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Holistic valuation of urban ecosystem services in New York City's Central Park

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ABSTRACT

Central Park is iconic Green Infrastructure that provides myriad ecosystem services to New York City that have significant economic value. We used the market value of Central Park as developable real estate as a proxy measure of the minimum value of the ecosystem services provided by Central Park. We present $500 billion as a reasonable estimate of the market value of Central Park as developable real estate. We assume this $500 billion of natural capital converted to money could earn a 5% annual return ($25 Billion per year). This return is an estimate of the value of annual ecosystem services provided by the 341 ha that constitute Central Park. This is over $70 million per hectare per year which is orders of magnitude higher than the estimated value of ecosystem services provided by the most valuable biomes of previous estimates. The very high value of the ecosystem services provided by Central Park result from an interaction of social, natural, human, and built capital. These interactions are poorly addressed from the dominant economic worldview that governs social and environmental policy today. These findings also suggest that the 'up vs. out' questions associated with sustainable urban development do not have simple answers.

1. Introduction

'Green Infrastructure' (GI) is earning increased recognition as a critical element of the urban environment because of the impacts GI has on human well-being and urban ecology (Tzoulas et al., 2007). Additionally, studies of GI raise some very fundamental and provocative questions with respect to economic rationalism and urban planning (Schaffler and Swilling, 2013; Laurans and Mermet, 2014). There are many differing definitions of GI (Young et al., 2014) several of which are described here: (1) GI is about preservation of natural urban environments via a suite of policies and strategies to conserve land and biodiversity (Newell et al., 2013), (2) GI is a worldview for maintaining and enhancing Ecological Function in an urban network of energy, materials, and species flows that provide benefits to human populations, (3) GI is viewed from an engineering perspective which sees natural and built networks as a part of the broader traditional infrastructure of the urban environment (Spatari et al., 2011; Pucher et al., 2010), and (4) GI is seen from the Ecological Economics perspective which focuses on provision of ecosystem services that result from the interaction of natural, social, human, and built capital. We regard all of these definitions as useful; however, we feel the Ecological Economics approach captures the very important idea of 'interaction' amongst natural, social, human, and built capital which necessitates a holistic perspective for analysis and understanding (Costanza et al., 2014). Here we adopt the idea that GI is the network of green spaces and water systems that provide myriad environmental, economic, and social benefits to urban areas (Ely and Pitman, 2012). We present an efficient and holistic approach to economic valuation of these benefits using New York City's Central Park as an iconic example of the natural capital associated with GI.

Green infrastructure is natural capital in the urban environment that provides valuable ecosystem services. The idea of ecosystem services is well established and there have been literally thousands of peer-reviewed publications in which economic valuation of various ecosystem services have been performed (Costanza; 2014). Triple bottom line (TBL) accounting (Elkington, 1997) suggests green infrastructure should be assessed from the three perspectives of social, environmental, and economic accounting (aka people, planet, and profit). The Millennium Ecosystem Assessment (MEA, 2005) argued for more of an ecosystem service assessment perspective. The TBL and MEA approaches are not incompatible; however, economic valuation from either perspective can be a formidable accounting task. Many ecosystem services can be roughly classified into these TBL and MEA

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categories. Ecosystem services typically associated with green infrastructure include: (1) Provisioning services such as food, water, timber, and genetic resources; (2) Regulating services such as climate regulation, air and water filtration, and carbon sequestration; (3) Cultural/Social services such as recreational, aesthetic, and spiritual; and (4) Supporting services such as soil formation and retention, nutrient cycling, and photosynthesis (De Groot et al. 2002). These general categories of ecosystem services don't necessarily enable appreciation of the real and tangible value of the specifically urban ecosystem services provided by GI (Young et al. 2014).

The challenging accounting task of estimating a dollar value for urban ecosystem services derived from GI would likely include the following:

1) **Ecological Benefits Assessment**: mitigation of urban heat island effect, temperature moderation by urban vegetation through evapotranspiration and shading (Zhang et al. 2014), wind speed moderation, air quality improvement through avoided emissions and pollutant removal, carbon sequestration, storage, and avoided greenhouse gas emissions via cooling (Qiu et al., 2013), reduced building energy use for heating and cooling because of parks, green walls, roofs, and shading (Ca et al. 1998), Hydrologic regulation via flow control and flood reduction, water purification, waste decomposition and nutrient cycling, noise level attenuation, biodiversity protection and enhancement (Bolund and Hunhammar, 1999).
2) **Human Health and Well-being Benefits Assessment**: improved physical well-being from increased physical activity, healthier food, healthier outdoor and indoor environments (Wang et al., 2014), improved social well-being from increased social interaction, social integration, community cohesion, and improved mental well-being from biophilic responses to GI (Takano et al., 2002).
3) **Social and Cultural Benefits Assessment**: food production from urban agriculture (edible landscapes, community gardens, etc.), opportunities for recreation and non-motorized transportation, improved socio-ecological resilience (Folke, 2006), benefits of social interaction and community integrity, benefits of connectivity of footpaths, sidewalks, and bike paths, integrated public spaces for recreation-education-research activities, value of sense of place and belonging, enhanced aesthetics via enhancing desirable views and restricting undesirable views, reduced social inequality through open access to desirable public space (Wolch et al., 2014).
4) **Marketed Economic Benefits Assessment**: improved property values and property tax revenues (McPhearson et al., 2013), enhanced local economic activity, reduced health care costs as a result of aforementioned human health and well-being benefits, monetary value of saved energy and reduced CO_2 emissions, value of avoided construction and management costs of grey infrastructure, avoided costs of flood damage, value of increased use of non-motorized transportation (walking and cycling).

The aforementioned list of valuable benefits provided by green infrastructure is both formidable and undoubtedly incomplete. Conducting an economic valuation of each and every one of these benefits would be an enormous task to complete for a large metropolitan area and it is very likely that it would be an underestimate fraught with isolated calculations that each have uncertainty and error associated with them and do not account for significant interactions. Additionally, many of these services are often complementary rather than substitutable (Ostrom, 2009; Daly and Farley, 2011). For this reason we adopt a new approach of 'holistic valuation' to estimate the economic value of all of these combined services which avoids many of these pitfalls and challenges. Holistic valuation is in one sense a 'revealed preference' of the public at large. Some might argue we are using an 'opportunity cost' perspective for the collective rather than the individual. The value of the 'opportunity' to sell off all of Central Park for development is 'revealed' as not desired by the public by the observation that selling off Central Park for development would be unacceptable to the public at large.

2. Approach

Estimating the economic value of the ecosystem services provided by the natural capital of GI is a daunting task for numerous reasons including questions of double counting, classification, and spatial and temporal scale (De Groot et al., 2010). Consequently we adopt an approach that bypasses and obviates almost all of these complexities by simply estimating the market value of the real estate occupied by Central Park in New York City and stating that this is a legitimate and logical estimate of the minimum economic value of the natural capital contained in Central Park. The logic is this: the public wants Central Park to exist and would not support any politician or political movement that argued for the sale and privatization of the real estate that constitutes Central Park (at least not at the current market value of the real estate) (S. Johanna Robledo NY Magazine, 2015). This is a 'revealed preference' of the public at large. Our 'holistic valuation' approach adopts the language of 'revealed preference' often associated with 'revealed preference theory' of neo-classical economics (Samuelson, 1938); however, any analogy is weak for several reasons including: 1) the non-sale of Central Park is a passive rather than an active act, 2) Central Park is a public good and the benefits and utility of the park or its potential sale are difficult to allocate accurately or coherently, 3) these are collective rather than individual decisions. Despite these complexities we are confident that any proposals to sell off Central Park to private interests and to use the proceeds of such sale to reduce the taxes of the citizens of New York City would be overwhelmingly rejected by the public. This idea enables the following simplifying assumption: *The market value of the real estate of Central Park is a minimum estimate of the value of the Natural Capital contained by Central Park*. Using this assumption it is a simple and straightforward task to estimate the dollar value of the GI represented by Central Park and to estimate the dollar value of the ecosystem services annually provided by Central Park.

Proceeding with this assumption leads us to questions of the dollar value of real estate in Manhattan. We are comfortable with order of magnitude errors in this particular case because the numbers are so large that they raise provocative questions for *any* reasonable estimate of the value of real estate in Manhattan. One estimate of $528,783,552,000 (over half of a trillion dollars) for the total value of the 843 acres of real estate in Central Park was conducted by the property appraisal firm of Miller Samuel and published in New York Magazine (S. Johanna Robledo NY Magazine, 2015). There is spatial variation in the value of real estate in all urban areas including Manhattan (Thunen and Hall, 1966). Midtown will have different values than the financial district which will in turn have different values than Harlem. Central Park spans enough area to undoubtedly capture some variation in per acre values of real estate; nonetheless, the Miller Samuel estimate produces an average per acre value of over $600 million. Another estimate can be derived from a story about a property that was destroyed by an explosion on the Upper East Side of Manhattan on east 62nd street (NYTimes, 2006). The house was leveled in an explosion and had an appraised value of $6 million. The open land without the structure was valued at $7 million and this was for an area of less than 0.05 acres. This works out to over $140 million per acre for a property which had a single family unit on it. This