Environmental Change, Sustainability and Justice

April 9, 2019

Prepared for distribution to the UC Berkeley Campus Community

Executive Summary

Global environmental change is the defining challenge of our age. The pace of this change is accelerating faster than our efforts to address it, and the change is already impacting communities around the world. There has never been a greater sense of urgency than now. Moreover, because impacts of rising global temperatures, drought, environmental degradation, and loss of biodiversity will fall disproportionately on traditionally disadvantaged communities, these environmental challenges have essential implications for social justice. In the following report, we outline a multi-themed plan of action for achieving equitable impact over a 5-10 year timeframe.

Berkeley has all the elements needed to establish itself as the intellectual and academic leader in solution-oriented research and education to address this global challenge. In this signature initiative, we develop three cross-cutting themes that will unlock the potential of Berkeley through cross-disciplinary integration and the investment of new resources that target specific focused themes. These themes will: advance our ability to project the details of future conditions and understand change (Theme 1); move us towards de-carbonizing our energy and transportation sectors (Theme 2); and inform on-the-ground adaptation planning that ensures sustainable and just solutions in anticipation of future conditions (Theme 3). Each of these three themes integrates disciplines from across the Berkeley campus to ensure that connections are established between Climate and Ecosystem Sciences, Engineering, the Social Sciences, Professional Schools, and the Arts and Humanities.

All three themes build on the broad disciplinary strengths that are a hallmark of UC Berkeley. Taken together, this initiative spans the broad areas of understanding and projecting environmental change, mitigating long-term climate change, and adapting to long-term environmental change, all while considering issues of sustainability and environmental justice. The three specific themes presented here provide focus to ensure maximum impact from the activities that lie within them.

Although the themes are presented independently in the sections that follow, there are a number of shared features and synergies between them. For example, research to improve the ability to understand and predict local conditions under scenarios of global change (Theme 1) will inform community-based

planning and policy that is anticipating those changes (Theme 3). Other synergies lie in the academic structures we propose to develop in order to unlock Berkeley's interdisciplinary potential. For example, the Climate Policy Lab (Theme 2) and the Adaptation Hub (Theme 3) both make use of a combination of graduate student fellowships, faculty fellow programs, and collaborative space to bring together researchers from disparate academic communities to focus deeply on particular environmental challenges that integrate across their disciplines. The working group would encourage campus to consider these synergies as we pursue the three themes, as new structures and approaches that better integrate across Berkeley's diverse strengths may emerge.

Contents:

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1. Earth's Future: Advancing Climate Science for Action

The global environmental-ecological-human system sustains all life on Earth and is made up of a vast array of interconnected components that both regulate and respond to climate and ecosystem function. Developing projections for the future of the planet is a challenge that requires new approaches, insights and breakthroughs across the sciences.

With better understanding of the trajectory of the global system, and the local manifestations of global change, society will be better able to manage, adapt and plan for the coming century. Examples of these opportunities include wildlife conservation and restoration that anticipates shifts in ranges and function of species, forest management that addresses simultaneous goals of ecosystem support, carbon sequestration and wildfire mitigation, and water resource planning that anticipates shifts in precipitation distributions and severity of storms. Each of these examples relies on better quantitative descriptions and improved scientific understanding and modeling of global change, including the downscaling of future trajectories to understand local conditions in detail.

This theme will leverage existing strengths at Berkeley and LBNL to advance our ability to detect and characterize change, develop projections of future environmental conditions, and translate that impact to action and impact. The core of the effort lies in two complementary structures, one that involves focused teams to engage deeply with key challenges in our understanding of climate and environmental change, and one that centers on the creation of a data commons to improve our ability to identify and characterize that change.

The first of these structures will be the creation of ***"Climate Tiger Teams"***, each of which will be formed for a period of 5 years to tackle grand challenges in climate or environmental science and modeling that connect to specific applications and decisions. The Tiger Teams will follow in the spirit they were originally envisioned during the space race, where they were described as "a team of undomesticated and uninhibited technical specialists, selected for their experience, energy, and imagination, and assigned to track down relentlessly every possible source of failure in a spacecraft subsystem". Here we take that concept and apply it to scientific and modeling challenges that limit our ability to plan and adapt to environmental change. The challenges to be addressed by the Tiger Teams will be evaluated and prioritized through active engagement of a scientific advisory board that will include scientific leaders, practitioners, decision-makers and other external stakeholders. This engagement with practice and decision-making is a part of the on-going investment as part of this theme that is described below. Including diverse perspectives on this advisory board is critical as it considers which challenges balance

the need for significant impact and likelihood of success; in the following paragraphs we provide two examples of the types of challenges that may be a priority.

- Fresh water is one of the most basic human needs. Patterns of rain and snow are essential to the economy of California and in some but not all analyses they are predicted to be changing faster than we can adapt our infrastructure, motivating a need for improved understanding of rain and snow at spatial scales of our state and time scales of 1-50 years. Currently, weather models predict rainfall with high accuracy out to 10 days and at 10 km resolution; climate models, on the other hand, focus on long-timescale projections of rainfall statistics, with spatial scales of 500-1000 km, and do not resolve events that shape water resource decision-making. A key barrier to bridging these timescales and spatial scales lies in the resolution of clouds and other environmental features that are smaller scale than climate models can resolve. Emerging efforts in resolving these scales involve embedding a cloud-resolving model into global circulation models, although this has not yet been operationalized for climate projections. As these approaches become more widely implemented, natural scientists and modelers will need to critically evaluate the success of the approach in the context of both historical data and future informational needs. This project will focus on reimagining the links between clouds, weather and climate and finding new paths forward that build directly on the behavior of clouds at their natural length scales and ensure accurate integration into regional weather and climate models to provide the necessary accuracy for California water resource development.

- Forests play a critical role in California, and globally, as harbors of biodiversity, dynamic elements of the global water cycle, and engines of carbon sequestration and storage. In semi-arid and Mediterranean-type climates, forests also serve as the fuel for wildfires which play critical ecological roles while also causing tragic destruction of our communities and worsening air pollution. In a changing climate, fire and drought- induced tree mortality release stored carbon and undermine ecosystem services, while in the long-term shifts in species distributions are key to maintaining ecological function. Coupling dynamic ecosystem models with climate models, experimental forest science and data-driven biodiversity analyses is critical to understand these multi-faceted effects and their implications for climate feedbacks and nature's benefits to society. The Berkeley campus and LBNL together have an outstanding comparative advantage in this area and the opportunity to advance the scientific understanding of the issue, with benefits to California and other regions of the globe as we face an ever-warming climate and associated threats to landscapes, species, economies and human livelihood.

The second structure to be formed as part of this theme will accelerate the convergence of data resources and data science on the Berkeley campus through the creation of the ***Environmental Change Data Commons (ECDC) at Berkeley***. Berkeley's leadership in the Data Sciences is unparalleled, and creates an opportunity to leverage the vast data sets, observational capabilities, and knowledge that already exist at Berkeley to describe and characterize environmental and climate change. This effort will build on the existing resources of the Berkeley Natural History Museums, Natural Reserves, and Field Stations, as well as specific structures like the HOLOS Ecoinformatics Engine, an informatics tool that organizes, integrates and visualizes biodiversity data and is a part of Berkeley Global Change Biology (BiGCB), which was formed with a goal of "mobiliz[ing] historic and modern biological data to understand how organisms and ecological systems have responded to past global change events". These vast resources in environmental change data will be supplemented with new observational data, including remote sensing of climatic conditions, and synthetic data from large-scale simulations at both UC Berkeley and LBNL. The massive and hybrid data resources that will make up ECDC would become a reservoir that would facilitate data-based inquiry and analysis of global change. ECDC would serve as a data hub for environmental, climate and ecosystem scientists and would also develop tools and techniques for data organization, analysis and visualization to ensure maximum availability and impact of the data.

In order to maintain a strong focus on decision-making and community needs, the Tiger Teams and the data analysis efforts within ECDC must be complemented by external engagement. To ensure that the technical work carried out under this theme creates maximum impact on policy and social decision-making, we will build capacity for co-development of the research efforts with affected communities and, more broadly, an emphasis on translation to practice. A structure to facilitate these connections would emerge through the creation of the ***Berkeley Environmental and Climate Change Service*** (***BECCS***), which would be modeled on the UC Cooperative Extension Service, and would provide a two-way linkage between the technical efforts (in Tiger Teams and ECDC) and state and regional decision-makers in order to identify and then solve the highest-impact challenges to our understanding of long-term change. Further, ***BECCS*** would provide feedback to the Tiger Teams and ECDC regarding the needs of decision-makers, and would provide input into the prioritization of topics for the Tiger Teams to address. These external facing efforts would also require the active engagement of external partners with political scientists, social scientists and data scientists from across the Berkeley campus before (to prioritize efforts), during (to identify appropriate solutions and continue to prioritize research efforts) and after (to ensure follow through and maintain relationships) the focused activity of each Tiger Team.

The implementation of this theme on the Berkeley campus would require the following components:

Faculty Expertise and Engagement: Berkeley and LBNL have extensive expertise in climate, environmental and ecosystem modeling (e.g., the Berkeley Atmospheric Science Center and the Climate and Ecosystem Sciences Division at LBNL). Similarly, for problems that involve changes in land use or

population trends, Berkeley's strength in the social sciences will provide a strong foundation for the Tiger Team to build on. In order to leverage this expertise, and to ensure the maximum impact of the Tiger Teams, we propose that a new Faculty Fellows program should be created. Similar to the Miller Fellows program, this Faculty Fellows program would provide Berkeley faculty with relief from teaching and administrative duties so that they can focus entirely on the Tiger Team activities. Additionally, we suggest that this Fellows program also be available to visiting researchers, which would allow Berkeley-LBNL Tiger Teams to bring in specific experts to contribute to the Team's activities. Finally, the Berkeley Climate Adaptation Service will require staff and faculty focused on translation to practice.

Fellowships: Tiger Teams would be expected to involve graduate students as part of their research team, and research fellowships should be provided for these students. The specific format of the Tiger Team will be developed through a proposal process, but we would expect 5-10 students participating in any one Tiger Team. The fellowships should be for the duration of the Tiger Team's activities (expected to be about 5 years) so that graduate students experience the entire research cycle.

Facilities and Infrastructure: Limited collaborative space would need to be made available for Tiger Team activities, and offices for graduate students and visiting scholars should be provided.

Programs, Curriculum, and Undergraduate Experience: A Tiger Team proposal will be expected to engage undergraduates in a Team's research activities. These activities would serve as discovery experiences for these students. Additionally, the Environmental Change Data Commons (ECDC) at Berkeley would have strong ties to the new Data Science Division, and may provide valuable datasets for data science connector courses.

Additional Investments: Translation to practice, and informing policy, is a key aspect of this theme, and provides the focus and motivation of the Tiger Teams' activities. The connection to practice will be accomplished through two structures: the Berkeley Climate Adaptation Service, which will require investment in personnel, and the Environmental Resilience Accelerator, which will require resources to amplify and apply the results of the Tiger Teams' work.

2. Accelerating the Clean Energy Transition

The use of fossil fuels to generate electricity and fuel transportation is having profoundly harmful effects on the global environment. Progress on mitigating these impacts is being made. But the urgency of climate change demands that we pick up the pace.

Dramatic advances in renewable energy, energy efficiency, and energy storage technologies make it possible to envision a complete de-carbonization of the energy and transportation sectors. However, formidable barriers stand between low or zero-carbon technologies and their full implementation. Market failures and regulatory frictions slow the current transition to cleaner electricity generation sources. Progress towards more sustainable transportation alternatives is significantly limited by existing urban

infrastructure and behavioral factors. Widespread adoption of promising energy efficient technologies can be hamstrung by energy prices that do not reflect the full social cost.

Fundamental science and technological advancement are essential inputs to the clean energy transition. Science and engineering research in this area will leverage some core strengths of the UC Berkeley campus and the Lawrence Berkeley National Lab. But ultimately, it is the behavior of human beings in creating, distributing, and using energy that causes climate change. Law, policy, and planning tools will be needed to coordinate rapid development and deployment of clean energy alternatives. And a conscious effort to engage a range of stakeholders is required to ensure that the energy transition is fair and equitable.

A more systemic approach to accelerating the clean energy transition sits at the intersection of a number of academic disciplines including engineering, chemistry, physics, material science, economics, law, public policy, urban planning, the humanities. UC Berkeley has internationally recognized strengths across all of these areas. With the right organizing principles and incentives, UC Berkeley is uniquely positioned to lead a transformative program to support a sustainable and just energy transition.

We envision two related initiatives that will galvanize and advance research, teaching, and public engagement in this area.

Energy Transition Partnerships

UC Berkeley is home to an outstanding group of intellectual leaders, academic units, and public facing initiatives working on various aspects of the clean energy transition. However, the current organization of research and teaching is not highly conducive to substantive collaborations across disciplinary boundaries. Institutional barriers notwithstanding, there are several examples of successful collaboration across disciplines. Our proposed approach to galvanizing impactful partnerships going forward builds on these successes.

Across campus, the most successful interdisciplinary partnerships have often focused on well-defined, first-order problems which require cooperation across disciplines to address. To keep collaborations manageable, these partnerships tend to be limited to the most essential disciplinary components. One example is the Blum Center's Development Impact Lab (DIL) which combines engineering and natural sciences with insights from economics and/or other social sciences to generate solutions to economic development challenges. This approach is now being used as a model for economic development initiatives at federal agencies such as US AID. Another is the collaboration between UC Berkeley climate scientists and climate change economists who are working to integrate and reconcile strands of evidence from these two disciplines in the context of the integrated assessment modeling. Berkeley has also had success with broader, long-term interdisciplinary engagement in the right academic settings, such as the Energy and Resources Group.

Building on these basic principles, Berkeley will launch a program to inform and accelerate the clean energy transition through strategic interdisciplinary partnerships that are designed to address critical implementation challenges. There are many examples of specific themes that require engagement across traditional disciplinary boundaries. Some examples include:

- *Renewable energy integration*: Large-scale grid operations and market design grew out of deep interdisciplinary collaborations between economists and engineers over the last three decades. Existing design and operating principles are largely based on conventional fossil-fuel and nuclear resources. A transition to higher levels of non-hydro renewable energy penetration will require fundamental changes in grid operating protocols and market design, along with a rethinking of the traditional roles of state and federal regulatory authorities. Higher levels of renewable energy utilization will also require progressively higher levels of energy storage in the form of pumped water, batteries, and hydrogen.
- *Energy use in emerging economies*: Future energy demand growth will happen primarily in emerging economies as an expanding middle class purchases appliances and vehicles to meet increasing demand for energy services. Improving the efficiency of energy consuming durables is at the heart of a global strategy to meet rising demand while mitigating environmental impact. To be successful, new technologies must be super-efficient, affordable, reliable, and well-matched to needs and preferences of new users. Moreover, in many developing countries, energy subsidies and distribution sector inefficiencies reduce demand for energy efficiency, a situation that will require thoughtful reform in order to accelerate needed demand-side energy efficiency improvements.
- *Reducing the energy intensity of materials processing and usage:* Humanity's unsustainable appetite for resource consumption and subsequent waste generation is a primary driver of climate change and other environmental impacts. We need to find ways to accomplish more while using fewer resources and find more sustainable ways to re-use, re-purpose, and if necessary dispose of the resources we do consume. Basic and applied scientific breakthroughs in material design, and synthesis can generate a new class of materials that self-assemble, self-heal, and self-decompose into non-toxic, recyclable components at end-of-life. Such discoveries are a must if we wish to extend the fruits of economic growth to all, while not irreversibly damaging our planet.
- *Electrification of the transportation system:* A decarbonization of the transportation system via a transition to electric vehicles will require major modifications of the grid in order to manage the vast increases in the amount of power, the use of vehicles as storage resources, the construction of charging infrastructure, and changes in power usage patterns. All of this will require technological advances in storage and grid management, institutional innovation to support market and regulatory infrastructures, and careful attention to negotiate the impending rise of self-driving vehicles. Additionally, life cycle analyses of different modes of transportation must be undertaken in order to understand the environmental impact of switching from fossil fuel-powered transportation to electrically powered transportation.

Energy Transition Partnerships would be organized around a small number (4-5) themes, each of which focus on a specific, well-defined problem or challenge that can be meaningfully addressed through an interdisciplinary partnership. Project selection would be led by a small group of co-directors representing core disciplines across UC Berkeley and LBNL. Dedicated space for the project leaders and graduate students will help bridge disciplinary divides, facilitate co-mentoring, and support the unplanned interactions that fuel effective partnerships.

Climate Policy Innovation

In many respects, the barriers that stand in the way of a clean and fair energy transition are more rooted in policy, economics, and behavior versus science, engineering, and technology. What suite of policies should be used to mobilize the needed innovation, investments and behavioral changes? How should concerns about cost effectiveness be balanced against concerns about equity and durability? What analytical tools and metrics should be used to chart our progress? How can the political and legal landscapes be steered in ways that can facilitate development of more ambitious de-carbonization policies? In a world where only a subset of sources is subject to emissions regulations, how should policies be designed to limit the "leakage" of economic activity to unregulated jurisdictions? How can policies be implemented in a way that compensates those who bear disproportionate costs?

Uncovering workable answers to these questions requires creative problem-solving and real-world policy experimentation. The state of California is one of the most dynamic climate policy laboratories in the world, experimenting with policies that have the potential to be transformative. UC Berkeley has a long history of informing and engaging with this policy process.

- Fundamental scientific research on energy use in buildings has shaped the way researchers and policymakers have designed and implemented transformative energy efficiency standards.
- Energy economists have bridged gaps between the frontiers of economic research and real-world policy applications such as California's GHG emissions trading program and low-income energy assistance.
- The UC Berkeley Environmental Law Clinic is working with California community-based organizations to prioritize the interests of vulnerable and disadvantaged communities as the state transitions away from fossil fuels.
- Faculty in the Energy and Resources Group have played a pivotal role in developing crucial tools for economic analysis of federal climate policies.
- The law school's Center for Law, Energy, and the Environment has worked intensively with the clean tech sector, California government, and other stakeholders to bridge to address issues ranging from distributed energy and electric vehicle deployment to legal barriers to renewable generation and transmission siting.
- The Goldman School's Center for Environmental Public Policy worked closely with a range of stakeholders to identify strategies to achieve California's GHG reduction goals while ensuring that environmental justice is being served.
- ESPM faculty have been working for over a decade with local communities to develop simple, flexible, and transparent metrics to track cumulative impacts and social vulnerability within California for use in citing, zoning, and environmental policy implementation.

Through these and other initiatives, UC Berkeley is widely recognized as a leader in energy and environmental policy scholarship and analysis. However, the current organization of research and teaching lacks a single integrative entity to coordinate disciplinary work in this area. Interaction between units working on different aspects of the same policy problem is surprisingly limited. Binding constraints on faculty time and resources limits the extent to which this community can engage with the first-order

climate change policy challenges we face. Moreover, Berkeley has not invested sufficiently in the translation of research insights to policy change.

We recommend that the University establish a **Climate Policy Innovation Lab** as an intellectual hub of energy and environmental policy scholarship and engagement on campus. Semester-long programs would be organized around specific policy design and implementation challenges chosen to maximize impact and cross-cutting engagement. A visitors-in-residence program could bring policy makers and other stakeholders together with faculty and students. Faculty affiliates would apply to spend a semester "in-residence"; reduced teaching and service responsibilities during that time would create the opportunity to initiate collaborations with other resident faculty, develop curricula around the program topic, and public engagement activities. Workshops and student seminars convened during the semester program would engage the broader campus community. Dedicated staff would support public-facing work to engage with key stakeholders including implementing agencies, local communities, industry actors. This Lab could be particularly important in bridging the gap between the social science/policy communities on campus and the scientists and engineers addressing the energy transition.

The implementation of this theme on the Berkeley campus would require the following components:

Faculty Expertise and Engagement: The organizational structures and incentives we propose would leverage the tremendous faculty expertise we already have on campus and at LBNL. Resources dedicated to reducing teaching and administrative obligations will incentivize and support strategic collaborations and public engagement. Small grants would seed strategic partnerships and research agendas to leverage untapped campus strengths. Investments in attracting leading academic scholars, policy practitioners, or other innovators to spend time at Berkeley for a sabbatical period would bring further intellectual diversity to research and teaching in these areas.

These organizational structures should also play an important role in identifying areas where future faculty appointments could complement existing strengths, fill gaps in expertise, and strengthen partnerships across related but distinct units. We can leverage this effort by linking existing interdisciplinary efforts on campus such as the Energy Resources Group and the department of Environmental Science, Policy and Management, which are very strong units in their own right, but have had limited success in creating broader campus-wide networks for interdisciplinary work.

Graduate and professional student education: Endowments to provide 3 years of support for graduate students working on partnership projects will reduce the funding pressure on faculty and allow students and faculty to pursue impactful research projects that fall outside traditional disciplinary lines. Co-advising and frequent graduate student interactions across energy transition partnership projects would create a transformative model for research and mentoring in this area. Graduate support would include PhD programs that are joint degrees with professional schools like law, public policy, or business. Interdisciplinary courses could provide opportunities for graduate and professional students to work together on real-world projects. The Climate Policy Innovation Lab, in addition to supporting workshops and coordinated curriculum development, could invest in creating off-campus opportunities for students

to engage in policy-related community partnerships, public sector activities, and engagement with key industry actors.

Undergraduate experience: An undergraduate course (or courses) on the clean energy transition that integrate the basic science, engineering, public policy, law, behavioral sciences, economics. The Climate Policy Innovation Lab could complement program-specific curriculum with outreach programs that identify undergraduate internship opportunities in community organizations, public agencies, and the private sector.

Facilities: Dedicated physical space to host 4-6 ETP projects across disciplines/departments. Space should be sufficient to support faculty and graduate student offices, collaborative space and seminar rooms. The Climate Policy Innovation Lab would require sufficient space to host support staff, faculty-in-residence, graduate students, visiting scholars and policy actors in residence.

3. Answers for Adaptation: Sustainable and Just Solutions for the New Normal

In November 2018, an explosive wildfire devastated the community of Paradise, CA, killing 86 residents and destroying almost every structure. Smoke from the fire settled into the San Francisco Bay Area for more than 10 days, creating health problems for the vulnerable and disrupting the lives of millions more. This was the event that California fire experts had long feared - the winds through the Jarbo Gap are renown for their ferocity - and the community of Paradise was among the most fire-ready in the state. The event in November of 2018, however, was unprecedented: the fuel stock was drier than it had ever been, the wind event was of a higher intensity and longer duration than historical events, and the ignition occurred earlier in the morning than most emergency plans had allowed for. Together, and in spite of leading-edge preparation, the Camp Fire became one of the most tragic natural hazard events California has experienced.

During and following the event, UC Berkeley's diverse experts activated around the issue, including fire and forest ecologists, atmospheric scientists, environmental and mechanical engineers, public health experts, political and social scientists, legal scholars, and humanists. The energy that emerged has led to a series of efforts - large-scale research proposals, workshops, and public fora - to address the threat of wildfires at the urban-wildland edge and to help communities around the state become more resilient to the growing risk of this natural hazard. This example demonstrates the latent capabilities and energy that exist at UC Berkeley in the area of environmental change and its impact on communities; in this theme, we propose to bring them to the surface in the form of a new academic community focused on the issue.

Beyond any single event, long-term environmental change, which will impact the physical, social and ecological systems that sustain communities, will be punctuated by a range of extreme events, including floods, fires, heat waves and drought. These events are increasingly likely to push the systems that support communities beyond their limits, resulting in adaptation pressures at a range of scales, from local

communities to states, regions and nations. Adaptation decision-making is made at a similar range of scales, including local protective measures, regional disaster planning and state-wide or larger-scale investment in infrastructure systems.

At the same time, it is critical to highlight the fact that the communities that are most vulnerable to environmental change are also frequently the most vulnerable with regard to a range of other socio-economic factors. This limits the ability of many communities to invest in adaptation strategies, and has the potential to result in environmental change exacerbating existing inequities.

Finally, it has become increasingly evident that natural ecosystems must be a part of future adaptation strategies, even in the most urbanized communities. Recent work has documented the value of green space for health and well-being, the role that natural features can play in mitigating urban and rural flooding, and the overall benefits of parks and 'connecting spaces' for social network formation. Successful integration of natural ecosystems into urban communities requires careful consideration of the sustainability of those ecosystems, and the interactions between the natural and built environments.

This theme will integrate all of these elements to understand and inform the adaptation of communities to rapid environmental change. The pressure imposed on communities by environmental change may exacerbate inequities and places the sustainability of natural ecosystems at risk. We propose to address these risks through integrated research and academic activity that integrates Berkeley's strengths in Natural (physical and ecological) Sciences, Public Policy, Planning, Political and Social Sciences, Engineering, Design, Humanities, Finance, Law, and Public Health. Additionally, although the specific projects we outline below are focused on forward-looking projects to create impact, we also see a significant opportunity to place the current moment in the context of human and natural history through engagement of Humanists, Historians and our Natural History Museums. Examples of projects that would fit into this theme include:

- Designs for transforming our communities (e.g., buildings, streets, and open spaces) and strategies for the physical and social infrastructure systems that provide them with critical services (e.g., water, energy, emergency services, health care, mobility, recreation) to be resilient in the face of extreme environmental events, with an emphasis on climate-readiness, environmental sustainability, equity, and access.
- Defining the role, and sustainability, of natural ecosystems within resilient communities and the implications for community health and vitality.
- Making decisions about public infrastructure in a changing climate: co-development with vulnerable communities, controlling development in high-risk areas, regional financing, the role of insurance, policy, legal and social barriers, and justice-driven adoption.

- Fostering just and equitable transitions to new social and environmental realities in the wake of radical shifts in environmental conditions and associated socio-political impacts.

This theme makes particular use of the unique breadth of academic strengths that exist at Berkeley. No other institution can compete with Berkeley simultaneously across the Natural Sciences, Planning and Social Sciences, Design, Engineering, Arts, Humanities, Finance and Law, each of which are engaged with questions related to adaptation to rapid environmental change in a variety of ways. At the same time, adaptation is not necessarily central to any one of these units, but instead is a component of the activity sitting within each. The opportunity for Berkeley to establish itself as the world academic leader in adaptation relies on establishing connections between these existing efforts, which requires deep, foundational integration across disciplines that goes beyond the scale of individual research projects or collaborations.

In order to achieve this level of integration, this initiative would establish a new academic community to serve as the central link bringing together disciplines around the topic of human adaptation to rapid environmental change. The ***Adaptation Hub*** would create a community of scholars through funding of graduate student fellowships and rotating faculty fellows that span all of the relevant disciplines, but organized around themes in adaptation. The physical manifestation of the Adaptation Hub would be a dedicated physical space that houses offices for students and research fellows, collaborative space for active pursuit of interdisciplinary ideas, seminar and conference rooms, and studio space, all organized around the adaptation theme. Through this space, the Adaptation Hub would host seminars, studio courses, workshops, conferences and design laboratories that establish new interdisciplinary linkages and facilitate the connection between academic researchers and community members and representatives. The creation of a hub with the theme of adaptation allows Student and Faculty Fellows to pursue research on adaptation issues that emerge within their home disciplines (economics of infrastructure financing, e.g., or the sustainability of urban ecosystems), but then amplify their work through interdisciplinary engagement in the Hub, creating connections between siloed disciplines in the context of community adaptation.

This theme would also invest in connecting these academic pursuits to practice, making use of three structures. First, the ***Environmental Resilience Accelerator*** (***Era***) is an emerging alliance between UC Berkeley and LBNL that leverages the strengths of the two institutions with active engagement of partners from industry, government and non-profits to create actionable solutions with funding, connections and oversight. A specific goal of Era is to create a more agile and outward-facing responsiveness to societal and environmental needs through deliberate transcendence of disciplinary silos. Finally, the Adaptation Hub will have as a key focus the practice and pedagogy of climate adaptation, which will be achieved through a structure similar to the Berkeley Environmental and Climate Change Service (BECCS, Theme 1 above), perhaps even as a part of that structure. In the context of this theme, we would create the ***Berkeley Climate Adaptation Service*** (***BCAS***), which, like BECCS, would be

modeled on the century-old UC Cooperative Extension Service. ***BCAS*** would develop and provide knowledge and expert guidance to state and regional decision-makers to solve the toughest problems in adapting to long-term climate and environmental change. In each of these cases, the connections to external partners would be leveraged by the Adaptation Hub throughout the research process, and the partnerships would be used to both prioritize and shape research efforts to maximize impact on adaptation decision making.

The fundamental goal of this theme is to create a new academic community centered around adaptation, and associated issues of sustainability and justice, in the face of rapid environmental change. We recommend the following steps be taken to ensure its success:

Faculty Expertise: Faculty who could contribute to the Adaptation Hub are highly diffuse on campus; examples of strengths to be leveraged include ReNUWIt, an NSF-funded center focused on urban water infrastructure, and Y-PLAN, a center that engages high school students in solving practical problems facing their communities. Once the Adaptation Hub is established and an academic community begins to form, an evaluation of expertise gaps and needs should be pursued so that hiring priorities can be identified.

Fellowships: A critical component in the success of the Adaptation Hub is the engagement of graduate student researchers from diverse disciplines, connected by applications related to adaptation to rapid change. To facilitate this, we recommend the creation of 20 Adaptation Fellowships for Graduate Students. These fellowships would allow the students to pursue research in their disciplines, but would include an expectation of engagement with seminars and collaborative activities in the Adaptation Hub.

Facilities and Infrastructure: The success of the Adaptation Hub rests on establishing deep connections across disciplinary boundaries, which will require a dedicated physical space to house offices for researchers, collaborative space, seminar and conference rooms, and studio space, all organized around the adaptation theme.

Programs and Curriculum: The Adaptation Hub would host seminars, studio courses, workshops, conferences and design laboratories that establish new interdisciplinary linkages and facilitate the connection between academic researchers and practitioners. More broadly, this theme will establish a variety of new connections across disciplines, and new curricular elements will almost certainly emerge. It is hard to anticipate what form these programs will take, but the Adaptation Hub should be created with an Academic Director to encourage the creation of new programs that leverage the diverse strengths that will assemble themselves in the Hub.

Additional Investments: Translation to practice, and informing policy, is a key aspect of this theme, but must be integrated with the research on community-centric solutions. The Berkeley Climate Adaptation

Service, which will provide a key link to policy, requires investment in personnel. The other two mechanisms to ensure translation to practice are the Accelerators: the Environmental Resilience Accelerator, which will emphasize the technical research breakthroughs, and the Adaptation Accelerator, which will ensure linkages with communities and public agencies. Both of these will require investment in personnel and external partnerships to ensure success.