Renewal Proposal for the

Penn State Center for Climate Risk Management (CLIMA)

http://clima.psu.edu

Submitted to the Earth and Environmental Systems Institute

by

K. Keller (Director)

and

K. Fisher-Vanden, C. Forest, M. Haran, J. Swim, and N. Tuana (Co-Directors)

Summary

The Center for Climate Risk Management (CLIMA) was established nine years ago with broad support across colleges and institutes to catalyze interdisciplinary research, education, and outreach in the area of climate risk management. CLIMA has achieved these goals through four main activities: (i) leading the development and running of large and successful proposals (e.g., to establish a cooperative agreement with NSF to establish a Network for Sustainable Climate Risk Management (SCRiM, scrimhub.org) or the NOAA supported Regional Integrated Sciences & Assessments (RISA) program MARISA: Mid-Atlantic Regional Integrated Sciences and Assessments (ii) helping provide and support new open source tools (e.g., to assess long-term flood risks), (iii) community building (e.g., through co-supporting a seminar series and small workshops), and (iv) outreach (e.g., a professionally designed and maintained webpage). CLIMA has enabled a considerable growth of the resource base as well as the international recognition of climate risk management at Penn State. Here we request continued administrative and financial support of $15k/yr to sustain and further expand CLIMA's scale. These funds are leveraged by existing research grants in the tens of millions, as well as funds from the Environment and Natural Resources Institute.

CLIMA-supported research, education, and outreach will continue to increase Penn State's ability to compete for new external grants in the rapidly growing field of climate risk management. CLIMA also addresses a question of increasing importance to the University's Sustainability Institute (as well as federal and industry funding programs), the University's strategic plan, and provides a tool for recruiting top-quality students and faculty. CLIMA supported research has also started to help with development activities in the College of EMS and beyond.

List of current CLIMA Associates, their Departments, and Colleges

(Co-) Directors in bold font, see http://www.clima.psu.edu/people.html for details

David Abler	Agricultural Economics, Sociology and Education, Agricultural Sciences
Richard Alley	Geosciences, Earth and Mineral Sciences
Saurabh Bansal	Supply Chain and Information Systems, Business
Seth Blumsack	Energy and Mineral Engineering, Earth and Mineral Sciences
Jamison Colburn	Penn State Law
Kenneth Davis	Meteorology, Earth and Mineral Sciences
Richard Duschl	Curriculum and Instruction, College of Education
Jenni Evans	Meteorology, Earth and Mineral Sciences
Darryl Farber	Science, Technology, and Society, Engineering and Liberal Arts
Karen Fisher-Vanden	Agricultural Economics, Sociology and Education, Agricultural Sciences
Chris Forest	Meteorology, Earth and Mineral Sciences
Murali Haran	Statistics, Science
Lara Fowler	Penn State Law & PSIEE
Armen Kemanian	Plant Science, Agricultural Sciences
Klaus Keller	Geosciences, Earth and Mineral Sciences
Andrew Kleit	Energy and Mineral Engineering, Earth and Mineral Sciences
Michael Mann	Meteorology, Earth and Mineral Sciences
Robert Nicholas	Earth and Environmental Systems Institute, Earth and Mineral Sciences
David Pollard	Earth and Environmental Systems Institute, Earth and Mineral Sciences
Mark Roberts	Economics, Liberal Arts
Tess Russo	Geosciences, Earth and Mineral Sciences
James Shortle	Agricultural Economics, Sociology and Education, Agricultural Sciences
Janet Swim	Psychology, Liberal Arts
Erica Smithwick	Geography, Earth and Mineral Sciences
Nancy Tuana	Philosophy, Liberal Arts
Mort Webster	Energy and Mineral Engineering, Earth and Mineral Sciences
Katherine Zipp	Agricultural Economics, Sociology, and Education, Agricultural Sciences

The Challenge

Unmanaged anthropogenic climate change poses serious risks. One vital question is how to manage these climate risks with approaches that are scientifically sound, economically viable, socially accepted, and ethically defensible. Funding agencies increasingly recognize the importance of mission-oriented basic science to inform this question. Recognition of the need for interdisciplinary research in this area translates into new and expanding funding availability, combined with an increase in the complexity and interdisciplinary nature of the research. Consider, as examples, the recent increase in publications (as well as private and public funding) in areas such as (i) adaptation to sea-level rise or drought, (ii) climate mitigation through carbon sequestration, or (iii) geoengineering. Analyses of these issues that neglect the interdisciplinary interactions (e.g., between scientific uncertainty, public understanding and response, as well as the economic and ethical implications) necessarily miss key aspects of the problem. Strong institutional support for interdisciplinary research is one compelling competitive advantage of Penn State. In addition, Penn State has the critical mass of researchers with the expertise to analyze and support climate change decision-making.

What does CLIMA do?

(i) CLIMA promotes transdisciplinary and inter-college interactions in a cutting-edge field by linking researchers across colleges within Penn State and by enabling Penn State to take a leading role worldwide in the critical emerging field of climate risk management.

(ii) CLIMA catalyzes new research collaborations through a co-sponsored seminar series as well as developing and supporting access to crucial research tools.

(iii) CLIMA secures new funding as well as sustains and leverages existing funding for interdisciplinary and multi-PI projects by supporting grant writing, providing tools, and supporting exploratory research that produces preliminary results that considerably improve grant proposals.

What has CLIMA achieved in the last three years?

In the last three years, CLIMA has primarily focused on **growing and sustaining external research support**. Examples of key successes in this area include:

- Catalyzing the successful establishment of the Network for Sustainable CLimate Risk Management (SCRiM, PI Keller). SCRiM is a NSF cooperative agreement that is centered at Penn State and linking 18 universities and five research institutions in six nations. SCRiM is funded at $11.9 million over five years.

- Supporting the proposal and establishment of a new NOAA RISA project: "Mid-Atlantic Consortium for Climate Assessment and Decision Support (MARISA) (lead PIs jointly Knopman at RAND and Keller at Penn State with an overall budget of $3.6 million over five years. MARISA provides strong linkages to decision makers in the Mid Atlantic region as well as considerable leverage opportunities.
- Supporting a successful NSF proposal and now project on "VIsualizing Forest Futures (VIFF)" (PI Smithwick) that combines many tools and methods developed with CLIMA co-support. VIFF is funded at $1.7 million over five years.
- Research groups at PSU, the U.S., and beyond are adapting and leveraging tools developed with CLIMA co-support. One key example includes simple coupled models of the carbon cycle, temperature changes, and flooding risks that have been ported to new software platforms and are now being integrated into many cutting-edge integrated assessment models of climate change.

CLIMA **supports capacity-building on campus** by co-sponsoring (with SCRiM and other projects) a seminar series to bring people together and catalyze new collaboration. CLIMA is also leveraging other funds by co-sponsoring speakers with topics relevant to climate risk management.

CLIMA researchers are part of efforts to **develop educational programs and resources**. For example, CLIMA resources are co-supporting the development of a summer scholars program and a summer school that are internationally advertised. Ongoing research is developing teaching materials for K-12 students.

In addition to invited talks, web resources, and contributions to the IPCC, etc., CLIMA researchers **contribute to outreach** through focused on interactions with decision makers and stakeholders facing challenging climate change adaptation problems. Key examples include:

i. Collaborations with WPSU to produce a television documentary on climate risk management with panel discussions and interviews.
ii. Collaboration with decision makers on coastal flood risk management (funded, for example, by NOAA and NSF).

What are funding opportunities?

There is a substantial and quickly growing support for mission-oriented basic science relevant to climate risk management (see, for example, the summary of just a subset of CLIMA related grants detailed above). Research and education in the area of climate risk management is supported, for example, by NSF, NASA, DOE, and NOAA, foundations and industry. The

proposed activities will increase the competitiveness for these funding opportunities. Specific examples of existing funding opportunities that CLIMA will continue to pursue include:

(1) NSF: Decision, Risk and Management Sciences,

(2) NSF, Dynamics of Coupled Natural and Human Systems (CNH),

(3) NSF, Innovations at the Nexus of Food, Energy and Water Systems (INFEWS),

(4) NSF: Science, Engineering and Education for Sustainability, and

Perhaps more importantly, CLIMA has and will continue improve the competitiveness of Penn State to secure larger-scale research grants.

Relationship to university-wide initiatives

CLIMA provides key building blocks for several university wide initiatives as well as support for a network that links these building blocks. For example, the Rock Ethics Institute has been leading an interdisciplinary hiring initiative to attract scholars that integrate ethics into research, education, and outreach at Penn State. Climate change and climate risk managements are key themes in this search. As a second example, consider the CLIMA-supported work in the areas of integrated assessment modeling and risk analysis that provides infrastructure that can be used by faculty across campus to evaluate the impact of new energy systems on climate risk.

CLIMA is a key foundation for many externally funded research, education, and outreach activities. CLIMA provides a stable base that catalyzes synergies between these externally funded activities, supports proposal writing, provide a long-term name recognition, and keep key parts of the network alive during the often necessary transitions between larger grants.

Where do we go from here?

Research on climate risk management has gained considerable momentum at Penn State over the last few years. The strategic investments through CLIMA have enabled much of the community as well as the tool building that was crucial factors in this success. We plan to continue on this path by:

(i) Sustaining existing and pursuing new larger and more complex research grants,
(ii) expanding to more fully integrate ethical analysis of climate change adaptation and geoengineering strategies, and
(iii) expanding the analysis of climate change adaptation strategies.

Management Structure

An executive committee of three (Forest, Keller, and Tuana) handles the day-to-day

management tasks. This committee meets typically biweekly (coordinated with project meetings). Decisions are made by a majority vote. Main strategic questions are be coordinated by email (and if need be in person) with the co-directors.

Center Needs / Budget

We have already secured additional leverage from the Environment and Natural Resources Institute ($2k/year). Here we request EESI funds of $15k/year. These funds are designed to support the preparation of new proposals.

Budget summary over the last three years

CLIMA received PSU funds of **$97,930.23** total over the last three years. Most of these funds have supported, thus far, computer equipment (36%), programming/administrative support (25%), postdocs/research associates (14%), travel (10%), and various seminars/workshops (6%).

Appendixes

(1) Short CV of the current center director

(2) Letter of Support from Jim Shortle, Director of the Environment and Natural Resources Institute

(3) Letter of Support from Erica Smithwick, Director of the Center for Landscape Dynamics

(4) Letter of Support from Nancy Tuana

(5) Letter of Support from Chris Forest

Klaus Keller

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EDUCATION

Technische Universität Berlin: B.S. (Vordiplom) in Environmental Engineering, 1991.
Massachusetts Institute of Technology: M.S. in Civil and Environmental Engineering, 1994.
Technische Universität Berlin: Engineer's Degree in Environmental Engineering, 1995.
Princeton University: M.A. in Civil Engineering and Operations Research, 1998.
Princeton University: Ph.D. in Civil and Environmental Engineering, 2000.

APPOINTMENTS

Penn State, Professor of Geosciences, July 2015 – present.
Carnegie Mellon, Adjunct Professor (full) of Engineering and Public Policy, March 2014 – present.
Penn State, Director of the Center for Climate Risk Management, July 2008 – present.
Macquarie University, Visiting Professor, July 2009 – December 2009.
Penn State, Associate Professor of Geosciences, July 2008 –June 2015.
Penn State, Assistant Professor of Geosciences, January 2002 – June 2008.
Princeton, Research Scientist, July 2001 – December 2001.
Princeton, Lecturer, spring term, 2001.
Princeton, Postdoctoral Research Associate, July 2000 - July 2001.
Gesellschaft für Umwelttechnik, Berlin, Engineer, 1995.

SELECTED PUBLICATIONS (89 PEER REVIEWED, GOOGLE H-INDEX = 30, HTTP://GOO.GL/EFKUKX)

Quinn, J. D., P. M. Reed, and K. Keller: Direct Policy Search for Robust Multi-Objective Management of Deeply Uncertain Socio-Ecological Tipping Points. Journal of Environmental Modelling and Software 92, 125–141, http://dx.doi.org/10.1016/j.envsoft.2017.02.017 (2017).

Ruckert, K. L., P. C. Oddo, and K. Keller: Accounting for sea-level rise uncertainty increases flood risk area: An example from San Francisco Bay. PLoSONE 12(3): e0174666. https://doi.org/10.1371/journal.pone.0174666, (2017).

Bessette, D. L. Mayer, B. Cwik, M. Vezer, K. Keller, R. Lempert, and N. Tuana: Building a Values-informed Mental Model for New Orleans Climate Risk Management. Risk Analysis http://onlinelibrary.wiley.com/doi/10.1111/risa.12743/full (2017).

Baldwin, D., S. Manfreda, K. Keller, and E.A.H. Smithwick: Predicting root zone soil moisture with soil properties and satellite near-surface moisture data across the conterminous United States. Journal of Hydrology http://dx.doi.org/10.1016/j.jhydrol.2017.01.020 (2017).

Ruckert, K., G. Shaffer, D. Pollard, T. E. Wong, C. E. Forest, and K. Keller: Assessing the impact of retreat mechanisms in a simple Antarctic ice sheet model using Bayesian calibration. PLOS ONE. http://dx.doi.org/10.1371/journal.pone.0170052 (2017).

Mayer, L. A., K. Loa, B. Cwik, N. Tuana, K. Keller, C. Gonnerman, A. M. Parker, and R. Lempert: Understanding Scientists' Computational Modeling Decisions about Climate Risk Management Strategies using Values-Informed Mental Models. Global Environmental Change, 42, 107-116, http://www.sciencedirect.com/science/article/pii/S0959378016306197 (2017).

Bakker, A., D. Louchard, and K. Keller: Deep uncertainties surrounding sea-level projections: Sources and Implications. *Climatic Change, Climatic Change, https://link.springer.com/article/10.1007/s10584-016-1864-1* (2016).

Diaz, D., and K. Keller: A Potential Disintegration of the West Antarctic Ice Sheet: Implications for Economic Analyses of Climate Policy. *American Economic Review*, 106(5): 607-11.DOI: 10.1257/aer.p20161103 (2016).

Garner, G., P. Reed, and K. Keller: Climate risk management requires explicit representation of societal trade-offs. *Climatic Change Letters,* doi:10.1007/s10584-016-1607-3 (2016).

Budescu, D. V., S. Broomell, R. J. Lempert, and K. Keller: Aided and unaided decisions with imprecise probabilities in the domain of losses. *European Journal of Decision Processes*, DOI 10.1007/s40070-013-0023-4 (2014).

Clarke, L., et al. (contributing author K. Keller): Assessing transformation pathways. Chapter six in the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, Working group III: Mitigation of Climate Change. Cambridge University Press (2014).

Hall, J., R. J. Lempert, K. Keller, A. Hackbarth, C. Mijere, and D. J. McInerney: Robust climate policies under uncertainty: A comparison of Robust Decision-Making and Info-Gap methods, *Risk Analysis*, 32, 1657-1672 (2012).

Goes, M, N. Tuana, and K. Keller: The economics (or lack thereof) of aerosol geoengineering, *Climatic Change*, DOI 10.1007/s10584-010-9961-z, (2011).

Olson, R., R. Sriver, M. Goes, N. M. Urban, H. D. Matthews, M. Haran and K. Keller: A climate sensitivity estimate using Bayesian fusion of instrumental observations and an Earth System model, *Journal of Geophysical Research, Atmosphere* 117, D04103, doi:10.1029/2011JD016620 (2012).

Irvine, P., Sriver, R. and Keller, K.: Tension between the objectives to reduce sea-level rise and rates of temperature change through solar radiation management, *Nature Climate Change*, 2, 97–100, (2012).

Keller, K., B. M. Bolker, and D. F. Bradford: Uncertain climate thresholds and economic optimal growth. *Journal of Environmental Economics and Management*, 48, 723-741 (2004).

SELECTED SYNERGISTIC ACTIVITIES

Director of the Sustainable Climate Risk Management Research Network.

Director of the Penn State Center for Climate Risk Management

Co-lead Principal Investigator for the Mid-Atlantic Regional Integrated Sciences and Assessments (MARISA) program

Editorial board of Climatic Change Letters and Earth System Dynamics.

Active outreach to K-12, decision makers, and the general public. My research was covered, for example, by Science, Nature, and Central Daily Times, by movies shown by the Discovery Channel and WPSX, and as contributing author for the last two IPCC reports.

PennState
College of Agricultural Sciences

Environment and Natural Resources Institute

The Pennsylvania State University
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April 13, 2017

Dear Klaus: This note is to express my continuing support for CLIMA, and to enthusiastically endorse your request for renewal of the center.

My primary hope in the development of CLIMA was that it would serve to build and energize an excellent group of researchers working on climate risks management. It has certainly done this and done it well. An outgrowth of that successful community building is the tremendous success that CLIMA has had in catalyzing funded research and publishing on high priority topics. CLIMA has been putting Penn State on the climate adaptation and policy map in ways that were not being realized before.

I applaud your efforts and continue to see CLIMA as an excellent investment for EMS and Penn State.

I am happy to commit ENRI support for CLIMA of $2000.00 annually for the next 3 years.

Cheers,
Jim

James S. Shortle
Distinguished Professor of Agricultural and Environmental Economics
Director, Environment and Natural Resources Institute

PennState

Department of Geography
College of Earth and Mineral Sciences
The Pennsylvania State University
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April 16, 2017

Dear Klaus,

I am writing as the director of the EESI Center for Landscape Dynamics (CLD) and a researcher in Earth and Mineral Sciences to offer my enthusiasm and strong support for renewing the Center for Climate Risk Management (CLIMA) as one of the research centers in the Earth and Environmental Systems Institute here at Penn State.

CLIMA offers several important contributions to the climate change research community here at Penn State and continues to grow this critical interdisciplinary research agenda. Though relatively new to the center, I have come to appreciate the significant energy and focus that characterizes the center. Klaus and I have successfully been rewarded a large external grant on climate change adaptation (NSF-CNH), which I see as an example of the interdisciplinary synergies between CLIMA and CLD. We continue to discuss ways to relate our center activities and collaborate on the themes of climate change, climate data management, and related management opportunities. Having CLIMA makes CLD stronger and builds capacity for EESI and the university (and vice versa). CLIMA also promotes visibility for EESI in the area of interdisciplinary global change science, thereby furthering EESI's strategic mission.

I am excited to be a part of CLIMA. As we continue to increase the presence of these research projects on campus, CLIMA will be central to these efforts. I strongly urge support of the center.

Sincerely,

Erica A.H. Smithwick

Erica A.H. Smithwick
Director, Center for Landscape Dynamics
Associate Professor of Geography, College of Earth and Mineral Sciences

PENNSTATE

Nancy Tuana, DuPont Class of 1949 Professor
of Philosophy and Women's Studies

College of the Liberal Arts
Department of Philosophy

The Pennsylvania State University
State College, PA 16803
(814)-865-1653

April 14, 2017

Dear Klaus,

I am writing to offer my enthusiastic and strong support for renewing the Center for Climate Risk Management (CLIMA) as one of the research centers in the Earth and Environmental Systems Institute here at Penn State University.

CLIMA is unique in linking the natural and social sciences with the humanities through its commitment to studying the ethical dimensions of climate risk management. The opportunity for ethicists to work alongside climate modelers and to be involved in decision support activities has contributed to cutting edge research in the sciences as well as the humanities and has raised the prestige of climate change research at Penn State in general. It has become a model of a richly interdisciplinary research agenda that has garnered national and international attention. I have benefited significantly from my association with CLIMA and I am excited to be a part of the co-director team to help guide CLIMA on its mission. As we continue to increase the presence of these research projects on campus, CLIMA will be central to these efforts.

Sincerely,

Nancy Tuana

Nancy Tuana
Dupont/Class of 1949 Professor of Philosophy
and Women's Studies

April 14, 2014

Dear Klaus,

I am writing to offer my enthusiasm and strong support for renewing the Center for Climate Risk Management (CLIMA) as one of the research centers in the Earth and Environmental Systems Institute here at Penn State University.

CLIMA offers several important contributions to the climate change research community here at Penn State and continues to grow this critical interdisciplinary research agenda. I have benefited significantly from my association with CLIMA because CLIMA has helped facilitate collaborations and coordinated research within the university and with external colleagues. This past year, with my visits to national labs and other universities, I am reminded that fostering a strong research environment requires more than just enthusiasm, it takes flexible resources to respond quickly to important requests. CLIMA has been very helpful in this regard with helping get outside researchers connected online at Penn State.

I am excited to be a part of the co-director team to help guide CLIMA on its mission. As we continue to increase the presence of these research projects on campus, CLIMA will be central to these efforts.

Sincerely,

Chris E. Forest

Department of Meteorology and Atmospheric Sciences
Department of Geosciences
EESI Associate