



Spatial-functional analysis of the central area of the ancient settlement at Tayma, North-Western Arabia, during the Nabataean, Roman and Late Antiquity periods

Luna Watkins

► To cite this version:

Luna Watkins. Spatial-functional analysis of the central area of the ancient settlement at Tayma, North-Western Arabia, during the Nabataean, Roman and Late Antiquity periods. Archaeology and Prehistory. Université Panthéon-Sorbonne - Paris I, 2020. English. NNT : 2020PA01H053 . tel-03330593

HAL Id: tel-03330593

<https://theses.hal.science/tel-03330593>

Submitted on 1 Sep 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



UNIVERSITÉ PARIS I – PANTHÉON SORBONNE

École Doctorale d'Archéologie – ED 112

Laboratoire de rattachement : ArScAn

THÈSE

Pour l'obtention du titre de Docteur en Archéologie

Présentée et soutenue publiquement le

7 février 2020

par

Luna WATKINS

**Spatial-functional analysis of the central area of the ancient settlement at Tayma,
North-West Arabia, during the Nabataean, Roman and Late Antique Periods**

Sous la direction de Dr HdR Michel MOUTON

Directeur de recherche CNRS, Directeur de l'Institut Français du Proche-Orient, MEAE -
Liban / IFPO

Membres du Jury :

Prof Dr Ricardo EICHMANN – Directeur, *Deutsches Archäologisches Institut* Orient
Department

PD Dr Habilit Arnulf HAUSLEITER – Senior Researcher, *Deutsches Archäologisches Institut*
– Orient Department

Dr HdR Michel MOUTON – Directeur de recherche CNRS, Directeur de l'Institut Français du
Proche-Orient, MEAE - Liban / IFPO, Paris 1

Dr Jérémie SCHIETTECATTE – Chargé de recherche CNRS, UMR 8167

ABSTRACT

Object of this thesis is the study of ancient spaces, their organization, function and perception by the people who created and lived them.

The focus of this thesis is the architectural evidence from the residential area of the Nabataean, Roman and Late Antique periods at the centre of the oasis of Tayma, NW Arabia. Excavated between 2004 and 2015, the rather well-preserved sequence of occupation levels supported their detailed investigation. The main aims of this study were to identify the spatial configuration of the domestic buildings and to understand how political, economic and social dynamics influenced the perception and conception of space in an urban environment. In this research, about space and its use, space syntax plays a key role.

Space syntax is a technique used in spatial analysis to capture the set of abstract rules that define the spatial configuration at a defined moment of its period of use and through different occupations.

Considering a large set of evidence and performing a multidisciplinary approach, this research shed new light on the spatial configuration of the buildings and on the changes that occurred between 2nd and 6th c. CE at Tayma. The main results of the analyses included: identifying access to individual buildings and movement within them and determining the functional differentiation of living spaces.

This research puts Tayma into the large-scale changes attested between the Nabataean and Roman periods by several other archaeological sites in NW Arabia, as the spatial configuration at this site during this period seems to have considerably changed. On the other hand, the transition to the Late Antique period shows clear signs of continuity attested by the buildings which often reuse the spatial configuration from the Roman period. This interpretation might point either to an absence of large investments of resources, or to a continuity in the use of domestic spaces.

RÉSUMÉ

La présente thèse est une étude des espaces anciens, de leur organisation, de leur fonction et de leur perception par les personnes qui les créèrent et y vécurent.

Cette thèse se focalise sur les restes architecturaux de la zone résidentielle, située au cœur de l'oasis de Tayma en Arabie du Nord-Ouest, et datant des périodes nabatéenne, romaine et tardo-antique. La séquence des niveaux d'occupation, mise au jour entre 2004 et 2015 et relativement bien préservée, en permet une investigation détaillée. Les principaux objectifs de cette étude consistent en l'identification de la configuration spatiale du bâti domestique et, par ailleurs, en la compréhension du rôle joué dans la perception et la conception de l'espace en environnement urbain par des facteurs politiques, économiques et sociaux. Dans ces recherches sur l'espace et son utilisation, le concept de la syntaxe spatiale – *space syntax* – joue un rôle essentiel.

La syntaxe spatiale est une technique d'analyse spatiale permettant de saisir les règles abstraites qui définissent la configuration d'un espace à un moment donné de son utilisation et lors de différentes occupations.

En ayant recours à des données nombreuses et variées ainsi qu'à une approche multidisciplinaire, cette analyse permet de mieux saisir la configuration spatiale des bâtiments ainsi que les changements qui eurent lieu à Tayma entre les II^{ème} et VI^{ème} siècles de notre ère. Parmi les principaux résultats obtenus, on peut citer l'identification des accès aux bâtiments individuels, l'analyse de la circulation à l'intérieur de ces bâtiments ainsi que la caractérisation des différences fonctionnelles observées au sein de ces espaces de vie.

À travers cette étude, il a aussi été possible de replacer Tayma, dont l'organisation spatiale a apparemment était notablement modifiée entre les périodes nabatéenne et romaine, dans le cadre plus large des changements attestés au même moment sur d'autres sites archéologiques de l'Arabie du Nord-Ouest. À l'inverse, la transition vers la période tardo-antique montre des signes évidents de continuité avec la période précédente, les bâtiments ré-utilisant souvent une configuration spatiale héritée de la période romaine. Par conséquent, ce résultat suggère soit l'absence d'investissements importants en ressources, soit une continuité dans l'utilisation des espaces domestiques.

KEYWORDS

Space syntax – spatial analysis – Tayma – Nabataean period – Roman period – Late Antique period – genotypes – phenotypes – architectural evidence.

MOTS-CLES

Syntaxe spatiale – analyse spatiale – Tayma – époque Nabatéenne – époque Romaine – Antiquité tardive – phénotype – génotype – restes architecturaux.

Para ti, minha avó preferida, da tua neta preferida.

“[...] human beings cannot fly, and buildings cannot float in the air.”

Hillier et al. Reply to Professor Leach. 1978

ACKNOWLEDGMENTS

This thesis would not have been possible without the structural and financial support of the *ArScAn* (UMR 7041) and the *LabEx DynamiTe*. Crucial to my research was access to the full dataset of the Tayma Project, granted to me by the Orient Department of the *Deutsches Archäologisches Institut* (DAI) in Berlin.

I express my sincere gratitude to:

Dr Michel Mouton, my thesis supervisor, for his support and helpful guidance.

Dr Arnulf Hausleiter for dedicating time to sharing his knowledge and advice, keeping me working at a smooth pace.

Prof Dr Ricardo Eichmann for opening the doors to the Orient Department (DAI) for me and including me in the Tayma research group.

To Dr Pierre-Marie Blanc, Dr Guillaume Gernez and Dr Jérôme Rohmer, members of my *comité de suivi*, for tracking my progress.

My colleagues Friedrich Weigel, MA, and Francelin Tourtet, MA, for the constructive discussions about my research.

To Dr Andrea Intilia for reviewing my bibliography and to Dr Sebastiano Lora for helping me grow as a professional.

To all the other colleagues at the Tayma project and the Orient Department (DAI) who made my research over the past years more enjoyable.

To Dr Cecilie Lelek Tvetmarken for reviewing part of my thesis and helping me to unwind once in a while and take a break.

To the library staff of the *Bibliothèque d'Archéologie et des Sciences de l'Antiquité*, Nanterre, and of the Orient Department, especially to Elena Tens for having, at all times, a space available for me in the library.

To Amélie Le Bihan for guiding me, in the first years, through the French administrative hurdles.

To my father for helping me to improve my English and to both him and my mother for believing in me at all times.

To my friends: Marie for reminding me in a crucial moment that there are no doors, Florence and Jean-Marc for always having an open door and a bed ready in Paris, Dominique for all sorts of discussions in a Parisian environment.

To all other family members and friends for being part of my life and motivating me.

To all other people I might have forgotten that lightened up my mood when my brain was focused on my research.

Last but not least, to my (in the meantime) husband, Emmanuele, for keeping my work-life balance up, for supporting all the ups and downs, and for all his constructive criticisms toward my research.

CONTENT

Abstract.....	ii
Résumé	iii
Keywords.....	iv
Mots-clés	iv
Acknowledgments	vii
Content	viii
Figures	xi
Tables.....	xx
Abbreviations	xxiv

CHAPTER I

INTRODUCTION	1
1 Research background	1
2 Research question	2
3 Thesis outline	4

CHAPTER II

SPATIOTEMPORAL FRAMEWORK.....	6
1 NW Arabian political, social and economic dynamics from the Nabatean to the Late Antique Period	6
2 The oasis of Tayma	11
2.1 History of research at the oasis of Tayma	13
2.2 Tayma: site-specific technicalities	14
2.3 The oasis of Tayma in the NW Arabian context.....	20
3 Case study: the residential area at the oasis of Tayma	25
3.1 Location	26
3.2 Chronostratigraphy.....	28

CHAPTER III

METHODOLOGICAL FRAMEWORK.....	30
1 Methodology: Spatial analysis	31
2 Technique: Space syntax	33
2.1 Space syntax analysis.....	35
2.2 Criticism towards space syntax	45

3	Tool: GIS.....	46
4	Definitions.....	48
5	Methodological review	50

CHAPTER IV

STARTING WITH THE PHENOTYPES: DESCRIPTIONS AND SPACE SYNTAX ANALYSIS..... 56

1	OL 4 phenotypes– Nabataean Period	57
1.1	Description – macro level	57
1.2	Building F-b3	58
2	OL 3 phenotypes – Roman Period	70
2.1	Description – macro level	70
2.2	Building E-b15.....	71
2.3	Building F-b1 East	90
2.4	Building F-b1 West	111
2.5	Building F-b2	123
2.6	Building F-b4	135
2.7	Building F-b7	146
2.8	Building F-b12	159
3	OL 2b phenotypes – Late Antique Period	171
3.1	Description – macro level	171
3.2	Building E-b11	172
3.3	Building F-b5	183
3.4	Building F-b8 (Phase 1)	203
4	OL 2a phenotypes – Late Antique Period	214
4.1	Description – macro level	214
4.2	Building E-b7.....	215
4.3	Building F-b8 (Phase 2)	226

CHAPTER V

UNCOVERING SPATIAL CONFIGURATION: RESULTS OF THE SPACE SYNTAX ANALYSIS..... 237

1	Synchronic analysis.....	238
1.1	OL 4	238
1.2	OL 3	241
1.3	OL 2b	246
1.4	OL 2a.....	250
2	Diachronic analysis	254
2.1	Description.....	254
2.2	Space syntax analysis – micro and nano level	258
2.3	Spatial behaviour – functional differentiation?	261

CHAPTER VI

MAKING GENOTYPES VISIBLE	272
1 One genotype to rule them all?	272
2 One genotype per occupation level?	274
3 New proposition for genotypes	279
3.1 “Transpatial” links	285
3.2 Transtemporal links.....	293
3.3 Focus on cases of subsequent buildings.....	295

CHAPTER VII

ZOOMING OUT: IMPACT OF THE POLITICAL, SOCIAL AND ECONOMIC DYNAMICS ON THE USE OF SPACE	297
1 Intrasite spatial analysis	297
2 Intersite spatial analysis	300
2.1 Mada’in Saleh	302
2.2 Dumat al-Jandal	327
2.3 Comparative study	331
3 Concluding remarks	334

CHAPTER VIII

CONCLUSION	337
1 Research.....	337
1.1 Restatement of the research questions	337
1.2 Summary of research findings	338
2 Evaluation	340
2.1 Limitations of the research.....	340
2.2 Significance of the results	341
3 Suggestions for further research.....	342

GLOSSARY	343
-----------------------	------------

BIBLIOGRAPHY	346
---------------------------	------------

ATTACHEMENT

SPACE SYNTAX CATALOGUE	I
-------------------------------------	----------

Content catalogue	I
-------------------------	---

FIGURES

Figure 1: The Nabataean Kingdom – Tayma circled (based on Fiema et al. 2015, fig. 7.1. (Map drawn by Aron Styba)).....	8
Figure 2: Provincia Arabia – Tayma circled (based on Fiema et al. 2015, fig. 7.2. (Map drawn by Aron Styba))10	
Figure 3: The Arabian Peninsula – Tayma circled (based on Magee 2014, fig. 9.1.)	12
Figure 4: The oasis of Tayma with the <i>sebkha</i> to the N of the site (©Google Earth. Imagery date: 8 May 2013 and 16 September 2016. Accessed 7 May 2018).....	12
Figure 5: The oasis of Tayma, <i>Qrayyah</i> located at the centre (Hausleiter and Eichmann 2018, fig. 7 (graphics: S. Lora, DAI, Orient-Abteilung)).....	15
Figure 6: <i>Qrayyah</i> with compounds and excavation areas (Hausleiter and Eichmann 2018, fig. 8 (DAI, Orient-Abteilung, S. Lora))	16
Figure 7: Arabian trade network (Hackl, Jenni, and Schneider 2003, Karte 2.)	22
Figure 8: Large complex Building E-b6 (in green) NW of the residential area.....	25
Figure 9: Residential area (Area E-South and Area F), S of Building E-b1, in <i>Qrayyah</i>	26
Figure 10: Birdseye view over the residential area (Area E-South and Area F), S of Building E-b1; view from S (© DAI Orient Department 2015 J. Krumnow)	27
Figure 11: Scheme of the methodological framework.....	30
Figure 12: Scheme of levels of resolution (based on Clarke 1977)	33
Figure 13: Example of justified graphs of a building from two perspectives: node 5 and node 10 – highlighted in grey (based on Hillier 2014, 21)	36
Figure 14: Example of an axial map of street spaces around buildings (grey); axial lines representing street spaces (black) (based on Al-Sayed 2014, fig. 2.2 b.)	37
Figure 15: Example of a building (left) with convex map (right) showing connections (black) between spaces (grey) (based on Al-Sayed 2014, fig. 2.3 a. and b.).....	38
Figure 16: Example of an unjustified graph (black) on top of a convex map (grey) (based on Al-Sayed 2014, fig. 2.3 c.)	40
Figure 17: Example of rings (red) on top of a convex map (grey) (based on Al-Sayed 2014, figs 2.3 and 2.4)...41	
Figure 18: Example of space types (A-type – turquoise; B-type – purple; C-type – yellow; D-type – green) on top of a convex map (grey) (based on Al-Sayed 2014, fig. 2.4).....	44
Figure 19: Workflow of GIS (based on Wheatley and Gillings 2002, fig. 1.2)	48
Figure 20: Workflow of the intrasite spatial analysis in this thesis (repeated task in italic)	51
Figure 21: Codes for justified graphs and plans (RA values, CV and permeability – from top to bottom).....	53
Figure 22: Architectural evidence from the Nabataean Period (OL 4) in the residential area (Area E-South/F)..	57
Figure 23: Building F-b3	58

Figure 24: Building F-b3; view from E (© DAI Orient Department 2016 F. Weigel).....	59
Figure 25: Wall SU 3969 with beam holes facing the entrance of Building F-b3 in the N; view from S (© DAI Orient Department 2011 F. Weigel)	60
Figure 26: Stone with grinding depressions in wall SU 3649 (on the right side); view from S (© DAI Orient Department 2009 C. Purschwitz)	61
Figure 27: Justified graph Building F-b3 (visitor-inhabitant).....	62
Figure 28: Coded justified graph of Building F-b3 (visitor-inhabitant).....	64
Figure 29: Building F-b3 (visitor-inhabitant)	65
Figure 30: Justified graph Building F-b3 (inhabitant-inhabitant)	66
Figure 31: Coded justified graph of Building F-b3 (inhabitant-inhabitant).....	68
Figure 32: Building F-b3 (inhabitant-inhabitant)	69
Figure 33: Architectural evidence from the Roman Period (OL 3) in the residential area (Area E-South/F).....	70
Figure 34: Buildings E-b15	71
Figure 35: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow).....	72
Figure 36: Justified graph Building E-b15 (visitor-inhabitant) – variation 1.....	74
Figure 37: Coded justified graph of Building E-b15 (visitor-inhabitant) – variation 1	76
Figure 38: Building E-b15 (visitor-inhabitant) – variation 1	77
Figure 39: Justified graph Building E-b15 (inhabitant-inhabitant) – variation 1.....	78
Figure 40: Coded justified graph of Building E-b15 (inhabitant-inhabitant) – variation 1	80
Figure 41: Building E-b15 (inhabitant-inhabitant) – variation 1	81
Figure 42: Justified graph Building E-b15 (visitor-inhabitant) – variation 2.....	82
Figure 43: Coded justified graph of Building E-b15 (visitor-inhabitant) – variation 2	84
Figure 44: Building E-b15 (visitor-inhabitant) – variation 2	85
Figure 45: Justified graph Building E-b15 (inhabitant-inhabitant) – variation 2.....	86
Figure 46: Coded justified graph of Building E-b15 (inhabitant-inhabitant) – variation 2	88
Figure 47: Building E-b15 (inhabitant-inhabitant) – variation 2	89
Figure 48: Building F-b1 East	90
Figure 49: Building F-b1 East; view from E (© DAI Orient Department 2016 F. Weigel)	91
Figure 50: Entrance of Building F-b1 East flanked by two vertical stones (SU 3973 and SU 3966) and the threshold (SU 8686), view from R17 in the interior to the exterior. Wall SU 3969 can be seen in the background (Building F-b3 roofing, see Figure 25); view from S (© DAI Orient Department 2016 F. Weigel).....	92
Figure 51: Justified graph Building F-b1 East (visitor-inhabitant) – variation 1	94
Figure 52: Coded justified graph of Building F-b1 East (visitor-inhabitant) – variation 1.....	96

Figure 53: Building F-b1 East (visitor-inhabitant) – variation 1	97
Figure 54: Justified graph Building F-b1 East (inhabitant-inhabitant) – variation 1	98
Figure 55: Coded justified graph of Building F-b1 East (inhabitant-inhabitant) – variation 1	100
Figure 56: Building F-b1 East (inhabitant-inhabitant) – variation 1.....	101
Figure 57: Justified graph Building F-b1 East (visitor-inhabitant) – variation 2.....	102
Figure 58: Coded justified graph of Building F-b1 East (visitor-inhabitant) – variation 2.....	104
Figure 59: Building F-b1 East (visitor-inhabitant) – variation 2	105
Figure 60: Justified graph Building F-b1 East (inhabitant-inhabitant) – variation 2	106
Figure 61: Coded justified graph of Building F-b1 East (inhabitant-inhabitant) – variation 2.....	108
Figure 62: Building F-b1 East (inhabitant-inhabitant) – variation 2.....	109
Figure 63: Buildings F-b1 West.....	111
Figure 64: Building F-b1 West; view from E (© DAI Orient Department 2016 F. Weigel)	112
Figure 65: F-b1:R3 with food preparation area; view from W (© DAI Orient Department 2009 C. Purschwitz)	114
Figure 66: Justified graph Building F-b1 West (visitor-inhabitant)	115
Figure 67: Coded justified graph of Building F-b1 West (visitor-inhabitant).....	117
Figure 68: Building F-b1 West (visitor-inhabitant)	118
Figure 69: Justified graph Building F-b1 West (inhabitant-inhabitant)	119
Figure 70: Coded justified graph of Building F-b1 West (inhabitant-inhabitant)	121
Figure 71: Building F-b1 West (inhabitant-inhabitant).....	122
Figure 72: Building F-b2	123
Figure 73: Building F-b2; view from SE (© DAI Orient Department 2015 J. Krumnow)	124
Figure 74: Threshold SU 1920 with grinding depressions (on the left); view from SW (© DAI Orient Department 2005 C. Purschwitz)	126
Figure 75: Justified graph Building F-b2 (visitor-inhabitant).....	127
Figure 76: Coded justified graph of Building F-b2 (visitor-inhabitant).....	129
Figure 77: Building F-b2 (visitor-inhabitant)	130
Figure 78: Justified graph Building F-b2 (inhabitant-inhabitant)	131
Figure 79: Coded justified graph of Building F-b2 (inhabitant-inhabitant).....	133
Figure 80: Building F-b2 (inhabitant-inhabitant)	134
Figure 81: Building F-b4	135
Figure 82: Building F-b4; view from SE (© DAI Orient Department 2015 J. Krumnow)	136
Figure 83: Staircase SU 5052; view from E (© DAI Orient Department 2016 F. Weigel).....	137
Figure 84: Justified graph Building F-b4 (visitor-inhabitant).....	138
Figure 85: Coded justified graph of Building F-b4 (visitor-inhabitant).....	140

Figure 86: Building F-b4 (visitor-inhabitant)	141
Figure 87: Justified graph Building F-b4(inhabitant-inhabitant).....	142
Figure 88: Coded justified graph of Building F-b4 (inhabitant-inhabitant).....	144
Figure 89: Building F-b4 (inhabitant-inhabitant)	145
Figure 90: Buildings F-b7.....	146
Figure 91: Building F-b7; view from N (© DAI Orient Department 2015 J. Krumnow).....	147
Figure 92: F-b7:R4, F-b7:R5, F-b7:R6, F-b7:R7; view from NNE (© DAI Orient Department 2009 M. Cusin)	148
Figure 93: Doorway in wall SU 5297 between F-b7:R2 and F-b7:R8; view from NNE (© DAI Orient Department 2009 M. Cusin).....	149
Figure 94: Channel SU 5294; view from W (© DAI Orient Department 2009 M. Cusin)	150
Figure 95: Justified graph Building F-b7 (visitor-inhabitant).....	151
Figure 96: Coded justified graph of Building F-b7 (visitor-inhabitant).....	153
Figure 97: Building F-b7 (visitor-inhabitant)	154
Figure 98: Justified graph Building F-b7 (inhabitant-inhabitant)	155
Figure 99: Coded justified graph of Building F-b7 (inhabitant-inhabitant).....	157
Figure 100: Building F-b7 (inhabitant-inhabitant)	158
Figure 101: Building F-b12	159
Figure 102: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)	160
Figure 103: Large slabs SU 7338 covering a cavity; view from N (© DAI Orient Department 2012 F. Weigel)	161
Figure 104: Wall SU 6285 with beam holes (on top); view from E (© DAI Orient Department 2012 F. Jürcke)	162
Figure 105: Justified graph Building F-b12 (visitor-inhabitant).....	163
Figure 106: Coded justified graph of Building F-b12 (visitor-inhabitant).....	165
Figure 107: Building F-b12 (visitor-inhabitant)	166
Figure 108: Justified graph Building F-b12 (inhabitant-inhabitant).....	167
Figure 109: Coded justified graph of Building F-b12 (inhabitant-inhabitant).....	169
Figure 110: Building F-b12 (inhabitant-inhabitant).....	170
Figure 111: Architectural evidence from the first phase of the Late Antique Period (OL 2b) in the residential area (Area E-South/F).....	171
Figure 112: Building E-b11	172
Figure 113: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow).....	173

Figure 114: Staircase SU 2647; view from W (© DAI Orient Department 2012 F. Jürcke).....	174
Figure 115: Justified graph Building E-b11 (visitor-inhabitant).....	175
Figure 116: Coded justified graph of Building E-b11 (visitor-inhabitant).....	177
Figure 117: Building E-b11 (visitor-inhabitant)	178
Figure 118: Justified graph of Building E-b11 (inhabitant-inhabitant).....	179
Figure 119: Coded justified graph of Building E-b11 (inhabitant-inhabitant).....	181
Figure 120: Building E-b11 (inhabitant-inhabitant)	182
Figure 121: Building F-b5	183
Figure 122: Building F-b5, view from W (© DAI Orient Department 2015 J. Krumnow)	184
Figure 123: Threshold SU 4736 (on the bottom); view from W (© DAI Orient Department 2016 F. Weigel) ..	185
Figure 124: Fire installation SU 6529; view from E (© DAI Orient Department 2011 F. Weigel)	186
Figure 125: Justified graph Building F-b5 (visitor-inhabitant) – variation 1	187
Figure 126: Coded justified graph of Building F-b5 (visitor-inhabitant) – variation 1.....	189
Figure 127: Building F-b5 (visitor-inhabitant) – variation 1	190
Figure 128: Justified graph Building F-b5 (inhabitant-inhabitant) – variation 1	191
Figure 129: Coded justified graph of Building F-b5 (inhabitant-inhabitant) – variation 1.....	193
Figure 130: Building F-b5 (inhabitant-inhabitant) – variation 1	194
Figure 131: Justified graph Building F-b5 (visitor-inhabitant) – variation 2.....	195
Figure 132: Coded justified graph of Building F-b5 (visitor-inhabitant) – variation 2.....	197
Figure 133: Building F-b5 (visitor-inhabitant) – variation 2	198
Figure 134: Justified graph Building F-b5 (inhabitant-inhabitant) – variation 2.....	199
Figure 135: Coded justified graph of Building F-b5 (inhabitant-inhabitant) – variation 2.....	201
Figure 136: Building F-b5 (inhabitant-inhabitant) – variation 2	202
Figure 137: Buildings F-b8 (phase 1).....	203
Figure 138: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)	204
Figure 139: Threshold SU 6297 with grinding depressions; view from E (© DAI Orient Department 2011 J. Kramer).....	205
Figure 140: Justified graph Buildings F-b8 (phase 1) (visitor-inhabitant).....	206
Figure 141: Coded justified graph of Buildings F-b8 (phase 1) (visitor-inhabitant)	208
Figure 142: Buildings F-b8 (phase 1) (visitor-inhabitant)	209
Figure 143: Justified graph Buildings F-b8 (phase 1) (inhabitant-inhabitant).....	210
Figure 144: Coded justified graph of Buildings F-b8 (phase 1) (inhabitant-inhabitant).....	212
Figure 145: Buildings F-b8 (phase 1) (inhabitant-inhabitant)	213
Figure 146: Architectural evidence from the second phase of the Late Antique Period (OL 2a) in the residential	

area (Area E-South/F)	214
Figure 147: Building E-b7	215
Figure 148: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow).....	216
Figure 149: Justified graph Building E-b7 (visitor-inhabitant).....	218
Figure 150: Coded justified graph of Building E-b7 (visitor-inhabitant)	220
Figure 151: Building E-b7 (visitor-inhabitant)	221
Figure 152: Justified graph of Building E-b7 (inhabitant-inhabitant)	222
Figure 153: Coded justified graph of Building E-b7 (inhabitant-inhabitant).....	224
Figure 154: Building E-b7 (inhabitant-inhabitant)	225
Figure 155: Buildings F-b8 (phase 2)	226
Figure 156: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)	227
Figure 157: Justified graph Buildings F-b8 (phase 2) (visitor-inhabitant).....	229
Figure 158: Coded justified graph of Buildings F-b8 (phase 2) (visitor-inhabitant)	231
Figure 159: Buildings F-b8 (phase 2) (visitor-inhabitant)	232
Figure 160: Justified graph Buildings F-b8 (phase 2) (inhabitant-inhabitant).....	233
Figure 161: Coded justified graph of Buildings F-b8 (phase 2) (inhabitant-inhabitant).....	235
Figure 162: Buildings F-b8 (phase 2) (inhabitant-inhabitant)	236
Figure 163: Total and usable area per building – Nabataean Period (OL 4).....	238
Figure 164: Foundation levels of newly built walls per building – Nabataean Period (OL 4)	239
Figure 165: Correlation between usable area and number of rooms – Nabataean Period (OL 4).....	240
Figure 166: Mean RRA value per building – Nabataean Period (OL 4).....	240
Figure 167: Total and usable area per building – Roman Period (OL 3)	242
Figure 168: Foundation levels of newly built walls per building – Roman Period (OL 3).....	243
Figure 169: Correlation between usable area and number of rooms – Roman Period (OL 3).....	243
Figure 170: Mean RRA values per building – Roman Period (OL 3).....	244
Figure 171: Total and usable area per building – first phase Late Antique Period (OL 2b).....	246
Figure 172: Foundation levels of newly built walls per building – first phase Late Antique Period (OL 2b)	247
Figure 173: Correlation between usable area and number of rooms – first phase Late Antique Period (OL 2b)	248
Figure 174: Mean RRA values per building – first phase Late Antique Period (OL 2b)	248
Figure 175: Total and usable area per building – second phase Late Antique Period (OL 2a)	251
Figure 176: Foundation levels of newly built walls per building – second phase Late Antique Period (OL 2a)	251
Figure 177: Correlation between usable area and number of rooms – second phase Late Antique Period (OL 2a)	252

Figure 178: Mean RRA values per building – second phase Late Antique Period (OL 2a).....	253
Figure 179: Total and usable area of all buildings – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods	255
Figure 180: Average total area of buildings and Standard Deviation for each OL – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods	256
Figure 181: Correlation of total and usable area for all OL – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods	256
Figure 182: Foundation levels of all buildings, black line indicates the OLs mean foundation level – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods	257
Figure 183: Average RRA values per OL and variations – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods	258
Figure 184: RRA values per OL and building with variations – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods.....	259
Figure 185: Correlation of CV and RA values per space type (visitor-inhabitant)	262
Figure 186: Correlation of CV and RA values per space type (inhabitant-inhabitant)	262
Figure 187: Correlation of CV and RA values for the alleys (visitor-inhabitant)	263
Figure 188: Correlation of CV and RA values for the entrance rooms (visitor-inhabitant, left) and for the former entrance rooms (inhabitant-inhabitant, right).....	264
Figure 189: Correlation of CV and RA values for the largest rooms (visitor-inhabitant, left; inhabitant-inhabitant, right).....	265
Figure 190: Correlation of CV and RA values for the smallest rooms (visitor-inhabitant, left; inhabitant-inhabitant, right).....	266
Figure 191: Correlation of CV and RA values for the most connected rooms (visitor-inhabitant, left; inhabitant-inhabitant, right).....	267
Figure 192: Correlation of CV and RA values for the staircases (visitor-inhabitant, left; inhabitant-inhabitant, right).....	268
Figure 193: Correlation of CV and RA values for the upper floors (visitor-inhabitant, left; inhabitant-inhabitant, right).....	269
Figure 194: Correlation of CV and RA values for the rooms with food processing areas (visitor-inhabitant, left; inhabitant-inhabitant, right).....	270
Figure 195: Average RRA and range for all analysed buildings of all OLs together, including the breakdown into variations – (variations for the Roman Period (OL 3) and first phase of the Late Antique Period (2b))....	273
Figure 196: H* for all analysed buildings of all OLs together, including the breakdown into variations – (variations for the Roman Period (OL 3) and first phase of the Late Antique Period (2b)); y-axis starts at 0.80	273
Figure 197: Average RRA and range per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b	275

Figure 198: H* per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b; y-axis starts at 0.80	276
Figure 199: Overlapping of all justified graphs per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b – from often represented path (dark green) to little represented path (yellow) (visitor-inhabitant relationship)	277
Figure 200: Overlapping of all justified graphs per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods) , including variations for OL 3 and OL 2b – from often represented path (dark green) to little represented path (yellow) (inhabitant-inhabitant relationship)	278
Figure 201: Mean RRA values per building – Roman Period (OL 3). Average RRA values under 1.000 circled	280
Figure 202: Mean RRA values per building – Late Antique Period (first phase: OL 2b + second phase: 2a)	280
Figure 203: Average RRA and range per genotype (A, B.I, B.II and C), including variations for genotypes B.I, B.II and C.....	281
Figure 204: H* per genotype, including variations for genotypes B.I, B.II and C; y-axis starts at 0.80	282
Figure 205: Overlapping of all justified graphs per genotype (A, B.I, B.II, C), including variations for genotype B.I, B.II and C – from often represented path (dark green) to little represented path (yellow) (visitor-inhabitant)	283
Figure 206: Overlapping of all justified graphs per genotype (A, B.I, B.II, C), including variations for genotype B.I, B.II and C – from often represented path (dark green) to little represented path (yellow) (inhabitant-inhabitant)	284
Figure 207: Plan of genotype A buildings – Nabatean Period (OL 4)	287
Figure 208: Plan of genotype B.I and genotype B.II buildings – Roman Period (OL 3).....	290
Figure 209: Plan of genotype C buildings – Late Antique Period (first phase: OL 2b on the top, second phase (OL 2a) on the bottom)	292
Figure 210: H* for the transition between two genotypes (Nabataean (A), Roman (B.I, B.II) and Late Antique (C) Periods).....	294
Figure 211: Tayma and comparative sites Mada'in Saleh and Dumat al-Jandal circled (based on Macdonald 2004, fig. 16.1).....	301
Figure 212: Mada'in Saleh. Location of the Areas excavated between 2008 and 2017, wadi on the E side (Nehmé 2018b, 6, fig. 1)	302
Figure 213: Mada'in Saleh. Area 1, Phase 2 (Nehmé 2011a, 42, fig. 13).....	307
Figure 214: Mada'in Saleh. Area 1, Phase 3 (Nehmé 2011a, 43, fig. 14).....	308
Figure 215: Mada'in Saleh. Area 1, Phase 4 (Nehmé 2011a, 44, fig. 15).....	309
Figure 216: Mada'in Saleh. Area 1, Phase 5 (Nehmé 2011a, 45, fig. 16).....	310
Figure 217: Mada'in Saleh. Area 1, Phase 6 (Nehmé 2011a, 35, fig. 3).....	311
Figure 218: Mada'in Saleh. Area 2 (Rohmer and Fiema 2016, fig. 9).....	312
Figure 219: Mada'in Saleh. Area 2, Phase 1 (Rohmer and Fiema 2016, fig. 10)	316

Figure 220: Mada'in Saleh. Area 2, Phase 2 (Rohmer and Fiema 2016, fig. 11)	317
Figure 221: Mada'in Saleh. Area 2, Phase 3 (Nehmé 2011a, 73, fig. 31).....	318
Figure 222: Mada'in Saleh. Area 2, Phase 4 (Nehmé 2011a, 75, fig. 34).....	319
Figure 223: Mada'in Saleh. Area 9 (Nehmé 2018b, 161, fig. 1).....	320
Figure 224: Mada'in Saleh. Area 9, trench A and trench B (Nehmé 2011a, 214, Pl. 1 on the top; Rohmer and Fiema 2016, fig. 5 on the bottom).....	322
Figure 225: Mada'in Saleh. Area 9, trench C and trench D (Nehmé 2018b, 178, fig. 22).....	325
Figure 226: Dumat al-Jandal. Plan of the archaeological area (based on Charloux and Loreto 2016, 101, fig. 1).	327
Figure 227: Dumat al-Jandal. Building A (Edificio A) and Building B (Edificio B), Sector A (Loreto 2017a, fig. 108 on the right).....	329
Figure 228: Dumat al-Jandal. Building A and Building B (Loreto 2017b, fig. 4)	329
Figure 229: Dumat al-Jandal. Building A, Sector A, courtyard with portico (Charloux and Loreto 2016, 114, fig. 16).....	330

TABLES

Table 1: Chronostratigraphy: Occupation periods (OPs) in Tayma (Hausleiter and Eichmann 2018, Table 1)	18
Table 2: Chronostratigraphy: Occupation periods (Ops) and occupation levels (OLs) in Tayma (Francelin Tourtet 2017, modified by Anja Prust 2018; personal communication)	19
Table 3: Residential area (Area E-South and Area F): Occupation levels (OLs) (adapted from Weigel 2019, 108, Table 1)	28
Table 4: Buildings of the residential area (Area E-South and Area F) – in bold the buildings where a space syntax analysis is possible.....	29
Table 5: D-values calculated for K=1 to K=20	43
Table 6: Micro level analysis of Building F-b3 (visitor-inhabitant)	63
Table 7: Nano level of analysis of Building F-b3, K = 7 and D = 0.340 (visitor-inhabitant)	63
Table 8: Micro level analysis of Building F-b3 (inhabitant-inhabitant).....	67
Table 9: Nano level of analysis of Building F-b2, k = 5 and D = 0.352 (inhabitant-inhabitant)	67
Table 10: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b3.....	69
Table 11: Micro level analysis of Building E-b15 (visitor-inhabitant) – variation 1	75
Table 12: Nano level of analysis of Building E-b15, K = 6 and D = 0.349 (visitor-inhabitant) – variation 1	75
Table 13: Micro level analysis of Building E-b15 (inhabitant-inhabitant) – variation 1	79
Table 14: Nano level of analysis of Building E-b15, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 1	79
Table 15: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b15, variation 1	81
Table 16: Micro level analysis of Building E-b15 (visitor-inhabitant) – variation 2	83
Table 17: Nano level of analysis of Building E-b15, K = 6 and D = 0.349 (visitor-inhabitant) – variation 2	83
Table 18: Micro level analysis of Building E-b15 (inhabitant-inhabitant) – variation 2	87
Table 19: Nano level of analysis of Building E-b15, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 2	87
Table 20: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b15, variation 2	89
Table 21: Micro level analysis of Building F-b1 East (visitor-inhabitant) – variation 1	95
Table 22: Nano level analysis of Building F-b1 East, K = 11 and D = 0.295 (visitor-inhabitant) – variation 1 ...	95
Table 23: Micro level analysis of Building F-b1 East (inhabitant-inhabitant) – variation 1	99
Table 24: Nano level of analysis of Building F-b1 East, K = 9 and D = 0.317 (inhabitant-inhabitant) – variation 1	99
Table 25: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 East, variation 1	101
Table 26: Micro level analysis of Building F-b1 East (visitor-inhabitant) – variation 2.....	103

Table 27: Nano level analysis of Building F-b1 East, K = 12 and D = 0.285 (visitor-inhabitant) – variation 2.	103
Table 28: Micro level analysis of Building F-b1 East (inhabitant-inhabitant) – variation 2.....	107
Table 29: Nano level of analysis of Building F-b1 East, K = 10 and D = 0.306 (inhabitant-inhabitant) – variation 2	107
Table 30: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 East, variation 2	110
Table 31: Micro level analysis of Building F-b1 West (visitor-inhabitant).....	116
Table 32: Nano level of analysis of Building F-b1 West, K = 7 and D = 0.340 (visitor-inhabitant).....	116
Table 33: Micro level analysis of Building F-b1 West (inhabitant-inhabitant).....	120
Table 34: Nano level of analysis of Building F-b1 West, K = 6 and D = 0.349 (inhabitant-inhabitant).....	120
Table 35: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 West.....	122
Table 36: Micro level analysis of Building F-b2 (visitor-inhabitant)	128
Table 37: Nano level of analysis of Building F-b2, K = 7 and D = 0.340 (visitor-inhabitant)	128
Table 38: Micro level analysis of Building F-b2 (inhabitant-inhabitant).....	132
Table 39: Nano level of analysis of Building F-b2, K = 6 and D = 0.349 (inhabitant-inhabitant).....	132
Table 40: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b2.....	134
Table 41: Micro level analysis of Building F-b4 (visitor-inhabitant)	139
Table 42: Nano level of analysis of Building F-b4, K = 7 and D = 0.340 (visitor-inhabitant)	139
Table 43: Micro level analysis of Building F-b4 (inhabitant-inhabitant).....	143
Table 44: Nano level of analysis of Building F-b4, K = 6 and D = 0.349 (inhabitant-inhabitant).....	143
Table 45: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b4.....	145
Table 46: Micro level analysis of Building F-b7 (visitor-inhabitant)	152
Table 47: Nano level of analysis of Building F-b7, K = 9 and D = 0.317 (visitor-inhabitant)	152
Table 48: Micro level analysis of Building F-b7(inhabitant-inhabitant).....	156
Table 49: Nano level of analysis of Building F-b7, K = 8 and D = 0.328 (inhabitant-inhabitant).....	156
Table 50: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b7.....	158
Table 51: Micro level analysis of Building F-b12 (visitor-inhabitant)	164
Table 52: Nano level of analysis of Building F-b12, K = 8 and D = 0.328 (visitor-inhabitant)	164
Table 53: Micro level analysis of Building F-b12 (inhabitant-inhabitant).....	168
Table 54: Nano level of analysis of Building F-b12, K = 7 and D = 0.340 (inhabitant-inhabitant).....	168
Table 55: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b12.....	170
Table 56: Micro level analysis of Building E-b11 (visitor-inhabitant)	176
Table 57: Nano level of analysis of Building E-b11, K = 6 and D = 0.349 (visitor-inhabitant)	176
Table 58: Micro level analysis of Building E-b11 (inhabitant-inhabitant).....	180
Table 59: Nano level analysis of Building E-b11, K =5 and D = 0.352 (inhabitant-inhabitant).....	180

Table 60: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b11.....	182
Table 61: Micro level analysis of Building F-b5 (visitor-inhabitant) – variation 1	188
Table 62: Nano level of analysis of Building F-b5, K = 6 and D = 0.349 (visitor-inhabitant) – variation 1	188
Table 63: Micro level analysis of Building F-b5 (inhabitant-inhabitant) – variation 1.....	192
Table 64: Nano level of analysis of Building F-b5, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 1.	192
Table 65: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b5, variation 1	194
Table 66: Micro level analysis of Building F-b5 (visitor-inhabitant) – variation 2	196
Table 67: Nano level of analysis of Building F-b5, K = 6 and D = 0.349 (visitor-inhabitant) – variation 2	196
Table 68: Micro level analysis of Building F-b5 (inhabitant-inhabitant) – variation 2.....	200
Table 69: Nano level of analysis of Building F-b5, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 2.	200
Table 70: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b5, variation 2	202
Table 71: Micro level analysis of Buildings F-b8 (phase 1) (visitor-inhabitant).....	207
Table 72: Nano level of analysis of Buildings F-b8 (phase 1), K = 5 and D = 0.352 (visitor-inhabitant)	207
Table 73: Micro level analysis of Buildings F-b8 (phase 1) (inhabitant-inhabitant)	211
Table 74: Nano level of analysis of Buildings F-b8 (phase 1), K = 4 and D = 0.333 (inhabitant-inhabitant)	211
Table 75: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Buildings F-b8 (phase 1)	213
Table 76: Micro level analysis of Building E-b7 (visitor-inhabitant)	219
Table 77: Nano level of analysis of Building E-b7, K = 6 and D = 0.349 (visitor-inhabitant)	219
Table 78: Micro level analysis of Building E-b7 (inhabitant-inhabitant)	223
Table 79: Nano level analysis of Building E-b7, K =5 and D = 0.352 (inhabitant-inhabitant).....	223
Table 80: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b7	225
Table 81: Micro level analysis of Buildings F-b8 (phase 2) (visitor-inhabitant)	230
Table 82: Nano level of analysis of Buildings F-b8 (phase 2), K = 5 and D = 0.352 (visitor-inhabitant)	230
Table 83: Micro level analysis of Buildings F-b8 (phase 2) (inhabitant-inhabitant)	234
Table 84: Nano level of analysis of Buildings F-b8 (phase 2), K = 4 and D = 0.333 (inhabitant-inhabitant)	234
Table 85: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Buildings F-b8 (phase 2)	236
Table 86: Average RRA values depending on variations of Building E-b15 and Building F-b1 East (visitor- inhabitant) – Roman Period (OL 3).....	244
Table 87: Average RRA values depending on variations of Building E-b15 and F-b1 East (inhabitant-inhabitant) – Roman Period (OL 3).....	245
Table 88: Average RRA values depending on the variations of Building F-b5 (visitor-inhabitant) – first phase	

Late Antique Period (OL 2b).....	249
Table 89: Average RRA values depending on the variations of Building F-b5 (inhabitant-inhabitant) – first phase Late Antique Period (OL 2b).....	249
Table 90: Summary of main characteristics for each genotype (A, B.II, B.I and C, ordered by difference/similarity: white – no information; red – difference; green - similarity).....	286
Table 91: Mada'in Saleh, Area 1, comparative phases (colours based on Tayma stratigraphy)	303
Table 92: Mada'in Saleh, Area 2, comparative phases (colours based on Tayma stratigraphy)	313
Table 93: Mada'in Saleh, Area 9 (trench A and trench B), comparative phases (colours based on Tayma stratigraphy)	323
Table 94: Mada'in Saleh, Area 9 (trench A and trench B), comparative phases (colours based on Tayma stratigraphy) – Correlation of local phases trench C and trench D based on Nehmé 2018b, 179 - Table 1.	326
Table 95: Dumat al-Jandal, Building A and Building B, comparative phases (colours based on Tayma stratigraphy)	330
Table 96: Comparative chronostratigraphy: Tayma, Mada'in Saleh and Dumat al-Jandal (colours based on Tayma stratigraphy)	333

ABBREVIATIONS

Abbreviation	Meaning
a.s.l.	above sea level
CE	Common Era
BCE	Before Common Era
BS	Building Stage
E	east
GIS	Geographic Information System
N	north
OL	Occupation Level
OP	Occupation Period
R	Room
S	south
SU	Stratigraphic Unit
W	west
vis-inh	visitor-inhabitant relationship
inh-inh	inhabitant-inhabitant relationship
var.	variation

CHAPTER I

INTRODUCTION

This PhD thesis presents the research activities carried out by the author between 2014 and 2019 as part of the Joint Saudi Arabian-German Archaeological Project at the oasis of Tayma in Saudi Arabia. It was submitted to the *Université Paris I Panthéon-Sorbonne (École Doctoral d'Archéologie – ED 112)* under the supervision of Dr HdR Michel Mouton.¹ The author received financial support from the *LabEx DynamiTe*, Paris (ANR-11-LABX-0046), as part of the programme *Investissements d'Avenir*, between 2014 and 2016.

Research was mainly carried out at the Orient Department of the *Deutsches Archäologisches Institut* (DAI) in Berlin and, especially the methodology, at the *Maison d'Archéologie et Ethnologie* (MAE) in Nanterre.

The first section of this chapter briefly presents the research background and motivation for the choice of topic, while the second section focuses on the research questions. The last section provides an outline of this thesis.

1 RESEARCH BACKGROUND

The notion of space (whether built space, personal space, social space, etc.) has been theorised in diverse research fields, including sociology and architecture, since the 1950s and 1960s. It was mainly in the 1970s that the analysis of this notion, through spatial analysis, was applied to archaeology. The diversity of methods used in this type of analysis depicts well the multitude of perspectives from which space can be examined. Space syntax analysis, as a technique for spatial analysis, was coined by Bill Hillier and his team in the 1970s to analyse spatial configuration mathematically and theorise its socio-cultural meaning. Since then it has been received with positive and negative feedback by scholars all over the world. Space syntax analysis is, fortunately, not a technique that has stagnated, and its methods have been revised not only by the original team but also by several scholars who understood that it must be critically adapted to individual case study. There have been numerous case studies that have applied this space syntax technique to archaeological evidence; usually in its more basic

¹ Research Director CNRS, General Director of the French Institute in the Middle East (MEAE - Liban / IFPO).

version to understand the use of space. Regardless of the quantity of previous case studies, each one provides an understanding of how space was used in a very particular context, such as in this thesis.

The residential area, located at the centre of the oasis of Tayma in North-West Arabia (NW Arabia), has been and is currently being studied from a range of different perspectives, including the classification and analysis of pottery,² object classification and the diachronic analysis of individual buildings.³ However, a systematic study of building plans has not yet been done. The focus has mainly been on understanding individual occupation levels (OLs⁴) in the residential area and not from a diachronic perspective. The state of preservation of thirteen buildings belonging to three continuous levels of occupation dated to the Nabataean, Roman and Late Antique Periods, turned out to be suitable for carrying out a space syntax analysis. Nevertheless, although this technique is applicable to the present case study, it must still be critically reviewed and adapted to maximise any attainable results.

2 RESEARCH QUESTION

Tayma is an oasis in NW Arabia between the Nafūd desert to the East and the Hijaz Mountains to the West, extending over an area of 9.23 km² and with an almost continuous occupation from the 3rd millennium BCE onward. A wide range of political, social and economic dynamics shaped the development of the oasis of Tayma between the Nabataean and the Late Antique Periods, which is the focus of the present study. One of the main hypotheses supporting this thesis is that an urban environment is charged with meaning,⁵ which is based on the assumption that the aforementioned dynamics made an impact on how space was understood at an everyday level at this crossroad on the Frankincense Road. This hypothesis, if accepted, leads to the question of how space was perceived and conceived, i.e. the organisation between public and private spaces; access to the buildings and to individual rooms; movement within buildings; and the interaction between various types of spaces. In short, the use of space.

² Francelin Tourtet, personal communication: PhD thesis in preparation by Francelin Tourtet at the Freie Universität Berlin: “Pottery at the oasis of Tayma (Kingdom of Saudi-Arabia): Chronological, typological and technological studies”.

³ Weigel in press; Kohl unpublished BA thesis.

⁴ Occupation level (OL), see Chapter II, Section 3.3.

⁵ Hillier and Hanson 2005.

In the **intrasite** spatial analysis, architectural evidence from the residential area at Tayma is at the centre of the analysis, focusing on three occupation levels, namely those of the Nabataean (OL E-South:4 and OL F:4), Roman (OL E-South:3 and OL F:3) and Late Antique (OL E-South:2 and OL F:2) Periods.

According to Hanson, a genotype is a “particular type of numerical consistency in spatial patterning”⁶, a set of abstract rules that defines a spatial configuration. The genotype then displays itself in phenotypes, that is in each single building. Results of this kind of analysis provide an understanding about the form (the formal property of space – that is the spatial configuration) and the function (the purpose of a building) of a building.⁷ The former can be obtained through a space syntax analysis, while the latter requires a discussion of the results within their contexts. The aim is to understand if a genotype can be attributed to each of the periods in the analysis, which is manifested through a variety of phenotypes.⁸

First, it is necessary to gain a basic understanding of the results obtained that can be from the space syntax analysis proposed in this case study. More precisely, how is the access to and movement through each building (phenotype)? Are there differences between individuals accessing the building from the outside – visitors – and those already moving inside – inhabitants?

Second, the results need to be understood within a wider setting, embedded in the context of the residential area as a whole. Assuming that there is a “value as a settlement space”⁹ in the already existing spatial configuration, the question that arises is: is there continuity in the spatial patterns brought to light? If the answer is positive – one set of rules defining the spatial configuration (genotype) that extends through all periods – this would mean that there is a “vertical construct”¹⁰ based on repetition of those rules and not variation. The residential area could be represented by one set, independently of the period. A negative answer – more than one set of rules (genotypes) could be observed – would mean that verticality does not exist and that each occupation is based on variation due to a comprehensive change of dynamics. Each period at the residential area could be represented by a changing set of rules defining the spatial configuration.

⁶ Hanson 1998, 32.

⁷ Foster 1989, 42.

⁸ Specific terminology used for space syntax technique (genotype, phenotype, spatial configuration, etc.) will be explained in more detail in Chapter III.

⁹ Bailey 1990, 42.

¹⁰ Bailey 1990, 24.

More concretely: are genotypes bound to each period in the residential area or are they cross-period phenomena? What impact did the Nabataean influence or the Roman annexation have on daily life at the oasis of Tayma? Can such influences be seen in the archaeological record on a domestic level, i.e. the architectural evidence?

It is hoped that this analysis will provide an understanding of the degree of influence that the political, social and/or economic dynamics had on the spatial configuration of the residential area, taking into consideration the mathematically captured use of space.

3 THESIS OUTLINE

Chapter II will start with an overview of the historical dynamics in NW Arabia for the Nabataean, Roman and Late Antique Periods. The second section will present the oasis of Tayma, including the history of research, the site-specific technicalities (temporal and spatial denominations used) and the embedment of the development of the oasis within the wider NW Arabian context, first in the earlier periods up until the Nabataean Period and then for the periods analysed in this research. The third section will present information about the residential area as the case study, including its location and chronostratigraphy.

Chapter III will present the methodological framework of this research. The first three sections will describe the methodology of spatial analysis, the space syntax technique and GIS as a tool with special attention given to the space syntax technique as it is the main analytical method in this thesis. The fourth section will define concepts that are significant for this case study and the fifth section will review the methodological framework and defines a workflow for the analysis of the residential area.

Chapter IV will provide a description and space syntax analysis for each of the buildings from the residential area (phenotypes) from the Nabataean, Roman and Late Antique Periods separately.

Chapter V will comprise of two sections, the first will present a synchronic analysis and the second a diachronic analysis of the residential area. The former will be based on the descriptions and space syntax analyses in Chapter IV and the latter compares these.

Chapter VI will discuss the results of the space syntax analyses to determine the genotypes that the buildings (phenotypes) comply with. In the first section the possibility of a cross-period genotype will be discussed, in the second section one genotype per period and the

CHAPTER I

third section will bring forward a new proposition.

Chapter VII will explore, in two sections, the results of the research by embedding those within the context of the oasis of Tayma and NW Arabia, including a comparison with other sites. The third section will address the limitation encountered during analysis. The last section will comprise concluding remarks that examine the political, social and economic dynamics that could have had an impact on the development of the residential area.

Chapter VIII will restate the main research questions and results before providing an evaluation of the limitations encountered during research and the significance of the results. The third and last section will suggest possible avenues for further research based on this study.

CHAPTER II

SPATIOTEMPORAL FRAMEWORK

The first section of this chapter presents an outline of the historical dynamics of NW Arabia, from the Nabataean Period to the Late Antique Period, which is the chronological focus of the present case study. The second section focuses on the oasis of Tayma: it starts with the research history of the site, followed by site-related specifics and finishes with an historical overview of Tayma in the NW Arabian context. The last section introduces the residential area as the case study of this research by locating it geographically and chronologically.

1 NW ARABIAN POLITICAL, SOCIAL AND ECONOMIC DYNAMICS FROM THE NABATEAN TO THE LATE ANTIQUE PERIOD

Archaeological research in NW Arabia is far from reaching its full potential. This part of the Arabian Peninsula has had a late start concerning systematic research, mainly because of unfavourable circumstances, such as climate.¹¹ Fortunately, today the investigations have multiplied and are based on diverse international collaborations. It is in this context that more light is being shed on a former largely unknown area.

For the present case study, the overall historical dynamics between the Nabataean and Late Antique Periods will be delineated for NW Arabia to serve an embedment for the later presentation of the oasis of Tayma, located in that region.

The origin of the Nabataeans is still uncertain, they were probably nomads with tribal roots,¹² however they became sedentary between the 4th and the 1st century BCE.¹³ The Nabatean Kingdom reached its fullest extension in the 1st century CE (Figure 1), covering an area from south Syria until the south part of NW Arabia, the Sinai and part of Negev¹⁴ with

¹¹ For a detailed account of the research history of the Arabian Peninsula see Eichmann 2011.

¹² Wenning 2007, 25. For a detailed account of the Nabataean history and sources see Hackl, Jenni, and Schneider 2003 and Politis 2007.

¹³ Macdonald 1991, 115.

¹⁴ Macdonald et al. 2015, 28.

CHAPTER II

borders that varied strongly.¹⁵ The most southern city was Hegra (modern Mada'in Saleh), while Dadan, about 20 km further south, was already outside of the domain of Nabataean influence and instead under the authority of the Lihyanite Dynasty.¹⁶ To the east evidence of the Nabataean Kingdom is attested as far as Duma (modern Dumat al-Jandal).¹⁷ They developed a strong presence in the trade of incense between Arabia and the Mediterranean.¹⁸ There were three major cities, Petra, Bosra and Hegra: Petra and Bosra as political, economic and cultural centres;¹⁹ Hegra as a trade centre and frontier post;²⁰ The capital of the kingdom was Petra, later moved by the last Nabataean king Rabbel II (70/1-106 CE) to Bosra²¹ because of the political and economic decline of Petra in the 1st century CE.²² This decline had been caused by the collapse of the Nabataean trading network,²³ which was caused by the shift of the land trade routes between South Arabia and Egypt to the Red Sea.²⁴

The Nabatean Kingdom had already passed their peak of force and Roman military forces under Syrian legate Cornelius Palma²⁵ seemed not to have encountered resistance when entering the Arabian Peninsula.²⁶ Unfortunately, sources are scarce for this period. Nevertheless, trade traffic with the Romans was already known from the period before,²⁷ leading to the presumption that a shift of power occurred in NW Arabia. The evidence of destruction in the 2nd century CE that can be found in some archaeological contexts have not been proved to be directly due to the Roman incursion and could have been a natural reaction of the population to new rulers.²⁸ Whether the reason for annexation was politically strategic or economic is still unclear.²⁹

¹⁵ Macdonald 1991, 106.

¹⁶ Nehmé 2011b, 137.

¹⁷ Loreto 2012, 166.

¹⁸ Wenning 2007, 26.

¹⁹ Fiema et al. 2015, 373.

²⁰ Nehmé 2011b, 137.

²¹ Macdonald et al. 2015, 30–32.

²² Fiema et al. 2015, 375.

²³ Fiema et al. 2015, 375.

²⁴ Bowersock 1983, 64–65.

²⁵ Fiema et al. 2015, 375.

²⁶ There are some sources that are ambiguous about this statement, see Retsö 2003, 625; Hackl, Jenni, and Schneider 2003, 52.

²⁷ Hackl, Jenni, and Schneider 2003, 52–53.

²⁸ Such as in Hegra – Mada'in Saleh, Area 9 (Nehmé 2015, 130). See also Fiema et al. 2015, 375.

²⁹ Fiema et al. 2015, 375.



Figure 1: The Nabataean Kingdom – Tayma circled (based on Fiema et al. 2015, fig. 7.1. (Map drawn by Aron Styba))

The Roman Empire annexed the Nabataean Kingdom in 106 CE³⁰ and the *Provincia Arabia* was established by Emperor Trajan.³¹ According to Ptolemy the *Provincia* was divided into three parts: *Arabia Petraea*, *Arabia Deserta* and *Arabia Felix*.³² The provincial governors' headquarters³³ was maybe established in Bosra.³⁴ The exact borders of the *Provincia Arabia* are still unclear,³⁵ Hegra being the southernmost known city.³⁶ It is in Hegra and Duma that

³⁰ Bowersock 1971, 231; Hoyland 2001, 73; Retsö 2003, 625; Macdonald 2009, 297; Wynbrandt 2010, 14; Tourtet and Weigel 2015, 388; Wenning 2007, 25; Macdonald et al. 2015, 28.

³¹ Macdonald et al. 2015, 72.

³² Macdonald 2009, 298.

³³ Fiema et al. 2015, 377.

³⁴ Macdonald et al. 2015, 30–32.

³⁵ Macdonald 2009, 300 ff.

³⁶ Macdonald et al. 2015, 30; Nehmé 2009, 40.

CHAPTER II

garrisons were stationed for better control of the area.³⁷ Strong building activities are attested for Petra at that time, while other sites do not show such activities in their archaeological evidence.³⁸

The first coinage read *adquisita* and not *capta*, suggesting a peaceful annexation; although some indirect literature suggest confrontations,³⁹ as mentioned above. The Nabataeans seem to have integrated themselves into the new form of governance by changing the meaning of their own nomenclature.⁴⁰

At first, in the 1st and 2nd centuries CE there was no change in the NW Arabian trade network.⁴¹ From the 3rd century CE onwards the trade routes shifted constantly; the new connections being the Persian Gulf – Mesopotamia – Armenia – North Syria and South Arabia – Ethiopia – Red Sea.⁴² This led to a disintegration of Arabia north of Hegra as part of the trade network, favouring the maritime to the land routes from South Arabia towards Egypt and the Mediterranean.⁴³

NW Arabia was abandoned by the Romans at the end of the 3rd century CE onwards,⁴⁴ giving space to the formation of local governments.⁴⁵ The causes of this decline have been explained with the crisis of the economic power of Rome and the conflicts with Persia.⁴⁶ The *Provincia Arabia* is reorganised under the reign of Diocletian in the 4th century CE.⁴⁷ Petra is now capital of *Palaestina Salutaris*, later *Tertia*, which integrates south Jordan, Negev and maybe the Sinai (Figure 2).⁴⁸

³⁷ Nehmé 2009, 38.

³⁸ Such as in Hegra – Mada'in Saleh, Area 9 (Fiema et al. 2015, 380).

³⁹ Fiema et al. 2015, 375–76; Hackl, Jenni, and Schneider 2003, 52.

⁴⁰ MacDonald wrote an interesting article about this subject; in particular: “As this happened, the concept of Nbtw would have changed from one of tribal identity, to being a subject of the Nabataean king, and, after the annexation, to having one's origins in a particular geographical and cultural area (Macdonald 1991, 106)”.

⁴¹ Fiema et al. 2015, 383.

⁴² Fiema et al. 2015, 383–84.

⁴³ Potts 1988, 135.

⁴⁴ Macdonald et al. 2015, 32.

⁴⁵ Macdonald et al. 2015, 33.

⁴⁶ Schiettecatte 2013, 12.

⁴⁷ Fiema et al. 2015, 385.

⁴⁸ Fiema et al. 2015, 385.



Figure 2: Provincia Arabia – Tayma circled (based on Fiema et al. 2015, fig. 7.2. (Map drawn by Aron Styba))

The idea that a decline occurred during the Late Antique Period is somewhat controversial, Schiettecatte wrote an interesting article discussing the various factors that had an impact on this so-called decline.⁴⁹ He argues that what seems to be a decline, such as the end of the monetarised economy and reduction of epigraphic sources, are more of a sign of transformation.⁵⁰ The 4th and 5th centuries CE are further characterised by an aridification of the climate, depopulation and disintegration of the urban system connecting NW Arabian oases.

51

⁴⁹ Schiettecatte 2013.

⁵⁰ Schiettecatte 2013, 9–10.

⁵¹ Schiettecatte 2013, 11–13.

At the end of the 4th century CE the Arab tribes slowly take over control of the areas south and east of Aila (Aqaba).⁵² After 400 CE there is no permanent Roman military presence south of Aila, including those formerly stationed in Hegra and Duma,⁵³ losing at the same time the administrative power in the region. Local governments rise at that point,⁵⁴ although it is not clear if and what kind of connection they continued to have with the Romans.⁵⁵ This is also the time when the Himyaritic kings get involved in the *Arabia Deserta*, annexing in 445 CE parts of central and western Arabia.⁵⁶

2 THE OASIS OF TAYMA

Tayma (coordinates: 27°37'37.20"N 38°32'58.21"E) – Province of Tabuk/Kingdom of Saudi Arabia⁵⁷ – is a NW Arabian oasis situated between the Nafūd desert to the East and the Hijaz Mountains to the West (Figure 3).⁵⁸ The site extends over an area of 9.23 km² and has had an almost continuous occupation and still is today.⁵⁹

The oasis of Tayma is located in a hyper-arid region.⁶⁰ To the north of the site is a former seasonal lake (*sebkha*) of about 19 km² that after starting to dry out between 8000 BP and 4000 BP, became silty marshes (Figure 4).⁶¹

⁵² Fiema et al. 2015, 385–86.

⁵³ Fiema et al. 2015, 386; Nehmé 2009, 39.

⁵⁴ Fiema et al. 2015, 387.

⁵⁵ Nehmé 2009, 39.

⁵⁶ Fiema et al. 2015, 388.

⁵⁷ For a general description of the oasis of Tayma see Hausleiter 2011. The most updated description can be found in Hausleiter and Eichmann 2018.

⁵⁸ Hausleiter 2011, 103.

⁵⁹ Hausleiter and Eichmann 2018, 8.

⁶⁰ Dinies et al. 2016, 59.

⁶¹ Engel et al. 2012, 140. For a detailed study about the *sebkha* see Engel et al. 2012; Dinies et al. 2016.

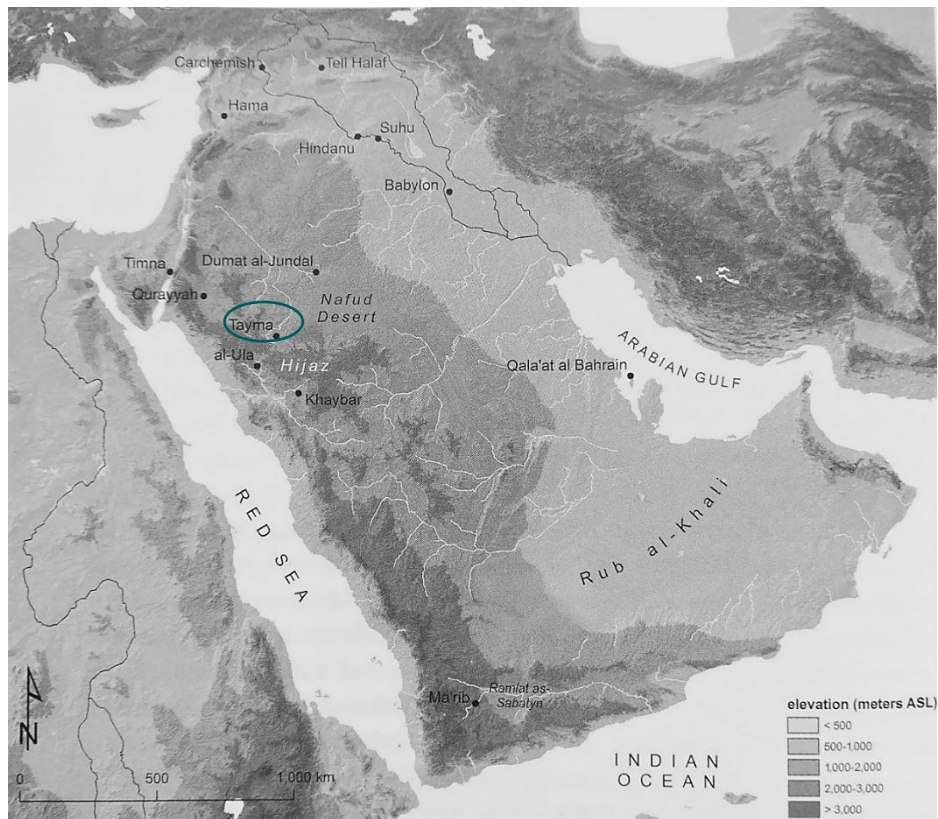


Figure 3: The Arabian Peninsula – Tayma circled (based on Magee 2014, fig. 9.1.)



Figure 4: The oasis of Tayma with the *sebkha* to the N of the site (©Google Earth. Imagery date: 8 May 2013 and 16 September 2016. Accessed 7 May 2018).

2.1 History of research at the oasis of Tayma

Explorations at the oasis of Tayma reach as far back as the mid-1840s:⁶² Wallin made the first description of Tayma in 1848; Guarmani passed through the site in 1864;⁶³ Doughty made a more detailed account and sketch in 1977;⁶⁴ Huber passed in 1880;⁶⁵ Huber and Euting discovered in 1883 the famous Tayma stone;⁶⁶ Jaussen and Savignac passed 1909 when making a survey in NW Arabia;⁶⁷ also in 1909, Carruthers passed through Tayma; the first archaeological investigations were carried out by Philby in 1951;⁶⁸ Winnett and Reed were in Tayma in 1962 when surveying NW Arabian epigraphy;⁶⁹ in the 1970s the Department of Antiquities made a survey including Tayma; the first archaeological excavation was carried out by Bawden, Edens and Miller in 1979.

The present archaeological investigations are being carried out by the Joint Saudi Arabian-German Archaeological Project since 2004 by the Orient Department of the German Archaeological Institute and the Saudi Commission for Tourism and National Heritage (SCTH).⁷⁰ Responsible for the German part are Dr Ricardo Eichmann as project director and Dr Arnulf Hausleiter as excavation director, and for the Saudi Arabian part Mohammed al-Najem, director of the Antiquities Office Tayma. The *Deutsche Forschungsgemeinschaft* (DFG) in Bonn is the main funder of the project.

The long history of research led to a large amount of evidence from the oasis of Tayma. Besides the archaeological evidence, many more sources were collected, such as archaeozoological evidence⁷¹ and epigraphic evidence.⁷² Furthermore, Tayma is mentioned in the Bible (Isa.21:14, Jer.25:23, Job.6:19, Gen.25:13-15, Cro.1:29-30, Gen.25:3), by Arabian

⁶² Based on Bawden, Edens, and Miller 1980, 73–74. For a detailed account of the exploration in NW Arabia see also Eichmann 2011.

⁶³ Guarmani 1938.

⁶⁴ Doughty 1936.

⁶⁵ Huber 1891.

⁶⁶ Euting 1896. Today the Tayma stone is in the Louvre Museum (accession number AO 1505).

⁶⁷ Jaussen and Savignac 1997.

⁶⁸ Philby 1957.

⁶⁹ Winnett and Reed 1970.

⁷⁰ Formerly known as the Saudi Commission for Tourism and Antiquities (SCTA).

⁷¹ Two papers about the archaeozoological evidence are in preparation by Anja Prust: *Taymā' and the Sea – Marine Goods in an Arabian Oasis Settlement* (Proceedings of the International Conference “Red Sea VIII: Coveted Treasure”, Warsaw, 4-7 July 2017); *Camel exploitation in the oasis of Taymā' – Caravan or consumption?* (Proceedings of the International colloquium „Les vaisseaux du désert“, Lyon, 15./16. September 2016).

⁷² For a detailed account of general and specific epigraphic research see bibliography by Michael MacDonald.

historians and geographers, such as al-Hamdani, Abu ‘Ubayd al-Bakri, al-Muqaddasi, al-Ya’qubi and Yaqut al-Rumi and by classical authors, such as Pliny the Elder, Ptolemy, Zenon, Diodorus of Sicily and Strabo;⁷³ besides the already mentioned explorers in Section 2.1 of this chapter.

2.2 Tayma: site-specific technicalities

The following part describes terms used to classify spatial and chronological data at the site of Tayma. The outer city wall comprises an area of about 9.23 km². The internal division of this wall is composed of seven compounds (A, A1, B, C, D, E, W), which extend over an area of about 2 km².⁷⁴ All compounds, except for Compound W, are located within the archaeological area of *Qrayyah* (Figure 5), which extends over an area of about 0.74 km².⁷⁵ A modern fence surrounds the area to protect the site (Figure 6).⁷⁶

⁷³ Eichmann 2009, 59; Hausleiter 2011, 103.

⁷⁴ Bawden, Edens, and Miller 1980, 75–76.

⁷⁵ Sometimes called Qrayyan or Qraya.

⁷⁶ Eichmann et al. 2012, 72.

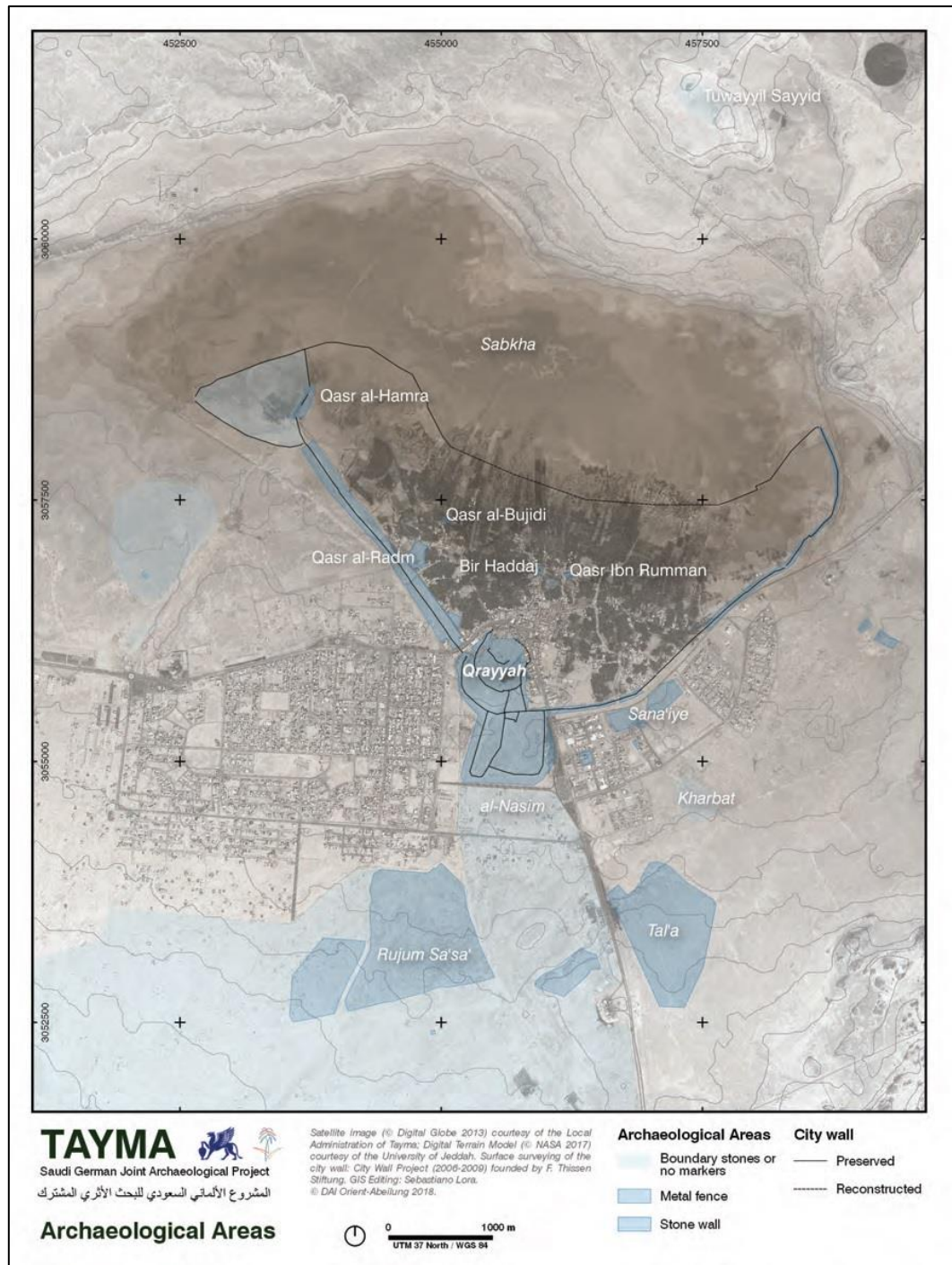


Figure 5: The oasis of Tayma, *Qrayyah* located at the centre (Hausleiter and Eichmann 2018, fig. 7 (graphics: S. Lora, DAI, Orient-Abteilung))

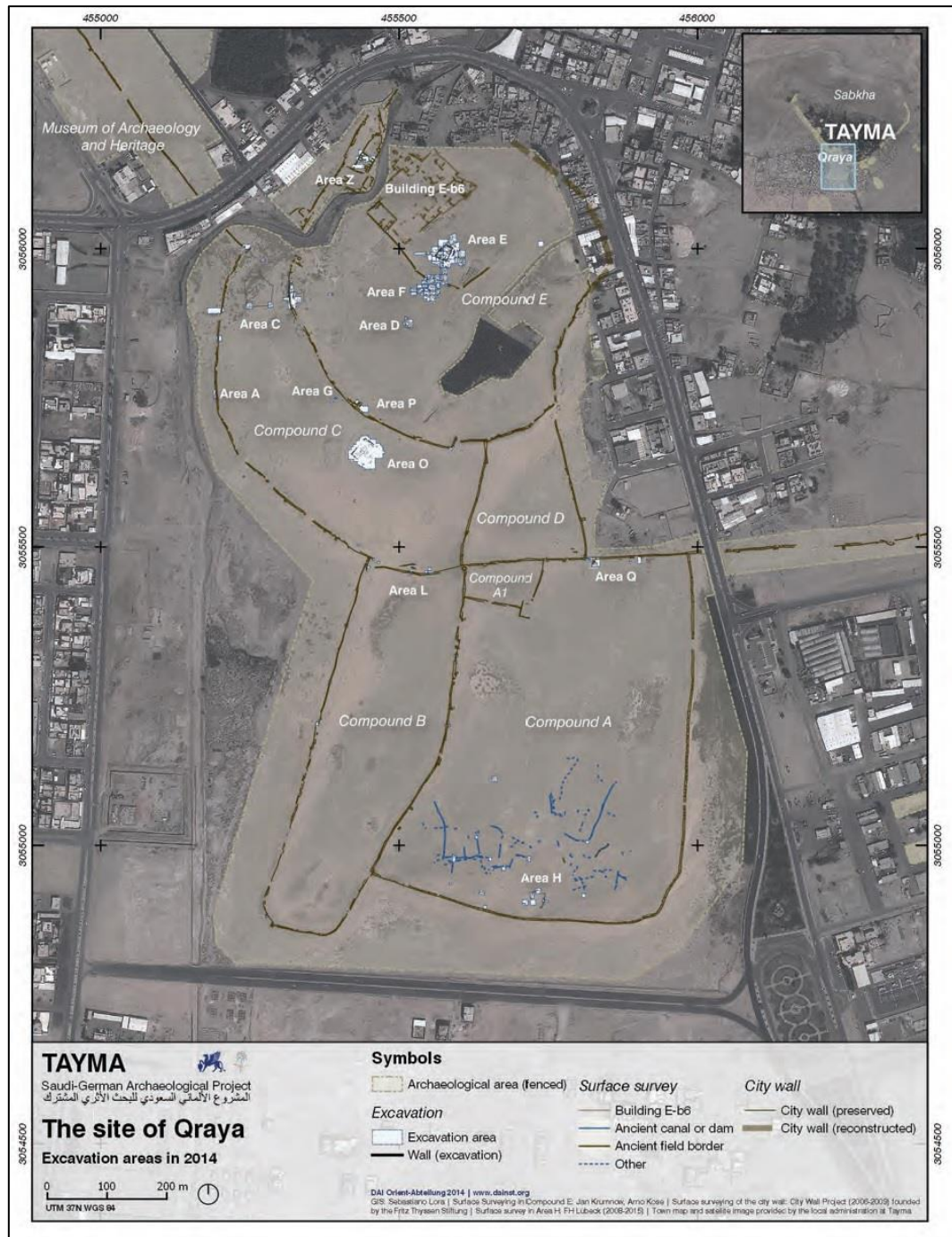


Figure 6: *Qrayyah* with compounds and excavation areas (Hausleiter and Eichmann 2018, fig. 8 (DAI, Orient-Abteilung, S. Lora))

The long-term interdisciplinary research at the oasis of Tayma produced a vast amount of information pertaining, among others, to archaeological, archaeozoological, palynological, hydrological, mineralogical fields. This resulted in the definition of twelve occupations named **Tayma Occupation Periods** or **Occupation Periods** (OPs):⁷⁷ from the Late Neolithic up until today. The Occupation Periods (OPs) are overall chronological divisions applied to the entire settlement (Table 1)⁷⁸; those are, from the latest to earliest: OP 1 – Contemporary; OP 2 – Islamic Period; OP 3a – Late Antiquity; OP 3b – Roman/Late Roman Period; OP 4 – Nabataean Period; OP 5 – Lihyanite Period; OP 6 – Mid- to Late Iron Age; OP 7 – Early Iron Age; OP 8 – Late Bronze Age; OP 9 – Middle Bronze Age; OP 10 – Early Bronze Age; OP 11 – Chalcolithic; OP 12 – Late Neolithic.

Single **excavation areas** follow the overall chronological division of the site (OPs) and are further subdivided into **occupation levels** (OLs), considering the data produced through research at that location.⁷⁹ They are attributed first independently from other areas and then put into concordance (Table 2). They are numbered from the latest occupation (“1”) until the first (n), according to the following scheme: “OL” area:n, as in OL F:3.

Building stages (BS) are a further subdivision specific to each excavation area and corresponding to the single building activities that have been identified within each OL. They are micro-levels of occupation and are named after the latest building activity (“a”) until the first stage of a new occupation level (n), according to the following scheme: “OL” area:OLn, as in OL F:2b.

Each building and its internal stages have a different label, according to the following scheme: area-“b”no. of building, as in F-b2. The same applies to the streets and alleys, according to the following scheme: area-“s”no. of street as in F-s1.

⁷⁷ According to the latest publication: Hausleiter and Eichmann 2018.

⁷⁸ Hausleiter and Eichmann 2018, Table 1.

⁷⁹ Eichmann et al. 2011, 65.

CHAPTER II

Table 1: Chronostratigraphy: Occupation periods (OPs) in Tayma (Hausleiter and Eichmann 2018, Table 1)

Taymā' Occupation Period	Chronology and archaeological / historical periods	Humans and environment	Archaeological correlates in the walled oasis	Extramural remains / Cemeteries
Taymā' 1	Contemporary (from 19 th cent. CE)		Modern occupation	
Taymā' 2	Islamic Period (7 th –18 th century CE)	The oasis as a flourishing settlement (Early Islamic period)	Shift of settlement towards the oasis; construction of public buildings NW of the former center of the settlement	
Taymā' 3a	Late Antiquity (4 th –6 th century BCE)	Intensive exploitation of dromedary	Internal reorganisation of settlement, including the residential area; large public building north of former temple E-b1; destruction of statues and inscriptions of the dynasty of Lihyān	
Taymā' 3b	Roman / Late Roman (2 nd to 4 th century BCE)			
Taymā' 4	Nabataean (2 nd century BCE–early 2 nd century CE)	Increase of dromedary in the diet	Partial reconstruction of temple E-b1 and construction of water-related installations; Nabataean royal inscriptions Affinities with contemporary pottery in the Southern Levant	Built stone cists with single burials
Taymā' 5	Period of the dynasty of Lihyān (5 th century to 2 nd century BCE)	Abandonment of the irrigation system in the southern part of settlement, probably because of changing groundwater table	Reduction of size of the central part of settlement (by 2/3); transformation of large areas into burial grounds; inscription of a Lihyānite governor of Taymā'; monumental sculpture; construction of a temple in the central part of settlement (E-b1) at a site with a long building tradition; residential quarter south of it (Area E-South/F)	New tradition of graves cut into the bedrock within the former area of the walled settlement (5 th to 3 rd century BCE), partly reusing tomb stones with the representation of human faces and Aramaic inscription
Taymā' 6	Mid to Late Iron Age (9 th to 5 th century BCE)		552–542 BCE: Babylonian king Nabonidus at Taymā' and other NW Arabian oases; stele and cuneiform inscriptions; no corresponding remains of public buildings Sana'iye Painted Ware (SPW) and pottery with Syro-Mesopotamian and Levantine affinities Contacts between Assyria and Arabia	Built rectangular tombs with collective burials (9 th to 5 th century BCE) with SPW; single child graves were attached to these chambers; inhumation burials next to the outer wall
Taymā' 7	Early Iron Age (12 th to 9 th century BCE)	Beginning of exploitation of domesticated dromedary Irrigation system in the southern part of settlement	Public building O-b1 (probably a temple) with Taymā' Early Iron Age Ware (TEIAW) and Egyptian and Syro-Levantine artefacts (Area O); repair of outer wall and attachment of buildings to it (Area A)	Circular tombs probably still in use; little evidence of pottery (TEIAW)
Taymā' 8	Late Bronze Age (Mid to late 2 nd millennium BCE)	Oasis agriculture with date palms (end of 2 nd millennium BCE)	Continuous occupation in the central part of settlement evidenced by Qurayyah Painted Ware (QPW)	Circular tombs probably still in use; little evidence of pottery (QPW)
Taymā' 9	Middle Bronze Age (Early 2 nd millennium BCE)		Continuous occupation in the central part of settlement evidenced by Red Burnished Ware (RBW); no unequivocal architectural remains	Circular tombs with single inhumation burials; ceremonial bronze weapons of Syro-Levantine type; ceramics outside the graves (RBW)
Taymā' 10	Early Bronze Age (3 rd millennium BCE)		Remains of permanent occupation in the central part of settlement; public building set onto the bedrock (E-b5); monumental wall enclosing the oasis and other large areas resulting in the almost largest extension of the oasis in pre-modern times; pottery: Reddish Coarse Ware (RCW) (late 4 th /early 3 rd millennium BCE) and Gritty Ware (GW) (mid-to-late 3 rd millennium BCE)	Cairns south of the oasis
Taymā' 11a	Late 5 th to 4 th millennium BCE (Chalcolithic)		Architectural traces in the centre of the settlement (pre-early 3 rd millennium BCE) and beneath the outer wall (pre-late 4 th /early 3 rd millennium BCE); probable beginning of pottery production: Reddish Coarse Ware (RCW)	Large stone structures on basaltic rock outcrops in the surroundings of the oasis (25–40 km distance)
Taymā' 11b			Waste deposit of flint drills and production refuse of disc shaped Carnelian beads (c. 4,000 BCE); wall in the eastern part of sabkha; wall and probable remains of agricultural irrigation	
Taymā' 11c		Beginning of oasis cultivation (c. 4,600 BCE) with grapevine and figs (?)		
Taymā' 12	Late Neolithic		Surface findings of lithic tools (late 7 th /early 6 th millennium BCE)	

CHAPTER II

Table 2: Chronostratigraphy: Occupation periods (Ops) and occupation levels (OLs) in Tayma (Francelin Tourtet 2017, modified by Anja Prust 2018; personal communication)

Tayma Occupation Period	A	C	D	E	E-East	E-South	F	H	Canals (Compound A)	O	Q3	W9	W41	Z
Tayma 1				E:1	E-East:1a E-East:1b					O:0				Z:1
Tayma 2				E:2			F:1							Z:2a Z:2b Z:2c
Tayma 3a				↓		E-South:2	F:2a F:2b			O:1?				Z:3a
Tayma 3b		C4:2 (SU 2138)	D:x	E-b1:3a E-b1:3b	E-East:2a	E-South:3	F:3			↓				
Tayma 4				E-b1:3c E-b1:3d	E-East:2b E-East:2c E-East:3a E-East:3b	E-South:4	F:4	↓		↓	Q3:1			(Z:3b?) (Z:4?)
Tayma 5				E-b1:3e	E-East:4a		F:5a (?)			O:2	Q3:2			
Tayma 6				E:4	↓			H-b2			Q3:3 Q3:4			
Tayma 7	A:1a A:1b A:1c A:2a A:2b1 A:2b2 A:2c A:3a A:3b A:4a A:4b			↓	↓		F:5b (?)	H-b1:1 H-b1:2 H-b1:3	Canals 1	O:3(a) O:3(b)	Q3:5 Q3:6			
Tayma 8				↓	↓				Canals 2?		Q3:7a		W41:1	
Tayma 9				E:5a E:5b	E-East:4b E-East:4c						Q3:7b Q3:7c		W41:2	
Tayma 10				E:5c E:5d	E-East:5a E-East:5b									
Tayma 11				E:6							Q3:8	W9 (SU 5908)		
Tayma 12														

2.3 The oasis of Tayma in the NW Arabian context

2.3.1 The oasis of Tayma until the Nabataean Period (OP 12 – OP 5)

The earliest archaeological evidence at the oasis of Tayma is a lithic production from the Late Neolithic (OP 12; for OP indications see Table 2).⁸⁰ The first indication for an oasis culture dates to the late 5th to 4th millennium BCE (OP 11c), nevertheless not necessarily the proof for a permanent sedentary life form.⁸¹ This is evidenced by palynological analysis of grape and fig that attested a date of 6000 calBP.⁸² Evidence of disc-shaped carnelian beads and associated drill tools found on the eastern side of the *sebkha* indicate a production site dated to the 4th millennium BC (OP 11b).⁸³

The city wall, enclosing and subdividing the site, is dated, according to the latest investigation⁸⁴, to the beginning of the 3rd millennium BCE (OP 10).⁸⁵ About 18.20 km of the wall are preserved, reaching up to 8 m in height. The building techniques and construction materials (stone or mudbrick) used are different for various wall units.⁸⁶ It is attested that there has been a continuous occupation of the oasis from the 3rd/2nd millennium BCE up until today.⁸⁷ Nevertheless, there are some older evidence: pottery – Reddish Coarse Ware (RCW) – from the Late 4th millennium/early 3rd millennium and a C14-date indicating a date of 3323-2928 calBC) underneath the outer wall (OP 11a).⁸⁸

At the centre of the oasis of Tayma evidence has been found, indicating a form of settlement from the late 3rd millennium/2nd millennium on (OP 9).⁸⁹ Notable of the Early 2nd millennium BCE are burials outside the wall (al-Nasim site), containing ceremonial bronze

⁸⁰ For a detailed description see Purschwitz 2017; see also Hausleiter and Eichmann 2018, 20.

⁸¹ Hausleiter and Eichmann 2018, 20.

⁸² Dinies et al. 2016, 69, 70–71, 72–73.

⁸³ Purschwitz 2017.

⁸⁴ Hausleiter 2018, 362.

⁸⁵ A sample of Area W9 resulted in 3323–2928 calBC: “TA 17356, SU 5908: Charcoal (*ficus carica* identified by R. Neef, Scientific Division at the Head Office of the DAI, Berlin; analyzed by the Center for Applied Isotope Studies, University of Georgia, Athens, GA; sample no. UGAMS 24656; Radiocarbon date: 4430±25; 2σ range, probability 95.4%; calibrated with OxCal v4.2.4. (Hausleiter 2018, 384, footnote 24)”.

⁸⁶ Hausleiter 2018, 362.

⁸⁷ Hausleiter 2011, 103, 109; Tourtet and Weigel 2015, 385.

⁸⁸ Hausleiter 2018, 383–84; Hausleiter and Eichmann 2018, 25.

⁸⁹ Hausleiter and Zur 2016, 137, footnote 20; Hausleiter and Eichmann 2018, 25. For a detailed study see Lora 2017.

weapons connected to the Syro-Levant.⁹⁰ Dispersed evidence of the Mid to Late 2nd millennium BCE (OP 8) do not give an exact notion of the site, nevertheless they indicate contacts with Egypt⁹¹ and that there was a continuous form of settlement, evidenced by the presence of Qurayyah Painted Ware at the outer city wall and the central part of the site of Tayma.⁹²

Tayma is from the 1st millennium BCE onward⁹³, particularly in the Early Iron Age (12th to 9th centuries BCE – OP 7)⁹⁴, an area of cultural contact, along the commercial routes of incense between South Arabia, the East Mediterranean, Syro-Mesopotamia, Egypt⁹⁵ and the Levant⁹⁶ (Figure 7). An architectural complex with a large building – Building O-b1 – is located further south of the central part of the site, in Compound C, and dates to the Early Iron Age.⁹⁷ There are also indications of commerce between Arabia and Assyria, despite a strongly hostile component accompanying their relationship.⁹⁸ South Arabia plays hereby an important role not only for being the origin of frankincense and myrrh but also for the arriving spices from South Asia and the Far East.⁹⁹ In this context, the oasis of Tayma was one of the important providers of water along the trade routes.¹⁰⁰

The Mid-to-Late Iron Age (9th to 6th century BCE – OP 6)¹⁰¹ is defined by the Babylonian occupation, when king Nabonidus conquered and stayed ten years in Tayma (552-542 BCE).¹⁰² The reason Nabonidus took an interest in the oasis of Tayma is still a point of discussion. Some scholars say that he had a religious reason, while others propose economic or political reasons.¹⁰³

⁹⁰ For a detailed description see Hausleiter and Zur 2016; see also Hausleiter and Eichmann 2018, 23–27.

⁹¹ For a detailed description see Sperveslage 2013; see also Hausleiter and Eichmann 2018, 27–28.

⁹² For a detailed study of Qurayyah Painted Ware (QPW) see Intilia 2016.

⁹³ Hausleiter 2011, 103.

⁹⁴ Hausleiter and Eichmann 2018.

⁹⁵ Hausleiter 2011, 103; Sperveslage 2013.

⁹⁶ Macdonald 1997; Hausleiter and Zur 2016.

⁹⁷ Hausleiter and Zur 2016, 138–39. For a detailed study see contributions entitled “Area O” by Andrea Intilia in the Tayma report in the ATLAL - The Journal of Saudi Arabian Archaeology.

⁹⁸ Hausleiter 2012, 820–23.

⁹⁹ Macdonald et al. 2015, 16.

¹⁰⁰ Hackl, Jenni, and Schneider 2003, 7–8.

¹⁰¹ Hausleiter and Eichmann 2018.

¹⁰² Schaudig 2001; Macdonald et al. 2015, 16–17; Dougherty 1980, Chapter X; the most detailed information can be read in Beaulieu 1989, 149ff.

¹⁰³ Hoyland 2001, 62; Groom 1981, 198; Dougherty 1980, 138–60.

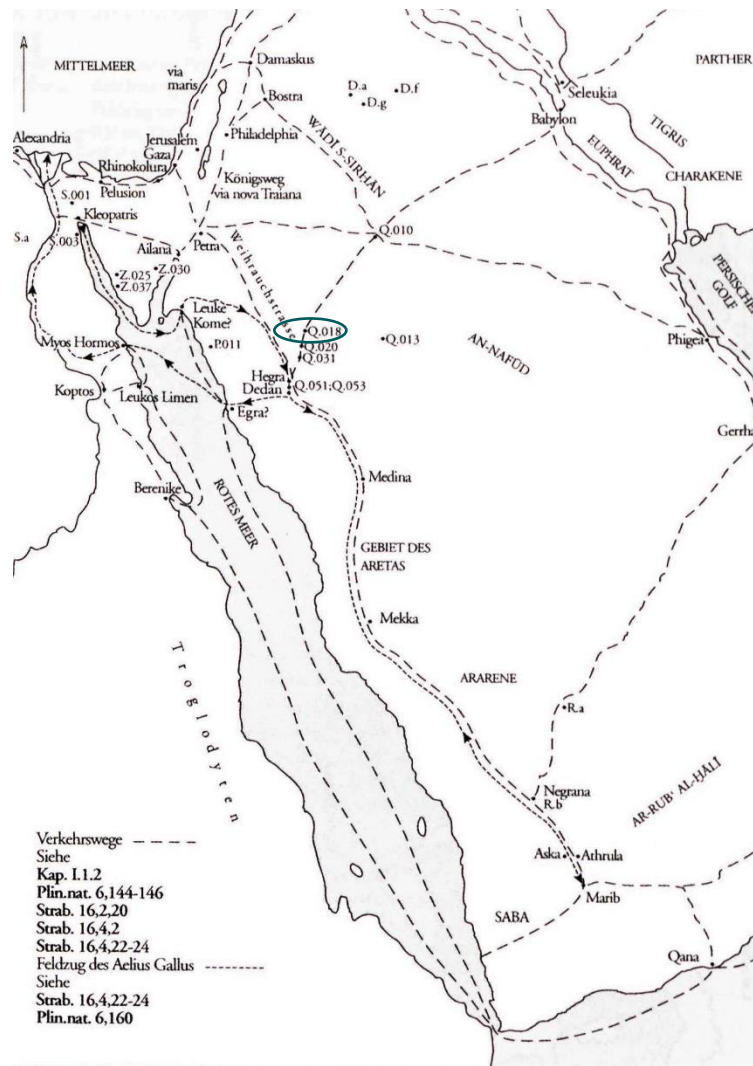


Figure 7: Arabian trade network (Hackl, Jenni, and Schneider 2003, Karte 2.)

The 5th century BCE to 3rd century BCE (OP 5)¹⁰⁴ is when the Lihyanite Dynasty¹⁰⁵ puts Tayma under their influence from their capital Dadan¹⁰⁶; at which point Hegra might also have been under the Lihyanite domain.¹⁰⁷ The conflicts between the two oases are attested in inscriptions¹⁰⁸ and influence through the presence of statues and Aramaic inscriptions.¹⁰⁹ The domination ended with the decline of the Kingdom of Lihyan, when the Nabataeans expanded

¹⁰⁴ Hausleiter and Eichmann 2018.

¹⁰⁵ Hausleiter 2011, 109–18. For a more detailed study about the Kingdom of Lihyan see Rohmer and Charloux 2015. Rohmer proposes a new dating for the Lihyanite dominance, presented at the ICAANE 2016: “A Revised Chronological Framework for Northwest Arabia in the Late 1st Millennium BC. New Evidence from Excavations in the al-Ula Area”.

¹⁰⁶ Macdonald 1997, 336; Hausleiter 2011, 116.

¹⁰⁷ Rohmer and Charloux 2015, 309.

¹⁰⁸ Macdonald 1997, 336; Hausleiter 2011, 116; Macdonald et al. 2015, 18.

¹⁰⁹ Eichmann et al. 2012, 82.

their border further south¹¹⁰ and established themselves in Hegra in the 1st century BCE.¹¹¹ The outer walls cease to be used during that time, while inner walls were constructed to contain the settlement at a reduced size.¹¹² A temple – Building E-b1 – of 500 m² was built in the central part of the site most likely during the 4th or 3rd century BC and was used, with various alterations, until the Late Roman Period.¹¹³ South of the temple, evidence of a residential area, including a multi-storey building – Building E-b9 – has been uncovered.¹¹⁴ The residential area was then in use until its abandonment after the Late Antique Period. The above-mentioned Building O-b1 had in the meantime been destroyed by a fire and a Hellenistic burial ground built above.¹¹⁵

2.3.2 The oasis of Tayma between the Nabataean and Late Antique Periods (OP 4 – OP 3a)

Nabataean influence on Tayma can be seen in the archaeological record between the 2nd century BCE and the early 2nd century CE (OP 4).¹¹⁶ When integrated into the Nabataean Kingdom, Tayma showed no signs of violence.¹¹⁷ The date of this incorporation remains unclear, but it is assumed to be around the 1st century BCE, the latest at the turn of the era. The evidence of an inscription that mentions King Aretas IV¹¹⁸ might indicate a connection with Hegra, the Nabataean southern centre for that period.¹¹⁹ Under the Nabataean influence, Tayma seemed to have maintained a regional status with a certain independency¹²⁰ and a possible presence in the Nabataean trade activities.¹²¹ The analysis of pottery finds in the residential area revealed parallels to the north, Petra, and to the south, Hegra.¹²²

¹¹⁰ Hoyland 2001, 68.

¹¹¹ Macdonald et al. 2015, 20; Nehmé 2011b.

¹¹² Hausleiter 2011, 118.

¹¹³ For a complete study of Building E-b1 see Lora 2017..

¹¹⁴ Hausleiter and Eichmann 2018, 34. For a detailed study of Building E-b9 see Weigel 2019. The subsequent occupations of this residential area, between the Nabataean and Late Antique Periods, are in analysis in the present research.

¹¹⁵ A PhD thesis analyses the burial ground in detail: Petiti 2013.

¹¹⁶ Hausleiter and Eichmann 2018, 36.

¹¹⁷ Tourtet and Weigel 2015, 388.

¹¹⁸ Tourtet and Weigel 2015, 388.

¹¹⁹ Hausleiter 2011, 118; Nehmé 2011b.

¹²⁰ Hackl, Jenni, and Schneider 2003, 307.

¹²¹ Nehmé 2011b, 139.

¹²² Tourtet and Weigel 2015, 399–400.

CHAPTER II

Tayma was integrated during the Roman Period (OP 3b) into the *Provincia Arabia* in 106 CE, showing also here no sign of resistance.¹²³ Strong building activities, that are usual after annexation, have not been proven in Tayma.¹²⁴ The presence of copper, tin and lead in the central part indicates that Tayma had to be connected through a long-distance trade, since neither were acquired locally.¹²⁵ Pottery from the residential area at the centre of the site revealed ties to the Levant, as have also the architectural traits.¹²⁶ The building furthest north of the residential area (Building E-b9) has its northern part razed to build an enclosure for Building E-b1.¹²⁷

During the Late Roman Period (OP 3b), 3rd/4th century CE, an 18000 m² large complex – Building E-b6 (Figure 8) – was built to the northwest of the residential area under analysis in this research.¹²⁸ The later built enclosure of this complex reaches the residential area from the northwest, interrupts where the buildings were standing, and continues to the other side in the direction southeast.

After the Romans abandoned NW Arabia, the oasis of Tayma was ruled by Jewish families according to Islamic sources.¹²⁹ A Nabataean inscription dated to 203 AD containing Jewish names except for one might indicate such a presence in Tayma but does not confirm this statement with certainty.¹³⁰ The residential area is abandoned at the centre of the site during the Islamic Period (OP 2), shifting occupation to the northwest.¹³¹

¹²³ Tourtet and Weigel 2015, 388.

¹²⁴ Tourtet and Weigel 2015, 388.

¹²⁵ For a detailed analysis see Liu et al. 2015.

¹²⁶ Tourtet and Weigel 2015, 399–400.

¹²⁷ Lora 2017, 37; Weigel 2019, 111.

¹²⁸ Hausleiter and Eichmann 2018, 37; Hausleiter 2011, 118.

¹²⁹ Macdonald et al. 2015, 33.

¹³⁰ For a presentation and discussion of this inscription see Al-Najem and Macdonald 2009.

¹³¹ Hausleiter and Eichmann 2018, 37–38.

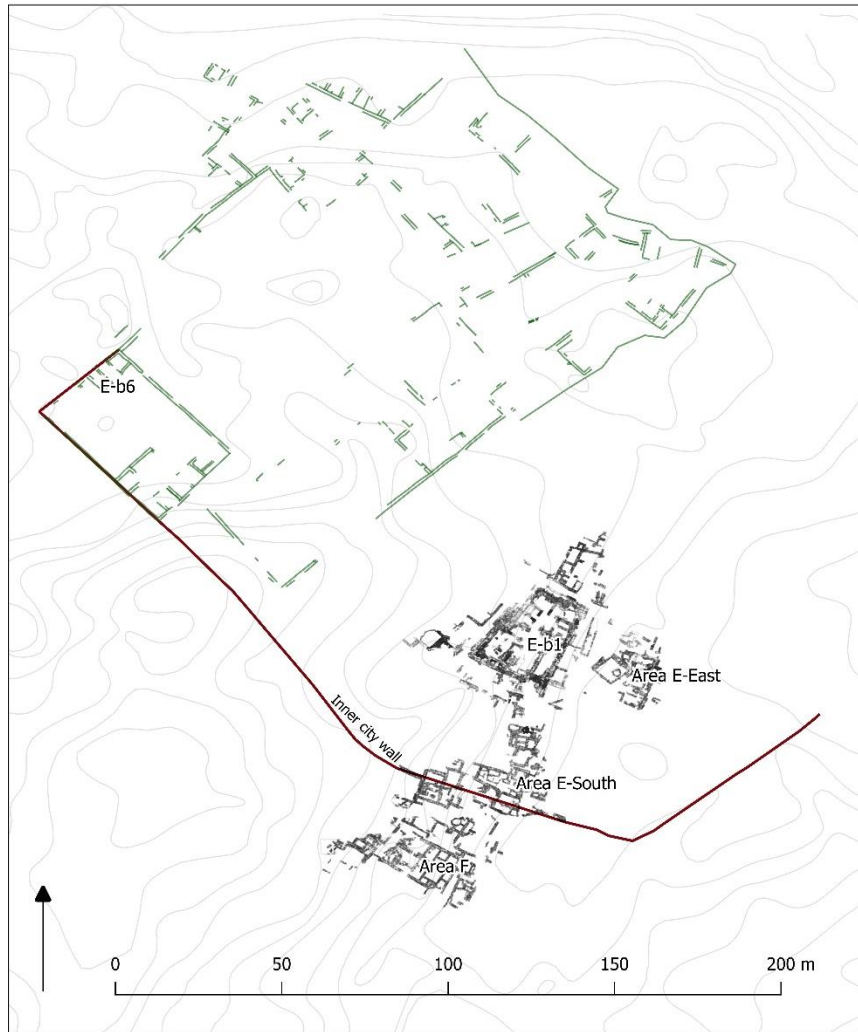


Figure 8: Large complex Building E-b6 (in green) NW of the residential area

3 CASE STUDY: THE RESIDENTIAL AREA AT THE OASIS OF TAYMA

The residential area in analysis in this research has been unearthed in Area E-South and Area F. They were excavated in 2005-2009, 2011-2012 and 2014-2015. Each area follows their own occupation level (OL) terminology; Area E-South and Area F have initially been excavated separately but have later been identified as having a shared stratigraphy (often named under the joint name “Area E-South/F”). This was already identified in the 2005/2006 excavation report, when the excavator at the time, Christoph Purschwitz, put forward that Area F seemed connected with the southern part of Area E (Area E-South).¹³²

¹³² Eichmann et al. 2011, 89.

3.1 Location

The uncovered residential area is in the northern part of *Qrayyah* (Figure 6), in the central Compound E, Area E-South¹³³ and Area F (Figure 9), and extends over an area of about 1600 m².¹³⁴ A slope of the surface to the northwest defines the natural elevation of the two areas, causing a favourable environment for the development of wadis.¹³⁵ This resulted in a mound of 18 m in height over the surroundings.¹³⁶



Figure 9: Residential area (Area E-South and Area F), S of Building E-b1, in *Qrayyah*.

¹³³ A subdivision of Area E. Area E includes Area E-South, E-b1 and Area E-East.

¹³⁴ “Area E-South/F” by Friedrich Weigel in Hausleiter and Al-Najem 2015.

¹³⁵ Eichmann et al. 2010, 131.

¹³⁶ Eichmann et al. 2011, 90.



Figure 10: Birdseye view over the residential area (Area E-South and Area F), S of Building E-b1; view from S (© DAI Orient Department 2015 J. Krumnow)

3.2 Chronostratigraphy

The archaeological remains uncovered in Area E-South and Area F were attributed to maybe the 3rd to 2nd millennium BCE and from 4th/3rd century BCE until the 6th century¹³⁷ with some modern evidence of the 19th/20th century CE (Table 3). Dating the occupation levels is based on pottery studies and ¹⁴C-dating.

The earliest evidence, maybe dated to the Early/Middle Bronze Age (3rd/2nd millennium BCE), is from Area F (OL F:5) and perhaps Area E-South (OL E-South:5) but, unfortunately, they are not enough to distinguish single buildings. This is followed by a hiatus in the Late Bronze Age and Early Iron Age in both areas. The Nabataean, Roman and Late Antique Periods are the better attested in the residential area and twenty-one buildings have been identified in total (Table 4). Two buildings have been uncovered from the Nabataean Period (OL E-South:4 and OL F:4). Eleven buildings were uncovered from the Roman Period (OL E-South:3 and OL F:3). Eight buildings are attributed to the Late Antique Period, which is divided into two phases in Area F (OL E-South, and OL F:2b and OL F:2a). The residential area was subsequently abandoned and became covered by debris and sand sometime after the 6th century CE (OL E-South:1 and OL F:1) with some scarce attested evidence.¹³⁸

Table 3: Residential area (Area E-South and Area F): Occupation levels (OLs) (adapted from Weigel 2019, 108, Table 1)

Chronology	Area E-South	Area F
Post 6 th -19 th /20 th c. CE	OL E-South:1	OL F:1
4 th -6 th c. CE	OL E-South:2	OL F:2a and OL F:2b
1 st /2 nd -4 th c. CE	OL E-South:3	OL F:3
4 th /3 rd c. BCE-1 st /2 nd c. CE	OL E-South:4	OL F:4
Late 2 nd -early 1 st millennium BCE	hiatus	hiatus
3 rd millennium BCE (?) - mid 2 nd millennium BCE (dating unclear)	OL E-South:5?	OL F:5

¹³⁷ Weigel 2019, 104.

¹³⁸ Eichmann et al. 2011, 92; Eichmann, Schaudig, and Hausleiter 2006, 167.

CHAPTER II

Of the twenty-one buildings, thirteen had the necessary evidence to carry out a space syntax analysis (Table 4, in bold).

Table 4: Buildings of the residential area (Area E-South and Area F) – in bold the buildings where a space syntax analysis is possible

OP	Area E-South	Area F	Buildings
OP 3a	OL E-South:2	OL F:2a	E-b7, F-b8 (phase 2) , F-b11
		OL F:2b	E-b8, E-b11, F-b5 , F-b6, F-b8 (phase 1)
OP 3b	OL E-South:3	OL F:3	E-b10, E-b13, E-b15, F-b1 West, F-b1 East, F-b2, F-b4, F-b7 , F-b9, F-b10, F-b12
OP 4	OL E-South:4	OL F:4	E-b9, F-b3

A basic spatial setting, in which relevant evidence can be embedded, is obtained by analysing the above mentioned thirteen buildings. The buildings are organised within a specific space and the way that space is organised reflects the social structures.¹³⁹ Since three succeeding occupation levels can be analysed, a temporal reflection of the spatial decisions is also possible. This made possible for this research to contain a synchronic and a diachronic analysis of the uncovered buildings. For this, a first a basic understanding of the spatial configuration must be attained.¹⁴⁰ A space syntax analysis is in this context a tool to provide exactly this kind of insight. The architectural evidence from the residential area is thus indicated to provide an understanding of the spatial-temporal context on an everyday level. And as are other types of evidence, such as objects or faunal and floral remains, embedded in a spatial dimension (i.e. the architectural evidence), are also everyday social choices of using space, such as specific ways of configuring space, embedded in a wider framework of historical dynamics that led to those choices.

Henceforth, OL E-South:5/OL F:5 will be abbreviated as OL 5, OL E-South:4/OL F:4 as OL 4, OL E-South:3/OL F:3 as OL 3, OL E-South:2/OL F:2b as OL 2b and OL E-South:2/OL F:2a as OL 2a because the attribution of the OL-number is strictly related to an excavation area, while the OPs refer to the entire site.

¹³⁹ “[...] individual behavioral decisions, which reflect more general cultural values, are embodied in the formation and use of built environment (Sanders 1990, 43)”.

¹⁴⁰ “...in order to compare dwellings with one another and to interpret their sociological significance, we have to solve a prior problem, that of identifying the elements and relations which make up the space pattern (Hanson 1998, 22).”

CHAPTER III

METHODOLOGICAL FRAMEWORK

A methodological framework will be outlined in the first three sections in order to define the methods applied in analysing the architectural evidence from the residential area (Figure 11): first, spatial analysis as an overall methodology; second, space syntax as a technique to analyse architectural evidence; third, geographical information systems (GIS) as a spatial toolbox capable of handling large amounts of data. The methodological framework is followed by a section with a definition of the concepts relevant to this research. To complete the chapter, the methodological framework will be reviewed considering the available evidence of the present case study in the last section.

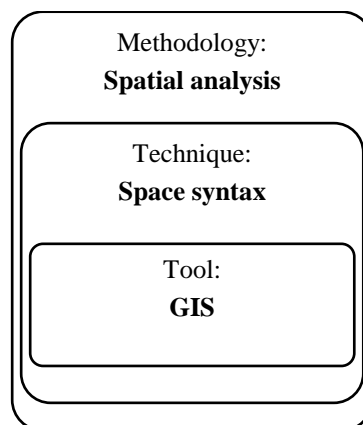


Figure 11: Scheme of the methodological framework

Space syntax is a key technique for the analysis in this thesis. Archaeological case studies often base their workflow, to carry out a space syntax analysis, on secondary literature, compromising the chance of performing a thorough analysis. Consequently, for this case study, the author decided to take a step back and review the primary literature available for this type of analysis. The drawback of this approach is that the technique, mainly developed for analysing complete urban layouts, must be reviewed to be applicable to archaeological architectural evidences that are *per se* fragmentary. The advantage is that commonly missed out steps of the technique might provide a more complete interpretation of the evidence.

1 METHODOLOGY: SPATIAL ANALYSIS

Sociologists, urban planners, architects and designers, such as Lewis Mumford, Kevin Lynch, Aldo Rossi and Bruno Zevi, have theorised on the notion of space in the fields of modern urbanism and architecture, mainly in the 1950s and 1960s.¹⁴¹ Nonetheless, it was not until the 1970s that spatial analysis was independently applied to the discipline of archaeology by the duo Hodder and Orton¹⁴² and Clarke.¹⁴³ While Hodder and Orton were concerned with the need for a focused study on the relationship between elements and a theoretical framework in the field, Clarke concentrated his study on a broader definition of what spatial analysis means.¹⁴⁴

Since then, spatial analysis has come a long way and the methods in use have expanded considerably,¹⁴⁵ including the space syntax technique, presented in the next section of this chapter. There are various book collections available that focus on the methodological diversity of spatial analysis.¹⁴⁶ Defining spatial analysis is a complex matter, due to the extension of the field: Wheatley and Gillings give importance to the **location** of objects,¹⁴⁷ while Carver similarly emphasises the existence of different **scales** where life is conducted.¹⁴⁸ In both cases, the authors give importance to different types of spaces (more local in the former and more global in the latter) and how they relate.

Hodder and Orton clearly stated that there is too much subjectivity when it comes to the interpretation of a map, therefore a systematic study of spatial patterns is essential.¹⁴⁹ The objectivity that a mathematical approach gives, as is common in spatial analysis, enables the archaeologist to deal with large amounts of data and directly compare them to other cases. The development of the tools that can be used for this purpose, such as GIS, will be presented in the third section of this chapter, as it is important not only to deal with large data but also to make them readable.

¹⁴¹ Mumford 1989; Lynch 1960; Rossi 2007; Zevi 1993.

¹⁴² Hodder and Orton 1976.

¹⁴³ Clarke 1977.

¹⁴⁴ Papaconstantinou 2006, 16–17; Seibert 2006, xv.

¹⁴⁵ “Spatial analyses of archaeological materials have become quite varied as diverse methods and theoretical approaches have emerged, making the concept of space somewhat nebulous (Seibert 2006, xiii).”

¹⁴⁶ Hietala 1984; Robertson et al. 2006; Paliou, Lieberwirth, and Polla 2014; Parker and Asencio 2008, among others.

¹⁴⁷ Wheatley and Gillings 2002, 126.

¹⁴⁸ Carver 2009, 265.

¹⁴⁹ Hodder and Orton 1976, 4.

Spatial analysis has various methods at its disposal to capture the location of the evidence and to analyse patterns.¹⁵⁰ The choice of methods to use depends on the type of evidence (such as a site, building or object group) and at what scale they are analysed (based on the question asked of the evidence). For the present study, which analyses architectural evidences, the spatial analysis focuses on two types of scale. These are: intra- and intersite spatial analysis and levels of resolution. Intra- and intersite spatial analysis oppose, respectively, the study within a site with a comparative study of a site with other sites.¹⁵¹ The intrasite spatial analysis has, as its main subject of study, the settlement itself and with that the variation between evidence, which in this study are firstly single buildings (phenotypes) and secondly all buildings of each occupation level (genotypes¹⁵²). This process identifies structural patterns of access and movement to define function. Although function cannot always be inferred from the patterns, it might be possible to differentiate different types of function. The intersite spatial analysis focuses on the comparative study between two or more settlements and the variations between the same types of evidence at each site, aiming at identifying wider dynamics that influences the evidence.

Levels of resolution, as first coined by Clarke, are the division of archaeological records into three levels: micro, semi-micro and macro (Figure 12).¹⁵³ The **micro level** stands for an analysis within structures based on proxemics and social models, where a **structure** stands for “[...] any small scale constructed or selected unit which contained human activities or their consequences”.¹⁵⁴ The **semi-macro level** stands for an analysis within sites based on social and architectural models, where a **site** stands for “[...] geographical locus which contained an articulated set of human activities or their consequences and often an associated set of structures”.¹⁵⁵ The **macro level** stands for an analysis between sites based on geographic and economic models, where a **site system** stands for a “[...] set of sites at which it is hypothesised that the interconnection between the sites was greater than the interconnection between any individual site and sites beyond the system”.¹⁵⁶ The purpose of this multilevel view of a record is to create virtually manageable units of analysis. Clarke further states that these units are

¹⁵⁰ For an overview of the methods see Carver 2009, 245–66.

¹⁵¹ Munday 1984, 32; Stadler 1985, 164–65.

¹⁵² “Phenotypes” and “genotypes” will be explained in detail in this chapter, Section 2.1.

¹⁵³ Clarke 1977, chap. 4.

¹⁵⁴ Clarke 1977, 11.

¹⁵⁵ Clarke 1977, 11.

¹⁵⁶ Clarke 1977, 14.

“terms-of-convenience” that can be subjected to changes according to the study¹⁵⁷, which is significant because it provides the means for an archaeologist to choose how narrow or broad the levels should be in accordance with the data in analysis.¹⁵⁸

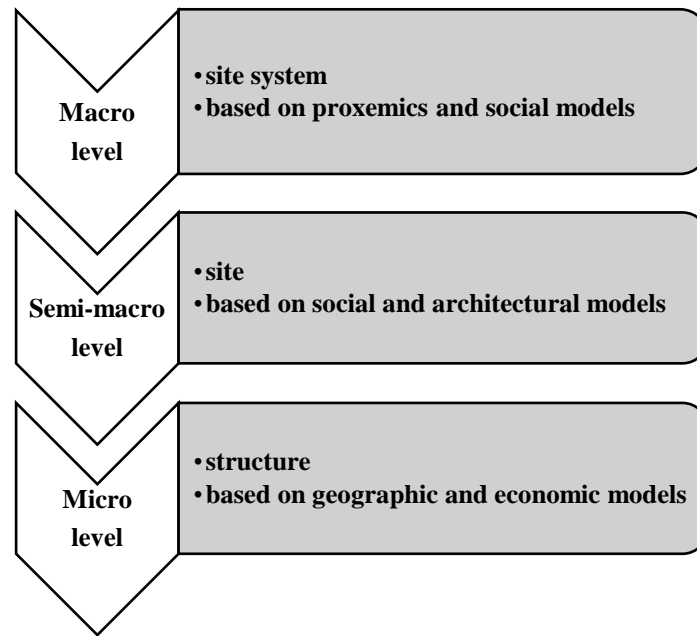


Figure 12: Scheme of levels of resolution (based on Clarke 1977)

2 TECHNIQUE: SPACE SYNTAX

The term **space syntax** was first coined by Hillier and his team in 1976.¹⁵⁹ Although the theoretical framework was set by their article entitled *Space syntax*, there has been a considerable development of the theories involved and case studies have multiplied.¹⁶⁰ Hillier himself has kept the first approach evolving, as demonstrated by his contribution *Spatial analysis and cultural information: the need for theory as well as method in space syntax analysis* in Paliou *et al.* from 2014. The technique of space syntax has encountered both positive and negative feedback (presented in Section 2.2 of this chapter) over the years: a

¹⁵⁷ “[...] the terms and entities are merely summarising terms-of-convenience and may be altered at will in particular studies by further subdivisions or the choice of other specific scales and criteria. [...] The scale of definition and resolution is a matter of choice for the purpose of the particular study in hand (Clarke 1977, 14)”.

¹⁵⁸ This can be seen in various case studies, such as: Keith 2003; Rainville 2005. Further theoretical framework on this subject was provided by Fletcher 1978; Carver 2009, to name a few.

¹⁵⁹ Hillier *et al.* 1978b.

¹⁶⁰ Foster 1989; Cooper 1995; Van Dyke 1999; Dawson 2002; Kirsan 2003; Starzmann 2007; Benech 2007; Stöger 2008; Letesson 2009; Wells 2009; Blanton 1994.

CHAPTER III

critical approach from Osman and Suliman¹⁶¹, a summarising article from Bafna¹⁶², a forward-looking summary from Griffith¹⁶³ and a manual written by Al-Sayed *et al.*¹⁶⁴, among many others.

To define space syntax, it is best to use Hillier's own words: "Space syntax is a set of techniques for analysing spatial configuration, and a set of theories linking space and society".¹⁶⁵

Considering that this technique was originally used for analysing contemporary urban spaces, the archaeological aims are not very different. The idea behind this is that there is a social meaning entrenched in the built space¹⁶⁶, where **boundary** plays a key role.¹⁶⁷ Boundaries give order to space, as they physically determine unlimited space¹⁶⁸, which in an archaeological context is mainly manifested through walls. Yet, movement between bound spaces can only occur by means of **permeability**, which in an archaeological context is mainly manifested through doorways. Permeability can either be granted or denied¹⁶⁹, consequently delimiting the same space in different ways. Space syntax is as such "[...] a graph-based theory used by architects to examine how the spatial layout of buildings and cities influences the economic, social, and environmental outcomes of human movement and social interaction. Archaeologists have explored this concept by analysing how social structure is reflected in the spatial configuration of public and domestic architecture".¹⁷⁰ The aim of space syntax is to handle archaeological data in a mathematical way at different levels. This technical approach not only makes possible an analysis within a site to be systematic and simplified, but also the comparative analyses to be direct.¹⁷¹

The results of a space syntax analysis are suitable for synchronic and diachronic studies, considering that spatial configuration can easily be compared.¹⁷² This will be clear in the

¹⁶¹ Osman and Suliman 1994.

¹⁶² Bafna 2003.

¹⁶³ Griffiths 2012.

¹⁶⁴ Al-Sayed 2014.

¹⁶⁵ Hillier 2014, 19.

¹⁶⁶ Al-Sayed 2014, 7.

¹⁶⁷ Bafna 2003, 17; Al-Sayed 2014, 7; Foster 1989, 41.

¹⁶⁸ There are other types of boundaries, such as psychological or social, that can affect the determination of space. For a more detailed discussion see Sanders 1990, 51.

¹⁶⁹ Foster 1989, 41.

¹⁷⁰ Dawson 2002, 464.

¹⁷¹ In Hanson's words: "[...] in order to compare dwellings with one another and to interpret their sociological significance, we have to solve a prior problem, that of identifying the elements and relations which make up the space pattern (Hanson 1998, 22)".

¹⁷² "[...] one of the merits of Space Syntax techniques is their potential to contribute to diachronic and synchronic comparisons of spatial configuration (Paliou 2014, 9)."

analytical part of this study when joining the technique with the multilevel view described in the section above.

As stated, the methods used in space syntax are graph-based and the analysis is of mathematical nature. Depending on the questions asked of the data in analysis, space syntax is applicable to various levels, such as buildings, sites, landscapes and entire cities.¹⁷³

2.1 Space syntax analysis¹⁷⁴

The concepts **genotype** and **phenotype** will be clarified before describing the space syntax analysis in detail.¹⁷⁵

A genotype is a **transpatial** concept that reflects the set of abstract rules that phenotypes comply with. A phenotype is therefore a **spatial** concept that displays the genotype in physical space in the form of buildings. Phenotypes can have **transtemporal** links, that is “ancestors and descendants” and **transpatial** links, that is “contemporaneous organisms of the same kind”. The set of rules of genotypes can undergo either revolutionary changes or evolutionary changes: they either follow a completely new set of rules or they evolve from previously existing rules.

The following two parts will demonstrate how phenotypes and then genotypes are formally understood by means of a space syntax analysis.

2.1.1 Phenotypes

The basic idea of space syntax is to represent bound spaces and their permeability graphically. This is achieved by creating a **justified grap**¹⁷⁶, which captures the spatial configuration.¹⁷⁷ Each space (room, courtyard, kitchen etc.) is represented by a circular node¹⁷⁸ and each link (permeability) between two spaces (door, opening, threshold etc.) is represented by a lined vertex.¹⁷⁹ Two spaces with such a permeability are considered as being **adjacent**. Hillier defined that a justified graph is based on a chosen node that is considered the root, on

¹⁷³ Bafna 2003, 17; Al-Sayed 2014, 7.

¹⁷⁴ See Glossary for a list of terms and calculations. There are various ways of abbreviating the single terms. For a consistent system of abbreviations, the author used the ones used in the software Agraph.

¹⁷⁵ Definition of *genotype* and *phenotype* based on Hillier and Hanson 2005, 42–45.

¹⁷⁶ Sometimes “justified permeability graph/map”, “(justified) access graph/map”.

¹⁷⁷ Hanson 1998, 24.

¹⁷⁸ “Node” and “space” are often interchanged because the former represents the latter graphically.

¹⁷⁹ Description based on Al-Sayed 2014, 12, 13; Hillier and Hanson 2005, 93.

top of which all the other nodes align according to their topological distance from that root node (Figure 13).¹⁸⁰

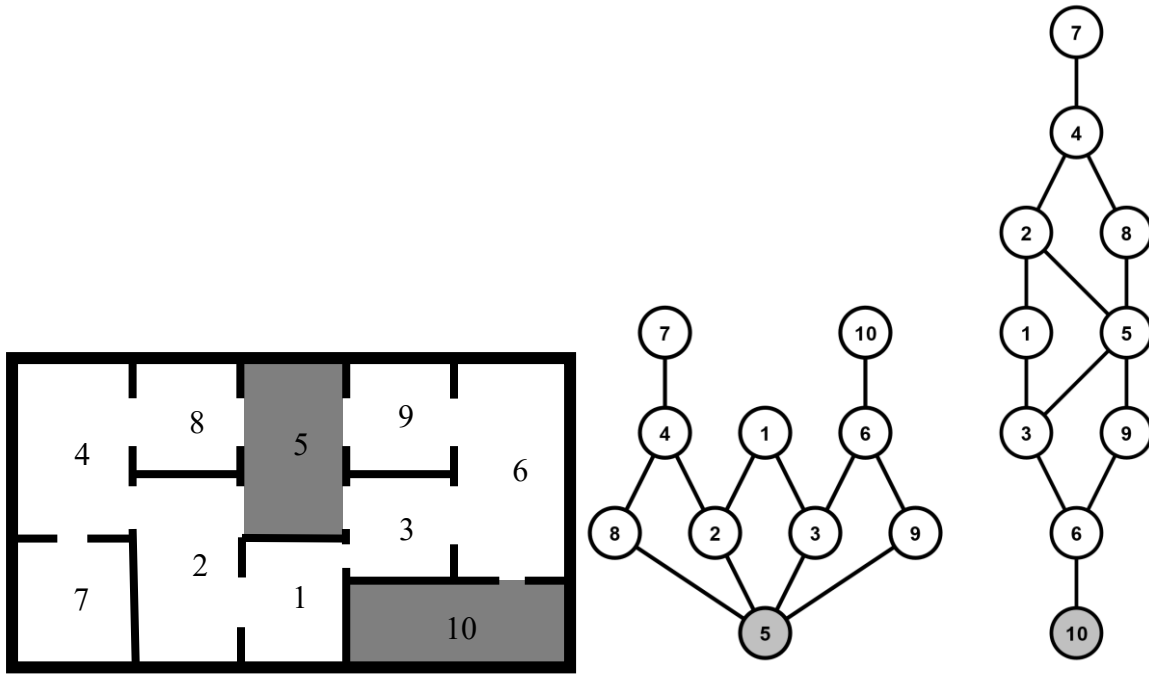


Figure 13: Example of justified graphs of a building from two perspectives: node 5 and node 10 – highlighted in grey (based on Hillier 2014, 21)

The justified graph provides the means to visualise the depth of a space (topological distance of a node¹⁸¹) and localises that space in the network by relating it to all the other spaces. The depth value is attributed as follows: an adjacent space has the value one, one space in between gives the space the value two, two spaces in between give the space the value three, etc.¹⁸² In this case, the real distance between spaces is disregarded,¹⁸³ a fact that will be discussed below in more detail when discussing the methods of space syntax.¹⁸⁴

The justified graph serves to visualise both an axial map and a convex map. They serve to answer distinct types of questions about data on different scales. An axial map focuses on the street spaces, reducing them to the minimum and the longest straight lines possible (Figure

¹⁸⁰ “[a] justified graph is where we pick a node and think of it as the root of the graph, and align the other nodes in layers above it according to the fewest other nodes we must pass through to get to that node from the root (Hillier 2014, 21).”

¹⁸¹ Teklenburg, Timmermans, and Van Wageningen 1993, 349.

¹⁸² Al-Sayed 2014, 12; Hillier, Hanson, and Graham 1987, 364.

¹⁸³ Bafna 2003, 23–24.

¹⁸⁴ In Section 2.2 of this chapter.

14).¹⁸⁵ In this case, the question of the data is based on movement and is one-dimensional.¹⁸⁶ Analysing an axial map can therefore answer the question of how a street network is shaped and perceived.¹⁸⁷

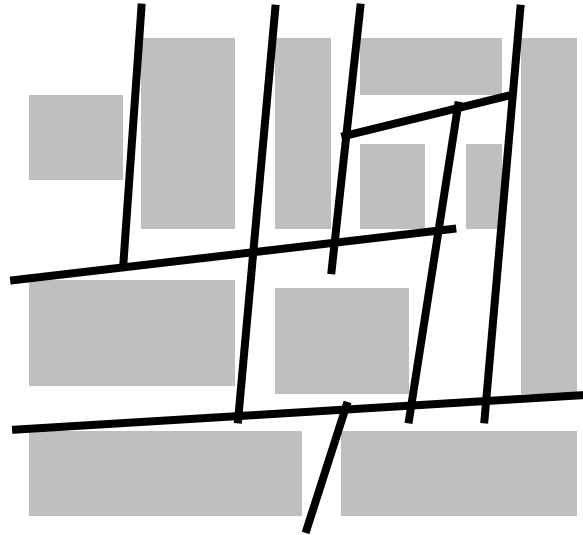


Figure 14: Example of an axial map of street spaces around buildings (grey); axial lines representing street spaces (black) (based on Al-Sayed 2014, fig. 2.2 b.)

A convex map focuses on architectural space (Figure 15 left), reducing the spaces to the minimum and largest convex polygons (Figure 15 right).¹⁸⁸ In this case, the question of the data is based on occupation¹⁸⁹ and is two-dimensional.¹⁹⁰ Analysing a convex map can therefore answer the question of how an architectural space is shaped and perceived.¹⁹¹

¹⁸⁵ Al-Sayed 2014, 11.

¹⁸⁶ Hanson 1998, 39.

¹⁸⁷ Hillier and Hanson 2005, 17; Al-Sayed 2014, 11–12.

¹⁸⁸ Any two points in a convex polygon can be connected without going outside of the perimeter of the polygon. See Hillier and Hanson 2005, 98, Fig. 39 for an example of a convex polygon. See also Al-Sayed 2014, 12.

¹⁸⁹ Hillier 1996, 248–49.

¹⁹⁰ Hanson 1998, 39.

¹⁹¹ Hillier and Hanson 2005, 17; Al-Sayed 2014, 12–13.

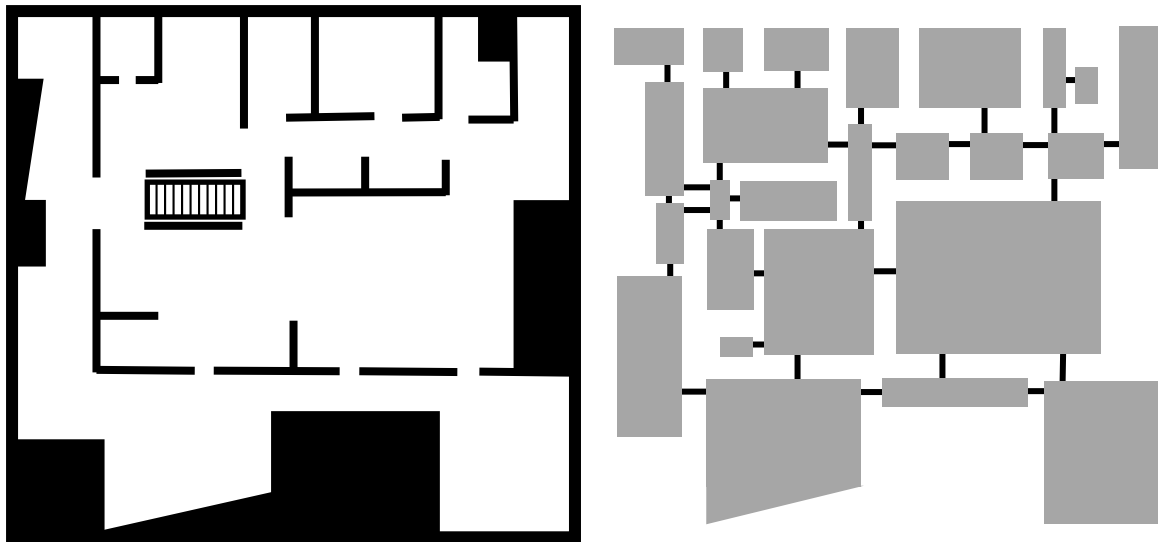


Figure 15: Example of a building (left) with convex map (right) showing connections (black) between spaces (grey) (based on Al-Sayed 2014, fig. 2.3 a. and b.)

There are two perspectives from which a convex map of a building can be analysed. If assuming that the inhabitants are a basic social unit, then strangers would, in Grahams words, oppose that unit.¹⁹² While strangers have no access to a certain building, a subgroup named “visitors” receive limited permission to do so. To understand the difference between the relationship of inhabitants and the relationship between them and visitors, the justified graph is first analysed with the node representing the exterior of the building – **visitor-inhabitant relationship** – and then without it – **inhabitant-inhabitant relationship**.

The steps described below focus on the analysis of convex maps, since the evidence to create an axial map is insufficient in the present study.¹⁹³ The analytical steps, applicable to both the visitor-inhabitant relationship and the inhabitant-inhabitant relationship, are:

- total number of spaces (K)
- number of connections (NC)
- total depth (TD)
- mean depth (MD)

¹⁹² Hillier and Hanson 2005, 146.

¹⁹³ Though the steps can also be applied to the axial map when required.

CHAPTER III

- relative asymmetry (RA)
- real relative asymmetry (RRA)
- control value (CV)
- relative ringiness (RR)
- types of spaces

Each space is represented by a node and each two nodes connected by a vertex when adjacent (Figure 16). Each node is represented by the variable “n” and the **total number of nodes** is represented by:

$$K = \text{total number of nodes}$$

As already mentioned above, the graphic representation can be done from any point of view, whether it is the space outside a building, in which case it is also seen as a unit, or a specific room within a building (Figure 13). The selected space is called a root space.¹⁹⁴ The result is an understanding of the depth of a particular space: when it is deep then many steps or turns are necessary to reach the space from the root, when it is shallow then not many steps or turns are necessary to reach the space from the root.¹⁹⁵

The **number of connections** (NC) counts the adjacent spaces a node has¹⁹⁶, which can then be represented by different colours, thicknesses, shades etc. either on the graph or on the convex spaces.

¹⁹⁴ Sometimes “carrier space”, as in Van Dyke 1999, 466.

¹⁹⁵ Hillier and Hanson 2005, 108; Al-Sayed 2014, 11.

¹⁹⁶ Al-Sayed 2014, 15.

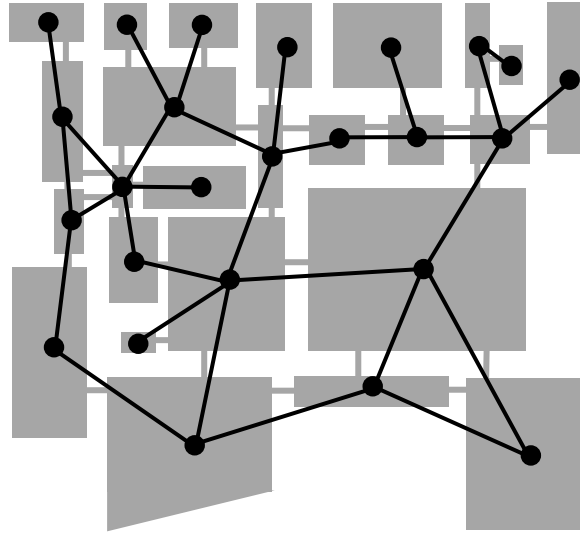


Figure 16: Example of an unjustified graph (black) on top of a convex map (grey) (based on Al-Sayed 2014, fig. 2.3 c.)

The **control value** (CV) evaluates how much control each space has over the others.¹⁹⁷ It is calculated by counting the **number of links** that each space has (NC) and then giving to each neighbouring space the value $\frac{1}{NC}$ (CVe). This procedure is done with all spaces and then the values given to each space are summed up. The result will have a value under one or above one. A value under one means weak control by that space over adjacent spaces and that it is rather controlled by those spaces. A value above one means strong control by that space over the adjacent spaces.

On the graph, justified or not, it can be visualised if it is composed of tree-like branches or rings (Figure 17). The **relative ringiness** (RR), a measure to quantify the degree of **choice** a spatial configuration offers¹⁹⁸, calculates the proportion between the real number of rings and the maximum possible number of rings in a graph:

$$RR = \frac{\text{total number of rings}}{2K - 5}$$

¹⁹⁷ Hillier and Hanson 2005, 109.

¹⁹⁸ Hanson 1998, 243.

The RR will have a value between zero and one. A lower RR, closer to zero, means **nondistributedness**, with more tree-like branches. A higher RR, closer to one, means **distributedness**, with more rings.¹⁹⁹ Assessing if there are rings in a graph can be done by comparing the number of nodes (K) and vertices. One vertex less than K means that it is a tree graph and has therefore no rings. The number of vertices equal or higher than K means that there are rings.²⁰⁰

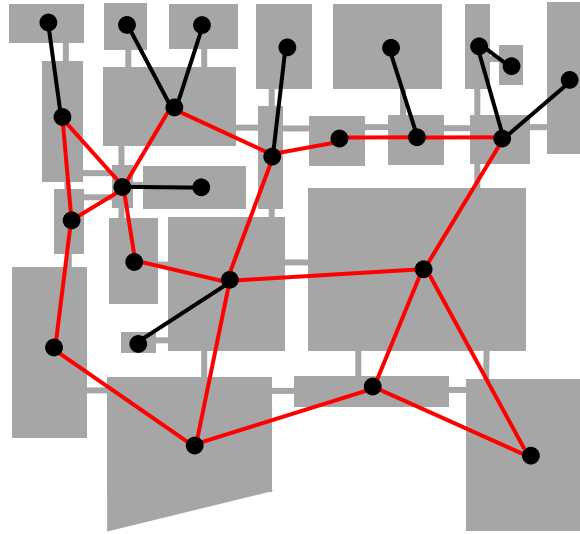


Figure 17: Example of rings (red) on top of a convex map (grey) (based on Al-Sayed 2014, figs 2.3 and 2.4)

The four steps described next (TD, MD, RA and RRA) are calculated in sequence.

Total depth (TD) is calculated by totalling all depths of a node to all the other nodes.²⁰¹ The result obtained is between the value one, which is the minimum number of steps that must be taken to reach another space, and $\sum_{n=1}^{K-1} n$, which is when, hypothetically, every node is connected to all other nodes minus itself.

The **mean depth (MD)** is the average depth of each space to all other spaces, as calculated with the following formula:²⁰²

$$MD = \frac{TD}{K-1}$$

¹⁹⁹ Van Dyke 1999, 466–67.

²⁰⁰ Hillier, Hanson, and Graham 1987, 364.

²⁰¹ Ostwald 2011, 452.

²⁰² Hillier and Hanson 2005, 108.

The result obtained is between the value one, which is the minimum average of steps to be taken to reach another node, and $\frac{K}{2}$, which again is the average when, hypothetically, every node is connected to all the other nodes minus itself.

The analysis proceeds with the calculation of the **relative asymmetry** (RA). The RA “[compares] how deep the system is from a particular point with how deep or shallow it theoretically could be - the least depth existing when all spaces are directly connected to the original [root] space, and the most when all spaces are arranged in a unilinear sequence away from the original [root] space, i.e. every additional space in the system adds one more level of depth”.²⁰³ The calculation for the RA is:²⁰⁴

$$RA = \frac{2(MD-1)}{K-2}$$

The RA will have a value between zero and one. A lower RA, closer to zero, means a closer location with a higher symmetry and a stronger **integration** in the whole system. A higher RA, closer to one, means a deeper location with a higher asymmetry and a stronger **segregation**.²⁰⁵

The result is bound to the space numbers (K) of the justified graph in analysis, resulting in the need to recalculate the RA to a **real relative asymmetry** (RRA). The RRA standardises the RA value, enabling the result to be directly compared with the results from other graphs with a different number of spaces (K):²⁰⁶

$$RRA = \frac{RA}{D - value}$$

The RRA will have a value under one or above one. A value under one means a higher symmetry/integration and a value above one means a higher asymmetry/segregation.²⁰⁷

²⁰³ Hillier and Hanson 2005, 108.

²⁰⁴ Hillier and Hanson 2005, 108.

²⁰⁵ Al-Sayed 2014, 13; Hillier and Hanson 2005, 108–9.

²⁰⁶ Hillier and Hanson 2005, 113.

²⁰⁷ Hillier and Hanson 2005, 113.

The D-values, mean RA values of diamond-shaped graphs with the same number of nodes, were tabulated by Hillier and Hanson in *The social logic of space*²⁰⁸, however only for five or more spaces.²⁰⁹ Table 5 presents the D-values for K=1 to K=20 based on the following formula:

$$D_k = \frac{2 (k(\log_2 \frac{k+2}{3} - 1) + 1)}{(k-1)(k-2)}$$

Table 5: D-values calculated for K=1 to K=20

K	D-value	K	D-value	K	D-value	K	D-value
1	-	6	0.349	11	0.295	16	0.251
2	-	7	0.340	12	0.285	17	0.244
3	0.211	8	0.328	13	0.276	18	0.237
4	0.333	9	0.317	14	0.267	19	0.231
5	0.352	10	0.306	15	0.259	20	0.225

Each space can be classified into four types: A-, B-, C- and D-type (Figure 18). **A-type** spaces have only one link; they are a dead-end space; the elimination of the link cuts the space from the rest of the graph. **B-type** spaces have more than one link; they are part of a tree branch; they are located on the way to an A-type space; the elimination of a link cuts one or more spaces from the rest of the graph. **C-type** spaces have more than one link; they are part of a ring with no A-type or B-type spaces; the elimination of a link creates a tree-branch. **D-type** spaces have more than two links; they are part of at least one ring; they are part of a complex of at least two rings, with no A-type or B-type spaces.

²⁰⁸ Hillier and Hanson 2005, Table 3.

²⁰⁹ Results for K = 3 and K = 4 are not very reliable.

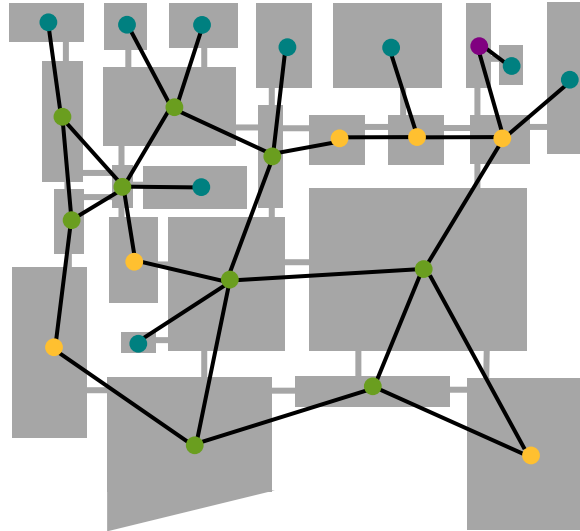


Figure 18: Example of space types (A-type – turquoise; B-type – purple; C-type – yellow; D-type – green) on top of a convex map (grey) (based on Al-Sayed 2014, fig. 2.4)

There are values that capture local characteristics and values that capture global characteristics in both types of relationship, visitor-inhabitant and inhabitant-inhabitant. The CV is a **local** measure, which relates a node strictly to its adjacent spaces. The RA and the RRA values are **global** measures, which determine the node's position within the building.²¹⁰ Correlating them shows if there is a connection between the control a node has over its surroundings and the position it assumes in the building, meaning the local-global characteristics of a node. Further, analysing both relationships of a building means distinguishing how the interior of the building is perceived, with all its spaces, from the outside, as opposed to how it is perceived once accessed.

2.1.2 Genotypes

As indicated previously, once the phenotypes (each building) are all understood, the analysis can proceed by defining the abstract rules they follow – genotypes.

A genotype has more common characteristics than differences. Although the RRA value is the basic comparative value, all other available information must be considered.

²¹⁰ Hillier and Hanson 2005, 109; Tomé 2015, 11; Klarqvist 1993, 11–12.

To verify the defined genotypes, the **difference factor** (H^*) is calculated, which identifies the variation of values within a given range:²¹¹

$$H^* = \frac{H - \ln 2}{\ln 3 - \ln 2}$$

$$\text{where } H = -\sum \left[\frac{a}{t} \ln \left(\frac{a}{t} \right) \right] + \left[\frac{b}{t} \ln \left(\frac{b}{t} \right) \right] + \left[\frac{c}{t} \ln \left(\frac{c}{t} \right) \right]$$

and where $a = \max \text{ RRA}$, $b = \text{mean RRA}$, $c = \min \text{ RRA}$

The closer the result is to the value one, the less variance and more similarities exist. This can be applied to any chosen set of RRA values, as in this case would be the mean RRA values of each building; but it can also compare RRA values of, for example, rooms with the same function, if the question requires so. Within a building a value of one would mean that there is no differentiation of spaces, while for a genotype or a combination of genotypes this would mean that they are similar in their underlying abstract rules.

2.2 Criticism towards space syntax

The methods used in space syntax have been the object of considerable criticism, mainly due to the lack of the “human factor” in this graph-based technique. A graph is abstract and therefore does not integrate all the available information, such as the dimension of the spaces (nodes) or the real distances between spaces (links) – instead measuring the topological distance.²¹² Most case studies have in common that they have saturated the basic use of space syntax, indicating more a **possibility** rather than a **determination** of function of the object in study.²¹³ As stated above, in Section 1 of this chapter, this is a general trend in spatial analysis, where rather a differentiation of function than function itself can be determined upon applying this type of methodology. However, as Van Dyke stated, additional information must be fed to

²¹¹ Hanson 1998, 30–31.

²¹² “The graphical representation of dwellings is dimensionless. It does not distinguish between spaces of differing sizes, hallways of differing lengths, or sizes of courtyards (Blanton 1994, 30).” Also see Ratti 2004, 480; Osman and Suliman 1994, 196–98.

²¹³ “[...] space syntax model suggests possibilities rather than provide a definitive tool to determine the function of a building (Cooper 1995, 281)”.

the values that result from a space syntax analysis:²¹⁴ room functions, building functions, dimensions, distances etc. are applied directly onto the graph so that the results obtained by the space syntax analysis can be further discussed. This is an issue that will be taken into consideration when reviewing the methodological framework (see Section 5 of this chapter).

Another argument, especially stated by Leach²¹⁵ and Ratti²¹⁶, is that the analysis does not consider the fact that space is three-dimensional. Interestingly, Hillier and colleagues answered this argument: “Human spatial organisation is not, contrary to general supposition, three dimensional in the same sense it is two dimensional, for very simple reasons: human beings cannot fly, and buildings cannot float in the air. The laying of cells on top of each other does not render human space fully three dimensional. It is always reduced to two dimensions so that human beings may traverse it, for example by stairs, ladders, lifts, etc. This has an important result for us: that multi-storey objects are accessible to the same kind of analysis as single storey complexes”.²¹⁷

Important to keep in mind is that space syntax analysis is a basic technique in an archaeological study; it is not an answer to all questions asked of the data. As Hillier and Hanson claimed: “The aim of the numerical side of syntactic analysis is to deepen descriptions by expressing in a concise way very complex relational properties of spaces and of the system as a whole. In particular, it is about considering individual spaces in terms of the whole system”.²¹⁸ This is precisely what the correlation between local (CV) and global (RRA) values means, as already described above.²¹⁹

3 TOOL: GIS

Geographical information systems (GIS), widely used by archaeologists²²⁰, were first developed in 1964 by the Canadian government’s Regional Planning Information Systems Division to manage resources.²²¹ The US government was developing similar programs for

²¹⁴ Van Dyke 1999, 470.

²¹⁵ Leach 1978, 400.

²¹⁶ Ratti 2004, 492.

²¹⁷ Hillier et al. 1978a, 403.

²¹⁸ Hillier and Hanson 2005, 108.

²¹⁹ In Section 2.1.1 of this chapter.

²²⁰ For a detailed account of the history of GIS see Wheatley and Gillings 2002; Seibert 2006.

²²¹ Wheatley and Gillings 2002, 12–14.

cartography in the 1970s. By the 1980s, it was commercialised and developed for new purposes, such as archaeology.

In archaeology, GIS started to be used around 1980.²²² It took ten years to be accepted as one of the possible tools used in archaeology, with the publication of *Interpreting Space: GIS and Archaeology* by Allen *et al.*²²³

Wheatley and Gillings defined that GIS serves four main purposes: to store, manipulate, analyse and present information about geographic space²²⁴; in short: a “spatial toolbox”.²²⁵ This definition already clarifies that the information handled is all spatially referenced in a coordinated system.

At first, GIS was used in archaeology for statistical purposes.²²⁶ Now it is commonly used for intrasite and intersite spatial analyses. As Carver simply argues: “The ultimate instrument for comparing spatial relations of everything is GIS”.²²⁷

There is a wide range of available software and components. In this thesis, the open source Quantum GIS (QGIS) was used.²²⁸

The workflow of GIS is as follows (Figure 19): the data collected on site (and completed off site) is entered into the database, there it is stored and can be retrieved at any time; next, it can be manipulated and analysed for the aimed purpose; the results can be visually represented in the form of graphs and maps.²²⁹ Given the fact that a substantial quantity of information can be stored in a GIS, it is important to keep in mind when producing a map, that readability is very important.²³⁰ The author encountered this issue when preparing the plans to represent the space syntax analysis of each building: two distinct values (CV and RA) had to be depicted on the same plan without compromising readability.

²²² Seibert 2006, xix.

²²³ Allen, Green, and Zubrow 1990.

²²⁴ Wheatley and Gillings 2002, 8.

²²⁵ Wheatley and Gillings 2002, 8.

²²⁶ Wheatley 2014, 116.

²²⁷ Carver 2009, 247.

²²⁸ QGIS Version 3.8.1. The Joint Saudi Arabian-German Archaeological Project has integrated GIS as a tool since excavations started in 2004.

²²⁹ Based on Wheatley and Gillings 2002, 8–9.

²³⁰ “However, the final map – despite the best efforts of the cartographer – must always represent an uneasy compromise between the conflicting goals of maximisation of information content and ease of visual extraction of that information (Marble 1990, 11).”

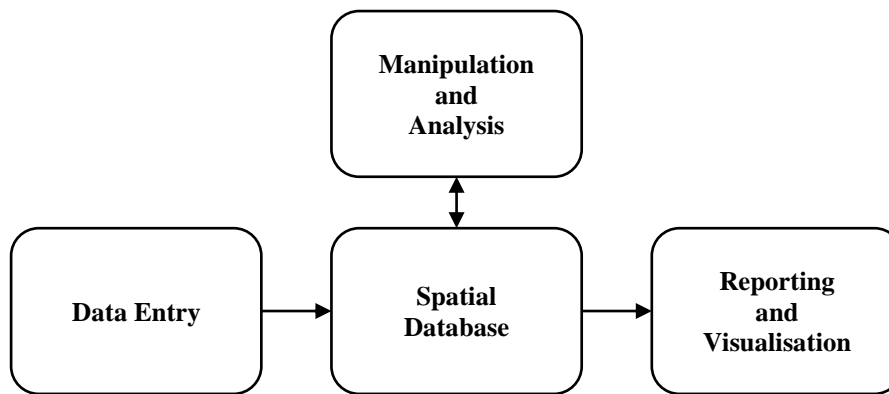


Figure 19: Workflow of GIS (based on Wheatley and Gillings 2002, fig. 1.2)

4 DEFINITIONS

In the paper following the conference *Household Archaeology in the Middle East and Beyond: Theory, Method, and Practice* held 2009 in Salt Lake City, Utah, Matthews concludes that there is a need for a “[...] definition of terms within individual contextualised studies [...]”²³¹, where “[...] it should be made explicit by each author what their world-view was as regards their subject of study”.²³² In agreement with this statement, the author defines the following concepts to avoid ambiguous interpretations:

- building
- house
- household
- space

The concept of **building** is bound to a very concrete, physical form of architectural remains. Hillier and Hanson, developers of the methods of space syntax, described a building “[...] as a certain ordering of categories, to which is added a certain system of controls, the two conjointly constructing an interface between the inhabitants of the social knowledge embedded

²³¹ “In addition to the need for definition of terms within individual contextualised studies, there was general agreement in the discussion session that it should be made explicit by each author what their world-view was as regards their subject of study. The need to demonstrate critical self-awareness and transparency in writing about ancient households is to the fore, and this should include an articulation of what the expectations were in taking particular approaches to the archaeological record (Matthews 2012, 560).”

²³² Matthews 2012, 560.

in the categories and the visitors whose relations with them are controlled by the building”.²³³ An interface can be understood here as a permeable (or not) boundary between inhabitants and visitors that can segregate space and control access.²³⁴ It is particularly in the visitor-inhabitant relationship that this interface plays a key role, relating the outside of a building with the interior. This concept is therefore to be used when describing and categorising the architectural remains, which can be physically captured and analysed.

The concept of **house** is based on the meaning with which a building is charged. Bailey defines that a house has two aspects: first, the aspect of context, which includes the social meaning that a house is given and the material content that a house has within; second, the aspect of time, which can be seen as a “vertical construct”²³⁵, where repetition and variation take place.²³⁶ Bintliff argued in a comparable way, when defining a house as a “[...] barometer for long-term transformations in social life as a whole”.²³⁷ With these two characterisations of the concept of house, it was clarified why it is an important source of information. This concept is to be used when interpreting and developing a discussion about the meaning with which the buildings in analysis are charged.

There is a more abstract facet to the house which can be defined by the concept of **household**. Novák defined it as being the sociological component of a house.²³⁸ Foster and Parker define a household as the “basic socioeconomic unit”.²³⁹ A house does not necessarily contain only one household activity, there can be household activity that extends over various houses.²⁴⁰ This concept would be used when discussing activities that took place in the buildings.

The concept of **space** has various definitions among researchers. First, it must be clarified that space can be perceived from different perspectives: psychological, geographical, personal, etc. In this study, space is in the first instance architectural space due to the available evidence. Wheatley and Gillings argued that “[s]pace was viewed as a neutral, abstract dimension in which human action took place. It was universal, clearly measurable, and fundamentally external backdrop to cultural activity”.²⁴¹ This is at first useful when speaking about

²³³ Hillier and Hanson 2005, 147.

²³⁴ Foster 1989, 41.

²³⁵ Bailey 1990, 23.

²³⁶ Bailey 1990, 23–24.

²³⁷ Bintliff 2014, 263.

²³⁸ Novák 1999, 7:299.

²³⁹ Foster and Parker 2012, 4.

²⁴⁰ Bernbeck 1997, 182.

²⁴¹ Wheatley and Gillings 2002, 8–9.

mathematical calculations that are part of the space syntax technique, aiming at capturing this physical aspect of space with a focus on its boundaries and permeability. However, once the discussion of the results unfolds, the concept of space can include other abstract meanings. This is also what Hillier and Hanson intended to transmit through their space syntax analysis. This dual meaning of the concept of space is well reflected in Seibert's argument that "[...] space, as an empirically neutral series of relationships between objects and the environment, and place, which is the meaningfully constituted and culturally constructed space that people dwell in".²⁴² A similar definition of "space" can be found in *The concise Oxford dictionary of archaeology*: "Physical space is of interest to archaeologists because human action is variously distributed in spatial terms and thus has to be explained. [...] More relevant, however, is social space, the arrangement of the world created by its inhabitants and defined by them in terms of differential values, emotions, and attributed meanings. This is when the physical space, previously captured by a space syntax analysis, is viewed in its context by adding any information available that can contribute to a better understanding."²⁴³ This concept is to be used when describing the built environment and to explore the intrinsic meaning.

5 METHODOLOGICAL REVIEW

In this section the methodological framework will be reviewed considering the available architectural evidence available for this case study.

The intrasite spatial analysis is based on the levels of resolution from Clarke. The levels are named nano, micro and macro level. The **nano level** of the analysis is aimed at the study of the smallest unit, the **room** itself. This is considered the minimum level of analysis in this study. The **micro level** of the analysis is aimed at the study of the middle-sized unit, the **building**. The **macro level** of the analysis is aimed at the study of the largest unit, the **residential area** as a whole.

The space syntax analysis can now be integrated into the basic scheme of levels of resolution and adapted to this case study, resulting in a proposed workflow for the analysis, as can be seen in Figure 20.

²⁴² Seibert 2006, xvii.

²⁴³ Darvill 2002, s. v. "space."

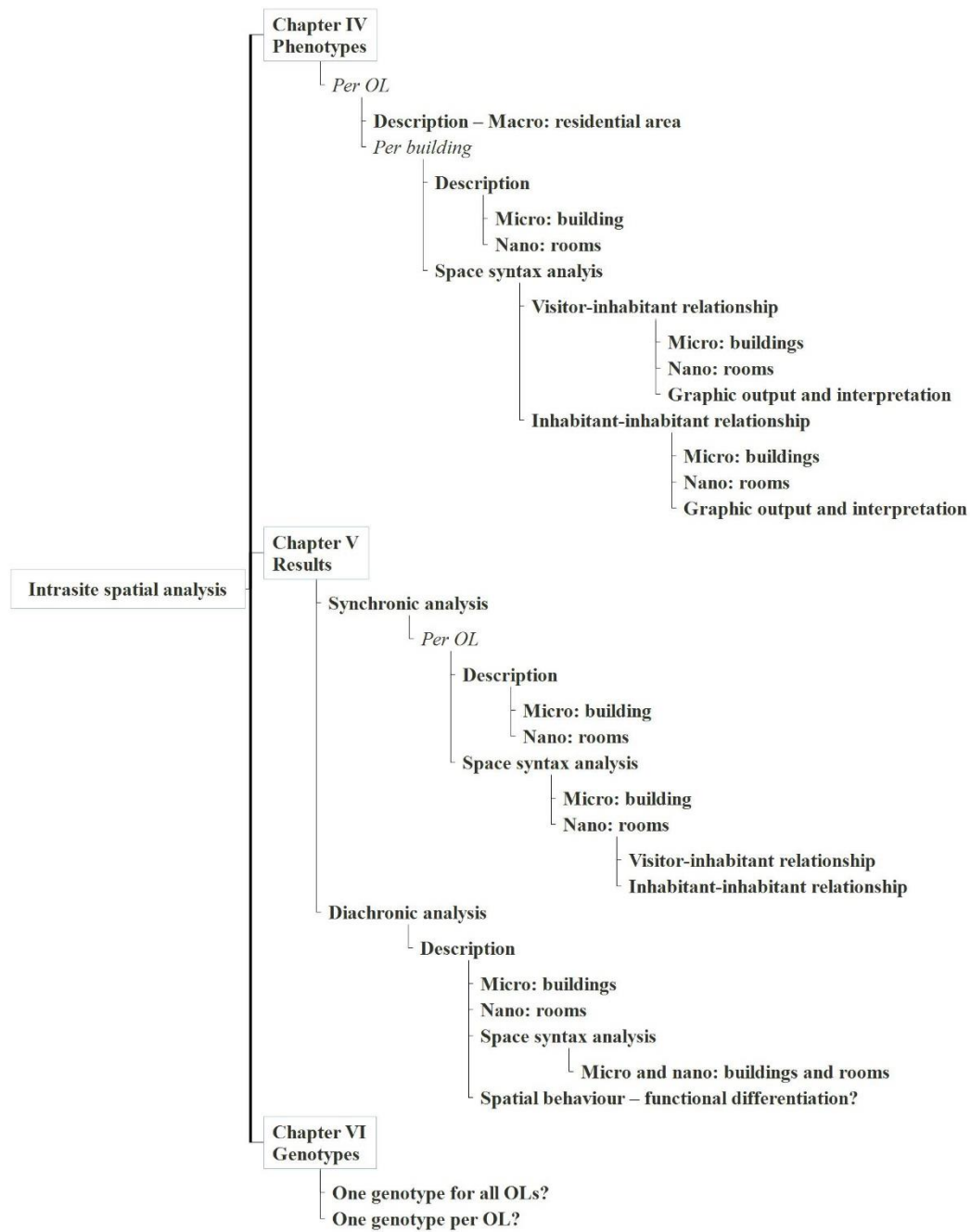


Figure 20: Workflow of the intrasite spatial analysis in this thesis (repeated task in *italic*)

The intrasite spatial analysis will be divided into three chapters: Chapter IV will focus on the space syntax analysis of each phenotype, Chapter V on the results of the analysis from the previous chapter and Chapter VI on the genotypes.

The phenotypes will be described and analysed per OL in Chapter IV, starting with the earliest. The description of the architectural evidence from the residential area from each OL falls in the macro level of analysis. This is followed by a description of each building on a

micro level and on a nano level; buildings are ordered alphabetically within each OL. The micro level focuses on the location, size and shape of the building, including the foundation levels of the newly built walls, and the height and width of the walls. The nano level focuses on the rooms, the permeabilities, and features and finds. The room description includes location and size. The permeabilities are described including the possible existence of such. The features and finds are a listing of installations and floors. Lastly, the additional data is included to complete any valuable information not mentioned before.

Then the space syntax analysis is applied on the micro level and nano level first on the visitor-inhabitant relationship, where the exterior of the building – the alley – is the root space. This is then repeated for the inhabitant-inhabitant relationship, where the first room accessed in the building – the entrance – is the root space.





A convex map is based on the reduction of spaces to the minimum and largest convex polygons, nevertheless this seems rather redundant given that no activity areas have been detected in this case study. Therefore, each space is simply represented by one polygon, independently from the shape the space has. As archaeological remains are fragmentary by default, a space syntax analysis is not always possible. In the cases where the fragmentary evidence is too scarce, a space syntax analysis was not carried out. If the evidence is enough or can be reconstructed, an analysis was carried out including all the possible variations.





For the space syntax analysis the following procedure was carried out: On the micro levels, a simple justified graph²⁴⁴ along with the total number of nodes (K) is followed by the mean RA and RRA values, which later will be used for comparison, from a table presenting the minimal, mean and maximal of the control value (CV), the total depth (TD), the mean depth (MD), the relative asymmetry (RA) and the real relative asymmetry (RRA) values of each building. On the nano level, the rooms with highest/lowest control (CV) and most/least integrated (RA), which will make possible a comparison of local and global measures, are highlighted from a table presenting the space types (A, B, C, D), the number of connections (NC), the control value (CV), the total depth (TD), the mean depth (MD), the relative asymmetry (RA) and the real relative asymmetry (RRA) values for the space of each building. The graphic output is shown through a codified justified graph and plan,²⁴⁵ followed by an interpretation of the results obtained for each building phenotype. The codes are applied

²⁴⁴ Justified graphs were first drawn in AGRAPH 3.0 (Manum, Rusten, and Benze 2017) for automated calculation and then redrawn in yEd 3.17.2 (computer software, www.yworks.com) to colourize and outline the nodes. Space syntax analysis is carried out with AGRAPH 3.0 and then copied, optimized and completed in Microsoft Excel.

²⁴⁵ Plans were drawn in QGIS 3.8.1.

according to these rules: colours between green and red represent the RA values²⁴⁶ between zero (symmetric) and one (asymmetric), line thicknesses from dashed to thick represents the CV below one (low control) and above one (high control), line types between nodes represent the type of permeability, and letters A to D represent the space types (Figure 21). For this chapter, since each building is analysed as a phenotype, the RA values can be used to define in which part of the resulting range each space falls.

	asymmetric (RA = 0.750-1.000)
	more asymmetric (RA = 0.500-0.749)
	more symmetric (RA = 0.250-0.499)
	symmetric (RA = 0.000-0.249)

	very high control (CV > 2.000)
	high control (CV = 1.000-1.999)
	low control (CV = 0.500-0.999)
	very low control (CV = 0.000-0.499)






	threshold
	doorway or buttress
	open space
	absence of evidence
	unknown/unclear

Figure 21: Codes for justified graphs and plans (RA values, CV and permeability – from top to bottom)

²⁴⁶ RA values are used to colour the graphs instead of RRA values since the result is bound to a range of values. This is possible because the analysis focuses on single buildings and does not compare them yet.

CHAPTER III

Chapter V is divided into two sections: the first section is a synchronic analysis and the second section a diachronic analysis. For this chapter the comparison must be made based on the RRA values (standardised RA values), since the buildings have a different K value.

The synchronic analysis focuses on the results of each OL. The micro level and the nano level are summarised at first based on the descriptions and then on the respective space syntax analysis presented in Chapter IV. This synchronic point of view aims at uncovering similarities and difference of phenotypes which might already occur within each OL. Correlating values in the descriptive part, such as usable area and the number of rooms, gives a deeper insight to how relationships might have worked between rooms.²⁴⁷

The diachronic analysis considers the micro level and the nano level of the descriptions and the space syntax analysis in general, enabling an understanding of how the spatial configuration of phenotype (buildings) varies across OLs. Standard Deviation of building sizes, correlation coefficient of total area and usable area,²⁴⁸ average values and range of values.

The second section also includes the above-mentioned criticism towards the space syntax analysis and Hillier and Hanson's own suggestion that it is necessary to integrate additional information about the analysed space. Hillier and Hanson mention in *The Social Logic of Space* that spaces are labelled and that their relationship captured to define the genotype. In turn the "genotypical trend" would define the syntactic position – the spatial configuration – of those labelled spaces²⁴⁹ This means that classification criteria need to be established to label spaces. Although there are many propositions of classification criteria to label space, such as those by Henrickson²⁵⁰ or Pfälzner,²⁵¹ it is difficult to establish beforehand which one is adequate. Therefore, the criteria will be defined according to the information that is available for the analysed spaces after the space syntax analysis is complete. This serves the purpose of understanding if spatial behaviour of single space labels is related to their functional differentiation. For this the local (CV) and global (RA) values are correlated.

²⁴⁷ Pfälzner defined how to analyse usable area and rooms (Pfälzner 2001, 60–61).

²⁴⁸ Analysing total area and usable area have been carried out in various other case studies that deal with architectural evidence, such as Castel 1992, XIII; Pfälzner 2001, 60–61.

²⁴⁹ Hillier and Hanson 2005, 150–54.

²⁵⁰ Henrickson 1981, 58, 79.

²⁵¹ Pfälzner 2001, 24–38.

CHAPTER III

Chapter VI takes up the research question presented in Chapter I, discussing if a cross-period genotype could be identified or if each OL is represented by one genotype. This is based on the descriptions and space syntax analyses of all phenotypes of all OLs. Average RRA values and the difference factor H^* play here an important role because they make it possible to quantify transpatial and transtemporal links. It remains to be seen if transpatial links can be applied to this case study, since it assumes that they are **contemporary**. If the hypothesis presented in the research question in Chapter I, where a cross-period phenomenon for the genotypes might be possible, turns out to be verified by the space syntax analysis, then the term **transpatial** cannot be applied. There would be a transtemporal link, which is transpatial by default.

CHAPTER IV

STARTING WITH THE PHENOTYPES: DESCRIPTIONS AND SPACE SYNTAX ANALYSIS

This chapter presents a description and a space syntax analysis for each building (phenotype) according to the workflow displayed in Section 5 of Chapter III by occupation level (OL), starting from the oldest and where buildings are ordered alphabetically:²⁵²

- OL 4:

Building F-b3

- OL 3:

Building E-b15

Building F-b1 East

Building F-b1 West

Building F-b2

Building F-b4

Building F-b7

Building F-b12

- OL 2b:

Building E-b11

Building F-b5

Building F-b8 (Phase 1)

- OL 2a:

Building E-b7

Building F-b8 (Phase 2)

²⁵² The collected information for the description of the residential area and, particularly, each building is based on the unpublished reports from the Joint Saudi-Arabian-German Archaeological Project (Hausleiter and Al-Najem 2005, 2006, 2007, 2008, 2009, 2011, 2012, 2014, 2015) and the articles published in the journal *ATLAL* (Eichmann et al. 2010, 2011, 2012; Hausleiter et al. 2017, 2018, 2019). Further details were collected from the field documentation, drawings, photos and the Tayma database (<http://tayma.dainst.org/>).

1 OL 4 PHENOTYPES– NABATAEAN PERIOD

1.1 Description – macro level

One building has been identified in Area E-South/F from OL 4 – Building F-b3 (Figure 22). A second building, Building E-b9, was identified in the area but does not have enough information to carry out a space syntax analysis.²⁵³ Further evidence, such as walls and installations uncovered from OL 4, did not provide the necessary information to determine other buildings.



Figure 22: Architectural evidence from the Nabataean Period (OL 4) in the residential area (Area E-South/F)

²⁵³ There is an article authored by Friedrich Weigel about Building E-b9, located in Area E-South/F (Weigel 2019).

1.2 Building F-b3

1.2.1 Description

Micro level

Building F-b3 (Figure 23, Figure 24) was built on collapsed walls and debris of an older OL (OL 5). The building has an estimated area of about 270.70 m² with a rectangular shaped ground plan. It has an estimated usable area of 157.40 m². The foundation levels of the newly built walls are set between 827.68 m a.s.l. and 828.72 m a.s.l. The preserved height of the walls is up to about 1.54 m. The width of the external walls is between 0.75 m and 1.00 m. The width of the internal walls is between 0.30 m and 1.00 m.



Figure 23: Building F-b3



Figure 24: Building F-b3; view from E (© DAI Orient Department 2016 F. Weigel)

Nano level

Rooms

The usable area is divided into five rooms. F-b3:R5 is located at the entrance on the north-eastern corner and has an area of about 9.70 m². F-b3:R3 is located on the east side and has an area of about 86.70 m². F-b3:R2 is located on the north side and has an area of about 28.30 m². F-b3:R1, an L-shaped room, is located on the west side and has an area of about 24.70 m². F-b3:R4 is located in the southwestern corner and has an area of about 8.00 m². All rooms are outer rooms.

The space before entering Building F-b3 is characterised by a roofed area (F-b3:R6), evidenced by beam holes in the wall facing the entrance (SU 3969) (Figure 25).



Figure 25: Wall SU 3969 with beam holes facing the entrance of Building F-b3 in the N; view from S
(© DAI Orient Department 2011 F. Weigel)

Permeabilities

The entrance was identified in the north-eastern corner, accessing the building from alley F-s3 first to a roofed area (F-b3:R6) and then to F-b3:R5. Doorways were identified between F-b3:R5 and F-b3:R3, F-b3:R1 and F-b3:R2, and between F-b3:R1 and F-b3:R4. Further permeability can only be identified through absence of evidence, such as no wall evidence between F-b3:R2 and F-b3:R3.

Features and finds

Floors were identified in two rooms. In F-b3:R1, the trodden floor SU 2388²⁵⁴ at approx. 828.45 m a.s.l. In F-b3:R3, the mud and stone floor SU 2984 at 828.40 m a.s.l. An installation with grinding depressions was reused as a building element of a wall (SU 3649, Figure 26) located in the western corner of F-b3:R1.

²⁵⁴ SU 2388 = SU 2084.



Figure 26: Stone with grinding depressions in wall SU 3649 (on the right side); view from S (© DAI Orient Department 2009 C. Purschwitz)

A sample of wooden remains from a beam in the east facade of the east pillar of the entrance (SU 3973) was dated to 371-202 calBC with ^{14}C -analysis.²⁵⁵ Another sample of wooden remains from the wall facing the entrance (SU 3969) was dated to 544-401 calBC with ^{14}C -analysis.²⁵⁶ The older date of the second sample is interpreted as being due to the reuse of wooden beams for the roofing of the entrance.²⁵⁷ A third sample, fragments of dates, was taken from the mud and stone floor SU 2982 and dated to 92-245 calAD with ^{14}C -analysis.²⁵⁸ Given that the date is more recent than of the other samples, the date is probably of the end of the use of Building F-b3.

²⁵⁵ Phoenix (palm) wood – *phoenix dactylifera* (TA 8624); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5543; date: 2210 ± 25 BP; 2σ range date: 371-202 calBC (95.4%); OxCal v4.1.7; June 2010. For more details see Tourtet and Weigel 2015, 390; Weigel 2019, 108, 109, 110 - Fig. 6.

²⁵⁶ Phoenix (palm) wood – *phoenix dactylifera* (TA 8201); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 8089; date: 2410 ± 25 BP; 2σ range date: 731-401 calBC (95.4%), 544-401 calBC (85.6%); OxCal v4.1.7; June 2010. For more details see Weigel 2019, 108, 110 - Fig. 6.

²⁵⁷ Weigel 2019, 108.

²⁵⁸ Fragments of dates (TA 8333); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5540; date: 1830 ± 25 BP; 2σ range date: 92-245 calAD (95.4%); OxCal v4.1.7; June 2010.

1.2.2 Space syntax analysis

It is not clear whether Building F-b3 had further subdivisions of space, such as F-b3:R3. The space syntax analysis therefore includes only the spaces that are certain.

Visitor-inhabitant relationship

Micro level

Building F-b3 is composed of K=7 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 27).

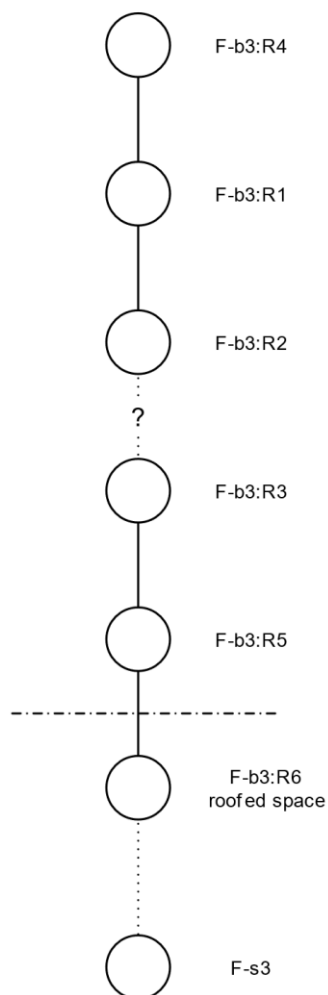


Figure 27: Justified graph Building F-b3 (visitor-inhabitant)

CHAPTER IV

Table 6 shows the results obtained for the building on a micro level, where the mean RA is 0.667 and the mean RRA is 1.963.

Table 6: Micro level analysis of Building F-b3 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	12.000	2.000	0.400	1.178
Mean	1.000	16.000	2.667	0.667	1.963
Max	1.500	21.000	3.500	1.000	2.944

Nano level

Table 7 shows the results obtained for each space. Two rooms are of type A and five are of type B. Alley F-s3 and F-b3:R4 have the lowest CV, whereas F-b3:R1 and F-b3:R6 have the highest CV. F-b3:R3 has the lowest RA value, whereas alley F-s3 and F-b3:R4 have the highest RA values.

Table 7: Nano level of analysis of Building F-b3, K = 7 and D = 0.340 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b3:F-s3	A	1	0.500	21	3.500	1.000	2.944
F-b3:R1	B	2	1.500	16	2.667	0.667	1.963
F-b3:R2	B	2	1.000	13	2.167	0.467	1.374
F-b3:R3	B	2	1.000	12	2.000	0.400	1.178
F-b3:R4	A	1	0.500	21	3.500	1.000	2.944
F-b3:R5	B	2	1.000	13	2.167	0.467	1.374
F-b3:R6	B	2	1.500	16	2.667	0.667	1.963

Graphic output and interpretation

The justified graph in Figure 28 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b3, while the plan in Figure 29 visualises the last two values.

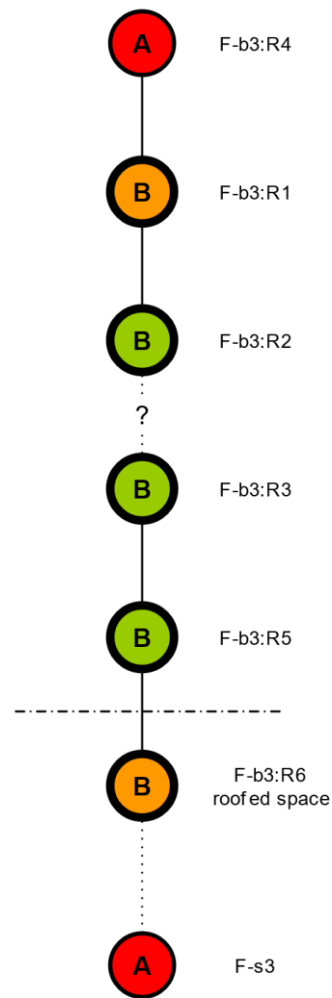


Figure 28: Coded justified graph of Building F-b3 (visitor-inhabitant)

Building F-b3 has a more segregated overall configuration (mean RA = 0.667 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b3 has a segregated position (the alley) in relation to the interior before entering the building. Before accessing the building, a more segregated roofed area is accessed (R6). Upon entering, a more integrated room (R5) is accessed, which initiates the sequence of rooms that follows. The next room is the largest room in the building and is more integrated (R3), followed by a more integrated room (R2), a more segregated room (R1) and a segregated back room (R4).

The highest control over adjacent rooms is exercised by the roofed space before the entrance of the building (R6) and R1.

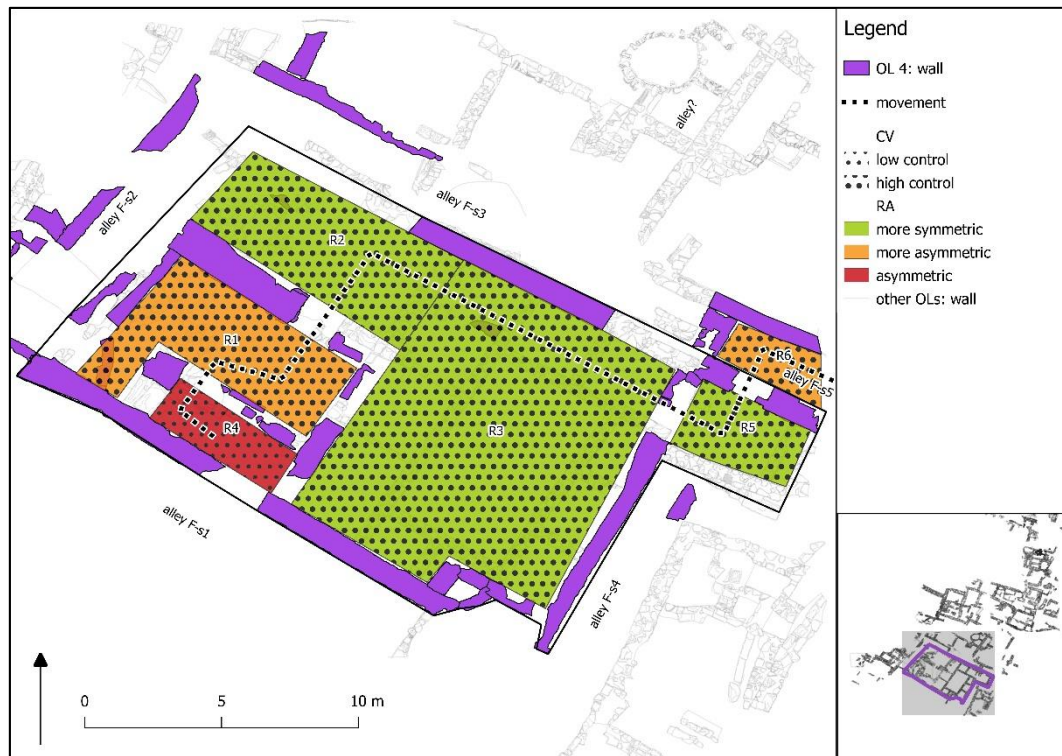


Figure 29: Building F-b3 (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b3 is composed of $K=5$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 30).

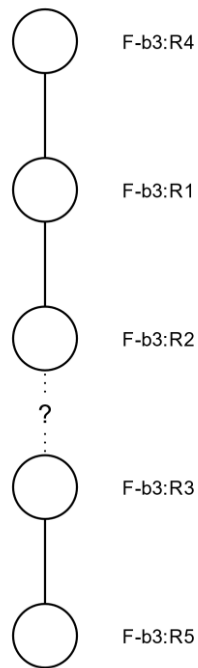


Figure 30: Justified graph Building F-b3 (inhabitant-inhabitant)

CHAPTER IV

Table 8 shows the results obtained for the building on a micro level, where the mean RA is 0.667 and the mean RRA is 1.894.

Table 8: Micro level analysis of Building F-b3 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	6.000	1.500	0.333	1.000
Mean	1.000	8.000	2.000	0.667	1.894
Max	1.500	10.000	2.500	1.000	2.841

Nano level

Table 9 shows the results obtained for each space on the nano level. Two rooms are of type A and three are of type B. F-b3:R4 and F-b3:R5 have the lowest CV, whereas F-b3:R1, F-b3:R2 and F-b3:R3 have the highest CV. F-b3:R2 has the lowest RA value, whereas F-b3:R4 and F-b3:R5 have the highest RA values.

Table 9: Nano level of analysis of Building F-b2, $k = 5$ and $D = 0.352$ (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b3:R1	B	2	1.500	7	1.750	0.500	1.420
F-b3:R2	B	2	1.500	6	1.500	0.333	0.947
F-b3:R3	B	2	1.500	7	1.750	0.500	1.420
F-b3:R4	A	1	0.500	10	2.500	1.000	2.841
Fb3:R5	A	1	0.500	10	2.500	1.000	2.841

Graphic output and interpretation

The justified graph in Figure 31 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b3, while the plan in Figure 32 visualises the last two values.

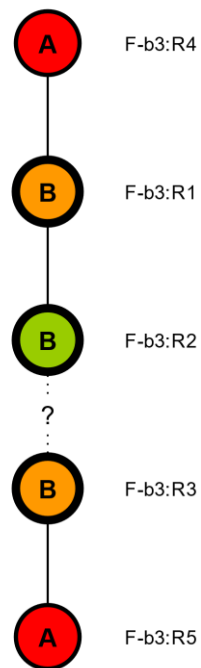


Figure 31: Coded justified graph of Building F-b3 (inhabitant-inhabitant)

CHAPTER IV

An individual moving inside of Building F-b3 is in more segregated surroundings (mean $RA = 0.667$ – inhabitant-inhabitant relationship). The entrance room (R5) loses control and becomes segregate as the back room (R4) (Table 10). The central rooms (R2, R3) gain control over adjacent rooms, equal to R1, while R1 and R2 increase its integration, R3 and R5 decrease it.

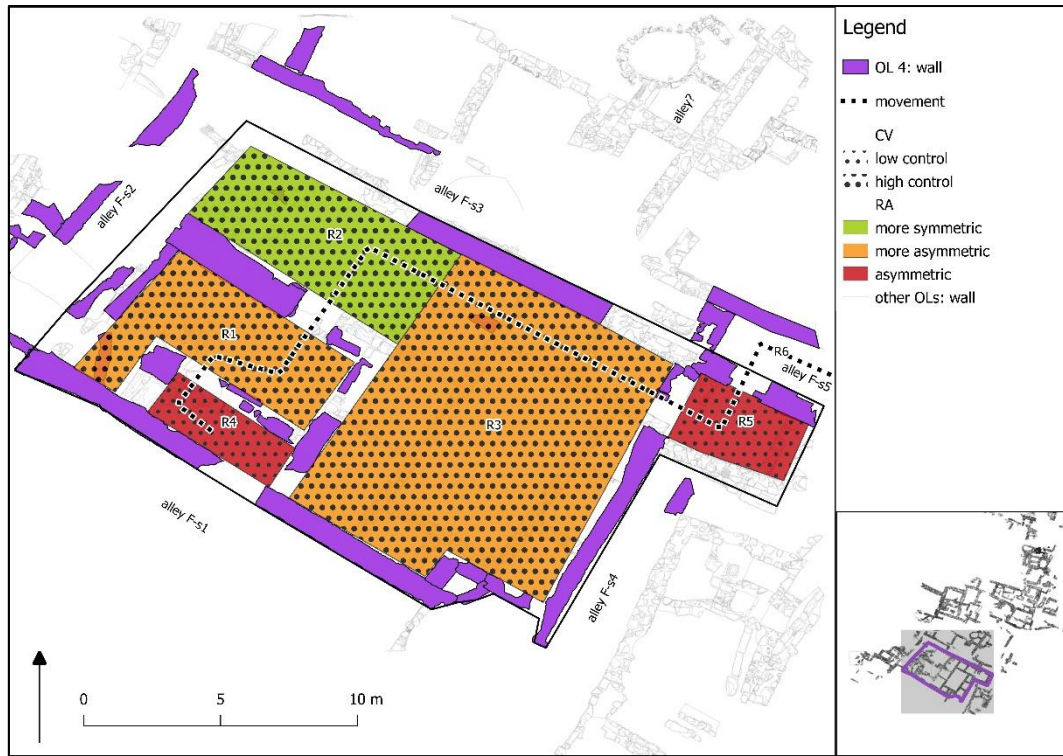


Figure 32: Building F-b3 (inhabitant-inhabitant)

Table 10: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b3

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b3:alley	0.500	-	1.000	-
F-b3:R1	1.500	1.500	0.667	0.500
F-b3:R2	1.000	1.500	0.467	0.333
F-b3:R3	1.000	1.500	0.400	0.500
F-b3:R4	0.500	0.500	1.000	1.000
F-b3:R5	1.000	0.500	0.467	1.000
F-b3:R6	1.500	-	0.667	-

2 OL 3 PHENOTYPES – ROMAN PERIOD

2.1 Description – macro level

Eleven buildings have been identified in Area E-South/F from OL 3 – Building E-b10; Building E-b13; Building E-b15; Building F-b1 West; Building F-b1 East; Building F-b2; Building F-b4; Building F-b7; Building F-b10; Building F-b12 (Figure 33). Of those, seven have enough information about the spatial layout to carry out a space syntax analysis. Further evidence uncovered from OL 3 did not provide the necessary information to determine other buildings.



Figure 33: Architectural evidence from the Roman Period (OL 3) in the residential area (Area E-South/F)

2.2 Building E-b15

2.2.1 Description

Micro level

Building E-b15 (Figure 34, Figure 35) was built on top of evidence of walls from an unidentified OL 4 building, reusing part of the existing walls. The building has an estimated area of about 118.00 m² with a roughly rectangular ground plan. It has an estimated usable area of about 62.70 m². The foundation levels of the walls are set between 829.80 m a.s.l. and 829.90 m a.s.l. Set at a lower level between 827.75 m a.s.l. and 827.95 m a.s.l. are the walls reused from an older building (OL 4). The preserved height of the walls is up to 2.05 m. The width of the external walls is between 0.45 m and 0.75 m. The width of the internal walls is between 0.50 m and 0.64 m.



Figure 34: Buildings E-b15



Figure 35: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into five rooms. E-b15:R4 is located in the centre and has an area of about 14.40 m². E-b15:R5 is located on the west side and has an area of about 26.80 m². E-b15:R4 and E-b15:R5 form probably an open space. E-b15:R2 is located in the eastern corner and has an area of about 16.30 m². E-b15:R3 is located on the south side, east of E-b15:R4, and has an area of about 7.50 m². E-b15:R1 is located in the south-eastern corner and has an area of about 2.20 m². All rooms are outer rooms.

Permeabilities

The entrance was possibly located at the south side, accessing the building from alley F-s8 to E-b15:R4, attested only by absence of evidence. Further permeabilities can only be identified through absence of evidence, such as interruptions of walls between E-b15:R3 and E-b15:R2 and between E-b15:R4 and E-b15:R3. It is not clear whether E-b15:R1 was accessed from E-b15:R2 or E-b15:R3. There is no visible division between E-b15:R4 and E-b15:R5, functioning possibly as an open space.

Features and finds

Floors were identified in three rooms. In E-b15:R5, the trodden mud floor SU 6677 at 830.21 m a.s.l. In E-b15:R4 and E-b15:R5, the clay floor SU 7340 at 829.90 m a.s.l. In E-b15:R3, the clay floor SU 7557 at 829.21 m a.s.l.

2.2.2 Space syntax analysis

2.2.3 Space syntax analysis – variation 1

Variation 1 of a space syntax analysis of Building E-b15 assumes a connection between E-b15:R1 and E-b15:R2.

Visitor-inhabitant relationship

Micro level

Building E-b15 is composed of K=6 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 36).

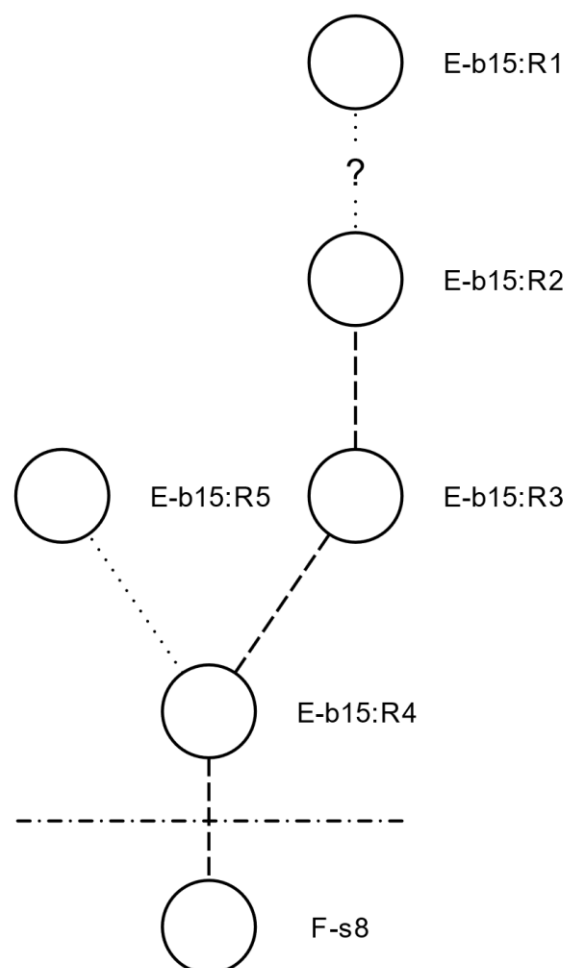


Figure 36: Justified graph Building E-b15 (visitor-inhabitant) – variation 1

CHAPTER IV

Table 11 shows the results obtained for the building on a micro level, where the mean RA is 0.567 and the mean RRA is 1.624.

Table 11: Micro level analysis of Building E-b15 (visitor-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.333	8.000	1.600	0.300	0.860
Mean	1.000	10.667	2.133	0.567	1.624
Max	2.500	14.000	2.800	0.900	2.579

Nano level

Table 12 shows the results obtained for each space. Three rooms are of type A and three are of type B. Alley F-s8 and E-b15:R5 have the lowest CV, whereas E-b15:R4 has the highest CV. E-b15:R3 and E-b15:R4 have the lowest RA values, whereas E-b15:R1 has the highest RA value.

Table 12: Nano level of analysis of Building E-b15, K = 6 and D = 0.349 (visitor-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
E-b15:F-s8	A	1	0.333	12	2.400	0.700	2.006
E-b15:R1	A	1	0.500	14	2.800	0.900	2.579
E-b15:R2	B	2	1.500	10	2.000	0.500	1.433
E-b15:R3	B	2	0.833	8	1.600	0.300	0.860
E-b15:R4	B	3	2.500	8	1.600	0.300	0.860
E-b15:R5	A	1	0.333	12	2.400	0.700	2.006

Graphic output and interpretation

The justified graph in Figure 37 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building E-b15, while the plan in Figure 38 visualises the last two values.

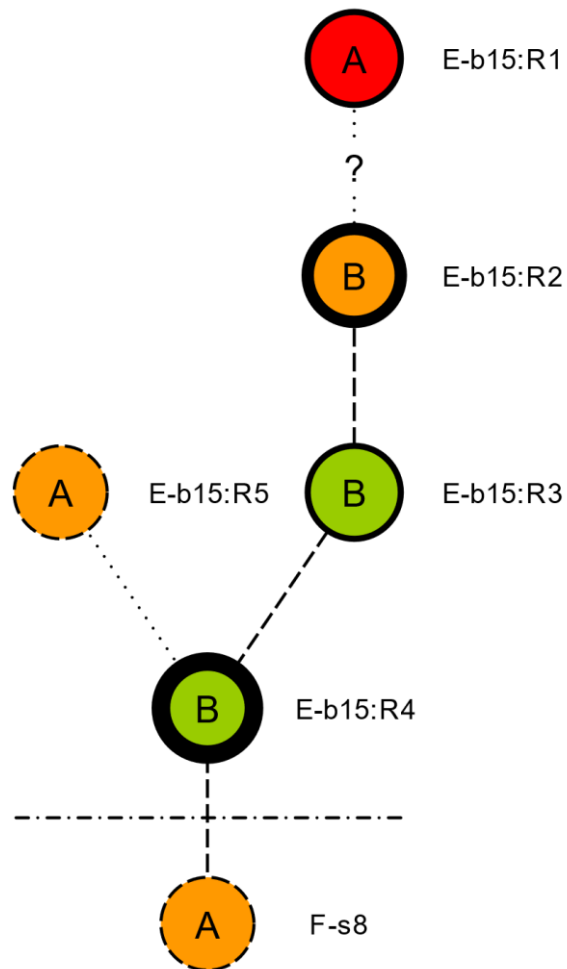


Figure 37: Coded justified graph of Building E-b15 (visitor-inhabitant) – variation 1

Building E-b15 has a more segregated overall configuration (mean RA = 0.567 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building E-b15 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, one of the two most integrated rooms (R4) is accessed. It gives access to the east and west parts. The east part is composed of three rooms, the first more integrated (R3), the second more segregated (R2) and the third a segregated back room (R1). The west part is composed of one more segregated room (R5), which was probably an open space together with R4.

The highest control over adjacent rooms is exercised by the room at the entrance of the building (R4), connecting the east and west parts.

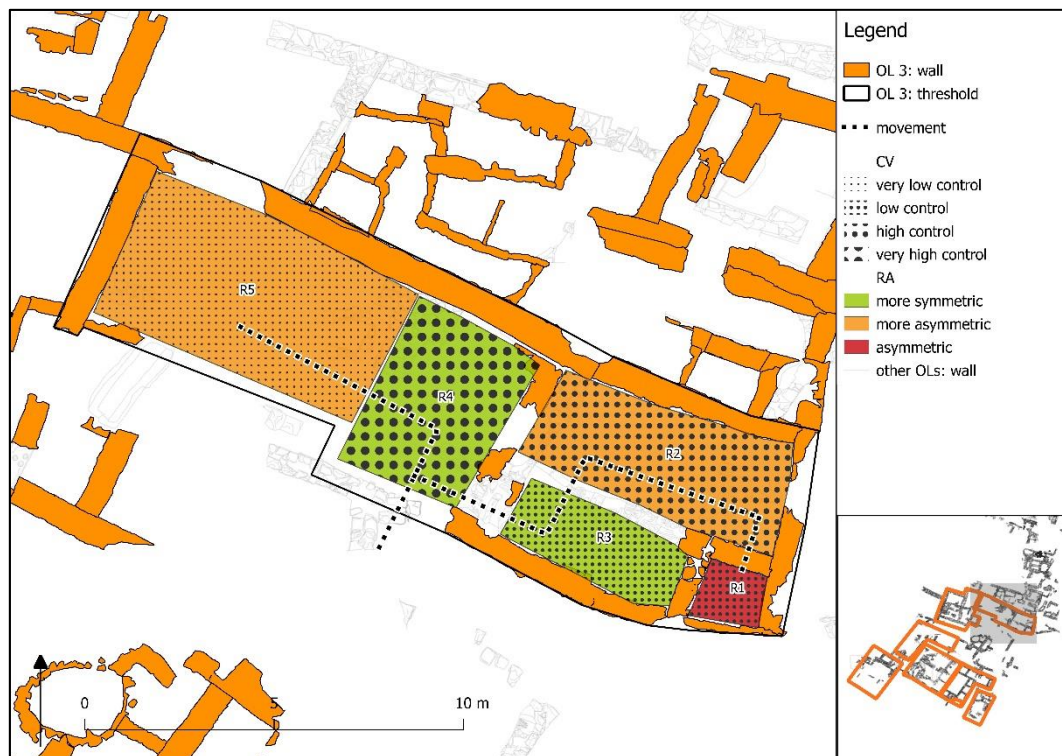


Figure 38: Building E-b15 (visitor-inhabitant) – variation 1

Inhabitant-inhabitant relationship

Micro level

Building E-b15 is composed of K=5 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 39).

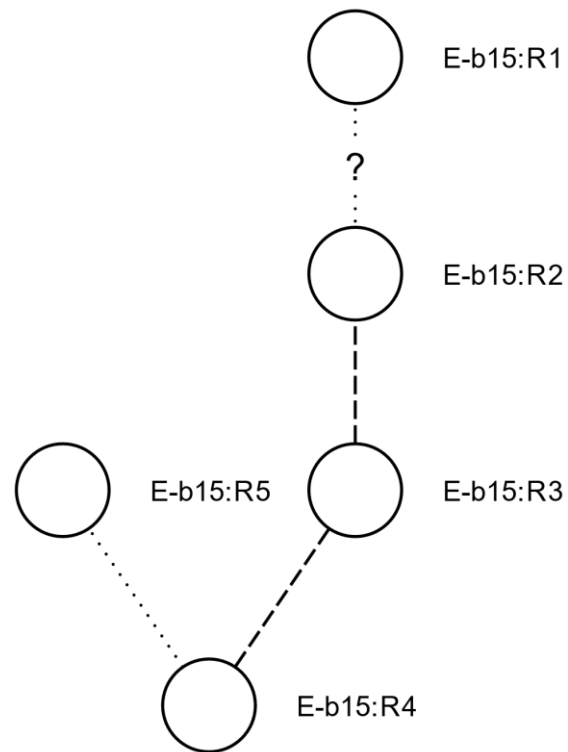


Figure 39: Justified graph Building E-b15 (inhabitant-inhabitant) – variation 1

CHAPTER IV

Table 13 shows the results obtained for the building on a micro level, where the mean RA is 0.667 and the mean RRA is 1.894.

Table 13: Micro level analysis of Building E-b15 (inhabitant-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.500	6.000	1.500	0.333	0.947
Mean	1.000	8.000	2.000	0.667	1.894
Max	1.500	10.000	2.500	1.000	2.841

Nano level

Table 14 shows the results obtained for each space on the nano level. Two rooms are of type A and three are of type B. E-b15:R1 and E-b15:R5 have the lowest CV, whereas E-b15:R2 and E-b15:R4 have the highest CV. E-b15:R3 has the lowest RA value, whereas E-b15:R1 and E-b15:R5 have the highest RA value.

Table 14: Nano level of analysis of Building E-b15, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
E-b15:R1	A	1	0.500	10	2.500	1.000	2.841
E-b15:R2	B	2	1.500	7	1.750	0.500	1.420
E-b15:R3	B	2	1.000	6	1.500	0.333	0.947
E-b15:R4	B	2	1.500	7	1.750	0.500	1.420
E-b15:R5	A	1	0.500	10	2.500	1.000	2.841

Graphic output and interpretation

The justified graph in Figure 40 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building E-b15, while the plan in Figure 41 visualises the last two values.

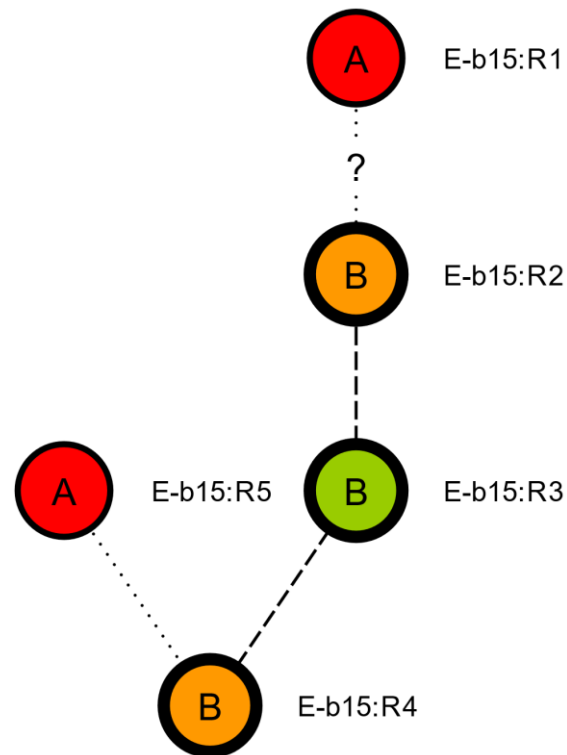


Figure 40: Coded justified graph of Building E-b15 (inhabitant-inhabitant) – variation 1

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.667 – inhabitant-inhabitant relationship). The entrance room (R4) loses some control (Table 15), sharing it now equally with R2. R3, leading to the east part and R5 to the west gain a bit of control. All spaces increase their segregation, except for R2.

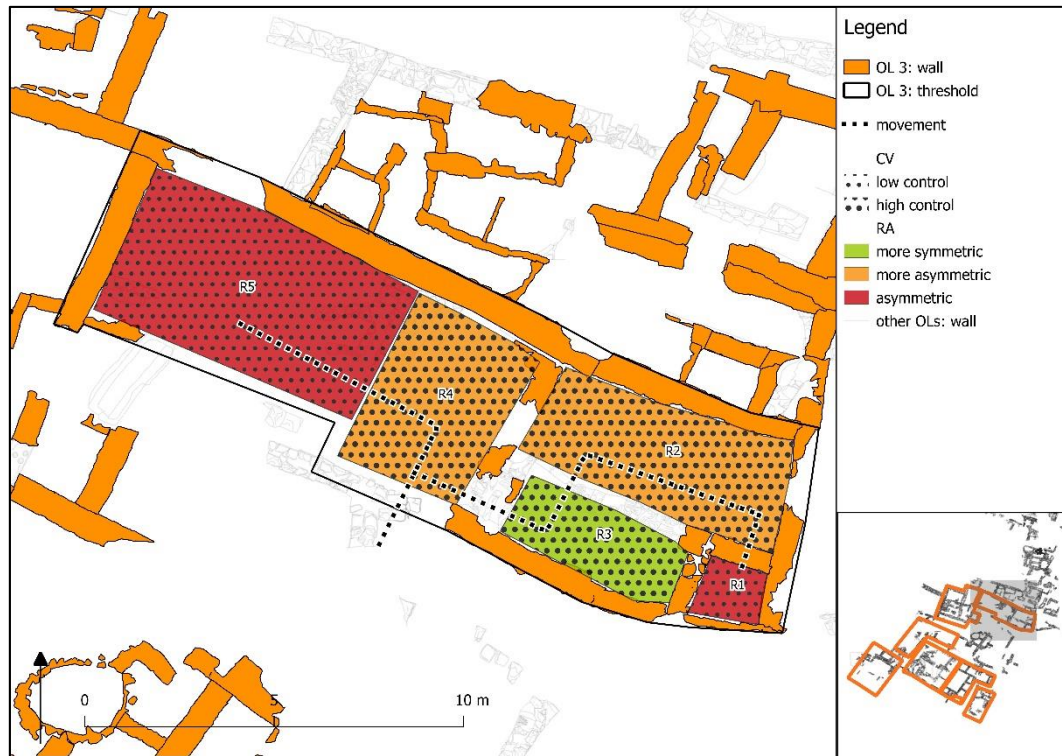


Figure 41: Building E-b15 (inhabitant-inhabitant) – variation 1

Table 15: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b15, variation 1

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
E-b15:F-s8	0.333	-	0.700	-
E-b15:R1	0.500	0.500	0.900	1.000
E-b15:R2	1.500	1.500	0.500	0.500
E-b15:R3	0.833	1.000	0.300	0.333
E-b15:R4	2.500	1.500	0.300	0.500
E-b15:R5	0.333	0.500	0.700	1.000

2.2.4 Space syntax analysis – variation 2

Variation 2 of a space syntax analysis of Building E-b15 assumes a connection between E-b15:R1 and E-b15:R3.

Visitor-inhabitant relationship

Micro level

Building E-b15 is composed of K=6 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 42).

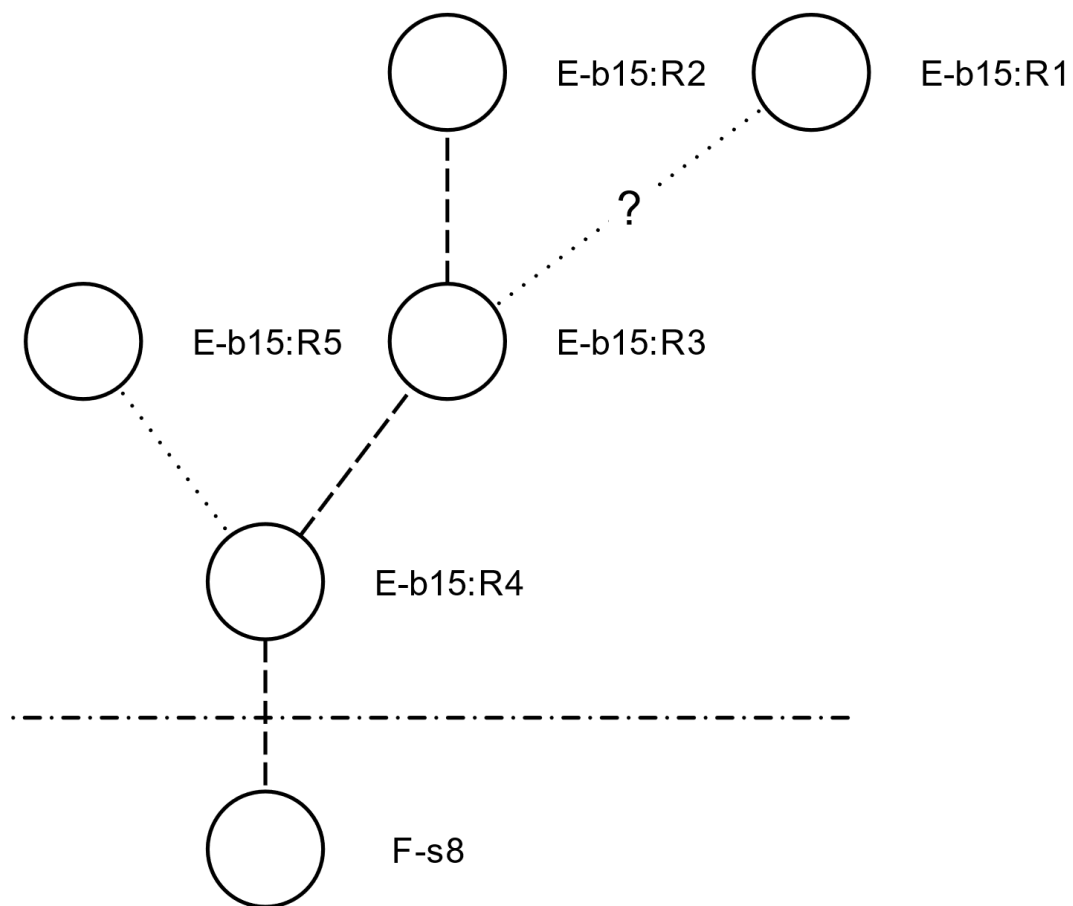


Figure 42: Justified graph Building E-b15 (visitor-inhabitant) – variation 2

CHAPTER IV

Table 16 shows the results obtained for the building on a micro level, where the mean RA is 0.467 and the mean RRA is 1.337.

Table 16: Micro level analysis of Building E-b15 (visitor-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.333	7.000	1.400	0.200	0.573
Mean	1.000	9.667	1.933	0.467	1.337
Max	2.333	11.000	2.200	0.600	1.719

Nano level

Table 17 shows the results obtained for each space. Four rooms are of type A and two are of type B. Alley F-s8, E-b15:R1, E-b15:R2 and E-b15:R5 have the lowest CV, whereas E-b15:R3 and E-b15:R4 have the highest CV. E-b15:R3 and E-b15:R4 have the lowest RA values, whereas alley F-s8, E-b15:R1, E-b15:R2 and E-b15:R5 have the highest RA values.

Table 17: Nano level of analysis of Building E-b15, K = 6 and D = 0.349 (visitor-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
E-b15:F-s8	A	1	0.333	11	2.200	0.600	1.719
E-b15:R1	A	1	0.333	11	2.200	0.600	1.719
E-b15:R2	A	1	0.333	11	2.200	0.600	1.719
E-b15:R3	B	3	2.333	7	1.400	0.200	0.573
E-b15:R4	B	3	2.333	7	1.400	0.200	0.573
E-b15:R5	A	1	0.333	11	2.200	0.600	1.719

Graphic output and interpretation

The justified graph in Figure 43 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building E-b15, while the plan in Figure 44 visualises the last two values.

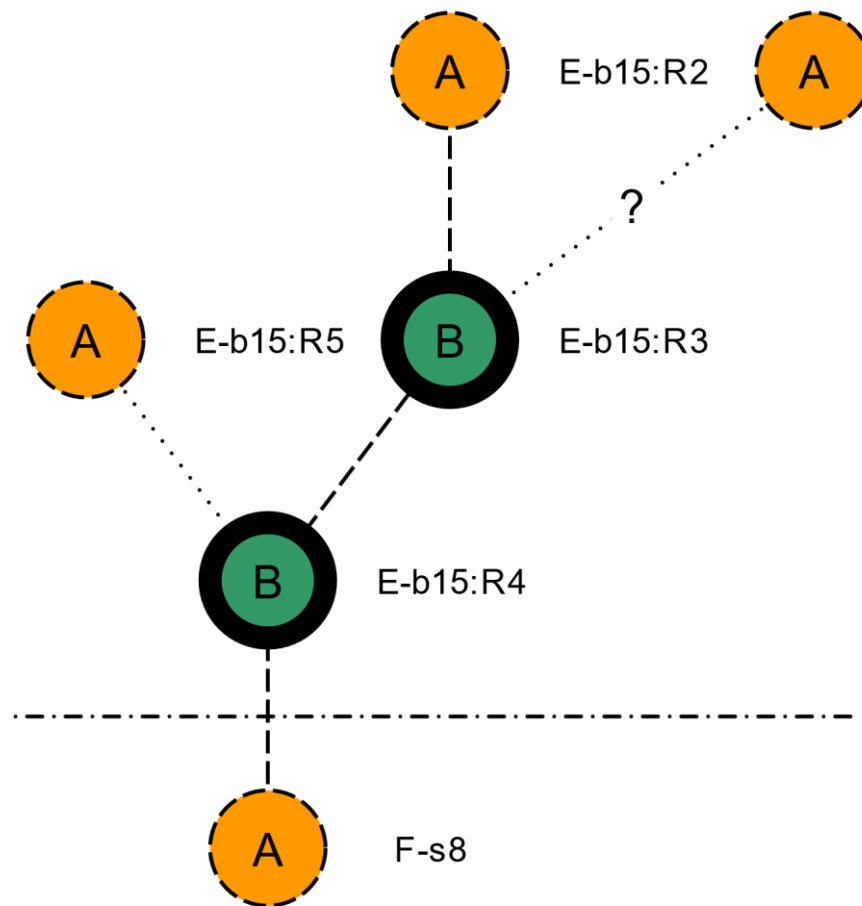


Figure 43: Coded justified graph of Building E-b15 (visitor-inhabitant) – variation 2

Building E-b15 has a more integrated overall configuration (mean RA = 0.467 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building E-b15 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, one of the two most integrated rooms (R4) is accessed. It gives access to the east and west parts. The east part is composed of three rooms, the first is, in this variation, the other integrated room (R3), the other two are more segregated (R2, R1). The west part is composed of one more segregated room (R5), which probably was an open space together with R4.

The highest control over adjacent rooms is exercised by the room at the entrance of the building (R4) and the first room to the east part (R3).

This variation of Building E-b15 is generally more segregated and control is distributed over two rooms instead of one.



Figure 44: Building E-b15 (visitor-inhabitant) – variation 2

Inhabitant-inhabitant relationship

Micro level

Building E-b15 is composed of K=5 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 45).

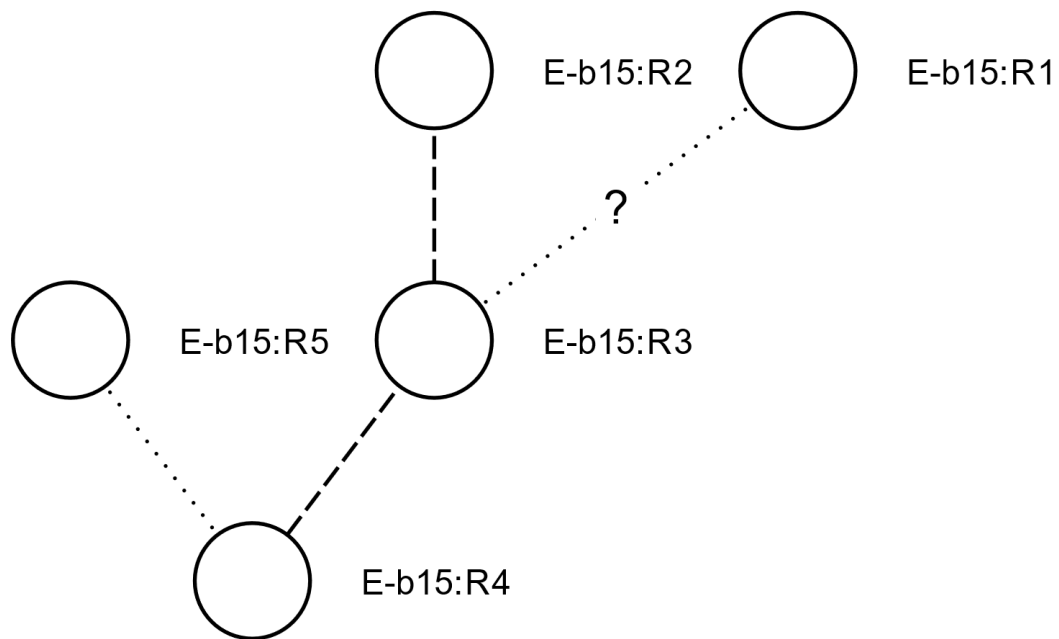


Figure 45: Justified graph Building E-b15 (inhabitant-inhabitant) – variation 2

CHAPTER IV

Table 18 shows the results obtained for the building on a micro level, where the mean RA is 0.533 and the mean RRA is 1.515.

Table 18: Micro level analysis of Building E-b15 (inhabitant-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.333	5.000	1.250	0.167	0.473
Mean	1.000	7.200	1.800	0.533	1.515
Max	2.500	9.000	2.250	0.833	2.367

Nano level

Table 19 shows the results obtained for each space on the nano level. Three rooms are of type A and two are of type B. E-b15:R1 and E-b15:R2 have the lowest CV, whereas E-b15:R3 has the highest CV. E-b15:R3 has the lowest RA value, whereas E-b15:R5 has the highest RA value.

Table 19: Nano level of analysis of Building E-b15, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
E-b15:R1	A	1	0.333	8	2.000	0.667	1.894
E-b15:R2	A	1	0.333	8	2.000	0.667	1.894
E-b15:R3	B	3	2.500	5	1.250	0.167	0.473
E-b15:R4	B	2	1.333	6	1.500	0.333	0.947
E-b15:R5	A	1	0.500	9	2.250	0.833	2.367

Graphic output and interpretation

The justified graph in Figure 46 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building E-b15, while the plan in Figure 47 visualises the last two values.

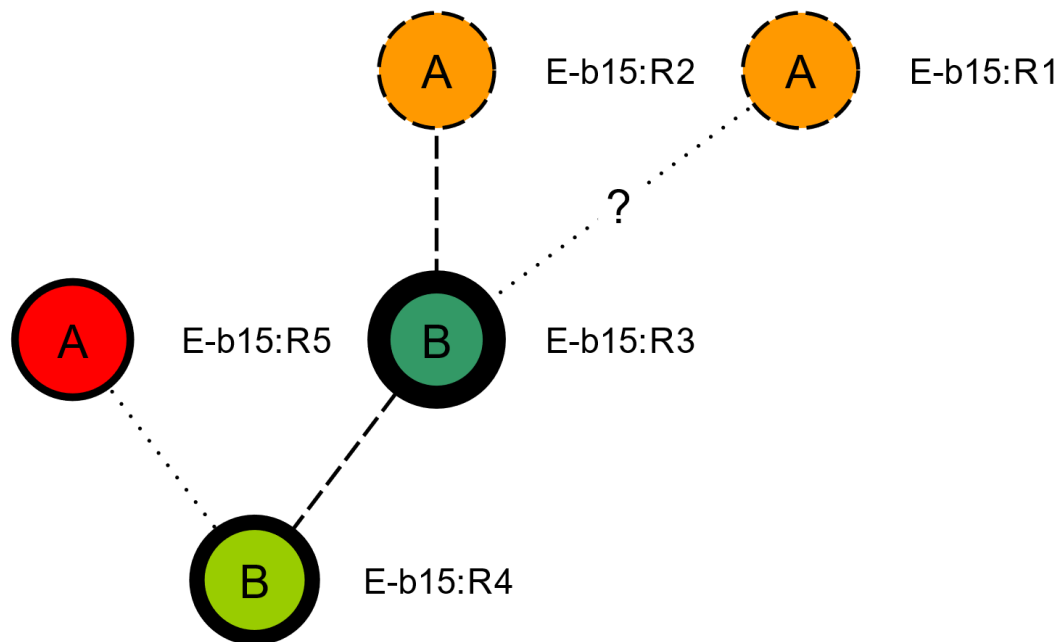


Figure 46: Coded justified graph of Building E-b15 (inhabitant-inhabitant) – variation 2

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.533 – inhabitant-inhabitant relationship). The entrance room (R4) loses control, shifting now to R3 (Table 20). R5 in the west part increases control. All spaces tend to become more segregated, except for R3, which becomes the most integrated one.

This variation of Building E-b15 is generally more segregated and the control has shifted from R2 and R4 to R3.

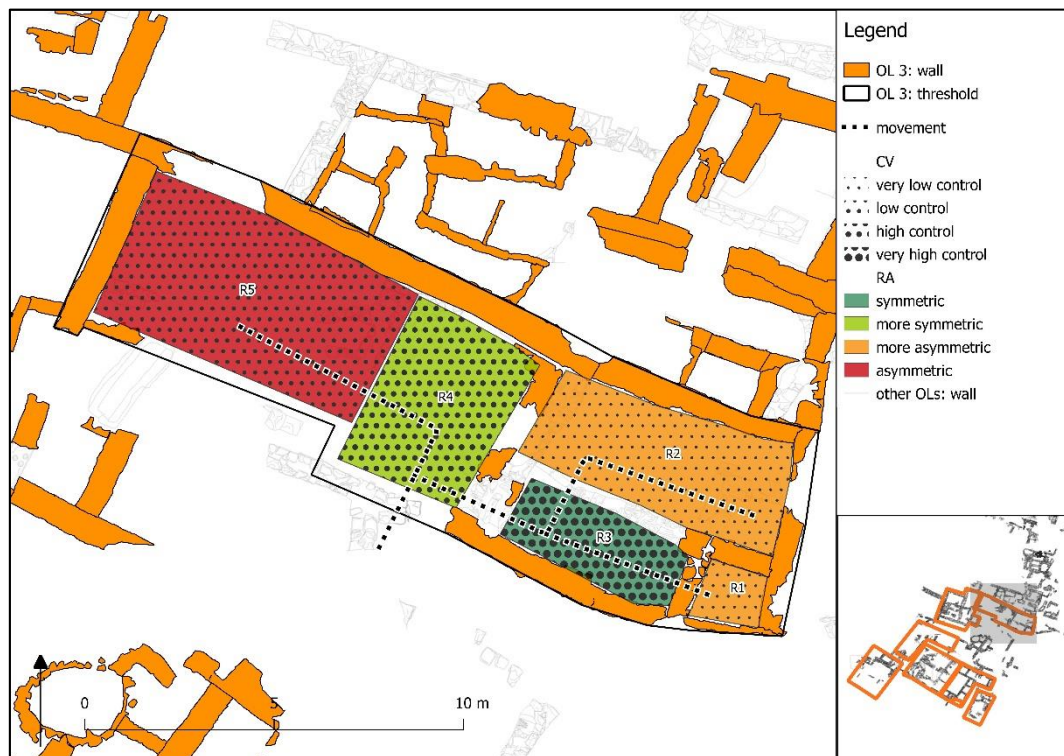


Figure 47: Building E-b15 (inhabitant-inhabitant) – variation 2

Table 20: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b15, variation 2

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
E-b15:F-s8	0.333	-	0.600	-
E-b15:R1	0.333	0.333	0.600	0.667
E-b15:R2	0.333	0.333	0.600	0.667
E-b15:R3	2.333	2.500	0.200	0.167
E-b15:R4	2.333	1.333	0.200	0.333
E-b15:R5	0.333	0.500	0.600	0.833

2.3 Building F-b1 East

2.3.1 Description

Micro level

Building F-b1 East (Figure 48, Figure 49) was built on top of the eastern part of Building F-b3 (OL 4), reusing part of the razed external walls as foundation for the newly built walls and also reusing OL 4 walls. The building has an estimated area between about 114.40 m² and 119.30 m² with an L-shaped ground plan. It has an estimated usable area between 60.40 m² and 62.30 m². The foundation levels of the walls from Building F-b1 East vary strongly, depending on the refill of an older OL (OL 4) and whether the walls are reused from Building F-b3 (OL 4) or not. For example, in the section crossing F-b1:R9, F-b1:R10 and F-b1:R17 (from west to E) the foundation of wall SU 2009 is at 828.70 m a.s.l. and the foundation of wall SU 3953 is at 827.70 m a.s.l. . The width of the external walls, reused from OL 4, is between 0.70 m and 0.90 m. The width of the internal walls is between 0.45 m and 0.50 m.



Figure 48: Building F-b1 East



Figure 49: Building F-b1 East; view from E (© DAI Orient Department 2016 F. Weigel)

Nano level

Rooms

The usable area is divided into nine or ten rooms. F-b1:R11 is an inner room located in the central west side and has an area of about 26.30 m². F-b1:R14, in the southwestern corner, is an outer room with an area of about 2.30 m². F-b1:R15 is an outer room located on the south side and has an area of about 2.50 m², respectively. F-b1:R12, F-b1:R18 and F-b1:R13, from northeast to southwest, are outer rooms located on the east to southeast side and have an area of about 2.50 m², 3.20 m² and 3.30 m², respectively. F-b1:R9 is an outer room located in the northern corner and has an area of about 4.70 m². F-b1:R10 and F-b1:R17 are outer rooms located in the north-eastern corner and together have an area of about 6.40 m² and 9.20 m², respectively. A buttress (SU 3963) of 1.00 by 0.70 m on the northeast entrance wall SU 3973 created a division between both rooms. Possibly an outer room, F-b1:R19, is located on the south corner and has an area of about 1.90 m².

The space before entering Building F-b1 East is characterised by an unroofed area (F-b1:R16).

Permeabilities

The entrance was identified in the north-eastern corner (Figure 50), accessing the building from the blind alley F-s5 first to an unroofed area (F-b1:R16) and then to F-b1:R17. This entrance is flanked by two vertical stones (SU 3973 and SU 3966, Figure 50), narrowing the opening to a width of 0.80 m and a threshold (SU 8686). A buttress defines the doorway between F-b1:R17 and F-b1:R10. Further permeabilities can only be assumed between F-b1:R11 and F-b1:R9, between F-b1:R11 and F-b1:R12, between F-b1:R11 and F-b1:R13, between F-b1:R11 and F-b1:R14, between F-b1:R11 and F-b1:R15 and maybe between F-b1:R15 and F-b1:R19 (if part of Building F-b1 East).

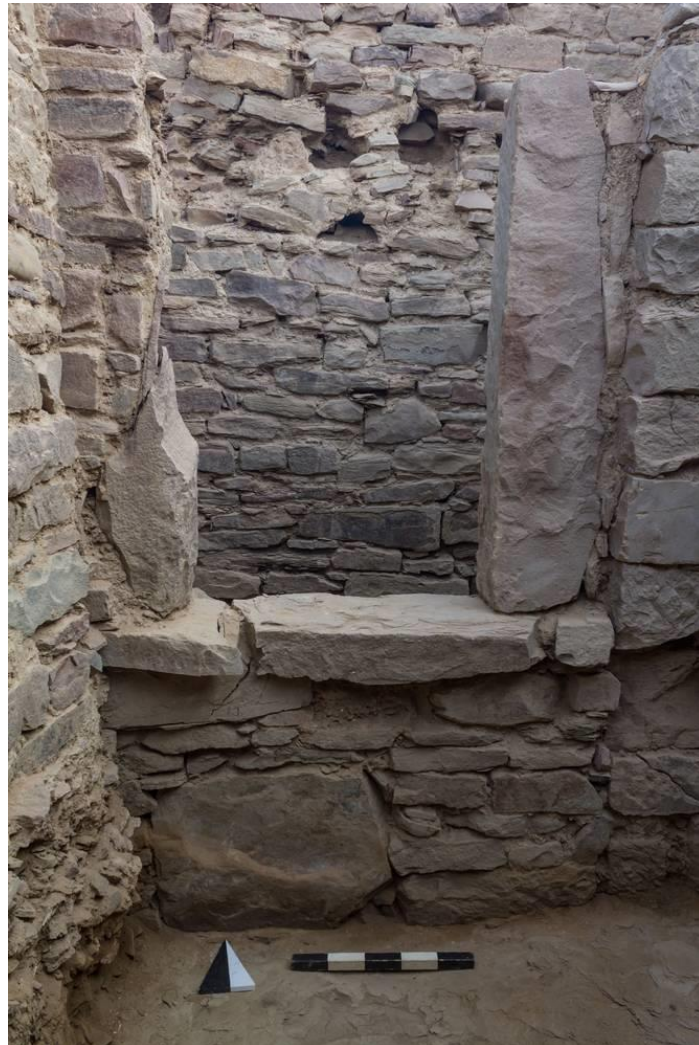


Figure 50: Entrance of Building F-b1 East flanked by two vertical stones (SU 3973 and SU 3966) and the threshold (SU 8686), view from R17 in the interior to the exterior. Wall SU 3969 can be seen in the background (Building F-b3 roofing, see Figure 25); view from S (© DAI Orient Department 2016 F. Weigel)

Features and finds

Floors were identified in seven rooms. In F-b1:R11, the 2-3 cm thick trodden floor SU 2392 at 828.60 m a.s.l. In F-b1:R14, the mud floor SU 5330 at max. 828.86 m a.s.l. In F-b1:R15, the mud and stone floor SU 5326 at 828.56 m a.s.l. The stones were reused from SU 5328 (OL 4). In F-b1:R18, the trodden floor SU 5788 at 828.77 m a.s.l. In F-b1:R13, the trodden, partially burnt floor SU 5786 at 828.67 m a.s.l. In F-b1:R9, the 10 cm thick mud floor SU 3964 at max. 828.80 m a.s.l. In F-b1:R10, the mud floor SU 3970 at max. 828.44 m a.s.l.

A sample of charred wood remains from mud and stone floor SU 5326 was dated to 376-186 calBC with ¹⁴C-analysis.²⁵⁹ The older date of the sample might be due to the stones used for the floor having been reused from OL 4 (SU 5328). Another sample, of vegetable material, from trodden floor SU 5786 was dated to 359-121 calBC with ¹⁴C-analysis.²⁶⁰ The older date might be an inclusion due to the deposits underneath, SU 5787, which was identified as being from OL 4 or the reuse of walls from Building F-b3 (OL 4).

Additional data

Building F-b1 East was remodelled during a second phase, as can be evidenced by the floor being raised in F-b1:R11: the 2-3 cm thick trodden floor SU 2385 at approx. 829.16 m a.s.l. was built on top of floor SU 2392. Walls SU 2378, SU 2444 and SU 3662 were razed to three rows and at least two rows of well-dressed ashlar were added.

²⁵⁹ Charred phoenix (palm) wood – *phoenix dactylifera* (TA 8037); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5538; date: 2200 ± 30 BP; 2σ range date: 376-186 calBC (95.4%); OxCal v4.1.7; June 2010.

²⁶⁰ Vegetable material (TA 8683); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5786; date: 2170 ± 25 BP; 2σ range date: 359-121 calBC (95.4%); OxCal v4.1.7; June 2010.

2.3.2 Space syntax analysis

2.3.3 Space syntax analysis – variation 1

Variation 1 of a space syntax analysis of Building F-b1 East does not assume F-b1:R19 as part of the building.

Visitor-inhabitant relationship

Micro level

Building F-b1 East is composed of K=11 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 51).

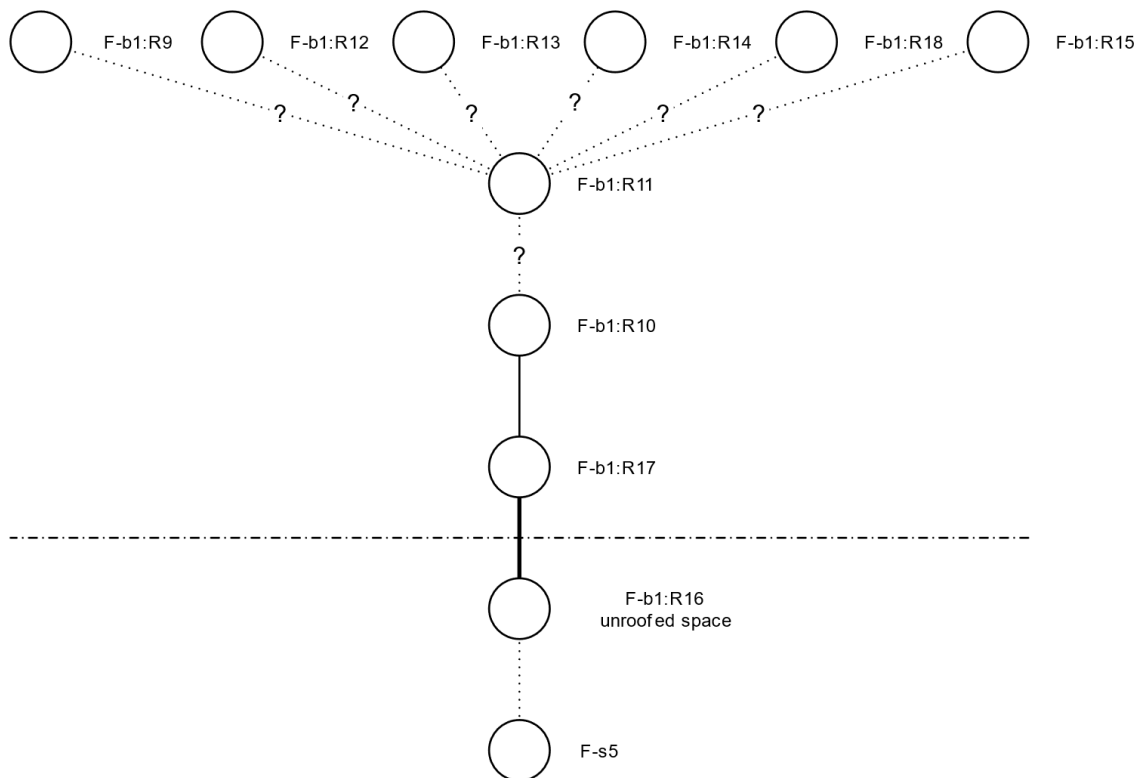


Figure 51: Justified graph Building F-b1 East (visitor-inhabitant) – variation 1

CHAPTER IV

Table 21 shows the results obtained for the building on a micro level, where the mean RA is 0.339 and the mean RRA is 1.151.

Table 21: Micro level analysis of Building F-b1 East (visitor-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.143	16	1.600	0.133	0.452
Mean	1.000	25.273	2.527	0.339	1.151
Max	6.500	40	4.000	0.667	2.261

Nano level

Table 22 shows the results obtained for each space. Seven rooms are of type A and four are of type B. F-b1:R9, F-b1:R12, F-b1:R13, F-b1:R14, F-b1:R15 and F-b1:R18 have the lowest CV, whereas F-b1:R11 has the highest CV. F-b1:R11 has the lowest RA value, whereas alley F-s5 has the highest RA value.

Table 22: Nano level analysis of Building F-b1 East, K = 11 and D = 0.295 (visitor-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
F-b1:F-s5	A	1	0.500	40	4.000	0.667	2.261
F-b1:R9	A	1	0.143	25	2.500	0.333	1.130
F-b1:R10	B	2	0.643	19	1.900	0.200	0.678
F-b1:R11	B	7	6.500	16	1.600	0.133	0.452
F-b1:R12	A	1	0.143	25	2.500	0.333	1.130
F-b1:R13	A	1	0.143	25	2.500	0.333	1.130
F-b1:R14	A	1	0.143	25	2.500	0.333	1.130
F-b1:R15	A	1	0.143	25	2.500	0.333	1.130
F-b1: R16	B	2	1.500	29	2.900	0.422	1.432
F-b1:R17	B	2	1.000	24	2.400	0.311	1.055
F-b1:R18	A	1	0.143	25	2.500	0.333	1.130

Graphic output and interpretation

The justified graph in Figure 52 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b1 East, while the plan Figure 53 focuses on the last two.

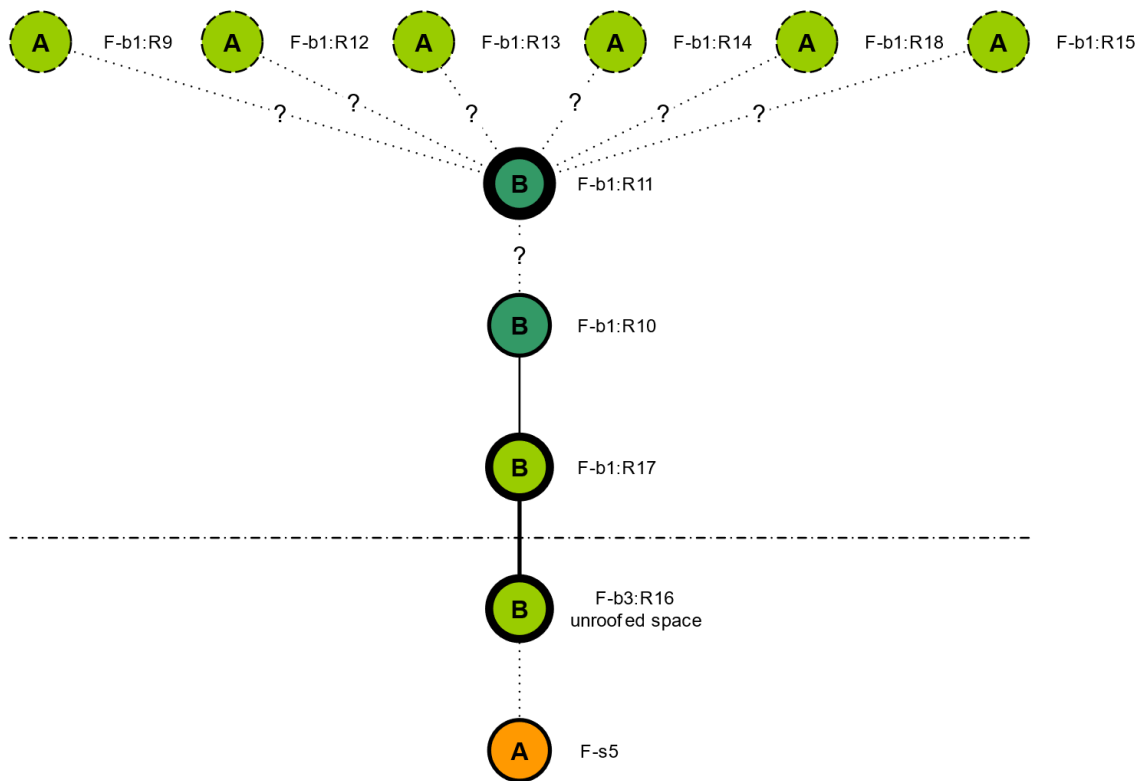


Figure 52: Coded justified graph of Building F-b1 East (visitor-inhabitant) – variation 1

Building F-b1 East has a more integrated overall configuration (mean RA = 0.339 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b1 East has a more segregated position (the alley) in relation to the interior before entering the building. Before accessing the building, an unroofed more integrated space is accessed (R16). Upon entering, a sequence of rooms with increasing integration (R17, R10) leads to the most integrated and largest space at the centre of the building (R11). From there the movement is distributed to six smaller – possibly storage – rooms (R9, R12, R13, R14, R15, R18).

The highest control over adjacent rooms is exercised by the central room (R11), connecting to the north, east and south parts, and then by the entrance room (R17) and R16.

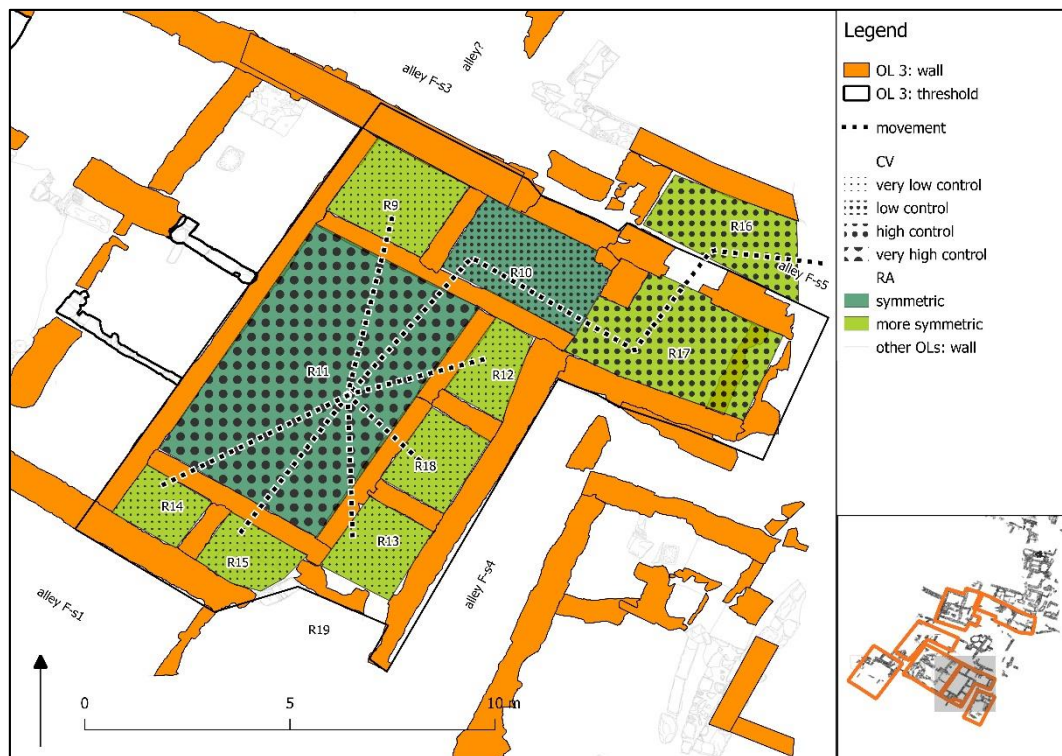


Figure 53: Building F-b1 East (visitor-inhabitant) – variation 1

Inhabitant-inhabitant relationship

Micro level

Building F-b1 East is composed of K=9 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 54).

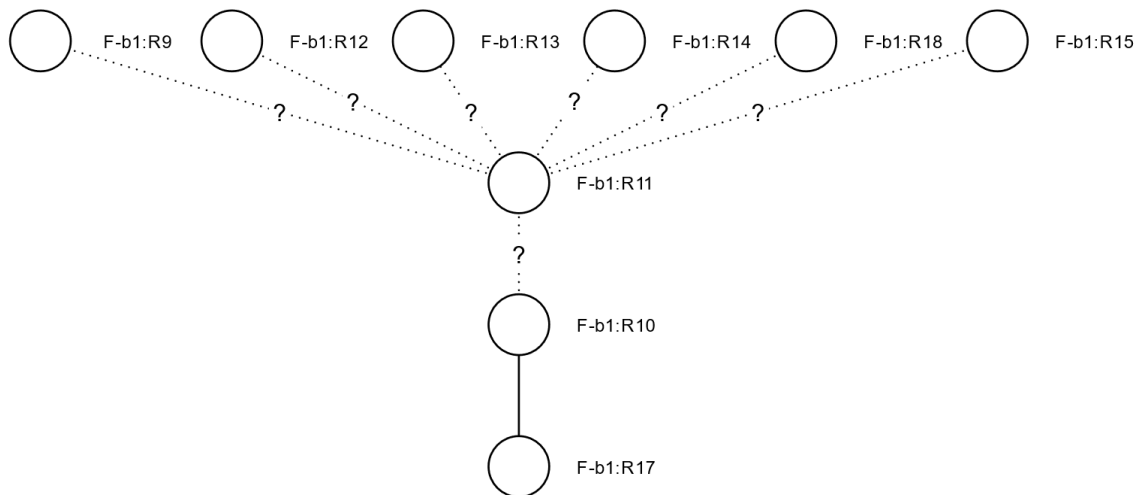


Figure 54: Justified graph Building F-b1 East (inhabitant-inhabitant) – variation 1

CHAPTER IV

Table 23 shows the results obtained for the building on a micro level, where the mean RA is 0.270 and the mean RRA is 0.852.

Table 23: Micro level analysis of Building F-b1 East (inhabitant-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.143	9.000	1.125	0.036	0.113
Mean	1.000	15.556	1.944	0.270	0.852
Max	6.500	21.000	2.625	0.464	1.466

Nano level

Table 24 shows the results obtained for each space on the nano level. Seven rooms are of type A and two are of type B. F-b1:R9, F-b1:R12, F-b1:R13, F-b1:R14, F-b1:R15 and F-b1:R18 have the lowest CV, whereas F-b1:R11 has the highest CV. F-b1:R11 has the lowest RA value, whereas F-b1:R17 has the highest RA value.

Table 24: Nano level of analysis of Building F-b1 East, K = 9 and D = 0.317 (inhabitant-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
F-b1:R9	A	1	0.143	16	2.000	0.286	0.902
F-b1:R10	B	2	1.143	14	1.750	0.214	0.676
F-b1:R11	B	7	6.500	9	1.125	0.036	0.113
F-b1:R12	A	1	0.143	16	2.000	0.286	0.902
F-b1:R13	A	1	0.143	16	2.000	0.286	0.902
F-b1:R14	A	1	0.143	16	2.000	0.286	0.902
F-b1:R15	A	1	0.143	16	2.000	0.286	0.902
F-b1:R17	A	1	0.500	21	2.625	0.464	1.466
F-b1:R18	A	1	0.143	16	2.000	0.286	0.902

Graphic output and interpretation

The justified graph in Figure 55 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b1 West, while the plan in Figure 56 focuses on the last two.

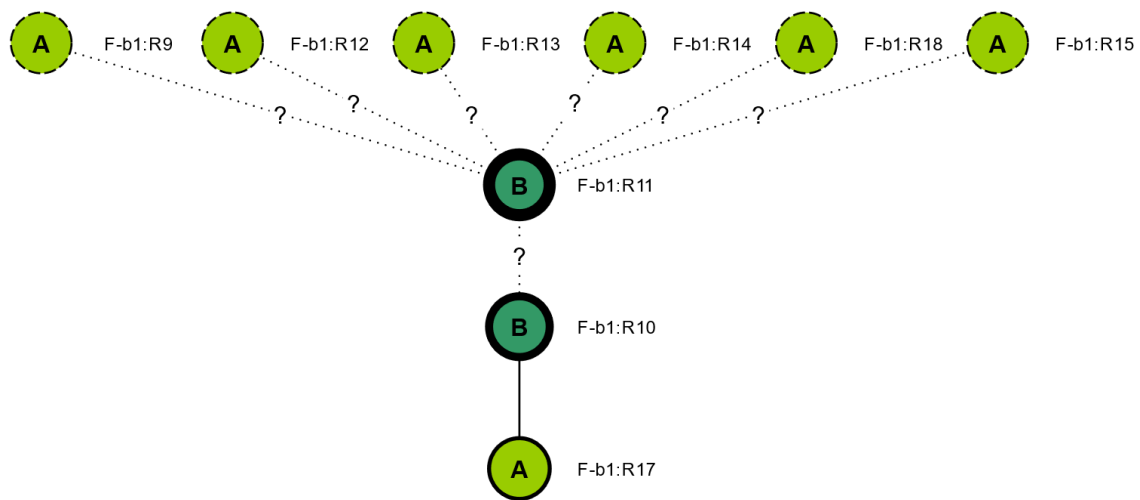


Figure 55: Coded justified graph of Building F-b1 East (inhabitant-inhabitant) – variation 1

CHAPTER IV

An individual moving inside of Building F-b1 East is in more integrated surroundings (mean RA = 0.270 – inhabitant-inhabitant relationship). Not much changes for an individual moving inside of the building (Table 25). The entrance room (R17) loses control that is shifted toward the room leading to the centre of the building (R10), which becomes more segregated. The small rooms (R9, R12, R14, R15, R18) and the central largest room (R11) become more integrated.

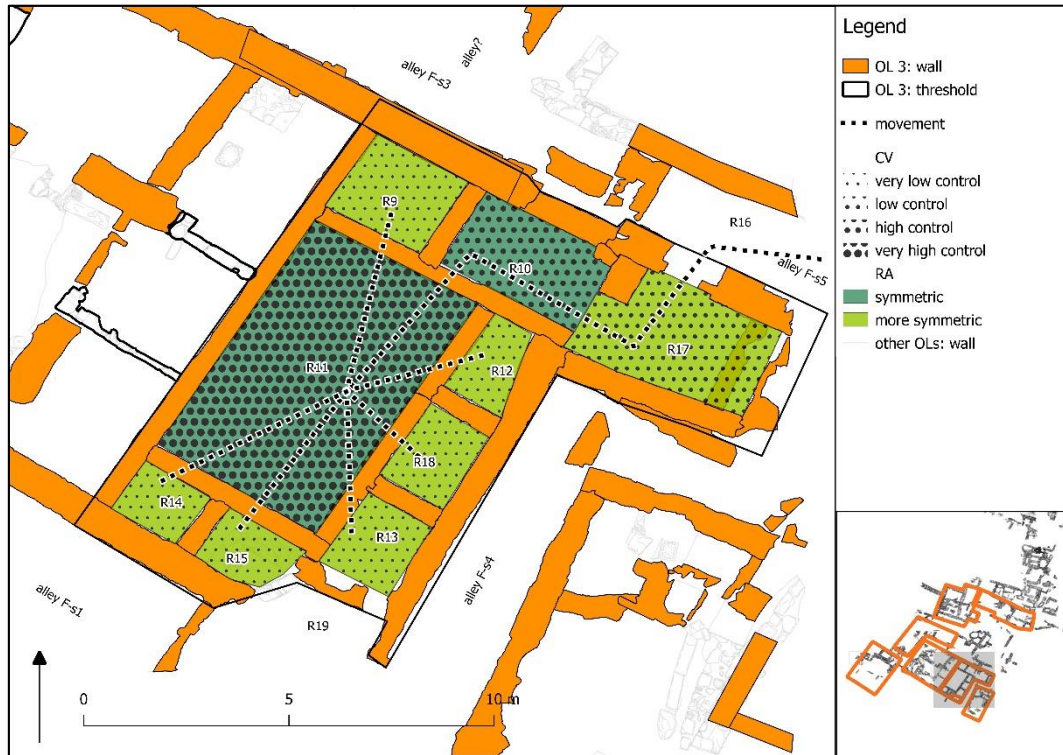


Figure 56: Building F-b1 East (inhabitant-inhabitant) – variation 1

Table 25: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 East, variation 1

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b1:F-s5	0.500	-	0.667	-
F-b1:R9	0.143	0.143	0.333	0.286
F-b1:R10	0.643	1.143	0.200	0.214
F-b1:R11	6.500	6.500	0.133	0.036
F-b1:R12	0.143	0.143	0.333	0.286
F-b1:R13	0.143	0.143	0.333	0.286
F-b1:R14	0.143	0.143	0.333	0.286
F-b1:R15	0.143	0.143	0.333	0.286
F-b1: R16	1.500	-	0.422	-
F-b1:R17	1.000	0.500	0.311	0.464
F-b1:R18	0.143	0.143	0.333	0.286

2.3.4 Space syntax analysis – variation 2

Variation 1 of a space syntax analysis of Building F-b1 East assumes F-b1:R19 as part of the building.

Visitor-inhabitant relationship

Micro level

Building F-b1 East is composed of K=12 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 57).

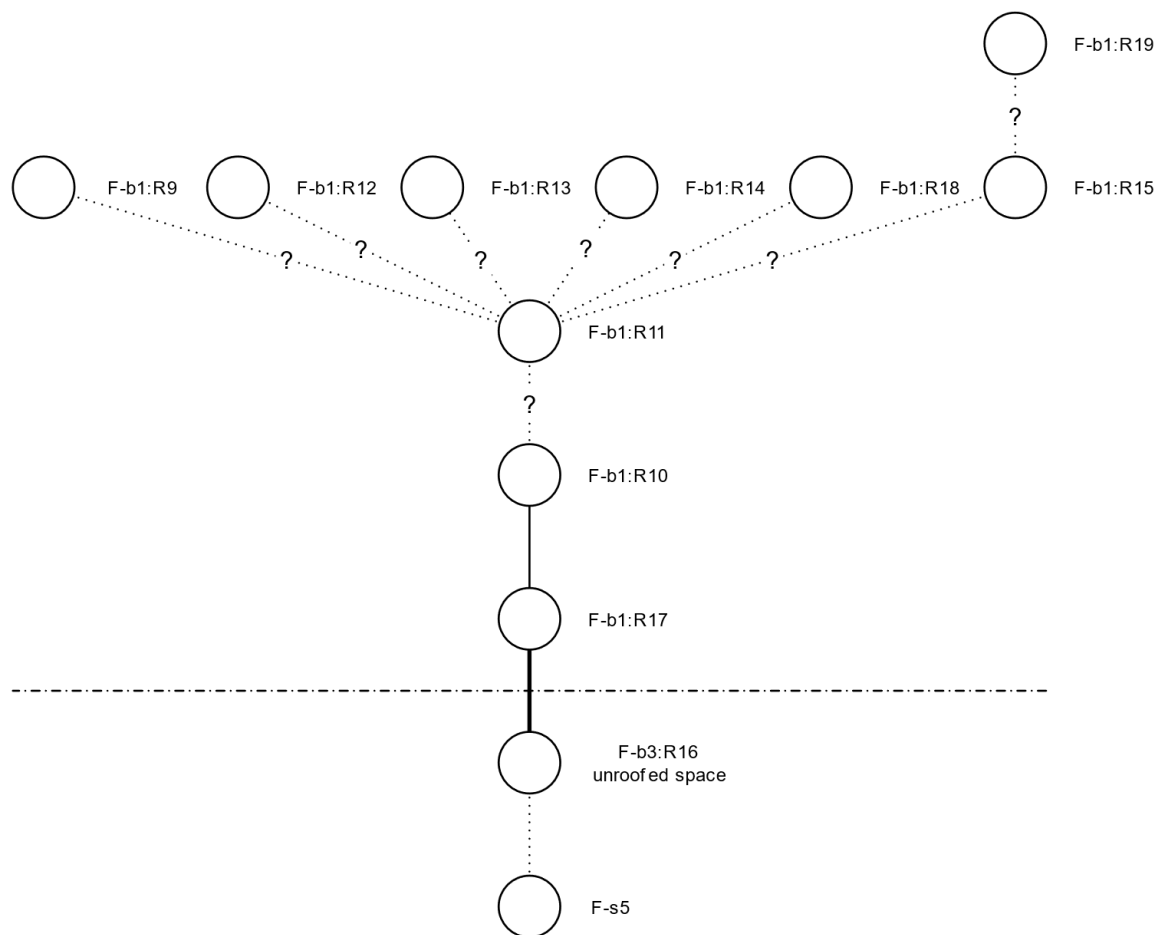


Figure 57: Justified graph Building F-b1 East (visitor-inhabitant) – variation 2

CHAPTER IV

Table 26 shows the results obtained for the building on a micro level, where the mean RA is 0.333 and the mean RRA is 1.170.

Table 26: Micro level analysis of Building F-b1 East (visitor-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.143	18	1.636	0.127	0.447
Mean	1.000	29.333	2.667	0.333	1.170
Max	6.000	46	4.182	0.636	2.234

Nano level

Table 27 shows the results obtained for each space. Seven rooms are of type A and five are of type B. F-b1:R9, F-b1:R12, F-b1:R13, F-b1:R14, F-b1:R15 and F-b1:R18 have the lowest CV, whereas F-b1:R11 has the highest CV. F-b1:R11 has the lowest RA value, whereas alley F-s5 has the highest RA value.

Table 27: Nano level analysis of Building F-b1 East, K = 12 and D = 0.285 (visitor-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
F-b1:F-s5	A	1	0.500	46	4.182	0.636	2.234
F-b1:R9	A	1	0.143	28	2.545	0.309	1.085
F-b1:R10	B	2	0.643	22	2.000	0.200	0.702
F-b1:R11	B	7	6.000	18	1.636	0.127	0.447
F-b1:R12	A	1	0.143	28	2.545	0.309	1.085
F-b1:R13	A	1	0.143	28	2.545	0.309	1.085
F-b1:R14	A	1	0.143	28	2.545	0.309	1.085
F-b1:R15	B	2	1.143	26	2.364	0.273	0.957
F-b1: R16	B	2	1.500	36	3.273	0.455	1.596
F-b1:R17	B	2	1.000	28	2.545	0.309	1.085
F-b1:R18	A	1	0.143	28	2.545	0.309	1.085
F-b1:R19	A	1	0.500	36	3.273	0.455	1.596

Graphic output and interpretation

The justified graph in Figure 58 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b1 East, while the plan Figure 59 focuses on the last two.

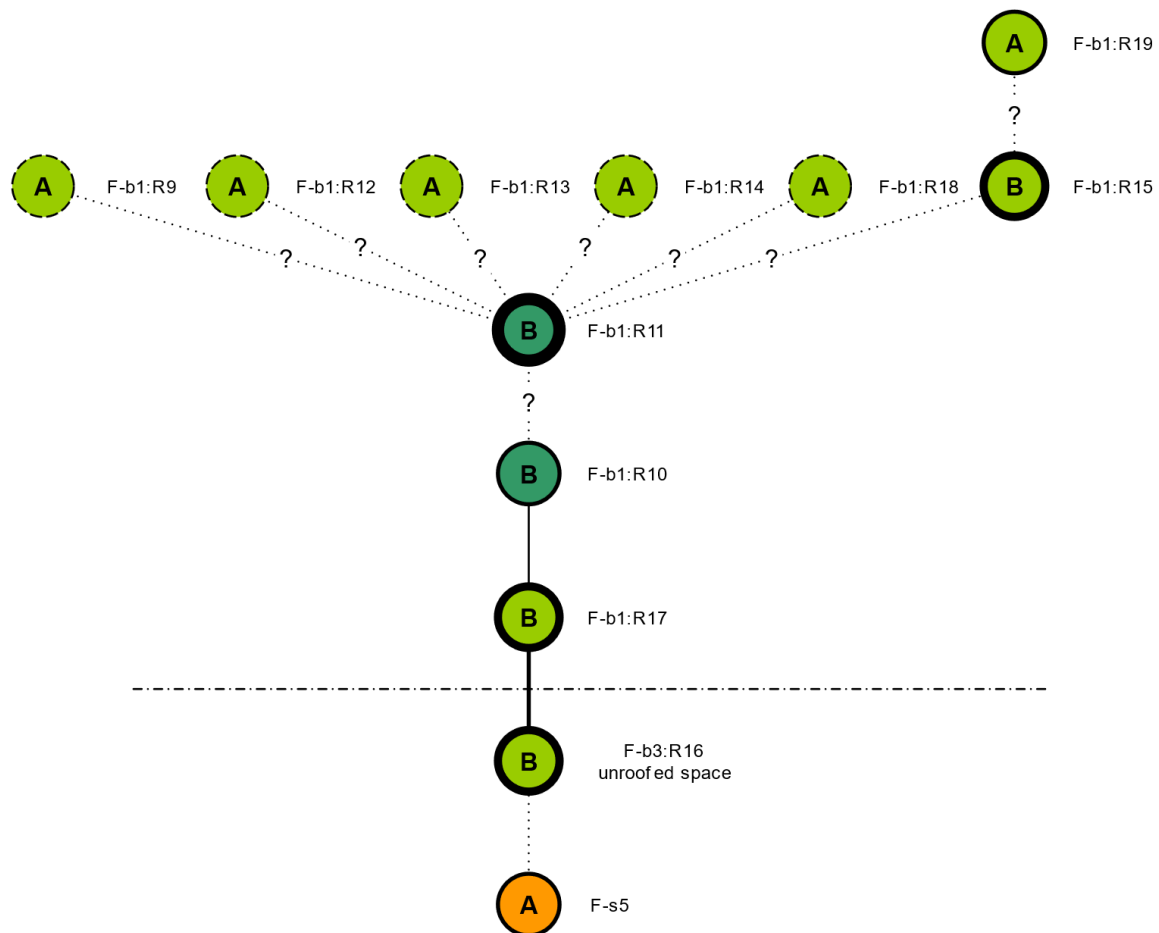


Figure 58: Coded justified graph of Building F-b1 East (visitor-inhabitant) – variation 2

Building F-b1 East has a more integrated overall configuration (mean RA = 0.333 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b1 East has a more segregated position (the alley) in relation to the interior before entering the building. Before accessing the building, an unroofed more integrated space is accessed (R16). Upon entering, a sequence of rooms with increasing integration (R17, R10) leads to the most integrated and largest space and at the centre of the building (R11). From there the movement is distributed to six smaller – possibly storage – rooms (R9, R12, R13, R14, R15, R18). R15 leads to equally more integrated R19.

The highest control over adjacent rooms is exercised by the central room (R11), connecting to the north, east and south parts, and then by the entrance room (R17) and R16.

This variation of Building F-b1 East has the same type of integration overall. The relation between rooms does not really change, besides R15 and R19 having more control than the other small rooms.

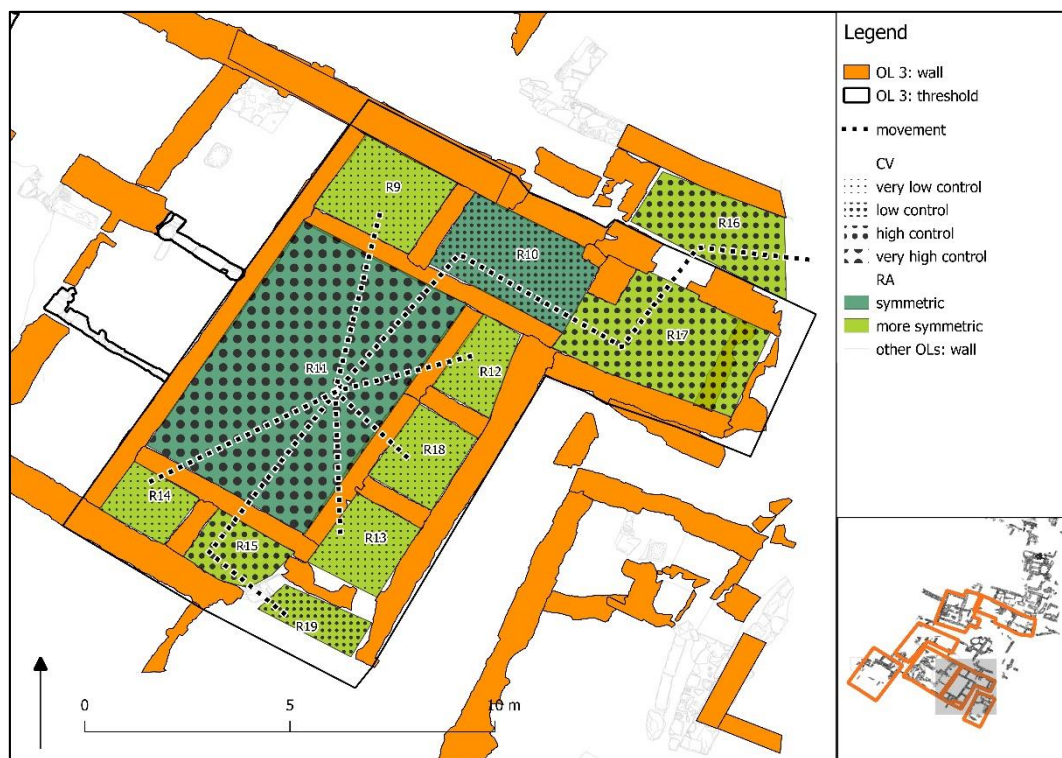


Figure 59: Building F-b1 East (visitor-inhabitant) – variation 2

Inhabitant-inhabitant relationship

Micro level

Building F-b1 East is composed of K=10 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 60).

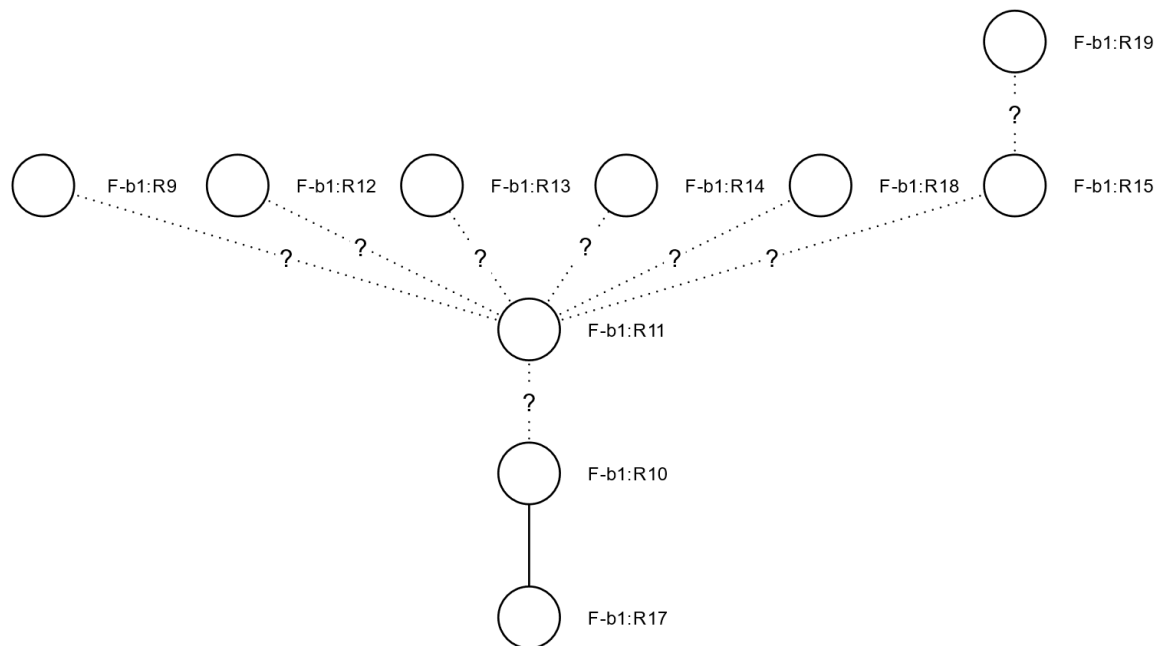


Figure 60: Justified graph Building F-b1 East (inhabitant-inhabitant) – variation 2

CHAPTER IV

Table 28 shows the results obtained for the building on a micro level, where the mean RA is 0.278 and the mean RRA is 0.909.

Table 28: Micro level analysis of Building F-b1 East (inhabitant-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.143	11.000	1.222	0.056	0.182
Mean	1.000	19.000	2.111	0.278	0.909
Max	6.000	25.000	2.778	0.444	1.455

Nano level

Table 29 shows the results obtained for each space on the nano level. Seven rooms are of type A and two are of type B. F-b1:R9, F-b1:R12, F-b1:R13, F-b1:R14, F-b1:R15 and F-b1:R18 have the lowest CV, whereas F-b1:R11 has the highest CV. F-b1:R11 has the lowest RA value, whereas F-b1:R17 and F-b1:R19 have the highest RA values.

Table 29: Nano level of analysis of Building F-b1 East, K = 10 and D = 0.306 (inhabitant-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
F-b1:R9	A	1	0.143	19	2.111	0.278	0.909
F-b1:R10	B	2	1.143	17	1.889	0.222	0.727
F-b1:R11	B	7	6.000	11	1.222	0.056	0.182
F-b1:R12	A	1	0.143	19	2.111	0.278	0.909
F-b1:R13	A	1	0.143	19	2.111	0.278	0.909
F-b1:R14	A	1	0.143	19	2.111	0.278	0.909
F-b1:R15	B	2	1.143	17	1.889	0.222	0.727
F-b1:R17	A	1	0.500	25	2.778	0.444	1.455
F-b1:R18	A	1	0.143	19	2.111	0.278	0.909
F-b1:R19	A	1	0.500	25	2.778	0.444	1.455

Graphic output and interpretation

The justified graph in Figure 61 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b1 West, while the plan in Figure 62 focuses on the last two.

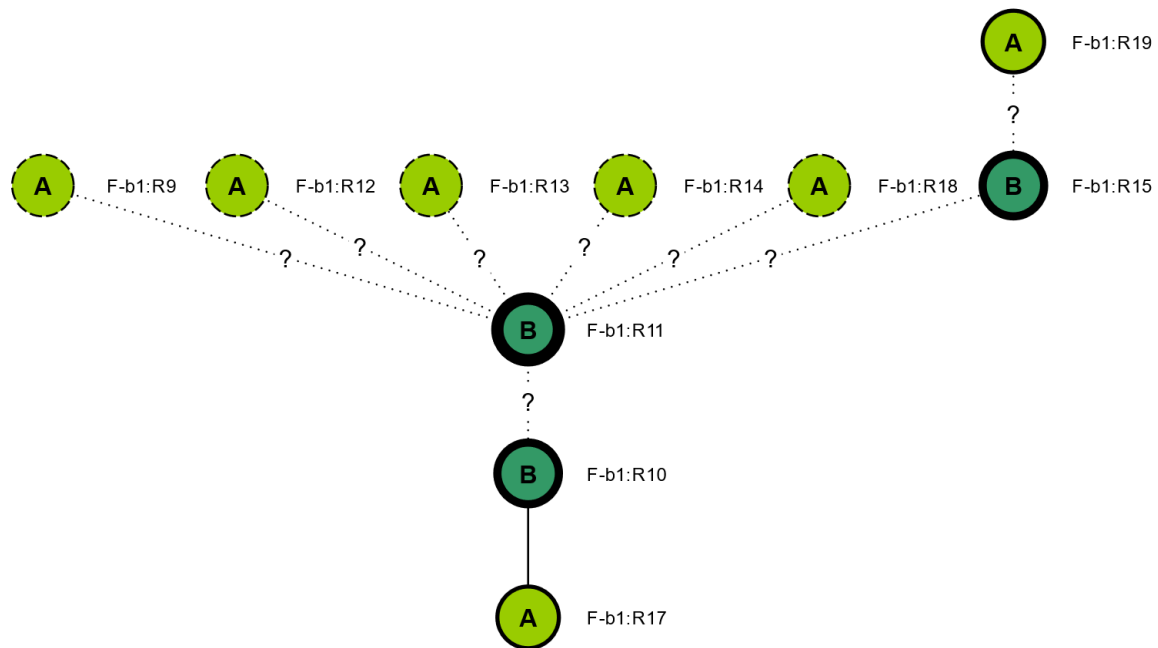


Figure 61: Coded justified graph of Building F-b1 East (inhabitant-inhabitant) – variation 2

An individual moving inside of Building F-b1 East is in more integrated surroundings (mean RA = 0.278 – inhabitant-inhabitant relationship).

Not much changes for an individual moving inside of the building (Table 30). The entrance room (R17) loses control that is shifted toward the room leading to the centre of the building (R10), which becomes more segregated. The small rooms (R9, R12, R14, R15, R18, R19) and the central largest room (R11) become more integrated.

This variation of Building F-b1 East has the same type of integration overall. The relation between rooms does not really change, besides R15 and R19 having more control than the other small rooms and R15 becoming integrated as the core of the building.



Figure 62: Building F-b1 East (inhabitant-inhabitant) – variation 2

CHAPTER IV

Table 30: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 East, variation 2

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b1:F-s5	0.500	-	0.636	-
F-b1:R9	0.143	0.143	0.309	0.278
F-b1:R10	0.643	1.143	0.200	0.222
F-b1:R11	6.000	6.000	0.127	0.056
F-b1:R12	0.143	0.143	0.309	0.278
F-b1:R13	0.143	0.143	0.309	0.278
F-b1:R14	0.143	0.143	0.309	0.278
F-b1:R15	1.143	1.143	0.273	0.222
F-b1: R16	1.500	-	0.455	-
F-b1:R17	1.000	0.500	0.309	0.444
F-b1:R18	0.143	0.143	0.309	0.278
F-b1:R19	0.500	0.500	0.455	0.444

2.4 Building F-b1 West

2.4.1 Description

Micro level

Building F-b1 West (Figure 63, Figure 64) was built on top of the western part of Building F-b3 (OL 4), reusing part of the razed external walls as foundation for the newly built walls and also reusing OL 4 walls. The building has an estimated area of 170.80 m² with a square shaped ground plan. It has an estimated usable area of about 89.70 m². The foundations levels of the walls are set at an average of about 828.60 m a.s.l. Set at a lower level are the walls reused from Building F-b3 (OL 4). The preserved height of the walls is up to about 1.00 m. The width of the external walls is about 0.70 m. The width of the internal walls is about 0.60 m.

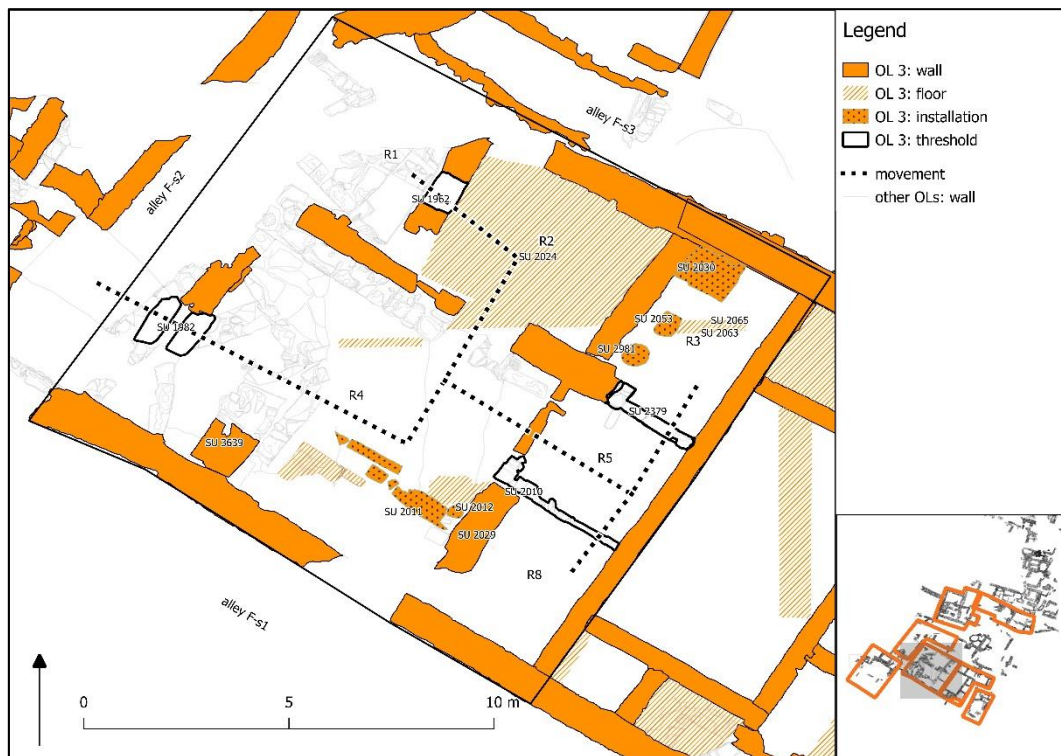


Figure 63: Buildings F-b1 West



Figure 64: Building F-b1 West; view from E (© DAI Orient Department 2016 F. Weigel)

Nano level

Rooms

The usable area is divided into six rooms. F-b1:R4²⁶¹ is located in the southwestern corner and has an area of about 42.40 m². F-b1:R1 is located in the north-western corner and has an area of about 7.60 m². F-b1:R2 is located on the north side and has an area of about 15.10 m². F-b1:R3 is located in the north-eastern corner and has an area of about 9.40 m². F-b1:R5 is located on the east side and has an area of about 7.30 m². F-b1:R8 is located in the south-eastern corner and has an area of about 7.90 m². All rooms are outer rooms.

²⁶¹ The room was first identified as three distinct rooms (F-b1:R4, F-b1:R6 and F-b1:R7), but then identified as one (F-b1:R4=6=7). Henceforth the room will be indicated as F-b1:R4.

Permeabilities

The entrance is evidenced by a threshold (SU 1982), accessing the building from alley F-s2 to F-b1:R4. A doorway was identified between F-b1:R2 and F-b1:R4. Thresholds were found between F-b1:R1 and F-b1:R2 (SU 1962, 828.55 m a.s.l.), F-b1:R4 and F-b1:R5 (SU 2029), F-b1:R5 and F-b1:R3 (SU 2379²⁶²), and F-b1:R5 and F-b1:R8 (SU 2010, approx. 827.70 m a.s.l.).

Features and finds

A millstone (SU 2012) is located in the southern corner of F-b1:R4 in floor 2013. Three installations were found in F-b1:R3 (Figure 65): a platform (SU 2030) of 1.25 by 0.95 m in the northern corner at 828.77 m a.s.l., a grinding installation supported by a stone base (SU 2053) measuring 0.60 by 0.45 m and 0.20 m high in the centre at 828.60 m a.s.l., and a storage jar (SU 2981, not in Figure 65) in a primary position on the south side. A buttress (SU 3639) of 1.25 by 1.15 m on the southwest wall created a division of space in F-b1:R4.

Floors were identified in three rooms. In F-b1:R4, the stone floor SU 2011 at 828.51 m a.s.l., formerly a wall from OL 4 partially razed for this purpose. In F-b1:R2, the trodden mud floor SU 2024. In F-b1:R3, trodden floor SU 2065.

A sample of charred millet from floor SU 2063 (see section below) was dated to 215-381 calAD with ¹⁴C-analysis.²⁶³

²⁶² SU 2379=7374.

²⁶³ Charred millet – *setaria* (TA 3285); Lab: University of Kiel; Lan number: KIA 30892; date: 1759 ± 26 BP; 2σ range date: 215 – 363 calAD (92.5%); Calib rev 4.3. For more details see Tourtet and Weigel 2015, 395.



Figure 65: F-b1:R3 with food preparation area; view from W (© DAI Orient Department 2009 C. Purschwitz)

Additional data

There is evidence of floors being raised in two rooms. In F-b1:R4, the stone floor SU 3644 at 828.56-828.67 m a.s.l. and the mud floor SU 2013 at approx. 828.85 m a.s.l. were built on top of floor SU 2011. In F-b1:R3, the trodden floor SU 2063²⁶⁴ was built on top of floor SU 2065.

²⁶⁴ SU 2063=2064.

2.4.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building F-b1 West is composed of K=7 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 66).

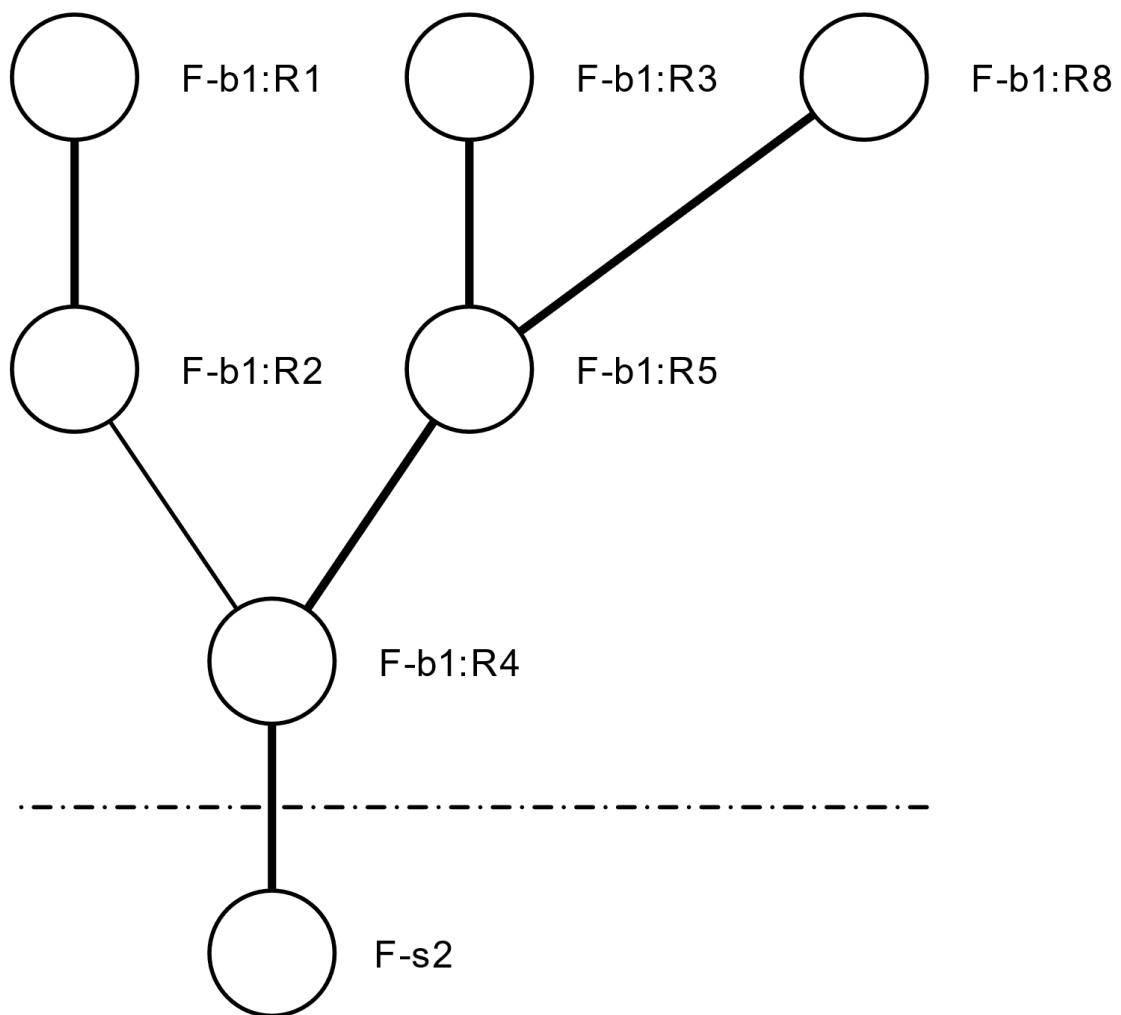


Figure 66: Justified graph Building F-b1 West (visitor-inhabitant)

CHAPTER IV

Table 31 shows the results obtained for the building on a micro level, where the mean RA is 0.476 and the mean RRA is 1.402.

Table 31: Micro level analysis of Building F-b1 West (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	9.000	1.500	0.200	0.589
Mean	1.000	13.143	2.190	0.476	1.402
Max	2.333	17.000	2.833	0.733	2.159

Nano level

Table 32 shows the results obtained for each space. Four rooms are of type A and three are of type B. Alley F-s2, F-b1:R3 and F-b1:R8 have the lowest CV, whereas F-b1:R5 has the highest CV. F-b1:R4 has the lowest RA value, whereas F-b1:R1 has the highest RA value.

Table 32: Nano level of analysis of Building F-b1 West, K = 7 and D = 0.340 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b1:F-s2	A	1	0.333	14	2.333	0.533	1.570
F-b1:R1	A	1	0.500	17	2.833	0.733	2.159
F-b1:R2	B	2	1.333	12	2.000	0.400	1.178
F-b1:R3	A	1	0.333	15	2.500	0.600	1.767
F-b1:R4	B	3	1.833	9	1.500	0.200	0.589
F-b1:R5	B	3	2.333	10	1.667	0.267	0.785
F-b1:R8	A	1	0.333	15	2.500	0.600	1.767

Graphic output and interpretation

The justified graph in Figure 67 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b1 West, while the plan in Figure 68 visualises the last two values.

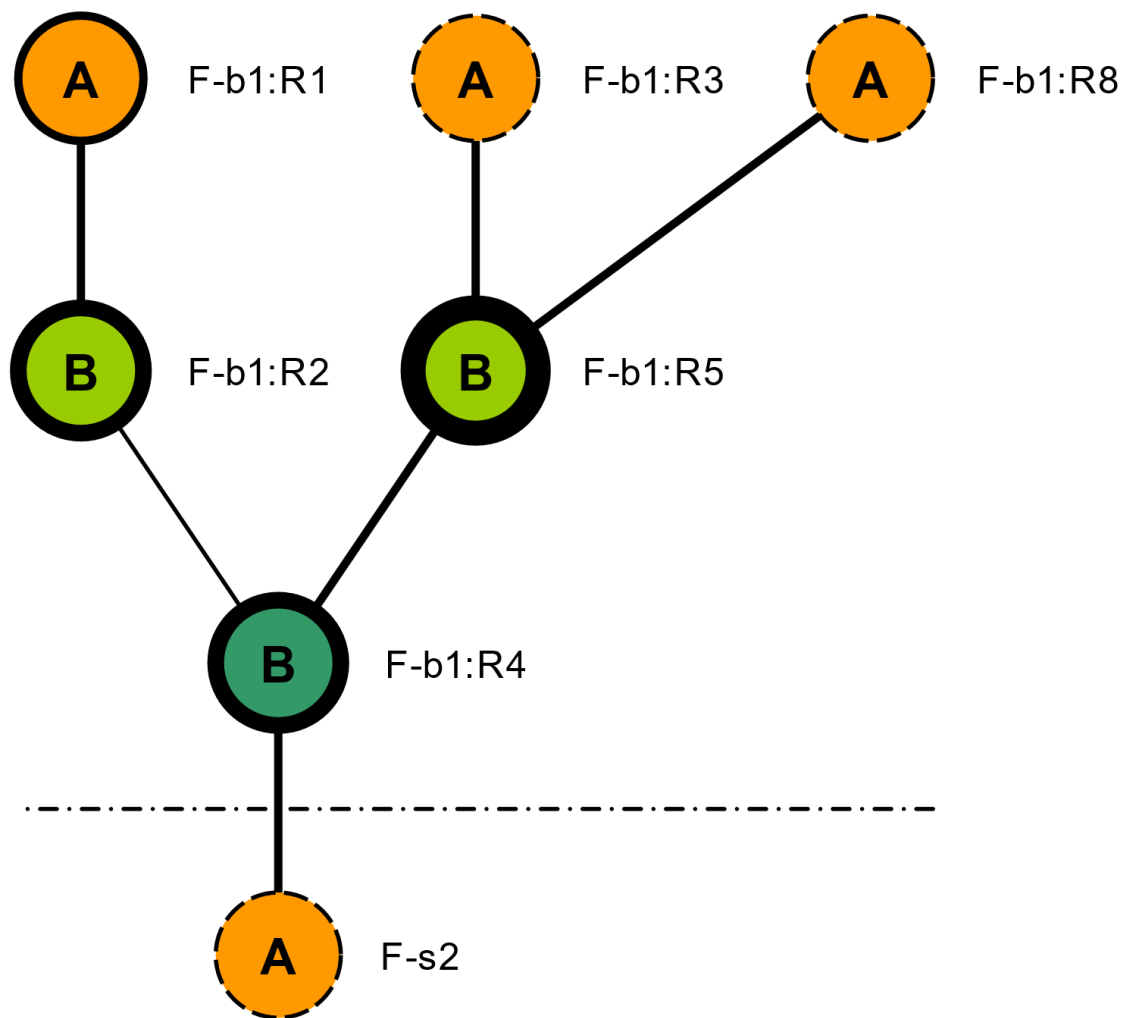


Figure 67: Coded justified graph of Building F-b1 West (visitor-inhabitant)

Building F-b1 West has a more integrated overall configuration (mean RA = 0.476 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b1 West has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, the most integrated room (R4) is accessed, which is also the largest room in the building and gives access to the north and east parts. The north part is composed of two rooms in a sequence, the first is a more integrated (R2) and the second a more segregated back room (R1). The east part is composed of a more integrated room (R5) that leads to two more segregated back rooms (R3, R8), one of which has several installations for food processing (R3).

The highest control over adjacent rooms is exercised by eastern R5, connecting the west, north and south parts.



Figure 68: Building F-b1 West (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b1 West is composed of $K=6$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 69).

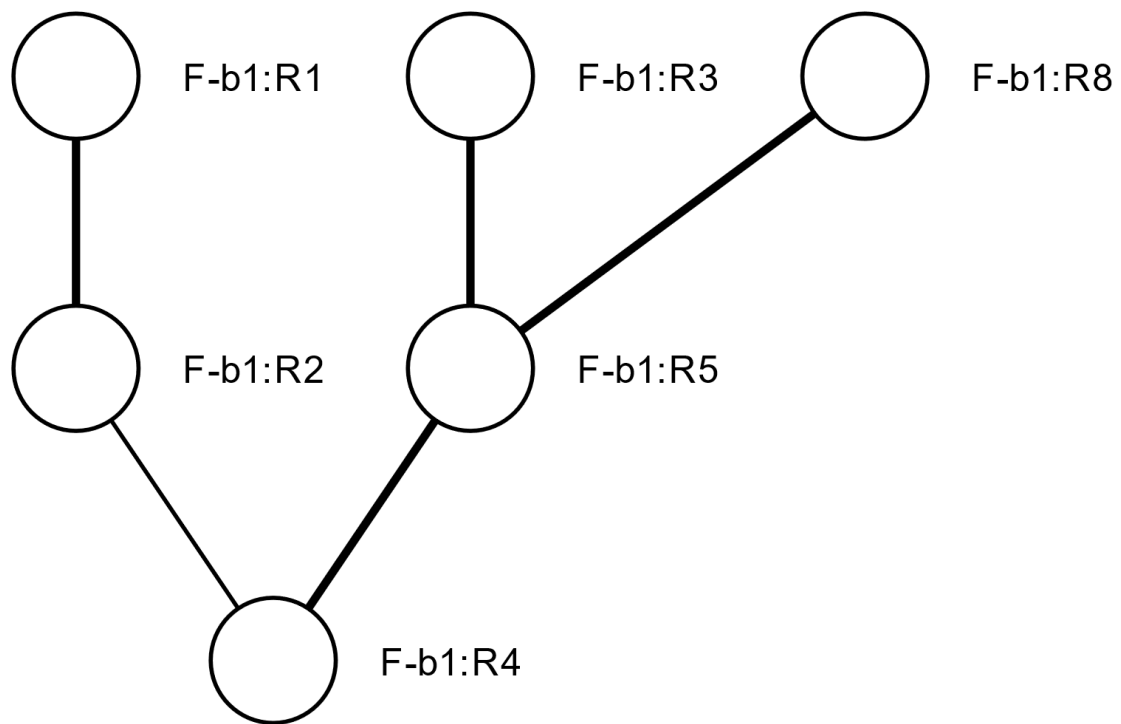


Figure 69: Justified graph Building F-b1 West (inhabitant-inhabitant)

CHAPTER IV

Table 33 shows the results obtained for the building on a micro level, where the mean RA is 0.567 and the mean RRA is 1.624.

Table 33: Micro level analysis of Building F-b1 West (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	8.000	1.600	0.300	0.860
Mean	1.000	10.667	2.133	0.567	1.624
Max	2.500	14.000	2.800	0.900	2.579

Nano level

Table 34 shows the results obtained for each space on the nano level. Three rooms are of type A and three are of type B. F-b1:R3 and F-b1:R8 have the lowest CV, whereas F-b1:R5 has the highest CV. F-b1:R4 and F-b1:R5 have the lowest RA values, whereas F-b1:R1 has the highest RA value.

Table 34: Nano level of analysis of Building F-b1 West, K = 6 and D = 0.349 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b1:R1	A	1	0.500	14.000	2.800	0.900	2.579
F-b1:R2	B	2	1.500	10.000	2.000	0.500	1.433
F-b1:R3	A	1	0.333	12.000	2.400	0.700	2.006
F-b1:R4	B	2	0.833	8.000	1.600	0.300	0.860
F-b1:R5	B	3	2.500	8.000	1.600	0.300	0.860
F-b1:R8	A	1	0.333	12.000	2.400	0.700	2.006

Graphic output and interpretation

The justified graph in Figure 70 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b1 West, while the plan in Figure 71 visualises the last two values.

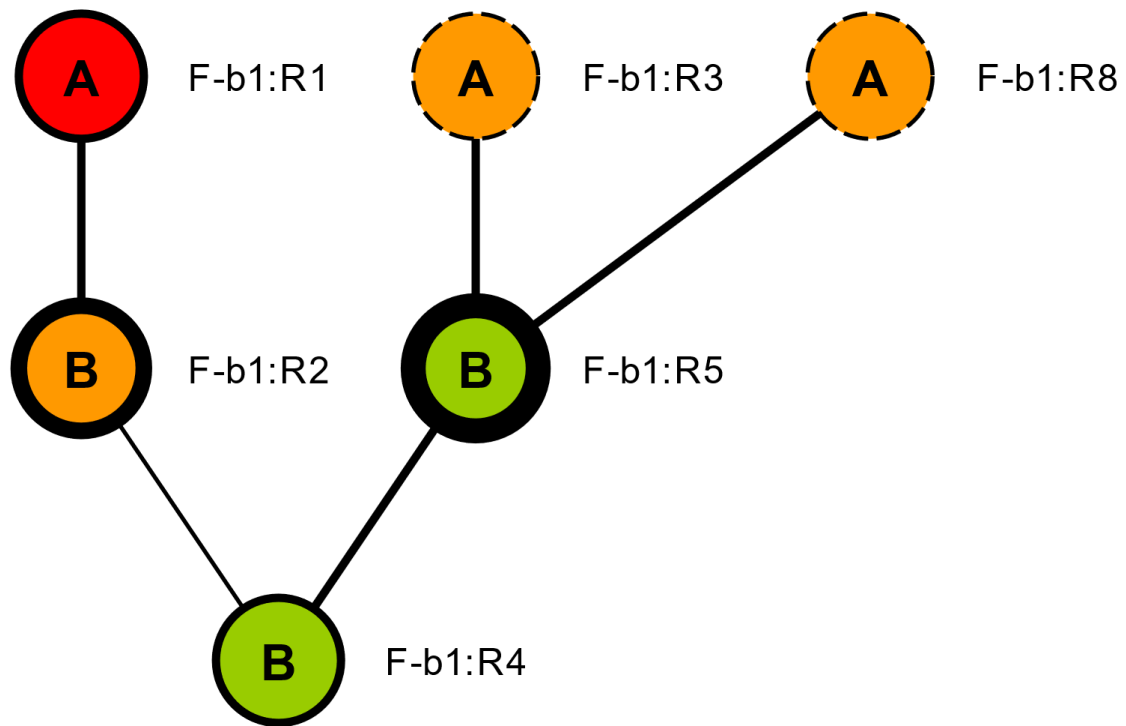


Figure 70: Coded justified graph of Building F-b1 West (inhabitant-inhabitant)

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.567 – inhabitant-inhabitant relationship). The entrance room (R4) loses control and part of its integrated position (Table 35). The north part of the building becomes increasingly segregated (R1, R2). The east part, where the food processing area is located (R3) stays more segregated.

R2 increases its control and R5 is now the room with the most control.



Figure 71: Building F-b1 West (inhabitant-inhabitant)

Table 35: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b1 West

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b1:F-s2	0.333	-	0.533	-
F-b1:R1	0.500	0.500	0.733	0.900
F-b1:R2	1.333	1.500	0.400	0.500
F-b1:R3	0.333	0.333	0.600	0.700
F-b1:R4	1.833	0.833	0.200	0.300
F-b1:R5	2.333	2.500	0.267	0.300
F-b1:R8	0.333	0.333	0.600	0.700

2.5 Building F-b2

2.5.1 Description

Micro level

Building F-b2 (Figure 72, Figure 73) was built on top of evidence of wall from an unidentified OL 4 building, reusing part of the existent walls from both levels. The building has an estimated area of 156.90 m² with a rectangular shaped ground plan. It has an estimated usable area of 87.90 m². The foundation levels of the walls built in OL 3 are set between 827.70 m a.s.l. and 828.29 m a.s.l. Set at a lower level are SU 1973 and SU 1992, reused from Building F-b10 (OL 4). The preserved height of the walls is up to about 1.80 m. The width of the external walls is between 0.70 m and 0.95 m. The width of the internal walls is between 0.25 m and 0.65 m.



Figure 72: Building F-b2



Figure 73: Building F-b2; view from SE (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into six rooms. F-b2:R5 is located in the centre and has an area of about 36.90 m². F-b2:R6 is located on the southwest side and has an area of about 32.70 m². This room was possibly divided into smaller spaces but there is no clear evidence for this, except for scattered indications for walls. F-b2:R4 is localised on the northern corner of F-b2:R1 and has an area of about 4.80 m². F-b2:R1 is localised in the northern corner and has an area of about 5.20 m². F-b2:R2 is localised on the north side and has an area of about 3.70 m². F-b2:R3 is localised in the north-eastern corner and has an area of about 4.60 m². All rooms are outer rooms.

Permeabilities

An entrance was identified in the east side, accessing the building from alley F-s7 to F-b2:R1. This entrance is evidenced by a threshold (SU 1920, 828.20 m a.s.l., Figure 74), a reused stone with grinding depressions. Further permeabilities can only be identified through absence of evidence, such as interruptions of walls between F-b2:R5 and F-b2:R3, between F-b2:R5 and F-b2:R4, between F-b2:R5 and F-b2:R6, between F-b2:R4 and F-b2:R1 and between F-b2:R1 and F-b2:R2.

Features and finds

Four standing stones with small stones at the bottom (SU 1994) of 0.65 by 0.50 by 0.45 m are located to the south of the main entrance in F-b2:R1 at less than 829.70 m a.s.l. and 830.10 m a.s.l. Three installations were found in F-b2:R4: a basin (SU 1959) of 0.65 by 0.55 m on top of a stone wall is located in the L-curve of the room at 827.70 m a.s.l., a stone with grinding depressions (SU 1964) of 0.90 by 0.60 m and 0.50 m high on floor SU 1985 at 827.70 m a.s.l., and a work platform (SU 1958 + SU 1963 + SU 1999) of 1.20 by 0.95 m and at least 0.50 m high on the south side of the room.



Figure 74: Threshold SU 1920 with grinding depressions (on the left); view from SW (© DAI Orient Department 2005 C. Purschwitz)

Floors were identified in three rooms. In F-b2:R5, the stone floor SU 1961 at 829.70 m a.s.l. and 829.86 m a.s.l. in the entrance area. In F-b2:R6, the trodden floor SU 5311 at 827.69 m a.s.l. In F-b2:R4, stone floor SU 1985 at 829.76 m a.s.l. around the stone with grinding depressions and the platform, and stone floor SU 1993 at less than 829.55 m a.s.l. and 829.59 m a.s.l. between the walls SU 1991 and SU 1911. F-b2:R1 had no built floor, but seemed to have been used directly on the bedrock at 827.45 m a.s.l.

A sample of charred tamarisk from trodden floor SU 5311 was dated to 30-210 calAD with ¹⁴C-analysis.²⁶⁵

²⁶⁵ Charred tamarisk wood (TA 8609); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5541; date: 1900 ± 25 BP; 2σ range date: 30-210 calAD (95.4%); OxCal v4.1.7; June 2010. For more details see Tourtet and Weigel 2015, 395.

2.5.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building F-b2 is composed of K=7 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 75).

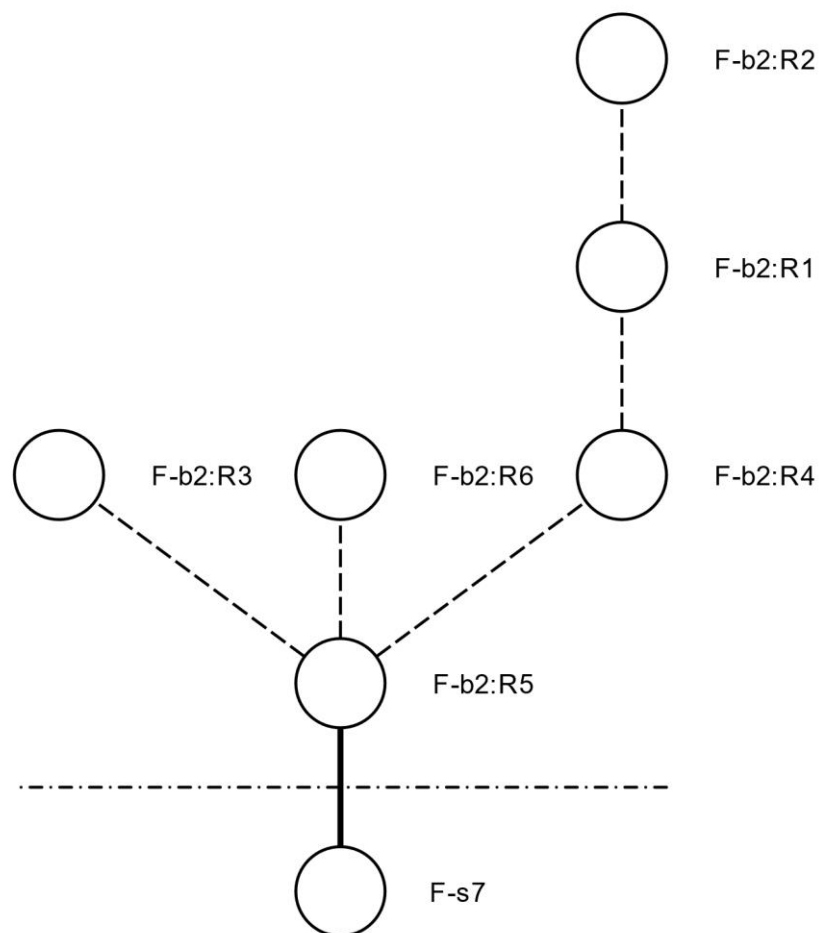


Figure 75: Justified graph Building F-b2 (visitor-inhabitant)

CHAPTER IV

Table 36 shows the results obtained for the building on a micro level, where the mean RA is 0.476 and the mean RRA is 1.402.

Table 36: Micro level analysis of Building F-b2 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.250	9.000	1.500	0.200	0.589
Mean	1.000	13.143	2.190	0.476	1.402
Max	3.500	18.000	3.000	0.800	2.355

Nano level

Table 37 shows the results obtained for each space. Four rooms are of type A and three are of type B. Alley F-s7, F-b2:R3 and F-b2:R6 have the lowest CV, whereas F-b2:R5 has the highest CV. F-b2:R5 has the lowest RA value, whereas F-b2:R2 has the highest RA value.

Table 37: Nano level of analysis of Building F-b2, K = 7 and D = 0.340 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b2:F-s7	A	1	0.250	14	2.333	0.533	1.570
F-b2:R1	B	2	1.500	13	2.167	0.467	1.374
F-b2:R2	A	1	0.500	18	3.000	0.800	2.355
F-b2:R3	A	1	0.250	14	2.333	0.533	1.570
F-b2:R4	B	2	0.750	10	1.667	0.267	0.785
F-b2:R5	B	4	3.500	9	1.500	0.200	0.589
F-b2:R6	A	1	0.250	14	2.333	0.533	1.570

Graphic output and interpretation

The justified graph in Figure 76 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b2, while the plan in Figure 77 visualises the last two values.

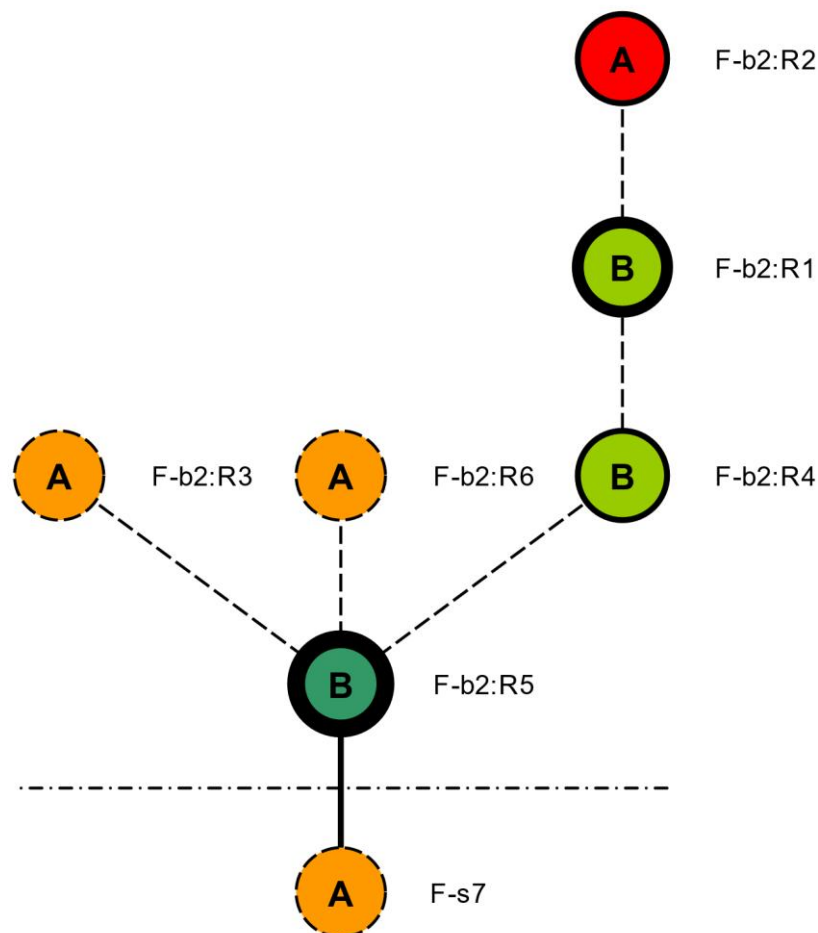


Figure 76: Coded justified graph of Building F-b2 (visitor-inhabitant)

Building F-b2 has a more integrated overall configuration (mean RA = 0.476 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b2 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, the most integrated room (R5) is accessed, which is also the largest room in the building and gives access to the north, east and south parts. The north part is composed of a sequence of three rooms of decreasing integration (R4, R1, R2): the first has several installations for food processing and the last is a segregated back room. The east part is a more segregated room (R3). The south part is equally a more segregated room (R6).

The highest control over adjacent rooms is exercised by the rooms at the entrance of the building (R5), connecting the north, east and south parts.

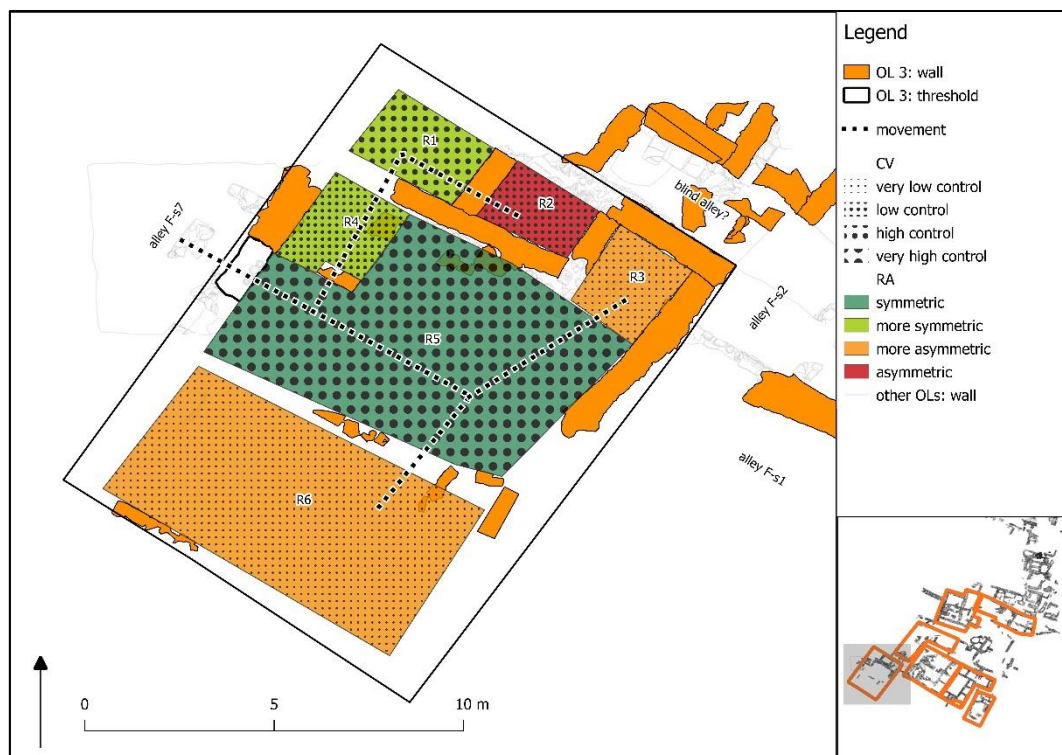


Figure 77: Building F-b2 (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b2 is composed of $K=6$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 78).

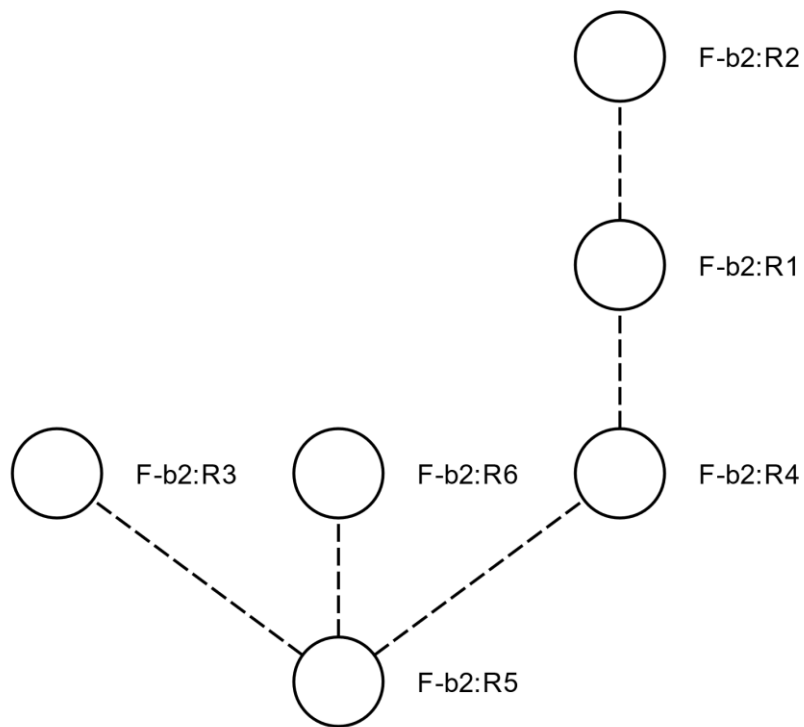


Figure 78: Justified graph Building F-b2 (inhabitant-inhabitant)

CHAPTER IV

Table 38 shows the results obtained for the building on a micro level, where the mean RA is 0.567 and the mean RRA is 1.624.

Table 38: Micro level analysis of Building F-b2 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	8.000	1.600	0.300	0.860
Mean	1.000	10.667	2.133	0.567	1.624
Max	2.500	14.000	2.800	0.900	2.579

Nano level

Table 39 shows the results obtained for each space on the nano level. Three rooms are of type A and three are of type B. F-b2:R3 and F-b2:R6 have the lowest CV, whereas F-b2:R5 has the highest CV. F-b2:R4 and F-b2:R5 have the lowest RA values, whereas F-b2:R2 has the highest RA value.

Table 39: Nano level of analysis of Building F-b2, K = 6 and D = 0.349 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b2:R1	B	2	1.500	10	2.000	0.500	1.433
F-b2:R2	A	1	0.500	14	2.800	0.900	2.579
F-b2:R3	A	1	0.333	12	2.400	0.700	2.006
F-b2:R4	B	2	0.833	8	1.600	0.300	0.860
F-b2:R5	B	3	2.500	8	1.600	0.300	0.860
F-b2:R6	A	1	0.333	12	2.400	0.700	2.006

Graphic output and interpretation

The justified graph in Figure 79 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b2, while the plan in Figure 80 visualises the last two values.

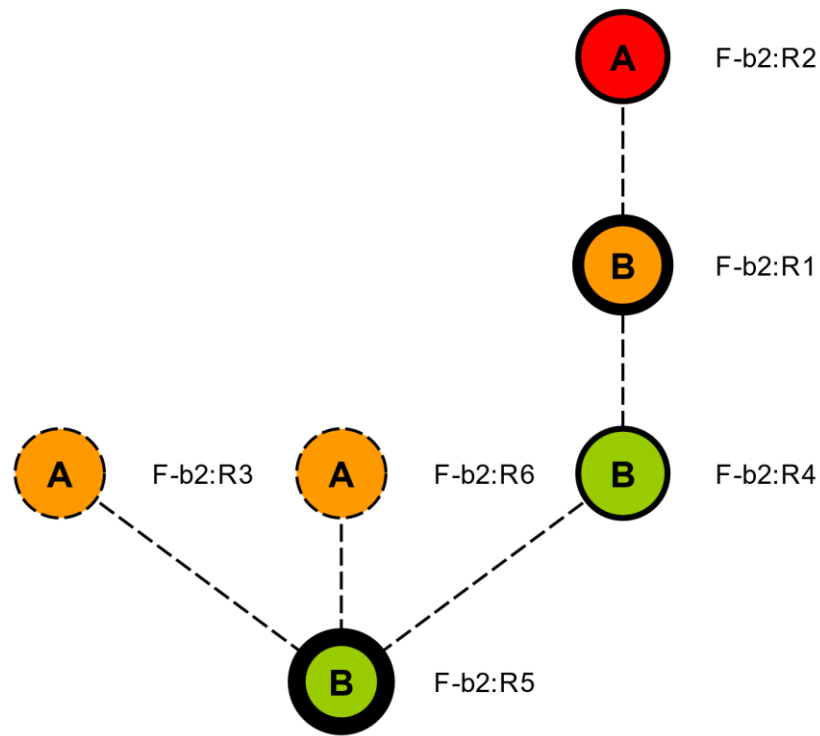


Figure 79: Coded justified graph of Building F-b2 (inhabitant-inhabitant)

CHAPTER IV

An individual moving inside of the building is in more segregated surroundings (mean $RA = 0.567$ – inhabitant-inhabitant relationship). The entrance room (R5) decreases its integration and a bit of control (Table 40); which is distributed to its adjacent rooms. The north, east and south parts of the building increase their segregation (R1, R2, R4, R3, R6).

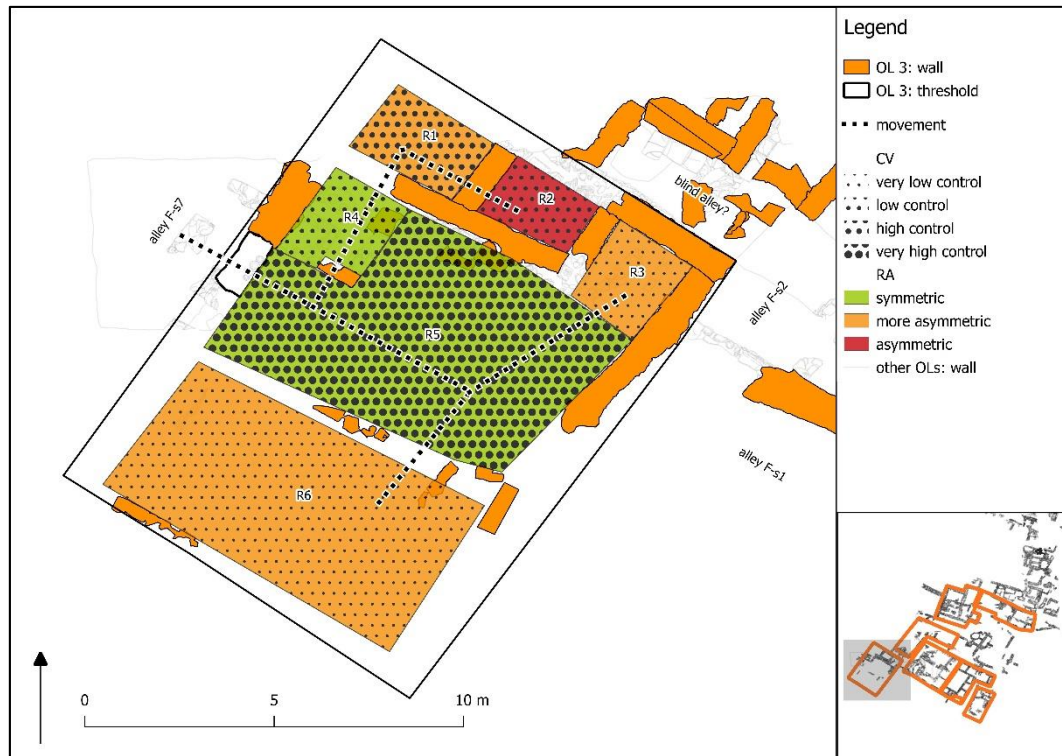


Figure 80: Building F-b2 (inhabitant-inhabitant)

Table 40: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b2

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b2:F-s7	0.250	-	0.533	-
F-b2:R1	1.500	1.500	0.467	0.500
F-b2:R2	0.500	0.500	0.800	0.900
F-b2:R3	0.250	0.333	0.533	0.700
F-b2:R4	0.750	0.833	0.267	0.300
F-b2:R5	3.500	2.500	0.200	0.300
F-b2:R6	0.250	0.333	0.533	0.700

2.6 Building F-b4

2.6.1 Description

Micro level

Building F-b4 (Figure 81, Figure 82) was excavated at its northeast and southwest limits. Part of the walls were reused from an unidentified OL 4 building. The building has an estimated area of 115.40 m² (including area not excavated) with an L-shaped ground plan. The usable area is at least 30.50 m² and is estimated at 61.20 m². The estimation does not encompass the possible other storey. The reused walls were originally built on bedrock. The foundation levels of the walls built in OL 3 are set between 828.05 m a.s.l. and 828.65 m a.s.l. The preserved height of the walls is up to about 1.90 m. The width of the external walls is about 0.60 m.



Figure 81: Building F-b4



Figure 82: Building F-b4; view from SE (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into at least five spaces. F-b4:R1 is located on the south side and has an area of at least 1.80 m². F-b4:R2 is located on the north side and has an estimated area of about 11.50 m². F-b4:R3 is located on the east side and has an area of about 17.20 m². The staircase and the possible other floor are considered two more spaces. All three rooms are outer rooms.

Permeabilities

The permeabilities of Building F-b4 are unclear. An entrance could be identified in the north side, accessing the building from an alley to F-b4:R2 through a 1.50 m wide threshold (SU 5034, 828.65 m a.s.l.). A doorway with a small staircase (SU 5052, Figure 83) could be identified east of F-b4:R2 but it is unclear where it leads to. Further permeability can only be identified through absence of evidence, such as between F-b4:R2 and F-b4:R3. The connection between F-b4:R2 and F-b4:R1 has not been excavated.²⁶⁶



Figure 83: Staircase SU 5052; view from E (© DAI Orient Department 2016 F. Weigel)

²⁶⁶ Since there is no evidence of division of space in the unexcavated area, it will be considered as one space for the purpose of the space syntax analysis.

2.6.2 Space syntax analysis

The space syntax analysis of Building F-b4 can only be carried out preliminarily due to large parts not being excavated yet.

Visitor-inhabitant relationship

Micro level

Building F-b4 is composed of at least $K=7$ spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 84).

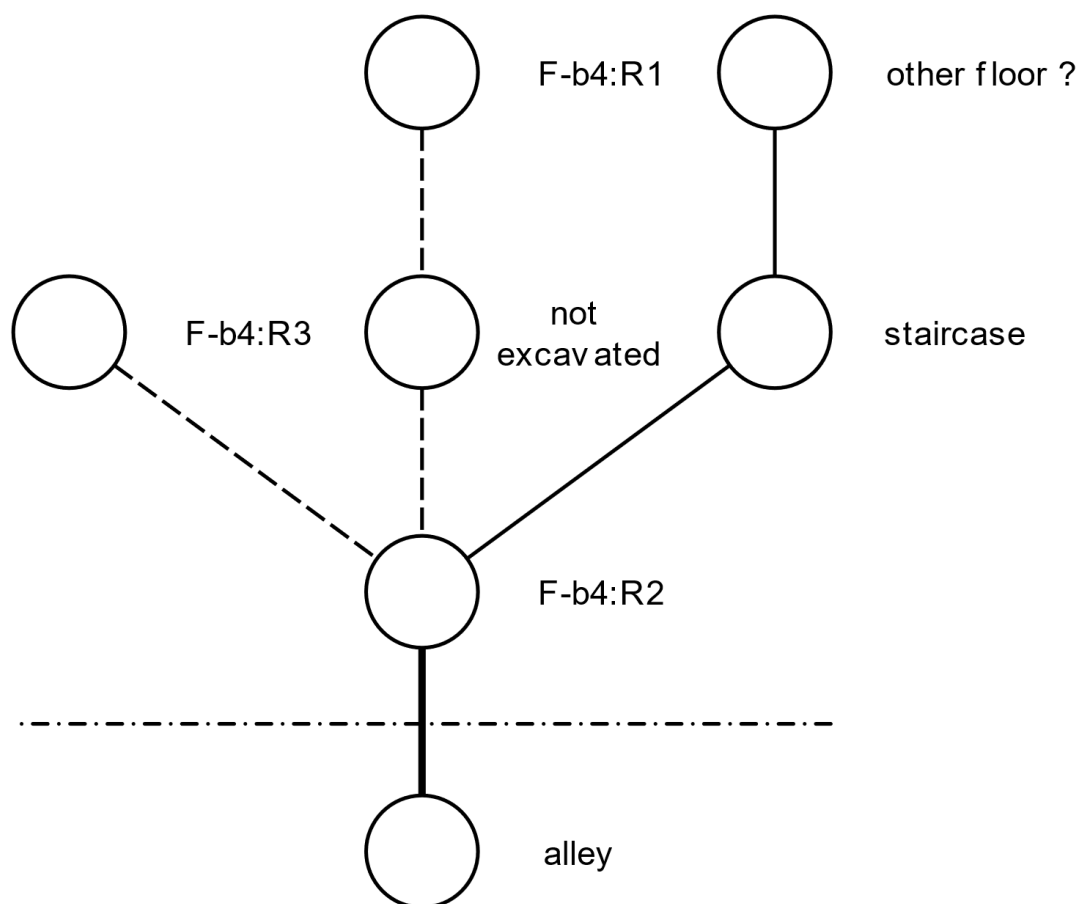


Figure 84: Justified graph Building F-b4 (visitor-inhabitant)

CHAPTER IV

Table 41 shows the results obtained for the building on a micro level, where the mean RA is 0.438 and the mean RRA is 1.290.

Table 41: Micro level analysis of Building F-b4 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.250	8.000	1.333	0.133	0.393
Mean	1.000	12.571	2.095	0.438	1.290
Max	3.000	16.000	2.667	0.667	1.963

Nano level

Table 42 shows the results obtained for each space. Four rooms are of type A and three are of type B. The alley and F-b4:R3 have the lowest CV, whereas F-b4:R2 has the highest CV. F-b4:R2 has the lowest RA value, whereas the F-b4:R1 and the other floor have the highest RA values.

Table 42: Nano level of analysis of Building F-b4, K = 7 and D = 0.340 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b4:alley	A	1	0.250	13	2.167	0.467	1.374
F-b4:R1	A	1	0.500	16	2.667	0.667	1.963
F-b4:R2	B	4	3.000	8	1.333	0.133	0.393
F-b4:R3	A	1	0.250	13	2.167	0.467	1.374
F-b4:staircase	B	2	1.250	11	1.833	0.333	0.981
F-b4:other floor?	A	1	0.500	16	2.667	0.667	1.963
F-b4:not excavated	B	2	1.250	11	1.833	0.333	0.981

Graphic output and interpretation

The justified graph in Figure 85 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b4, while the plan in Figure 86 visualises the last two values.

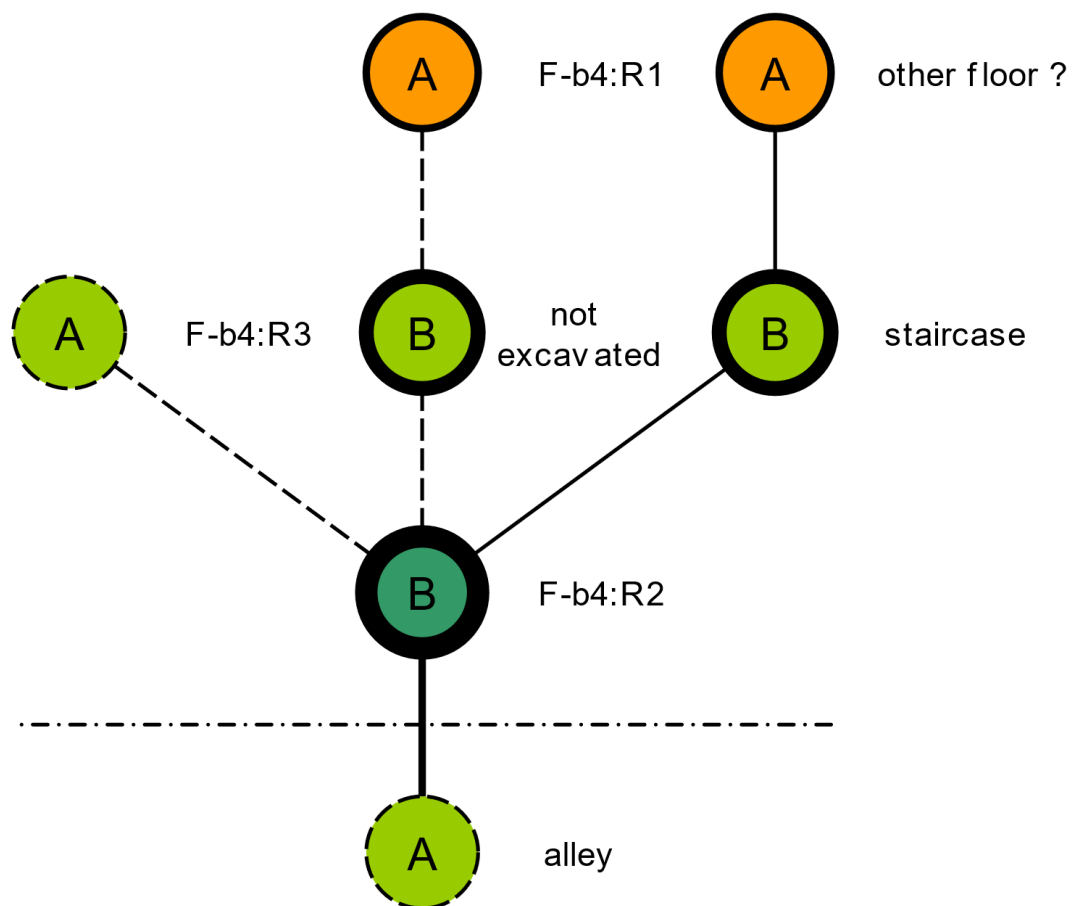


Figure 85: Coded justified graph of Building F-b4 (visitor-inhabitant)

Building F-b4 has not been completely excavated and can therefore not be analysed thoroughly by a space syntax analysis. Nevertheless, a preliminary interpretation can be made based on the three existent rooms and the staircase.

Building F-b4 has a more integrated overall configuration (mean RA = 0.438 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b4 has a more integrated position (the alley) in relation to the interior before entering the building. Upon entering, the most integrated room (R2) is accessed. This room gives access to the east and south part and the staircase to another possible floor.

R3, to the east, is more integrated but with very low control. The room in the south part (R1), after the part not excavated, is more segregated and has a low control. The staircase has a more integrated position and control that leads to a more segregated floor.

The highest control over adjacent rooms is exercised by the room at the entrance of the building (R2).



Figure 86: Building F-b4 (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b4 is composed of at least $K=6$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 87).

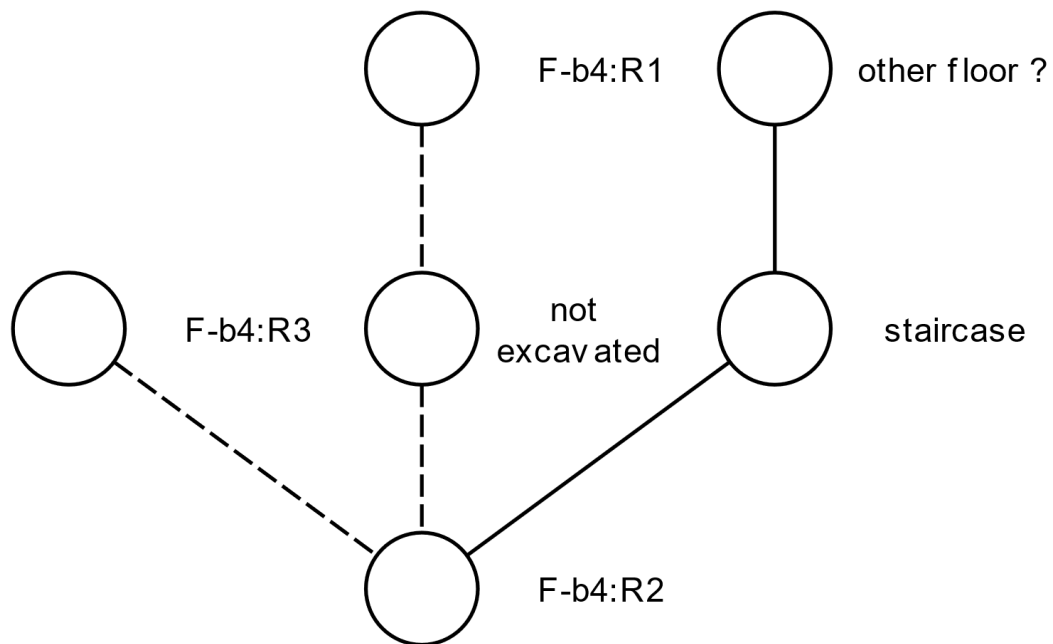


Figure 87: Justified graph Building F-b4(inhabitant-inhabitant)

CHAPTER IV

Table 43 shows the results obtained for the building on a micro level, where the mean RA is 0.533 and the mean RRA is 1.528.

Table 43: Micro level analysis of Building F-b4 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	2.000	1.000	0.000	0.000
Mean	1.000	10.333	2.067	0.533	1.528
Max	2.000	3.000	1.500	1.000	4.742

Nano level

Table 44 shows the results obtained for each space on the nano level. Three rooms are of type A and three are of type B. F-b4:R3 has the lowest CV, whereas F-b4:R2 has the highest CV. F-b4:R2 has the lowest RA value, whereas F-b4:R1 and the other floor have the highest RA values.

Table 44: Nano level of analysis of Building F-b4, K = 6 and D = 0.349 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b4:R1	A	1	0.500	13	2.600	0.800	2.292
F-b4:R2	B	3	2.000	7	1.400	0.200	0.573
F-b4:R3	A	1	0.333	11	2.200	0.600	1.719
F-b4:staircase	B	2	1.333	9	1.800	0.400	1.146
F-b4:other floor?	A	1	0.500	13	2.600	0.800	2.292
F-b4:not excavated	B	2	1.333	9	1.800	0.400	1.146

Graphic output and interpretation

The justified graph in Figure 88 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b4, while the plan in Figure 89 visualises the last two values.

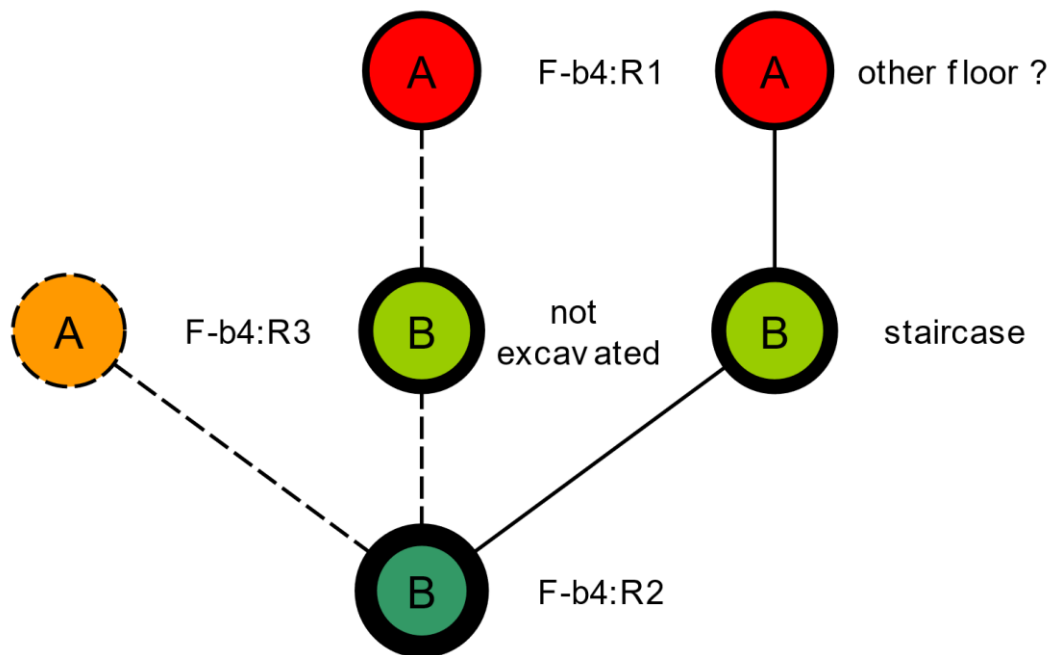


Figure 88: Coded justified graph of Building F-b4 (inhabitant-inhabitant)

CHAPTER IV

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.533 – inhabitant-inhabitant relationship). The entrance room (R2) loses some control (Table 45). The east and south parts (R1, R3) and the staircase of the building obtain more control. Overall all spaces increase their segregation.

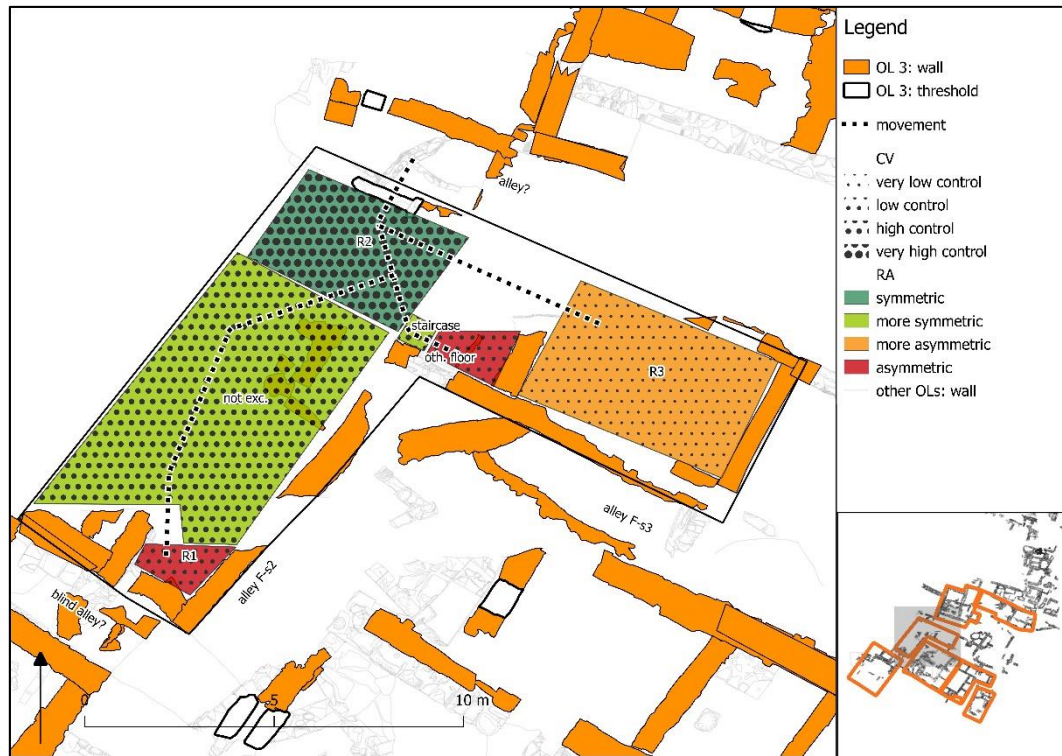


Figure 89: Building F-b4 (inhabitant-inhabitant)

Table 45: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b4

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b4:alley	0.250	-	0.467	-
F-b4:R1	0.500	0.500	0.667	0.800
F-b4:R2	3.000	2.000	0.133	0.200
F-b4:R3	0.250	0.333	0.467	0.600
F-b4:staircase	1.250	1.333	0.333	0.400
F-b4:other floor?	0.500	0.500	0.667	0.800
F-b4:not excavated	1.250	1.333	0.333	0.400

2.7 Building F-b7

2.7.1 Description

Micro level

Building F-b7 (Figure 90, Figure 91) was probably built on debris from OL 4. The building has an estimated area of 60.50 m² with a rectangular shaped ground plan. It has an estimated usable area of about 28.20 m². The foundation levels of the walls are built in OL 3 at about 829.20 m a.s.l. The width of the external walls is between 0.50 m and 0.70 m. The width of the internal walls is between 0.25 m and 0.70 m.



Figure 90: Buildings F-b7



Figure 91: Building F-b7; view from N (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into eight rooms. F-b7:R1 is an outer room located in the central west side and has an area of about 14.50 m². F-b7:R2 is an outer room located to the south of F-b7:R1 and has an area of about 2.50 m². F-b7:R3 is an outer room located in the north-western corner and has an area of about 3.50 m². F-b7:R4 is an inner room located in the central north side and has an area of about 0.50 m². F-b7:R5 is an outer room located on the north side and has an area of about 1.00 m². F-b7:R7 is an outer room located on the northeast side and has an area of about 0.80 m². F-b7:R6 is an outer room located in the north-eastern corner and has an area of about 0.80 m². Possibly an outer room, F-b7:R8, is located on the south side of R2 and has an estimated area of about 4.60 m², since it has not been completely excavated. The rooms F-b7:R3, F-b7:R4, R5, F-b7:R7 and F-b7:R6 are “pit-like spaces²⁶⁷” (Figure 92), possibly part and accessed from F-b7:R1.



Figure 92: F-b7:R4, F-b7:R5, F-b7:R6, F-b7:R7; view from NNE (© DAI Orient Department 2009 M. Cusin)

²⁶⁷ Deep small rooms. See Purschwitz [2009?], 20.

Permeabilities

Evidence of permeability is scarce. An entrance was identified on the west side, accessing the building from alley F-s4 to F-b7:R1, which was later blocked. A doorway was identified between F-b7:R2 and F-b7:R8, later blocked (Figure 93). Access to the smaller rooms in the northeast of the building (F-b7:R3 to F-b7:R7) was probably made from above through F-b7:R1. A further passage can only be identified through absence of evidence, such as an interruption of the wall between F-b7:R1 and F-b7:R2.

It is not clear if the entrance has shifted in another phase to another position.



Figure 93: Doorway in wall SU 5297 between F-b7:R2 and F-b7:R8; view from NNE (© DAI Orient Department 2009 M. Cusin)

Features and finds

A buttress or platform (SU 5793) of 1.20 by 0.90 m is located on the north side of F-b7:R3. A channel (SU 5294, Figure 94) at 829.30 m a.s.l. and an attached wall (SU 5293) are located on the east side of F-b7:R1. The channel has a preserved height of 0.30 m, a width of 0.30 m and slopes toward southwest. The wall is 0.50 m wide. A possible casual hearth (SU 5290 – ashes, charcoal and probably uncarbonized plant remains) of 0.05 m thickness was identified at 829.52 m a.s.l., partially covered by one of the walls from F-b1 (SU 5794).

Floors were identified in one room. In F-b7:R1, the stone paved floor SU 5291 at 829.28 m a.s.l., localised under the channel. Also, in R1, the trodden mud floor SU 5296 on the south and west sides.

A sample of charred hordeum and barley from stone paved floor SU 5291 was dated to 245-385 calAD with ¹⁴C-analysis.²⁶⁸



Figure 94: Channel SU 5294; view from W (© DAI Orient Department 2009 M. Cusin)

²⁶⁸ Charred hordeum and barley (TA 8615); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 5542; date: 1730 ± 25 BP; 2σ range date: 245-385 calAD (95.4%); OxCal v4.1.7; June 2010. For more details see Tourtet and Weigel 2015, 395.

2.7.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building F-b7 is composed of K=9 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 95).

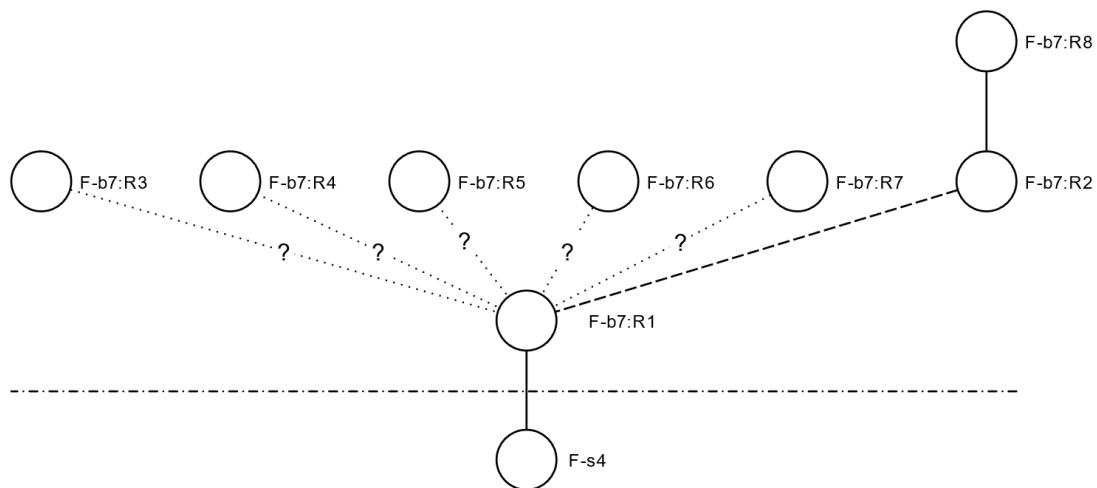


Figure 95: Justified graph Building F-b7 (visitor-inhabitant)

CHAPTER IV

Table 46 shows the results obtained for the building on a micro level, where the mean RA is 0.270 and the mean RRA is 0.852.

Table 46: Micro level analysis of Building F-b7 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.143	9.000	1.125	0.036	0.113
Mean	1.000	15.556	1.944	0.270	0.852
Max	6.500	21.000	2.625	0.464	1.466

Nano level

Table 47 shows the results obtained for each space. Seven rooms are of type A and two are of type B. Alley F-s4, F-b7:R3, F-b7:R4, F-b7:R5, F-b7:R6 and F-b7:R7 have the lowest CV, whereas F-b7:R1 has the highest CV. F-b7:R1 has the lowest RA value, whereas F-b7:R8 has the highest RA value.

Table 47: Nano level of analysis of Building F-b7, K = 9 and D = 0.317 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b7:F-s4	A	1	0.143	16	2.000	0.286	0.902
F-b7:R1	B	7	6.500	9	1.125	0.036	0.113
F-b7:R2	B	2	1.143	14	1.750	0.214	0.676
F-b7:R3	A	1	0.143	16	2.000	0.286	0.902
F-b7:R4	A	1	0.143	16	2.000	0.286	0.902
F-b7:R5	A	1	0.143	16	2.000	0.286	0.902
F-b7:R6	A	1	0.143	16	2.000	0.286	0.902
F-b7:R7	A	1	0.143	16	2.000	0.286	0.902
F-b7:R8	A	1	0.500	21	2.625	0.464	1.466

Graphic output and interpretation

The justified graph in Figure 96 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b7, while the plan in Figure 97 visualises the last two values.

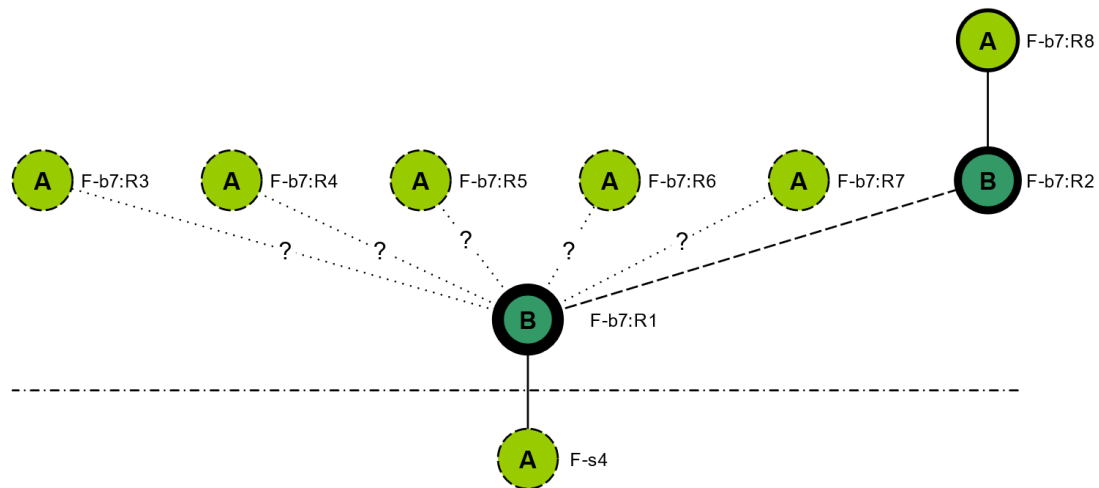


Figure 96: Coded justified graph of Building F-b7 (visitor-inhabitant)

Building F-b7 has an integrated overall configuration (mean RA = 0.270 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b7 is in an already more integrated position (the alley) in relation to the interior before entering the building. Upon entering, the most integrated room (R1) is accessed, which is also the largest room in the building and gives access to the north and south parts. The room has a channel-like structure on its east side. The north part is composed of six smaller more integrated rooms (R3, R4, R5, R6, R7). The south part is composed of a sequence of two long rooms, the first integrated (R2) and the second less integrated (R8).

The highest control over adjacent rooms is exercised by the room at the entrance of the building (R1), connecting the north and south parts, and then the room that gives passage to the south part (R2).



Figure 97: Building F-b7 (visitor-inhabitant)

Inhabitant-inhabitant relationship*Micro level*

Building F-b7 is composed of $K=8$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 98).

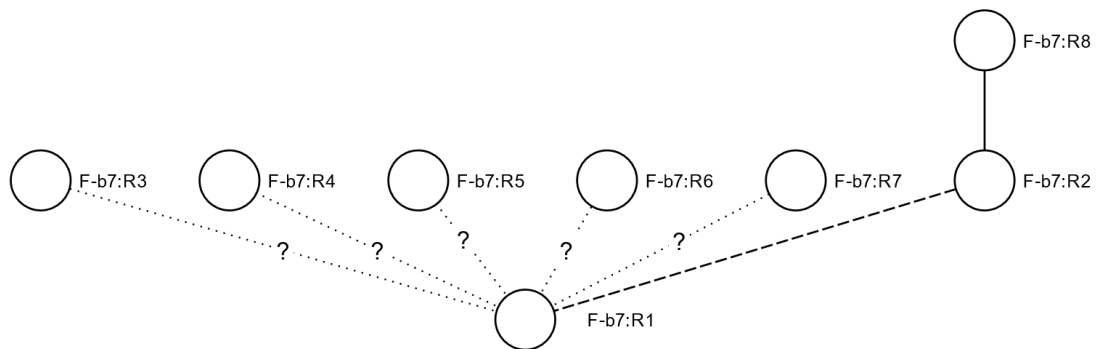


Figure 98: Justified graph Building F-b7 (inhabitant-inhabitant)

CHAPTER IV

Table 48 shows the results obtained for the building on a micro level, where the mean RA is 0.310 and the mean RRA is 0.943.

Table 48: Micro level analysis of Building F-b7(inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.167	8.000	1.143	0.048	0.145
Mean	1.000	13.500	1.929	0.310	0.943
Max	5.500	18.000	2.571	0.524	1.595

Nano level

Table 49 shows the results obtained for each space on the nano level. Six rooms are of type A and two are of type B. F-b7:R3, F-b7:R4, F-b7:R5, F-b7:R6 and F-b7:R7 have the lowest CV, whereas F-b7:R1 has the highest CV. F-b7:R1 has the lowest RA value, whereas F-b7:R8 has the highest RA value.

Table 49: Nano level of analysis of Building F-b7, K = 8 and D = 0.328 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b7:R1	B	6	5.500	8	1.143	0.048	0.145
F-b7:R2	B	2	1.167	12	1.714	0.238	0.725
F-b7:R3	A	1	0.167	14	2.000	0.333	1.015
F-b7:R4	A	1	0.167	14	2.000	0.333	1.015
F-b7:R5	A	1	0.167	14	2.000	0.333	1.015
F-b7:R6	A	1	0.167	14	2.000	0.333	1.015
F-b7:R7	A	1	0.167	14	2.000	0.333	1.015
F-b7:R8	A	1	0.500	18	2.571	0.524	1.595

Graphic output and interpretation

The justified graph in Figure 99 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b7, while the plan in Figure 100 visualises the last two values.

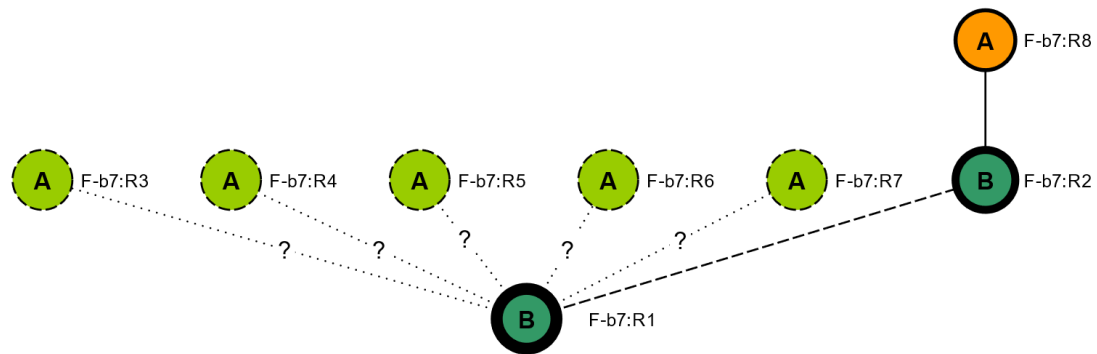


Figure 99: Coded justified graph of Building F-b7 (inhabitant-inhabitant)

An individual moving inside of the building is in more integrated surroundings (mean $RA = 0.310$ – inhabitant-inhabitant relationship). The entrance room (R1) loses some control and decreases its integration (Table 50). The north part (R3, R4, R5, R6, R7) increases a bit of its control and becomes increasingly integrated. R2 to the south has a bit more control and less integration, while the back room in the south part (R8) becomes more segregated.

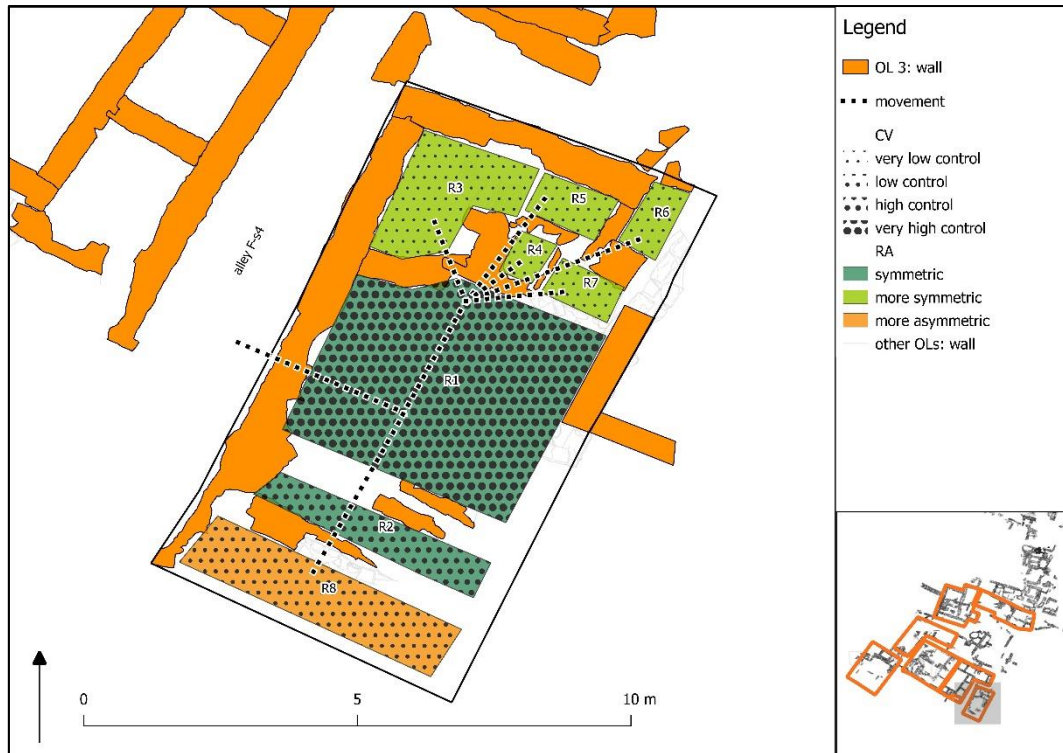


Figure 100: Building F-b7 (inhabitant-inhabitant)

Table 50: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b7

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b7:alley	0.143	-	0.286	-
F-b7:R1	6.500	5.500	0.036	0.048
F-b7:R2	1.143	1.167	0.214	0.238
F-b7:R3	0.143	0.167	0.286	0.333
F-b7:R4	0.143	0.167	0.286	0.333
F-b7:R5	0.143	0.167	0.286	0.333
F-b7:R6	0.143	0.167	0.286	0.333
F-b7:R7	0.143	0.167	0.286	0.333
F-b7:R8	0.500	0.500	0.464	0.524

2.8 Building F-b12

2.8.1 Description

Micro level

Building F-b12²⁶⁹ (Figure 101, Figure 102) was probably built on debris of an older OL (earlier than OL 3). The building has an estimated area of 143.70 m² with a roughly L-shaped ground plan. It has an estimated usable area of about 63.90 m². The estimation does not encompass the possible other storey of the building. The foundation levels of the walls are set between 829.25 m a.s.l. and 830.26 m a.s.l. The preserved height of the walls is up to 0.65 m. The width of the external walls is between 0.55 m and 1.20 m. The width of the internal walls is between 0.35 m and 1.00 m.



Figure 101: Building F-b12

²⁶⁹ Building number attributed by the author.



Figure 102: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into seven rooms. F-b12:R4 is attached to the building on the east side and has an area of about 2.70 m². F-b12:R3 is localised on the south side and has an area of about 27.10 m². F-12:R1 is localised on the north side and has an area of about 17.00 m². From F-b12:R1 is a kind of cavity going down covered by large slabs (SU 7338), probably leading to a part on a lower storey (Figure 103). F-b12:R2 is localised in the north-eastern corner and has an area of about 14.60 m². All rooms are outer rooms. F-b12:R5 is a passage between F-b12:R1 and F-b12:R3 of about 2.50 m².



Figure 103: Large slabs SU 7338 covering a cavity; view from N (© DAI Orient Department 2012 F. Weigel)

Permeabilities

The entrance was identified through the east side, accessing the building from alley F-s8 to F-b12:R4. A threshold was found between F-b12:R5 and F-b12:R1 (SU 7776, 828.14 m a.s.l.) and between F-b12:R3 and F-b12:R2 (SU 6295). Doorways were identified between F-b12:R4 and F-b12:R3 and F-b12:R3 and F-b12:R5.

Features and finds

F-b12:R2 was probably roofed, since there is evidence of beam holes on its west (SU 6285, Figure 104) and east (SU 6286) confining wall. The thick walls of the building lead to the hypothesis of a second storey to the building.



Figure 104: Wall SU 6285 with beam holes (on top); view from E (© DAI Orient Department 2012 F. Jürcke)

2.8.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building F-b12 is composed of K=8 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 105).

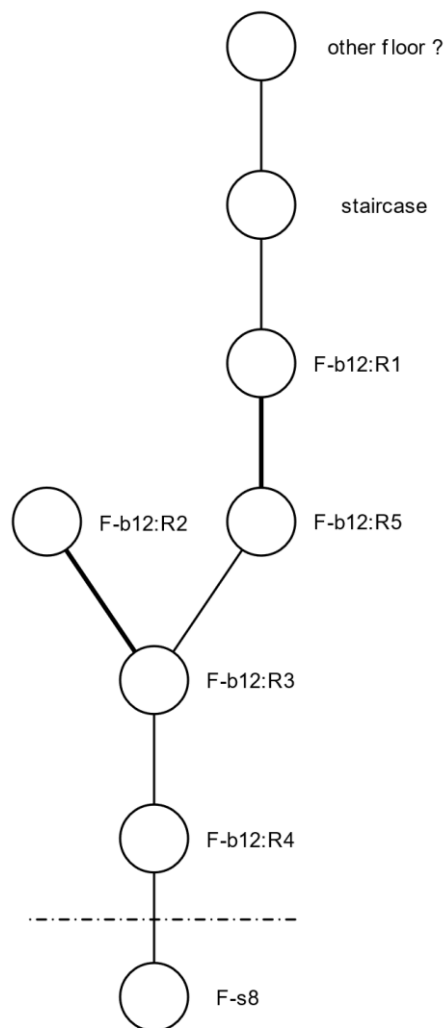


Figure 105: Justified graph Building F-b12 (visitor-inhabitant)

CHAPTER IV

Table 51 shows the results obtained for the building on a micro level, where the mean RA is 0.571 and the mean RRA is 1.740.

Table 51: Micro level analysis of Building F-b12 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	14.000	2.000	0.333	1.015
Mean	1.063	19.000	2.714	0.571	1.740
Max	2.000	26.000	3.714	0.905	2.755

Nano level

Table 52 shows the results obtained for each space. Three rooms are of type A and five are of type B. F-b12:R2 has the lowest CV, whereas F-b12:R3 has the highest CV. F-b12:R3 and F.b12:R5 have the lowest RA values, whereas the possible other floor has the highest RA value.

Table 52: Nano level of analysis of Building F-b12, K = 8 and D = 0.328 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b12:F-s8	A	1	0.500	24	3.429	0.810	2.465
F-b12:R1	B	2	1.000	16	2.286	0.429	1.305
F-b12:R2	A	1	0.333	20	2.857	0.619	1.885
F-b12:R3	B	3	2.000	14	2.000	0.333	1.015
F-b12:R4	B	2	1.333	18	2.571	0.524	1.595
F-b12:R5	B	2	0.833	14	2.000	0.333	1.015
F-b12:staircase	B	2	1.500	20	2.857	0.619	1.885
F-b12:other floor?	A	1	1.000	26	3.714	0.905	2.755

Graphic output and interpretation

The justified graph in Figure 106 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b12, while the plan in Figure 107 visualises the last two values.

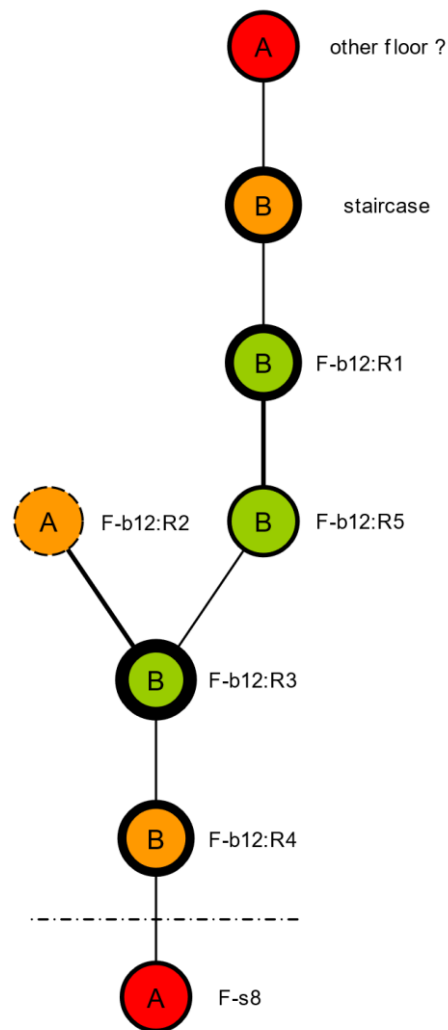


Figure 106: Coded justified graph of Building F-b12 (visitor-inhabitant)

Building F-b12 has a more segregated overall configuration (mean RA = 0.571 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b12 has a segregated position (the alley) in relation to the interior before entering the building. Upon entering, a more segregated small room (R4) is accessed. This leads to one of the two most integrated rooms in the building. It is the largest room (R3), which gives access to the north and northeast parts. The north part is composed of an integrated passage, the other most integrated room, (R5), which leads to a more integrated room (R1) and then a more segregated staircase to a possibly segregated other floor. The northeast part is composed of a more segregated room (R2).

The highest control over adjacent rooms is exercised by the largest room of the building (R3).



Figure 107: Building F-b12 (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b12 is composed of $K=7$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 108).

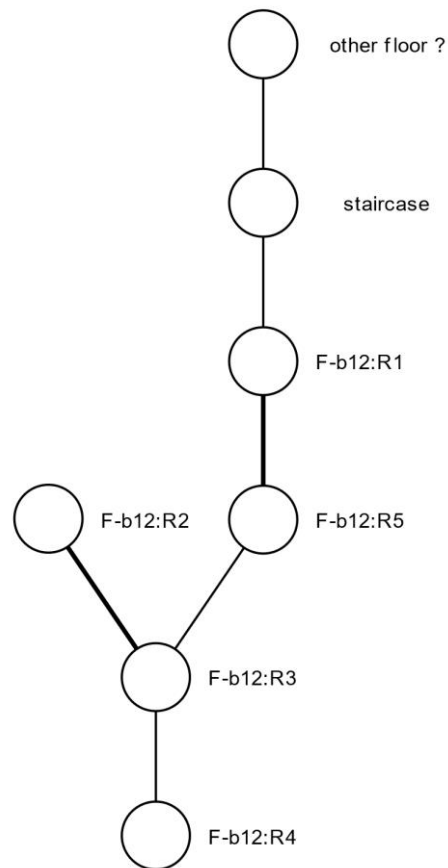


Figure 108: Justified graph Building F-b12 (inhabitant-inhabitant)

CHAPTER IV

Table 53 shows the results obtained for the building on a micro level, where the mean RA is 0.590 and the mean RRA is 1.738.

Table 53: Micro level analysis of Building F-b12 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	11.000	1.833	0.333	0.981
Mean	1.000	14.857	2.476	0.590	1.738
Max	2.500	20.000	3.333	0.933	2.748

Nano level

Table 54 shows the results obtained for each space on the nano level. Three rooms are of type A and four are of type B. F-b12:R2 and F-b12:R4 have the lowest CV, whereas F-b12:R3 has the highest CV. The passage F-b1:R5 has the lowest RA value, whereas the possible other floor has the highest RA value.

Table 54: Nano level of analysis of Building F-b12, K = 7 and D = 0.340 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b12:R1	B	2	1.000	12	2.000	0.400	1.178
F-b12:R2	A	1	0.333	17	2.833	0.733	2.159
F-b12:R3	B	3	2.500	12	2.000	0.400	1.178
F-b12:R4	A	1	0.333	17	2.833	0.733	2.159
F-b12:R5	B	2	0.833	11	1.833	0.333	0.981
F-b12:staircase	B	2	1.500	15	2.500	0.600	1.767
F-b12:other floor?	A	1	0.500	20	3.333	0.933	2.748

Graphic output and interpretation

The justified graph in Figure 109 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b12, while the plan in Figure 110 visualises the last two values.

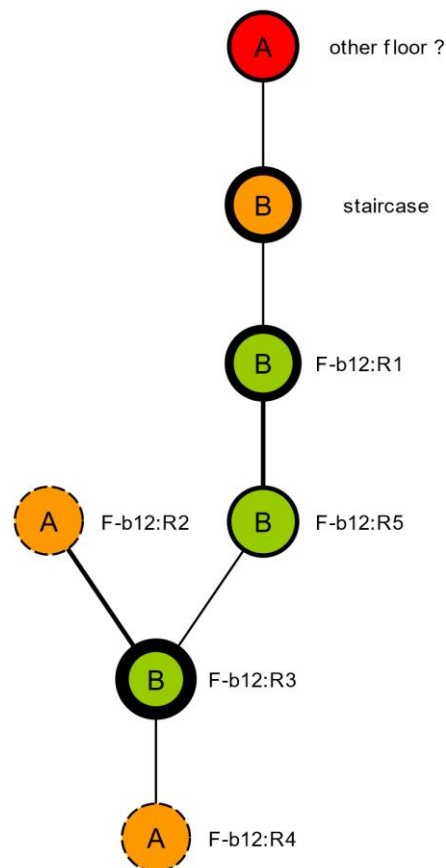


Figure 109: Coded justified graph of Building F-b12 (inhabitant-inhabitant)

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.590 – inhabitant-inhabitant relationship). The entrance room (R4) loses control and its integrated position becoming more segregated, just as the other storey (

Table 55). The largest room (R3) on the other hand gains even more control and is the most integrated. R1 and the staircase increase integration, while R2 increases its segregation.



Figure 110: Building F-b12 (inhabitant-inhabitant)

Table 55: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b12

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b12:F-s8	0.500	-	0.810	-
F-b12:R1	1.000	1.000	0.429	0.400
F-b12:R2	0.333	0.333	0.619	0.733
F-b12:R3	2.000	2.500	0.333	0.400
F-b12:R4	1.333	0.333	0.524	0.733
F-b12:R5	0.833	0.833	0.333	0.333
F-b12:staircase	1.500	1.500	0.619	0.600
F-b12:other floor?	1.000	0.500	0.905	0.933

3 OL 2B PHENOTYPES – LATE ANTIQUE PERIOD

3.1 Description – macro level

Five buildings have been identified in Area E-South/F from OL 2b – Building E-b8; Building E-b11; Building F-b5; Building F-b6; Building F-b8 (phase 1) (Figure 111). Of those, three buildings have enough information about the spatial layout to carry out a space syntax analysis. Further evidence uncovered from OL 2b did not provide the necessary information to determine other buildings.

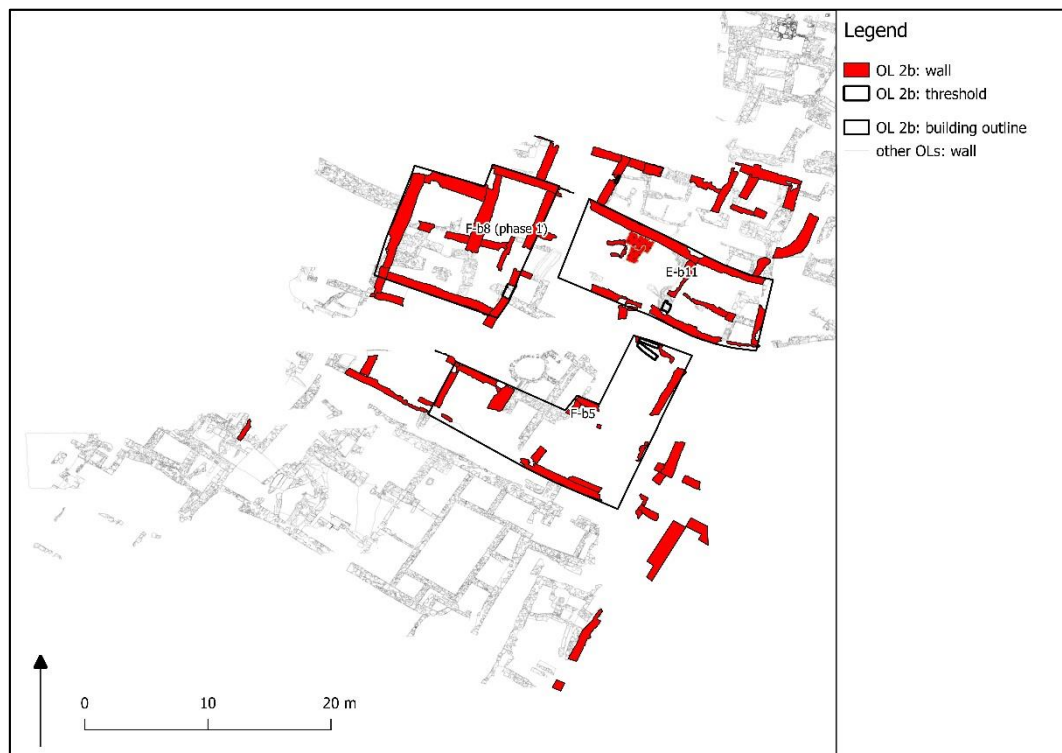


Figure 111: Architectural evidence from the first phase of the Late Antique Period (OL 2b) in the residential area (Area E-South/F)

3.2 Building E-b11

3.2.1 Description

Micro level

Building E-b11 (Figure 112, Figure 113) was built on top of Building E-b15 (OL 3), reusing part of the existing walls. The building has an estimated area of 107.90 m² with a roughly rectangular ground plan. It has an estimated usable area of 52.30 m². The estimation does not encompass the possible other storey. The foundation levels of the walls are not excavated. Set at about 829.85 m a.s.l. the walls are reused from Building E-b15 (OL 3). The width of the external walls is between 0.45 m and 0.75 m. The width of the internal walls is between 0.64 m and 0.70 m.

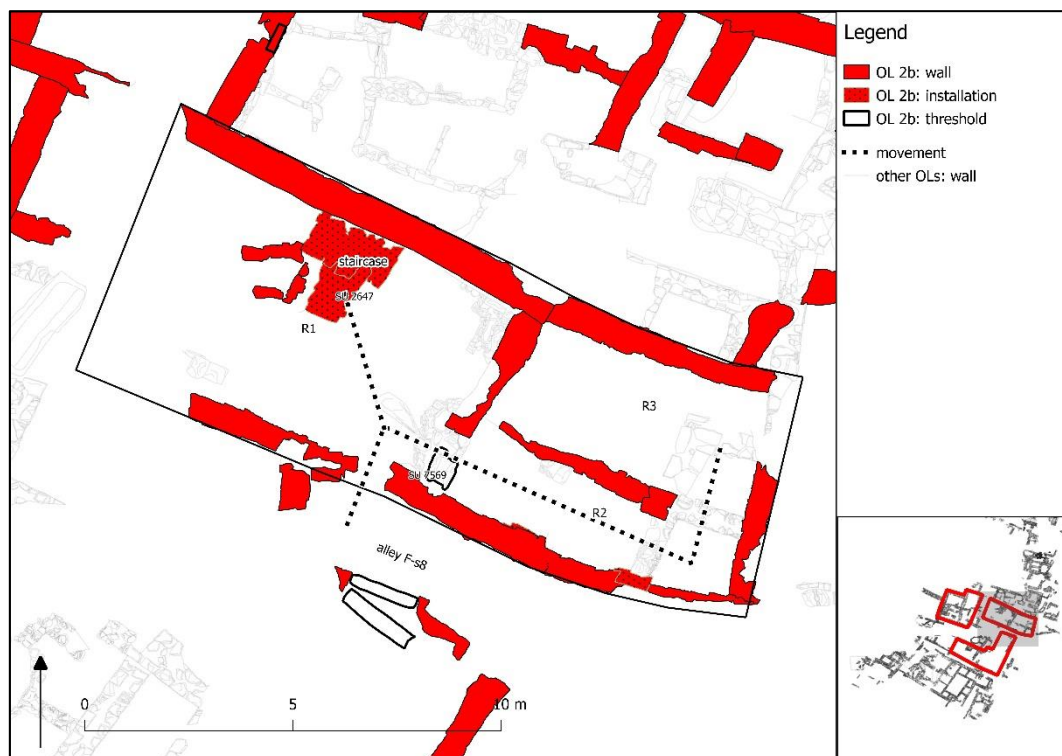


Figure 112: Building E-b11



Figure 113: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into at least three rooms. E-b11:R1 is located at the entrance on the west side and has an area of about 30.50 m². A staircase is located on the north side of the room leading to a possible upper floor. E-b11:R3 is located on the northeast side and has an area of about 12.60 m². E-b11:R2 is located on the southeast and has an area of about 9.20 m². All rooms are outer rooms. It is not clear if the building continues further to the west.

Permeabilities

The entrance was identified in the southwest side, accessing the building from alley F-s8 to E-b11:R1. A doorway with a threshold (SU 7569, 830.11 m a.s.l.) was identified between E-b11:R1 and E-b11:R2. A staircase (SU 2647, Figure 114) is located on the north side of E-b11:R1, evidencing a possible second storey. Further permeabilities can only be identified through absence of evidence, such as interruptions in walls between E-b11:R2 and E-b11:R3 and between alley F-s8 and E-b11:R1.



Figure 114: Staircase SU 2647; view from W (© DAI Orient Department 2012 F. Jürcke)

Features and finds

Floors were identified in two rooms. In E-b11:R1, the antique surface SU 7340 at 829.97 m a.s.l. In E-b11:R2, the clay floor SU 7557 at 829.95 m a.s.l.

Additional data

Building E-b11 was remodelled, changing the size of the building and the quantity and location of rooms, it is therefore considered as a new building (Building E-b7, described and analysed below).

3.2.2 Space syntax analysis

It is not clear whether Building E-b11 continues to the west. It is displayed in the justified graphs, although not integrated in the space syntax analysis.

Visitor-inhabitant relationship

Micro level

Building E-b11 is composed of $K=6$ spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 115).

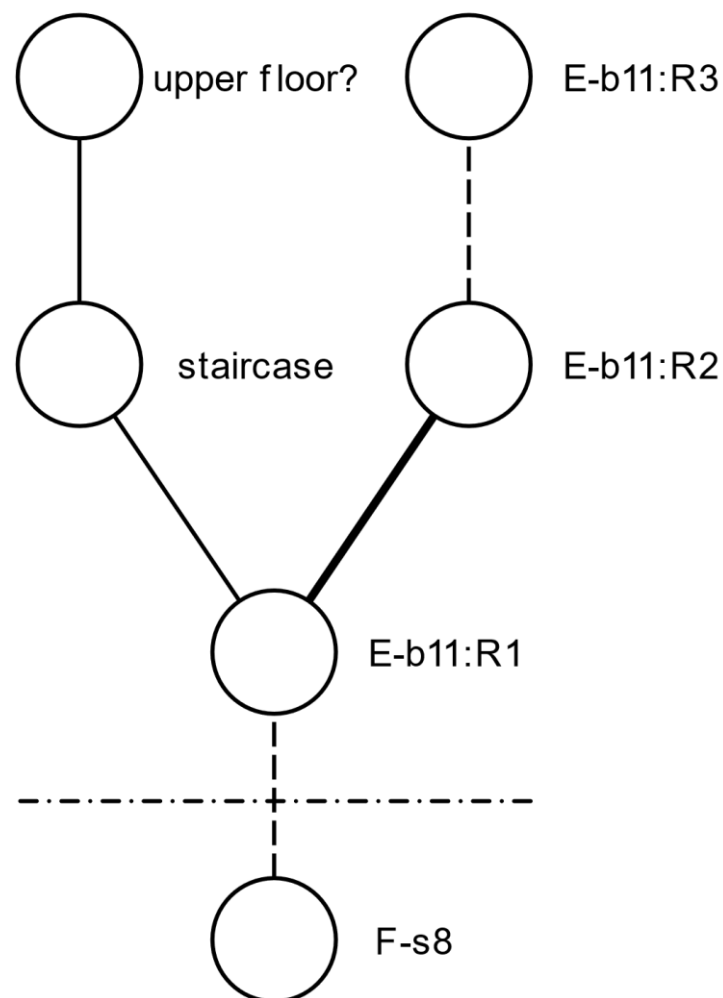


Figure 115: Justified graph Building E-b11 (visitor-inhabitant)

CHAPTER IV

Table 56 shows the results obtained for the building on a micro level, where the mean RA is 0.533 and the mean RRA is 1.528.

Table 56: Micro level analysis of Building E-b11 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	7.000	1.400	0.200	0.573
Mean	1.000	10.333	2.067	0.533	1.528
Max	2.000	13.000	2.600	0.800	2.292

Nano level

Table 57 shows the results obtained for each space. Three rooms are of type A and three are of type B. Alley F-s8 has the lowest CV, whereas E-b11:R1 has the highest CV. E-b11:R1 has the lowest RA value, whereas the E-b11:R3 and the upper floor have the highest RA values.

Table 57: Nano level of analysis of Building E-b11, K = 6 and D = 0.349 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
E-b11:F-s8	A	1	0.333	11	2.200	0.600	1.719
E-b11:R1	B	3	2.000	7	1.400	0.200	0.573
E-b11:R2	B	2	1.333	9	1.800	0.400	1.146
E-b11:R3	A	1	0.500	13	2.600	0.800	2.292
E-b11:staircase	B	2	1.333	9	1.800	0.400	1.146
E-b11:upper floor?	A	1	0.500	13	2.600	0.800	2.292

Graphic output and interpretation

The justified graph in Figure 116 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building E-b11, while the plan in Figure 117 visualises the last two values.

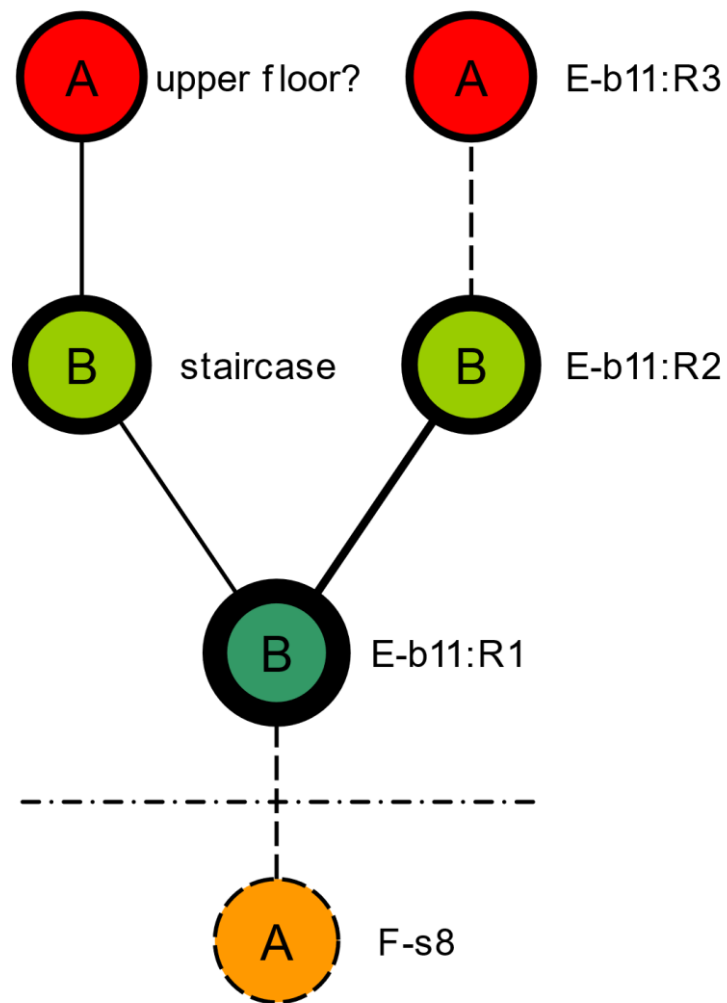


Figure 116: Coded justified graph of Building E-b11 (visitor-inhabitant)

Building E-b11 has a more segregated overall configuration (mean RA = 0.533 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building E-b11 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, the most integrated room (R1) is accessed. This room leads to the east part and to a staircase. The east part is composed of two rooms in a sequence, the first more integrated (R2) and the second segregated (R3). The staircase is a more integrated space, leading to a segregated possible upper floor.

The highest control over adjacent rooms is exercised by the room at the entrance of the building (R1), leading to the east part and upstairs.

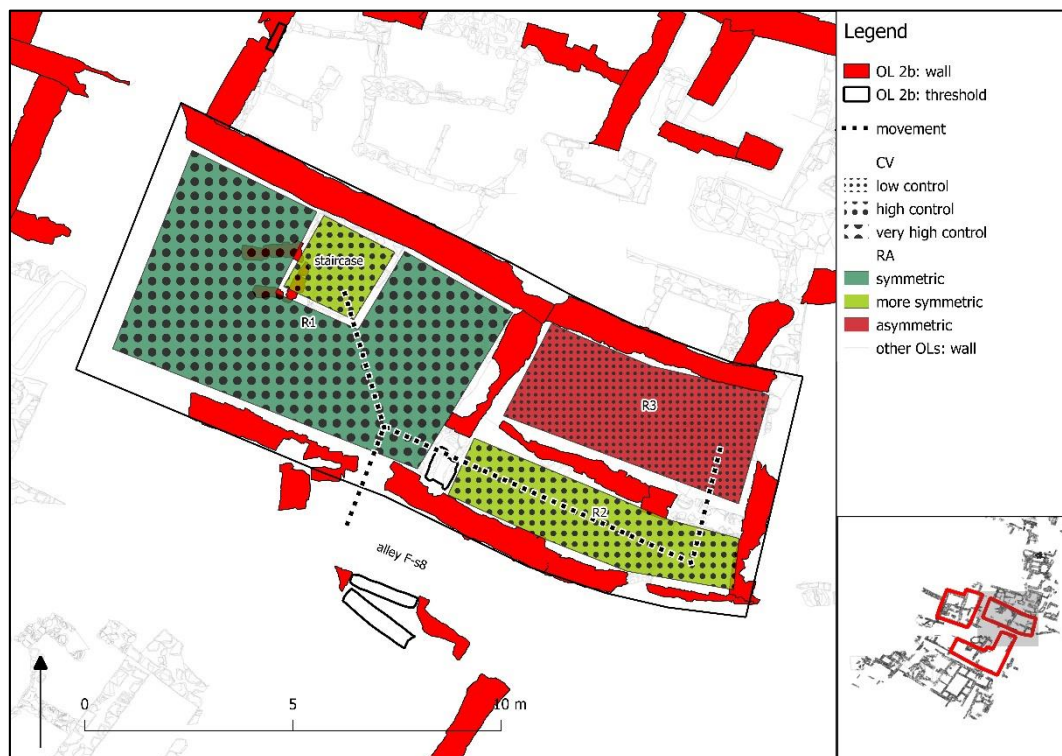


Figure 117: Building E-b11 (visitor-inhabitant)

Inhabitant-inhabitant relationship

Macro level

Building E-b11 is composed of $K=5$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 118).

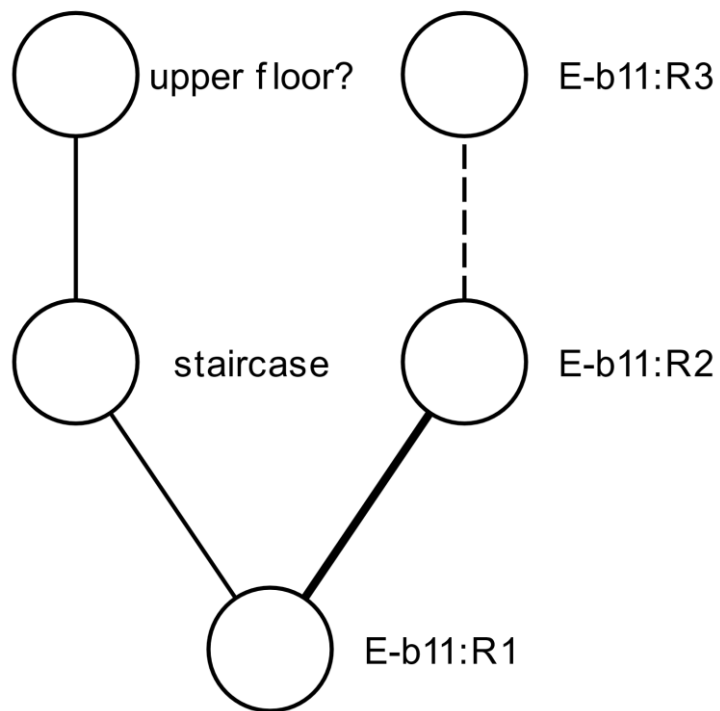


Figure 118: Justified graph of Building E-b11 (inhabitant-inhabitant)

CHAPTER IV

Table 58 shows the results obtained for the building on a micro level. The mean RA is 0.667 and the mean RRA is 1.894.

Table 58: Micro level analysis of Building E-b11 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	6.000	1.500	0.333	0.947
Mean	1.000	8.000	2.000	0.667	1.894
Max	1.500	10.000	2.500	1.000	2.841

Nano level

Table 59 shows the results obtained for each space. Two rooms are of type A and three rooms are of type B. E-b11:R3 and the upper floor have the lowest CV, whereas E-b11:R2 and the staircase have the highest CV. E-b11:R1 has the lowest RA value, whereas E-b11:R3 and the upper floor have the highest RA values.

Table 59: Nano level analysis of Building E-b11, K =5 and D = 0.352 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
E-b11:R1	B	2	1.000	6	1.500	0.333	0.947
E-b11:R2	B	2	1.500	7	1.750	0.500	1.420
E-b11:R3	A	1	0.500	10	2.500	1.000	2.841
E-b11:staircase	B	2	1.500	7	1.750	0.500	1.420
E-b11:upper floor?	A	1	0.500	10	2.500	1.000	2.841

Graphic output and interpretation

The justified graph in Figure 119 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building E-b11, while the plan in Figure 120 visualises the last two values.

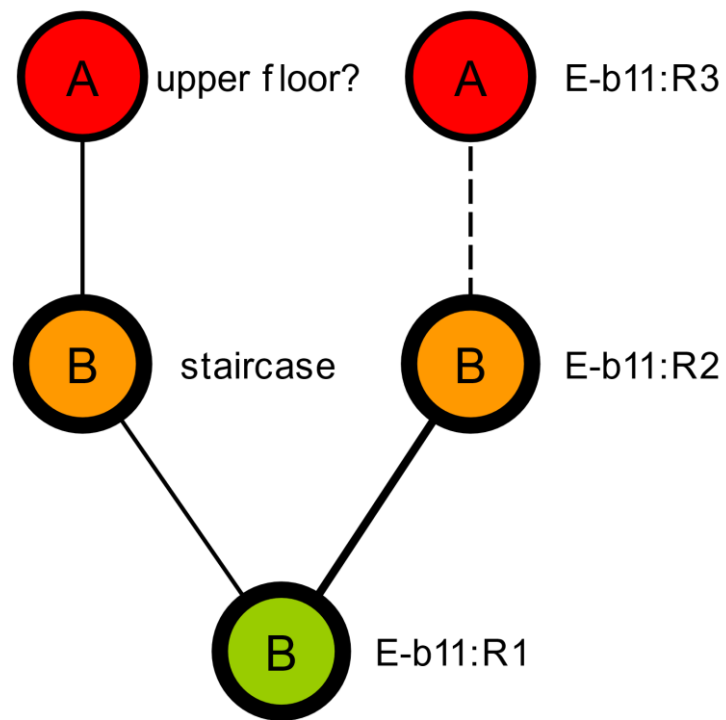


Figure 119: Coded justified graph of Building E-b11 (inhabitant-inhabitant)

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.667 – inhabitant-inhabitant relationship). The entrance room (R1) loses control and its most integrated position, distributed now between E-b11:R2 and the staircase (Table 61). All spaces increase segregation.

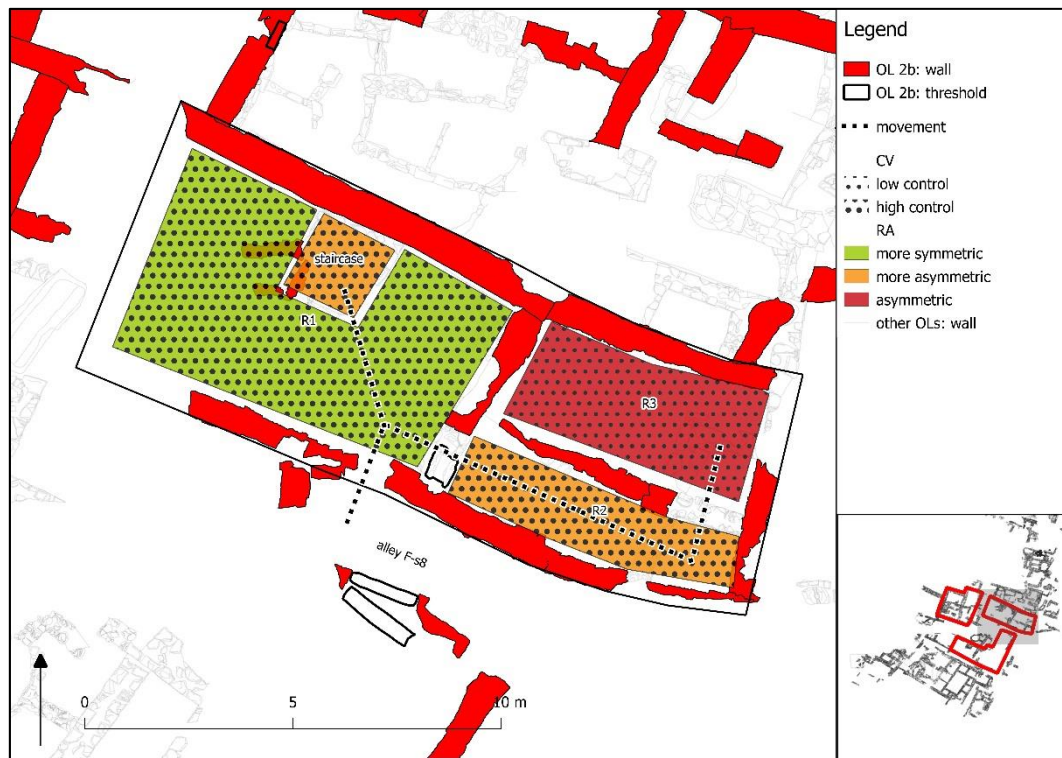


Figure 120: Building E-b11 (inhabitant-inhabitant)

Table 60: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b11

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
E-b11:F-s8	0.333	-	0.600	-
E-b11:R1	2.000	1.000	0.200	0.333
E-b11:R2	1.333	1.500	0.400	0.500
E-b11:R3	0.500	0.500	0.800	1.000
E-b11:staircase	1.333	1.500	0.400	0.500
E-b11:upper floor?	0.500	0.500	0.800	1.000

3.3 Building F-b5

3.3.1 Description

Micro level

Building F-b5 (Figure 121, Figure 122) was built on top of debris from OL 3. The building has an estimated area of 136.30 m² with an L-shaped ground plan. It has about 54.40 m² of usable area excavated and is estimated at 83.80 m². The foundation levels of the walls are set between 830.08 m a.s.l. and 830.60 m a.s.l. The width of the external walls is between 0.55 m and 0.60 m. The width of the internal walls is about 0.55 m.

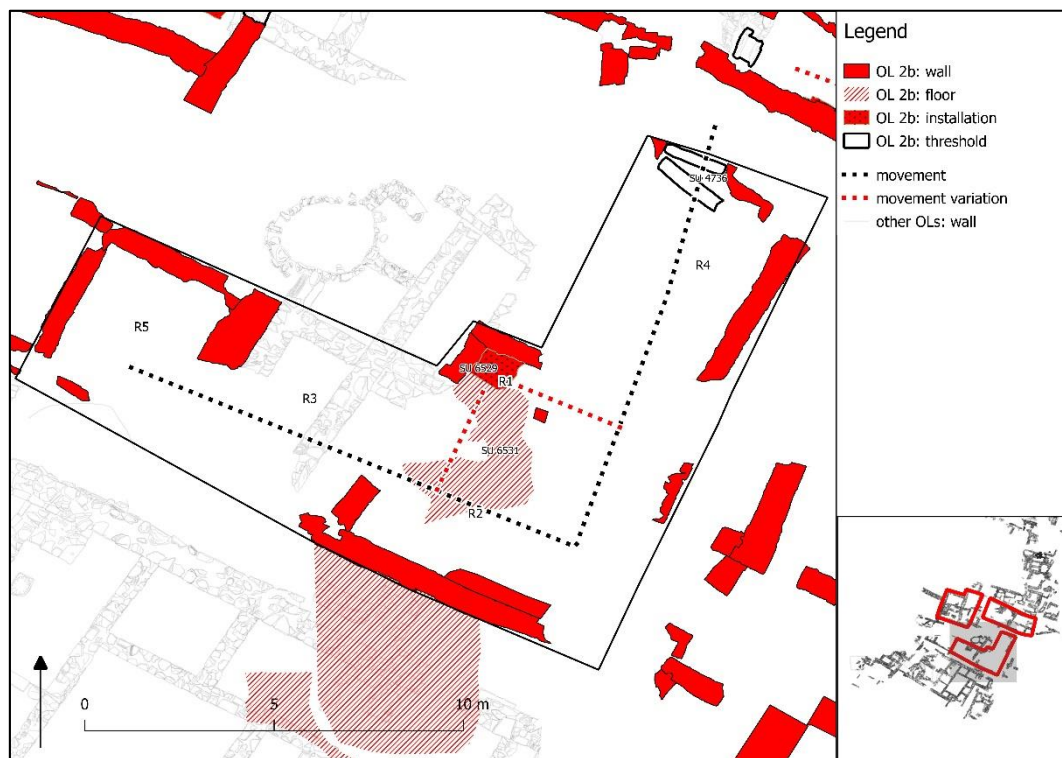


Figure 121: Building F-b5



Figure 122: Building F-b5, view from W (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into five rooms. F-b5:R4 is located on the north-eastern corner and has an area of at least 11.60 m² (excavated), estimated at about 26.70 m². F-b5:R1 is located on the north side and has an area of about 2.80 m². F-b5:R2 is located on the south side and has an area of at least 13.90 m² (excavated), estimated at about 28.20 m². F-b5:R3 is located on the west side and has an area of about 15.30 m². Further on the west side is F-b5:R5 with an area of about 10.80 m². All rooms are outer rooms.

Permeabilities

An entrance was identified in the north side, accessing the building from alley F-s8 to F-b5:R4. This entrance is evidenced by a threshold (SU 4736, 831.00 m a. s. l, Figure 123). A doorway was identified between F-b5:R3 and F-b5:R5. Further permeabilities can only be identified through absence of evidence, such as interruptions of walls between F-b5:R2 and F-b5:R3. It is not clear whether F-b5:R1 was accessed via F-b5:R4 or F-b5:R2.



Figure 123: Threshold SU 4736 (on the bottom); view from W (© DAI Orient Department 2016 F. Weigel)

Features and finds

A fire installation was identified in F-b5:R1 composed of two standing ashlar (SU 6529) and filled with SU 6530 (Figure 124).

A clay floor (SU 6531) was identified in F-b5:R1 and F-b5:R2 at about 830.40 m a.s.l.

A date stone sample from the fire installations filling (SU 6530) was dated to 389-535 calAD with ^{14}C -analysis.²⁷⁰

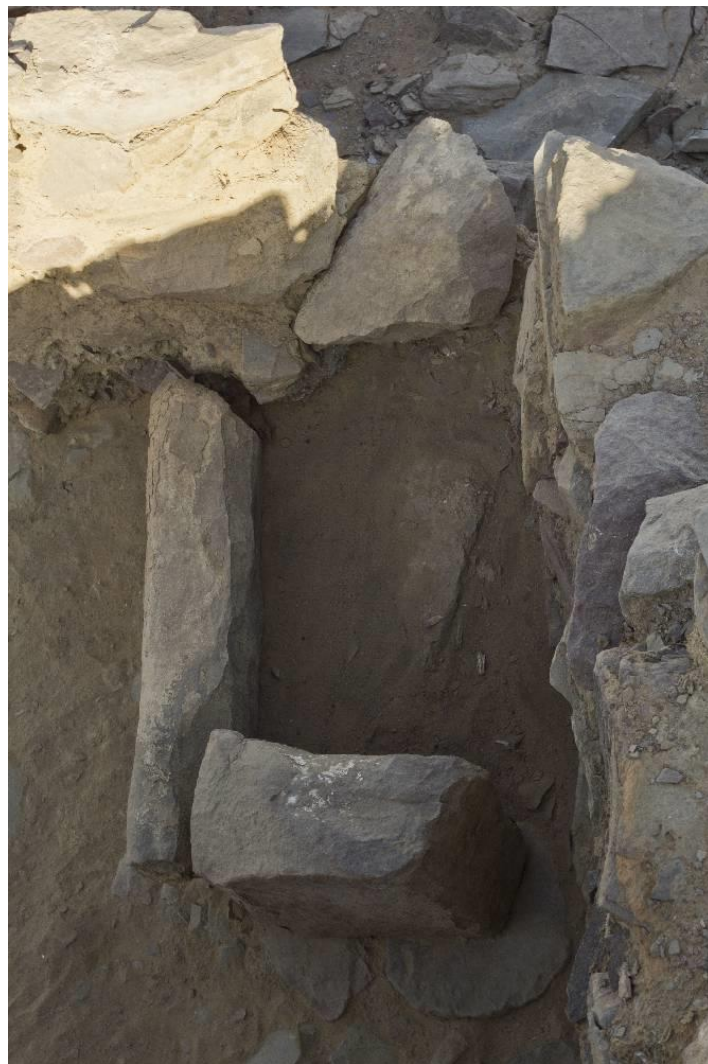


Figure 124: Fire installation SU 6529; view from E (© DAI Orient Department 2011 F. Weigel)

²⁷⁰ Date stone (TA 7745); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 13428; date: 1620 ± 25 BP; 2σ range date: 389-535 calAD (95.4%); OxCal v4.2.2; May 2013.

3.3.2 Space syntax analysis

3.3.3 Space syntax analysis – variation 1

Variation 1 of a space syntax analysis of Building F-b5 assumes a connection between rooms F-b5:R2 and F-b5:R1.

Visitor-inhabitant relationship

Micro level

Building F-b5 is composed of K=6 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 125).

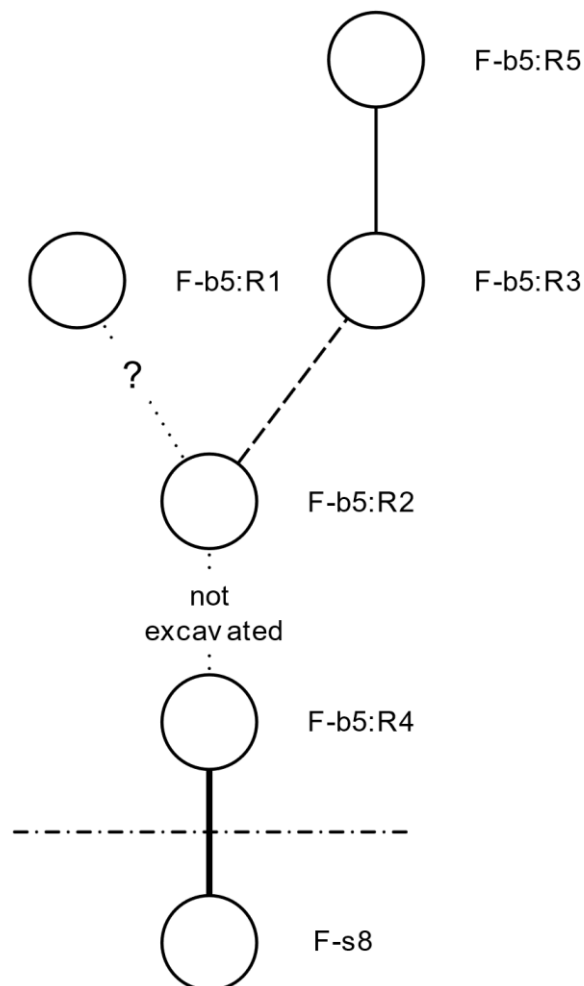


Figure 125: Justified graph Building F-b5 (visitor-inhabitant) – variation 1

CHAPTER IV

Table 61 shows the results obtained for the building on a micro level. The mean RA is 0.533 and the mean RRA is 1.528.

Table 61: Micro level analysis of Building F-b5 (visitor-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.333	7.000	1.400	0.200	0.573
Mean	1.000	10.333	2.067	0.533	1.528
Max	2.000	13.000	2.600	0.800	2.292

Nano level

Table 62 shows the results obtained for each space. Three rooms are of type A and three are of type B. F-b5:R1 has the lowest CV, whereas F-b5:R2 has the highest CV. F-b5:R2 has the lowest RA value, whereas alley F-s8 and F-b5:R5 have the highest RA values.

Table 62: Nano level of analysis of Building F-b5, K = 6 and D = 0.349 (visitor-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
F-b5:F-s8	A	1	0.500	13	2.600	0.800	2.292
F-b5:R1	A	1	0.333	11	2.200	0.600	1.719
F-b5:R2	B	3	2.000	7	1.400	0.200	0.573
F-b5:R3	B	2	1.333	9	1.800	0.400	1.146
F-b5:R4	B	2	1.333	9	1.800	0.400	1.146
F-b5:R5	A	1	0.500	13	2.600	0.800	2.292

Graphic output and interpretation

The justified graph in Figure 126 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b5, while the plan in Figure 127 visualises the last two values.

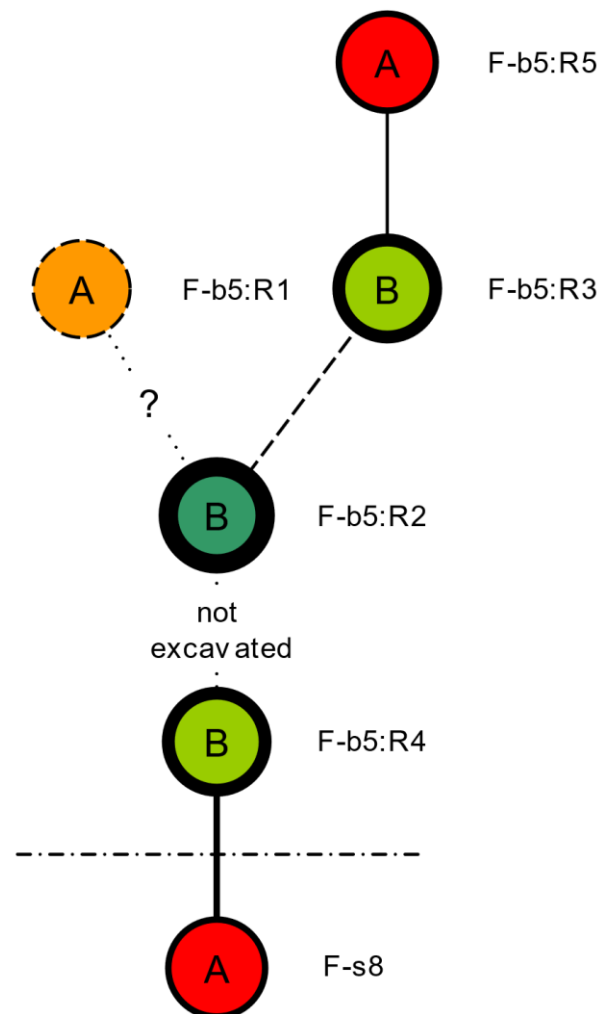


Figure 126: Coded justified graph of Building F-b5 (visitor-inhabitant) – variation 1

Building F-b5 has a more segregated overall configuration (mean RA = 0.533 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b5 has a segregated position (the alley) in relation to the interior before entering the building. Upon entering, a more integrated room is accessed (R4), which leads to the most integrated room (R2). That room distributes to a more segregated room with an installation to the north part (R1) and a sequence of two rooms to the west part. The first room is a more integrated (R3) and the second a segregated back (R5).

The highest control over adjacent rooms is exercised by the room that leads to the room with the installation and the west part (R2).

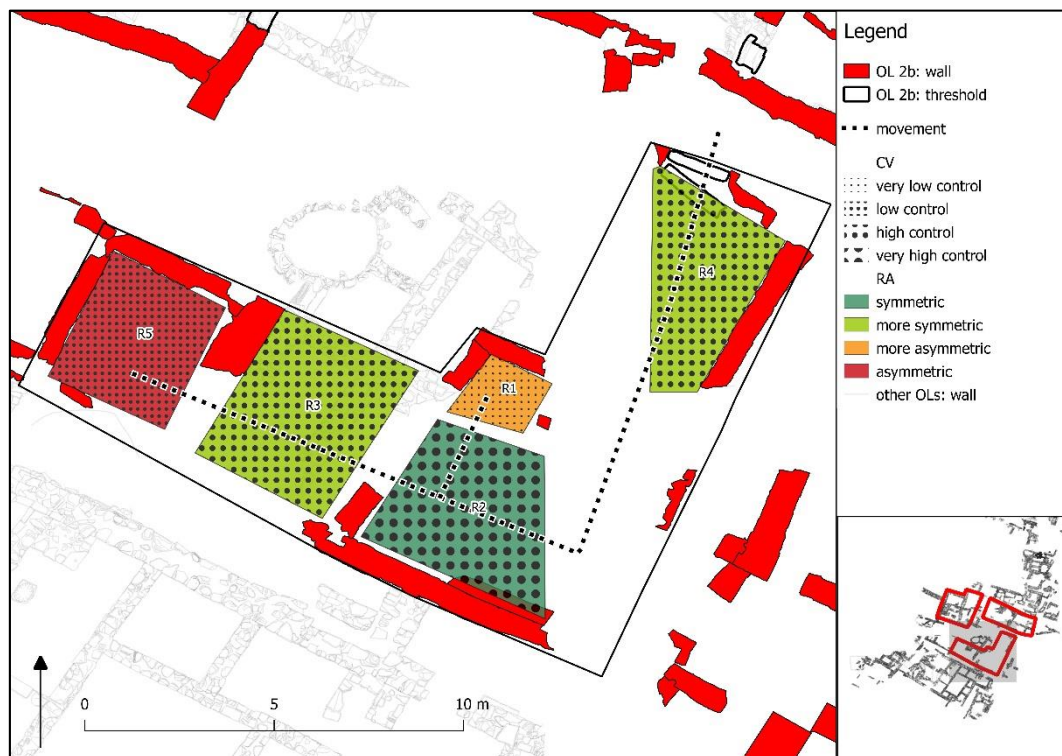


Figure 127: Building F-b5 (visitor-inhabitant) – variation 1

Inhabitant-inhabitant relationship

Micro level

Building F-b5 is composed of K=5 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 128).

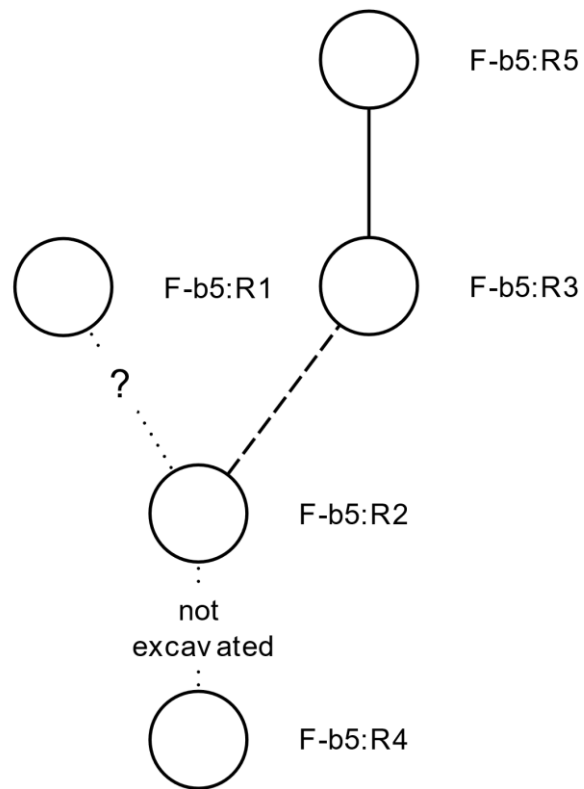


Figure 128: Justified graph Building F-b5 (inhabitant-inhabitant) – variation 1

CHAPTER IV

Table 63 shows the results obtained for the building on a micro level. The mean RA is 0.533 and the mean RRA is 1.515.

Table 63: Micro level analysis of Building F-b5 (inhabitant-inhabitant) – variation 1

	CV	TD	MD	RA	RRA
Min	0.333	5.000	1.250	0.167	0.473
Mean	1.000	7.200	1.800	0.533	1.515
Max	2.500	9.000	2.250	0.833	2.367

Nano level

Table 64 shows the results obtained for each space on the nano level. Three rooms are of type A and two are of type B. F-b5:R1 and F-b5:R4 have the lowest CV, whereas F-b5:R2 has the highest CV. F-b5:R2 has the lowest RA value, whereas F-b5:R5 has the highest RA value.

Table 64: Nano level of analysis of Building F-b5, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 1

space	type	NC	CV	TD	MD	RA	RRA
F-b5:R1	A	1	0.333	8	2.000	0.667	1.894
F-b5:R2	B	3	2.500	5	1.250	0.167	0.473
F-b5:R3	B	2	1.333	6	1.500	0.333	0.947
F-b5:R4	A	1	0.333	8	2.000	0.667	1.894
F-b5:R5	A	1	0.500	9	2.250	0.833	2.367

Graphic output and interpretation

The justified graph in Figure 129 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b5, while the plan in Figure 130 visualises the last two values.

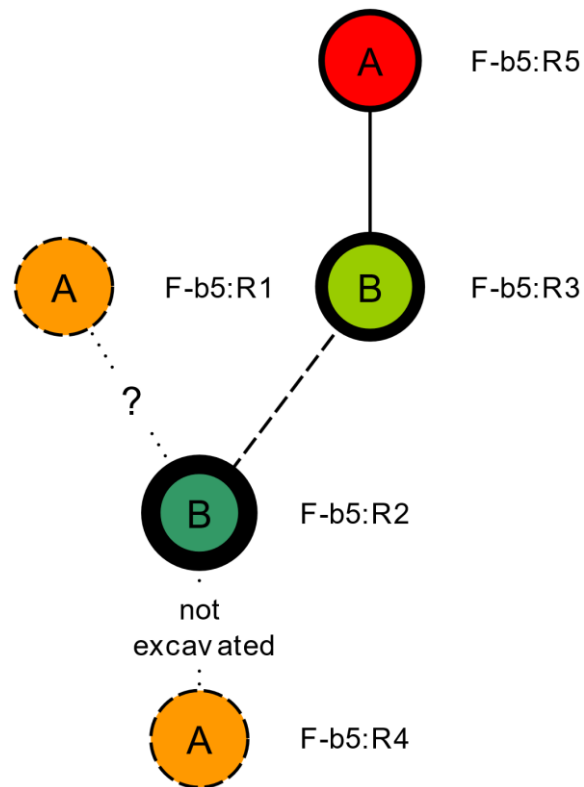


Figure 129: Coded justified graph of Building F-b5 (inhabitant-inhabitant) – variation 1

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.533 – inhabitant-inhabitant relationship). R2 gains more control and R4, previously an entrance room, loses control (Table 65). R2 and R3, at the centre of the building become increase their integration, while the rooms on the outer ends (R1, R4, R5) decrease their integration.

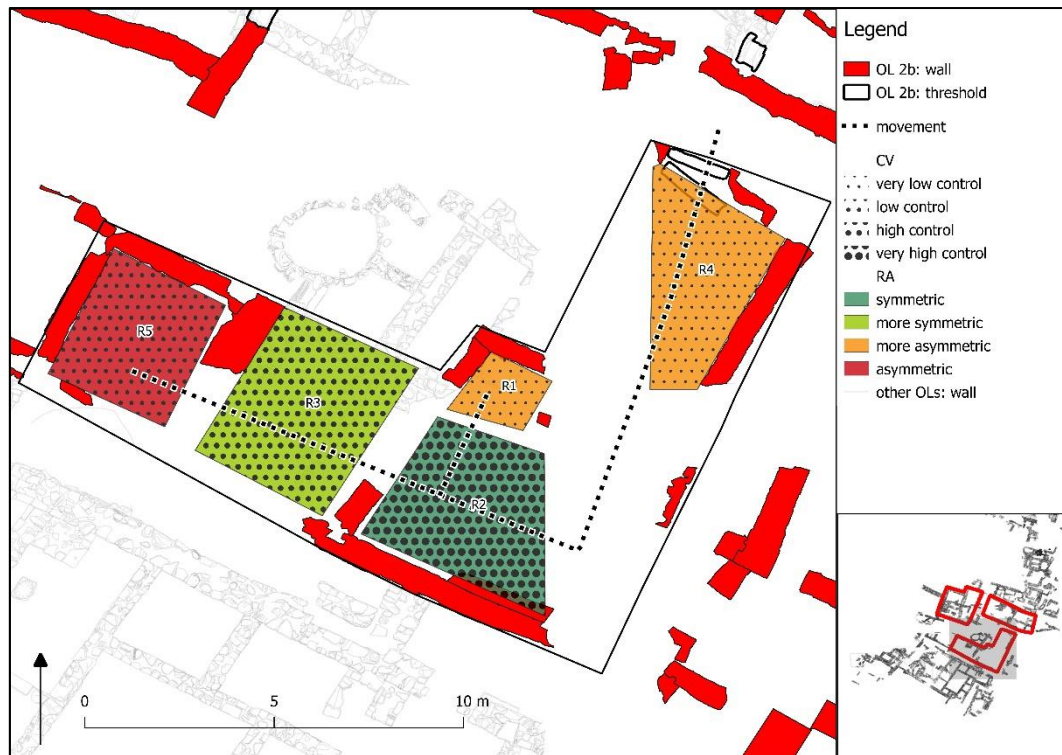


Figure 130: Building F-b5 (inhabitant-inhabitant) – variation 1

Table 65: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b5, variation 1

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b5:F-s8	0.500	-	0.800	-
F-b5:R1	0.333	0.333	0.600	0.667
F-b5:R2	2.000	2.500	0.200	0.167
F-b5:R3	1.333	1.333	0.400	0.333
F-b5:R4	1.333	0.333	0.400	0.667
F-b5:R5	0.500	0.500	0.800	0.833

3.3.4 Space syntax analysis – variation 2

Variation 2 of a space syntax analysis of Building F-b5 assumes a connection between rooms F-b5:R4 and F-b5:R1.

Visitor-inhabitant relationship

Micro level

Building F-b5 is composed of K=6 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 131).

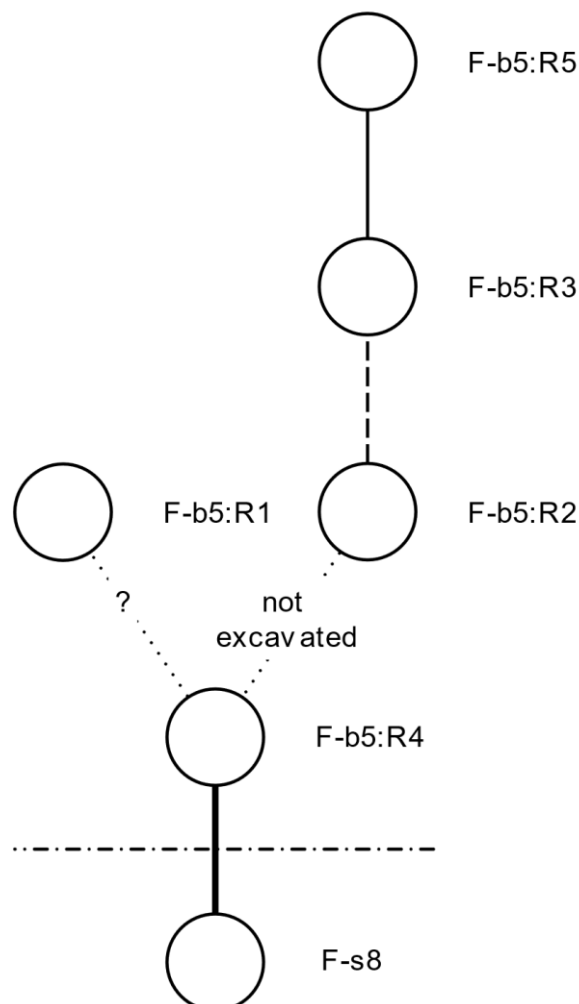


Figure 131: Justified graph Building F-b5 (visitor-inhabitant) – variation 2

CHAPTER IV

Table 66 shows the results obtained for the building on a micro level. The mean RA is 0.567 and the mean RRA is 1.624.

Table 66: Micro level analysis of Building F-b5 (visitor-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.333	8.000	1.600	0.300	0.860
Mean	1.000	10.667	2.133	0.567	1.624
Max	2.500	14.000	2.800	0.900	2.579

Nano level

Table 67 shows the results obtained for each space. Three rooms are of type A and three are of type B. Alley F-s8 and F-b5:R1 have the lowest CV, whereas F-b5:R4 has the highest CV. F-b5:R2 and F-b5:R4 have the lowest RA values, whereas F-b5:R5 has the highest RA value.

Table 67: Nano level of analysis of Building F-b5, K = 6 and D = 0.349 (visitor-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
F-b5:F-s8	A	1	0.333	12	2.400	0.700	2.006
F-b5:R1	A	1	0.333	12	2.400	0.700	2.006
F-b5:R2	B	2	0.833	8	1.600	0.300	0.860
F-b5:R3	B	2	1.500	10	2.000	0.500	1.433
F-b5:R4	B	3	2.500	8	1.600	0.300	0.860
F-b5:R5	A	1	0.500	14	2.800	0.900	2.579

Graphic output and interpretation

The justified graph in Figure 132 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b2, while the plan in Figure 133 visualises the last two values.

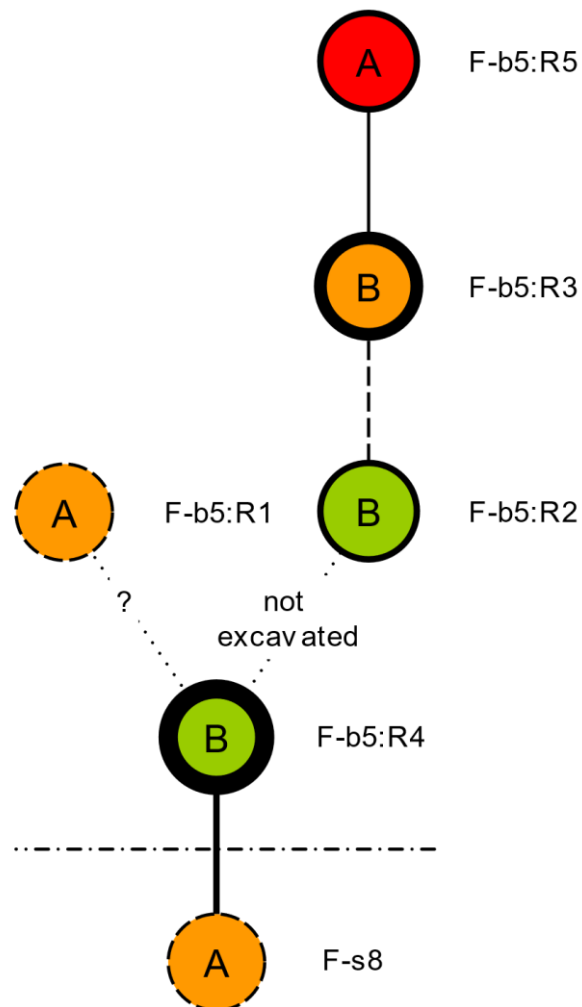


Figure 132: Coded justified graph of Building F-b5 (visitor-inhabitant) – variation 2

Building F-b5 has a more segregated overall configuration (mean RA = 0.567 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b5 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, the first of the two most integrated rooms is accessed (R4). This leads to the more segregated room with an installation (R1) and to the other more integrated room (R2). From there to the west part, first a more segregated room is accessed (R3) and then a segregated back room (R5).

The highest control over adjacent rooms is exercised by the room at the entrance (R4).

This variation of Building F-b5 is a bit more segregated and the control is centred on R4 instead of R2.

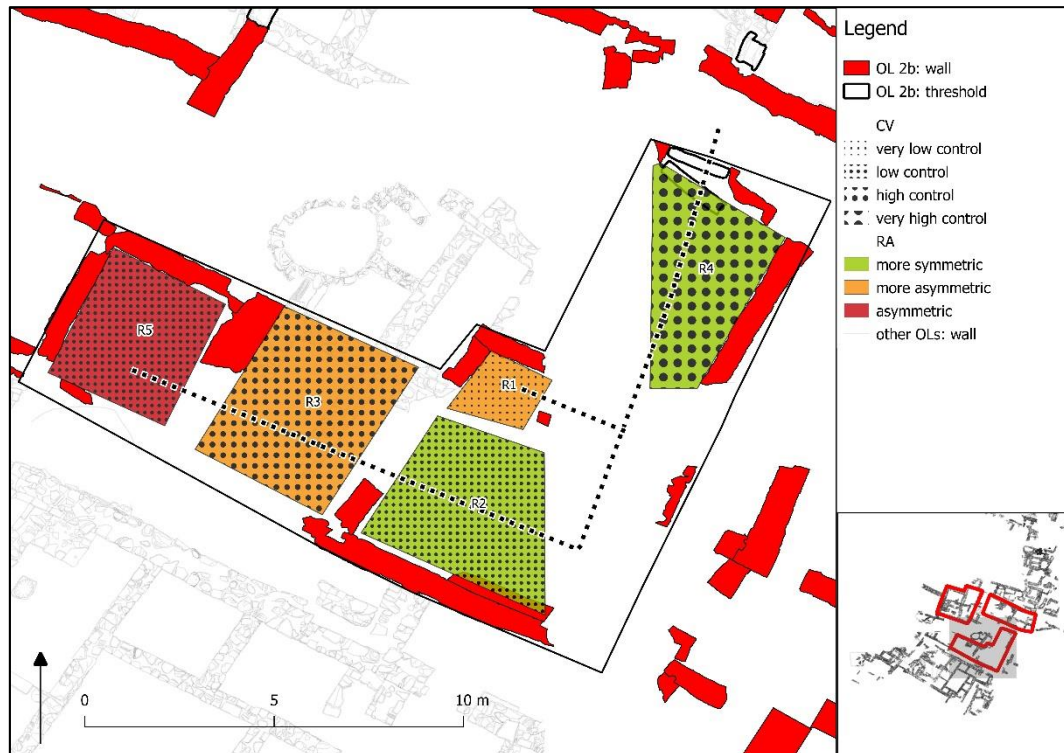


Figure 133: Building F-b5 (visitor-inhabitant) – variation 2

Inhabitant-inhabitant relationship

Micro level

Building F-b5 is composed of K=5 spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 134).

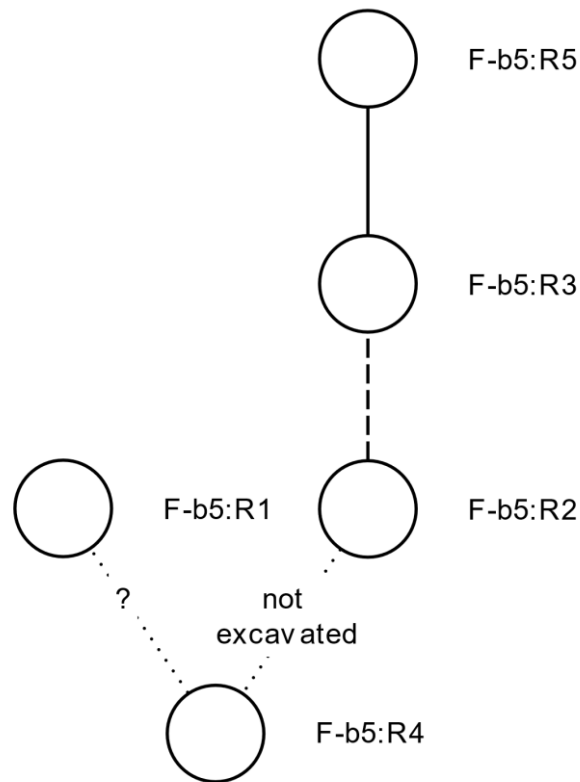


Figure 134: Justified graph Building F-b5 (inhabitant-inhabitant) – variation 2

CHAPTER IV

Table 68 shows the results obtained for the building on a micro level. The mean RA is 0.667 and the mean RRA is 1.894.

Table 68: Micro level analysis of Building F-b5 (inhabitant-inhabitant) – variation 2

	CV	TD	MD	RA	RRA
Min	0.500	6.000	1.500	0.333	0.947
Mean	1.000	8.000	2.000	0.667	1.894
Max	1.500	10.000	2.500	1.000	2.841

Nano level

Table 69 shows the results obtained for each space on the nano level. Two rooms are of type A and three are of type B. F-b5:R1 and F-b5:R5 have the lowest CV, whereas F-b5:R3 and F-b5:R4 have the highest CV. F-b5:R2 has the lowest RA value, whereas F-b5:R1 and F-b5:R5 have the highest RA values.

Table 69: Nano level of analysis of Building F-b5, K = 5 and D = 0.352 (inhabitant-inhabitant) – variation 2

space	type	NC	CV	TD	MD	RA	RRA
F-b5:R1	A	1	0.500	10	2.500	1.000	2.841
F-b5:R2	B	2	1.000	6	1.500	0.333	0.947
F-b5:R3	B	2	1.500	7	1.750	0.500	1.420
F-b5:R4	B	2	1.500	7	1.750	0.500	1.420
F-b5:R5	A	1	0.500	10	2.500	1.000	2.841

Graphic output and interpretation

The justified graph in Figure 135 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b2, while the plan in Figure 136 visualises the last two values.

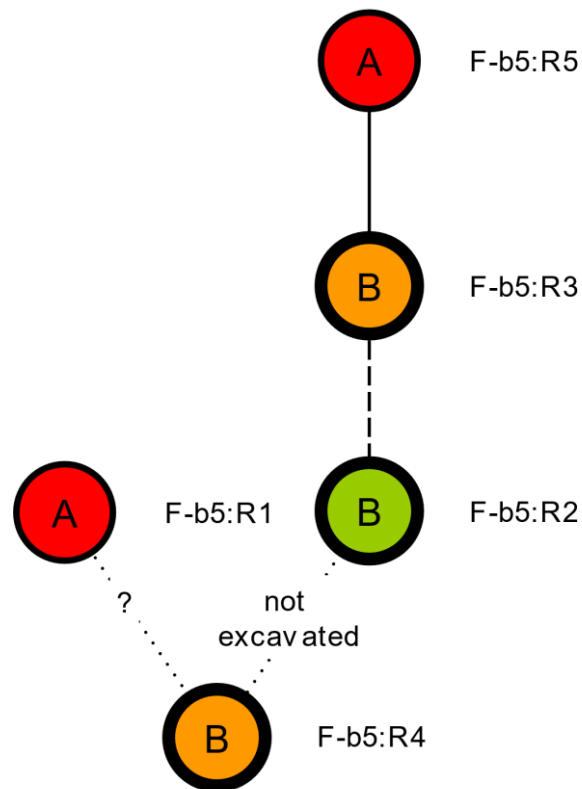


Figure 135: Coded justified graph of Building F-b5 (inhabitant-inhabitant) – variation 2

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.667 – inhabitant-inhabitant relationship).

The entrance room, R4, loses control and its integrated position (Table 73). The most control is now shared by R3 and R4 equally. R1, with the installation, increases its control and becomes segregated. All spaces increase their segregation except for R3.

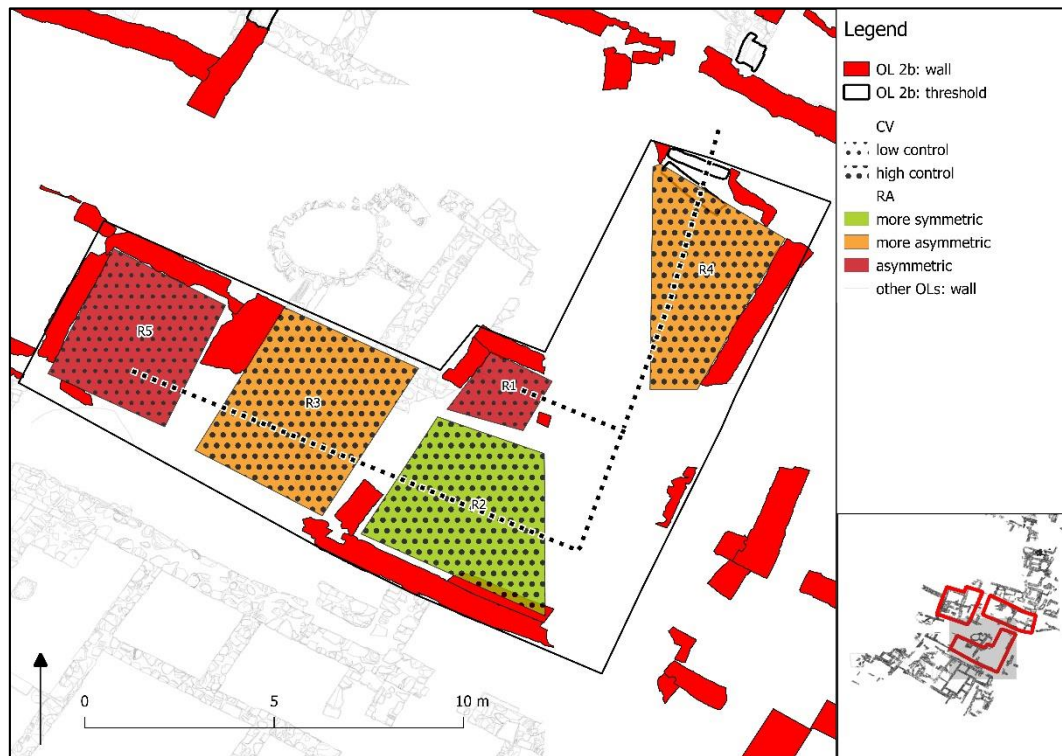


Figure 136: Building F-b5 (inhabitant-inhabitant) – variation 2

Table 70: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building F-b5, variation 2

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b5:F-s8	0.333	-	0.700	-
F-b5:R1	0.333	0.500	0.700	1.000
F-b5:R2	0.833	1.000	0.300	0.333
F-b5:R3	1.500	1.500	0.500	0.500
F-b5:R4	2.500	1.500	0.300	0.500
F-b5:R5	0.500	0.500	0.900	1.000

3.4 Building F-b8 (Phase 1)

3.4.1 Description

Micro level

Building F-b8 (Figure 137, Figure 138) was built on top of Building F-b12 (OL 3), reusing part of the existing walls. The building has an estimated area of 119.40 m² with a roughly L-shaped ground plan. It has an estimated usable area of about 64.40 m². The foundation levels of the walls are set between 829.45 m a.s.l. and 830.26 m a.s.l. Set at a lower level are the walls reused from Building F-b12 (OL 3). The width of the external walls is between 0.55 m and 1.20 m. The width of the internal walls is between 0.35 m and 0.70 m.



Figure 137: Buildings F-b8 (phase 1)



Figure 138: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into four rooms. F-b8:R4 is a passage on the east side of the building and has an area of about 2.20 m². F-b8:R3 is localised on the south side and has an area of about 32.60 m². F-b8:R1 is localised in the north-western corner and has an area of about 14.20 m². F-b8:R2 is localised on the northeast side and has an area of about 15.40 m². All rooms are outer rooms.

Permeabilities

The entrance was identified in the south-eastern corner, accessing the building from alley Fs-8 to F-b8:R3. This entrance is evidenced by a threshold (SU 6297, UE 830.70 m a.s.l., Figure 139), a reused stone with grinding depressions. Doorways were identified between F-b8:R4 and F-b8:R3, between F-b8:R4 and F-b8:R2, and between F-b8:R3 and F-b8:R1.



Figure 139: Threshold SU 6297 with grinding depressions; view from E (© DAI Orient Department 2011 J. Kramer)

Features and finds

Floors were identified in three rooms. In F-b8:R3, the trodden mud and stone floor SU 6294 at 829.30 m a.s.l. (east) to 829.76 m a.s.l. (northwest). In F-b8:R1, the trodden mud floor SU 6676 at 830.30 m a.s.l. In F-b8:R2, the trodden mud floor SU 6293 at 830.25 m a.s.l.

Additional data

Building F-b8 (Phase 1) was remodelled after OL 2b. The changes, along with the space syntax analysis, will be presented in Section 4.3 of this chapter concerning OL 2a under the same building name F-b8 (Phase 2).

CHAPTER IV

Table 71 shows the results obtained for the building on a micro level. The mean RA is 0.553 and the mean RRA is 1.515.

Table 71: Micro level analysis of Buildings F-b8 (phase 1) (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	5.000	1.250	0.167	0.473
Mean	1.000	7.200	1.800	0.533	1.515
Max	2.500	9.000	2.250	0.833	2.367

Nano level

Table 72 shows the results obtained for each space. Three rooms are of type A and two are of type B. Alley F-s8 and F-b8:R2 have the lowest CV, whereas F-b8:R4 has the highest CV. F-b8:R4 has the lowest RA value, whereas F-s8:R1 has the highest RA value.

Table 72: Nano level of analysis of Buildings F-b8 (phase 1), K = 5 and D = 0.352 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b8:F-s8	A	1	0.333	8	2.000	0.667	1.894
F-b8:R1	A	1	0.500	9	2.250	0.833	2.367
F-b8:R2	A	1	0.333	8	2.000	0.667	1.894
F-b8:R3	B	2	1.333	6	1.500	0.333	0.947
F-b8:R4	B	3	2.500	5	1.250	0.167	0.473

Graphic output and interpretation

The justified graph in Figure 141 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b8, while the plan in Figure 142 visualises the last two values.

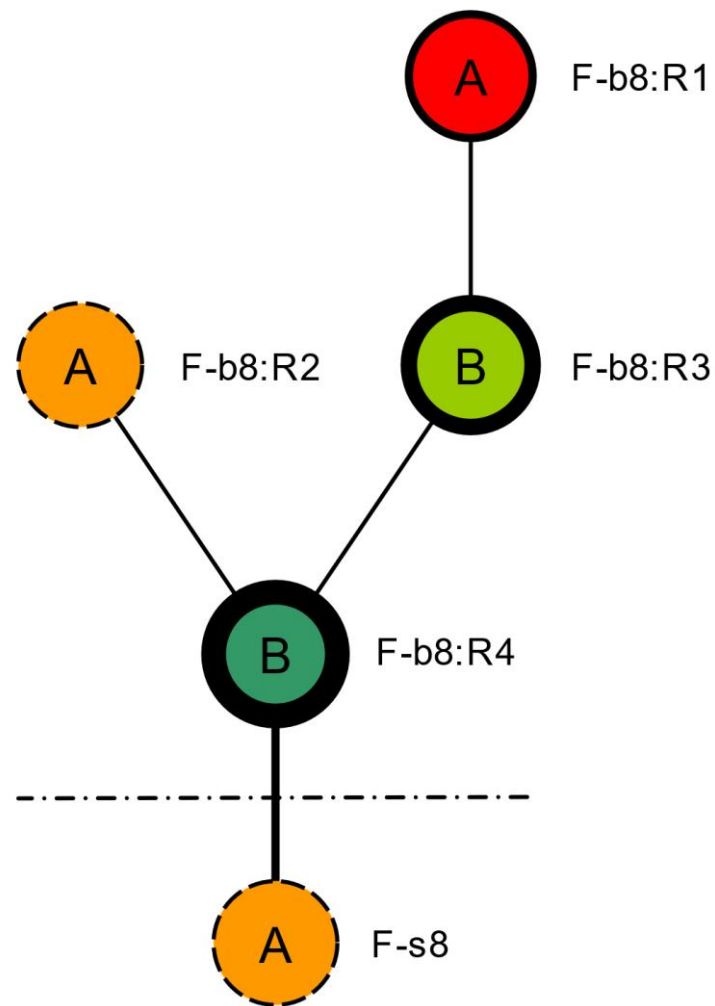


Figure 141: Coded justified graph of Buildings F-b8 (phase 1) (visitor-inhabitant)

Building F-b8 has a more segregated overall configuration (mean RA = 0.533 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b8 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, a small integrated passage (R4) is accessed, which leads on one hand to the northeast part and on the other hand to the south and then north parts of the building. To the north part is a more segregated room (R2). To the south is the largest, more integrated room (R3) that then leads to a segregated room to the north part (R1).

The highest control over adjacent rooms is exercised by the passage at the entrance (R4), leading to the other parts of the building.

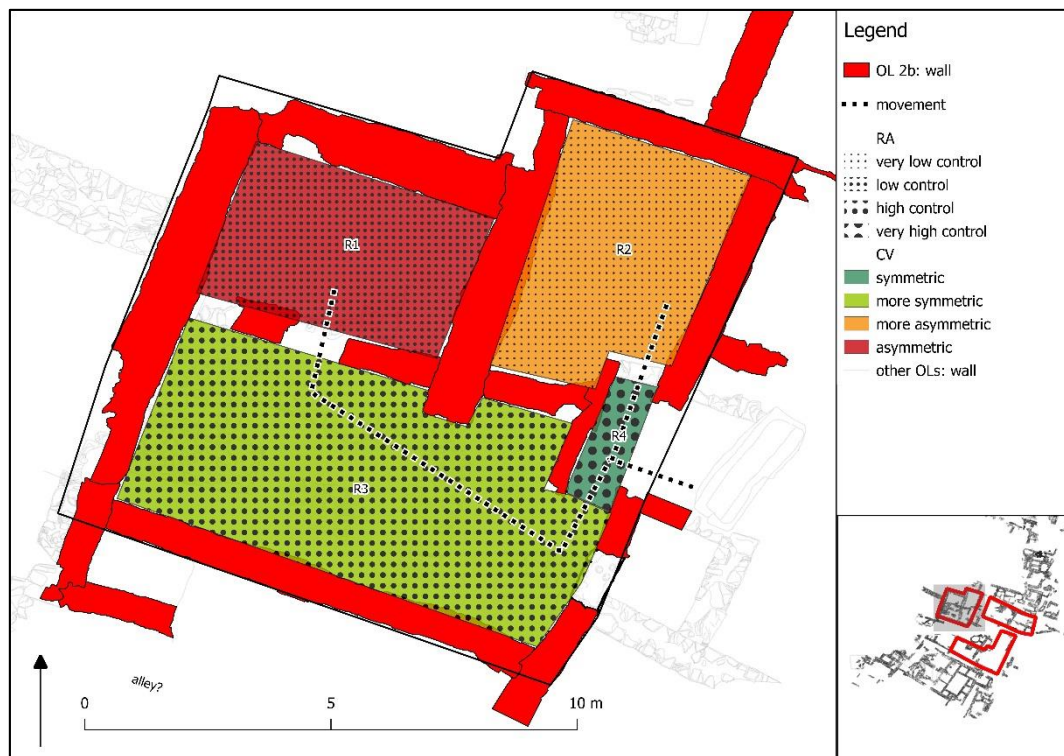


Figure 142: Buildings F-b8 (phase 1) (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b8 is composed of $K=4$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 143).

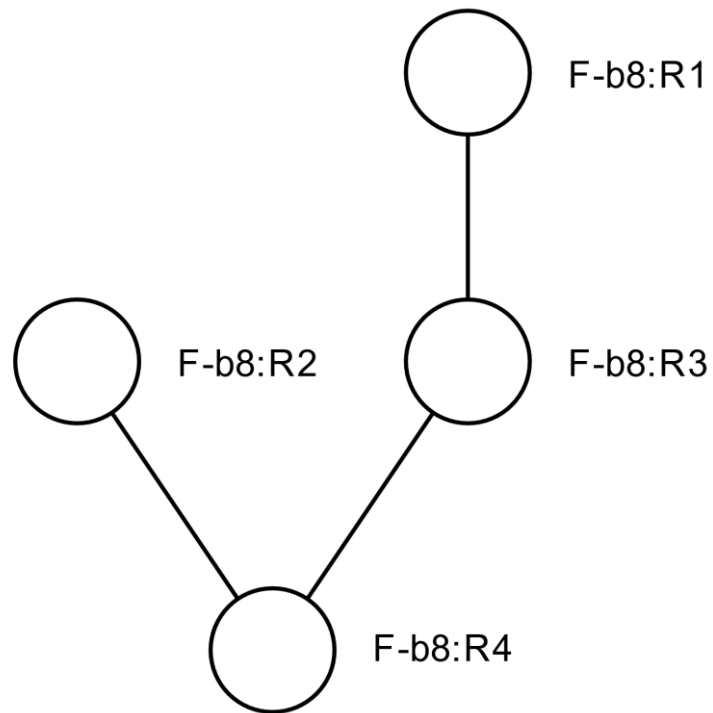


Figure 143: Justified graph Buildings F-b8 (phase 1) (inhabitant-inhabitant)

CHAPTER IV

Table 73 shows the results obtained for the building on a micro level. The mean RA is 0.667 and the mean RRA is 2.000.

Table 73: Micro level analysis of Buildings F-b8 (phase 1) (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	4.000	1.333	0.333	1.000
Mean	1.000	5.000	1.667	0.667	2.000
Max	1.500	6.000	2.000	1.000	3.000

Nano level

Table 74 shows the results obtained for each space on the nano level. Two rooms are of type A and two are of type B. F-b8:R1 and F-b8:R2 have the lowest CV, whereas F-b8:R3 and F-b8:R4 have the highest CV. F-b8:R3 and F-b8:R4 have the lowest RA values, whereas F-b8:R1 and F-b8:R2 have the highest RA values.

Table 74: Nano level of analysis of Buildings F-b8 (phase 1), K = 4 and D = 0.333 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b8:R1	A	1	0.500	6	2.000	1.000	3.000
F-b8:R2	A	1	0.500	6	2.000	1.000	3.000
F-b8:R3	B	2	1.500	4	1.333	0.333	1.000
F-b8:R4	B	2	1.500	4	1.333	0.333	1.000

Graphic output and interpretation

The justified graph in Figure 144 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b8, while the plan in Figure 145 visualises the last two values.

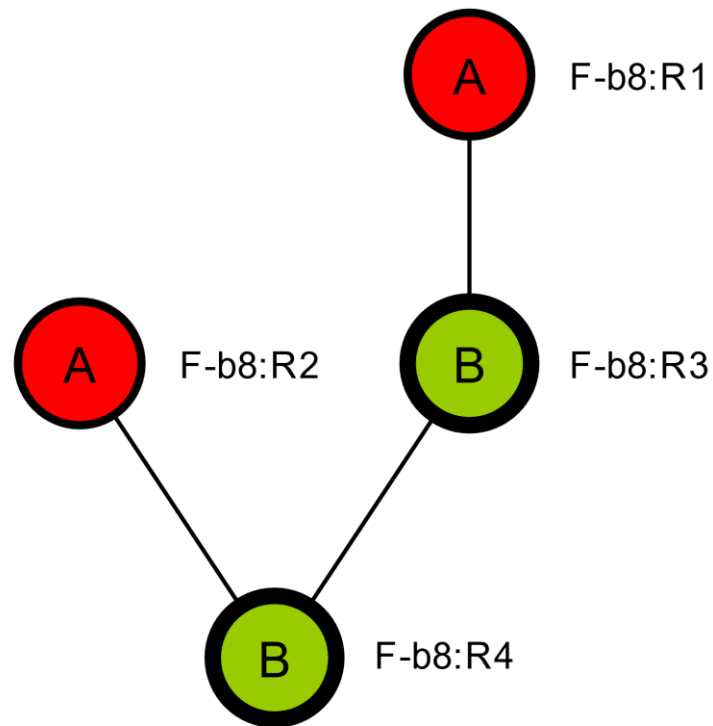


Figure 144: Coded justified graph of Buildings F-b8 (phase 1) (inhabitant-inhabitant)

CHAPTER IV

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.667 – inhabitant-inhabitant relationship).

The passage at the entrance (R4) decreases its control, which is now evenly distributed between F-b8:R3 and the passage (Table 79). R2 also increases its control and is now equal to R1. The passage R4, R1 and R2 increase their segregation.

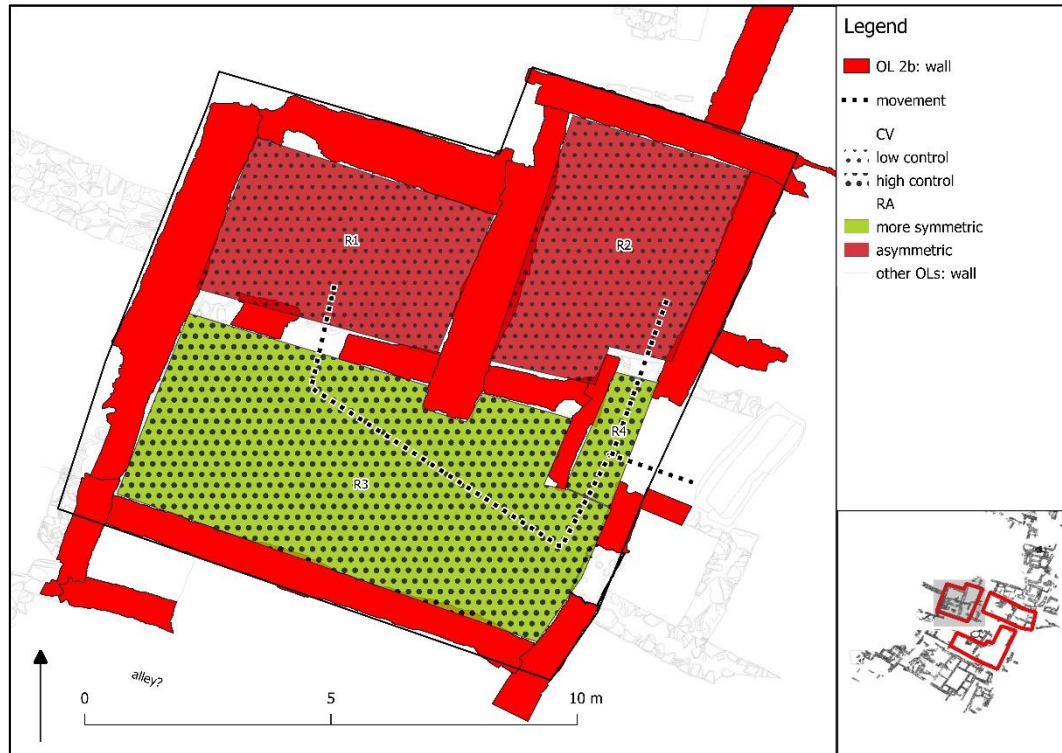


Figure 145: Buildings F-b8 (phase 1) (inhabitant-inhabitant)

Table 75: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Buildings F-b8 (phase 1)

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b8:F-s8	0.333	-	0.667	-
F-b8:R1	0.500	0.500	0.833	1.000
F-b8:R2	0.333	0.500	0.667	1.000
F-b8:R3	1.333	1.500	0.333	0.333
F-b8:R4	2.500	1.500	0.167	0.333

4 OL 2A PHENOTYPES – LATE ANTIQUE PERIOD

4.1 Description – macro level

Three buildings have been identified in Area E-South/F from OL 2a – Building E-b7; Building F-b8 (phase 2); Building F-b11 (Figure 146). Of those, two buildings have enough information about the spatial layout to carry out a space syntax analysis. Further evidence uncovered from OL 2a did not provide the necessary information to determine other buildings.



Figure 146: Architectural evidence from the second phase of the Late Antique Period (OL 2a) in the residential area (Area E-South/F)

4.2 Building E-b7

4.2.1 Description

Micro level

Building E-b7 (Figure 147, Figure 148) was built on top of Building E-b11 (OL 2a), reusing part of the existing walls. The building has an estimated area of 126.30 m² with a roughly rectangular ground plan. It has an estimated usable area of 69.90 m². The foundation levels of the walls are set between 830.68 m a.s.l. and 830.86 m a.s.l. Set at a lower level are the walls reused from Building E-b15 (OL 3). The width of the external walls is between 0.45 m and 0.70 m. The width of the internal walls is between 0.55 m and 0.80 m.

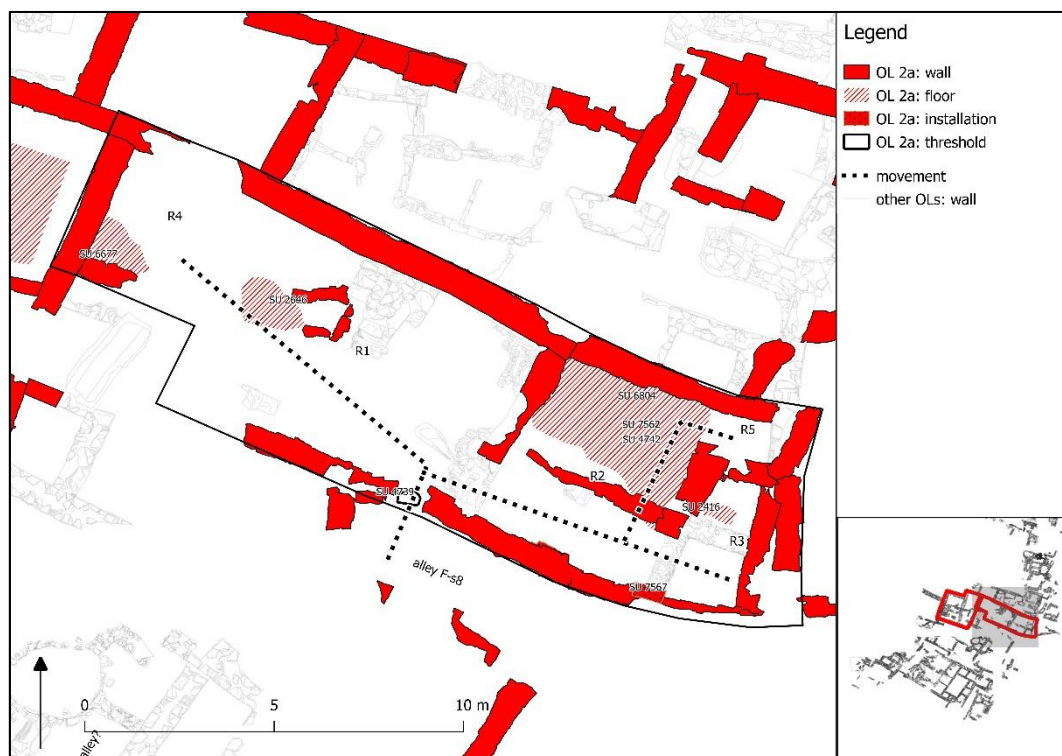


Figure 147: Building E-b7



Figure 148: Final excavation photo of Building E-b15, Building E-b11 and Building E-b7; view from W (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into five rooms. E-b7:R1 is located in the centre and has an area of about 35.30 m². E-b7:R4 is located on the west side and has an area of about 8.50 m². E-b7:R2 is located to the east side of E-b7:R1 and has an area of about 18.60 m². E-b7:R is located in the north-eastern corner and has an area of about 1.50 m². E-b7:R3 is located in the south-eastern corner and has an area of about 6.00 m². All rooms are outer rooms.

Permeabilities

The entrance was identified in the south side, accessing the building from alley F-s8 to E-b7:R1, evidenced by a threshold (SU 4739, 830.95 m a.s.l.). Doorways were identified between E-b7:R1 and E-b7:R2. There is no division evidenced between E-b7:R1 and E-b7:R4, probably being a large open space. Further permeabilities can only be identified through absence of evidence, such as interruptions in walls between E-b7:R2 and E-b7:R3 and between E-b7:R2 and E-b7:R5.

Features and finds

Floors were identified in three rooms. In E-b7:R1, the mud floor SU 2646 at approx. 830.50 m a.s.l. on the west side. In E-b7:R4, the trodden mud floor SU 6677 at 830.21 m a.s.l. In E-b7:R2, floor SU 7562 was identified at 830.67 m a.s.l. In E-b7:R3, the trodden floor SU 2416 at approx. 830.70 m a.s.l.

A date stone sample from floor SU 7567 was dated to 355-118 calBC with ¹⁴C-analysis.²⁷¹ The older date might be an inclusion due to the long usage of the building, which has large parts reused from other OLs – Building E-b11 from OL 2b and Building E-b15 from OL 3.

Additional data

Building E-b7 was remodelled, as can be evidenced by the floor being raised in E-b7:R2, where first the mud floor SU 6804 was built and then the trodden floor SU 4742 at 830.82 m a.s.l. A casual hearth (SU 4743, 830.82 m a.s.l.) is located on top of floor SU 4742 on the east side of E-b7:R2.

²⁷¹ Date stone (TA 11831); Lab: Center for Applied Isotopes Study, University of Georgia, Athens (GA); Lab number: UGAMS 30733; date: 2160 ± 20 BP; 2σ range date: 355-118 calBC (95.4%); OxCal v4.3.2; September 2017.

4.2.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building E-b7 is composed of K=6 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 149).

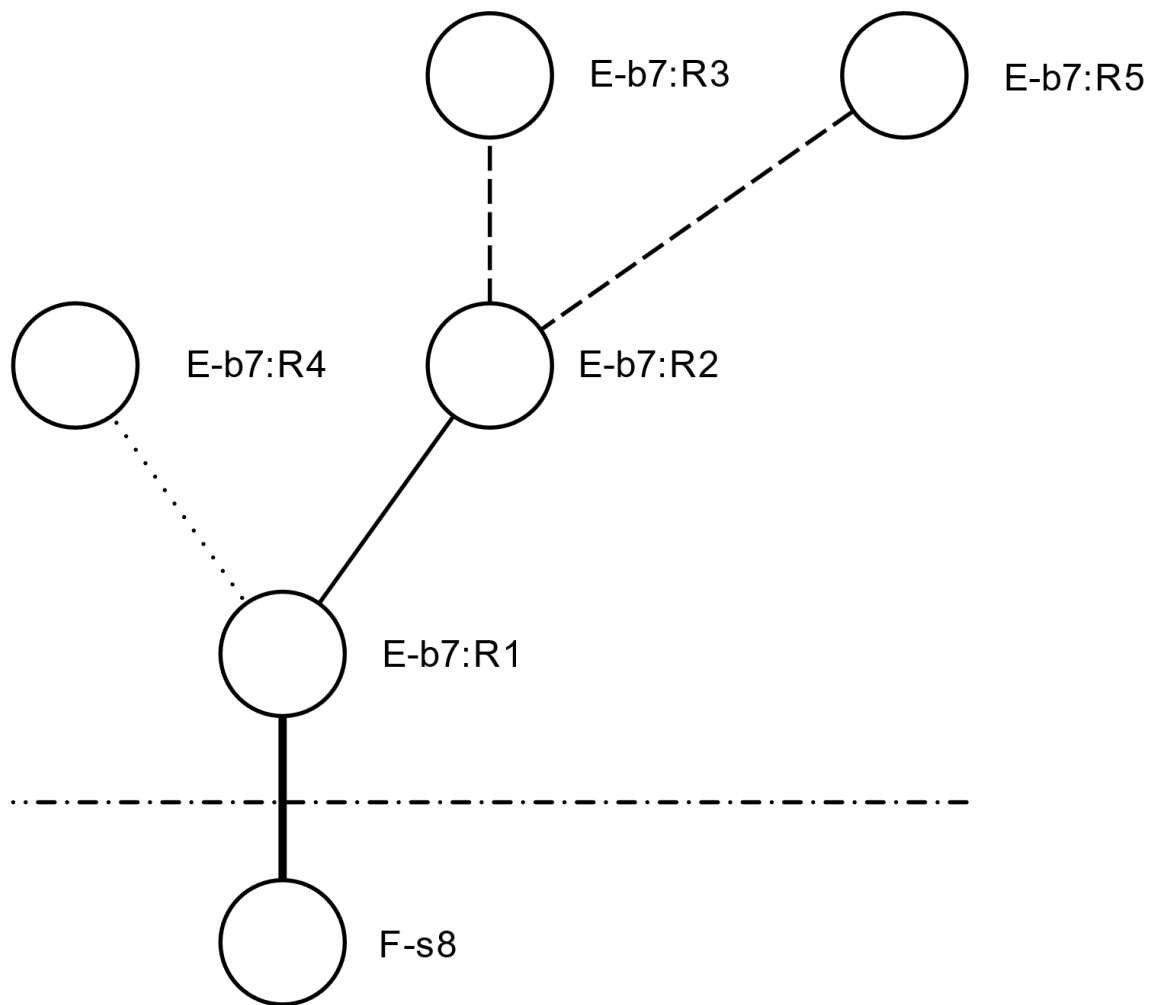


Figure 149: Justified graph Building E-b7 (visitor-inhabitant)

CHAPTER IV

Table 76 shows the results obtained for the building on a micro level. The mean RA is 0.467 and the mean RRA is 1.337.

Table 76: Micro level analysis of Building E-b7 (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	7.000	1.400	0.200	0.573
Mean	1.000	9.667	1.933	0.467	1.337
Max	2.333	11.000	2.200	0.600	1.719

Nano level

Table 77 shows the results obtained for each space. Four rooms are of type A and two are of type B. Alley F-s8, E-b7:R3, E-b7:R4 and E-b7:R5 have the lowest CV, whereas E-b7:R1 and E-b7:R2 have the highest CV. E-b7:R1 and E-b7:R2 have the lowest RA values, whereas alley F-s8, E-b7:R3, E-b7:R4 and E-b7:R5 have the highest RA values.

Table 77: Nano level of analysis of Building E-b7, K = 6 and D = 0.349 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
E-b7:F-s8	A	1	0.333	11	2.200	0.600	1.719
E-b7:R1	B	3	2.333	7	1.400	0.200	0.573
E-b7:R2	B	3	2.333	7	1.400	0.200	0.573
E-b7:R3	A	1	0.333	11	2.200	0.600	1.719
E-b7:R4	A	1	0.333	11	2.200	0.600	1.719
E-b7:R5	A	1	0.333	11	2.200	0.600	1.719

Graphic output and interpretation

The justified graph in Figure 150 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building E-b7, while the plan in Figure 151 visualises the last two values.

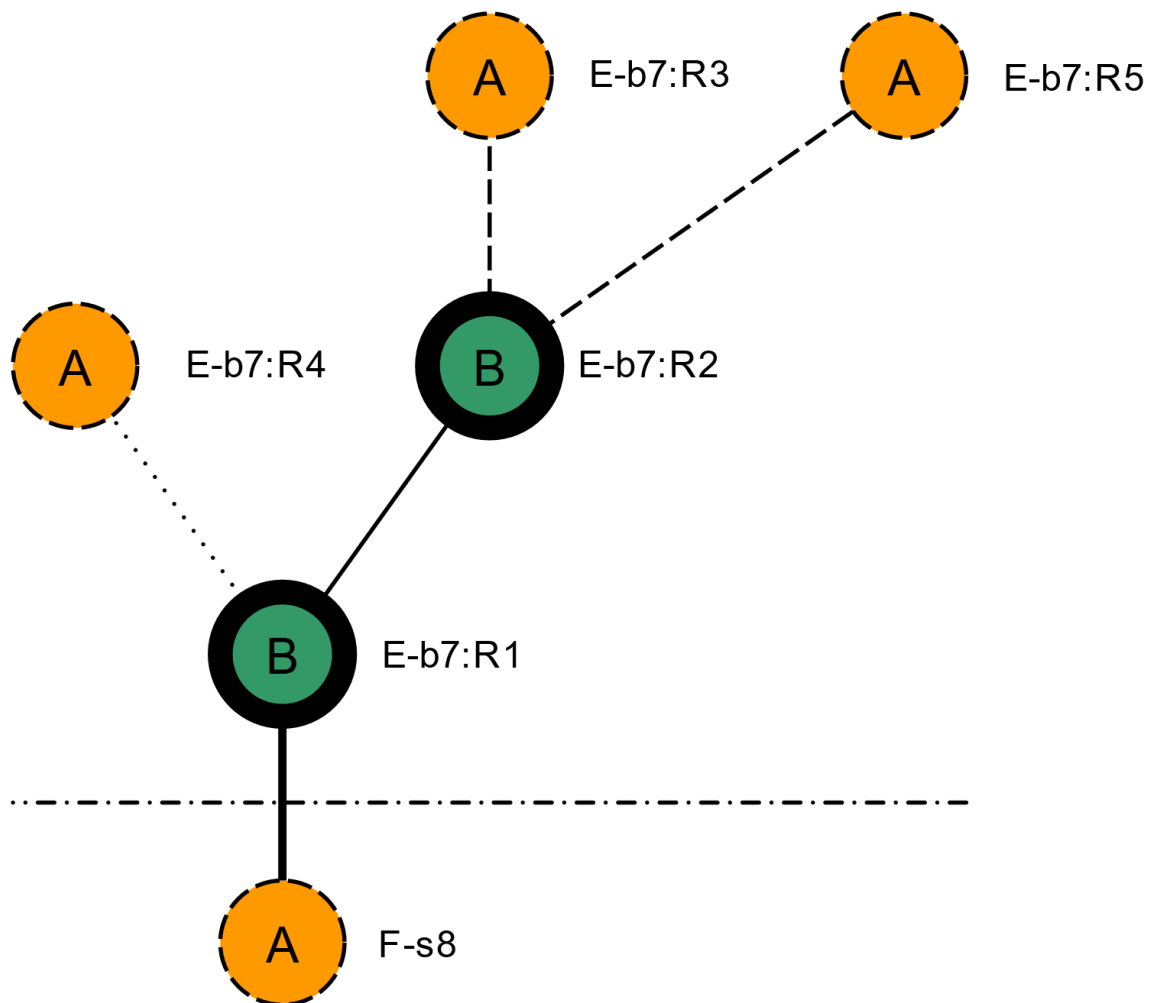


Figure 150: Coded justified graph of Building E-b7 (visitor-inhabitant)

Building E-b7 has a more integrated overall configuration (mean RA = 0.467 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building E-b7 has a more segregated position (the alley) in relation to the interior before entering the building. Upon entering, the largest room is accessed (R1), which leads to a possible more segregated room (R4) to the west and to the east part. R1 shares equally the most integration with the first room to the east (R2). R2 leads to two more segregated rooms (R3, R5).

The highest control over adjacent rooms is exercised by the room at the entrance (R1) together with the first room to the east (R2).

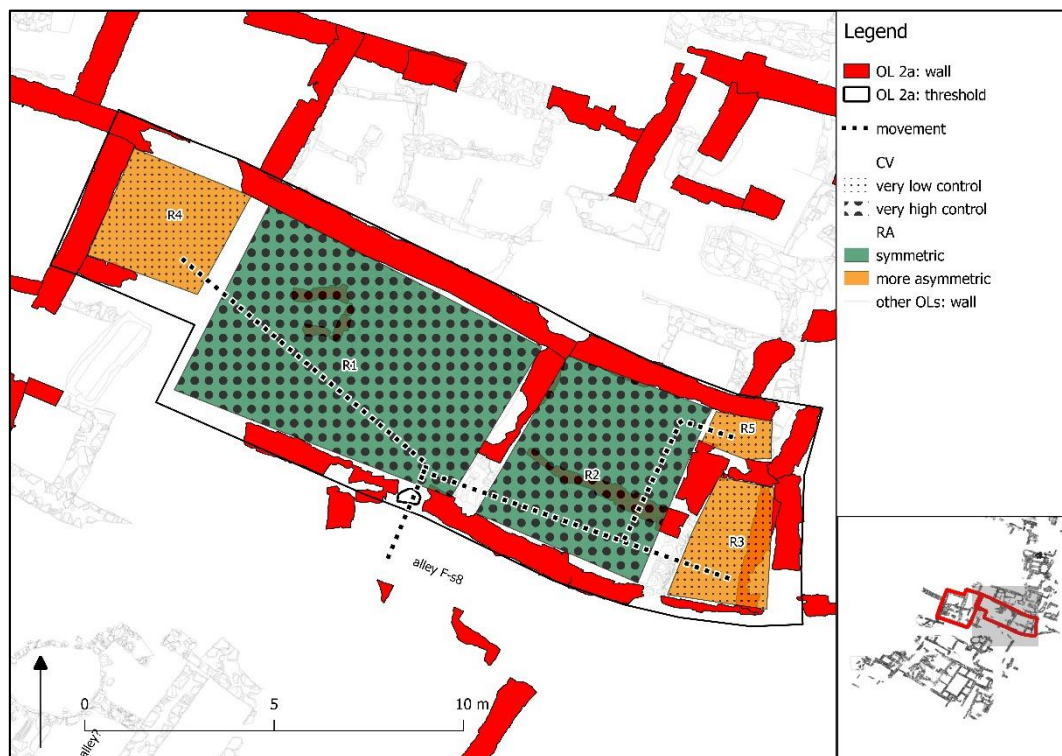


Figure 151: Building E-b7 (visitor-inhabitant)

Inhabitant-inhabitant relationship*Macro level*

Building E-b7 is composed of $K=5$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 152).

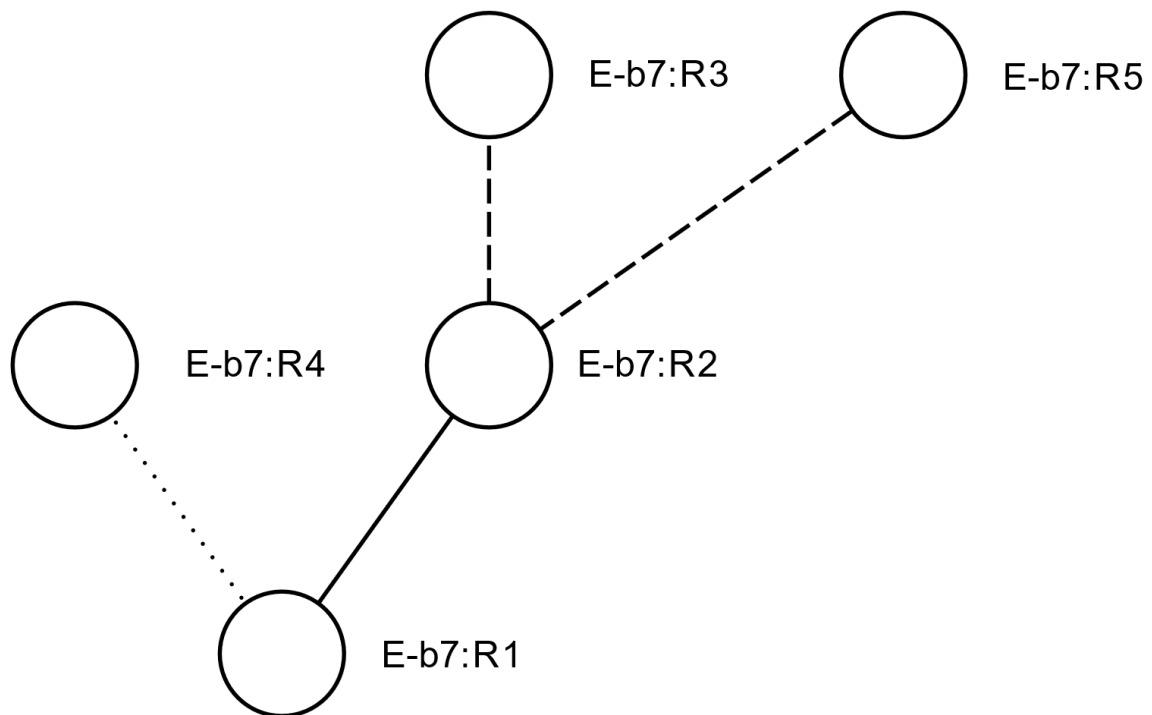


Figure 152: Justified graph of Building E-b7 (inhabitant-inhabitant)

CHAPTER IV

Table 78 shows the results obtained for the building on a micro level. The mean RA is 0.533 and the mean RRA is 1.515.

Table 78: Micro level analysis of Building E-b7 (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	5.000	1.250	0.167	0.473
Mean	1.000	7.200	1.800	0.533	1.515
Max	2.500	9.000	2.250	0.833	2.367

Nano level

Table 79 shows the results obtained for each space. Three rooms are of type A and two rooms are of type B. E-b7:R3 and E-b7:R5 have the lowest CV, whereas E-b7:R2 has the highest CV. E-b7:R2 has the lowest RA value, whereas E-b7:R4 has the highest RA value.

Table 79: Nano level analysis of Building E-b7, K =5 and D = 0.352 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
E-b7:R1	B	2	1.333	6	1.500	0.333	0.947
E-b7:R2	B	3	2.500	5	1.250	0.167	0.473
E-b7:R3	A	1	0.333	8	2.000	0.667	1.894
E-b7:R4	A	1	0.500	9	2.250	0.833	2.367
E-b7:R5	A	1	0.333	8	2.000	0.667	1.894

Graphic output and interpretation

The justified graph in Figure 153 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building E-b7, while the plan in Figure 154 visualises the last two values.

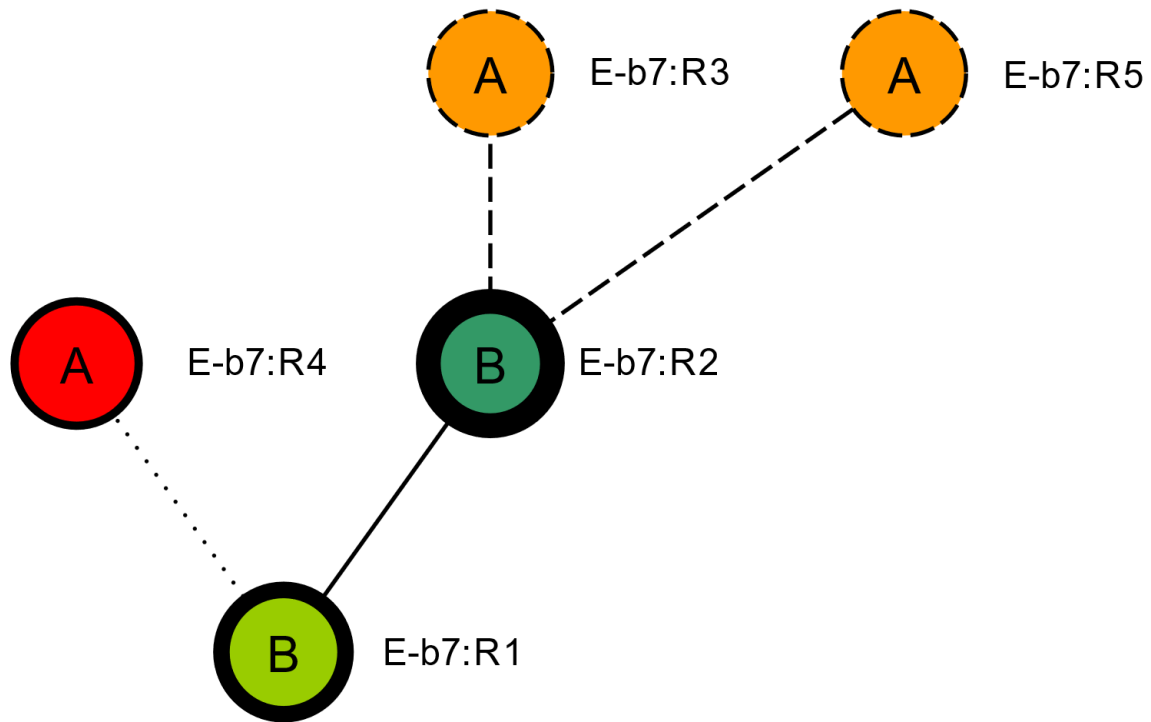


Figure 153: Coded justified graph of Building E-b7 (inhabitant-inhabitant)

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.533 – inhabitant-inhabitant relationship). The entrance room, R1, and the room to the west, R4, lose control (Table 80). Instead, the most control is now exercised by R2, the first room to the east part. Except for R2, which becomes increasingly integrated, all spaces increase their segregation.

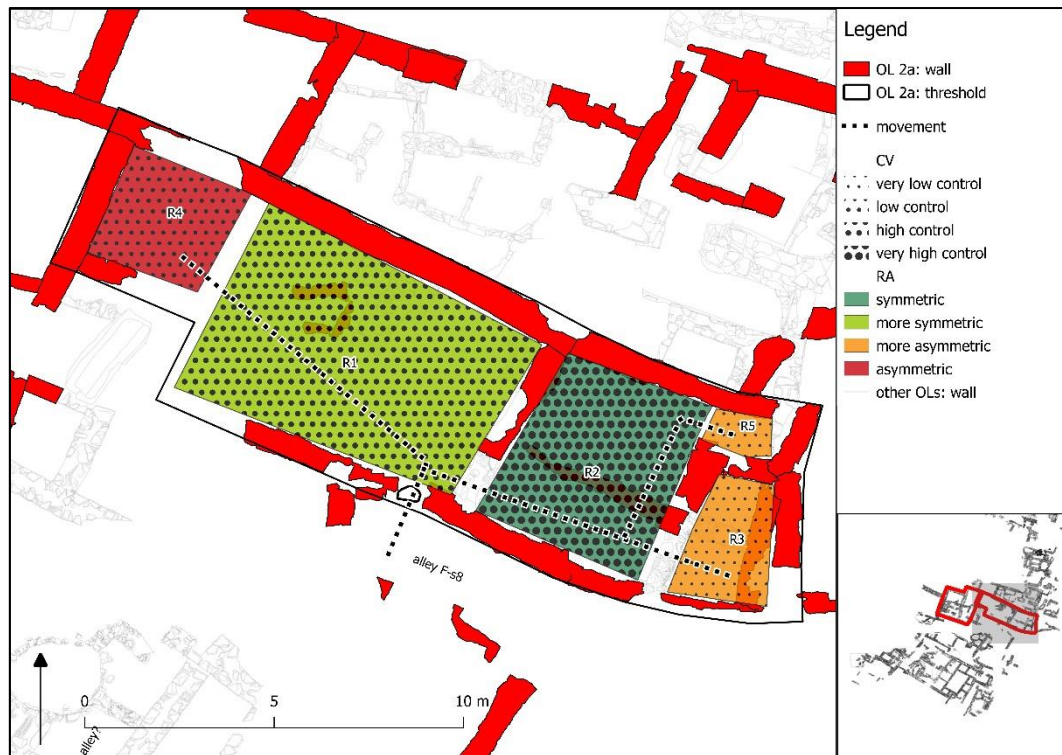


Figure 154: Building E-b7 (inhabitant-inhabitant)

Table 80: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Building E-b7

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
E-b7:F-s8	0.333	-	0.600	-
E-b7:R1	2.333	1.333	0.200	0.333
E-b7:R2	2.333	2.500	0.200	0.167
E-b7:R3	0.333	0.333	0.600	0.667
E-b7:R4	0.333	0.500	0.600	0.833
E-b7:R5	0.333	0.333	0.600	0.667

4.3 Building F-b8 (Phase 2)

4.3.1 Description

Micro level

The location of the entrance and the passage R4 were changed in Building F-b8 (Figure 155, Figure 156) during OL 2b. It keeps reusing part of the walls from Building F-b12 (OL 3), which had been already reused during the OL 2a phase of Building F-b8. The building area stays estimated at 119.40 m² with a roughly L-shaped ground plan. It also stays at an estimated usable area of about 64.70 m². The foundation levels of the walls are set between 829.45 m a.s.l. and 830.26 m a.s.l, as in the older phase of the building. Also, set at a lower level are the walls reused from Building F-b12 (OL 3). The width of the external walls is between 0.55 m and 1.20 m and the width of the internal walls is between 0.35 m and 0.70 m, as they don't change for this phase of the building.



Figure 155: Buildings F-b8 (phase 2)



Figure 156: Final excavation photo Building F-b12, Building F-b8 (first phase and second phase); view from SE (© DAI Orient Department 2015 J. Krumnow)

Nano level

Rooms

The usable area is divided into four rooms. F-b8:R4 is a passage localised at the entrance on the east side of the building and has an area of about 2.20 m². F-b8:R3 is localised on the south side and has an area of about 32.60 m². F-b8:R1 is localised in the north-western corner and has an area of about 14.20 m². F-b8:R2 is localised on the northeast side and has an area of about 15.70 m². All rooms are outer rooms.

Permeabilities

The entrance was shifted to the east side, accessing the building from alley F-s8 to F-b8:R4. The view to the interior of the building is blocked by an L-shaped wall (SU 6298) built to access F-b8:R3 to the south and impeding the way to F-b8:R2 in the northwest part. Doorways were identified between F-b8:R4 and F-b8:R3, and between F-b8:R3 and F-b8:R1. It is not clear how the access from F-b8:R3 to F-b8:R2 was.

Features and finds

Floors were identified in three rooms. In F-b8:R3, the trodden mud and stone floor SU 6294 at 829.30 m a.s.l. (east) to 829.76 m a.s.l. (northwest). In F-b8:R1, the trodden mud floor SU 6676 at 830.30 m a.s.l. In F-b8:R2, the trodden mud floor SU 6293 at 830.25 m a.s.l.

4.3.2 Space syntax analysis

Visitor-inhabitant relationship

Micro level

Building F-b8 is composed of K=5 spaces, as can be seen in the justified graph of the visitor-inhabitant relationship (Figure 157).

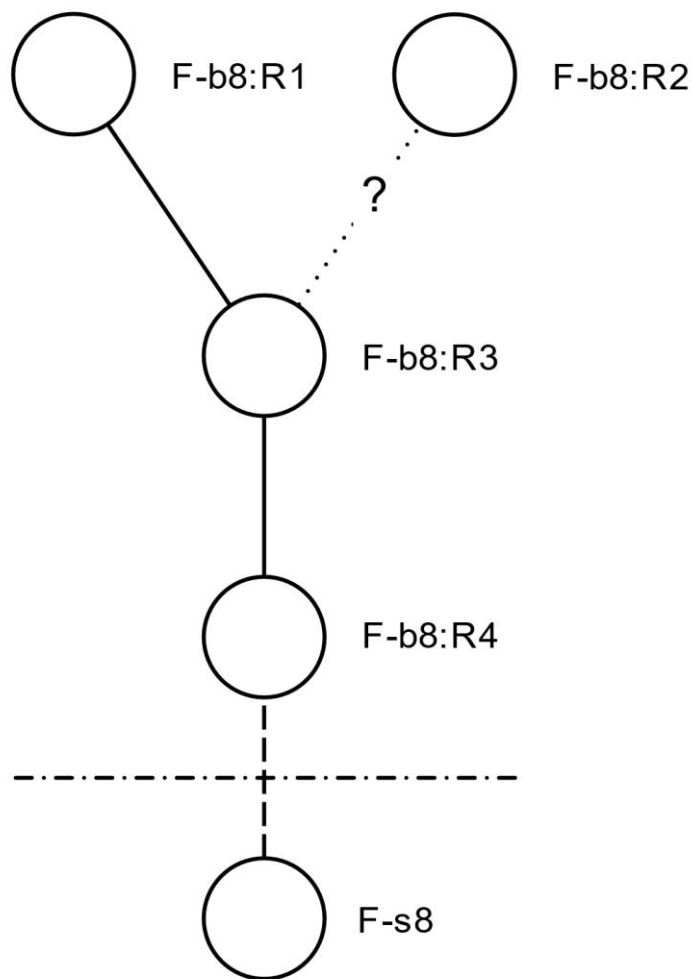


Figure 157: Justified graph Buildings F-b8 (phase 2) (visitor-inhabitant)

CHAPTER IV

Table 81 shows the results obtained for the building on a micro level. The mean RA is 0.553 and the mean RRA is 1.515.

Table 81: Micro level analysis of Buildings F-b8 (phase 2) (visitor-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.333	5.000	1.250	0.167	0.473
Mean	1.000	7.200	1.800	0.533	1.515
Max	2.500	9.000	2.250	0.833	2.367

Nano level

Table 82 shows the results obtained for each space. Three rooms are of type A and two are of type B. F-b8:R1 and F-b8:R2 have the lowest CV, whereas F-b8:R3 has the highest CV. F-b8:R3 has the lowest RA value, whereas alley F-s8 has the highest RA value.

Table 82: Nano level of analysis of Buildings F-b8 (phase 2), K = 5 and D = 0.352 (visitor-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b8:F-s8	A	1	0.500	9	2.250	0.833	2.367
F-b8:R1	A	1	0.333	8	2.000	0.667	1.894
F-b8:R2	A	1	0.333	8	2.000	0.667	1.894
F-b8:R3	B	3	2.500	5	1.250	0.167	0.473
F-b8:R4	B	2	1.333	6	1.500	0.333	0.947

Graphic output and interpretation

The justified graph in Figure 158 shows the space types, CV and RA values for the visitor-inhabitant relationship of Building F-b8, while the plan in Figure 159 visualises the last two values.

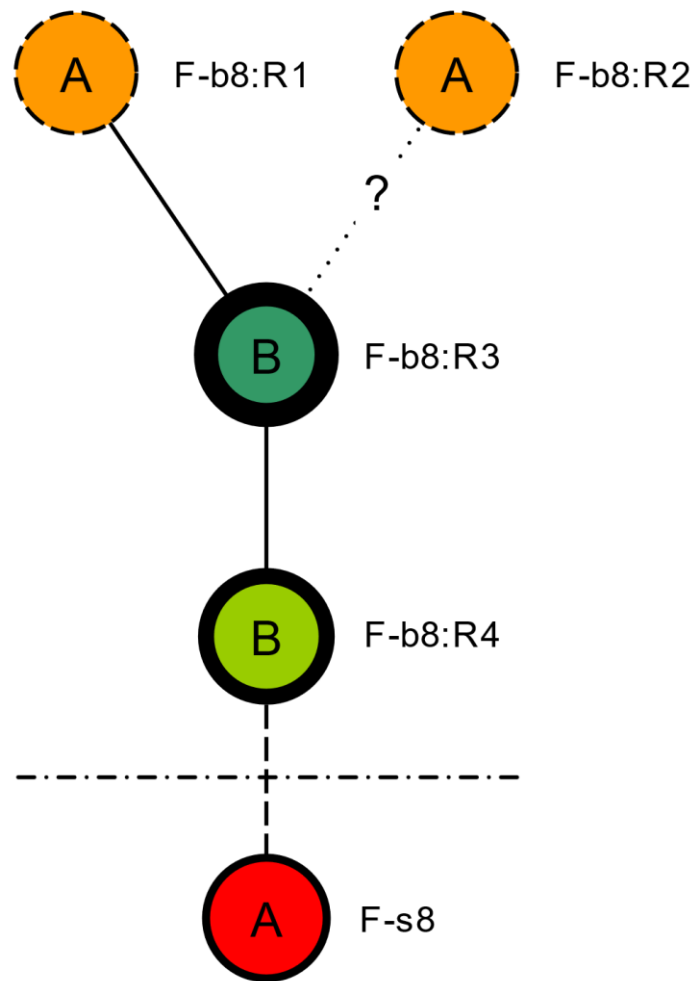


Figure 158: Coded justified graph of Buildings F-b8 (phase 2) (visitor-inhabitant)

Building F-b8 has a more segregated overall configuration (mean RA = 0.533 – visitor-inhabitant relationship), when the alley is included.

An individual approaching Building F-b8 has a segregated position (the alley) in relation to the interior before entering the building. Upon entering, a small more integrated passage (R4) is accessed, which leads to the largest, most integrated room (R3) in the building. R3 leads to two more segregated rooms in the north part (R1, R2).

The highest control over adjacent rooms is exercised by the largest room (R3), leading to the north part of the building.



Figure 159: Buildings F-b8 (phase 2) (visitor-inhabitant)

Inhabitant-inhabitant relationship

Micro level

Building F-b8 is composed of $K=4$ spaces, as can be seen in the justified graph of the inhabitant-inhabitant relationship (Figure 160).

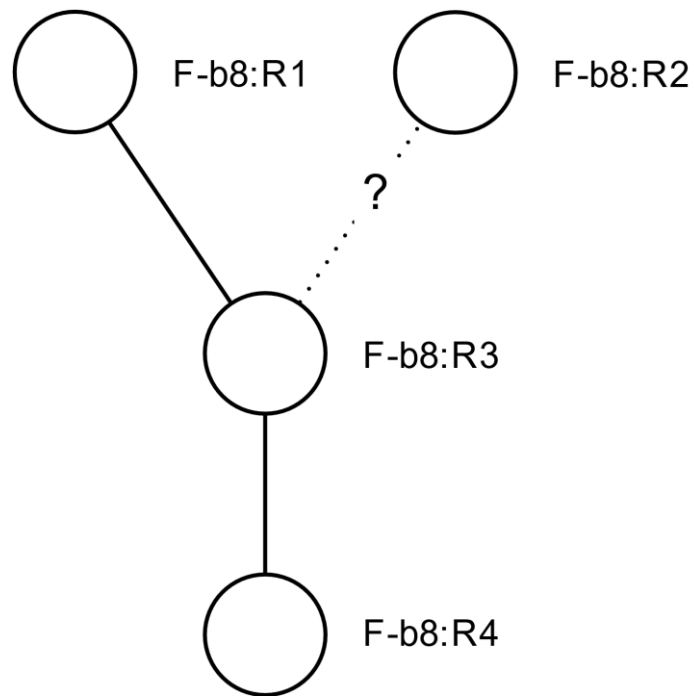


Figure 160: Justified graph Buildings F-b8 (phase 2) (inhabitant-inhabitant)

CHAPTER IV

Table 83 shows the results obtained for the building on a micro level. The mean RA is 0.500 and the mean RRA is 1.500.

Table 83: Micro level analysis of Buildings F-b8 (phase 2) (inhabitant-inhabitant)

	CV	TD	MD	RA	RRA
Min	0.500	4.000	1.333	0.333	1.000
Mean	1.000	4.500	1.500	0.500	1.500
Max	1.500	6.000	2.000	1.000	3.000

Nano level

Table 84 shows the results obtained for each space on the nano level. Three rooms are of type A and one is of type B. F-b8:R, F-b8:R2 and F-b8:R4 have the lowest CV, whereas F-b8:R3 has the highest CV. F-b8:R3 has the lowest RA value, whereas F-b8:R1, F-b8:R2 and F-b8:R4 have the highest RA values.

Table 84: Nano level of analysis of Buildings F-b8 (phase 2), K = 4 and D = 0.333 (inhabitant-inhabitant)

space	type	NC	CV	TD	MD	RA	RRA
F-b8:R1	A	1	0.333	5	1.667	0.667	2.000
F-b8:R2	A	1	0.333	5	1.667	0.667	2.000
F-b8:R3	B	3	3.000	3	1.000	0.000	0.000
F-b8:R4	A	1	0.333	5	1.667	0.667	2.000

Graphic output and interpretation

The justified graph in Figure 161 shows the space types, CV and RA values for the inhabitant-inhabitant relationship of Building F-b8, while the plan in Figure 162 visualises the last two values.

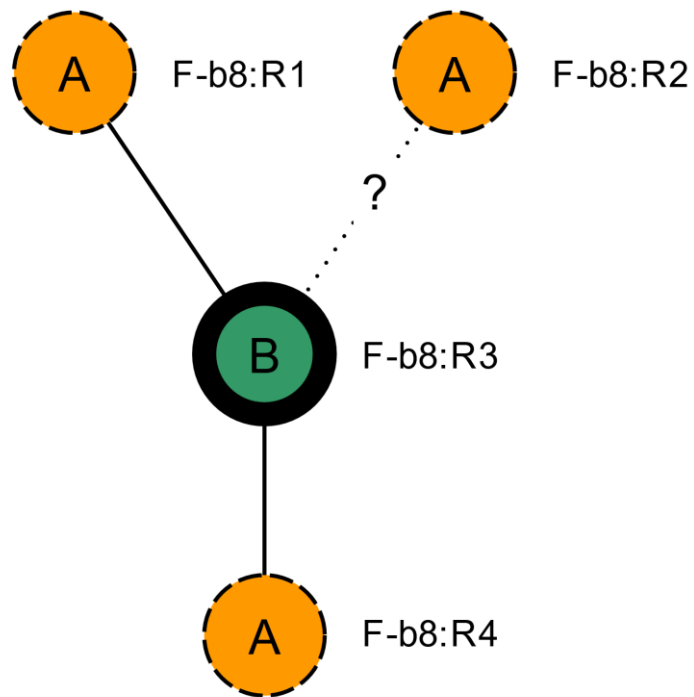


Figure 161: Coded justified graph of Buildings F-b8 (phase 2) (inhabitant-inhabitant)

CHAPTER IV

An individual moving inside of the building is in generally more segregated surroundings (mean RA = 0.500 – inhabitant-inhabitant relationship).

The largest room, R3, increases the control and becomes as integrated as possible. R4, on the other hand, decreases control and becomes more segregated.

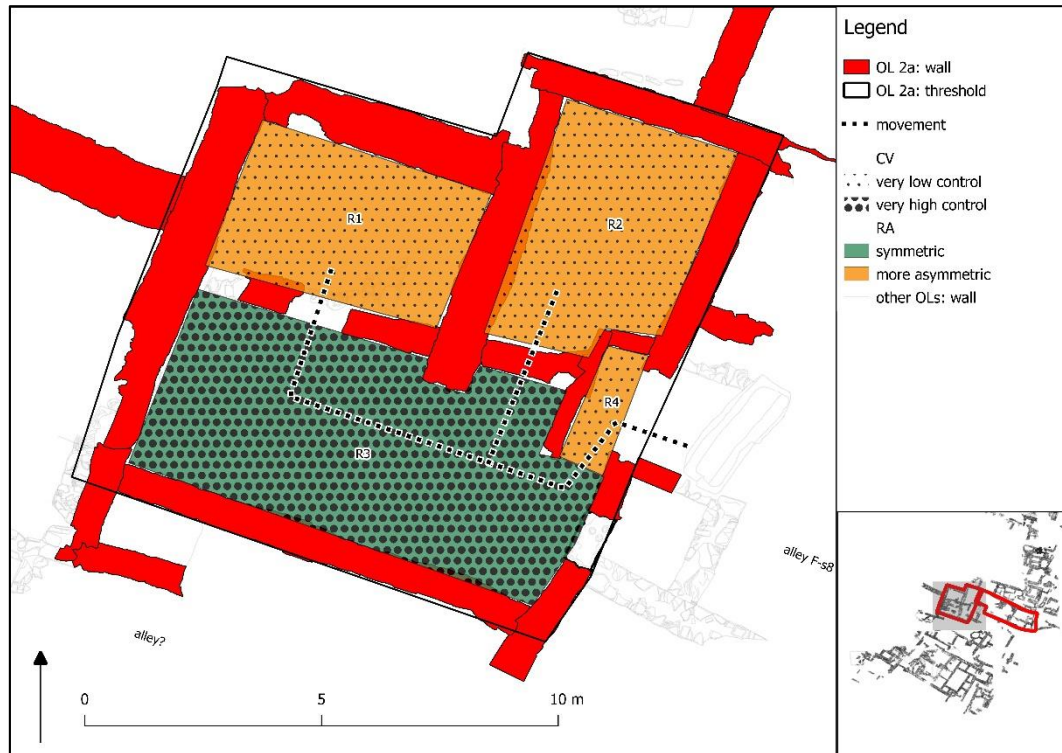


Figure 162: Buildings F-b8 (phase 2) (inhabitant-inhabitant)

Table 85: Comparison visitor-inhabitant (vis-inh) and inhabitant-inhabitant (inh-inh) Buildings F-b8 (phase 2)

space	CV vis-inh	CV inh-inh	RA vis-inh	RA inh-inh
F-b8:F-s8	0.500	-	0.833	-
F-b8:R1	0.333	0.333	0.667	0.667
F-b8:R2	0.333	0.333	0.667	0.667
F-b8:R3	2.500	3.000	0.167	0.000
F-b8:R4	1.333	0.333	0.333	0.667

CHAPTER V

UNCOVERING SPATIAL CONFIGURATION: RESULTS OF THE SPACE SYNTAX ANALYSIS

This chapter presents the results obtained from the space syntax analysis described in detail for each of the buildings in Chapter IV.

The first section comprises a synchronic analysis, where the descriptions and space syntax analyses are summarised for each occupation level (OL).

The second section is a diachronic analysis of all three OLs that first compares the descriptions and space syntax analyses and then analyses the general spatial behaviour in an attempt to relate these with a functional differentiation. For the latter, due to the absence of information about the room functions, labels were attributed to most of the spaces: exterior; entrance room; largest room; smallest room; room(s) with the highest NC; room with a food processing area. This makes it possible to compare and associate differently labelled spaces with different spatial behaviours.

Some notes of caution are due here, because enough information is not always available or the results can be ambiguous. OL E-South:4/OL F:4 and OL E-South:2/OL F:2a are based on a small sample size. This is particularly valid for OL E-South:4/OL F:4, which is just a single building and cannot be considered representative of an entire OL. Ambiguous results can be caused by variations (var.) of buildings,²⁷² which occurs in two cases from OL E-South:3/OL F:3²⁷³ and one from OL E-South:2/OL F:2b²⁷⁴, or by the presence of similar results produced by the space syntax analysis.

²⁷² Variations of buildings occurred because of the lack of evidence to place the location of permeability between spaces. See Chapter IV: Space syntax analyses of Building E-b15 var.1 and var. 2 (Section 2.2), Building F-b1 East var. 1 and var. 2 (Section 2.3) and Building F-b5 var. 1 and var. 2 (Section 3.3).

²⁷³ Building E-b15 and F-b1 East.

²⁷⁴ Building F-b5.

1 SYNCHRONIC ANALYSIS

This first section focuses on a synchronic analysis of each OL (OL 4, OL 3, OL 2b and OL 2a). The analysis is based on the descriptions and space syntax analysis, as presented in Chapter IV, per OL.

1.1 OL 4

1.1.1 Description

Micro level

Only one building (Building F-b3) of OL 4 had the necessary information to carry out a space syntax analysis (Figure 22). This does not make it possible to filter out accurately the spatial configuration for this OL. Nevertheless, the results will be presented here and used, when possible, to compare with the other occupation levels.

This building was built on collapsed walls and debris of an older OL (OL 5). The rectangular shaped total area occupied by the building is about 270.70 m² (Figure 163). The usable area, 157.40 m², is 58% of the total area.

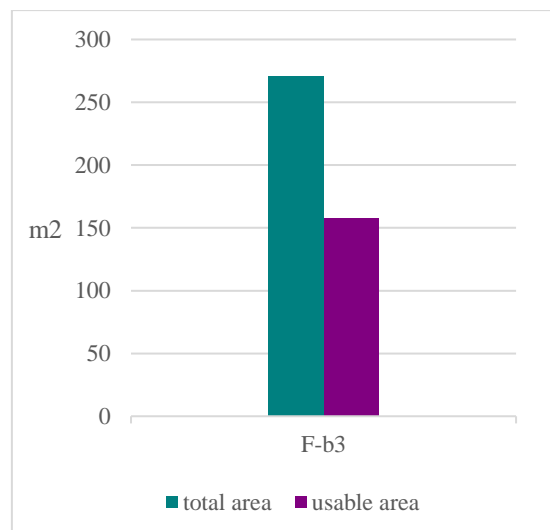


Figure 163: Total and usable area per building – Nabataean Period (OL 4)

CHAPTER V

The foundation levels of the newly built walls are between 827.68 m a.s.l. and 828.72 m a.s.l., averaging 828.27 m a.s.l. (Figure 164). The highest level, 828.72 m a. s. l., is a result of the wall SU 3966 having been built on bedrock, which is not as deep as under the rest of Building F-b3.

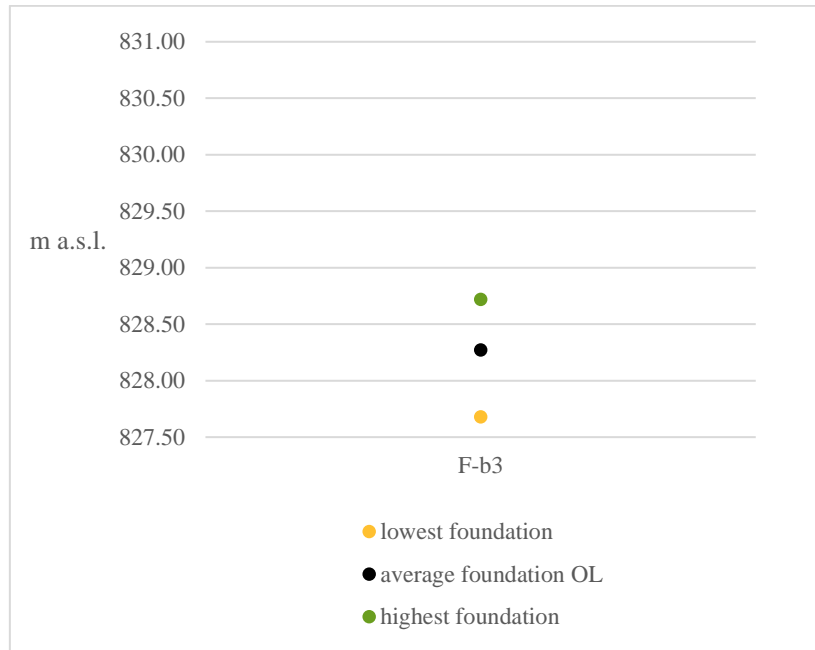


Figure 164: Foundation levels of newly built walls per building – Nabataean Period (OL 4)

The width of the external walls is between 0.75 m and 1.00 m, while the internal walls is between 0.30 m and 1.00 m.

Nano level

There are five rooms, of which the smallest measures about 8.00 m² and the largest about 86.70 m² (Figure 165). As Figure 165 illustrates, there is not enough information to state if there is a relationship between the number of rooms and the available usable area of Building F-b3 because at least two more cases would be needed to establish a reliable trendline.

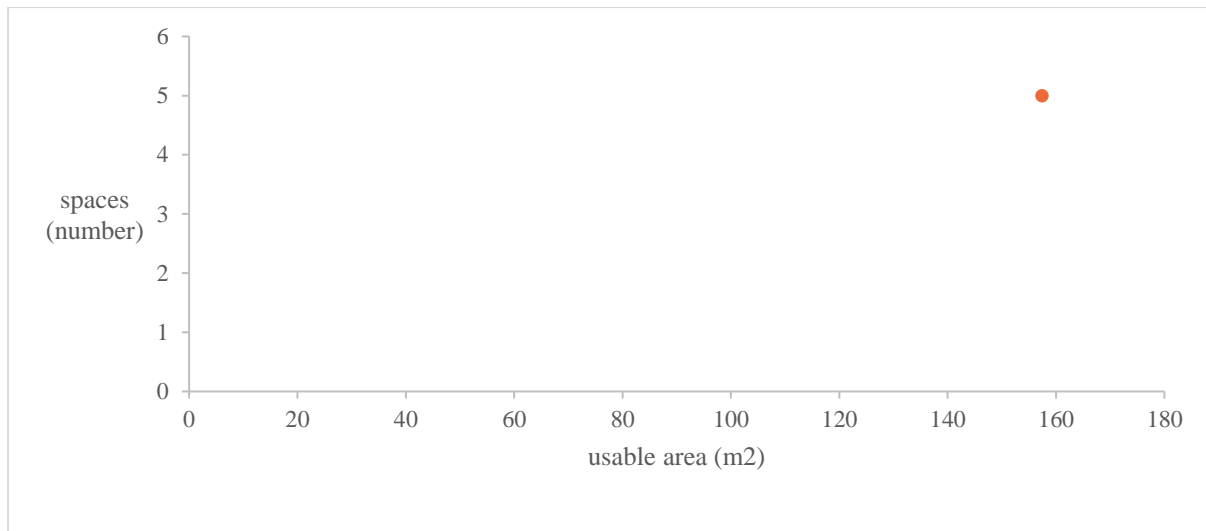


Figure 165: Correlation between usable area and number of rooms – Nabataean Period (OL 4)

1.1.2 Space syntax analysis

Micro level

The mean RRA value for the visitor-inhabitant relationship of Building F-b3 is 1.963 (Figure 166). In the inhabitant-inhabitant relationship the RRA value decreases to 1.894, therefore indicating a lower segregation of the building as a closed unit.

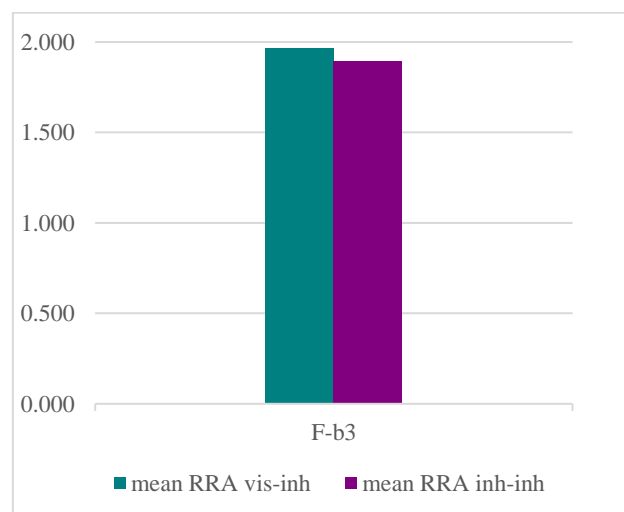


Figure 166: Mean RRA value per building – Nabataean Period (OL 4)

Nano level²⁷⁵

Visitor-inhabitant relationship

When approaching the Building F-b3 of OL 4, an individual is in a segregated position. Upon entering, a path of rooms is accessed, of which the first is a small entrance room. The largest room is the most integrated room, while the back room is the most segregated.

The highest control is exercised by the three rooms at the centre of the path, which are also the rooms with the highest number of connections. This can be confirmed by the correlation coefficient of 0.84 when comparing control value (CV) and number of connections (NC) directly.

Inhabitant-inhabitant relationship

An individual already moving inside of Building F-b3 of OL 4 is equally in a more segregated surrounding.

The highest control is shared by the largest room and the room leading to the back room because they control the access to both ends of the path that the rooms form, and all three rooms have the highest number of connections. This can be confirmed by the correlation coefficient of 0.91 when comparing control value (CV) and number of connections (NC) directly. This means that the former entrance room loses its function of controlling access to the building and becomes completely segregated as the back room.

1.2 OL 3

1.2.1 Description

Micro level

Two buildings (Building F-b1 East, Building F-b1 West) reused walls from the same OL 4 building (Building F-b3), three buildings (Building E-b15, Building F-b2, Building F-b4) reused OL 4 walls that could not be attributed to a building and two buildings (Building F-b7, Building F-b12) were built on top of OL 4 debris; for all buildings new walls were built (Figure 33). For two buildings, Building E-b15 and Building F-b1 East, two variations were proposed because of unclear evidence of permeability. The average total area occupied by a building is

²⁷⁵ See “Graphic output and interpretation” in Chapter IV, Section 1.

either 125.70 m² (considering Building F-b1 East var. 1) or 126.40 m² (considering Building F-b1 East var. 2), ranging between 60.50 m² and 170.80 m² (Figure 167). The shape of the buildings vary between rectangular, L-shaped and one of them square. The usable area is on average 52% (ranging between 44% and 57%) of the total area: between 28.20 m² and 89.70 m²; in all cases, although the total area occupied by the building changes, the percentage of usable area is always the same.

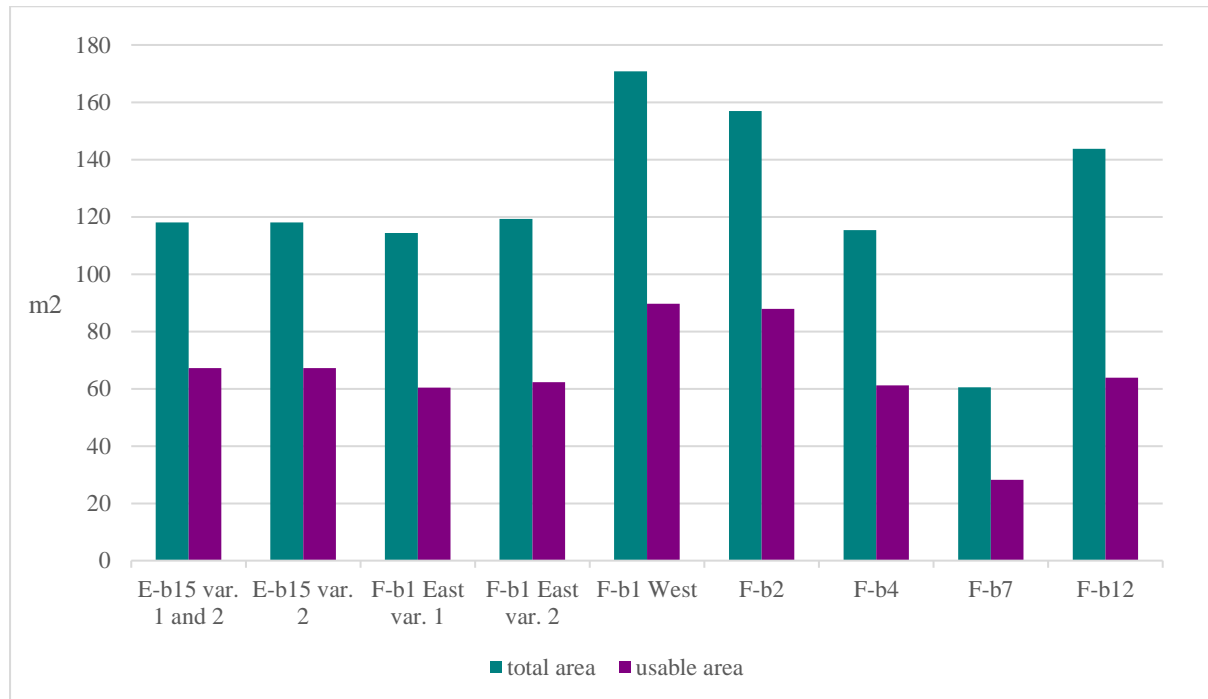


Figure 167: Total and usable area per building – Roman Period (OL 3)

The foundation levels of the newly built walls are between 827.70 m a.s.l. and 829.90 m a.s.l., averaging 828.52 m a.s.l. (Figure 168²⁷⁶). The graphs shows the slope under the residential area very well: on the left side of the graph the buildings (E-b...) located north have walls founded at a higher level than the buildings (F-b...) on the right side of the graph, located on the south side of the area.

²⁷⁶ Foundation levels of newly built walls are not available for Building E-b13 and Building F-b7. There is no space syntax analysis of Building E-b10 and Building E-b13.

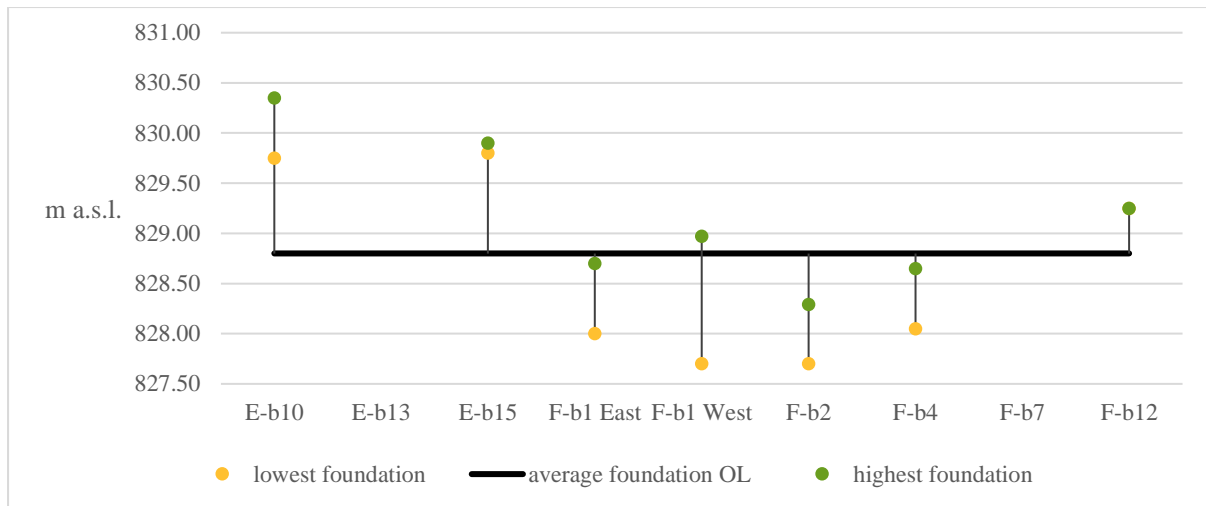


Figure 168: Foundation levels of newly built walls per building – Roman Period (OL 3)

The width of the external walls is between 0.45 m and 1.20 m, generally wider than the internal walls, which is between 0.25 m and 1.00 m.

Nano level

The number of rooms in each building varies between five and ten, of which the smallest measures about 0.50 m² and the largest about 42.40 m². The correlation coefficient between usable area and the number of rooms is about -0.50 (Figure 169), indicating that there might be a relationship.

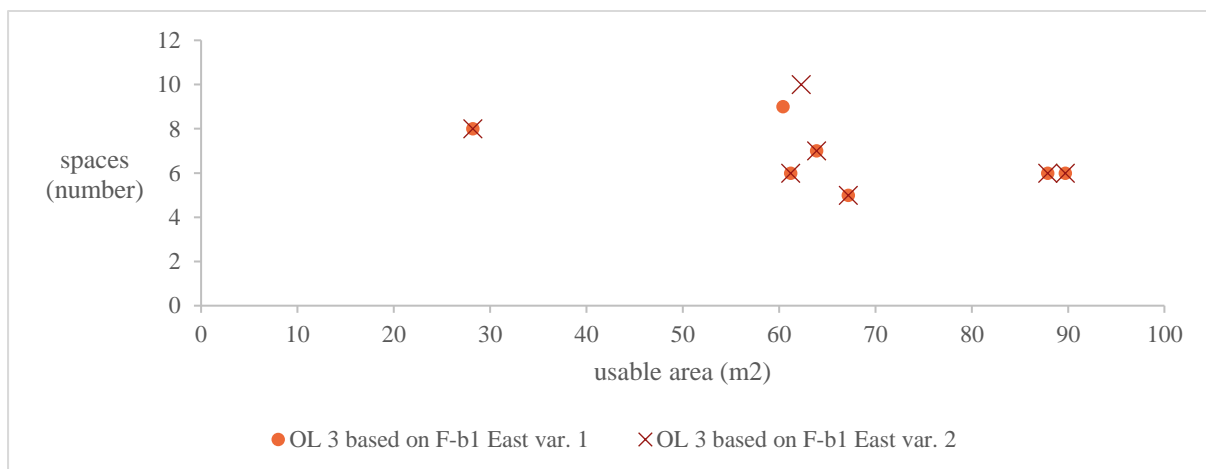


Figure 169: Correlation between usable area and number of rooms – Roman Period (OL 3)

1.2.2 Space syntax analysis

Micro level

Figure 170 shows the mean RRA values for all buildings and variations for the buildings from OL 3.



Figure 170: Mean RRA values per building – Roman Period (OL 3)

There are four different possible average RRA values for a visitor-inhabitant relationship of the buildings from OL 3, depending on which variation of Building E-b15 and Building F-b1 East is used for the calculation in combination with the buildings with no variations (Table 86). The average RRA value is therefore between 1.311 and 1.354.

Table 86: Average RRA values depending on variations of Building E-b15 and Building F-b1 East (visitor-inhabitant) – Roman Period (OL 3)

E-b15 var. 1	E-b15 var. 2	F-b1 East var. 1	F-b1 East var. 2	average RRA value
x		x		1.351
	x	x		1.311
x			x	1.354
	x		x	1.313

The same procedure can be followed for an inhabitant-inhabitant relationship (Table 87): here the average RRA value lies between 1.403 and 1.466. In all four cases the average increases, therefore indicating a higher segregation when analysing the buildings as closed units.

Table 87: Average RRA values depending on variations of Building E-b15 and F-b1 East (inhabitant-inhabitant) – Roman Period (OL 3)

E-b15 var. 1	E-b15 var. 2	F-b1 East var. 1	F-b1 East var. 2	average RRA value
x		x		1.457
	x	x		1.403
x			x	1.466
	x		x	1.412

Nano level²⁷⁷

Visitor-inhabitant relationship

When approaching a building of OL 3, an individual is in four cases in a more segregated position (Building E-b15, Building F-b1 East, Building F-b1 West, Building F-b2), more integrated in two cases (Building F-b4, Building F-b7) and in one case segregated (Building F-b12). Upon entering, the most or one of the most integrated rooms is accessed immediately (Building E-b15, Building F-b1 West, Building F-b2, Building F-b4, Building F-7) or, alternatively, an integrated room leading to the most integrated room (Building F-b1 East) or a more segregated room leading to the most integrated room (Building F-b12).

The highest control over adjacent spaces is exercised by the room with the most connections, which has a distributary character; it is either it located at the entrance (Building E-b15, Building F-b2, Building F-b4, Building F-b7) or at the centre of the building (Building F-b1 East, Building F-b1 West, Building F-b12). This can be confirmed by the correlation coefficient of 0.98 or 0.99 when comparing control value (CV) and number of connections (NC) directly.

²⁷⁷ See “Graphic output and interpretation” in Chapter IV, Section 2.

Inhabitant-inhabitant relationship

An individual moving inside a building of OL 3 is usually in more segregated surroundings (Building E-b15, Building F-b1 West, Building F-b2, Building F-b4, Building F-b12), though more integrated in two cases (Building F-b1 East, Building F-b7).

The highest control over adjacent spaces is in all buildings maintained by the room(s) with the most connections, as proven by the correlation coefficient of 0.98 or 0.99 between control (CV) and number of connections (NC).

1.3 OL 2b

1.3.1 Description

Micro level

Two buildings (Building E-b11, Phase 1 of Building F-b8) were built reusing part of the walls from OL 3 buildings (Building E-b15, Building F-b12, respectively), while one building (Building F-b5) was built on OL 3 debris; for all buildings new walls were built (Figure 111). For one building, Building F-b5, two variations were proposed because of unclear evidence of permeability. The average total area occupied by a building is 121.20 m², ranging between 107.90 m² and 136.30 m² (Figure 171). The shape of the buildings varies between rectangular and L-shaped. The usable area is on average 55% (ranging between 48% and 61%) of the total area: between 64.40 m² and 83.80 m²; in all cases, although the total area occupied by the building changes, the percentage of usable area is always the same.

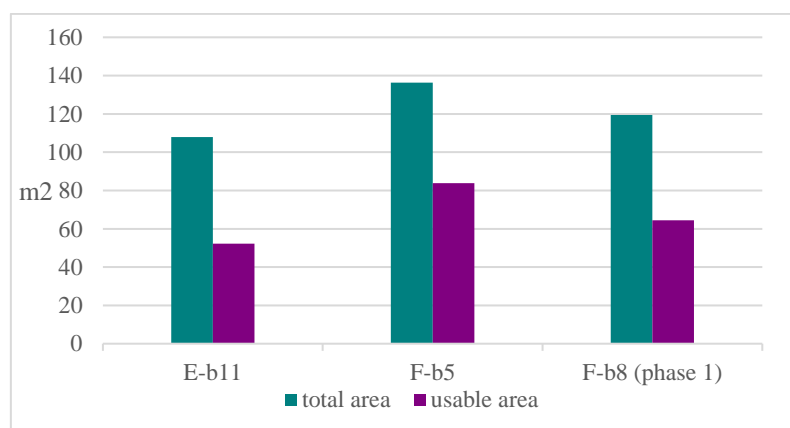


Figure 171: Total and usable area per building – first phase Late Antique Period (OL 2b)

The foundation levels of the newly built walls are between 827.70 m a.s.l. and 830.95 m a.s.l., averaging 830.15 m a.s.l. (Figure 172²⁷⁸). Although not as pronounced as for the buildings from OL 3, still the graphs shows signs of the slope under the residential area: on the left side of the graph the building (E-b...) located north has walls founded at higher levels than the buildings (F-b...) on the right side of the graph, located on the south side of the area.

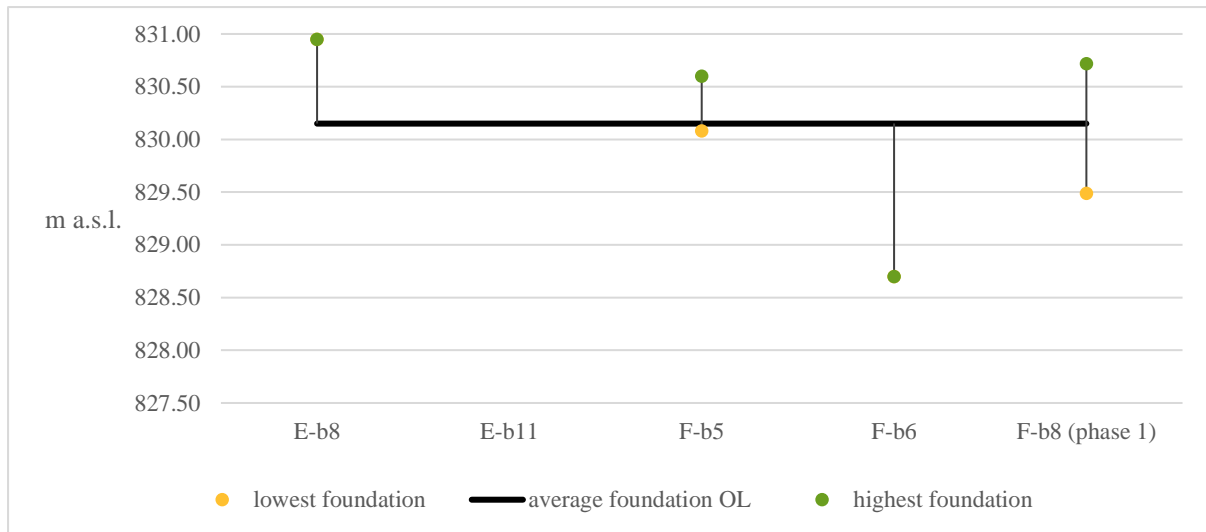


Figure 172: Foundation levels of newly built walls per building – first phase Late Antique Period (OL 2b)

The width of the external walls is between 0.45 m and 1.20 m, generally wider than the internal walls, which is between 0.35 m and 0.70 m.

Nano level

The number of rooms in each building varies between four and five, of which the smallest measures about 2.20 m² and the largest about 32.60 m². The correlation coefficient between usable area and the number of rooms is -0.13 (Figure 173), meaning that there is almost no relationship between them.

²⁷⁸ Foundation levels of newly built walls is not available for Building E-b11. There is no space syntax analysis of Building E-b8 and Building F-b6.

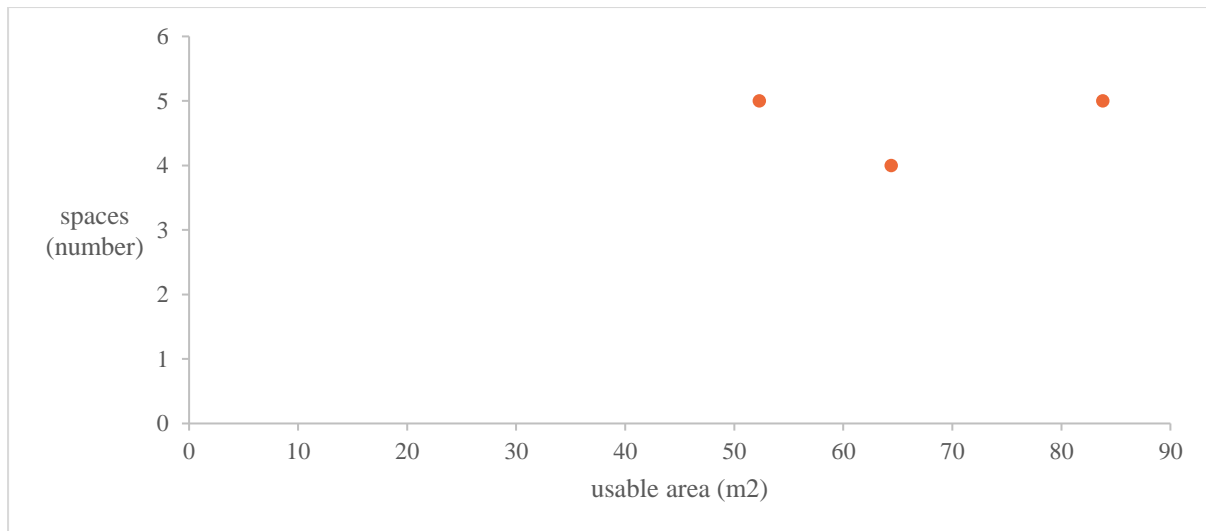


Figure 173: Correlation between usable area and number of rooms – first phase Late Antique Period (OL 2b)

1.3.2 Space syntax analysis

Micro level

Figure 174 shows the mean RRA values for all buildings and variations for the buildings from OL 2b.

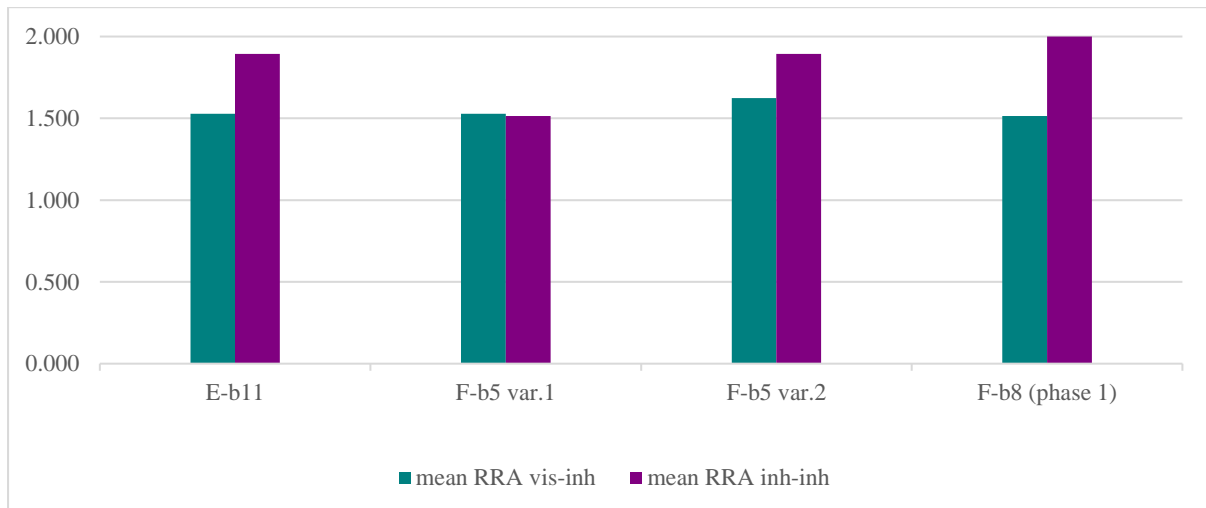


Figure 174: Mean RRA values per building – first phase Late Antique Period (OL 2b)

There are two different possible average RRA values for a visitor-inhabitant relationship of the buildings from OL 2b, depending on which variation of Building F-b5 is used for the calculation in combination with the buildings with no variations (Table 88). The average RRA value is therefore between 1.524 and 1.558.

Table 88: Average RRA values depending on the variations of Building F-b5 (visitor-inhabitant) – first phase Late Antique Period (OL 2b)

F-b5 var. 1	F-b5 var. 2	average RRA value
x		1.524
	x	1.558

The same procedure can be followed for an inhabitant-inhabitant relationship (Table 89): here the average RRA value lies between 1.789 and 1.924. In both cases the average increases, therefore indicating a higher segregation when analysing the buildings as closed units.

Table 89: Average RRA values depending on the variations of Building F-b5 (inhabitant-inhabitant) – first phase Late Antique Period (OL 2b)

F-b5 var. 1	F-b5 var. 2	average RRA value
x		1.789
	x	1.924

Nano level²⁷⁹

Visitor-inhabitant relationship

When approaching a building of OL 2b, an individual is either in a more segregated position (Building E-b11, Building F-b5 var. 2) or segregated position (Building F-b5 var. 1, Phase 1 of Building F-b8). Upon entering, the most integrated room is accessed (Building E-b11, Building F-b5 var. 2, Phase 1 of Building F-b8) or, alternatively, a more integrated room leading to the most integrated room (Building F-b5 var. 1). The divergent case is the first variation of Building F-b5, indicating that the second variation is probably the correct one, as it has the same characteristics as the other buildings of the same occupation level.

²⁷⁹ See “Graphic output and interpretation” in Chapter IV, Section 3.

The highest control over adjacent spaces is exercised by the room with the most connections, which has a distributary character; it is either located at the entrance (Building E-b11, Building F-b5 var. 2, Phase 1 of Building F-b8) or at the centre of the building (Building F-b5 var. 1). This can be confirmed by the correlation coefficient of 0.97 or 0.99 when comparing control (CV) and the number of connections (NC) directly.

The divergent case is the first variation of Building F-b5, indicating that the second variation is probably the correct one, as it has the same characteristics as the other buildings of the same occupation level.

Inhabitant-inhabitant relationship

An individual moving inside a building of OL 2b is, in all cases, in a more segregated surrounding.

The highest control over adjacent spaces is in all the buildings maintained by the room(s) with the most connections, as proven by the correlation coefficient of 0.94 or 0.98 between control (CV) and the number of connections (NC).

1.4 OL 2a

1.4.1 Description

Micro level

Both of the buildings from OL 2a (Building E-b7, Phase 2 of Building F-b8) were built by reusing walls of the buildings from OL 2b (Building E-b11, Phase 1 of Building F-b8, respectively) and by building new walls (Figure 146). The average total area occupied by a building is 122.90 m^2 , ranging between 119.40 m^2 and 126.30 m^2 (Figure 171). The shape of the buildings varies between rectangular and L-shaped. The usable area is on average 55% (ranging between 54% and 55%) of the total area: between 64.70 m^2 and 69.90 m^2 ; in all cases, although the total area occupied by the building changes, the percentage of usable area is always the same.

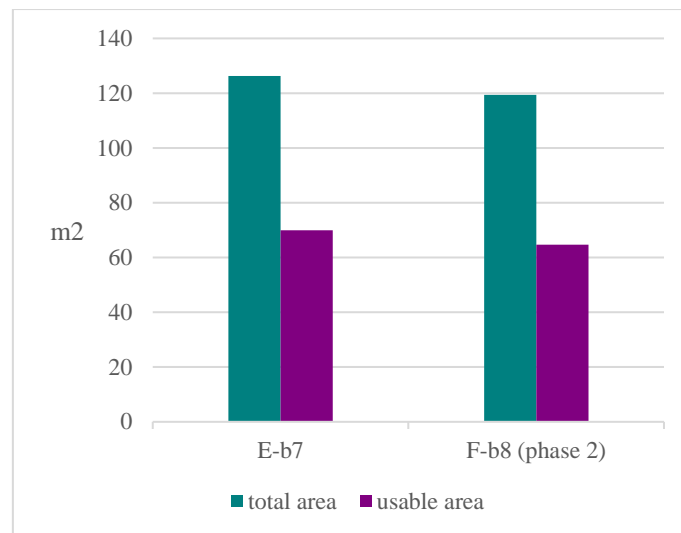


Figure 175: Total and usable area per building – second phase Late Antique Period (OL 2a)

The foundation level of the newly built walls is between 830.70 m a.s.l. and 830.82 m a.s.l., averaging 830.74 m a.s.l. (Figure 176²⁸⁰).

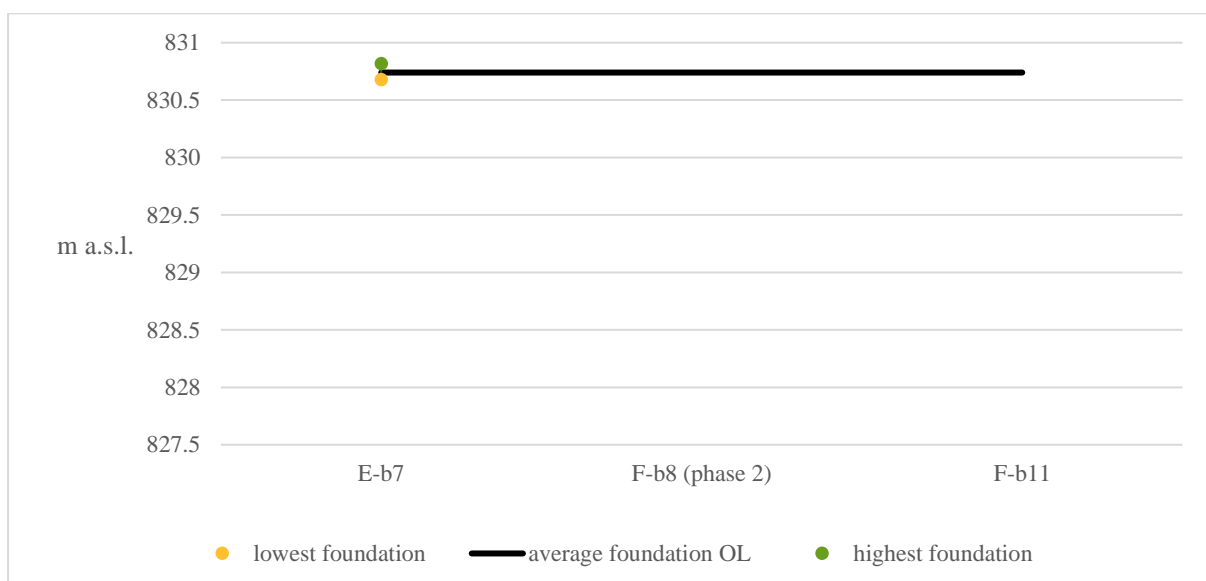


Figure 176: Foundation levels of newly built walls per building – second phase Late Antique Period (OL 2a)

²⁸⁰ Foundation levels of newly built walls are not available for Building F-b8 (phase 2) and Building F-b11. There is no space syntax analysis of Building F-b11.

The width of the external walls is between 0.45 m and 1.20 m, generally wider than the internal walls, which is between 0.35 m and 0.70 m.

Nano level

The number of rooms in each building varies between four and five, of which the smallest measures about 1.50 m² and the largest about 35.20 m². Calculating the correlation coefficient between usable area and number of rooms (Figure 177) is unprofitable because the result would always be -1.00 or 1.00 for two samples. At least one more case would be needed to start to have a reliable result.

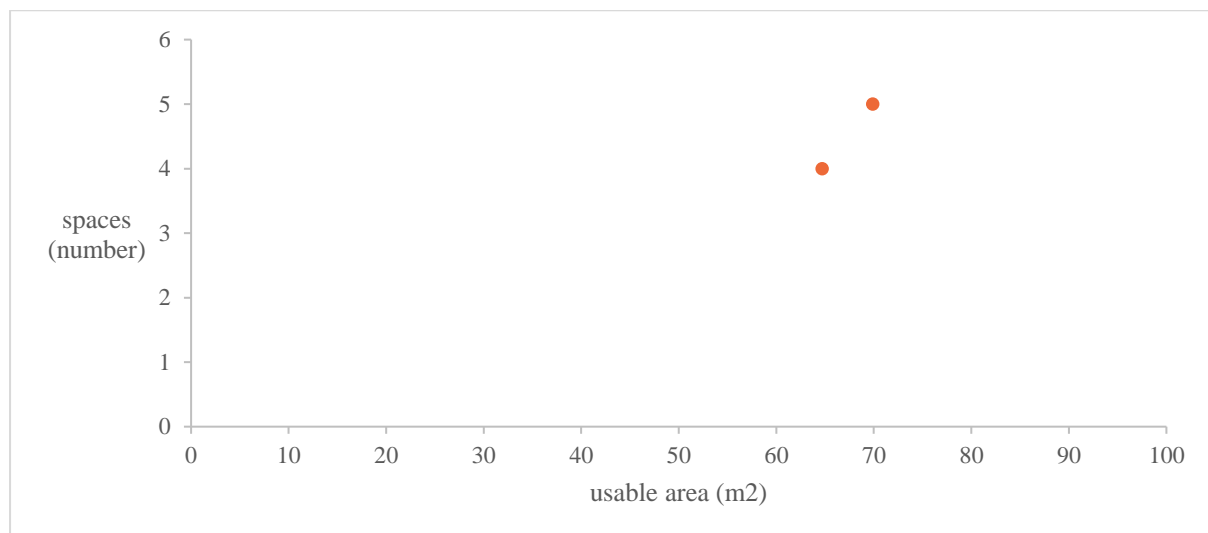


Figure 177: Correlation between usable area and number of rooms – second phase Late Antique Period (OL 2a)

1.4.2 Space syntax analysis

Micro level

Figure 178 shows the mean RRA values for both buildings of OL 2a. The average RRA value for the visitor-inhabitant relationship is 1.418. In the inhabitant-inhabitant relationship the RRA value increases to 1.508, therefore indicating a higher segregation when analysing the buildings as closed units.

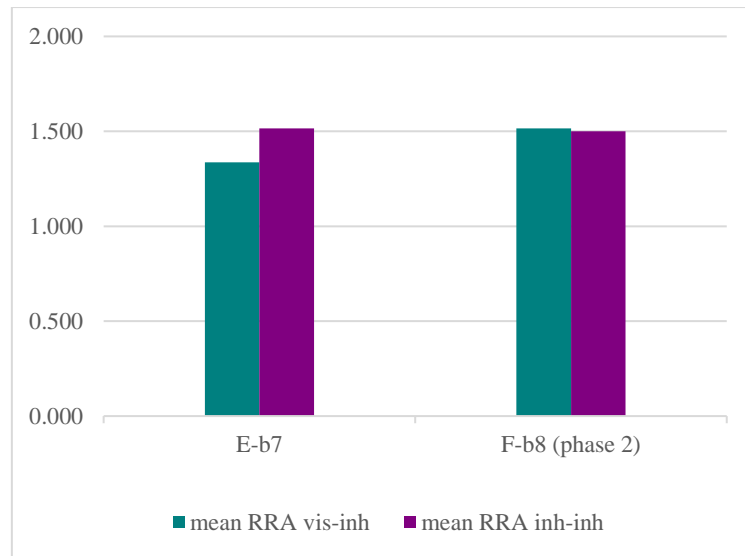


Figure 178: Mean RRA values per building – second phase Late Antique Period (OL 2a)

Nano level²⁸¹

Visitor-inhabitant relationship

When approaching a building of OL 2a, an individual is in a more segregated (Building E-b7) or segregated position (Phase 2 of Building F-b8). Upon entering, the two most integrated room(s) is accessed (Building E-b7) or an integrated room leading to the most integrated room (Phase 2 of Building F-b8).

The highest control over adjacent spaces is exercised by the room(s) with the most connections. This can be confirmed with the correlation coefficient of 1.00 when comparing control (CV) and number of connections (NC) directly.

Inhabitant-inhabitant relationship

An individual moving inside a building of OL 2a is in more segregated surroundings.

The highest control over adjacent spaces is in all buildings maintained by the room with the most connections, as proven by the correlation coefficient of 0.99 between control (CV) and number of connections (NC).

²⁸¹ See “Graphic output and interpretation” in Chapter IV, Section 4.

2 DIACHRONIC ANALYSIS

This second section focuses on a diachronic analysis of all OLs in analysis (OL 4, OL 3, OL 2b and OL 2a). The analysis is based on the synchronic analysis in Section 1 of this chapter.

2.1 Description

2.1.1 Micro level – general

The only analysed building from OL 4 has been built on debris of an older OL (OL 5). Further uncovered walls, which were not enough to define a building from the same level, have also been reused from an older OL (OL 5). Buildings of OL 3, OL 2b and OL 2a mostly reused walls of older OLs or rebuilt them in the same position as before, but also built on debris of older OLs. Additionally, some new walls were built regardless to where walls stood in an older OL.

From OL 4 to OL 3 mainly the external walls are maintained, while the building's interior is laid out differently (Building F-b3 to Building F-b1 East and Building F-b1 West). The layout of the building's interior changes from OL 3 to OL 2b (such as Building E-b15 to Building E-b11), although in some cases the thicker interior walls are rebuilt in the same position (such as Building F-b12 to Building F-b8). The transition between OL 2b and OL 2a is mainly characterised by small variations of the layout of the building's interior (such as Building E-b11 to Building E-b7; Phase 1 of Building F-b8 to Phase 2 of Building F-b8).

The buildings of all four OLs are predominantly rectangular or L-shaped, although there is one case of a square shaped building in OL 3 (Building F-b1 West).

There is a wide range of total and usable area that the buildings occupy: between 60.50 m² and 270.70 m² (Figure 179).

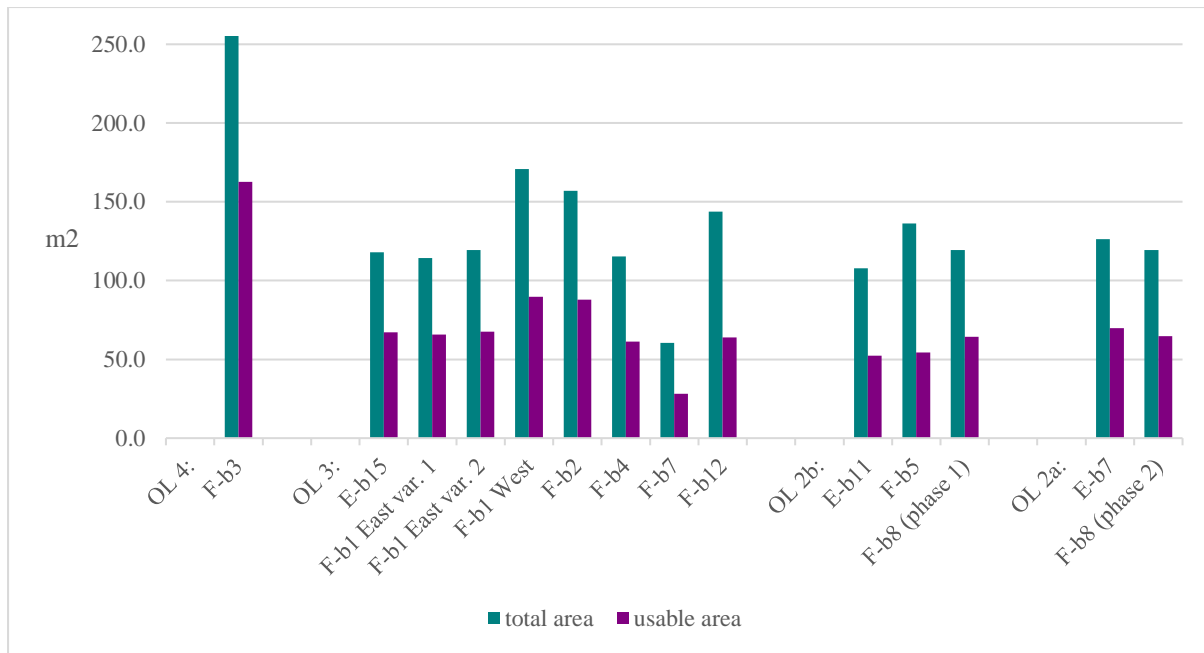


Figure 179: Total and usable area of all buildings – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

The average total area of buildings per OL is (Figure 180): OL 4 – 270.70 m²; OL 3 – either 125.70 m² (considering Building F-b1 East var. 1) or 126.40 m² (considering Building F-b1 East var. 2); OL 2b – 121.20 m²; OL 2a – 122.90 m². OL 4 has the largest building – Building F-b3 – of all OLs in analysis, about 100 m² larger than the next largest building – Building F-b1 West from OL 3. OL 3 has a wide range of building sizes, as a Standard Deviation between 33.5 (incl. Building F-b1 East var. 1) and 33.4 (including Building F-b1 East var. 2) demonstrates. OL 2b and OL 2a do not show such a wide range in their building sizes, given their Standard Deviation (11.7 and 3.5, respectively).

There is a large difference in building sizes between OL 4 and OL 3. Buildings from the other OLs have similar sizes.

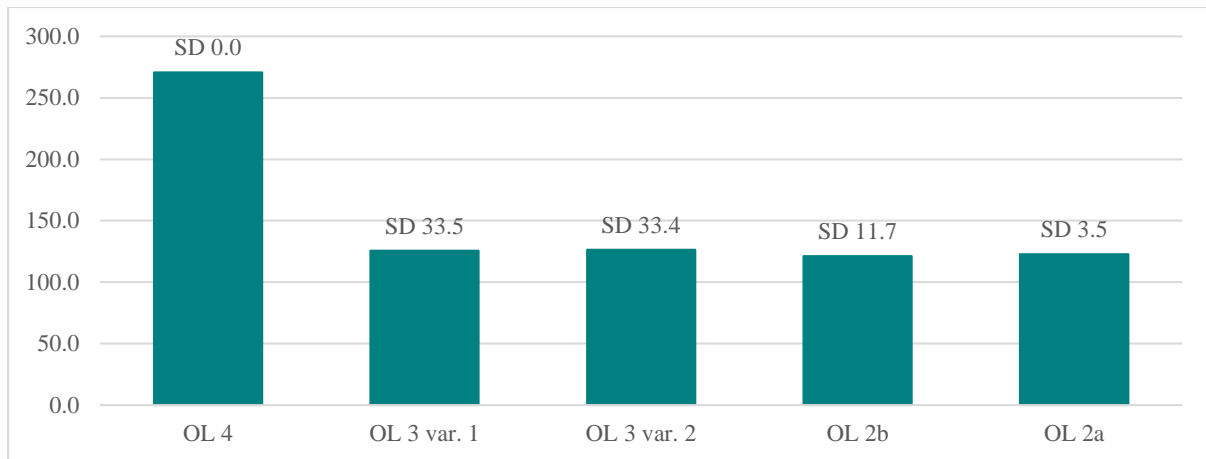


Figure 180: Average total area of buildings and Standard Deviation for each OL – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

The usable area of all the buildings analysed is between 44% and 61%. The correlation coefficient between total area and the usable area for all analysed buildings is together 0.98 (Figure 181). Interestingly, this indicates that the surface of usable area has always been optimised in the same proportion, independent of the total size of the building and the OL they belong to. This is very well represented by the two buildings at both ends of the trendline in Figure 181: Building F-b7 from OL 3 on the lower left end of the trendline and Building F-b3 from OL 4 on the upper right end of the trendline have a completely different amount of total and usable area, yet the proportion between both areas is roughly the same.

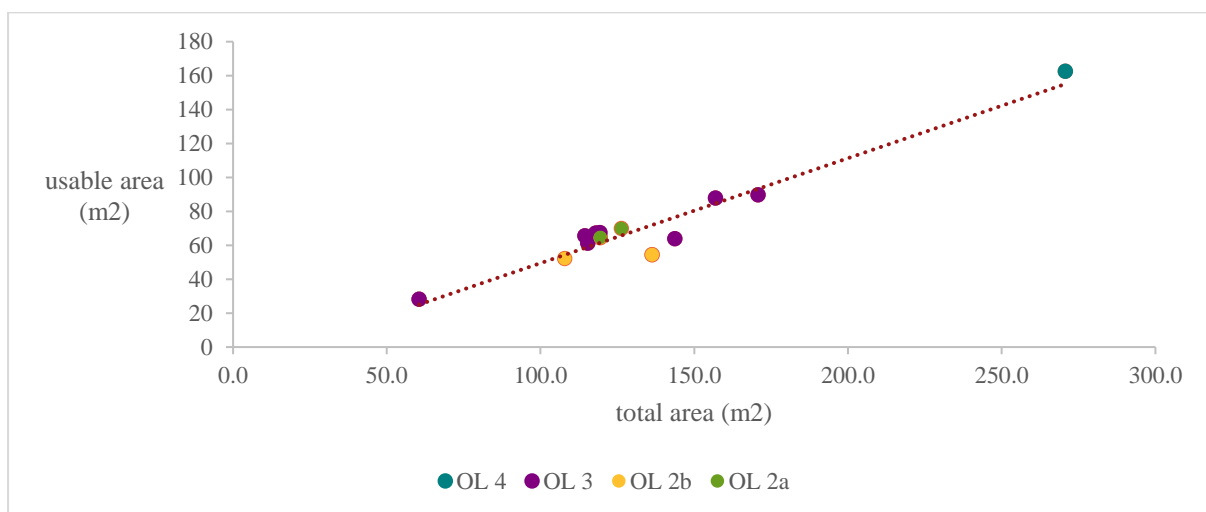


Figure 181: Correlation of total and usable area for all OL – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

The average foundation levels of the newly built walls are lower for OL 4 and increase towards OL 2a (Figure 182). The overlapping foundation levels of newly built walls across OLs can be explained by the existence of a slope in the residential area, as mentioned in Chapter II, Section 3.1. Buildings on the north side of the residential area (E-b...) have a general trend of having higher founded new walls, while the buildings on the south side (F-b...) have lower founded new walls. This is especially pronounced in OL 3 but can also be seen in OL 2b.

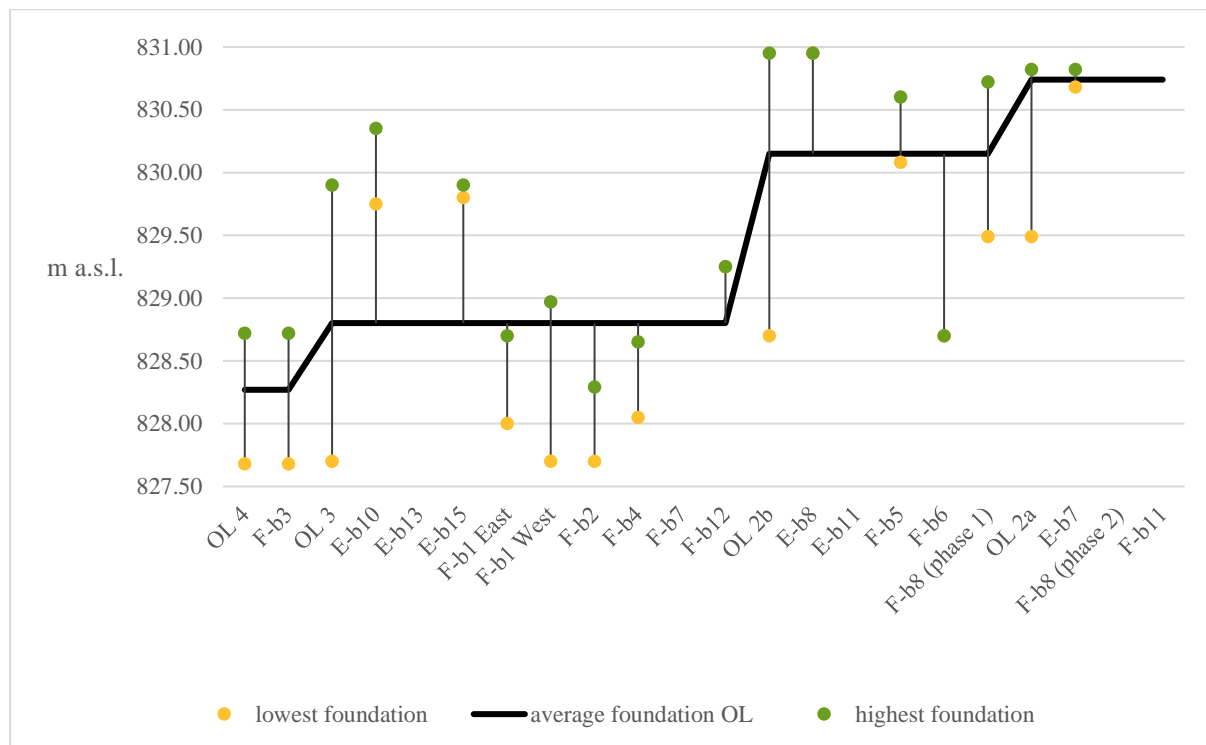


Figure 182: Foundation levels of all buildings, black line indicates the OLs mean foundation level – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

2.1.2 Nano level – general

The number of rooms in each building varies between four and nine (or possibly then, considering F-b1 East var. 2), of which the smallest measures about 0.50 m² and the largest about 86.70 m². OL 3 has the greatest variation in the amount of rooms – four to nine or ten, while the other OLs have a lesser amount – four or five. OL 4 has the greatest variation of rooms sizes, namely in Building F-b3. The other OLs have a more even distribution of room sizes, although there are cases of very small or very large rooms.

A correlation coefficient between usable area and the number of rooms could only be established for OL 3 and OL 2b. OL 3 has a correlation coefficient of -0.50, which might indicate a relationship, but this is not certain. For OL 2b the correlation coefficient is -0.13, indicating, with a very high probability, that there is no relationship between usable area and the number of rooms. Not enough buildings from OL 4 and OL 2a have been analysed to make such a calculation, because at least three would be needed and only one or two, respectively.

2.2 Space syntax analysis – micro and nano level

Turning now to the results of the space syntax analysis, first the micro level of analysis will be discussed followed by the nano level of analysis.

The micro level is analysed by comparing the mean RRA values of buildings of each OL and its variations. As can be seen in Figure 183, average RRA values for the visitor-inhabitant relationship are all above 1.00, meaning that the buildings are generally segregated. These average RRA values increase even more in an inhabitant-inhabitant relationship, meaning that their segregation also increases.

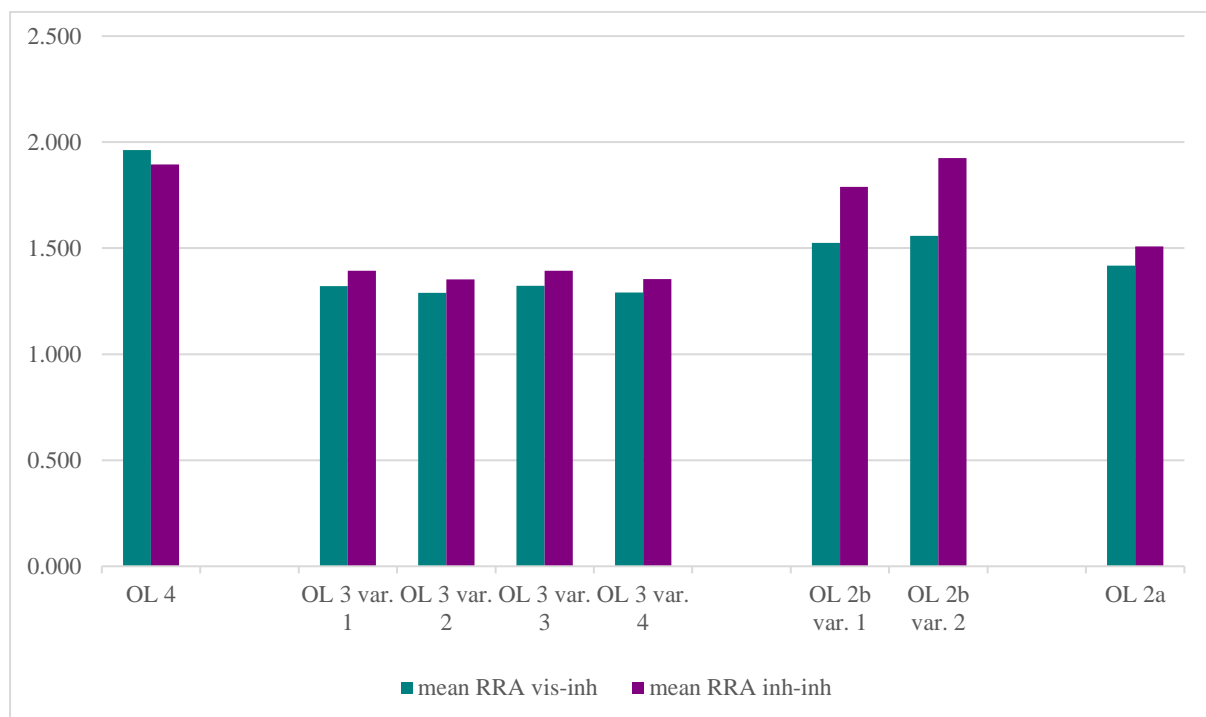


Figure 183: Average RRA values per OL and variations – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

Nevertheless, these are **average** RRA values for each OL and some buildings decrease their mean RRA value in an inhabitant-inhabitant relationship (Figure 184). This is the case of Building F-b3 from OL 4, Building F-b1 East (both variations) and Building F-b12 from OL 3, Building F-b5 var. 1 from OL 2b and Phase 2 of Building F-b8 from OL 2a.



Figure 184: RRA values per OL and building with variations – Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods

The next part will focus on movement patterns for a visitor-inhabitant relationship and an inhabitant-inhabitant relationship. For this the justified graphs will be considered. None of the buildings provide the means for a circulatory movement. As can be seen in each space syntax analysis of buildings in Chapter IV, none of the buildings' analysis included the calculation of the RR (relative ringiness), although this has been presented in Section 2.1.1 of Chapter III; instead, movement is along a path of spaces or through a path with a furcation of various degrees: bi- or multifurcations. A bifurcation signals a choice of path once entering a space (excluding a return through the same way). A multifurcation suggests a central room from which movement is distributed to other spaces.

How the topological distance changes can immediately be identified through the justified graphs of the visitor-inhabitant relationship: if upon entering a building only one choice of connection is possible from the room accessed, then the topological distance in the inhabitant-inhabitant relationship is going to reduce; if upon entering a building the room accessed has two choices, one with one topological distance and one with more, then the topological distance is maintained in the inhabitant-inhabitant relationship; if upon entering a building the room accessed has at least two choices with more than one topological distance, then the topological distance is going to increase. This means that the behaviour of the topological distance between the visitor-inhabitant relationship and the inhabitant-inhabitant relationship already gives an indication of movement characteristic such as a path-like entrance, a furcation with one single space path or a furcation with at least two paths with multiple spaces.

As for the visitor-inhabitant relationship, OL 4 is characterised by a path of spaces, including the exterior of the building. The longest topological distance from the perspective of a visitor is five. OL 3 has none such path-like aligned spaces, instead all the buildings contain bi- or multifurcations, which can already occur upon entering the building or further inside. The topological distance from the perspective of a visitor is between three and six. All OL 2b buildings contain one bifurcation but no multifurcations. The longest topological distance from the perspective of a visitor is between three and four. Buildings from OL 2a contain only bifurcation. The longest topological distance from the perspective of a visitor is three.

As for the inhabitant-inhabitant relationship, where buildings are analysed as a closed unit, OL 4 is still characterised by a path of spaces and the longest topological distance reduces. OL 3 buildings contain one bifurcation or multifurcations and the topological distance reduces in two cases, maintains in three cases and increases in two cases. Spaces of buildings from OL 2b are now either aligned on a path or contain one bifurcation and the longest topological distance reduces in the first variation of Building F-b5, is maintained in two cases, if considering the second variation of Building F-b5, and reduces in one case. OL 2a has only one bifurcation and the longest topological distance reduces in one case and is maintained in another.

2.3 Spatial behaviour – functional differentiation?

As mentioned in Chapter III, Section 5, Hillier and Hanson had in mind that additional information is necessary to complete the results obtained from a space syntax analysis. This information is primarily drawn from the room function, but since evidence to define these is scarcely available for this case study²⁸², labels were given to the spaces mainly based on location and size rather than their function. It is expected by this approach, where location and size precede, that functional differentiation can be inferred.²⁸³ The six space labels established for the buildings at Tayma are the following:

- the exterior, namely the alley;
- the entrance room;
- the largest room;
- the smallest room;
- the room(s) with the most connections (highest NC);
- the staircase;
- the upper floor;
- the room where a food processing area was evident.

The analysis of spatial behaviour is based on the correlation of the values for control (CV) and integration/segregation (RA) are correlated and the space types (A-, B-, C- or D-type) are defined in a visitor-inhabitant relationship and in an inhabitant-inhabitant relationship. The first value is a local value and the second is a global value, enabling to understand the placement of each space within both the local and the global surrounding. Figure 185 – representing the visitor-inhabitant relationship – and Figure 186 – representing the inhabitant-inhabitant relationship – illustrate that a higher control is always connected to integration and a lower control with segregation. A-type spaces generally tend towards a segregated area with low control, while B-type spaces are less segregated and have more

²⁸² This case study does not contain a room function analysis but works rather with the functions already interpreted by the archaeologist that excavated the residential area.

²⁸³ Note of caution: “functional differentiation” and not “room function”. The former focuses on the fact that rooms have different functions while the latter focuses on the function itself.

control. This confirms A-type spaces as dead-end spaces and B-type spaces as part of tree branches, as they have been defined in Chapter III, Section 2.1.1.

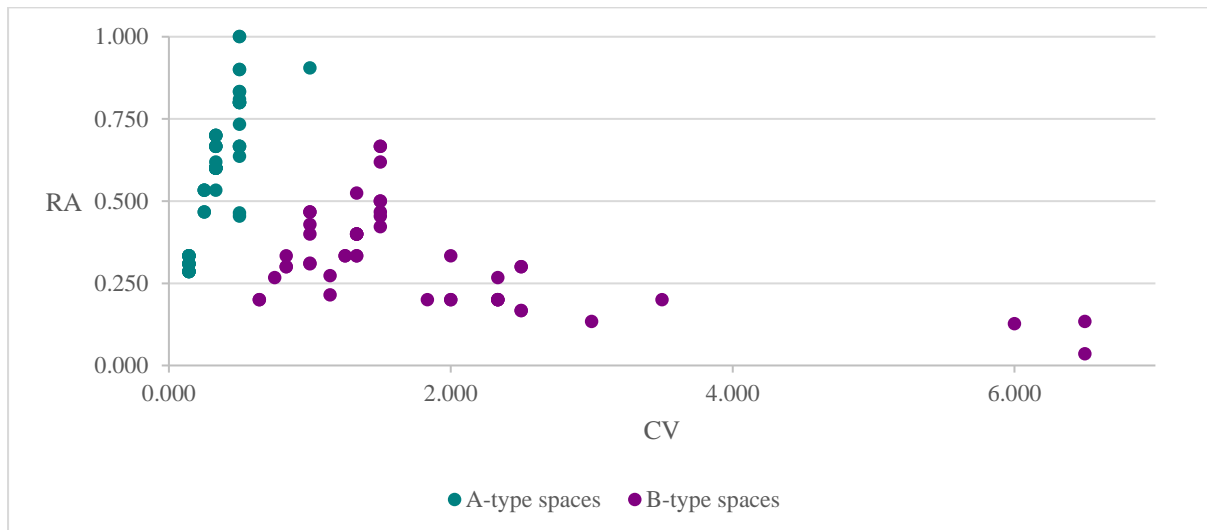


Figure 185: Correlation of CV and RA values per space type (visitor-inhabitant)

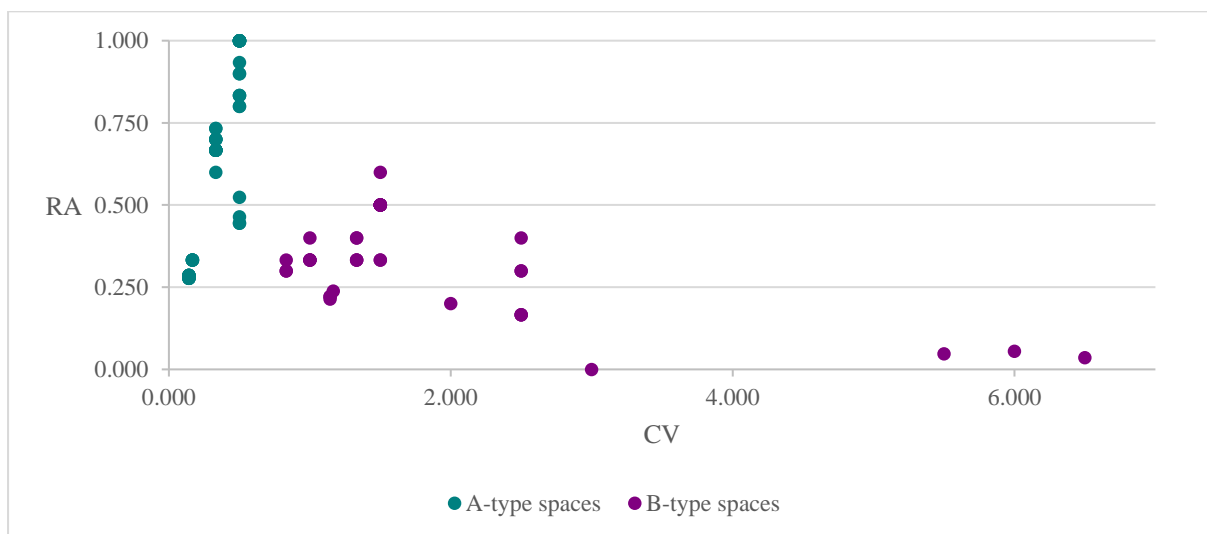


Figure 186: Correlation of CV and RA values per space type (inhabitant-inhabitant)

The same correlation between CV and RA is analysed according to the above-mentioned labels in the following paragraphs.

The spaces labelled as **exterior** (alley) are always A-type spaces – dead-ends – that are segregated and have no control over the building’s interior (Figure 187). These spaces are on the outer side of the boundary defined by the walls of the building. Nevertheless, alleys are not always the most segregated space, indicating that there was not a high control to access the building.

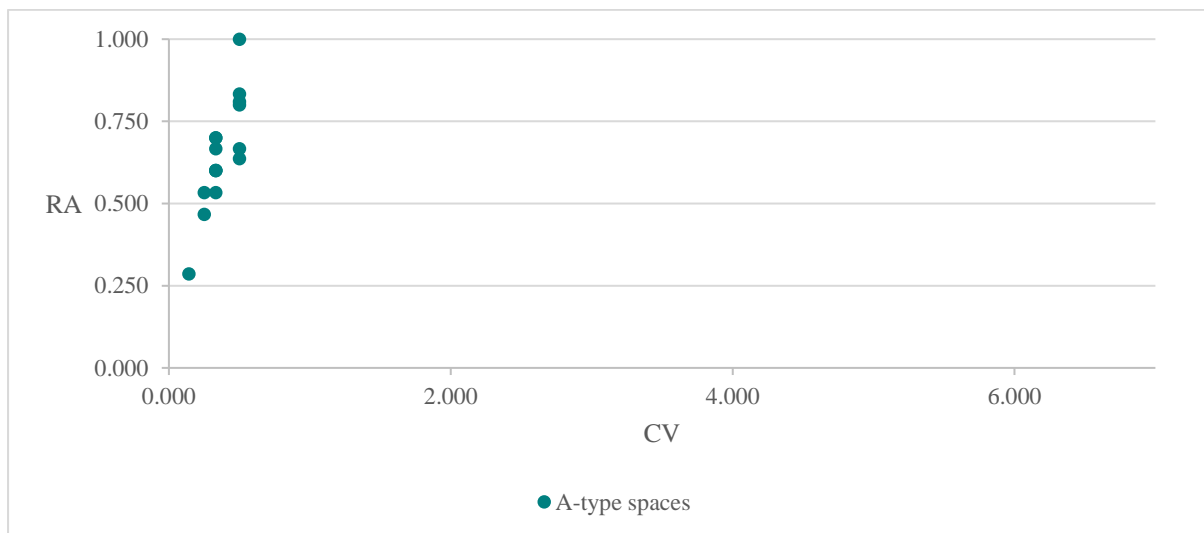


Figure 187: Correlation of CV and RA values for the alleys (visitor-inhabitant)

The spaces labelled as **entrance room** have a controlling function in a visitor-inhabitant relationship, shielding the interior of the building from the outside (Figure 188, left). It is always a B-type space. This also implies its integrated position in the building. Once that function ceases to be necessary, as in an inhabitant-inhabitant relationship, the former entrance room becomes more similar to the other rooms in the building (Figure 188, right), i.e. more segregated and with less control over adjacent spaces. The former entrance rooms become either an A-type or a B-type space, this depends if they only connect to the alley and to one interior space or if they had multiple connections to the interior. The first space type (A-type) could probably indicate a single function for the room (as entrance), while the second type (B-type) would then indicate the occurrence of further functions within the same room. The change occurring between both types of relationship (visitor-inhabitant relationship to inhabitant-inhabitant relationship) indicates that the entrance room has a more prominent role when used as interface between visitors and inhabitants but not for the inhabitants already moving inside the building.

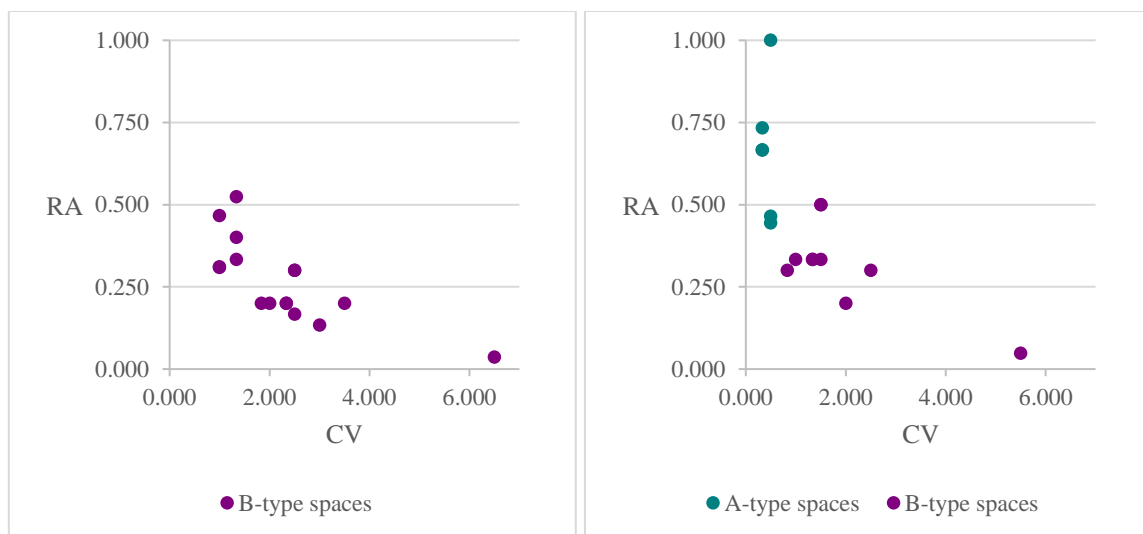


Figure 188: Correlation of CV and RA values for the entrance rooms (visitor-inhabitant, left) and for the former entrance rooms (inhabitant-inhabitant, right)

The spaces labelled as **largest room** in the building are from a visitor-inhabitant perspective usually in a more integrated position and have distributed values of control (Figure 189, left). Most of these rooms are B-type spaces connected to a higher number of rooms, while in exceptional cases they are A-type spaces. There is not completely clear why the latter occurs, since two of them are a variation of the same building²⁸⁴ and in the third case the building has not been completely excavated²⁸⁵; but observing their justified graphs, the largest room is, in all these exceptions, a dead-end space, while all the other cases have their largest room at the entrance or centre of the building and with multiple connections. Most of these rooms are therefore located in a more central location of the buildings, giving access to at least two other spaces. The inhabitant-inhabitant perspective does not change the range of control values but increases the segregation of a space (Figure 189, right). The division between A-type and B-type spaces remains the same.

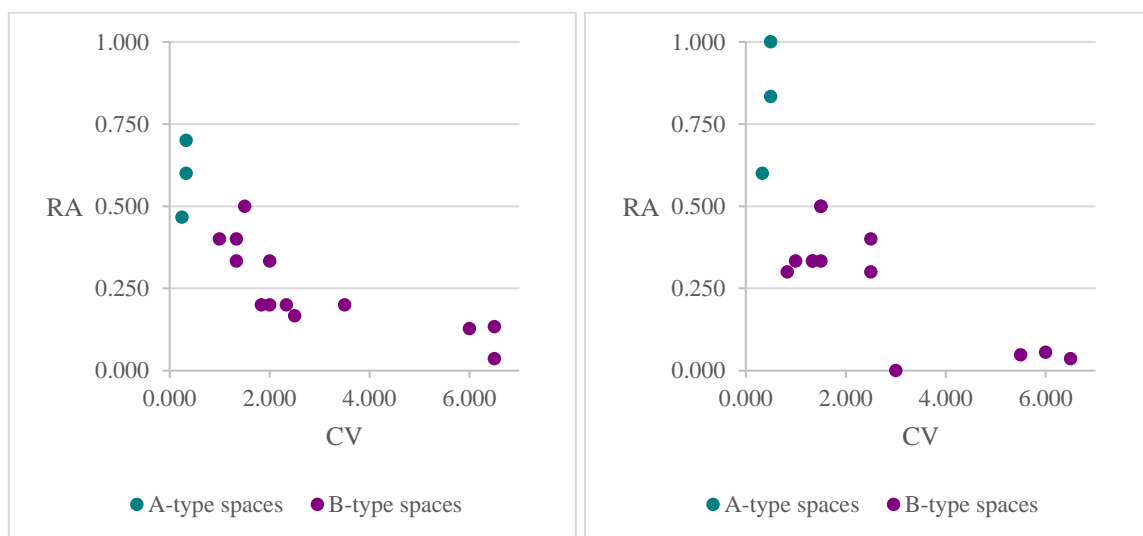


Figure 189: Correlation of CV and RA values for the largest rooms (visitor-inhabitant, left; inhabitant-inhabitant, right)

²⁸⁴ Building E-b15 (OL 3), R5.

²⁸⁵ Building F-b4 (OL 3), R3.

The spaces labelled as **smallest room** in every building display A-type and B-type distinction that are inverted in comparison with the largest room. The smallest room is in a visitor-inhabitant perspective usually in a more segregated position and with a low control value (Figure 190, left). Most of them are A-type spaces, while in exceptional cases they are B-type spaces. In one case the smallest room is a small entrance room,²⁸⁶ in another case the smallest room is a corridor-like entrance room,²⁸⁷ which explains why they have a high control over adjacent spaces although they are the smallest room in the building, and in the third case the permeability is not clear.²⁸⁸

Most of these rooms are therefore located at the end of the buildings and with no choice except returning the same way as the room was accessed. The control values decrease for an inhabitant-inhabitant perspective (Figure 190, right). The division between A-type and B-type space remains the same.

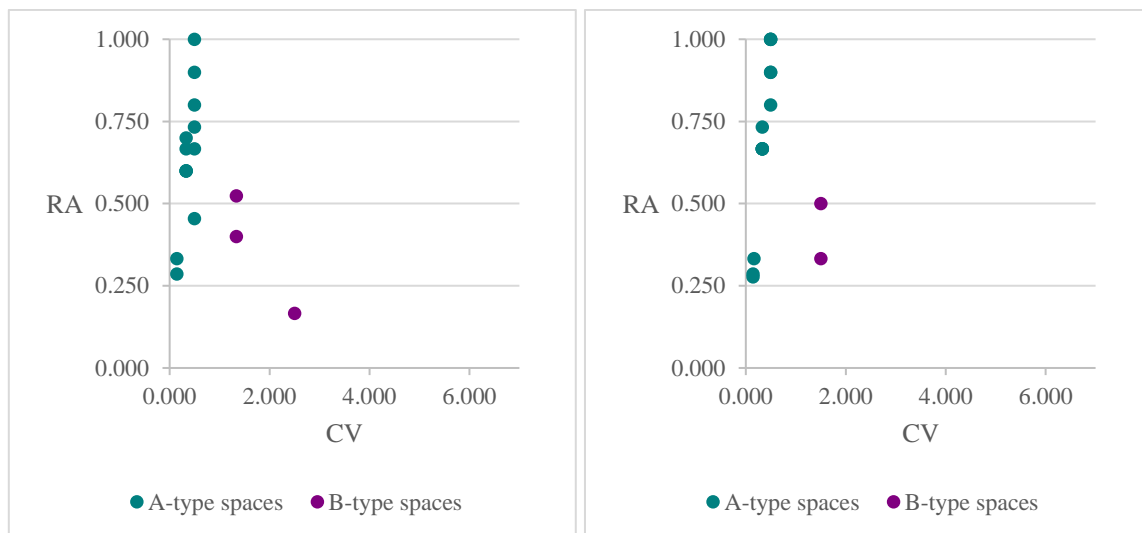


Figure 190: Correlation of CV and RA values for the smallest rooms (visitor-inhabitant, left; inhabitant-inhabitant, right)

²⁸⁶ Building F-b12 (OL 3), R4.

²⁸⁷ Building F-b8 (OL 2a, Phase 2), R4.

²⁸⁸ Building E-b11 (OL 2b), R2.

The **most connected** rooms in a visitor-inhabitant relationship have a high or very high control since they have access to the most spaces (Figure 191, left). They are always B-type spaces, since they have at least two connections. Some of these rooms change in an inhabitant-inhabitant relationship (Figure 191, right), especially the rooms that decrease their number of connections: they now have a higher segregation and a lower control than before; in one case it even becomes an A-type space, since it loses its position as most connected room if the second variation of the building is considered.²⁸⁹ The rooms that still have the highest connectivity in the building always have a higher control than other spaces. They are also still B-type spaces.

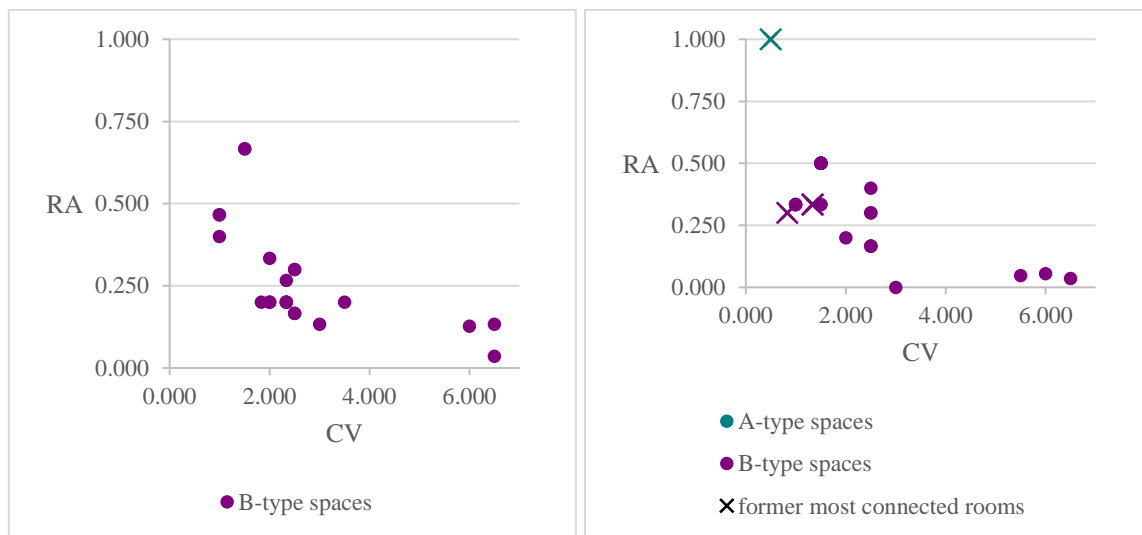


Figure 191: Correlation of CV and RA values for the most connected rooms (visitor-inhabitant, left; inhabitant-inhabitant, right)

²⁸⁹ Building E-b15 var. 2 (OL 3), R4. This would not be the case for Building E-b15 var. 1 (OL 3), R4.

The spaces labelled as **staircase** are from a visitor-inhabitant perspective usually in a more integrated or more segregated position and have a high value of control (Figure 192, left). Although the latter value it is very high, still it is much lower than differently labelled B-type spaces (such as the most connected or the largest rooms) and is more similar to the A-type spaces labelled as the exterior. All these transition spaces between the lower and upper floor are B-type spaces. The inhabitant-inhabitant perspective does not change on average both the analysed values (Figure 192, right).

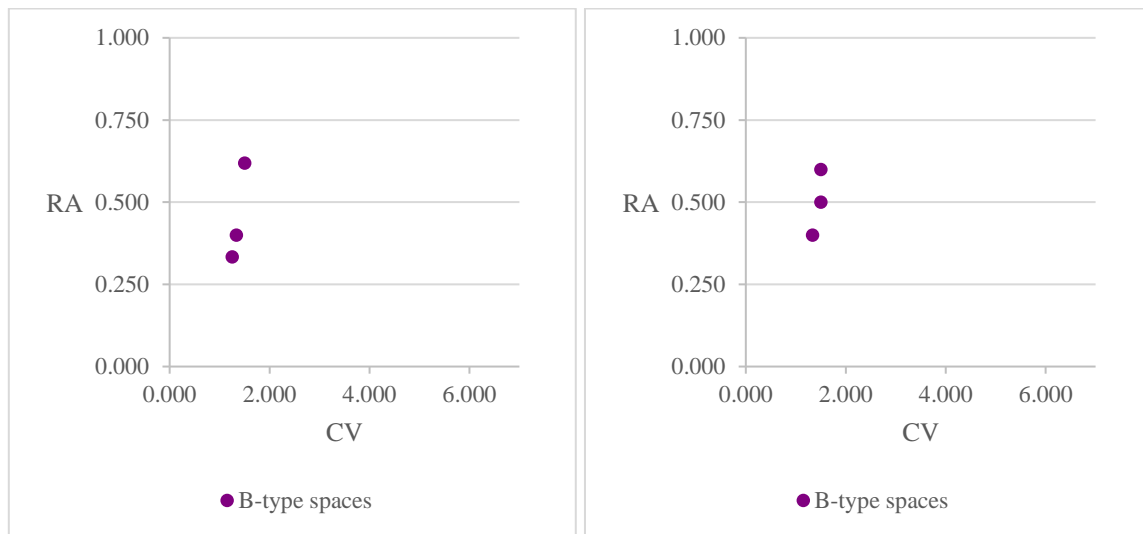


Figure 192: Correlation of CV and RA values for the staircases (visitor-inhabitant, left; inhabitant-inhabitant, right)

The spaces labelled as **upper floor** are from a visitor-inhabitant perspective usually in a more segregated or segregated position and have a low or high value of control (Figure 193Figure 192, left). The one high value of control must be interpreted with caution because it is the minimum value (1.000) to belong to that category and not the low control category. In all cases the upper floor is an A-type space. The segregation and lack of control increases in the inhabitant-inhabitant relationship, displaying the same characteristics as the spaces labelled exterior (Figure 193, right).

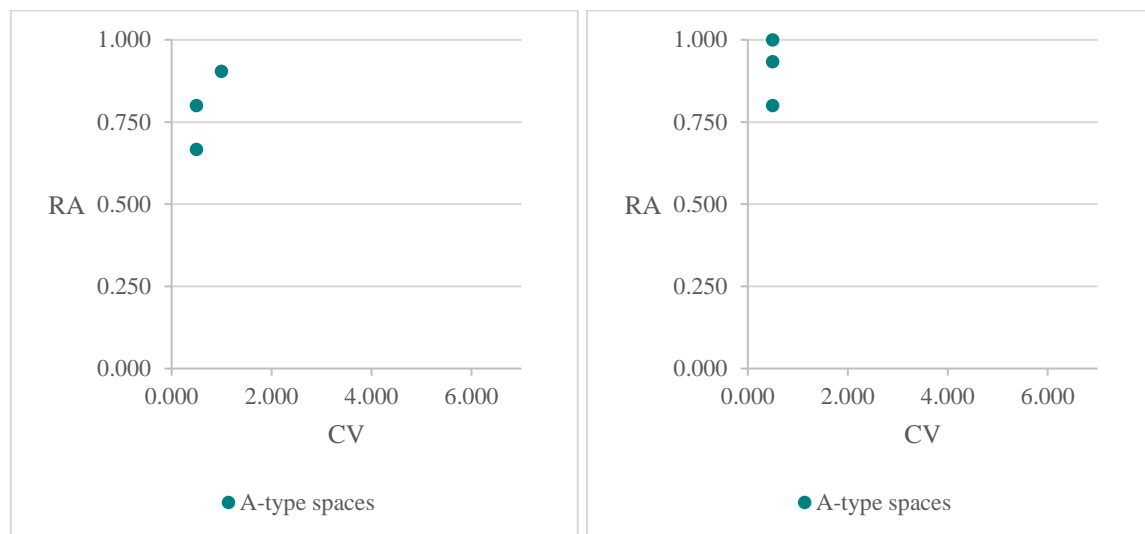


Figure 193: Correlation of CV and RA values for the upper floors (visitor-inhabitant, left; inhabitant-inhabitant, right)

The two rooms containing a **food processing** area have in neither case a position of control and are located in an area of more segregation from a visitor-inhabitant perspective (Figure 194, left). There is no evidence to make a typological identification for the rooms with food processing areas, because one A-type and one B-type space is known. From an inhabitant-inhabitant perspective these rooms increase segregation but do not change their space type (Figure 194, right).

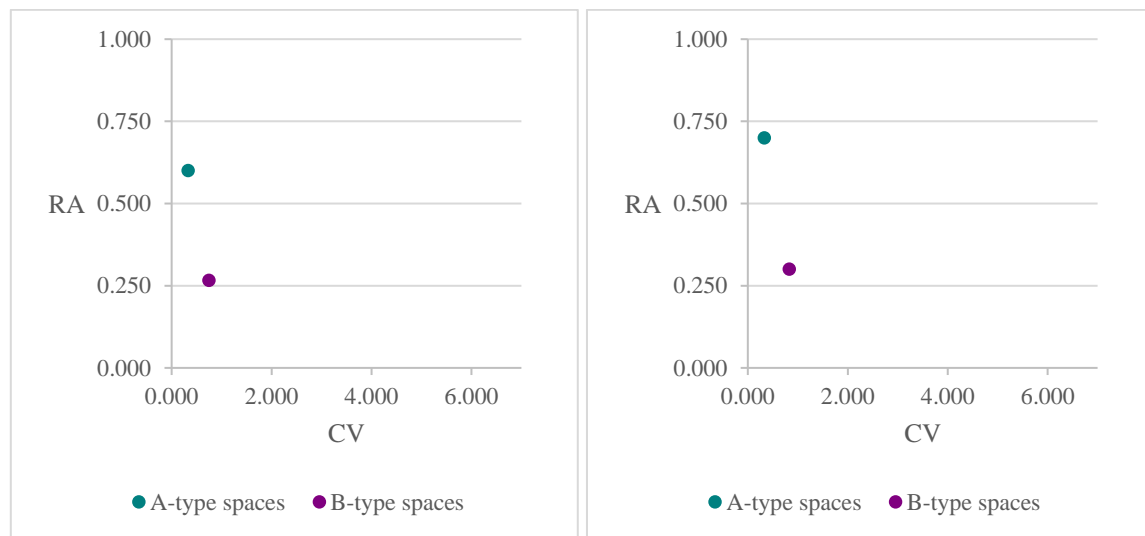


Figure 194: Correlation of CV and RA values for the rooms with food processing areas (visitor-inhabitant, left; inhabitant-inhabitant, right)

By analysing the spatial behaviour of the differently labelled spaces, it could be shown that spaces with the same label follow similar spatial configuration and behaviour changes from the visitor-inhabitant relationship to the inhabitant-inhabitant relationship. From that it can be assumed that the rooms with the same labels could also have had the same or very similar functions. The alley, for example, is usually more segregated from the buildings' interior, while the largest room with its mostly distributary character is most of the time in a position of control within the building.

In some cases, spaces can also have multiple functions. The entrance room, for example, has a function as interface between a visitor and an inhabitant, dividing the outside public space from the inside private space. This function is not maintained when considering the building as a closed unit, leading to the assumption that the room probably had another function once the door to the outside was closed.

Since this diachronic analysis showed that there is some degree of similarity between spaces with the same labels across OLs, it might show that the arrangement of space did not change radically from occupation to occupation level. The layout of buildings are changed and rooms are added or joined, but there is a verticality²⁹⁰ in the built environment that keeps the tradition of room arrangement and probably their function also.

²⁹⁰ As mentioned in Chapter I, Section 2.

CHAPTER VI

MAKING GENOTYPES VISIBLE

This chapter discusses the results presented in Chapter V based on the question as to whether the spatial configuration of the analysed buildings is a cross-period phenomenon – one genotype for all four occupation levels (OLs) in analysis – or if each OL can be represented by one genotype.²⁹¹ Arguments supporting and contradicting the various possibilities will be presented, followed by a description and comparison of the identified genotype(s).

1 ONE GENOTYPE TO RULE THEM ALL?

To assess if there is a cross-period genotype, the average RRA value for all analysed buildings – OL 4, OL 3, OL 2b and OL 2a – is calculated together. Figure 195 shows this value for all four OLs together and includes the variations caused by the variations of single buildings.²⁹² The average RRA value for the visitor-inhabitant relationship is 1.415 and for the inhabitant-inhabitant relationship it is 1.514. The value itself does not indicate whether there is only one genotype for all OLs, but it shows that the buildings from the residential area are, on average, overall asymmetric (RRA above 1.000) in both types of relationship. The range between the lowest and highest RRA values (Figure 195) shows that the existence of one genotype seems unlikely: for the visitor-inhabitant relationship this is on average 1.111 and for the inhabitant-inhabitant relationship this is on average 1.120. This means that there is a great difference between the spatial configuration of the buildings in analysis, indicating that there must be more than one genotype.

²⁹¹ As presented as research question in Chapter I, Section 2.

²⁹² OL 3: E-b15 var. 1 and var. 2, F-b1 East var. 1 and var. 2; OL 2b: F-b5 var. 1 and var. 2.



Figure 195: Average RRA and range for all analysed buildings of all OLs together, including the breakdown into variations – (variations for the Roman Period (OL 3) and first phase of the Late Antique Period (2b))

By calculating the difference factor H^* , it is possible to quantify the variance of the RRA values (Figure 196) within the above-mentioned range. In both the visitor-inhabitant relationship and the inhabitant-inhabitant relationship this is on average 0.87, meaning that there is a similarity between all buildings. Nevertheless, this value has to be placed in relation to the results from the next section where it is tested through the same argumentative line that each OL might have one genotype.

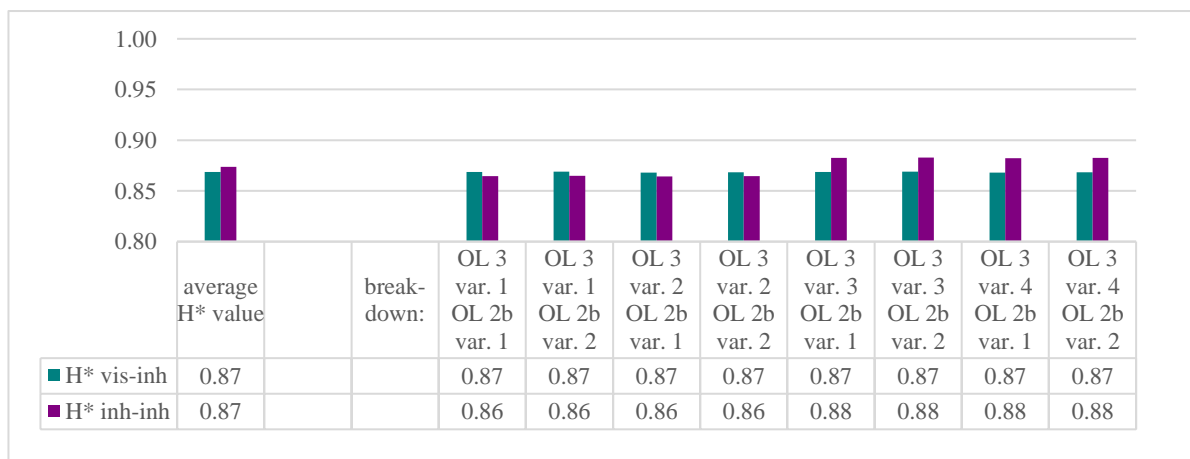


Figure 196: H^* for all analysed buildings of all OLs together, including the breakdown into variations – (variations for the Roman Period (OL 3) and first phase of the Late Antique Period (2b)); y-axis starts at 0.80

2 ONE GENOTYPE PER OCCUPATION LEVEL?

The second possibility presented by the research question is that the buildings of each OL are represented by one genotype, respectively. Figure 197²⁹³ shows the average RRA values for each OL, including the variations of single buildings (see footnote 292). The average RRA for OL 4 is 1.963 in the visitor-inhabitant relationship and 1.894 in the inhabitant-inhabitant relationship; for OL 3 it is between 1.290 and 1.322 in the visitor-inhabitant relationship and between 1.353 and 1.394 in the inhabitant-inhabitant relationship; for OL 2b it is 1.524 or 1.558 in the visitor-inhabitant relationship and 1.789 or 1.924 in the inhabitant-inhabitant relationship; for OL 2a it is 1.418 in the visitor-inhabitant relationship and 1.508 in the inhabitant-inhabitant relationship. The RRA values show, as in Section 1 of this chapter, that the buildings of all OLs are overall asymmetric (RRA above 1.000) in both types of relationship. But in this case there are visible variations within their asymmetry: OL 4 and OL 2b (only inhabitant-inhabitant relationship) have a higher asymmetry, while OL 3, OL 2b (inhabitant-inhabitant relationship) and OL 2a have a lower asymmetry. The last two indicate a similarity in the RRA values. Although the division into four genotypes is far more likely than one genotype for all OLs, the range of RRA values within each OL needs to be examined. Since there is only one building in OL 4, the range is 0.000 for both the visitor-inhabitant relationship and the inhabitant-inhabitant relationship and has therefore no additional evidence as to whether the genotype is likely to be obtained or not. Yet, when looking at OL 4, which has a different average RRA value than OL 3, it must be a different genotype. OL 3 has a range of RRA values that is 0.888 in the visitor-inhabitant relationship and between 0.825 and 1.042 in the inhabitant-inhabitant relationship. The range is lower than the one presented in Section 1 of this chapter, increasing the likelihood of a single genotype for this OL, but still it is very high in comparison to the other OLs. The range of RRA values in OL 2b is, in the visitor-inhabitant relationship, between 0.013 and 0.109 and in the inhabitant-inhabitant relationship between 0.106 and 0.485, hence very low. Likewise, in OL 2a the range is also very low: 0.178 in the visitor-inhabitant relationship and only 0.015 in the inhabitant-inhabitant relationship. The examination of the range of RRA values within each OL shows that OL 4, OL 2b and OL 2a can be represented by one genotype each, while OL 3 most likely does not.

²⁹³ Version without range values shown already in Chapter V, Section 2.2.

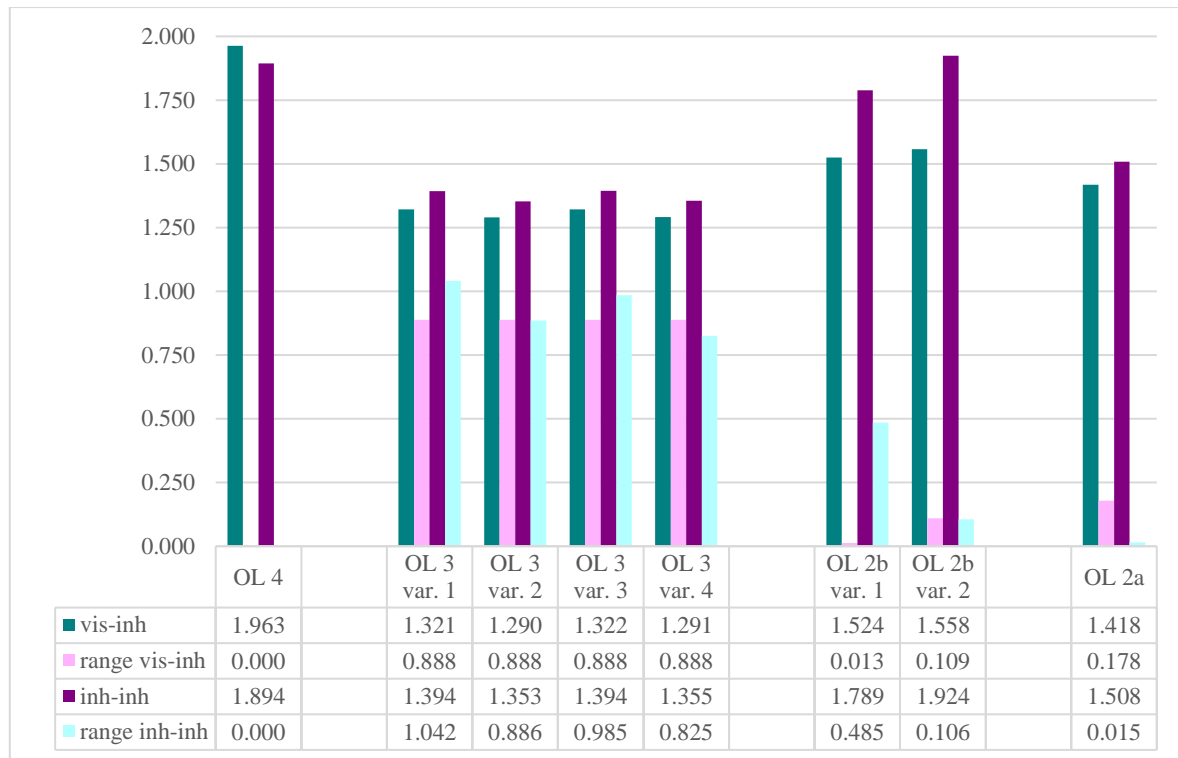


Figure 197: Average RRA and range per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b

The next step is to calculate the difference factor H^* , which quantifies the variance of RRA values within the above-mentioned range. H^* is for OL 4 1.00, which means no variance at all, again resulting from only one building being analysed. H^* is in the visitor-inhabitant relationship of OL 3 0.90 and in the inhabitant-inhabitant relationship between 0.88 and 0.92, meaning that there is almost no variance within the RRA values, but still there is. H^* in the visitor-inhabitant relationship of OL 2b is 1.00, that is no variance, and in the inhabitant-inhabitant relationship 0.98 or 1.00, that means there might be some variance. OL 2a has both, in the visitor-inhabitant relationship and the inhabitant-inhabitant relationship, 1.00 as H^* value, indicating no variance. The H^* values are higher for this division of the genotypes per OL, as for one genotype for all OLs together (on average 0.87). This confirms that the latter is not possible, and that the former seems far more likely. Again OL 3 has a higher variance than the other OLs, indicating that there is more than one genotype for this OL.

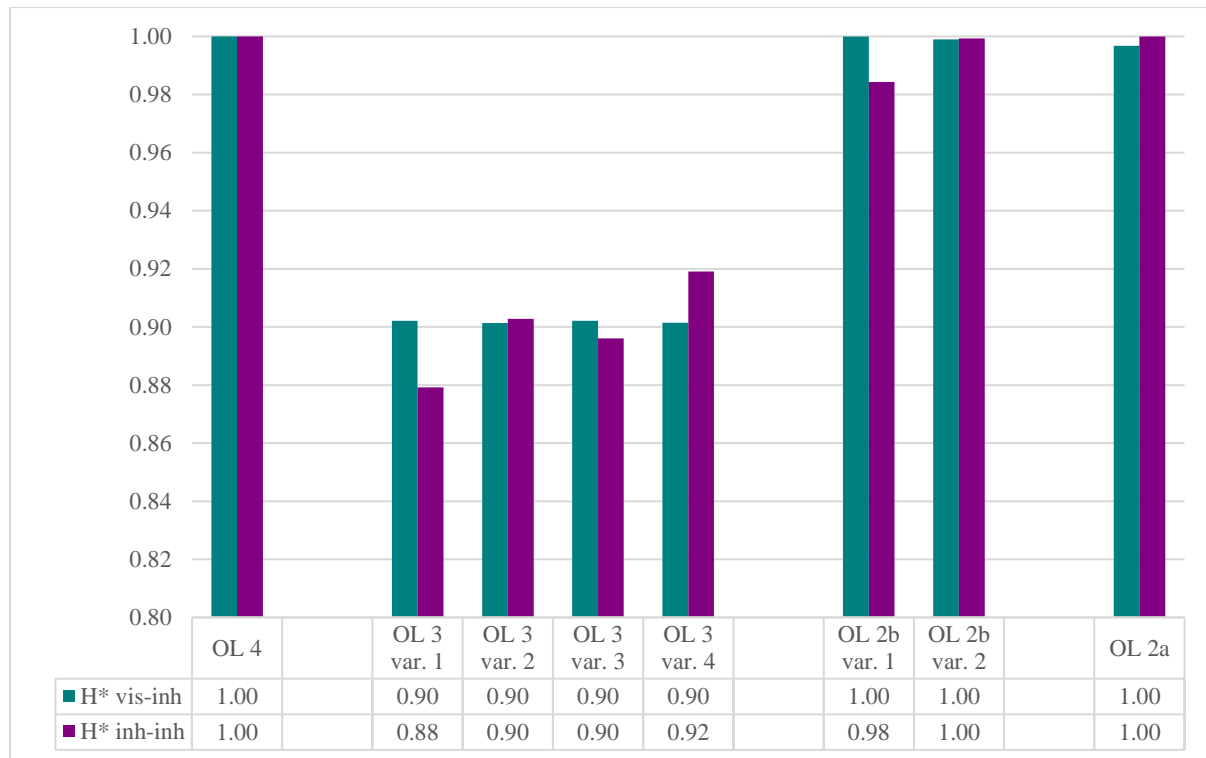


Figure 198: H* per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b; y-axis starts at 0.80

The high probability of a genotype in OL 4, OL 2b and OL 2a, respectively, and the low probability of only one genotype in OL3 can be well visualised by overlapping all the justified graphs (visitor-inhabitant relationship: Figure 199; inhabitant-inhabitant relationship: Figure 200).²⁹⁴ The darker the green lines are, the more occurrences of that path the buildings have within one OL, while on the other end of the scale orange shows only one occurrence of that path. OL 3 has a high quantity of paths that occur only once and therefore there must be at least one other genotype for that OL. OL 2b and OL 2a show they have a very similar path.

²⁹⁴ As presented in Chapter IV for each building.

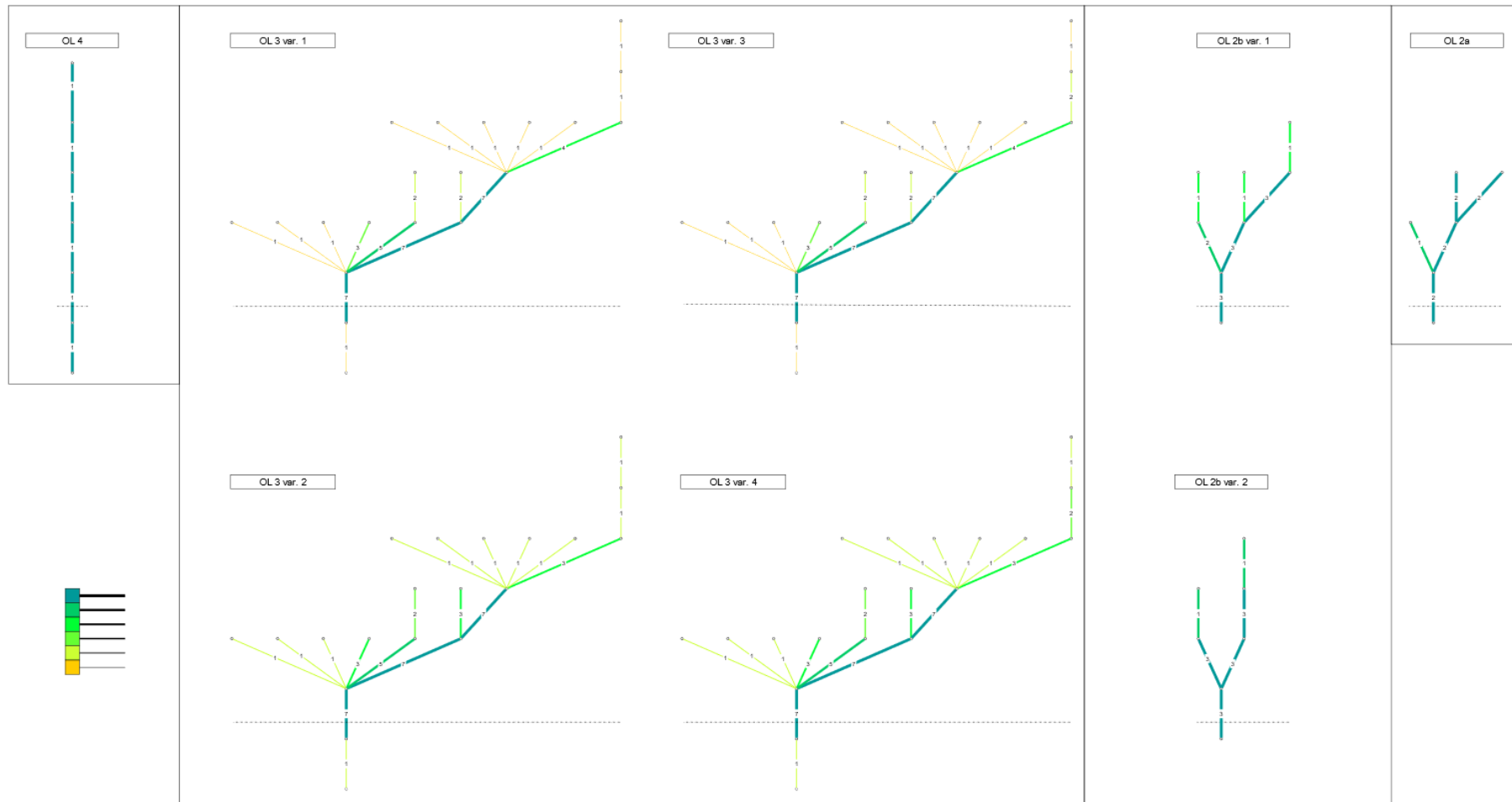


Figure 199: Overlapping of all justified graphs per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods), including variations for OL 3 and OL 2b – from often represented path (dark green) to little represented path (yellow) (visitor-inhabitant relationship)

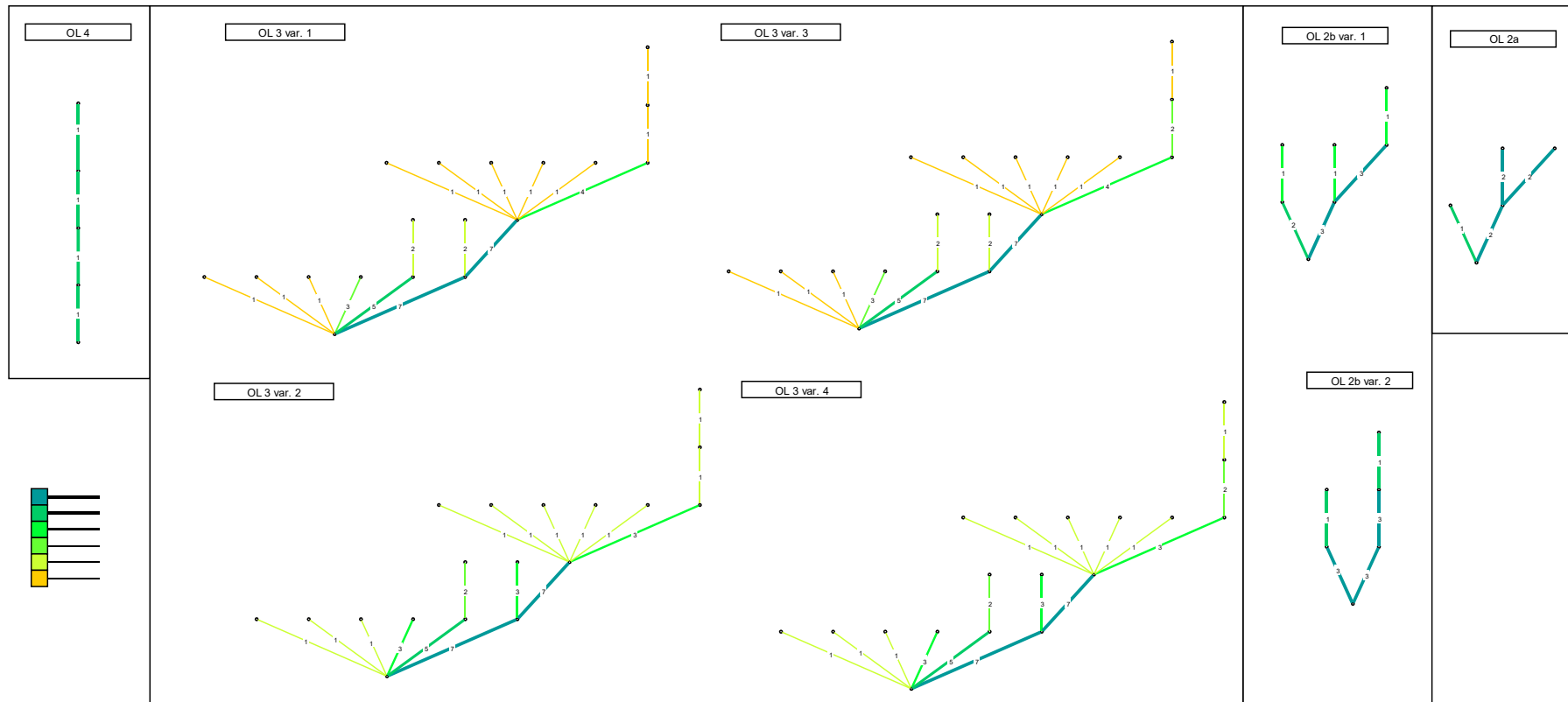


Figure 200: Overlapping of all justified graphs per OL (Nabataean (OL 4), Roman (OL 3) and Late Antique (first phase: 2b, second phase: 2a) Periods) , including variations for OL 3 and OL 2b – from often represented path (dark green) to little represented path (yellow) (inhabitant-inhabitant relationship)

3 NEW PROPOSITION FOR GENOTYPES

At this point of the line of argumentation presented in Section 1 and Section 2 of this chapter, it could be identified that the building from OL 4 can be represented with one genotype, distinct from OL 3. The genotype for OL 4 is henceforth named genotype A and is represented by phenotype Building F-b3.

Buildings from OL 3 follow the spatial configuration of at least two genotypes, which have not yet been defined in more detail. OL 2b and OL 2a are distinct from OL 3 but show evidence of similarities amongst themselves. The possibility of defining more than one genotype for OL 3 will now be analysed first and then a possible joint genotype for OL 2b and 2a.

Firstly, the buildings of OL 3 have a high variance of average RRA values: between 0.852 and 1.740 in the visitor-inhabitant relationship and between 0.852 and 1.894 in the inhabitant-inhabitant relationship. Building F-b1 East and Building F-b7 have a much lower average RRA value than the other buildings (Figure 201) and their justified graphs show they have a high multifurcation (up to six spaces connected to a single space) that the other buildings do not have.²⁹⁵ Joining the buildings with a higher average RRA value, their common spatial configuration is henceforth named genotype B.I and is represented by the phenotype Building E-b15, Building F-b1 West, Building F-b2, Building F-b4 and Building F-b12. The two buildings with a lower average RRA value, Building F-b1 East and Building F-b7, follow the spatial configuration of the henceforth named genotype B.II.

²⁹⁵ See justified graphs in Chapter IV: Section 2.3.2 for Building F-b1 East and Section 2.7.2 for Building F-b7.

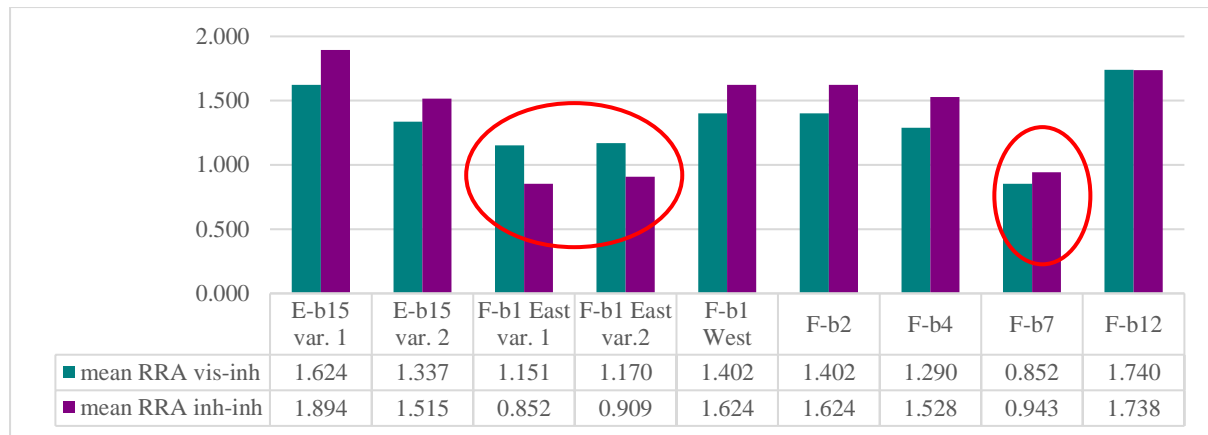


Figure 201: Mean RRA values per building – Roman Period (OL 3). Average RRA values under 1.000 circled

Secondly, buildings from OL 2b and OL 2a display similarities in their average RRA values (Figure 174), which is between 1.337 and 1.624 in the visitor-inhabitant relationship and between 1.500 and 2.000 in the inhabitant-inhabitant relationship. Hence, the values are very similar, positioned well above the value 1.000 as minimum indicator of asymmetry. The same applies to their justified graphs, which display a simpler furcation in all cases,²⁹⁶ opposed to the multifurcation of up to seven nodes in OL 3. Buildings from both OL 2b and OL 2a are jointly to henceforth be named genotype C, represented by the phenotypes Building E-b11, Building F-b5, Building F-b8 (Phase 1), Building E-b7 and Building F-b8 (Phase 2).

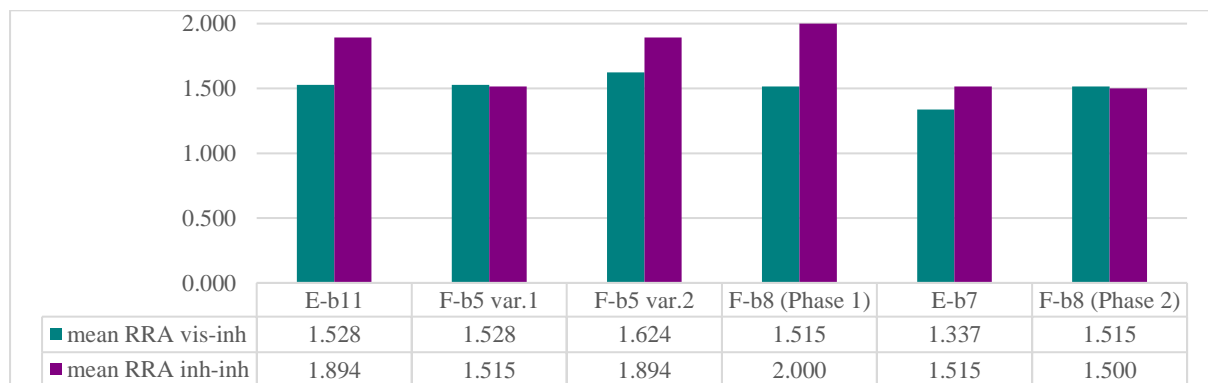


Figure 202: Mean RRA values per building – Late Antique Period (first phase: OL 2b + second phase: 2a)

²⁹⁶ See justified graphs in Chapter IV, Section 3.2.2 for Building E-b11, Section 3.3.2 for Building F-b5, Section 3.4.2 for Building F-b8 (Phase 1), Section 4.2.2 for Building E-b7 and Section 4.3.2 for Building F-b8 (Phase 2).

Now that the genotypes have been defined, the same line of argument, as in the first two sections of this chapter, can be followed for each: average RRA values, difference factor H^* and the overlap of justified graphs.

The average RRA value for genotype A is 1.963 in visitor-inhabitant relationship and 1.894 in inhabitant-inhabitant relationship. Genotype B.I has an average RRA value of 1.446 or 1.495 in the visitor-inhabitant relationship and in the inhabitant-inhabitant relationship the average RRA value is 1.613 or 1.676. Genotype B.II has an average RRA value of 1.1016 or 1.034 in the visitor-inhabitant relationship and an RRA value of 0.895 or 0.924 in the inhabitant-inhabitant relationship. Genotype C has an average RRA value of 1.483 or 1.503 in the visitor-inhabitant relationship and an average RRA value of 1.679 or 1.762 in the inhabitant-inhabitant relationship. The range of average RRA values per OL is in all cases lower than 0.450, indicating a very low variance of those values and therefore substantiate the suggested genotypes.

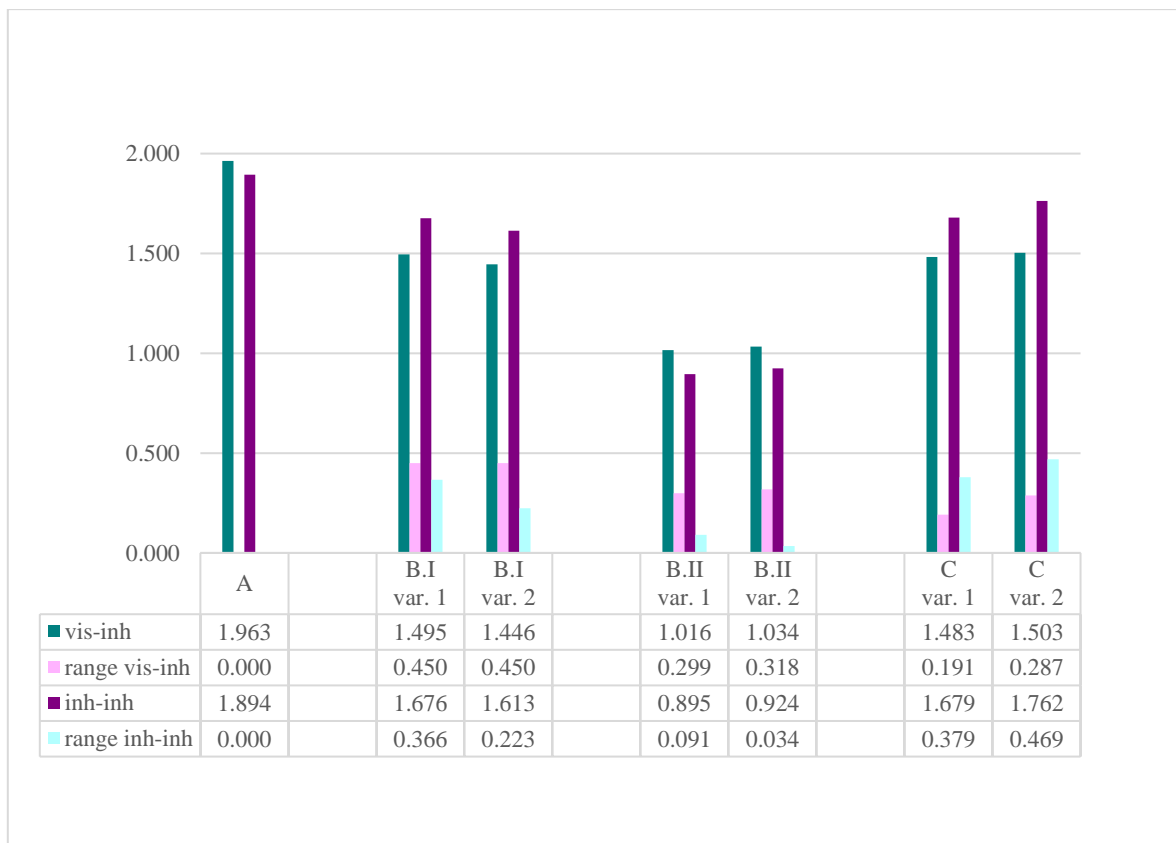


Figure 203: Average RRA and range per genotype (A, B.I, B.II and C), including variations for genotypes B.I, B.II and C

The next step, as in Section 1 and Section 2 of this chapter, is to calculate the difference factor H^* , which quantifies the variance of the range of RRA values, mentioned in the previous paragraph. For genotype A is H^* in the visitor-inhabitant relationship and in the inhabitant-inhabitant relationship 1.00, which results, as already stated, from the fact that there is only one phenotype analysed for this genotype. Genotype B.I has an H^* value of 0.98 in the visitor-inhabitant relationship and 0.99 or 1.00 in the inhabitant-inhabitant relationship. Both relationships show that there is almost none or no variance of RRA values. The H^* value for the visitor-inhabitant relationship of genotype B.II is 0.98 and in the inhabitant-inhabitant relationship 1.00, which also here indicates almost none or no variance at all. The difference factor H^* is much higher for this division of OL 3 into two genotypes than the factor calculated in Section 2 of this chapter for the same OL as a whole (0.90 in the visitor-inhabitant relationship and between 0.88 and 0.92 in the inhabitant-inhabitant relationship), therefore genotype B.I and B.II are far more likely. Genotype C has a difference factor H^* in the visitor-inhabitant relationship of 0.99 or 1.00 and in the inhabitant-inhabitant relationship of 0.99. The difference factor is for OL 2b and OL 2a, when separate, basically the same as when joined to one genotype, meaning that although each OL has almost none or no variance of RRA values, they keep having the same quantity of variance as one genotype.

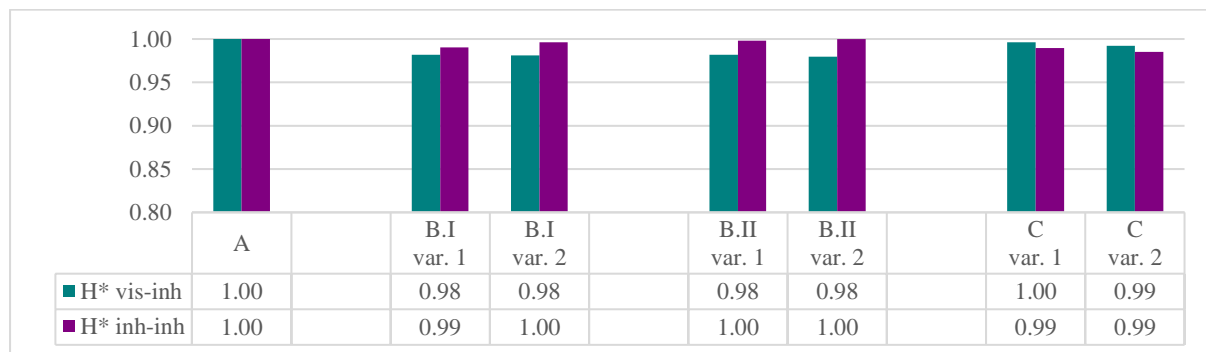


Figure 204: H^* per genotype, including variations for genotypes B.I, B.II and C; y-axis starts at 0.80

Overlapping all justified graphs (visitor-inhabitant relationship: Figure 205; inhabitant-inhabitant relationship: Figure 206) now shows a different colour scheme than in Section 2 of this chapter, Figure 199 and Figure 200, where there was a high quantity of paths that occur only once in all phenotypes per OL (in orange). Now the paths are mainly on the dark green side of the scale, indicating a higher occurrence of the same path. The lighter colours on the graphs show in this case a variation of a genotype.



Figure 205: Overlapping of all justified graphs per genotype (A, B.I, B.II, C), including variations for genotype B.I, B.II and C – from often represented path (dark green) to little represented path (yellow) (visitor-inhabitant)

CHAPTER VI

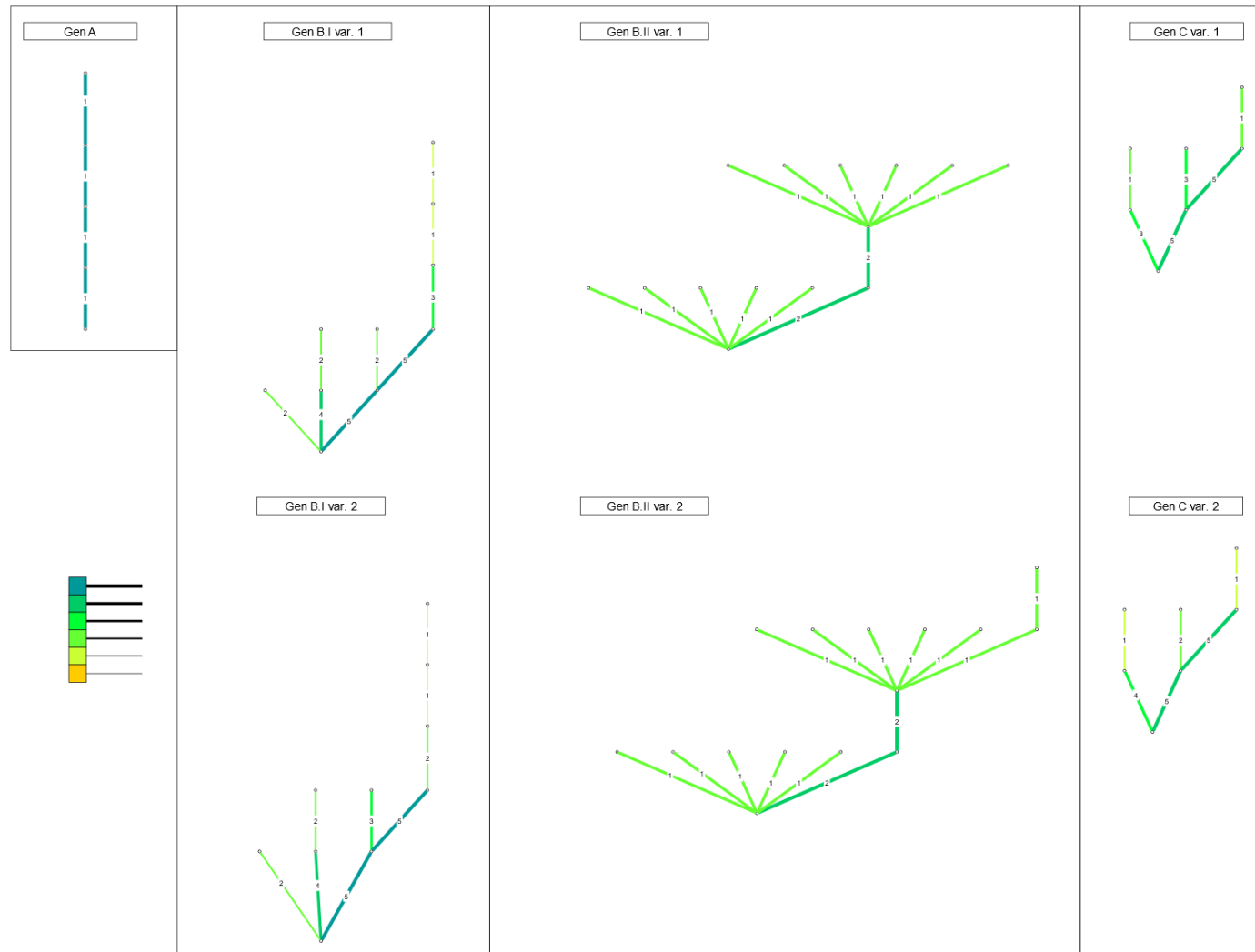


Figure 206: Overlapping of all justified graphs per genotype (A, B.I, B.II, C), including variations for genotype B.I, B.II and C – from often represented path (dark green) to little represented path (yellow) (inhabitant-inhabitant)

3.1 “Transpatial” links


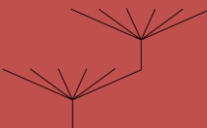


Transpatial links have been defined in Chapter III, Section 2.1 as a concept that indicates similarities among contemporary phenotypes. The author has criticised this by stating that the same genotype can also be cross-period phenomenon and therefore a search for **contemporary transpatial** links might not be possible to apply in such cases, as in this study, which would be genotype C.²⁹⁷ These **transpatial links** are termed **links** for the purpose of describing each genotype in this case study.

The results presented in the synchronic analysis in Chapter V, Section 1 focused on the characteristics of buildings – phenotypes – pertaining to the same OL and hence contemporary.²⁹⁸ This part will review these characteristics and summarise them anew considering the phenotypes based on the same spatial configuration – genotype – and hence not necessarily contemporary (Table 90).

²⁹⁷ For the discussion about transpatial links see Chapter III, Section 5.

²⁹⁸ As a side note: in this case the concept of *transpatial* links can be applied because only contemporary phenotypes were compared.

Table 90: Summary of main characteristics for each genotype (A, B.II, B.I and C, ordered by difference/similarity: white – no information; red – difference; green - similarity)

	Genotype A	Genotype B.II	Genotype B.I	Genotype C
OLs	OL 4	OL 3	OL 3	OL 2b and 2a
Period	Nabataean Period	Roman Period	Roman Period	Late Antique Period
Buildings	1	2	5	5
Walls	New	New, rebuilt, reused	New, rebuilt, reused	New, rebuilt, reused
Area				
- average total	270.70 m ²	89.45 – 89.90 m ²	140.96 m ²	121.86 m ²
- average usable	157.40 m ²	44.30 – 45.25 m ²	73.98 m ²	67.02 m ²
- usable of total	58%	50% – 51%	52%	55%
- smallest	270.70 m ²	60.50 m ²	115.40 m ²	107.90 m ²
- largest	270.70 m ²	114.70 m ² or 119.30 m ²	170.80 m ²	136.30 m ²
Rooms				
- number	5	8 – 9 or 10	5 – 7	4 – 5
- size	8.00 – 86.70 m ²	0.50 – 26.30 m ²	1.80 – 42.40 m ²	1.50 – 35.30 m ²
Average RRA				
- vis-inh	1.963	1.1016 – 1.034	1.446 – 1.495	1.483 – 1.503
- inh-inh	1.894	0.895 – 0.924	1.613 – 1.676	1.679 – 1.762
Path type	Linear	Multifurcation	Complex furcation	Simple furcation
				
H* (transpatial links)				
- vis-inh	1.00	0.98	0.98	0.99 – 1.00
- inh-inh	1.00	1.00	0.99 – 1.00	0.99
H* transitions (transtemporal links)				
- from genotype				
- vis-inh		genotype A 0.86	genotype A 0.96	genotype B.I 0.98
- inh-inh		0.86 – 0.88	0.99	0.99 genotype B.II 0.92 – 0.93 0.88 – 0.90

Genotype A defines the spatial configuration of Building F-b3 from OL 4, which dates to the Nabataean Period (Figure 207). This genotype is a labile case study because only one building has been uncovered from this period, yet it shows some very distinct characteristics making it different from the other analysed buildings. The walls of the building were built new on debris from older occupations. The building is distinctively large, about 271 m², in comparison with all other buildings from the other three genotypes (the next largest is Building F-b1 West from genotype B.I with a total area of about 171 m²). Building F-b3 has five rooms with a considerable range of sizes: the smallest measures merely 8.00 m², while the largest is

86.70 m². The building of genotype A is very asymmetric in both the visitor-inhabitant relationship and the inhabitant-inhabitant relationship. This is because all the rooms are aligned on a path, letting the individual move in the building but with absolutely no choice of movement. Nevertheless, the largest room in the building has, anyway, the highest control over adjacent spaces, followed by the most connected rooms and the entrance (the latter only in the visitor-inhabitant relationship). This leaves the smallest room in a position of less control and is segregated from the rest of the rooms.

To sum it up, since there is only one building of genotype A, there is no way possible to compare it with other buildings that might have a link to Building F-b3.



Figure 207: Plan of genotype A buildings – Nabatean Period (OL 4)

Genotype B.I defines the spatial configuration of Building E-b15, Building F-b1 West, Building F-b2, Building F-b4 and Building F-b12 from OL 3, which dates to the Roman Period (Figure 208). Building E-b15 has two variations analysed because it is not clear from where a room has been accessed, yet both variations show similar characteristics.²⁹⁹ Most of the walls of the buildings have been newly built, especially in the northern part of the residential area where almost no walls from OL 4 have been identified, other walls were rebuilt on the same location as in the preceding OL, especially the outer walls in the southern part where Building F-b3 from OL 4 stood. There is a difference of about 55 m² between the smallest (Building F-b4³⁰⁰) and the largest (Building F-b1 West) building from genotype B.I. Although the sizes of the buildings vary so much, their number of rooms varies merely between five and seven. In fact, a correlation coefficient of -0.09 shows that there is almost no relation between the usable area of the buildings and the quantity of rooms in them. Buildings of genotype B.I are all asymmetric in the visitor-inhabitant relationship, although some (Building E-b15 var. 1³⁰¹ and Building F-b12) are more than the others. This is caused by the two buildings having, after a bifurcation, a deeper path of aligned rooms in topological terms (the last room is up to six topological steps from the entrance). The most connected room holds the highest control, resulting from the fact that they are in the position from which the individual, moving in the building, can have up to four ways to choose, caused by a complex furcation. The movement in the buildings is therefore not restricted or pre-determined. In the inhabitant-inhabitant relationship the asymmetry within the buildings increases, caused by the occurrence of longer paths of aligned rooms, which puts their furthest room very distant from the opposite end of the building.

Finally, although some variations between the five buildings of genotype B.I exist, their link is still very strong.

²⁹⁹ See Chapter IV, Section 2.2.

³⁰⁰ In this case the size is an estimation, since part has not been excavated.

³⁰¹ Building E-b15 var. 2 would be more like the other buildings.

Genotype B.II defines the spatial configuration of Building F-b1 East and Building F-b7 from OL 3, which dates to the Roman Period (Figure 208). Building F-b1 East has two variations analysed because it is not clear if there is an additional room or not, yet both variations show similar characteristics.³⁰² The spatial configuration is so distinct from other buildings that the genotype itself is clear, although only two buildings were attributed to it. Most of the walls have been newly built, especially in the southeaster part of the residential area where no walls from OL 4 have been identified, other walls were rebuilt on the same location as in an older OL (OL 5), especially the outer walls in the southern part where Building F-b3 from OL 4 stood. Although with the same spatial configuration, the size of the buildings is different with one (Building F-b1 East) having the double the size of the other (Building F-b7). Still, the number of rooms is very similar, the smaller building having eight and the largest nine or ten. Since there are only two buildings of genotype B.II, a correlation coefficient cannot be calculated.³⁰³ Buildings of genotype B.II are generally very symmetric, caused by a multifurcation type of path centred around a possible courtyard. Besides the alley in front of Building F-b1 East, all rooms are symmetric, meaning that the rooms are integrated in the movement within the building and never too far from each other. The control is held by the courtyard that determines the distribution of connections to most of the rooms within the building. The only difference of movement between both buildings is that in entering Building F-b1 East a path of rooms is first accessed before reaching the courtyard, while in Building F-b7 the courtyard is accessed immediately from the alley.

To sum it up, the link between the two buildings of genotype B.II is very strong, resulting from the fact that there are only two phenotypes.

³⁰² See Chapter IV, Section 2.3.

³⁰³ The correlation coefficient will always be 1.00 or -1.00, indicating maybe a false correlation.



Figure 208: Plan of genotype B.I and genotype B.II buildings – Roman Period (OL 3)

Genotype C defines the spatial configuration of Building E-b11, Building F-b5, Building F-b8 (Phase 1), Building E-b7 and Building F-b8 (Phase 2) from OL 2b and OL 2a, both of which are two phases dated to the Late Antique Period (Figure 209). Building F-b5 has two variations analysed because it is not clear from where a room has been accessed, yet both variations show similar characteristics.³⁰⁴ Most of the walls from buildings of genotype C from OL 2b have been reused or rebuilt on the same location as in OL 3. The same happened in OL 2a, where most of the changes are new walls in the interior of the buildings. Only in the northern part were walls from OL 2b and OL 2a found. Buildings of genotype C have not got a large variation of building sizes, having a difference of about 28 m² between the smallest (Building E-b11) and largest (Building F-b5). The number of rooms is very similar for genotype C buildings, either four or five. A correlation coefficient of 0.20 shows here that there is a slight relation between the usable area of each building and their number of rooms. The buildings of genotype C are asymmetric. Building E-b7 is in the visitor-inhabitant relationship mathematically symmetric, this could however be reconsidered because the value is just under the limit defining symmetric and asymmetric. Since all the other buildings are asymmetric, it would be likely that Building E-b7 would be too. The buildings all have a simple furcation, leaving an individual, circulating in the building, with a choice. The most connected rooms hold the highest control, regulating choice of movement for the individual.

To sum it up, a strong link could be assessed for the buildings of genotype C, although they are from two different phases of occupation.

³⁰⁴ See Chapter IV, Section 3.3.



Figure 209: Plan of genotype C buildings – Late Antique Period (first phase: OL 2b on the top, second phase (OL 2a) on the bottom)

3.2 Transtemporal links

It is necessary, now that the genotypes have been defined, to understand the way they are connected. In Chapter III, Section 2.1 these connections have been defined by the concept of **transtemporal** links that are either **evolutionary** or **revolutionary** changes. Evolutionary changes are minor changes occurring within the existence of one genotype to another. A revolutionary change would then happen when a complete new set of rules for spatial configuration is used to determine the layout of the buildings. To define the transtemporal links the difference factor H^* for two chronologically superimposed genotypes is calculated (Figure 210): genotype A (OL 4) with genotype B.I and genotype B.II (both OL 3), genotype B.I and genotype B.II with genotype C (OL 2b + OL 2a).

There is a difference factor of 0.96 in the visitor-inhabitant relationship and 0.99 in the inhabitant-inhabitant relationship between genotype A and genotype B.I, which are genotypes from two consecutive OLs. This is only an apparent similarity, mainly for the inhabitant-inhabitant relationship, which results from the fact that the path of genotype B.I contains several furcations, while the spatial configuration of genotype A is a linear path. Although they are similar and seem to have a transtemporal link, it needs to be interpreted with caution: genotype A is based on one building and the type of paths of each genotype is different. It is an evolutionary change, from the mathematical perspective, but it seems more likely that they are revolutionary changes, since no other links could be established.³⁰⁵

Between genotype A and genotype B.II are not many similarities, as a difference factor of 0.86 in the visitor-inhabitant relationship and of 0.86 or 0.88 in the inhabitant-inhabitant relationship shows. This means a continuity could not be established, although they are from two consecutive OLs. The former has all spaces aligned on a path, as stated above, and the latter has distinct multifurcation as a spatial configuration. The transtemporal link is a revolutionary change, leading to a new set of rules and therefore a new genotype.

Genotype B.I and genotype C have a difference factor of 0.98 in the visitor-inhabitant relationship and 0.99 in the inhabitant-inhabitant relationship, which indicates that there are

³⁰⁵ As described in this chapter, Section 3.1.

similarities between them. While the former has a more complex furcation of up to four spaces linked to a central space, the latter is characterised by more simple furcation of up to three spaces linked to one. The spatial configuration is different, but a certain evolution between both can be identified, hence there is a minor transtemporal link with evolutionary changes.

Lastly, between genotype B.II and genotype C there are not many similarities: the difference factor in the visitor-inhabitant relationship is 0.92 or 0.93, while in the inhabitant-inhabitant relationship it is between 0.88 and 0.90. Here too the kind of furcation seems decisive because the former has a multifurcated path while the latter is composed of a simple furcation. The transtemporal link, can be considered here, as being a mix between evolutionary and revolutionary change, but a revolutionary change seems more likely.

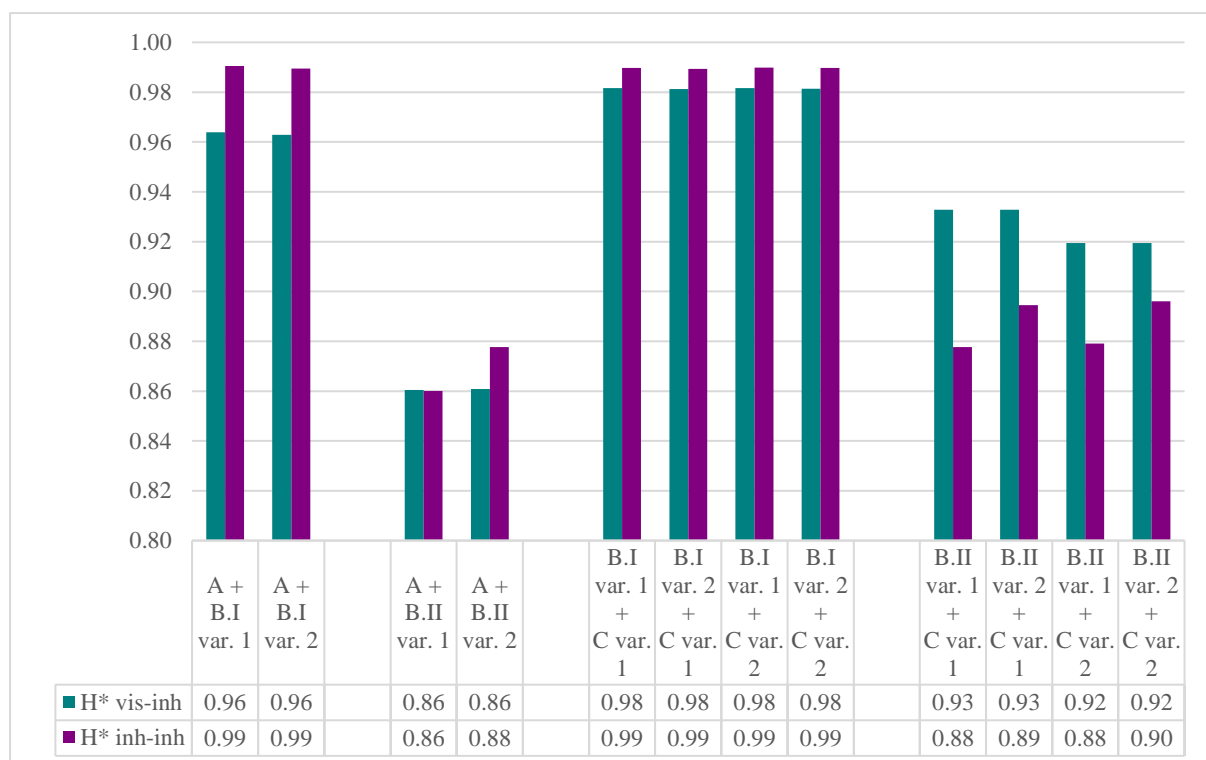


Figure 210: H* for the transition between two genotypes (Nabataean (A), Roman (B.I, B.II) and Late Antique (C) Periods)

3.3 Focus on cases of subsequent buildings

This part focuses in more detail on subsequent buildings from different OLs but built on the same location. These are: Building F-b3 from OL 4, succeeded by Building F-b1 East and Building F-b1 West from OL 3; Building F-b12 from OL 3, first succeeded by Building F-b8 (phase 1) from OL 2b and then Building F-b8 (phase 2) from OL 2a; Building E-b15 from OL 3, first succeeded by Building E-b11 (OL 2b) and then Building E-b7 from OL 2a.

After the disuse of Building F-b3 from OL 4, it was divided, in OL 3, into two buildings, Building F-b1 East and Building F-b1 West, separated by a common wall but with different entrances. Most of the outer walls from Building F-b3 have been reused or rebuilt on the same location. The interior layout has been built completely new and movement within the two new buildings is now different from the earlier building. Although both new buildings have a spatial configuration that follows a set of rules of different genotypes (Building F-b1 East is genotype B.II and Building F-b1 West is genotype B.I), still Building F-b3 was much more asymmetric. This is due to the rooms in Building F-b3 being aligned on a path, leaving a moving individual with no choice, while Building F-b1 East is based on a central courtyard that distributes the movement to smaller rooms and Building F-b1 West has two bifurcations that leaves the individual with a choice. Interestingly, the number of rooms increases in OL 3 although the buildings are half the size.

Building F-b8 (phase 1) from OL 2b was built on top of Building F-b12 from OL 3, reusing mainly the outer walls and the central thick internal wall running northeast-southwest. The location of the entrance is the same for both buildings. The interior layout has been simplified by reducing the quantity of rooms from five rooms and a staircase to an upper floor to four rooms. The spatial configuration of Building F-b8 follows the set of rules of genotype C, while the earlier building follows the rules of genotype B.I. Still, in both cases, there is only one bifurcation that gives the moving individual a choice. The new building is more integrated when accessed from the exterior (visitor-inhabitant relationship) but becomes completely asymmetric once moving inside the building. This results from the rooms of Building F-b8 in OL 2b all being aligned on a path. The spatial configuration does not change in Building F-b8 (phase 2) from OL 2a, although the access to one room (R2) is shifted. The visitor-inhabitant

relationship stays the same, but the inhabitant-inhabitant relationship changes to less asymmetric, on the border to symmetric.

The external walls of Building E-b11 from OL 2b were mostly maintained from the earlier Building E-b15 from OL 3, except for the east part of the building, reducing the size of the building. Although some interior walls were rebuilt on the same location, the spatial configuration still changes from following the rules of genotype B.I to genotype C. The main change is the addition of a staircase to another floor for which there has been no evidence in the earlier building. The access to one room of Building E-b15 (R1) is not clear and depending on which variation being used to compare, the comparison to Building F-b8 (both phases) has a different outcome. Building E-b7 from OL 2a has reused most of the walls from Building E-b11, but expanding the building again to the west, adding two rooms and probably not having a second floor.³⁰⁶ Movement within the building became more complex, changing from one bifurcation, when accessing the building, to two, nevertheless the spatial configuration, as a whole, is maintained. The interior circulation changes from a simple path aligning all the rooms to the existence of a bifurcation. Interestingly, variation 1 of Building E-b15 is more similar to Building E-b11, while variation 2 is the same as Building E-b7, opening the question of has the genotype B.I been correctly attributed to Building E-b15. Unfortunately, no evidence has been found to clarify this question for now.

³⁰⁶ There is no evidence of a second floor.

CHAPTER VII

ZOOMING OUT: IMPACT OF THE POLITICAL, SOCIAL AND ECONOMIC DYNAMICS ON THE USE OF SPACE

This chapter takes a closer look at the results and discussions of this research, by zooming out of the detailed study of the residential area as was done up until this point. The focus is on the overall significance they have in the context of the oasis of Tayma and NW Arabia during the Nabataean, Roman and Late Antique Periods.³⁰⁷

The first section presents the results, obtained through the space syntax analysis, embedding them in the context of the political and spatial development of the oasis of Tayma.

The second section is a presentation and comparison of residential areas in the same chronological frame (Nabataean, Roman and Late Antique Periods) from other sites in NW Arabia, namely Mada'in Saleh and Dumat al-Jandal. Since a space syntax analysis is not possible for these sites, it bases the comparison on the “additional information”³⁰⁸ available.

The third section consists of the concluding remarks, resulting from the complete research carried out in this study, by focussing on the political, social and economic dynamics that had an impact on the development of the residential area.

1 INTRASITE SPATIAL ANALYSIS

The oasis of Tayma underwent significant changes at the beginning of the period under analysis here. In the 4th/3rd century BCE the outer city wall ceased to be used, reducing the size of the oasis significantly to only encompass Compound E. The Kingdom of Lihyan, based in Dedan, the dominant power in the region and therefore over Tayma, is in a state of decline.³⁰⁹ The Nabataean Kingdom from the north is in the meantime extending its borders to the south reaching Hegra in the 1st century BCE.³¹⁰

The residential area at Tayma (Area E-South/F), evidenced in this context, has continuous occupation between the 4th century BCE and the 6th century CE (OL 4, OL 3, OL 2a and OL

³⁰⁷ The context has been presented and referenced in Chapter II.

³⁰⁸ “Additional information” as mentioned in Chapter III, Section 5.

³⁰⁹ Hoyland 2001, 68.

³¹⁰ Macdonald et al. 2015, 20.

2b). For the Nabataean Period (OL 4: 4th/3rd century BCE – 1st/2nd century CE) only two buildings could be identified: one in the south of the excavated area and a multi-storey building in the north. For the Roman Period (OL 3: 1st/2nd – 4th century CE) a total number of eleven buildings were uncovered, extending over the whole 1600 m² of the excavated area. The eight buildings from the two phases of the Late Antique Period (OL 2b and OL 2a: 4th – 6th century CE) seem to have condensed to the north side of the area, leaving the south side, except for scattered evidence, empty. The second phase (OL 2a) is further characterised by the construction of an 18000 m² large complex (Building E-b6) northwest of the residential area and a later enclosure wall that extends to the residential area and then continues on its southeast side. The residential area is abandoned, at the latest, during the 6th century CE.

Thus, the long and continuous usage of the residential area, spanning four levels of occupation, is evidenced by a total number of twenty-one buildings. The present research focussed on thirteen buildings of those occupation levels, given that not all the architectural remains attributed to a building had the necessary minimum information to carry out a space syntax analysis (boundaries and permeabilities). ¹⁴C dates, preliminary pottery analysis³¹¹ and the foundation levels of the walls provided evidence to date the single buildings, giving this research a solid chronological base to work from.

The reuse of primarily external but also internal walls in different occupation levels showed at first sight a more or less stable continuous occupation, which considering major supra-regional changes – the expansion of the Nabataean Kingdom until further south in the 1st century BCE, the later annexation by the Romans to integrate the *Provincia Arabia* in 106 CE and the leaving of the Romans after the 3rd century CE – would seem rather unusual if considering large buildings programs could have been carried out to establish political dominance, i.e. the Romans. Previously published studies on buildings about the residential area indicated a certain continuity in the technique of local production of pottery between the Nabataean and Roman Period.³¹² However, most of the pottery shapes in the Nabataean Period find their parallels towards Hegra instead of Petra, hence regional, while in the Roman Period parallels can mostly be found in the direction of the Levant: more standardised but still produced locally. This is interesting, because just as the buildings of the Roman occupation

³¹¹ See Tourtet and Weigel 2015; Eichmann et al. 2010, 131–32, 2011, 89–95; Hausleiter et al. 2019, 77–82. Furthermore, a PhD thesis in preparation by Francelin Tourtet at the Freie Universität Berlin: “Pottery at the oasis of Tayma (Kingdom of Saudi-Arabia): Chronological, typological and technological studies”.

³¹² Tourtet and Weigel 2015; Weigel 2019.

reuse the pre-existent situation, i.e. the reuse of walls, the pottery production place also did not change. However, the spatial configuration of these buildings, as the pottery shapes, have changed. It shows an adaptability to the given circumstances.

Although single studies of selected buildings provided some insight into the residential area,³¹³ the architectural evidence had not yet been systematically studied. And hence, the space syntax analysis carried out in this study uncovered the underlying differences and also similarities between buildings of the same period and with other periods by mathematising the conception and perception of space.

The space syntax analysis resulted in the determination of four different genotypes that set the rules for the spatial configuration of the buildings – phenotypes – attributed to them. In the Nabataean Period this is genotype A, characterised by a newly built large building with rooms aligned on a linear path and hence resulting in a high asymmetry. During the Roman Period two genotypes were determined with part of the walls reused from the Nabataean Period: genotype B.I, characterised by buildings that are composed of a complex furcation but still rather asymmetric; genotype B.II, characterised by multifurcating symmetric buildings with most of the rooms surrounding a large courtyard. In the Late Antique Period, although composed of two building phases, only one genotype was determined: genotype C is characterised by a simple furcation that is also asymmetric and probably evolving from genotype B.I from the Roman Period, while genotype B.II ceases to be built.

The function of single buildings could not be determined, based on this type of analysis, however different types of spaces could be determined based on labels attributed to them, in considering other information other than the archaeological material found in them: the exterior, the entrance room, the largest room, the smallest room, the room(s) with the most connections, the staircase, the upper floor, the rooms with food processing areas. The analysis of each of the group of spaces showed that they have similar spatial configurations within their group.

The similarity of this spatial behaviour, within groups, resulted in the proposition that there would be a functional differentiation between each labelled group. What exactly this function would be cannot be determined. Still, some statements can be made for the labelled

³¹³ Building E-b9, OL 4: Weigel 2019; Building F-b12, OL 3, and Building F-b8, OL 2a and 2b: Kohl, unpublished BA thesis.

space groups: the alley is segregated from the building's interior; the entrance has a high control over its surroundings but partially loses it when the door to the exterior is closed; the most connected room, especially the courtyards of genotype B.II in the Roman Period, have a very high control over the adjacent rooms; the staircases are segregated from the lower floor, but not as segregated as the upper floor. The food processing areas, since only two were determined, displayed, unfortunately, unclear results.

Interestingly, these patterns of spatial configuration, and with this their assumed functional differentiation, are fairly maintained across all three periods. This means that there is no genotypical trend of functional differentiation of spaces, as would be expected based on the fact that four genotypes with different spatial configurations were determined.

To sum up, a change in the use of space could be determined on a micro level of analysis (buildings) between the Nabataean Period and Roman Period, while between the Roman Period and Late Antique Period this change could only be shown, unequivocally determined, for one of the (geno-)types of buildings. On the nano level of analysis (spaces) there is a certain continuity as to the functional differentiation of the rooms. These two different patterns of behaviours are very interesting and shall be discussed further when the impact of political, social and economic dynamics is discussed.

2 INTERSITE SPATIAL ANALYSIS

The following section will investigate comparative evidence of architectural remains from residential areas within the same spatio-temporal frame as this research. Unfortunately, most of the sites have not enough data to make a comparative space syntax analysis, which means that the architectural remains lack the minimum necessary information needed, **boundaries** and **permeability**. Furthermore, many times research has been restricted to soundings and therefore buildings have not been excavated in their integrity. These parameters make it difficult to achieve a substantial comparative analysis. As has been mentioned repeatedly throughout this research, a space syntax analysis often falls short regarding the quantity and quality of the available data, a confrontation that also the present study encountered. This is where additional information plays a key role. So, the focus in this chapter will be on the information that is in fact available and can provide insight on how space has been perceived and conceived in residential areas in the region during the Nabataean, Roman

and Late Antique Periods. Mada'in Saleh (ancient Hegra) and Dumat al-Jandal (ancient Duma), both in the same NW Arabian context as Tayma, provided the comparative data needed (Figure 211).



Figure 211: Tayma and comparative sites Mada'in Saleh and Dumat al-Jandal circled (based on Macdonald 2004, fig. 16.1)

Hegra was the southernmost city and Duma the easternmost city of the Nabataean Kingdom. When integrated in the Roman *Provincia Arabia*, garrisons were stationed in both these cities.³¹⁴ In both cases they played a key role as strategic frontier posts³¹⁵ and therefore interesting comparative sites as examples of how dynamics would impact on oases in the periphery.

³¹⁴ Nehmé 2009, 38.

³¹⁵ Especially Hegra: Nehmé 2011b, 137.

2.1 Mada'in Saleh

Mada'in Saleh (coordinates: 26°47'05.14"N 37°57'10.33"E) is a NW Arabian oasis on the eastern side of the Hijaz Mountains and about 110 km southwest of Tayma. Excavations of the Saudi-French Archaeological Mission in Mada'in Saleh have been carried out since 2008 under the direction of Laïla Nehmé, François Villeneuve and Daifallah al-Talhi.³¹⁶ Three areas in the so-called residential area in Mada'in Saleh have comparative evidence (Figure 212): Area 1, Area 2 and Area 9.

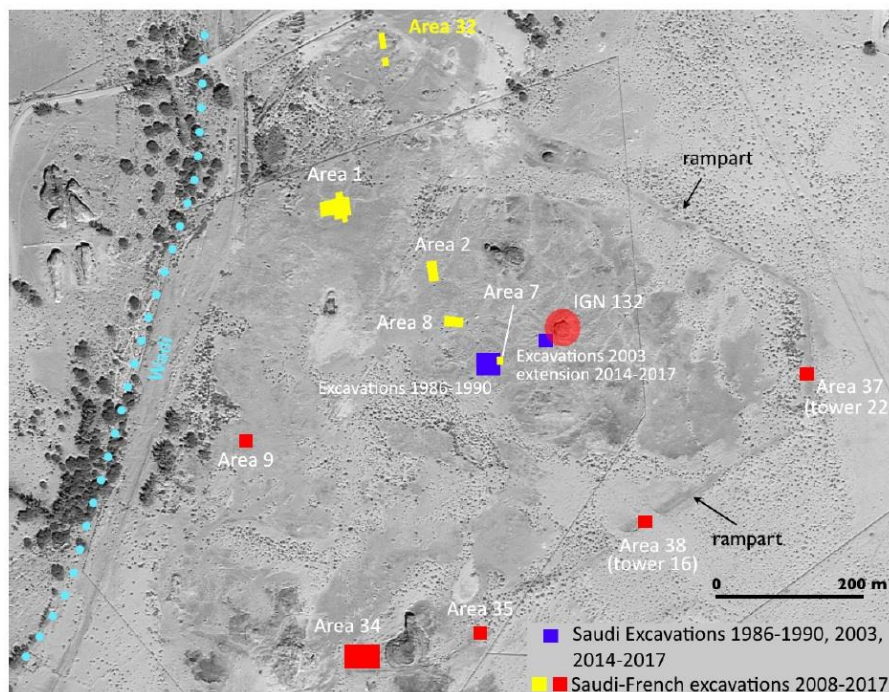


Figure 212: Mada'in Saleh. Location of the Areas excavated between 2008 and 2017, wadi on the E side (Nehmé 2018b, 6, fig. 1)

2.1.1 Area 1

Area 1 was excavated between 2008 and 2011.³¹⁷ Five of the six phases identified in the excavated area, Phase 2 to Phase 6, have comparable evidence, dating between the 2nd/1st c. BCE and the 7th c. CE (Table 91).³¹⁸

³¹⁶ See reports: Nehmé, Al Thali, and Villeneuve 2010a; Dentzer et al. 2002; Nehmé, Al Thali, and Villeneuve 2010b; Nehmé 2011a, 2015, 2016a, 2016b, 2018b, 2018a.

³¹⁷ See reports: Nehmé, Al Thali, and Villeneuve 2010a, 47–82; Nehmé, Villeneuve, and Al Thali 2011, 17–41; Nehmé, Al Thali, and Villeneuve 2010b, 19–46; Nehmé 2011a, 27–47.

³¹⁸ Nehmé 2011a, 32–33.

Table 91: Mada'in Saleh, Area 1, comparative phases (colours based on Tayma stratigraphy)

Phase	Dating	Events
Phase 6	6th - 7th c. CE	<ul style="list-style-type: none"> - contiguous housing - walls: reused, newly built - street - some rooms unroofed - courtyard - E lower than W (terrace system?) - end: abandonment (in situ objects)
Phase 5	4th - 5th c. CE	<ul style="list-style-type: none"> - street + two channels substituting Ph. 4 channel - E: change of circulation - new rooms
Phase 4	2nd - 3rd c. CE	<ul style="list-style-type: none"> - minor changes - walls: new added - floor level raised (mudbrick filling) - street + channel on top of Ph. 3 channel
Phase 3	mid - end 1st c. CE	<ul style="list-style-type: none"> - street + channel - walls: Ph. 1 and 2 destroyed/robbed, newly built - walls: undercoat for white coating - end: destruction layer
Phase 2	2nd/1st c. BCE - mid 1st c. CE	<ul style="list-style-type: none"> - various changes - street founded - walls: Ph. 1 partially destroyed, reused and newly built - postholes, kind of roofing - settling of mobile groups before permanent settlement? - Nabataean arrival?
Phase 1	3rd - 2nd c. BCE	<ul style="list-style-type: none"> - on virgin soil - no street - channel - solid mudbrick walls (pure clay) - roofing unclear - end: dumped ash layers in room

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

Phase 2, divided into three sub-phases (2a, 2b and 2c), (Figure 213) is dated to the 2nd/1st c. BCE to the mid – 1st c. CE.³¹⁹ Some walls from Phase 1 have been destroyed, while the walls from Phase 2 are reused from the previous phase or newly built.³²⁰ Two adjacent rooms (Room 10289, Room 10292) have been identified but no permeability between them.³²¹ Postholes have been found throughout the area, indicating a kind of roofing but unfortunately no further information as to the type could be made.³²² During the earliest subphase (2a) a street was founded north of the rooms.³²³ Phase 2 is interpreted as domestic environment, that might show, based on the postholes, the transition of mobile groups to a more permanent settlement, reflecting the Nabataean arrival to Mada'in Saleh, although this is still under discussion.³²⁴

Phase 3 (Figure 214) is dated to the mid- to end of the 1st c. CE.³²⁵ The walls from Phase 1 and Phase 2 have been robbed or destroyed in transition to this phase and consequently most of the walls have been newly built.³²⁶ Four adjacent rooms (Room 10294, Room 10295, Room 10296, Room 10300) could be identified but no permeability between them.³²⁷ During this phase Channel 10367 was added to the street.³²⁸ The north-western room, Room 10295, was interpreted as a possible storage room, because of the buried jars found in it.³²⁹ An undercoat and white plaster were identified in three rooms, while other walls featured only the undercoat.³³⁰ A destruction layer was found at the end of the usage of this phase.³³¹

Phase 4 (Figure 215) is dated to the 2nd to 3rd c. CE.³³² Only minor changes were made from the previous phase by building new walls and raising the level of the floors.³³³ Three rooms are used as in Phase 3 (Room 10294, Room 10295, Room 10296), while one has two

³¹⁹ Nehmé 2011a, 32–33.

³²⁰ Nehmé, Al Thali, and Villeneuve 2010b, 22–23.

³²¹ Room 10289 is described for Phase 1 (Nehmé, Al Thali, and Villeneuve 2010b, 22), the description of Phase 2 (Nehmé, Al Thali, and Villeneuve 2010b, 22–23) and the corresponding plan (Figure 213) indicate no change of rooms. For Room 10292 see Nehmé, Al Thali, and Villeneuve 2010b, 23.

³²² Nehmé, Al Thali, and Villeneuve 2010b, 23.

³²³ Nehmé 2011a, 32–33.

³²⁴ Nehmé, Al Thali, and Villeneuve 2010b, 23.

³²⁵ Nehmé 2011a, 32.

³²⁶ Nehmé, Al Thali, and Villeneuve 2010b, 24.

³²⁷ Nehmé, Al Thali, and Villeneuve 2010b, 24.

³²⁸ Nehmé 2011a, 32.

³²⁹ Nehmé, Al Thali, and Villeneuve 2010b, 24.

³³⁰ Nehmé, Al Thali, and Villeneuve 2010b, 25.

³³¹ Nehmé, Al Thali, and Villeneuve 2010b, 25.

³³² Nehmé 2011a, 32.

³³³ Nehmé, Al Thali, and Villeneuve 2010b, 25.

walls changed (Room 10301).³³⁴ The plan shows four more adjacent rooms to the eastern side, but they have not been named. A doorway was identified between Room 10294 and Room 10295 and possible doorways between Room 10296 and Room 10301, and Room 10301 and the room to the eastern side.³³⁵ Further permeability has not been identified. The street is still being used in this phase and Channel 10324 is built on top of the previous one.³³⁶

Phase 5 (Figure 216) is dated to the 4th to 5th c. CE.³³⁷ New walls were built in this phase, adding new rooms to the eastern side and changing the circulation.³³⁸ One room is used as in Phase 4 (Room 10301), while the other six rooms have walls changed (Room 10297, Room 10298, Room 10302, Room 10303, Room 10304, Room 10307).³³⁹ The plan shows another adjacent room to the south-eastern side, but they have not been named. A doorway was identified between Room 10302 and Room 10304 and between Room 10302 and Room 10301.³⁴⁰ A possible doorway was identified between Room 10303 and Room 10304,³⁴¹ and from Room 10307 to the east.³⁴² Further permeability has not been identified. The street keeps being used in this phase and two channels (both Channel 1033) were built substituting the previous one.³⁴³

Phase 6 (Figure 217) is dated to the 6th to 7th c. CE.³⁴⁴ This phase is particularly well represented in comparison with all the previous phases, because it has been excavated in area rather than in soundings.³⁴⁵ It is characterised by a system of “contiguous housing”.³⁴⁶ Although some walls are reused from the previous phase, almost all are newly built.³⁴⁷ The southern quarter from the perspective of the street is characterised by larger rooms that become smaller the further south.³⁴⁸ In total 14 rooms (Room 10110, Room 10111, Room 10112, Room

³³⁴ Nehmé, Al Thali, and Villeneuve 2010b, 25.

³³⁵ Nehmé, Al Thali, and Villeneuve 2010b, 25 and Figure 215.

³³⁶ Nehmé 2011a, 32.

³³⁷ Nehmé 2011a, 32.

³³⁸ Nehmé, Al Thali, and Villeneuve 2010b, 26.

³³⁹ Nehmé, Al Thali, and Villeneuve 2010b, 26.

³⁴⁰ Nehmé, Al Thali, and Villeneuve 2010b, 26.

³⁴¹ Nehmé, Al Thali, and Villeneuve 2010b, 26.

³⁴² Nehmé, Al Thali, and Villeneuve 2010b, 26.

³⁴³ Nehmé 2011a, 32.

³⁴⁴ Nehmé, Al Thali, and Villeneuve 2010b, 21.

³⁴⁵ Nehmé 2011a, 32.

³⁴⁶ Nehmé, Al Thali, and Villeneuve 2010b, 27.

³⁴⁷ Nehmé, Al Thali, and Villeneuve 2010b, 27.

³⁴⁸ Charloux et al. 2018, 51.

CHAPTER VII

10113, Room 10114, Room 10115, Room 10136, Room 10185, Room 10187, Room 10188, Room 10189, Room 10190, Room 10305, Room 10369) and a courtyard (Courtyard 10184) were identified.³⁴⁹ Doorways have been identified from Room 10190 to the west, between Room 10113 and Room 10112, between Room 10113 and Room 10110, between Room 10110 and Room 10111, between Room 10188 and Room 10187, between Room 10136 and Room 10185, between Room 10185 and Room 10305, between Room 101305 and Courtyard 10184, from the Courtyard 10184 to the street on the east and to a space to the west.³⁵⁰ Two further doorways with thresholds have been identified on the north side of the street to the Northern quarter.³⁵¹ Further permeability has not been identified. The street is still being used in this phase.³⁵² The area is abandoned, at the latest, in the second half of the 7th c. CE.³⁵³

³⁴⁹ Nehmé, Al Thali, and Villeneuve 2010a, 53–55; Nehmé, Villeneuve, and Al Thali 2011, 20–24; Nehmé, Al Thali, and Villeneuve 2010b, 27 and Figure 217.

³⁵⁰ Nehmé, Al Thali, and Villeneuve 2010a, 53–55; Nehmé, Villeneuve, and Al Thali 2011, 20–24; Nehmé, Al Thali, and Villeneuve 2010b, 27 and Figure 217.

³⁵¹ Nehmé 2011a, 32.

³⁵² Nehmé 2011a, 32.

³⁵³ Charloux et al. 2018, 62.

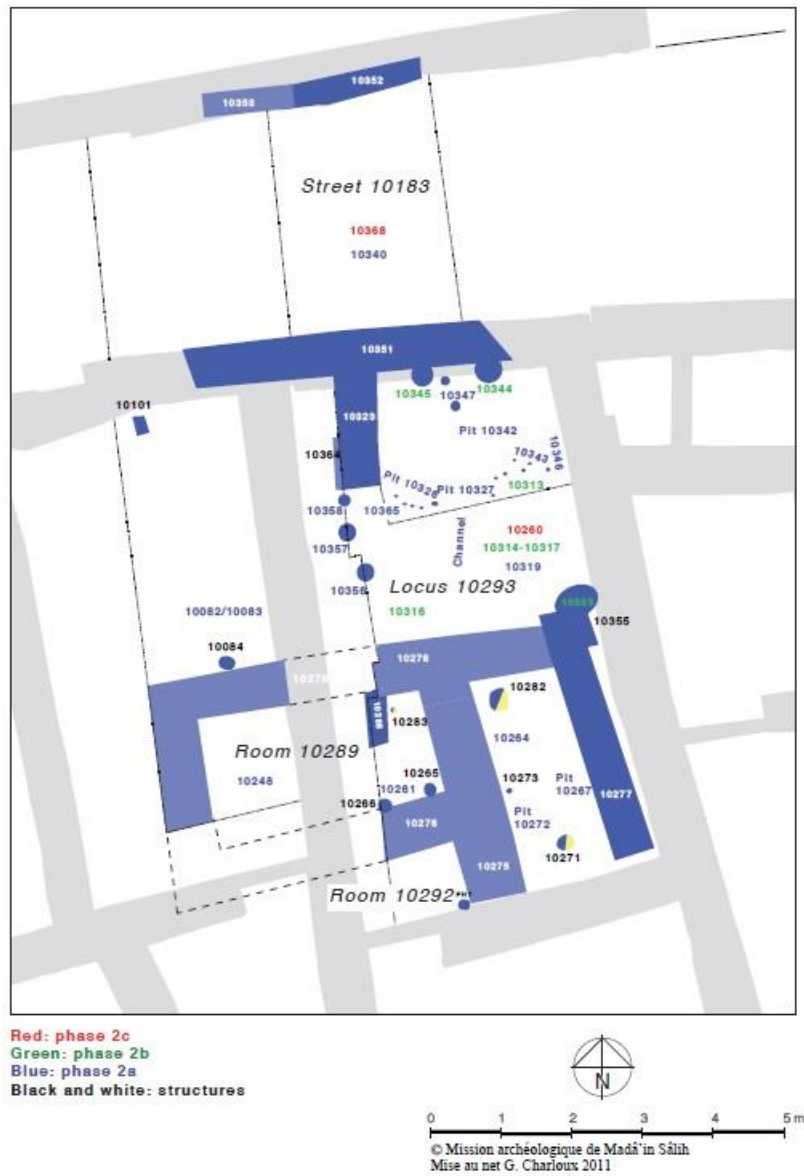


Figure 213: Mada'in Saleh. Area 1, Phase 2 (Nehmé 2011a, 42, fig. 13)

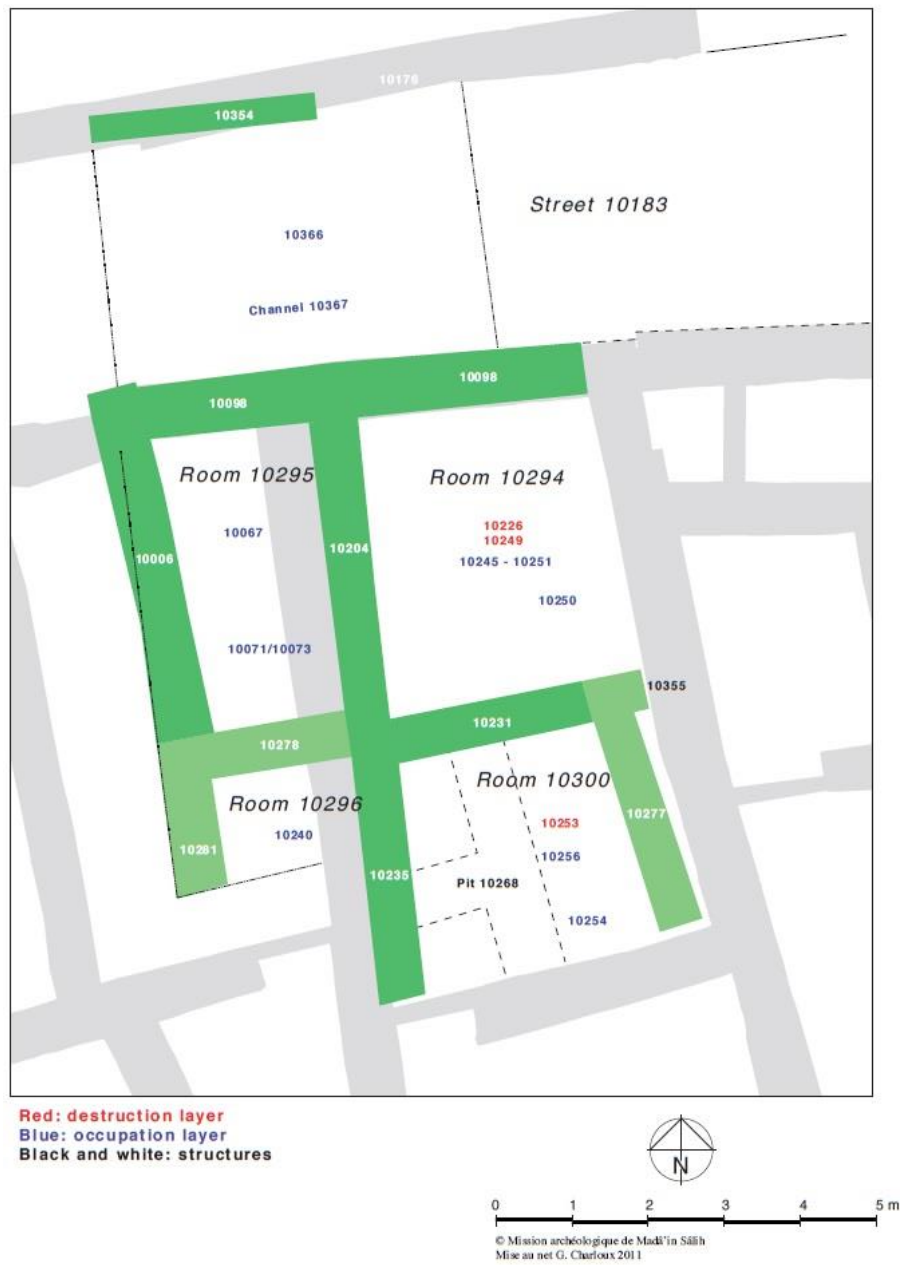


Figure 214: Mada'in Saleh. Area 1, Phase 3 (Nehmé 2011a, 43, fig. 14)

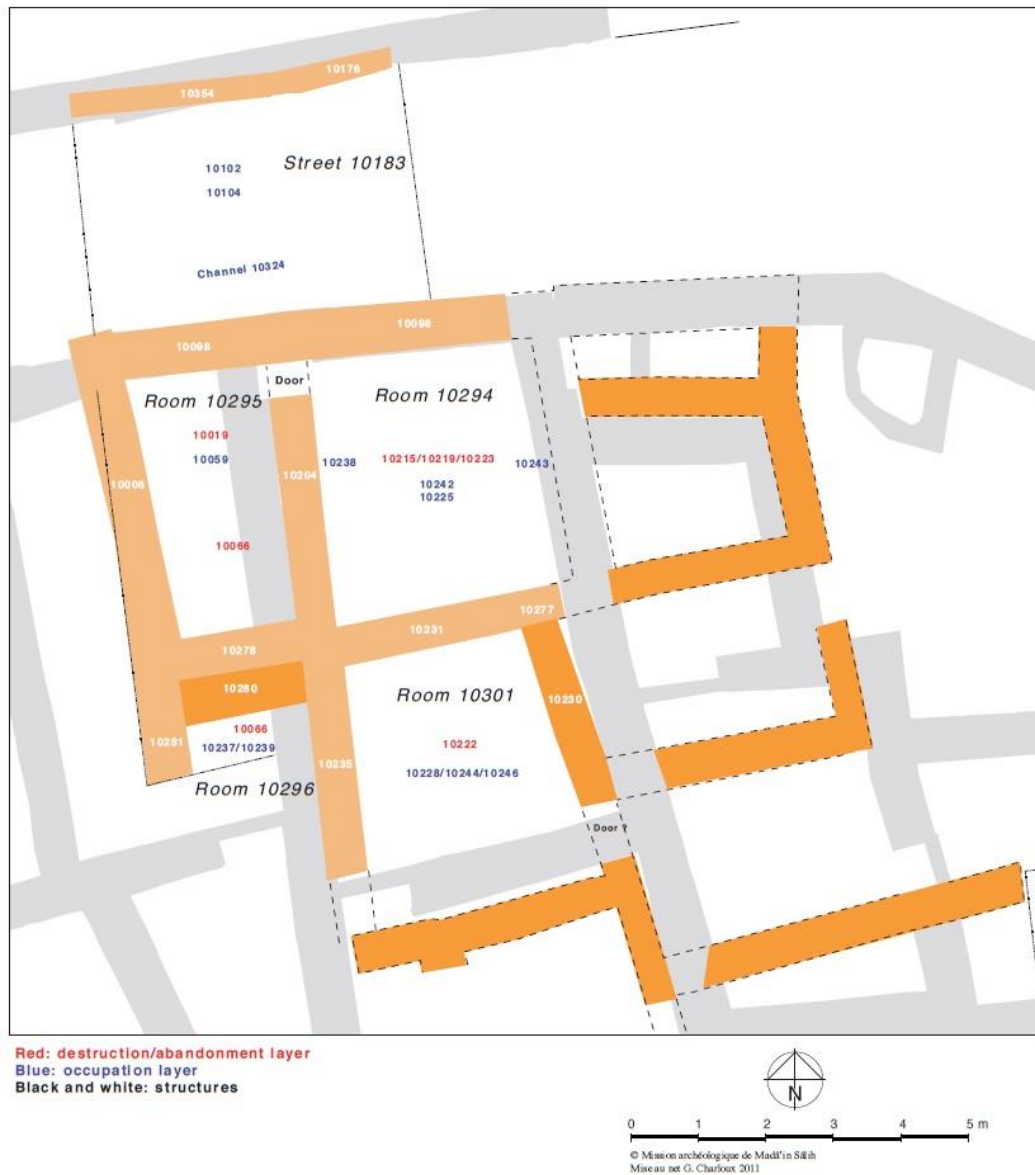


Figure 215: Mada'in Saleh. Area 1, Phase 4 (Nehmé 2011a, 44, fig. 15)

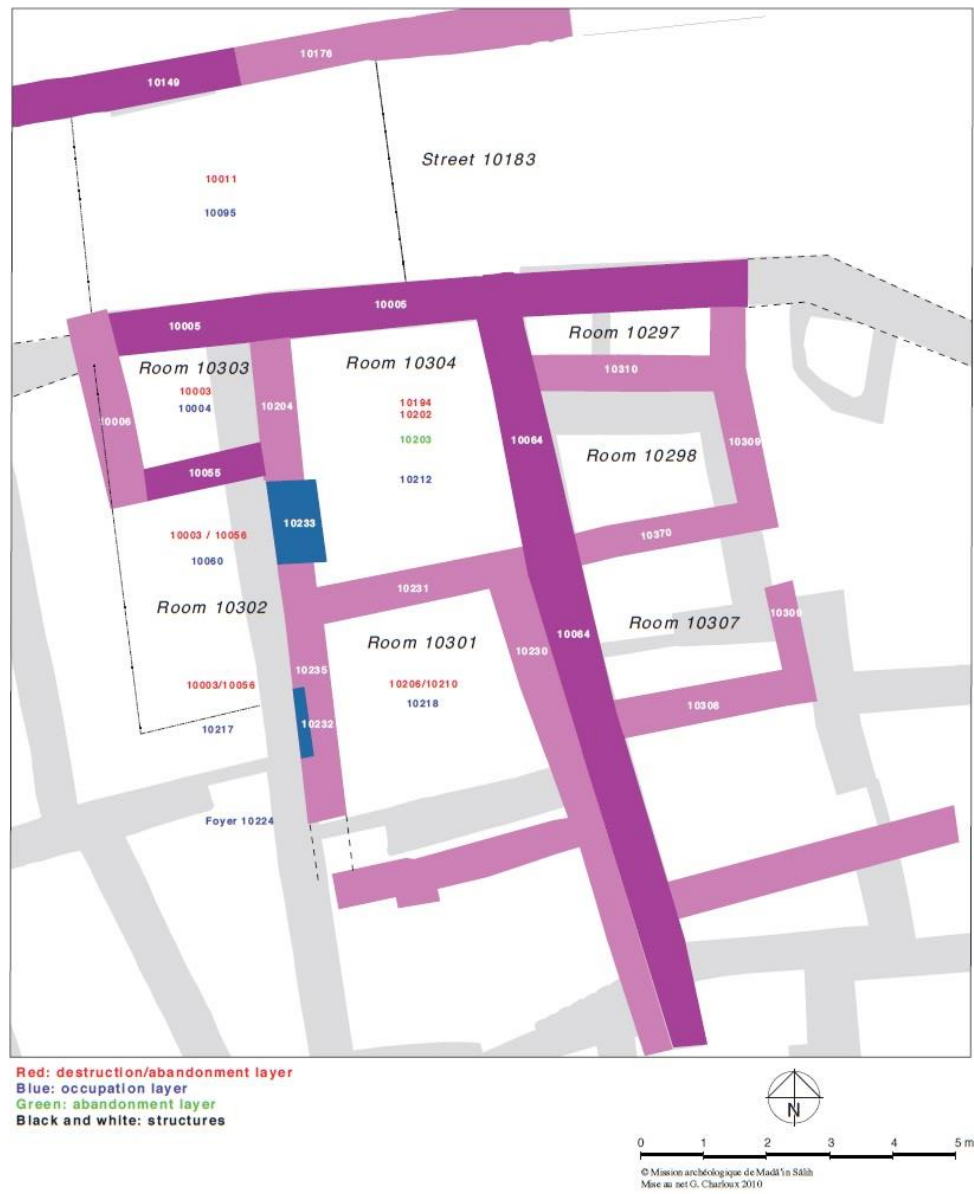


Figure 216: Mada'in Saleh. Area 1, Phase 5 (Nehmé 2011a, 45, fig. 16)

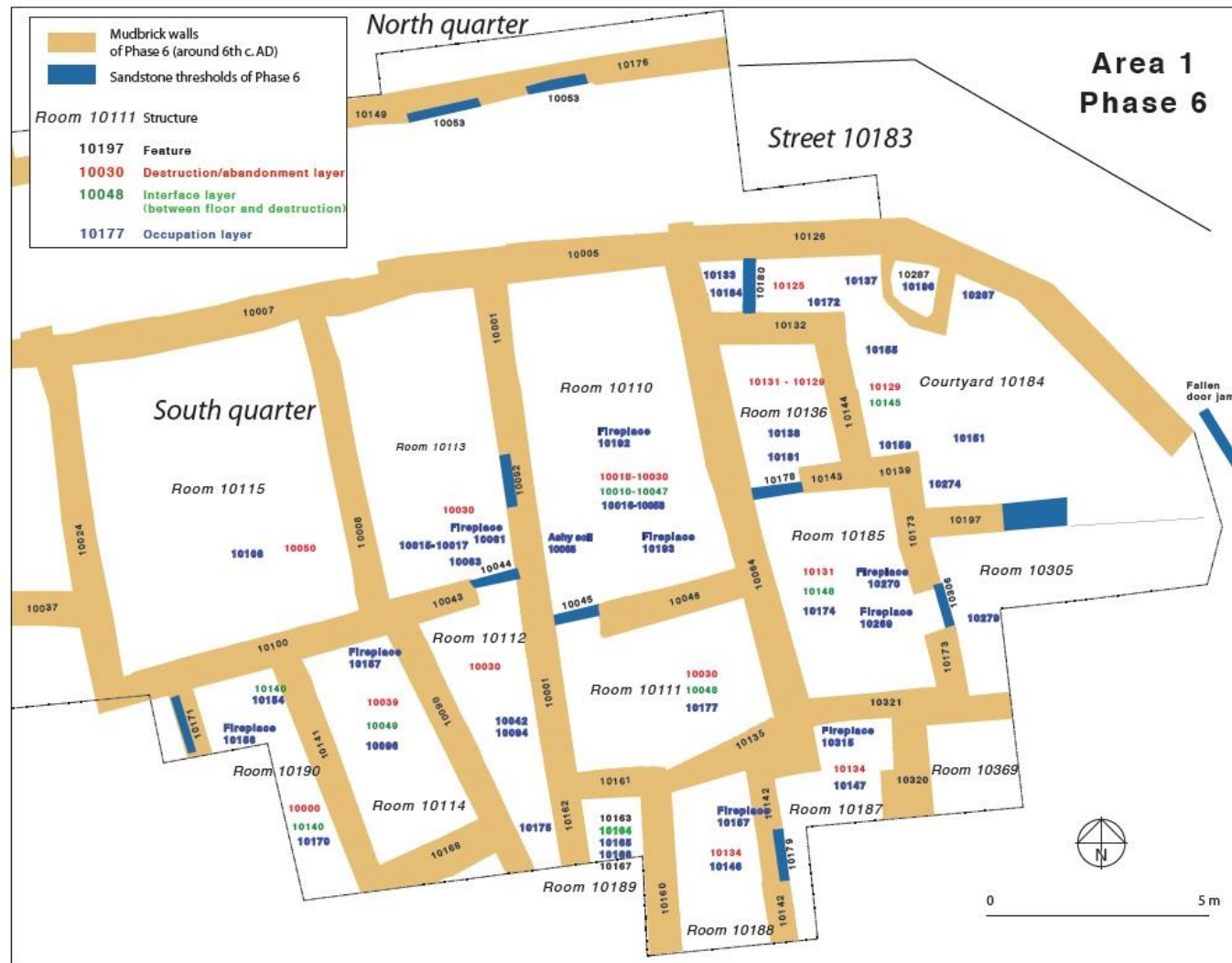


Figure 217: Mada'in Saleh. Area 1, Phase 6 (Nehmé 2011a, 35, fig. 3)

2.1.2 Area 2

Area 2 (Figure 218) was excavated between 2008 and 2011.³⁵⁴ All four identified phases, in the excavated area, Phase 1 to Phase 4, have comparable evidence, dating between the late 1st c. BCE and the 3rd/early 4th c. CE (Table 92).³⁵⁵ Though not completely excavated, the description of the location of features is described according to trench limits and not building limits.



Figure 218: Mada'in Saleh. Area 2 (Rohmer and Fiema 2016, fig. 9)

³⁵⁴ See reports: Nehmé, Al Thali, and Villeneuve 2010a, 83–150; Nehmé, Villeneuve, and Al Thali 2011, 43–123; Nehmé, Al Thali, and Villeneuve 2010b, 47–102; Nehmé 2011a, 49–76.

³⁵⁵ Nehmé 2011a, 59–62.

Table 92: Mada'in Saleh, Area 2, comparative phases (colours based on Tayma stratigraphy)

Phase	Dating	Events
Phase 5	6th - 7th c. CE?	- hearths, junk pits - layer of disuse
Phase 4	3rd/ early 4th c. CE	- reoccupation N sector: minor changes - S sector abandoned - disuse
Phase 3	2nd/ early 3rd c. CE	- minor changes - S sector mostly disused: basin, oven - N sector changes: courtyard in the E - stone paved room - channel to street used, then abandoned - street not divided, hard-beaten surface - end: destruction and disuse, flooding
Phase 2	1st c. CE	- levelling and reorganisation N sector - wall reinforcements S sector - rooms smaller - courtyard larger - channel to street - street divided? - end: some destruction, flooding?
Phase 1	late 1st c. BCE - early 1st c. CE	- first occupation - more or less orthogonal - N + S sector - street dividing sectors - courtyard - staircase (upper floor?) - Nabataean building program? - end: walls partially levelled

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

Phase 1 (Figure 219) is dated to the late 1st c. BCE – early 1st c. CE.³⁵⁶ The first building activities take place in this period and are considered being a Nabataean building program based on the Nabataean pottery, coins and funerary architecture.³⁵⁷ A street divides the area into a northern and a southern sector.³⁵⁸ The walls are all made of mudbrick.³⁵⁹ In the northern sector at least three rooms were identified on the east side, a possible room at the centre and a courtyard on the northwest side.³⁶⁰ A doorway was identified between the courtyard and the street, and between the middle east room and the southern east room; further permeability could not be recognised. The southern sector is composed of at least three rooms.³⁶¹ The room on the east side might have had a staircase (20028) to an upper floor.³⁶² No permeability was identified.

Phase 2 (Figure 220) is dated to the 1st c. CE.³⁶³ This phase is characterised by a reorganisation of the northern sector and by wall reinforcements and the construction of stone walls with possible mudbrick superstructures in the southern sector.³⁶⁴ The Phase 2 walls in the northwest part of the northern sector are razed to build stone walls that form a larger enclosed area, probably a courtyard, than the previous.³⁶⁵ The east part of that sector is now composed of at least seven rooms: three at the centre from the north to the street and four on the east part, also from the north to the street.³⁶⁶ The courtyard is possibly connected to the west side of the area and connected to the room on its east side, followed by possibly another passage to the room further east. The connection between the central east room and the east room by the street might have still been in use.³⁶⁷ Rooms are generally smaller, while the courtyard has been enlarged. A channel was uncovered, leading from the central northern room to the street.³⁶⁸ It is not clear, in this phase, if the street is divided into two segments by a large wall running from the south of the southern sector against the southern wall of the northern sector.³⁶⁹ The southern

³⁵⁶ Rohmer and Fiema 2016, fig. 10. More precisely, it is later than 9 BCE because of the discovery of a coin from the reign of Aretas IV (Nehmé 2011a, 52, 59).

³⁵⁷ Rohmer and Fiema 2016, 294.

³⁵⁸ Rohmer and Fiema 2016, 289.

³⁵⁹ Rohmer and Fiema 2016, 289.

³⁶⁰ Rohmer and Fiema 2016, 292 and Figure 219.

³⁶¹ Nehmé, Al Thali, and Villeneuve 2010b, 93.

³⁶² Nehmé, Al Thali, and Villeneuve 2010b, 93.

³⁶³ Nehmé 2011a, 60.

³⁶⁴ Nehmé, Al Thali, and Villeneuve 2010b, 50, 94–95.

³⁶⁵ Rohmer and Fiema 2016, 292.

³⁶⁶ Nehmé, Al Thali, and Villeneuve 2010b, 52, 69 - Fig. 6.

³⁶⁷ Nehmé, Al Thali, and Villeneuve 2010b, 50–54.

³⁶⁸ Nehmé, Al Thali, and Villeneuve 2010b, 51.

³⁶⁹ Nehmé, Al Thali, and Villeneuve 2010b, 95.

sector almost does not change, besides the reinforcement of the walls on the northeast part.³⁷⁰ It is possible that at the end of this phase there had been some kind of flooding episode, destroying parts of the area.³⁷¹

Phase 3 (Figure 221) is dated to the 2nd/early 3rd c. CE.³⁷² In this phase minor changes took place in the northern sector, while the southern is largely disused.³⁷³ There are now at least seven rooms and one courtyard.³⁷⁴ The courtyard from Phase 2 in the northwest is divided into two rooms. The central room in the north is paved with stones and the channel is only used at the beginning of Phase 3.³⁷⁵ On the northeast side a courtyard is created with a smaller room to its south side. An L-shaped room is now besides the street on the east side. The passage in the northwest part, from the former courtyard, is now without a context to the east. A passage was found from the western room of the former courtyard to the west and another passage was found from the eastern room of the former courtyard to the north. Passages have also been unearthed from the paved room to the east courtyard and to the room on its south side. The courtyard has further passages to the east and to the roofed room to the south. The two rooms along the street on the east side of the area are also connected by a passage. The street in Phase 3 not divided as had been assumed in Phase 2, this is evidenced by the construction of a wall parallel to the street (20003).³⁷⁶ The southern sector is mostly levelled but some single evidence, such as a monolithic basin and an oven, has been found.³⁷⁷ At the end of this phase evidence of destruction and disuse have been found, possibly associated to another flooding of the area.³⁷⁸

Phase 4 (Figure 222) is dated to the 3rd/early 4th c. CE.³⁷⁹ This phase is characterised by some reoccupation of the northern sector after the accumulation of a layer of disuse of about 15 to 20 cm and a complete abandonment of the southern sector.³⁸⁰ The formerly two rooms

³⁷⁰ Rohmer and Fiema 2016, 289, 292.

³⁷¹ Rohmer and Fiema 2016, 292.

³⁷² Nehmé 2011a, 60–61.

³⁷³ Nehmé, Al Thali, and Villeneuve 2010b, 56, 95–96.

³⁷⁴ Nehmé, Al Thali, and Villeneuve 2010b, 56–57.

³⁷⁵ Nehmé, Al Thali, and Villeneuve 2010b, 56.

³⁷⁶ Nehmé, Al Thali, and Villeneuve 2010b, 96–97.

³⁷⁷ Nehmé, Al Thali, and Villeneuve 2010b, 95–97.

³⁷⁸ Nehmé, Al Thali, and Villeneuve 2010b, 97.

³⁷⁹ Nehmé 2011a, 61–62.

³⁸⁰ Nehmé, Al Thali, and Villeneuve 2010b, 57, 97; Nehmé 2011a, 54.

on the west side of the northern sector, divided in Phase 3 from the Phase 2 courtyard, are now again joined and the three central rooms seem not to have any walls dividing them. The east side does not change layout. Passages are maintained as in Phase 3, except for the northern passage of the now joined rooms on the west side of the area. At the end of this phase a 25 cm thick layer of disuse was identified and only some hearths and junk pits of the Late Byzantine/Early Islamic Periods have been found (Phase 5).³⁸¹

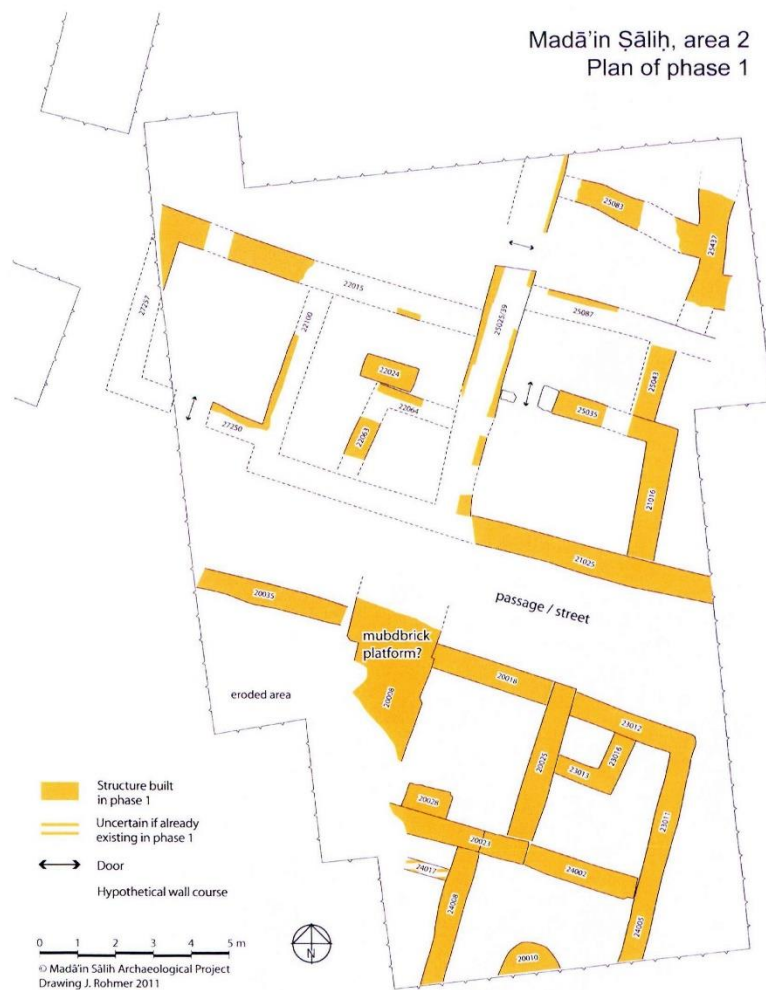


Figure 219: Mada'in Saleh. Area 2, Phase 1 (Rohmer and Fiema 2016, fig. 10)

³⁸¹ Nehmé 2011a, 54–55.

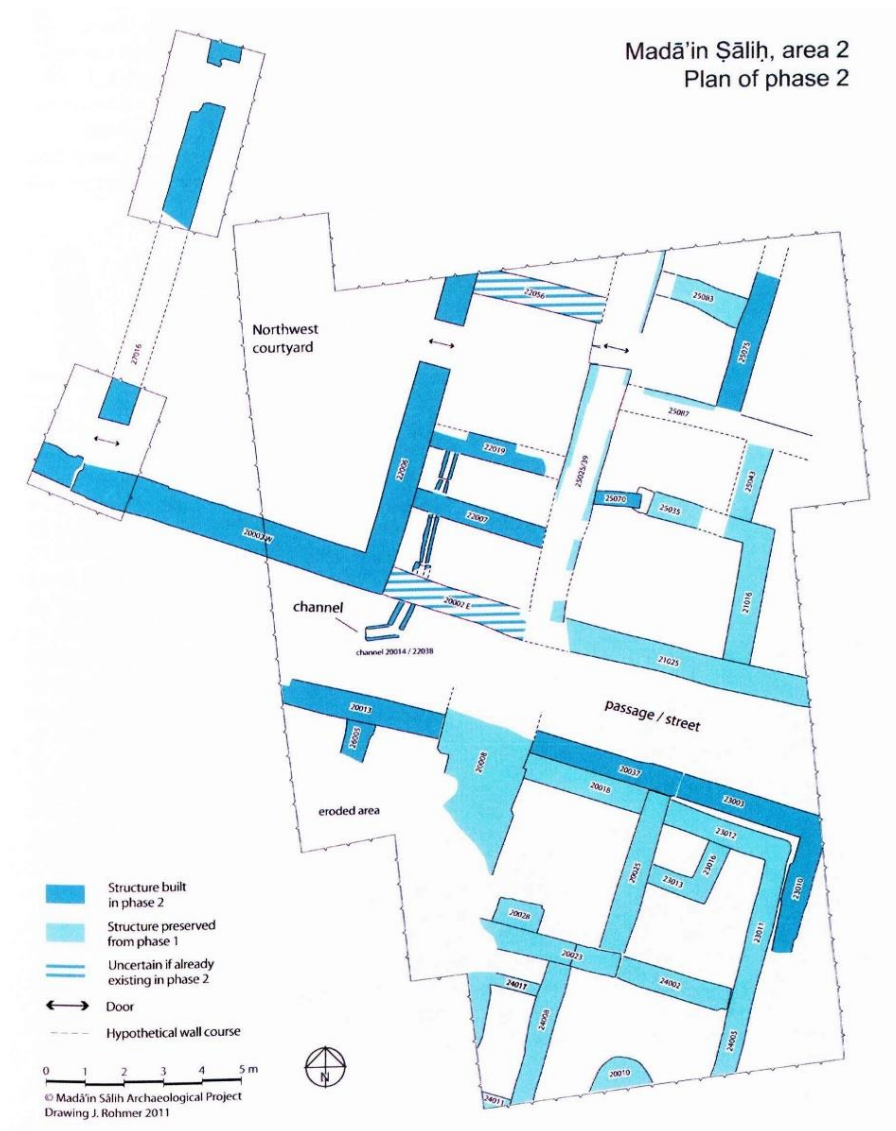


Figure 220: Mada'in Saleh. Area 2, Phase 2 (Rohmer and Fiema 2016, fig. 11)

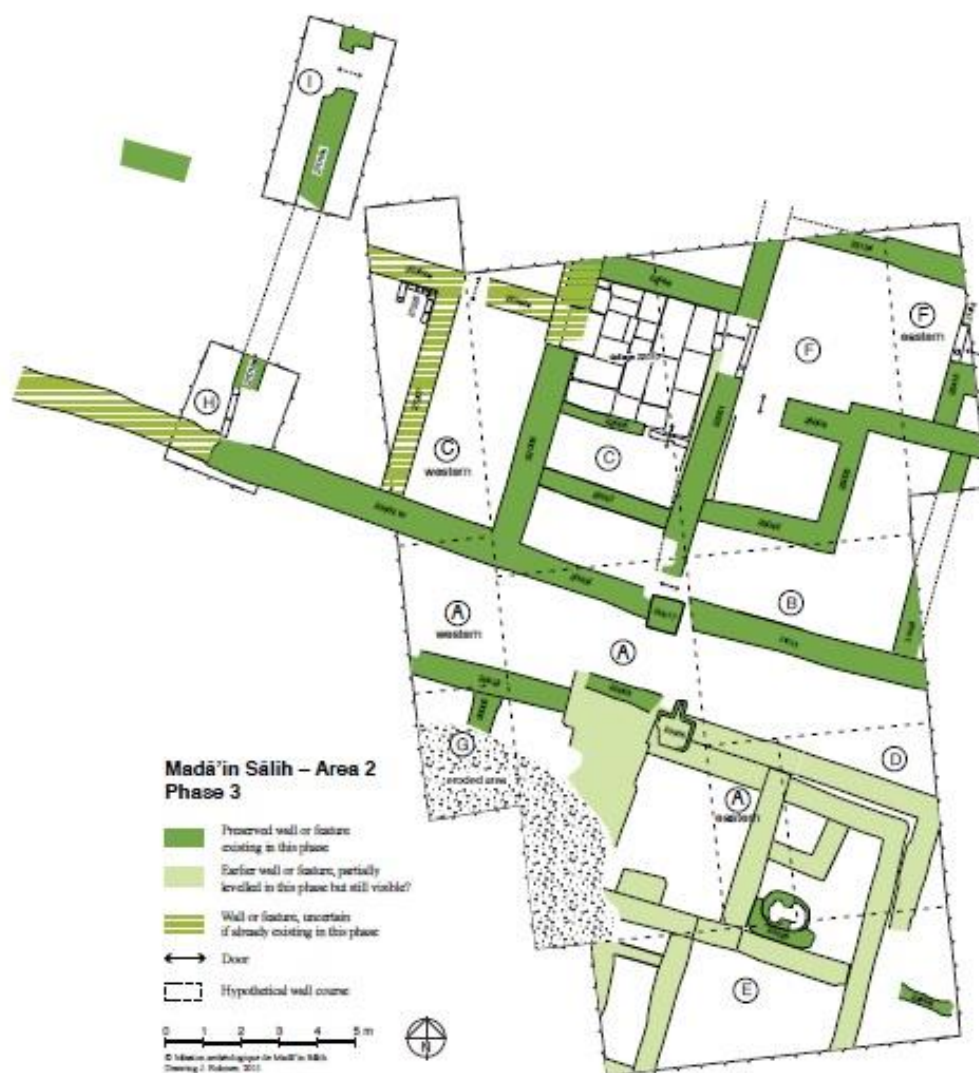


Figure 221: Mada'in Saleh. Area 2, Phase 3 (Nehmé 2011a, 73, fig. 31)

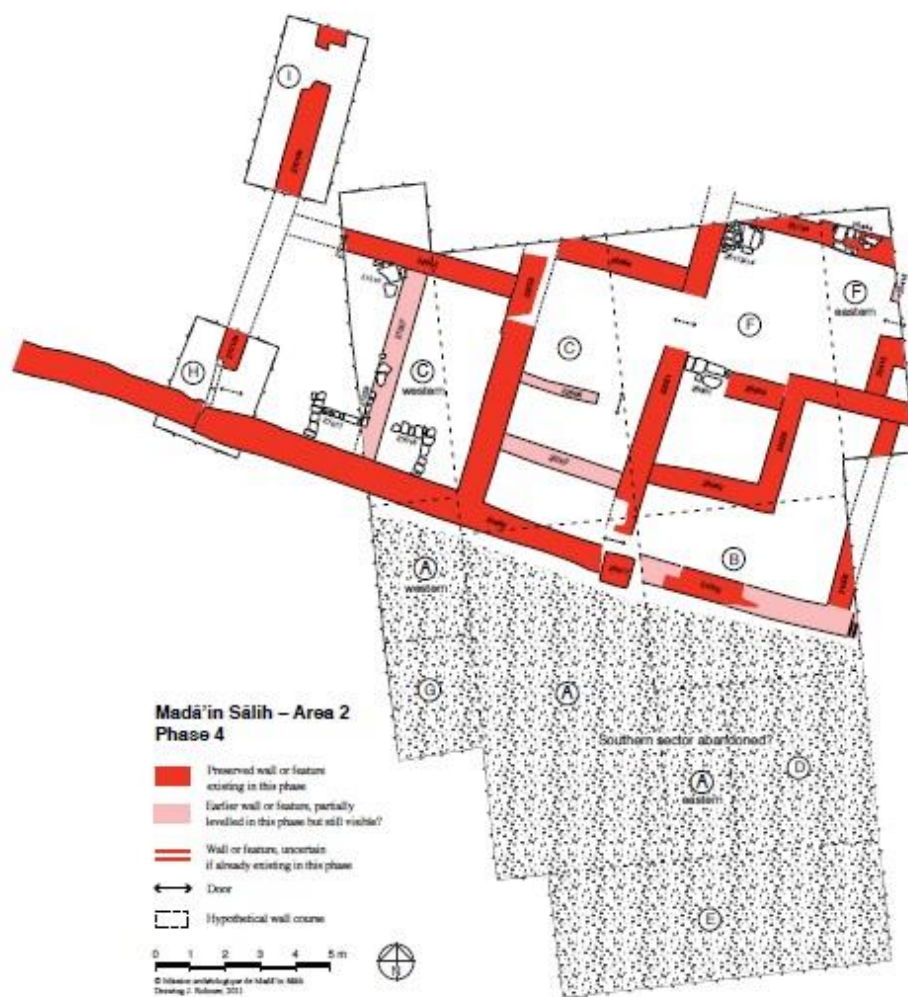


Figure 222: Mada'in Saleh. Area 2, Phase 4 (Nehmé 2011a, 75, fig. 34)

2.1.3 Area 9

Area 9 (Figure 223) has been excavated in 2010, 2011, 2014 and 2017.³⁸² Comparable evidence is: eight of the eleven phases identified in trench A and trench B, Phase 3 to Phase 10, dating between the 2nd/1st c. BCE and the 4th c. CE³⁸³; all three identified phases in trench C, Phase C1 to Phase C3, dating between (2nd/) late 1st c. BCE and the 4th c. CE³⁸⁴; all four identified phases in trench D, Phase D1 to Phase D4, dating between the 2nd/1st c. BCE and the (3rd/) 4th c. CE.³⁸⁵



Figure 223: Mada'in Saleh. Area 9 (Nehmé 2018b, 161, fig. 1)

³⁸² See reports: Nehmé, Al Thali, and Villeneuve 2010b, 189–215; Nehmé 2011a, 165–222, 2015, 125–40, 2018b, 161–79.

³⁸³ Rohmer and Fiema 2016, 286–87.

³⁸⁴ Nehmé 2018b, 179 - Table 1.

³⁸⁵ Nehmé 2018b, 179 - Table 1.

Trench A and trench B

In trench A and trench B (Figure 224), Phase 3 to Phase 10 are dated between the 2nd/1st c. BCE and the 4th c. CE (Table 93).

In trench A and trench B, Phase 3 to Phase 5 are dated to the 2nd/1st c. BCE.³⁸⁶ These phases are characterised by dumping operation onto older Phase 2 (4th/3rd c. BCE) mudbrick walls with probable postholes to hold a wooden structure.³⁸⁷

Phase 6 is dated between the late 1st c. BCE to the first half of the 1st c. CE.³⁸⁸ Trench A is not used during this phase, while in trench B some occupation occurred.³⁸⁹

Phase 7 is dated to the 1st c. CE.³⁹⁰ The first “well-defined” occupation occurs in this phase, characterised by a “lower complex”.³⁹¹ Western trench A is composed of a rectangular space with a doorway on the northern wall and a drainage system; it is interpreted as probably being domestic.³⁹² In eastern trench B two stone walls were uncovered that shape a corner of a large building with a monumental doorway; The “lower complex” is interpreted as probably being cultic on the east side and domestic on the west side.³⁹³

Phase 8 is dated to the end of the 1st c. CE/beginning of the 2nd c. CE.³⁹⁴ Flooding destroyed the “lower complex” during this phase.³⁹⁵

Phase 9 and Phase 10 are dated up until the 4th c. CE.³⁹⁶ During this phase an “upper complex” is built.³⁹⁷ A room was identified that maintained the northern walls of the “lower complex”, while the eastern and southern walls were newly built.³⁹⁸ The doorway of the “lower complex” in the northern walls has been blocked during this phase.³⁹⁹

³⁸⁶ Rohmer and Fiema 2016, 286.

³⁸⁷ Rohmer and Fiema 2016, 286.

³⁸⁸ Rohmer and Fiema 2016, 286.

³⁸⁹ Rohmer and Fiema 2016, 286.

³⁹⁰ Rohmer and Fiema 2016, 287.

³⁹¹ Rohmer and Fiema 2016, 287.

³⁹² Rohmer and Fiema 2016, 287.

³⁹³ Rohmer and Fiema 2016, 287.

³⁹⁴ Rohmer and Fiema 2016, 287.

³⁹⁵ Rohmer and Fiema 2016, 287.

³⁹⁶ Rohmer and Fiema 2016, 287.

³⁹⁷ Rohmer and Fiema 2016, 287.

³⁹⁸ Nehmé 2011a, 186.

³⁹⁹ Nehmé 2011a, 187.

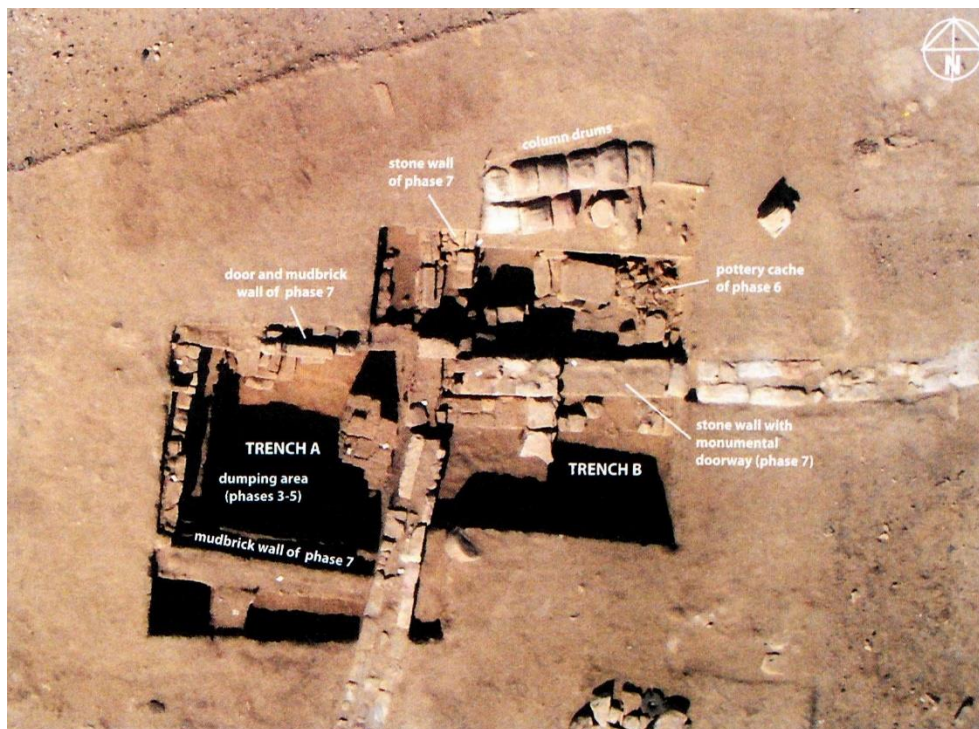
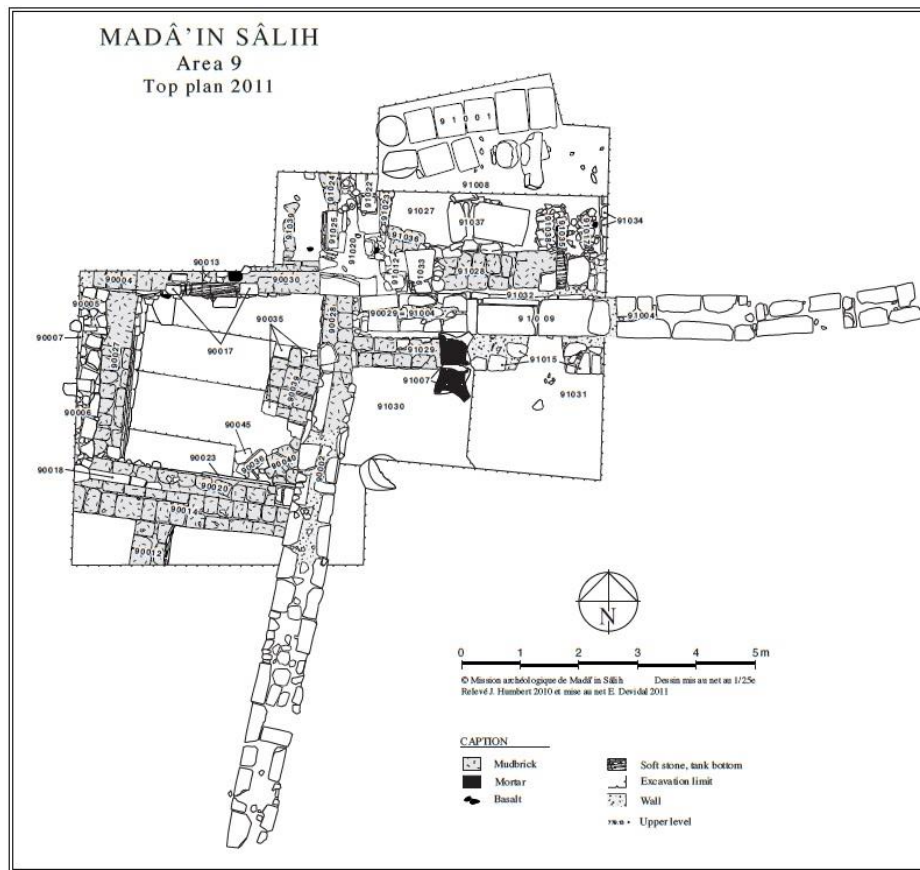


Figure 224: Mada'in Saleh. Area 9, trench A and trench B (Nehmé 2011a, 214, Pl. 1 on the top; Rohmer and Fiema 2016, fig. 5 on the bottom)

CHAPTER VII

Table 93: Mada'in Saleh, Area 9 (trench A and trench B), comparative phases (colours based on Tayma stratigraphy)

Phase	Dating	Events
Phase 9-10	until 4th c. CE	<ul style="list-style-type: none"> - "upper complex" - walls: N wall reused, newly built - doorway from "lower complex" blocked - reuse Nabatean building elements
Phase 8	end 1st c./ beg 2nd c. CE	- destruction, flooding
Phase 7	1st c. CE	<ul style="list-style-type: none"> - first "well-defined" occupation - "lower complex" - T. A: room, doorway, drainage system, domestic? - T. B: corner, monumental doorway, cultic?
Phase 6 (only T. B)	late 1st c. BCE - 1st half 1st c. CE	- minor occupation
Phase 3-5	2nd/1st c. BCE	- dumping operations
Phase 2	4th/3rd c. BCE	

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

Trench C and trench D

In trench C and trench D (Figure 225), Phase 1 to Phase 4 are dated between the 2nd/1st c. BCE and the 4th c. CE (Table 94).

Phase 1 (phase C1 and phase D1) is dated to the 2nd/1st c. BCE. This phase is characterised by mudbrick walls and an oven or kiln.⁴⁰⁰

Phase 2 (phase C2 – with two subphases – and phase D2; Figure 225) is dated to the 1st/early 2nd c. CE. Three mudbrick walls, some with stone foundations, were uncovered in this phase; two of them joined parallel at the centre by the third. Between the two subphases of C2 a short disuse was identified.⁴⁰¹ A destructive event seems to have taken place at the end of this phase.⁴⁰²

Phase 3 (phase D3 – with two subphases; Figure 225) is dated to the (2nd-/) 3rd c. CE. A wall (stone and mudbrick foundation with a mudbrick superstructure) probably forming a room to the east of trench D was identified in one subphase (D3a) and a long platform in the other subphase (D3b).⁴⁰³

Phase 4 (phase C3 – with four subphases – and phase D4; Figure 225) is dated to the (3rd-/) 4th c. CE. A rectangular enclosure made of mudbrick and stone walls was uncovered for this phase.⁴⁰⁴ The enclosure was divided into two parts by a mudbrick wall.⁴⁰⁵ Permeability was identified at three points: an open doorway through the northern wall and two doorways through the southern door (at least one is an open doorway as well).⁴⁰⁶ In the northern part a staircase was uncovered.⁴⁰⁷ The enclosure was probably composed as an open-air forecourt, leading to an important room or building.⁴⁰⁸ Reused Nabataean architectural elements can be connected to Phase 9 of trench B.⁴⁰⁹ The enclosure has been interpreted as probably domestic, although it has a monumental character.⁴¹⁰ To the south of the rectangular enclosure lies, presumably, a street.⁴¹¹

⁴⁰⁰ Nehmé 2018b, 168.

⁴⁰¹ Nehmé 2018b, 165.

⁴⁰² Nehmé 2015, 130.

⁴⁰³ Nehmé 2018b, 173.

⁴⁰⁴ Nehmé 2015, 125–26, 128–29.

⁴⁰⁵ Nehmé 2015, 125–26.

⁴⁰⁶ Nehmé 2015, 125–26.

⁴⁰⁷ Nehmé 2015, 125–26.

⁴⁰⁸ Nehmé 2015, 128–29.

⁴⁰⁹ Nehmé 2015, 128–29.

⁴¹⁰ Nehmé 2015, 125–26, 128–29.

⁴¹¹ Nehmé 2018b, 170.



Figure 225: Mada'in Saleh. Area 9, trench C and trench D (Nehmé 2018b, 178, fig. 22)

CHAPTER VII

Table 94: Mada'in Saleh, Area 9 (trench A and trench B), comparative phases (colours based on Tayma stratigraphy) – Correlation of local phases trench C and trench D based on Nehmé 2018b, 179 - Table 1.

Phase Trench C Trench D	Dating Trench C Trench D	Phase Trench C	Dating Trench C	Phase Trench D	Dating Trench D	Events
Phase 4	(3rd -) 4th c. CE	C3	2nd - 4th c. CE	D4	late 3rd ? - 4th c. CE	- monumental architecture - rectangular enclosure - open-air forecourt? - reused Nabataean elements - domestic?
Phase 3	(2nd -) 3rd c. CE	-	-	D3	3rd c. CE 2nd/3rd c. CE	- room - platform?
Phase 2	1st/ early 2nd c. CE	C2	late 1st/ 2nd c. CE late 1st c. BCE - early 1st c. CE	D2	later 1st/ early 2nd c. CE	- walls: newly built - disuse in between two subphases - end: destruction (can't be connected to annexation)
Phase 1	2nd/1st c. BCE	C1	(2nd -) 1st c. BCE	D1	2nd/ late 1st c. BCE	- some walls - oven or kiln

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

2.2 Dumat al-Jandal

Dumat al-Jandal (coordinates: 29°48'40.93"N 39°52'04.60"E) is located on the northern border of the Nafūd desert and about 275 km NNE of Tayma. Investigation began in 2008 with a survey carried out by Alessandro de Maigret, followed by a Saudi-Italian Archaeological Mission of excavation the year after.⁴¹² The excavation is now being carried out by a joint Saudi-Italian-French Archaeological Mission directed by Romolo Loreto and Guillaume Charloux.⁴¹³

Two Nabataean buildings have been identified in Sector A, trench 1 (Figure 226), Building A and Building B, during the excavations between 2010 and 2015.⁴¹⁴



Figure 226: Dumat al-Jandal. Plan of the archaeological area (based on Charloux and Loreto 2016, 101, fig. 1).

Building A (Figure 227, Figure 228, Figure 229) is a Late Nabataean building from the 1st c. CE, reused various times in the Roman/Byzantine Period between the 2nd and 6th c. CE

⁴¹² Loreto 2012, 165.

⁴¹³ See reports: Charloux and Loreto 2014, 2016. Further reports are unpublished, except for notes published yearly in the *Newsletter Archeologia CISA*: De Maigret 2010; Loreto 2011, 2015, 2016, 2017b.

⁴¹⁴ Loreto 2016, 173, 2017a, 179.

until its destruction in the Early Islamic Period (6th – 8th c. CE) ().⁴¹⁵ The building is protected by a ten-metre-long retaining or terrace wall on its southwestern side.⁴¹⁶ A street is located to the southern side of the building.⁴¹⁷ Only partially excavated, it measures at least 13 by 17 m and has an open-air courtyard with a portico to the west side.⁴¹⁸ A low wall of two courses between the courtyard and the portico presumably had wooden pillars to support the covering for this portico.⁴¹⁹ The portico of 0.90 by 5.5 m was partially floored.⁴²⁰ To the south of the courtyard is a large rectangular room with a double entrance to the courtyard.⁴²¹ The walls of the building are all 0.50 m thick (except for one 0.40 – 0.45 m thick wall).⁴²² Traces of white plaster were found covering the retaining or terrace wall, the external wall and the floor of the southern room and on the portico, leading to the assumption that the building could have been covered in that white plaster.⁴²³ Evidence found in the foundation (level 10) and floor (level 9) date to the 3rd c. BCE – 1st CE, explained as reused ancient materials used for the construction of the building. The ground floor and the reoccupation level (level 8) evidenced Roman, Byzantine and early Islamic material, an indicator of the use and various reuses of the building until its destruction.⁴²⁴ The building is interpreted as being a private or public (civic or religious) dwelling of a local elite, this based on the building technique of walls and floors.⁴²⁵

Northwest of Building A is a second Nabataean building, Building B (Figure 227, Figure 228). It is composed of two concentric aligned rooms.⁴²⁶ As on Building A, Building B was covered in white plaster.⁴²⁷ An entrance was identified in the southern room, but none in the northern room,⁴²⁸ leading to the assumption that Building B was used for storage, both liquid and/or solid.⁴²⁹ Unfortunately, the building has not yet been completely excavated.⁴³⁰

⁴¹⁵ Charloux and Loreto 2016 tab. 1; Loreto 2012, 171, 178; Loreto and Charloux 2018; Charloux and Loreto 2013, 31.

⁴¹⁶ Loreto and Charloux 2013, 216.

⁴¹⁷ Loreto 2017a, fig. 108.

⁴¹⁸ Charloux and Loreto 2013, 29.

⁴¹⁹ Charloux and Loreto 2013, 29.

⁴²⁰ Charloux and Loreto 2014, 132.

⁴²¹ Charloux and Loreto 2014, 128.

⁴²² Loreto 2012, 170.

⁴²³ Loreto and Charloux 2013, 216.

⁴²⁴ Loreto 2012, 171.

⁴²⁵ Charloux and Loreto 2013, 29.

⁴²⁶ Loreto 2017a, 181.

⁴²⁷ Loreto 2016, 173.

⁴²⁸ Loreto 2017a, 181.

⁴²⁹ Loreto 2016, 173.

⁴³⁰ Loreto 2017a, 181–82.

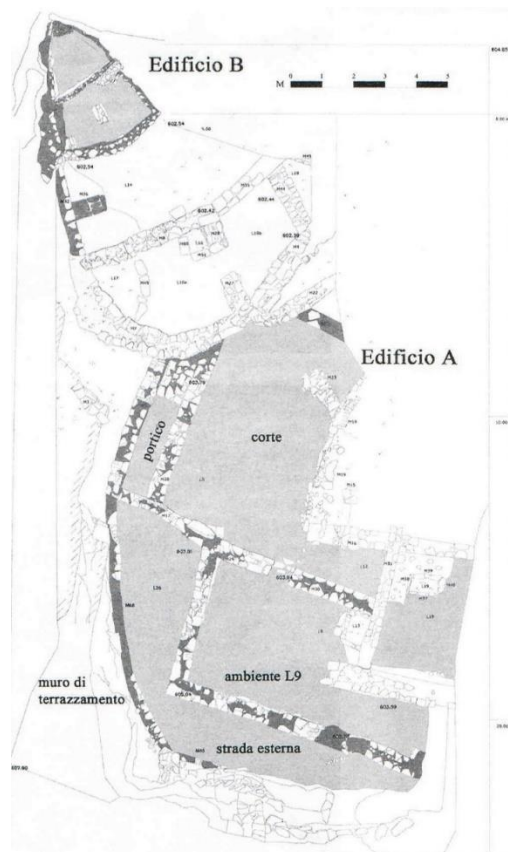


Figure 227: Dumat al-Jandal. Building A (Edificio A) and Building B (Edificio B), Sector A (Loreto 2017a, fig. 108 on the right)



Figure 228: Dumat al-Jandal. Building A and Building B (Loreto 2017b, fig. 4)



Figure 229: Dumat al-Jandal. Building A, Sector A, courtyard with portico (Charloux and Loreto 2016, 114, fig. 16)

Table 95: Dumat al-Jandal, Building A and Building B, comparative phases (colours based on Tayma stratigraphy)

level	Dating	Events
level 8	2nd - 6th c. CE	- reoccupation of buildings - destruction (Islamic Period)
level 9	1st c. CE	- construction Building A and Building B - floor level buildings - reuse older building material
level 10	1st c. BCE - 1st c. CE	- foundation buildings - reuse older building material

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

2.3 Comparative study

The information collected from the residential areas of Mada'in Saleh and Dumat al-Jandal were joined with those of Tayma in a table by equating the dating of single occupations of all three sites (Table 96). The result is a comparative chronostratigraphy that can be used to compare the architectural evidence from the Nabataean, Roman and Late Antique Periods. The aim is to understand whether the residential areas of the comparative sites might have had the same impact of the political, social and economic dynamics as in Tayma.

The Nabataean Period in Tayma (OL 4) is characterised by the new construction of walls on collapses and debris of the previous occupation of the area. Area 1 in Mada'in Saleh, on the contrary, has part of previous walls destroyed, some reused and some newly built (Phase 2). This phase is interpreted as possibly coinciding with the Nabataean arrival to Mada'in Saleh and the transition from mobile to permanent housing. A second phase of the Nabataean Period (Phase 3) evidenced by newly built walls as a consequence of destruction or robbery in the area. The probable Nabataean building program is evidenced more intensely in Area 2 in Mada'in Saleh. While the first occupation (Phase 1) has defined the general layout of the area, until the end of the occupation, the next phase (Phase 2) evidences itself as a monumentalization of the residential area. The first phases of trench A and trench B Area 9 in Mada'in Saleh are characterised by a minor occupation and only in Phase 7 is there a construction of a complex, possibly of cultic and domestic character. Trench C and trench D display little occupation until a later phase (Phase 2) that combines Nabataean and Roman elements. All areas, except for trench C and trench D of Area 9, evidenced a destruction horizon, perhaps because of flooding. Since there is no evidence for the cause of the flooding, it can either be natural or artificial as a means of destruction, since there is a wadi located to the E of the residential area (Figure 212). If the latter would be true, then it could be a sign of violence originated by the Roman Annexation. In Dumat a-Jandal the two uncovered buildings are from the Late Nabataean Period, evidencing a long-term use throughout the Roman/Byzantine Period.

To sum it up, it seems that the Nabataean Period is largely characterised by the first construction of houses in the residential areas of all three sites. For Mada'in Saleh this has been interpreted perhaps as a sign that permanent housing has replaced the mobile lifestyle. However, this must be interpreted with caution, permanent houses are not evidence of the first

occupation of the sites. As has been presented before⁴³¹, Tayma has evidence of an oasis culture from the late 5th/4th millennium BCE, which is compatible with a mobile lifestyle, and continuous occupation from the 3rd/2nd millennium onwards.

The Roman Period in Tayma is characterised by a mix of reuse or rebuilding of walls from the Nabataean Period and the construction of new walls on debris. Two (geno-)types of buildings could be differentiated. Area 1 in Mada'in Saleh is characterised by reuse of some walls from the previous occupation and the addition of new walls. The first Roman phase (Phase 4) is especially characterised by the construction of a street, hinting to a better planned layout of the residential area, while the second phase (Phase 5) is defined by a change of circulation. The latter phase is dated to a transition between the Roman and Late Antique Period. In Area 2 in Mada'in Saleh major changes took place (Phase 3), mainly by discontinuing the southern sector and reorganisation of the northern sector. After a phase of disuse, the northern sector is again reused in a second Roman phase (Phase 4). It is not clear of the reason for the disuse phase between both of the Roman dated phases. Area 9 in Mada'in Saleh is characterised by a rebuilding of the Nabataean complex after flooding at the end of the Roman Period (Phase 9-10). Trench C evidenced a disuse in a first Roman phase (Phase 3). Major changes took place in trench C and trench D in the second Roman phase (Phase 4), with the construction of a complex with probably an open-air forecourt. There is no such evidence in the other sites, opening the question as to why this monumental architecture was built in this area. All areas in Mada'in Saleh have been reused, also destroyed at the end of the Nabataean Period, and partially monumentalized. While Area 1 and Area 2 maintain a similar layout as before, Area 9 is completely restructured. After the Roman Period, the residential areas are largely abandoned except for Area 1. The buildings from Dumat al-Jandal were still being used as they were constructed in the Late Nabataean Period with some minor changes.

To sum up, while in Area 1 and 2 in Mada'in Saleh and Dumat al-Jandal a continuity of the use of space could be seen, Area 9 in Mada'in Saleh is characterised by a larger investment in monumentalization. In Tayma an investment is also visible, although not as monumental as in Mada'in Saleh.

⁴³¹ See Chapter II, Section 2.3.1.

CHAPTER VII

Table 96: Comparative chronostratigraphy: Tayma, Mada'in Saleh and Dumat al-Jandal (colours based on Tayma stratigraphy)

Tayma		Mada'in Salih												Dumat al-Jandal											
Area E-South/F OL Dating		Area 1 Phase Dating		Area 2 Phase Dating		Area 9, Trench A and B Phase Dating		Area 9, Trench C and D Phase Dating Phase Dating Phase Dating Trench C Trench C Trench C Trench C Trench D Trench D						Sector A, Trench 1 level Dating											
		Phase 6	6th - 7th c. CE	Phase 5	6th - 7th c. CE?																				
2a	4th -	Phase 5	4th - 5th c. CE											level 8	2nd - 6th c. CE										
2b	6th c. CE																								
3	2nd - 4th c. CE	Phase 4	2nd - 3rd c. CE	Phase 4	3rd/ early 4th c. CE	Phase 9-10	until 4th c. CE	Phase 4	(3rd -) 4th c. CE	C3	2nd - 4th c. CE	D4	late 3rd ? - 4th c. CE												
				Phase 3	2nd/ early 3rd c. CE			Phase 3	(2nd -) 3rd c. CE	-	-	D3	3rd c. CE	2nd/3rd c. CE											
4	2nd c. BCE - early 2nd c. CE	Phase 3	mid - end 1st c. CE	Phase 2	1st c. CE	Phase 8	end 1st c./ beg 2nd c. CE	Phase 2	1st/ early 2nd c. CE	C2	late 1st/ 2nd c. CE	D2	later 1st/ early 2nd c. CE	level 9	1st c. CE										
Phase 2	2nd/1st c. BCE - mid 1st c. CE	Phase 1	late 1st c. BCE - early 1st c. CE			Phase 7	1st c. CE							Phase 6	late 1st c. BCE - 1st half 1st c. CE	Phase 3-5	2nd/1st c. BCE	Phase 1	2nd/1st c. BCE	C1	(2nd -) 1st c. BCE	D1	2nd/ late 1st c. BCE	level 10	1st c. BCE - 1st c. CE
	5th - 2nd c. BCE	Phase 1	3rd - 2nd c. BCE			Phase 2	4th/3rd c. BCE																		

	Roman/Late Antique Period
	Roman Period
	Nabataean/Roman Period
	Nabataean Period
	pre-Nabataean Period

In the Late Antique Period, the residential area in Tayma is primarily characterised by the reuse of Roman buildings in the northern part, changing gradually, probably as repair was due, and the abandonment of the southern part. Besides this, a large complex was built northwest of the residential area, evidencing a rerouting of investment of resources to another area, leaving the residential area, in analysis, to be abandoned after the Late Antique Period.

In Mada'in Saleh only in Area 1 have resources been largely used to build continuous housing in the same area, while Area 2 and Area 9 do not evidence an occupation.

To sum up, the Late Antique Period and later seems to be characterised by the general abandonment, little by little, focusing the construction of housing in only a few areas.

3 CONCLUDING REMARKS

An overall aim of this research was to uncover the political, social and economic dynamics that made an impact on the residential area of the oasis of Tayma during the Nabataean, Roman and Late Antique Periods. The space syntax analysis, on first sight a very mathematical and seemingly static technique of analysis, in connection with additional information from the oasis itself and two other sites, Mada'in Saleh (ancient Hegra) and Dumat al-Jandal (ancient Duma) provided a much more complex and intertwined outcome than would have been expected. Not only the different levels of resolution – macro, micro and nano – showed that variation and continuity can occur within the same evidence, depending from which point of view it is analysed, but also that different dynamics – political, social and economic – had a different impact on the development of a residential area.

On a political scale, a distinct change took place when the Nabataean Kingdom expanded, evidenced by permanent housing being built. This seems to have been the case of all three residential areas, Tayma, Mada'in Saleh and Dumat al-Jandal since no compelling evidence prior to this first occupation of the areas was found. The impact of the Roman annexation proved to be connected to major changes taking place in the residential area of Tayma and Area 9 in Mada'in Saleh, while the other areas in Mada'in Saleh and Dumat al-Jandal have been restructured, in the case of the former, or simply reused, in the case of the latter. The Late Antique Period is characterised by a change of the location of the residential areas. In Tayma the area is still partially reused and restructured but generally a decline can be seen in the previously established residential area. Investment goes into building a complex towards the

northwest of the area. In Area 1 in Mada'in Saleh a similar development occurs, but instead of shifting the area, continuous well-built houses are constructed on top of the Roman residential area. This concept of decline during the Late Antique Period has been discussed when the framework of this research was presented.⁴³² It seems that it would be more appropriate to look at the changes occurring during this period in NW Arabia as transformations rather than a decline as such, otherwise there would not be such building activities in both Tayma and Mada'in Saleh. The aridification of the climate, depopulation, demonetization of the economy etc. all lead to the disintegration of an urban system, leading to a stronger regionalisation and localised development of the NW Arabian oases.

In Tayma the political changes could very well be analysed with the space syntax analysis, showing a change of spatial configuration between the Nabataean and Roman Period and then the continuation of usage of one of the (geno-)types of buildings in the Late Antique Period.

It is more challenging to interpret the results on a social scale, especially because the comparative sites did not offer enough evidence for this aspect since a space syntax analysis was not possible. Nevertheless, some observations can be made. While on a political scale interplaying variation and continuity could be detected on a macro and micro level (the residential area as a whole and the spatial configuration of the buildings), on a nano level (the single rooms) a different observation was made. The functional differentiation of rooms is strikingly continuous. Disassociated from the overall development of the residential area, the conception of space on a small scale still seems not to have changed. This might be because the social perception of these spaces did not change, even with strong political changes occurring. This questions if the political dynamics were indeed as impacting as they seem, on a larger scale, and if they might have simply been formal and not as influencing on daily life in an oasis located not quite on the periphery of the Nabatean Kingdom and later Roman Arabia.

On an economic scale, investment of resources could be observed with the Nabataean arrival, since buildings were constructed on scarcely occupied or empty areas. An investment could also be observed for the Roman Period, although many of the walls were reused, evidenced in Tayma, Mada'in Saleh and especially in Dumat al-Jandal. This opens the question

⁴³² Chapter II, Section 1. Especially based on Schiettecatte 2013, who discusses this subject in length.

CHAPTER VII

as to why resources were economised, since the spatial configuration of the buildings does change in the Roman Period. Perhaps there was no economic capacity to do so or, and this seems more likely, there was no socio-political need for it. Keeping the occupation of NW Arabia more administrative, spatial changes were not regarded as necessary to demonstrate control.

CHAPTER VIII

CONCLUSION

The last chapter of this thesis is divided into three sections. The first section is a restatement of the research questions together with the main research findings. The second section contains an evaluation of the limitations encountered during research and the significance of the results. The third section suggests possible avenues for further research.

1 RESEARCH

1.1 Restatement of the research questions

The aim of this study was to gain a more in-depth understanding of the perception and conception of space in the residential area (Area E-South and Area F) at the oasis of Tayma during the Nabataean (OL 4), Roman (OL 3) and Late Antique (OL 2a and OL 2b) Periods⁴³³ by carrying out a space syntax analysis of the architectural evidence.⁴³⁴

The purpose of such an analysis was to provide the necessary means to perform a synchronic and diachronic analysis of the spatial configuration of the buildings from all three periods. The results of this analysis would then enable us to understand the configuration of the buildings themselves – phenotypes – as well as the underlying set of abstract rules they comply with – genotypes.

Regarding phenotypes, the focus in the study presented here was on two aspects of the spatial configuration, namely (a) the interaction between public and domestic space and access to buildings (visitor-inhabitant relationship), and (b) the movement through the buildings, through the individual rooms and their interaction (inhabitant-inhabitant relationship).

Regarding genotypes, the first step was to determine the set of rules that characterise them, after which they were compared in terms of continuity and variation. The “transtemporal” links (similarities with older or earlier genotypes) and transpatial links (similarities with contemporary buildings) could either be confirmed or not. The aim of defining these links was to gain an understanding as to whether genotypes evolved from or to

⁴³³ See Chapter I, Section 2 for the detailed research question.

⁴³⁴ See Chapter III, Section 2 and Section 5 for the space syntax analysis.

genotypes typical of other occupation levels (evolutionary changes) or if a new set of rules was established (revolutionary changes). This would then provide the means for a discussion about the meaning of the determined genotypes.

The results of the above-outlined analysis was then embedded within the historical context of the site, in order to provide a better understanding of the transition from the Nabataean Period to the Roman Period and then to the Late Antique Period. This was then compared with evidence from contemporary residential areas at other sites in the NW Arabian region.⁴³⁵

This research was made so as to gain an understanding of the impact of political, social and economic dynamics on the residential area of an oasis located in a relatively hostile climatic region, within but not far from the southern periphery of the Nabataean Kingdom and the later more extensive *Provincia Arabia* and including the transformations occurring in Late Antique NW Arabia.

1.2 **Summary of research findings**

Based on the hypothesis that an urban environment – here the residential area – is charged with meaning⁴³⁶, the political, social and economic dynamics, that had an impact on the residential area, could be determined.

The analysis of individual buildings (**phenotypes**)⁴³⁷ provided a detailed understanding the interaction between public and domestic space, the movement within buildings and the spatial differentiation between individual spaces. The entrances of buildings are a protective interface between public and private domain, keeping the visitor in a segregated position from the building, in almost all cases. The movement through buildings followed different patterns: either along a single path or by bi- or multifurcations, the latter which signals choice for a circulating individual. Rooms with different spatial behaviour – variations of

⁴³⁵ See Chapter II, Section 1 and Section 2.

⁴³⁶ Discussion held in the Introduction and Chapter 1 in “The Social Logic of Space” (Hillier and Hanson 2005).

⁴³⁷ See Chapter IV for the complete space syntax analysis.

integration/segregation and control over adjacent spaces – could be discerned within the same building, suggesting that they might have had different functions.⁴³⁸

The analysis of the set of abstract rules defining the spatial configuration (**genotypes**) resulted in the determination of four distinct genotypes by period of occupation of the residential area (A, B.I, B.II and C).⁴³⁹ In the Nabataean Period (genotype A) only one building was preserved well enough, to enable an analysis of its path-shaped spatial configuration. A path is here defined as a spatial configuration that dictates the movement of people within it. In the Roman Period, two completely disconnected new sets of rules, for spatial configuration, was determined (genotype B.I and genotype B.II). Genotype B.I is characterised by a spatial differentiation within each building, where a bifurcation represents a form of choice of movement. Genotype B.II, probably a type of courtyard house, is characterised by the control of the largest room over six or seven smaller rooms. The Late Antique Period can be divided into two phases where the layout of the building interior changed but not the set of rules guiding it (genotype C). The rules of spatial configuration seem to have evolved from the Roman genotype B.I (path with bifurcation).

The determination of the genotype in the context of Tayma and two other sites from the region, Mada'in Saleh and Dumat al-Jandal,⁴⁴⁰ resulted in a thesis as to how political, social and economic dynamics had an impact on the development of the residential area.⁴⁴¹ While the political dynamics during the expansion of the Nabatean Kingdom, the Roman Annexation and the Late Antique disintegration of the region had a more substantial impact on the configuration of the residential area and its buildings, especially during the former two, the impact of social and economic factors do not appear to have been the same. On a smaller scale – i.e. single rooms – this impact has not been observed to the same degree. Instead, the results of the analysis suggest a steady continuation of spatial differentiation, which could be interpreted as a lack of the need for change on a social scale. Economically, the reuse of walls in the Roman Period and especially in the Late Antique Period occurred extensively in the residential area. The lack of investment in new resources could perhaps have been related to the economic inability or, more likely, it may not have been necessary, since a mere administrative control over the oasis could have been enough. An oasis can be defined as a place of paramount

⁴³⁸ See Chapter V, Section 2.3.

⁴³⁹ See Chapter VI, Section 3.

⁴⁴⁰ See Chapter VII, Section 2.

⁴⁴¹ See Chapter VII, Section 2.3.

importance in the NW Arabian context, providing water, food and rest in a quite hostile, hyper-arid region; the availability of these resources was of a higher importance than the demonstration of control through a complete change in the configuration, and thus in the perception and conception of space.

2 EVALUATION

2.1 Limitations of the research

To evaluate the limitations encountered in this research, the methodological approach and the archaeological evidence has to be considered.⁴⁴²

A space syntax analysis is conditioned whether evidence of boundaries and permeability is present: boundaries determine space, otherwise unlimited, and permeability makes movement through those enclosed spaces possible. These two criteria form the basis for carrying out this type of analysis, since it studies the spatial configuration different spaces have in connection with each other, both on a local and a global scale.

An archaeological excavation, as such, always provides incomplete evidence. This limits the capacity of a space syntax analysis as some of the parameters needed for the analysis may not be available: scarcity and/or absence of evidence of boundaries, such as walls; unclear and/or absence of evidence of permeability, such as doorways. This limitation is evident for the following cases: (a) when there is not enough evidence to delimit buildings and (b) when there is not enough evidence to determine the exact location of permeability. There are instances in all three occupation levels when there was evidence of walls, but these were not included in this analysis; their presence did enclose space in such a way that individual buildings could be determined, but still they had to be left out of the space syntax analysis. This limitation especially affected the space syntax analysis of the architectural evidence from the Nabataean Period, since only one building could be determined. Making generalising statements based on the results of the analysis of a single building for an entire occupation level where there is clearly undetermined evidence of further walls, must always be discussed with caution. As for the necessary evidence of permeability, the exact location of such connections between spaces is not always clear. This was the case, when a variation of the analysis was carried out to include all possible connections. However, if it is clear which spaces have a

⁴⁴² See Chapter III, Section 2.2 for a criticism of space syntax analysis.

connection, but it is not known exactly where they are, along a wall interfacing both spaces, then it can still be included in the analysis. This is because in a space syntax analysis the available information is reduced to a mere presence or absence of permeability; the exact location along a boundary is not required.

A space syntax analysis is, as has already been discussed in this thesis⁴⁴³, a graph-based technique that reduces reality to nodes and links. The results must, therefore, be considered in their context, possibly including additional information when it becomes available.

2.2 Significance of the results

Despite the limitations stated above, this thesis has provided new insight into the spatial configuration of and the impact of political, social and economic dynamics on the residential area at the oasis of Tayma.

The systematic study of the buildings themselves and placing them in the context of the occupation levels they are attributed to, adds to the understanding of revolutionary or evolutionary changes that the residential area underwent in the transition from the Nabataean Period to the Roman Period and then to the two phases of the Late Antique Period. Such a study has not been carried out for the residential area in Tayma before and therefore provides important groundwork for further research.

The buildings themselves were analysed from two perspectives: the outside, from a visitor's viewpoint, and the inside, from an inhabitant's viewpoint. In this way, the space syntax analysis of individual buildings contributed to our understanding of the movement into and within and the spatial differentiation for each building.

Nonetheless, despite a limited sample size from the Nabatean Period, a different spatial configuration was detected in contrast with the other periods: the path-shaped building clearly binds the movement of an individual to entering and exiting the same way. In the Roman Period, two types of buildings could be determined: one based on path-like buildings with bifurcations that indicates a choice of movement, the other with small-sized spaces grouped around the largest room suggesting a courtyard house that also enables a choice of movement. Both phases of the Late Antique Period were characterised by one type of building that evolved,

⁴⁴³ See Chapter III.

based on their spatial configuration, from the path-like buildings pertaining to the Roman Period.

The space syntax analysis proved itself to be an effective technique that provides a basic understanding of the perception and conception of space; however, the results must always be considered in their context.

To sum up, the nature of the development of the use of space could be determined in the residential area, despite the fragmentary archaeological evidence and the fact that not all findings, such as objects and samples, were considered.

3 SUGGESTIONS FOR FURTHER RESEARCH

In evaluating the limitations and significance of the results from this study, I suggest using the groundwork laid out in this study to integrate more of the available additional information of the residential area. This includes (a) analysing evidence, such as pottery, objects and archaeozoological evidence, that might indicate room-functions, which can then be correlated with the spatial differentiation proposed in this study; (b) discussing the different types of permeability, i.e. distinguishing between staircases, doorways, open spaces, etc., and understanding their implication on movement; and (c) analysing more in-depth certain spaces, such as courtyards, roofed areas and entrances, and explore their function within the residential area. The deeper insight obtained of the residential area at Tayma through this interdisciplinary study would then be reanalysed in the NW Arabian context.

Furthermore, this research has demonstrated that a space syntax analysis can also be carried out on a single building and therefore can be applied to other cases at a site, even if it is not in the context of a residential area. However, it must be kept in mind that a minimum amount of evidence for boundaries and permeability is necessary and that the analysis might have to adapt to each study. Nevertheless, it is possible to carry out space syntax analysis to obtain a basic understanding of the use of space, putting it together with any other available evidence to complete the picture.

GLOSSARY

Term	Definition
axial line	graphical reduction of streets to the minimum and longest straight lines possible; one-dimensional
axial map	graphical representation of space (usually streets) through axial lines
boundary	physical determination of otherwise unlimited space
correlation coefficient	$r = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$ <p>Pearson correlation coefficient; measures the linear relationship between two sets of values</p>
convex map	graphical representation of space (usually buildings) by convex spaces
convex space	graphical reduction of architectural space to the minimum and largest geometrical convex polygon possible; two-dimensional
CV <i>control value</i>	CV = sum of all CVe a space receives local measure; measure of control of a space over adjacent spaces
CVe	$CVe = \frac{1}{NC}$ <p>control given to adjacent spaces</p>
D	$D_k = \frac{2(K(\log_2 \frac{K+2}{3} - 1) + 1)}{(K-1)(K-2)}$ <p>mean RA value of a diamond-shaped graph to calculate the RRA</p>
depth	topological distance between two nodes
evolutionary changes	genotype that follows/adapts from a set of abstract rules of a preceding type
genotype	transpatial concept; underlying set of abstract rules with which phenotypes comply
global measure	analysis of a node in relation to all other nodes on a justified graph

H* <i>difference factor</i>	$H^* = \frac{H - \ln 2}{\ln 3 - \ln 2}$ <p>, where $H = -\sum \left[\frac{a}{t} \ln \left(\frac{a}{t} \right) \right] + \left[\frac{b}{t} \ln \left(\frac{b}{t} \right) \right] + \left[\frac{c}{t} \ln \left(\frac{c}{t} \right) \right]$ and where a = max RRA, b = mean RRA, c = min RRA measure of the degree of variation existent in a chosen set of values</p>
justified graph	graphic representation of spatial configuration with a root space ; composed of nodes and lined vertices
K	total number of nodes in a justified graph
lined vertex <i>also link</i>	graphic representation of permeability
local measure	analysis of a node in relation to its adjacent nodes on a justified graph
MD <i>mean depth</i>	$MD = \frac{TD}{K-1}$ <p>mean depth of a node to all other nodes</p>
NC <i>number of connections</i>	number of adjacent spaces
node	graphic representation of a single space
permeability	connection between two spaces
phenotype	spatial concept; display of the genotype in physical space (usually single buildings)
RA <i>relative asymmetry</i>	$RA = \frac{2(MD-1)}{K-2}$ <p>global measure; measure of integration/segregation of a node in a justified graph</p>
revolutionary changes	genotype that follows a new set of abstract rules
ring	circular movement on a justified graph
root space	node above which all other nodes are aligned in a justified graph
RR <i>relative ringiness</i>	$RR = \frac{\text{total number of rings}}{2K-5}$ <p>measure of rings in a justified graph</p>
RRA <i>real relative asymmetry</i>	$RRA = \frac{RA}{D\text{-value}}$ <p>global measure; standardised RA</p>

Glossary

space	architectural space with boundaries and permeability ; represented by a node in a justified graph
space syntax	technique to analyse spatial configuration
space type	A, B, C or D-type; classification of spaces according to the quantity of links that a node has and to whether they are positioned on a ring or not
spatial configuration	description of the relationship between spaces
TD <i>total depth</i>	TD = sum of depths of a node to all other nodes
topological distance	number of lined vertices between spaces
transpatial link	elements shared by contemporary phenotypes
transtemporal link	elements shared with previous or succeeding genotypes
tree branch	linear movement on a justified graph

BIBLIOGRAPHY

A

- Allen, Kathleen M. S., Stanton W. Green, and Ezra B. W. Zubrow, eds. 1990. *Interpreting Space: GIS and Archaeology*. Applications of Geographic Information Systems. London: Taylor & Francis.
- Al-Najem, Mohammed, and Michael C. A. Macdonald. 2009. "A New Nabataean Inscription from Taymā'." *Arabian Archaeology and Epigraphy* 20, no. 2 (26 October 2009): 208–17. <https://doi.org/10.1111/j.1600-0471.2009.00316.x>.
- Al-Sayed, Kinda. 2014. *Space Syntax Methodology*. With contributions by Bill Hillier, Shinichi Iida, Sam Griffiths, Karimi Kayvan, Nick Dalton, Alan Penn, Laura Vaughan, Kerstin Sailer, Tao Yang, and Ava Fatah gen. Schieck. London: Barlett School of Architecture, UCL. <http://discovery.ucl.ac.uk/id/eprint/1415080>.

B

- Bafna, Sonit. 2003. "Space Syntax: A Brief Introduction to Its Logic and Analytical Techniques." *Environment and Behavior* 35, no. 1 (1 January 2003): 17–29. <https://doi.org/10.1177/0013916502238863>.
- Bailey, Douglass W. 1990. "The Living House: Signifying Continuity." In *The Social Archaeology of Houses*, edited by Ross Samson, 19–48. Edinburgh: Edinburgh University Press.
- Bawden, Garth, Christopher Edens, and Robert Miller. 1980. "The Archaeological Resources of Ancient Tayma: Preliminary Investigations at Taymā'." *ATLAL: The Journal of Saudi Arabian Archaeology* 4:69–106.
- Beaulieu, Paul-Alain. 1989. *The Reign of Nabonidus, King of Babylon 556–539 B.C.* Yale Near Eastern Researches 10. New Haven: Yale University Press.
- Benech, Christophe. 2007. "The Use of 'Space Syntax' for the Study of City Planning and Household from Geophysical Maps: The Case of Dura-Europos (Syria)." In *Städtisches Wohnen im östlichen Mittelmeerraum, 4. Jh. v. Chr. - 1. Jh. n. Chr.: Akten des Internationalen Kolloquiums v. 24. - 27. Oktober 2007 an der Österreichischen Akademie der Wissenschaften*, edited by Sabine Ladstätter and Veronika Scheibelreiter, 403–16. Archäologische Forschungen 18. Vienna: Austrian Academy of Sciences Press. <https://hal.archives-ouvertes.fr/hal-00541836>.
- Bernbeck, Reinhard. 1997. *Theorien in der Archäologie*. UTB Für Wissenschaft 1964. Tübingen: A. Francke Verlag.

Bibliography

- Bintliff, John. 2014. "Spatial Analysis of Past Built Environments: Houses and Society in the Aegean from the Early Iron Age till the Impact of Rome." In *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, edited by Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla, 263–76. Topoi: Berlin Studies of the Ancient World 18. Berlin: De Gruyter. <https://doi.org/10.1515/9783110266436>.
- Blanton, Richard E. 1994. *Houses and Households: A Comparative Study*. Interdisciplinary Contributions to Archaeology. New York: Springer Science+Business Media.
- Bowersock, Glenn W. 1971. "A Report on Arabia Provincia." *The Journal of Roman Studies* 61:219–42. <https://doi.org/10.2307/300018>.
- Bowersock, Glenn W. 1983. *Roman Arabia*. Cambridge, Massachusetts: Harvard University Press.
- C
- Carver, Martin. 2009. *Archaeological Investigation*. London: Routledge.
- Castel, Corinne. 1992. *Habitat urbain néo-assyrien et néo-babylonien: de l'espace bâti ... à l'espace vécu*. Bibliothèque archéologique et historique de l'Institut français d'archéologie de Beyrouth 143. Paris: Librairie Orientaliste Paul Geuthner.
- Charloux, Guillaume, and Romolo Loreto. 2013. *Dûmat al-Jandal. 2800 Years of History in the Kingdom of Saudi Arabia*. Riyadh: Saudi Commission for Tourism and Antiquities - EADS Airbus Group. <https://hal.archives-ouvertes.fr/hal-00997895>.
- Charloux, Guillaume, and Romolo Loreto. 2014. *Dûma 1: 2010 Report of the Saudi-Italian-French Archaeological Project at Dûmat al-Jandal, Saudi Arabia*. Riyadh: Saudi Commission for Tourism and Antiquities. <https://hal.archives-ouvertes.fr/hal-00997906>.
- Charloux, Guillaume, and Romolo Loreto. 2016. *Dûma 2: The 2011 Report of the Saudi-Italian-French Archaeological Project at Dûmat al-Jandal, Saudi Arabia*. Riyadh: Saudi Commission for Tourism and National Heritage. <https://hal.archives-ouvertes.fr/hal-01509443>.
- Charloux, Guillaume, Charlène Bouchaud, Caroline Durand, Yvonne Gerber, and Jacqueline Studer. 2018. "Living in Madâ'in Sâlih/Hegra during the Late Pre-Islamic Period. The Excavations of Area 1 in the Ancient City." *Proceedings of the Seminar for Arabian Studies* 48:47–65.
- Clarke, David L. 1977. "Spatial Information in Archaeology." In *Spatial Archaeology*, edited by David L. Clarke, 1–32. London: Academic Press.
- Cooper, Laurel Martine. 1995. "Space Syntax Analysis of Chacoan Great Houses." PhD dissertation, The University of Arizona. <https://repository.arizona.edu/handle/10150/187184>.

Bibliography

D

- Darvill, Timothy. 2002. *The Concise Oxford Dictionary of Archaeology*. Oxford: Oxford University Press.
- Dawson, Peter C. 2002. "Space Syntax Analysis of Central Inuit Snow Houses." *Journal of Anthropological Archaeology* 21, no. 4 (2 December 2002): 464–80. [https://doi.org/10.1016/S0278-4165\(02\)00009-0](https://doi.org/10.1016/S0278-4165(02)00009-0).
- De Maigret, Alessandro. 2010. "Joint Saudi-Italian Archaeological Project at Dûmat al-Jandal. Preliminary Report of the 1st Excavation Campaign (2009)." *Newsletter di Archeologia CISA* 1:66–83.
- Dentzer, Jean-Marie, A. Kermorvant, Laïla Nehmé, Laurent Tholbecq, and Hassan Abu al-Hassan. 2002. "Report on the Second Season (2009) of the Madâ'in Sâlih Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 18:61–80.
- Dinies, Michèle, Reinder Neef, Birgit Plessen, and Harald Kürschner. 2016. "Holocene Vegetation, Climate, Land Use and Plant Cultivation in the Tayma Region, Northwestern Arabia." In *The Archaeology of North Arabia. Oases and Landscapes. Proceedings of the International Congress Held at the University of Vienna, 5–8 December, 2013*, edited by Marta Luciani, 57–78. OREA – Oriental and European Archaeology 4. Vienna: Austrian Academy of Sciences Press.
- Dougherty, Raymond Philip. 1980. *Nabonidus and Belshazzar: A Study of the Closing Events of the Neo-Babylonian Empire*. Yale Oriental Series Researches 15. New York: AMS Press.
- Doughty, Charles M. 1936. *Travels in Arabia Deserta*. London: Cape.

E

- Eichmann, Ricardo. 2009. "Archaeological Evidence of the Pre-Islamic Period (4th – 6th Cent. AD) at Tayma." In *L'Arabie à la veille de l'Islam: bilan clinique. Table ronde tenue au Collège de France, Paris, les 28 et 29 août 2006, dans le cadre du projet de l'Agence nationale de la recherche "De l'Antiquité tardive à l'Islam"*, edited by Jérémie Schiettecatte and Christian Julien Robin, 59–66. Paris: De Boccard.
- Eichmann, Ricardo. 2011. "Archaeological Exploration of the Arabian Peninsula: European Contributions to International Research, in Particular in Central and Northwest Arabia." In *Roads of Arabia: The Archaeological Treasures of Saudi Arabia*, edited by Ute Franke and Joachim Gierlichs, 48–57. Tübingen: Wasmuth Verlag.

Bibliography

- Eichmann, Ricardo, Arnulf Hausleiter, Mohammed Al-Najem, and Said al-Said. 2010. "Tayma – Autumn 2004 and Spring 2005, 2nd Report on the Joint Saudi Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 20:101–147.
- Eichmann, Ricardo, Arnulf Hausleiter, Mohammed Al-Najem, and Said al-Said. 2011. "Tayma – Autumn 2005 and 2006 (Spring and Autumn), 3rd Report on the Joint Saudi-Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 21:64–118.
- Eichmann, Ricardo, Arnulf Hausleiter, Mohammed Al-Najem, and Said al-Said. 2012. "Tayma 2007 – 4th Report on the Joint Saudi-Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 22:72–117.
- Eichmann, Ricardo, Hanspeter Schaudig, and Arnulf Hausleiter. 2006. "Archaeology and Epigraphy at Tayma (Saudi Arabia)." *Arabian Archaeology and Epigraphy* 17, no. 2 (8 December 2006): 163–76. <https://doi.org/10.1111/j.1600-0471.2006.00269.x>.
- Engel, Max, Helmut Brückner, Anna Pint, Kai Wellbrock, Andreas Ginau, Peter Voss, Matthias Grottker, Nicole Klasen, and Peter Frenzel. 2012. "The Early Holocene Humid Period in NW Saudi Arabia – Sediments, Microfossils and Palaeo-Hydrological Modelling." *Quaternary International* 266 (17 July 2012): 131–41. <https://doi.org/10.1016/j.quaint.2011.04.028>.
- Euting, Julius. 1896. *Tagebuch Einer Reise in Inner-Arabien*, 2 vols. Leiden: Brill.

F

- Fiema, Zbigniew T., Ahmad Al-Jallad, Michael C. A. Macdonald, and Laïla Nehmé. 2015. "Provincia Arabia: Nabataea, the Emergence of Arabic as a Written Language, and Graeco-Arabica." In *Arabs and Empires before Islam*, edited by Greg Fisher, 373–433. Oxford: Oxford University Press.
- Fletcher, Roland. 1978. "Issues in the Analysis of Settlement Space." In *Social Organization and Settlement: Contributions from Anthropology, Archaeology and Geography*, edited by David Green, Colin Haselgrove, and Matthew Spriggs, 225–40. BAR International Series 47. Oxford: British Archaeological Reports.
- Foster, Catherine P., and Bradley J. Parker. 2012. "Introduction: Household Archaeology in the Near East and Beyond." In *New Perspectives on Household Archaeology*, edited by Bradley J. Parker and Catherine P. Foster, 1–12. Winona Lake, Indiana: Eisenbrauns.
- Foster, Sally M. 1989. "Analysis of Spatial Patterns in Buildings (Access Analysis) as an Insight into Social Structure: Examples from the Scottish Atlantic Iron Age." *Antiquity* 63 (238): 40–50. <https://doi.org/10.1017/S0003598X00075566>.

G

- Griffiths, Sam. 2012. "The Use of Space Syntax in Historical Research: Current Practice and Future Possibilities." In *Proceedings of the Eighth International Space Syntax Symposium*, edited by Margarita Greene, José Reyes, and Andrea Castro, 8193:1-8193:26. Santiago de Chile: PUC.
- Groom, Nigel 1981. *Frankincense and Myrrh: A Study of the Arabian Incense Trade*. Arab Background Series. London: Longman.
- Guarmani, Carlo. 1938. *Northern Najd: A Journey from Jerusalem to Anaiza in Qasim*. Translated by Lady Capel-Cure. London: Argonaut Press.

H

- Hackl, Ursula, Hanna Jenni, and Christoph Schneider. 2003. *Quellen zur Geschichte der Nabatäer: Textsammlung mit Übersetzung und Kommentar*. Novum Testamentum et Orbis Antiquus 51. Göttingen: Universitätsverlag Freiburg Schweiz Vandenhoeck & Ruprecht.
- Hanson, Julianne. 1998. *Decoding Homes and Houses*. Cambridge: Cambridge University Press.
- Hausleiter, Arnulf. 2011. "Ancient Tayma': An Oasis at the Interface Between Cultures. New Research at a Key Location on the Caravan Road." In *Roads of Arabia: The Archaeological Treasures of Saudi Arabia*, edited by Ute Franke and Joachim Gierlich, 102–120. Tübingen: Wasmuth Verlag.
- Hausleiter, Arnulf. 2012. "North Arabian Kingdoms." In *A Companion to the Archaeology of the Ancient Near East*, edited by Daniel T. Potts, 816–32. Blackwell Companions to the Ancient World. Malden, MA: Wiley-Blackwell.
- Hausleiter, Arnulf. 2018. "The Outer Wall of Taymā' and Its Dating to the Bronze Age." In *To the Madbar and Back Again. Studies in the Languages, Archaeology, and Cultures of Arabia Dedicated to Michael C.A. Macdonald*, edited by Laila Nehmé and Ahmad Al-Jallad, 361–91. Studies in Semitic Languages and Linguistics 92. Leiden: Brill. https://doi.org/10.1163/9789004357617_020.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2005. "Tayma 2005. Saudi-German Archaeological Project. Third Season." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2006. "Tayma 2006. Saudi-Arabian – German Archaeological Joint Project. Spring Season." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2007. "Tayma 2007. Saudi-Arabian – German Archaeological Joint Project. Spring Season." Unpublished report.

Bibliography

- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2008. "Tayma 2008. Saudi-Arabian – German Archaeological Joint Project. Spring Season." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2009. "Tayma 2009. Saudi-Arabian – German Archaeological Joint Project. Spring Season." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2011. "Tayma 2011. Saudi Arabian – German Joint Archaeological Project. Spring Season." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2012. "Saudi-German Joint Archaeological Project at Tayma. Spring Season 2012." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2014. "Saudi-German Joint Archaeological Project at Tayma. Spring Season 2014." Unpublished report.
- Hausleiter, Arnulf, and Mohammed Al-Najem, eds. 2015. "Saudi-German Joint Archaeological Project at Tayma. Spring Season 2015." Unpublished report.
- Hausleiter, Arnulf, and Ricardo Eichmann. 2018. "The Archaeological Exploration of the Oasis of Taymā'." In *Taymā' I: Archaeological Exploration, Palaeoenvironment, Cultural Contacts*, edited by Arnulf Hausleiter, Ricardo Eichmann, and Mohammed Al-Najem, 2–58. Taymā': Multidisciplinary Series on the Results of the Saudi-German Archaeological Project 1. Oxford: Archaeopress.
- Hausleiter, Arnulf, Ricardo Eichmann, Mohammed H. al-Najem, and Said al-Said. 2017. "Tayma 2008 – 5th Report on the Joint Saudi Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 24:31–78.
- Hausleiter, Arnulf, Ricardo Eichmann, Mohammed H. al-Najem, and Said al-Said. 2018. "Tayma 2009 – 6th Report on the Joint Saudi Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 25:45–105.
- Hausleiter, Arnulf, Ricardo Eichmann, Mohammed H. al-Najem, and Said al-Said. 2019. "Tayma 2011 – 8th Report on the Joint Saudi Arabian-German Archaeological Project." *ATLAL: The Journal of Saudi Arabian Archaeology* 27:47–99.
- Hausleiter, Arnulf, and Alina Zur. 2016. "Taymā' in the Bronze Age (c. 2000 BCE): Settlement and Funerary Landscapes." In *The Archaeology of North Arabia. Oases and Landscapes. Proceedings of the International Congress Held at the University of Vienna, 5–8 December, 2013*, edited by Marta Luciani, 135–73. OREA - Oriental and European Archaeology 4. Vienna: Austrian Academy of Sciences Press.
- Henrickson, Elizabeth. 1981. "Non-Religious Residential Settlement Patterning in the Late Early Dynastic of the Diyala Region." *Mesopotamia. Rivista di archeologia, epigrafia e storia orientale antica* 16:43–140.
- Hietala, Harold J., ed. 1984. *Intrasite Spatial Analysis in Archaeology*. New Directions in Archaeology. Cambridge: Cambridge University Press.

Bibliography

- Hillier, Bill. 2007. *Space Is the Machine: A Configurational Theory of Architecture*. London: Space Syntax. <http://spaceisthemachine.com/>.
- Hillier, Bill. 2014. "Spatial Analysis and Cultural Information: The Need for Theory as Well as Method in Space Syntax Analysis." In *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, edited by Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla, 19–48. Topoi: Berlin Studies of the Ancient World 18. Berlin: De Gruyter.
- Hillier, Bill, and Julienne Hanson. 2005. *The Social Logic of Space*. Cambridge: Cambridge University Press.
- Hillier, Bill, Julienne Hanson, and Heather Graham. 1987. "Ideas Are in Things: An Application of the Space Syntax Method to Discovering House Genotypes." *Environment and Planning B: Planning and Design* 14 (4): 363–85. <https://doi.org/10.1068/b140363>.
- Hillier, Bill, Adrian Leaman, P. Stansall, and M. Bedford. 1978a. "Reply to Professor Leach." In *Social Organization and Settlement: Contributions from Anthropology, Archaeology and Geography*, edited by David Green, Colin Haselgrove, and Matthew Spriggs, 403–5. BAR International Series 47. Oxford: British Archaeological Reports.
- Hillier, Bill, Adrian Leaman, P. Stansall, and M. Bedford. 1978b. "Space Syntax." In *Social Organization and Settlement: Contributions from Anthropology, Archaeology and Geography*, edited by David Green, Colin Haselgrove, and Matthew Spriggs, 343–81. BAR International Series 47. Oxford: British Archaeological Reports.
- Hodder, Ian, and Clive Orton. 1976. *Spatial Analysis in Archaeology*. Cambridge: Cambridge University Press.
- Hoyland, Robert G. 2001. *Arabia and the Arabs from the Bronze Age to the Coming of Islam*. London: Routledge.
- Huber, Charles. 1891. *Journal d'un voyage en Arabie (1883-1884)*. Paris: Imprimerie nationale.

I

- Intilia, Andrea. 2016. "Qurayyah Painted Ware: A Reassessment of 40 Years of Research on Its Origins, Chronology and Distribution." In *The Archaeology of North Arabia. Oases and Landscapes. Proceedings of the International Congress Held at the University of Vienna, 5-8 December, 2013*, edited by Marta Luciani, 175–255. OREA – Oriental and European Archaeology 4. Vienna: Austrian Academy of Sciences Press.

J

- Jaussen, Antonin, and Raphaël Savignac. (1909) 1997. *Mission archéologique en Arabie*. Vol. II A. Reprint, Le Caire: Institut français d'archéologie orientale.

K

- Keith, Kathryn. 2003. "The Spatial Patterns of Everyday Life in Old Babylonian Neighborhoods." In *The Social Construction of Ancient Cities*, edited by Monica L. Smith, 56–80. Washington, D.C: Smithsonian Institution Press.
- Kirsan, Ciler. 2003. "Detective Work with a Deficient Sample: Syntactic Analysis of the Houses of Conflict." In *Proceedings of the 4th International Space Syntax Symposium*, 57.1–57.28. University College London, London.
- Klarqvist, Björn. 1993. "A Space Syntax Glossary." *Nordisk Arkitekturforskning* 6 (2): 11–2.
- Kohl, Luis. "Eine Baustrukturanalyse des Gebäudes F-b8 in der archäologischen Ausgrabung Tayma (Saudi-Arabien)." BA thesis, Freie Universität Berlin.

L

- Leach, Edmund. 1978. "Does Space Syntax Really 'Constitute the Social'." In *Social Organization and Settlement: Contributions from Anthropology, Archaeology and Geography*, edited by David Green, Colin Haselgrove, and Matthew Spriggs, 385–401. BAR International Series 47. Oxford: British Archaeological Reports.
- Letesson, Quentin. 2009. *Du phénotype au génotype: Analyse de la syntaxe spatiale en architecture minoenne (MMIIIB-MRIB)*. Aegis. Thèses de doctorat 2. Louvain-la-Neuve: Presses universitaires de Louvain.
- Liu, Siran, Thilo Rehren, Ernst Pernicka, and Arnulf Hausleiter. 2015. "Copper Processing in the Oases of Northwest Arabia: Technology, Alloys and Provenance." *Journal of Archaeological Science* 53 (11 November 2014): 492–503. <http://dx.doi.org/10.1016/j.jas.2014.10.030>.
- Lora, Sebastiano. 2017. "A Religious Building Complex in the Ancient Settlement of Tayma (North-West Arabia) during the Nabataean Period: Changes and Transformations." *Syria. Archéologie, art et histoire* 94:17–39.
- Loreto, Romolo. 2011. "Saudi-Italian-French Archaeological Mission in Saudi Arabia, Dūmat al-Jandal 2010. The Excavation of Sector A." *Newsletter di Archeologia CISA* 2:179–217.
- Loreto, Romolo. 2012. "The Saudi-Italian-French Archaeological Mission at Dūmat al-Jandal (Ancient Adumatu). A First Relative Chronological Sequence for Dūmat al-Jandal. Architecture and Pottery." *Proceedings of the Seminar for Arabian Studies* 42:165–82.
- Loreto, Romolo. 2015. "Preliminary Report of the 2014 Campaign of the Italian Archaeological Mission in the Kingdom of Saudi Arabia in the Framework of the Saudi-Italian-French Archaeological Project at Dūmat al-Jandal (Ancient Adummatu)." *Newsletter di Archeologia CISA* 6: 211–21.

Bibliography

- Loreto, Romolo. 2016. "Note on the Activities of the Italian Archaeological Mission in the Kingdom of Saudi Arabia in the Framework of the Saudi-Italian-French Archaeological Project at Dumat." *Newsletter di Archeologia CISA* 7:173–80.
- Loreto, Romolo. 2017a. *Alle origini degli Arabi: un viaggio nell'archeologia dell'Arabia Saudita*. Milano: Mondadori Università.
- Loreto, Romolo. 2017b. "Note on the Eight Season of the Italian Archaeological Mission in the Kingdom Saudi Arabia, Dumat al-Jandal (Ancient Adummatu)." *Newsletter di Archeologia CISA* 8:135–42.
- Loreto, Romolo, and Guillaume Charloux. 2013. "The Saudi-Italian-French Archaeological Project at Dumat al-Jandal (Preliminary Report of the 2012 Season)." *Newsletter di Archeologia CISA* 4:211–51.
- Loreto, Romolo, and Guillaume Charloux. 2018. "Dumat Al-Jandal Excavations 2010-2011 Seasons." *ATLAL: The Journal of Saudi Arabian Archaeology* 25:107–24.
- Lynch, Kevin. 1960. *The Image of the City*. Cambridge, Massachusetts: MIT PRESS.

M

- Macdonald, Michael C. A. 1991. "Was the Nabataean Kingdom a "Bedouin State"?" *Zeitschrift des Deutschen Palästina-Vereins* 107:102–119. <https://www.jstor.org/stable/27931416>.
- Macdonald, Michael C. A. 1997. "Trade Routes and Trade Goods at the Northern End of the 'Incense Road' in the First Millennium BC." In *Profumi d'Arabia: atti del convegno*, edited by Alessandra Avanzini, 333–49. Saggi di storia antica 11. Roma: 'L'Erma' di Bretschneider.
- Macdonald, Michael C. A. 2004. "Ancient North Arabian." In *The Cambridge Encyclopedia of the World's Ancient Languages*, edited by Roger D. Woodard, 488–533. Cambridge: Cambridge University Press.
- Macdonald, Michael C. A. 2009. "Arabs, Arabias, And Arabic Before Late Antiquity." *Topoi. Orient-Occident* 16 (1): 277–332. <https://doi.org/10.3406/topoi.2009.2306>.
- Macdonald, Michael C. A., Aldo Corcella, Touraj Daryaee, Greg Fisher, Matt Gibbs, Ariel Lewin, Donata Violante, and Conor Whately. 2015. "Arabs and Empires before the Sixth Century." In *Arabs and Empires before Islam*, edited by Greg Fisher, 11–89. Oxford: Oxford University Press.
- Magee, Peter. 2014. *The Archaeology of Prehistoric Arabia : Adaptation and Social Formation from the Neolithic to the Iron Age*. Cambridge World Archaeology. Cambridge: Cambridge University Press.

Bibliography

- Marble, Duane F. 1990. "The Potential Methodological Impact of Geographic Information Systems on the Social Sciences." In *Interpreting Space: GIS and Archaeology*, edited by Kathleen M. S. Allen, Stanton W. Green, and Ezra B. W. Zubrow, 9–21. Applications of Geographic Information Systems. London: Taylor & Francis.
- Matthews, Roger. 2012. "About the Archaeological House: Themes and Directions." In *New Perspectives on Household Archaeology*, edited by Bradley J. Parker and Catherine P. Foster, 559–656. Winona Lake, Indiana: Eisenbrauns.
- Mumford, Lewis. 1989. *The City in History: Its Origins, Its Transformations, and Its Prospects*. A Harvest Book. San Diego, California: Harcourt.
- Munday, Frederick C. 1984. "Middle Paleolithic Intrasite Variability and Its Relationship to Regional Patterning." In *Intrasite Spatial Analysis in Archaeology*, edited by Harold J. Hietala, 32–43. New Directions in Archaeology. Cambridge: Cambridge University Press.

N

- Nehmé, Laïla. 2009. "Quelques éléments de réflexion sur Hégra et sa région à partir du II^e siècle après J.-C." In *L'Arabie à la veille de l'Islam: bilan clinique. Table ronde tenue au Collège de France, Paris, les 28 et 29 août 2006, dans le cadre du projet de l'Agence nationale de la recherche "De l'Antiquité tardive à l'Islam"*, edited by Jérémie Schiettecatte and Christian Julien Robin, 37–58. Paris: De Boccard. <https://hal.archives-ouvertes.fr/hal-00681519>.
- Nehmé, Laïla, ed. 2011a. *Report on the Fourth Excavation Season (2011) of the Madā'in Salih Archaeological Project*. With contributions by Wael Abu Wazizeh, Christophe Benech, Guillaume Charloux, Nathalie Delhopital, Caroline Durand, Zbigniew T. Fiema, Khâled Al-Hâitî, Solène Marion De Procé, Nina-Ann Müller, Mâher Al-Mûsa, Jérôme Rohmer, Ibrahim As-Sabban, Isabelle Sachet, Jacqueline Studer, Daifallah Al Talhi, Francelin Tourtet, Jean Humbert, and Silvie Eliès. <https://hal.archives-ouvertes.fr/halshs-00671451>.
- Nehmé, Laïla. 2011b. "The Nabataeans in Northwest Arabia." In *Roads of Arabia: The Archaeological Treasures of Saudi Arabia*, edited by Ute Franke and Joachim Gierlichs, 136–44. Tübingen: Wasmuth Verlag.
- Nehmé, Laïla, ed. 2015. *Report on the Fifth Season (2014) of the Madā'in Salih Archaeological Project*. With contributions by Wael Abu-Azizeh, Thomas Bauzou, Nathalie Delhopital, Caroline Durand, Khalid Alhaiti, Mahmoud al-Hajiri, Maher Al-Musa, Laïla Nehmé, Jérôme Rohmer, Ibrahim As-Sabban, Jacqueline Studer, Laurent Tholbecq, and François Villeneuve. <https://hal.archives-ouvertes.fr/halshs-01122002>.

Bibliography

- Nehmé, Laïla, ed. 2016a. *Madâ'in Sâlih Archaeological Project. Report on the 2015 Season*. With contributions by Khalid Alhaiti, Charlène Bouchaud, Nathalie Delhopital, Caroline Durand, Zbigniew T. Fiema, Yvonne Gerber, Laïla Nehmé, Laurent Tholbecq, François Villeneuve, and Jean Humbert. <https://hal.archives-ouvertes.fr/halshs-01311865>.
- Nehmé, Laïla, ed. 2016b. *Madâ'in Sâlih Archaeological Project. Report on the 2016 Season*. With contributions by Khalid Alhaiti, Thomas Bauzou, Pierre-Marie Blanc, Patricia Dal-Prà, Caroline Durand, Damien Gazagne, Zbigniew T. Fiema, Yvonne Gerber, Laurence Hapiot, Gilles Lubineau, Mohammad Al-Mathami, Maher Al-Musa, Laïla Nehmé, Marie Peillet, Jacqueline Studer, Daifallah Al-Tahli, François Villeneuve, and Rozenn Douaud. <https://hal.archives-ouvertes.fr/hal-01518460>.
- Nehmé, Laïla, ed. 2018a. *Report on the 2017 Season of the Madâ'in Sâlih Archaeological Project*. With contributions by Pierre-Marie Blanc, Thomas Bauzou, Caroline Durand, Zbigniew T. Fiema, Damien Gazagne, Yvonne Gerber, Khalid Alhaiti, Ahmad Al-Jallad, Mohammad Al-Mathami, Maher Al-Musa, Marie Peillet, Jérôme Rohmer, Irene Rossi, Ibrahim As-Sabhan, Delphine Seigneuret, Jacqueline Studer, François Villeneuve, Jean Humbert, and Rozenn Douaud. <https://hal.archives-ouvertes.fr/hal-01804965>.
- Nehmé, Laïla, ed. 2018b. *Mission archéologique de Madâ'in Sâlih. Rapport de la campagne 2018*. With contributions by Charlène Bouchaud, Caroline Durand, Pierre-Louis Gatier, Yvonne Gerber, Martine Leguilloux, Juliette Milon, Laïla Nehmé, Marie-Dominique Nenna, Rozenn Douaud, and Ariadni Ilioglou. <https://hal.archives-ouvertes.fr/hal-02096625>.
- Nehmé, Laïla, Daifallah Al-Talhi, and François Villeneuve. 2010a. *Hegra I – Report on the First Excavation Season at Madâ'in Sâlih: 2008 Saudi Arabia*. With contributions by Wael Abu-Azizeh, Charlène Bouchaud, Guillaume Charloux, Nathalie Delhopital, Caroline Durand, Zbigniew T. Fiema, Mathilde Gelin, Yvonne Gerber, Mahmoud al-Hajri, Solène Marion De Procé, Maher Al-Musa, Laïla Nehmé, Jérôme Rohmer, Isabelle Sachet, François Villeneuve, and Jean Humbert. Series of Refereed Archaeological Studies, 6. Riyadh: Saudi Commission for Tourism and Antiquities.
- Nehmé, Laïla, Daifallah al-Talhi, and François Villeneuve. 2010b. *Report on the Third Excavation Season (2010) of the Madâ'in Sâlih Archaeological Project*. With contributions by Christian Augé, Christophe Benech, Charlène Bouchaud, Paul Courbon, Eric Fouache, Guillaume Charloux, Caroline Durand, Zbigniew T. Fiema, Yvonne Gerber, Solène Marion De Procé, Laïla Nehmé, Jérôme Rohmer, Jacqueline Studer, François Villeneuve, Jean Humbert, and Sylvie Eliès. <https://halshs.archives-ouvertes.fr/halshs-00542793>.

Bibliography

Nehmé, Laïla, François Villeneuve, and Daifallah Al Talhi. 2011. *Report on the Second Season (2009) of the Madâ'in Sâlih Archaeological Project*. With contributions by Abdulhâdî Al Anzi, Charlène Bouchaud, Guillaume Charloux, Nathalie Delhopital, Caroline Durand, Zbigniew T. Fiema, Yvonne Gerber, Mahmoud Al Hajîrî, Solène Marion De Procé, Mutlaq Al Mutlaq, Jérôme Rohmer, Isabelle Sachet, Jean Humbert, and Sylvie Eliès. <https://halshs.archives-ouvertes.fr/halshs-00548747>.

Novák, Mirko. 1999. *Herrschaftsform und Stadtbaukunst: Programmatik im mesopotamischen Residenzstadtbau von Agade bis Surra Man Ra'ā*. Schriften zur vorderasiatischen Archäologie 7. Saarbrücken: Saarbrücker Druckerei und Verlag.

O

Osman, Khadiga M., and Mamoun Suliman. 1994. "The Space Syntax Methodology: Fits and Misfits." *Architecture and Behaviour* 10 (2): 189–204.

Ostwald, Michael J. 2011. "The Mathematics of Spatial Configuration: Revisiting, Revising and Critiquing Justified Plan Graph Theory." *Nexus Network Journal* 13, no. 2 (9 June 2011): 445–70. <https://doi.org/10.1007/s00004-011-0075-3>.

P

Paliou, Eleftheria. 2014. "Introduction." In *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, edited by Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla, 1–17. Topoi: Berlin Studies of the Ancient World 18. Berlin: De Gruyter.

Paliou, Eleftheria, Undine Lieberwirth, and Silvia Polla, eds. 2014. *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*. Topoi: Berlin Studies of the Ancient World 18. Berlin: De Gruyter.

Papaconstantinou, Demetra. 2006. *Identifying Domestic Space in the Neolithic Eastern Mediterranean: Method and Theory in Spatial Studies*. BAR International Series 1480. Oxford: Archaeopress.

Parker, Robert Nash, and Emily K. Asencio. 2008. *GIS and Spatial Analysis for the Social Sciences: Coding, Mapping and Modelling*. Contemporary Sociological Perspectives. New York: Routledge.

Petiti, Emmanuele. 2013. "People of Tayma. Bioarchaeological Analysis of the 4th-3rd Century B.C. Burial Ground from Tayma (Kingdom of Saudi Arabia)." PhD dissertation, Università degli Studi di Firenze.

Pfälzner, Peter. 2001. *Haus und Haushalt: Wohnformen des dritten Jahrtausends vor Christus in Nordmesopotamien*. Damaszener Forschungen 9. Mainz am Rhein: Phillip von Zabern.

Philby, Harry St. John Bridger. 1957. *Land Of Midian*. Ernest Benn.

Bibliography

- Politis, Konstantinos D., ed. 2007. *The World of the Nabateans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans" Held at the British Museum, 17 - 19 April 2001*. Oriens et Occidens 15. Stuttgart: Franz Steiner Verlag.
- Potts, Daniel T. 1988. "Trans-Arabian Routes of the Pre-Islamic Period." In *L'Arabie et ses mers bordières. I. Itinéraires et voisinages. Séminaire de recherche 1985-1986*, edited by Jean-François Salles, 127–62. Travaux de la Maison de l'Orient 16. Lyon: G. S. Maison de l'Orient et de la Méditerranée.
- Purschwitz, Christoph. [2009?]. "The Residential Architecture of Area F and E-South. Results on Stratigraphy, Chronology and Development of an Oasis Quarter from the Late Iron Age to Pre-Islamic Times (2005 to 2009 Seasons of Excavations)." Unpublished report.
- Purschwitz, Christoph. 2017. "The Prehistory of Tayma: The Chipped Stone Evidence. The Surface Finds and a Techno-Typological Analysis of Chert Artefacts from the Carnelian Bead Workshop SE 2." *Zeitschrift für Orient-Archäologie* 10:288–311.
- R**
- Rainville, Lynn. 2005. *Investigating Upper Mesopotamian Households Using Micro-Archaeological Techniques*. BAR International Series 1368. Oxford: Archaeopress.
- Ratti, Carlo. 2004. "Space Syntax: Some Inconsistencies." *Environment and Planning B: Planning and Design* 31 (4): 487–99. <https://doi.org/10.1068/b3019>.
- Retsö, Jan. 2003. *The Arabs in Antiquity: Their History from the Assyrians to the Umayyads*. London: Routledge.
- Robertson, Elizabeth C., Jeffrey D. Seibert, Deepika C. Fernandez, and Marc U. Zender, eds. 2006. *Space and Spatial Analysis in Archaeology*. Calgary: University of Calgary Press.
- Rohmer, Jérôme, and Guillaume Charloux. 2015. "From Lihyān to the Nabataeans: Dating the End of the Iron Age in Northwestern Arabia." *Proceedings of the Seminar for Arabian Studies* 45:297–320.
- Rohmer, Jérôme, and Zbigniew T. Fiema. 2016. "Early Hegra: New Insights from the Excavations in Areas 2 and 9 at Mada'in Salih (Saudi Arabia)." In *The Archaeology of North Arabia. Oases and Landscapes. Proceedings of the International Congress Held at the University of Vienna, 5-8 December, 2013*, edited by Marta Luciani, 281–316. OREA – Oriental and European Archaeology 4. Vienna: Austrian Academy of Sciences Press.
- Rossi, Aldo. 2007. *The Architecture of the City*. Oppositions Books. Cambridge, Massachusetts: MIT Press.

S

- Sanders, Donald. 1990. "Behavioral Conventions and Archaeology: Methods for the Analysis of Ancient Architecture." In *Domestic Architecture and the Use of Space: An Interdisciplinary Cross-Cultural Study*, edited by Susan Kent, 43–72. New Directions in Archaeology. Cambridge: Cambridge University Press.
- Schaudig, Hanspeter. 2001. *Die Inschriften Nabonids von Babylon und Kyros' des Grossen samt den in ihrem Umfeld entstandenen Tendenzschriften: Textausgabe und Grammatik*. Alter Orient und Altes Testament 256. Münster: Ugarit-Verlag.
- Schiettecatte, Jérémie. 2013. "À la veille de l'islam: effondrement ou transformation du monde antique?" In *Les préludes de l'islam. Ruptures et continuités des civilisations du Proche-Orient, de l'Afrique orientale, de l'Arabie et de l'Inde à la veille de l'Islam*, edited by Christian Julien Robin and Jérémie Schiettecatte, 9–36. Orient et Méditerranée 11. Paris: De Boccard. <https://halshs.archives-ouvertes.fr/halshs-00914206>.
- Seibert, Jeffrey D. 2006. "Introduction." In *Space and Spatial Analysis in Archaeology*, edited by Elizabeth C. Robertson, Jeffrey D. Seibert, Deepika C. Fernandez, and Marc U. Zender, xiii–xxiv. Calgary: University of Calgary Press.
- Sperveslage, Gunnar. 2013. "Ägyptische Einflüsse auf der Arabischen Halbinsel in vorislamischer Zeit am Beispiel der Oase von Tayma." *Zeitschrift für Orient-Archäologie* 6:234–52.
- Stadler, Peter. 1985. "Was ist 'Spatial Analysis' in der Archäologie." *Mitteilungen Der Anthropologischen Gesellschaft in Wien* 115:163–68.
- Starzmann, Maria Theresia. 2007. *Archäologie des Raumes: soziale Praxis und kulturelle Bedeutung am Beispiel der Wohnarchitektur von Fara*. Wiener offene Orientalistik 5. Wien: LIT.
- Stöger, Hanna. 2008. "Roman Ostia: Space Syntax and the Domestication of Space." In *Layers of Perception. Proceedings of the 35th International Conference on Computer Applications and Quantitative Methods in Archaeology (CAA), Berlin, April 26, 2007*, edited by Axel Posluschny, Karsten Lambers, and Irmela Herzog, 322–27. Kolloquien zur Vor- und Frühgeschichte 10. Bonn: Dr. Rudolf Habelt GmbH. <http://hdl.handle.net/1887/14459>.

T

- Teklenburg, Jan A. F., Harry J. P. Timmermans, and Andreas F. van Wageningen. 1993. "Space Syntax: Standardised Integration Measures and Some Simulations." *Environment and Planning B: Planning and Design* 20, no. 3 (1 June 1993): 347–57. <https://doi.org/10.1068/b200347>.

Bibliography

Tomé, André. 2015. "Circulating through the City: An Analysis of Movement and Urban Space of a Northern Mesopotamian City." In *Broadening Horizons 4. A Conference of Young Researchers Working in the Ancient Near East, Egypt and Central Asia, University of Torino, October 2011*, edited by Giorgio Affanni, Cristina Baccarin, Laura Cordera, Angelo Di Michele, and Katia Gavagnin, 9–20. BAR International Series 2698. Oxford: Archaeopress.

Tourtet, Francelin, and Friedrich Weigel. 2015. "Taymā' in the Nabataean Kingdom and in Provincia Arabia." In *Proceedings of the Seminar for Arabian Studies* 45:385–404.

V

Van Dyke, Ruth M. 1999. "Space Syntax Analysis at the Chacoan Outlier of Guadalupe." *American Antiquity* 64 (3): 461–73. <https://www.jstor.org/stable/2694146>.

W

Weigel, Friedrich Wilhelm. 2019. "Dwelling(s) in a Northwest Arabian Oasis: Decoding Residential Architecture at Taymā'." *Arabian Archaeology and Epigraphy* 30:103–33.

Wells, Johua J. 2009. "A Space Syntax Analysis of Dohack and Range Phase Villages in the American Bottom." In *Tools of the Trade: Methods, Techniques and Innovative Approaches in Archaeology*, edited by Jayne Wilkins and Kirsten Anderson, 257–73. Calgary: University of Calgary Press. <http://www.jstor.org/stable/j.ctv6gqwx0.19>.

Wenning, Robert. 2007. "The Nabataeans in History." In *The World of the Nabateans. Volume 2 of the International Conference "The World of the Herods and the Nabataeans" Held at the British Museum, 17 - 19 April 2001*, edited by Konstantinos D. Politis, 25–44. *Oriens et Occidens* 15. Stuttgart: Franz Steiner Verlag.

Wheatley, David. 2014. "Connecting Landscapes with Built Environments: Visibility Analysis, Scale and the Senses." In *Spatial Analysis and Social Spaces: Interdisciplinary Approaches to the Interpretation of Prehistoric and Historic Built Environments*, edited by Eleftheria Paliou, Undine Lieberwirth, and Silvia Polla, 115–134. *Topoi: Berlin Studies of the Ancient World* 18. Berlin: De Gruyter. <https://doi.org/10.1515/9783110266436>.

Wheatley, David, and Mark Gillings. 2002. *Spatial Technology and Archaeology: The Archaeological Applications of GIS*. New York: Taylor & Francis.

Winnett, Frederick V., and William L. Reed. 1970. *Ancient Records from North Arabia*. Near and Middle East Series 6. Toronto: University of Toronto Press.

Wynbrandt, James. 2010. *A Brief History of Saudi Arabia*. New York: Facts On File.

Bibliography

Z

Zevi, Bruno. 1993. *Architecture as Space: How to Look at Architecture*. New York: Da Capo Press.

Software

Manum, B., E. Rusten, and P. Benze. 2017. *AGRAPH, Software for Drawing and Calculating Space Syntax 'Node-Graphs' and Space Syntax 'Axial-Maps.'* <http://www.ntnu.no/ab/spacesyntax/05.07.2017> (downloaded July 2017).

ATTACHEMENT

SPACE SYNTAX CATALOGUE

CONTENT CATALOGUE

Building F-b3	II
Building E-b15 var. 1	III
Building E-b15 var. 2	IV
Building F-b1 East var. 1	V
Building F-b1 East var. 2	VI
Building F-b1 West	VII
Building F-b2	VIII
Building F-b4	IX
Building F-b7	X
Building F-b12	XI
Building E-b11	XII
Building F-b5 var. 1	XIII
Building F-b5 var. 2	XIV
Building F-b8 (Phase 1)	XV
Building E-b7	XVI
Building F-b8 (Phase 2)	XVII

Building F-b3

Visitor-inhabitant relationship (K=7; D=0.340)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b3:F-s3	-	A	1	1.000	0.500	21	3.500	1.000	2.944
F-b3:R1	24.70	B	2	0.500	1.500	16	2.667	0.667	1.963
F-b3:R2	28.30	B	2	0.500	1.000	13	2.167	0.467	1.374
F-b3:R3	86.70	B	2	0.500	1.000	12	2.000	0.400	1.178
F-b3:R4	8.00	A	1	1.000	0.500	21	3.500	1.000	2.944
F-b3:R5	9.70	B	2	0.500	1.000	13	2.167	0.467	1.374
F-b3:R6	-	B	2	0.500	1.500	16	2.667	0.667	1.963

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b3:R1	24.70	B	2	0.500	1.500	7	1.750	0.500	1.420
F-b3:R2	28.30	B	2	0.500	1.000	6	1.500	0.333	0.947
F-b3:R3	86.70	B	2	0.500	1.500	7	1.750	0.500	1.420
F-b3:R4	8.00	A	1	1.000	0.500	10	2.500	1.000	2.841
F-b3:R5	9.70	A	1	1.000	0.500	10	2.500	1.000	2.841

Building E-b15 var. 1

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b15:F-s8	-	A	1	1.000	0.333	12	2.400	0.700	2.006
E-b15:R1	2.20	A	1	1.000	0.500	14	2.800	0.900	2.579
E-b15:R2	16.30	B	2	0.500	1.500	10	2.000	0.500	1.433
E-b15:R3	7.50	B	2	0.500	0.833	8	1.600	0.300	0.860
E-b15:R4	14.40	B	3	0.333	2.500	8	1.600	0.300	0.860
E-b15:R5	26.80	A	1	1.000	0.333	12	2.400	0.700	2.006

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b15:R1	2.20	A	1	1.000	0.500	10	2.500	1.000	2.841
E-b15:R2	16.30	B	2	0.500	1.500	7	1.750	0.500	1.420
E-b15:R3	7.50	B	2	0.500	1.000	6	1.500	0.333	0.947
E-b15:R4	14.40	B	2	0.500	1.500	7	1.750	0.500	1.420
E-b15:R5	26.80	A	1	1.000	0.500	10	2.500	1.000	2.841

Building E-b15 var. 2

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b15:F-s8	-	A	1	1.000	0.333	11	2.200	0.600	1.719
E-b15:R1	2.20	A	1	1.000	0.333	11	2.200	0.600	1.719
E-b15:R2	16.30	A	1	1.000	0.333	11	2.200	0.600	1.719
E-b15:R3	7.50	B	3	0.333	2.333	7	1.400	0.200	0.573
E-b15:R4	14.40	B	3	0.333	2.333	7	1.400	0.200	0.573
E-b15:R5	26.80	A	1	1.000	0.333	11	2.200	0.600	1.719

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b15:R1	2.20	A	1	1.000	0.333	8	2.000	0.667	1.894
E-b15:R2	16.30	A	1	1.000	0.333	8	2.000	0.667	1.894
E-b15:R3	7.50	B	3	0.333	2.500	5	1.250	0.167	0.473
E-b15:R4	14.40	B	2	0.500	1.333	6	1.500	0.333	0.947
E-b15:R5	26.80	A	1	1.000	0.500	9	2.250	0.833	2.367

Building F-b1 East var. 1

Visitor-inhabitant relationship (K=11; D=0.295)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:F-s5	-	A	1	1.000	0.500	40	4.000	0.667	2.261
F-b1:R9	4.70	A	1	1.000	0.143	25	2.500	0.333	1.130
F-b1:R10	6.40	B	2	0.500	0.643	19	1.900	0.200	0.678
F-b1:R11	26.30	B	7	0.143	6.500	16	1.600	0.133	0.452
F-b1:R12	2.50	A	1	1.000	0.143	25	2.500	0.333	1.130
F-b1:R13	3.30	A	1	1.000	0.143	25	2.500	0.333	1.130
F-b1:R14	2.30	A	1	1.000	0.143	25	2.500	0.333	1.130
F-b1:R15	2.50	A	1	1.000	0.143	25	2.500	0.333	1.130
F-b1:R16	-	B	2	0.500	1.500	29	2.900	0.422	1.432
F-b1:R17	9.20	B	2	0.500	1.000	24	2.400	0.311	1.055
F-b1:R18	3.20	A	1	1.000	0.143	25	2.500	0.333	1.130

Inhabitant-inhabitant relationship (K=9; D=0.317)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:R9	4.70	A	1	1.000	0.143	16	2.000	0.286	0.902
F-b1:R10	6.40	B	2	0.500	1.143	14	1.750	0.214	0.676
F-b1:R11	26.30	B	7	0.143	6.500	9	1.125	0.036	0.113
F-b1:R12	2.50	A	1	1.000	0.143	16	2.000	0.286	0.902
F-b1:R13	3.30	A	1	1.000	0.143	16	2.000	0.286	0.902
F-b1:R14	2.30	A	1	1.000	0.143	16	2.000	0.286	0.902
F-b1:R15	2.50	A	1	1.000	0.143	16	2.000	0.286	0.902
F-b1:R17	9.20	A	1	1.000	0.500	21	2.625	0.464	1.466
F-b1:R18	3.20	A	1	1.000	0.143	16	2.000	0.286	0.902

Building F-b1 East var. 2

Visitor-inhabitant relationship (K=12; D=0.285)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:F-s5	-	A	1	1,000	0,500	46	4,182	0,636	2,234
F-b1:R9	4,70	A	1	1,000	0,143	28	2,545	0,309	1,085
F-b1:R10	6,40	B	2	0,500	0,643	22	2,000	0,200	0,702
F-b1:R11	26,30	B	7	0,143	6,000	18	1,636	0,127	0,447
F-b1:R12	2,50	A	1	1,000	0,143	28	2,545	0,309	1,085
F-b1:R13	3,30	A	1	1,000	0,143	28	2,545	0,309	1,085
F-b1:R14	2,30	A	1	1,000	0,143	28	2,545	0,309	1,085
F-b1:R15	2,50	B	2	0,500	1,143	26	2,364	0,273	0,957
F-b1:R16	-	B	2	0,500	1,500	36	3,273	0,455	1,596
F-b1:R17	9,20	B	2	0,500	1,000	28	2,545	0,309	1,085
F-b1:R18	3,20	A	1	1,000	0,143	28	2,545	0,309	1,085
F-b1:R19	1,90	A	1	1,000	0,500	36	3,273	0,455	1,596

Inhabitant-inhabitant relationship (K=10; D=0.306)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:R9	4,70	A	1	1,000	0,143	19	2,111	0,278	0,909
F-b1:R10	6,40	B	2	0,500	1,143	17	1,889	0,222	0,727
F-b1:R11	26,30	B	7	0,143	6,000	11	1,222	0,056	0,182
F-b1:R12	2,50	A	1	1,000	0,143	19	2,111	0,278	0,909
F-b1:R13	3,30	A	1	1,000	0,143	19	2,111	0,278	0,909
F-b1:R14	2,30	A	1	1,000	0,143	19	2,111	0,278	0,909
F-b1:R15	2,50	B	2	0,500	1,143	17	1,889	0,222	0,727
F-b1:R17	9,20	A	1	1,000	0,500	25	2,778	0,444	1,455
F-b1:R18	3,20	A	1	1,000	0,143	19	2,111	0,278	0,909
F-b1:R19	1,90	A	1	1,000	0,500	25	2,778	0,444	1,455

Building F-b1 West

Visitor-inhabitant relationship (K=7; D=0.340)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:F-s2	-	A	1	1,000	0,333	14	2,333	0,533	1,570
F-b1:R1	7,60	A	1	1,000	0,500	17	2,833	0,733	2,159
F-b1:R2	15,10	B	2	0,500	1,333	12	2,000	0,400	1,178
F-b1:R3	9,40	A	1	1,000	0,333	15	2,500	0,600	1,767
F-b1:R4	42,40	B	3	0,333	1,833	9	1,500	0,200	0,589
F-b1:R5	7,30	B	3	0,333	2,333	10	1,667	0,267	0,785
F-b1:R8	7,90	A	1	1,000	0,333	15	2,500	0,600	1,767

Inhabitant-inhabitant relationship (K=6; D=0.349)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b1:R1	7,60	A	1	1,000	0,500	14	2,800	0,900	2,579
F-b1:R2	15,10	B	2	0,500	1,500	10	2,000	0,500	1,433
F-b1:R3	9,40	A	1	1,000	0,333	12	2,400	0,700	2,006
F-b1:R4	42,40	B	2	0,500	0,833	8	1,600	0,300	0,860
F-b1:R5	7,30	B	3	0,333	2,500	8	1,600	0,300	0,860
F-b1:R8	7,90	A	1	1,000	0,333	12	2,400	0,700	2,006

Building F-b2

Visitor-inhabitant relationship (K=7; D=0.340)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b2:F-s7	-	A	1	1,000	0,250	14	2,333	0,533	1,570
F-b2:R1	5,20	B	2	0,500	1,500	13	2,167	0,467	1,374
F-b2:R2	3,70	A	1	1,000	0,500	18	3,000	0,800	2,355
F-b2:R3	4,60	A	1	1,000	0,250	14	2,333	0,533	1,570
F-b2:R4	4,80	B	2	0,500	0,750	10	1,667	0,267	0,785
F-b2:R5	36,90	B	4	0,250	3,500	9	1,500	0,200	0,589
F-b2:R6	32,70	A	1	1,000	0,250	14	2,333	0,533	1,570

Inhabitant-inhabitant relationship (K=6; D=0.349)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b2:R1	5,20	B	2	0,500	1,500	10	2,000	0,500	1,433
F-b2:R2	3,70	A	1	1,000	0,500	14	2,800	0,900	2,579
F-b2:R3	4,60	A	1	1,000	0,333	12	2,400	0,700	2,006
F-b2:R4	4,80	B	2	0,500	0,833	8	1,600	0,300	0,860
F-b2:R5	36,90	B	3	0,333	2,500	8	1,600	0,300	0,860
F-b2:R6	32,70	A	1	1,000	0,333	12	2,400	0,700	2,006

Building F-b4

Visitor-inhabitant relationship (K=7; D=0.340)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b4:alley	-	A	1	1,000	0,250	13	2,167	0,467	1,374
F-b4:R1	1,80	A	1	1,000	0,500	16	2,667	0,667	1,963
F-b4:R2	11,50	B	4	0,250	3,000	8	1,333	0,133	0,393
F-b4:R3	17,20	A	1	1,000	0,250	13	2,167	0,467	1,374
F-b4:staircase	-	B	2	0,500	1,250	11	1,833	0,333	0,981
F-b4:other floor?	-	A	1	1,000	0,500	16	2,667	0,667	1,963
F-b4:not excavated	30,70	B	2	0,500	1,250	11	1,833	0,333	0,981

Inhabitant-inhabitant relationship (K=6; D=0.349)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b4:R1	1,80	A	1	1,000	0,500	13	2,600	0,800	2,292
F-b4:R2	11,50	B	3	0,333	2,000	7	1,400	0,200	0,573
F-b4:R3	17,20	A	1	1,000	0,333	11	2,200	0,600	1,719
F-b4:staircase	-	B	2	0,500	1,333	9	1,800	0,400	1,146
F-b4:other floor?	-	A	1	1,000	0,500	13	2,600	0,800	2,292
F-b4:not excavated	30,70	B	2	0,500	1,333	9	1,800	0,400	1,146

Building F-b7

Visitor-inhabitant relationship (K=9; D=0.317)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b7:F-s4	-	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R1	14,50	B	7	0,143	6,500	9	1,125	0,036	0,113
F-b7:R2	2,50	B	2	0,500	1,143	14	1,750	0,214	0,676
F-b7:R3	3,50	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R4	0,50	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R5	1,00	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R6	0,80	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R7	0,80	A	1	1,000	0,143	16	2,000	0,286	0,902
F-b7:R8	4,60	A	1	1,000	0,500	21	2,625	0,464	1,466

Inhabitant-inhabitant relationship (K=8; D=0.328)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b7:R1	14,50	B	6	0,167	5,500	8	1,143	0,048	0,145
F-b7:R2	2,50	B	2	0,500	1,167	12	1,714	0,238	0,725
F-b7:R3	3,50	A	1	1,000	0,167	14	2,000	0,333	1,015
F-b7:R4	0,50	A	1	1,000	0,167	14	2,000	0,333	1,015
F-b7:R5	1,00	A	1	1,000	0,167	14	2,000	0,333	1,015
F-b7:R6	0,80	A	1	1,000	0,167	14	2,000	0,333	1,015
F-b7:R7	0,80	A	1	1,000	0,167	14	2,000	0,333	1,015
F-b7:R8	4,60	A	1	1,000	0,500	18	2,571	0,524	1,595

Building F-b12

Visitor-inhabitant relationship (K=8; D=0.328)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b12:F-s8	-	A	1	1,000	0,500	24	3,429	0,810	2,465
F-b12:R1	17,00	B	2	0,500	1,000	16	2,286	0,429	1,305
F-b12:R2	14,60	A	1	1,000	0,333	20	2,857	0,619	1,885
F-b12:R3	27,10	B	3	0,333	2,000	14	2,000	0,333	1,015
F-b12:R4	2,70	B	2	0,500	1,333	18	2,571	0,524	1,595
F-b12:R5	2,50	B	2	0,500	0,833	14	2,000	0,333	1,015
F-b12:staircase	-	B	2	0,500	1,500	20	2,857	0,619	1,885
F-b12:other floor?	-	A	1	1,000	1,000	26	3,714	0,905	2,755

Inhabitant-inhabitant relationship (K=7; D=0.340)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b12:R1	17,00	B	2	0,500	1,000	12	2,000	0,400	B
F-b12:R2	14,60	A	1	1,000	0,333	17	2,833	0,733	A
F-b12:R3	27,10	B	3	0,333	2,500	12	2,000	0,400	B
F-b12:R4	2,70	A	1	1,000	0,333	17	2,833	0,733	A
F-b12:R5	2,50	B	2	0,500	0,833	11	1,833	0,333	B
F-b12:staircase	-	B	2	0,500	1,500	15	2,500	0,600	B
F-b12:other floor?	-	A	1	1,000	0,500	20	3,333	0,933	A

Building E-b11

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b11:F-s8	-	A	1	1,000	0,333	11	2,200	0,600	1,719
E-b11:R1	30,50	B	3	0,333	2,000	7	1,400	0,200	0,573
E-b11:R2	9,20	B	2	0,500	1,333	9	1,800	0,400	1,146
E-b11:R3	12,60	A	1	1,000	0,500	13	2,600	0,800	2,292
E-b11:staircase	-	B	2	0,500	1,333	9	1,800	0,400	1,146
E-b11:upper floor?	-	A	1	1,000	0,500	13	2,600	0,800	2,292

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b11:R1	30,50	B	2	0,500	1,000	6	1,500	0,333	B
E-b11:R2	9,20	B	2	0,500	1,500	7	1,750	0,500	B
E-b11:R3	12,60	A	1	1,000	0,500	10	2,500	1,000	A
E-b11:staircase	-	B	2	0,500	1,500	7	1,750	0,500	B
E-b11:upper floor?	-	A	1	1,000	0,500	10	2,500	1,000	A

Building F-b5 var. 1

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b5:F-s8	-	A	1	1,000	0,500	13	2,600	0,800	2,292
F-b5:R1	2,80	A	1	1,000	0,333	11	2,200	0,600	1,719
F-b5:R2	28,20	B	3	0,333	2,000	7	1,400	0,200	0,573
F-b5:R3	15,30	B	2	0,500	1,333	9	1,800	0,400	1,146
F-b5:R4	26,70	B	2	0,500	1,333	9	1,800	0,400	1,146
F-b5:R5	10,80	A	1	1,000	0,500	13	2,600	0,800	2,292

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b5:R1	2,80	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b5:R2	28,20	B	3	0,333	2,500	5	1,250	0,167	0,473
F-b5:R3	15,30	B	2	0,500	1,333	6	1,500	0,333	0,947
F-b5:R4	26,70	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b5:R5	10,80	A	1	1,000	0,500	9	2,250	0,833	2,367

Building F-b5 var. 2

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b5:F-s8	-	A	1	1,000	0,333	12	2,400	0,700	2,006
F-b5:R1	2,80	A	1	1,000	0,333	12	2,400	0,700	2,006
F-b5:R2	28,20	B	2	0,500	0,833	8	1,600	0,300	0,860
F-b5:R3	15,30	B	2	0,500	1,500	10	2,000	0,500	1,433
F-b5:R4	26,70	B	3	0,333	2,500	8	1,600	0,300	0,860
F-b5:R5	10,80	A	1	1,000	0,500	14	2,800	0,900	2,579

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b5:R1	2,80	A	1	1,000	0,500	10	2,500	1,000	A
F-b5:R2	28,20	B	2	0,500	1,000	6	1,500	0,333	B
F-b5:R3	15,30	B	2	0,500	1,500	7	1,750	0,500	B
F-b5:R4	26,70	B	2	0,500	1,500	7	1,750	0,500	B
F-b5:R5	10,80	A	1	1,000	0,500	10	2,500	1,000	A

Building F-b8 (Phase 1)

Visitor-inhabitant relationship (K=5; D=0.352)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b8:F-s8	-	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b8:R1	14,20	A	1	1,000	0,500	9	2,250	0,833	2,367
F-b8:R2	15,40	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b8:R3	32,60	B	2	0,500	1,333	6	1,500	0,333	0,947
F-b8:R4	2,20	B	3	0,333	2,500	5	1,250	0,167	0,473

Inhabitant-inhabitant relationship (K=4; D=0.333)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b8:R1	14,20	A	1	1,000	0,500	6	2,000	1,000	3,000
F-b8:R2	15,40	A	1	1,000	0,500	6	2,000	1,000	3,000
F-b8:R3	32,60	B	2	0,500	1,500	4	1,333	0,333	1,000
F-b8:R4	2,20	B	2	0,500	1,500	4	1,333	0,333	1,000

Building E-b7

Visitor-inhabitant relationship (K=6; D=0.349)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b7:F-s8	-	A	1	1,000	0,333	11	2,200	0,600	1,719
E-b7:R1	35,30	B	3	0,333	2,333	7	1,400	0,200	0,573
E-b7:R2	18,60	B	3	0,333	2,333	7	1,400	0,200	0,573
E-b7:R3	6,00	A	1	1,000	0,333	11	2,200	0,600	1,719
E-b7:R4	8,50	A	1	1,000	0,333	11	2,200	0,600	1,719
E-b7:R5	1,50	A	1	1,000	0,333	11	2,200	0,600	1,719

Inhabitant-inhabitant relationship (K=5; D=0.352)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
E-b7:R1	35,30	B	2	0,500	1,333	6	1,500	0,333	0,947
E-b7:R2	18,60	B	3	0,333	2,500	5	1,250	0,167	0,473
E-b7:R3	6,00	A	1	1,000	0,333	8	2,000	0,667	1,894
E-b7:R4	8,50	A	1	1,000	0,500	9	2,250	0,833	2,367
E-b7:R5	1,50	A	1	1,000	0,333	8	2,000	0,667	1,894

Building F-b8 (Phase 2)

Visitor-inhabitant relationship (K=5; D=0.352)

		visitor-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b8:F-s8	-	A	1	1,000	0,500	9	2,250	0,833	2,367
F-b8:R1	14,20	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b8:R2	15,70	A	1	1,000	0,333	8	2,000	0,667	1,894
F-b8:R3	32,60	B	3	0,333	2,500	5	1,250	0,167	0,473
F-b8:R4	2,20	B	2	0,500	1,333	6	1,500	0,333	0,947

Inhabitant-inhabitant relationship (K=4; D=0.333)

		inhabitant-inhabitant relationship							
node	area	type	NC	CVe	CV	TD	MD	RA	RRA
F-b8:R1	14,20	A	1	1,000	0,333	5	1,667	0,667	2,000
F-b8:R2	15,70	A	1	1,000	0,333	5	1,667	0,667	2,000
F-b8:R3	32,60	B	3	0,333	3,000	3	1,000	0,000	0,000
F-b8:R4	2,20	A	1	1,000	0,333	5	1,667	0,667	2,000