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City-Wide Collaborations for Urban Climate Education

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Although cities cover only 2 percent of the Earth's surface, more than 50 percent of the world's people live in urban environments, collectively consuming 75 percent of the Earth's resources. Because of their population densities, reliance on infrastructure, and role as centers of industry, cities will be greatly impacted by, and will play a large role in, the reduction or exacerbation of climate change. However, although urban dwellers are becoming more aware of the need to reduce their carbon usage and to implement adaptation strategies, education efforts on these strategies have not been comprehensive. To meet the needs of an informed and engaged urban population, a more systemic, multiplatform and coordinated approach is necessary.

The Climate and Urban Systems Partnership (CUSP) is designed to explore and address this challenge. Spanning four cities—Philadelphia, New York, Pittsburgh, and Washington, DC—the project is a partnership between the Franklin Institute, the Columbia University Center for Climate Systems Research, the University of Pittsburgh Learning Research and Development Center, Carnegie Museum of Natural History, New York Hall of Science, and the Marian Koshland Science Museum of the National Academy of Sciences. The partnership is developing a comprehensive, interdisciplinary network to educate urban residents about climate science and the urban impacts of climate change.

11.1. CITIES AND CLIMATE CHANGE

As urban centers continue to expand, the infrastructures on which these populations rely, including energy, water, transportation, and public health, face unique vulnerabilities to climate change. High population density, interdependent networks of infrastructure and resources, and roles as centers of industry heighten the importance of urban vulnerabilities. Furthermore cities, as centers of economic activity and dense populations, may be responsible for between 40 and 80 percent [*Satterthwaite*, 2008, references therein] of greenhouse gas emissions. Cities can simultaneously be paradigms for low-carbon living; for example, transportation sector emissions are low when population density is high, and urban planning and public transportation are robust. Cities can also be paradigms for transformative and integrated adaptation planning efforts that simultaneously improve quality of life. Responding to climate change in cities, through both adaptation and mitigation, can reduce and prevent future impacts locally and globally.

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Cities are likely to be greatly impacted by a changing climate. Higher temperatures and an increased frequency and intensity of extreme heat events, projected for most cities globally, are likely to increase heat-related illness and mortality [*Li et al*., 2013]. Those at greatest risk include the elderly, young children, and people with preexisting medical conditions [*ClimAID*, 2011]. A warmer climate also has the potential to impact the critical infrastructure of cities. More frequent high temperature days may cause buckling and deterioration of materials used in railway tracks and road surfaces, for example. With warmer temperatures, there will be an increased strain placed on energy systems as a result of increased demand from greater air conditioning use~~. Material breakdown and increased strain on the grid can both cause service disruptions in critical transportation and energy systems~~ [*New York City Panel on Climate Change (NPCC)*, 2010]. Heat-related climate impacts in cities are exacerbated by the urban heat island effect, a condition that results in urban centers and cities being several degrees warmer than their surrounding areas [*Blake et al*., 2011].

Cities are also particularly vulnerable to extreme, short duration rainfall events, which are projected to increase in the urban Northeast and many other regions in the future [*Horton et al*., 2011; *Intergovernmental Panel on Climate Change (IPCC)*, 2012]. The high percentage of impervious surface cover in urban areas causes less water to be absorbed at the surface, resulting in more runoff. The increased runoff leads to flooding of streets, sewers, underground transit tunnels, homes, and businesses. More frequent heavy rainfall may cause an increase in combined sewer overflows, which can pollute urban waterways [*Horton et al*., 2010]. Changing frequency and intensity of droughts locally and regionally also has the potential to impact the availability of water to cities.

Many of the world's largest cities are located in close proximity to the coast, making them extremely vulnerable to sea-level and coastal flooding. Coastal flooding will occur more frequently with sea-level rise alone, even without changes in storm frequency and intensity. The greatest impact from rising sea levels will be the potential for inundation of coastal areas surrounding urban centers. Similar to the effect of increased heavy rainfall, sea-level rise will cause flooding of streets, sewers, homes, and businesses. Many cities have transportation corridors that are along the coast, and these transportation systems often have underground tunnels that are vulnerable to sea-level rise. Saltwater can damage equipment at energy-generating facilities and wastewater treatment plants, which often are within the flood plain.

Finally, the characteristics of dense, urban environments further enhance the vulnerability of cities to the adverse effects of climate change. For example, the high population density of cities could amplify the spread of vector-borne disease, one potential impact of a warmer and wetter climate. In addition, cities often have large groups of residents who, based on socioeconomic factors, are poorly prepared to respond to a changing climate and plan for future impacts. The close interconnectivity of city systems also increases the risks. Failure of critical infrastructure in one system can have cascading effects on other systems (i.e., electricity outages stopping transit service.)

Given the potential impacts of global climate change on the systems on which urban populations rely and the potential for these populations to positively impact mitigation efforts, it is clear how important public engagement with these issues is for the successful development of adaptation and mitigation strategies. Sound understandings of the relevant climate science, tailored to the circumstances of particular cities and the concerns of specific communities, are fundamental to making these connections meaningful and useful in personal and civic decision making. Although the notion of global climate change strikes many non-experts as distant, abstract, or even fanciful, cities make the global local by translating distant abstractions into real consequences for land, air, water, the built environment, and public health. As city residents become more informed about how changes will directly impact them and the familiar urban systems on which they depend, they can begin to take informed action to respond to climate change. Many city leaders are wisely pursuing proactive adaptation and mitigation policies, seeing win-win opportunities to improve urban quality of life through economic benefits and enhanced infrastructure [*Rosenzweig et al*., 2010]. These efforts will succeed only if urban residents deepen their climate literacy and meaningfully engage in issues around climate change.

11.2. CLIMATE CHANGE EDUCATION AT THE CITY SCALE

How then should we design educational systems to engage urban audiences in ways that activate, educate, and mobilize with respect to climate change? The conventional approach might be to teach people knowledge about climate change and then expect that they would change their behavior based on a rational understanding of atmospheric science and the impact of human behavior.

However, recent studies suggest that understanding the science behind climate change does not automatically, or even predictably, lead to individual choices that are scientifically informed or environmentally sensitive [e.g., *Shepherd and Kay*, 2011; *Kahan et al*., 2012]. In some cases, a focus on knowledge without attention to the moral, ethical, and emotional aspects intrinsic to climate change can even result in individuals making choices that are the opposite of what a climate educator might intend [*Roeser*, 2012]. For knowledge to lead to action, climate change education may have to be broadened to address a range of factors beyond scientific information, including self-efficacy belief, perceived personal relevance, concern, and ethical or emotional responses to climate change [*Patchen*, 2010; *Roeser*, 2012; *Akerlof et al*., 2013].

Recent educational studies also suggest that climate education may have to broaden beyond individual messaging to explicitly address how individuals see themselves as part of larger groups. Identity, social norms, and community influence are consistently predictive variables when examining environmentally friendly behaviors—often much better predictors of behavior than knowledge [*Barr*, 2007; *Nigbur et al*., 2010; *Crowell and Schunn*, 2013]. For example, *Kahan and colleagues* [2012] found that among those who were highly knowledgeable about climate change science, political ideology was the strongest predictor of level of concern for climate change. This pattern appeared to be the result of the powerful influence of individuals' identity groups: the communities to which they are most dependent for social and physical resources.

Because people's identities and communities have a stronger effect on their behaviors than their scientific knowledge, the research from multiple fields supports a learning model that leverages community-level learning, rather than individual-level learning [e.g., *Devine-Wright, et al*., 2004; *Shandas and Messer*, 2008]. Knowledge about climate and response to climate change should be embedded in contexts that are a part of a citizen's daily life and community in the city. There should be multiple opportunities to encounter, discuss, and share climate messaging within established social and community groups. Urban residents who are already participants in their own communities (of interest or of geographic proximity) should get the sense that "people like me" are talking about, thinking about, caring about, and responding to climate information because it is something that people like me do in this city.

As an example of how one might design for this kind of impact, consider a project where, over the course of 12 years, the city of Portland, Oregon, engaged citizens in watershed management projects by partnering with community organizations and providing expertise and leadership from both the city's public works department and the local university's urban planning faculty. The university partners, who advised the community projects, identified three main questions that drove the success of the Community Watershed Stewardship Program: "How can citizens become more involved? What is the optimal mix of local technical expertise and community capacity? And what innovations and accommodations must public agencies make?" [*Shandas and Messer*, 2008, pp. 414–415. They found that citizens' involvement in watershed management programming increased when they were included as stakeholders with real ownership from the beginning of the projects, and that "community members became more aware of the connection between their actions and the health of the environment" by working with others to improve the condition of their regional waterways (p. 414). The authors also emphasize the need for tangible results in these projects—increasing awareness and an enhanced network of community partners were important aspects of the projects' success, but real results helped to give participants a sense that their work contributed to real improvement.

11.3. CLIMATE AND URBAN SYSTEMS PARTNERSHIP

When the current state of climate change education across Philadelphia, New York, Pittsburgh, and the District of Columbia is reviewed, it is clear that city-wide audiences are not yet engaged in ways that will lead to effective city-scale response to climate change. However, at the same time, significant resources and efforts are currently being employed with the goal of improving the state of understanding about climate and climate change. The problem is that many of these efforts are not coordinated into a larger city-scale learning system [*Abbasi*, 2006]. Each educational effort most often moves forward with its own set of goals and approaches to learning and climate change. Although individual programs may be strong and well designed, the collection of efforts too often appears as a random assortment of projects moving in different directions and even at times contradicting each other. The result, at best, provides little synergy, and at worst, could be counterproductive. If two members of the same family were to encounter different programs using different approaches to climate change education, it is not difficult to imagine that the resulting discrepancy in understanding could lead to the promulgation of the notion that climate change itself is a debated topic.

The diversity of efforts and organizations should be turned to an advantage. Imagine if organizations across a city could be organized both in goals, message, and language. Individual projects "tuned" to each other and strategically deployed could produce resonance across the multiorganizational field of urban communities. Reinforcing experiences across multiple platforms would provide opportunities for coordinated interventions. If those interventions could also be concentrated physically or temporally, urban community members could encounter multiple reinforcing messages across several experience platforms. Such coordination would also increase the efficiency of up-scaling efforts aimed at engaging with—and voicing citizen perspectives to—urban policy makers and decision makers.

CUSP is working toward this goal by developing a collaboration of Urban Learning Networks (ULNs) designed to implement a coordinated set of integrated climate science learning initiatives across a broad spectrum of learning environments in each partner city. The ULNs bring together the wealth of organizations currently working in each city to mount a unified effort to improve city-wide climate literacy. To begin, an urban resident is thought of who throughout his or her daily activities would encounter multiple experiences that impact learning and understanding of climate science. Although not everyone will have the same experiences, given the considerable variation in daily routines, such common everyday experiences have the potential to constructively increase climate literacy through repeated exposure and common themes. Therefore, to be most effective, programming targeted at increasing climate science literacy in the general public will harness the reinforcing effects of multiple encounters across these platforms by developing a targeted and coordinated approach.

The ULNs will implement programs and curricula in such a way that they are targeted to specific community organizations and neighborhood-level groups, coordinated by presenting consistent and clear opportunities to engage with the science of climate change and concentrated across time and space. Further, the end goal of the coordinated programming (be it messaging, literacy, or engagement) will be customized as appropriate to the communities served. With such an approach, information about climate change and its potential impacts will be available through a broad range of learning experiences, providing multiple reinforcing opportunities to engage in quality climate science learning across each city. The development of a collaborative network of agencies and organizations committed to developing thematically and temporally coordinated climate science education programs that serve their interest or geographically based members or audiences will result in consistent learning experiences about climate science to the diverse publics of the cities. The result will be a relevant, city-wide approach to improving the state of climate literacy in the urban environment.

That said, the complexity of climate science and the current minimal state of public knowledge presents an extremely large hurdle when approaching the development of climate change education programs. With the resources assembled, what then should be the approach to climate science learning? Based on recent research, it is clear that a purely knowledge-based individual target approach will be insufficient to meet the learning needs of the intended audience [*Shepherd and Kay*, 2011; *Kahan et al*., 2012]. Rather, to be most effective, a set of design principles will be needed that consider not only cognitive learning but also the social and emotional aspects of climate change and rely on the power of community-level learning [*Patchen*, 2010; *Roeser*, 2012; *Akerlof et al*., 2013]. We are working with three core design principles, rooted in the learning sciences and educational research literatures:

1. **Framing for Relevance**. Not all audiences have the same values or come into a conversation from the same point of view. For more conservative audiences, environmentally friendly behavior is much more attractive when it is framed as an issue of economic or energy security, such as seeking independence from foreign oil, or an act of patriotism, such as buying goods made in the United States. For audiences that experience oppression, framing climate change as an issue of justice can be a good way to tap into what people are already passionate about and personally affected by, because economically disadvantaged communities are often more heavily affected by extreme weather events. It is this personal relevance and connection to personal passions that serves as the starting point for programming.

2. **Participation**. Participation is one of the most powerful mechanisms for learning and is one of the primary forms of engagement in informal learning. Participation refers to hands-on, interactive, and authentic (i.e., in-context) experiences that lead to learning, development of attitudes, and the making of personal connections. Urban residents may participate in a hands-on learning activity that educates about the dynamics of heavy rain events and combined sewer overflows, or they may work together to care for an urban garden and learn about changes in plant growth seasons and ranges.

3. **Systems Thinking**. Fundamentally, climate change will be experienced through its impacts on the urban systems on which citizens depend. Understanding this, however, will require a level of system thinking that is not taught in schools, nor is it generally recognized as a strong attribute in most highly educated adults. To understand systems, people need to be able to engage with the intersections of science, society, individual passions, and unfamiliar topics. For example, heat wave mortality is partly a climate science issue, partly an air quality issue (because in the urban Northeast air quality is often poor during heat events), partly an infrastructure issue (because electrical systems may be more prone to failure precisely when air conditioning is most needed), and partly a social issue (because vulnerability to heat depends on a number of societal factors). Climate change is thus a "socio-scientific" problem, meaning that it is more than simply a "problem of science" [*Houser*, 2009].

These three design principles have been used to design the overall approach for project programming. CUSP programming begins with framing issues in a way that is relevant personal passions. What do city residents care about? What are the issues, topics, and activities with which residents personally and socially identify? Framing educative efforts for relevance to the concerns urban residents have that intersect with climate change provides the necessary starting point with which to begin a deeper conversation about climate change and city systems.

Establishing and promoting programming as a conversation is a key element of participation. Learning is more than just receiving a message; it means engaging with others who are more, less, or equally expert on the various intersecting ideas. Facilitating space for those conversations to happen and generating a shared language and trust among the people having the conversation,= will be a, important aspect of CUSP.

The next step in that conversation is to connect personal interests to the urban systems on which they rely. In an urban setting, few issues, activities, or hobbies are not dependent on one or more citywide systems. Whether one identifies as a gardener, advocates for public transportation, or worries about the cost of electricity, there is always an underlying urban system. By connecting urban residents' passions to this urban system, CUSP programming will take the first step in developing urban residents' understanding of how climate change can disrupt the systems that connect them to the things they care about. Frames of relevance and processes of participation in the multi-issue field of climate change adaptation and mitigation should encourage understanding of systems, just as systems thinking should support the development and evolution of relevant frames and processes of participation. To understand climate change as it impacts the systems that people depend on, people need the opportunity to engage with the intersections of science, society, individual passions, and unfamiliar topics as they relate to those systems. The CUSP model and principles are coordinated to provide multiple and varied opportunities for this type of engagement.

This model of connecting personal passions, urban systems, and a changing climate through participatory learning experiences forms the basis of the CUSP programming approach. However, a final element is needed. When faced with the issues associated with climate change, people often have mixed reactions. On the one hand the sheer scope of the issues can result in a feeling of powerlessness. The negative emotional connotation of this reaction does not bode well for the chances of either continued engagement with learning about climate science or meaningful engagement with further climate issues. On the other hand, there are those who respond with the need to engage in immediate individual action. Although this result may be no worse than neutral, the reality of the limited impact of individual action can lead once again to a sense of powerlessness. This is particularly true in the context of the city. The networked organizations that make up the heart of CUSP ULNs are uniquely situated to connect urban residents to the governmental, organizational, and community-based efforts that enact adaptation and mitigation strategies on a community-wide level. Examples of engagement around coastal flood risk in New York City at each of these three levels include the Mayor's Office of Long Term Planning and Sustainability, The Trust for Public Land, and local environmental justice groups. By interfacing with these and other groups, urban residents who want to take action can find a meaningful outlet and those who might feel powerless in the face of the issues are provided with the support network they need.

11.4. CURRENT PROGRESS AND FUTURE WORK OF CUSP

CUSP calls for a targeted, coordinated approach that relies on connecting personal passions to urban systems and how they will be impacted by a changing climate. Because this requires engaging multiple organizations and efforts and because these efforts need to be aligned, participants will be defined by time, space, and interest rather than a "target audience." A bottom-up approach has been taken by focusing on the general public rather than key decision makers because the long-term success of any adaptation or mitigation efforts will rely greatly on what the average person does. The project will focus on local impacts matching the need for personal engagement. Taking that into account, participants should be urban residents who have common values and shared interests who gather in a space that can be occupied by multiple organizations simultaneously. Given the large role that has been identified for community identity, the most appropriate target for the CUSP approach is a community, such as a neighborhood, a group of people who care about air quality issues, or a club of beekeepers. By engaging with the various communities in the cities, multiple existing programs can be can used to coordinate content and materials, while the shared interests and values of each community provide the opportunity to engage around shared passions, all which results in interactions between individuals and within communities that increase climate literacy and overall engagement with climate change issues.

Community itself can be broadly defined, but CUSP has identified four different community types that they will support through their programming:

- Virtual communities: the ever growing digital communities facilitated by the Internet and social media
- Temporal communities: those communities of shared values that coalesce around time-limited events such as festivals
- Physical communities: the physical geographic neighborhoods that make up the city
- Communities of practice: the shared communities of those engaged in and aligned with climate change education

As of this writing (April 2013), CUSP partners have been focused on developing a set of digital tools, festival kits, neighborhood programming, and professional workshops designed to support each of these communities. First, the digital tools are focused around the development of an online mapping system that will allow ULN members to use the interests and concerns of the digital audiences they serve to select appropriate overlays for the map, enabling users to select information that interests them. ULN members will also integrate the map into their programming, from uploading citizen science data to sharing stories and pictures via the map.

Second, the temporal communities are supported by a library of festival booth activity kits that ULN organizations will use to tap into festival-goers' curiosity. The kits offer hands-on activities related to topics such as the temperature effects of alternative roofing materials, the carbon footprint of mass-transit versus car-centered transit systems, and urban stormwater management. With kits distributed among the booths of several community organizations, visitors will have multiple opportunities for interactive learning that catalyzes conversations about climate change and their city.

Third, the neighborhood community group is establishing a pilot site in the city of Philadelphia to test collaborative programming opportunities for physical communities. Programs currently active within the pilot neighborhood (at libraries, recreation centers, railway stations, and so on) are developing a shared set of learning goals to be incorporated into the broad set of programs offered. These programs are not all necessarily climate-based educational programs. Rather they represent the mix of experience opportunities (gardening, childhood literacy, school assembly programs) currently offered. Within the pilot neighborhood, each of these educational assets will provide a coordinated set of climate learning opportunities within a three-month period.

Fourth, the communities of practice platform is developing new tools to build the capacity of ULN member organizations to effectively deliver climate change education programming to their specific memberships, target audiences, and interest- or need-based communities. A recurring theme heard from ULN members is that these groups want to improve their capacities to help their target audiences examine climate issues and make the most appropriate choices. The communities of practice group has developed and tested a training workshop for ULN community organizations and developed educational modules they can use with their audiences. The modules highlight choices and tradeoffs at a community level.

The plan is to iteratively design and document, using principles of design-based research [*Barab and Squire*, 2004], each of the climate change learning platforms, one in each of the four cities. Developers and educators are in biweekly contact with one another to ensure that each platform is being developed in a flexible enough framework to be successfully implemented in each of the other three cities after the initial round of design-based research is complete. Implementation will be conducted through design-based implementation research [*Penuel et al*., 2011] integrating the different platforms into a single, city-scale learning environment for climate change. As the learning scientists, developers, and educators are iterating the designs of each platform; the climate scientists are developing local climate projections and working with the ULNs to identify areas of vulnerability and opportunities to adapt in each city. Finally, the evaluators are tracking progress at each step and will ultimately identify the extent to which the program has been successful in reaching audiences and changed knowledge of and response to climate at the city-scale.

CUSP aims to coordinate the efforts of multiple organizations and efforts, themed around and targeted to those issues and topics about which particular communities are passionate. These learning platforms will connect urban residents' passions to the urban systems that surround and support them and explore the climate science underlying the threat posed by a changing climate. By providing multiple opportunities to encounter reinforcing learning experiences, connecting and coordinating efforts across multiple organizations to create the opportunity for resonance, and situating these efforts in community and tapping into personal passions, CUSP will develop a unique, effective and substantial format for reaching across the urban landscape to engage city residents and their communities in climate science and the impacts of climate change.

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