Session: REALITY CHECK WORKSHOPREVISITED! Quito, Ecuador

The New Resolution in Eco-efficient Design for Quito, Ecuador and its Consequences for Sustainable Development

Maks Davis, M., Jacome Polit, D., Masache, M., Barros, J. L.

Abstract:

Quito´s urban sprawl poses fundamental challenges from an ecological and economic perspective, but reverting this trend also provides a unique opportunity to plan, develop, build and manage a city that is simultaneously more ecologically and economically sustainable and more resilient. The construction of the first line of the metro, which crosses the upper plateau from north to south within the city, and the extensions of BRT lines, provide the possibility of socially profiting from this infrastructure. The proposal launches an instrument of urban planning based on the theory of smart growth, and aims to guide the development of areas of the city that are affected by mass transit systems, to achieve orderly and sustainable growth by maximizing access to public transport through strategies like mixed uses and high density, and where the real estate market offers to the public access to affordable housing, commerce, services and green and social infrastructure. All these strategies aim to discourage the use of the private vehicle, promote collective mobility, alleviate vehicular congestion, improve air quality and limit carbon emissions.

Furthermore, Quito is a city that grows and develops without being able to adequately manage natural and manmade risks, becoming increasingly vulnerable. Accelerated growth, lack of planning and the dynamics of the informal market foster a state of vulnerability already latent in the territory. From this point of view, and the perspective of resilience, urban development around mass transit stops is an opportunity to help change this trend. If this proposal includes mitigation measures to environmental impacts derived from buildings, then the proposal does not only look at the construction of short-term resilience by helping reduce vulnerability in the territory, but also contributes to the construction of long-term resilience by helping to demand fewer resources and services from nature. The present paper analyzes how The New Resolution in Eco-efficient Design for Quito helps out in this task and becomes a versatile instrument, part of a broader tool, in contributing to the goals mentioned before. First, by providing incentives to locate new real estate projects where the city can receive more buildings, and then by focusing the efforts of designers and builders where the environmental footprint of the city requires.

Keywords:

Urban Design, Legislation, Sustainable Certification, Transport, Resilience

Introduction

The first metro line of Quito, among other solutions such as the Quito Cables or the extension of BRT coverage, "has been one of the most important projects to solve the problems of mobility in the city" (PMDOT 2015- 2025 (iv), MDMQ). However, sustainable development as a concept with a broader scope requires looking at mobility, urban planning, land use, and environmental issues together to propose a holistic tool. The New Resolution in Eco-efficient Design for Quito becomes an instrument that can help pave the road to a better contribution to sustainable development. This paper sets out to examine, through secondary research, the contexts beyond the parameters of the Resolution, and in this manner determine the type of sustainable development for Quito that is promoted.

Second, an analysis is to be made to encourage designers and the building industry to concentrate efforts in reducing the environmental footprint of buildings. Overall, work by Todd, Pyke & Tufts (2013) shows how ecological rating systems for buildings allow for environmental assessments to be given and promote market transformations. Additionally, it is noted that tensions can be created in the application of the rating systems and subsequent building design requirements.

Ecuador is located in Latin America and is characterized by having a mild climate with little seasonal variation, though the climatic conditions vary according to height more than the time of year. In the Andean mountains the temperatures tend to be between 12 and 25 degrees Celsius, whereas in the Amazon and the coastal regions, the temperature often approaches 30 degrees (Inamhi, 2015). There is a negligible energy demand related to heating in the building sector when considering the context of the weather. Additionally, it means that international certifications such as LEED and BREEAM are not necessarily suitable to be used in the Ecuadorian context, given their focus on reducing the energy demand of the buildings to be certified (Figure 1).

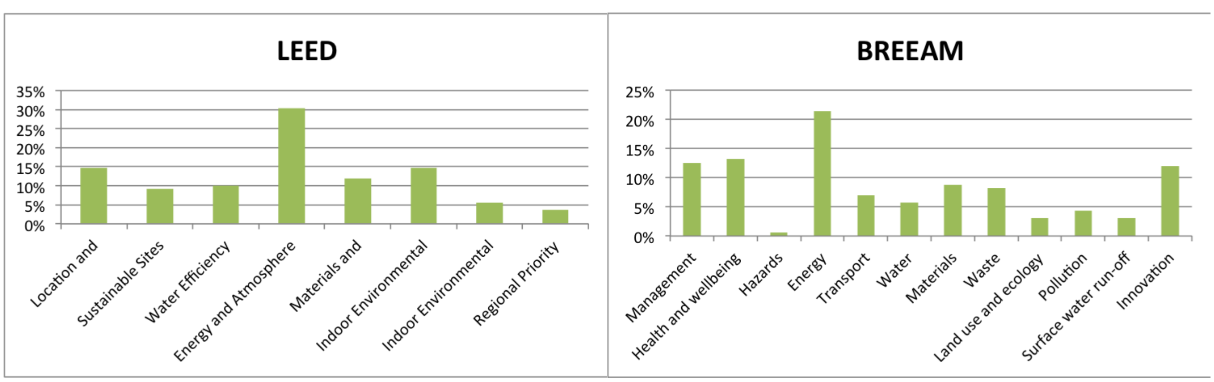

Figure 1: Parameters for LEED and BREEAM certifications (adapted from LEED, 2016 and BREEAM, 2016)

In contrast, national certifications have come about in Ecuador from public bodies and the private sector. Regarding the private sector, the Environmental Evaluation System was introduced in 2013 by the Mutualista Pichincha. In the public realm, the Ministry of the Environment (MAE) brought the Punto Verde certification for ecological buildings into development in 2014. The parameters for both are shown in Figure 2, where it can be seen how there is a shift from energy demands towards water resources, materials and residues.

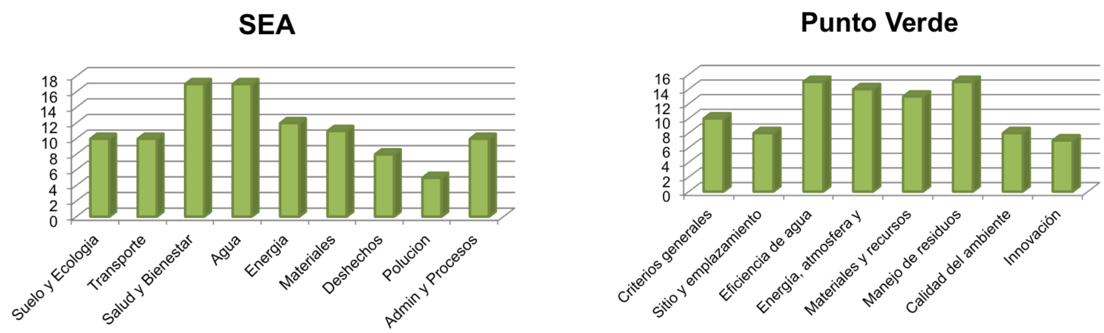

Figure 2: Parameters for SEA and Punto Verde certifications (adapted from SEA, n.d. and MAE)

The Resolution No. 13-2016 of the Secretary of Territory, Habitat and Housing of the Municipality of Quito (the Resolution) offers a different perspective on eco-efficient design from LEED and BREEAM, where it builds on the parameters offered by SEA and Punto Verde. The aim was to encourage designers and the building industry to greatly reduce the environmental footprint of new buildings, in conjunction with moving away from private vehicles to mass public transport usage. In this context, the certification is aimed at the promotion of a compact city, with high-rise buildings located within 400m to the mass public transport hubs. In the instance of being within 400m of a Rapid Bus Transit Station, it is possible to increase the building height by up to 50%. If the construction is within 400m of a Metro station, the building height can be increased by 100%.

This offers an economic incentive for the building developers to comply with eco-efficient design and, to date, a great interest has been shown already in the building sector.

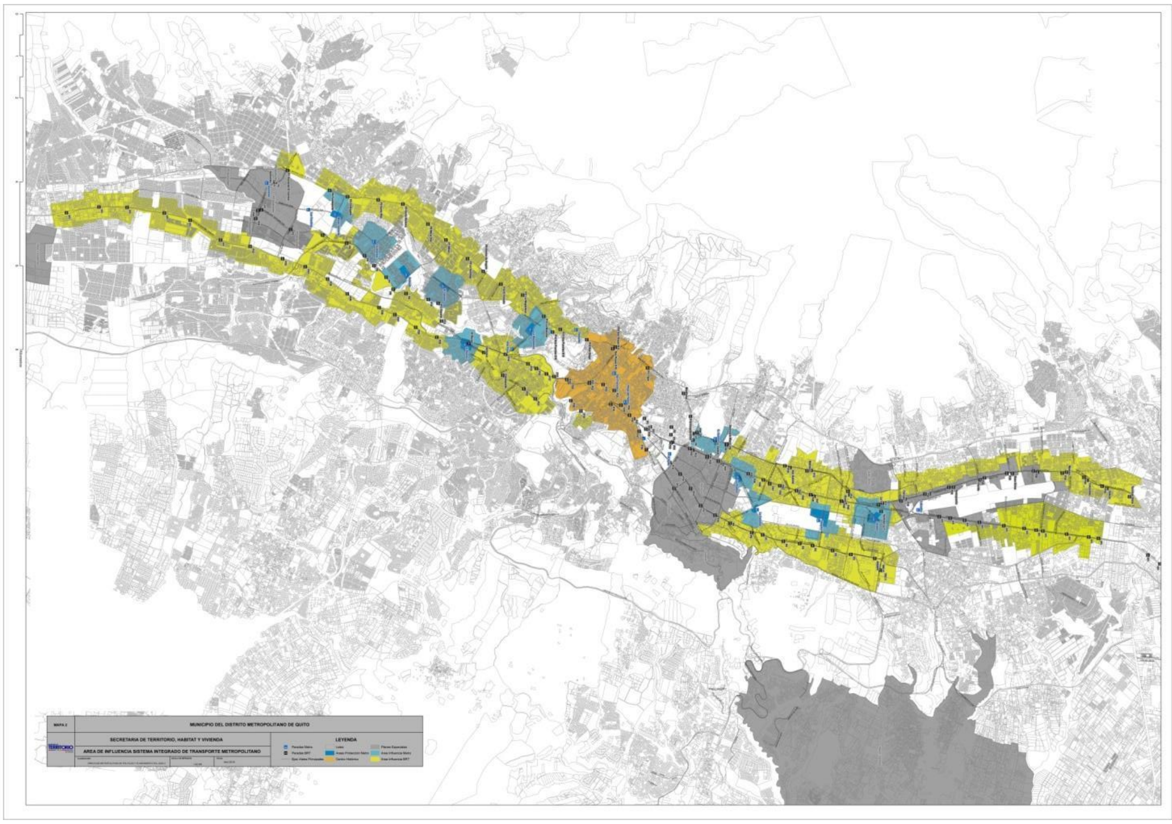

Figure 3: Urban polygons showing 400m within Quito's Rapid Bus Transit System or planned Metro stations

Second, the Resolution dedicates 35% of the total percentage available to water (consumption, wastewater management and surface runoff), compared to 10% and 6% for LEED and BREEAM respectively (LEED, 2016 and BREEAM, 2016). Third, of the 30% dedicated to energy, 21% is related to the promotion of diversification of uses to mitigate the need to travel large distances by car to meet shopping, work and leisure needs (Figure 2). This is in relation to 42% of Ecuador's national energy demand being from the transport sector (MCSE, 2015).

Limitaciones en Consumo de Agua	35%					
				Eficiencia en el consumo de agua potable y disposición de aguas negras y grises		
		Parámetro	Retención de agua en superficie	Eficiencia en consumo de agua	Reutilización de aguas grises	Disposición de aguas al alcantarillado municipal
		Ponderación	12,25%	7,58%	7,58%	7,58%

Limitaciones en Consumo de Energía	30%					
			Consumo anual de energía		Eficiencia en consumo de energía relacionada a la movilidad	
		Parámetro	Consumo de energia	Balance consumo/generación	Espacios para comercio barrial o sectorial y/o equipamiento social (Sin variar la compatibilidad)	Diversidad de Usos
		Ponderación	5,40%	3,60%	5,25%	15,75%

Aportes Ambientales, Paisajísticos, Tecnológicos	35%												
			Tecnológicos		Ambientales				Paisajísticos				
		Parámetro	Materiales: Renovables, reciclados, locales, reuso, bajas emisiones	Uso de materiales livianos en mamposterías	Plan de minimización de escombros y desechos de construcción	Plan de instalaciones para manejo de residuos sólidos	Plan de mantenimiento del edificio	Plantas nativas y adaptables	Unificación de lotes	Asoleamiento	Reflectancia solar	Integración del retiro frontal a la acera (2 1eras plantas - múltiple aislado)
		Ponderación	3,50%	5,25%	2,11%	2,11%	2,11%	2,11%	9,50%	3,15%	3,15%	2,00%

Figure 3: Parameters for the Resolution 13-2016

Methodology

This paper sets out to examine, through secondary research, the contexts beyond the parameters of the Resolution, and in this manner determine the type of sustainable development for Quito that is promoted. The work is divided according the parameters shown in Figure 2: Agua (Water), Energía (Energy) and Aportes APT (Environmental, Landscape and Technological Contributions).

Agua (water)

Quito is under an incredible strain regarding its wastewater treatment facilities, where currently, wastewater from the city is discharged untreated into surrounding rivers. according to the Public Metropolitan Company of Potable Water and Sanitation (EPMAPS) of Quito (2011), the sewerage discharge rates to the main rivers of the city are:

- Manchángara river = 3.48 m3/s.
- Monjas river = 0.64 m3/s.
- San Pedro river = 0.69 m3/s.

Rainwater runoff plays an important role in determining the urban wastewater distribution system capacity in addition to the daily sewerage discharges from the city. As the urban area of Quito expands, the amount of permeable ground of that previously unoccupied area is replaced by hard surfaces that lead to increased surface runoff (Berndtsson 2009). This causes a sharp increase in the flow rate that is needed to be absorbed by the city's sewerage system. Estimates by Davis and Tapia (2016) for the increased loads in times of peak rainfall showed a 12-fold increase from 3.48 m^3/s into the Manchángara river to 55.32 m^3/s average. This puts an incredible strain on the sewerage system, and diminishes the chances at all future attempts of pre-treating the wastewater before discharge into local waterways.

In this context the Resolution sets out to:

1. Ensure the retention of rainwater runoff from new constructions and that this is not discharged directly to the sewerage system.
2. Promote a drastic reduction in the discharge of residual waters that would be produced by the new buildings.

To this extent 12.25% is dedicated to point 1, where a minimum of 46% of permeable surfaces are required or otherwise a strategy to retain at least 16% of the rainwater runoff volume. Regarding point 2, this is approached in a three-step process. First, the consumption of potable water from the municipality may not be 40% greater for the building with an increased height than for the original building that would otherwise be permitted. Second, at least 30% of the greywater produced needs to be recycled within the building. Third, the building with an increased height can only discharge 75% of the volume of wastewater into the municipal sewerage system, when compared to the discharge that would be caused by the original building that would otherwise be permitted. By complying with the greywater recycling the parameter related to potable water consumption is easily met. The determining factor for this section is the inability to discharge wastewater into the municipal sewerage system, where it has been found in practice that the buildings with increased height need to have 4-5 m^2 green space with an irrigation demand using recycled water of 5 litres/m^2/day for every building occupant. This turn has led to vertical gardens becoming more popular in eco-efficient buildings designed in accordance with the Resolution.

Energía (energy)

Buildings have connections and interactions with their surroundings: they have a place within the urban context through their users, they relate to mobility needs, they serve as a channel to access, integrate and participate in the community on an urban scale (Anderson, Wulfhorst, & Lang, 2015). Within this context, promoting sustainable urban transport enables a connection between individual buildings and the city where they are placed within, enhancing sustainability and helping to achieve reductions in energy consumption and environmental impacts (Larson, Liu, & Yezer, 2012). Furthermore, the promotion of renewable energies along with energy efficiency is considered the most widely spread solutions to control GHG (Lee & Chang, 2008 and Özbuğday & Erbas, 2015). Installation of renewable energies in buildings can also be linked to a decentralization of the energy system, enhancing independence, reducing energy consumption, and increasing the resilience of the city in order to enhance urban sustainability (Kammen, & Sunter, 2016). As mentioned in Sadorsky (2014), renewable energy technologies address the need to meet the demands from growths in urban population and wealth, whilst also limiting GHG emissions and moving towards a more sustainable city. In the case of Ecuador and as previously mentioned in the Introduction, the energy consumption for the building sector in Ecuador is far less than the international average, given that there is a negligible heating demand. According to the National Institute of Renewable Energies and Energy Efficiency of Ecuador INER (2016), Ecuador has 6 different climate zones. Quito is placed inside the climate zone three (3), which follows a climate criteria of CDD 10°C for places ≤ 2500 masl and HDD 18°C for places ≤ 2000 masl. According to these characteristics, the need for cooling or heating in a building is not as important as targeting reductions in electricity demands, the promotion of sustainable mobility, and water heating using renewable energies. The largest factor in energy demands is transport, which according to the most recent study carried out by the Ministry of the Coordination of Strategic Sectors makes up 42% of total national energy demands (MCSE, 2015). In Ecuador residential buildings mainly need gas and electricity (MCSE, 2016) for cooking, water heating and electrical appliances respectively. In terms of electrical energy, 42% was met by hydroelectricity in 2014 (MCSE, 2015) and this is expected to increase dramatically with the inauguration of the Coca Codo Sinclair plant (MEER, n.d.). As such it is argued here that the electricity supply is to become renewable in the future, and the aim is to ensure that the demands remain within the production capacity limits of Ecuador's hydropower plants. In relation to gas, this is mainly used for cooking and water heating. There has been a governmental push to replace three million gas cookers with electric induction technology (MEER, 2015), which would mitigate the gas demand to electricity supplied from hydroelectric plants. In terms of water heating, it is not efficient to produce hot water with electricity (MacKay, 2008), and as such solar water heating becomes of interest.

In this context the Resolution sets out to:

1. Limit the increase in energy demands, despite the increase in building heights permitted.
2. Produce hot water through renewable energies located on site.
3. Ensure commercial areas are included in the ground floor of the building.
4. Promote mixed-use buildings.

To this extent 5.4% is dedicated to point 1, where the increase in building height needs to correspond to a limit of an 150% increase in energy demand. Regarding point 2, in order to gain 3.6%, at least 8% of the energy demand for water heating needs to come from renewables (such as solar thermal panels). Finally, at least 30% of the ground floor needs to be dedicated to commercial areas and 30% of the whole building to uses other than the primary use of the building. Overall, there is a relation of 9% connected with energy demand of the building (points 1 and 2), with the remaining 21% related to the implications for transport (points 3 and 4). This reflects the context of the majority of the national energy demand being due to transport (42%), and only 12% from the residential sector (MCSE, 2015). It remains to be seen however if the buildings designed under the Resolution will achieve the impacts desired in practice.

Aportes APT (Environmental, **Landscape and Technological Contributions)**

Both LEED and BREEAM recognise the importance of Environmental, Landscape and Technological Contributions. LEED dedicates a total of 36% to parameters that can said to be related to this area (15% Location and Transportation, 9% Sustainable Sites and 12% Materials and Resources) (LEED, 2016).

BREEAM has a somewhat higher value of 37% dedicated (1% Hazards, 9% Materials, 8% Waste, 3% Land use and ecology, 4% Pollution, 12% Innovation) (BREEAM, 2016). The Resolution reflects the logic of LEED and BREEAM, with a weighting of 35% dedicated to this area. The parameters to be measured were inspired by both LEED and BREEAM, with adjustments were made for them to be appropriate for the local context of Quito, Ecuador.

In this context the Resolution sets out to:

1. Encourage the use of local, renewable, lightweight materials for building constructions.
2. Transform the construction process and final building in use from being a polluting activity to one that transforms waste into nutrition and enhances local biodiversity.
3. Make the new constructions have a positive contribution to local public space.

To this extent a total of 8.75% of the eco-efficiency matrix is aimed towards point 1 (3.5% Materials that are local, recycled, renewable or with low VOC emission, 5.25% for lightweight materials in masonry and structures). Regarding point 2, 8.44% is dedicated into closing cycles and promoting local biodiversity (2.11% Plans to minimize residues from construction, 2.11% Plans to manage waste from the building in use, 2.11% Maintenance plans for the building installations, 2.11% Use of native plants). Finally, 17.8% of the matrix is related to improving public space (9.5% Unifying allocations of land for construction, 3.15% Shading cast by the new building, 3.15% Reflectivity, 2% Integration of the building front with public space). Overall, by taking inspiration from LEED and BREEAM and then adjusting the parameters to local necessities, the section of the certification aimed towards Environmental, Landscape and Technological Contributions should have a more positive impact than would be the case if the LEED and/or BREEAM parameters were applied directly. It remains to be seen how these parameters will influence building design in practice however.

Conclusions

Quito is working to improve and expand the coverage of the integrated mass transit system of the city. As these works are important, it is necessary to adjust the rules and regulations of urban planning of the city to this new reality. These adjustments must relate directly and narrowly to environmental and urban dimensions, in order to achieve a synergy that favors a correct urban development. The rules and regulations also need reflect the extra financial investments made by the building industry in the construction of ecological, high density buildings.

Quito, within its own context, has a complex environmental footprint distributed differently than other cities. The energy demand and the high carbon emissions is almost entirely due to traffic, due to Quito being a city that has grown with an incoherent morphological structure, resulting in a dispersed, city with little compacyness. Such complexity requires a solution just as sophisticated. The city not only needs incentives to revert the trends of urban sprawl, but also needs to reduce the burden the city exerts on the environment.

The Resolution in Eco-efficient design for Quito brings together all of these considerations and organizes them into a tool to unify urban and environmental dimensions in an integral way, where designers must put the greatest technical effort in the environmental components that most affect the ecological footprints of the city, while at the same time contribute to mitigating the same. As a requirements matrix, the tool is highly adaptable. However, just like with any other tool to assess and certify green buildings, it needs to be changed or adapted as the city accumulates its own experience and data on the subject, Overall the final goal is to build a more resilient and sustainable city.

Recommendations for further research

Further work needs to be carried out in measuring the performance of buildings designed under the Resolution in practice. Additionally, it would be recommendable to review the Resolution with case studies and expertise in the field, drawing from of past projects performance measured from buildings certified under LEED, BREEAM, SEA and Punto Verde. Finally, the Resolution works on the assumption that a progressive baseline data is set up in the process of building design. In the future it would be interesting to establish a baseline set of data for building construction in Quito, which the improvements in eco-efficiency presented in the new building designs can be compared with.

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