COLUMBIA UNIVERSITY
TASK FORCE ON CLIMATE: REPORT

Delivered to President Bollinger

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Contents

Preface—University Task Force Process of Engagement

This document lays out recommendations for what more Columbia can do to tackle the world's rapidly worsening **climate crisis** and **challenges** through academic research, education, external engagement, and the design and implementation of solutions. It is informed by the work of the **University Task Force on Climate**, a committee established in September 2019 by President Bollinger. The recommendations take the form of **eleven principles** set out below. A key recommendation is that Columbia establish a **Climate School** but that it should be a school that is designed like no other. This document does not lay out a detailed blueprint for the School or how it would operate. Assuming broad agreement on the principles outlined here, these elements will be developed through a follow-up design process described below.

The 24-person Task Force was chaired by Alex Halliday, director of the Earth Institute, and met four times over the course of the fall semester. Task Force members are listed in Appendix B. Members were deliberately selected from diverse backgrounds, invited to serve not as representatives of their schools, departments, or even disciplines—but rather to consider the needs and opportunities that the climate challenge presents and how the University, as a whole, can respond.

Climate is an unusually broad topic—the causes, impacts, and solutions require expertise across vastly different subjects. A broad level of engagement is needed, embodied to some extent in the composition of the Task Force, but also necessitating additional research into the university's current activities. To this end, Alex Halliday engaged personally with each Columbia school to explore with the deans and their colleagues the key subject areas in which there is strength, or where greater capability would be useful. Given the urgency of the situation and the complexity of the possible solutions and responses, Columbia needs to consider what it can do that is both novel and impactful. To discuss these and other aspects, Halliday held nearly 30 meetings with representatives of individual schools, divisions, and other relevant entities such as Barnard College, Teachers College, and the Data Science Institute. In addition, two student town halls and four town halls for the Earth Institute and Lamont-Doherty Earth Observatory campus communities were held. He received over 85 emails with feedback from various university constituents. All of this feedback was considered in Task Force discussions and much is reflected in this report; a summary of this feedback is found in Appendix C. Earth Institute staff also developed summaries of each school's activity around climate change based on information available from websites. This was shared with the respective deans and their senior staff to review, edit, and expand. The results are found in Appendix E.

This document first lays out a case for new action—what is the climate crisis and why do we need to act more boldly now? It then makes the case that Columbia is the best place to engage in the critical work necessary to address the challenges of climate. It goes on to discuss the ways in which Columbia could achieve this by outlining the 11 key principles for defining Columbia's activities around climate going forward. These design principles describe the structure of how the University would move forward—through a new institutional hub and spokes model of a school unlike any other structure at Columbia University. The Climate School needs to be flexible, diverse, porous, and dynamic. The details of the School's organization will be designed in the coming months; however, the report lays out some preliminary ideas for structuring research, education, impact, and faculty. It includes consideration of the physical space needs, including a commitment to match the scale and ambition of this academic vision with campus sustainability goals that are equally bold and forward-looking. It concludes with next steps.

Executive Summary: Principles of a Climate School

The climate crisis is a problem like no other in terms of its scale, complexity and all-encompassing nature. Many consider it the greatest threat facing humanity. At this stage, scientists cannot predict exactly how things will develop, with accelerated change and tipping points now a major concern. However, with anthropogenic greenhouse gases pushing the behavior of the climate system to extremes not witnessed in recent history, it is expected that global heating and the increased frequency of anomalous weather patterns will lead to further aridity and wildfires, as well as threats to water supplies and food production. Rising sea levels combined with storm surges and changes in the behavior of hurricanes increase the risk of catastrophic flood damage. The threat to human life and well-being posed by such change, as well as by the associated pollution, collapse of ecosystems, and migration of diseases will be hugely damaging for many societies with particular impact felt by developing countries, fragile coastal communities, and vulnerable populations. As the lifestyles of people, their environment and the associated biodiversity are all impacted, areas of Earth will become effectively uninhabitable, leading to mass migration, societal unrest, and instability. Therefore, the impacts of climate change are global and unprecedented in scale. Ultimately, climate change is a manifestation of the pressures placed on the natural environment by economic growth, pursued without regard to environmental degradation. As such, the crisis faced is symptomatic of a broader societal problem that undermines the ability of humans to build a better world.

This existential threat is so important that universities urgently need to consider what more can be done to accelerate discoveries and novel technologies, as well as to provide expertise and helpful partnerships. Columbia is particularly strong in many of the underlying basic disciplines. To have greater impact, the University could usefully marshal and expand these and other powerful academic resources to focus on this issue. A transdisciplinary approach is needed based on a systems-level view of how the atmosphere, oceans, and biosphere interact both with each other and with society to provide a healthy and livable planet. This requires not only the science behind the problem of decarbonization, but also human and societal conditions and values surrounding it. The science and social science should feed into policies just as the issues that are addressed should be informed by the real problems on the ground. Climate change "solutions" may tackle the manifestation of the "disease" (e.g. build a sea wall to keep out rising waters), but also need to address the root causes (e.g. the critical role of carbon in economies). Finally, equality and justice should be intrinsic to this work.

Therefore, Columbia's new efforts around climate need to be radically inclusive both within and outside the university through extensive partnership. This multidimensional problem cuts across nearly every element of society and every discipline in academia—and so the work must as well. Combining disciplines, or bringing together theory and practice, while important, will, on their own, be inadequate for the challenges. Instead, the focus needs to be on forming teams that co-design something innovative and new. The University must transform not just what it does and how it does it, but how it thinks about the problems. Columbia must frame the right questions, fundamentally changing how it approaches the research and education process. Students, academics from non-academic backgrounds, communities, local and national governments, NGOs, and businesses all need to be a part of the process. Crucially, the ability to effect such change will be informed and strengthened by partnership and collaboration with local communities and policymakers, as well as other researchers. Non-academic sources of knowledge are essential.

Columbia is well-poised to advance its existing leadership and make a bold commitment to address the challenges and opportunities climate presents. It has an outstanding foundation upon which to build. Its opportunity—and responsibility—is to improve and elevate what already is, arguably, the world's leading institution on climate and sustainability.

The University Task Force on Climate was convened to make recommendations regarding how Columbia can maximize its impact on the climate crisis. It recommends the following design principles:

1. The challenges of climate change are now so immense and urgent that the University must act **boldly**, but also **collaboratively** to develop innovative climate education, support groundbreaking research, and foster essential planetary solutions.

2. The University should form a "**Climate School.**" This will, thus far, be **unique in design and purpose**, built around **inter- and transdisciplinary** engagement and **partnership**.

3. The "School" will be an enduring institution that addresses the **long-term** climate issues that will be with future generations, and yet will also **act swiftly** given the short timeframe with which the world must act.

4. A School will create an **intellectually integrated academic center** at the University connecting, amplifying, and advancing the extensive and impressive work currently undertaken at the University on climate education, research, and solutions, while serving as an innovation hub to spark new areas of inquiry and research. Central to serving as a hub around climate will be a **dedicated physical space** for an immersive, interdisciplinary experience.

5. The School will organize around some version of a **"hub" and "spokes"** model whereby many new faculty have **joint appointments** and many existing faculty are **networked** into the School. Some faculty appointments within the School will be in the form of **5-to 10-year secondments** to focus on particular inter-disciplinary problems for a limited period. The School will serve as a **resource and benefit** to the rest of the University, supporting the "spokes" to expand their own capacity in the areas of climate.

6. The School will design and foster novel **education** through extensive **climate-focused curricula**, which will build on, complement, and strengthen the successes already achieved in climate-related education at existing schools. These dynamic curricula will explore new pedagogical models able to adapt and respond to the constantly changing nature of climate knowledge, enabling the School to fundamentally **reimagine** and integrate climate learning across the University.

7. The School will embody activity across a full **continuum—**from basic research, deep scholarship, and fundamental discovery to applied research, design solutions, and community partnerships.

8. The School will develop **solutions** to the major issues facing humanity due to climate change, prioritizing **climate in a just society.** A critical element of the School's work will be partnership and two-way knowledge exchange with the public, and bringing knowledge to action.

9. The School will embed goals around **the Fourth Purpose** into its mission, extending Columbia's ability to bring knowledge, in tandem with actors beyond the campus, to more effectively address pressing human problems. It will pay deep attention to creating the **infrastructure** to move into the world of action.

10. The School will be **dynamic** and **nimble**, so that it can adapt to the changing nature of this planetary-scale problem.

11. The School will be built around a robust and **innovative business model** to ensure it meets its goals and leverages the vast and growing public demand for climate knowledge.

Introduction: The Climate Challenge

The climate crisis may be the greatest threat facing humanity in the twenty-first century. Although the increasing intensity of extreme weather events experienced in recent years is often ascribed to climate change, these are minor compared with expected impacts decades into the future under "business-as-usual" scenarios. The time lag in the response of the Earth system to increasing greenhouse gases means that the full impact of today's anthropogenic carbon emissions will not be experienced for decades. Therefore, there is the expectation that things will get worse even if no more greenhouse gases are emitted. Furthermore, the carbon dioxide remains in the atmosphere and continues to affect climate for hundreds of years. Without more effective ways to reduce carbon dioxide levels in the atmosphere to at least offset what is emitted, global heating will intensify. The planet is being pushed to a state that modern humans have not experienced.

Although climate change models are now sophisticated and reliable, it still is difficult to model the details of future effects, such as rainfall, reliably. What is clear, however, is that society is not prepared for the changes and relatively little is being done to prevent them. Judging by the unequivocal record of Earth history at times before modern humans when carbon dioxide levels in the atmosphere were similar to those currently, the longer-term impacts of unabated carbon emissions for many parts of society will be catastrophic. Furthermore, the bad seasons and extreme events associated with phenomena like El Niño will be rendered even more extreme.

Humankind has never before had to deal with something so all-encompassing. How should academics help civilization prepare for the consequences of increasing temperature, rising sea level, and a planet that is being pushed beyond its normal mode of self-regulation? How can they do this in a way that is inclusive and participatory with those most impacted? Can and should the role of the University itself be reimagined with a greater focus on direct societal application? Universities are crucial to solving the problems posed by changing climate. They bring unique research capabilities across a breadth of relevant subject areas needed to understand both climate science and the impact on society. In a world in which the public dialogue about climate change is rife with hyperbole, exaggeration, and rhetoric, universities bring the credibility, independence, and objectivity needed to inform, explain, and improve public understanding of what the future holds and how society should adapt. Universities also play a critical role in educating future generations of leaders. To address the climate challenge with necessary urgency, a university must also have deep capabilities in areas not traditionally seen as academic strengths, including communicating to broad audiences; partnering with communities, policymakers, and leaders of private industry; and developing feasible and pragmatic solutions.

An argument can be made that universities globally have been failing to treat this with the seriousness it deserves. The intellectual resources of the academic world need to be marshalled and expanded in ways proportional to the gravity of this situation. Universities need to consider if they can generate a new kind of intellectual power. Such an existential challenge demands the attention of Columbia in particular, given its strength in many of the underlying disciplines. Given this foundation, Columbia is well-poised to advance its existing leadership and make a bold commitment to address the climate challenge.

A novel approach to addressing and solving the climate change problem is founded on the concept that solutions must view the problem across a variety of scales—from local or regional to planetary or global—and across disciplines ranging from policy to physics and medicine to geoengineering. This is based on a systems-level view of how the atmosphere, oceans, and biosphere interact with each other and society to provide a healthy and livable planet. Current approaches to address climate change are analogous to early approaches to address human health and wellbeing prior to the systems view developed by public health and social work. These early efforts focused on diagnosing and treating individual patients and providing for the poor. However, they were inherently hamstrung by their failure to identify and address the root causes of poor health and poverty. Population level changes only emerged when public health and social work were established as new disciplines.

Currently, climate change "solutions" are, by and large, tackling the manifestation of the "disease" (e.g. build a sea wall to keep out rising waters) and not often enough the root causes (e.g. the critical role of carbon in our global economy), primarily in very local (and predominately wealthy) settings. Few, if any, solutions are being developed using a systems perspective across the variety of scales needed, at the planetary scale in particular. Few solutions are being developed in partnership with local communities, where non-academic sources of knowledge feed into the process and inform the outcomes. As public health and social work schools have established themselves as essential to producing the knowledge and practice needed to tackle important societal challenges, so could a new breed of climate "schools"—founded with a mission to understand and address climate change with the systems perspective needed to equitably solve the problem.

The Columbia University Response

This document presents a vision for a **Columbia Climate School.** The School would build upon the current excellent work of diverse schools, institutes, and centers across Columbia, and enhance, amplify, and provide resources for that existing work. It would allow the University to significantly expand in this area. An argument can be made that Columbia is ***the place*** to lead globally in tackling the challenges of climate because it has:

- strength across a range of relevant disciplines
- extensive experience conducting interdisciplinary work
- experience co-producing knowledge and solutions with external stakeholders
- global reach and an international network
- a location in New York City—a hub of global innovation and activity
- established itself as a global leader in environmental and sustainability education, pioneering interdisciplinary pedagogy in undergraduate, professional masters, and doctoral degree programs.

First, the foundation for the Climate School is outlined.

Columbia's Strengths

Columbia is strong in many of the key climate disciplines, particularly climate geosciences. This is mainly because of the Lamont-Doherty Earth Observatory, which is funded primarily from soft money. For this reason, Columbia has the largest base of Earth science researchers in any top-ranked university, many of whom are working to understand the implications of rising CO_2 levels on climate, ecosystems, ocean life, and essential resources. Scientists engage in research across the natural and physical sciences including paleoclimate, geochemistry and geophysics, ocean and climate physics and modeling, and terrestrial and marine geology, in an effort to improve observation, computation and theory related to understanding, anticipating and managing climate.

Not only is Columbia the top school for geosciences/climate science, it also possesses depth and strength in many other fields. It is distinguished as one of the world's premiere liberal arts colleges, with a long history of excellence in subjects like the humanities, arts, and social sciences—which can be marshalled towards the climate problem. Similarly, Columbia's professional schools like the Schools of Engineering, Journalism, Business, Public Health, and Law are among the top ranked in their respective fields. Therefore, combining the geosciences with academics working on climate in all these other fields probably affords Columbia the world's strongest group of researchers in this area. Columbia is not strong in everything. It has pockets of excellence, but few faculty representing some very relevant topics like agriculture, environmental ethics, forestry, nuclear engineering, hydrology, and biodiversity, to name a few.

The climate researchers at Columbia are at the forefront of many strategic areas of climate research and innovation, including decarbonization, battery storage, grid integration strategies, carbon capture, utilization, and storage; and financial and infrastructure-based strategies for climate adaptation, among others. They are well suited for investigating humankind's role as both drivers of and responders to global climate and ways in which society can better utilize understanding of climate variability and change to improve human welfare. Indeed, in recent years, **Columbia researchers have contributed more authorships to IPCC (Intergovernmental Panel on Climate Change) reports than any other American university**.

Those who will determine our future are not academics, but public sector leaders who make policy, and private sector leaders who decide how to deploy trillions of dollars in capital. To have impact, the insights from leading academic work must be produced in ways that shape the decisions those leaders make. Columbia has a demonstrated commitment to such engagement, long recognizing that academic work, while necessary, on its own is insufficient. Columbia developed the Earth Institute to generate innovative insights in the formats and on the timeframes needed to solve real-world sustainability problems. In fact, the Earth Institute and other parts of Columbia, such as ICAP, have already been doing this type of *convergence* research for over a decade, providing a platform for developing new transdisciplinary efforts. Similarly, many Columbia schools are engaged in work with communities, businesses, and regional and national government bodies. The newly formed Columbia World Projects is attempting to do something similar.

Columbia has also established itself as a global leader in sustainability education, providing a comprehensive set of offerings that meet the needs of this growing field. There are disciplinary-based programs, such as earth and environmental science in the Department of Earth and Environmental Sciences (DEES), earth resources engineering in SEAS, as well as interdisciplinary climate and sustainability programs that the Earth Institute helped develop across the University at the School of International and Public Affairs (SIPA), the Graduate School of Arts & Sciences (GSAS), Columbia College (CC), the School of General Studies (GS), and the School of Professional Studies (SPS).

Climate change raises unique and vexing collective action challenges and requires a globally coordinated response in ways that few other problems do. It requires that solutions account for regional differences and population vulnerability. Columbia's links to the United Nations and our network of Global Centers and deep international partnerships give it a special perspective and the footprint necessary to engage with a global problem like climate change.

Finally, at the same time, Columbia, as its name extols, is in the City of New York. The multidimensional issues of climate play out across New York City and New York State, and the city can serve as a living laboratory for implementation of ambitious new policies at the state and city level. Columbia can serve as a key research and implementation partner to demonstrate how cities such as New York can meet ambitious climate neutrality goals and offer a model for other states and cities across the US and globally.

Columbia's Limitations

Despite these advantages, Columbia faces some obstacles in moving ahead on climate. Given the breadth and nature of fields and areas of study around climate, there is no central academic home from which to build this subject in a coordinated fashion and in a way that facilitates major expansion. The Lamont-Doherty Earth Observatory, which represents a major footprint around climate, has been quite independent from the rest of the university. It does not sit in any school but rather within the Earth Institute. It mainly is funded by soft money and endowment, and its success has been independently driven and not because of any particular action by one of Columbia's schools. The Department of Earth and Environmental Sciences (DEES), which, while sitting alongside LDEO at Lamont, sits within the Arts and Sciences (A&S) and pursues its own governance and strategy, despite sharing scientific labs, teams, and students. The lack of strategic alignment and integration between LDEO and DEES limits a coordinated vision from just the physical science perspective.

One might ask why one needs a school if Columbia has an Earth Institute (EI), the University-wide entity devoted to the study and practice of sustainability, including climate. The EI delivers research programs and has trail-blazed in sustainability education, such that its courses are copied throughout the world. It also focuses on providing practical solutions to societal problems and achieving great connectivity and impact through its communication and public engagement activity. However, since it is not a school, it has encountered structural challenges that limit its success and growth. First, it cannot appoint faculty, which limits its ability to recruit and retain the top academics in their respective fields. Second, and relatedly, it has limited ability to determine who teaches in its co-sponsored education programs, which are housed at schools and are themselves limited by their own faculty hires. Third, it has no major tuition base of hard funding to subsidize its soft-money research endeavor. It is well understood that academic research cannot support itself and must be cross-subsidized with other funding, typically tuition but also endowment. Finally, and relatedly, it has no alumni with which to develop a pipeline for fundraising. Though its graduates are affiliates of the Earth Institute, they are alumni of chools. Each of these pose their own unique challenges, but together, they limit the opportunities for academic excellence and impact. Such structural challenges could be directly addressed by forming some type of school. A bigger, better funded EI could not address most of these issues. Instead, a Climate School might build on the decades of success in the Earth Institute but have new capabilities that would address these critical limitations.

Lastly, there are a number of structural limitations more broadly at the University. Columbia is the fifth oldest higher education institution in the U.S.; and like at any university, there are organizational challenges in developing anything novel and new. Universities are inherently bureaucratic, and the traditional academic department structure creates silos that are hard to cross. Academia is grounded in the need for disciplinary expertise, reflected in processes like how scholars publish papers or receive tenure. It can be difficult for students to take courses outside of their school, as different schools have different requirements and tuition models. These issues are certainly not unique to Columbia, but they are important to address at this time when we have a unique opportunity to develop a new structure that will support interdisciplinary, impact-oriented scholarship.

Why a School?

There are a number of reasons why a new School focused on climate makes sense.

A Developing Multifaceted Societal Problem: Universities have, over the decades, needed every now and then to build out new cohorts of faculty and students, while drawing on what already exists and enhancing certain disciplines in order to respond appropriately to new needs of the world. Much like the creation of schools of public health, business, and social work, this is one such case. Schools sometimes provide a focus of activity in a particular discipline such as engineering or law. This is nothing like the subject of climate. However, they also sometimes focus on a developing issue, like public health, that requires a trans-disciplinary “systems” or “convergence” approach. This is the case with climate—a developing multifaceted societal problem that is even broader than public health and requires convergence thinking to derive effective solutions.

An Enduring Problem: Climate will be a growing issue for decades. It is a manifestation of the pressures that society creates for itself and the natural environment, worsened with the opportunity for improved global living standards. As such, it is symptomatic of a major problem in both developed and developing society that undermines humanity’s ability to build a better world.

Future Leaders: Columbia educates some of the world’s best and brightest students, and trains them to become skilled and productive members of society. In order to ensure that these students are equipped with the knowledge and tools to lead in the 21st century, Columbia needs to make climate a central part of its overall educational framework. No matter what students go on to do, they will need to understand the climate crisis and its impacts.

New Education Programs: A Climate School will be able to develop new education programs that will be needed for the future in subjects like climate ethics, or as joint degree programs such as climate and journalism.

A Cohesive Academic Home: There is no central academic home from which to build this subject in a coordinated fashion and in a way that facilitates major expansion. It is hard to imagine how additional distributed funding or other encouragement will produce the same intellectually integrated academic horsepower that could be directed at solving these issues.

An Immersive Academic Experience: The overwhelming scale and complexity of the climate crisis requires more than simply combining discipline X with discipline Y, bringing together theory and practice, or bringing scientists and designers together, etc. These actions are important, but insufficient and are already happening across the University at various scales, distributed across three campuses. A new, physical "hub" is needed for academic engagement and innovation to house faculty, students, and researchers who may also sit elsewhere, but are excited by novel new spaces that effectively facilitate the interdisciplinary activity needed. A Climate School could provide an immersive experience that generates a community where there is sustained interaction by the relevant stakeholders, internally and externally. A new building on the Manhattanville campus could provide a "home base" for the Lamont scientists to spend time on the downtown campus, engaging more regularly with those faculty based there. An inviting, open building serves to support the spontaneous and planned interactions that are required for deep transdisciplinary activity.

Appointment and Tenure: A School has the power of appointment and tenure, the ability to create a coherent group focused on these issues. Only a school/department can grant faculty appointments. Institutes and centers, like the Earth Institute and Lamont-Doherty Earth Observatory cannot appoint faculty and, as such, are limited in their ability to recruit and build up diversity. A School will facilitate the recruitment and retention of rising stars and established leaders in their respective fields who require faculty positions. Not only will a School have the power to appoint and grant tenure, but it can directly control the diversity of its faculty and can set its review criteria such that they value impact on society (embedding the fourth purpose into practice within the School). The traditional model is one in which scholarship is measured by publications, while applied achievements are harder to measure. Different measures of scholarship and success are therefore needed. Hiring individuals who are strongly applied and whose excellence is judged more by their direct impact on society, as opposed to their peer reviewed publications and grant proposals, is a challenge because it is more difficult to measure their achievements and suitability for academic life. This is equally true for the tenure process, requiring new incentives for junior scholars to engage in interdisciplinary and transdisciplinary work.

Leadership: The Climate School will also provide an attractive new concept in academia. It will make the University more attractive to the kinds of intellectual talents we seek in faculty and students. If Columbia takes this pioneering stance, as it has done with other subjects in the past, it is likely to be emulated across other universities. It provides a mechanism to achieve massive scale in our efforts to tackle climate change.

Fundraising Potential: Finally, Columbia cannot make a bold statement without substantial resources. A School would lead to additional funding flowing to the University. The Climate School has enormous fundraising potential; it will allow the University to make the greatest impact possible across all parts of Columbia, more so than if we were to simply enhance existing structures or fund large projects. A bold commitment requires bold resources, and the Climate School is the way to achieve both.

A Columbia Climate School

Columbia is strong in many disciplines but can achieve more with collective support of its devolved entities and goals. The Climate School should aim to be a vehicle for existing schools and centers to expand their programs and hire new faculty. A key goal should be to "raise all boats" with the Climate School acting as a resource to the rest of the University.

The Task Force recommends the following broad design principles for Columbia's new climate initiative. These principles will be used to develop a detailed design for the Climate School in 2020.

1. The University must act **boldly**, but also collaboratively to develop innovative climate education, groundbreaking research, and essential planetary solutions. Columbia must lead by example and demonstrate the critical importance of this issue to others. It is not a time for incremental change. This increased activity within Columbia must be matched with effective partnership with communities and stakeholders, embedding local knowledge in our research and co-developing responses to on the ground challenges.

2. The University should form a "**Climate School.**" This will be **unique in design and purpose**, built around **inter- and transdisciplinary** engagement and partnership. Climate change is a multidimensional problem that cuts across nearly every element of society and every discipline in academia, thus the University's work must as well. The School will be structured unlike anything currently at the University; the urgency of the climate crisis requires an entirely new model of university engagement. The School will operate in close partnership with other schools to bring together climate-related expertise and knowledge from across the University. It will fundamentally change how interdisciplinary work is developed and executed at Columbia, transforming how academia and other stakeholders can come together to address societal problems.

3. The "School" will be an enduring institution that addresses the **long-term** climate issues that will be with future generations, and yet will also **act swiftly** given the short timeframe within which the world must act. An intensification of research, education, and knowledge transfer is needed to address this issue before the societal and economic costs of response become unmanageably high. Recognizing the need for solutions on a diverse set of timescales, the School will build capacity for addressing the risks and challenges of the future, while also deploying resources to implement solutions immediately, including on our own campuses.

4. A School will create an **intellectually integrated academic center** at the University, connecting, amplifying, and advancing the extensive and impressive work currently undertaken at the University on climate education, research, and solutions, while serving as an innovation hub to spark new areas of inquiry and research. Central to serving as a hub around climate will be a **dedicated physical space** for an immersive, interdisciplinary experience. Given the breadth and nature of fields and areas of study within the University, it is critical that the School provide a central academic home from which to massively expand the subject of climate change in a strategic, cohesive manner. In time, this will also manifest as a defined and recognizable physical presence that supports interactions and socialization for research, education, outreach, and impact. Such a physical space will be important to facilitate the regular networking and community-building across the University that will be needed to understand new problems that will emerge and to creatively address them.

5. The School will organize around some version of a **"hub" and "spokes"** model whereby many new faculty have **joint appointments** and many existing faculty are **networked** into the School. Some faculty appointments within the School will be in the form of **5-to 10-year secondments** to focus on particular inter-disciplinary problems for a limited period. The School will serve as a **resource and benefit** to the rest of the University, supporting the "spokes" to expand their own capacity in the areas of climate. While the School needs a central "hub" for its activity, attention and resources will also focus on activity in the rest of the university that are connected via the "spokes." This will not only create real financial support for schools, but will also allow faculty, scientists and students the opportunity to work on problem-oriented research that is intellectually interesting and outside their normal scope of work. It allows faculty to maintain their core connection to their home discipline while also engaging in this interdisciplinary activity. The spokes model will build upon the current excellent work at the schools and provide new resources for expanding that work. The spokes model can also ensure that there is not "one sizes fits all" for how each school engages with the Climate School, since each school is very different in terms of structure and resources.

6. The School will design and foster novel **education** through extensive and dynamic **climate-focused curricula**, which will build on, complement, and strengthen the successes already achieved in climate-related education at existing schools. These dynamic curricula will explore new pedagogical models able to adapt and respond to the constantly changing nature of climate knowledge, enabling the School to fundamentally **reimagine** and integrate climate learning across the University. The School will help integrate climate education so that it is interwoven across all disciplines and programs throughout the University. Climate will be made part of the fabric of the educational structure, from the undergraduate level to executive education, from individual courses to certificates to joint degrees. The School will provide a knowledge base for climate information and make this knowledge easily accessible to not only the Columbia community, but also public and private sector actors and the general public.

7. The School will embody activity across a full **continuum** from fundamental discovery to applied research, design solutions, and community partnerships. Regular interaction between researchers engaged in these different ways will fundamentally inform each other's work. Close engagement in solution implementation can feed back into new basic and applied research questions and activities. At the same time, it is crucial to preserve the integrity of each, and especially to encourage interdisciplinary work without the pressure of immediate application, whether on the science side or the humanities side. The School will seek to develop solutions to the major issues facing humanity due to climate change in the context of a just society. The School will have the goal of having a real impact on the climate crisis in the world.

8. A critical element of the School's work will be two-way knowledge exchange with the public and bringing knowledge to action. Solutions—from capacity-building to policy recommendations—will not be considered without input from those that are most impacted. While academia can bring intellectual rigor and methods to "climate problem-solving" it needs to consider multiple perspectives and voices to ensure inclusive, relevant, and actionable results. The crisis is being faced head-on by communities around the world whose lives and societies have already been fundamentally changed by these evolving threats. Columbia must not only value those efforts, but support and learn from them as well as establish deep and meaningful collaborations with these parties.

9. The School will embed goals concerning **the Fourth Purpose** extending Columbia's abilities to bring knowledge, in tandem with actors beyond the campus, to more effectively address pressing human problems. It will pay deep attention to creating the infrastructure for moving into the world of action. This structure will facilitate direct engagement with stakeholders, helping new technologies, policies, and institutional approaches to solving climate problems come to fruition. The School will develop and implement new hiring,

promotion, tenure, mentoring, and administrative policies to support the Fourth Purpose, serving as a demonstration to other schools.

10. The School will be **dynamic and nimble**, so that it can adapt to the changing nature of this planetary-scale problem. The impacts of climate change will evolve as society mobilizes to meet its challenges, and the School needs to be fluid enough to evolve and adapt as the field changes. This means finding ways to transcend bureaucracy; to continue to innovate when it comes to hiring, research, and educating; to enable new fields, topics, and discourse to emerge. The School should foster a sense of innovation such that it can help humanity meet the new and complex challenges that will arise as the climate changes.

11. The School will be built around a robust and **innovative business model** to ensure it meets its goals and leverages the vast and growing public demand for climate knowledge. While the School will need significant endowment, it also needs to consider what business model will be sustainable in the long-term so that it continues to provide resources across the University and beyond. The business model will need to be as new and novel as the organizational structure; ensuring a stable source of revenue is key to the success of this endeavor.

The Climate Task Force carefully developed the above 11 principles outlining a framework for how to move forward. The rest of the report discusses various elements that *might* align with a Climate School and that will be explored in much greater detail as the School's mission, structure, and business model are carefully and thoughtfully designed.

Research

The Climate School will link and build upon Columbia's existing expertise through the development of new research platforms grounded in interdisciplinary and transdisciplinary approaches. The overarching organization would take the form of **three research themes** that are broad enough to address anticipated and emergent challenges over the next century. These broad themes provide a framework, within which multiple research questions and ideas would emerge for decade-long projects. Recognizing that key issues are likely to evolve with the developing climate crisis and accompanying socio-political situation, the research questions are expected to change, perhaps dramatically, over the coming decades. The changing nature of sets of projects over time enable a nimbleness, adapting to problems that are yet to be articulated, while still operating under a larger strategic framework.

The three interdisciplinary research themes are as follows:

(1) Living with a Changing Planet: To address how the planet will change and what **adaptation** measures are needed. Anthropogenic emissions are combining with the natural cycles of carbon compounds to lead to fundamental changes in the Earth's system. Better **understanding** of Earth's behavior and predicting the future paths of this evolving system are essential, but so are **adaptation**, resiliency, and disaster preparedness. This includes not only geosciences but also resilient infrastructure, ecosystems, biodiversity, food security, water, heat, and migration.

(2) Climate Management: This mainly is concerned with the **decarbonization** of various sectors of the economy. This would include renewable energy, transportation, manufacturing, and energy storage, as well as land use—forestry, agriculture, and rewilding. It should also include geoengineering—especially carbon removal, novel carbon use, and new materials. This particular theme will build strong interdisciplinary work between engineering, policy and law.

(3) Climate and an Ethical Society: This is concerned with understanding the sociopolitical roots of climate change; the present political, legal, social, and economic structures and processes that allow for the continuation of the crisis; and the disproportionate impact it is having on vulnerable and oppressed populations. It will also focus on effectively communicating both causality and solutions with governments, institutions, and the public in order to foster policy change and more effective governance.

Within each of these themes, there also are sub-themes. All three combine elements of both **understanding** and **responding** to the problem. The School must expand knowledge of the problems at hand—both from a scientific and engineering perspective as well as a socio-economic and political one. The definition of the problems and the values that inform competing solutions are best considered in a setting that includes diverse perspectives. Our discussion and study of the problems must recognize, from the start, that climate touches on so many existing and new forms of academic and nonacademic knowledge. From there, research will seek to resolve those issues —both to address underlying root causes as well as symptoms. Response and solutions-oriented research that draws on all forms of knowing and solving would be a critical component of the academic agenda of the School.

Each theme requires deep inter- and transdisciplinary scholarship across faculty, researchers, and students, who will develop novel solutions, in partnership with stakeholders. Each discipline frames research in different ways and brings unique methods and tools that must be brought together to significantly change how we conceive the research enterprise. There are two pathways that would be pursued across these themes: 1) seeking greater knowledge about the ***known*** problems that must be addressed and co-developing solutions to those problems, but also 2) developing a collaborative community to identify the new problems that are not yet in the academic or public discourse and collectively designing frameworks to study and address them. Transdisciplinary approaches are best equipped to address the problems and interventions we cannot yet imagine. Through this lens, problems can be framed through the collective and holistic insights of multiple disciplines, perspectives, and expertise working together to address the complex challenges of climate change. This will inevitably require reimagining and expanding conceptions of knowledge and expertise, knowledge producing processes, and the nature of substantive collaboration and partnerships.

In each of these research clusters, the School will push the disciplines to understand the implications of climate on "non-climate" scholarship within their own fields. Does it alter the discipline itself? For example, how does the reality of climate fundamentally change the way we think about core disciplines like economics, development, and capitalism? Does climate change affect how we practice urban design and urban planning? How does it change how we understand geopolitics and international affairs in general? Does it change our understanding of the core concepts of civics and ethics? And so on.

The descriptions below include *some elements* of what might form and evolve under these themes, but it is by no means comprehensive.

1 - Living with a Changing Planet / Adaptation

This research theme would seek to understand future Earth scenarios and the expected impacts of climate change and increasing climate variability, as well as the societal implications of those changes. It would include work on understanding the current and past functioning of the Earth. For example, elucidation of the interactions between the solid Earth, hydrosphere, biosphere, and atmosphere, and how these interactions control the natural and anthropogenically-perturbed carbon cycle are needed to inform our understanding of the future.

The groups working in this theme would aim to improve our estimates of what is likely or possible in terms of future climate and its consequences for Earth systems, ecosystems, and human health and wellbeing. Topics would include enhanced modeling, melting ice sheets, sea level change, changes to the planet's carbon cycles, biodiversity loss, extreme events, heat and wildfires, water and food security, political unrest and mass migration, etc. Additional efforts would study how to address or adapt to these changes. Working with climate scientists, this cluster would apply methods and knowledge from sociology, anthropology, psychology, ecology, biology, and philosophy to consider and address how humans and ecosystems can survive (or perhaps even thrive) on a changing planet. What kinds of futures are possible in a planet altered by climate change? What kinds of societies?

An example of one element of this cluster is understanding and addressing **sea-level rise**, which poses one of the most comprehensive risks to society. The core challenge presented by rising seas requires using the best science to inform immediate and actionable design, planning, legal, and policy frameworks that will ensure that humanity can anticipate and plan for an equitable, economically stable, and just path forward despite increasing uncertainty. It is essential that we improve our predictions of how fast and by how much sea level will rise over the coming decades and centuries. This requires better glaciology and modeling of ice sheets. Communities around the world also need to understand now how their coastlines will change, which requires complex new science. Further, there is the association of rising sea level with storm surges and coastal flooding. Rising seas therefore will impact coastal habitability, urban development, and the health and sustainability of (economically valuable) ecosystems. There are many issues to address. For example: What are the technical solutions? What natural solutions might be feasible? When and where can they be deployed over other methods? How can communities adapt to the loss of their lifestyles? If certain regions become effectively uninhabitable, where do people go? This has strong connections to Theme 3 (below).

This is just one example, but there are many more in this theme. For example, we also need to better understand the stress that climate change exerts on the biosphere more broadly and its role in mass extinction. Aridity and wildfires are a growing concern. Water resources and food security will be major issues. All of this research needs to incorporate infrastructure planning, architecture, geosciences, ecology, engineering, urban design, public health, policy, economics, and finance with work in the humanities and arts to understand how our cities, landscapes, people, and livelihoods must adapt and how to facilitate those changes justly and equitably.

Climate change is not just about the long-term effects of global warming. Climate is already highly variable today on a year to year basis because of effects like El Niño. This variability and the extremes that are experienced are expected to worsen because of the long-term global heating of the planet's surface. Columbia, most particularly the **International Research Institute for Climate and Society (IRI)**, is **world leading** in the underlying research and delivery of climate services to address this. In order to work, such climate services depend on a solid understanding of how climate fits into the broader decision context, as well as the political will to foster multidisciplinary research and practice. Climate services use past and current climate data (such as measures of precipitation) to address risks and opportunities at relevant time scales with appropriate solutions, informed by high-quality data (such as whether or not to fertilize in certain areas or to buy index insurance this growing season). Climate services are being offered commercially by some, but the depth of understanding of the science and the associated assessment of risk are nowhere near as powerful as are achieved through IRI. This is an important part of Columbia that long has been funded from soft money but now is also supported by Columbia World Projects funding of ACToday.

There are other aspects, too. We need to understand the risk of cascading societal impacts within and across nations, including collapse of real estate values, inability to finance and deliver critical infrastructure services, major population shifts away from coastlines, and political instability. A subgroup could pursue and quantify the

various aspects of these risks and how to use this information to reduce exposure and risk, making decisions on where to devote efforts for actions and solutions across all scales.

For this research, the cluster must consider issues of racism, conflict, justice, indigenous sovereignty, and migration. What happens to people displaced by climate change (both within communities and across nations)? Who pays for those changes and how? These sorts of questions require expertise from history, law, economics, business, philosophy, political science, and geosciences. It will also require local sources of knowledge from the communities themselves that inform the discussion, including their own history, values, culture, and religion.

2 - Climate Management / Decarbonization

Without rapid innovation in energy production and other decarbonization and sequestration technologies, it is unlikely that we will limit global warming to 2°C let alone 1.5°C, as is recommended to limit the worst effects of global warming. While renewables have rapidly advanced in recent years, they will not be sufficient to replace our current carbon-based energy production. The fundamental challenge of reducing global greenhouse gas emissions while continuing to increase the standard of living worldwide requires new technological solutions plus insights into how these solutions will manifest themselves in society.

This research cluster will address the urgent need to decarbonize our global economy and infrastructure. Decarbonization will require major industry transitions, including the power, transportation, building/real estate, and agriculture sectors, but also shipping, heavy industry, and aviation, among others. This research theme studies and seeks to rapidly advance the actions required in the various emitting sectors of our economy, particularly those that are difficult to decarbonize such as building heat, agriculture, and manufacturing. Transitioning these industries and infrastructure poses technical, political, social, and behavioral challenges. The opportunity presents itself to combine diverse attempts to address these challenges, considering that innovation is both truly essential and realizable with appropriate investments. A critical question will be how to stimulate the research & development, innovation, and diffusion needed to drive net emissions to zero?

This theme would include research on climate and mitigation activity in the context of a dynamic risk management and control problem, which entails a) predictions for the future, including an understanding about the uncertainty around these predictions and how they evolve over time; b) models of the mitigation levers, their possible efficacy and cost, and how these actions interact with the downstream predictions; and c) economic modeling of all of these phenomena. To do this well, it must include climate science, engineering, and applied sciences with political science, policy, and law, as well as business, economics, health, architecture and planning, and finance, and psychology, sociology, anthropology.

The research will require interdisciplinary partnership to understand how to decarbonize over time, in line with different temperature targets and climate impact projections as well as in response to different external influences (policies, social and cultural changes, and pressures). The research will expand work on how climate policy should be adopted in the context of macroeconomic policy, as well as the economics of the energy transition. This cluster will require collaborative knowledge creation around the “social cost of carbon,” which requires ethical considerations from multiple disciplines as well as climate science and economics. It will need to partner with communities that will be upended as entire sectors of the economy are uprooted to understand how they might adapt to these changes. This research cluster must consider the impact on vulnerable populations in the economic transition and explore how different entities, such as governments, can ensure that the transition is just and equitable.

This cluster will naturally focus heavily on developing and implementing technical solutions: expanding and creating next generation carbon-free energy sources, including ones that are neither intermittent nor site specific. This includes work on renewables, nuclear, hydrogen, and others. This cluster will also focus heavily on other technical solutions that are needed at rapid and massive scales, such as energy efficiency, advanced batteries,

advanced grids and grid operation, as well as work on negative emissions/carbon dioxide removal, storage, and utilization.

The deployment of these technologies will be important as well. Research should seek to better understand the interactions between the technologies and the economic, social, political, and financial systems that they would function within—particularly the governments that will regulate and incentivize their use, the companies that will commercialize them, the financial institutions that would fund projects, and the consumers that would use them. With what certainty can such advanced technological solutions be found and what is the shortest time scale over which a solution could be deployed in an ethical manner?

This theme must also consider the ethical challenges of technological change—such as geoengineering. This work sits at the intersection of psychology and experimental philosophy and could draw in many other fields. Finally, the relationship between humans and technology can be as interesting and relevant as that between humans and nature. Historians and anthropologists can work with engineers and scientists to study how technology developed, and how technology, as it developed, shaped societies. What can we learn from technology transitions of the past to apply to what will be needed today and in the future?

3 - Climate and an Ethical Society

Climate ethics, decision-making, and governance can serve as a cross-cutting theme that will support the adaptation and decarbonization clusters, but given its outsize influence on impact, it can also form a separate research hub. The cluster will address the enablers for mitigation and adaptation across all levels of society – social justice, policy and law, finance, corporate management, and communication.

Climate change is the most profound and urgent problem that humanity has ever faced. Part of the reason for this is because it, like nothing before, brings together anthropogenic global biophysical processes and socio-political, ethical, and economic processes at multiple scales. This research theme will consider the historical context that led to this global crisis in order to understand the behavior of governments, institutions, and individuals and to support adaptation and protect the world's most vulnerable citizens. This will also require difficult and speculative conversations about what kind of future we want and how to produce that kind of future.

For example, one crucial topic in this theme would be climate-related migration. Scholars working here would seek to understand the deep histories of movement and migration in a region, with an eye to the historic geopolitical drivers for relations between territories, colonizing nations, institutions, and individuals and an eye towards contemporary seemingly non climate-related drivers of migration like war, economic inequality, and the like. By grounding questions of climate migration in this way, the theme allows for a more nuanced understanding of the structural inequalities driving migration and when, where, and why people move in the face of floods, fires, sea level rise, decreased agricultural possibilities, and decreased food or water security. The Climate School will then be poised to offer robust solutions that support and mitigate the social factors underpinning migration as well as the climate-related causalities.

Having identified the causes for global and local climate-related structural inequalities it will then focus on how these inequalities are or are not addressed at multiple scales by seeking to understand how and why individuals, institutions and governments act (or do not act) today in morally or ethically just ways given the climate emergency today. With this it would also work to understand the power dynamics and politics across scales that lead to optimal or suboptimal outcomes that improve or worsen climate justice. It will study the capacity and responsibility of various stakeholders, like nations, fossil fuel companies, and global governance institutions like the United Nations, to act. Tied to this, scholars would also research methods to compel non-cooperative actors to participate, and mechanisms by which environmental justice can be embedded in those processes. Having worked to understand the ethical issues above, this cluster would focus on questions of how to communicate

across scales and platforms to better inform policy, governance, and decision-making processes at both institutional and individual scales, and how to foster ethical approaches to a variety of climate-related situations.

Teams working under this theme might also study human cognition and how individuals in power, like politicians, and individuals with seemingly little power, like voters, form attitudes and beliefs about climate change, and how those attitudes and beliefs influence their climate-related behaviors. When people say that they "believe" or "don't believe" in climate change, where do those beliefs come from? How are they shaped? Can they be changed, and if so, how? At the individual level, research can focus on how individuals align their values, morals, and actions with their personal contribution to the problem. How can people reconcile the conflicts of their daily lives with the societal needs for change? What are the psychological effects on a generation of young people growing up with climate change as a given? How does it change their views of the world, society, and themselves? Young people, in particular, find the outlook depressing. Do we need to consider climate communication alongside psychological well-being and health?

Going further, how does this process change from an individual to that of groups? If human behavior is contributing to climate change, then research on behavior change can address tools for education, persuasion, and behavior change more generally to identify means for reducing our climate impact. This cluster would research both individual decision-making and collective action on climate change, and could develop experimental labs on cooperation, collective decision-making, and communication. This could also bring in data science as well as the study of social media and its influence on society.

This cluster would draw from a variety of disciplines including business, psychology, philosophy, anthropology, sociology, economics, and climate science to consider how people make decisions around climate and how to influence the process. This group would include research on individual and collective firms, particularly given the absence of government action and withdrawal of major nation-states from global leadership around climate (e.g. U.S., Brazil). How can major multinational companies make progress toward mitigating and adapting to climate? What is the role of shareholder activism and regulatory reform? This cluster will seek to better understand the institutional barriers towards action within the business community (real estate, insurance, finance, consumer goods, etc.) and to develop systems and tools to overcome these challenges.

There is a critical need to provide public and private stakeholders (decision-makers) with actionable information—for both adaptation *and* mitigation. Given the constrained choices available to policymakers, the standard climate scenarios do not provide sufficient level of specificity to aid decision-making. The governance cluster could create "bespoke" emission scenarios based on real choices or real projects that would be run using state-of-the-art climate models and whose impacts — for climate, air quality, public health, crop yields, ecosystems, etc.—would be of immediate value to decision-makers. This process could define a new level of 'best available science' that could become standard for all environmental assessment reports.

Education

It is critical that whatever form the Climate School takes, existing climate-focused and sustainability education programs are allowed to build on the success they have achieved. The Climate School must give them greater visibility, and allow them the opportunity to expand, while filling educational gaps, as they exist and as the market demands.

Columbia needs to consider what skills and knowledge its graduates will need to address the challenges of the future. Students who build up a knowledge base around climate change will have a key advantage when building their careers, as they will have the expertise required to address challenges that will need attention for decades

to come. The climate crisis cuts across every sector and industry and impacts people in every corner of the globe. Students in the Climate School might become experts in climate science and solutions, to be able to tackle the challenge head-on. Or, they might take just a few courses on climate, to be able to incorporate that knowledge with their careers. The education structure of the Climate School should support all different interests and desired levels of climate knowledge. It should create a common knowledge base that is easily accessible by any Columbia student, regardless of degree program, to help ensure that future change makers and industry leaders bring a climate perspective to bear on their work.

The School could also fundraise to develop new fellowships and scholarships for students across the University who wish to enter climate fields. For example, the path of a climate lawyer or a SIPA graduate going into climate policy at a non-profit will not be as lucrative as some more traditional non-climate paths. Columbia's Climate School could help facilitate inroads toward this important field.

Courses

A Climate School could start by first (quickly) building new courses, not degree programs. It should be easier for anyone and everyone to study climate, today. This could be done by incentivizing existing faculty and scientists to teach a new course in a climate-relevant field.

Faculty from across the University could be challenged to incorporate climate into their teaching, particularly for those that have no currently. Climate should be seen as an interesting and exciting problem upon which to apply a discipline's methods and tools. The Climate School could ask each department to develop and offer one course in climate. To help do that, the Climate School could offer course development funds and/or course release to faculty (or buy out of academic time) to create such courses. The Climate School could also incentivize joint-teaching from two or more disciplines. The courses could be at the undergraduate, masters, or doctoral level and be offered in their home department, but ideally be open for students across the university.

Over time, as new faculty are hired directly in the Climate School, they would create their own courses in areas that are not being taught anywhere else at the University. The courses offered directly by the new School would be open to students at all schools. For example, doctoral students from any department could take climate sequences (2-3 courses) at the Climate School that complement their core disciplinary training in their school/department. Masters students could take electives from the Climate School. Undergraduates could take courses or sequences offered by the School that align with their existing curricular requirements. These courses would be resources to the rest of the University and those schools' students.

The Climate School could also offer a creative intellectual and physical space (eventually in a building) for inter-departmental courses, such as studios, clinics, workshops, and other practical, hands-on based classes for experiential, learning-by-doing. Students from SEAS, SIPA, GSAPP, etc. could come together for a course on a specific actionable problem related to climate and working with communities. Tapping into the creative powers of students from multiple degree programs/disciplines, Columbia could develop strategic relationships with government entities to provide out of the box ideas and consulting-like experiences. This enables transdisciplinary learning for students, and direct engagement in societal solutions. Similar work is done already in many schools, in the form of capstone projects or studios, but this could be unique in that each project would include students from different schools — working together on a semester-long or year-long project. Climate School faculty might lead these courses, partnering with faculty from other schools depending on the given project/client/problem. Co-curricular, club-based, or non-course programming could be developed similarly for students to engage together, across degree programs.

Certificates

Courses could ultimately be paired together into "tracks" or 12-point masters-level certificates. A "core" climate curriculum could be created—four interdisciplinary courses that could form an introductory certificate for anyone

interested in climate, taken as a stand-alone or in conjunction with a degree elsewhere in the University. It might also offer more specialized certificates such as "food security and climate" or "climate justice" that might entice students who may not want a full degree but want focused knowledge on an element of the climate problem combined with specific methods, tools, and practical approaches relative to those issues. Certificates could generate some revenue for the School.

Graduate Programs

The Climate School could collaborate with other schools to help deliver and expand existing climate-focused or climate-related masters programs in a similar manner to the Earth Institute's current educational role. If agreeable to the other schools, existing climate-relevant degrees could become "co-sponsored" by the Climate School (like many are now co-sponsored/co-branded with the Earth Institute), even though these would not be true "dual/joint degrees" (in that a second/parallel degree is not actually granted by the Climate School).

In this way, the Climate School could offer its new faculty the opportunity to teach in existing, well-established, and well-regarded programs. This could bring in more students who are attracted to Columbia both for its Climate School as well as its more disciplinary-based schools. This model enables existing environmental and climate related programs to expand without requiring new funds at their "primary" school. The Climate School resources could help grow the size of the programs and generate more tuition for the "primary school". This would be one way for the Climate School to provide tangible financial and academic value to the Schools. It would not necessarily be a revenue-generating endeavor for the Climate School, but rather a service to the University.

The Climate School could eventually offer its own master's degree, perhaps as dual degrees with schools that don't already have climate-focused degrees (e.g. an MS in Climate from the Climate School and a JD from the Law School; an MS in Climate and an MS from Journalism; MS in Climate and MFA from the School of the Arts; and so on). Such joint degrees likely would not be necessary for schools like SIPA (thus the "co-sponsor" model mentioned above). In this model, the School could, over time, develop a core interdisciplinary climate curriculum that students would pair with their professional degree in another School. These joint degrees would help attract students to Columbia for the opportunity to pair an interest in climate with a more traditional professional degree (like Law, Business, or even Nursing). It would be in these new degree offerings where the School could generate its own tuition revenue. One could envision a time when any student at Columbia, regardless of their program or School, could take a Climate program (whether a certificate, new dual-degree or one of the climate co-sponsored degrees). Whatever new programs are developed should have clear learning objectives; students should understand the skills being developed and the job market available after graduating with such a degree.

The School could also help to increase the sizes (through dedicated fundraising) of climate-relevant doctoral programs like those in sustainable development, earth and environmental science, and ecology and evolutionary biology, to build a pipeline for academic scholars in these areas. Perhaps over time it might create a new doctoral degree, if warranted. For the near term, the Climate School would seek to expand offerings in existing doctoral degrees and develop sustainable mechanisms for interactions through regular seminars, events, seed funding, workshops, and courses. Again, the School is providing a service for the University to invest further in its students.

Undergraduate Education

The Climate School could facilitate the reworking of the undergraduate core curriculum, such that all undergraduates at Columbia are exposed to the issues related to climate. This does not require a major overhaul of the core curriculum.

First, a 4-week module in "Frontiers of Science" could be devoted to climate, which would enable all undergraduates to be exposed to some climate science. In addition, new full courses in climate science could be created as approved options to fulfill the undergraduate core science requirement. Similarly, "University Writing" could offer a section using climate as a specific theme—"UW: Readings in Climate Change." It already offers a half

dozen subject-specific sections. The School could also challenge/incentivize existing faculty of the current University Writing sections to consider climate as a vehicle ***within*** their own subjects. For example, "UW: Contemporary Essays," "UW: Readings in Data and Society," "UW: Readings in Law & Justice," "UW: Readings in Human Rights" each could lend themselves to incorporating elements of the climate challenge. Similarly, the Climate School could facilitate the introduction of climate change into "Contemporary Civilization" as climate change is arguably the greatest challenge facing our civilization today. The "Global Core" could also add courses that examine global cultures and civilizations in the context of a changing climate. In each of these instances, climate is used as a tool or lens to learn the core curriculum. These changes could be made quickly, if we could find existing faculty/scientists to teach them. It could then be expanded once new faculty are hired and more sections/course options are developed.

Finally, existing undergraduate majors, such as Environmental Science, Earth Science, and Sustainable Development, could each be expanded to add additional climate course offerings. Any and all of these changes could be done without adding any new majors or concentrations, which the School might also develop in time as it assesses the current landscape of offerings and where new programs are needed.

Executive Education

The School could become a center for executive education offering customized courses and gatherings, large-scale climate forums, and the possibility for professionals and others to "keep up" – not only with the technical and applied climate knowledge and practices that exist across campus but with the hybrid ideas that can transform their respective practices. The School could work directly with major companies to teach and "accredit" their leadership, boards, or staff in climate-relevant knowledge applicable to their businesses (such as the recent program with Alliance Bernstein and Lamont-Doherty Earth Observatory on climate risk). This could be done similarly for government employees. This, of course, could extend to the Columbia Global Centers which could co-produce knowledge focused on regional climate issues and consider offering various kinds of climate certification and/or ongoing memberships in support of local efforts to address climate change's complex and scaled impacts. Executive education could grow into a viable, sustainable revenue stream for the school, and have a significant impact as firms and governments directly and quickly implement the knowledge learned at the Climate School.

Global & Local Education/Training

The Climate School could include multiple models of education, training and retooling for audiences around the world. This may include short (weekend or weeklong), zero-credit courses taught at the Global Centers. It could include training programs geared towards scientists who want to learn new skills and engage in something more practice oriented. It could include online training for a general audience on topics like climate resilience, climate science, adaptation, renewable energy, and more. It could also include short leadership training courses in New York. These are distinct from executive education in that they would be tailored more toward individual learners, community leaders, and non-traditional students, rather than customized courses for companies. This would not likely be a major revenue stream (likely just covering costs), but a mission-oriented, impact-driven activity.

It could also develop and expand existing outreach, training, and education for K-12 students and teachers, either via global online courses for science teachers, hands-on learning experience for students on campus, or summer workshops to gather and train teacher-mentors in climate-related topics. Local outreach could include visits to New York City schools for talks or demonstrations to help raise awareness and motivate younger students to address climate change in their daily lives.

Solutions and Impact

Columbia has a social responsibility, not only to its students, faculty, and staff, but to its community and to broader society. The Climate School could be structured to amplify the University's societal impact on behalf of climate change mitigation and adaptation solutions. The Climate School could engage directly with companies, government organizations, civil society, multilateral organizations, and finance institutions, as well as other academics to deliver real change in society.

A community-based approach is key; the University should not just set the agenda but rather have two-way engagement with communities, listening and being supportive to real-world needs in the climate context. An important facet of the School could be working with local and regional communities to co-produce knowledge and develop place-based solutions to climate change challenges. The School could serve as a hub for creating, testing, and disseminating knowledge about regional climate projections and adaptation strategies, and then engage directly with the local communities to test and implement solutions. In particular, the School could work in our own backyard, in Harlem and Morningside Heights, to set up real projects that use our surrounding community as a 'living lab.' The School must acknowledge inequitable distribution of climate impacts across populations, with low income and communities of color being in most need, include these communities in decision-making, and give them a seat at the table.

Policy will also necessarily be a focus of the Climate School—both on the academic and practice sides. The Climate School could purposely build the capacity to inform the policy debate, design policy solutions, and assist legislators in developing climate policy and government ministries and agencies in implementing those policies. This capacity requires both academic research as well as policy expertise, experience, and relationships.

Extension Services / Knowledge Support

The School could develop a robust decision-support service, like the agricultural extension service, for climate for specific stakeholders on specific problems. The School could engage on the issues that matter most to them, bringing our knowledge to practice. This will provide stakeholder engagement and information on climate risk, adaptation, and mitigation options for private and public actors, connecting the knowledge generated at Columbia to action and helping the School's faculty and students to forge and manage the broadest possible range of external relationships. Through the Climate School, Columbia could take the lead in creating an open-source archive and data library (building on the IRI's) for climate-related research, knowledge, and applied practices in order to strengthen its commitment to serving the public good across the world.

Convening

The School could convene stakeholders at all levels to harness both the academic and non-academic knowledge needed to address this crisis. Through both small and large events—lectures, conferences, seminars, workshops, and more—the School could seek to convene both the broader public, as well as the local community, around climate change. The School could also engage in partnerships with industry, NGOs, governments, and many others to convene on local, regional, national, and even global scales. Columbia's location in New York City provides unparalleled access to a variety of communities, institutions, businesses, and sectors.

Communications

The Climate School could build a major activity in new forms of climate communication. This would be both a practice activity, and an area of academic excellence, bringing in subjects like psychology and decision-science (tied to research theme 3). On the practice-side, it will train journalists as well as scientists in a two-way knowledge sharing to improve media coverage of science. The communications initiative would have strong interactions with journalism, the arts and humanities, and could run periodic trainings for journalists, writers and artists in residence, and exhibits.

Faculty Resources

The School would provide new resources for new and existing faculty to build up capacity around climate.

New Faculty Hiring

A Climate School would aim to recruit **the most outstanding, diverse faculty to Columbia**. The research will be focused on difficult issues that require brilliant scholarly minds to advance existing subjects and define and build new areas of study that are critical to addressing this problem. They should be drawn by the ambition and opportunity of this novel and ambitious new school, as well as by the strength of the institution. The faculty might work in research teams supported by endowment funding, as well as external grant income. A critical mass of the top minds and rising stars in the world would be recruited such that we can address climate change issues on a time frame and scale that matches the challenge. A strategic priority would be to recruit faculty with diverse gender, racial, and cultural backgrounds, in order to reflect the makeup of populations that are most impacted by climate. Complex problems like those associated with climate change cannot be solved with just the voices of a few. Diversity, equity, and inclusion would not just be a value statement, but a framework by which to hire and recruit, mentor, and retain. The skill sets and experience needed to make a difference mean that not all faculty would be drawn from traditional academic backgrounds, though many, and possibly most, would. There would be a range from traditional academic tracks to leaders in policy and finance who demonstrate the ability to bring their expertise and experience to bear in producing original, first-rate scholarship.

Appointment and Tenure

In some instances, hiring will necessitate the recruitment of different kinds of academics. It will require practitioners and others with non-traditional academic backgrounds whose expertise and experience are necessary to craft the policies and other solutions necessary to turn research into action. Addressing climate means hiring individuals with diverse subject expertise as well as ones with distinct types of professional experience from industry, other businesses, and government and not-for-profit organizations. The strength and impact of work in climate will depend in part on Columbia's ability to achieve new levels of academic appointment from non-academic backgrounds, and the metrics by which we evaluate success. The Climate School could take advantage of the University's advancing work in identifying and developing the necessary academic and administrative support structures for the **"Fourth Purpose of the University—Impact"** including new hiring procedures, appointments, and tenure processes. The Climate School could demonstrate to the rest of the University that such changes are not only feasible but necessary to facilitate the very best of what Columbia can achieve. In turn, Columbia can show the rest of the world the future of academia.

Joint Appointments

The goal of this new entity is to help bring together climate knowledge and expertise from across the University. It must operate in partnership with the other Schools and serve to strengthen connections between already existing work around climate change. Joint appointments foster cooperation, bringing together resources, knowledge, and tools from the separate entities to enable cross-cutting research capabilities. Faculty could be appointed as joint faculty members in the Climate School and another department, granting them a disciplinary home as well as a place for interdisciplinary, problem-focused climate work. This would free up resources in departments and schools, allowing them more flexibility to hire others and pursue new research activity, thus benefiting Columbia at large.

Another model could be the buying out of 50 - 100% of a faculty member's time to work in interdisciplinary climate activity over the course of 5-10 years – an internal secondment-like appointment. This secondment model also facilitates the flexibility to adapt to the changing nature of the problem over time. The secondment model might also be attractive to some individuals from outside Columbia wanting to focus their attention on a problem at the Climate School for a significant period, but without promising a tenured position, which would lock up resources.

A School for Faculty

The Climate School could intensify, accelerate, and scale up climate knowledge and its spread across all of the disciplines and practices at the University by exposing the largest possible number of faculty to climate science. Similarly, climate scientists could be encouraged to take classes about other elements of the climate challenge—health, political science, psychology, etc. Modelled on the idea of faculty leave, every faculty at the University could be supported to take classes at the Climate School on a regular basis. The cross pollination that would ensue would place our faculty fundamentally at the forefront of climate-knowledge across all disciplines and practices. For the University as a whole, the continued but also intensified and focused education of its own faculty would bring the most burning questions to climate science while in return enabling faculty to bring back to their own disciplines the crucial new modes of framing and radical paradigm shifts that are desperately and urgently needed. Science-based climate knowledge would quickly spread across the campuses and beyond, infiltrating all aspects of intellectual life, its engagements and actions. At scale, within a decade, the University would see an organic and fundamental transformation across all schools, departments, programs, and classes. Every school could present itself with confidence as a climate-based school, attracting the best students as a result. The faculty would be known as uniquely qualified to address the intersection between their home discipline and climate science, continuously informed by the ever-changing discoveries and challenges that climate change is already producing.

Physical Space

Manhattanville: Columbia cannot create a major new school over the long term without additional space. Establishing a home for the Climate School, presumably on the Manhattanville Campus, provides a method of achieving this. A defined and recognizable physical presence would support interactions and socialization for research, education, outreach, and impact.

A "Climate Building" would not just be a space for education and research in the normal sense. A building could also be a space that facilitates an immersive experience in climate. Students, researchers, staff, and faculty would interact informally, for example over meals, as well as in developing seminars and discussions. With the hub and spokes model this need for a physical space for interaction and spending time is especially important. It offers something that currently is unavailable across Columbia for working on the issue of climate. In addition, some centers and important think-tanks, currently scattered across Columbia could usefully co-locate within the new building, providing a degree of interaction that is badly needed.

Therefore, a partial list of priorities for a new building includes multiple, flexible spaces for people to meet and convene; modern and environmentally sustainable space for faculty and researcher offices; administrative and support offices; student study areas; classrooms, seminar rooms or conference rooms; a large multi-use event space, as well as smaller event spaces and conference rooms; collaboration hubs; and a café/lounge for Columbia affiliates and the public. It could also possibly include a green tech incubator space for private sector collaborations including those specifically for alumni and the local community. It could include short-term housing for visiting faculty and scholars or those on short-term appointments, and perhaps even students. It would be important that from the inception of a building, sustainability is central to every element of the design. A Columbia Climate building should be a world-class example of sustainability and incorporate cutting edge and forward-thinking approaches to create a net-zero building. In this way, the building itself would serve as a laboratory for learning about climate-forward approaches to building, system design, and behavioral change for building occupants.

Lamont-Doherty Campus: The Climate School should also help invest in infrastructure on the Lamont-Doherty campus to revive it and keep pace with peer institutions in the geosciences. With science remaining a key component of the proposed School, the scientific laboratories on the Lamont campus must be considered carefully to ensure it can deliver cutting edge scientific breakthroughs. It badly needs state of good repair upgrades as well as new scientific facilities to enable the recruitment and retention of the top scientists. It also needs greater connectivity with the downtown campus (e.g. more buses, the possibility of electric boats between campuses, and better meeting facilities at Lamont to bring up downtown faculty).

Living Lab: Students from across the University would work closely with the Office of Environmental Stewardship, through courses, studios, internships, capstones, and co-curricular projects to improve the sustainability of our University. The campuses can be utilized as "living labs" for research and education on sustainable operations and management, including energy usage, built environment, carbon footprint, and more. This could become an integral part of the student experience in the Climate School—hands on experience making an impact on the University itself.

A University Pledge: Sustainability

Columbia needs to lead by example and focus on its own sustainability. A Climate School that does not also look inward will come across as hypocritical. The need to balance long-term institution building with immediate action is perhaps no clearer than with the University's own footprint and endowment portfolio. **The University should consider making a bold pledge, such as carbon neutrality**. Many also think divestment from fossil fuels is necessary to make a true statement about the University's leadership on climate. If Columbia could figure out a way, say, to source its power entirely sustainably, it would send a clear and unambiguous message to other universities that climate change demands significant action now. The University could also consider enhancing travel incentives for biking and commuters, massively improving and building up virtual meeting facilities as an alternative to travel and providing carbon offsets for long-distance university travel. These activities can address concerns that Columbia needs to act swiftly in order to address the urgency of the climate issue, as a School will take years to build and will be a structure for the longer-term challenge.

Next Steps

This report is the first step among many in bringing a Climate School to fruition. In the first half of calendar year 2020, following the Trustees' review of the core ideas/principles embedded in this report, the University would proceed with a detailed planning process. The University could, for example, organize a two-day, facilitated, design-thinking process to lay out the details of the school. This could include working groups on the following topics, which would continue in small groups over the spring semester and year. Some of these could happen concurrently, while others more sequentially (e.g. a building design is dependent on the program). These would necessarily involve key administrative and operational partners around the University.

During the design process we may consider what the School might look like in ten years, and reverse engineer the design from that point. Committees may also evaluate what has worked well and what has not, with respect to the topics under their purview. The design process, like the Task Force and engagement process around it, will continue to be broadly participatory, bringing in faculty, scientists, students, and staff from around the University. It will remain transparent and open to the community at large

School Design: Developing the details of a working model that is innovative, but also makes sense from a structural, practical, political, and financial perspective. This working group would develop how a school would function and what it looks like at Columbia (e.g. hub and spokes model, role of Lamont and Earth Institute to the school, relationship to Columbia World Projects, etc.). It would build upon the principles laid out here, developing the plan in much greater detail than is possible for this report.

Business Model: This group would establish the details of a financial model for the School, taking into account the relationship to other parts of the University laid out in School Design. This would include sequencing of activity that builds up to a self-sustaining long-term model, subsidized in early years through initial philanthropy.

Fundraising: This group would lay out a development plan for what will need to be raised to execute on the vision of the Climate School. It would seek to develop the details for what resources are needed and when, as well as connect to donor cultivation and stewardship.

Curriculum Design: This group would develop the pedagogical design of new curricula as well as the incentive mechanisms to bring existing faculty to teach new climate-related courses in their existing departments and programs. They would establish the initial tools for enabling a curriculum that changes over time as new knowledge, skills, and tools are needed to address the full range of climate issues.

Physical Space/Building: This group, once a design for the school/academic program is established, would begin the process for designing a building in Manhattanville, and how it links to upgrades at the Lamont campus and the ongoing space master-planning exercises for Arts & Sciences, as well as other new buildings at Manhattanville. The group would serve as a master-planning space committee for the Climate School, working closely with other relevant entities at Columbia.

Columbia Carbon Neutrality: This group might consider how the Climate School interfaces with the campus sustainability efforts to elevate current ambitions related to the University footprint, including how it could advise on energy retrofitting, divestment, travel offsets, and other options the University might consider.

Appendix A: Frequently Asked Questions about a Columbia Climate School

1. **Universities don't usually organize Schools around "problems." How can we be sure this is not just a fad that in 20 years, or, when we "solve" the climate crisis, becomes irrelevant?**
   Climate change is not something that will go away. Even if we achieved massive decarbonization (which we are not nearly on track to do), the built-in impacts will be felt far into the future, and the solutions will lead to new issues that have not yet been considered. The issues and impacts around climate will be relevant for centuries, and the skills and techniques used to solve those issues will be relevant to future global scale phenomena.

2. **What about topics of sustainability, sustainable development, the environment, etc.? Do these belong in the Climate School?**
   Yes—these broader environmental issues are important to the climate challenge, and even though the School will be called "Climate" the education and research footprint will be more comprehensive. One can't talk about climate without discussing the environment and sustainability.

3. **What will happen to the Earth Institute (EI) and Lamont (LDEO) under this structure?**
   The next stage of planning and design will be important to determining the structure, and how EI/LDEO relate to the school. EI and LDEO have both achieved great success and have strong brands, and the School should build on that.

4. **What will happen to existing education programs around climate (i.e. MA in Climate & Society, MPH Climate & Health concentration) or sustainability (e.g. MS in Sustainability Management)?**
   Existing programs will not change unless the schools that house them would like to leverage the Climate School resources. The expectation is that the Climate School would enhance existing programs by providing a broader community to engage with, additional faculty, and co-curricular, cross-program activities for students.

5. **How can we ensure that new education programs don't compete with existing ones?**
   The Climate School will create education programs that fill specific gaps at Columbia (e.g. a joint degree in climate and law); it is not intended that it will create programs that compete with or cannibalize existing activity.

6. **Won't the Climate School rob existing schools of their faculty?**
   The hub and spokes model is designed to prevent this. In fact the Climate School should help recruit faculty and students interested in coming to Columbia because of its existence and the opportunity it provides for novel interdisciplinary activities, even if they are appointed in existing schools. It will attract individuals that would not have come otherwise.

7. **What does the job market for graduates of the Climate School look like? Is there a demand for this type of education?**
   Initial market analysis shows that there is a growing demand among employers and growing interests among students for training and knowledge in climate issues. Climate touches all aspects of society and the economy, and graduates with climate-relevant knowledge and tools will be employable across multiple fields and jobs. Further market research is needed as specific degrees/joint degrees/certificates are developed.

8. **Will there be an undergraduate degree?**
   There are no immediate plans for a new undergraduate degree in the first stage. The School will work to incorporate climate education in existing undergraduate structures (with new courses, incorporation into the Core, etc.) as the detailed curriculum design for climate education across the university is considered.

9. **Will there be a master's program in the School?**
   While the curriculum has yet to be designed, initially the School would likely develop joint degrees and certificates in climate, so that anyone at the University can supplement their education with climate knowledge. These joint degrees would be targeted in parts of the university that do not already have climate-specific or related education. Eventually, there may be a stand-alone MA/MS program or programs.

10. **Do you have faculty recruits already targeted?**
    Yes, there are faculty recruits who are both recognized superstars in their field and superb rising stars that would make excellent targeted hires as the School develops.

11. **Who at the University benefits from a Climate School?**
    The goal is for everyone at the University whose work touches upon climate to benefit from this. The School will not only amplify and uplift existing work, but provide financial resources to Schools through joint appointments, student fellowships, expanded visibility, enhanced competitiveness for interdisciplinary grants, etc. Additionally, the School will become an entry point for climate knowledge, for those faculty or students who may be interested in the issues but don't have a formal or clear avenue to access that knowledge.

12. **Who at the University might be negatively impacted by a Climate School?**
    There have been some concerns that the Climate School will be a competitor for resources, students and faculty. This is why the School must not be like a traditional school; and would be organized around a hub and spokes model intended to send resources and other benefits back to the spokes in concrete, clear ways. The next stage of discussion will be very important to ensure the Climate School is a resource for the rest of the University.

13. **How will the School generate revenue?**
    Endowment and other major gifts are needed to support the school, and revenue will come from a diverse mix of tuition, grant funding and executive education programs.

14. **Will the School have departments?**
    This will be determined in the next planning stage, but it is likely that the School might organize around projects and themes instead of traditional departments.

15. **How do you ensure this doesn't create simply another silo? Or another layer of bureaucracy?**
    The next stage of this process—design and planning—will be important in carefully crafting a structure that is nimble, collaborative and porous. The Climate School must be truly novel in its structure and activities to ensure that it remains a creative force for bringing people together around this problem.

16. **What do you foresee as the biggest challenge in creating a Climate School?**
    The biggest challenge will be making progress at a pace that is commensurate with the need for rapid action on climate.

Appendix B: Task Force Member Bios

Amale Andraos is the Dean of the Columbia University Graduate School of Architecture, Planning and Preservation. Andraos is committed to design research and her writings have focused on climate change and its impact on architecture as well as on the question of representation in the age of global practice. Her recent publications include *We'll Get There When We Cross That Bridge* (Monacelli Press, 2017), *Architecture and Representation: the Arab City* (Columbia Books on Architecture and the City, 2015) co-edited with Nora Akawi, *49 Cities* (Inventory Press, 2015), and *Above the Pavement, the Farm!* (Princeton Architectural Press, 2010) in collaboration with Dan Wood.

Andraos is co-founder of WORKac, a New York-based firm that focuses on architectural projects that reinvent the relationship between urban and natural environments. WORKac was recently named the #1 design firm in the United States by Architect Magazine and has also been recognized as the AIA New York State Firm of the Year. WORKac has achieved international acclaim for projects such as the Miami Museum Garage in Miami's Design District, The Edible Schoolyards at P.S. 216 in Brooklyn and P.S. 7 in Harlem, a public library for Kew Gardens Hills, Queens, the Stealth Building in New York and a new student center for the Rhode Island School of Design. Current projects include a large-scale residential development in Lebanon, the Beirut Museum of Art in Lebanon, a new public library for North Boulder Colorado and new offices for a headquarter bank in Lima, Peru.

Andraos has taught at numerous institutions including the Princeton University, Harvard University, and the American University in Beirut. She serves on the board of the Architectural League of New York, the AUB Faculty of Engineering and Architecture International Advisory Committee, and the New Museum's New INC. Advisory Council, in New York.

Richard Axel is a University Professor at the Zuckerman Mind Brain Behavior Institute at Columbia University and an Investigator at the Howard Hughes Medical Institute. In earlier studies with his colleagues, Michael Wigler and Saul Silverstein, he developed gene transfer techniques that permit the introduction of virtually any gene into any mammalian cell. These studies not only afforded a novel approach to isolate genes, but also permitted a detailed analysis of how they worked. This approach led to the isolation and functional analysis of the gene for the lymphocyte surface protein CD4, the cellular receptor for the AIDS virus, HIV.

He then began to apply molecular biology to problems in neuroscience with the expectation that genetics could inter- face with neuroscience to approach the relationship between genes and behavior. His studies on the logic of the sense of smell with Linda Buck revealed over a thousand genes involved in the recognition of odors and provided insight into how genes shape our perception of the sensory environment. Current work in his lab centers on how the recognition of odors is translated into an internal representation of sensory quality in the brain and how value is imposed on this representation to elicit meaningful thoughts and behavior.

Carol Becker is Dean of Faculty and Professor of the Arts at the School of the Arts. She was previously Dean of Faculty and Senior Vice President for Academic Affairs as well as Professor of Liberal Arts at the School of the Art Institute of Chicago. She earned her B.A. in English literature from State University of New York at Buffalo and her PhD in English and American literature from the University of California, San Diego. With research interests that range from feminist theory, American cultural history, the education of artists, art and social responsibility, to South African art and politics, she has published numerous articles and books on cultural criticism including: The Invisible Drama: Women and the Anxiety of Change (translated into seven languages); The Subversive Imagination: Artists, Society and Social Responsibility; Zones of Contention: Essays on Art, Institutions, Gender, and Anxiety; Surpassing the Spectacle: Global Transformations and the Changing Politics of Art and Thinking in Place: Art, Action, and Cultural Production.

She lectures extensively in the U.S. and abroad and is the recipient of numerous awards. She also is a member of the Global Agenda Council on the Role of Art in Society for the World Economic Forum.

Robin Bell is a Palisades Geophysical Institute (PGI) Lamont Research Professor at the Lamont-Doherty Earth Observatory, directing research programs in Antarctica and Greenland, and she has developed technology to monitor our changing planet. She obtained her B.A. (magna cum laude) in Geology from Middlebury College, Vermont, in 1980 and her M.S., M. Phil, and Ph.D., from Columbia University, New York, in 1989. Bell has coordinated 10 major aero-geophysical expeditions to Antarctica and Greenland, studying what makes ice sheets collapse. She has discovered a volcano beneath the West Antarctic ice sheet, several large lakes locked beneath two miles of ice, and demonstrated that ice sheets can thicken from below. Bell also led a Lamont team to map the Hudson River from Staten Island to Albany. During the International Polar Year, Bell led a major expedition to Antarctica to explore the last unknown mountain range on Earth, the Gamburtsev Mountains, which were completely covered with ice. Bell's team discovered that water hidden beneath the ice sheet runs uphill. Using the new IcePod and gravity technologies, Bell's team is currently exploring the Ross Ice Shelf, a floating piece of ice the size of France that covers the least-known piece of Earth's ocean floor.

Dr. Bell has studied the mechanisms of ice sheet collapse and the chilly environments beneath the Antarctic ice sheet, including Lake Vostok, and she has led seven major aero-geophysical expeditions to Antarctica. After receiving her undergraduate degree from Middlebury College in Vermont, she built a 24-foot dory, which she sailed and rowed down the Hudson River past Lamont and Columbia on to Woods Hole where she worked for several years. Returning to the Hudson River Valley, she received her doctorate in marine geophysics from Columbia University. She has chaired the National Academy of the Sciences Polar Research Board and served as Vice Chair of the International Planning Group for the International Polar Year. She is currently president of the American Geophysical Union.

Lee C. Bollinger became Columbia University's 19th president in 2002. Under his leadership, Columbia stands again at the very top rank of great research universities, distinguished by comprehensive academic excellence, an innovative and sustainable approach to global engagement, the institution's most ambitious campus expansion in over a century, and what was, at the time, the largest capital campaign in Ivy League history.

Bollinger is Columbia's first Seth Low Professor of the University, a member of the Law School faculty, and one of the country's foremost First Amendment scholars. His latest book, *The Free Speech Century*, co-edited with Geoffrey R. Stone, was published in 2018. From 1996 to 2002, Bollinger was the President of the University of Michigan at Ann Arbor.

Courtney D. Cogburn is an Associate Professor of Social Work. She employs a transdisciplinary approach to examining the role of racism in the production of racial inequalities in health. She is on the faculty of the Columbia Population Research Center and a faculty affiliate of the Center on African American Politics and Society and the Data Science Institute. The National Institutes of Health, the Robert Wood Johnson Foundation, and the Brown Institute for Media Innovation at the Columbia School of Journalism have supported her work.

Dr. Cogburn is interested in the ways we characterize and measure racism and the effects of racism on racial inequalities in health. She has focused on examining the effects of cultural racism in the media on acute physiological, psychological, and behavioral stress responses as well as associations between chronic psychosocial stress exposure and Black/White disparities in cardiovascular health and disease. She is also developing a project using data science to explore links between media-based racism and population health.

Dr. Cogburn is the lead creator of 1000 Cut Journey, an immersive virtual reality racism experience that was developed in collaboration with the Virtual Human Interaction Lab at Stanford University and which premiered at the Tribeca Film Festival in 2018. The team is now exploring the use of the VR experience in affecting empathy, racial bias, structural competence and behavior.

Prior to Columbia, Dr. Cogburn was a Robert Wood Johnson Foundation Health & Society Scholar at the Harvard T.H. Chan School of Public Health and the Harvard Center for Population and Development Studies. She holds a BA in Psychology from the University of Virginia, an MSW from the University of Michigan School of Social Work, and a PhD in the Combined Program in Education and Psychology from the University of Michigan. Dr. Cogburn is also a board member of the International Center Advocates Against Discrimination.

Ruth DeFries is a professor of ecology and sustainable development at Columbia University in New York. She uses images from satellites and field surveys to examine how the world's demands for food and other resources are changing land use throughout the tropics. Her research quantifies how these land use changes affect climate, biodiversity and other ecosystem services, as well as human development. She has also developed innovate education programs in sustainable development. DeFries was elected as a member of the U.S. National Academy of Sciences, one of the country's highest scientific honors, received a MacArthur "genius" award, and is the recipient of many other honors for her scientific research. In addition to over 100 scientific papers, she is committed to communicating the nuances and complexities of sustainable development to popular audiences, most recently through her book "The Big Ratchet: How Humanity Thrives in the Face of Natural Crisis." DeFries is committed to linking science with policy, for example through her involvement with the Environmental Defense Fund, Science for Nature and People, World Wildlife Fund, and reconciling conservation and development in central India.

Göran Ekström's is a Professor of Earth and Environmental Sciences. His main research interest is global earthquake seismology. This includes the detailed study of individual earthquake ruptures, and the relationship between seismicity and the large scale tectonic deformation of the crust and mantle over geologic time. Professor Ekström's teaching interests include Environmental Geology, in particular the science and policy aspects of the assessment and mitigation of Geologic Hazards. He is a member of the U.S. National Academy of Sciences.

Ekström leads the Global Centroid Moment Tensor Project (CMT) at the Lamont-Doherty Earth Observatory. The goal of that project is to integrate seismic data rapidly from every large earthquake and determine its source characteristics. Beyond providing regular information on tectonic activity along Earth's plate boundaries and in intraplate settings, the CMT solutions have led Ekström to identify several unusual types of seismic sources, including volcanic earthquakes, glacial earthquakes, and large landslides. His work also involves the three-dimensional imaging of the seismic structure of the Earth's mantle, including not only seismic wave speeds but their direction dependence, the rate at which propagating seismic waves lose energy, and the density. His results are widely used by mineral physicists seeking to understand the composition and mineralogy of the mantle and by geodynamicists who are modeling the mantle's internal convective motions.

Wafaa El-Sadr, MD, MPH, MPA is a University Professor of Epidemiology and Medicine at Columbia University, the director of ICAP at Columbia University, and director of the Global Health Initiative at the Mailman School of Public Health. Founded by Dr. El-Sadr, ICAP is a global leader in HIV, other global health threats, and health systems strengthening that provides technical assistance, implementation support, and conducts research in partnership with governmental and non-governmental organizations in more than 21 countries.

In this role, she leads the design, implementation, scale-up, and evaluation of large-scale HIV, tuberculosis (TB) and maternal-child health programs in sub-Saharan Africa and Asia that provide access to HIV services to more than 2.2 million people and collect data from more than 5,200 health facilities.

Dr. El-Sadr is a prominent researcher and has led numerous epidemiological, clinical, behavioral, and implementation science research studies that have furthered the understanding of the prevention and management of HIV, TB, and non-communicable diseases. She is a principal investigator of the NIH-funded HIV Prevention Trials Network (HPTN), which seeks to prevent HIV transmission, globally.

Dr. El-Sadr is a member of the NIH Fogarty International Center Advisory Board. In 2008, she was named a John D. and Catherine T. MacArthur Foundation Fellow, and in 2009, she was appointed to the National Academy of Medicine. In 2013, she was appointed University Professor, Columbia's highest academic honor. She also holds the Dr. Mathilde Krim-amfAR Chair in Global Health.

Mark T. Gallogly is Cofounder and Managing Principal of Centerbridge Partners, L.P., a $28 billion private investment management firm focused on private equity; credit, distressed strategies and special situations; and real estate investing. Prior to founding Centerbridge in partnership with Jeffrey H. Aronson in October 2005, Mr. Gallogly was with the Blackstone Group for 16 years. At Blackstone, he was most recently a Senior Managing Director, the head of private equity and a member of the firm's management and investment committees.

Throughout his 30-year career in investing and finance, Mr. Gallogly has been involved in a broad spectrum of industries, businesses and investment cycles. Mr. Gallogly served on President Obama's Council on Jobs and Competitiveness from 2010 to 2012 and the President's Economic Recovery Advisory Board from 2008 to 2010. He currently serves on the Columbia Business School Board of Overseers and as Vice Chair of the Board of Trustees of Columbia University. He is a member of the Board of Trustees of The Economic Club of New York, as well as the Advisory Council of the Hamilton Project, an economic policy group at the Brookings Institution. He is a partner of the Partnership for New York City and member of the Council on Foreign Relations.

Mr. Gallogly graduated with honors from the University of Notre Dame and attended Sophia University in Tokyo. He received his MBA from Columbia Business School in 1986.

Pierre Gentine is an Associate Professor of Earth and Environmental Engineering. He investigates the continental hydrologic cycle using multi scale modeling and big data (machine learning, remote sensing, high-resolution turbulent simulations) in the context of rising CO2 concentrations. Gentine hopes to answer questions such as what will be the future of droughts and extreme dryness/precipitations, and how will they impact agricultural production?

Pierre Gentine received his undergraduate degree from SupAéro, the French National Aeronautical and Space Engineering School in Applied Mathematics in Toulouse, France. He obtained a MSc and PhD in civil and environmental engineering from Massachusetts Institute of Technology (MIT) in 2006 and 2010, respectively. He joined the faculty of the Department of Applied Mathematics and Applied Physics at Columbia Engineering in 2010.

Susan Glancy joined the Office of the President as Chief of Staff in 2006, and she is responsible for providing administrative and strategic support to President Bollinger and his senior staff for University initiatives as well as day-to-day operations. Previously, she was Executive Director for Special Projects for Columbia University Human Resources and Director of Human Resources for Columbia Business School. Prior to Columbia, Susan worked for The Walt Disney Company in New York City. Susan graduated from New York University, Tisch School of the Arts with a degree in Theatre and received a Master's in Social and Organizational Psychology from Teachers College, Columbia University.

Alex N. Halliday is the Director of Columbia University's Earth Institute. He joined the Earth Institute in April 2018, after spending more than a decade at the University of Oxford, during which time he was dean of science and engineering. With about 400 published research papers, Halliday has been a pioneer in developing mass spectrometry to measure small isotopic variations in everything from meteorites to seawater to living organisms, helping to shed light on the birth and early development of our solar system, the interior workings of the Earth, and the processes that affect Earth's surface environment.

His scientific achievements have been recognized through numerous awards, including the Murchison Medal of the Geological Society, the Bowen Award and Hess Medal of the American Geophysical Union, the Urey Medal of the European Association of Geochemistry, and the Oxburgh Medal of the Institute of Measurement and Control. He is a Fellow of the UK's Royal Society and Foreign Associate of the US National Academy of Sciences. His contributions to science and innovation have been recognized with the award of a knighthood in the UK.

Halliday has also helped to lead a variety of distinguished scientific societies and advisory panels. He is the former Vice President of the Royal Society and former President of the Geochemical Society. He has served as an external board member for Britain's Natural Environment Research Council, the Max Planck Society, London's Natural History Museum, the American Geophysical Union, and more.

As a professor in Columbia's Department of Earth and Environmental Sciences, Halliday divides his time between Columbia's Morningside campus and his geochemistry lab at Lamont-Doherty Earth Observatory.

Ira Katznelson (Ph.D., Cambridge, 1969) is Interim Provost; Ruggles Professor of Political Science and History; and Deputy Director, Columbia World Projects. He is an Americanist whose work has straddled comparative politics and political theory as well as political and social history. He returned in 1994 to Columbia, where he had been assistant and then associate professor from 1969 to 1974. In the interim, he taught the University of Chicago, chairing its department of political science from 1979 to 1982; and the Graduate Faculty of the New School for Social Research, where he was dean from 1983 to 1989.

Professor Katznelson is President of the Social Science Research Council. He was President of the American Political Science Association for 2005-2006. Previously, he served as President of the Social Science History Association and Chair of the Russell Sage Foundation Board of Trustees. He has been a Guggenheim Fellow and is a Fellow of the American Academy of Arts and Sciences and the American Philosophical Society.

Michal Lipson is the Eugene Higgins Professor at Columbia University. Her research focus is on Nanophotonics and includes the investigation of novel phenomena, as well as the development of novel devices and applications. Lipson pioneered critical building blocks in the field of Silicon Photonics, which today is recognized as one of the most promising directions for solving the major bottlenecks in microelectronics. She is the inventor of over 30 issued patents and has co-authored more than 200 scientific publications. In recognition of her work in silicon photonics she was elected as a member of the National Academy of Sciences.

She was also awarded the NAS Comstock Prize in Physics, the MacArthur Fellowship, the Blavatnik Award, the Optical Society's R. W. Wood Prize, the IEEE Photonics Award, and has received an honorary degree from Trinity College, University of Dublin. Since 2014 every year she has been named by Thomson Reuters as a top 1% highly cited researcher in the field of Physics.

Frances Negrón-Muntaner, Professor of English and Comparative Literature, is an award-winning filmmaker, writer, curator, scholar and professor at Columbia University, where she is the founding director of the Media and Idea Lab and founding curator of the Latino Arts and Activism Archive at Columbia's Rare Books and Manuscripts Library. Among her books and publications are: Boricua Pop: Puerto Ricans and the Latinization of American Culture (CHOICE Award, 2004), The Latino Media Gap (2014), and Sovereign Acts: Contesting Colonialism in Native Nations and Latinx America (2017). Her most recent films include Small City, Big Change (2013), War for Guam (2015) and Life Outside (2016).

For her work as a scholar and filmmaker, Negrón-Muntaner has received Ford, Truman, Scripps Howard, Rockefeller, Pew, and Chang-Chavkin fellowships. Major funders such as Social Science Research Council, Andy Warhol Foundation, and Independent Television Service have also supported her work. In 2008, the United Nations' Rapid Response Media Mechanism recognized her as a global expert in the areas of mass media and Latin/o American studies; in 2012, she received the Lenfest Award, one of Columbia University's most prestigious recognitions for excellence in teaching and scholarship. Negrón-Muntaner also served as director of Columbia's Center for the Study of Ethnicity and Race from 2009-2016. In 2017, she was the recipient of an inaugural OZY Educator Award.

Costis Maglaras is dean and the David and Lyn Silfen Professor of Business at Columbia Business School. He received his BS in Electrical Engineering from Imperial College, London and holds MS and PhD degrees in Electrical Engineering from Stanford University.

An expert in operations research, data analytics and quantitative finance, Dean Maglaras has served as chair of the Decision, Risk & Operations Division; as faculty director for the Risk Management course administered through Executive Education; and as a member of the Executive Committee of Columbia University's Data Science Institute. He has received both the Dean's Award for Teaching Excellence and the Dean's Award for Teaching Innovation. Prior to joining the School in 1998, Dean Maglaras was a research scientist at Canon Research Center America.

His research centers on stochastic modeling and data science, with an emphasis on stochastic networks, financial engineering, and quantitative pricing and revenue management. His research has been recognized through the 1999 INFORMS Nicholson Prize for best paper in Operations Research and Management Science and the 2008 INFORMS Revenue Management and Pricing Section best research paper award.

Outside of the Business School, in 2007, Dean Maglaras helped found Mismi Inc., a financial technology firm that introduced innovative quantitative electronic trading algorithms and transaction analytics tools to the marketplace. He served as Mismi's head of research through 2014. He is a frequent consultant to industry, primarily in areas of quantitative finance and electronic trading.

Alison Miller is the Deputy Director for Management of Columbia University's Earth Institute, where she manages day-to-day operations as well as leading strategic initiatives. She is also the Associate Director of the Research Program on Sustainability Policy and Management at the Earth Institute, where she engages in research related to organization-level sustainability issues. Prior to Columbia, Miller worked as a business development associate for an asset management firm.

She has written about climate policy, sustainability metrics, and management. Miller is the co-author, with Steven Cohen and William Eimicke, of the 2015 book, *Sustainability Policy: Hastening the Transition to a Cleaner Economy*. She teaches courses on sustainable development and sustainability management and policy. In 2014, she was selected as one of City & State's 40 under 40 Rising Stars in NYC Politics & Policy. Miller received her MPA in Environmental Science and Policy at Columbia's School of International and Public Affairs and her BA in Economics and International Relations from the University of Delaware.

Kenneth Prewitt is the Carnegie Professor of Public Affairs. Previous positions he has held are: Director of the U S Census Bureau, President of the Social Science Research Council, Senior Vice President of the Rockefeller Foundation, Director of the National Opinion Research Center, and Professor at the University of Chicago. Among his awards are a Guggenheim Fellowship, honorary degrees from Carnegie Mellon and Southern Methodist University, a Distinguished Service Award from the New School for Social Research, and The Officer's Cross of the Order of Merit from the Federal Republic of Germany. He is a Fellow of the American Academy of Arts & Sciences, the Academy of Political and Social Science, and the American Association for the Advancement of Science. His current professional Boards and Committees include the National Academies' Standing Committee on Social Science Evidence for Use (chair) and The State of the USA (Vice-Chairman). His most recent books are The Legitimacy of Philanthropic Foundations and The Hard Count: The Political & Social Challenges of Census Mobilization; and, in preparation, Racial Counting in America: Past, Present, and (?) Future. He is married to Columbia Professor Susan M. Vogel, African Art Historian and Film Maker.

Maureen E. Raymo, Bruce C Heezen Lamont Research Professor and Director of the Lamont-Doherty Core Repository at Columbia University, is a sought after public speaker and distinguished scientist. For over 30 years, she has been a pioneer in the study of climate change over Earth's history. In addition to publishing foundational work on the stratigraphy and chronology of recent geologic epochs, Raymo has proposed hypotheses explaining why ice ages occur in Earth's history, why ice sheets wax and wane with characteristic frequencies over the last few million years, and developed new ways of studying past sea level change.

According to the European Geosciences Union which recognized her accomplishments with the Milankovic Medal, "Maureen E. Raymo's work has given names to critical, foundational ideas: the 'uplift-weathering hypothesis', the '41-thousand-year problem', 'Pliocene sea level paradox', and 'the Lisiecki-Raymo δ18O Stack' are all central themes in palaeoceanography that appear in textbooks and have their roots in Raymo's research and intellectual contributions." Maureen's work, firmly based on observations and data, has shaped our understanding of Earth's natural climate variability and her many landmark papers have influenced a generation of climate scientists.

Maureen has spent years carrying out research in the field—planning, participating in and leading numerous scientific expeditions around the world, on land, sea and ice. She is a fellow of The Explorers Club and a member of the National Academy of Sciences, one of the highest honors given to scientists in the United States. In 2014, she became the first woman to be awarded the Wollaston Medal, the Geological Society of London's most senior medal and highest accolade, first awarded to William Smith in 1831 and later to Charles Darwin, Louis Agassiz, and Charles Lyell.

Maureen speaks widely, to audiences ranging from scientists, to student groups, to the general public, on topics ranging from her latest research to the much broader problem of global climate change. Her talks are always informative and inspiring with the twin goals of empowering individuals through a better understanding climate science and motivating action on behalf of our shared global environment.

Gerald Rosberg is senior executive vice president of the University. He works with the president and the University's senior leadership on long-term planning and human resource and other strategic issues, with a particular focus on coordination across departments. He served for 20 years as a senior executive of the Washington Post Company (now Graham Holdings). Before that he was a lawyer in private practice and a professor of law at the University of Michigan Law School.

Jeffrey Shaman is a professor in the Department of Environmental Health Sciences and Director of the Climate and Health Program at the Mailman School of Public Health. He studies the survival, transmission and ecology of infectious agents, including the effects of meteorological and hydrological conditions on these processes. He uses a variety of mathematical and statistical approaches to describe, understand, and forecast the transmission dynamics of infectious disease systems, and to investigate the broader effects of climate and weather on human health. In addition, he studies a number of climate phenomena, including Rossby wave dynamics, atmospheric jet waveguides, and tropical cyclogenesis.

Miguel Urquiola is professor and chair of the Department of Economics, Columbia University. He is also a member of the faculty of the School of International and Public Affairs, and of the Columbia Committee on the Economics of Education.

Outside Columbia, Urquiola is a Research Associate at the National Bureau of Economic Research, and has held prior appointments at Cornell University's Economics Department, the World Bank's research department, the Bolivian Catholic University, and the Bolivian government. He is on the editorial board of the *American Economic Journal: Applied Economics*, and was previously co-editor of the *Journal of Human Resources*.

His research is on the Economics of Education, with a focus on understanding how schools and universities compete, and how they form reputations for quality. It covers how students select educational providers, and the consequences such choices have on academic performance and labor market outcomes.

Alan C. West is the Samuel Ruben-Peter G. Viele Professor of Electrochemistry. He creates, analyzes, and develops electrochemical technologies used for materials, sensors, energy storage and conversion, and the sustainable production of chemicals. He has worked on the design of novel electrodes for next-generation batteries and has collaborated extensively with industry on electrochemical metallization methods used in semiconductor manufacturing.

West has developed novel methods that couple electrochemical and biological technologies that may potentially be used to produce fuels from renewable electricity, to convert inorganic waste streams to fuels, and to enable alternative processes for use in copper mining. Of particular interest to West are the experimental and numerical methods used to characterize transport phenomena and reaction mechanisms in electrochemical systems. He has simulated and analyzed a variety of metallization and dissolution processes, including studies by which the design of the electrolyte composition controls film growth and nucleation, and thus properties in geometries of relevance to the manufacturing of electronic devices. He has developed models of battery electrodes that capture experimental observations ranging from the atomistic scale to the mesoscale to the full scale of the electrode. Due to the multi-scale, complex nature of batteries, West works closely with a range of scientists and engineers, including chemists, material scientists, physicists, and mechanical and electrical engineering.

West received a BS in chemical engineering from Case Western Reserve in 1985 and a PhD in chemical engineering from the University of California, Berkeley, in 1989. He is a fellow of the Electrochemical Society, and in 2014 he received the society's Electrodeposition Award. He joined the faculty of Columbia Engineering in 1992.

Paige West, the Claire Tow Professor of Anthropology, the Director of the Columbia University Center for the Study of Social Difference and the Co-Director of the Barbara Silver Horowitz 55' Scholars of Distinction program at Barnard, joined the faculty in 2001 the year after earning her Ph.D. in cultural and environmental anthropology at Rutgers University.

Dr. West's broad scholarly interest is the relationship between societies and their environments. More specifically, she has written about the intersections between indigenous epistemic practices and conservation science, the linkages between environmental conservation and international development, the material and symbolic ways in which the natural world is understood and produced, the aesthetics and poetics of human social relations with nature, and the creation of commodities and practices of consumption. She has conducted ethnographic fieldwork in Papua New Guinea (PNG), Australia, Germany, England, and the United States.

In 2002 Dr. West received the American Anthropological Association's Anthropology and Environment Junior Scholar Award, in 2004 she received the American Association of University Women Junior Faculty Fellowship and the American Council of Learned Societies Faculty Fellowship, and in 2006 she received the Rockefeller Foundation's Bellagio Fellowship. In 2012 she became the Chair of the Ecology and Culture University Seminar at Columbia University. In 2013 Dr. West delivered the Leonard Hastings Schoff Memorial Lectures at Columbia University. In 2017 / 2018 she was the distinguished national speaker for Phi Beta Kappa.

Dr. West is a past president of the Anthropology and Environment Section of the American Anthropological Association as well as past chair of the Association of Social Anthropology in Oceania and past chair of the Department of Anthropology at Barnard College. She is also the founder of the journal Environment and Society: Advances in Research and served as its editor for a decade.

In addition to her academic work, Dr. West is a co-founder of the PNG Institute of Biological Research, a small NGO dedicated to building academic opportunities for research in PNG for Papua New Guineans. She is now on its board of directors. Dr. West is also the volunteer anthropologist for the PNG NGO Ailan Awareness (AA), a marine-focused organization that works with communities in New Ireland and New Hanover to facilitate the conservation of their traditions, languages, and natural resources.

Appendix C: Engagement across the University

Alex Halliday, as chair of the Task Force, sought wide engagement around Columbia. The following chart summarizes that activity from mid-September through the end of November 2019.

Summary Data

Meetings

	Schools and Institutes	People In Attendance	Approximate # of People
1	Climate Task Force (4 meetings)	Faculty, senior staff	25
2	Graduate School of Architecture, Planning & Preservation	Dean & faculty	8
3	School of the Arts	Dean & Assc. Dean	2
4	School of Social Work	Dean & faculty rep	2
5	Columbia Law School	Faculty	8
6	Columbia Business School	Dean & faculty	10
7	Columbia College & General Studies	Deans	2
8	School of Professional Studies	Dean & faculty	25
9	Mailman School of Public Health	Faculty	25
10	School of Nursing	Dean	1
11	Fu School of Engineering & Applied Sciences	Dean & faculty	12
	Graduate School of Arts & Sciences		
12	Deans	Deans	3
13	Natural Sciences	Dept. chairs	8
14	Social Sciences	Dept. chairs	6
15	Humanities	Dept. chairs & faculty	12
16	Policy & Planning Committee	Dean, faculty	20
17	A&S Faculty	Faculty	180
18	Natural Sciences Climate Response	Faculty	8
19	DEES Faculty	Faculty	20
20	School of International & Public Affairs	Dean, faculty & PhD students	40
21	Barnard College	Dean	1
22	Teachers College	President & Provost	2
23	Data Science Institute	Faculty & researchers	10
24	Misc Deans Meetings (multiple)	Deans	4
25	Earth Institue Faculty	Faculty, senior staff	60
26	Earth Institute Executive Committee	Senior faculty, scientist, staff	20
27	Lamont Senior Staff	Senior faculty, scientist, staff	20
28	Senior University Leadership (multiple)	EVPs, Senior Administrators	6
	Total		***~540***

	Town Halls	People In Attendance	Approximate # of People
	Student Town Halls		~200 total
1	Town Hall #1	All students	100
2	Town Hall #2	All students	100
	Earth Institute & Lamont Town Halls		~180 total
3	Moringside Campus Town Hall #1	Faculty, scientists, staff	25
4	Moringside Campus Town Hall #2	Faculty, scientists, staff	30
5	Lamont Campus Town Hall #1	Faculty, scientists, staff	50
6	Lamont Campus Town Hall #2	Faculty, scientists, staff	75
	Total		***~380***

Email Engagement	**Approximate # of Emails Received**
Emails from faculty, students, and affiliates from across the unversity	
Expressing interest in helping	20
Advice/ideas from CU & non-CU	55
Students	10
Total	***~85***

The comments/feedback received throughout the engagement process have been collected and synthesized here.

The Climate Crisis & the Need to Act Now

- "Institutional courage" is necessary, and people are excited about the stance Columbia is taking.
- Everything is in the context of urgency. There needs to be a balance between addressing short-term needs and long-term impacts.
- Some concern that setting up a school, and the time and bureaucracy that comes with it, will take away time and resources from addressing the urgent climate crisis. Need to do something quickly with new resources to have a meaningful impact.
- Climate issues are of such critical importance that Columbia should entertain major structural changes if that is what it takes to effectively address them.
- The urgency of this crisis calls for an approach to research and teaching that in part reshuffles existing areas of knowledge even as it extends our understanding by focusing on the human-environmental interaction.
- Urgency is often more related to governance than the science. We know enough to start acting, but for the most part, we are not. How do we impact change in this regard?
- Let's ask ourselves what success will look like in 20 years (and how success may be measured differently) and walk back from there to create our path. Reverse engineer it.

Why Columbia?

- The existence of EI and Lamont make Columbia the perfect place for this task, as the structures and expertise are already in place; we need to capitalize on LDEO's success and EI's brand.
- Columbia also has unique strengths and deep history in the liberal arts and humanities, and top ranked programs in journalism, engineering, business, and more. Only Columbia has such strength in all the required areas to address this challenge.
- There is much, much more going on in climate and environment than is evident publicly or even internally. Lots of existing work in a huge number of departments.
- We have the scientific rigor and disciplinary strength, and experience in interdisciplinary work.
- This provides a great opportunity to strategically seek cohesiveness, intellectually, across numerous efforts around Columbia connected to climate—the university already does so much in this area. Connecting it all together, underscored by serious resources, could have a major impact.
- The climate crisis is so much more than climate ***change***, and our strength is providing information and expertise on the whole big picture.
- Columbia is unparalleled in the breadth of expertise across disciplines, this university is the perfect place to bridge the gap between innovative technology solutions and mitigation/adaptation solutions.
- Columbia has an international student body and this is a great advantage when thinking about addressing global challenges.

What will Columbia Do?

- **An interdisciplinary approach is necessary**. Climate is inseparable from other key issues and needs to be interwoven across the University. There are opportunities to fill current gaps that exist between disciplines/silos at the university.
    - Need to include the social sciences and humanities at scale!
    - Incorporate a systems thinking approach to climate education—currently missing.
- This is an opportunity to reformulate existing fields/disciplines with climate at the intersection.
- We will ***become the go-to place*** for climate expertise and knowledge.

- An opportunity to utilize the expertise of the young, international and diverse voices that make up the Columbia student body—young people are driving the climate movement.
- Columbia should also use its Ivy League influence to motivate other higher education institutions to take action—in a collaborative way, not just so we can be the "first."
- Question: This could potentially swing into advocacy—what is the university's role in being an advocate?

Research

Key areas to expand/focus on include:

- **Climate-forced migration**
- Climate resilience/adaptation
- Climate impact & risk
- Behavioral science/decision-making/psychology
- Carbon innovation
- Ecosystems/natural resources
- Food security
- Environment & security
- Land-use
- Urbanization
  Resource extraction
- Climate modeling
- Climate & religion
- Role of gender
- Climate journalism/**climate communications**
- Ecological economics
- Fusion
- Decarbonization/sequestration
- **Environmental justice**
- Climate theater/art
- Insurance management and innovation
- Geoengineering solutions
- Sustainable design
- Business & climate
- Climate finance
- Indigenous sovereignty
- Cloud dynamics
- Language & climate impacts
- Renewable energy
- Accuracy in modeling
- Economic modeling
- Climate history
- Innovative technology solutions
- Climate ethics
- Feedback loops/cascading impacts
- Intersection of population & climate
- Mental health and climate
- Political/moral decision-making
- Extinction
- Climate conflict
- Climate sensitivity
- Complexity science

Two umbrella subjects: (1) Climate Governance (law, policy, justice, decision-making, institutions, etc.) and (2) Technological Innovation (fusion, efficiency, carbon, negative emissions, renewables, etc.).

Impact & Communication (Engaging with the World)

- Climate school can build on and add to the role EI fills already, as an interdisciplinary knowledge hub that feeds decision-making on climate for the world.
- Climate work requires hiring practice-oriented people who can help connect academia to work on the ground. These practitioners need to be seen as academics and given tenure for **impact-oriented** work (vs traditional peer-reviewed publications).
- We could develop a robust decision-support service, like the agricultural extension service, for climate services, climate impacts, climate risks, etc. for specific stakeholders on specific problems. Engage on the issues that matter most to them, bringing our knowledge to practice. Only a university can play this key role.
- Need to really understand local culture, language, religion in communities to be able to work with them (bring in humanities to do so).
- The Task Force needs to find ways to access and bridge gaps to public sector, i.e. civil servants, government, policymakers.
    - Example: Training/course for congressional staffers
    - Example: Many countries are assembling ministries of climate affairs, so how can we plug into these types of efforts?

  - Example: Take advantage of new NYC and NYS laws to demonstrate how these laws can be implemented. Demonstrate and then replicate.
  - Find a way to work in ways they actually need, where decisions are actually made.
- Work with private sector leaders, who are agents of change and can deploy capital at huge scales and move markets.
- In order to have a global impact, the school would need partner organizations around the world.
  - We also shouldn't try and replicate what's done well elsewhere. Let's do what no one is doing and collaborate to expand our capacity in areas we don't have.
  - This includes Universities and places across the country; we should not just be coastal elites.
- Community-based approach is key; the University should not just set the agenda but rather have two-way engagement with communities, listen and be supportive to real-world needs in the climate context. *They* inform *us* about the type of information needed for them to act.
  - Outreach to faith communities is important.
  - Think about the role of Columbia in the Morningside/Harlem/Manhattanville communities where we have a physical presence and how to include voices of typically marginalized groups.
- Art installations and citizen science involvement could help make this accessible.
- Two obstacles to having impact: (1) forms for interdisciplinary work and (2) getting our work into the hands of decision makers on the ground. We need more ways to do that.
- Connect researchers with platforms for implementation (e.g. of new technologies).
- AMNH has a program called the science café, that Columbia could adopt—a climate café—ideally off campus. This would engage local community members. Further events that are organized not by faculty but by either community members or students would help to remove the discussions from the "elite" sphere of the university.
- We could create a writer-in-residence program.
- Question: What will be the metrics for impact?

Education

- The future of climate education is experiential, project-based, transdisciplinary, and incorporates vocational skills as well as potentially, a climate core curriculum.
- It should be easy for every student at Columbia to learn climate.
  - Need to determine entry point for that knowledge in current curriculum/structure, whether it is a course, case study within a course, orientation session, etc.
- Students should have opportunities to work on projects where services are being delivered. Bring students in to research and practice activity.
- Students should be given real resources (e.g. travel funding for students to attend events like COP, to give them a seat at the table; student projects).
  - Fellowships and scholarships to provide financial incentives to engage in or study climate issues (this may be especially important for degrees like law, where the alternate job opportunities are much more lucrative).
- Problem-based learning and participatory action research should be key concepts during this process. Need to put together a team of subject-matter experts to work with people who are education designers (pedagogy experts) to work with schools and departments to look at curriculum.
  - Suggestion: Create canvas commons for curriculum sharing.
- Important to focus on climate education on a broader, global scale (citizen science on large geospatial scales, non-credit training programs, online, etc.).

- Develop resources with climate as the example, which could be integrated into a wide range of programs or courses (e.g. case study on international cooperation using climate) that any course instructor could use (even if the class itself has nothing to do with climate).
- Engagement with K-12 teachers to build up basic knowledge in society.
- Know the job market. We need to make sure graduates have clear paths and that students have professional qualifications and skills that employers want.
- Hire generalist scholars/practitioners who interpret, translate and work with people on action.
- Could also include strategic workforce planning to support the transition off of fossil fuels.
- Executive education to bring knowledge to institutional leaders, tailored to their needs (training, tools, primers, etc.). Business executives want information and training in a way that combines science, solutions and business. This type of training does not yet exist at scale.
    - Example: Mailman's SHARP program for professionals; other exececutive education at the Data Science Institute or Business School (all are seeing high demand/interest).
- There is also an education opportunity among skilled scientists who already have degrees, as a way to "retool" and teach them to apply the science skills they have to the climate crisis.
- Already we see doctoral students bringing in environmental approaches to their work (in multiple non-environment departments). But their mentors don't use those approaches. There is a drive by younger scholars for this type of scholarship. Opportunity to engage them.
- The EPIC interdisciplinary learning by doing approach could be helpful, would allow Columbia to make money, and would harness the capabilities of both students and staff. This would also allow for interdisciplinary knowledge production without eliminating departments.
- This would provide students interested in climate (or the various facets of climate) a range of faculty for mentorship.
- In any new program, need to consider the history and politics of the University, and ensure we are not just creating competition for current offerings.
- Specific degree recommendations:
    - Double majors (or minor/concentrations) could play a key role in this. Students in all fields have an interest in climate even if they don't get a job in climate-related work.
    - Dual degrees (e.g. MPA/JD/etc. and MS in Climate) could be interesting and attractive to students. But they are administratively difficult for the students and the cultures of different schools need to be considered when cross-registering (e.g. teaching methods are very different). Joint programs should not devalue what already exists.
    - Remove barriers related to students taking courses outside their school (tuition complications.)
    - Develop a concentration/certificate that professional master's students at other schools could get from the Climate School.
    - New courses should be interdisciplinary, not tailored for specific majors.
- Recommendations for the near-term:
    - There are mechanisms that already exist at Columbia for doing concentrations in different subjects—this could be done for climate in the short-term, while building up a school.
        - Example: PhD specialization in data science
    - Important to consider how to target the undergraduates. Suggestion to build in climate studies into the core curriculum (i.e. within Frontiers of Science).
    - University Writing course is a required course but can be subjected based—suggestion to include a climate writing course there. Similar addition to the Global Core.
    - Go to every department and ask them to develop a climate course.

  - Need more courses on methods and techniques, i.e. how to apply science to solve a problem, network analysis, complexity science.
  - Resources for student groups that don't have much support currently.
- Questions:
  - What is the core degree program?
  - Is there a student base / demand for this type of degree?
  - What will graduates might do for careers? What is the utility of the degree?
  - How can we maintain the disciplinary strength in the core areas that students need?

Structure and Organization

- The School needs to make connections on campus. Massively scale up and make it easier to bring together intellectual resources, students, ideas—a creative "space" for interaction.
- Challenge of schools without a true discipline is they have trouble holding together over time.
- Is the word 'climate' alone too limiting? Many wanted "climate and ____" to reflect that there are other issues involved.
  - Some ideas included: "climate and sustainable development," "climate governance," "climate change," "climate and earth stewardship"
  - The key is to ensure that other areas of sustainability, beyond climate, are not excluded, and not drained of resources and attention.
- Structure needs to be fluid, flexible, dynamic. Do not add bureaucracy to an already complicated place. Schools and institutes are ancient models, and this calls for something new.
- A School should include a continuum of activity from basic science, to applied work (engineering, tech development, policy development) to solutions-design and engagement with stakeholders. Cannot disconnect solutions-side from underlying science.
- It is important to not remove people from their existing departments. Talented academics need and generally want a disciplinary home, for intellectual rigor and high tenure standards, but they may also want a place for interdisciplinary, problem-focused climate work.
  - Need to find a balance, as interdisciplinary work can spread someone too thin.
- There is broad support for joint appointments with other schools/departments, however, they risk creating more bureaucracy as each School does appointments somewhat differently. Details would need to be carefully worked out.
- One model is to have a core group of faculty hired within the school, and another group of faculty with joint appointments.
- Another model could be buying out 50% of a faculty's time to work in climate over the course of 10 years. This allows the home department to hire more people and have more flexibility in hiring. One challenge, however, is department labor and who takes on that work.
  - This provides financial resources for schools, and also an interesting intellectual opportunity for faculty to work on something new/different.
- Visiting Professors could add short-and medium-term faculty.
- We can use SIPA as a model, with its relationship to the political science department, and A&S.
- Create a center of shared analytical instrumentation, consolidating resources that are now scattered all over the campuses (and at AMNH), adding key facilities that may be too costly for individual PIs, ensuring broad and efficient, timely access, and hardening technical support.
- The global centers could provide a helpful model, as well as the MIT Schwarzman College of Computing, as a newly established college.
- Introducing a competitive process for funding opportunities could increase representation and disciplinary inclusivity.

- How does this new structure generate revenue? Fundraising does not sustain a school in the long term.
- The hub and spokes model is a helpful one when structuring the school.
    - Some possible umbrella hubs include: living with a changed planet, climate management, and/or climate cooperation.
    - Other possible hub problem areas could include: causality, adaptation, mitigation, resilience, and reparations.

Earth Institute/Lamont

- In general, there was a lot of anxiety about EI interaction/absorption as well as LDEO's role. It will be important to determine how EI and the school fit together, and their distinctive roles.
- Concern over how Lamont fits into this model. Consensus that there needs to be a clear path to putting Lamont on a sustainable footing and that it must remain central to the new enterprise. Science, reliable monitoring, and predictions are critical underpinning to any other activity.
- Concern by those in EI that new funds/investment will only be new people. We need to support and better fund the people who are here and have made LDEO/EI/CU this successful so far.
- Increase connectivity between Lamont and the rest of Columbia. Younger scholars at Lamont, in particular, are not as well networked with the main campus and vice versa.
- We need to figure out a system that will reward interdisciplinarity, because institutions and research mechanisms do not traditionally do this. It should facilitate, encourage and incentivize.
    - This new structure is an opportunity to strengthen processes for this work.
    - Need grant writing and administration support to facilitate interdisciplinary work.

Departments:

- It needs to be organized in a cohesive way.
- Organized around problems to solve. Example: What systems are needed to cope with a +3-4 degree C world in 2100 and how does it all fit together?
- Departments within the School aren't necessary and could limit the interdisciplinary nature. Something like divisions might be one way to test structures.
- One proposed structure: Department of Climate and Life; Department of Climate and Sustainability Solutions; Department of Climate and Society;
    - LDEO spanning across as science foundation; other disciplines spanning across (law, engineering, ethics, etc.)
- Department of or Field of Climate Impacts and Risks - determining how climate will influence something outside the climate system (infrastructure, finance, health, ecosystems and so forth) while also accounting for uncertainties, and posing problems in terms of risk, meaning that one considers not only the most likely outcome but the full range of possibilities.
- Divisions could offer an alternative to departments.

Questions:

- How will a school function within the university and how will it interact with existing schools/programs/EI?
- Can EI be used as a model?
- How will this be funded? Will we accept money from fossil fuel companies?
- Would this create a new silo?
- Is this simply the integration of Lamont and DEES?
- Should the new school have departments?

  - Why not just use this money to fund existing and new work around climate within existing structures?
  - Why would a school "drastically improve" climate work being done at Columbia?
  - Is it possible to bring in "super-additive" grants to study climate solution technologies?
  - What are the potential issues with opening up a school focused around a "specific" problem, rather than a field or discipline?
  - How do you prevent this new school from taking funding away from other, currently underfunded schools?

Space

- There could be a new research lab that is, itself, interdisciplinary. Build a large research laboratory to bring together the various disciplines that want to collaborate on energy science and technology (chemists, physicists, computer types, engineers of various sorts, etc.).
- Space at Columbia also creates siloes.
- Lamont could be given a physical presence in the city.
- Build something new in Manhattanville.
- Need state of the art teleconferencing and reliable transportation to better connect LDEO to Morningside and Manhattanville. Also, if done really well, could reduce faculty's long-distance travel (and carbon footprints).
- Invest in infrastructure at Lamont to revive the campus and keep pace with peer institutions.
- Build a conference center and exhibition space at Lamont Hall.
- Questions:
  - How could the design of the new school play into its goals? It is helpful and necessary to include architects and designers in this.

Columbia's Sustainability

- The principles of sustainability should be embodied in the physical operations of our structures and systems.
- Campus as a living lab for students to learn about sustainable operations and facilities.
  - Demonstrate/pilot carbon capture on campus.
  - Model our own resiliency efforts.
- Columbia needs to lead by example and focus on its own sustainability. Specifically, many think it is critical that Columbia become a net zero university (on all campuses).
  - Investing in renewable technology and green energy will make us an institution that leads by example to make immediate changes.
  - Programs/initiatives to influence individual behavior change.
  - Use purchasing power with vendors.
  - Example: Yale's Carbon Tax.
- Currently work is being done with students around Columbia facilities and sustainability. Connect with them.
- Suggested actions include retrofitting building systems, putting solar on our buildings, banning plastic water bottles at University offices and meetings, providing travel incentives for biking and commuters, enhancing virtual meeting facilities, and providing carbon offsets for long-distance university travel.

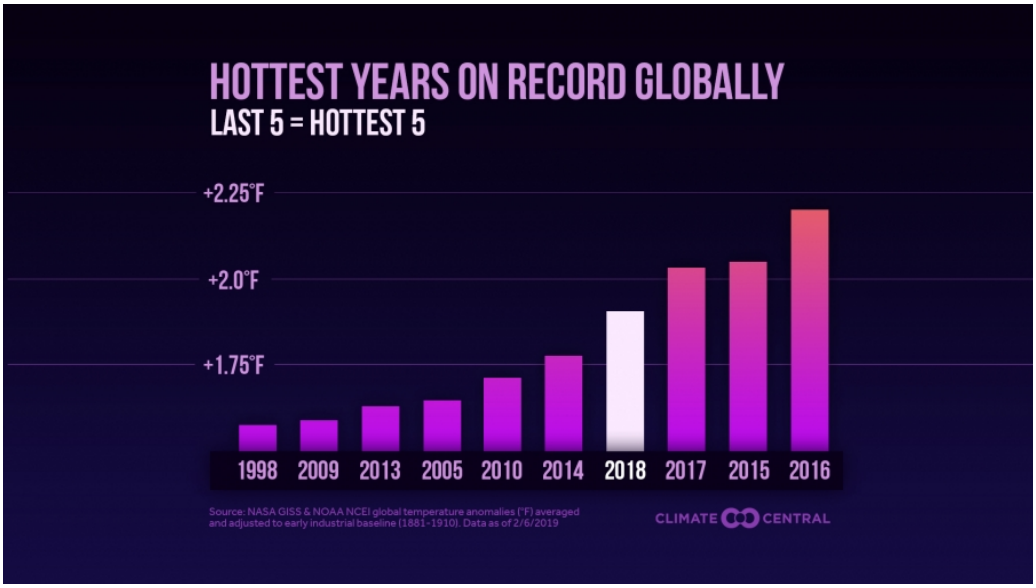
Appendix D: A Climate Change Primer

The vast majority of scientists around the world agree that our climate is changing at a faster rate than ever recorded in human history because of our use of hydrocarbon-based fuels such as coal, oil and gas, so-called fossil fuels. Since the 19th century, it has been known that carbon dioxide could accentuate the greenhouse properties of Earth's atmosphere, preventing heat introduced by the Sun from escaping back as thermal radiation into space. The heat trapped by carbon dioxide warms our oceans and atmosphere. The greenhouse effect more broadly is what enables life on this planet, keeping Earth at a livable global temperature.

The Science of Carbon Dioxide

The concentration of greenhouse gases in the atmosphere—measured in parts per million (ppm) of carbon dioxide—has drastically increased since the start of the Industrial Revolution, in the 18th Century. When fossil fuels are burned to produce electricity, or to heat and cool buildings, or to power machines, carbon dioxide is released. Human emissions from the burning of fossil fuels and other activities such as agriculture and manufacturing are feeding vast amounts of carbon dioxide (tens of billions of tons per year) into the atmosphere. The global average atmospheric carbon dioxide concentration in 2018 was 407.4 ppm, while the global average in the early 1700s was 280 ppm. The changes to our climate largely match the effects expected from the increase in emission of greenhouse gases.

Scientists have observed the results: The Earth's average temperature has risen about 1 degree Celsius or 2 degrees Fahrenheit since the 1880s, with the trend accelerating since 1950. The five warmest years on record have happened during the past five years (2014–2018), and eighteen of the warmest 19 years have occurred since 2000. Global temperature in 2016 is the highest recorded annual temperature since 1880, when such record-keeping began. Weather dynamics often affect regional temperatures, so not every region experienced the same degree of warming. Specific places are warming much faster. For example, warming trends have been consistently the strongest in the Artic, where 2018 saw high temperatures and continuing loss of sea ice.



Source: Climate Central (2019) https://www.climatecentral.org/gallery/graphics/the-10-hottest-global-years-on-record

That this global warming phenomenon is largely caused by the world's use of fossil fuels was documented by the Intergovernmental Panel on Climate Change, which represents the scientists of nearly all nations. Their findings have been officially endorsed by practically all of the world's national governments. The conclusion also comes from other international bodies such as the World Meteorological Organization, and within the United States, from our universities, private research institutions, and all the relevant government agencies and advisory bodies, including NASA, the National Oceanic and Atmospheric Administration, the U.S. Department of Agriculture, the U.S. Geological Survey, the National Academy of Sciences (which produced this short primer on climate), and the U.S. Environmental Protection Agency. The EPA designated carbon dioxide as a dangerous pollutant, and the U.S. judiciary upheld the designation.

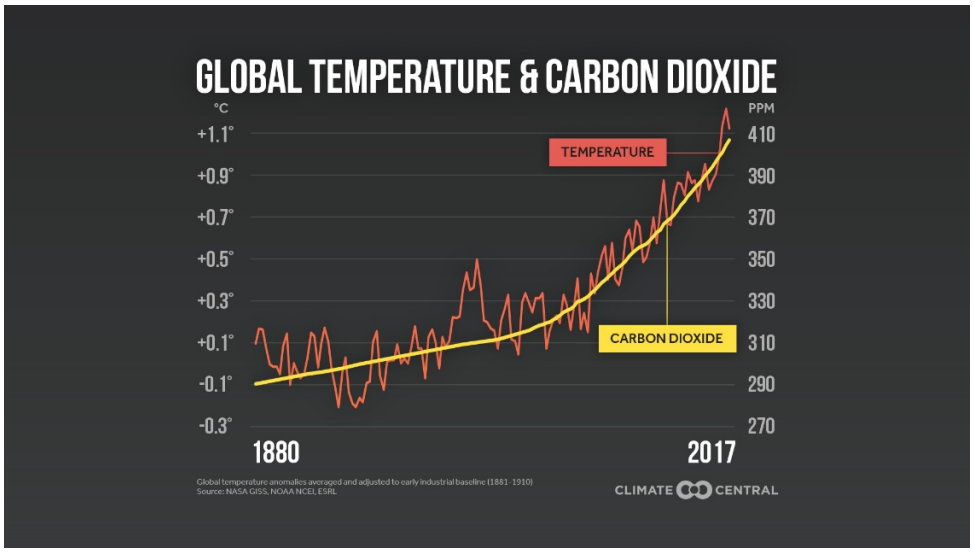
While natural cycles have long driven climate shifts on scales of tens, hundreds, thousands and millions of years, the rate of change we are seeing today far exceeds anything historically observed. The natural shifts have been huge. Eons ago, crocodile-like creatures able to live in warm conditions inhabited what is now the Arctic. Fifty million years ago (just 1% of Earth history) there were no ice sheets in Antarctica or the Arctic. Broadly speaking Earth's surface has been getting colder since that time. Antarctica ice sheets had developed by 30 million years ago and Northern Hemisphere glaciation and the onset of the ice ages started about 3 million years ago.

Ice cores provide evidence that atmospheric carbon dioxide levels have stayed between 170 and 300 parts per million for the last 800,000 years, oscillating between glacial and inter-glacial cycles. Just 15,000 years ago, a mile of ice lay over what is now the New Jersey Turnpike. These shifts took millennia to happen. For the past few hundred thousand years there has been a switch every 100,000 years from glacial periods when atmospheric carbon dioxide concentrations were about 170 ppm to interglacials when they were reached up to about 300 ppm. Carbon dioxide levels today should be high (280 ppm) as a result of *natural* climate change. Instead, they are off-scale because of human activity.

Short term regional fluctuations have been recorded and are well known. Heat waves and droughts have ravaged ancient civilizations. We know all this because scientists have for decades been analyzing ancient signs of these events locked in ice cores, tree rings, cave formations, corals, lake bottoms, ocean sediments, and other natural records. These are the same scientists telling us that the changes we are seeing now are primarily due to human emissions—not natural causes.

The most powerful drivers of long-term swings, from ice ages to warm periods, are variations in Earth's orbit, but orbital changes take place over tens or hundreds of thousands of years; they do not explain the changes that scientists have observed over the last century. The energy output of the sun itself also varies—but as measured over the last century, it has changed very little, so that process does not explain anything either. Particles spewed by volcanoes can also affect the climate—but mainly to cool it temporarily, as we saw after the 1991 eruption of the Philippines' Mt. Pinatubo.

Since about 1750, the start of the Industrial age, the atmospheric carbon dioxide level has risen from 280 to more than 400 parts per million. The rise in carbon dioxide matches well the curve of known human emissions. These two curves match very well with the increase in temperature.



Source: Climate Central (2018) https://www.climatecentral.org/gallery/graphics/co2-and-rising-global-temperatures

The overwhelming evidence shows that carbon dioxide emissions are the dominant factor driving climate change, and the increase in global temperature has multiple impacts across the Earth—sea-level rise, changing precipitation patterns, warming oceans, melting glaciers, ecosystem changes—and much more.

New Knowledge

The gross workings of the climate system have been well understood for a long time. Some key pieces of the modern science, including understanding natural climate cycles and how human influences differ from them, have been done at the Lamont-Doherty Earth Observatory, starting in the 1950s.

But each year brings new discoveries and surprises. One of the most important pictures to recently come into focus is the degree to which the ice sheets in Greenland and Antarctica respond to climate change. Conventional thinking was that they responded slowly to climate variations. It turns out that this is incorrect. Multiple mechanisms have been identified that suggest they melt much more quickly than previously thought. These include how water can infiltrate the base of ice sheets, how floating ice shelves can disintegrate quickly, and how warming ocean waters are destabilizing the West Antarctic ice sheet.

There are also new studies on past sea level changes. Because the polar ice sheets were the principal cause of sea-level variations over the past several million years, their fluctuating masses can be inferred from historical estimates of sea level changes. Such studies also support the idea that the ice sheets can melt much more quickly than we thought. Greenland and West Antarctica have multiple meters of sea level rise stored in their ice, so these findings are warning signs.

Another recent advance is our ability to assess the role that global warming is playing in current extreme events, such as droughts, heat waves and hurricanes. It used to be a refrain that no single event could be attributed to climate change. Now we can much more effectively quantify the probabilities of these events with and without human influence, and often can say humans have made an event significantly more likely or more extreme. This is based partly on improved physical measurements, and the accuracy and speed with which we can model climate. But it is also because the impacts of human-caused warming are now that much larger and easier to identify. It's an undeniable fact that human influences on the climate are impacting us now and getting worse.

Appendix E: Climate at Columbia: An Inventory

The following is a summary of climate activity across Columbia University, organized by each School, and including two cross-University Institutes (Data Science Institute and the Earth Institute). Each summary lists the relevant expertise and disciplines within the unit; how that expertise is applied to climate; and notes relevant centers, initiatives, and education programs. This is meant to be a broad overview of climate research, education, and impact work that already exists within the University.

Columbia Business School

Columbia Business School is one of the top business and management schools in the U.S. The school is committed to educating and developing leaders and builders of enterprises who create value for their stakeholders and society, as well as creating and disseminating pathbreaking knowledge, concepts, and tools which advance the understanding and practice of management.

Columbia Business School is home to many leading experts in the climate change field who study **climate change as an economic problem**. Faculty research areas include climate risk and investment strategy, carbon pricing, decarbonization, corporate social responsibility, climate change and agricultural productivity, and modeling future climate risk.

The School has offered graduate-level courses in the climate change field for over a decade, from **climate finance to financing energy markets**. Through the School's Tamer Center for Social Enterprise, students can enroll in the Climate Change and Business Program which focuses on how to use markets and business skills to mitigate and adapt to climate change and its global impact. The Three Cairns Climate Fellowship provides financial support and mentorship to students who complete semester- or year-long projects at the **intersection of climate change and business**.

In addition to offering courses that explicitly address the challenges and opportunities climate change poses, Columbia Business School provides a wide array of programming designed to help students hone their business acumen, entrepreneurial skills, and problem-solving abilities so they are better equipped to tackle the environmental challenges we face.

Key Disciplines

Identifying and addressing the economic issues climate change poses necessitates a breadth of business knowledge and skills. The coursework offered at the School helps students master the following academic disciplines:

- Accounting
- Economics
- Finance
- Management
- Marketing
- Decision, Risk and Operations

Centers, Units, Initiatives, and Programs that Study Climate

- Tamer Center for Social Enterprise: The Tamer Center seeks to educate leaders to use business knowledge, entrepreneurial skills, and management tools to address social and environmental challenges. Offered through the Center, the Climate Change and Business program offers courses, experiential learning opportunities, research, conferences, and seminars on the global climate crisis and its business implications. One of the four key areas of focus is **sustainability and the environment**.
- Climate Science & Investment Conference: Annual conference co-hosted by the Tamer Center and the Lamont-Doherty Earth Observatory that **brings together climate scientists and business leaders** to understand how new advances in climate science can inform investments in specific sectors of the global economy.
- Program for Financial Studies Climate Change and Finance Initiative: Partnership between academia and industry whose goal is to understand how a changing climate and the policies directed at mitigating climate change will affect U.S. business, with particular emphasis on the financial sector.

- India Business Initiative: This initiative within the Jerome A. Chazen Institute for Global Business is a resource for articles and research on **leading voices on climate change and its effects on global economies**, specifically from the Indian context.

Relevant Education Programs

Program	Partner
Undergraduate Special Concentration in Business Management	Columbia College, School of General Studies, Mendelson Center for Undergraduate Business Initiatives
M.B.A.	SIPA, SEAS, Law, GSAPP, SPS, GSAS, Mailman School of Public Health, Journalism
E.M.B.A.	SIPA, SEAS, Law, GSAPP, SPS, GSAS, Mailman School of Public Health, Journalism
Ph.D.	SIPA, SEAS, Law, GSAPP, SPS, GSAS, Mailman School of Public Health, Journalism
M.S.	Decision, Risk, and Operations and SEAS
Dual Degrees	Law, Journalism, GSAPP, SIPA

MBA and EMBA programs include a core curriculum and a series of electives that facilitate the development of specialized areas of expertise, including climate change (see here). The School also offers students the opportunity to develop specialized areas of expertise in related topics like corporate social responsibility, social ventures, and impact investing (see here for a list). Even students who are considering careers with no direct relationship to environmental issues are encouraged to take courses that provide a framework for thinking about climate change and its consequences for business (see here).

FACULTY RESEARCH

Members of the Columbia Business School faculty who have an expertise in the economics of climate change, include: Bruce Usher, Kent Daniel, Geoff Heal, Stijn Van Nieuwerburgh, Chris Mayer, David Sherman, Patrick Bolton, and Joseph Stiglitz.

- **Geoffrey Heal**, Donald C. Waite III Professor of Social Enterprise is an environmental economist whose work touches on the following topics: uncertainty about the extent and impacts of climate change; effective carbon tax design; and how to model the social cost of carbon and the choice of discount rates used in these models. His work has also measured the impact of sea-level rise on property values in the US, the impact of rising temperatures on labor productivity, and the costs of transitioning to renewable energy. He serves as the Director of the Program for Financial Studies Climate Change and Finance Initiative.
- **Kent Daniel**'s research shows how uncertainty about climate fragility affects the social cost of carbon. He also examines how behavioral interventions, such as message framing, can enhance acceptance of carbon pricing policies and climate legislation. He currently serves as the Senior Vice Dean for Faculty Affairs and is the William von Mueffling Professor of Business.
- **Patrick Bolton**, Barbara and David Zalaznick Professor of Business is an expert on corporate finance and governance. His research considers the role of corporate governance and financial markets in mitigating the effects of climate change and climate-change policy. He also examines how investors and asset managers can invest green without sacrificing returns.

- **Bruce Usher**, co-director of the Tamer Center for Social Enterprise; Elizabeth B. Strickler '86 and Mark T. Gallogly '86 faculty director; and Professor of Professional Practice has authored a book on renewable energy and translated his insights into climate change cases that he uses in the classrooom. He has planned, led, and spoken at various climate-focused conferences.
- **Joseph Stiglitz**, Nobel Leaurate and executive director and co-founder for the Initiative for Policy Dialogue (IPD) is a renowned scholar with a research focus on carbon pricing that drives climate action. Additionally, IPD's Climate Change Task Force is dedicated to advancing the discourse on what would constitute the least unfair bargaining equilibrium on a climate change agreement, especially from the perspective of developing countries. The Task Force brings experts from both developed and developing countries to the table to push the dialogue on a climate change agreement forward.

Additional research interests by other faculty include the effect of climate change on property values and climate change and finance.

By the Numbers

Category	#
Number of Total Enrollment Across All Programs (Academic Year 2018-2019) taking climate related courses *Includes M.B.A., Dual, M.S., Ph.D., Non-unique students*	474
Number of Total Enrollment Across All Programs (Academic Year 2018-2019) taking climate related courses *Includes E.M.B.A.; Non-unique students*	11
Number of Total Faculty	152
Number of Climate-Related Faculty	8

Data Science Institute

Data science has a key role to play in the climate challenge. The science, policy, and communication practices around data science, machine learning, and artificial intelligence have important implications for the climate crisis and the solutions society will utilize in the future. From machine learning to data visualization, data science techniques are used to study the effects of climate change on marine biology, land use and restoration, food systems, patterns of change in vector borne diseases, and other climate-related issues. **Data science is a powerful tool** to help researchers **understand the uncertainties and ambiguities** inherent in data, to **identify interventions, strategies, and solutions** that realize co-benefits for humanity and the environment, and to evaluate the multiple–and sometimes conflicting–goals of decision-makers.

The Data Science Institute (DSI) at Columbia University advances the state of the art in data science; transforms all fields, professions, and sectors through the application of data science; and ensures the responsible use of data to benefit society. DSI researchers use the methods and tools of the growing field of data science and apply them to issues relevant to climate change and the environment.

DSI researchers combine techniques from data science and environmental science to **understand patterns in the global food system** and develop strategies that make food supply chains more nutritious and sustainable. They look at how machine learning can **reduce the uncertainty of climate models**, use deep learning for climate model superresolution, and help **visualize carbon emissions** based on raw data. Some combine machine learning with simulations of atmospheric turbulence to develop new models that can track air pollutants and reconstruct 3D scalar fields from 2D satellite images. Others provide innovative training in environmental health sciences, including **climate and health**. Researchers developed a data collaborative to harness geospatial data to **help characterize populations displaced by disaster**. This kind of information may **help with planning for and responding to large scale natural disasters** associated with climate change.

DSI students complete capstone projects to **apply data science techniques to real world problems**. One recent project **used climate data to predict heavy snowfall**. Using a data set of regional climate simulations, the student team calculated the frequency of large snow storms and tracked how the storm statistics will change in the future. Another project **used machine-learning methods to develop mapped estimates of surface ocean CO2 concentrations** from the limited ocean data available to monitor carbon sink to predict climate change. DSI helps its students interpret environmental data by teaching how data are managed, stored, and disseminated, as well as how they are enrolled into various narratives and models of climate change.

CLIMATE RESEARCH HIGHLIGHTS

Deep Learning for Climate Model Superresolution

Ryan Abernathey, Earth and Environmental Sciences
Peter deMenocal, Earth and Environmental Sciences and Lamont-Doherty Earth Observatory
Mu Xu, Lamont-Doherty Earth Observatory

Eddy transport of tracers (e.g. heat, salt, dissolved chemicals, etc.) by mesoscale turbulence is important in climate models. However, the scales of eddy transport are about 10~200 km, which are not resolved by coarse-resolution global climate models. Consequently, the mesoscale tracer transports must be parameterized using a subgrid scheme. The goal of parameterization is to predict the tendencies of physical variables including velocity, temperature, salinity etc. due to the unresolved turbulent motions. There are many different types of mesoscale subgrid schemes, and many different tuning parameters. However, evaluating the performance of subgrid scheme quantitatively is difficult. In this work, we present a framework to evaluate the accuracy of subgrid schemes

quantitatively with a data-driven method. We run a high-resolution simulation with resolution of about 5 km and consider this as our "truth." With a coarse-grain method, the high-resolution data is projected to a low-resolution grid. The quantitative aim of eddy parameterization is to mitigate the loss of tracer transport due to the coarse-graining. Based on this consideration, we develop an offline system to calculate the eddy parameterization predictions and evaluate the performance of different subgrid schemes. This work lays a foundation for future data-driven statistical-learning-based methods for ocean eddy tracer transport parameterization.

The Effect of Climate Change on Marine Biology

Joaquim Goes, Lamont-Doherty Earth Observatory
Ankit Peshin, Ziyao Zhang, and Paridhi Singh, Data Science Institute

This research team travels by ship to different parts of the Atlantic Ocean to collect water samples to study the effects of climate change on marine biology. They are designing an automated system through which seawater may be drawn into their moving ship and continuously analyzed. This automated system is an advancement over the usual method of collecting samples; ocean researchers typically stop their ships at pre-planned locations to collect samples. Data is also being gathered on the diversity of microscopic plant life, particularly plankton, which are critical to the marine ecosystem and to assess the ocean's ability to sequester carbon dioxide from the atmosphere. Plankton form the basis of many food chains and are an important indicator of an ocean's health. When fully functional, the system will provide data required to validate satellite images of the ocean now being developed by NASA, NOAA, and other agencies.

Tracking Air Pollutants and Reconstructing 3D Scalar Fields from 2D Satellite Images via Machine Learning

Marco Giometto, Civil Engineering and Engineering Mechanics
Pierre Gentine and Mostafa Momen, Earth and Environmental Engineering
Carl Vondrick, Computer Science

Satellite images are routinely used to track pollutant dispersion in the atmosphere, but the inherently two-dimensional information is limited and often impedes the development of effective rapid response plans. This project will develop a machine learning model to predict the three-dimensional structure of pollutant concentrations from satellite images of the dispersion process. Machine learning will be combined with high-fidelity simulations of atmospheric turbulence to guide the development of a model to track scalar dispersion as well as a model to reconstruct the corresponding three-dimensional concentration field from two-dimensional satellite-like information.

Machine Learning to the Rescue: Eliminating the Damage Caused by the Tsetse Fly in Sub-Saharan Africa

Zsuzsa Marka and Szabolcs Marka, Physics and Columbia Astrophysics Laboratory
John Wright, Electrical Engineering
Zelda Moran, Earth Institute

Control of tsetse flies — the vector responsible for African Trypanosomiasis or sleeping sickness — is highly dependent on precise, high-volume, and cost-effective separation of tsetse genders. Enabling broad deployment, this team is pioneering machine learning-based robotic systems that use infrared imaging to peek inside tsetse pupae for early, robust, and fast identification of males to be used to suppress the wild tsetse population.

Data-Driven Techniques to Study the Global Food System

Ruth DeFries, Ecology, Evolution and Environmental Biology
Walter Baethgen, International Research Institute for Climate and Society
Michael Puma, Center for Climate Systems Research, NASA Goddard Institute for Space Studies
Kyle Davis, Data Science Institute

This project combines field work with data-driven techniques to study how to improve patterns of food trade in Latin America, sub-Saharan Africa, and South and Southeast Asia. Food trade patterns are essentially the import and export links that connect the production of food in one country to the consumption of it in another. If, for instance, an exporting country experiences a shortage in food production, it may be unable to provide the usual amount of exports to its trade partners. This projects assesses how vulnerable these exporting countries are to production shortfalls, and how importing countries may buffer themselves against these possible shortfalls so they are not adversely affected. Research in food-system sustainability aims to minimize the effects of food production on the environment, working with local residents and experts to adapt agricultural systems to protect the environment and mitigate climate change.

Carbon Catalogue

Christoph Meinrenken, Earth Institute

Carbon Catalogue, a free online interactive tool, visualizes the carbon emissions embedded in hundreds of consumer and commercial products around the world. Co-developed with CoClear, a Columbia-alumna founded sustainability analytics firm, Carbon Catalogue is based on raw data from CDP (formerly the Carbon Disclosure Project). Its visualization features were further honed during a DSI hackathon.

Harnessing the Geospatial Data Revolution for Good: Characterizing Populations Displaced by Disaster

Robert Chen, Center for International Earth and Science Information Network

Groups tasked with planning for and responses to disasters and humanitarian crises contend with data that is often fragmented, delayed, and limited in reliability. This project focuses on setting up the Data Collaborative and Modalities of Communication involving key users from the Platform on Disaster Displacement, (PDD) Columbia University's humanitarian research community, selected commercial providers, and other relevant data science organizations and experts. It also identifies data/information needs of the humanitarian/displacement tracking community, and reviews the literature and develops pilot tests of selected data streams (Internet location, night-time lights, etc.).

Using Climate Data to Predict Heavy Snowfalls

Gavin Schmidt, NASA Goddard Institute for Space Studies and Earth Institute

Every winter the news media covers stories of massive disruption caused by large snowfalls for which cities and counties in the Eastern U.S. are apparently ill-prepared. The impact of large snow events is worse in regions that rarely get them for obvious reasons and the observational statistics of their likelihood are limited because of their rarity. Nonetheless, there are anticipated changes in these statistics because of two possible counterbalancing factors in climate change — overall warming which might reduce snow events at the southern edge of the region and greater intensity of precipitation and higher atmospheric water vapor content, which might increase heavy snowfalls. Using a 50 member regional climate model ensemble, we explore the statistics of highly impactful snowfalls and address where and when we might be able to detect and expect significant changes over time.

Monitoring Carbon Sink to Predict Climate Change

Galen McKinley, Earth and Environmental Science and Lamont Doherty Earth Observatory

Climate is changing due to human emissions of carbon to the atmosphere. But not all the carbon emitted remains in the atmosphere. In fact, over the course of the industrial era the ocean has absorbed the equivalent of 41 percent of all human fossil-fuel derived carbon dioxide emissions, a phenomenon known as "sink." Studying the ocean carbon cycle is critical to understanding and predicting climate change. It is also essential for efforts to limit climate change by reducing the growth rate of atmospheric CO2 concentrations. Ocean data are quite sparse, and CO2 in water cannot be directly measured from space. This team uses machine-learning methods to develop mapped estimates of surface ocean CO2 concentrations from the limited data available.

Interpreting Urban Environmental Data

The course is a pilot and part of a broader rethinking of archaeology at Columbia. Faculty work toward developing a more integrated archaeology program to bring together expertise and resources from different departments and which may be offered at the MA level and better serve our undergraduate population. The course also provides training in historical terrestrial palaeoecology and cultivates an informed historical consciousness and an understanding of the wider repercussions beyond the field of scientific research and reporting.

Key Disciplines

- Biology
- Cybersecurity
- Engineering
- Mathematics
- Psychiatry
- Business
- Data Processing
- Finance
- Medicine
- Public Health
- Computer Science
- Economics
- Informatics
- Neuroscience
- Statistics

Centers, Units, Initiatives and Programs that Study Climate

- The **Center for Computing Systems for Data-Driven Science** explores the design, analysis, and application of massive-scale computing systems for processing data in the most general sense. Its goal is to address the underlying systems aspects of Big Data— including data processing, storage, and retrieval—which are central to some of the key research and societal challenges of the 21st century. **Climate is one of many application areas**.
- The **Center for Data, Media and Society** looks at the human in data. Students and faculty engage in both creative as well as research practices grounded in data. **They use data to understand human behavior**, and address questions about how data and data processing shape how we work, how we live, and what it means to be a person in a networked, digitized world.
- The **Center for Financial and Business Analytics** develops analytical and computational tools to manage risk and to support decisions using the growing volume and variety of data available on the Internet and elsewhere. **Insurance risk and natural disasters is one of its research thrusts**.
- The **Health Analytics Center** is located at the Columbia University Irving Medical Center and works to improve the health of individuals and the health care system through data-driven methods and understanding of health processes. Research is conducted on **the impacts of climate change on our health**.
- The **Sense, Collect and Move Data Center** focuses on the physical aspects of generating, collecting, storing, and transporting large data sets, including **air quality data**. Sensing data includes research on novel sensors and sensing modalities, collecting data includes technology to connect sensors to data sinks, and moving data includes advances in models, protocols, architectures and technologies for data centers and networks in many scales and modalities.

- The **Smart Cities Center** develops and monitors **sustainable urban infrastructure and buildings**, improves the power supply through smart grid technology, detects and counteracts problems with aging urban infrastructure, calculates and communicates optimal transportation routes under congested traffic conditions, and deploys ubiquitous sensing devices to facilitate everyday activities in a crowded urban environment.

Education Programs

Program	Partners
M.S. in Data Science	School of Engineering and Applied Science Graduate School of Arts and Sciences
Ph.D. with a specialization in Data Science	Applied Mathematics; Computer Science; Electrical Engineering; Industrial Engineering; Operations Research; Statistics
Certification of Professional Achievement in Data Sciences	School of Engineering and Applied Science Graduate School of Arts and Sciences

By the Numbers

Category	#
Year Established	2012
Affiliated Faculty	350+
Columbia Schools, Institutes and Colleges	17
Industry Affiliates	27
Research Centers	8
Working Groups	3
Seed Fund Proposals (2017–present)	104
Current Students (Fall 2019)	365
MS in Data Science Alumni	350
Job/Internship Placement Three Months after Graduation	98%
Bootcamp Participants	263
Undergraduate and Graduate DSI Scholars (Fall 2019)	14
Collaboratory Projects	20
Campus Connection Projects	60+

Faculty of Arts and Sciences

The **Faculty of Arts and Sciences at Columbia** is the organizational framework to unify faculty and allow for shared leadership and governance across schools. Two of these schools—Columbia College and the School of General Studies, are home to Columbia's Arts and Sciences undergraduate student body. The School of the Arts offers Master's programs; the School of Professional Studies offers post-baccalaureate and Master's programs; and the Graduate School of Arts and Sciences is home to many of our department-based Master's programs, as well as to all Arts and Sciences doctoral students. The Faculty of Arts and Sciences has academic oversight of 28 departments that fall within three core divisions: humanities, social sciences, and natural sciences. Each department is listed below under their respective divisions.

Humanities	Natural Sciences	Social Sciences
• Art History & Archaeology • Classics • East Asian Languages & Cultures • English and Comparative Literature • French & Romance Philology • Germanic Languages • Italian • Latin American & Iberian Cultures • Middle Eastern, South Asian, & African Studies • Music • Philosophy • Religion • Slavic Languages	• Astronomy • Biological Sciences • **Chemistry** • **Earth & Environmental Sciences (DEES)** • **Ecology, Evolution & Environmental Biology (E3B)** • Mathematics • Physics • Psychology • **Statistics**	• Anthropology • African-American & African Diaspora Studies • **Economics** • **History** • Political Science • Sociology

Faculty across the Arts and Sciences engage in research and teaching that address climate change, including **basic climate science, data collection, decision-making, modeling, historical climate, forecasting, adaptation, mitigation, and more generally the complex ways that humans interact with their environments**. The Department of Earth and Environmental Sciences (DEES) has the greatest concentration of research and applications in these areas, but climate change is a major focus as well in: Chemistry; Ecology, Evolution and Environmental Biology (E3B); and is a subject of research for faculty in Economics; English and Comparative Literature; History; Music; and Statistics.

Historically, Columbia faculty have made crucial contributions to our understanding of climate change, as they continue to do today. Former DEES faculty member Wallace Broecker in his *Science* paper *"*Are We on the Brink of a Pronounced Global Warming?" published in 1973, is credited not only with coining the term "global warming," but with defining "much of today's understanding of the climate system" (*Nature,* 2019). DEES faculty and colleagues at Lamont Doherty Earth Observatory have shown how natural climate cycles work; how carbon dioxide is now influencing Earth's temperature; the hidden roles that oceans play in regulating climate; and, most recently, how ongoing rapid climate change is affecting nature and human societies.

Today, faculty in the Arts and Sciences continue to lead their fields in climate change science, applications, and research. DEES geochemist **Galen McKinley**'s research group **studies how ocean physical and biogeochemical processes impact large-scale carbon cycling**, deepening our understanding of the important role of the ocean as the Earth's primary carbon sink. DEES glaciologist **Jonny Kingslake**'s research group **studies glacial processes to improve predictions of ice-sheet evolution**, which is crucial to our understanding of past and future sea level rise. E3B Professor **Dustin Rubenstein**'s research group **studies how organisms cope with environmental change** through studies that combine behavior, ecology, and evolution with those of the underlying molecular and neuroendocrine mechanisms.

E3B Professor **Maria Uriarte**'s lab **examines forest ecological dynamics** in response to natural disturbance (e.g., hurricanes) and human land use, with particular focus on Puerto Rico following Hurricane Maria. Professor of History **Rhiannon Stephens** studies how **historical climate events shaped East African societies** before colonial conquest, and how people responded to the pressures generated by such events. **Jennifer Wenzel** is a thought leader in considering how **energy extraction affects cultures across the world**. These are examples from the 90 plus faculty working in climate change related research. Arts and Sciences faculty include Nobel Prize and MacArthur awardees, members of the National Academy of Sciences, and numerous other winners of disciplinary prizes and awards.

Key Disciplines

- Atmospheric science
- Climate change history
- Conservation biology
- Ecology
- Emerging infectious diseases
- Environmental humanities
- Macroeconomics
- Materials chemistry
- Natural Hazards
- Paleoceanography
- Public policy
- Solid Earth geophysics
- Carbon sequestration
- Climate forecasting
- Decision-making
- Econometrics
- Energy humanities
- Environmental policy
- Marine microbial evolution
- Meteorology
- Ocean and climate physics
- Paleoclimatology
- Science education
- Theoretical chemistry
- Chemical oceanography
- Comparative historical research
- Earth & ocean observations
- El Niño forecasting
- Environmental history
- Extreme weather
- Materials and technology
- Microeconomics
- Paleobiology
- Physical oceanography
- Solar energy conversion
- Theoretical modeling

Centers, Units, Initiatives and Programs that Study Climate

- Center for Climate and Life: supports climate, ocean, and life science research to **accelerate understanding of climate change risks and solutions**.
- Center for Economy, Environment and Society (CEES): studies the **interdependencies between the environment, the economy, and society**.
- Center for Energy, Marine Transportation and Public Policy (CEMTPP): supports research in **marine transportation and energy**, as well as provides a space for stakeholders across sectors to engage in discourse on energy policy.
- Center for Science and Society: explores the intersection of science and society through innovative interdisciplinary methods. The cluster on Environmental Sciences and Humanities brings together scholars in the ecological and Earth sciences, economics, political science, anthropology, philosophy, history, geography, and literature, to explore the possibilities for an **integrated approach to environmental problem-solving.**

- Columbia Science Commits: Strategic research and education priorities for the A&S Natural Sciences division (Climate Response, Neuroscience, Precision Medicine, Data and Society, Quantum Science, and Fundamental Science). **Climate Response** is a key focus area and seeks to advance knowledge of **climate impacts and adaption, accuracy of predictions** and forecasting, and **climate solutions**.

Relevant Education Programs

The following encompasses programs from Columbia College, the School of General Studies, Graduate School of Arts and Sciences, School of the Arts, and School of Professional Studies.

Program	Partner
B.A./B.S. in Earth Science; Environmental Biology; Environmental Chemistry; Environmental Science; Sustainable Development	Columbia College; School of General Studies
M.A. in Climate and Society	GSAS, SEAS
M.A. in Ecology, Evolution, and Conservation Biology	GSAS
Ph.D. in Civil Engineering and Engineering Mechanics	GSAS; SEAS
Ph.D. in Earth and Environmental Engineering	GSAS
Ph.D. in Earth and Environmental Sciences	GSAS
Ph.D. in Ecology, Evolution and Environmental Biology	GSAS
Ph.D. in Economics	GSAS
Ph.D. in Environmental Health Sciences	GSAS, Mailman School of Public Health
Ph.D. in Epidemiology	GSAS, Mailman School of Public Health
Ph.D. in History	GSAS
Ph.D. in Statistics	GSAS
Ph.D. in Sustainable Development	SIPA, Earth Institute
Ph.D. in Urban Planning	GSAS, GSAPP
M.S. Sustainability Management	SPS, Earth Institute
M.S. Sustainability Science	SPS, Earth Institute
M.S. Negotiation and Conflict Resolution	SPS
Certifications in: Sustainability Analytics Sustainable Finance Sustainable Water Management Ecology, Evolution and Environmental Biology United Nations Studies	 SPS, Earth Institute SIPA

Undergraduate and graduate degrees in **Earth and Environmental Sciences** are among the most respected in the world, given Columbia's continuous standing in the **top ten Earth Science** departments in the nation and internationally. The MA program in **Climate and Society** uses an interdisciplinary approach to train professionals and academics to understand and cope with the **impacts of climate variability and climate change on society** and the environment. Masters and Certificate students at Columbia's **School of Professional Studies** are taught by leading educators and practitioners to gain the skills to move their careers, communities and industries forward in **Sustainable Finance** and **Water Management**, as well as **Sustainability Analytics**. Research and education include topics of **climate forecasting and variability**, climate adaptation, carbon sequestration, climate change

law, science writing, humanitarian **preparedness for natural disasters**, and working with diaspora communities in the wake of natural disasters, such as Hurricane Maria.

By the Numbers

Category	#
Number of Total Students in Arts & Sciences Schools	15,351
Number of Full-Time Faculty	1,012
Number of Climate-Related Faculty	>90
Annual Grant Income Related to Climate	Likely > $10M

The Fu Foundation School of Engineering and Applied Science

Columbia Engineering, the Fu Foundation School of Engineering and Applied Science (SEAS), is among top engineering schools in the U.S and is the #1 ranked Engineering School in the Ivy League. It seeks to expand knowledge and advance technology through research, while educating students to become leaders and innovators informed by an engineering foundation. Guided by its strategic vision, "Columbia Engineering for Humanity," SEAS aims to translate ideas into innovations that foster a sustainable, healthy, secure, connected, and creative humanity.

Columbia Engineering is at the forefront of many strategic areas of research that are focused on our vision of Engineering for a Sustainable Humanity, from fundamental breakthroughs in materials and computation, to translational technologies and capabilities which shape an **environmentally sustainable future.** Our education and research programs cut across all nine departments within SEAS and encompass several research centers organized around specific cross-disciplinary fields that engage faculty from across departments and also other schools.

SEAS has a **diverse and exciting portfolio of research and education activity related to climate and sustainability**. This includes leading work on:

- decarbonization—from carbon capture, utilization and storage to clean and low carbon manufacturing to sustainable materials and zero carbon fuels; from renewable energy to nuclear fusion to electrochemical energy storage;
- the future of water—from understanding and sustaining the hydrology of the earth to affordable clean water technologies and sustainable agriculture; from advanced waste water treatment methods to green roofs for urban stormwater management; sustainable mining;
- smart electric systems—from smart metering to smart buildings to smart cities; from green data centers to new centralized and decentralized energy grids, from the electrification of cars to the electrification of marine and global transportation;
- climate management—from the measurement and prediction of land-atmosphere interactions to technologies for sustainable mining to the forecasting of extreme weather, from understanding global hydrology, climate sensitivity, and climate dynamics to financial and infrastructure based strategies for climate adaptation and risk management.

*Future ambitions: SEAS has ambitions to further expand our faculty, research laboratories, and education efforts in this highly cross-disciplinary area of **Global Sustainability and Confronting our Climate Future** as a key element of our Manhattanville Site 6 expansion – the **Engineering Institute for Humanity**. Of the anticipated 80-100 faculty that will call Site 6 their primary academic home, we envision an expansion of 20 to 25 faculty members across our strategic research areas of climate and sustainability, which will require support for endowed professorships, endowed doctoral fellowships, and research seed funding as well as the significant funds needed for establishing the Site 6 building itself and its embedded state-of-the-art laboratories.*

Departments and Disciplines

- Applied Physics
- Applied Mathematics
- Artificial Intelligence
- Biomedical Engineering
- Chemical Engineering
- Computer Science
- Computational Engineering Science
- Data Science
- Earth Engineering
- Engineering Mechanics
- Environmental Engineering
- Industrial Engineering
- Materials Science
- Mechanical Engineering

- Civil Engineering
- Electrical Engineering
- Nano Science and Engineering
- Operations Research

Cross-Disciplinary Centers, Units, Initiatives and Programs that Study Climate

Columbia Engineering has over 40 faculty with some significant level of their research effort focused on addressing the global challenges of sustainability and our climate future; these efforts take place in individual faculty labs, and joint collaborative centers, as well as via other initiatives and programs. Some examples of these activities are listed below:

- *Lenfest Center for Sustainable Energy (LCSE) (with the Earth Institute)*: This center is focused on developing the next generation of **carbon capture, utilization and storage (CCUS) technologies**, as well as technologies that will improve energy efficiency and thus reduce carbon emissions.
    - Research Coordination Network: Carbon Capture, Utilization and Storage (RCN-CCUS): The RCN-CCUS is a project funded by the National Science Foundation (NSF) under the Science, Engineering and Education for Sustainability (SEES) program. The aim of the RCN-CCUS is to advance the field of CCUS by coordinating interdisciplinary research, training and educational activities.
- Quadracci Sustainable Engineering Lab *(with the Earth Institute)*: The Lab brings together a diverse set of faculty and researchers who work in collaboration to engineer **sustainable energy solutions** to development issues. Much of this work has focused on decentralized electric and water grids in off-grid communities in the developing world—and how these innovations can feed back into the developed world.
- Columbia Electrochemical Energy Center (CEEC) *(with the Earth Institute)*:The Center is a collaboration across Columbia Engineering—Chemical Engineering, Earth and Environmental Engineering, Electrical Engineering, Materials Science, Mechanical Engineering, Operations Research, Civil Engineering and NanoScience—it also draws on expertise from the Earth Institute, Lamont-Doherty Earth Observatory, SIPA Center for Global Energy Policy, and Columbia Technology Ventures. Its research ranges from the discovery of new materials for energy storage to learning how to use new technologies in complex systems such as the electrical grid.
- Center for Life Cycle Analysis: The Center is focused on the comprehensive Life Cycle Analysis (LCA) of materials and energy systems, with the aim of understanding and reducing the embodied energy in everything from products to urban systems.
- Clean Air Toolbox for Cities (with the Earth Institute): A scalable approach to reduce air pollution and protect human health in cities across the Global South. Developing technical capacity and science-based clean air solutions with a deep understanding of relationships between air-quality and climate.
- Columbia Water Center (CWC) (with the Earth Institute): The Center's mission is to develop interdisciplinary research toward global water sustainability. Its research focuses on quantifying the role of climate variability and change in determining interlinked water, energy, food, industry, mining and urban risks, and their mitigation using financial, infrastructure, and policy solutions from farm to city to nation to global scales, recognizing supply and value chains and the uncertainty propagation across them. Its research ranges from the physics and statistics of the climate determinism of extreme floods and droughts, to technological solutions that increase water, agriculture, and energy productivity, to parametric insurance products and optimization models that can provide economically and socially effective solutions to uncertain climate, technological and economic futures.
- Columbia Initiative on Extreme Weather and Climate : Understanding the risks to human life and property from extreme weather events, both in the present and future climates, and developing solutions to mitigate risks. In the last five years the Initiative has hosted a wide range of events on different aspects of the scientific and human dimensions of different kinds of extreme events, supported the research of

undergraduate and MS students, and fostered interactions between Columbia scientists and the private sector, especially the insurance industry.

- Columbia Nano Initiative: Research initiatives in nanoscience and nanotechnology; photonics for green data centers; quantum technologies; energy efficient coatings.

Relevant Education Programs

SEAS offers numerous Bachelor of Science degrees, Master of Science degrees, and PhD and ScD degrees—some of which have very specific connection to sustainability and confronting climate change, some with concentrations or specializations related to sustainability and climate, as well as numerous other courses across SEAS departments that provide elective options for those interested in sustainability and climate. Note that all of our degrees prepare students with a foundation to have impact on this global challenge. For purposes of brevity, we are not listing all of the many specializations and concentrations available to our students.

Undergraduate Degree Programs	Master of Science Degree Programs
B.S. in Earth and Environmental Engineering	M.S. in Materials Science and Engineering
B.S. in Chemical Engineering	M.S. in Electrical Engineering
B.S. in Electrical Engineering	M.S. in Mechanical Engineering
B.S. in Applied Mathematics	M.S. in Industrial Engineering
B.S. in Applied Physics	M.S. in Operations Research
B.S. in Mechanical Engineering	M.S. in Financial Engineering
B.S. in Civil Engineering	M.S. in Business Analytics (with the Business School)
B.S. in Materials Science	M.S. in Management Science & Engineering (with the Business School)
B.S. in Industrial Engineering	M.S. in Computer Science
B.S. in Operations Research	M.S. in Data Science (degree offered by CS and IEOR, in collaboration with Statistics of A&S)
B.S. in Financial Engineering	M.S. in CS and Journalism
B.S. in Computer Science	M.S. in Biomedical Engineering
B.S. in Biomedical Engineering	M.S. in Biomedical Engineering/MD in CUIMC

Doctoral Degree Programs:
Ph.D. (with GSAS) or Eng.Sc.D. in - Earth and Environmental Engineering - Chemical Engineering - Applied Physics - Applied Mathematics - Materials Science and Engineering - Electrical Engineering - Mechanical Engineering - Civil Engineering - Industrial Engineering - Operations Research - Financial Engineering - Computer Science - Biomedical Engineering MD/PhD Biomedical and CUIMC

By the Numbers

Category	**#**
Number of Total Undergraduate Students across all programs	1670
Number of Entering MS Students—all programs	1500
Total Number of PhD students across all programs	760
Number of Total Full Time Faculty	230
Number of Climate-Related Faculty	~40

Graduate School of Architecture, Planning and Preservation

The Graduate School of Architecture, Planning and Preservation (GSAPP) is a leader in developing new forms of design research and scholarship around the study **of architecture and the design and planning of cities, with an emphasis on environmental** and social sustainability.

The built environment is a significant contributor to climate change—residential and commercial buildings alone are responsible for nearly 40 percent of US carbon dioxide emissions—which renders architects, urban planners, and designers, as well as developers, crucial to addressing the climate crisis. In recognition of architecture and the built environment's critical and collective **responsibility to address the challenges facing the planet today**, GSAPP has fundamentally recast its various curricula to engage social and environmental sustainability across scales.

Key Disciplines

- Architecture
- Preservation
- Real estate
- Urban planning

Centers, Units, Initiatives and Programs that Study Climate

Research centers, labs, and initiatives housed at GSAPP are integrated with the curriculum to cultivate new knowledge, produce public programming, and collaborate with external partners.

- Center for Resilient Cities and Landscapes: The Center for Resilient Cities and Landscapes (CRCL), led by Professor Kate Orff and Research Scholar and Adjunct Associate Professor Thaddeus Pawlowski, uses planning and design to help communities and ecosystems adapt to the pressures of urbanization, inequality, and climate uncertainty. CRCL integrates resilience thinking into design education and academic programming, supports interdisciplinary collaborations and external partnerships, and brings real-world challenges into the classroom to train future design leaders.
- Urban Community and Health Equity Lab: The Urban Community and Health Equity Lab, led by Associate Professor Malo Hutson, conducts interdisciplinary research to transform institutions, policies, and practices that cause health inequities. Its research uses a social justice framework and conducts applied research that brings together leading academic professionals and practitioners who are focused on improving the built environment by protecting ecological systems, developing a circular economy, and promoting the health and well-being of urban populations.
- Hudson Valley Initiative: The Hudson Valley Initiative (HVI), led by Research Scholar and Adjunct Associate Professor Kaja Kühl, is linked to the MSAUD program and facilitates applied research into the complex spatial, ecological, and economic opportunities of the Hudson Valley. HVI works with a range of partners to advance the communities' goals and enhance students' educational experience through real-world collaborations. HVI pursues projects that improve the built and natural environment by expanding social impact design and by providing tools and knowledge to build resilient communities.
- Embodied Energy Project: The Embodied Energy Project, led by Associate Professor David Benjamin, explores architecture and sustainability through the lens of embodied energy – the energy required to extract, produce, transport, and assemble materials into buildings. The Embodied Energy Project involves student research and workshops, some of which have become part of the curriculum for the Advanced Architecture Studios. The project has also resulted in international public exhibitions, a symposium with experts from different disciplines, and the 2017 book Embodied Energy and Design.

EVENTS AND PUBLIC PROGRAMMING

As the second ranked architecture school in the U.S., GSAPP has a long legacy of shaping the disciplines and practices of architecture and the built environment through extensive public programing, with a significant impact on New York, but also internationally. The School acts as an **important cultural producer** and platform for critical dialogue, producing timely content through symposia, conferences, lectures, publications, and exhibitions. Public programming and events are described below.

- ***"Public Works for a Green New Deal" Supercrit,*** Nov. 22, 2019: "Public Works" is an initiative sponsored by the Temple Hoyne Buell Center for the Study of American Architecture to assemble a series of courses from across GSAPP that consider the social, technical, and political contours of the Green New Deal. The students and faculty of these nine courses share their outcomes, and will be joined by guest critic Kate Aronoff (Type Media Center), author of "With a Green New Deal, Here's What the World Could Look Like for the Next Generation." The Buell Center has focused its research on the topic of Power and Climate Change for the past two years.
- ***The Green New Deal: A Public Assembly,*** Nov. 17, 2019: "The Green New Deal" is a day-long public assembly co-hosted by the Buell Center and the Queens Museum. Taking place in U.S. Congressional District 14, jurisdiction of the GND Resolution's sponsor Rep. Alexandria Ocasio-Cortez (D-NY), the assembly welcomes advocates, organizers, and political leaders to explore the GND's relationship to society, policy, and the built environment. The event focuses on modeling democratic debates that consider the ambitions and challenges of the GND.
- **Lessons from Rebuild by Design: Urban Ecologies in the Era of Climate Change,** Sep. 17, 2019: "Lessons from Rebuild by Design" is a conversation between Shaun Donovan, former United States Secretary of Housing & Urban Development, and Professor Kate Orff, Director of the MSAUD Program, organized by the Center for Resilient Cities and Landscapes and Columbia World Projects.
- **A Framework for Understanding Community Relocation Due to Natural Hazards,** Sep. 3, 2019: This lecture is by Professor Robert Olshansky, Professor Emeritus of Urban and Regional Planning, University of Illinois at Urbana-Champaign. His teaching and research have covered land use and environmental planning, with an emphasis on planning for natural hazards. He has published extensively on post-disaster recovery planning and environmental impact assessment.
- **Climate Change at the Building Scale**, Feb. 22 and Apr. 5, 2019**:** "Climate Change at the Building Scale" is a series of summits that bring together architects and researchers from around the world who are directly addressing climate change and environmental responsibility in their design work. Organized as part of GSAPP's Advanced Architecture Studio curriculum in the MSAAD and MArch programs, the series starts from the practice of architectural design. Advanced Studios have a unique opportunity to address climate change at the scale of the building through design.
- **Cities and Climate Action: New Orleans, Rio, NYC**, Apr. 7, 2017: "Cities and Climate Action" presents a discussion about the critical role cities play in driving the agenda on climate change and the steps federal governments must take to assist cities in their efforts to respond to the vast environmental, economic, and cultural impacts. Moderated by Michael Kimmelman, the conversation features presentations by former and current city government officials from New Orleans, Rio de Janeiro, and New York City.
- **Embodied Energy and Design**, Apr. 22, 2016: This event frames embodied energy—defined as the sum of all energy required to extract raw materials and then produce, transport, and assemble the elements of a building – in the context of broader design ecosystems and architectural issues.
- **Climate Change & the Scales of Environment,** Dec. 4, 2015: This full-day symposium hosts experts and practitioners from Columbia and internationally to critically reframe our thinking about the built environment and our actions in shaping it, reflecting on the specificity of local conditions and histories as well as the challenges of climate change as a shared concern across the globe.

PUBLICATIONS by Columbia University Press on Architecture and the City

A Moving Border: Alpine Cartographies of Climate Change (2019) surveys variations in the boundary line between Italy, Austria, and Switzerland as the shifting natural watershed moves the border, diverging from its representation on official maps. Running mostly at high altitudes, the borderline follows a watershed that crosses snowfields and perennial glaciers – all of which are now melting as a result of anthropogenic climate change.

A Year Without a Winter (2018) brings together science fiction, history, visual art, and exploration. Edited by Dehlia Hannah in collaboration with science fiction editors Brenda Cooper, Joey Eschrich, and Cynthia Selin, it includes a suite of commissioned short stories. Weather extremes brought about by anthropogenic climate change pose relentless cognitive and imaginative challenges.

Blue Dunes: Climate Change by Design (2017) chronicles the design of artificial barrier islands developed to protect the Mid-Atlantic region in the face of climate change. Authors Jesse Keenan and Claire Weisz narrate the complex, and sometimes contradictory, research agenda of an unlikely team of analysts, architects, ecologists, engineers, physicists, and planners addressing extreme weather and sea level rise within the practical limitations of science, politics, and economics.

Climates: Architecture and the Planetary Imaginary (2016) brings together writings and design projects at the intersection of architecture and climate change. The essays consider the cultural values ascribed to climate and ask particularly how climate figures in our conception of what architecture is and does. The volume features contributions from over forty authors and also contains a dossier of precedents for thinking about architecture and climate change drawn from a number of leading practitioners.

Water Infrastructure: Equitable Development of Resilient Systems (2016) tackles the issue of water and sanitation as one of the most pressing and urgent issues of our time. Authors S. Bry Sarte and Morana M. Stipisic highlight the ways in which resilient design for water infrastructure can be reframed as critical connective tissue and as a living system that provides a variety of benefits, such as decreasing urban heat island effects, releasing pressure on aging infrastructure, absorbing water for flood protection, filtering and reusing water, and providing ecological and ecosystem services.

Relevant Education Programs

All programs at GSAPP – spanning architecture, urbanism, preservation, and even real estate development – have retooled themselves to be **directed toward the climate crisis**. The crisis has galvanized an intellectual project that engages most of the School's faculty and students. Below are some of the programs that have engaged the issue most comprehensively.

Program	Partner
M.S. Architecture and Urban Design	-
M.S. Urban Planning	-
Ph.D. in Urban Planning	-

MS Architecture and Urban Design: Directed by Professor Kate Orff, the MSAUD program advances new paradigms of research, practice, and pedagogy to meet the urgent challenges of rapid urbanization, the increasing threats of climate change, and the growth of social inequality. The program frames the city not as a fixed territory

but instead as a gradient of varied landscapes supported by networks of agricultural production, energy, resources, culture, transportation, and capital. The program's course work stresses threats to ecosystems, framing urban design as an inclusive, activist, tools-based project for specific sites and communities.

MS Urban Planning: Directed by Professor Weiping Wu, the MSUP program considers how increased disaster risks and other aspects of the climate crisis will influence the planning for equitable and sustainable development. Urbanization of entire regions has been associated with increasing energy use and related emissions and climate vulnerabilities. The program has developed courses to examine practices and policies in which risk reduction and resilience-building are integrated into urban planning and management.

PhD in Urban Planning: Directed by Associate Professor Malo Hutson, the PhD in UP program immerses students in the theoretical and methodological tools of the social sciences in order to contribute to the advancement of knowledge in the field of planning. Current PhD candidates are addressing a range of topics, including the relationship between climate change and city or regional planning. This research includes studies related to land development under conditions of high risk and uncertainty, renewable energy policy and electricity market reforms in Brazil, and the feasibility and impact of low-carbon cities being developed in China, among others.

FACULTY

Professor **Kate Orff i**s Director of the MSAUD program and Director of the Center for Resilient Cities and Landscapes. She is a landscape architect and the founder of SCAPE whose activist and visionary work on design for climate dynamics has been shared and developed in collaboration with arts institutions, governments, and scholars worldwide. In teaching and practice, Orff has advanced concepts of sustainable planning and urban design at multiple scales. At GSAPP, she coordinates interdisciplinary studios on urban systems that aim to discover new ways of integrating social life, infrastructure, urban form, biodiversity, and community-based change.

Associate Professor **Malo Hutson** is Director of the PhD in Urban Planning program and Director of Project Development at Columbia World Projects. He is a scholar, teacher, and practitioner whose research at the intersection of urban planning and health inequities is of profound relevance to the planning of cities across the United States and around the world. Hutson's focus is on the relationships between community development and urban equity, racial and ethnic inequalities and urban policy, and the built environment and health. He has worked on community-centered projects to improve the economic, environmental, political, and social well-being of urban residents.

Associate Professor **David Benjamin** is Director of Advanced Architecture Studios at GSAPP and founding principal of the firm The Living. In his academic and professional work, Benjamin combines research and practice, and he explores new ideas through prototyping. Focusing on the intersection of biology, computation, and design, his work expands the definition of architecture to consider buildings as dynamic systems rather than static, inert objects. He has articulated three frameworks for harnessing living organisms for architecture: bio-processing, bio-sensing, and bio-manufacturing.

By the Numbers

Category	#
Number of Total Students Across All Programs	565
Number of Total Faculty	134
Number of Climate-Related Faculty	3

Mailman School of Public Health

The Columbia Mailman School of Public Health is a world leader in research and education on the effects of climate change on human health, and solutions needed to protect health, lives, and wellbeing. In 2008, Columbia Mailman launched its Climate and Health Program (CHP), the first in a school of public health; it offers innovative, cross-disciplinary, translational scholarship on how climate change impacts health, and on knowledge-based solutions. Through CHP, the School now offers a MPH certificate on Climate and Health and offers the first doctoral training program in the world on climate and health. In 2017, the School created the Global Consortium on Climate and Health Education, a global network of health professions schools and programs, who are asked to commit to educating their students on the health impacts of climate change and other planetary health challenges, and provides online curriculum for the world's use. This was an outcome of COP21 and endorsed by WHO. The Global Health Justice and Governance Program, launched in 2018, integrates public health, legal, and scientific scholarship to advance human rights and justice on complex public health challenges, with a focus on climate/health and food justice.

While the Climate and Health program, located in the Department of Environmental Health Sciences, is home to much of the School's work, research and programming now spans the School**.** Faculty study and teach an array of climate-related topics including air pollution; water; food security, nutritional content, and sustainability; economic impact of climate change; forced migration and climate refugees; urban health; invasive species; changes in chronic and infectious diseases; and human rights and justice issues. They study the health impacts from climate-related extreme weather events, such as heat waves, heavy rainstorms, and impacts on food and water security. The School particularly considers the impacts of climate change on vulnerable populations, who are often already contending with health disparities. For each issue, they develop innovative, evidence-based solutions to protect health of populations. An increasingly integrated structure is being developed to create synergies across faculty and programs.

SELECT AREAS OF RESEARCH & PROGRAMMING

Air Pollution: The School is a leader in comprehensively characterizing adverse health effects of air pollution in a changing climate across the lifespan, from conception to death; from neurodevelopment to neurodegeneration; on a range of chronic diseases (e.g., lung and cardiovascular), and at both high and low air pollution concentrations. Air pollution mitigation to protect health also mitigates climate change, as demonstrated in research from China to India, Poland, Ghana, and the U.S. In New York City, working closely with neighborhood groups such as WE ACT for Environmental Justice, Mailman faculty and students study the local health benefits from actions aimed at reducing greenhouse pollutants, which can deliver immediate and localized co-benefits such as lower rates of asthma from lowered pollution and heat.

Infectious Disease: The School develops highly accurate forecast systems to predict outbreaks of infectious diseases, with special focus on how climate and environmental factors influence the transmission of influenza, its seasonality, and the underlying mechanisms; how warmer temperatures influence insect populations, resulting in changing disease transmission models; how immune function, vaccine efficacy, and chronobiology are modulated by a changing climate; and how climate variability and change affect the dissemination and prevalence of HIV, malaria, dengue, Zika, and chikungunya.

Urban: The School examines how to mitigate impact of, predict, prepare for, and respond to climate-related weather events from extreme heat to storms to wildfires, whether in NY or Ahmedabad. Our faculty work at the intersections of the built environment, equity, energy insecurity, resilience, and health.

Food: Evidence indicates that along with the threats of warmer temperatures on food security and safety, rising CO2, by itself, poses a threat to global nutrition. Faculty study all of these issues, along the whole food chain from agriculture to food consumption, and evaluate how changed practices—including pesticide use – impacts food safety, and how agricultural practices and food production need to change to feed a population of 10 billion with nutritious food produced sustainably. In 2019, we launched a new educational and research program on food systems, nutrition, and health in the era of climate change.

Forced Migration: The convergence of floods, drought, and food shortage due to climate change has resulted in escalating conflict and climate refugees, leaving many groups extremely vulnerable. Our longstanding Program in Forced Migration has reshaped itself to provide leadership on health protection for the 67 million displaced people in the world. This program has added education on climate change and migration to its highly regarded DrPH program.

Global Health Justice and Governance: School-wide program focused on human rights and justice issues associated with climate change and food security, adequate nutrition, and sustainability, and governance solutions. There is a global lack of policy protections for climate refugees and regarding global food security and climate justice, and a need for legal and policy frameworks.

Policy & Programming: Faculty research evaluates the bases for economic investments to protect health in the context of climate change, informs regulatory action, and influences the design of interventions for maximal impact. They examine the relationship between the environment and productivity, and human capital and decision-making.

METHODS

A variety of methods, many of which were developed by Columbia public health faculty, are used to assess impacts. These low-cost innovations include portable monitors such as drones, backpacks, and silicon bracelets to collect real-time data on health threats such as black carbon, mercury, radiation, and other air pollutants**.** They investigate how hydrologic variability affects mosquito ecology and mosquito-borne transmission, and how climate change is affecting water quality and safety. Quantitative approaches to climate-health research include epidemiological methods, mathematical modeling approaches, Bayesian inference, bioinformatics, and machine learning, AI, and other data science capabilities. Projects include collaborations with members of the Earth Institute and the Data Science Institute.

Key Disciplines

- Atmospheric science
- Biology
- Biostatistics
- Earth Science
- Economics
- Environmental science
- Epidemiology
- Genetics
- Human Rights
- Hydrology
- Law
- Plant physiology
- Public Health
- Public Policy
- Urban Health

Centers, Units and Initiatives Relevant to Climate

- Climate and Health Program: The Program fosters innovative translational scholarship on the human health dimensions of climate change, with the goal of advancing society's capacity to understand, anticipate, and prevent adverse health consequences. It accomplishes its mission by catalyzing cross-disciplinary science to address basic questions about how climate change affects health; offering training in the public health dimensions of climate change vulnerabilities, impacts, and adaptation strategies; and

partnering with governments, NGOs, and clinicians to ensure that the knowledge generated informs strategies for reducing harm to vulnerable populations.

- Global Consortium on Climate and Health Education is a global network of health professional schools and programs, including those of public health, medicine, and nursing committed to training the future public health workforce on how to prevent, reduce, and respond to the health impacts of climate change. To date, nearly 200 health professional schools from all regions of the world have committed to incorporating education on the health impacts of climate change into their education curriculum.
- The Program on Global Health Justice and Governance, launched in 2018, addresses gender, the environment and climate, and food justice. The Program sheds a light on governance deficiencies that allow injustice to happen and advances policy and scientific interventions to prevent and address such deficiencies.
- Columbia Center for Children's Environmental Health uses a combination of methods to further understand how early life exposures to environmental pollutants, material and nutritional deficiencies, maternal distress during pregnancy, and interactions with certain genetic compositions increase children's risk of disease.
- NIEHS Center for Environmental Health in Northern Manhattan works to identify and understand environmental exposure contributing to the pathophysiology of human disease.

Relevant Education Programs

Program	Content Focus and Partner Schools
M.P.H.	Certificate in Climate and Health; Have dual degree agreements with Dental, Law, Jewish Theological Seminary, Business, SIPA, VP&S, Professional Studies, Occupational Therapy, Social Work, and GSAPP
M.S.	Toxicology (EHS)
Dr.P.H.	Forced Migration (Population and Family Health)
Ph.D.	Climate and Health (Environmental Health Sciences)

The MPH program has many certificates that examine climate change's impact on health, including the climate and health, environmental health policy, public health and humanitarian action, molecular epidemiology, toxicology, and global health certificates. The **Climate and Health certificate** trains students to understand, anticipate, and prevent adverse health consequences from climate variability and change. **The Environmental Health Policy certificate** produces leaders who are fluent in both environmental health science and policy analysis. Students in the **Public Health and Humanitarian Action certificate** consider the implications of climate change on refugee and population movements.

The PhD program in Climate and Health builds upon diverse theoretical and methodological frameworks to provide students with the competencies necessary to understand and respond to the complex linkages between climate and human health. Students in the program train for professional careers where they will conduct advanced research, teach, and/or hold leadership positions in the private and public sector.

Students enrolled in other programs through the Environmental Health Sciences Department, including the MS and DrPH, obtain a deep grounding in how the environment contributes to health—whether measuring the effect of toxic substances on brain development, reducing levels of arsenic found in drinking water, or understanding how climate change and air pollution affect health.

By the Numbers

Category	#
Number of Total Students Across All Programs	1571
Number of Full-Time Faculty	248
Number of Climate-Related Faculty	49

School of International and Public Affairs

Ranked the #1 public policy school in International and Global Affairs by *US News & World Report*[1], the School of International and Public Affairs (SIPA) is a professional graduate school with a longstanding focus on global issues and solutions. Core areas for degree programs, faculty, and policy engagement are domestic and international dimensions of energy and the environment; international security and foreign policy; international finance, trade and economic policy; economic and political development; urban and social policy; and human rights, humanitarian policy and conflict resolution. Sustainability and climate-related issues are special areas of cross-cutting strengths. SIPA faculty and graduate students— with their interdisciplinary expertise in economics, politics and policy, and motivation to promote the global good—are particularly well-suited to tackle climate-related issues and serve as the interdisciplinary hub of policy issues at Columbia University.

FACULTY RESEARCH AND IMPACT

SIPA's 75 full-time faculty and 17 full-time research scholars encompass top academic researchers and eminent practitioners, generating a rare and valuable cross-fertilization between the academic and policy worlds. Faculty research and engagement, supported by SIPA's five research centers, are at the forefront of thinking about global challenges such as poverty elimination; international energy markets and geopolitics; climate change and sustainability broadly; global governance (including responses to climate change); and security threats such as regional conflicts, state fragility, terrorism, and international refugee flows (including the ways in which they are exacerbated by climate change). The Center on Global Energy Policy, for example, is a highly regarded and active external facing research center on energy policy and markets.

SIPA professors and professors of practice are highly prominent in their fields. Numerous have been economic and financial ministers, candidates for head of state and held other major policy roles. With respect to climate and environmental policy, SIPA faculty have been important contributors to both policy development and research. They have played important roles on both the Intergovernmental Panel on Climate Change (Joseph Stiglitz, Geoff Heal, Ben Orlove, and Scott Barrett) and the UN Framework Convention on Climate Change (Jeffrey Sachs, and Barrett). SIPA faculty also have produced important research on the economic and social impacts of climate change; policy and negotiating frameworks for addressing climate change, at the domestic and international levels (Barrett, Heal); and efforts to mitigate and adapt to change (for example, Jason Bordoff, Ignacia Mercadal, John Mutter, Wolfram Schlenker, and Jeffrey Shrader, as well as research scholars Jonathan Elkin, Noah Kaufman, and David Sandalow). See Attachment A for faculty profiles.

In addition to full-time faculty, SIPA appoints visiting professors and about 300 part-time faculty each year, most of whom are full-time practitioners who bring specialized expertise to the classroom, including numerous courses on climate, sustainable development, energy and environmental policy. Examples who teach climate courses include Ruben Lubowski (Environmental Defense Fund): *Carbon Pricing*; Alfred Griffin (New York Green Bank): *Clean Energy Financial Innovation*; Adam Zurofsky (Office of the Governor, New York State): *Role of States, Cities & Subnationals in Meeting the Climate Challenge*.

[1] *US News and World Report* (2018, 2019) ranks SIPA as the #1 public policy school in International and Global Affairs (Kennedy School #2, Georgetown and Princeton Woodrow Wilson tied for #3).

Key Disciplines

- Economics
- Finance
- Geopolitics
- International relations
- Political science
- Public policy

Centers, Units, Initiatives and Programs that Study Climate

Three of SIPA's six research units focus squarely on climate or sustainable development:

- Center for Development Economics and Policy (CDEP): applies microeconomics to identify actionable solutions to poverty.
- Center for Environmental Economics and Policy (CEEP): launched in 2019, CEEP undertakes original research into the causes of environmental change, the consequences of this change for humanity, and the policies that can prevent and—where possible—reverse harmful environmental change to ensure sustainable development.
- Center on Global Energy Policy (CGEP): approaching energy as an economic, security, geopolitical, and climate issue, CGEP combines academic research with the experience of senior energy experts from government, industry and non-governmental organizations to produce independent, balanced and actionable analysis, which the Center disseminates through public forums, research, roundtable discussions, conferences and the media—in the US and other key energy countries, including Brazil, Turkey, India and China.

FUNDRAISING AND PLANS FOR THE FUTURE

The School of International and Public Affairs is building for its future via the "What. Can. Be. Campaign," aiming to raise $150 million ($108 million so far) to fund new professorships, financial support for students and programming in areas essential for the future of the school – and of the global society. One of the focuses of this campaign is Energy, Environment and Sustainability. Within this, SIPA hopes to add more faculty and to tackle issues such as the **human cost of climate change**; **policy responses**, including a **carbon tax**; **climate investment and finance**; **mitigation and adaptation**, including fostering innovation and data-driven solutions, among other areas.

Relevant Education Programs

Program	Partner School/Degree Program
Ph.D. in Sustainable Development	Earth Institute
M.P.A. in Environmental Science and Policy	Earth Institute
M.P.A. in Development Practice	Earth Institute
M.P.A. in Economic Policy Management	
M.I.A.	Dual degrees offered with schools of Journalism; Business; Public Health; Law; Social Work; Arts and Sciences; GSAPP
M.P.A.	Dual degrees offered with schools of Law; Public Health; Social Work; Arts and Sciences
Executive M.P.A.	-

Applied social sciences—include microeconomics and macroeconomics—underpin all SIPA degree programs. Experiential learning is emphasized throughout the master's degree programs, including summer internships and

other special opportunities, such as the Dean's Public Policy Challenge Grant. The flagship capstone workshop program is the final, integrative step in master's programs, in which small teams of SIPA students, under a faculty supervisor, take on real-world problems for external clients in the US and around the world; there were nearly 100 capstone projects in 2018-2019.

SIPA offers the highly selective PhD in Sustainable Development (SDEV). Inaugurated in 2004 in collaboration with the Earth Institute, SDEV combines doctoral education in the social sciences—particularly economics—and the natural sciences or engineering. It was the first doctoral program in this domain and has been emulated by schools around the world. SDEV students and graduates are pursuing field-leading research and policy assessment on sustainable development and climate change, being particularly well-known for path-breaking empirical estimation of climate impacts

SIPA's largest programs are two professional master's degrees:

- *The Master of International Affairs (MIA)*, which is underpinned by SIPA's unrivaled expertise on issues that transcend national boundaries, prepares students to address major international issues as experts and leaders in governments and organizations around the world.
- *The Master of Public Administration (MPA),* which adopts a globally oriented and comparative approach to national policy-making, prepares students to address major national policy issues and manage organizations in the US and other countries around the world.

MIA and MPA students complete a rigorous set of core courses, including economics, quantitative analysis and management, as well as distinctive courses on global or national politics and policy. In addition, students complete one of six concentrations (majors), four of which include courses that address sustainable development and climate-related issues from their distinctive vantage points:

- *Economic and Political Development:* includes courses on economic development, the private sector and development outcomes, and issues in rural development.
- *Energy and Environment:* provides students with advanced knowledge on global energy and environmental issues and how governments, businesses, and civil society can lead effective action; courses on energy systems, environmental science for sustainable development, adaptation to climate change (including management of climate-related international conflict), geopolitics of oil and gas, and energy decarbonization.
- *Urban and Social Policy:* includes courses on urban sustainability, global developing cities, and global inequality.
- *International Finance and Economic Policy:* includes courses on banking and sustainable development, the green transition in emerging markets, and infrastructure investment and development.

In addition to the two-year MPA, SIPA offers four specialized MPA programs, all of which include substantial emphases on sustainable development, climate or related topics:

- *MPA in Economic Policy Management:* offers a concentration in energy policy and markets.
- *Executive MPA*: offers a concentration in Environmental Policy and Sustainability Management.
- *MPA in Environmental Science and Policy: d*elivers a unique combination of environmental science, management and policy analysis.
- *MPA in Development Practice:* includes several courses on sustainable development challenges in both developing and developed economies.

SIPA also offers a total of 11 dual and two joint degrees with other units at Columbia, and it offers dual degrees with six premier public policy schools around the world.

Altogether, SIPA offers more graduate courses on the political, economic and policy-related dimensions of sustainable development, energy, environment and climate than any other comparable unit at Columbia. In addition, each year about 15 capstone projects address issues related to sustainable development and climate. Recent examples include: Climate Smart Investment; Renewable Energy Markets in South America; and Countries, Sectors and Policies to Lead Climate Change Action. See Attachment B for more examples.

ALUMNI

Founded in 1946, SIPA today has a global network of more than 22,000 alumni in more than 160 countries. Among SIPA alumni who graduated since 1980, at least 965 (in 61 countries and every state) are currently employed in a climate or environment-related field, including more than 100 at multilateral institutions. Examples of prominent positions include Chief Executive of Climate and Societal Interactions, NOAA; Chairman and CEO, ReNew Wind Power Pvt Ltd; President, Conservation International; Director, Environment/Natural Resources Management, USAID; Chief Sustainability Officer, Tiffany & Co.

By the Numbers

Category	#
Total Students Across All Programs	1,289
Students in Sustainable Development & Climate-Related Programs	487
Number of Full-Time Faculty	75
Number of Full-Time Research Scholars	17
Number of Sustainable Development & Climate-Related Faculty & Scholars	28

SIPA Attachment A
Profiles of Selected Faculty and Research Scholars
Who Work on Climate, Sustainable Development and Related Topics

Scott Barrett is Vice Dean of the School of International and Public Affairs and the Lenfest-Earth Institute Professor of Natural Resource Economics. He is a leading scholar on transnational and global challenges, including climate change, global public goods, ocean governance, and infectious disease. His research focuses on how institutions like customary law and treaties can be used to promote international cooperation. Barrett has advised a number of international organizations, including the United Nations, the World Bank, the OECD, the European Commission, and the International Task Force on Global Public Goods. He was previously a lead author of the Intergovernmental Panel on Climate Change and a member of the Academic Panel to the Department of Environment in the UK. He currently is a Member of the Expert Group, High Level Panel for a Sustainable Ocean Economy, the Rockefeller Foundation Economic Council on Planetary Health, and the Expert Advisory Board for the Mercator Research Institute on Global Commons and Climate Change. He has received the Publication of Enduring Quality Award from the Association of Environmental and Resource Economists, and the Erik Kempe Prize from the European Association of Environmental and Resource Economics. He is the author of *Why Cooperate? The Incentive to Supply Global Public Goods* and *Environment and Statecraft: The Strategy of Environmental Treaty-Making*. He is also the author of recently published articles including "Choices in the Climate Commons" in *Science* and (with Astrid Dannenberg) "An Experimental Investigation into 'Pledge and Review' in Climate Negotiations in *Climatic Change*. He received his PhD from the London School of Economics.

Jason Bordoff is Professor of Professional Practice in International and Public Affairs and Founder and Director of the Center on Global Energy Policy at Columbia University. He focuses on the intersection of economics, energy, environment, and national security. He served in several positions in the White House from 2009-2013, including as Associate Director for Energy and Climate Change on the Council on Environmental Quality, as Senior Advisor for Energy and Environmental Policy on the National Economic Council, and as Special Assistant to the President and Senior Director for Energy and Climate Change on the National Security Council. He is a member of the Council on Foreign Relations and the National Petroleum Council, a consultant to the National Intelligence Council, and serves on the boards of Winrock International (a leading nonprofit organization that works to empower the disadvantaged, increase economic opportunity, and sustain natural resources), the New York Energy Forum and the Association of Marshall Scholars. During the Clinton Administration, Bordoff served as an advisor to the Deputy Secretary of the U.S. Treasury Department. He is the editor (with Jaosn Furman) of *Path to Prosperity.* Recent articles include "Getting Real about the Green New Deal" in *Democracy Journal,* "This Isn't Your Father's OPEC Anymore" in *Foreign Policy,* and "Withdrawing from the Paris Climate Agreement Hurts the US" in *Nature Energy.* He received his JD from Harvard Law School.

Jonathan Elkin is a Senior Research Scholar at the Center on Global Energy Policy at Columbia University's School of International and Public Affairs. He is also a Distinguished Associate with Energy Futures Initiative. Elkind came to the Center following a career devoted to energy and environment policy in the private and public sectors. He worked on international energy and climate issues at the United States Department of Energy, helping to coordinate energy policy in the Obama Administration and leading climate and energy programs with key global partners. He departed DOE as Assistant Secretary for International Affairs. Before his service in the Obama Administration, he founded Eastlink Consulting, LLC where he guided corporate and non-profit clients on commercial energy projects in Europe and Eurasia, and he served as a non- resident senior fellow at the Brookings Institution, researching international energy security issues. Early in his career, Elkind focused on energy, environment, and economic issues in the post-Soviet nations in a variety of posts with the Joint Global Change Research Institute, the U.S. National Security Council, Office of the Vice President of the United States, the Department of Energy, and the Council on Environmental Quality. Elkind holds a Master of Business Administration in Strategy and International Business from the R.H. Smith School of Business at the University of Maryland, a Master of Arts in Russian History and Certificate in Soviet Studies from the W. Averell Harriman Institute, and a Bachelor of Arts with Distinction in History from the University of Michigan, Ann Arbor.

Geoffrey Heal is the Donald C. Waite Professor of Social Enterprise and Professor of Economics and Finance at Columbia's Graduate School of Business, and Professor of International and Public Affairs at Columbia's School of International and Public Affairs. His fields of specialization include the economics of energy, natural resources, and the environment; regulation and increasing returns; and resource allocation under uncertainty. He is a past President of the Association of Environmental and Resource Economists, a recipient of its prize for publications of enduring quality, and a Life Fellow. He is also a member of the Scientific Advisory Board of the Environmental Protection Agency and a Director of the Union of Concerned Scientists. Heal has also chaired a committee of the National Academy of Sciences on valuing ecosystem services, was a Commissioner of the Pew Oceans Commission, and co- founded and Chairs the Advisory Board of the Coalition for Rainforest Nations. He is the author of eighteen books including *Endangered Economies: Why the Neglect of Nature Threatens our Prosperity*, *Nature and the Marketplace*, and *Valuing the Future: Economic Theory and Sustainability.* Recent articles include (with Kolstadt, Pindyck, Gillingham, and others) "Opportunities for Advances in Climate Change Economics" in *Science* and "What Will it Take for the US to Reduce Carbon Emissions 80% by 2050" in *Review of Environmental Economics and Policy*. He received his PhD from the University of Cambridge.

Noah Kaufman is Research Scholar at the Center on Global Energy Policy at Columbia University's School of International and Public Affairs. He is an economist who has worked on energy and climate change policy in both the public and private sectors. At World Resource Institute, Noah led projects on carbon pricing, the economic impacts of climate policies, and long-term decarbonization strategies. Under President Obama, he served as the Deputy Associate Director of Energy & Climate Change at the White House Council on Environmental Quality. Previously, he was a Senior Consultant in the Environment Practice of NERA Economic Consulting. He has published peer-reviewed journal articles on the social cost of carbon dioxide emissions and the role of risk aversion in environmental policy evaluations, among other topics. Noah received his BS in economics, cum laude, from Duke University, and his PhD and MS in economics from the University of Texas at Austin, where his dissertation examined optimal policy responses to climate change.

Ignacia Mercadal is Assistant Professor of International and Public Affairs at Columbia University's School of International and Public Affairs where she teaches energy economics. Her research centers on industrial organization and energy economics, with a particular focus on electricity markets. She previously served as a postdoctoral fellow at the MIT Center for Energy and Environmental Policy Research and the MIT Sloan School of Management. She is coauthor (with John Birge, Ali Hortacsu and Michael Pavlin) of *Limits to Arbitrage in Electricity Markets: A case study of MISO* (Energy Economics, 2018). Mercadal holds a PhD in Economics from the University of Chicago, a MSc from Tilburg University, and an MA and a BA from Pontificia Universidad Católica de Chile.

John Mutter is Professor of Earth and Environmental Sciences at Columbia University and Professor of International and Public Affairs at Columbia University's School of International and Public Affairs. His research focuses on the role of natural disasters in constraining development opportunities for poor and emerging societies. Meteorological extremes are expected to increase as a result of human-induced climate change, and his work attempts to assess who are most vulnerable to disasters such as the 2010 Haiti earthquake and Hurricane Katrina. At SIPA, Mutter created and teaches the core course Environmental Science for Sustainable Development which provides the basis of understanding Earth systems behavior needed for students in the PhD program in sustainable development as well as masters candidates in several programs. He also created and teaches Climate Change, Development and Human Rights. He leads the Earth Institute's partnership with the UNEP's Post-Conflict and Disaster Management Branch, researching environmental degradation as both an outcome and driver of disasters and conflicts. Mutter is also a principal investigator on the National Science Foundation-funded ADVANCE program, designed to create institutional change that will improve the opportunities for women in earth science and engineering at Columbia.

Benjamin Orlove is Professor of International and Public Affairs in the School of International and Public Affairs, Senior Research Scientist at the International Research Institute for Climate and Society, Director of the MA Program in Climate and Society, Director of the Center for Research on Environmental Decisions, and a Faculty Member of the Earth Institute. Trained as an anthropologist, his focus areas include climate change adaptation, environmental anthropology, human response to glacier retreat in mountain regions, water management and governance, natural hazards and disaster risk reduction, and urban sustainability. Among other activities, he is currently a Lead Author for the Intergovernmental Panel on Climate Change. His early work focused on agriculture, fisheries and rangelands. More recently he has studied climate change and glacier retreat, with an emphasis on water, natural hazards and the loss of iconic landscapes. In 2018, he received the American Anthropological Association President's Award for "scholarship and contributions to documenting anthropogenic climate change." Orlove's recently edited books include (with Wiegandt and Luckman, eds.) *Darkening Peaks: Glacial Retreat, Science and Society* and (with Strauss, ed.) *Weather, Culture, and Climate.* Recent articles include (with Roncoli, Ungemach, Dowd-Uribe, West, Milch, and Sanon) "Enough is Enough: How West African Farmers Judge Water Sufficiency" in *Regional Environmental Change* and (with Thomas, Hardy, Lazrus, Mendez, Rivera-Collazo, Roberts, Rockman, Warner, and Winthrop) "Explaining Differential Vulnerability to Climate Change: A Social Science Review" in *Wiley Interdisciplinary Reviews—Climate Change.* He received his PD from the University of California, Berkeley.

Jeffrey Sachs is University Professor and the Director of the Center for Sustainable Development at Columbia University. He also served as Director of Columbia's Earth Institute from 2002-2016. His research focus areas include the resource curse and extractive industries, the history of economic development, sustainable development, and climate change. He is the co-recipient of the 2015 Blue Planet Prize, the leading global prize for environmental leadership, and has twice been named among *Time Magazine*'s 100 most influential world leaders. He serves as Special Advisor to UN Secretary General Antonio Guterres on the Sustainable Development Goals, is the Director of the UN Sustainable Development Solutions Network, and has played an important role on the UN Framework Convention on Climate Change. His work on ending poverty, overcoming macroeconomic instability, promoting economic growth, fighting hunger and disease, and promoting sustainable environmental practices has taken him to more than 125 countries. He was among the outside advisors to Pope John Paul II on the encyclical Centesimus Annus and currently works closely with the Pontifical Academy of Sciences and the Pontifical Academy of Social Sciences on issues of sustainable development. He is author of hundreds of scholarly articles and many books, including *The Age of Sustainable Development, Common Wealth: Economics for a Crowded Planet,* and (with Humphreys and Stiglitz, eds.) *Escaping the Resource Curse*. He received his PhD from Harvard.

David Sandalow is the Inaugural Fellow at the Center on Global Energy Policy at Columbia University's School of International and Public Affairs and co-Director of SIPA's Energy and Environment Concentration. Sandalow writes and speaks widely on energy and climate policy. He founded and directs the Center's U.S.-China Program. Sandalow has served in senior positions at the White House, State Department and U.S. Department of Energy. He came to Columbia from the U.S. Department of Energy, where he served as Under Secretary of Energy (acting) and Assistant Secretary for Policy & International Affairs. Sandalow is a member of the Innovation for Cool Earth Forum (ICEF) Steering Committee and chair of ICEF Innovation Roadmap Project. He serves as a director of Fermata Energy and Highview Power Storage; a member of the Global CO2 Initiative Advisory Board, Zayed Future Energy Prize Selection Committee, University of Michigan Energy Institute Advisory Board, Electric Drive Transport Association's "Hall of Fame" and Council on Foreign Relations. Recent works include *Electric Vehicle Charging in China and the United States* (February 2019, co-author), *Direct Air Capture of Carbon Dioxide Roadmap* (December 2018, project chair), *Guide to Chinese Climate Policy* (July 2018), *A Natural Gas Giant Awakens* (June 2018, co-author), *The Geopolitics of Renewable Energy* (2017, co-author), *Financing Solar and Wind Power: Lessons from Oil and Gas* (2017, co-author), *CO2 Utilization Roadmap 2.0* (2017, project chair) and *The History and Future of the Clean Energy Ministerial* (2016). Sandalow is a graduate of the University of Michigan Law School and Yale College.

Wolfram Schlenker is Professor of International and Public Affairs at Columbia University's School of International and Public Affairs, Co-Director of Columbia's Center for Environmental Economics and Policy and Co-Director of SIPA's Energy and Environment Concentration. His area of focus is environmental and natural resource economics, agricultural economics and health economics. He studies the effect of weather and climate on agricultural yields and migration, how climate trends and the US biofuel mandate influences agricultural commodity prices, and how pollution impacts both agricultural yields and human morbidity. He is a Research Associate at the National Bureau of Economic Research and serves on the Board of Reviewing Editors at Science. His recent publications include *Estimating Global Agricultural Effects of Geoengineering using Volcanic Eruptions* (Nature, 2018), *The Cost of a Warming Climate—Feeling the Heat* (Nature, 2017), *Asylum Applications Respond to Temperature Fluctuations* (Science, 2017), *Consistent negative response of US crops to high temperatures in observations and crop models* (Nature Communications, 2017). He holds a PhD in Agricultural and Resource Economics from the University of California, Berkeley (2003) and a Master of Engineering and Management Sciences from the University of Karlsruhe, Germany (2000), as well as a Master of Environmental Management from Duke University (1998).

Jeffrey Shrader is Assistant Professor at Columbia University's School of International and Public Affairs. He is an environmental and labor economist with research focusing on the role of expectations and forecasts in helping individuals prepare for changing environmental and economic conditions. This work helps policymakers understand the benefits and limitations of information-based policy interventions and sheds light on the total economic costs of environmental changes. Shrader also studies how individuals choose to use their time and the implications that time use decisions have for economic productivity. Prior to joining SIPA, he was the 2017–2018 Economic Fellow at the Institute for Policy Integrity at New York University School of Law. At the Institute, he worked to improve federal and state decision-making related to climate, environmental, and energy policies. He holds a PhD in economics from the University of California, San Diego and a BA in economics and mathematics from Columbia University.

Joseph Stiglitz is University Professor at Columbia University. His focus areas include the economics of uncertainty, risk and agriculture, natural resources, international economics, and development. He was lead author and member of the Steering Committee of the 1995 Report of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize. He also received the 2001 Nobel Prize in Economics. In 2011, he was named one of the 100 most influential people in the world by *Time.* Stiglitz has served a member of the Council of Economic Advisors during the Clinton Administration, and served as its chairman from 1995- 1997. He then became Chief Economist and Senior Vice-President of the World Bank from 1997-2000. Stiglitz currently chairs a High Level Expert Group at the OECD on the Measurement of Economic Performance and Social Progress, through which he has published reports such as (with Kanbur and Patel) "Sustainable Development Goals and Measurement of Economic and Social Progress." He is also the author of numerous books, including *Sustainable Development and Neo-Liberalism,* as well as recent articles including "Overcoming the Copenhagen Failure with Flexible Commitments in *Economics of Energy and Environmental Policy* and "An Agenda for Sustainable and Inclusive Growth for Emerging Markets" in *Journal of Policy Modeling.* He received his PhD from The Massachusetts Institute of Technology.

SIPA Attachment B
Examples of Climate-focused Capstones (Clients and Project Titles)
School of International and Public Affairs

United Kingdom Department of Energy and Climate Change
Political Assessments for Carbon Markets Through the United Nations Framework Convention on Climate Change (UNFCCC)

World Bank Group, Finance, Competitiveness & Innovation
The Role of Insurance in Promoting Climate Smart Agriculture

BCG Platinion
Climate Change Driven Political Risk in Soft Commodity Markets

China Ministry of Finance
Innovative Climate Financing Mechanisms Involving Public-Private Partnership

Credit Agricole and World Bank Joint Project City Resilience Program
Understanding the Role of Private Capital to Assist the World Bank in its Initiative to Build Resilience to Disaster and Climate Risks in Rapidly Growing Cities

International Center for Tropical Agriculture (CIAT)
Operationalizing and Financing Climate Smart Investment Plans in Asia and Africa

StatOil
Sustainability and Climate Leadership for an Oil, Gas, and Energy Company in 2030

School of Journalism

Columbia Journalism School utilizes expertise in media, communications, writing, literature, storytelling, visual presentation, photojournalism, data analysis, investigative reporting and more to give students the fundamental skills to report on and write about critical societal issues, including those of climate and the environment. Faculty have expertise in **scientific, medical and environmental journalism.** Programs offer distinct approaches to exploring science stories in rigorous, creative ways.

One course on *Covering Climate: Story & Animation* teaches students how to **report on the many stories of climate change**. Students learn the underlying science, explore how climate intersects with global society, and develop an animated piece as part of a capstone. Another course, *Storytelling about the Environment* focuses on documentary storytelling, teaching students how to report on and **think critically about science** issues. These courses help students learn how to cover climate correctly, comprehensively, and creatively. Students in the MA Science concentration focus all coursework on **science journalism**, learning to probe deeply, ask advanced questions, and study fields such as **climate change science** with a landscape view, looking at **history and patterns of discovery and innovation.**

Recent student work has covered issues such as the effects of **climate change on mental health** in indigenous communities; emergency care coverage at hospitals; **environmental testing** in New York City public schools; and the role of a melting glacier in Exxon's biggest disaster.

Key Disciplines

- History
- Literature
- Visual Arts

Centers, Units, Initiatives and Programs that Study Climate

- Columbia Journalism Review: CJR aims to be an intellectual leader in the rapidly changing world of journalism. In 2019, CJR unveiled an exhibit called "**Flood the News: Bringing the Climate Change Crisis to the Front Page**" in collaboration with visual artist Joan Wong, and the Earth Institute as part of:
    - Covering Climate Now Initiative**:** a global journalism initiative committed to bringing more and better coverage to the defining story of the present day. The initiative includes over 300 outlets worldwide, with a combined audience of more than 1 billion people.
- Brown Institute for Media Innovation: This institute is a collaboration between Columbia and Stanford, to encourage and support new endeavors in media innovation. The Institute is exploring **new ways to convey challenges and choices around climate change** with greater engagement and impact.
- Science Surveyor: Through a collaboration with Stanford and with support from the Brown Institute, this project developed an algorithmic tool to improve science journalism. The tool takes text from an academic paper, searches databases for similar terms, and surfaces relevant articles to show **how scientific thinking has changed** through use of language.
- John B. Oakes Award for Distinguished Environmental Journalism: this annual award is given for news reporting that makes an exceptional contribution to the **public's understanding of environmental issues.**

Relevant Education Programs

(All programs)

Program	Partner School
Ph.D. in Communications	-
M.A.	-
M.S.	-
M.S. in Data Journalism	-
M.S. in Journalism/Computer Science	School of Engineering and Applied Science
M.S./M.I.A.	School of International and Public Affairs
M.S./J.D.	School of Law
M.S./M.B.A.	School of Business
M.S./M.A.	Department of Religion

The MA program has a concentration in science, emphasizing themes and ways of thinking that can be used to cover any scientific field—from health, to technology, to hard sciences. Students get an understanding of the culture and practice of science, and are taught skills to interpret peer-reviewed studies. Students delve into **climate science, including politics of the field**, as well as **ecology, public health,** medicine, and frontiers in physics.

School of Law

Columbia Law School houses expertise in **environmental law, climate law, energy law and regulation,** natural resources and human rights**.** Environmental law courses look at litigation and other legal methods to resist cutbacks in federal climate change regulations; displacement and **relocation as a result of climate change**; legal status of small island nations who are threatened by climate impacts; **international agreements on climate**; novel courses of electricity regulation; and new development in carbon markets. Courses look at international environmental law and implementation of frameworks such as the **United Nations Framework Convention on Climate Change**, the Kyoto Protocol and the Paris Agreement. Students also study **U.S. environmental laws**, such as the Clean Air Act, Clean Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation and Liability Act (Superfund), National Environmental Policy Act, and the Endangered Species Act.

Law students study basic problems and approaches that characterize contemporary environmental regulation, and examine how statutes operate in actual practice. Students learn about various legal tools, including **cap-and-trade schemes; carbon taxation**; command-and-control regulation; litigation; information disclosure; and voluntary action. Topics covered include international human rights, **energy security,** economic competitiveness, federalism, **environmental justice,** international and intergenerational equity, **climate adaptation and geoengineering**. Other courses look at **energy regulation,** energy resources and energy facilities, including the future of renewable energy and nuclear energy. They also examine how environmental law affects sectors like business and agriculture.

In the **Environmental Law Clinic**, students are confronted with environmental problems brought to them by clients and work together with the client, their colleagues, and a professor to identify strategies for seeking innovative solutions for the clients' concerns.

A Law School professor led the preparation of a book with the most comprehensive set of federal, state and local actions to move the U.S. economy away from fossil fuels, and is now leading an effort to recruit pro bono law firms to draft the model laws recommended by the book. More than 20 Big Law firms have signed on to help cities and states fight climate change. These efforts focus on energy efficiency, fossil-free electricity generation, and switching away from liquid and gaseous fossil fuels.

Key Disciplines

- Economics
- Environmental Law
- Finance
- International Law
- Law
- Public Policy

Centers, Units, Initiatives and Programs that Study Climate

- Sabin Center for Climate Change Law: develops legal techniques to fight climate change, trains students and lawyers in their use, and provides up-to-date resources on key topics in **climate change law and regulation.** Researchers study how the field of **energy law** can be updated and expanded to create a sustainable energy future. They also examine **adaptation law**, looking for ways that existing laws and regulations can prompt adaptation efforts by government and private actors**.** The **Cities Climate Law Initiative** works with city legal departments and sustainability offices, and the networks that link them together, to provide key resources to efficiently and effectively address legal questions confronting the urban climate transition. The center runs the Climate Deregulation Tracker, identifying steps taken by U.S. government to scale back climate mitigation and adaptation measures, and the Silencing Silence Tracker,

to track government attempts to restrict or prohibit scientific research, education or discussion, or the publication or use of scientific information. The Center's climate litigation databases are used by lawyers, judges, scholars and students around the world as the only comprehensive collection of climate change cases. The center also runs a Climate Law Blog, providing a forum for legal and policy analysis on a variety of climate-related issues.

- Columbia Center on Sustainable Investment: develops and disseminates practical approaches for governments, investors, communities, and other stakeholders to maximize the impact of international investment for sustainable development. CCSI researchers study the nexus of **natural resource investments, climate change and international investment law.** They look at how institutional investors can engage fossil fuel companies to move towards a **decarbonized economy**, and build tools such as a mapping document to help renewable energy sector actors contribute to sustainable development goals (SDGs).

Relevant Education Programs

(All programs)

Program	Partner School
J.D.	Joint Degrees with: GSAS (Ph.D.); Business (M.B.A.); Journalism (M.S.); Public Health (M.P.H.); GSAPP (M.S.); SIPA (M.I.A. or M.P.A.); School of the Arts (M.F.A.); Social Work (M.S.W.)
LL.M./J.S.D.	-
Executive LL.M.	-

School of Nursing

The School of Nursing at Columbia is a part of the Columbia University Irving Medical Center, which also includes the College of Physicians and Surgeons, the Mailman School of Public Health, and the College of Dental Medicine. The School of Nursing is designated a World Health Organization Collaborating Center. Much of the ongoing research at the School of Nursing focuses on **health disparity among underserved populations.** The School applies the World Health Organization's Social Determinants of Health Model across multiple programs of research and focus not only on ameliorating physical, mental, and social consequences of health disparities, but on decreasing vulnerabilities, and reducing exposures.

Expertise at the School of Nursing can be used to study the **health impacts of climate change on disadvantaged groups**. Columbia Nursing recently published several papers on the connection between climate change, the built environment, place, and respiratory health, and examining the role that nurses can play in reducing deleterious impacts. Researchers at the School have vocalized interest in studying the **physical and mental health risk** factors of increased susceptibility due to climate change; how **climate-change induced stress and trauma** can increase symptoms of depression, anxiety and fatigue including among seasonal or migrant workers; social factors that either induce or inhibit **climate adaptations**; palliative **care for patients following climate-related disaster** or emergency; and an examination of how groups can incorporate infection prevention and control during climate catastrophes, and how nurses can reduce carbon footprint in in clinical care and in in their health care settings (e.g. green prescribing, reduced use of medical aerosols). Our NIH-funded Precision in Symptom Self-Management Center applies a socioecological lens (including environmental changes) to advance symptom science and symptom self-management for Latinos. Methodologically, the Center applies an information and data science infrastructure including data mining and natural language processing from multiple data sources. We also have expertise in the design, implementation and dissemination of innovative behavioral interventions and novel technology solutions to support communities and populations most at risk.

The School of Nursing also works towards sustainability in its operations as part of Sustainable Columbia. The School is reducing office supply waste, promoting recycling, reducing carbon emissions of delivery vehicles by consolidating supply orders, installing energy-efficient lighting, using low-flow appliances and green cleaning products, and encouraging sustainable commute options for employees and students. The School of Nursing was awarded a **GOLD Workplace Certification** from Columbia's Office of Environmental Stewardship, and in 2017, their new building was awarded a **LEED Gold certification.**

Key Disciplines

- Anesthesiology
- Asthma
- Communication
- Data sciences and informatics
- Gerontology
- Global health
- Health Policy
- LGBT health
- Mental health
- Behavioral science
- Technology solutions
- Midwifery
- Oncology
- Palliative care
- Pediatrics
- Primary care
- Vulnerable populations
- Symptom and disease self-management
- Women's health

Relevant Education Programs

(All programs)

Program	Partner School/Department
Masters Direct Entry (M.D.E.) / Ph.D.	-
Masters Direct Entry (M.D.E.)	-
Master of Science (M.S.) in Nurse Anesthesia	-
Post-BS (D.N.P.) Doctor of Nursing Practice Specialties in adult gerontology acute care; family; pediatric primary care; psychiatric-mental health	-
Ph.D.	-
Post-B.S. Doctor of Nursing Practice (D.N.P.)	-
M.S. in Advanced Clinical Management and Leadership	-

By the Numbers

Category	#
Number of Total Students Across All Programs	700-750
Number of Total Faculty	172
Number of Climate-Related Faculty	6

School of Professional Studies

The School of Professional Studies was designed to prepare students for rapidly evolving job markets on a global scale**.** Students are equipped to confront rapidly changing phenomena like **climate change** in organizations, global markets and economies, and among communities. SPS empowers responsible leaders to make a real-world impact.

Key Disciplines

- Actuarial science
- Bioethics
- Biology
- Business management
- Earth science
- Ecology
- Economics
- Environmental science
- Finance
- International Relations
- Medicine
- Organizational management
- Political science
- Psychology
- Public policy

Centers, Units, Initiatives and Programs that Study Climate

- **Sustainability Management Student Association (SUMASA):** designed to equip sustainability leaders with the practical knowledge and cutting-edge skills required to effectively manage the complex opportunities and risks of sustainable development.

Relevant Education Programs

Program	Partner
M.S. Sustainability Management	Earth Institute
M.S. Sustainability Science	Earth Institute
M.S. Negotiation and Conflict Resolution	Earth Institute
Certifications in: Sustainability Analytics Sustainable Finance Sustainable Water Management Ecology, Evolution and Environmental Biology United Nations Studies	 Earth Institute SIPA

The MS in Sustainability Management program is designed for students who wish to pursue a career in management that takes into account **both the environment and the economy.** The curriculum emphasizes the physical dimensions of sustainability (e.g., **water, energy, greenhouse gas emissions, and environmental infrastructure**), general and financial management, economics, quantitative analysis, and policy so that students can thrive in the job market. The MS in Sustainability Science program prepares students for a career in technical aspects of sustainability. These programs offer skill-specific seminars focused on a wide range of topics, including LEED certification, GIS, sustainability metrics, lifecycle assessments, and GHG accounting, among others. Graduates from these programs are ready to become **leaders in the growing field of sustainability.**

Coursework addresses many facets of the field of sustainability. Topics include diverse issues such as **climate science for decision-makers,** urban transportation, financing natural infrastructure, sustainable operations, agriculture, disaster risk management, sustainable investing, **sea level rise and Earth's climate systems.** Students study **environmental racism** and injustice, **sustainable economies**, the interactions of **climate change and**

urbanization, community access to science, and environmental pedagogy, among many other topics in this interdisciplinary field.

By the Numbers

Category	#
Number of Total Faculty	636

School of Social Work

Columbia University's School of Social Work is a top-ranked school and the first social work school established in the U.S. The mission of the Columbia School of Social Work is to develop leaders in social work practice and research whose work advances professional values, knowledge, and skills through programs and policies that enhance well-being and **promote human rights and social justice at the local**, national, and global levels. Recognizing the importance of New York as a global city, the School seeks academic relationships with many countries and regions. The School aims to prepare graduate students for advanced social work practice and professional leadership within a **diverse learning environment and advance knowledge for effective social work practice and education**.

Faculty and students are interested in issues of **environmental justice**, refugee resettlement, poverty and food insecurity, and **the social and mental health impacts of climate change.** Faculty have expertise in social justice, mental health, behavioral change, healthcare, policy analysis, poverty, hardship, and inequality, and migration and immigration, and are increasingly discussing how this expertise can be used to address the climate crisis.

Key Disciplines

- Clinical Social Work
- Demography
- Economics
- Social policy
- Psychiatry
- Psychology
- Sociology

Centers, Units, Initiatives and Programs that Study Climate

- Like several other professional schools at Columbia, the School of Social Work does not have a formal department structure. The School's priority areas are determined centrally by the Dean in conjunction with full-time faculty. Environmental justice and migration/immigration are currently among the topics of focus.
- Columbia Population Research Center: The Columbia Population Research Center (CPRC) is a University-wide center administratively housed at the School of Social Work. It supports NIH-funded research that addresses the health and well-being of vulnerable populations. Signature research areas include urbanism, migration, sexual and reproductive health, and children and families. Recent on urbanism and migration in particular focus on population displacements, so anticipate many of the social consequences of global warming.
- Global Health Research Center of Central Asia: The Global Health Research Center of Central Asia (GHRCCA), directed by Professors El-Bassel and Gilbert and funded by the NIH, focuses on health threats facing vulnerable communities, particularly labor migrants, in Kazakhstan and other Central Asian countries.

Relevant Education Programs

(All programs)

Program	Partner
Master of Science in Social Work (M.S.S.W.)	-
Ph.D. in Social Work	-
Continuing Education	-

By the Numbers

Category	#
Number of Total Students Across All Programs	950
Number of Total Faculty	40 full-time
Number of Climate-Related Faculty	10

School of the Arts

The School of the Arts faculty is comprised of acclaimed and internationally renowned artists, film and theatre directors, writers of poetry, fiction, and nonfiction, playwrights, producers, critics, and scholars. Programs of study focus on film; film and media studies; theatre; visual arts and sound art; and writing. Students in visual arts pursue moving image, new genres, painting, photography, printmaking, and sculpture. In 2017, the School opened the Lenfest Center for the Arts, a multi-arts venue designed as a hub for the presentation and creation of art across disciplines.

Faculty, scholars and students at the school use different art mediums to portray issues related to climate, environment and sustainability. They aim to draw attention to how art functions as a lens for better understanding the current human moment.

Key Disciplines

- Visual Arts
- Writing
- Film
- Theatre
- Film and Media Studies

Centers, Units, Initiatives and Programs that Study Climate

- The **Year of Water** is Columbia University's year-long exploration of the power of earth's most precious resource. The School of the Arts is spearheading this initiative to engage over 40 institutes, schools and programs at the University on **research, action, and programming on water-related issues**.
- The School of the Arts worked closely with **Columbia World Leaders Forum** to present a public lecture by acclaimed Danish-Iceladic visual artist **Olafur Eliasson** on September 26, 2019, as a launch to the Year of Water. Eliasson presented climate and water-related works such as *New York City Waterfalls* and *Ice Watch*, which spark critical dialogue about climate change and humanity's relationship to nature.
- The School of the Arts has taken a **public pledge to stop using single-use plastic bottles** at its facilities and events, with the aim of being fully plastic-bottle free by January 2020.
- ***WATERLICHT*** by Dutch artist and innovator Daan Roosegaarde is an immersive, site-wide installation, presented on the plaza of the Manhattanville campus for three evenings (October 22, 23, and 24, 2019). Translated as "Water Light," this monumental public-art event illuminates the power and poetry of water, while raising awareness about rising global sea levels.
- Held at the Lenfest Center for the Arts and organized by Professor of Film and Media Studies **Rob King**, the monthly film series *Lenfest Kids: H20* is geared toward families and children and explores oceans as spaces of adventure, fantasy, wonder, and mystery. Films in the Fall 2019 series include *March of the Penguins* and *Finding Dory*.
- Co-organized by Senior Lecturer of Film and Media Studies **Ron Gregg**, the film series *Water, Sound, and Indigenious Film* presents documentaries by indigenous filmmakers of the Americas, including the October 10 screening of *Ushui*, by the **Bunkuaneyuman Communications Collective** of indigenous Wiwa people of the Sierra Nevada de Santa Marta in Colombia.
- Miller Theatre has commissioned a new musical piece by composer **Vijay Iyer.** Titled ***Song for Flint***, the piece mediates upon water inequities in the contemporary United States. It premiered on October 24, 2019.
- Miller Theatre and the School of the Arts have jointly commissioned a new and water-related musical piece by **Arturo O'Farrill and the Afro-Latin Jazz Orchestra** that will premiere in Miller Theatre on April 4, 2020. In advance of the premiere, O'Farrill will lecture about the work in the Lenfest Center on April 2, 2020.

- The School of the Arts has commissioned, ***Water Study***, a site-specific performance for the plaza in front of the Lenfest Center. Choreographed by visual artist **Phoebe Osborne**, the performance will coincide with the Manhattanville Community Day on April 18, 2020.
- Miller Theatre commissioned a site-specific mural by visual artist **Adema Delphine Fawundu**, *Tales from the Mano River,* which extends the artist's research into the African water deity, Mami Wata. On display in Miller Theatre lobby: September 2019–June 2020.
- The Arts Initiative and Miller Theatre's annual tradition, **Morningside Lights**, returned in September 2019 with the theme *Island*, featuring 50+ community-built, water-themed lanterns that illuminated a procession from Morningside Park to Columbia's campus.
- Design curator **Paola Antonelli** presented her vision for *Broken Nature: Design Takes on Survival* at the 22nd edition of the Milan Triennial, at the Lenfest Center in October 2019.
- For the Year of Water, the School of the Arts has co-presented water-related events with Columbia World Projects (*Lessons from Rebuild by Design*, with **Kate Orff, Shaun Donovan**, and **Nicholas Lemann**); with the Maison Française (a screening of the Senegalese film *Atlantics (Atlantique)* by **Mati Diop**); with **Upmanu Lall**, Columbia Water Center, and the **Columbia Aquanauts** (*Liquid Futures: Designing a World with Wate*r for All); and plans to co-present water- and climate-related events with **Kate Marvel** and the Earth Institute.
- Visual Arts Professor **Sarah Sze**'s installations and paintings investigate landscape and our relationship to the environment as well as everyday and mass-produced objects.
- Assistant Professor of Writing **Leslie Jamison** collaborated with photographer Ryan Spencer on *Such a Mean Estate*, a book of images "appropriated from films about apocalypse…unstable weather and atmosphere; global poverty; [and] nuclear fallout."
- Associate Professor of Film **Ramin Bahrani**'s 2007 *Chop Shop* follows an orphan living in an automobile junkyard in Willet's Point, Queens. His 2014 film *99 Homes* examines the US foreclosure crisis in single-family-home, suburban Florida.
- Assistant Professor of Visual Arts **Nicola López**'s prints and installations "describe and reconfigure our contemporary—primarily urban—landscape."
- Associate Professor of Theatre **Lynn Nottage**'s play *Sweat* investigates fallouts from the closure of a factory in Reading, Pennsylvania that had been central to the city's economic and social fabric.
- Dean **Carol Becker**'s memoir *Losing Helen* explores the loss of a parent alongside the experience of a destructive hurricane in Tamarac, Florida.
- Professor of Writing **Phillip Lopate**'s *Waterfront: A Walk Around Manhattan* details "every inch of [the island's] perimeter, telling stories on the way of pirates (Captain Kidd) and power brokers (Robert Moses), the lowly shipworm and Typhoid Mary, public housing in Harlem and the building of the Brooklyn Bridge."
- Associate Professor of Film **Maureen Ryan** produced *The Gates*, a documentary about Christo and Jeanne-Claude's titular 2005 public art project in Central Park**.**
- Associate Professor of Writing **Dorothea Lasky**'s *Animal* "constellat[es] four central topics—ghosts, colors, animals, and bees."
- Visual Arts Mentor **Kiki Smith**'s prints and sculptures depict animals and patterns found in nature, among many other topics.
- For *Expedition Gyre*, Visual Arts Mentor **Mark Dion** traveled to the North Pacific Plastic Gyre to collect and display plastic ocean waste. For a permanent installation at The Kampong in Coconut Coconut, Florida, Dion recreated the historic laboratory of the American botanist David Fairchild.
- The LeRoy Neiman Center for Print Studies has produced prints that depict animals as well as rural and urban landscapes by **Kiki Smith, Mark Dion, Nicola López, Valerie Hammond, Cecily Brown, LeRoy Neiman, Kara Walker, Jonas Mekas, Ann Craven, LeRoy Neiman, Sarah Sze,** and **Sanford Biggers.**

- Hosted the visiting artists **Mel Chin** and **LaToya Ruby Frazier** (both 2018), both of whom have explored the water crisis in Flint, Michigan in their work.
- Mellon Visiting Artist and Thinker **Joan Jonas**' (2015) multimedia performance and visual art incorporates elements of nature as well as footage of landscapes in Cape Breton, Nova Scotia.
- Mellon Visiting Artist and Thinker **Rebecca Solnit**'s (2016) writing and cartographic practice has explored place, landscape, history, gender, and social activism.
- Visiting artist **Tomás Saraceno**'s (2017) interdisciplinary work investigates public space, climate, and fossil-fuel-free futures. At the Lenfest Center, he delivered a lecture and led a workshop on his Aerocene project with students of Visual Arts, SIPA, and Engineering.
- Hosted a screening the documentary *Chasing Coral*, followed by a conversation between Producer and alumna **Larissa Harris**, **Maureen Ryan**, and coral-expert **James Porter**.

Relevant Education Programs

(All programs)

Program Enrollment:	**Partner School**
M.F.A. Film: 274 M.A. Film & Media Studies: 47 M.F.A. Theatre: 167 M.F.A. Visual Arts & Sound Art: 61 M.F.A. Writing: 315 Total M.F.A.: 864	-
J.D./M.F.A.	Law School
B.A. Creative Writing B.A. Visual Arts B.A, Film and Media Studies	Columbia College; General Studies Columbia College; General Studies Columbia College; General Studies

By the Numbers

Category	**#**
Number of Total Students Across All Programs	864
Number of Full Time Total Faculty	84
Number of Adjunct Faculty	283
Number of Climate-Related Faculty	Many
Annual Grant Income Related to Climate: 1) Alfred P. Sloan Foundation Film Awards, which fund films and screenplays related to science and technology at the School of the Arts. In FY18, $20,000 was awarded to Josalynn Smith for her film Something in the Water, a narrative film that centers around the effects of lead contamination in water. 2) In FY19, Victoria Rivera was given $10,000 for a screenplay treatment about a marine biologist who is investigating the disappearance of hammerhead sharks.	Varies

The Earth Institute

Climate-based research at the Earth Institute spans multiple disciplines. Columbia's Earth Institute (EI) has the **largest base of Earth science researchers** globally who can mobilize to understand the implications of rising CO_2 levels on climate, ecosystems, ocean life, and essential resources. Climate scientists work to understand, predict, and respond to climate change and variability through a **transdisciplinary approach** that integrates basic and applied research. The Earth Institute has the largest collection of climate experts in the world.

Scientists at the Lamont-Doherty Earth Observatory (LDEO) study the Earth's climate in order to document its change and to build an understanding of its controlling forces. LDEO scientists study **Earth's climate dynamics**, from sea ice and polar ice sheets, to the oceans and atmosphere, to the response of land and marine ecosystems, and excel in the development of cutting-edge computer models. They conduct research on **past climate and past environments**, including information from deep-sea and lake-bottom sediment cores, samples from coral reefs and ice cores, and growth rings of trees. Scientists engage in research across the natural and physical sciences including paleo-climate, geochemistry and geophysics, ocean and climate physics, and terrestrial and marine geology in an effort to improve observation, computation and theory related to understanding, anticipating and managing climate.

The Earth Institute is also playing a unique role in the development and utilization of cutting-edge scientific research in **climate forecasting and climate change projections**, to inform decision-making and planning and help shape approaches to building climate resilience. Scientists work to provide an enhanced understanding of the **Earth's climate sensitivity and variability**, and the forcing and feedback mechanisms that control them. Its scientists study long-term climate changes that have the potential to impact human populations and environmental sustainability, using global climate models, physically based impact models, and chemical tracer models.

The Earth Institute's research in **climate and society** investigates humankind's role as both drivers of and responders to global climate and ways in which society can better utilize understanding of climate variability and change to improve human welfare. EI is examining the economics of **climate change mitigation**, and the complex processes at play in **international climate negotiation**, as well as the **legal and political context** of policies relating to climate change mitigation and the energy transition. Researchers are studying extreme weather events, both in the present and future climate, in order to develop solutions to mitigate risks to human life and property. The Earth Institute is at the forefront of developing **technologies and policy solutions** to help ensure a sustainable energy future. EI's researchers are dedicated to creating the next generation of **carbon capture and storage technologies**, and addressing important questions related to renewable energy, nuclear power and the conversion of solid waste into usable energy.

The Earth Institute is also devoted to studying and working with communities to utilize climate information to **prepare for the effects of climate change** already occurring. EI studies the impact of climate change on agriculture, human health, infrastructure, water, and ecosystems. Activities include real-time global seasonal forecasts, forecast development, diagnostics and modeling research, and tool development and capacity-building. The Earth Institute leads research on **coastal climate resilience** through vulnerability mapping and assessments, and examines what makes a community resilient in the face of disaster. EI also studies infrastructure solutions, models the movements of populations, optimizes risk communication, and coordinates within various law and policy frameworks to address infrastructure planning and evacuation. The Earth Institute conducts **education and outreach** to ensure effective transfer of key research results to private enterprise, civic stakeholders, and the

public at large. EI works to **communicate the science and impacts of climate change** to society and provide policy analysis and advising to stakeholders and decision-makers.

Examples of the Earth Institute's **scientific and technical capabilities include:** Earth system modeling and prediction, seasonal climate forecasting and monitoring, climate vulnerability and adaptation assessment, big data analytics and transdisciplinary data integration, geospatial analysis and Internet-based mapping tools, multi-hazard risk assessment and modeling, social impact assessment and project evaluation, information system design and implementation, legal and institutional design and evaluation, social surveys and field monitoring, mobile app development and crowd-sourcing tools, long-term data preservation and access, and conflict resolution and peacebuilding.

Key Disciplines

- Biology
- Business
- Climate Science
- Earth Science
- Ecology
- Economics
- Engineering
- Environmental Science
- Finance
- Geochemistry
- Geography
- Geology
- Geophysics
- Law
- Paleoclimate
- Physics
- Political Science
- Public Health
- Public Policy
- Urban Planning

Centers, Units, Initiatives and Programs that Study Climate

- Advanced Consortium on Cooperation, Conflict and Complexity (AC4): connects thought leaders at Columbia to address social and environmental conflict, peace and security.
- Center for Climate and Life (CCL): mobilizes scientists across disciplines to accelerate the understanding of **how climate impacts the security of food, water, and shelter**, and to explore sustainable energy solutions.
- Center for Climate Systems Research (CCSR): investigates Earth systems and how they can inform efforts to both adapt to and mitigate climate change. Research areas include **global climate modeling**, atmospheric composition, global food security, and climate impacts.
- Center for Earth Ethics *(with Union Theological Seminary)*: examines the value systems placed on humanity and the planet, in hopes of establishing a new system. Key research areas include eco-ministry, environmental justice & civic engagement, original caretakers (indigenous knowledge systems), and sustainability & global affairs.
- Columbia Electrochemical Energy Center (CEEC) *(with the Engineering School)*: research ranges from the discovery of new materials for energy storage to learning how to use new technologies in complex systems such as the electrical grid.
- Center for Environmental Sustainability (EICES): studies human well-being through biodiversity management, preservation efforts, and the promotion of ecosystem services.
- Center for International Earth Science Information Network (CIESIN): works with online data management geospatial data, and interdisciplinary studies on how humans interact with their natural environment.
- Center for Sustainable Development (CSD): focuses on four key areas—health, education, gender equality, and climate action—in order to achieve the Sustainable Development Goals.
- Center for Sustainable Urban Development (CSUD): addresses urban sustainability and equity issues through multidisciplinary approaches to urban planning and strategic systems-based thinking.
- Center on Global Energy Policy (CGEP) *(with the School of International and Public Affairs)*: provides independent, balanced, data-driven analysis to help policymakers navigate the complex world of energy; CGEP approaches energy as an economic, security, geopolitical, and climate concern.

- Climate Adaptation Initiative: brought together researchers for networking and events around a common theme, with a focus on **urban adaptation, managed retreat** and ecosystem conservation.
- Columbia Center on Sustainable Investment *(with Columbia Law School):* studies the nexus of natural resource investments, climate change, and international investment law.
- Columbia Climate and Health Program *(with the Mailman School of Public Health)*: researches the **health impacts of climate change**, focusing on urban health, climate and health, and global health.
- Columbia Initiative on Extreme Weather and Climate: is focused on understanding the risks to human life and property from extreme weather events, both in the present and future climates, and on developing solutions to mitigate those risks.
- Columbia Water Center: integrates earth science, policy and engineering to address water crises and water scarcity.
- Consortium on Climate Risk in the Urban Northeast (CCRUN): With three research themes—climate science, engineering and urban design, and **social dimensions of adaptation**—CCRUN partners with the NOAA to enhance climate resilience with impending sea-level rise and extreme weather events.
- Initiative on Communication and Sustainability: seeks to develop a space for scientists, journalists and policymakers to communicate more effectively on climate issues.
- International Research Institute for Climate and Society (IRI): enhances society's capacity to understand, anticipate and manage climate impacts in order to maintain human well-being and environmental conditions, with a particular focus in developing countries.
- Lamont-Doherty Earth Observatory: seeks fundamental knowledge about the origin, evolution and future of the natural world. Its scientists study the planet from its deepest interior to the outer reaches of its atmosphere, on every continent and in every ocean, providing a rational basis for the difficult choices facing humanity. LDEO works within the following divisions:
  - Biology & Paleo Environment
  - Geochemistry
  - Marine Geology and Geophysics
  - Ocean & Climate Physics
  - Seismology, Geology and Tectonophysics
- Lenfest Center for Sustainable Energy: researches new, sustainable energy technology, within the following key research themes: novel materials/nanotechnology, novel reaction pathways, catalysis, separations, and earth systems.
- NASA Goddard Institute for Space Studies: researches both natural and anthropogenic global changes over different time scales to investigate Earth's habitability. The Institute is working on global climate modeling, astrobiology, climate impacts, cloud climatology, and water.
- National Center for Disaster Preparedness: aims to advance the United States' ability to **prepare for and recover from natural disasters,** looking at both governmental and non-governmental action, human resilience and community action.
- Program on Climate Science, Awareness and Solutions: conducts climate change research, and translates that research to the general public, making information accessible to people across educational backgrounds.
- Research Program on Sustainability Policy and Management: provides a rigorous analytic base to help inform sustainability decision-making.
- Sabin Center for Climate Change Law *(with Columbia Law School)*: cultivates legal toolkits and techniques to fight climate change and provide information on the legal and regulatory aspects of climate.
- Sustainable Engineering Lab: uses engineering techniques to address issues of development, including software and digital solutions for urban planning, and accessibility of critical services in the developing world.

- Urban Design Lab: focuses on design solutions for sustainable urbanization. Using New York City as a model, the lab focuses on how design solutions could be implemented globally.

Relevant Education Programs

Program	Partner School
B.A. Sustainable Development	Columbia College, School of General Studies
M.S. Sustainability Management	School of Professional Studies (SPS)
M.S. Sustainability Science	School of Professional Studies (SPS)
Certifications in: Sustainability Analytics, Sustainable Finance, Sustainable Water Management	School of Professional Studies (SPS)
M.A. Climate and Society	Arts & Sciences, Department of Earth and Environmental Science (DEES)
M.P.A. Environmental Science & Policy	School of International and Public Affairs (SIPA)
M.P.A. Development Practice	School of International and Public Affairs (SIPA)
Ph.D. Sustainable Development	School of International and Public Affairs (SIPA)

By the Numbers

Category	#
Number of Total Students Across All Programs	700
Number of Climate-Related Faculty & Scientists	1,000 full and part-time (All EI, including affiliated units)
Annual Grant Income Related to Climate	$70M (total EI/LDEO FY20 budged private and government grant revenue)

Barnard College

Barnard College is the undergraduate women's college at Columbia. Barnard's mission includes a "responsibility to address issues of gender in all of their complexity and urgency and to help students achieve the personal strength that will enable them to meet the challenges they will encounter throughout their lives." Barnard places a strong emphasis on social action and impact, including through the Foundations Curriculum, which includes six modes of thinking courses, oriented toward interdisciplinary thought and issues facing both the local and global community.

Barnard College is committed to ensuring that all members of the community work together to tackle the urgent challenge of climate change. The College has identified **a 360-degree approach that prioritizes the role of women and marginalized communities in defining new paradigms of climate leadership**, with targets in three main areas: (1) **Academics:** Support and expand teaching and research in the areas of climate change, sustainability, environmental stewardship, and the human–nature relationship, with a focus on interdisciplinary work and partnerships in New York City; (2) **Finance and governance**: Incorporate climate and sustainability into all decision making, from strategic planning and capital improvements to daily choices; (3) **Campus operations and culture:** Develop and execute a comprehensive and innovative emissions reduction plan that lowers emissions across all three scopes and intersects with social goals such as equity, inclusion, and health.

ACADEMICS

Currently, Barnard offers a comprehensive, growing array of coursework to support learning and activism for students interested in **climate action and leadership**, including:

- The Environmental Science Department, which offers majors in Environmental Science, Environmental Biology, and Environment & Sustainability;
- The Urban Studies Department, which offers a specialization in Environmental Science;
- The History Department, which offers a concentration in Science, Technology, and the Environment;
- Multiple departments, such as Anthropology, Architecture, Economics, Dance, and Theatre, which offer coursework that engages with the human relationship to the natural world, including climate and sustainability.

Furthermore, the Environmental Science Department, which is affiliated with the Earth Institute and chaired by professors Martin Stute and Brian Mailloux, works with a number of environmental organizations and initiatives to provide opportunities to its students. Professor Stute has done significant research in the area of **climate and energy, and carbon sequestration** in the subsurface. As a part of the Columbia Superfund Research Program, Barnard students are studying **arsenic contamination in the groundwater resources of Bangladesh**. Barnard also works at the interface of **ecology and climate change** in New York City and at Black Rock Forest, just upstate from the Columbia campus. Barnard is a part of the Environmental Consortium of Hudson Valley Colleges and Universities, which is spearheaded and hosted by Pace University. It aims to **research and protect resources** in the Hudson-Mohawk River Watershed.

FINANCE AND GOVERNANCE

In 2017, Barnard appointed Associate Professor of Professional Practice Sandra Goldmark as Director of Campus Sustainability and Climate Action. Goldmark has created research and engagement opportunities in **design and the circular economy, consumer culture, and environmental decision-making**. The College also recently appointed Leslie Raucher as Associate Director, with a focus on developing sustainable practices campuswide. The

Sustainable Practices Committee (SPC) is co-chaired by Goldmark and the Vice President for Campus Services, Roger Mosier, and is composed of students, faculty, and administrators. The Committee is charged with developing and implementing a **comprehensive climate action vision** for the College.

Barnard has committed to aligning its endowment investments with its goals as an academic institution, by **divesting from fossil fuel companies** that "deny climate science or who otherwise seek to thwart efforts to mitigate the impacts of climate change." Working with Barnard faculty, students, staff, and trustees, in partnership with FFI (formerly Fossil Free Indexes) and the Union of Concerned Scientists, the College developed six rigorous criteria to evaluate the extent to which a company's words and actions support climate science, provide transparency, and support the free flow of information.

CAMPUS OPERATIONS AND CULTURE

The school is leading by example when it comes to **climate impact and action**, with two high-performance buildings: The Diana Center is **LEED Gold certified**, and the Milstein Center features **green roofs, sustainable materials, and efficient energy systems**, with an anticipated LEED Silver certification. Furthermore, past action by the College demonstrates our commitment to sustainable building and energy practices. As a part of the NYC Carbon Challenge for Universities in 2009, Barnard achieved a **30% emissions reduction of scopes 1 and 2 emissions** from 2005 levels, ahead of schedule.

Barnard has taken a unique approach to scope 3 emissions, creating a **comprehensive carbon footprint** to begin to fully assess emissions across all three scopes. Initiatives to tackle scope 3 emissions include adopting **single-stream recycling, introducing organics collection on campus, and supporting initiatives to develop a robust internal circular economy**. For example, during move-out, students help collect unwanted dorm-goods, including fridges, lamps, and textbooks for a fall "Green Sale." These items are stored and then resold at reduced prices in the fall. At the 2019 Green Sale, an estimated 21,000 kg of carbon-equivalent emissions were saved. In March 2019, Barnard hosted "Women, Clothing, & Climate," which featured panel discussions on **sustainable fashion**, repair and reuse workshops, and a used clothing sale. And the Theatre Department has developed an innovative program to **track and budget for circularity in design** and production in the performing arts.

Sustainability programming and initiatives are integrated into student life through student groups and centers on campus. The Student Government Association includes the **SGA Committee on Sustainability**, which contributes to campus sustainability policy and programming. Additional student initiatives include Sprout Up, which provides **free environmental education** to local public elementary schoolers, the Barnard/Columbia chapter of the Sunrise Movement, Barnard's Community Garden, the Barnard Outdoor Adventures Team, and a dedicated group of work-study students employed by Barnard Sustainability.

Key Disciplines

- Anthropology
- Biology
- Chemistry
- Economics
- English
- Environmental Science
- Physics
- Psychology
- Public Policy
- Sociology
- Urban Studies

Centers, Units, Initiatives and Programs that Study Climate

- Summer Research Institute: provides summer funding, subsidized campus housing, and supportive programming for students conducting STEM research under the guidance of a faculty mentor.

- Athena Center for Leadership Studies: The Athena Center is co-hosting a student design challenge in spring 2020 that will focus on generating climate solutions and drawing connections between the campus of today and New York in 2080.
- Beyond Barnard: Beyond Barnard provides students with access to and information about career opportunities and professional pathways. Climate initiatives included a panel discussion at the fall 2019 Opportunities Fair and an upcoming Roundtable on Careers in Climate.
- The Barnard Center for Research on Women (BCRW), the Forum on Migration, and the Barnard library have all presented programming, talks, and other initiatives that intersect with issues of climate and sustainability.
- The Barnard Design Center has engaged in a range of sustainable initiatives, including a Sustainable Design Challenge as part of the "Women, Clothing, & Climate" event, mending workshops, and more.

Relevant Education Programs

Program	Partner
B.A. in Environmental Science	Environmental Science Department
B.A. in Environment and Sustainability	Environmental Science Department
B.A. in Environmental Biology	Environmental Science & Biology Departments
Minor in Environmental Science	Environmental Science Department
B.A. in Urban Studies, Specialization in Environmental Science	Urban Studies Program/Environmental Science Department
B.A. in History, Concentration in Science, Technology and the Environment	History Department

By the Numbers

Category	#
Number of Total Students Across All Programs	2,573
Number of Total Faculty	305 (with some double appointments)
Number of Climate-Related Faculty	25
Annual Grant Income Related to Climate	$120,000/year average over the last 5 years

Teachers College

Teachers College, Columbia University (TC) is the first and largest graduate school of education in the country. Teachers College was founded in the late 19th century with the belief that education writ broadly is the path to a better future. At the heart of its philosophy has always been a recognition that education is the "great equalizer" and the basis of a healthy society. Teachers College has a proud legacy of innovating to meet the needs of the times while building on a solid foundation of evidence and practice. The faculty and researchers at TC are some of the most influential scholars in the world in the fields of education, health, psychology, and leadership. They regularly engage with practitioners and policymakers who put their knowledge to use and enhance its impact, and often work across disciplines to tackle the most challenging problems in their fields.

Climate-related work happens in a number of different areas at the College including Health & Behavior Studies, International & Transcultural Studies, and Education Policy. While work is happening across the College, there is a concentrated focus in the Teachers College Initiative for Sustainable Futures.

The Teachers College Initiative for Sustainable Futures champions people's right to have access to Environmental and Sustainability Education (ESE), an interdisciplinary pedagogical movement that examines the interactions between environmental, social, health, and economic issues that together promote the long-term health of complex living systems. The growing list of coursework under the ESE umbrella includes **environmental health and behavior studies, nutritional ecology, and sustainability education.** Current ESE research focuses on public perception of **environmental education**, TC's own ecological footprint, improvements to **sustainability education** in New York, and **urban displacement**. Researchers suggest that by engaging teachers with **climate science, energy history,** and related subjects, schools can help young people grasp reality amid today's noise and polarization, and shape academic, civic and career paths that can help build a climate-safe future. TC researchers also study **public opinion on teaching global warming and climate change** in secondary schools. In 2018, TC partnered with the New York City Department of Education (DOE) on **public-school sustainability goals**, as a part of the initiative to have zero landfill waste by 2030. Now in its fifth year, TC and the DoE's Office of Sustainability formed a research partnership, which strives to improve **schools' engagement with sustainability** through the development of research-based knowledge and evidence. As part of this collaboration, TC also hosted an open house for parents interested in implementing **environmental sustainability plans** in their children's schools.

Teachers College recently partnered with The Common Market, a local food distributor in the city, to focus on **sustainable eating practices** and locally sourced produce in their dining hall. The campus adopted a **single-stream recycling program** in all academic buildings in 2011, and this helped contribute to a **diversion of 76% of waste** produced on campus in 2016.

Key Disciplines

- Curriculum & Teaching
- Communication, Media, & Learning Technologies Design
- Education Leadership
- Education Policy
- Health Education
- International & Comparative Education
- Nutrition & Public Health
- Science Education
- Social Organizational Psychology

Centers, Units, Initiatives and Programs that Study Climate

- Teachers College Initiative for Sustainable Futures: The mission of this initiative is to create educational materials and promote educational practices that encourage sustainability as a factor of ecological and global health systems. Scholars approach sustainability from an education-based perspective, helping to create a world where **everyone has access to education** that will empower them to **live sustainably**, and address climate change and environmental impact.
- Tisch Center for Food, Education and Policy: The Tisch Food Center, in the program in Nutrition, researches **sustainable food systems** and their intersections with public policy, social change, and community activism.

By the Numbers

Category	#
Number of Total Students Across All Programs	5,572
Number of Total Faculty	180 full-time