Nagasaki along the years: An urban fractal analysis

Myriam B. Mahiques
Faculty of Architecture Design and Urbanism of Buenos Aires. Laboratory of Mathematics and Design
mbmahiques@gmail.com

Abstract
It is very difficult to define what ruins are, by definition, irreparable remnants of human construction by an act or destructive process. We can not talk about them as objects, even though we know that one day buildings reach their end, the question is on how to reach this final. Fragment causes mental associations with the person who perceives, that happens to be a mystery, since no one knows the facts that have been associated with the final ruins. However, the mental reconstruction is not straightforward, because the ruins interact with nature, are absorbed by it, change over time. This is our aim to show this dynamic situation in which man intervenes in the reconstruction, by a mathematical analysis of the city of Nagasaki based on fractal geometry, and evaluate if there is any related urban morphological pattern before and after the bomb. The method applied is Box Counting.

Keywords: City reconstruction; Fractal geometry; Box counting method

Introduction:

A Brief History of Nagasaki

Nagasaki was founded before 1500, as a modest harbor village. In 1542, a Portuguese ship accidentally landed nearby allowing the first contact with European explorers. In years, the city grew into a port city. Nagasaki became a free port in 1859, with ship building as the main industry. Since many Japanese warships were built in its factories and docks, the city became a target for the detonation of the second nuclear bomb, in August 9th 1945.

Among other considerations, the target of Hiroshima and Nagasaki was selected because of the expectation to produce the greatest amount of damage by primary blast effect plus fires. The maximum blast effect of the bombs was calculated to extend over an area of approximately 1 mile in radius.

Description of Damages

Adapted from The Atomic Bombings of Hiroshima and Nagasaki. By The Manhattan Engineer District. June 29, 1946, we reproduce this basic data to understand the plain aerial view in the aftermath of the bomb:

All Japanese homes were destroyed within 1 1/2 miles from X, being X the very target. 1500 feet from X, high quality steel frame buildings were not completely collapsed, but the entire buildings suffered mass distortion; 2,000 feet from X, reinforced concrete buildings were collapsed; brick walls were completely destroyed; multi-story brick buildings were completely demolished. Similar buildings were destroyed to 5,300 feet.

The actual collapse of buildings was observed at the extreme range of 23,000 feet from X in Nagasaki. 14,000 or 27% of 52,000 residences were completely destroyed and 5,400, or 10% were half destroyed.

Reconstruction

After the bombing, people began to put up precarious huts to live in, using the materials collected from the collapsed buildings. Housing construction commenced in 1946. The reconstruction of Hiroshima and Nagasaki was very slow, despite the efforts of the cities’ governments. There was not enough money to pay for the materials and the workers. In 1949 Nagasaki was declared by the
Japanese Parliament “The City of International Culture” and was granted a sum of money for the reconstruction. (Langley, p. 79)

Though a slow process, the post war period saw the gradually increase in independent citizens’ organizations and movements which had profound effects on the city’s development and on the urban planning system (Sorensen, p. 154). Special rules had to be established for suburban areas with a mixture of urban and rural uses. Town planning was decentralized and projects were the responsibility of municipalities with citizens’ participation. Urban plans were based on the Tokyo Earthquake reconstruction project. There were new standards for buildings, lot coverages and 10% of the urban area was destined to parks and the designation of greenbelts to avoid sprawl. New grand avenues were open to accommodate future motorization. The result was a “modern” urban pattern, but based in the 1919 city planning system (Sorensen, p. 159) with its real limitations.

Large areas of land on the fringe were zoned residential or industrial, but without any powers to guide urban design or development standards, and future patterns of development were largely at the discretion of landowners”. (Sorensen, p.160)

Methodology

Our objective is to analyze the urban morphologies of the City of Nagasaki along the years, and see if there was any hidden similarity among them, though urban patterns are very different at first glance. If so, we can state that a cultural-psychological behavior has been kept even after a catastrophe, reflected in the urban pattern.

In Euclidean mathematics two geometrical objects are called similar if they both have the same shape, precisely, if one is congruent to the result of a uniform scaling of the other. But, while applying a fractal analysis, we understand similarity in its broad sense and the only scaling we are considering is based on iterations. We can go further and see if they also have auto similarity.

As we see in the aerial picture of old Nagasaki, there was no urban Euclidean pattern, houses were spread with no planification, areas cut up by hills and mountain, with no regularity. To find out the Fractal Dimension, we used the software ImageJ and followed these steps:

- Enhance the aerial picture giving more contrast and sharpen the edges
- Find edges and transform into a binary file
- Calculation of the Fractal Dimension with the Box Counting Methods.
- The aerial pictures after the bombing and reconstruction under planning regulations were treated under the same steps and method.

Figure 1. Nagasaki before the bombing
Figure 2. Nagasaki before the bombing. Binary file ready for the Box Counting method.

Figure 3. Nagasaki before the bombing, screen shot. Plot showing $D=1.8701$. The results of quantity of cells imply auto-similarity.

Figure 4. Nagasaki destroyed after the bombing.

Figure 5. Nagasaki after the bombing, binary file ready for the Box Counting method. The circles and label for "X" does not affect in the analysis.
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Figure 6. Nagasaki after the bombing, screen shot. Plot of $D$ showing $D=1.8664$

Figure 7. Current aerial view of Nagasaki.

Figure 8. Current Nagasaki. Binary file ready for the Box Counting method

Figure 9. Current Nagasaki, screen shot. Plot of $D$ showing $D=1.8628$
Results

One of the main properties of fractals is auto similarity. All structural conditions are the same all through different scaling. The simplest example is the cauliflower, each flower inside is auto similar to the main flower. They keep the same properties.

Once the system is affected by an external issue (in this case, the bomb), the fractal pattern as a geometrical representation, could be changed. We divide the urban pattern in three: before-after the bomb and current. With the results below we are able to demonstrate that they have very similar values for the fractal dimension D, it means rugosity and urban fabrics –open vs filled space-, the same ratio values in land occupancy before and after the bombing, even when the land was devastated. In other words, the form of the rebuilt city could be different, but its fractal pattern appears to be the same, for the reasons we discuss later.

The software allows us to see the box counting at each iteration (I) with auto similarity in each case:

<table>
<thead>
<tr>
<th>Iterat.</th>
<th>I9</th>
<th>I8</th>
<th>I7</th>
<th>I6</th>
<th>I5</th>
<th>I4</th>
<th>I3</th>
<th>I2</th>
<th>I1</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>87939</td>
<td>44866</td>
<td>27305</td>
<td>13263</td>
<td>7870</td>
<td>2124</td>
<td>137</td>
<td>1.870</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After</td>
<td>41906</td>
<td>23374</td>
<td>14713</td>
<td>7351</td>
<td>4270</td>
<td>1972</td>
<td>1112</td>
<td>280</td>
<td>1.8664</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>61329</td>
<td>31958</td>
<td>19632</td>
<td>9402</td>
<td>5465</td>
<td>2467</td>
<td>1442</td>
<td>375</td>
<td>1.8628</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Regrettably, while working on this paper, Japan has suffered from another catastrophe due to the terrible tsunami of 8.9 magnitude temblor near the East coast, that killed thousands of people and engulfed entire towns. And the attitude of the citizens kept alive helps us to understand if there was a cultural behavior in these two events separated by long years. We have seen above that after the bomb, there were independent citizens’ organizations and movements which had profound effects on the city’s development and on the urban planning system, due to lack of money or failure at administration processes. In consequence, people began to build without the authorities’ control, what finally was materialized in a complex urban pattern. Progress in our research, tells us that there is also a psychological reason that makes the citizens work alone: “The only country ever hit by a nuclear attack, Japan has a visceral appreciation of the uncertainties of radiation exposure, how it can spare some people in its wake and poison others silently, causing disease years later. (…) Compounding the problem, Japanese psychologists say, is that many of their countrymen will attempt to manage their anger, grief and anxiety alone. (…) The quake, tsunami and radiation have destroyed or defiled what may be the islands’ most precious commodity, land, dealing a psychological blow that for many will be existentially disorienting. “In rural communities especially, there’s a very strong feeling that the land belongs to you and you belong to it,” said Kai Erikson, a sociologist at Yale who studied mining towns of the Buffalo Creek hollow in West Virginia, where more than a dozen towns were destroyed and at least 118 people killed when a dam burst in 1972, unleashing a wall of water as high as 30 feet that swept down the hollow. “And if you lose that, you’re not just dislocated physically, but you start to lose a sense of who you are.” (Carey, New York Times, march 2011)

Conclusions

‘Insofar as the statements of geometry speak about reality, they are not certain, and insofar as they are certain, they do not speak about reality’. (Einstein, 1921, p. 3.)

Fractal geometry has emerged as a direct solution to the need for more accurate mathematical descriptions of reality, and no doubt it is a powerful and appropriate tool for interpreting complex systems, impossible to see under the light of Euclidean geometry. D (Fractal Dimension) quantifies concepts in terms of shape, texture, size, quantity, color, recursion, similarity, regularity, heterogeneity, roughness, and other properties of the urban fabric. In principle, we can say that the original urban fabric of Nagasaki, unplanned, somehow reflects the private actions that have not strictly followed the guidelines of the postwar planning. With respect to the image of Nagasaki affected by the bomb, the software analyzes particles too, and this is the most curious aspect of the
analysis, since we only see the ground zero. However, there must be progress on other morphological features studies, since D is not the only parameter, and there are other analytical methods, like Cellular Automata, Dynamic Urban Evolutionary Model, Percolation systems, and one of the most important to discover hidden structures, the Fourier transformation. (FFT) The subject developed over these pages approaches us to the problem of urban theorists, who, from the social-psychological field, have found the visual paradigm empty for the purpose of studying the socio-historical processes. We tried to open a new perspective in considering the impact of the physical determinants of them. In this regard, Japan is an unique example of urban development after the bombs.

The comparison above with an American town, is not enough to prove that rebuilt urban patterns will show the same fractality everywhere in similar conditions, also we should consider that Japanese people has distrusted that the government is telling them the whole truth about the nuclear events. Neither the earthquake, nor the tsunami that followed, nor days without electricity, water or heat could drive people from their home, except for radiation. (See Fackler, New York Times, march 2001). That is for us a strong cultural tendency, the aim to go back and keep one’s dwelling as it originally has been.

A comparison with the Chernobyl disaster is not possible also, because the area is in an Exclusion Zone controlled by the Administration of the Alienaion Zone within Ukraine's Ministry of Emergencies and Affairs of Population Protection from Consequences of Chernobyl Catastrophe. Inside this area, buildings are abandoned, as residential, civil or commercial activities in the zone are prohibited.

As a preliminary approach, we would state that Japanese people has done much better than Russians. UN through the Chernobyl Programme believes that 'The evacuation of hundreds of thousands of people, particularly from less contaminated areas, is seen as an over-reaction, which in some cases did more harm than good. 'The first reaction was to move people out. Only later did we think that perhaps some of them shouldn't have been moved. It has become clear that the direct influence of radiation on health is actually much less that the indirect consequences on health of relocating hundreds of thousands of people.' Among relocated populations, there has been a massive increase in stress-related illnesses, such as heart disease and obesity, unrelated to radiation. (Browne, Guardian.co.UK, January 6th 2002)

We consider that while the research continues and years pass by to understand and improve the results, the application of a new order based on fractality is the answer we propose to the phrase of the worried Einstein quoted here.

Acknowledgments

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References


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