One Katrina Every Year: The Challenge of Urban Flooding in Tropical Cities

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Figure 1, Joinville, Brazil, February 2009

In Latin America we have destruction equivalent to one hurricane Katrina every year. The number of deaths from urban flooding in the rainy area that go from south Mexico to northern Argentina hits the thousands. Every year (fig. 1). In southeast Asia we probably have the equivalent of two Katrinas. Every year. In most of those regions where 2 billion people live, the majority of them in cities, annual rainfall is over 50 inches.

Nevertheless, large cities such as São Paulo, Buenos Aires, Calcutta or Manila have been struggling to keep their water supplies in pace with growing demand and drying watersheds. Meanwhile global warming has been fueling two trends: stronger storms and longer periods of draught, making water deadly both ways, when it falls and when it does not.

This paper reports on three years of researching and teaching around urban flooding to discuss the impact of our work as architects, educators and activists on seeking a better built environment.

hile the usual approach to the problem has been at the scale of urbanism and public policy, architecture has indeed an important contribution. I intend to look at urban flooding to argue that beyond matters of governance and infra-structure, individual buildings should do much more to engage water in a responsible way.

RESEARCHING RAIN

For 500 years we have been struggling with the rainy season in Latin America and Southeast Asia. For most of the region the amount of annual rain varies from 40 to 70 inches, mostly concentrated in the summer during which rainfall can achieve 20 inches per month and it is not uncommon to have 4 inches in a single day. If 18,000 liters (5,000 gallons) can fall on a single regular lot (12 X 30 M) during a summer shower we can imagine the impact of that much volume in the storm-water system of any major city.

In a historical perspective, it becomes clear that the Europeans who conquered the land after the 1500s were never prepared for that much water, coming from places where it rains much less: 11 inches in Madrid, 21 inches in Lisbon, 25 inches in Paris, 29 inches in London.

One need only to look at average building in most of the tropics nowadays and the inability to deal with rain becomes remarkable. Water infiltration is the rule in low-income houses which, in addition to being pressured by densification, have been paving every open space, resulting in a fully impermeable terrain. Yet the problem is not bound by income and class stratification, upscale apartment buildings are no less incompetent when it comes to water proofing and soil permeability.

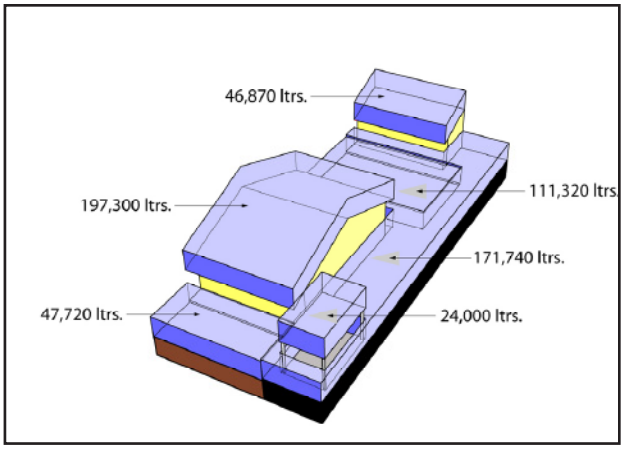

Figure 2. Average amount of water that falls yearly on each surface of a regular-sized house.

If we can agree that any problem have the seeds of its solution, we can hope that a responsible architecture attitude towards water conservancy and soil permeability can have a tremendous impact in the deadly and costly path of water. My main purpose with this teaching-research-activism project is to engage with the way architects design it and the public at large build to argue that both need to be much more serious about water.

For instance, a regular lot in a region under 60 inches of rainfall receives something in the magnitude of half a million liters of rainfall per year (fig 2). Given the average consumption of 150 liters per persons per day in Latin America (less in SE Asia), the amount of rainfall in a single lot is double the consumption average of a family of four. In cities where water treatment is already available, rainfall could be used only to non-human uses such as flushing the toilets, watering plants and washing cars or pavements.

In the same regular home of 1000 sqf, only the water collected in the roof (160.000 liters) would be enough for non-human uses year round. A simple underground reservoir of 2 x 3 x 3 meters (18.000 liters) should be enough for storing enough water to undergo 3 month of no rain and still keep your home clean and your plants green. With the current cost of water in Sao Paulo at about U$ 2.80 per m3, the economy is at the scale of U$ 512 per year or 6% of GDP per capita.

The cost of the underground reservoir would be recovered in 3-4 years only. In terms of reducing the runoff even further, a single garden with 36 sqm (6 x 6 m or any combination of smaller gardens adding up to 36 sqm) receding 10 cm into the ground would be able to collect the entire volume of 10mm of rain falling into the property and allow it to infiltrate in about 1 hour maximum.

The many different urban arrangements of the present time have advantages and disadvantages in terms of dealing with water. The North American traditional suburb, for example, present a high degree of permeability and has in the large lawn its most valuable asset, but it is unsustainable from the point of view of transit and extremely harmful to the natural environment for occupying vast amount of space with very low densities.

Still, the traditional cities in the developing world suffers from the opposite problem: high densities are necessary to cover the cost of the infrastructure and the concentration of services, making possible good transit solutions and consequently lower energy consumption. Areas such as the Plano Piloto in Brasília seems to provide the best of both worlds: reasonable density, public transportation and high permeability. But the cost (those who live there know better) is prohibitive for a large portion of the population. In the dense areas of the traditional city the use of space is so intense that almost nothing is free for water infiltration, causing heat islands due to absence of evaporation, and flooding whenever it rains.

TEACHING RAIN

In 2007 I worked with a colleague from the planning ranks at the University of (to be provided later) on developing a course that was called Global Shelter Crisis after the register's office argued that SLUM: a Four Letter Word would be too much of a controversial name for a course. It was the first time in decades that a course was offered by faculty of both architecture and planning and as much as we believed that it was the right approach, the risks and the expectations were higher that we would be comfortable with. Nevertheless, the course was very successful with more than 30 graduate students interested from which we selected 8 from architecture and 4 from urban planning. We conducted the first part of the course as a seminar and in the second part students had a studio project in which they worked in groups of 3 (2 architects and 1 planner) to design solutions for an informal settlement in Phnom Penh, Cambodia.

The city of Phnom Penh has a tragic history of being emptied by the Khmer Rouge and then chaotically reoccupied a decade later. As a result any kind of legal tenure is fragile in the city. Around the largest city lake (lowest point in the whole area which is already safeguarded by levees) a community of squatters built their structures on stilts, right above water (fig. 3).

Figure 3: The lake squatter community in Phnom Penh, Cambodia.

The class used the lake squatters as a site for a design investigation that proved remarkably robust given that they only had 6 weeks for the project and were working with teams that had very different modes of thinking (architecture vs. planning).

In the following summer (2008) a 6-week studio traveled to Belo Horizonte, Brazil, to engage with the problem of flooding and lack of infra structures in a Brazilian favela. Acaba-Mundo is a small informal community of about 300 houses or 1300 inhabitants, in a sloped area southeast of downtown Belo, dissected by two water streams that come together in the entrance of the favela. The buildings are erected upon very rudimentary foundations, specially when we see the residents often adding a second and some times even a third floor to their homes. With a density of about 300 people/ha (4 times the average density of São Paulo, twice the

density of Tokyo) the settlement is still somehow permeable given that every extra income is spent on another room, not on paving the backyard. But with the Brazilian economy growing steadily and the working class increasing their income (which we hope will continue) the tendency is that all interstitial spaces be paved for maximum usage. This would be a recipe for disaster. Our calculations show that if the favela is fully paved the amount of water coming down to the stream will double and so will the water velocity. Upon fragile foundations one can only imagine what might happen.

In 2009 the Global Shelter Crisis seminar focused on Acaba Mundo and used the large amount of data we collected the summer before. In parallel I offered a graduate studio on the same topic and site. Overall, I have attempted to address this problem by using the favelas as a site and the students creative power as the catalyzer for a deeper investigation into the favela's problem. Students responded passionately and worked extra hard to first understand and later propose design solutions. It has been a fantastic learning curve for everybody involved.

Figure 4: The Acaba Mundo favela in Belo Horizonte, Brazil

A partnership with the City of Belo Horizonte gave us access to very detailed socio-demographic data in addition to the knowledge accumulated over two decades of working in the favelas. We were also invited to participate in seminars and round-table discussions with city architects and planners every time we visited and those sessions proved invaluable for the rich exchange of information they provided. Being an international group gives us the distance and the perspective to view their work with broader lenses and relate that to other experiences around the world were myself or the students have previously worked.

PREACHING RAIN

Struggling to keep my practice alive in Brazil while teaching in the US I abandoned any hope that I could have private clients (as I once had) and reshaped my work following the NGO model. Studio Toró was founded in 2006 as a research-practice-activism focused on building under 40 inches or more of rainfall. Since then I have talked in more than 20 K-12 schools when in Brazil during the summer, teaching the kids about the problems related to an impermeable city under 15 inches of monthly rainfall (November to February in south-eastern Brazil). The energy of the kids is visible in their drawings and their excitement, and when speaking to architecture students (in the US and in Brazil) I was approached by a few that wanted to volunteer and do the same thing. In 2009 7 students have used Toró materials (basically a power-point presentation and some directions) and volunteered their time to speak to school children in Belo Horizonte, João Pessoa in the Brazilian northeast, Belem in the mouth of the Amazon river and even in Quito, Ecuador. The NGO model has proved to be very effective, feeding energy back into the studio and vice versa in a positive cycle of mutual reinforcement (fig. 5).

Figure 5. Speaking at an elementary school in Brazil, 2008.

As a result of those exchanges I was invited to be a consultant on a design for public spaces in the most violent of all favelas in Belo Horizonte. A group of young architects commissioned to work at Pedreira Prado Lopes has been in contact with our work for a few years and is now testing some of our ideas against budgetary and bureaucratic constrains.

PROVISIONAL CONCLUSIONS

Approximately 2 billion people—30% of the world's population—live in substandard housing - 1 billion of these people reside in urban slums, the large majority of them between the tropics under 40 inches or more of rainfall per year. Despite these astounding numbers and the images of urban flooding that we see in the media every week (as I write Manila is 80% under water with a death toll of 250), the issue has been absent from conversations in architecture schools in both the developed and the developing world.

In the informal settlements that shelter about one third of mankind, normal rainfall signifies fear. What is noteworthy from this informal construction process is the degree to which our buildings traditions are absorbed and carried out by people unfamiliar with architecture as we would define it. The Iberian tradition of paving everything which works very well for places where precipitation is below 30 inches has been stubbornly applied in places where it rains double that amount in half the time. What is most striking, five centuries of intense socio-economic transformations have not impacted such building tradition.

The work presented here is a modest attempt at the problem, starting from the studio where we are most comfortable and stretching to the public realm where it is most challenging but also most needed, in hopes that little by little we can dissociate flooding from the routine of tropical metropolitan regions.

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