II. Executive Summary – There is *no greater threat to human existence* than Earth's ongoing global climate change. If we are to mitigate current climate change trends, and survive them, <u>we must build solutions supported by three vital – and vitally interconnected - pillars:</u>

1) understanding *climate impacts and feedbacks within all natural Earth environmental systems* (atmosphere; lithosphere; hydrosphere; biosphere) – *past, present and future*

2) understanding how *human systems (national security, economy, migration, health; infrastructure; nutrition; cities; society)* interact with changing environmental systems

3) engaging in *effective communication and exploration* of this knowledge with the public *(visual and performing arts; writing; reporting, education, social-action)* to inspire, empower and motivate sustainable adaptation and meaningful change.
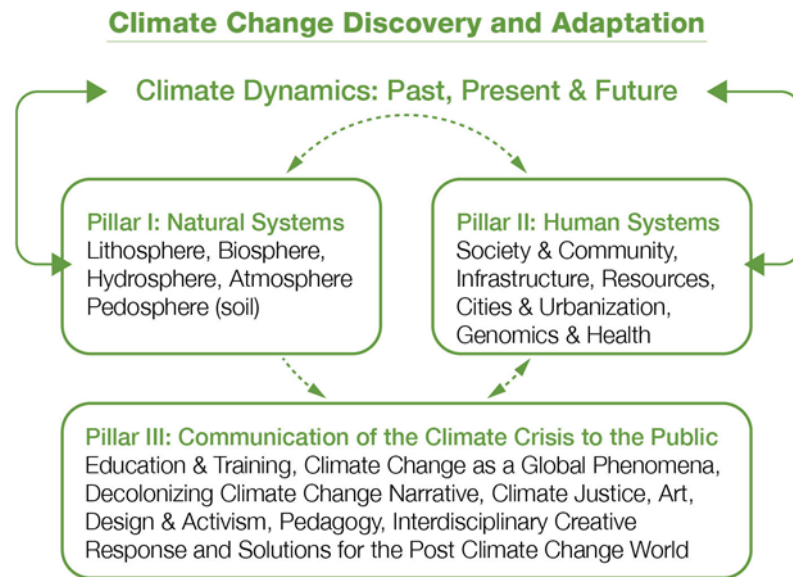
Our proposed Area, ***Climate Change Discovery and Adaptation, is built upon these three pillars.*** The Intergovernmental Panel on Climate Change *(IPCC) confirms* that significant gaps remain in our knowledge of how climate change impacts natural and human systems and in our ability to relay this imminent threat *to the public*. **Adapting to any aspect of the climate crisis requires a multidisciplinary effort inclusive of natural scientists, social scientists, engineers, architects, artists and educators.** The National Academies of Science emphasizes the efficacy of *combining sciences and engineering with design, arts and humanities*. **UNC Charlotte,** with its rich tradition of interdisciplinary research and education, and its *urban-research mission*, **is well-positioned for** <u>emerging excellence</u> **in building climate change solutions by bringing together** <u>existing excellence</u> **within and across the three pillars above.**

Climate change is not a distant hypothetical scenario limited in scope relating to melting glaciers or the imagination of scholars. It is upon us, as the *catastrophic weather from Feb-2021 clearly shows*. The greatest costs of such events are *borne by those with the least resources* to protect themselves. *Climate change discovery and adaptation* is therefore a matter of equity and social justice, just as it is a problem for science or industry. **This Area of Excellence is thus well aligned with priorities of local and** *national policy*, *federal* **funding agencies, and** *local* **and** *international* **NGOs.** It is also vital to the wellbeing of North Carolina and Charlotte, as climate change impacts *hit ever closer to home*.

We are **a diverse cohort of 61 faculty from 11 departments and 4 colleges** supporting this nomination. We have built lauded scholarly and creative research programs addressing climate change impacts **through a full range of methodologies supported by >$74 million in external and >$500k in internal funding since 2016.** Our articles total **thousands of citations (two of us rank** *in the top 2% in the world***) in the highest-impact multidisciplinary journals** (e.g. *Nature*, *Science*, *Nature Climate Change*, *P. National Academy of Sciences*). We have, or are developing, **patented, commercially available solutions to climate-related problems**. We reach broad audiences at international and national *museums*, professional conferences, regional and national outreach events, and even international popular press (e.g. *BBC*, *ThePrint*). We are *scientific ambassadors to our local community***, and our work is amplified by** *past* **(>1000 total) and** *current* **trainees: 72PhD, 74 MA/MA, 36BA/BS and 7 postdoctoral fellows.**

As a formal *Area of Excellence,* this creatively assembled cohort could grow and thrive through weekly seminars, co-led courses, and increased connections between ourselves, the community *and* the huge numbers of *other* UNC Charlotte faculty and students who believe - as we do - that addressing **the crises of climate change is a moral, societal, educational and academic imperative for our University, our City, our region, our country and our Planet.**

III. **Evidence of Strength and Excellence – <u>Climate Change Discovery and Adaptation</u>**

Climate Change Discovery and Adaptation

Climate Dynamics: Past, Present & Future

Pillar I: Natural Systems
Lithosphere, Biosphere, Hydrosphere, Atmosphere Pedosphere (soil)

Pillar II: Human Systems
Society & Community, Infrastructure, Resources, Cities & Urbanization, Genomics & Health

Pillar III: Communication of the Climate Crisis to the Public
Education & Training, Climate Change as a Global Phenomena, Decolonizing Climate Change Narrative, Climate Justice, Art, Design & Activism, Pedagogy, Interdisciplinary Creative Response and Solutions for the Post Climate Change World

Pillar I. *Interaction of climate and environmental systems* Climate impacts all natural Earth systems, but **<u>*paleo*- and *modern* links and feedbacks between climate and these systems remain poorly characterized.</u>** (e.g. How does climate control: flooding● landslides● heat waves●storms hurricanes ●erosion● weathering● species diversity●plant and animal physiology ●genetics**?**)

Members of our group have explored these and other complex concepts through past and ongoing collaborations **funded by NSF, NIH, NOAA, NCDOT, NC Seagrant, NASA, Duke Energy, and the Catawba Lands Conservancy.** Our interdisciplinary approaches combine fields ranging from geology to genetics in order to study how climate change impacts phenomena like: paleo-climate and -fires, rock weathering and landslides, water chemistry and microbial genomics, storms and atmospheric heating. *Local community partners* grant us access to thousands of acres of streams, groundwater, and soils, and to atmospheric data for study. **We have documented novel findings related to climate change in top interdisciplinary journals** (e.g. *Science*; *Nature*, *Proceedings of the National Academy of Sciences*, *Nature Communications*, *Nature Geoscience*) **and we have been recognized by** *national* **and** *international* **awards and Professional Society Fellowships.**

Pillar II. *Human interactions with climate and environmental systems*
Climate change impacts innumerable human systems. Climate change is leaving some areas previously ideal for *growing crops*, struggling to produce. Warming ocean temperatures intensify *tropical cyclones* (hurricanes) in more than just the Atlantic Basin. More than 50% of the US *population lives near the coast*, with more continuing to move there each day, while sea levels continue to rise, which can worsen *impacts from tropical cyclones*. Last year (2020), *California saw record wildfires*. Energy jobs are shifting as society moves towards more energy independence and reliability. The war in *Syria* has even been linked to climate change.

Past and continuing **connections among our group, and our community and NGO partners, have result in funding from agencies like: the City of Charlotte; Mecklenburg County, NIH, NSF, DOE, DOD, CDC, USDA, Cares Act, US Fish and Wildlife, EPRI, NCDOT, and American Institute of Architects.** Our research addresses topics including: ●crop improvement●robustness of food supply●biointegration in urban structures●energy and transportation efficiency● natural hazard impacts to society and infrastructure●long-term paleoclimate and archaeological perspectives on cities and climate change●social fragility● socio-spatial disparities and health at the local, regional and global scales●climate change resilience. These collaborations and research programs have already gained **local, national and international exposure through high impact journal publications** (*Nature Palgrave Communications*, *Nature*, and *PNAS*), **news articles (***BBC*, *NYT*, *ThePress***), and media**

attention (*The Weather Channel*; *Charlotte Talks*). **We have ongoing partnerships with state and local government entities or NGOs in multiple states (NC, LA, AL, NJ, SC) to manage biological diversity, water quality, weather patterns, hazards, and renewable energy.** We have brought local attention to crucial climate change issues like tree canopy loss (*WFAE*, *Charlotte Observer*, *Spectrum News*).

Pillar III. *Communicating the climate crisis to the public*

      Research clearly demonstrates that until public opinion is swayed to understand and appreciate the climate crisis, meaningful adaptation is not possible. Yet scientists often fail to communicate complex data and results. **Effective communication makes STEM research more effective, inspiring society to adapt.** Art and science separated in the 19th century. Today artists (visual, performing, literary), scientists and educators increasingly recognize the opportunity of much broader, deeper, positive impact and contribution by reunification. Through arts, humanities and design, we create intellectual and emotional connections to scientific facts, drive personal engagement, and motivate people to action. Artists work as activists, creative researchers and direct *communicators* of scientific ideas. Furthermore, the importance and the benefits of involving art in STEM education has been recognized globally in school systems and within the framework of cultural and research institutions.

      Members of our group regularly communicate issues of climate change science employing: ●sculpture● film●design●history●painting●data visualization●architecture●and pedagogical research and education. We have received funding for these alliances through local to international **organizations like the ASC and the University of Tasmania, though *Broader Impacts* on NSF grants, through STEM pedagogical research (DOD), and through funding from the Knight Foundation, NSF, USDA, and EPRI.**   We have explored and addressed - in high-visibility public venues – climate change issues such as climate *migration*, large-scale environmental *degradation,* mass *consumption* of nature and the *landscape* in *Anthropocene,* climate *justice*, climate and *postcolonialism*. We have communicated complex national-award-winning scientific work through *video* and *artistic depictions*. We have published our communications efforts in high impact journals (*Architecture and Culture*; *Bulletin of American Meteorological Society*; *Earth Sciences History*), **and *won* – or *been nominated for* – local and national awards for teaching and engagement of students**. We have engaged with partners like the *NC Academy of Science*, *the Bechtler Museum*, and *Discovery Place*.

Three Pillars working Together

      Though we now have a better scientific understanding that Earth can survive and evolve through extreme climates, many humans *might not*. With this nomination, we highlight a creative pathway by which **UNC Charlotte may lead the way in developing new solutions to the climate change crisis** - namely by building and bridging <u>all three pillars</u> of successful climate change survival and adaptation. **Bridging all three 'pillars' is emerging as one of the most exiting components** of this overall Area of Excellence here at UNC Charlotte. Many of us have been working as teams across two bridges, but few if any of us across three. **Through this nomination process itself, however, <u>ALL</u> of us have <u>discovered new potential collaborations across campus and new connections to one or more "pillars".</u>** Nationwide, students and community – regardless of their academic interests - continuously *demand opportunities to address Climate Change* in some way **– this Area of Excellence will tell the world that UNC Charlotte has been, and plans to continue, leading the way in Climate Change.**

IV. Alignment with Regional and National Priorities

To say climate change is a significant local, regional and national priority would be an understatement. Understanding climate change and suggesting potential solutions is an international imperative. **The universal urgent call for adaptation is unprecedented.**

President and Congress: The incoming Presidential Administration has issued a *pledge to address the growing emergency* of Climate Change. Already, the President has issued Executive Orders to honor the Paris Agreement to lower emissions, establish the White House Office of Domestic Climate Policy and position of National Climate Advisor. In congress, there is a recent push for new environmental legislation including efforts like the "Green New Deal".

Federal Funding Agencies: *NSF*, *NASA*, *DOE*, *NIH*, *NOAA*, *USDA*, *USGS*, *US Fish and Wildlife*, *DOD*, *DOT*, the *National Endowment for the Arts* - and more – all **identify all or part of our '3 pillars' as crucial to their current funding missions (links are to the direct climate-change statements).** There is a US Government inter-agency *group* devoted to just that, and another *NIH-sponsored group* devoted to climate change and health. The *NSF Earth Sciences Division's 2020-2030 Science Priorities* include questions directly related to our three pillars including: *How does the critical zone (i.e. weathering and erosion) influence climate? What does Earth's past reveal about the climate system? How is Earth's water cycle changing? How do biogeochemical cycles evolve? How do geological processes influence biodiversity? How can Earth science research reduce the risk and toll of geohazards?*

Professional Society and Organization Priorities: *The National Academy of Science's* recent '*affirmation of the scientific evidence of climate change*' states "*The National Academies are focused on further understanding climate change and how to limit its magnitude and adapt to its impacts, including on health. We also recognize the need to more clearly communicate what we know*". *The American Institute of Architects* "calls on architects around the world to support humanity's collective call to climate action through an unrelenting commitment to sustainable and resilient design". Other statements are available from *The American Geophysical Union*, *the Geological Society of America*, *the American Meteorological Society*, *Architecture 2030, American Society of Civil Engineers, American Institute of Biological Sciences, and more.*

State, Regional, Local: *The EPA lays out* the harmful impacts of Climate Change to North Carolina - as does Gov. Coopers' *Climate Science Report* - prompting development of a NC *Climate Risk Assessment and Resilience Plan*. Equity, social and cultural diversity in NC *are directly impacted by the impending Climate Crisis*. Already, the *Outer Banks* face increasing crises as rising water levels threaten lives and livelihoods; several fatal landslides led NC DEQ to reinstate its *landslide hazard program*. Because climate change impacts are even greater elsewhere, NC might become a climate migration destination. The Washington Post lays out how *lack of public consensus precluded significant forward motion until disasters struck*. NC is an exemplar for needing effective climate communication to change hearts and adapt.

UNC Charlotte: This Area of Research Excellence falls squarely within the central mission of the RI Commission call at a global level: address the "most complex and urgent societal challenges that often transcend traditional departmental or disciplinary boundaries". **It also addresses the University's commitment to address all parts of: "the cultural, economic, educational, environmental, health, and social needs of the greater Charlotte".**

V. Supporting Documents: **Names, titles, and a short description of the contribution or expertise of each member.**

Name	Title	Contribution/Expertise *Climate Change and:*
Allan, Craig	Professor of Geography & Earth Sciences	Surface Water Hydrology, Biogeochemistry, Fluvial Geomorphology
Anderson, Nadia	Associate Professor, School of Architecture Director, City Building Lab	Stormwater Management, Housing energy efficiency, socio-economic impacts of urbanization
Azarbayjani, Mona	Associate Professor and Director of Graduate Programs, Architecture	Energy performance of buildings, the study of thermal comfort with new technologies, and climate-responsive building design.
Bai, Liquan	Assistant Professor of System Engineering and Engineering Management	DER optimization and control, power system operation under uncertainties, multi-energy system integration, and electricity markets.
Barclay, Nicole	Assistant Professor, Engineering Technology and Construction Management	Water infrastructure asset management, stormwater management, socio-technical interactions for infrastructure, flooding resilience
Bobyarchick, Andy	Associate Professor of Earth Sciences	Tectonics; Applied geophysics; Online and non-traditional experiential geosciences education

Chen, Don	Professor of Civil Engineering Technology & Construction Management	Parametric Modeling and Visualization in Design and Construction
Chen, Gang	Associate Professor of Geography, Geography M.A. Coordinator	Remote Sensing, Spatial Ecology, Human-Environment Interaction
Chen, Shen-En	Professor of Civil Engineering	Hurricane impacts to buildings and power structures, green mining, green energy solutions
Chen, Yuting (Tina)	Assistant Professor, Civil Engineering Technology & Construction Management	Data analytics, automation /robotics/VR/BIM, organizational and individual resilience vs. construction safety, organizational maturity vs. risk management of projects
Clinton, Sandra	Research Assistant Professor of Geography & Earth Sciences	Urban Stream Ecology, River Restoration, Molecular Methods in Freshwater Ecosystems
Cooper, Elizabeth	Assistant Professor of Bioinformatics and Genomics	Adaptation and diversity in agriculturally important species
Daniels, John	Professor & Department Chair of Civil and Environmental Engineering	Geotechnical and geoenvironmental engineering testing of materials; Subsurface contaminant transport; Public policy and technology transfer
Davenport, Casey	Assistant Professor of Meteorology	Severe thunderstorms, Severe Local Storms, Mesoscale Processes, Science Education

Delmelle, Eric	Associate Professor of Geography	GIScience, Spatial Analysis, Epidemiology, Uncertainty
Diemer, John	Professor of Earth Sciences, Associate Director of INES Ph.D.	Sedimentology, Facies Analysis, Depositional Environments, Basin Analysis, History of Geology
Dornburg, Alex	Assistant Professor of Bioinformatics and Genomics	Species persistence in environmental change.
Eastin, Matt	Associate Professor of Meteorology	Urban heat islands, Mesoscale Process, Urban Meteorology, Severe Local Storms, Tropical Cyclones, Societal Impacts
Ellinger, Jefferson	Associate Professor of Architecture	building integrated bio; bioremediation; carbon fixation, food security
Eppes, Martha Cary (Missy)	Professor of Earth Sciences	erosion, weathering; hazards; documenting past climates
Ewers, Michael	Assistant Professor of Geography	Migration, Human Capital, Economic Geography
Falconer, Steve	Professor of Anthropology	Comparative analyses of rise and collapse of early urbanized civilizations, reconstruction of communities and social responses
Fall, Pat	Professor of Geography & Earth Sciences	Long-term societal responses, Human-environmental interactions

Fan, Wei	Professor of Civil & Environmental Engineering and Director of USDOT CAMMSE University Transportation Center	Connected and autonomous vehicles; Shared mobility; Multimodal transportation system planning; Traffic operations and control
Fodor, Anthony	Professor of Bioinformatics and Genomics	Microbial response to environmental challenges; Reproducible genomics tools.
Gagne, Sara	Associate Professor of Geography & Earth Sciences, Earth Sciences Graduate Coordinator	Urban Ecology, Landscape Ecology, Effects of urbanization on biodiversity
Gamez, Jose	Professor and Interim Associate Dean for Research and Graduate Programs in Architecture and Urban Design	Applied Geography, Culture in Architecture and Urbanism, Environmental Design
Gibas, Cynthia	Professor of Bioinformatics and Genomics and Assistant to the Dean - Graduate Programs	Environmental metagenomics, impacts of human activity, pandemic outbreak surveillance.
Godlewska, Maja	Associate Professor, Painting: Area Coordinator, Art & Art History	Global tourism, Instagrammable Sublime, Visual consumption of Nature, and the Phenomenology of the Landscape

Hippensteel, Scott	Associate Professor of Earth Sciences	Coastal Geology, Environmental Geology, Geoarchaeology, Micropaleontology
Jay, Jeremy	Research Assistant Professor of Bioinformatics	Reproducible Functional Genomics Tools
Kangmennaang, Joseph	Assistant Professor of Geography	Community Wellbeing; Health inequalities, Environment and Health
Keanini, Russell	Professor of Mechanical Engineering	Stochastic processes and applications; Green's function methods and applications; Fluid mechanics; Applied math
Kim, Kyoung-Hee	Associate Professor of Architecture and Director of IDR Lab	Climate responsive architecture, Sustainable design
Lai, Luca	Instructor of Archaeology	Archaeology of ancient Mediterranean, stable isotope analysis of human and animal diet and environments
Light, Lydia	Assistant Professor of Anthropology	Primate Behavioral Ecology, GIS and Remote Sensing, Primate Conservation
López-Duarte, Paola	Assistant Professor of Biology	Marine Biology; Environmental Rescue; Food Web Interactions in Coastal Communities
Magi, Brian	Associate Professor of Meteorology	Atmospheric Sciences, Climate Change, Air Quality
McCormick, Elizabeth (Liz)	Assistant Professor of Architecture and	Energy consumption of commercial buildings in developing hot-humid climates

	Building Technology	
Munir, Mariya	Assistant Professor of Civil & Environmental Engineering	Microbial water quality and public health issues; Sustainability and green energy technologies
Ogunro, Vincent	Associate Professor of Civil & Environmental Engineering	Industrial wastewater treatment and management; Monitoring and numerical modeling of instrumented transportation and geoenvironmental infrastructure
Papanikolaou, Dimitris	Assistant Professor of Architecture and Computer Science	Efficiency in on-demand transportation in urban environments.
Parrow, Matthew	Academic Vice Chair and Associate Professor of Biology	Eukaryotic microbiology, Harmful algal blooms; Applications of algae and fungi in Biotechnology
Pilkington, Stephanie	Assistant Professor of Engineering Technology and Construction Management	Community impacts and recovery from natural hazards, community resilience, adaptability of communities, and the socio-physical interaction between people, infrastructure, and their environment, before, during, and after a natural hazard event.
Pulugurtha, Srinivas	Director of IDEAS Center Professor & Research Director of Civil & Environmental Engineering	Impact of connected and automated vehicles on built environment and climate change; Transportation planning and climate change; Interactions between the transportation system, land use, and environment

Ranis, Marek	Associate Professor & Sculpture Area Coordinator of Art and Art History	Social, political, and anthropological aspects of phenomena such as climate change explored through sculpture, installation, painting, photography and video.
Reid, Robert	Assistant Research Professor of Bioinformatics	Gene expression response to heat stress, Crop Genomics & Genome Assembly, Nutrition
Rice-Boayue, Jacelyn	Assistant Professor of Engineering Technology & Construction Management	Indirect (de facto) reuse of treated wastewater; Water quality and contaminant modeling; Coupled natural and human systems; Water-energy nexus
Rogers, Rebekah	Assistant Professor of Bioinformatics and Genomics	Genetic responses in species threatened under environmental threat.
Scheff, Jacob (Jack)	Assistant Professor of Meteorology and Earth Sciences	Climate Change, Water Cycle, Atmospheric Circulation
Shoemaker, Doug	Director of Research and Outreach - CAGIS	Environmental Change, GIS
Tang, Wenwu	Associate Professor of Geography, Executive Director for the Center for Applied GIScience	CyberGIS, Spatial Modeling, Complex Adaptive Spatial Systems, Land Use And Land Cover Change
Thill, Jean-Claude	Knight Distinguished Professor of Geography	Transportation, Infrastructure, Resilience, Sustainable Urbanization, Geospatial Data Science

Thomas, Deb	Professor & Department Chair of Geography & Earth Sciences	Disasters, Environmental Health, Global Health, Human-environment Interaction
Tolone, William	Professor and Associate Dean, College of Computing and Informatics	Computer Science, Infrastructure, Modeling and Simulation
Vinson, David	Assistant Professor of Earth Sciences	Hydrogeochemistry, Groundwater Hydrology, Isotope Geochemistry
White, Richard Allen III	Assistant Professor of Bioinformatics	Multiomics of modern microbialites and rhizosphere microbiomes/viromes
Willis, Andrew	Associate Professor and EE Associate Chair and Director of Undergraduate Programs	Computer Vision; Pattern Recognition; Image Processing; Computational Geometry in Multiple (>2) Dimensions
Wu, Jy S.	Professor and Program Director of Infrastructure and Environmental Systems Doctoral Program	Renewable energy development, and environmental and economic Impacts
Yang, Jing	Professor of Computer Science	Visual analytics of spatial videos, spatiotemporal data, time series and events, image and text collections, high dimensional data, hierarchies, and graphs

Zhu, Lei	Assistant Professor of Systems Engineering and Engineering Management	Smart Mobility and Spatial Sensing (GPS/GIS/LiDAR/Camera/Radar); Big Data and Artificial Intelligence in Transportation; Shared and Automated Mobility and Micro-mobility Modeling and Simulation; Transportation Sustainability, Safety, and Electrification