Intensity Mapping: a Non-Essentialist Approach to Methods in Urban Morphology

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Abstract: In assemblage theory, all entities have extensive and intensive properties and intensity is one of the core concepts that explains the processes of morphogenesis. Extensive qualities are related to the material features and define boundaries, whereas intensive properties are linked with becoming and dynamic processes that are forming the identity of an entity. Both aspects are interdependent. In urban morphology the analysis has often focused on the extensive properties and their permanence. There is a limited exploration of the dynamic aspects of the extensive qualities or or intensive properties that guide change. Thus, this paper asks, how can we apply the intensive and extensive properties in studies of the built environment? How can the concept of intensity be explored in the analysis of urban morphology?
The paper begins with defining the concept of intensity in assemblage theory based on the difference and uses a case study approach to apply and test various intensity mappings. The aim is to discuss the potential contribution to the analysis focusing intensive mappings. Intensive maps are visualising dynamic phenomena and the paper is comparing intensive with extensive results. The maps are using ArcGIS and standard deviation to generate intensity data and compare the spatial characteristics of various intensities. The results contrast a range of interpretations of the intensity and their visualisation.

1. Introduction

Assemblage theory could be considered as useful framework to advance existing theories as it focuses on the aspects often overlooked in those theories, such as dynamics, changes, relationships and complexity. It is often used as a "conceptual toolkit" that opens a different way of thinking and analysing the world (Massumi, 1987: XII). Therefore, when mobilized with other theories, application of the concept of assemblage does not replace but adds new ideas (McFarlane, 2011, p. 208). There are three main ways how assemblage theory has been applied to other theories: empirical (explaining actual assemblages), methodological (creating new and advancing exiting methods) and ontological sphere (Brenner, Madden, & Wachsmuth, 2011: 230). It has been applied to global anthropology e.g. Ong and Collier (2004); Collier (2006); actor-network theory e.g. Law and Hassard (1999); Castree (2002), Latour (2005); place theory Dovey K. (2010); critical urban theory e.g. McFarlane (2011); Brenner *et al.* (2011) and human ge-

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ography e.g. Anderson, Kearnes, and McFarlane (2012). Despite the wide potential, there is not much experimentation with its applications, particularly in the fields of urban morphology (K. Dovey, Rao, & Pafka, 2018, p. 265).

However, because of these diverse applications there are problematic aspects of assemblage theory in relation to its consistency and clarity. Namely, there is hardly any coherence in what is called "assemblage theory". In addition, the concepts are fully explained and explored only once they are contextualized in various disciplines (McFarlane, 2011, p. 207) which further contributes to this seeming inconsistency. Furthermore, Delanda (2016, p. 138) argues that the relationship between concept of assemblage and the real actual assemblages should be established one case at the time, having different application depending on individual context, thus resulting in dynamic and incoherent state of the assemblage discourse rather than a theory. However, there are also attempts to structuralize it into a coherent theory (Anderson *et al.*, 2012), which might be argued to oversimplify the existing discourse and the core intention by Deleuze.

Another critique often presented towards assemblage theory is related to the clarity of discourse and definitions in assemblage theory. It could be argued that concepts such as emergence, heterogeneity, ephemeral etc. are fashionable and thus gaining popularity, whereas in reality, they generate "…enduring puzzles about `process` and `relationship`" without creating their definitions (Markus & Saka, 2006, p. 102). However, all those aspects are popular because they are offering something new that is usually omitted from the mainstream theories, especially because it is a slippery field, difficult to grasp. Thus, it could also be argued that this is a new area of research that has the potential to advance existing theories, and that because of this it also needs to develop a new discourse (K. Dovey *et al.*, 2018, p. 266). Furthermore, the intention of Deleuze's philosophy, might be argued, is in dynamic, incoherent and open-ended qualities of a discourse and not in the clear structured definitions.

In this paper, when referring to assemblage theory it is dominantly the work of Deleuze and Delenda that are considered for the contributions to this opus. Deleuze's opus attempts to build a new materialism, that which is different from the dialectical materialism and positions it between materialism and phenomenology (Deleuze, 1994, p. 222). At the broadest sense, this approach corresponds well with morphology as it focuses on the material aspects of the built environment. Furthermore, in assemblage theory the focus is on the dynamic processes produced within the material world, its aim is to explain the processes of change and transformation by the intrinsic characteristics of the material. Therefore, assemblage theory has the potential to intersect and contribute to the studies in morphology.

The studies of urban form are naturally dealing with various forms of change, often the change is described with the intention to understand its origin or cultural meaning and implications, however there is no focus on the "abstract model of change" (Kropf, 2001, p. 29). There are various types of change that are covered by various authors and their different approaches in the analysis. For example, Conzen identifies street, plot and building systems in their planar representation and studies the change through burgage cycle and fringe-belt formation. Muratori and Caniggia identify building types bounded by territories and regions. Both approaches are dealing with different type of change and degree of change as they are also demonstrating different levels of complexity. Fringe-belt formation represents an example of complex single object and transformation of types referrers to class or population of buildings. In defining the change in urban morphology most of the concepts are deriving from the natural history, one referring to ontogenesis (the origin and development of the individual, also called development) and phylogenesis (the history and evolution of the type, evolution) (Kropf, 2001, p. 32).

Ontogenesis can be differentiated into two types depending on their complexity, single object (like a house for example) and aggregate object (a settlement).

Assemblage theory offers a different approach to understanding of change that opposes essentialist approach (exemplified within typological approach in morphology) and focuses on the dynamics and aims to explain the processes of transformation and individualisation through the multiplicities. Multiplicity is thus the concept that replaces the essence (M. Delanda, 2002, p. 9). Essence is usually referred to as the characteristic of certain entity that defines its identity. If an entity loses its essence it will become something else. Essences are thus important elements that define types. However, in Deleuze's ontology, identity is not framed through existence of essences but through dynamic morphogenetic processes, "...multiplicities specify the structure of space of possibilities, space which in turn, explain regularities exhibited by morphogenetic processes" (M. Delanda, 2002, pp. 9-10). This difference in approach has the implication that identity is not observed as something static and eternal but a dynamic and developed progressively.

Even though assemblage theory is not using the classification based on the essences, it does not mean that all transformations are observed at individual level. The main difference is in classification, which is relative in assemblage theory and depends on the process of transformation in question. One of the examples offered in this sense is deriving from geometry. Instead of classifying the geometrical shapes by using their characteristics common to all cubes, spheres, or circles just to name few, they are classified based on how they "...are affected (or not affected) by active transformations, that is figures are classified by their response to events that occur to them" (M. Delanda, 2002, p. 18). The classification process that describes transformation might not be changing the ideas in morphology, as it seems quite similar, however, what is different is the focus on the process that determines such transformations.

This paper is focusing on the change of the individual object, defined as ontogenesis or development. The ontogenesis or transformations in assemblage theory are explored through processes guided with the intensive qualities. This is where the division on the intensive and extensive qualities becomes useful for building a new approach to understand transformation in built environment. Thus, this paper aims to explore how can intensive and extensive properties be applied to analysis in built environment? And more broadly, how can the concept of intensity be explored in the analysis of urban morphology?

The paper is divided in three parts. Firstly, definitions of intensive and extensive properties in assemblage theory are presented. Secondly the definitions from philosophy are applied in methodology and methods to the urban morphology analysis. And thirdly the analysis is tested at the concrete case studies.

2. Intensive and extensive properties

In assemblage theory all entities can be defined through intensive and extensive properties (M. Delanda, 2005, p. 80). The division derives from thermodynamics, however Deleuze has used that definition to broaden it into a philosophical approach that can be then applied to various fields.

In thermodynamics the division to intensive and extensive properties is defined based on divisibility. Extensive properties are related to the physical aspects of the space and are divisible and intensive properties are indivisible (M. Delanda, 2002, p. 45). To explain this in simple terms we can use the example of room. The volume, length, width and area would represent extensive properties of the room that are changed if the room is divided for example in two rooms, thus those are divisible properties in this case. However, the properties such as temperature of the air or pressure would not change upon the division of the room thus those belong to indivisible properties. Intensive properties include all those challenging to measure qualities, such as joy, love, hate, grief, beliefs, desires etc. Importantly, difference in intensity can produce change, as a spontaneous flow that tends to cancel the difference in intensities and restore the equilibrium (M. Delanda, 2005, p. 81). Therefore, differences in intensities are important guide to the processes of change in space. Furthermore, intensive factors or differences in intensities are main forces that define the process of individualisation, forming the character of any entity.

This could be applied to the space and changes in built environment. Process of gentrification is one of the most common drivers of change in cities. With the sudden attraction of certain location, the creative class starts to move in, creating intensity through a difference in the population that drives the change in built environment. Once fully gentrified the built environment is also fully transformed changing its identity. After reaching the equilibrium a new tendency will emerge, and change will take place again. However, the question remains if there might be some intensity found within the extensive characteristics of the built environment that can generate the difference and transformations, which are going to be explored through the examples in this paper. Furthermore, the question is shifted towards the material aspects, and asks if there are some qualities in the built environment itself that can produce intensities and thus generate processes of change.

3. Actual/virtual and real

Another important aspect of the division between the extensive and intensive properties is the tendency towards the singular state that any assemblage is striving towards. All assemblages are having a tendency towards the absolute state of equilibrium. For Delanda this is a "final state" which acts as "attractor" or singularity (M. Delanda, 2002). Those attractors, "...even while not being fully actual, since they guide real processes towards a definite outcome.".., they are objective and real (M. Delanda, 2005, p. 83). They act as the "space of possibilities" (ibid). Furthermore, there is no singular equilibrium state but multiple states that define importance of history and avoid the existence of essences. In other theories we would assume the ultimate singularity that is absolute and not changeable, an essence, while here the singularity has the potential to change depending on the circumstances that entity is going through. Applied to the analysis in the morphology, this implies that there is no singular archetype that everything else is evolving around, actually there are numerous singularities that buildings are striving to.

To define those tendencies and singularities (M. Delanda, 2005, p. 86) uses terms of actual and virtual spaces. Both actual and virtual spaces are real. Virtual tendencies are guiding the processes of change, which are caused through intensive properties. On the other hand, virtual should not be confused with the possible. "Possible is opposed to the real; the process undergone by the possible is therefore a 'realisation'. By contrast the virtual is not opposed to the real; it possesses a full reality by itself. The process it undergoes is that of actualisation". (Deleuze, 1994, p. 211) The virtual is thus not a simple possibility that might be happening sometime in the future, it is actual element of the reality in any particular moment.

Interestingly, the interpretation of virtual might be considered very similar to the phenomenon. Once we see a building or a place the phenomenon emerges which is the intersection between our memory, emotions, knowledge, mood etc and the actual world. Thus, there are virtual elements associated with the actual reality that we experience. Delanda does not fully exclude the existence of phenomenon but something in between that is defined as noumenon.

4. Methodology

Focusing on the intensity is shifting the analysis from static states to dynamic processes, remaining however within the material world. To analyse intensity in this paper, firstly the concept of the intensity in the built environment needs to be developed. One way of capturing intensity that is most applicable to urban analysis is using the intensity maps and diagrams (M. Delanda, 2016, p. 110). These maps are different from the usual extensive maps that are capturing the actual physical characteristics of the built environment. Intensive map captures the differences in intensities and dynamic phenomena focusing on the thresholds that mark the changes. Thus, intensive maps are representing the relationships between the elements instead of elements themselves. Delenda often mentions as an example of intensive map the weather maps that we see on television everyday with high- and low-pressure systems. But the question what these maps are in the built environment still needs further explorations.

Intensive maps do not resemble the extensive qualities of the space. They have certain level of abstraction and thus could be considered diagrams rather than maps. Intensive maps are capturing the changes that occur within the entity according to external parameters that are also called phase diagrams (M. Delanda, 2016, p. 117). In assemblage theory diagrams, "multiplicities", "structure of space of possibilities" and intensive maps are used with the same meaning, whereas in urban analysis those are different analytical tools. On the one hand map represents the extensive qualities of built environment with a particular focus on certain aspect of that extensity. Diagrams on the other hand are abstract representations of certain systems that usually have no reference to the actual extensive qualities. In previous studies (Muminovic, 2019) it was found that the balanced approach between abstract and actual map is the most useful in understanding the space. Thus, for the purpose of this paper the intensity map used is a kind of the diagram, focusing on the one aspect of the assemblage, with the clear reference to the extensive qualities of the space. Therefore, the intensive map has clear reference to the actual space.

The diagrams in general and their levels of abstraction are defined through two main aspects, number and type of transformations and invariants (M. Delanda, 2016, p. 113). Every diagram could be defined through elements that are not changing (invariants) and those that are transformable. Invariants are not absolute constants; they are relative to the context and type of transformation that one assemblage is undergoing. Thus, defining the invariants and transformations is important first step in the analysis. In this particular paper the invariant element of the built environment will be the actual geographical position of the qualities, the extensive property of smallness will become the transformable characteristic.

Furthermore, depending on the number of factors diagram could consist of various number of dimensions in maps, it could be one-dimensional as the line or two-dimensional as surface etc. The more dimensions diagram is using in analysis, the more detailed understanding of the assemblage (M. Delanda, 2016).

To define intensity the paper uses the concept of difference that is calculated through standard deviation. Standard deviation can be defined as statistical tool that shows how much variation there is from the average (the mean) of all. If the standard deviation is low, then this means that the element in question is close to the mean (or the average of the whole). If the standard deviation is high, then that means that the element in question is far from the average of the whole, generating larger difference, thus intensity. In this analysis standard deviation is used to define the classification based on the size, thus all of the classes are generated based on the proportional distance of standard deviation from the mean. This defines the level of difference that each element of the assemblage is bringing, thus, the intensity. The classes (groups) are calculated based on the characteristics of the assemblage that they belong to. Thus, the classification process is relative and depends on individual assemblages; which is in accordance to the non-essentialist approach discussed in previous section.

To further spatialise the relationships between various classes the clustering method was used. Clusters are aggregations of elements of assemblage with similar characteristics (in this case of the same class) in actual space. For this purpose, Ord G* statistical analysis defining to which degree high or low values cluster together. This demonstrates the highest difference within the assemblage and thus the highest level of the intensity.

Spatial statistical tools are used in Arc GIS, hot spot analysis which identifies statistically significant spatial clusters with the highest and lowest values based on selected weighted values (in this case length). The tool calculates both p-value and z-score and identifies the significant spatial clustering. Low p-value and high z-score are showed at the hot spots and they demonstrate that there is less likely that the pattern observed is random (low p-value) and that it is the most different from the average (high z-score) intensive zones. In relationship with the intensity and its link to the difference this tool identifies the most different elements clustered in space, thus the highest and lowest intensities.

5. Analysis and results: case study: intensity of smallness

For the purpose of testing the intensity maps and statistical methods we will use the case study from Tokyo, Yanesen. This area has been chosen as a case study because its urban character, grounded within the smallness and the relationship between public and private spaces (Muminovic *et al.*, 2014). The link between the extensive qualities and identity or the character of the place is important for testing the intensity mapping. Namely, this sets direct link between the extensive qualities that are generating the intensity in creation of the urban character.

Yanesen is located in central area in Tokyo and belongs to one of the 23 central wards. It consists of three neighbourhoods, Yanaka, Nezu and Sendagi. To test the link between the urban characteristic of smallness and intensity maps firstly we have applied the analysis of the sizes of elements of built environment: building footprint, height of the building, streets and blocks. The classification is based on the standard deviation classification method that uses size of the elements.

5.1. *Streets*

There are total of 189 streets in Yanesen. The calculation of sizes has been based on the area due to the similarity of the calculations for other elements in built environment. Furthermore, this element calculates both length and width, that are both important in the perception of the smallness.

5.2. *Blocks*

There are total of 212 blocks in Yanesen that were considered for this analysis. The number of classes are showing less diversity compared with the streets, there were no elements that belong to the extra small nor extra-large class. The calculation is based on the area of the block.

5.3. *Building Footprint*

There were 4811 buildings in Yanesen that were analysed. The sizes of plots are omitted for the purpose of this analysis as the Tokyo maps do not have such information. The analysis has shown the highest level of diversity having all five classes populated.

5.4. *Building height*

This is an important element that contributes to the sense of scale in the built environment in addition to the building footprint. The calculation is based on the number of floors.
The analysis has demonstrated that there are maximum five classes of sizes, each calculated individually that were named xs (extra small), s (small), m (medium), l (large) and xl (extra-large) (Table 1). Spatial distribution of the classes of sizes shows how each of the elements contributes to the experience of the small as part of the noumenon. The smallest streets are grouped in the area of Nezu and Sendagi. The medium, large and extra-large classes of streets are scattered throughout all area, not generating any significant cluster in space. Blocks have only three classes of sizes. Small blocks are dominantly aggregated in Nezu and Sendagi with some small aggregations in Yanaka. Interestingly, both large and small blocks are dominating the area, with almost no blocks in the medium size. Although insignificant in numbers, large blocks take almost the same area as the small blocks. The classes of building footprint do not demonstrate any significant clustering, they are scattered throughout all area. Similarly, building height has no specific clustering in small and medium classes. However, the extra-large class as expended shows higher classification in proximity to the major thoroughfare Shinobazu Dori (Figure 1).

The spatial distribution of the classes and number of elements in each class show that Yanesen is dominated with small elements of built environment, however it also demonstrates that there are significant large elements that tend to group in Yanaka. Thus the next analysis will focus on mapping the clusters of the most different elements in the space applying the hot spot analysis in ArcGIS. The analysis is conducted separately for each element of the built environment. The aggregations are defined based on the sizes of elements and their proximity in space. Thus a cluster contains the elements similar in their sizes which are the most different from the average that are located in the proximity. The proximity of elements is calculated based on the whole assemblage; thus, all classifications are relative and depend on the whole. In addition, the cluster is not based on the elements of the same sizes, but on the similar sizes which are given on the degrees of small and large, and dependant on the whole assemblage.

Results show (Figure 2) that there are three clusters of the smallest streets all located in the Sendagi and Nezu and only one cluster of the largest streets. At the level of blocks there are two clusters of the smallest blocks located in Nezu and Sendagi and one cluster of the largest blocks that covers almost all Yanaka. At the level of buildings, the number of clusters is larger

Table 1.

elements/size	xs	s	m	l	xl
street	-	89%	5%	2%	4%
blocks	-	91%	3%	6%	-
building footprint	6%	85%	6%	1%	2%
building height	-	81	15	3	1

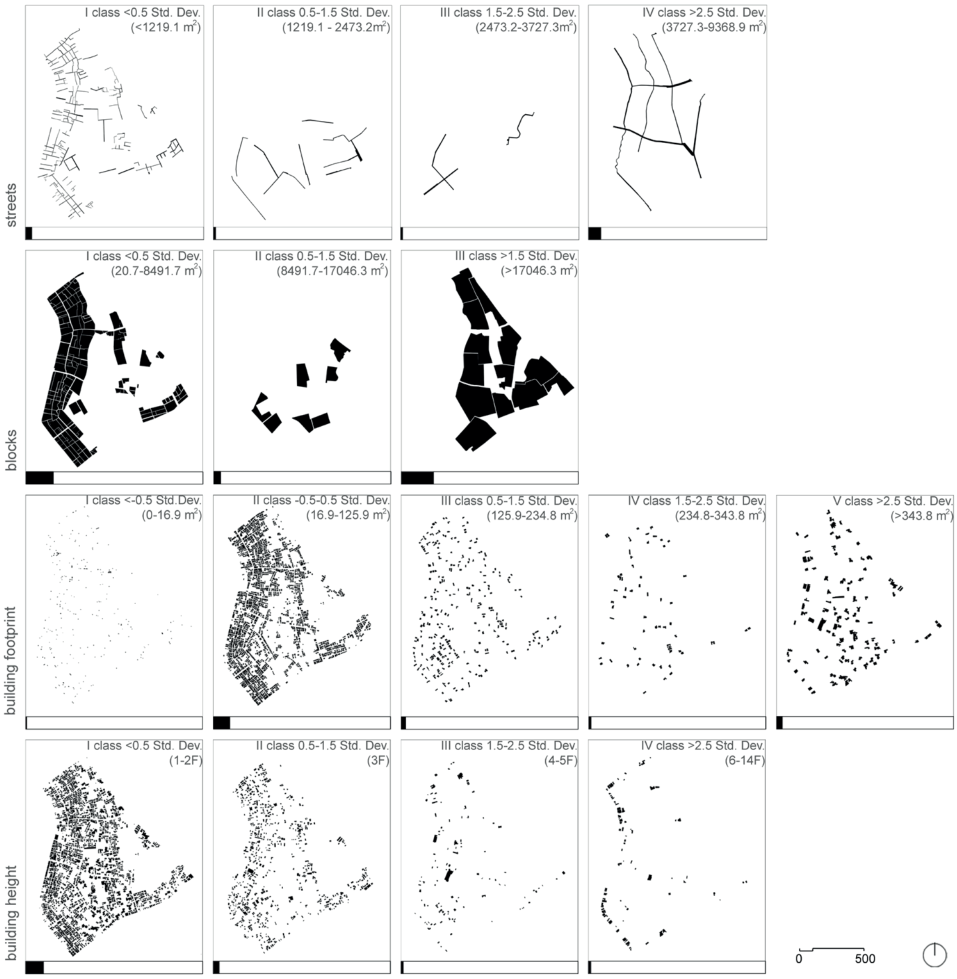

Figure 1.

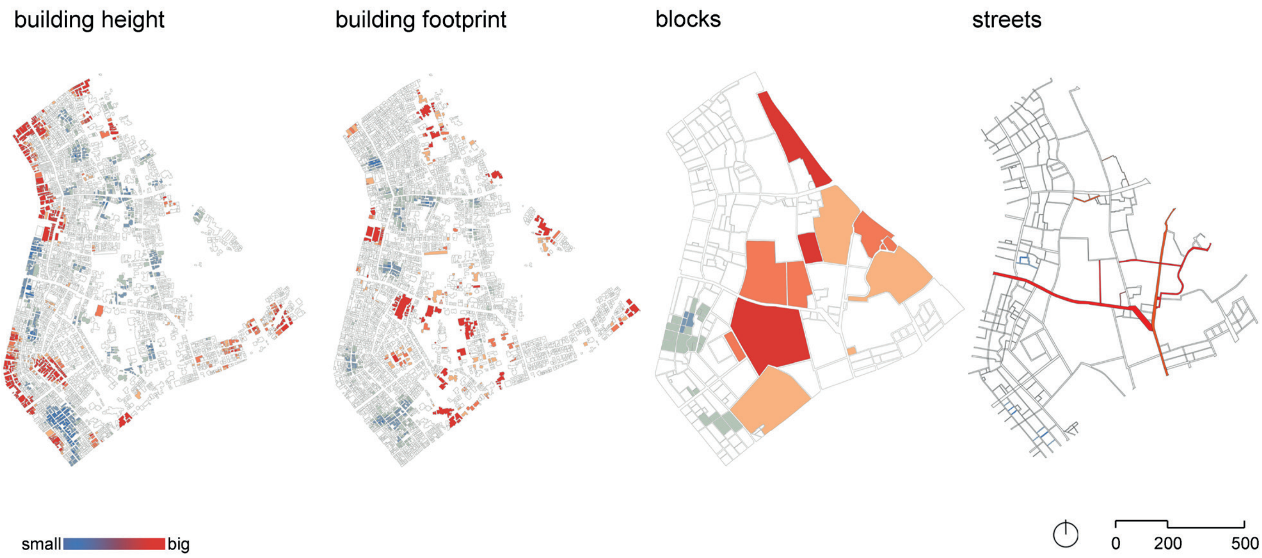

Figure 2.

due to the significantly larger number of elements. There were 8 clusters of smallest elements are dominantly located in Nezu and Sendagi and the largest aggregations 12 clusters in total are scattered throughout all Yanesen. The analysis of the building height shows 15 clusters of lower buildings scattered throughout all area and 13 clusters of highest buildings dominantly at the edges of Yanesen.

To demonstrate how each of those clusters are interacting we have separated the large and small elements and mapped their spatial connections. The analysis aims to map the significant connections between the smallest and largest elements that contribute to the experience of smallness. The results show that the relationships between the large elements in space do not demonstrate any significant grouping in space, they are scattered, while small elements tend

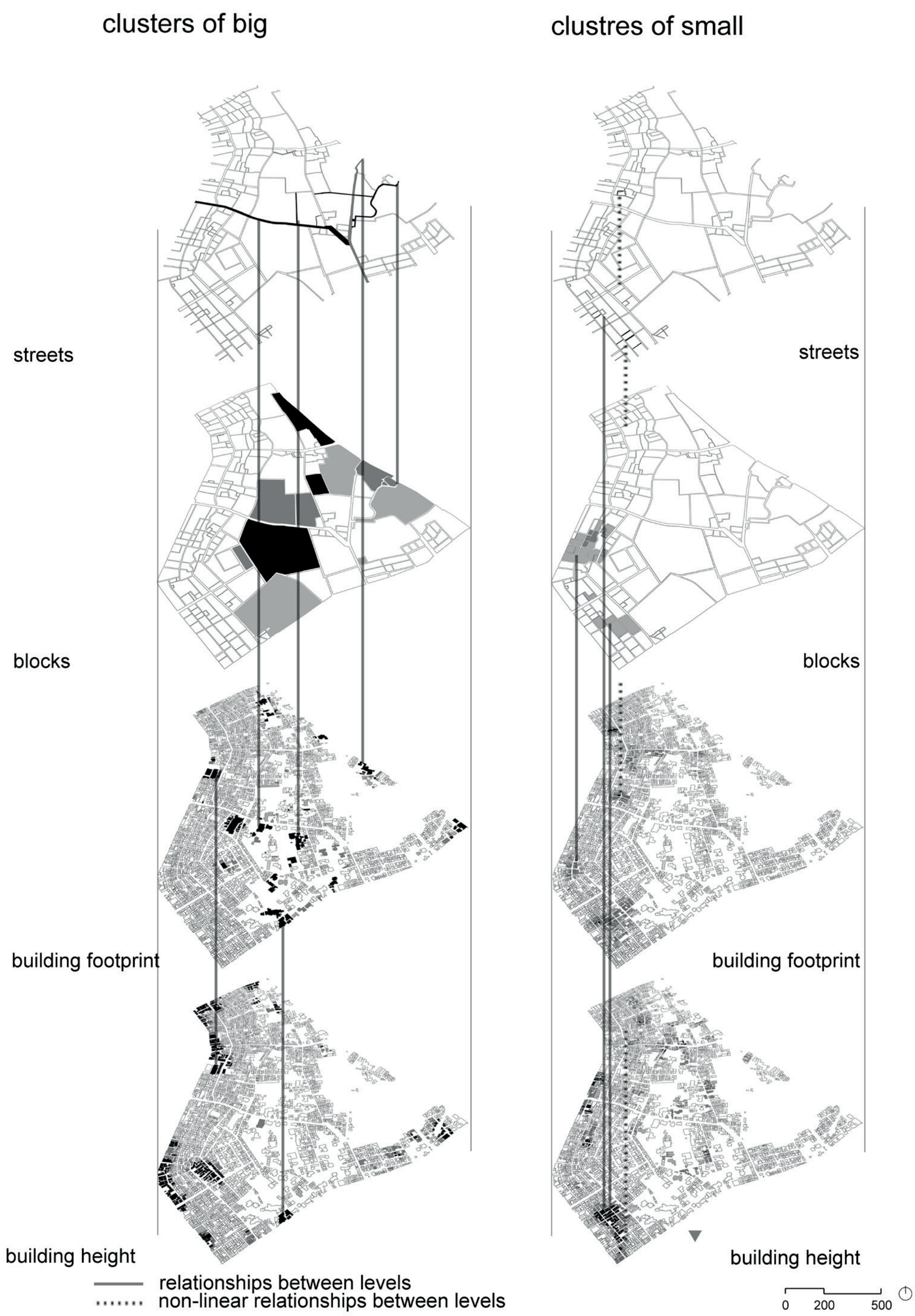

Figure 3.

to aggregate in Nezu and Sendagi. Those relationships appear between all elements of the built environment, the streets, blocks, building footprint and building height (Figure 3).

Once all elements overlapped with 50% of transparency, the intensive map of smallness is generated (Figure 4). The borders of the intensity are blurred as it shows the gradual transition from high to low intensity of smallness.

6. Discussion/Conclusion

This paper has tested various methods to generate the intensive maps. The analysis has focused on the intensity of smallness that has the statistical analysis to calculate groupings. In this particular case, the smallness is related to the urban character, thus it might be argued that inten-

Figure 4.

sity of smallness is important feature that contributes to this character. However, the question on how to repeat analysis focusing on a different character remains. In addition, for this type of analysis the calculation demands numerical values.

The difference had important aspect to defining the intensity. The difference was also calculated based on the relative values that depend on the whole assemblage. Thus, the classification will depend on the assemblage, and there is no absolute value, no essence and class sizes will differ from location to location. On the other hand, the urban character in Yanesen is grounded in the smallness. This smallness has to be the dominant feature of the area, as it was confirmed within the analysis of the classes, that show that every element has more than 80% of small class. Furthermore, there are some areas that show concentration of the small and large elements. Thus, the assemblage is not homogeneous.

The aggregations of the largest and smallest elements in the space demonstrated the discontinuities or heterogeneities in the space. When the elements with similar characteristics are aggregated in certain area then based on the multiplication of similar elements the experience of that particular area might be amplified. Thus, in case of Yanesen the aggregation of smallest elements in space will generate the experience of the smallness or the intensity of smallness in spatial characteristics. The noumenon proposed in the assemblage theory is thus combining both material and experiential aspects through the intensity.

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