The Urban Ecology:
The Tri-dimensional Approach

By Colin Manasse

Abstract

Problems abound when considering the environmental challenges of an increasingly urban society. Among these are a decreasing vegetation cover of the soil, water absorption capacity, shade and temperature regulating vegetation, and an increasing level of air, noise, water and light pollution. While many have attributed these problems to a plethora of factors; the main cause remains the properties of the materials used in the urbanization process. This is itself a result of economic circumstances that favor the use of cheap and inorganic materials. It is counterintuitive, therefore, that these very same materials could be used further in the provision of a solution to the problems associated with the urban environment, especially in the case of countries in the "southern cone," especially Brazil.

Solving the environmental problems associated with urbanization requires lateral thinking, or rather vertical thinking. The surface area of vegetation that is displaced by the urbanization of an area, for example a city block, removes the services that are usually provided by that area of vegetation: heat energy absorption by plant leaves, temperature cooling from plant evapotranspiration, air filtration from plant respiration and the carbon cycle, noise reduction from plant asymmetries, etc.... The solution lies in the utilization of the surface area that is created by the vertical expansion of the buildings; in other words, the sides and roof tops. These are areas on which vegetation could grow, and further provide its services, only to the urban environment. The use of plants on rooftops is slowly emerging as a technique for reducing excessive temperature regulating energy, as well as for treating water. Ford Motor Company installed one on the top of one of their buildings in Dearborn, Michigan. The use of rooftops could help to restore approximately 60 to 90 percent of the vegetation area that has been eliminated, and vines on the sides of the buildings could actually increase this percentage beyond the original surface area.

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The problems associated with the urban environment are of increasing importance in the realm of global environmental concern. This can be related to the fact that urbanization is a steadily growing trend globally, and the problems associated therewith are correspondingly of greater concern to societies around the world. Until the nineteenth century, less than 5% of the world's population lived in cities, and by 1950 a third of the world's population had urbanized. This trend did not slow down, even in the post industrial economies, which has led to today's urban population reaching almost 50%, or 3 billion people. This number is projected to grow to 6 of 9 billion, or a swing to an urban ratio of two to one. The ever increasing urban population requires sustainable solutions to the many environmental, social, and economic consequences of this urban migration. (TIBAIJUKA 2005)

The global consequences of solving the problems of the urban environment are best depicted in Our Urban Future:

A country's global success rests on its cities' shoulders. In a rapidly urbanizing world, it is the city that increasingly contains the social, economic, and political details of a country… Governments are the watchdogs that can ensure that environmental standards are being met and ecosystems are not being dismantled, that local services are not arbitrarily withheld from the poor, that citizens have the opportunity to participate in decisions that affect them, that safety nets are in place in case of emergency, and that norms of integrity are upheld by local officials. Therefore, one of the most urgent tasks facing governments everywhere is the formulation of a coherent set of policies that enables cities to take their place at the centre of national economic and social development. (TIBAIJUKA 2005)

The welfare of a city's and the rest of the country's population are intimately linked. The cities not only contain a significant portion of the country's population, but also portray the image of that country to much of the rest of the world, since the economic centers of most of the countries around the world lie in their cities. It is therefore of utmost importance that the quality of life within the cities rise so as to elevate the quality of life within the entire country, if only by attracting foreign investment, and creating a demand for their city.

The cities contained within the scope of this paper are those which could be qualified as “global cities”. Saskia Sassen, of the University of Chicago, describes these cities as “expanded central urban areas”, “business nodes…that are strategic sites in the global economy” (SASSEN 2005). To better understand these global cities and their function in future social development, Sassen continues to describe this concept by saying: “global cities concentrate both the leading sectors of global capital and a growing share of disadvantaged populations (immigrants, many of the disadvantaged women, people of color generally, and, in the megacities of developing countries, masses of shanty dwellers).” Sassen has here described the concept of he global city, but has also touched on one of the important dimensions of the urban environment: the center-periphery divide.

On an international scale, the center-periphery divide depicts the separation of the rich and poor, not only as access to economic relief and possibilities, but as physical location from the economic centers. As one’s position is more removed from the center, the quality of life and the potential for improvement decrease. This can be seen in the urban sprawl phenomenon in many of the global cities, where the shanty towns referred to above are located on the outskirts of the city, and the greater the number of people migrate the more official the inner shanties become, which will lead to their development by the city, and continue to force the poor and disadvantaged further away. This kind of development leads to a growing mass of disadvantaged, whose problems include pollution and the spread of diseases, as well as increasing casualties and damage during rains or other disasters. The increased casualties are mostly due to the lack of physical structure of the developments, as well as the lack of flora which physically holds the top layers of soil in place during these rains, leading to landslides during heavy rains. The population of slum dwellers is expected to rise from 1 to 3 billion by 2050 (UN-HABITAT 2005), and is therefore a pressing concern when considering the urban environment.

Sassen concludes that it is through this point of view that we can now understand the global cities as locations for “a whole series of conflicts and contradictions.” (SASSEN 2005) This reiterates the link between the many problems associated with the urban environment: social,

economic, and environmental. The cities are the new frontiers where national efforts and policies protecting the environment may lead to international treaties that are ratified, and whose enforcement is unnecessary. These cities are the gateway for establishing environmental primacy simultaneously by the international and local communities.

The natural environment should be thought of as an industrial process, which is the most complex regulating system known to us. It provides many services, including filtering the air and water on which we are so dependant, but also provides nutrition and sources of income by transforming our waste and the energy from the sun into natural resources. This is a closed loop system of which we are a part, and the greater the inefficiency of our development, the worse human health can be expected to get. It is this point of view which will allow for understanding the solutions that are needed to provide a cleaner urban environment, as well as solutions to social and economic problems associated with the urban migration.

The most widely publicized problem particular to the urban environment is that known as the Heat Island Effect. This refers to the phenomenon where the temperatures within urban areas reach higher daily levels than those in less developed areas. This has been attributed to the fact that cities are mainly comprised of concrete and asphalt, which absorb the heat from the sun during the day, and continue to radiate that same heat at night. The heat pollution can be linked to the incidents in Paris and London a few years ago in which older members of the population, with no air conditioning, died from heat exhaustion. This heat pollution also leads to increased energy use through artificially high needs for cooling loads of buildings, which contributes directly to increased air and water pollution, acid rain, and the plethora of problems associated with the use of fossil fuels. Therefore, this is a starting point in the reduction of urban pollution and the cleaning of the urban environment. The solution that many cities in the developed world are turning to is known as “Green Roofs.”

The footprint of urban development on a physical level is the area that is taken from nature, and replaced with a building or paved streets. In most cases, buildings allow for an increase in density of people or services by vertically developing the space used. The area of flora that is transformed can be understood as a corresponding loss in ecosystem services that were provided

by that area (this is the loss of possible air and water filtration, heat absorption, etc…). The surface area that replaces it, from a bird's eye view, is often left unused, as only a mere asphalt shingled roof that serves only one purpose, to separate those inside from "the elements." It is this surface area that provides the opportunity for restoring those ecosystem services that have been so undervalued by developers and planners so far. These roofs can be used to plant gardens and restore some vegetation to the urban environment which would help to restore some of the services provided by nature.

The vegetation could help to filter the air polluted by the internal combustion transportation systems so prevalent in urban areas. This would help to reduce the incidents of health problems such as asthma and respiratory diseases that are strongly correlated with high levels of air pollution. Also, acid rain which causes great harm to national monuments, buildings, and the environment in which it is released would be filtered, and the amounts of urban runoff would be mitigated during heavy rains since much of that rain could be absorbed by the soils and plants on the roofs of the buildings. In addition, the cooling load of buildings would be greatly reduced for two reasons: the soil would provide an extra layer of insulation, which reduces the excess cooling load attributed to leaks, and the heat attributed to sunlight would be absorbed by the plants and other vegetation on the roof by fueling their photosynthetic processes. The shear number of services that would be provided by a citywide implementation of these roofs far outweigh the possible costs.

The tri-dimensional approach mentioned in the title, and heretofore left unexplained takes the concept of the green roof one step further. Since buildings are used to increase the amount of people that can fit onto an area by expanding that area into three dimensional space (elevating that area far above ground), the same development could be applied to the vegetation associated with a building. The soil on the roof of the building can be used to house the roots of vines, which can be allowed to grow along the vertical surfaces of the buildings. This would directly increase the vegetation of a surface area beyond that which was originally possible without any development. The use of vines would provide greater temperature regulation by providing the green roof cover to the sides of the buildings, and an extra epidermal layer of insulation in cold climates. This would also increase the services that were provided by the vegetation, such as air

filtration and water absorption and filtration to meet the needs of a population that lives in three dimensional space.

The vines on the sides of the buildings would help to provide not only the same ecosystem services that are provided by the green roofs, but could potentially provide for the mitigation of other forms of pollution that are specific to urban areas: light and noise pollution. The increased density of populations in urban areas, as well as the diverse nature of the urban economy has meant that services and lifestyles have also diversified: people are awake at all hours of the night, traders must be awake to start trading on foreign financial markets…These varied lifestyles correspond to more light being used in densely populated areas, whose buildings have windows and other reflective surfaces which create light corridors that promulgate a single light to many different buildings, and therefore to many different people. The vegetation on the sides of buildings would help to mitigate such effects by reducing the corridor down which the light can travel, as well as by reducing the reflective surface area. The concept being similar for sound waves as it is for light, this absorptive capacity should therefore also apply to noise pollution. In urban areas, sound waves propagate and reverberate by bouncing off the hard surfaces of concrete and glass that are usually uncovered. The very flexible and malleable nature of vines, and vegetation in general, should also help to reduce the noise pollution attributed to cars, buses, and general activity which takes place at all hours of the day or night in global cities. The capacity of vegetation to absorb and transform are the keys to future urban development, and to that development being associated with a high quality of life.

The choice of vegetation used in the provision of urban ecosystem surfaces will vary depending on many environmental factors, as well as economic and social ones. The environmental factors that will affect which vines are used include: yearly temperatures, climate, latitude, and all other factors having to do with the geographical location of a specific city. In this regard, it provides an opportunity for that global city to reconnect to its region. This should help to mitigate some of the social problem associated with urban development, as it would provide ties for the migrant urban poor who migrated from the rural areas to their place of origin, and to something familiar. This might help to reduce the social division between the rich and poor, and help to ease the transition from rural to urban life on a psychological level.

The choice of vegetation will also affect the city on an economic basis, since much of the vines that can be chosen provide sources of revenue for the cultivators. Tomatoes, raisins, and grapes are just some of the choices that will affect the economic interests of the city, and those of its citizens. The increased urban production of produce or flowers will have disseminating economic effects, since there will be an increased demand for the services associated with the agricultural sector, and those linked to it. The cultivation and collection of the fruit and vines will require agricultural knowledge, mostly associated with rural settings, so the immigrating rural poor will have greater opportunity for employment, thereby reducing poverty, and the increase in food availability will help to raise the quality of life. The organization of the cultivating and collecting activities will help to provide management level employment in the private companies or cooperatives formed to efficiently collect the produce. Associated with this, is the need for constantly clearing the windows from obstruction, and therefore vine trimmers should develop as a profession, much like high altitude window cleaners. These are all constant employment opportunities, unlike construction projects which only last as long as the project itself takes to complete.

The nutrients that would be required for the continued growth of the vines and agricultural production associated with it would have to be organic in nature, since the widespread application of chemical fertilizers and pesticides in urban areas would constitute unfathomable health risks. To that end, a city wide organic waste recycling program could be implemented. This waste could be composted on the roofs of the buildings, which would localize the waste to nutrient transformation. Since it is likely that the rate of organic waste production would outpace its absorption as nutrients, the recycling of the waste into nutrients should be accelerated, probably using earthworms (class Oligochaeta) since they both till he soil and their castings improve its texture, although experts should be consulted, and specificities determined. The recycling program, from collection to compost, would again help to provide permanent employment opportunities for the increasing numbers of urban poor.

There are some problems that may be associated with the increase in flora in urban areas; most obvious is the corresponding increase in fauna. The increased vegetation is likely to bring into the city some of the pests and insects that are commonly associated with farms, and they are

likely to bring some of the diseases and health problems with which they are linked. This could reduce the overall health benefits of urban agriculture in the short term, though not significantly. In the long-term, as with much of ecology and evolution, increased exposure will increase the population's resistance, so human vulnerability to such diseases and insects will decrease over time.

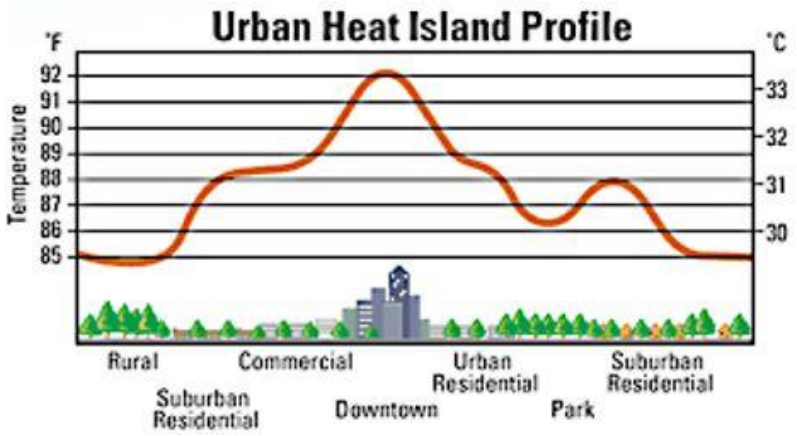
More pertinent to the agricultural vine developments, is the possibility of bioaccumulation. The vines that grow the produce and filter the air do so in part by absorbing the toxins that are in the air. There is therefore a possibility that these toxins may accumulate in the fruit that they produce, and could therefore pollute some of the fruit. While this is unlikely, its possibility must be investigated before deciding which vines should be grown, since it will have effects on human health as well as the economy, and possibly international political relations since the fruit would be available for export. It would therefore be prudent that the first few vines be floral in nature, to avoid compromising the citywide implementation of this solution.

This solution addresses mostly the center of the urban center-periphery division of the city. The solutions for the periphery require that financing be taken into account before any further questions may be addressed, since the global city already has financing and infrastructural services at its disposal, these can be assumed, which is not the case for the periphery. The solution for the periphery is much the same as for the center. Vines would help clean up the air and the general environment, as well as provide increased quality of life by providing alternate sources of food for those who cannot afford it. If the vines are planted in the ground, which is uncovered in shanty towns, and allowed to grow atop the shanties they would provide "anchors" for the top soil, which will help to mitigate the disastrous landslide effects of rains, as well as shade and cooler temperatures for the shanty residents.

The problems arises when the financing of the vines and associated costs are being considered. We must here link the center to the periphery on a political level, since only proper political financing structures will help provide the necessary incentives. The vegetation cover that is lacking due to window clearance provides a financing opportunity in a tax/trade structure for the center to provide the means of growing these vines to the periphery. If tax deductions are

provided for growing vines on the sides of buildings, it could be reduced accordingly by the lack of vegetation in the windows. The proprietors could therefore be offered the opportunity to compensate for this lack of vegetation by increasing the vegetation cover in the periphery. The incentive would arise from a tax reduction, but also in the overall lowered costs associated with landslides and generally on the social benefit of having a higher quality of life for all city residents, such as reduced crime. The incentive would have to be provided according to those services, such as a reduction in health care taxes for those participating members, though limited only to the surface area covered by the windows of the buildings so as not to remove incentive for central urban solution implementation. This addresses a major flaw depicted by Blair Ruble when considering past development plans: "master plans proved too inflexible to respond to the rapid growth of informal settlements" (RUBLE 2005).

The tri-dimensional approach applies on a physical, as well as on a conceptual level. The approach calls for floral development in three physical dimensions (height, width, length). The implementation of this approach provides solutions in three dimensions as well: the social, the economic, and the environmental. Raw data still needs to be generated, collected, and analyzed so that more accurate cost benefit analyses may be carried out. However, on a theoretical basis, vines and green roofs seem to provide many solutions to the problems within the urban environment, and should therefore be seriously considered by all global cities as a means to move past the limits of urban development provided by physical limitations, and into the development of their populations by increasing the employment, the ties to the region, and the quality of life for its citizens generally.



Source: EPA

Participants of the ***International Congress on Environmental Planning and Management – Environmental Challenges of Urbanization***, held in Brasilia, Brazil, from September 11th to 15th, 2005, decided to adopt the following Charter of Brasília, inspired by the presentations and the papers submitted, and by the outcomes of the discussions that took place during the event: Charter of Brasília in PDF.

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Colin Manasse is currently studying International Environmental Policy at the Monterey Institute of International Studies, in Monterey California, specializing his studies in renewable energy development in Asia and Africa. I am therefore conducting most of my research in those areas, both topical and geographic, but enjoy researching and studying urban and sustainable development. Colin is currently working at the Transportation Agency for Monterey County, which is a transportation planning agency. He will be interning at the United Nations Statistics Division this summer, which he looks forward to with great anticipation.

Contact Colin at: colinmanasse@hotmail.com