *Enrollment summary by program level*. https://research.schev.edu/enrollment/E01_Report.asp. (Accessed: November 13, 2022).

⁶⁹ State Council of Higher Education for Virginia (SCHEV). *Completions, program detail*. https://research.schev.edu/Completions/C_Totals_report.asp (Accessed: November 13, 2022).

**State Council of Higher Education for Virginia
Summary of Projected Enrollments in Proposed Program**

Year 1		Year 2		Year 3		Year 4 Target Year (2-year institutions)			Year 5 Target Year (4-year institutions)		
2024 - 2025		2025 - 2026		2026 - 2027		2027 - 2028			2028 - 2029		
HDCT <u>18</u>	FTES <u>9</u>	HDCT <u>36</u>	FTES <u>18</u>	HDCT <u>54</u>	FTES <u>27</u>	HDCT <u>54</u>	FTES <u>27</u>	GRAD _____	HDCT <u>54</u>	FTES <u>27</u>	GRAD <u>27</u>

Assumptions:

Retention percentage: 95%

Full-time students: 1% Part-time students: 99%

Full-time students credit hours per semester: 9-12

Full-time students graduate in 2 years

Part-time students credit hours per semester: 6

Part-time students graduate in 3 years

Projected Resource Needs for the Proposed Program

Resource Needs

Virginia Tech and the College of Natural Resources and Environment will have all of the faculty, classified support, equipment, space, library, and other resources necessary to initiate the proposed M.P.S. in Climate Leadership degree program. Assessments of need for full-time, part-time, and adjunct faculty are based on a ratio of 1.0 FTE of instructional effort for every 9 FTE in students. The proposed program will utilize a total of 1.00 FTE faculty instructional effort in 2024-2025, rising to 3.6 FTE by the target year of 2027-2028.

One faculty member will serve as the program lead. The program lead will teach required courses in the proposed program. The person will be responsible for the day-to-day operations of the program including admission, plans of study including experiential learning experience, and monitoring student progress within the degree program requirements.

Full-time Faculty

In year one, 2024-2025, no full-time faculty FTE of instructional effort will be dedicated to the proposed program.

In year two, 2025-2026, two existing faculty members from the College of Natural Resources and Environment will increase their instructional effort from 0.40 FTE instructional effort each

to 0.80 FTE instructional effort each to the proposed program. A total of 1.60 FTE full-time instructional effort will be dedicated to the proposed program in year two.

In year three, 2026-2027, two existing faculty members from the College of Natural Resources and Environment will continue to dedicate 0.80 FTE instructional effort each to the proposed program. Additionally, two existing faculty members from the College of Natural Resources and Environment will increase their instructional effort from 0.20 FTE instructional effort each to 0.50 FTE instructional effort each to the proposed program. A total of 2.60 FTE full-time instructional effort will be dedicated to the proposed program in year three.

The level of full-time faculty instructional effort of 2.60 FTE for the four existing faculty members in the College of Natural Resources and Environment is expected to remain constant through year five, 2028-2029, of the proposed program.

Part-time Faculty

In year one, 2024-2025, one existing faculty member from the College of Natural Resources and Environment will be reallocated to dedicate 0.20 FTE instructional effort to the proposed program.

New hire

In year one, 2024-2025, the College of Natural Resources and Environment will seek to hire one (1) new faculty member at the associate professor level that will dedicate 0.40 FTE instructional effort to the proposed program. A doctorate in climate science, environmental sociology, environmental analytics, risk analysis, cognitive or decision sciences, or a related discipline will be required for the position. The position will have an approximate salary of \$125,000 and fringe benefits of \$45,125 for a total of \$170,125. The portion of salary devoted to the proposed program in year one will be \$50,000 with fringe benefits of \$18,050 for a total of \$68,050.

New hire

In year one, 2024-2025, the College of Natural Resources and Environment will seek to hire one (1) additional new faculty member at the assistant professor level that will dedicate 0.40 FTE instructional effort to the proposed program. A doctorate in climate science, environmental sociology, environmental analytics, risk analysis, cognitive or decision sciences, or a related discipline will be required for the position. The position will have an approximate salary of \$100,000 and fringe benefits of \$38,830 for a total of \$138,830. The portion of salary devoted to the proposed program in year one will be \$40,000 with fringe benefits of \$15,532 for a total of \$55,532.

The total part-time faculty FTE instructional effort for the proposed program in year one will be 1.0 FTE.

In year two, 2025-2026, one existing faculty from the College of Natural Resources and Environment will continue to dedicate 0.20 FTE instructional effort to the proposed program. Also in year two, one additional existing faculty in the college will be reallocated to dedicate 0.20 FTE instructional effort to the proposed program. The total part-time faculty FTE instructional effort for the proposed program in year two will be 0.40 FTE.

In year three, 2026-2027, one existing faculty from the College of Natural Resources and Environment will be reallocated to dedicate 0.40 FTE instructional effort to the proposed program. The total part-time faculty FTE instructional effort for the proposed program in year two will be 0.40 FTE.

The level of part-time faculty instructional effort of 0.40 FTE for the existing faculty member in the College of Natural Resources and Environment is expected to remain constant through year five, 2028-2029, of the proposed program.

Adjunct Faculty

In year four, 2027-2028, three existing adjunct faculty will contribute to core coursework in the proposed program. Each adjunct faculty member will be expected to contribute 0.10 FTE instructional effort to the proposed program. Adjunct faculty members will be expected to hold a doctorate in climate science, environmental analytics, environmental science, environmental sociology, public policy, international affairs, or related field. The adjunct Professors of Practice are active in the climate profession presenting, consulting, publishing, or serving in professional societies and associations; have demonstrated professional leadership experience (e.g., serve on the board of an organization); have regional or national recognition in their specialty; and are effective teachers of the research and policy that is relevant to developing climate professionals. The college has ongoing, working relationships with a pool of environmental/climate professionals.

The three adjunct faculty members will receive approximately \$7,000 each in salary per semester. Adjunct faculty are not paid fringe benefits. The total cost for the adjunct faculty salaries will be \$42,000 annually.

Graduate Assistants

No graduate assistants will be required to initiate or sustain the proposed program.

Classified Positions

No classified positions will be required to initiate or sustain the proposed program.

Targeted Financial Aid

No targeted financial aid will be available or is needed to initiate or sustain the proposed program.

Special Tuition or fee charges

Should the degree program be approved by SCHEV, the institution intends to seek Board of Visitor approval for a set tuition rate of \$950 per credit hour. Students will be responsible for any additional fees set forth by the institution (e.g., technology fee) based on the Bursar fee schedule for Graduate and Extended Campus students. Students in the proposed program will also be responsible for an additional fee, projected at \$3,650, for costs associated with the study abroad component of the course. The fee will cover lodging and meals during the experiential learning experience.

Equipment (including computers)

No additional equipment will be needed to initiate or sustain the proposed program. No equipment purchases will be needed for the two (2) new hires. There is adequate existing equipment to support the new hires.

Library

No new library resources are needed to initiate or sustain the proposed degree program. The Virginia Tech Library has adequate and appropriate resources for faculty and student research, teaching, and learning to support the proposed degree program. Resources include journals and publications related to climate change (e.g., Climate Policy, Climate Change: Impacts and Responses). As a member of the Virtual Library of Virginia (VIVA), on-line access to journals is also available.

Telecommunications

The proposed program requires no new telecommunications to launch or sustain the proposed program.

Space

Sufficient faculty office space, including for the new hires, and instructional space currently exists both in Blacksburg and at the Arlington Virginia Tech Research Center.

Other Resources

No other resources are needed to launch or sustain the proposed program.

Funds to Initiate and Operate the Degree Program

Figures provided in the table below will be compared to SCHEV funding estimates using the current base adequacy model. This comparison will serve as a reference for the estimated costs. If there are large discrepancies, SCHEV may request additional clarification to ensure the institution's assumptions are correct, or require modifications as a condition of approval.

Note: Institutions must use the recommended student-faculty ratio when estimating FTE enrollments and required faculty FTEs.

Cost and Funding Sources to Initiate and Operate the Program			
Informational Category		Program Initiation Year 2024 - 2025	Program Full Enrollment Year⁷⁰ 2026 - 2027
1.	Projected Enrollment (Headcount)	18	54
2.	Projected Enrollment (FTE)	9	27
3.	Projected Enrollment Headcount of In-State Students	9	27
4.	Projected Enrollment Headcount of Out-of-State Students	9	27
5.	Estimated Annual Tuition and E&G Fees for In-state Students in the Proposed Program	\$135,450	\$406,350
6.	Estimated Annual Tuition and E&G Fees for Out-of-State Students in the Proposed Program	\$135,450	\$406,350
7.	Projected Total Revenue from Tuition and E&G Fees Due to the Proposed Program	\$270,900	\$812,700
8.	Other Funding Sources Dedicated to the Proposed Program (e.g., grant, business entity, private sources)	\$	\$

⁷⁰ For the "Full Enrollment Year" use: for associate degrees, initiation year plus 1; for baccalaureate degrees, initiation plus 3; for masters degrees, initiation plus 2; for doctoral degrees, initiation plus 3.

Part V: Certification Statements

1. A request of any kind will be submitted to the General Assembly for funds to initiate and/or maintain the proposed degree program.

Yes

No

If “Yes” is checked, include narrative text to describe: when the request will be made, how much will be requested, what the funds will be used for, and what will be done if the request is not fulfilled.

2. The proposed degree program is included in the institution’s most recent six-year plan.

Yes

No

If “No” is checked, include narrative text to explain why the program is being advanced at the present time despite not being included in the six-year plan.

3. The institution’s governing board has been provided information regarding duplication (if applicable) and labor market projections as part of its approval action.

Yes

No

If “No” is checked, include narrative text to explain why the governing board has not been provided the information.

The institution’s Chief Academic Officer attests to the accuracy of the above statements

Name (Printed)

Signature

Date

Appendices

Appendix A
Sample Plans of Study

Full-time Students

Year One			
Fall Semester	Credits	Spring Semester	Credits
CL 5004: Climate Science and Policy for Leaders	3	Restricted Elective Course	3
CL 5024: Climate Leadership	3	Restricted Elective Course	3
Restricted Elective Course	3	NR 5544: Climate Adaptation and Mitigation Planning	3
CL 5034: Risk and Rationality in Climate	3		
Total	12	Total	9
Year Two			
Fall Semester	Credits		
NR 5114: Global Issues in Environmental Sustainability	3		
Restricted Elective Course	3		
Restricted Elective Course	3		
Total	9		

Credit Hours – Year One – Fall Semester 12

Credit Hours – Year One – Spring Semester 9

Credit Hours – Year Two – Fall Semester 9

Total Credit Hours: 30

Part-time students

Year One			
Fall Semester	Credits	Spring Semester	Credits
CL 5004: Climate Science and Policy for Leaders	3	NR 5544: Climate Adaptation and Mitigation Planning	3
CL 5024: Climate Leadership	3	Restricted Elective Course	3
Total	6	Total	6
Year Two			
Fall Semester	Credits	Spring Semester	Credits
CL 5034: Risk and Rationality in Climate	3	NR 5114: Global Issues in Environmental Sustainability	3
Restricted Elective Course	3	Restricted Elective Course	3
Total	6	Total	6
Year Three			
Fall Semester	Credits		
Restricted Elective Course	3		
Restricted Elective Course	3		
Total	6		

Credit Hours – Year One – Fall Semester	6
Credit Hours – Year One – Spring Semester	6
Credit Hours – Year Two – Fall Semester	6
Credit Hours – Year Two – Spring Semester	6
Credit Hours – Year Three – Spring Semester	6

Total Credit Hours: 30

Appendix B Course Descriptions

New courses are denoted with an asterisk (*).

Core Courses

***CL 5004: Climate Science and Policy for Leaders (3 credits)**

Earth, atmospheric, ecological science, and policy fundamentals that leaders need to solve climate related challenges. Drivers of the earth's climate and climate variation throughout the earth's history. Human-climate interaction and the science of how human behavior created the Anthropocene. Future climate scenarios and possible consequences for humans. The roles of adaptation and mitigation and the need to decarbonize societies. Climate law, energy policy, and international agreements to facilitate climate responses. The role of cognitive and social sciences, culture, and communications to develop effective climate and energy policy. Students draft science-based policy briefing.

***CL 5024: Climate Leadership (3 credits)**

Leadership challenges resulting from the wicked problem of climate change defined and the competencies and behaviors needed to coordinate and facilitate efforts to collaborate with stakeholders across programmatic missions and sectors. Lessons from leadership responses to climate change throughout history. Leadership paradigms considered in the context of climate and sustainability. Creating climate-adapted and sustainable organizations. Alignment of organizational values around climate objectives. Boundary spanning leadership in climate change. Expert political judgment and the role of climate leaders in climate decision making.

***CL 5034: Risk and Rationality in Climate (3 credits)**

Inform and guide government officials, businesses, and the general public on the hazards and risks posed by climate change; analyze data to identify and assess climate risks. Reasoning and decision-making skills that inform climate change risk assessments. Complex probabilistic assessments versus simple rule-based reasoning for climate risk assessment. Recognize and manage uncertainty in climate-related risk responses. Avoiding common errors in reasoning under conditions of uncertainty. Ethics, values and emotions in risk management and decision making. Risk perceptions across cultures and incorporating diversity, equity, and inclusion into risk governance. Communicating the risks and uncertainties of climate actions and inaction to government, businesses, and the public. Students conduct risk assessment and develop communication plan for key stakeholders.

NR 5114: Global Issues in Environmental Sustainability (3 credits)

Competencies sustainability professionals need to address global sustainability challenges and pursue sustainability careers globally. Situate specific country challenges in larger global trends. Investigate specific sustainability situations outside the US, including goals, strategies, and stakeholders. International travel experience; cultural competencies. Team/collaborative project management. May be repeated three times, visiting different countries and different content, for a maximum of nine credit hours.

NR 5544: Climate Adaptation and Mitigation Planning (3 credits)

Competencies needed to develop and implement strategic climate mitigation, adaptation, and resilience plans at local to national scales. Impacts of climate change. Climate vulnerability assessment for communities, environments, and businesses. Strategic mitigation, adaptation, and resilience approaches for sustainability. Scenario planning at local and national scales and in developed and developing countries. Communication, process, justice, and politics of implementation. Limits of adaptation. Climate adaptation and resilience planning.

Restricted Elective Courses**Human Dimensions of Climate Change*****CL 5104: Climate and the Human Experience (3 credits)**

Climate as a driver of human history, cultural development, and colonization. Human awareness and perceptions of climate change as a threat throughout history and across the world. Cognition and mental processing of climate information; societal and factional influences in climate beliefs and understanding. Effective climate communication using technical and non-technical information and the use of storytelling in climate narratives.

***CL 5114: Environmental and Climate Decision Science in the Anthropocene (3 credits)**

Examination of how people interact with and make management decisions about the environment in the Anthropocene. Exploration of the rights to decision making in management of nature and identifying who (e.g., nations, socioeconomic groups) is responsible for addressing climate change. Exploration of the roles of social sciences to inform environmental decision-making and the need to integrate social sciences with decision science in climate adaptation and planning. Analysis of the role of emotion and cognition in attitude formation toward nature and climate and in the formulation of adaptation actions. Application of Structured Decision-Making (SDM) and PrOACT (Problem, Objectives, Alternatives, Consequences, Trade-offs) decision processes to achieve desired environmental outcomes. Recognition of the value of scientists as honest information brokers and their role in governance to affect environmental climate action. The role of science and scientists in climate related environmental conflict management.

***CL 5124: Climate One Health (3 credits)**

One Health and its utility in the context of climate change. Climate change effects on human, domestic animal, and wildlife health. Global examples of the spread of zoonotic infectious diseases due to climate change. One Health strategies to mitigate the effects of climate change on disease. Inclusion of climate change in the agenda of international agencies working on human and animal health.

***ES 5704: Climate Justice (3 credits)**

Impacts of climate change are distributed inequitably across class, race, ethnicity, gender, and country. Community-based, participatory action strategies for climate justice. Case-based examination of strategies to address climate injustice at the global, national, and local levels.

***ES 5774: Environmental Justice and Human Security (3 credits)**

Environmental justice examined through the lens of UN human security, global freedom from fear, want and indignity. The uneven distribution of environmental harms and threats such as

famine, flooding, violence, and economic crises. Case studies of public policy, geography, economic opportunity, systemic inequities, and other factors that result in human vulnerability to environmental hazards and risk.

Economics, Finance, and Corporate Risk and Resilience

*CL 5204: Greenhouse Gas Accounting and Climate Solutions Design (3 credits)

Major sources of greenhouse gas (GHG) emissions and the sectors creating them. Methods for GHG emissions inventories for natural and anthropogenic sources. Corporate and industrial emissions assessment using International Organization for Standardization (ISO) 14064 and Greenhouse Gas Accounting and Verification protocols. Life cycle and supply chain analysis for total GHG accounting. GHG mitigation opportunities and the design of GHG reduction solutions that avoid maladaptation.

*CL 5214: Dynamic Integrated Climate-Economy Modeling (3 credits)

Dynamic Integrated Climate-Economy modelling to understand and predict the effects of climate change on the economy and how different courses of actions can lead to different economic outcomes. Understanding the crucial role of discount rates and the value of time in climate-economy modeling. Evaluating climate actions for their economic benefits and assess abatement actions and technologies for their economic feasibility and desirability. Examining the roles of carbon taxes, cap-and-trade policy, and other policies necessary to transition to a low carbon society. Critique of calculations of the social cost of carbon and examining its role in policy development.

*CL 5224: Financing Climate Adaptation and Mitigation (3 credits)

Environmental, Social and Governance criteria and Socially Responsible Investment in climate adaptation and mitigation finance. Public policy and regulation in climate financing. Financing and trading of carbon credits in environmental markets. Financing the big three: solar, wind, and hydropower at scale. Climate-informed investing for non-climate investments: portfolio approaches for hedging climate risks. Insurance, climate risks, and financial markets.

*CL 5324: Energy Economy, and Climate (3 credits)

Energy's role in human well-being, energy contributions to climate change, consequences of transitioning to renewable energy. Costs and benefits of various forms of renewable energy including hydroelectric, solar, wind, ocean, biomass, and geothermal. Storing renewable energy and grid modernization for delivery. Environmental effects of renewable energy and issues of environmental justice. Geopolitical and economic consequences in moving from fossil fuels to renewable energy. Nuclear power and other non-renewable low-carbon energy in energy portfolios.

*ES 5564: Environmental Security, Finance, and Governance (3 credits)

Sustainable investing theory for environmental security. Environmental risks and opportunities, including pollution, green bonds, climate tech, venture capital, natural resources. Social risks and opportunities, including inequality, human rights, impact investment, social finance. Corporate governance risks and opportunities, including conflicts of interest, duties of prudence and loyalty, shareholder advocacy, private and state owned enterprises.

***ES 5574: Climate Risk and Corporate Resilience (3 credits)**

Climate risk and corporate resilience for environmental security professionals and the business community. Corporate agility, change readiness, and supply chains in an uncertain world. Decarbonization, energy, and the clean technology sector. Housing, real estate planning, and construction planning for climate resilience. Mitigation and resilience in the agriculture, water, travel, tourism, investment sector, and medical and pharmaceutical sectors.

***ES 5794: Environmental Justice and Global Capitalism (3 credits)**

Impacts of capitalism on the natural environment, people, and institutions. Comparisons of emerging shared value model vs. shareholder primacy model of capitalism as it affects environmental security, polarized frameworks of capitalism, and new business models for addressing climate change. Environmental security perspective on the United Nations Sustainable Development Goals

Environmental Security

***ES 5004: Environmental Security Fundamentals (3 credits)**

Traditional environmental topics and paradigms examined through a security lens. The environmental, human, and technological components of environmental security. Strategies for evaluating risks and drivers of insecurity. Fundamental laws, policies, and international agreements relevant to environmental security. Perspectives and missions of organizations that address environmental security, ranging from Department of Defense (DoD) and North Atlantic Treaty Organization (NATO) to Intergovernmental Panel on Climate Change (IPCC) Arctic Council and National Aeronautics and Space Administration (NASA) to corporate roundtables.

***ES 5014: Environmental Security Causes and Trends (3 credits)**

Analysis, assessment, and typification of environmental security causes and trends. Causes of insecurity include polarized societies, corruption, land distribution, environmental refugees, commodity-centered economies, oligopoly of violence and climate change as a risk multiplier. Trends include resource-based wars, eco-terrorism, inter-group social conflicts, illicit economies, wildlife trafficking and pandemics. Scenario building and Futures Thinking methods used to analyze causes and trends.

***ES 5114: Environmental Security Resolution Strategies (3 credits)**

History, trends, evolution, purpose, and advocates of security resolution strategies, including conflict resolution, peace building, humanitarian assistance, disaster response, and related policy – as well as techniques like rapid analysis, negotiation, and participatory design. Comparative frameworks and best practices advocated by US, international, and multilateral institutions. Consideration of strategies that work at different scales, local to international, together with illustrative case studies across issue areas and regions.

***ES 5664: International institutions and Agreements (3 credits)**

International institutions and agreements and their impact on environmental security. Origins of environmental security in international bodies and relevance to human security. The role of national governments, NGOs, and non-state actors in addressing environmental security. International institutions and agreements in addressing environmental security. Multilateral diplomacy strategies for environmental security. Practicing multilateral diplomacy.

***ES 5674: Legal Frameworks for Environmental Security (3 credits)**

US and global legal frameworks impacting environmental security. National and global laws, case studies, policies, draft principles, resolutions, and UN treaties to address security challenges that will threaten U.S. and global environmental security, energy development, and global extractive industries. Case studies such as conflict minerals and the Dodd-Frank Rule, nuclear testing, U.S. water law, U.S. Military response to climate change, Compact of Free Association (COFA) and migration from the Marshall Islands, and executive orders on climate change. Perspectives from U.S., Department of Defense, the UN and other international institutions. Use of legal frameworks to manage drivers of environmental insecurity.

***ES 5694: Climate and Security Policy (3 credits)**

Intersection of climate change and national security for environmental security professionals. Global and national policy issues and debates. Science-based policy development and process for climate security issues. Role of US government agencies and international institutions in setting policies. Best practices in policy formulation for climate security. Climate security examples.

Quantitative Tools and Analytics

***CL 5304: Climate Models for Decision-making (3 credits)**

Examination of climate models to estimate temperature, precipitation, sea-level rise, and other physical processes relevant to adaptation, mitigation, and other responses to climate change. Selecting appropriate models for climate decision-making and evaluating model requirements and computational demands. Recognizing model limitations and the implications of error and certainty to decision-making. Critique and application of widely used climate and emissions scenarios for decision making. Formulation of novel scenarios for specific applications. Incorporation of model output and uncertainties into communications.

***CL 5314: Ecological Models for Decision-making (3 credits)**

Ecosystem effects of climate change and the role of ecological models in climate assessment and adaptation planning. Evaluating data needs and computational demands for building models and significance of model uncertainty for decision-making. Modeling climate envelopes, species distributions, and species migrations under climate change. Climate change effects on ecosystem services, phenology, and ecological processes including fire regimens. Evaluating green (plants, soils, etc.) and gray infrastructure (gutters, pipes, sewers, etc.) for climate resistance, resilience, and adaptation planning. Coupled climate and ecological and infrastructure models to develop future scenarios for planning.

***CL 5334: Climate Information and Visualization Tools (3 credits)**

Information and visualization technology to communicate climate science to political and public audiences. Social and cultural knowledge embedded in information and visualization tools for climate science communication and policy making. GIS and mapping, data visualization, social network visualization, strategy building, and game design tools in climate science communication. Design of communication for climate science outcomes and methods for choosing specific technologies for specific audiences. Constructing information and data visualizations for urgent topics. Assessing the effectiveness of climate science communication using information and visualization tools.

***ES 5034: Environmental Security Analytics (3 credits)**

Quantitative methods for evaluating environment and security. Relevant sources of environmental and socioeconomic data are utilized to investigate components of environmental security. Systems thinking principles applied to complex adaptive systems. Statistical and geospatial techniques and tools. Data-based case study.

***ES 5334: Geospatial Tools for Environmental Security (3 credits)**

Application of geospatial concepts and technologies to environmental and security issues. Sources of geospatial data. Applied remote sensing for characterizing environmental security risks and opportunities. Case studies in vector and raster geospatial analysis for environmental security. Production of publication quality environmental security maps and graphics derived from geospatial analysis.

***ES 5344: Modeling and Forecasting for Environmental Security (3 credits)**

Tools for identifying, interpreting, modeling, forecasting, and managing environmental security risks such as climate change and resource depletion. Evaluate relative contributing factors to environmental insecurity including socioeconomic and inter/intra state conflict. Tools and techniques for quantitatively evaluating environmental change. Addressing uncertainty.

***ES 5364: Strategic Environmental Assessment (3 credits)**

Environmental assessment as a critical socio-political tool of natural disaster planning. Basic environmental science for vulnerability and risk analysis. Assessment and planning for environment, health, safety and national security risks. Strategic thinking tools for planning, risk assessment and communicating with policy makers. Communicating and mitigating environmental risks. Develop a portfolio of tools for risk and hazard assessment.

Leadership and Policy

***CL 5414: Leadership in Climate Advocacy and Coalition Building (3 credits)**

Best practices for designing and leading effective climate related advocacy campaigns and coalitions. Fundamental theories on organizational structure, roles, and information exchange in diffused and institutional governance structures. Climate-based advocacy campaigns to address and affect business policies and practices. Methods to establish trust with stakeholders and maintain social capital in a coalition. Climate justice in coalitions.

***CL 5424: Climate Communications: Politics, People and Connection**

Fundamental concepts, theory, and language of climate communication issues. Effects of threat-based messages on climate engagement. Climate communications and the “Six Americas”. Behavioral change through climate communications. Communications in community-based social marketing for climate action. Climate communication approaches used by politicians, experts, communities, and the media. Communication and the origins of disagreement and polarization around climate change.

***CL 5444: Scenario Planning for Climate Change (3 credits)**

Quantitative and qualitative future scenarios for climate policy development, organizational decision-making, contingency planning, and risk management in climate adaptation. Benefits and limitations of scenario-based approached in climate planning. Complex scenario planning for

integrated multi-sectoral planning and to inform climate-related decision-making under conditions of high uncertainty. Case studies and analysis of applied scenario planning in climate adaptation.

*ES 5684: Ethics, Governance, and Emergency Response to Environmental Insecurity (3 credits)
Ethical dilemmas and governance challenges in emergency response for environmental security professionals. Impact of socio-cultural, political, and normative structures in which emergency response takes place. Case studies of global and local emergency responses. Major US and global emergency management agencies and organizations. Short-, medium-, and long-term strategies and best practices in emergency response.

*ES 5694: Climate and Security Policy (3 credits)
Intersection of climate change and national security for environmental security professionals. Global and national policy issues and debates. Science-based policy development and process for climate security issues. Role of US government agencies and international institutions in setting policies. Best practices in policy formulation for climate security. Climate security examples.

NR 5534: Climate Change Policy (3 credits)
Policy tools needed by sustainability professionals to address climate change. US and International policies and efforts to address climate issues. Business policies for adaptation and mitigation. Climate justice. Local government policy tools for mitigation, adaptation, sequestration. Climate geoengineering.

Military Operations and Implications

*CL 5444: Scenario Planning for Climate Change (3 credits)
Quantitative and qualitative future scenarios for climate policy development, organizational decision-making, contingency planning, and risk management in climate adaptation. Benefits and limitations of scenario-based approaches in climate planning. Complex scenario planning for integrated multi-sectoral planning and to inform climate-related decision-making under conditions of high uncertainty. Case studies and analysis of applied scenario planning in climate adaptation.

*ES 5444: National Security Impacts of Climate (3 credits)
National security impacts of climate change for environmental security professionals, both in the United States and around the world. Security impacts of environmental and social changes exacerbated by climate change. Academic and public policy debates and political context of climate-related civil conflict, migration, governance, and inter-state war. Role of international institutions. Risk management for building climate security resilience.

*ES 5454: Environmental Implications of Military Operations (3 credits)
Environmental implications of military operations for environmental sustainability professionals, including basing, training, operations and cleanup. Application of domestic and international environmental law to full spectrum of military operations. Beneficial and detrimental environmental impacts of military operations. Human-centered approach to understanding military response to environmental security. Limitations on military responses during environmental stability response.

*ES 5464: Civil/Military Disaster and Humanitarian Response (3 credits)

Civil and military responses to natural and anthropogenic hazards, and public health emergencies. Humanitarian system architecture, disaster response and civil-military coordination mechanisms. International policies, legal frameworks, standards and practices. Urban, rural, and camp contexts. Environmental impacts of humanitarian assistance. Competing priorities between humanitarian goals, security objectives and environmental concerns and civil-military coordination of responsibilities and tasks.

*ES 5474: Military and Community Climate Security (3 credits)

Impact of climate change on military and surrounding communities. Infrastructure dependencies and interdependencies across and between military and community. Knowledge of military planning processes for climate resilience. Long-term collaborative public planning process including communities and military facilities. Federal legislation and executive orders changing military future planning and climate resilience-building practices. Options to develop shared projects and prioritization and funding strategies.

Appendix C
Faculty Curriculum Vitae (abbreviated)

Lindsey, Kieran, Ph.D. in Wildlife Biology, 2007, Texas A&M University, Faculty. Specialization: urban ecosystem and wildlife management and human-wildlife conflict.

Mortimer, Michael, Ph.D. in Forest Resource Policy, 2001, University of Montana and J.D., 1991, Pennsylvania State University, Faculty. Specialization: environmental policy, international institutions, and environmental impacts and issues related to globalization.

Talley, Emily, Master of Natural Resources in Natural Resources, 2014, Virginia Tech and M.A. Communication and Leadership Studies, 2007, Gonzaga University, Faculty. Specialization: systems thinking, communication, and leadership strategies used to address sustainability challenges related to climate change.

New hire, Ph.D. in climate science, environmental sociology, environmental analytics, risk analysis, cognitive or decision sciences, geospatial technology, predictive modelling, artificial intelligence, or a related discipline. Associate professor. Specialization: climate change.

New hire, Ph.D. in climate science, environmental sociology, environmental analytics, risk analysis, cognitive or decision sciences, geospatial technology, predictive modelling, artificial intelligence, or a related discipline. Assistant professor. Specialization: climate change.