Increasing the efficacy of best practices on climate change: A focus on Green Infrastructure and Integrated Transportation

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Abstract

Green infrastructure and integrated transportation are the two dominant green best practices that cities around the world are implementing and that research related to the climate change impacts of extreme temperatures and air pollution advocate for. Are these policies enough to address climate change and its impacts on human health, now and in the future? The answer to this question depends on whether cities choose to continue with the same status quo policies or develop new policies in the light of climate change. The article will explore these issues by discussing what green infrastructure and integrated transportation are, and then suggesting how the policy tools of education and information technology could be utilized to maximize the short-term and long-term benefits of these best practices. Some insights will be given on how the cities of Portland and Glasgow have ingrained in their citizens the civic identity of environmental stewardship.

Introduction

The focus of city planning in recent years has been on the promotion of green economies, green building guidelines, and green infrastructure[1]. This surge in "green" practices has its benefits. It is drawing attention to an immediate and long-term issue, climate change and its impacts; further green practices are being advocated as beneficial for human health and well-being[2]. Do green policies effectively address climate change and human health? Assuming they are effective, can these policies be expanded and developed further to increase their potential? Green infrastructure and integrated transportation are the two dominant green best practices that cities around the world are implementing and that research related to the climate change impacts of extreme temperatures and air pollution advocate for[3]. Are these policies sufficient for addressing climate change and its impacts on human health, now and in the future? The answer to this question depends on whether cities choose to continue with the same status quo policies or develop new policies in the light of climate change. The latter choice involves building a culture around these policies, such that they become part of the identity and values of citizens. To understand how this is possible there must be a discussion of what green infrastructure and integrated transportation are, then suggest how the policy tools of education and information technology could be utilized to maximize the short-term and long-term benefits of these best practices.

Green Infrastructure: Just a trend?

Green Infrastructure (GI) is the incorporation of nature into the built environment[4]. While not an entirely new concept, GI has become a dominant best practice in the efforts to mitigate the impacts of climate change in cities[5]. Dialogue on addressing urban heat islands (UHI) focus on the use of green roofs, green walls, and tree planting as means to cool the urban environment[6]. GI is an effective policy tool, as it encourages consideration of **how the urban ecosystem depends on the natural ecosystem,** both outside and inside its boundaries[7]. More critically, GI offers numerous benefits for both human and environmental health. At the core of these benefits is the **recognition of the services that the environment provides** itself and the urban ecosystem, known as ecosystem services.

Before discussing the ecosystem services provided by GI, understanding how cities incorporate GI into the urban fabric is essential. A key principle of GI is **protection of the local landscape and of both the plant and animal biodiversity** it consists of. As such, incorporating GI into the urban environment is a science that recognizes what species of plants suit the local environment and not harm or threaten the local ecosystem[8]. Hong Kong's green infrastructure plan is one demonstration of how research into what species of plants would best be incorporated into the urban fabric can ensure that GI is successful[9]. The result was a catalogue of over 200 plant species that would and could be incorporated into the **city's gray infrastructure via green roofs, green walls, and parks**[10]. Recognizing what plant species suit the local environment is critical in reducing the risks of alien plant species taking over the local environment, causing more damage and creating greater threats not only to the urban ecosystem but also to the natural ecosystem surrounding the city.

Constructing green roofs, green walls, green ways and parks are not the only means by which GI is established in urban environments. GI is also concerned with the **natural environment adjacent to cities**. The natural ecosystem is where the vast majority of ecosystem services are derived from, and as such its protection is critical for mitigating climate change impacts on both human health and

[1] Barton, 2009; Coburn, 2009; Tzoulas, et al, 2007
[2] Barton, 2009; WHO, 2008; Tzoulas et al, 2007; Proust et al, 2012
[3] Tzoulas, et al, 2007; Proust, et al, 2012; Cheng and Barry, 2013
[4] Tzoulas, et al, 2007
[5] Whiston Spirn, 2012; Tzoulas, et al, 2007;
[6] Barton, 2009, Coburn, 2009
[7] Rees and Wackernagel, 1997, Whiston-Spirn, 2012; Corvalan, et al, 2006
[8] CEDD, 2012
[9] CEDD, 2012
[10] CEDD, 2012

the environment. **Land-use change is the greatest risk to the loss of the natural environment** and its ecosystem services, and consequently the greatest promoter of climate change[11].

Humans derive a range of services from the urban (and wider) ecosystem(s): water, air quality, storm protection, flood mitigation, sewage treatment, micro-climate regulation, recreation, culture and health services[12]. Each of these services has been adapted and interwoven into the **social and political processes** that guide the functioning of the urban ecosystem[13]. Ecosystem services are those received from the natural environment. They have been divided into **4 categories** containing 17 services[14], which the table below summarizes:

Table 1. Ecosystem Services

Category	Services
Provisioning Services	Food, raw materials, fresh water and medicinal resources
Regulating Services	Local climate and air quality regulation; carbon sequestration and storage; moderation of extreme weather events; wastewater treatment; erosion prevention and maintenance of soil; pollination; biological control
Habitat/Supporting Services	Habitats for species; Maintenance of genetic diversity
Cultural Services	Recreation, physical and mental health; Tourism; Aesthetic appreciation and inspiration for culture, art and design; Spiritual experience and sense of public space

The most important ecosystem services provided by GI in relation to **climate change and health in urban environments** are[15]:

1. Food through urban agriculture and community gardens;
2. Local climate and air quality regulation via tree planting, green spaces and parks;
3. Moderation of extreme weather events via natural barriers provided by trees;
4. Wastewater treatment related to the protection of ecologically diverse sites such as wetlands, which have a role in water purification;
5. Recreation, and physical and mental health, green space and access to nature have been shown to improve physical and mental health.

The integration of GI into urban environments is focused on **enhancing these services.** As such, cities are looking to **maximize the potential of land and space** in support of these services. Consequently, cities such as Vancouver will use the opportunity to plant urban orchards, thereby not only cooling but providing local food for the population[16]. In Tokyo, recently, the roofs of several transportation stations have been converted into urban garden/agricultural plots that residents can buy and tend[17]. Beyond greening the city, the plots provide a space for relaxation and an

[11] Tzoulas, et al, 2007; Corvalan, et al, 2006
[12] Rees and Wackernagel, 1996; Ernston, et. al. 2010
[13] Rees and Wackernagel, 1996; Ernston, et. al. 2010; Pickett, et. al., 2011; Corvalan, et al, 2006
[14] Corvalan, et al, 2006
[15] Corvalan, et al, 2006; Wolf, 2003
[16] Citystudio, 2012
[17] http://popupcity.net/japanese-commuters-grow-veggies-on-train-station-rooftops/

opportunity for citizens to participate in a productive activity that has benefits for their health and well-being, and society at[18].

GI is also focused on the **protection of the natural environment**, its biodiversity and genetic diversity. To ensure the long term survival of their ecosystems, cities are giving priority to the protection of natural environments within and around their boundaries[19]. Hong Kong protects its nearby wetlands[20]; Abu Dhabi protects the mangroves that grow along its coast[21], Auckland emphasizes the protection of nature and aligns its plans with Maori cultural practices[22].

GI has its challenges, specifically in relation to **safety and security, and use**[23]**,** and each is interconnected with the others[24]. Use of GI, particularly green spaces, green ways and parks, is complex. Depending on the location, however, there is the chance that a park may not be used as intended. A common fear is that parks can and will be used for illicit drug use or as gang turf, and become sites of other potentially violent crimes[25], dangers which prevent their maximum use and benefit to society. If a community cannot take ownership because their collective and individual security is perceived to be threatened, green spaces run the risk of turning into places of dereliction and under-utilization, and thereby losing their appeal as a valuable public benefit for climate change and health.

As such, how can cities incorporate GI into the urban landscape while **creating community ownership** of these spaces, especially in neighborhoods where GI is desperately needed but faces the barriers posed by use? Community policing? Innovative action? Urban agricultural politics?

Hugh Barton's work focuses on how policies can support the urban and natural ecosystems while simultaneously supporting human health and well-being[26]. Barton's work is valuable especially for cities planning for climate change and balancing the needs of their citizens. What is interesting about Barton's work is its highlighting of **potential links to other subsystems** within the urban system via the focal point of health.

Table 2. Health and the Urban Environment (Barton, 2009)

Urban Issue	Key Points
Lifestyle: Physical Activity	Requires space and opportunity Influenced by built environment "Obesogenic environment"- increasingly used by urban health professionals, link between obesity and urban environment Affects all age groups Urban parks, good pedestrian networks, access to recreation facilities Promotion of active travel, all aspects of daily life
Active Travel	Closely linked to physical activity More about trips taken by walking and cycling rather than motorized transport to carry out tasks. Proximity to work, recreation, school Safety Accessibility Increasing opportunities for "spontaneous" exercise beyond planned exercise

[18] Ibid
[19] Tzoulas, et al, 2007; Matsuka and Kaplan, 2008; Chiersur, 2004
[20] CEDD, 2012
[21] Abu Dhabi
[22] Auckland City Council,
[23] WHO, 2013; Chiersur, 2004
[24] WHO, 2013; Chiersur, 2004
[25] Chiersur, 2004; Matsuoka and Kaplan, 2008
[26] Barton, 2009; Younger, et al, 2008

Recreational Activity	Includes physical activity, as well as social activity. Dependent on spatial provision (green space): private gardens, allotments and community gardens Provides access to healthy food – links to improved diet still weak, but maybe linked through housing. Safety
Community and Mental Well-being	Social networks critical to mental and emotional well-being Quality of relationships, links to safety and sense of belonging Green spaces facilitate physical activity, which leads to improved social interactions and social cohesion
Local Economy and Income Issues	Employment important role in health – mental and physical Links to social perception Mortality and illness rates correlated to unemployment Long-term unemployment correlated with depression Poverty has links to mental and physical health; via limiting access to jobs, access to social activities, - positive feedback loop
Activities, Space and Networks	Spatial planning influences activities through decisions on infrastructure, land and buildings, SP role in social exclusion and health inequalities – housing, transport and economic opportunities Poor quality housing = poor health outcomes
Local bio-region	Relationship between environmental pollution and health was the main reason for development of spatial planning practices – persists today Air quality significant impacts on health Land use impacts felt most significantly in urban areas. UHI – managed by greening the city

Integrated Transportation: Co-benefits

Integrated public transportation, transportation demand management, and transit oriented development: these are the key ideas dominating the realm of transportation policy in relation to climate change[27]. Cities have focused on **comprehensive transportation policies as a means to mitigate greenhouse gas emissions and improve air quality**, as the use of automobiles has been a key contributor to pollution. The focus of these policies has been on getting people to leave their cars and use public transportation: buses, trains, light rail systems and electric car shares[28]. In addition, the promotion of active travel has the added benefit of improving physical health.

Active travel is focused on getting people to use non-motorized transportation options, namely walking and cycling[29]. While still a heavily debated topic, it is evident that choosing **active transportation has extensive co-benefits for human health and mitigating climate change**. It can reduce obesity; improve mental health, physical fitness and an overall sense of well-being, while it simultaneously reduces greenhouse gas emissions and other forms of pollution into the atmosphere[30]. Promotion of walking and cycling through policies focused on encouraging the use of bikes through improved cycling lanes, bike shares, and employers' providing facilities for staff to bike to work is undoubtedly beneficial[31]. However, as the WHO points out in its guide for cities looking to implement cycling schemes and improving walkability, the changes may be negligible for populations that are already active[32]. Further, like GI, cycling and walking, face challenges related to use, safety and security that limit their acceptance. Understanding these barriers,

[27] Barton, 2009; WHO 2013; Younger, et al, 2008
[28] Barton, 2009; WHO 2013
[29] Barton, 2009; Wolf, 2003; Younger, et al, 2008
[30] Cheng and Barry, 2013; Proust et al, 2012; Younger, et al, 2008; Barton, 2009
[31] http://www.heatwalkingcycling.org/
[32] http://www.heatwalkingcycling.org/

however, can be valuable in developing policy to maximize the acceptance and future evolution of active transport.

Maximizing Public Education and Engagement

The success of policies and programs that advocate for GI and integrated transportation are dependent upon their adoption and integration into the lives of the people they are intended to benefit[33]. The challenge for cities lies in ensuring that these policy actions become embedded in the cultural milieu. **Education and information technology (IT) have a potential role in ensuring their success,** not only in establishing awareness but in growing and expanding the range of these policies.

Portland, Oregon in the US and Glasgow, Scotland in the UK have plans focused on education. **Portland**'s plan builds on its already deeply ingrained **pro-environmental culture**, which is supported through a wide range of environmentally oriented programs. For example, the city works with school districts to develop the curriculum for its Outdoor Conservation School. The School is intended to cultivate a life-long ethic in favor of outdoor activities in nature and recognition of nature's contributions to daily life[34]. Evidence of this comes from the PDX vision, which is interconnected with visions of life in Portland's future. The scenarios highlight how Portlanders with a variety of backgrounds and interests can all contribute to the preservation of the natural environment and its resources, and take long-term actions to mitigate climate change[35]. The key lesson from Portland is its fostering of a community culture and identity and its maintenance by forecasting a vision of the city to 'sell' and outlining the pathway to that vision[36].

Glasgow's Climate Change Strategy and Action Plan[37] is based on the social determinants of health, and as such its first focus is on human health and well-being. The plan moves from health as its starting point, to build on other key determinants such as education. Like Portland, Glasgow focuses on delivering eco-education that builds an appreciation for nature and its health benefits[38]. There is a strong focus on **local food promotion and farming in the urban environment**. The city also recognizes the value of active transportation and its role in physical health. Glasgow is unique in its prompt recognition that education can play a key role in getting people to adopt active transport. Glasgow goes beyond providing cycling lanes. The city provides a guide to **polite cycling online**[39]. The website provides information to potential cyclists and reminds them of the importance of politeness and respect for the rules of the road[40]. The actions by Glasgow in this regard highlight an important factor for all cities in the process of implementing and advocating integrated transportation. Referring back to the issues of safety and security that prevent individuals from using active modes of transport, Glasgow has 'hit the nail on the head' by educating cyclists on sharing the road with pedestrians and cars (and, perhaps more critically, by recognizing the opportunities for social interaction offered by cycling). Often cities in the race forget that educating cyclists, drivers and pedestrians is a key factor in the success of these policies.

However, education is not limited to schools and childhood. Policy can engage citizens in **creatively educational strategies,** and GI presents a multitude of opportunities for civic engagement. Community gardens and urban agriculture plots can become year-round educational opportunities for people of all ages. Like for protected natural sites. There are challenges in developing, promoting and attracting people to such initiatives, and this is where information technology (IT) can play a vital role. .

IT can be used by cities primarily for disseminating information to the public via the web. City planners can use IT for **modelling and mapping**, **as well as for winning over public opinion** on new

[33] Hosking and Campbell-Lendrum, 2012
[34] City of Portland, 2012; visionPDX, 2010
[35] ibid
[36] ibid
[37] Glasgow City Council, 2010
[38] ibid
[39] Ibid; http://www.politecycling.info/glasgow.html
[40] Ibid

initiatives via online surveys[41]. There is greater potential for IT that has already been used for disseminating information and in aiding people to make informed choices[42]. One such application (app) is Walkscore[43], developed to calculate the **walkability of neighborhoods**, thus enabling people to choose neighbourhoods where they can cultivate less car-dependent lifestyles. The city of Montreal has begun to explore IT's potential with its Eco-Montrealers website[44], the objective being to provide Montrealers with tips on how to integrate sustainable and environmentally friendly actions into their daily lives. Cities can take this concept further and develop apps for use on smart phones. An app would provide an opportunity for **collaboration with a range of stakeholders**, from private to other levels of government, who wish to acquire information and data that can be disseminated to citizens in a meaningful way.

As an idea, community gardens and protected nature areas allocated for recreation use can also become **interactive sites for learning**; for example using scan-able barcodes (or QR) codes to label plants that can provide information on plant species. Smart phones in particular can play a vital role for the vast majority of people, in relation to policies on climate change. IT is an opportunity to engage and inform people in a way that adapts to their lives and the tools used to carry out daily activities[45]. There are risks and challenges. With massive amounts of available information, the challenge will be in making the app stand out and be engaging, informative and dynamic in a practical way that attracts a broad and diverse audience. The potential of linking IT and education into existing best practices is limitless.

Conclusion

Cities have an opportunity to take the best practices of green infrastructure and integrated transportation, and use them as means for educating the public on the impacts of climate change. Further, these best practices provide a forum for informing the public on how their daily choices can make a difference. Moreover, information technology and education have the potential to innovate and expand the effects of these policies if used in a manner that will engage people. Several cities discussed here have shown this potential, and the efficacy of using continuing education and IT as tools for informing the public about policy and encouraging its adoption. This is ultimately an area of policy formation that needs to be explored, especially with respect to its capacity for collaboration with a wide range of stakeholders.

[41] Poplin, 2012; Filippi and Balbo, 2011
[42] Holmner et al, 2012; Papa, et al, 2013
[43] http://www.walkscore.com/
[44] http://ville.montreal.qc.ca/portal/page?_pageid=7137,78133603&_dad=portal&_schema=PORTAL
[45] Papa, et al, 2013; Holmner et al, 2012; Poplin, 2012

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