

Anna-Maria Chatzi, Lisa-Marie Wesseler

OGOS+ – A Tool to Visualize Densification potential

Open Access via institutional repository of Technische Universität Berlin

Document type

Conference paper | Published version

(i. e. publisher-created published version, that has been (peer-) reviewed and copyedited; also known as: Version of Record (VOR), Final Published Version)

This version is available at

<https://doi.org/10.14279/depositonce-11845>

Citation details

Chatzi, Anna-Maria; Wesseler, Lisa-Marie (2020). OGOS+ - A Tool to Visualize Densification potential. In: Holzer, Dominik; Nakapan, Walaiporn; Globa, Anastasia; Koh, Immanuel (eds.), RE: Anthropocene, Design in the Age of Humans - Proceedings of the 25th CAADRIA Conference - Volume 1, Chulalongkorn University, Bangkok, Thailand, 5-6 August 2020, pp. 773-782.

http://papers.cumincad.org/cgi-bin/works/paper/caadria2020_012.

© 2020 and published by the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA), Hong Kong

Terms of use

This work is protected by copyright and/or related rights. You are free to use this work in any way permitted by the copyright and related rights legislation that applies to your usage. For other uses, you must obtain permission from the rights-holder(s).

OGOS+

A Tool to Visualize Densification potential

ANNA-MARIA CHATZI¹ and LISA-MARIE WESSELER²

¹*HafenCity University Hamburg*

¹*anna-maria.chatzis@hcu-hamburg.de*

²*Technical University Berlin*

²*l.wesseler@campus.tu-berlin.de*

Abstract. OGOS+ is a GIS data-based tool, which would offer urban planners, architects, and researchers visualisations of potential building mass in the form of 3D models. It compares the height of existing buildings to the maximum permitted height by German zoning law and calculates the potential building mass. To ensure minimum building footprints it only calculates the densification potential on top of existing buildings. It summarises information of the building potential for future utilisation. The goal is an increase of urban density achieved with micro interventions.

Keywords. Urban densification; City Information Modeling and GIS; Big Data and Analytics in Architecture.

1. Introduction

One third of the German population lives in cities, which are developing quickly. Due to the decrease of not occupied space, rents are increasing. In 2018 Berlin counted 3.6 Mio residents. Until 2030 this number will increase to 3.8 Mio. Berlin needs to supply 200 000 more people with a place to live, work, learn and move. After WWII most of Berlin was destroyed. The city got rebuild but its density is still beneath the density of 1940s Berlin. (Brichetti 2011; Haubrich 2016; Quantum 2017, Senat Stadtentwicklung 2018).

Developing inhabitable space in already developed inner-city areas could be a possible solution for Berlin's housing problem. By using already developed areas it would not be necessary to build new infrastructure from scratch. The costs of improving inner-city infrastructure is only one third compared to developing a new one. Inner-city densification would be an alternative to development in the periphery of the city. This is one way to minimise additional land sealing. Moreover, it is a possibility to bring work, living and leisure together more closely. Short distances can decrease traffic, emissions and save time. Disadvantages could be a decrease in livability and biodiversity due to higher buildings and less open space. Inhabitants of the area could be disturbed during construction processes and therefore could be opposed to changes in their neighbourhood. (Architektenkammer NRW 2009, BBSR 2014).

RE: Anthropocene, Proceedings of the 25th International Conference of the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA) 2020, Volume 1, 773-782. © 2020 and published by the Association for Computer-Aided Architectural Design Research in Asia (CAADRIA), Hong Kong.

1. Regulation Parameters (German Zoning Law)

1

Stores allowed by regulations

2

Land Use

BauNVO
German Zoning Law

BauNVO ist ein Bundesgesetz, das die allgemeinen Grundsätze für die Festsetzung von Bauvorschriften in den Gemeinden regelt. Es enthält die allgemeinen Grundsätze für die Festsetzung von Bauvorschriften in den Gemeinden. Es enthält die allgemeinen Grundsätze für die Festsetzung von Bauvorschriften in den Gemeinden.

- 1. Allgemeines
- 2. Zweck und Geltungsbereich
- 3. Begriffe
- 4. Bauvorschriften
- 5. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 6. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 7. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 8. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 9. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 10. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 11. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 12. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 13. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 14. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 15. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden
- 16. Bauvorschriften für die Festsetzung von Bauvorschriften in den Gemeinden

3

Equations to determine distance space and Floor Area Ratio (FAR)

BauNVO
BauGB
BauOBln
German zoning law

2. Open Street Map (OSM)

4

Buildings Polylines

5

Plot Polylines

6

Stores of existing building

3. Calculated parameters by Grasshopper (GH), Python for GH, Elk, Lunchbox

7

Floor Area Ratio (FAR) of existing buildings

FAR = (Storey area [sqm]) / Plot area [sqm]

8

Floor Area Ratio (FAR) by regulations

FAR = (Storey area [sqm]) / Plot area [sqm]

9

Distance space of existing building

10

Distance space by regulations

11

Building area

12

Plot area

4. Parameters supplied by user with HumanUI

13

Chosen Plot

14

Distance between public space and building

15

Land Use of adjacent plots

16

Location of building on plot

Figure 1. Parameters.

Open spaces for densification can be a gap between houses, patios and additional storeys on already existing buildings. Infills and buildings in patios are more versatile whereas an addition in storeys leaves the smallest building footprint. Large building projects are hard to get realised. Micro interventions could be easier to get permission for than huge development projects. Costly testing of zoning laws make smaller sites less lucrative. That is why an automatization in zoning law testing could be beneficial. (Architektenkammer NRW 2009, BBSR 2014; Kim, & Clayton, 2010; Lobeck et al, 2016).

Previous studies have shown the potential of regulations for the design process. For example, Hugh Ferriss visualised possible building shapes considering safety issues for the city of New York in 1922. (Donath, & Lobos, 2008). A more recent study conducted by Kaisersrot and KCAP in 2007 visualised the maximal buildable space according to zoning regulations for their design proposal 'Neuplanung Umfeld Hauptbahnhof Zürich'. (Kaisersrot, & KCAP, 2007). OGOS+ takes up the approach of Zoning laws as design parameters. The tool tries to automatise the calculation of building regulations for a larger urban area.

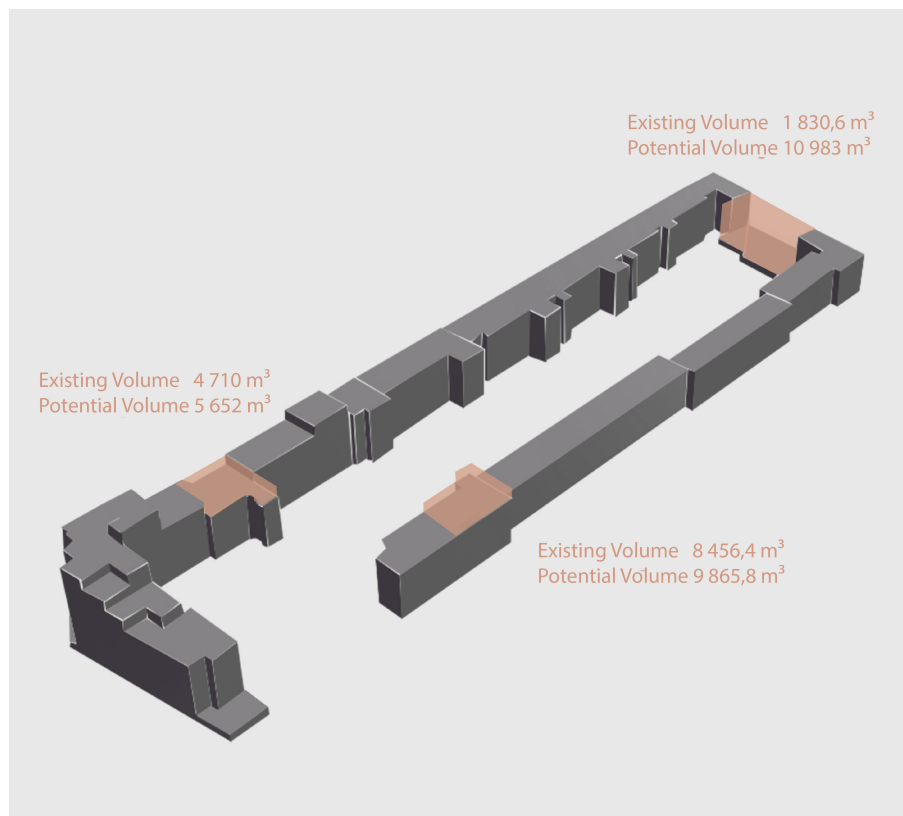


Figure 2. Findings.

2. Tool

2.1. PARAMETERS

OGOS+ uses various kinds of urban data as input for 3D visualisations of potential building masses. To work easier with all the data the input was organised into four categories [Figure 1].

The first input category is called ‘regulation parameters’. It contains the number of storeys allowed by regulations (development plan or BauGB), the existing kind of Land Use, and equations to determine distance space and the Floor Area Ratio (FAR). The second category contains all the OSM-data (OpenStreetMaps) such as Building Polylines, Plot Polylines, and the number of storeys of existing buildings. The third input category is ‘calculated parameters’. This category includes the Floor Area Ratio (FAR) of existing buildings, the FAR by regulations, distance spaces of existing buildings, distance space by regulations, the building and plot areas. All connexions of the parameters can be found in the German Zoning Law. The fourth input category contains parameters supplied by the user. It is crucial to acquire information regarding the chosen plot, the distances between public spaces and buildings, the current land use of adjacent plots and about the location of a building on its plot.

There is some data which was supposed to be obtained from the open geo data sets but was not included in it. That is why it was required to assign each plot and its corresponding building an ID manually. The ID is necessary to refer a geometry to its specific data set. Another issue is that meta data regarding storey heights is lacking in the geo data for Berlin. A generic storey height of three meters is therefore set for all buildings. Three meters are assumed as average storey height for Berlin. (Mäder, 2001).

2.2. INPUT SOURCES

2.2.1. Regulations

German zoning law is divided into federal law such as ‘Baugesetzbuch’ (BauGB, Federal Building Code), ‘Baunutzungsverordnung’ (BauNVO, Federal Land Utilisation Ordinance) and state law, in this case ‘Bauordnung Berlin’ (BauO Bln, Building code Berlin) and development plans.

The city of Berlin offers an open data platform called ‘Berlin open data’. ‘Berlin open data’ offers Berlin GIS data and development plans. Development plans are available as PDF documents but not as statistical data. (Senatsverwaltung für Stadtentwicklung und Wohnen, n.d.).

2.2.2. Open Street Map (OSM)

The required geo data was obtained via ‘OpenStreetMaps’ in form of OSM files. (OpenStreetMap, n.d.).

2.2.3. Plug-Ins for calculations

Grasshopper (GH) was used for coding, Python for more flexibility in coding, Elk to utilise OSM data and Lunchbox to read Excel files, which contain additional data.

2.2.4. Plug-Ins for user interface

HumanUI was implemented to both gather data by the user and to visualise results. Human UI is a grasshopper plug-in to implement a user interface in the algorithm. (Food for Rhino, 2018c).

2.3. ALGORITHM

The algorithm aims to calculate all relevant distances to get the potential building mass. The user chooses a building and its corresponding plot. The algorithm detects the distances between the selected building polyline and the plot polyline (x). Each building is assigned to a data sheet according to its ID number. The data in the list of the ID number is used in the calculations of the algorithm. The ID list contains data of the existing building (number of stories, FAR, area of building) and the regulations (number of storeys, FAR, land use). The number of storeys of the existing building and the number of storeys by regulation are multiplied by the storey height to define the height of the existing building and the height of the potential building mass according to the regulations. Each type of land use is associated with a constant. The result of the multiplication of the height of the existing building and the constant is the distance space of the existing building (y). The multiplication of the height of the potential building mass and the constant is the distance space by regulation (z). The user is required to provide some extra information. The user enters the land use of adjacent plots and the distance between public space and building (u) into the user interface. The algorithm begins to repeatedly compare the factors (x, y, z, u) to find the final potential building mass. There are three possibilities [Figure 3]. If the distance between the selected building polyline and the plot polyline is zero ($x=0$), equal to or greater than the distance space by regulation ($x \geq z$) then the height by regulation is usable. If the distance between the selected building polyline and the plot polyline is greater than zero and smaller than the distance space of the existing building ($0 < x < y$) then the height of the existing building is already the maximum height that is allowed to build. If the distance between the selected building polyline and the plot polyline is less than the distance space of the existing building and bigger than the distance space by regulation ($y < x < z$) then the user's answers are relevant. If the distance space by regulation is bigger than the distance between public space and building ($z > u$) then the distance space by regulation is recalculated with the height of the potential building mass minus one storey height. This process is repeated until the distance space by regulation is less than the distance between public space and building ($u \geq z$). That means that the height of the existing building is not equal to the height of the regulation and that a potential building mass exists. The potential building mass is visualized in the form of a 3D model. [Figure 2].

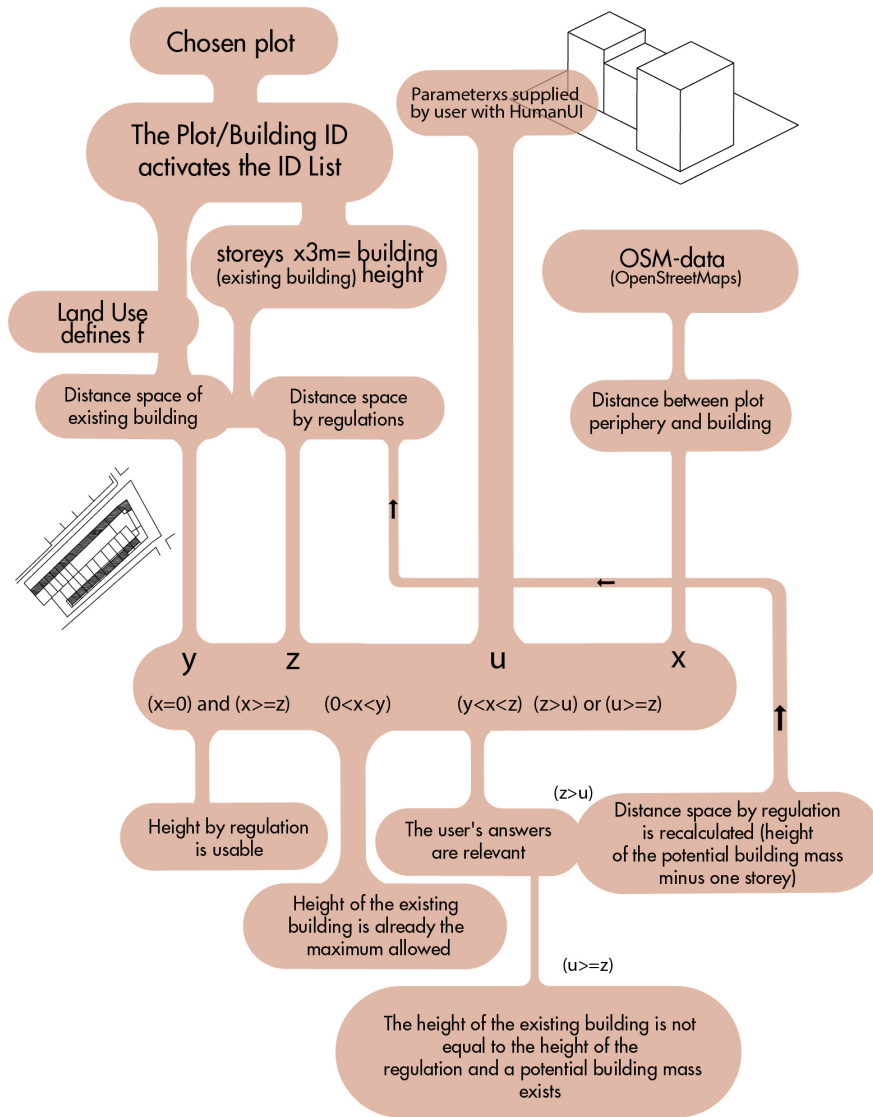


Figure 3. Workflow.

2.4. SPACIAL CASE

Not every plot has a development plan that contains information regarding the number of storeys allowed by regulation. In this case the algorithm analyses all the storeys of the buildings of adjacent plots to find the highest number of storeys of a building. This number defines the stories allowed by regulation (BauGB § 34). The highest number of storeys is set as number of storeys by regulation for all buildings in the block. The algorithm proceeds as described above.



Figure 4. Case Study.

2.5. CASE STUDY

Although, this tool can be applied for whole Berlin, three inner-city building blocks were selected as case studies [Figure 4]. Each building block meets different criteria. The algorithm was firstly applied and developed to a block with development plan [1]. It was important to pick a small block to understand and verify the gathered information. To confirm the results of the tool the calculations performed by the algorithm had to be done manually as well.

No development plan applies to the other two selected areas [2 + 3]. They were chosen to deal with special cases and to focus on emerging problems. In order to make the calculations for each case work the algorithm had to be altered several times.

2.6. USER INTERFACE

To navigate the tool a user interface is implemented. On the first tab, the user chooses a plot and the corresponding building. On the second tab, the chosen plot and building are shown, as are the distances between both. The second interface asks the user for the cardinal direction in which a public plot is located. On the second tab, the existing and potential building including the dimensions and storeys of the new volume are visualised. [Figure 5].

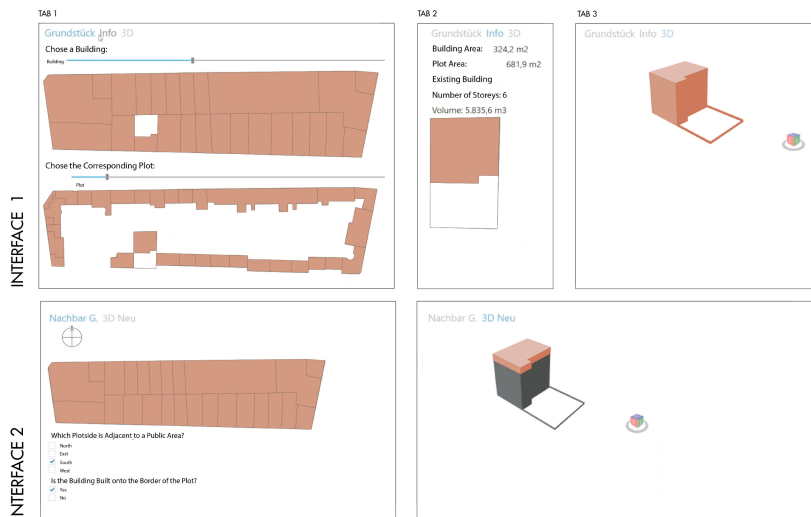


Figure 5. User Interface.

2.7. MANUAL

1. The user needs to download Rhino and Grasshopper.
2. The Grasshopper plugins (Human-Ui, gh-python-remote, lunchbox, elk) which can be found at www.food4rhino.com are required.
3. The plug-ins have to be linked to Grasshopper.
4. The script needs to be downloaded.
5. One wants to open the file 'OGOS+.3dm' in Rhino and 'OGOS+.gh' in Grasshopper.
6. The Excel file 'OGOS+.xlsx' needs to be opened.
7. All data links are required to be updated.
8. A plot and corresponding building are chosen.
9. A few questions about the plot are required to be answered.
10. The potential building mass together with the existing building mass are visualised in form of a 3D model as is some additional information.

3. Conclusion

OGOS+ proposes a tool which uses open source data and German zoning law to calculate potential building mass. It gains to increase inner-city densification with as little soil sealing as possible.

While developing the tool we had some limitations. A generic test area in Berlin was chosen to reduce the required data. Berlin GIS data has some shortcomings in terms of additional information layers (e.g. function or height) and accuracy (e.g. overlapping lines). The documentation of Berlin zoning law had to be done manually and reimplemented into the tool with Excel files.

The tool works within the regulations of the German zoning law. It can be argued that this zoning system is not able to adapt to changes quickly (e.g. urban density factor) and make mixed-use development difficult. (BauNVO §1).

At the moment the tool can only be used to analyse one plot but not a block in total. The tool is not able to save the findings. In later versions, the user could filter the building potential for a specific kind of use and size and would be able to save the findings [Figure 6].

It is easier to get permission for smaller building projects. The time consuming testing of zoning laws effects the lucrativeness of smaller sites. Using the tool in the beginning of design processes could save time and labour in making analysis less costly and increase building development. (Donath, & Lobos, 2008; Grazziotin et al, 2004; Kim, & Clayton, 2010).

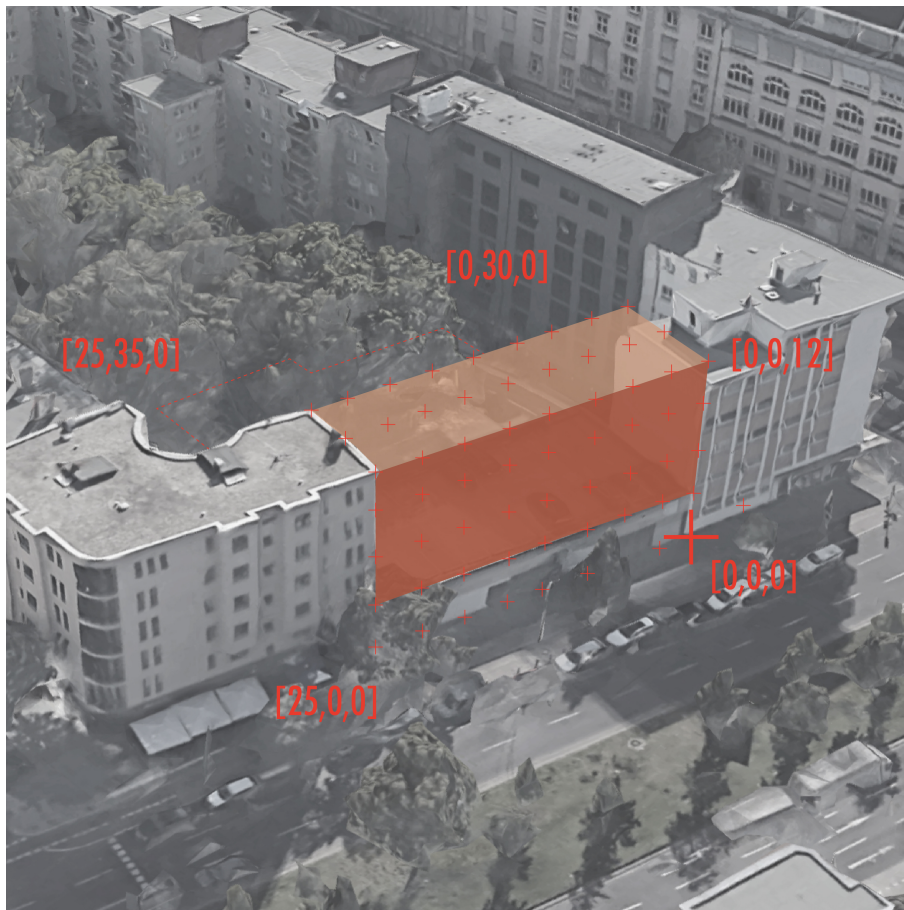


Figure 6. Prospect.

References

- “Food for Rhino - Human UI” : 2018. Available from <<https://www.food4rhino.com/app/human-ui>> (accessed 3rd December 2019).
- “Food for Rhino - GH Python Remote” : 2018. Available from <<https://www.food4rhino.com/app/gh-python-remote>> (accessed 3rd December 2019).
- “Bauordnung für Berlin - BauO Bln 2005” : 2018. Available from <<http://gesetze.berlin.de/jportal/?quelle=jlink&query=BauO+BE&psml=bsbeprod.psml&max=true&aiz=true>> (accessed 3rd December 2019).
- “Food for Rhino - ELK” : 2018. Available from <<https://www.food4rhino.com/app/elk>> (accessed 3rd December 2019).
- “Food for Rhino - LunchBox” : 2018. Available from <<https://www.food4rhino.com/app/lunchbox>> (accessed 3rd December 2019).
- Architektenkammer, N.-W.: 2009, *Entwicklung der Innenstädte. Positionspapier der AKNW zur Nachverdichtung und Baulückenschließung*, Architektenkammer Nordrhein-Westfalen, Düsseldorf.
- Brichetti, K.: 2011, *Berlins neue Mitte*, Sutton Verlag, Erfurt.
- Bundesamt, F.J.: 1962, “Verordnung über die bauliche Nutzung der Grundstücke - Baunutzungsverordnung BauNVO (2017)” . Available from <<https://www.gesetze-im-internet.de/baunvo/>> (accessed 3rd December 2019).
- Bundesamt, F.J.: 2017, “Baugesetzbuch BauGB” . Available from <<https://www.gesetze-im-internet.de/bbaug/>> (accessed 3rd December 2019).
- Donath, D. and Lobos, D.: 2008, Massing Study Support, *Architecture in Computro 26th eCAADe Conference Proceedings*, Antwerpen, 101-108.
- Grazziotin, P. C., Benamy, T., Sclovsky, L. and Freitas, C.M.D.S.: 2004, Cityzoom - A tool for the visualization of the impact of urban regulations, *Proceedings of the 8th Iberoamerican Congress of Digital Graphics*, Porte Alegre, Brasil, 216-220.
- Haubrich, R.: 2016, “Die Welt - Neue Wohnungen - wir müssen wieder bauen wie um 1900” . Available from <<https://www.welt.de/debatte/kommentare/article152736886/Neue-Wohnungen-wir-muessen-wieder-bauen-wie-um-1900.html>> (accessed 3rd December 2019).
- Kim, J. B. and Clayton, M. J.: 2010, Support Form-based Codes with Building Information Modeling – The Parametric Urban Model Case Study, *ACADIA 10: LIFE, On Responsive Information and Variations in Architecture*, New York, 133-138.
- Lobeck, M., Wiegandt, P.D.C.-C. and Wiese-von Ofen, D.-I.I.: 2006, *Entwicklung von umsetzungsorientierten Handlungsschritten zur Mobilisierung von Baulücken und zur Erleichterung von Nutzungsänderungen im Bestand in Innenstädten NRWs. Kurzfassung*, Geographisches Institut der Universität Bonn, Bonn.
- Mäder, K.: 2001, “Die Raumhöhe im Mietwohnungsbau” . Available from <spurbreite.ch/download/raumhoehe_im_wohnungsbau.pdf> (accessed 3rd December 2019).
- Bundesinstitut für Bau-, Stadt- und Raumforschung, B.: 2016, *Städtebauliche Nachverdichtung im Klimawandel. ExWoSt-Informationen 46/1-12/2014.*, BBSR Bundesinstitut für Bau-, Stadt- und Raumforschung, Bonn.
- Scharmanski, D.r. A. and Beneking, A.: 2017, Innenentwicklung als Chance für urbanes Wohnen, *Quantum Focus*, **26**(4), 11, 16, 27.
- Senatsverwaltung, F.W.E.U.B.: 2018, “Berlin Open Data” . Available from <<https://daten.berlin.de/>> (accessed 3rd December 2019).