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PROJECT REPORT

Contribution and role of UGEC project

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ABSTRACT
This paper provides a brief history of the Urbanization and Global Environmental Change (UGEC) core project of the erstwhile International Human Dimensions Programme on GEC and the evolution of the science it supported and advanced from 2006 to 2017. This paper arises out of its synthesis phase, which concluded by planning the transition into an urban component of Future Earth. This legacy is vital in the context of our now predominantly urban planet and the associated flowering of urban research and related policy initiatives. The paper also analyses UGEC’s role and contribution as a global science coordination (networking) project and, on this basis, offers guidance and future research suggestions for the urbanization and environmental change community.

1. Introduction

The Urbanization and Global Environmental Change (UGEC) core project of the International Human Dimensions Programme (IHDP) devoted 10 years to the study of urbanization processes and global environmental change (GEC) interactions that occur at multiple scales. Although UGEC ended in 2017, the importance of urban issues has grown even larger for both research and policy since its inception. With more than half of the world’s population living in urban areas and with many regions urbanizing rapidly, these development processes (and the associated challenges and opportunities) have major implications for the future of our planet. This requires that actionable knowledge and the uptake of urban scholarship into decision-making are accelerated, which can be done only through stronger collaboration between academics, political decision-makers and practitioners across sectors and scales.

This paper analyses the development process and contributions of the UGEC project in an effort to highlight obstacles and opportunities facing GEC projects in their operations. This analysis is timely given the renewed effort to create Global Research Projects and Knowledge Action Networks under Future Earth (FE), an international effort sponsored by the International Council of Science and the United Nations Environmental Programme. GEC research Projects have failed adequately to extract and disseminate lessons learned from their implementation processes that could help similar projects avoid repeating mistakes and take advantage of potential synergies and opportunities. These projects usually have a 10-year lifespan and most often conclude with a scientific publication, in some cases focusing on a major topic or a synthesis of major scientific achievements. Upon review of these publications, we did not find any attention given to operational lessons learned.

The first part of this paper provides a brief history of the UGEC project and the evolution of the science it supported and advanced. This legacy is particularly important given the growing interest in ‘the urban’ across multiple research domains and policy circles, and the recent changes within the GEC landscape, such as the restructuring to the FE framework.
mentioned above. Second, it provides an analysis of the project’s role and contribution as a global science coordination (networking) project, as well as a discussion of the factors surrounding the somewhat challenging nature of such an assessment. To our knowledge, this has not been done before by other GEC projects. Although the content of this paper is specific to the experiences and dynamics of UGEC, we hope that these resonate with those of other science networks and sister GEC research projects that are continuing to make important contributions within their respective research areas. The following reflection and analysis concludes by offering some potential guidance and suggestions for the urbanization and environmental change research community going forward.

2. Background and history

GEC research in the natural sciences has a long pedigree, focusing especially on climate change and modelling. Thematically, land-use cover change has predominated, led by bodies such as the World Climate Research Programme (WCRP) and the International Geosphere–Biosphere Programme (IGBP). Growing awareness of the importance of deploying social scientific perspectives prompted the International Social Science Council to establish a Human Dimensions Programme (HDP) for this purpose in 1990 but interaction with the natural sciences was lacking. Consequently, negotiations with the International Council for Science (ICSU) – then known as the International Council of Scientific Unions – led to joint sponsorship of a relaunched IHDP on GEC in Bonn in 1996 (http://www.ihdp.unu.edu/pages/?p=about).

The IHDP emulated the then established model of collaborative international scientific research, launching a series of thematically focused ‘core projects’. This approach served as the main research vehicle for all the GEC programmes’ until the transition into the new umbrella organization, FE, officially launched in 2012 (Future Earth 2013) and the closure of the various programmes when their respective funding periods expired – in the IHDP’s case in 2014. IHDP’s core projects arose from priority-setting discussions within its internationally diverse Scientific Committee (SC), sometimes originating as external suggestions. Promising proposals were advanced by small working groups of leading experts from different disciplinary and geographical backgrounds, with seed funding to undertake horizon scanning and literature searches in order to produce a coherent Science Plan. These were then assessed by several independent external referees and revised accordingly prior to a final decision by the SC. Approved plans were then mandated as IHDP core projects with a 10-year life and to be led by an international Scientific Steering Committee (SSC) and anchored by an International Project Office (IPO), usually based at the home institution of the SSC chair or deputy chair. IHDP provided modest core funding to cover the costs of an annual SSC meeting and some of the IPO’s operating costs but co-funding from the host institution or a national research council was required for viability.

This design, coupled with the lack of funding for actual research, constituted a major weakness of the model, as discussed in Section 4. The actual research consequently had to be financed through conventional individual project grant applications to various funding bodies by individual or groups of researchers affiliated to core projects. Crucially, this limited the effectiveness of the programme in two cognate ways. The first was that SSCs and IPOs faced formal IHDP compliance and reporting processes that exceeded what might have been justified by the small core funding. Hence, the IHDP relied on increasingly fragile moral authority over time. Second, without research funding to allocate, SSCs were unable to drive or steer research directions coherently. Instead they had to rely on ‘soft’ tactics, such as promoting their Science Plans as actively as possible, encouraging researchers to address priorities identified therein, and offering light touch ‘endorsements’ of projects and project proposals that did so. Individual researchers working on comparable projects or subjects could also apply as Research Fellows or for Project Associate (PA) status.

Most core projects also organized periodic international conferences in order to bring their respective research communities together – commonly around the end of their inception phases and again during the synthesis phases in the final year or two of their lives. Such synthesis conferences have been used to progress or stimulate key publications as markers of what the project has achieved in terms of scientific advances (e.g. Sygna et al. 2013). However, the nature, calibre and dissemination of such final outputs have varied considerably.

This paper constitutes one of UGEC’s synthesis outputs. In addition to the efforts of individual core projects, for much of its life, IHDP organized biennial Open Meetings (1995–2009, with a four-year gap
prior to the last) to foster a broader sense of social scientific GEC community. These were dynamic and exciting events, attracting transdisciplinary participation from around the world, demonstrating effectively the value of the collective endeavour. These also provided the only opportunities for systematic interaction between the SC, core project SSCs, researchers, funders and non-academic partners. Unfortunately, these meetings were discontinued as one of the first victims of successive funding cuts and staffing changes that became symptomatic of the general donor cutbacks which ultimately prompted the Belmont Forum funding consortium to drive the establishment of FE as a single, integrated GEC research umbrella.

2.1 The landscape of urban GEC research in the early 1990s

The perceived need for greater attention to specifically urban aspects and consequences of GEC prompted the IHDP SC to establish a working group\(^2\) in 2003, charged with developing a Science Plan for what in 2005 became the UGEC core project. The working group’s literature survey and horizon scanning for the UGEC Science Plan (Sánchez-Rodríguez et al. 2005) revealed that although already then growing quite rapidly, coverage was both thematically and geographically highly uneven. There was an overwhelming preponderance of single-city studies, themselves concentrated predominantly on large and megacities in the global North. Within these categories, coastal cities like Tokyo, London and New York received disproportionate attention, no doubt reflecting their well-staffed and resourced municipal offices, concentrations of academic research capacity and perceptions of GEC vulnerability. Coverage of the global South was very limited and tended to focus on a few cities like Mexico City and Cape Town, where exposure to GEC risk was high, where particular research centres with GEC interests were based or international groups had found appropriate local partners. Small and intermediate urban centres were conspicuously absent. While a small proportion of these publications adopted a citywide perspective, most addressed particular industries, localities or communities where emissions profiles or vulnerability and risk were problematically high. At that time, literature on urban emissions reduction schemes, soft as opposed to hard engineering barriers and urban greening, integrated public transport, retrofitting of buildings and other interactions, responses and coping strategies was in its infancy but indicative of the way forward.

UGEC’s Science Plan was designed as a multidimensional conceptual framework. It sought to emphasize the importance of transcending fragmented perspectives focusing only on one direction of causation to bidirectional perspectives illustrating the dynamic interactions between UGEC (see Figure 1). An important part of the conceptual framework was its holism, constituted via a clear understanding of how the four themes interlocked. Exiting literature at that time concentrated thematically very much on sources and urban processes contributing directly or indirectly to emissions and GEC. International scientific literature began also to draw attention to how global warming affects urban areas and systems. These two approaches, clearly important to GEC research, became Themes 1 and 2 in the UGEC Science Plan. It also recognized that bidirectional interactions between GEC and urbanization are dynamic and result in new processes, either urban areas affecting GEC, as addressed by Theme 3, or how GEC affects urban areas, addressed in Theme 4. By contrast with Themes 1 and 2, there was very little coverage in the international literature at that time of what became Themes 3 and 4, namely the consequences of dynamic interactions within urban systems on GEC.

The Science Plan’s framework recognizes that urban areas result from the modification of the natural landscape by social processes, thereby illustrating the importance of contextual approaches in the study of bidirectional interactions mentioned above. This facilitates understanding of the root causes of vulnerability to the impacts of GEC in urban areas, and to some extent, the driving forces of impacts of urban areas on GEC. It also recognizes that GEC involves not only biophysical and chemical processes but is the result of these processes interacting with social processes. This is an important analytical framework that anticipated recent international discussions of the Anthropocene (Castree 2016; Fulton 2016) and the renewed attention to planetary boundaries based only on biophysical and chemical processes (Rockström et al. 2009; Steffen et al. 2015). Recent efforts seeking to connect these boundaries with social processes (Leach et al. 2012; Steffen and Stafford Smith 2013) exemplify the importance of multidimensional perspectives that the UGEC’s Science Plan sought to create.
Within each of the four themes, the Science Plan (Sánchez-Rodríguez et al. 2005) identified a set of key research questions to guide future research, with particular encouragement to researchers to address those under Themes 3 and 4, as well as to increase dramatically research in and on the global South and the transitional economies of central/eastern Europe. Although it is difficult to assess precisely what impact this framing had in practice, the UGEC Science Plan was a landmark document at a time when the Intergovernmental Panel on Climate Change (IPCC) did not yet specifically address urban areas in their own right, something which commenced properly only in general terms (human settlements) with the Fourth Assessment Report in 2007 (IPCC 2007) but it was not until the Fifth Assessment Report in 2014 that a specific chapter was dedicated to urban areas (IPCC 2014). Its analysis of the literature today reveals the dramatic increase in volume and geographical coverage, particularly relating to UGEC Themes 1–3, with Theme 4 still trailing some way behind.

Following some revision, the Science Plan was approved and UGEC came into being in late 2005, commencing activities in earnest the following year, with the mission of seeking to better our understanding of the regional and global implications of urbanization and the complex dynamic systems of urban areas that affect and are affected by global environmental change. The project fostered dialogue and collaboration on major research and societal needs on how cities can be (re)built in ways that best respond to the constraints and opportunities of global environmental change processes (https://ugec.org/about/mission-objectives/).

UGEC also recognized the importance of bridging the gap between science and practice and policy and it sought to construct interdisciplinary and transdisciplinary research. This, in turn, was to be achieved through five linked objectives, namely to

- Foster transdisciplinary research and develop innovative conceptual and methodological frameworks to expand and improve our knowledge of the interactions between urban areas and GEC.
- Develop and expand networks of scholars with common geographic or thematic interests in the UGEC field of research.
- Facilitate the cooperation and exchange of scientific knowledge among researchers, decision-makers, practitioners and other end-users
at the international, national and local levels in urban areas.

- Build the capacity of emerging scholars, particularly in developing countries, and provide opportunities for their engagement.
- Strengthen its role as a central node in the network of urban sustainability scientists and practitioners (https://ugec.org/about/mission-objectives/).

3. The GEC project model and UGEC identity

The core project/IPO structuring is distinct and complex due to the landscape within which it operates and the multiple actors that characterize it, as introduced in the previous section. These dynamics undoubtedly influence not only how a core project functions (what it can accomplish and how) but also its overall contribution or ‘effectiveness’. GEC core projects’ landscapes generally include the following players:

- the parent organization, now FE (formerly the GEC Programmes: IHDP, IGBP and DIVERSITAS before they phased out over 2014–2015),
- the institutional home of the IPO (generally a university or research institute),
- portfolio of funders supporting IPO operations (most often a combination of federal and local institutional support over varied timeframes),
- SSC, who are individual researcher ‘volunteers’ from around the world and
- the wider community that participates in a number of ways dependent upon how the project structures its activities and the buy-in or perceived value-added in ‘joining’ a project.

Looking back, one of the idiosyncrasies of UGEC has been its identity in terms of defining the who of the UGEC network or ‘membership’ and, by extension, the what that comprises the body of UGEC research. The former can be described as including a number of actors with different participation levels or degrees of engagement and influence. These include the IPO staff, the SSC and the PAs, the Principal Investigators and Senior Personnel named on the grant, those included on the listserv, participants who attend one to multiple workshops or other activities and who co-author articles or other written works and so on.

The what can be defined most easily as research linked to activities initiated through the IPO. However, this is a somewhat limiting definition. For example, if a SSC member or PA were to lead an activity or produce a publication relevant to the Science Plan but which was not funded by the IPO, the activity’s formal association with UGEC would still often be made, given the lead’s affiliation or status with the project. This was done with the intention of showcasing the advancement of science though the broader channel of the UGEC network, rather than fulfilling a proprietary need to claim intellectual ownership or inflate the project’s achievements. However, this speaks to a subtle distinction between UGEC, the institution or project and UGEC research. Since no clear rules about identity were made from the project’s inception, it was tricky and sometimes delicate to manage, and no less so here in terms of analysing the project’s contribution and influence.

In some cases, influence on science advancement has been clearer. For example, UGEC-funded activities with a visible result such as a journal article or other tangible output are easily distinguishable, but the ‘intangibles’ are otherwise a grey area. These would be, for example, the emergence of new relationships or collaborations and/or knowledge creation (that might manifest in entirely new research projects or publications, etc.) that might be set in motion by a UGEC activity. Again, much of the difficulty in determining what UGEC can rightly take credit for comes from the nature of the project itself and the ‘build the plane while it’s flying’ approach associated with building the network from the ground up.

In addition to the difficulty of determining ‘causality’, a weakness of the project was the failure to initiate a preset evaluation mechanism, including metrics of success. This has made its influence, progress or successes difficult to assess and was complicated further by inconsistencies in branding. Upon reflection, there were missteps in this regard when it came to properly branding a product as ‘UGEC’. For example, in most cases of journal publications that were outputs from UGEC-funded workshops, UGEC was not mentioned in the acknowledgments. One could see this as being rather trivial; however, for a project that is attempting to establish itself and a global community, omission of these relatively easy forms of acknowledgement is unfortunate and unhelpful as it muddies the project’s identity and undermines a traceable legacy.

Despite the challenges just described, this paper offers an insight into UGEC’s contributions by considering the myriad of factors that influenced UGEC’s
landscape and dynamics as well as the extent to which these have shaped both its operational and scientific outcomes over 10 years. The paper draws heavily on a synthesis workshop associated with the 2015 UGEC SSC Annual Meeting and incorporates findings from a survey sent out to the UGEC listserv for feedback on the project’s contributions. To support the analysis, the authors retrospectively documented activities (conferences, workshops, sessions, other fora) initiated by the UGEC IPO each year, those who participated, traceable outputs, the associated UGEC theme, region of focus (if any) and any other identifiable outcomes. Other activities that were not necessarily funded or initiated by the IPO but had thematic relevance and the involvement of at least one identifiable UGEC ‘member’ were also included. This exercise of identifying and mapping the people and the connections, ideas and research developments helped to clarify the project’s evolution. This offered a starting point to assess what the project accomplished and in what areas it seemed to excel or fall short. The following section provides a discussion of some of the project’s major operational contributions and the activities that supported them.

4. Fostering a community around UGEC scholarship

The introduction noted the early landscape of the urban and GEC, whereby it was clear that a number of scholars working on and researching various facets of the urban environment existed, but not an established community per se that was researching the interactions and feedbacks of UGEC (and particularly in a global context) in an integrated way as it is presented in the Science Plan. Therefore, an immediate and challenging task for the IPO and UGEC SSC was to focus efforts toward establishing a global platform that would both draw greater attention to this research arena with the intention of advancing the science as well as offer a platform for support and interaction between scholars and practitioners. A good move in hindsight and notable advantage was the diversity that existed amongst the SSC membership base. Although most were geographers, their different research interests (e.g. land-use and land-cover change [LULCC] and remote sensing, urban vulnerability and risk, climate change adaptation; development–environment interrelations), physical locations and research locales created this valuable regional diversity. The composition became increasingly diverse as time passed, to eventually include representation across the major world regions (the Americas, SE Asia and China, sub-Saharan Africa, Europe, Australia and the Pacific Islands). The establishment of PAs, who were less committed than the SSC but voluntarily held the UGEC flag through event leadership and publication collaborations, filled the remaining gaps in diversity not covered by the SSC.

Workshops constituted the main activities facilitated by the IPO, since, as previously noted, the bulk of funding was for the support of participants to attend such events, rather than support for actual research. But workshops were also a conscious strategy to build collective multidimensional knowledge of the complex and dynamic interactions between UGEC. The increasing attention to these issues by the scientific community and international organizations required a continuous socialization of recent advances in scientific knowledge in this area. These workshops fell into two categories, either thematic or regionally focused.

The latter, particularly in the early years, catalysed the building of the UGEC regional networks that exist today and were critical for enabling a shared understanding of the key research questions and capacity needs of the various communities, offering a basis for comparative analysis and synthesis across regions in the later years of the project. The diverse SSC membership thus provided an entry point into the regions of interest and inevitably shaped where exactly such efforts would focus upon their leadership. Although regional diversity is perceived as being rather well accomplished, there was noticeable variability in connectivity and depth, and the need for broader, more encompassing regional representation is also acknowledged. In other words, the level of engagement in certain regions was higher than in others or was strong for a certain length of time but then subsided during other periods. A large contributing factor to this is the modest funding that enabled at most 2–3 workshops per year. This created difficulty in balancing a level of continuity within regions and also exploring and establishing networks in new ones. Also, given the breadth of the UGEC framework, giving equal attention in the event/activity space to the numerous topics and themes was challenging if not near impossible. Funding aside, there were other factors, such as an evolving SSC, that in turn led to changing interests and priorities.
In addition to the regional workshops, thematic and training workshops and international conferences were important catalysts for collaborative writing and network building, broadening the disciplinary scope and the involvement of younger scholars and practitioners. Since the initiation of the project, it grew from a project dominated by geographers, urban planners and environmental scientists to engaging interest among other disciplines across both the social and natural sciences, e.g. economics, public policy, ecology, climatology and atmospheric science, engineering, development studies, public health and sociology.

Most thematic workshops addressed areas of research that specifically required interdisciplinary expertise, thus requiring the need the intentional efforts to reach out to sister core projects or broader networks to fill disciplinary gaps. One example is the 2011 workshop which explored forecasting urban land-use change and Earth system responses. This workshop included different disciplinary perspectives (e.g. geography, urban planning, remote sensing, economics, conservation and landscape ecology) and methodological approaches (e.g. remote sensing, statistical and econometric modelling, system dynamics modelling, agent-based models), bringing together urban growth modellers, urban planners, users of urban growth models and graduate students (Dell’Acqua et al. 2011).

Furthermore, it was important from the outset that the project incorporated mechanisms through which the wider community could contribute and be connected to the UGEC network. The UGEC Viewpoints newsletter was one such initiative that had a particularly strong impact on younger scholars and researchers in countries where strict English language requirements are significant obstacles to publishing in peer reviewed ‘international’ journals. From 2008 to 2014, the IPO published 10 issues of the roughly biannual journal (both hardcopy and virtual), before changing formats in 2015 to an online blog in order to reach a larger audience and remain up to date with communications trends. This format change opened up conversations on a wider range of urban topics, such as the UN urban Sustainable Development Goal (SDG), disaster risk reduction (DRR), vulnerability to climate variability and climate change in urban areas, urban climate resilience and urban air quality among others.

The institutional arrangement also provided several advantages to the project. The IPO of UGEC was housed in the Julie Ann Wrigley Global Institute of Sustainability (GIOS) at Arizona State University. Founded in 2004, GIOS was created as a university-wide initiative to develop, promote and support interdisciplinary and transdisciplinary efforts to address key sustainability challenges, including rapid urbanization. The intellectual and research landscape already in place in GIOS made the integration of the UGEC IPO relatively seamless and created fertile ground for interactions among the multiple projects. What UGEC brought to the table was a global focus and global network of scholars, both critical for the strategic development of GIOS.

The IPO was funded through two successful proposals to the National Science Foundation and received administrative support from GIOS. In addition to funding the IPO staff and activities, the NSF and support from GIOS provided funds and facilities for workshops and meetings of the SSC and the PAs. Although a great deal of work was conducted by staff through the IPO in Arizona, UGEC maintained a distributed model by working with staff and faculty at other universities and research institutes around the world. Given the global scope of the project and the Science Plan, a distributed model was philosophically imperative and from a practical perspective necessary for carrying out its goals. Of course, the global scope of the project meant that the IPO did suffer from ‘transaction costs’ associated with international collaboration (e.g. visa issues, challenges with local arrangements for workshops, scheduling conference calls across multiple time zones) but having the security, stability and support of being housed in an institute and university that aligned with the goals of the project was on balance a positive situation.

5. The evolution of UGEC scholarship in the urban era

The UGEC decade has witnessed a veritable explosion of both pure and applied (including diverse forms of co-production) urban research worldwide (see Figure 2), characterized by reduced unevenness in coverage and also by far greater output by researchers based in the global South. These trends are attributable principally to the almost universal awareness of, and concerns regarding the challenges of, humankind having become a predominantly urban species. Indeed, we are now in what
is often referred to as ‘the urban era’ and even the Anthropocene – which was formally recognized as a distinct geological era in 2016 by the International Geological Congress (Castree 2016; Fulton 2016).

The associated challenges relate to planning and supply of infrastructure, shelter and other basic needs but also to the implications in terms of climate/environmental change and DRR/resilience. In this respect, UGEC has provided notable leadership for enhanced understanding and research through its Science Plan’s four bidirectionally interlocking themes (Figure 1). Its integrated and systematic approach to understanding urban interactions and much-needed highlighting of the importance of social science perspectives on global-scale urbanization research has provided it with lasting relevance. Broad in scope, the Science Plan sought to fill a rather large gap in the GEC literature – the study of the impacts of GEC on urban areas and the people who live in them, in particular in developing countries (Sánchez-Rodríguez et al. 2005). Although such a broad framework posed challenges for synthesis, this characteristic, along with its integrative nature, was helpful in fostering an interdisciplinary community around issues of urban sustainability and scale. Indeed, it is still regularly cited in the scientific literature.

The prominence of the geographical sciences in UGEC’s early years was complemented later on by the deliberate inclusion of a number of other disciplines across the scientific domains to become more multi-, inter- and transdisciplinary, with a stronger presence in the literature (see Figure 3) and a range and diversity of outputs (thematic and systematic with regional foci). Notable features of the evolving landscape of research and practice, and the associated literatures, include far more expansive or holistic approaches to urban planning. These have shifted increasingly from narrow perspectives driven principally by demographic and formal economic processes and manifest in technicist master planning, to more nuanced, integrated and participatory practices and policies. These approaches were generally developed in metropoles or dynamic small and intermediate cities in the global North where particular champions or engaged civil society groups influenced the process. However, they have spread and been experimented with in many parts of the world, often driven by the ‘wicked problems’ and unprecedented challenges of DRR and GEC, especially when they intersect with economic crisis (as since 2008) or pressing short-term development priorities (e.g. Leck and Roberts 2015). Also linked to this process has been the emergence of urban ecology and associated planning and management concerns with urban biodiversity and greening (in a plethora of ways – see Simon 2016 for a recent critical review), including a new emphasis on soft rather than just hard infrastructure in terms of promoting resilience to more frequent and severe extreme events and GEC (Elmqvist et al. 2013).

Closely related to the above has been a broadening and deepening of holistic understandings of sustainability and what it means in different
disciplinary and geographical contexts and scales, not least the urban. One noteworthy dimension of this has been the growing emphasis on networks and systems of cities and the flows and interrelationship within these, as well as between these and their wider national, regional and global hinterlands. One approach has focused on measuring the increasing volumes and intensities of flows (e.g. air passengers, financial transfers, commodities) and the changing connectivities of nodes in these evolving networks, sometimes linked to perceived resource constraints and pollution or emissions. Another, more novel, approach closely associated with UGEC has explored the increasing nature and intensity of global interconnectedness of urban-related processes and resources – known as teleconnections (Seto et al. 2012) – as urbanization and urban consumption-driven lifestyles expand.

Other advances traceable to the UGEC agenda include linking urban ecology and environmental justice frameworks (Boone and Fragkias 2013), reviewing and refining methods to identify and evaluate conditions under which urban transitions and transformations take place (Solecki et al., in review), and promoting multidimensional approaches that link climate change adaptation, mitigation, transformation and urban development (Sánchez-Rodriguez 2012; Simon and Leck 2015; Solecki et al. 2015). Specifically, urban work has both contributed to and reflected the increased importance attached to inter- and transdisciplinary research and practice since the complexity of issues cannot be tackled successfully in traditional silos or by urban representatives and officials alone.

Increasing inter- and transdisciplinary urban research at the global scale became a specific focus of the UGEC project in its final phase. In collaboration with the Stockholm Resilience Centre, multiple partners contributed to the goal of co-developing a broader, more inclusive and interdisciplinary urban research agenda and urban governance platform within the FE framework. This capitalized on the increasing interest in ‘urban’ from multiple GEC projects across the spectrum of natural and social sciences and other stakeholders working in the urban space, such as IGOs, NGOs and development banks. Under the title ‘Livable Urban Futures’, this initiative resulted in multiple workshops and scoping exercises producing valuable insights for how urban and GEC issues could be addressed or supported within FE along with concrete project pathways (see https://ugec.org/livable-urban-futures/).
Finally, it is worth recalling the point made in Section 2 about the increasing coverage of urban issues and urban areas within successive IPCC reports, and also other such global reports by UN and other international agencies and NGOs. These represent and provide powerful recognition of the impossibility of achieving sustainability globally, regionally or nationally without urban sustainability. That is the quintessential marker of the urban age.

6. Missed opportunities or underachievements

The synthesis of the last 10 years of UGEC provides a constructive criticism of the missed opportunities and underachievements of the project. One of these areas is UGEC’s goal of developing a close collaboration and interaction with practitioners in an effort to close the science-policy/practice gap that has characterized Global Environmental Programs and projects (Sánchez-Rodríguez et al. 2005, p. 46). In a way, this was a visionary goal of UGEC later recognized and implemented in FE through the creation of its Stakeholder Committee. UGEC was able to develop interactions with practitioners in several regional meetings but was not able to create sustained collaboration to enrich its research agenda as planned since the early stages of the project. Cultural and operational differences between academics and practitioners were difficult to overcome and financial constraints limited opportunities to collaborate. We have learned that building science–practice collaboration is context dependent. Practitioners have clear goals, interests and expectations related to their own cities and it was difficult for UGEC to develop an ongoing collaboration with them within the broad research framework of UGEC’s Science Plan and limited resources available for special projects. Despite this underachievement, research carried out by UGEC members has developed collaborations with practitioners and decision-makers in several cities (Sánchez-Rodríguez 2011; Leck and Roberts 2015; Rosenzweig and Solecki 2015), creating useful precedents for future initiatives. These collaborations addressed vulnerability and adaptation to climate variability and change and DRR within the context of local development and they have had different levels of success influencing policy and practices in those cities.

Opportunities to construct collaborations with practitioners were also constrained by our lack of success in developing extended regional networks of scholars. One of UGEC’s initial goals was to create regional networks of scholars and practitioners. This proved to be a much more difficult task than initially envisaged. SSC members represented different regions of the world and UGEC relied on them to create functional networks in their own regions. Two major obstacles to achieve this goal were (1) SSC members and UGEC scholars were subject to intensive demands on their time and found it difficult to dedicate time and effort to create regional networks without additional support; (2) it was extremely difficult to find financial support to create short- and medium-term regional initiatives to foster these regional networks. For the same reasons, the creation of functioning regional networks of scholars has been a major challenge for GEC projects, particularly in low- and some middle-income countries. It remains a pending task for FE in order to create balanced and equitable regional representation in research networks essential in global environmental research programmes and projects.

One missed opportunity in our project was not publishing the Science Plan as a peer-reviewed article to enhance and expand the visibility of UGEC. The introduction to this article mentioned that UGEC was created when international attention to urban areas was fragmented. UGEC’s Science Plan sought to create a research framework for UGEC but also for the broad international community working on the interactions between urbanization and GEC. The Science Plan was not intended to be addressed fully by UGEC research. Rather, it was intended as an initial contribution to creating coherence in dispersed and fragmented research agendas. Its focus on the dynamic bidirectional interactions between urban areas and GEC is still a useful research framework (see Figure 1). UGEC undertook regional initiatives to enhance its presence and visibility but neglected to communicate the Science Plan broadly and to foster a feedback process to enrich and update it periodically. In hindsight, UGEC also missed the opportunity to use its Open Science Conferences better as a tool to enrich and update the Science Plan and the core project’s activities. This is a lesson perhaps useful to other GEC projects. It is important to update the initial Science Plan or equivalent foundational document periodically in order to take advantage of new knowledge and emerging ideas in the international scientific community. There is no perfect plan,
particularly when it addresses complex research areas where large volumes of new knowledge are produced every year. Periodic updates of the plan would have strengthened UGEC’s research agenda.

In the same vein, UGEC Open Science Conferences and UGEC’s international workshops created opportunities to develop interdisciplinary initiatives to strengthen UGEC activities. These initiatives could have been particularly relevant to transcend research based on city-specific case studies and foster the development of conceptual and methodological frameworks still needed to improve our knowledge on the complex interactions between UGEC. UGEC’s Science Plan provided a good departure point in this direction but as mentioned above, it required a concerted and permanent effort during the lifespan of the project. We believe future international initiatives through a follow-up project of UGEC, FE, or through other efforts should provide more attention to strengthen their conceptual and methodological frameworks to study GEC.

7. Moving forward and recommendations for the future of urbanization and GEC

The UGEC experience, like that of other IHDP core projects (e.g. Sygna et al. 2013), has demonstrated the cost-effective value of such scientific co-ordination networks operating over a long enough time period to be able to demonstrate broad impact in evolving research and policy priority areas. Despite funding constraints and some missed opportunities, the core project’s continuity and convening power, allied to engagement by leading and emerging figures from different continental regions, has facilitated the building of some robust networks using specific workshops and themed conferences to develop leading edge debates and publications.

Increasing urbanization processes and climate change uncertainty will continue to modify the environment at multiple scales by altering the hydrological and carbon cycles, land use and cover and biodiversity (Grimm et al. 2008a), with clear and often unequal implications for urban communities and populations, particularly in poorer countries (Satterthwaite et al. 2007). Profound environmental changes occur where urbanization is rapid (e.g. sub-Saharan Africa; East and Southeast Asia) (Martine et al. 2008; United Nations, Department of Economic and Social Affairs (UNDESA), Population Division 2014), but poverty and lack of infrastructure and social/governance institutions make it difficult to cope (Parnell et al. 2007). There is a large, urgent opportunity to influence the urbanization trajectory and underlying processes that result in built urban infrastructure and supporting systems before irreversibility and lock-in occur (Romero-Lankao et al. 2014; Sánchez- Rodríguez 2015). It is important to continue exploring ways that this great force of urbanization can enhance global sustainability in resilient and equitable ways.

One lesson from UGEC (to be elaborated in a separate paper) is that in order to build a better understanding of the interactions between UGEC, particular emphasis should be placed on:

- opportunities to expand and improve the construction of knowledge due to the evolution of parallel and unco-ordinated research agendas, particularly between the abundant and rapidly expanding literature on urban issues and the environmental literature addressing diverse dimensions of GEC (ecosystem services, low-carbon cities, adaptation to climate change, resilience and vulnerability among others);
- the construction of new imaginaries of urban areas for the twenty-first century in the context of globalization and GEC. Sustainable cities, eco-cities, resilient cities, low-carbon cities, productive cities, green cities, inclusive and fair cities and intelligent cities are responses to growing expectations and demand on urban areas but they are also competing imaginaries. The analysis considers their common elements in an effort to contribute to future research agendas.

Emerging research points to the importance of continuing such efforts and greater disciplinary integration moving forward. For example, the UGEC community has begun to understand the driving forces responsible for development patterns and processes in cites and their effects on other biophysical systems, such as the carbon cycle (Marcotullio et al. 2014) or hydroclimate (Shepherd 2013). This includes how specific types of GEC and resulting impacts (e.g. heatwaves, floods or drought) affect local and regional processes and conditions (e.g. poverty, economic activities and migration patterns), with implications for urban well-being (e.g. human and ecosystem...
health, livelihoods, quality of urban life) (Seto and Solecki 2016). Second, although many cities are at the forefront of climate change adaptation and mitigation responses, local actions to address climate change are moving faster than our capacity to understand the effectiveness, benefits and unintended consequences of those actions (Sánchez-Rodríguez 2012; Carmin et al. 2013). Thus, investigation of the policy and political dimensions and dynamics that shape urban responses (e.g. why and how decisions are made that affect urban climate responses and development, and the underlying influences of power, political processes and actors) would offer a significant contribution.

Such insights might help to identify the intervention points that could help transition urban areas to lower carbon development pathways that are equitable and just (Geels 2014; Marcotullio et al. 2014). Third, it is well understood that global environmental variability and change (including weather extremes, climate change and biodiversity loss) and urbanization put pressure on local and regional environments (e.g. air and water pollution, or land degradation), having multiple implications for societies (Grimm et al. 2008a, 2008b; Romero-Lankao et al. 2013). However, increasing social–ecological resilience in urban areas will depend on understanding vulnerability and risk as they relate to food, energy, water and the climate linkages that occur at multiple scales. This understudied arena would benefit from contributions and coordination among diverse disciplines such as health, natural, physical and social sciences (urban and regional planning; meteorology, climatology and atmospheric science; disease ecology; and human geography). Finally, in a world where poverty and inequality are likely to worsen in many areas, prioritizing research that seeks to enhance the capacities of the urban poor is essential. Looking deeper into GEC interactions with human security and vulnerability would be a key contribution, in particular, to the implementation of the urban SDG and its targets to ‘make cities inclusive, safe, resilient and sustainable’ (UN (United Nations) 2015).

Distinct from the science agenda as such, one particular success has been the training and involvement of younger scholars through targeted involvement in our activities alongside senior researchers but also through bespoke training workshops, often linked to IHDP Open Meetings or UGEC SSC meetings in order to maximize synergies and the value of travel funds being used. Several now well-respected researchers from different regions are graduates of these workshops. Second, particularly during UGEC’s later years, progress was also made in attracting some non-academic researchers and practitioners into transdisciplinary collaborations around disaster risk reduction and climate change action, in particular. This remained limited, however, in part because of the severe time constraints and specific priorities facing practitioners, but the transition process into the emergent FE provided renewed opportunities through specific committee mechanisms and the provision of travel funds to enable participation in planning and launch meetings.

The origins of FE lie in demands from the Belmont Forum of GEC research funders that the previous programmes like IHDP, DIVERSITAS and IGBP needed to integrate their agendas and secretariats in order to continue to receive funding. This reflects the twin pressures of financial constraints in the major donor countries and a strong perception that greater inter-and multi-disciplinarity is required to make the next generation of breakthroughs. Following a few years of intense negotiations, FE formally came into being in 2014/2015. UGEC participated actively in the process, from having one of its co-chairs (Roberto Sánchez- Rodríguez) serve in the negotiating team, to submitting a successful bid for funding to the interim Science Committee that enabled a transition team led by former UGEC and Diversitas SSC members and IPO staff to consult widely and produce a framework for an urban component within FE. The permanent FE SSC designated urban as one of its first suite of thematic priorities and accepted the report, the recommendations of which have now been subsumed within the emergent Urban Knowledge–Action Network (UKAN) – http://futureearth.org/future-earth-urban. Through the UGEC team’s engagement with the transition process into FE, considerable efforts have been made to lay the foundations for continued recognition of the importance of urban dynamics and agendas within ongoing GEC research and engagement.

Current efforts to update and improve GEC research under FE and other international initiatives can benefit from decades of operation of previous GEC projects. The lack of attention to disseminating lessons learned not only from the outcomes but also from the operation and implementation of previous projects can help both current and future research. The analysis of the decade of UGEC operations
provided in this paper constitutes one contribution to this end. A critical examination of the design, operational components and outcomes of GEC research projects is not only relevant but also indispensable to help science deliver the contributions expected and needed in societies to address the challenges of the twenty-first century.

Notes

1. Future Earth merged DIVERSITAS, the International Geosphere–Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP).
2. This comprised Roberto Sánchez-Rodríguez (SC member and University of California Riverside), Frauke Kraas (Cologne University), Gregor Laumann (IHDP Secretariat) Karen Seto (Stanford University), David Simon (Royal Holloway, University of London) and Bill Solecki (Hunter College, City University of New York).

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