



NATIONAL SCIENCE FOUNDATION
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ALEXANDRIA, VIRGINIA 22314

NSF 23-079

Dear Colleague Letter: CiviL Infrastructure research for climate change Mitigation and Adaptation (CLIMA)

April 3, 2023

Dear Colleagues:

The civil infrastructure sector is a major component of the global economy and provides employment for millions of people in the USA and worldwide. For example, the construction industry alone employs more than 7 million people in the USA and almost 300 million worldwide. Also, construction, operation, maintenance, retrofit, and decommissioning of physical infrastructure systems account for a significant portion of the Gross Domestic Product (GDP) in economically developed countries and even more so in economically underdeveloped countries.

Civil infrastructure investments are among the largest capital investments by both the public and private sectors and are expected to fulfill their intended function for several decades. As such, there continues to be a compelling economic and operational need to extend the service life of existing civil infrastructure and to develop new civil infrastructure to stimulate and sustain continuing economic growth and prosperity in both urban and rural areas as well as to accommodate population growth, mobility, safety, security, and overall quality of life.

Production of infrastructure materials and construction processes are energy intensive, and they are estimated to contribute about one-third of the worldwide greenhouse gas (GHG) emissions. They also lead to the disruption of various natural ecosystems, e.g., deforestation due to wood harvesting and depletion of riverbeds caused by sand and gravel mining. Furthermore, civil infrastructure systems contribute significant GHG emissions during their entire lifecycle for operation/maintenance and they need to continuously adapt to environmental and societal changes.

Increased GHG emissions are associated with increased average planet temperature, rise in sea levels, and a change in weather patterns featuring more extremes, e.g. long periods of droughts, intense precipitations, more frequent hurricanes and tornados. Under these conditions, flooding in coastal regions has increased in frequency and has created significant

temporary and permanent damage to civil infrastructure, which has adversely affected communities. As other times in the history of humanity, global changes require for humans to adapt to these new conditions by retreating from less habitable places, strengthening the resilience of existing infrastructure, designing new infrastructure under evolving conditions of operations, and taking full as well as prompt advantage of technology innovation.

Any successful strategy seeking to mitigate the anthropogenic contributions to climate change and to implement adaptation solutions that increase the resilience of communities must include civil infrastructure innovation. Balancing civil infrastructure needs with the associated social and environmental effects is increasingly more challenging due to the increase of natural hazard risks exacerbated by climate change and by progressive infrastructure aging and deterioration. Furthermore, infrastructure aging and deterioration disproportionately affect marginalized, low-income communities that are not considered priorities in typical civil infrastructure investments.

This Dear Colleague Letter (DCL) is intended to stimulate forward-thinking, convergent, ambitious civil infrastructure research on transformative ideas or approaches that will contribute equitable solutions to climate change mitigation and/or adaptation. CLIMA proposals should develop novel, creative, and fundamental approaches drawing from multiple scientific fields to create holistic pathways to infrastructure and community resilience, social equity, and improved long-term performance. The Foundation seeks the contribution of interdisciplinary teams with expertise in the research areas of the participating core programs listed at the end of this document. Proposals suitable for submission to individual programs will not be considered responsive to this DCL.

Topics of interest to this DCL include, but are not limited to:

- Green construction, operation, and maintenance of civil infrastructure:
 - Waste material utilization and recycling, including post-hazard debris.
 - Usage of locally sourced materials, distributed material manufacturing, and modular manufacturing.
 - Optimization of material use or reduction of consumption while enhancing performance.
 - Material recycling that combines mechanics and mechanical behavior with assessment of cost and energy requirements for recycling (grinding, cleaning, transportation, etc.).
 - Alternative, sustainable, green materials or additives with superior performance in infrastructure construction and long-term service which are economically competitive and environmentally benign. For example, recyclable/degradable materials under complex environmental conditions and novel biomaterials and structures with consideration to the entire life cycle.
- Smart civil infrastructure for health, security, and economic growth:

- Novel policy frameworks and funding mechanisms for civil infrastructure investments.
- Data infrastructure to enable longitudinal, comparative, open science studies of community's risk, unmet need, and adaptive capability.
- Theories, methods, and testbeds for developing, benchmarking, and validating coupled, multi-agent models and next-generation Artificial Intelligence (AI) tools.
- Integration of engineering and nature-based solutions for healthier cities.
- Sustainable and integrated civil infrastructure systems:
 - Materials and structures that serve their primary engineering function and also provide climate change mitigation/adaptation functions (CO₂ sequestration, energy harvesting, energy storage, etc.).
 - New concepts that accommodate more distributed infrastructure systems operations (such as electric microgrids and distributed water systems).
 - New methods to incorporate durability, aging, and deterioration considerations in management processes to extend the useful life of existing(?) civil infrastructure.
 - Designing/adapting civil infrastructure to accommodate sea-level rise and extreme weather events.
 - Use-inspired novel and advanced material and manufacturing concepts, e.g., programmable matter and structures and living engineered materials (in contrast to engineered living materials), for integrated, multifunctional, physically intelligent, and inherently adaptive responses to evolving conditions.
- Climate change-informed design and systems science methods
 - Design of civil infrastructure systems for operations under extreme conditions and addressing climate change uncertainty.
 - New systems modeling methods that accommodate mitigation and adaptation strategies, as well as reuse and manufacturing strategies.
 - New design methods and tools that accommodate the extended timescale of civil infrastructure retrofitting and adaptation.
 - Plug-n-play materials and structures that enable convenient, efficient, and practical retrofitting of infrastructure with very long lifecycle in response to changing environment.

SUBMISSION PROCESS

With the CLIMA DCL, the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) of the Directorate for Engineering (ENG) invites the submission of EARly-concept Grants for Exploratory Research (EAGER) proposals, research proposals engaging more than one of the participating core programs, and conference proposals that address the sustainability, resilience, equity, and accessibility of civil infrastructure under the evolving conditions induced by climate change.

Prospective principal investigators (PIs) must send an email inquiry to clima@nsf.gov prior to submission to ascertain whether the proposal is suitable for the CLIMA DCL and to identify suitable programs. In the email inquiry, the PI should provide an indication of the target programs for the proposed topic. Please note that the PI-indicated target programs may not be the only programs that will consider the submitted inquiry. Research concept outlines or brief summaries (no longer than 2 pages) are required for conference and EAGER proposals. They are also strongly encouraged for CLIMA research proposals. If the topic is found suitable, PIs will be directed to submit the proposal to the appropriate program. CLIMA proposals will be co-reviewed and co-funded by the relevant participating programs.

Guidance on the preparation and submission of research proposals is contained in Chapter II.D of the [NSF Proposal & Award Policies & Procedures Guide](#) (PAPPG). Proposers submitting EAGER or conference proposals should follow the guidance contained in PAPPG Chapter II.F.

The titles for all submissions should include the prefix "CLIMA: " in addition to and in accordance with PAPPG specific title requirements.

Proposals will be accepted at any time, but they should be submitted by **May 31, 2023** for full consideration for FY 2023 funding.

PARTICIPATING PROGRAMS

The following NSF programs are participating in this opportunity:

Advanced Manufacturing (ENG/CMMI/AM)
Civil Infrastructure Systems (ENG/CMMI/CIS)
Dynamics, Control and Systems Diagnostics (ENG/CMMI/DCSD)
Engineering for Civil Infrastructure (ENG/CMMI/ECI)
Engineering Design and Systems Engineering (ENG/CMMI/EDSE)
Humans, Disasters, and the Built Environment (ENG/CMMI/HDBE)
Manufacturing Systems Integration (ENG/CMMI/MSI)
Mechanics of Materials and Structures (ENG/CMMI/MoMS)
Operations Engineering (ENG/CMMI/OE)

KEY CONTACTS

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Sincerely,

Susan S. Margulies
Assistant Director
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