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AN IHDP CORE PROJECT

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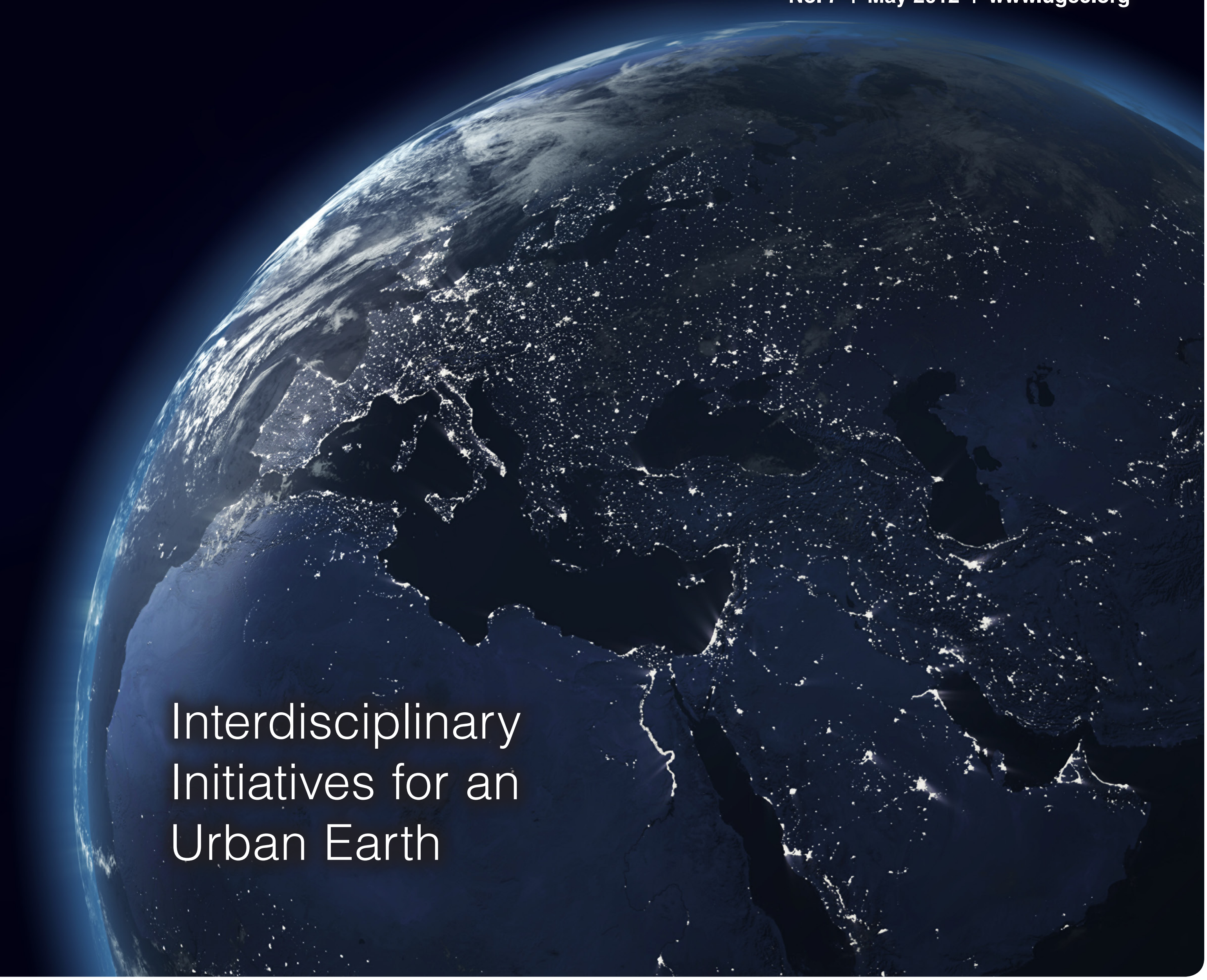

Interdisciplinary Initiatives for an Urban Earth

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Editorial

Dear friends of the UGEC project,

The seventh issue of *UGEC Viewpoints* is inspired by the discussions held during the recent 'Planet under Pressure 2012' conference about the future of Global Environmental Change research. Naturally, many discussions revolved around the new reorganization of activities within 'Future Earth'. With this issue we attempt to showcase a small sample of 'Interdisciplinary Initiatives for an Urban Earth'. We have tried to exhibit new integrative research that meets the needs of stakeholders at different scales – stakeholders who are currently struggling with addressing both challenges and opportunities of global urbanization and environmental change.

The current issue of the UGEC Viewpoints is of special importance to me because this coming August marks the end of my journey as the Executive Officer of the UGEC project. This editorial offers me the chance for a short reflection over the past 5+ years. First of all, I'm grateful for the wonderful opportunity to be part of a stellar and generous group of international scientists and practitioners at the forefront of urbanization and global environmental change issues. This group includes past and present members of the UGEC Scientific Steering Committee, Project Associates and UGEC endorsed projects, an amazing colleague and friend at the UGEC IPO, UGEC partners, past and present members of the IHDP Secretariat and its Scientific Committee, past and present IHDP core project EOs and SSC members, and the many scientists working in the UGEC theme around the world. Special thanks go out to the co-chairs of the UGEC project, Roberto Sánchez-Rodríguez and Karen Seto, for their continuous and unwavering support during all phases of the project.

The UGEC IPO – together with its growing network – has worked hard towards solidifying the UGEC science and practice identity in the past few years. During this period attention to the challenges and opportunities presented by global urbanization has significantly increased. I personally believe that UGEC has had an important role to play in this process. Credit of course goes to our funders: UGEC operations have so far been possible through the generous support of the U.S. National Science Foundation and our gracious hosts at Arizona State University. I sincerely thank everyone at ASU who has supported and assisted the UGEC project in achieving its goals.

The list of activities, products and outcomes from the project so far is long so I urge you to continue visiting our webpage at **http://www.ugec.org** for the most up to date information about the project. I look forward to being involved with UGEC in the future, working towards new science and improved practice on various urbanization and global environmental change themes. I wish my soon to be identified successor all the very best. Science coordination is challenging, but very rewarding work. I'm confident that the IPO will continue to be in good hands in the years to come!

Enjoy reading the 7th issue of *UGEC Viewpoints*!

Best regards,

Michail Fragkias
UGEC Executive Officer

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Germany, Rhine River Valley

The Importance of Ecosystem Services for Urban Areas: Valuation and Modelling Approaches

Dagmar Haase

We are living in an increasingly urbanized world (UN Habitat, 2010). Currently, more than 50% of the world's population (approximately three billion people) live in urban areas (Kabisch & Haase, 2011) and urban economies generate nearly 95% of the global GDP. Urban lifestyles will increase both in number and importance due to the growing total urban population and increased proportion of population living in urban areas worldwide (TEEB, 2011). It is estimated that in the near future almost two billion more people will move to cities (UN, 2011), with urban expansion occurring even faster than pure population growth. Most of this urbanisation will occur in the Global South (Seto et al., 2011). Along with population growth, inequalities of wealth and income distribution, and energy consumption are also likely to increase (Sahakian & Steinberger, 2011). This increase in magnitudes and rates of growth and resulting impacts will more than ever before stress cities and their ecosystems (Satterthwaite, 2009). As such, it is imperative that ecosystem services are appropriately valuated and incorporated into urban management, as cities and their inhabitants increasingly depend on healthy ecosystems – the foundation for human health and well-being (Guo et al., 2010).

Meaning and value of urban ecosystem services

Regardless of the multiple impacts humans have on the natural environment of cities, urban areas also provide a range of benefits to sustain and to improve human life; these are known as urban ecosystem services (TEEB, 2011). Although urban ecosystem services have been classified differently, they are most commonly divided into four categories: *provisioning services, regulating services, habitat* or *supporting services*, and *cultural services* (TEEB, 2011; Cowling et al., 2008). Provisioning services involve the material outputs from ecosystems including food, water, medicinal plants and other resources. Regulating services act as regulators, e.g., regulating the quality of air and soil or by providing flood, storm and disease control. Habitat/Supporting services underpin almost all other services, as they provide living spaces for organisms. Supporting services also maintain a diversity of different breeds of plants and animals. Cultural services include the non-material benefits and enhancement of well-being that people obtain from their interactions with ecosystems. These include aesthetic, spiritual and psychological benefits as well as tourism (TEEB, 2011).

Healthy ecosystems are the bases for sustainable life in both cities and urban regions, undoubtedly determining, influencing and affecting human well-being and most economic activities (Ash et al., 2010). But, urbanisation creates impervious surfaces, destroys fragile wetlands, fragments ecosystems, endangers species, and has severe impacts on the carbon cycle through changes in the net primary productivity of affected ecosystems (Nuissl et al., 2009; Vitousek, 1997). Contemporary cities are therefore far from achieving a resilient or sustainable urban form in terms of energy balance, material flows and counteracting urban heat waves. An expanding number of growing cities also means rapidly increasing demands for land, food, freshwater and energy. And, it is still unclear how an individualising and ageing population, as we find it in the western developed world and in China, will alter this demand.

Spatial scales of urban ecosystem services

Cities cannot fully satisfy their demand on ecosystem services from only the services and ecosystem functions provided in their immediate area (Cox & Searle, 2009). Additional ecosystem services are available in the peri-urban regions around cities as well as in regions scattered across the globe. Current research has begun to address urban teleconnections, which in this case refers to the distal flows and connections of people, economic goods and services, and land use change processes that drive and respond to urbanisation. In this sense, cities and their regions are connected to and dependant on other regions, even in other continents, as well as being connected across different spatial and temporal scales. Synergies, trade-offs and net-losses (Rodríguez et al., 2006) of ecosystem services thus do not only occur in a specific region but must be considered in terms of these connections.

Valuation of urban ecosystem services

At the same time and due to the fact that ecosystem services are utilized within urban areas, cities have the chance to make some very positive changes, saving on municipal costs, stimulating the economy, enhancing quality of life and securing livelihoods (TEEB, 2011). The critical role that ecosystem services play in cities' economies is often taken for free (Gómez-Baggethum et al., 2010). It is necessary to maintain the urban natural environment because there is a tipping point at which degraded ecosystems will cease to supply the services the city relies upon, and it can be very expensive, time-consuming, or sometimes impossible to restore the ecosystems and/or find an alternative technical solution (Gómez-Baggethum et al., 2010). Therefore, ecosystems need to be included as a factor into urban planning, management and budgets (TEEB, 2011). By identifying the benefits that ecosystems provide, and by recognizing the value of these benefits, an urban society might be able to move towards creating a sustainable city.

Quantifying and modelling urban ecosystem services

For transitioning to a sustainable city, it is crucial to consider the ecological, social and economic aspects of urban land management alike. Therefore, any kind of quantification and modelling of urban ecosystem services must ensure this by integrating monitoring, modelling, indicator development, and valuation of land use/ management practices. Particularly with respect to urban areas, assessments of ecosystem services, including their quantification and modelling, become difficult due to the fact that we have complex land use patterns, resulting in a full range of overlaying ecosystem functions and needs/demands that urban dwellers have on them (Kroll et al., 2012). Additionally, urban land use can change in comparatively short periods of time. Consequently, urban ecosystem services can support but also impair each other and thus produce a full range of synergies and trade-offs.

But how do we best approach a quantification of urban ecosystem services supply and demand? Model-based analysis of (urban) ecosystem assessments currently lacks support in scale-adequate model development. The simulation of ecosystem functions along with land use patterns for ecosystem assessments can either be performed on a very coarse scale and with highly aggregated models such as InVEST, GUMBO or MIMES (Seppelt et al., 2009), or with highly complex and partially empirically based modelling systems which require a high degree of parameterization that is often difficult to provide with adequate quality (Strohbach & Haase, 2012; Bowler et al., 2010). For capturing the major variables of an urban (eco-)system on the one hand and to solve the data-availability problem on the other, the development and use of more generic models with demonstration sites across the globe needs to occur for modelling urban ecosystem services.

Generic models that approximate relevant urban-regional or local scale processes with adequate complexity need to consider limitations of data availability and incorporate meta-analyses of available scientific results. Such models have to be built upon available, well-tested, and robust regional and local scale models for core urban ecosystem services and/or regression model-based

Table 1 I Urban ecosystem services, their meaning and ways to model them (according to TEEB, 2011; modified and extended for the urban context)

Type	Service	Meaning	Modelling Approach
Provisioning	Food	Conditions for growing food	Statistical models; yields
	Raw materials	Materials for construction and fuel	Carbon storage and forest growth models
	Fresh water	Surface and groundwater	Physical and empirical water balance models
	Medicinal resources	Traditional medicines and input for pharmaceutical industry	Habitat and population models, genom, DNA sequences
Regulating	Local climate, air quality regulation	Trees provide shade and remove pollutants; forests influence rainfall; green spaces provide transpiration cooling	Empirical models of the effects of tree shade (Bowler et al., 2010); iTree http://www.itreetools.org/
	Carbon sequestration, storage	Trees/plants grow and remove CO_2 from the atmosphere	iTree, UFORE; laser scanning, allometric equations (Strohbach & Haase, 2012); InVEST
	Moderation of extreme events	Ecosystems buffer natural hazards (floods, landslides…)	2D/3D inundation models, risk assessment models
	Waste-water treatment	Microorganisms in soil/wetlands decompose human waste	Destruction curves and metabolic models
	Erosion prevention, soil fertility	Ecosystems prevent land degradation and desertification	USLE, SWAT, SWOT, CANDY
	Pollination	Many global food crops depend upon animal pollination	Empirical models, InVEST, individuum-based models (IBM)
	Biological control	Regulation of pests and vector borne diseases	Distribution models, IBM
Supporting	Habitats for species	Provision of survival place for individual organisms	InVEST, Biomapper, regression models
	Genetic diversity	Basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock	Genom, genetic footprint, DNA sequences, diversity indicés
	Soil filter	Secures clean water	SWAT, SWOT
	Buffering capacity	Buffers acid and alkaline inputs	Acid and base neutralisation capacity
	Nutrient delivery	Creates, transforms and provides nutrients to organisms	SWAT, SWOT, CANDY
Cultural	Recreation, mental & physical health	Maintenance of mental and physical health, stress alleviation	Distance and accessibility models (GIS-based), URGE
	Tourism	Considerable economic benefits and vital source of income	Cost-distance models, hedonic pricing
	Aesthetics and inspiration	Language, knowledge, appreciation of the natural environment	Hedonic pricing, surveys, interviews, landscape architecture, art (e.g., paintings)
	Spiritual experience, sense of place	Common element of all major religions, local identity, sense of belonging	Surveys, interviews, map or list of sacred places

meta-analyses from empirical studies (see Larondelle & Haase, 2012; Strohbach et al., 2009). Moreover, quantifying trade-offs and synergies between different urban ecosystem services, ecosystem services and human-well-being and urban economics at local to regional scales supports identifying alternative land use choices in both disaggregated and more stylized forms. Integration must be carried out mainly by developing and using a model-based indicator framework (Table 1) where modelling results will be merged into integrative maps (Figure 1). Such maps will greatly support discourses amongst scientists and urban planners and policy makers.

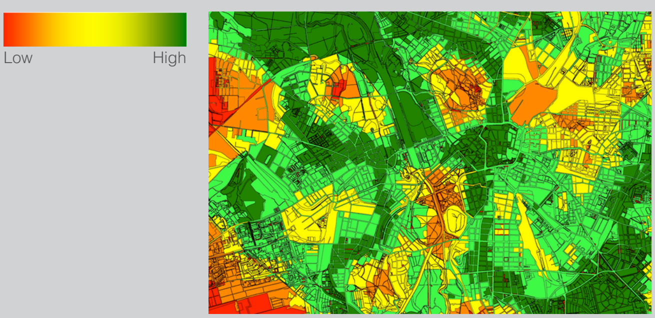
In cooperation with urban economists, modelled patterns of urban ecosystem services can be transformed into socio-economic benefits and values, e.g., using willingness-to-pay surveys, hedonic pricing or determining transfers of goods from the urban to the rural (Lautenbach et al., 2011) or to distal systems.

Figure 1 | Modelling and mapping urban ecosystem services using four core services in Leipzig, Germany (Haase, 2009; Strohbach & Haase, 2012)

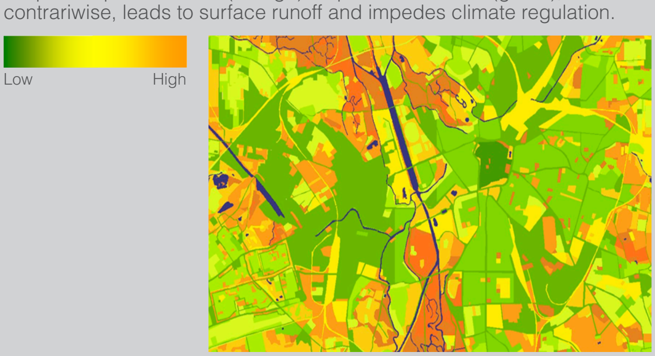
Flood regulation (mm run-off water) Impervious (red color) land cover hinders rainfall infiltration and flood regulation which is provided by open or vegetated soils (green).

Carbon sequestration (MgC per hectare) Urban forests and trees are able to sequester and to store CO_2 in the form of C in their roots and thus help to remove it from the atmosphere and to lower the carbon footprint of a city.

Habitats for species (Green woodpecker) Urban structure types with a heterogeneous build pattern, e.g., 19th century-type buildings that border floodplain forests (green), provide optimal habitats for urban species such as the green woodpecker.



Local climate regulation (mm ETP) Urban green spaces such as forests or parks provide local climate regulation and cooling by tree shading and evapotranspiration flows (orange). Impervious surface (green), contrariwise, leads to surface runoff and impedes climate regulation.



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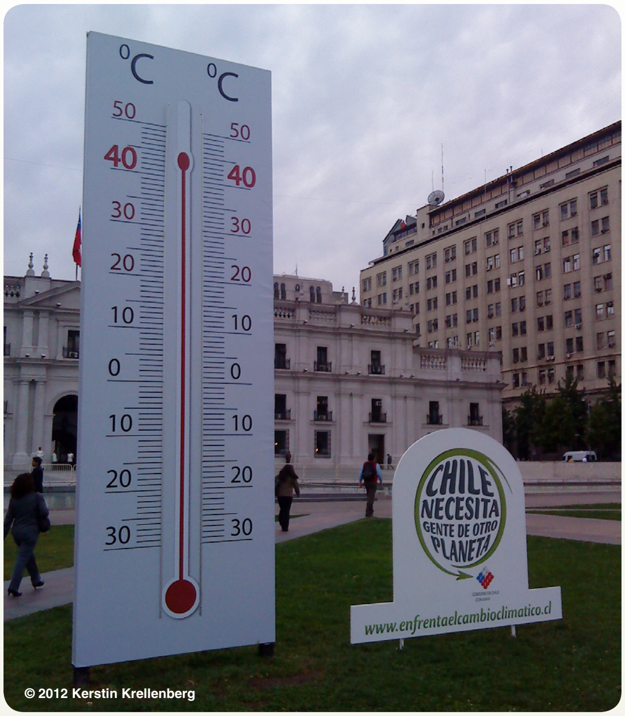

A sign reading 'Chile needs people from another planet' shows that climate change awareness is on the rise in Santiago.

Adaptation at the Urban-Regional Level in Santiago de Chile — A Science-Policy Research Approach

Kerstin Krellenberg

In the Metropolitan Region of Santiago de Chile (MRS) climate change has not yet achieved much attention socially or politically, although its impacts are already perceptible today. It is only at the national level that a Climate Action Plan has been developed as a short-term response (2008-2012) to the priorities and objectives of the 2006 National Climate Change Strategy, but adaptive response action at an urban-regional level has yet to emerge (Krellenberg et al., 2010). To address this gap, the Climate Adaptation Santiago (CAS)[1] project has developed an interdisciplinary and transdisciplinary science-policy research approach of which the outcome will be a regional climate adaptation plan with concrete adaptation measures to be incorporated into the budgets of the institutions responsible for the development of a regional climate change strategy – the Regional Government (Gobierno Regional – GORE) and the Regional Secretary of the Ministry of the Environment (SEREMI MedioAmbiente – MMA). This strategy will be ready for implementation in 2013.

Challenges for climate change adaptation in Santiago de Chile

The existing Chilean National Climate Action Plan, which is sectoral in nature and has a strong focus on mitigation activities, outlines areas in which precise plans should be developed by year 2012. The need to generate regional climate action plans is clear (Chile consists of 15 Regions, including the Metropolitan Region of Santiago), but the ways in which these will coincide with the existing national plan remains uncertain. As such, a science-policy research approach is key for the development of a regional climate adaptation plan for the Metropolitan Region of Santiago de Chile which consists of 52 urban and rural municipalities and roughly seven million inhabitants.

Presently, regional and local actors in Chile are only very loosely engaged in climate change discourse, despite the fact that responses to climate change impacts evolve within local-level

1 The *ClimateAdaptationSantiago* (CAS) project is funded by the International Climate Initiative of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). For further information see http://www.climate-adaptation-santiago.ufz.de.

institutions. Consequently, the development of an adaptation plan with concrete adaptation measures at an urban-regional level proves challenging. What is more, an overall guiding instrument to shape sectoral and territorial policies, plans and investments, especially on a regional level, is still absent in the MRS (Barton & Kopfmüller, 2012). The same holds true for the science of local climate change and its impacts. On the other hand, a new national-level environmental institutional structure was implemented in 2010 as a result of legislation that specifically addresses climate change, mandating that "the Ministry shall be especially responsible for proposing policies and formulating plans, programs and plans of action in the area of climate change" (Art.70, letter h of Law 20.417 of 2010).

The CAS science-policy research approach

According to the IPCC (2007), the CAS science-policy research approach can be described as a form of anticipatory, public and planned adaptation. It includes a.) an impact and vulnerability assessment of climate changes that identifies and specifies the need for action, and b.) a participatory process to include decision-makers who will develop and put adaptation action onto the political agenda. For the MRS, this policy process is innovative. It allows for a common level of understanding of climate change science amongst different local, regional and national stakeholders. About 20 key institutions from public and private sectors, and civil society are intensively involved through Round Table meetings - a participatory process that bridges science and policy by fostering a collective response to climate change. Both GORE and SEREMI MMA, which are the key institutions for implementing the Regional Climate Adaptation Plan, are actively taking part in its development.

Participation in a CAS Round Table Meeting, Santiago

This approach which carries the development of the regional climate adaptation plan is based on different concepts and methodologies from both natural and social sciences. Adaptation as a mainstream strategy for climate vulnerability has developed rapidly over the last few years, but a systematic approach to monitoring and evaluating climate change adaptation has yet to emerge (Preston et al., 2011). According to Klein et al. (2003), adaptation requires an understanding of the vulnerability of societies and ecosystems, their capacity to respond to impacts, and the socio-economic costs of adapting to climate change.

Impact and vulnerability assessment of climate changes

Undertaking a climate change impact and vulnerability assessment has been an essential component of the CAS science-policy approach which builds upon downscaled information of the major climate changes at the urban-regional level in Santiago de Chile. This natural science-based information is new in its spatial extent and largely contributes to existing knowledge regarding climate change in the MRS. Regional climate changes are estimated for the window of 2045-2065, applying a statistical downscaling (Wilby et al., 2004) based on the probability distribution of hydro-meteorological variables. The results predict that the MRS will be dryer and hotter, with a high number of days with extreme temperatures and increased drought during winter and summer (McPhee et al., 2012).

Additionally, based on these estimations, the current and expected future impacts for the year 2050 in the fields of energy, water, and land use were assessed applying an explorative scenario approach adopted from Kopfmüller et al. (2009). The results clearly show the need for action, like in the case of land use (changes), where a strong linkage between ongoing urbanization processes, flood and heat hazard generation and climate changes can be observed. Following the urban vulnerability concept developed by Kuhlicke et al. (forthcoming), the CAS project focuses on the assessment of hazard exposure in the context of housing and socio-economic conditions of the population, rather than conducting a full urban vulnerability assessment which is due to difficulties in data availability.

The analysis reveals the need for adaptation in order to decrease exposure of people and housing infrastructure. Based on these results and international cities' experiences, concrete adaptation measures have been developed and are then analyzed by Chilean experts to assess their implementation feasibility while taking existing and potential future conditions, i.e., institutional, legal, financial, etc., into account.

Participatory process

The process of linking science and policy involves an awareness of the complex ways in which existing instruments have been designed and implemented, the limitations and opportunities for incorporating climate change dimensions, and the politics of the process itself. Therefore, connecting potential adaptation measures closely to existing policy and management is very crucial (Dovers, 2009; Corfee-Morlot et al., 2011). For Santiago, this is especially important as no additional resources for specific climate change measures are available to date, and it is still unclear if existing funds such as the national fund for regional development (*Fondo Nacional de Desarrollo Regional*) may be used for this purpose.

Transferring scientific results to local practitioners and integrating their knowledge are essential components of the decision-making process (Roux et al., 2006; Sánchez-Rodríguez, 2009). In this regard, the idea of collective action has a long tradition. According to Adger (2003), adaptation strategies to climate change are equally dependent on the ability of individuals and communities to act collectively and involve intervention and planning by the state. The importance of collective action and building social capital have been noted as important elements within institutional processes for enhancing climate change adaptation capacity (Adger, 2003). The Santiago approach involves an intensive participatory process that includes representatives of relevant public authorities from different administrative sectors at national, regional and local levels as well as private entities and NGOs in a series of Round Table meetings from the very beginning. This process results in more robust strategies over multiple governance levels and sectors. Here, existing measures related to climate change for the MRS are evaluated and prioritized, and a set of climate change adaptation measures proposed by scientists are discussed, further detailed and developed in a collaborative manner. Stakeholders are encouraged to reflect on their knowledge and experiences, and to discuss priority action areas, obstacles, barriers and challenges, feasibility, as well as policy implementation and monitoring. A common framework of understanding is supported by briefing and working papers prepared by scientists. The involvement of GORE and SEREMI MMA as key partners in the project assures a strong institutional backing and a high level of legitimacy as a policy-planning process.

Santiago de Chile

Lessons learned from Santiago and Latin America

Reflecting on the achieved outcomes of the science-policy approach discussed here thus far, it can be stated that both the participatory process and adaptation actions have led to a wider consciousness about climate change, impacts and particularly, adaptation. The participatory process has helped to open up dialogue on the topic between sectors and administrative levels (e.g., regional and national). The participation of key stakeholders in the process is well-established and active involvement is taking hold. The interest in concrete, quantitative, up-to-date and available scientific information is tremendous and shows that despite inherent uncertainties, it is regarded with high importance, however, must to be communicated appropriately so that a shared understanding is achieved (Smith et al., 2011).

According to Corfee-Morlot et al. (2011), this open, local and participatory process exemplifies the type of collaborative process which provides the foundation for the evolution of collective responses to climate change including both science and policy circles. According to Bulkely & Newell (2010) and other scholars, climate change policies are especially complex due to the involvement of political decision-makers at multiple scales and the changes required in policy, plans and investments. Despite the added emphasis on local adaptation, it is still evident that the multi-dimensional, crosscutting nature of climate change poses significant challenges for local governance, in which there is "a lack of 'fit' between the nature of the problem to be governed and the institutions undertaking governance" (Betsill & Bulkeley, 2007).

Bearing this in mind, the activities and achievements of the CAS project are just a first step forward. It is important to guarantee the commitment of continual learning, exchange and financial resources in order to achieve appropriate implementation of concrete measures necessary to respond to climate change impacts over time. In addition to Santiago, the CAS project contributes to the building of capacity for developing adaptation measures in five other Latin American cities (Mexico City, México; Bogotá, Colombia; Sao Paulo, Brazil; Buenos Aires, Argentina; and Lima, Peru) through the Regional Learning Network of scientists and decision-makers. These efforts have proven beneficial for increasing the potential of effective and long-lasting implementation of short-term political objectives through learning from experiences, both positive and negative, across cities.

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Building Stakeholder Collaborations through Innovative Data Sharing: The J-Earth Project

Lela Prashad, Scott Dickenshied, Shay Cheeseman and Philip Christensen

Climate change is a notable example of the complex challenges facing cities today that impact the entire urban system and require a wide range of applied expertise. In order to understand future outcomes and develop solutions to these challenges, cities aim to create meaningful partnerships between urban decision makers, physical and social scientists, engineers, and the public and private sectors. Collaboration on an issue such as climate change adaptation requires not only dialogue, but also the compilation and analysis of datasets across sectors and disciplines. In order for cities to adequately understand the risk and vulnerability of their populations to potential climate change, decision makers must have access to many different datasets. As a starting foundation, climate model scenarios, satellite imagery, population and demographic information, land use and land cover classifications, and local environmental datasets are needed. Creating actionable information by combining and comparing these data is not a trivial task; not only are urban datasets complex but they are often in different formats and are measured at different scales.

The fact that trans-disciplinary data is necessary for cities to understand their major challenges is an opportunity to develop stronger cross-sector collaboration. It is usually outside the scope of urban decision makers' positions to collect and process this data themselves. Often, outside experts from academia and the private sector contribute their knowledge and skills to create simplified products for urban decision makers. Currently, these experts have no standard way to share and analyze data with each other and with decision makers through a single hub where a complete picture can start to be built.

There are initiatives in development that are attempting to build connections between researchers and practitioners through data. Two notable examples are **The Climate Group's Connected Urban Development** initiative and the **IBM Smarter Cities** project. These projects are focused on improving efficiency in cities to improve services and reduce CO_2 emissions. Arizona State University's J-Earth is a project that has its foundation in NASA data and climate change models. J-Earth is an analysis and visualization platform, open to all, and is being built with the active participation of urban researchers and practitioners.

Figure 1 I The basic J-Earth user interface

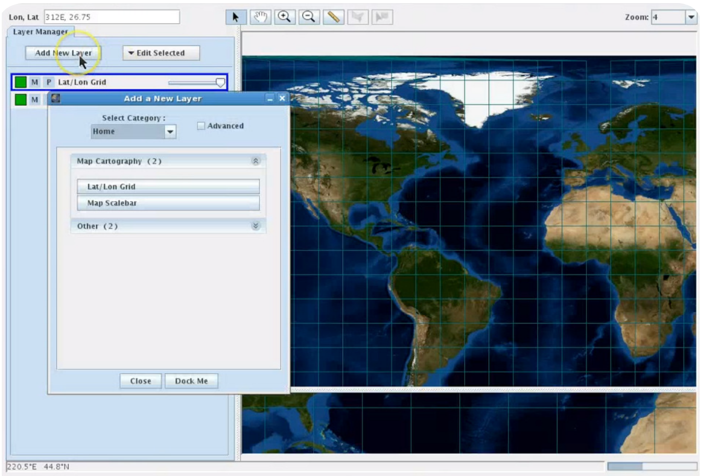
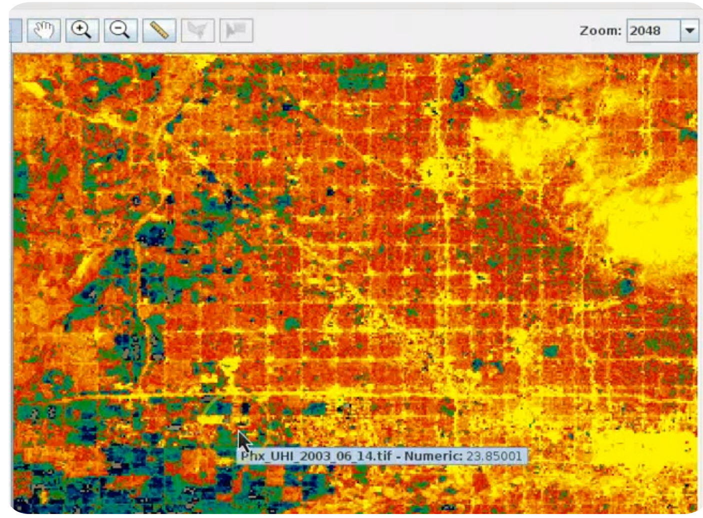


Figure 2 I An example of an urban heat island map in J-Earth made from ASTER satellite remote sensing data for Phoenix, AZ



The Arizona State University (ASU) **100 Cities Project** and **Mars Space Flight Facility** are developing J-Earth with the goal of providing a single platform to facilitate data sharing, visualization, and analysis between scientists, practitioners, students and the public. Urban applications are a main focus for J-Earth, but it is also being designed for physical science applications. J-Earth is a platform composed of a Geographic Information System (GIS), map server and data archive system, developed in the Java programming language. It is free to all users and runs on most common operating systems. It is an open source software project, meaning that its source code is available to users who want to see how it functions and who would like to make additions to the platform.

J-Earth is itself a unique, cross-discipline collaboration. J-Earth is part of the Java Mission-planning and Analysis for Remote Sensing (JMARS) suite of geospatial applications developed at ASU. This suite of software is currently used for mission planning and scientific data analysis by active NASA missions to Mars, the Moon and the asteroid Vesta by scientists, researchers and students of all ages from more than 40 countries around the world. The software suite began in 1998 and has over 55 person-years of NASA-funded development effort.

While it may seem odd to study Mars and cities on Earth with the same tools, NASA researchers have been doing this for decades with multi-spectral satellite remote sensing data. NASA thermal infrared sensors, for example, are used on both planets to map rocks and minerals, and in Earth's cities to map urban building materials and heat island effects.

In cities, satellite imagery is critical for monitoring everyday conditions and studying long-term trends. Urban multi-spectral satellite data is currently used to monitor and forecast weather, measure air and water pollution, measure ecological impacts of development, develop land use and land cover classifications, and analyze urban heat island effects. Since this data is acquired across the globe, independent of political boundaries, at regular time intervals, it can be used to compare cities and regions across time and from global to local scales. Specialized expertise is required to process raw multi-spectral satellite data into a useful map of a city's temperature or pollution patterns. The goal of the J-Earth project is to provide a single platform where researchers and practitioners can easily view and analyze remote sensing data and other datasets to understand problems and make decisions.

The J-Earth platform is a work in progress and the project is actively seeking advice on its functionality and included datasets. The current version of J-Earth was developed in response to the ASU April 2011 joint NASA/NSF-sponsored workshops on forecasting land use change and urban remote sensing (Dell'Acqua et al., 2011). Feedback was received from workshop participants representing city governments, climate modelers, geographers, and urban planners. Previous input on the design of J-Earth for decision making has come from the National Science Foundation Central Arizona Project Long Term Ecological Research Project.

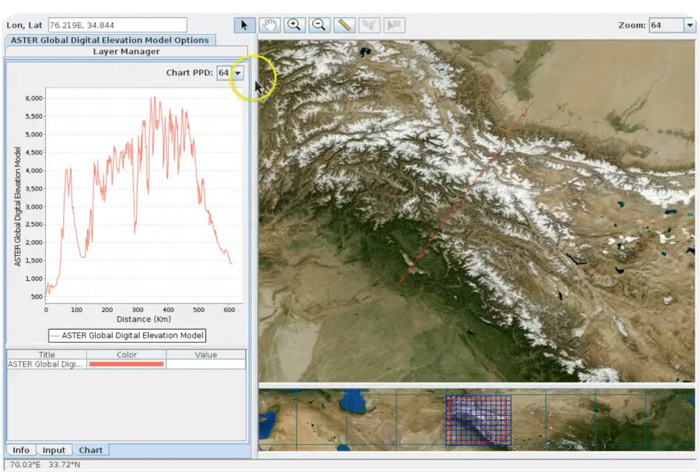
J-Earth currently allows public access to a range of global NASA/NOAA data, including ASTER, Landsat, MODIS, GOES, TIMS and "Lights at Night", in addition to ecological, demographic, climatic and land use/cover datasets. These initial datasets are a starting foundation for J-Earth and will grow based on user input. The project is open to suggestions on further datasets to include on global, regional, or city scales from potential users.

Since J-Earth is intended for users with widely ranging technical skills, J-Earth starts new users off in a "Basic" mode that introduces a few pertinent datasets. All users have the ability to switch to the "Advanced" mode which contains all data publicly accessible within J-Earth. Users can also create custom maps with their own data to share between a group of users or they can keep their uploaded data private.

Through the J-Earth login system, the datasets shown in "Basic" mode can depend on the type of user. For example, urban planners could start with data specific to their city plus satellite-derived maps of vegetation and temperature for their region. A researcher studying demography in global cities could instead start with a gridded global population dataset and a few global climate change model scenarios. The ASU team is currently in the process of developing customized "Basic" start up modes, based on user feedback.

J-Earth includes GIS functionality and analysis tools. Users can analyze multi-variate trends plotted across profile lines and use polygonal areas (shapefiles) to perform statistical calculations upon numeric datasets. These tools allow a user to assess the physical and socioeconomic parameters of the area, including census variables, land cover, surface temperature, topography and elevation. Additionally, J-Earth can be used to visualize change over time, globally, or for a specific area. To visualize changing variables across a region, data can be rendered in 3D using any variable as the "elevation". Data can currently be incorporated in J-Earth starting at sub-meter resolution.

Figure 3 | Datasets can be plotted along a transect in J-Earth – these can be elevation data or any other numeric variable, such as demography, economics or pollution levels



Sharing datasets and conducting analysis together across a single platform can help bridge different sectors and disciplines and generate greater understanding about urban systems. Cities currently have few ways to quantitatively compare their strategies and progress, as there are no standard indicators for comparing solutions. While projects such as the **Global Cities Indicator Facility**, **World Bank**, **UN-HABITAT**, and **ICLEI-Local Governments for Sustainability** have launched initiatives to create common indicators, these are still in development. A collaborative data sharing and analysis platform would not only help individual cities understand and address their own challenges, but would lead to greater comparability of problems and solutions across cities. The ASU J-Earth project provides an opportunity for urban practitioners and researchers to participate in the development of a common data platform for cities (see Table 1). ASU is inviting urban practitioners and researchers to participate in the development of J-Earth. They request all interested parties to test J-Earth and participate in its development. The J-Earth project would like input on datasets to include, suggestions for functionality and design, and the development of urban use cases. Download the most recent version of J-Earth at **http://jmars.mars.asu.edu/download-jearth** and keep up-to-date at the JMARS blog: **http://jmars.posterous.com/**.

Table 1 | How to participate in the Arizona State University J-Earth Project

Download and try J-Earth
Read the JMARS blog
Submit urban data suggestions
Take a short survey on your data analysis needs
Provide feedback on J-Earth

Please contact Lela Prashad at **lprashad@asu.edu** for more information or with questions.

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Flooding in São Paulo, confluence of the Tietê and Pinheiros Rivers

Flood Control and Water Management in Metropolitan São Paulo: Prospects of Integration in the Context of Urban Environmental Change

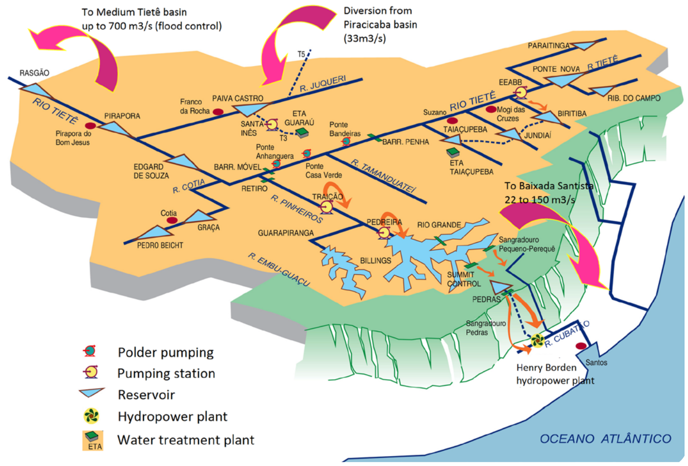
Ricardo Toledo Silva

Floods are the most common and frequent disaster events connected to urban environmental change in Metropolitan São Paulo. The severity and frequency of urban floods are clearly escalating, but to what extent climate change and changing urban structure individually contribute, remains uncertain. There is sufficient evidence of weaknesses in the existing design and operational standards of flood control, which underpins a number of measures meant to offset the increasing risks of cascading failures vis-à-vis other infrastructure services. These measures are: upgrading risk assessment, improving detention capacities, promoting urban resilience and enhancing drainage performance of major channels. Upgraded risk assessment involves refining flood forecasting, a precondition for evaluating climate change effects on the overall urban environmental system. As the scale and scope of complexities of the metropolitan system evolves, cross-sector connections between flood control and other hydraulic infrastructure systems – namely water supply, sanitation and energy safety – begin to emerge. Flood control, as a uni-sectoral and non-profitable infrastructure service, has practically no other source of financing besides the state fiscal revenue. However, it does generate tangible gains for other water uses, if the benefits of safer control are adequately accounted for in cross-sector integration. In this context, growing metropolitan complexity impels the search for joint solutions to problems which are insoluble when separately considered.

Flood control, a permanent concern

Since the late 19th century urban works in São Paulo have dealt with a contradictory relationship of the city and its waters. The fact that the city lies in the upstream area of a river basin, since the Tietê River flows westwards rather than to the coast, implies alternate extremes of water scarcity and severe flooding. Water availability is limited within the 5,985 km^2 basin area, despite a relatively high annual rainfall around 1,450 mm.

Figure 1 | Isometric scheme of the Upper Tietê river basin operation



Source: São Paulo SSE (2010)

However, despite integrated urban water management practices pioneered in the 20th century including the integrative guidelines established in the Upper Tietê Basin Plan, a great deal of improvements are needed to strategically combine water management for quantity and quality and, even more so, urban best practices for sustainability (FUSP, 2002; FUSP, 2009; Braga et al., 2006).

Urban environmental changes

Changing rainfall patterns is not the only responsible factor for the increasingly severe flood events observed throughout the last 10 years. The urban metropolitan structure has changed as well, and these changes clearly have effects not only on the floods themselves, but on all urban water uses.

The first urban centers of São Paulo and surrounding municipalities have generally developed in the best sites regarding flood and landslide safety. Typically, the wealthier occupy the safer and better connected central areas and the poorer communities reside either along the city outskirts or environmentally fragile remnants of central areas unsuitable for urbanization, such as floodplains and steep slopes. New neighborhoods develop next to the older central areas, reproducing similar standards of infrastructural access, continuously enlarging the boundaries of the expanded center. Most of the poorer households formerly living in the expansion area tend to be relocated to more distant outskirts, driven either by economic reward, if legally settled, or by eviction, if illegal.

This urban logic promotes increasing environmental degradation, since the next available land where the poor are able to settle tends to be more fragile than the preceding sites. Socio-environmental vulnerability assumes different forms depending on the specific risks and processes of degradation involved. Situations where degradation mainly affects the inhabitants themselves at these occupied sites – e.g., through direct exposure to floods in the floodplains or to landslides in steep slopes – are different from others where, besides these internal disturbances, there are external impacts – e.g., the pollution of water catchments for urban supply and the intensification of flash floods due to runoff increases. These are the most common external effects of precarious peripheral urbanization. Public policies tend to prioritize interventions in areas where degradation results in external outcomes such as in the case of the latter.

The complexity of metropolitan growth, however, tends to mix and magnify both internal and external outcomes. When two or more local centralities merge, parts of their former peripheries are replaced by the newly expanded center. As a result, this causes an overspill of the poor settlements towards more distant and vulnerable outskirts, except for the remaining enclaves of precarious urbanization on steep slopes and floodplains.

Figure 2 depicts the peripheral concentration of poverty in the metropolitan territory, resulting from the successive merging of centralities. Lighter areas represent smaller percentages of low-income households. The main channels of Tietê and Pinheiros rivers are highlighted to make clear their locations in relation to the metropolitan conurbation. The centrifugal movement of poor settlements is clear, as well as their proximity to major metropolitan water reservoirs and floodplains (compare to Figure 1).

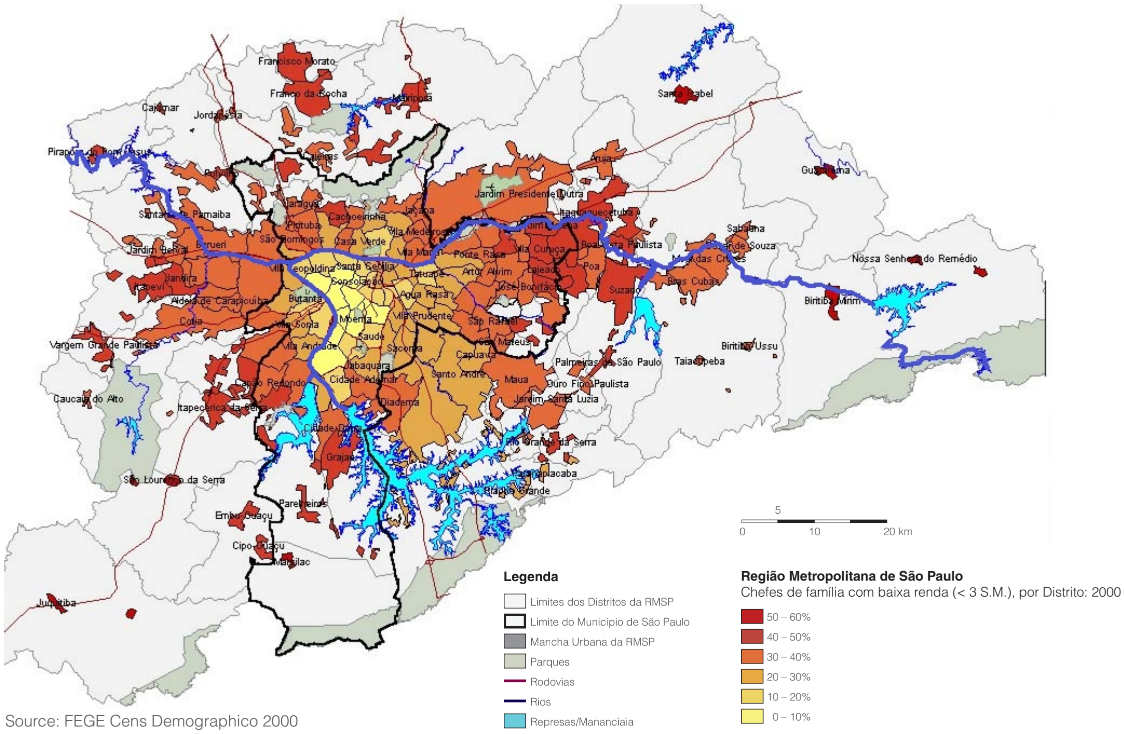
Proposed measures

Four groups of measures, defined upon intensive collaboration between researchers at the University of São Paulo (in particular the Department of Hydraulics and Environmental Engineering at the Polytechnic School) and the technical staff of the State Secretariat for Water Supply, Sanitation and Energy (Barros, 2010; São Paulo SSE, 2010), are presently under implementation: upgrading risk assessment, improving detention capacities, promoting urban resilience and enhancing drainage performance of major channels.

1. Upgrading flood forecasting and risk assessment

The 2009-10 severe floods in São Paulo showed that risk assessment systems were insufficient. Not only were the radar and telemetric stations unable to predict extreme rain intensities with sufficient precision – at a less than 4 km^2 area definition

Figure 2 I São Paulo Metropolitan Area distribution of low-income households (2000)



Source: FEGE Cens Demographico 2000

and more than a one hour prediction – but, more than that, the specific impacts of heavy rains onto the actual waterbeds. Sedimentation and washouts due to urban degradation have changed the hydraulic topology all over the expanded basin territory, consequently changing the assumed relationship between rain intensity and stream flows behind stage-discharge curves. Qualitative general observations and localized quantitative assessments strongly support this hypothesis, but no sufficient systematic and comprehensive data are available to review design parameters. The assessment of primary physical data to support this revision requires detailed field work, now in the scope of the new macro-drainage plan for the Upper Tietê river basin (São Paulo SSE, 2010; DAEE, 2010).

Another dimension to be explored in a new perspective of risk assessment is that between floods and geotechnical instability. Landslides are not so much connected to rain intensities but to rain persistence and soil saturation. The São Paulo State Institute of Technological Research has developed detailed mapping of landslide risks all over the metropolitan territory. But, real time risk monitoring of rain continuity requires further advances in modeling.

Besides the urgent needs on real time control, the improvement of rainfall and hydrologic forecasting considering the present urban and hydraulic topology is a precondition to assess possible specific impacts of climate change. Epistemic uncertainty, associated with incomplete knowledge is different from variability uncertainty, which is inherent (Zevenbergen et al., 2008). In the São Paulo metropolitan complex, targets to measure progress are already set to reduce epistemic uncertainty. Upon this progress, hypotheses of possible variability uncertainties could be more easily proposed.

2. Improving detention capacities upstream the contributing basins

Besides structural measures such as the construction of detention ponds, management practices regarding land use and urban design would also be valid measures to deter contributing flows. But, they have never been counted as potential substitutes to detention ponds due to poor knowledge about their possible performance in the São Paulo metropolitan area, where soils are predominantly impervious. Similar to the knowledge base for topological changes, systematization of the tangible potentialities of best management practices for flood control require heavy field work.

3. Promoting resilience

More challenging than the adoption of best management practices for urban flood control is the promotion of flood resistant solutions from an urban resilience perspective. Experiences noted by Zevenbergen et al. (2008) contrast with the very nature of flooding of urban areas in the Brazilian context.

São Paulo, Brazil

Technological solutions and urban standards for enhancing resilience in relation to floods tend to involve heavy investments. The main reason why socially deprived populations occupy environmentally vulnerable areas is economic, creating a cycle of exposure to escalating risks. In some peripheral settlements in the extreme east of São Paulo, not only the floodplains but parts of the river meanders have been artificially dried by illegal landfilling, creating totally unstable sites. It would be unfeasible to make any attempt to improve resilience in such sites, where floods mix with backflowing waste waters.

As such, if seen not as a localized process but more broadly as an attribute of the metropolitan system, resilience improvement should be considered in the São Paulo metropolitan agenda. One example is the duplication of electricity connections from different distribution circuits on pumping stations and operated dams, to mitigate the cascading risk of flood and blackout. This has been a macro-metropolitan initiative, since some of the emergency circuits have been directly connected to the coastal power plant downhill the metropolitan plateau (EMAE, 2010).

4. Improving drainage capacity on the main channels

There are no real structural improvements to be made in terms of flow capacity in the main river channel, already rectified and deepened to its limits. The nominal capacity of the main channel in the western downstream extremity – of about 1400 m^3/s – is nearly twice the capacity of the channel in the Medium Tietê stream just after the western dam. This means that the control of extreme flash floods shall rely on the buffer capacity of the western reservoir Pirapora, which is actually large, but not so large to support more than 45 days of continuing heavy rain as registered in 2009/10. It is sufficient for absorbing very high instant floods, but it is not equally as efficient to support the overflow of all the saturated detention structures upstream. The only existing solution to the combined effects of extreme flash floods and saturation is via the Pinheiros river channel, operated at an inverted flow.

Current guidelines, combined with backup needs for out-season floods, require a capacity increase on reverse flow pumping that would never be covered by the flood control budget. Should reversion apply not only for flood control but also for dry season operation and electricity generation up to the full capacity of the coastal power plant, part of these costs could be covered by the sale of electricity.

Studies on technological alternatives for depollution, however, have shown that complying with water quality standards has not been affordable (FCTH, 2009). The extra costs of advanced technology would possibly be covered only in the prospect of wider cross-sector cooperation, involving energy safety, water supply, sanitation, urban development and macro-metropolitan environmental recovery. As pointed out in a previous analysis (Silva, 2011), environmental agendas are very efficient in linking important global issues to local priorities. But they generally disregard the metropolitan and macro-metropolitan scales in between.

Conclusions

The combined changes observed both in the hydrologic regime and in the urban structure at the metropolitan scale were sufficient to identify priorities regarding flood control and integrated water management. It is clear that neither the state authorities nor the scientific community have enough information to establish precise causal relationships regarding these changes. But this cannot justify a passive attitude vis-à-vis their tangible adverse impacts.

In practice, decisions must be taken before the maturation of relevant scientific knowledge.

Evidence explored in this article mixes advances in scientific research and operational observation in an ongoing process of mutual feedback. There is sufficient information to support immediate measures for preventing new forms of vulnerability as well as reshaping strategic priorities of flood control in its wider integration with water and urban management. This does not exclude further refinement of both strategies and practices, consistent with the advances of the knowledge base.

The escalating socio-environmental challenges of the metropolitan area are not responsive, anymore, to sector based initiatives. Apart from cross-scale integration, beyond the global-local duality, it is crucial to promote effective forms of *cross-sector integration* between different networks sharing common water resources and the metropolitan hydraulic infrastructure.

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Urban agriculture in Dar es Salaam, Tanzania

Building Capacity for Understanding, Managing and Reducing Risks and Vulnerabilities in Urban Areas

Jon Padgham and Clark Seipt

Half of the world's population currently reside in urban areas and virtually all of the projected 2.5 billion increase in human population over the next few decades is expected to occur in the developing world's urban areas. High birth rates in urban areas as well as accelerated rural to urban migration are driving urban growth, with the highest annual rates of growth occurring in Africa and Asia. These regions face significant adjustment pressures, which will be compounded by risks from climate change.

The constellation of issues around global environmental change (GEC) and urbanization constitutes one of the fastest growing areas of the Global Change System for Analysis, Research, and Training's (START) portfolio in Asia and is becoming an increasingly important focus of START's work in Africa. START supports and carries out a number of activities each year with the aim of building adaptive capacities for managing and reducing risks and vulnerabilities in urban areas related to the interactions of climate change with other drivers of global environmental change, including rapid urban growth. This article highlights START programs on urban and peri-urban agriculture, Asian coastal megacities and disaster forensics.

Urban and peri-urban agriculture

Food security is a paramount challenge in rapidly urbanizing regions of the developing world, where the urban poor typically allocate more than half their income to food (Cohen & Garrett, 2009). Therefore, strategies to strengthen urban food systems and bolster food security in urban centers will take on increasing urgency as climate change and rapid urbanization play out over the next several decades and beyond.

Urban and peri-urban agriculture (UPA) could be an important part of this effort given its contribution, in many cities, to nutritional diversity of urban diets and livelihood security for the urban poor who engage in production, transport, processing, storage and marketing of UPA products. UPA provides important environmental services to urban and peri-urban areas that can help cities to become more resilient to extreme climatic events. For example, land used for agriculture provides permeable surfaces that dampen storm water runoff velocity and increase infiltration; UPA creates favourable urban microclimates, and helps to reduce the urban waste stream by utilizing municipal organic waste and wastewater as crop production inputs.

On the other hand, UPA systems in the developing world face many challenges with respect to their long-term sustainability, including urban encroachment and marginality of the land resource base for producing crops, soil and water degradation, risks of biological and chemical contamination of fresh foods, and lack of policy support for UPA. Extreme climatic events manifested as intense storms, floods, heatwaves, and drought are additional stressors that are expected to intensify with climate change.

UPA assessment

START in partnership with the United Nations Environment Programme, World Meteorological Organization, Intergovernmental Panel on Climate Change, University of Ghana, University of Dar es Salaam and Bangladesh Centre for Advanced Studies, and with support from the European Commission, are undertaking a 9-city assessment on urban and peri-urban agriculture and climate change. Interdisciplinary teams of researchers are carrying out the assessments in Dakar, Senegal; Tamale, Ghana; Ibadan, Nigeria; Dar es Salaam, Tanzania; Kampala, Uganda; Addis Ababa, Ethiopia; Dhaka, Bangladesh; Kathmandu, Nepal; and Chennai, India.

The assessment focuses on how rapid urbanization and global environmental change, including climate change, could affect agricultural production systems in and around these cities. Such production systems generate a significant portion of the fresh fruits and vegetables, poultry, eggs, fish, dairy and other non-staple foods in cities that contribute significantly to dietary security for urban dwellers and are a key livelihood resource of the urban poor.

The assessments aim to broaden understanding of the long-term sustainability of UPA as related to:

- water and land availability and quality as cities experience rapid growth and climate change;
- the potential and limitations of UPA as a food security strategy;
- opportunities and risks associated with use of urban wastes as an input to UPA production; and,
- UPA as a motivation to promote more proactive urban land use planning.

The assessments will identify and compile sources of knowledge (from focus group discussions, surveys and interviews, multi-stakeholder dialogues, and reviews of secondary 'grey' literature and peer reviewed literature) and develop recommendations for policies, investments and capacity building that can help cities develop along a greener and more food secure trajectory. The teams will develop communication strategies for informing a wide range of decision makers about the findings of the assessment, which will conclude in 2012.

Urban adaptation in Asian coastal megacities

Urban systems are both natural and social, and climate change and natural hazards are most often only few of the multiple stressors influencing urban systems. As such, it is imperative that the interplay of these multiple stressors and the potential rippling impacts – both physical and socio-economic in nature – be taken into account when considering overall vulnerability and adaptive capacity of people and institutions. For example, many Asian coastal cities are increasingly vulnerable to flooding disasters resulting from the combined effects of climate change (e.g., sea level rise, intensified storms, and storm surges), land subsidence and rapid urban growth. Within such systems, climate change and climate change adaptation must be integrated with development and development challenges – the two cannot operate separately.

Urban dairy operation in Kampala, Uganda

Urban poultry operation, Dar es Salaam, Tanzania

Indeed, current vulnerabilities and recent disasters or extreme events are an important catalyst for exploring and improving risk management and adaptation in the context of sustainable development.

An ongoing, multi-year START-led program entitled *"Cities at Risk" (CAR)* aims to promote and support the development of urban adaptive capacities in Asian coastal megacities, with particular emphasis on integrating science and policy in managing and reducing the risks and vulnerabilities brought on by climate change and urban growth. Program activities bring together scientists, city planning professionals, representatives from policy and development organizations and other civil society practitioners for international conferences, visioning exercises, regional training and assessment workshops and city-specific research, training and communication initiatives. *CAR* is implemented in partnerships with the Southeast Asia START Regional Research Center (SEA-START), the East West Center (EWC) and several other organizations.

The second international conference on *"Cities at Risk: Building Adaptive Capacities for Managing Climate Change Risks in Asian Coastal Cities* (*CAR II*)" held April 11-13, 2011 in Taipei, Taiwan was an important recent activity of the *CAR* program. The conference was co-organized by START, the EWC and the Coastal Cities at Risk (CCaR) project, sponsored by the Integrated Research on Disaster Risk International Centre of Excellence (IRDR ICoE) in Taipei and hosted by the Academy of Sciences (Taipei). The conference sought to: a.) assess progress of *CAR* city teams in advancing program related efforts; b.) to consolidate a network of researchers, decision-makers and institutions in the region; and c.) to identify priority knowledge and capacity needs to guide design of future program activities.

The *CAR II* discussions acknowledged that there is urgent need to rethink approaches to risk and vulnerability assessment so that such processes are better positioned to capture and operate within the complexity of systems, particularly urban systems. This must include investigation of both the direct risks and impacts (e.g., flood risks, flood events, infrastructure damage) as well as intangible and indirect risks and impacts, such as those related to psychological health and risk perceptions. In addition, simple risk and vulnerability assessments as well as systemic assessments are required, the latter of which must include consideration of cascading risks, both spatially and temporally. Such approaches will support better understanding of the complex processes at play between social vulnerability and urban development.

Furthermore, there is the need for better understanding of how environmental change itself impacts risks and our options for reducing that risk. This will require integrated approaches to understanding and managing risks, particularly in urban settings where the linkages between social vulnerability and urban development patterns are strong and dynamic. Stronger linkages between physical/engineering approaches and social science related approaches to problem solving will also be critical. Indeed, an important first step in building awareness of urban adaptation options may be building trust and facilitating exchange of perspectives between those who must work together to advance common goals.

A priority emphasis of all activities facilitated as part of the *CAR* program is policy relevant analysis of research that is made useful and accessible for decision-making. *CAR* participants agree that together, we must think about the unthinkable, prepare for the worst and redefine what "preparedness" really means. Because adaptation is a dynamic process of adjustment, our policies, plans and frameworks cannot be expected to be compatible if they are not also dynamic.

Like others before them, *CAR II* participants drafted a series of actionable recommendations that were intended to carry forward activities beyond the conference and beyond the current *CAR* network. Recommendations were aligned with major challenges that participants identified to collective understanding and action with regards to risk and vulnerability assessment and communication efforts in Asian coastal cities, and integration of urban development planning, disaster risk management and climate change adaptation. A full description of these recommendations is available in the *CAR II* conference report (available for download on the START website at **www.start.org**).

Related *CAR* activities that are already underway include organization of a national science policy dialogue for North Coastal Jakarta (Indonesia) that produced a two-year action plan for climate change training and communication activities for the city; initiation of a visiting scientists and young scholars' program at the IRDR ICoE in Taipei with biannual themes related to climate change adaptation and disaster risk reduction; and collaborative efforts to create, test and promote dissemination of training modules that support integration of climate change and climate change adaptation into the curriculum of Asian planning schools.

Supporting "forensic investigations" of disasters

The Integrated Research on Disaster Risk (IRDR) program, a decade-long program of international research and related activities, aims to bring together the natural, socio-economic, health and engineering sciences in coordinated efforts to address the challenges brought about by natural disasters, mitigate their impacts and improve related policy-making mechanisms. One of the initial research components of the program is a set of internationally organized, in-depth case studies (the Forensic Investigation of Disasters (FORIN) project) that investigate how natural hazards do – or do not – become disasters. FORIN studies are uniquely designed to approach disaster risk research via one of four basic approaches – critical causal analysis, meta-analysis, longitudinal studies and scenarios of disasters. Each approach values success stories as well as failures in understanding the root causes of disasters and disaster risk. (IRDR, 2011)

START is the capacity building partner of the IRDR program and is currently collaborating with the IRDR International Project Office, the IRDR ICoE in Taipei and other international partners to contribute to achievement of IRDR goals and objectives. In 2012, START will collaborate with the ICoE colleagues in Taipei to organize and facilitate two Advanced Institutes on IRDR topics. The first of these Institutes will focus on FORIN and will provide approximately 15-20 young to middle-career researchers and practitioners from Southeast Asia with the enhanced understanding, skills and resources to design, organize and carry out FORIN related studies in their own countries. Institute sessions will include educational modules, hands-on interactive exercises and field visits. Special attention will be given to disasters that have impacted cities in Southeast Asia. All Institute participants will conceptualize an individual or collaborative project to be presented in plenary at the conclusion of the Institute, which may later be submitted for competitive funding to support follow-up activities. The second Advanced Institute in 2012 is expected to focus on IRDR issues of risk interpretation and analysis (RIA) – that is, how people make decisions in the face of risk (see **www.irdrinternational.org**).

For more information on these and related START efforts, please visit the START website (**www.start.org**) or contact Jon Padgham (**jpadgham@start.org**) and Clark Seipt (**cseipt@start.org**).

Urban encroachment on urban agriculture lands, Dar es Salaam, Tanzania

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Panorama of Totnes, Devon, England

UK Environmental Governance through Community

Gerald Aiken

"I'm no longer skeptical. Now I do not have any doubt at all. I think climate change is the major challenge facing the world. I have waited until the proof was conclusive that it was humanity changing the climate."

~ *David Attenborough (2006)*

"I don't want to hear warm words about the environment. I want to see real action. I want this to be the greenest government ever."

~ *David Cameron (2010)*

Climate change and neoliberalism

Climate change is the major issue facing humanity. How humanity responds to it will say much about our capacity to adapt, to reflect, and to work together. For governments it represents a major challenge. Failure to deal with it could store up greater problems in the future: rising sea levels, climate refugees, wholly unpredictable changes to the natural climate and weather patterns being just a few.

Indeed, changing environmental patterns challenge the very notion of the nation-state, forces which hold no allegiance to seemingly arbitrary national borders. Here, any given environmental problem is distant in both space and time with respect to its generation and effect. Climate change requires international co-operation, and collective action on a scale never seen before.

Given this geographic plexus, *what can the role of the State be in governing the environmental behaviours and practices of its citizens?* The uphill nature of this challenge for the State becomes near vertical, when a State's 'traditional' capacity to act is undermined by forces of neoliberalism. This involves the roll back of the State.

Neoliberalism, in theory, strongly favours individual rights, especially the right to private property, and has a high degree of faith in the efficacy of both the law and the markets, alongside free trade (Jessop, 2002). Harvey (2005, pp. 64-86) describes how in practice the neoliberal state *"depart[s] significantly from the template that theory provides"* (2005, pg.64). Despite this, there is a general 'roll back of the State' that we can associate with neoliberalism. The State then has an ideological reason not to intervene with individual environmental behaviours and practices, or in imposing regulation. Given we are now in what Cameron now calls an "Age

1 http://www.guardian.co.uk/politics/2009/apr/26/david-cameron-conservative-economic-policy1 Accessed 28 Jan 2012.

of Austerity"[1], in both fiscal and ideological terms, the State lacks a capacity to respond to the challenge posed by climate change.

It is against this backdrop that the notion of governing by community of environmental actions must be understood. The idea of *"government by community"* (Raco & Imrie, 2000), or *"government through community"* (Rose, 1996) is not entirely new. However it does emerge against the backdrop of increasing neoliberalisation of the State as explored above. What government through community here means is based heavily on Foucault's notion of 'governmentality'.

At the heart of governmentality is the notion that liberty and security, or consensus and coercion, are not binary opposites but can rather reinforce and balance each other. For community to be adopted as a form of governmentality then, means that the State's governing is not through an encroaching of individual liberties, which neoliberalism abhors, but though a manufactured consent. 'Community' here is used in order to help internalise that consent. In this way 'community' is a technology of government.

The type of community envisioned here is firmly location bound. As Amin (2005) points out, when community is used it is often elided with a silently implied prefix of local. This is government through (local-) community. Governing by community also implies the notion of governing at a distance; rather than directly regulating, the State governs at 'arms length'.

In States characterised by dispersed networks, rather than nodes of power, and also the prominence of 'freedom of choice' for its citizens, such a form of govenmentality is required to negotiate the environmental challenge faced. It is here that this primarily place-based 'community' enters.

Community and environmental governance

The first reason to explain the rise in 'community' responses to climate change is that such language helps generate buy-in from local residents to, for example, any proposed renewable energy project. The 'community' label varies in use: from projects owned and managed by local residents, to those being branded by 'outside' developers as a way to assuage local opposition, and a full spectrum in between (Walker & Devine-Wright, 2008). The attraction of using 'community' rhetoric is that it can be a useful tool in attempting to see off potential objections from local residents to any new project. Community has long been used as a *"warmly persuasive word"* that is *"never used unfavourably"* (Williams, 1983, pg. 76), and can be adopted by energy companies as a positive label to be associated with and help in attempts to pre-empt potential objections, NIMBY or otherwise, to developers' plans (Toke et al., 2008; Warren & McFadyen, 2010).

The community 'branding' can make such schemes much more appealing. Devine-Wright (2005) and Toke (2005) both argue that a shift to local ownership of wind farms results in higher levels of acceptance, local support and equity. Warren & Birnie (2009) outline how potential conflict over renewable energy schemes are not so much arguments over facts, but *"'whether they and their community had a personal stake in their development'"*; this was down to no more than a *"subjective 'sense of ownership'"*, of which the 'community' branding or labeling has associations (2009, pg. 117). This subjective sense is crucial here, as the 'community' label still retains the positive perception whether or not the project is owned and invests their profits locally.

In this way community is used not to refer to any explicit meaning (although it does retain connotations of local – territorially bounded, small scale – the traditional community of place), rather it is as a way to gain legitimacy for energy projects.

Walker et al. (2007, pg. 17) again repeats the *"diversity of ways in which the 'community' label has been utilised"* in environmental policy. Despite this, one continual motif throughout this literature is the way in which 'community' is used as a synonym for the local (Amin, 2005). It is often in the reception of the label 'community' that its subjective aspects become politically useful.

Governing by 'community', and the rise of 'localism' narratives then are two forms of responses to the challenges laid out above. Against the backdrop of neoliberal ideology, and in times of financial crisis, it is also a crucially cheaper means to govern environmental actions.

Case study: Governance by community from above

There are many examples of the rise of 'community' in environmental governance 'at-a-distance'. Here the focus is on the Climate Challenge Fund (CCF), the chosen means by the Scottish Government to reduce their ambitious carbon reduction targets.

In 2008, the Scottish National Party, supported by the Green Party established the CCF, in order to combat deleterious climate change generating emissions, reduction being explicitly through the medium of 'community'. There were only three criteria for those who could apply to this scheme for funding: the *"community should be at the heart of the decision making process"*; the project *"should lead to significant CO_2 reductions"*; and *"it should result in a positive legacy for your community"*[2]. Despite the central importance

2 CCF website: http://ccf.keepscotlandbeautiful.org/ Accessed 28 Jan 2012.

of 'community', it was not tightly defined. This is typical of the use of 'community', gesturing towards some positive well-meant sense of locality, rather than anything firmly described, other than in a via negativa sense of not standing for NGOs and local authorities. Yet it was in and through 'community' that the carbon reduction targets were to be achieved.

A government commissioned study reviewing the first three years of the CCF concluded; *"that community projects are well-placed to deliver pro-environmental behaviour change"* (Scottish Government, 2011, pg. 8). This was due to three reasons: their *"ability to tailor and personalise their messages and interventions to appeal to individual participants' motivations"*; *"Their position in the community as trusted entities that are seen to have the community's interest at heart";* and *"their ability to engage those who are 'moderately interested' in the environment and open to the idea of change, and spark them into action"*.

There are several interesting aspects to this conclusion. As is typical, the word 'community' is used three times, to what seems like three apparently different ends (project, location, group). A key word in their reasons for their success is that these projects were 'seen' to act nobly. Again, like Warren & Birnie's (2009) conclusion to the use of 'community' when applied to renewable energy schemes, the appearance is important here, rather than any actual specific denoted meaning.

Seen through the lens of Foucault's concept of governmentality above however, it is noticeable that the Scottish Government, through CCF, seeks to govern the environmental behaviours of its citizens. By appealing to their 'individual motivations', gaining widespread consent across major sectors of the population, not just a minority interest group of 'usual suspects' who would take environmental action.

Case study: Governance by community from below

When this policy was announced, there was understandable upset from the NGOs, and local authorities, who couldn't apply for these funds. The CCF wanted locally rooted, sub-national, 'community' groups. They had to genuinely emerge to represent the 'wider community', not be a front for an existing organisation. Where were such groups to be found?

Fortunately, or rather symbiotically, there emerged concurrently a model of 'community' action to fill this void: that of the *Transition Towns* movement.[3]

Edinburgh, Scotland

Transition Towns emerged from Totnes in Devon in 2005. They emphasise the role of 'community' in facing the current environmental crisis. Dismayed by lack of State-led action, and daunted by the inefficacy of individual action, their oft-quoted rallying cry is: *"If we wait for governments, it'll be too little, too late. If we act as individuals, it'll be too little. But if we act as communities, it might be just enough, just in time."*

As Transition Towns spread virally from South West England, different expressions emerged in different locations to take local action on their key concerns of climate change and peak oil. The *Transition Town* branding reached Scotland then as the CCF came into existence. Each *Transition* 'cell' was nominally separate, autonomous - thus fulfilling the criteria of the CCF.

Both emerged to serve the others needs. For the CCF, this captivating Transition narrative of 'taking control of our future' resulted in a consented, and crucially cheaper way to govern environmental behaviours at-a-distance. For Transition Towns, they had much more funding than they otherwise could have dreamed. (Cheap by national budget standards, overwhelming by local).

3 Transition Network website: http://www.transitionnetwork.org/support/what-transition-initiative Accessed 28 Jan 2012.

It looks eerily like Foucault's notion of governmentality. Here, the government doesn't proscribe and legislate over individuals, but through a discourse of 'community' subjects can actively participate in their own subjugation.

Governing environmental behaviours through 'community' is proving more influential in Edinburgh, but what of the potential for up-scaling such ventures? At the very core of what these ventures are is a desire to govern at the micro level, the community-level. It would seem unlikely then, that these experiments, such as Transition Towns would have any impact beyond their immediate context and environment. However this 'level' is only one aspect of scale – the other is size.

It is possible for these examples to be 'up-scaled' on the level of size. This would require the seeding off, and sparking of other similar initiatives. Such a vision would look more akin to 'a thousand flowers blooming' in the parlance, rather than an individual community project that outgrows its original starting point. This, given the appropriate funding conditions, would indicate no reason for these examples to stop where they currently find themselves, and become an increasingly prominent method of environmental governance in Western cities.

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Varanasi (Benares) at sunset, Uttar Pradesh, from the Ganga River, India

Confronting the Challenges and Opportunities of Indian Urbanization: Insights from the 2011 India Urban Conference

Kavita Wankhade and H. S. Sudhira

The India Urban Conference (IUC) included a series of events designed to increase the salience of urban challenges and opportunities for India's development as well as identify new research areas and collaborations. The series, organized by the Indian Institute for Human Settlements (IIHS), Janaagraha Centre for Citizenship and Democracy (JCCD), and Yale University's South Asia Council was comprised of an academic conference in New Haven, CT, USA; an ideas-forum and discussion of emerging evidence and research in Mysore; a policy conference in Delhi; and a national student challenge seeking innovative proposals for urban solutions. The conference raised several key questions and generated several debates on some of the critical challenges faced by contemporary urban India.[1]

Research gaps

One striking insight that emerged from the conference events was the paucity of appropriate and adequate data that capture the urban and the urbanization process. Owing to a variety of reasons and prominently due to the lack of requisite and timely data, our understanding of Indian urbanization is largely restricted to the available data from Census enumerations as well as from the National Sample Survey Organization's assessment on different cities with respect to certain variables at varied intervals of space and time. Thus, any meaningful comparative studies of Indian cities have been centred on population and its derivatives, as captured in the Census. Ironically, although the objective of the conference was to gather and present evidence on and from Indian cities for a meaningful dialogue, most speakers and participants re-iterated the need for systematic data capturing. Particular need was felt for spatial data; limited spatial datasets are available for urban areas, apart from metropolitan cities.

Additionally, concerns emerged surrounding definitional challenges that are associated with existing institutional arrangements and their operational procedures. It was often emphasized that unless the institutional issues coupled with their jurisdictional constraints are addressed systemically, these data challenges will continue to persist. Specifically, the definition of what is 'urban' and the consequent demarcation of

1 Further details of the conference and some of the presentations are available at: http://www.iihs.co.in/events/conferences/iuc2011/. Some of the videos from the IUC 2011 – Delhi conference are available here: http://www.youtube.com/playlist?list=PL7CDFC41ADE17678D.

the city jurisdiction within which various metrics have to be measured remains a 'holy grail' for urban research in India. One of the participants, while raising concerns on the definition of urban, questioned its applicability in nationwide missions with massive funding outlays. It also poses pertinent questions on the distribution and settlement size classifications of both India's urban and rural population over the next half century as India moves from a rural-agrarian to an urban industrial/services-led economy. Furthermore, the reclassification of urban itself could impact the 'grey zone' between Class IV to VI towns (with populations greater than 5,000 and less than 20,000) and the large fraction of the rural population who live in villages of more than 5,000 people and have an increasing urban character. It is estimated that there are between 80-140 million people living within this zone.

Many at the conference spoke out about the need to address these urban areas, beyond the big metropols. Indeed much of the financial outlay by the federal government is dependent upon the classification of settlements based on population size. Much of the funding has been biased towards large cities, and so has been much of the research. Thus, a knowledge gap exists – much of the current and on-going research focuses on the megacities or million-plus cities as opposed to the remaining 7,900 towns and cities, which are indeed rapidly urbanizing and are under a population of one million.

Moving forward

Cognisant of these data gaps, and realising that an objective view of the urbanization process can only be possible from data and insights obtained from a wide range of literature, analyses and experiences, IIHS has come with two research products: *Urban India 2011: Evidence* and *Urban Atlas. Urban India 2011: Evidence* was released at the Delhi policy conference in an attempt to provide context for the discussions with policy makers, and also to extend the discussions beyond the IUC conference series. This publication pulls together available evidence from national surveys, the Census of India, remote sensing data on urban spatial dynamics as well as published and grey literature. With the purpose of informing the Delhi policy conference, the analysis is a reference for policymakers and starts to place diverse individual experiences in some semblance of a broader context. It provides a starting point for developing a shared understanding of the trends underlying the everyday and individual observations of how India and its urban areas, in particular, are evolving. While efforts are underway to make the publication available online, it is hoped that it will be challenged, augmented, and improved. Much needs to be done in way of producing this data for more meaningful research. Hence, IIHS is committed to providing the platform for a network of researchers to engage, share, disseminate and discuss some of these pressing challenges and realise the opportunities.

In an on-going effort to understand the dynamics of Indian cities, IIHS is mapping and publishing urban land cover and its changes for the top 400 cities (in terms of population size as per the 2011 Census) in *Urban Atlas*. Land cover and land use change are critical components of the urbanization process which influence the different sub-systems that interact within the greater urban system. Preliminary work on the land cover change for the top 100 cities suggests that built-up areas have increased significantly and that the rates of land cover change, especially of built-up areas, are higher than population growth. This has several implications: a) this rapid change in built-up areas is affecting other land cover – notably water bodies and vegetation; b) built-up densities are decreasing which implies cities are sprawling. It is suspected that the decrease in densities is also resulting in the fragmentation of landscapes. However, much needs to be done in terms of focussed research examining

Participants during the session at the IUC 2011: Delhi Conference the extent of these changes, their patterns and underlying dynamics which are shaping these forms.

Barring a few studies specific to the Indian context (Reilly et al., 2009; Angel et al., 2010) not much evidence exits in terms of published literature on land use and land cover changes within the region and the implications for environmental resources and sustainability across scales. With increasing urban sprawl, it remains to be investigated the impact this has on ecosystems and their services. This raises some questions about what the appropriate metrics are to measure urban forms, land cover changes, densities, their fragmentation and ecosystem services. The effects of rapid urbanization on resources, especially water and energy, apart from its consequences in terms of pollution, need to be addressed systematically. Thus, a pertinent theme for research is to comprehensively understand the interactions of urban land cover and ecosystem services in the Indian context.

An attempt to initiate discussions on the relationship between land, infrastructure and environment was made through a session on 'Land, Infrastructure and Ecological Sustainability in Indian Cities' during the Mysore conference. A background note was also prepared that elicited some of the critical challenges and raised several pertinent questions specific to the Indian context (Wankhade & Balakrishnan, 2011). However, apart from the particular session, there was limited discussion concerning the impacts of urbanization on environmental change and the need for sustainability during the conference. It was highlighted by several experts at the close of the conference that while the conference presented a number of interesting papers and discussions on poverty, there was a surprising lack of discussion on environmental concerns.

Clearly, the urban transition in India poses fundamental challenges for sustainability, land use dynamics and resources. Whereas the IIHS is beginning to tackle these challenges, the urgent need for further research and action in this context was made only that much more evident at the 2011 India Urban Conference.

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Informal settlements vulnerable to flooding in Bangkok, Thailand

Mainstreaming Urban Climate Change Adaptation: Engaging 'Early Adopters'

Elizabeth Parker, Sam Kernaghan and Tim Hawley

There is an urgent need to mainstream climate change adaptation. Whilst mitigation activities are becoming common place, there remains a significant gap in knowledge and capacity surrounding adapting to an uncertain climate. As climate change impacts increasingly affect populations concentrated in urban areas, cities will be responsible for shaping and leading an integrated response. Successful mainstreaming of climate change adaptation will rely on the ability of 'innovators' – the minority of actors currently engaged in adaptation thinking and practice – to clearly and succinctly communicate their findings to the wider population. Experiences from the Asian Cities Climate Change Resilience Network (ACCCRN) indicate that there are a few vital steps that innovators must take to ensure that their messages are heard and acted upon. Key strategies include refining and using a clear and simple message, aligning this message with existing drivers, and ensuring that a range of entry points exist to enable the engagement of and taking of action by multiple stakeholders.

Where are we now?

The Intergovernmental Panel on Climate Change's (IPCC) climate change scenarios for 2100 are stark. They project a best case scenario of 1.1°C global average temperature rise and 18cm sea level rise, and a worst case scenario of 6.4°C global average temperature rise and 59cm sea level rise (IPCC, 2007). More recent evidence points to global greenhouse gas emissions tracking well above the emissions pathway for the worst case scenario, suggesting that without significant efforts to mitigate emissions, a global mean sea level rise of an excess of 1m by 2100 is entirely plausible (Church et al., 2008).

Organisations such as the Rockefeller Foundation, UN-Habitat and the World Bank are increasingly turning their attention to the role of cities in combating the impacts of climate change. However, to-date, few cities have integrated the long-term impacts of an increasingly variable climate into their planning processes. The C40 Cities Climate Leadership Group initiative illustrates this point. The C40 is a network of 40 of the world's largest cities (plus an additional 18 that are affiliated through the Clinton Climate Initiative) that are committed to implementing meaningful and sustainable climate-related actions. These cities have taken steps to mitigate climate change, implementing strategies to reduce their carbon emissions and increase energy efficiency. However, adaptation plans are less clearly defined and activities identified as contributing to climate change adaptation are general, such as the planting of trees and urban greening. In a 2011 study of these cities only 19 (out of 36 responding) had allocated funding for adaptation measures, and only around 12 (out of 21 responding) had developed a climate change adaptation plan (C40, 2011). The limited uptake of climate change adaptation planning by pioneering and future-confronting cities such as those involved in the C40 Clinton Climate Initiative is indicative of a much broader inertia amongst cities globally.

Are you an 'innovator'?

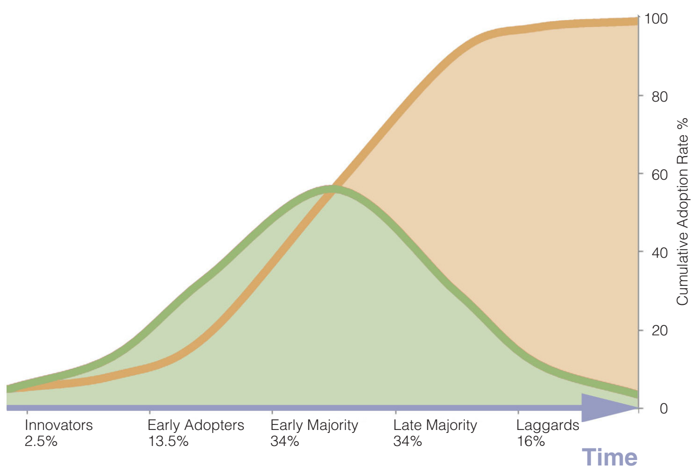
Everett Rogers introduced his 'Diffusion of Innovation' theory in 1962 and it has been absorbed most notably into the marketing and social-media industries, but is also relevant to questions of organisational and urban change. Rogers explains how, why and at what rate 'innovations' (new ideas and practices) spread through cultures and become integrated into conventional practice. When introduced to innovations, people respond to the proposed changes in different ways (Rogers, 2003). Whilst in general people are risk-adverse, there are those who are comfortable adopting new ideas, referred to as 'innovators' and 'early adopters', and others that are more apprehensive, referred to as the 'late majority' and 'laggards' (Figure 1). Critically important to this diversity in adoption are the decisions of those who are listened to and well-respected by the persons considering these new ideas. This is shown as an adoption curve (see Figure 1), with change progressing from left to right, starting slowly and then accelerating.

The theory provides a useful framework for those seeking to mainstream climate change adaptation. Experience across urban adaptation programs including the ACCCRN and the C40 initiative indicates that the innovators, or those individuals pioneering adaptation approaches, have the challenge of knowing how to engage early adopters in order to create the momentum needed for change in their local context.

A defining characteristic of innovators is their openness to new opportunities and their eagerness to define and develop new practices and ideas (Rogers, 2003). Climate change adaptation is still seeking clarity and definition as an approach, not least because the magnitude and intensity of climate change impacts are uncertain at the city scale. This makes the practical application of adaptations difficult for city decision making, particularly as the traditional infrastructure and planning paradigm of 'predict and prevent' (Brown & Kernaghan, 2011) is undermined by an uncertain climate.

The ten ACCCRN cities located across India, Indonesia, Thailand and Vietnam are experimenting with a range of activities that will improve their ability to withstand, prepare for and to recover from current and future impacts of climate change. A diverse range of city actors have recognised that in order to mainstream climate change adaptation, they need to engage in a process of exploration, incorporating integrated city wide strategies and 'learning by doing'. ACCCRN cities are focussed on generating tangible case studies and illustrating examples of successful strategies, an approach which will enable these innovators to begin to encourage and convince early adopters to take up the challenge.

Figure 1 | Rate of adoption of new ideas by different social groups



Source: Adapted from Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Convincing 'early adopters'

One of the most important elements of Rogers' theory is the purported S-shaped curve of which the successful spread of an innovation is thought to follow (see Figure 1). That is to say, once an innovation is adopted by approximately 10-25% of a group, a period of rapid uptake that subsequently tapers out follows thereafter. To reach this 'tipping point' (see Gladwell, 1996) it is critical to secure the support of the early adopters – in this case city actors who are recognised as opinion leaders and who are influential in leveraging

In a rapidly changing urban environment, what are the drivers for climate change adaptation? (Bangkok, Thailand)

the wider population (Rogers, 2003). Across the four ACCCRN countries significant effort is being invested to identify and widen the group of credible individuals who are early adopters by joining existing champions or change agents.

As with any change, there are some key challenges associated with informing, engaging and persuading early adopters of the need to integrate climate variability into decision making processes; these challenges of mainstreaming have been structured around three areas that are key to co-opting the support of early adopters:

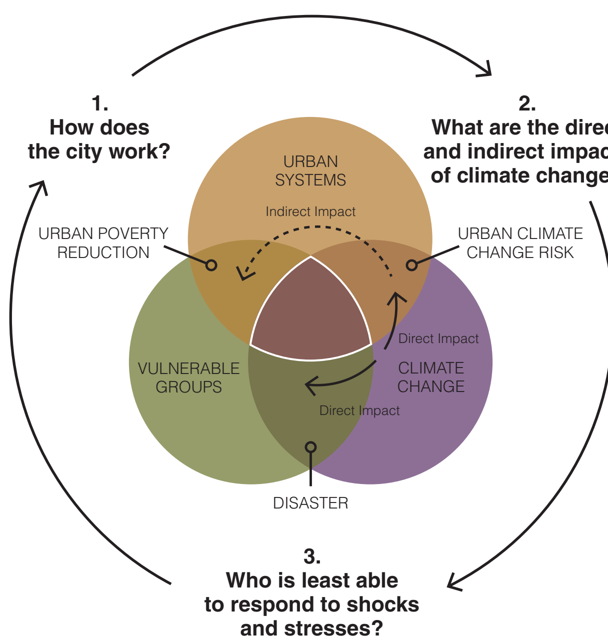
1. What are we saying? ***Clarity of message***

Climate change adaptation is not an easily isolated issue (ODI, 2012) - that is, climate change affects people directly, e.g., through rainfall and temperature variations, and indirectly through changing migration patterns, global food prices and access to resources. The impacts of climate change are felt by everyone, although the poor and the vulnerable are typically at a greater disadvantage due to heavy reliance on seasonal employment, limited access to clean water and exclusion from affordable credit (DfID, 2004). The impacts of climate change are unique to local conditions; no two cities are affected in exactly the same way.

That climate change can affect different cities and city actors in different ways makes the development of a succinct and clear message for the promotion of climate change adaptation challenging. Innovative ideas and processes that have greater degrees of success are ones that are simple, are compatible with the context and are visible to others, hence optimising communication (Rogers, 2003). This simplicity of message can be seen in gender mainstreaming – 'men and women are equal,' and HIV/AIDS – 'practice safe sex.' By identifying and promoting a clear message, it ensures that all of those lobbying for change will speak with the same voice, particularly important when ideas are translated across multiple languages and cultures.

The need to broadcast a unifying and easily accessible message has been key from the start of ACCCRN. From very early on the intersection of climate change, vulnerability and urban systems has been articulated as a Venn diagram (Figure 2). As the organisations involved in ACCCRN come from different technical backgrounds (urban poverty reduction, climate science, disaster risk reduction, urban systems and infrastructure), this clarity has helped to highlight the range of different entry points for responding to the climate change challenge. This graphic also illustrates the need to go beyond the direct impacts of climate change, to include indirect impacts which may (among other things) require cross-sectoral actions at the city scale (ACCCRN, 2010).

Figure 2 I Potential entry points for thinking about climate change impacts in cities



Source: Adapted from ACCCRN. (2010). *Building urban climate change resilience: ACCCRN Intervention Project criteria, process & progress.* [Online]

2. Why is it important? *Motivation*

Climate variability is typically a low priority for city officials compared to other issues such as economic development or poverty reduction (Mertz et al., 2009). In many cases the existing provision of services and infrastructure, especially in low and middle income sectors within the city, are inadequate for current conditions. For instance, in many urban areas the lack of provision for installing and maintaining drainage means that relatively minor rainstorms cause serious flooding (Satterthwaite et al., 2009).

Experiences from ACCCRN have indicated that there is a close link between the clarity of message communicated to early adopters and the degree to which they are motivated to act. For example, when engaging the city of Gorakhpur in India, the Gorakhpur Environmental Action Group (GEAG) found that by shifting their message from climate change, which was perceived as a secondary issue, to emphasising vulnerability and poverty, which were key concerns, they were able to engage a broader range of stakeholders and begin taking action to address climate vulnerability. The motivation of early adopters to engage with climate change adaptation will be greater if it ties to their existing priorities and needs.

3. How do you apply it? *Incremental integration*

Cities have recognized that any local strategy or plan needs to be informed by multiple stakeholders and must set out not only what infrastructure to build, but also how to strengthen capacities of decision makers (Brown & Kernaghan, 2011). However, the reality in many middle and low income countries is that cities often have limited funding, resources and constrained institutional capacities, with restricted budgets for staff development (Satterthwaite et al., 2009).

If a new practice can be adopted incrementally, through experimenting and testing, the more likely it is to be accepted (Rogers, 2003). If it is too difficult to apply, or requires an 'all or nothing' approach, it will be significantly more challenging to integrate it into everyday tasks and decision making. This is a critical barrier to mainstreaming climate change adaptation because it is often understood as requiring a complex, multi-stakeholder approach that can be costly and resource intensive.

To address each of these challenges, the ACCCRN process has included these key steps:

- Identify city champions and, where possible, political buy-in;
- Build on 'now' issues (such as flood, health issues or coastal subsidence) that the city is already facing, and research/analyse how climate change might increase these risks;
- Enable key stakeholders (including government, community, academia and business) to engage with new information, to reflect on how it is useful to them and could be translated into action;
- Generate a city wide strategy which engages decision makers and vulnerable populations in the responses to and management of changes in climate; and,
- Implement specific activities at the city, sectoral and community level to build understanding and develop tangible examples of how to respond.

Each of these steps enables innovators to engage, share knowledge and perspectives, and creates opportunities for identifying other innovators. However, it is likely that the tangible examples – steps taken to test new ways of working and acting – will enable the innovators to begin co-opting the early adopters and enable successful mainstreaming.

Climate change adaptation is a new and challenging issue. Despite evidence from current climate data and increasingly accurate projections, there remains significant inertia when it comes to factoring risks into city policy, planning and investment decisions.

To-date, the majority of work in this area has been research focussed or exploratory, driven by 'innovators' who are better defining the problem and developing a range of solutions. Successful mainstreaming of climate change adaptation will rely on the ability of these innovators to clearly and succinctly communicate their findings to 'early adopters'.

The key challenges are primarily related to messaging. First, innovators need to ensure there is clarity and uniformity of message, and that this message aligns with the early adopters' motivations. Second, there must be a range of entry points to enable the engagement of multiple stakeholders to begin taking incremental steps. Finally these first two must be based on evidence and practice – ACCCRN cities are now generating tangible examples of action and these are creating the messages that are beginning to engage a wide range of city actors in adapting to climate change.

This paper was inspired by the authors' involvement in the Asian Cities Climate Change Resilience Network (ACCCRN) 'Knowledge Forum'. In September 2011, 22 ACCCRN practitioners met to discuss the range of challenges that the ACCCRN cities are facing when mainstreaming climate change adaptation. This paper seeks to highlight some of the successes observed by the authors across ACCCRN and combine them with insights from other programmes in which Arup has been involved. The authors would like to specifically acknowledge and thank Shiraz Wajih, Gorakhpur Environmental Action Group; and Stephen Cook and Debra Lam, Arup for their time and input. For further information on ACCCRN please go to ***www.acccrn.org***

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Urban Sustainability and Ecology of Environmental Justice

Christopher Boone

Science for the 21st century requires an engagement between the natural and social sciences as a means of understanding the dynamic relationships between human and biophysical systems, and to identify alternative paths towards sustainability (Collins et al., 2010). An integrated socio-ecological approach offers a suitable framework for identifying and ultimately measuring such feedback relationships, particularly in urban areas where human activity is concentrated (Pickett et al., 2011). While significant advances have been made in the field of ecological economics that empirically link ecological structure and function with economic processes and states, the third aspect of sustainability – the social realm – has been largely neglected or oversimplified in ecological models. A central tenet of sustainability is that neither the benefits nor costs should be concentrated in the hands of a few; in other words, the distribution of the environmental "goods" and "bads" should be just.

The environmental justice movement emerged about twenty years ago in response to the uneven distribution of hazards, such as toxic waste facilities, and the recognition that these hazards were disproportionately located in communities occupied by racial and ethnic minorities, even while controlling for income (Bullard, 1990). Over the last two decades, the environmental justice movement has become a significant force in defining social and environmental issues, while scholarship on environmental justice has developed into a large scientific endeavor guided by substantiated theory and robust, replicable methods of analysis. That environmental justice should prevail stems in part from moral reasoning (Shrader-Frechette, 2002), but others have argued that inequitable distributions of environmental goods and bads can have compounding negative effects on ecosystems and ultimately to societies (Dobkowski & Wallimann, 2002). Furthermore, others argue that the democratic access to knowledge and grassroots activism that the environmental justice movement has fostered has been a major factor in the reduction of toxins released into the air, water, and soil (Schlosberg, 2007). Environmental justice, thus conceived, is fundamentally critical for the ecological, social, and economic dimensions of sustainability.

Increasing focus on the concept of sustainable cities (Rodriguez-Sanchez, 2008) highlights the need for better science about how cities function and can function as socio-ecological systems. The growing field of urban ecology also is grappling with how biophysical and social science methods and models, developed relatively independent of one another, can be brought to bear on understanding cities as human ecosystems. Philosophically, the long standing divide between the "green" (bio-centric) and "brown" (human-centric) agendas of environmentalism are beginning to break down (McGranahan & Satterthwaite, 2002). Environmental justice, traditionally rooted in the brown agenda and inspired by the civil rights movement, increasingly recognizes the ultimate importance of green agenda concerns, promoted by most ecologists, of inter-species and inter-generational equity to social justice (Pellow & Brulle, 2005). The deep-seated view that environmental justice can come only at the expense of ecological health and vice versa, is a false dichotomy (Shrader-Frechette, 2007). The sustainability literature has helped to challenge such dichotomies, but remnants of this long-standing intellectual bifurcation linger.

Urban ecosystem services

Despite increasing intellectual acceptance of linking ecological and social systems, scientists have not adequately made the *empirical* connections between environmental justice and ecological structure and function. However, the concept of *ecosystem services* provides a meaningful mechanism for bridging ecological and social dynamics, including the relationship between ecosystem structure and function and environmental justice. Ecosystem services are measurable benefits to human beings that are derived from ecosystem dynamics (Costanza et al., 1997). Services can be divided into four categories: supporting (e.g., primary production, soil production), provisioning (e.g., freshwater, wood and fiber), regulating (e.g., water quality, flood and climate regulation), and cultural (e.g., aesthetics and educational). The Millennium Ecosystem Assessment (2005) reports that 60 percent of the world's ecosystem services necessary to support life are being degraded or used unsustainably, and that such actions will have uneven consequences, affecting primarily the poorest. A variety of valuation methods have been developed to quantify ecosystem services, most often in monetary units (see for example, Costanza et al., 1997), but the physical manifestations of ecosystem services, such as tons of stored carbon or reduction in volume of stormwater treated, are also measured.

In metropolitan regions, increasing and maintaining tree cover has become a management priority because of the multiple benefits derived from trees. The Sacramento Area Council of Governments, for example, had pledged to double the tree canopy (to 35% average canopy cover) by 2045 (McPherson, 2006). The City of Baltimore has signed a similar agreement. Through a partnership with community groups and businesses, the City of Los Angeles has launched a million tree program, and a recent analysis demonstrated sufficient space for up to 2.2 million trees (Wu, Chao, & McPherson, 2008). The City of Miami drafted a Tree Master Plan to reach a minimum canopy cover goal of 30 percent by 2020. These agencies recognize that among other benefits trees can provide shade, mitigate extremes of climate, reduce human vulnerability to heat stress, provide habitat for wildlife, absorb pollutants, reduce loads on stormwater systems, and add value to properties. As urban amenities, street trees have been shown to attract more business and customers to retail areas and provide an amenity advantage for luring new investors and residents (Wolf, 2005). In anticipation of likely regulations on greenhouse gas emissions, municipalities are promoting increased tree planting and improved stewardship for carbon sequestration and storage benefits (Cumming, Twardas, & Nowak, 2008). Tree canopies can also provide disservices, such as falling limbs on property or burdening residents with maintenance, and the empirical evidence of assumed benefits from trees is far from complete (Pataki et al., 2011). Nevertheless, increasing tree canopy has become a widespread goal for many cities.

While municipalities embrace the benefits of increasing tree canopy cover, little attention has been paid to the environmental justice implications of such investments. Measuring the distribution of ecosystem service benefits from urban forests in relation to where different social groups live is a first step in measuring the sustainability of green infrastructure investments.

A synthesis effort

With support from the US National Center for Ecological Analysis and Synthesis, I was part of a group of ecologists and social scientists gathered in Santa Barbara, California to answer the following three research questions:

1. In metropolitan regions, are ecosystem services derived from tree canopies distributed unjustly?
2. Do these patterns differ significantly by metropolitan area?
3. What biophysical and social factors explain any differences in distribution of ecosystem services?

For the analyses, we used high resolution tree canopy and census data for five US metropolitan areas – Baltimore, Washington, D.C., New York City, Philadelphia, Raleigh, Sacramento, and Los Angeles. The group is still working on the analysis but

Hyde Park in Sydney, Australia

preliminary results suggest that income is the key predictor of urban tree canopy cover. In some cities, when we control for income, the racial and ethnic composition of the neighborhood is significantly associated with tree canopy in both negative (what we expect) and positive (what we did not expect) directions. These findings beg more careful comparative analysis of site specific properties of the metropolitan areas, including their biophysical and built form characteristics as well as the past and present institutional factors that generated present-day landscapes.

A related effort of the group is a critical examination of the relationship between urban ecosystem structure and function and the human- and place-mediated ecosystem services that are (or are not) enjoyed. In the context of broad shifts in urban management from the sanitary to the sustainable city ideal, the group is examining how the increasing adoption of ecosystem services as a management tool will affect environmental justice outcomes. The results of both of these efforts we hope will contribute to environmental justice and urban ecology theory, and be used to suggest appropriate interventions to make these other regions more sustainable and better managed.

Going global

Although the environmental justice movement originated in the United States, it has inspired similar forms of inquiry and action in other parts of the world. The Aarhus Convention, for instance, has now been signed by 41 countries, mainly in Europe and Central Asian countries. Similar to the Environmental Planning and Community Right to Know Act passed by the US Congress in 1986, this convention provides the public with information about activities that are potentially harmful to people and the environment. Environmental justice movements have been growing in strength in other parts of the world as well (Claudio, 2007). At the global scale, climate justice has emerged as an offshoot of environmental justice. Climate justice examines the uneven negative impacts of global climate change especially on poor countries that contribute only a small portion to global greenhouse gas emissions (Shepard & Corbin-Mark, 2009).

Sustainability and environmental justice

The strength of environmental justice is that it moves beyond risk by focusing on the rightness or wrongness of the distribution, and processes that lead to the distribution, of environmental goods and bads. This does not negate the need for risk or vulnerability analysis, but shifts the priority to assessing the fairness of risk and vulnerability. Sustainability is founded on principles of equity for present and future generations. An environmental justice perspective that examines the fairness of services and disservices provided by the environment therefore brings us closer to the goal of urban sustainability (Boone, 2010).

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