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MAIN SECTION

Bridging the Gap: Morphological Mapping of the Beqaa's Vernacular Built Environment

Lynn Abdouni — College of Engineering, University of Georgia, USA
Contact: abdouni@uga.edu

ABSTRACT

Located 30 km inland from Lebanon's coast, The Beqaa Valley (or Beqaa Plains) is considered the agricultural backbone of the country. The Beqaa's built geographies were shaped by the political and economic hierarchies established by the Roman and Ottoman Empires and revised by the French Mandate. Local and regional economic hardships in the last six decades have led the Beqaa to cycle through periods of decline and recovery, with quick introductions of infrastructural technologies, spurts of loosely regulated building development, and hasty innovations in industrial activity. In this vein, 'reflexive realism' concepts of risk regime, logic of production, topographical fragmentation, and internal connectivity 1, are useful to examine how towns and cities in the Beqaa developed, deteriorated, and adjusted. However, spatial evidence that would inform such inquiries in Rayak, Beqaa, is far from similar to evidence observed in Beirut. Urban morphology research techniques combined with the concept of vernacular architecture can help decode the layers and uses of the built environment. This article introduces a mapping workflow that typologizes built fabrics using five morphological criteria (streets, density, open space, architectural character, and land use) to construct a spatial narrative that can begin characterizing the nature of the Beqaa's cities and towns.

KEYWORDS
Spatial Data; Urban Morphology; Vernacular Architecture; Beqaa Valley; Mediterranean Imaginaries

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1. Introduction

Lebanon's strategic significance in the Mediterranean region is historically linked to its coastal cities, particularly Beirut, Tripoli, and Sidon, which have thrived as port cities since the Phoenician era.[1] The Beqaa Valley, situated between two mountain ranges that run from the northeast to the southwest (refer to Fig. 1), represents a region characterized by agricultural and natural landscapes. This area is framed by two major cities, Baalbeck and Zahlé, along with numerous smaller towns and villages. The Ottoman empire and French mandate solidified the Beqaa's regional role as an agricultural and natural resources provider,[2,3] and began developing its strategic role as a commercial and industrial hub through the Beirut-Damascus rail line in 1891. The rail ushered the development of Rayyak, a Beqaa'i town, as a dry port, with access to an airport in the early 1900's. It was further transformed into a hub for parts manufacturing and engineering education. The second line installed in Lebanon connected Rayyak to Baalbek in 1902, and coastal lines were installed in later years. The Beirut-Damascus rail line shaped the growth patterns of towns that hosted train stations in Jdita, Mrejat, Saadnayel, Maallaka, Rayyak, and Yahfoufa.[4] These rail towns are characterized by networks of narrow organic streets bordered by an intricate arrangement of buildings and small courtyards centered around train stations. Rail ridership for leisure, education, and commerce peaked in the late 1960s, then began declining.[5] This may have been due in part to increased ownership of personal vehicles, that provided a faster commute to and from Beirut. Nevertheless, the train ceased to operate with the beginning of the 1975- 1990 civil war.[6] That same civil war brought a tangible increase in rapid urbanization from citizens fleeing conflict-ridden Beirut and turning to the Beqaa for hastily developed new dwellings. Naturally, deteriorating security conditions and weakened governance in Lebanon had a cascading effect on the rail. Gradual deterioration was further compounded by issues of encroachment and looting. The rail was never reinstated since then. War and post-war urbanization in the Beqaa took a different form with wider streets and larger apartment buildings adorning the affronts of the Beirut-Damascus road. Post-war infrastructural investments led the Beqaa into a period of economic development, but the rapid changes in land use, formalized in spurts of

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1 William W. Harris, *Lebanon: A History, 600-2011* (New York: Oxford University Press, 2012),

2 Mehmet Narsullah, Mehmet Eshref and Mehmet Rushdi, *Mukemmel Ve Mufassal Atlas = Complete and Detailed Atlas* (Istanbul: Istanbul, 1909),

3 Zadiq Khanzadian, *Atlas De Géographie Économique De Syrie Et Du Liban* (Paris: Chez L. De Bertalot, 1926),

4 Eddy Choueiry and Elias B. Maalouf, *Liban Sur Rail / Lebanon on Rail /* لبنان على السكة (Beirut: Biblioteque Improbable du Pinacle, 2013),

5 Regional Projects Department, *Appraisal of Highway Project in Lebanon*, (1973): https://documents1.worldbank.org/curated/en/763811468263990879/pdf/multi-page.pdf (accessed Nov 1, 2023).

6 Choueiry and Maalouf, *Liban SurRail*,

urban growth, destabilized existing land use patterns while reinforcing the clientelist political system in Lebanon.[7]

The national and regional value of the Beqaa was – and continues to be – closely tied to its ability to bolster the economic and political power of the cities it serves. In government or academic efforts investigating the Beqaa, the subject focus typically addresses economic development,[8,9] the health of agricultural and natural resources,[10,11,12] the Syrian refugee crisis, [13,14,15] and some historic preservation. While these investigated issues are pressing and essential to the Beqaa's current and future condition, research initiatives are often content with critiquing the built environments, describing them as haphazard growth contributing to resource depletion.[16] The built environment is rarely examined beyond this narrative.

This article aims to delve into the functions and physical characteristics of the built environment in the Beqaa through urban morphology, and it will concentrate on villages in central and west Beqaa, especially the towns along main or arterial roads.

In subsequent sections, the article frames the built environment as a blend of vernacular and informal elements, advocating for the application of urban morphology as an analytical approach. It then puts forward a practical classification system that can be seamlessly integrated into Lebanon's existing governmental mapping frameworks.

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7 Karen Sweid, *The Politcal Economy of Patronage in Lebanon - the Case of the Council of Development and Reconstruction* (Thesis Dissertation: 2021),

8 McKinsey & Company, *Lebanon Economic Vision,* (2018), https://www.economy.gov.lb/media/11893/20181022-1228full-report-en.pdf

9 Rabih Mohamad Kamleh, *Study of Cows' Milk Quality in Two Regions in the Bekaa and its Effect on Baladi Cheese Quality* (Thesis Dissertation: 2002),

10 Ghida El Dirany, *Sustainability of Family Farming in the Bekaa and the Inclusion of Youth: Damask Rose Vs. Small Ruminant Production* (Thesis Disseration, 2022),

11 Elsy Sakr, *Can Sustainable Pasture Management Improve the Ecosystem Services for Small Ruminant Farmers and Rural Communities? A Case Study from West Bekaa, Lebanon* (Thesis Dissertation: 2023),

12 Rami Sami Assaf, *The Waste Management Value Chain in West Bekaa: Contributions to Labor Markets and Rural Development* (Thesis Dissertation: 2018),

13 Katrin Hermanek, *A Micro-Perspective on Governance in Informal Tented Settlements* (Thesis Dissertation: 2016),

14 Loubna Milad Abi Khalil, *Syrian Refugees and Lebanese Christians, Together Against the Turmoil.* (c2015) (Thesis Dissertation: 2016),

15 Nour Antoine Nashef, *Linking Household Food Insecurity with Food Safety Knowledge and Practices of Syrian Refugee Mothers: Findings from a Pilot Study in the Bekaa Region, Lebanon* (Thesis Dissertation, 2018),

16 Eric Verdeil, Ghaleb Faour and Sébastien Velut, "Changes in Land use," in *Atlas Du Liban* (Beirut: Presses de Ifpo, 2012), 91-116.

FIG. 1 The Beqaa in its regional context. Data was collected from the indicated study area. Source: map was produced by author using ArcGIS pro, underlying imagery and labels were contributions from ESRI, OpenStreetMap, HERE, Garmin, FAO, NOAA, USGS, Earthstar Geographics.

1.1 Informal, Vernacular, Formal: Conceptual and Spatial Boundaries

The 'vernacular' architecture is the built habitat constructed without the intervention of a trained architect or a specialist designer,[17,18] retaining some of the urban and architectural historic heritage while aspiring to modernity. It negotiates with the technological and resource limitations imposed by the environment.[19] There is a considerable overlap – conceptual and methodological – between 'traditional' and 'vernacular' built environments, where the 'vernacular' built environment is considered a

17 Paul Oliver, *Built to Meet Needs: Cultural Issues in Vernacular Architecture* (Jordan Hill: Routledge, 2006),

18 Henry Glassie, "Architects, Vernacular Traditions, and Society," T*raditional Dwellings and Settlements Review* 1, no. 2 (1990): 9-21,

19 Jean-Paul Bourdier and Nezar Al Sayyad, *Dwellings, Settlements and Tradition - Cross-Cultural Perspectives* (Lanham: University Press of America, 1989),

subset of the 'traditional' environment.[20] Distinctions between the two – traditional and vernacular – can shed light on the socio-cultural context that produced these built environments [21,22] and how both traditional and vernacular architectures reflect changes in the identity of their dwellers' communities.[23] This paper does not aim to contribute to this distinction, but is striving to expand the disciplinary and spatial boundaries of what is considered research on the 'vernacular' built environment.[24,25] The aim is to utilize any and all documentation methods deployed for built forms considered antithetical to the 'formal', the 'planned', and the 'designed' built environment. In this article, the term 'vernacular' here encompasses 'traditional', 'indigenous', 'folk' and 'vernacular' architecture.

In the same vein, the agency of the dweller in the production of the built environment creates common grounds between the 'vernacular' and the 'informal' architecture. In both cases – vernacular and informal – the dweller is also often the builder. The builder adopts community-based or traditional construction techniques to create a habitat that negotiates with material/economic/environmental limitations and constraints and aspires to modernity – be it architectural or technological.[26,27] The intermingling of vernacular and informal can be observed in the shape and distribution of public spaces, construction material, and building façades.[28] It can also be observed in emerging transportation networks and the built environment's response to those networks.[29] Assemblages of temporality and permanence evident in built and agricultural environments,[30] and the juxtaposition of land uses and architectural characteristics[31] are also illustrations of the vernacular and the informal built environment.

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20 Nezar AlSayyad, *Traditions: The "Real", the Hyper, and the Virtual in the Built Environment* (London: Routledge, 2014),

21 Mariana R. Correia, Paulo B. Lourenco and Humberto Varum, *Seismic Retrofitting: Learning from Vernacular Architecture* (London: CRC Press, 2015),

22 Hesam Kamalipour and Mostafa Zaroudi, "Sociocultural Context and Vernacular Housing Morphology: A Case Study," *Current Urban Studies* 2, no. 3 (2014): 220-232

23 Jani Vibhavari, *Diversity in Design: Perspectives from the Non-Western World* (New York: Bloomsbury Publishing, 2011),

24 Adrian Green, "Confining the Vernacular: The Seventeenth-Century Origins of a Mode of Study," *Vernacular Architecture* 38, no. 1 (2007): 1-7

25 Daniel Maudlin, "Crossing Boundaries: Revisiting the Thresholds of Vernacular Architecture," *Vernacular Architecture* 41, no. 1 (2010): 10-14

26 John F. C. Turner, *Freedom to Build* (New York: Macmillan, 1972),

27 Thomas Hubka, "Just Folks Designing," *Journal of Architectural Education* (1984) 32, no. 3 (Feb 1, 1979): 27-29

28 Hesam Kamalipour and Kim Dovey, "Mapping the Visibility of Informal Setlements," *Habitat International* 85 (2019): 63-75

29 Petra Samaha and Amer Mohtar, "Decoding an Urban Myth: An Inquiry into the Van Line 4 System in Beirut, Lebanon," *Journal of Transport Geography* 85 (2020),

30 Baohui Chai and Karen C. Seto, "Conceptualizing and Characterizing Micro-Urbanization: A New Perspective Applied to Africa," *Landscape and Urban Planning* 190 (2019),

31 Fatema Meher Khan, Elek Pafka and Kim Dovey, "Understanding Informal Functional Mix: Morphogenic Mapping of Old Dhaka," *Journal of Urbanism* 16, no. 3 (2023): 267-285

1.2 Making the Case for Urban Morphology for Mapping Vernacular Built Environments

Urban morphology is the study of the built fabric, and the processes and people shaping it.[32] The motivations of the founding schools of thought (Conzenian, Muratorian, and French) can be housed under two foci: focus on the object of study, which is to understand the complexities of the built form; and focus on the manner and purpose of study, which is the analysis of the evolution of the built city, or morphogenesis and the distilling of normative modalities that guide future planning goals.[33, 34]

Deploying urban morphology to produce maps is a developing research avenue: in their work 'Mapping Urbanities', Dovey, Pafka and Ristic[35] delve into the connection between the spatiality and the sociality of the of the city through assemblage theory, which promotes the practice of looking at relationships, synergies, and symbioses characterizing and communicating the representation of the city.

Urban morphology relies on field visits to capture the specificities of the built environment and on the value of comparative study. This positions it as a reliable research method for understanding and planning for the futures of cities and regions.[36, 37, 38]

Functionally, the study of the urban form examines buildings, streets, and the spaces in between them. Urban morphological research often relies on these spatial elements and their scale as organizing denominators, especially in typo-morphological analysis and the typological process.[39] The process of identifying objects and scales – spatial and temporal – for comparison and the levels of distinction can provide grounds upon which a cognitive inquiry and/or a grounded theory[40] is constructed. In the same vein, Kropf highlights the necessity of avoiding the normative impulse to conform the case study to existing notions of what the built environment

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32 International Seminar of Urban Forum, "Glossary," https://urbanform.org/glossary/

33 Anne Vernez Moudon, "Urban Morphology as an Emerging Interdisciplinary Field," *Urban Morphology* 1, no. 1 (1997): 3-10

34 Stephen Marshall and Olgu Çalişkan, "A Joint Framework for Urban Morphology and Design," *Built Environment* (London. 1978) 37, no. 4 (2011): 409-426

35 Kim Dovey, Elek Pafka and Mirjana Ristic, *Mapping Urbanities: Morphologies, Flows, Possibilities* (New York: Taylor & Francis, 2017),

36 Brenda Case Scheer, "Urban Morphology as a Research Method," in *Planning Knowledge and Research*, ed. Thomas W. Sanchez (New York: Routledge, 2018), 167-181.

37 Davide Ponzini, "The Unwarranted Boundaries between Urban Planning and Design in Theory, Practice and Research," in *Planning Knowledge and Research*, ed. Thomas W. Sanchez (Abingdon: Routledge, 2018), 182-195.

38 Robert Beauregard and Laura Lieto, "Towards an Object-Oriented Case Methodology for Planners," in *Planning Knowledge and Research*, ed. Thomas W. Sanchez (Abingdon: Routledge, 2018), 153-166.

39 Gianfranco Caniggia and Gian Luigi Maffei, *Interpreting Basic Building* (Firenze: Alinea, 2001),

40 Vítor Oliveira, *Urban Morphology: An Introduction to the Study of the Physical Form of Cities* (Cham: Springer International Publishing, 2016),

ought to be.[41]

Dell Upton defined studies of traditional and vernacular architecture under five avenues: the object-oriented studies, concerned with the built environment and how they were constructed; socially oriented studies, where the built environment is examined as evidence for the past; culturally oriented studies, which explores the cultural implications and constructions of the built environment; symbolically oriented studies, which delve into the symbolic dimension of architecture; and design-oriented studies that are concerned with affirming regional identity.[42]

With commonalities of the theoretical and motivations between vernacular architecture research and urban morphological research, using morphological approaches to study the vernacular built environment is intuitive if not warranted.

2. Methodology: Morphological Cartography

Historically, there are few examples of research addressing the nature of the Beqaa's built environment. The Doxiadis national housing plan for Lebanon is one of these examples. In 1957, Constantinos Doxiadis, an internationally known urban and regional planner, and his team conducted a national assessment of cities and towns at the Lebanese Government's behest to develop housing plans and policy recommendations. Due to the time pressure placed by the Lebanese government on Doxiadis and the lack of census and cartographic data, he and his team resorted to creating their own dataset. They divided Lebanon and 1680 locales (cities, towns and villages) into distinct regions. The team them visited each locale, collecting photos and diagrams of the town's centers and commercial streets, and conducting informal conversations with town dwellers and local government officials to contextualize their findings.[43] The work composed a thorough portrait of the built environment in Lebanon via maps, photos, and supporting material illustrating not only how it was constructed, but also lived. The government did not implement the team's recommendations for housing policies and model villages due to the 1958 civil war and a change in government and national priorities. Yet, to the Beqaa, the Doxiadis study was arguably the first examination of the built environment that overturned the extractive lens that has dictated the Beqaa's status as no more than an agricultural and natural resource to the country.

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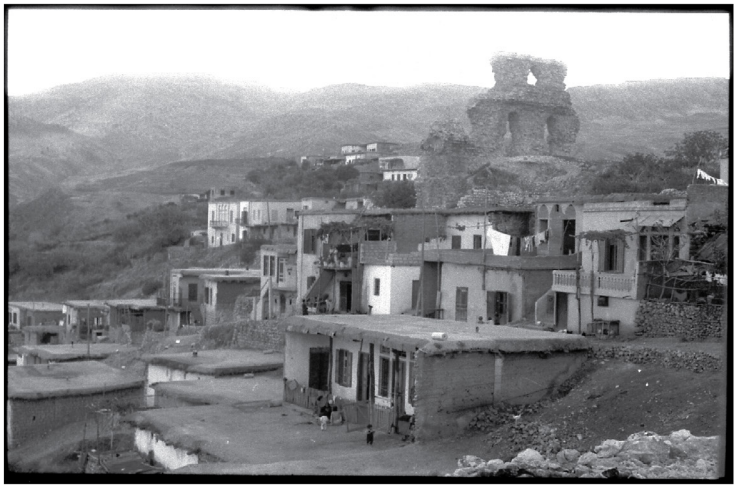
41 Karl Kropf, *The Handbook of Urban Morphology* (New York: Wiley, 2008),

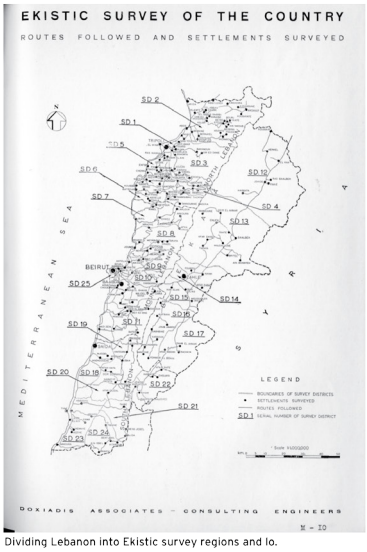
42 Dell Upton, "The Power of Things: Recent Studies in American Vernacular Architecture," *American Quarterly* 35, no. 3 (1983): 262-279

43 Hashem Sarkis, *Circa 1958: Lebanon in the Pictures and Plans of Constantinos Doxiadis = Le Liban À Travers Les Photos Et Plans De Constantinos Doxiadis* (Beirut: Dar El Nahar, 2003),

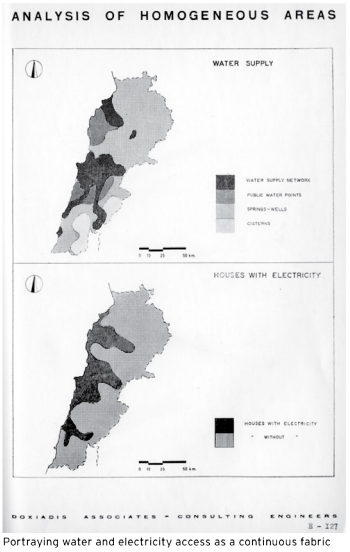
Ekistics is a term Doxiadis coined and developed throughout his career as an urban planner. It perceives built environments or human settlements as living organisms with their own laws and evolution patterns, and promotes the necessity for an interdisciplinary approach to solve its problems.[44] While there are evident theoretical intersections between Ekistics and urban morphology, this article refrains from delving into them. Doxiadis' work in Lebanon is relevant to this article from a methodological standpoint: the team in 1957 set a precedent for utilizing urban morphology techniques without explicitly addressing these theoretical commonalities (see Fig. 2). The team documented everyday artefacts such as electricity transformers, water canals, construction sites, trash bins, and produced diagrams and maps to assess the distribution of forms, activities and resources in multiple Lebanese towns. The exploration of the intersection between urban morphology and ekistics could provide exciting avenues for future research.



View of Qab Elias, Beqaa, circa 1957



Dividing Lebanon into Ekistic survey regions and lo.



Portraying water and electricity access as a continuous fabric

FIG. 2 Surveying documents from the Doxiadis team 1957-1958. Source: Constantinos Doxiadis Archives.

44 Costantinos Apostolou Doxiadis, "Ekistics, the Science of Human Setlements," *Ekistics* 33, no. 197 (1972): 237-247

To summarize, urban morphology is not a novel discipline, its focus continues to be the analysis of the city and its evolution to distill normative modalities for future planning. However, recent scholars begin leveraging urban morphology as a research method that integrates multiple data sources with site observations. The systemization of general processes combine on-site and on-screen analyses[45] to categorize built forms, paths, and landscapes that compose the built fabric.[46] This intends to suspend the planner's normative impulse long enough to compare different fabrics and components and examine the essence of the built environment.[47] This combined process can easily be the foundation for a mapping workflow is informed by urban morphology.[48] The article proposes a workflow that builds upon these techniques (see Fig. 3).

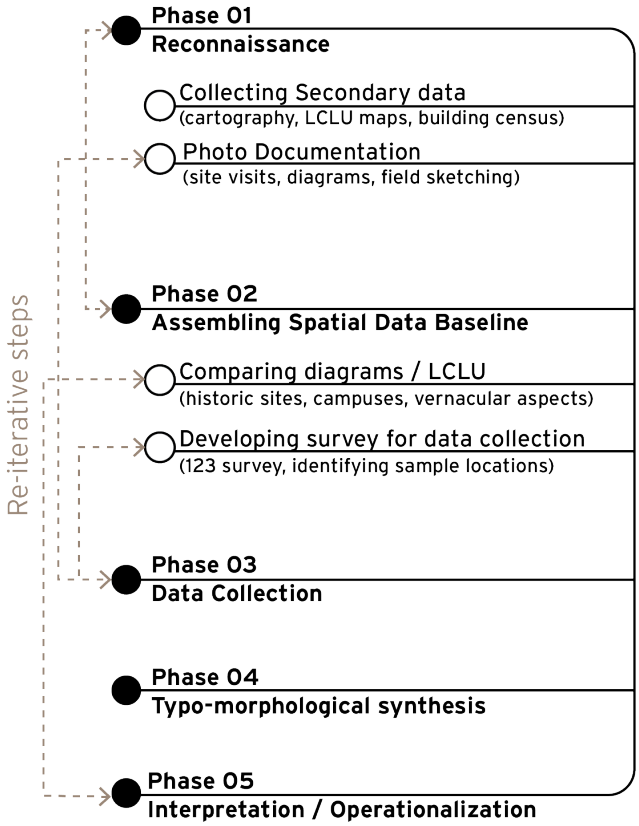


FIG. 3 Morphological mapping workflow. Source: produced by author.

Phase 01: Reconnaissance. Initial data collection included harvesting spatial and archival data (Geographic Information Systems (GIS) layers, cartography, building census etc.), of which the most significant was the Land Cover Land Use (LCLU) classification set produced by the National

45 Kropf, *Handbook Urban Morphology*, 50-173.

46 Scheer, "Urban Morphology," 167-181.

47 Kropf, *Handbook of Urban Morphology*, 8-17.

48 Dovey, Pafka and Ristic, *Mapping Urbanities*,

Remote Sensing Center in Lebanon. Due to the lack of spatial data specific to the Beqaa's built environment, the LCLU map is the best possible 'baseline' for this research. This phase also included preliminary field observations (diagrams, photographs, informal conversations with residents).

Phase 02: Gap Identification. This included an examination of the classification system used for the LCLU map in the Beqaa valley, with special emphasis on the classes representing the built environment. Upon comparing the diagrams and photos collected in the field with the Land Cover Land Use (LCLU) classes used to classify the built environment, a significant disconnect emerged, highlighting a clear semantic gap between spatial knowledge and the actual physical environment detailed in Fig. 4. Notable built environments or aspects of the built environment were extracted from the diagrams, photos, and secondary dataset collected in Phase 01. This preliminary analysis informed the design of a morphological survey on ArcGIS Survey 123.

Phase 03: Data Collection. 500 data points were collected from a sample of the built, agricultural, and natural landscapes in Central and West Beqaa. Sampling was conducted either from the center of a town or village moving outwards to the agricultural or natural fringes, or moving inwards from a main road (Beirut-Damascus Main road, Zahle – Baalbeck) to the center of the town or village. Additional photographs and notes for points collected in the built environment (n=170) were attached for further detail. The collected points were uploaded to the ArcGIS Survey 123 online database for download and analysis.

Phase 04: Typo-Morphological Synthesis. A comparison of photos from the sample locations revealed an assemblage of materials and styles in the construction of buildings, street grids, land uses, and shape of open spaces. To compare these different aspects of these built environments, data points were visually assessed into a matrix with five distinct criteria: 1) density; 2) street grid; 3) architectural style; 4) land use; 5) open space type.

Phase 05: Interpretation/Operationalization. This final phase explored avenues where these typologies can inform actionable spatial knowledge for planning. Much like previous steps, this phase is especially iterative. A spatial projection of the typo-morphological matrix began to demonstrate the distribution of the assessed criteria in the Beqaa and how the composition of the built fabric changes by function of space type, use, and character (see Fig. 10 to 14). This phase also begins to explore how classification typologies could be used for existing mapping systems in Lebanon.

3. Results: Morphological Cartography

3.1 Phase 01 and 02: Assembling Spatial Data Baseline

The Land Use Classification System crafted by the National Center for Remote Sensing Center (NCRS) for the Beqaa Valley in Lebanon is hierarchical with 4 levels ranging in coarseness to render it amenable to different scales and study requirements. In this process, the classes used to describe the built environment were the most relevant. 23 built environment classes were identified (See Fig. 4). Concurrently, field documentation of these classes begins to elucidate the coincidence – or lack of – between spatial information of the place and the actual place. This phase also shed light on the temporal aspects and densities that would elude a rigid classification.

Existing Built Environment Classes
National Remote Sensing Center of Lebanon

1. Dense Urban Fabric
2. Urban Fabric Medium Density
3. Informal Urban Fabric Medium Density
4. Urban Fabric Low Density
5. Informal Urban Fabric Low Density
6. Touristic Complex
7. Archaelogical Site
8. Large Facility
9. Industrial or Commercial Zone
10. Airport
11. Quarry
12. Dump
13. Urban and/or Worksite Extension
14. Urban Vacant Land
15. Urban Green Space
16. Large Sports or Leisure Facility
17. Urban Sprawl on Field
18. Urban Sprawl on Orchard
19. Urban Sprawl on Sparse Forest
20. Urban Sprawl on Shrub Zone

Example of fabrics classified as 'Dense Urban Fabric' but that are fundamentally different. Fabric A has visibly lower density (single family home) and a wall separating the private from public space. Fabric B has a higher density, with apartment buildings, shops, and no private open space.

Example of fabrics classified differently but are very similar. Fabric C (Urban Sprawl) and Fabric D (High Density) share similar street widths, density, and mixed uses of residential and commercial.

FIG. 4 Semantic gap between classification descriptors and space. Source: photos captured by author.

3.2 Phase 03: Data Collection

ESRI Survey 123, a smartphone application, was utilized to collect locations, land uses, and photos from the built, natural, and agricultural landscapes in the area. The collection method populates a Geographic Information Systems (GIS) tabular dataset, where each point would have longitude and latitude attributes in addition to a set of qualitative attributes that includes land use type, land cover, number of floors in the building if any, availability of open space, and site observations.

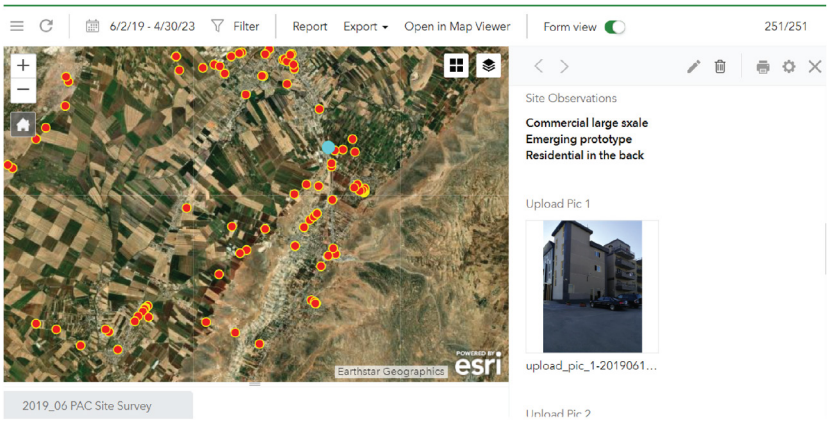


FIG. 5 Snapshot of ESRI survey123 data collection. Source: the survey and portrayed data points are designed and collected by author. The app platform is an ESRI product.

3.3 Phase 04: Synthesis of Typo-Morphological Matrix

In line with the elements observed in urban morphological studies, photographs and aerial views of building and adjacent open spaces, street grid, and fabric character were considered. The field documentation was compared to what could be discerned from aerial imagery through the ESRI ArcGIS online platform, which is supplied by more than one provider including Maxar, Earthstar, and GeoEye. This was particularly important as any future classification would ideally require high-resolution satellite imagery, ideally at a 1 meter/pixel resolution or higher (75 cm/p or 50 cm/p). The following criteria were distilled from this analysis (see Fig. 6):

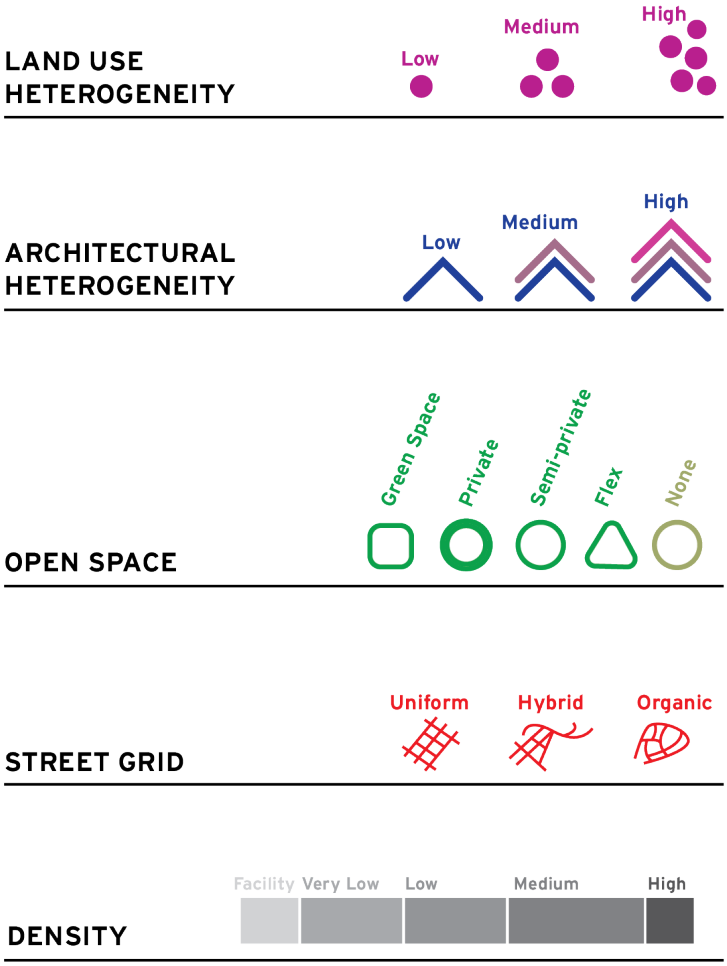


FIG. 6 Synthesized Typo-Morphological Categories. Source: produced by author.

A. Density: There are four categories for density, informed by the number of floors per building, and its proximity to other buildings. This was restricted to data points collected in the built environment. To that effect and considering that the Beqaa overall remains less dense than some of the coastal cities such as Beirut, Tripoli, and Sidon, the number of floors were only used to distinguish medium density from high density. High density was only recorded in a few locations in the study. The rest of the fabric was medium density. Low density designates built environments (mostly apartment buildings) interlaced with agricultural or natural landscapes, and very low density is used to characterize villas (which house one family) and small dispersed houses (Fig. 7). In case the landscape considered is a facility or a campus, then the term "facility" as a type of density would be used to omit confusion.

B. Street Grid: The street is an essential element in urban morphological analysis, especially the character, width, and enclosure.[49, 50] Street grids

49 Brenda Case Scheer, "The Epistemology of Urban Morphology," *Urban Morphology* 20, no. 1 (2015): 5-17

50 Joan Busquets, Dingliang Yang and Michael Keller, *Urban Grids: Handbook for Regular City Design* (Harvard: ORO Editions, 2019),

in the Beqaa were categorized under three typologies: Organic, Uniform, and Hybrid. The organic street grid was mostly visible in older parts of the towns and on slopes, which dictated that roads proceed with switch-backs and attention to changes in elevation. Uniform grids are mostly observed on flat terrain with newer and larger apartment buildings. Hybrid grids were visible near rivers or large curves in main roads with old and new buildings

FIG. 7 Density and Street Grids. Source: photos by author, aerial views extracted from ArcGIS online. Imagery contributions from ESRI, HERE, Garmin, and Maxar technologies.

C. Open Space: The nature of the open spaces between buildings dictates much about the character and the function of the town. Considering the shortage of non commercial public spaces in the Beqaa, small areas between buildings become 'flex' spaces that can accommodate parking, informal commercial activity, or leisure. They could also be repurposed as programmed public spaces using simple interventions such as seating areas and shading structures (see Fig. 8).

FIG. 8 Open space typologies. Source: photos captured by author.

Private spaces can be separated from the public realm by shorter walls, providing permeability and a balance of seclusion and openness. Villas were often surrounded with private landscaped yards, separated from the public by taller walls (2 to 3 meters). Open spaces were classified under five categories: Private for walled-in yards; Semi-private for spaces and patios that are separated by a grade change or by a permeable wall; Flex Space for an open space that blends with the street; and Green Space for parks, commercial landscaped areas, school yards and hospital open spaces. Buildings that had no distinctive open spaces were classified as having "none" open space. In central and western Beqaa, it is uncommon to find a dominant type of open space typical of a single neighborhood or town (see Fig. 12). Instead, what we often observe are combinations of various open spaces working in harmony. This dynamic interplay creates a multifaceted boundary, marked by a range of permeabilities, between the private and public spheres within the built environment.

The assessment of morphological characteristics for both formal and informal environments suggests the need for site-specific criteria that don't fit into rigid categories, but rather permit some variability, much like a spectrum.[51, 52] the remaining two criteria "Land Use Heterogeneity" and "Architectural Heterogeneity" were distilled along this thought. Land uses and architectural styles were considered as hard to extricate, seeing how the built fabric combines different architectural styles and various land uses in interlaced spaces, and the scale of the study does not consider individual buildings but rather fabrics. There was no attempt to identify individual land uses or architectural styles. Instead, following the idea of "functional mix" concept, heterogeneity considers a gradient of mixes without attempting to discern which places are work, live, or play/visit. Then the criteria measured not the function but the mixes found within the data point area. To further elaborate:

D. Land Use Heterogeneity: This would measure how heterogeneous a land use mix would be in any group of buildings. A category of 'low' would be used to describe industrial areas or residential villas. A category of 'medium' would include residential, commercial, and/or entertainment. A category of 'high' would include residential, commercial, and/or entertainment, in addition to civic and religious institutions or industrial. These categories were delineated for the purpose of facilitating the analysis, but the gradient of low heterogeneity – high heterogeneity can be categorized under different criteria (See Fig. 9).

E. Architectural Heterogeneity: Based on the nature of the vernacular and the informal, how the urban fabric is constructed is at best unpredictable and at worst illegible. For these reasons, a category 'low' would mean that all the buildings and their adjacent spaces follow the same or similar construction material, proportions, and architectural style. A category 'medium' would be buildings that are generally constructed with similar design parameters but that show some variations such as roof structure, size, patio space, etc. A 'high' category would be very different buildings (old construction, apartment buildings, unfinished inhabited structure) juxtaposed together (See Fig. 9).

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51 Kim Dovey and Hesam Kamalipour, "Informal/Formal Morphologies," in *Mapping Urbanities*, ed. Kim Dovey, Elek Oafka, Mirjana Ristic (New York: Routledge, 2018): 223-248

52 Ananya Roy and Nezar AlSayyad, *Urban Informality: Transnational Perspectives from the Middle East, Latin America, and South Asia*, (Lanham, Boulder, New York, Toronto and Oxford: Lexington Books, 2004), viii

FIG. 9 Land use and Architecture heretogeneity. Source: photos by author, aerial views extracted from ArcGIS online. Imagery contributions from ESRI, Maxar Geolye, Earthstar Geographics, CNES/Airbus DS, USDA, AeroGRID, IGN, HERE, Garmin.

3.4 Phase 05: Interpretation/Operationalization

Organized by morphological criteria (Street Grid, Density, Open Space, Land Use Heterogeneity, and Architectural Heterogeneity), the "Built Environment" data points were classified and spatially projected as seen in Figs. 10 through 14. The resulting portrait begins to construct the distribution of morphological characteristics across the Beqaa's built environment, in turn shedding light on the relationships between densities, architectural styles, and mixes of activities. Some of these distributions are predictable: most town centers contain the highest densities and architectural heterogeneity, with little to no open space (see Fig. 10 and 12); Street grids tend to be organic near older town centers and uniform further out (see Fig. 11). Semi-private spaces are prevalent regardless of the density, land use, and architectural heterogeneity (see Fig. 12). Of the many ramifications this could have, two direct repercussions become evident: 1) In typologizing the character of the Beqaa, the porosity of the boundaries

emerges as a driving characteristic of the architectural vernacular, much like brick tile roofs and triple arches in traditional Lebanese architecture; 2) In planning for the future of the Beqaa, connecting semi-private, public and flex via multi-use street networks could improve the circulation of the built environment and promote commercial and leisure activity. This projection of morphological characteristics brings some other insights. Aside from facilities – which would naturally have one distinct use such as industrial, health or educational – there are few fabrics that sport low land use heterogeneity and low architectural heterogeneity. The built fabric in the Beqaa tends towards diversifying land uses even at its lowest density. If one assumes that fabrics with lower architectural heterogeneity tend to be more recently constructed, then buildings on the fringe of the Beirut-Damascus road and the upcoming Arab Autostrad are newer. A comparison between Fig. 13 and Fig. 14 shows that buildings in these main road affronts also tend to have higher land use heterogeneity, but also connect town centers (high architectural heterogeneity, medium land use heterogeneity) with a growing commercial corridor. This, too begins to set a stage for how this connection could be used for transportation planning – perhaps a revival of the commuter train – and dweller-oriented experiences. On an operationalization front, other trends become evident:

1. Expressing Densities: The element of density was a foundational element in distinguishing between different built environments, and this study considered typical number of floors and space between buildings as indicators of density. Very low densities are expressed as 'villas' or 'settlements'. Neighborhoods and functional mixes of low to medium density can be categorized under 'town', and 'urban' is used to express high density. The terms "low density" or "medium density" are only retained at Level 04 for fabrics that are still developing (See Developing Fabric below).

2. Facilities: The baseline LCLU system included a facilities class encompassing leisure and sports centers. In the sample, there were other observed facilities such as markets, hotels, eco-lodges, resorts, and education centers. This list is not immune to temporal impacts, especially with the growing scales of development. This list could include new types of facilities such as office parks, or convention centers.

3. The residential-only typology: There are 3 types of typologies where only one land use occurs, which are the nomadic settlements, refugee settlements, and villas. The distinguishing difference between nomadic and refugee settlements is the street grid. The nomadic grows incrementally on organic grids with fluid boundaries whereas the refugee settlements are more planned, on uniform and hybrid grids with designated land parcels. The difference between the nomadic / refugee settlement and the villa is the typology of the open space. Where villas have private green spaces such as yards, the settlements either have no open space or some flex space.

4. Developing Fabric: Field notes showed that some fabrics can be interpreted as on the cusp of growth. Those typically include low (1-2 floor buildings) to medium densities (2-4 floor buildings) adjacent to vacant lots, defunct agricultural lands, or construction sites. While characterizing this as "changing" or "developing" does delve into the predictive aspect of mapping, which arguably falls outside the scope of this study, it is important to make that distinction because the nature of the imminent construction would decide the eventual typology of the fabric. For example, a low-density neighborhood (buildings 1-4 floors) with vacant lots can become a medium density neighborhood if more of the same buildings are installed in the empty lots, whereas it could become a functional mix fabric if larger buildings with commercial services are installed. In the unlikely event of the vacant lot becoming a green space, then it would be anchored as a low-density neighborhood.

5. Historic versus modern fabric: Phases 01 and 02 of the study revealed the need to discern between different aspects the of architectural vernacular. The overarching pre-car / post-car trend adopted to assess the street grid and the land use heterogeneity is applicable here: dwellings constructed prior to the commercialization of the car tended to house less families (1 to 2), presented aspects of traditional 'Lebanese' architecture, including the red tile roofs, arched windows and doors, and walls dressed with natural stone. Dwellings constructed post car commercialization tended to house more families on multiple apartment floors, and either reduce or remove expensive construction material such as natural stone in favor of concrete and paint. This rule is not consistent across all post-car commercialization construction: many buildings constructed after the civil war are of low density (such as villas) and establishments such as restaurants and eco-lodges retained aspects of traditional architecture.

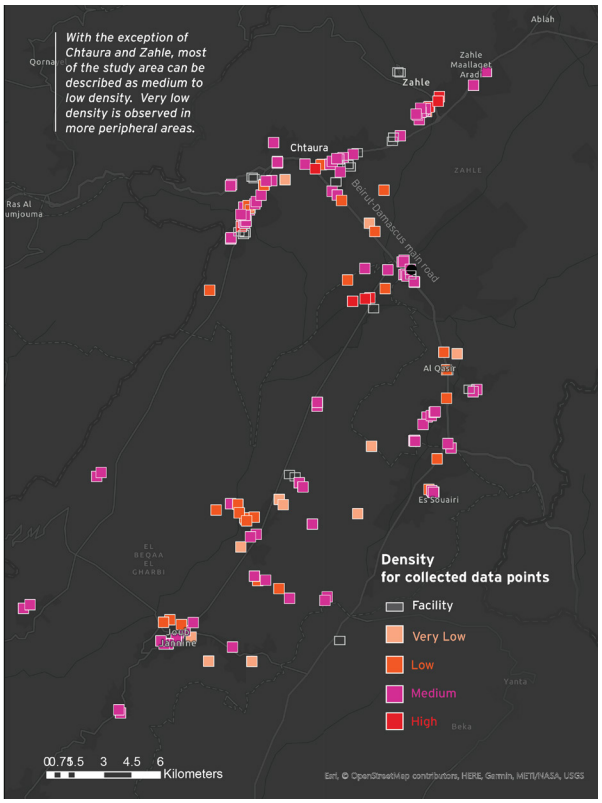

FIG. 10 Distibution of Densities in the Beqaa Built Environment. Source: Data points collected by author. Underlying basemap contributions by ESRI, OpenStreetMap, HERE, Garmin, NASA, USGS.

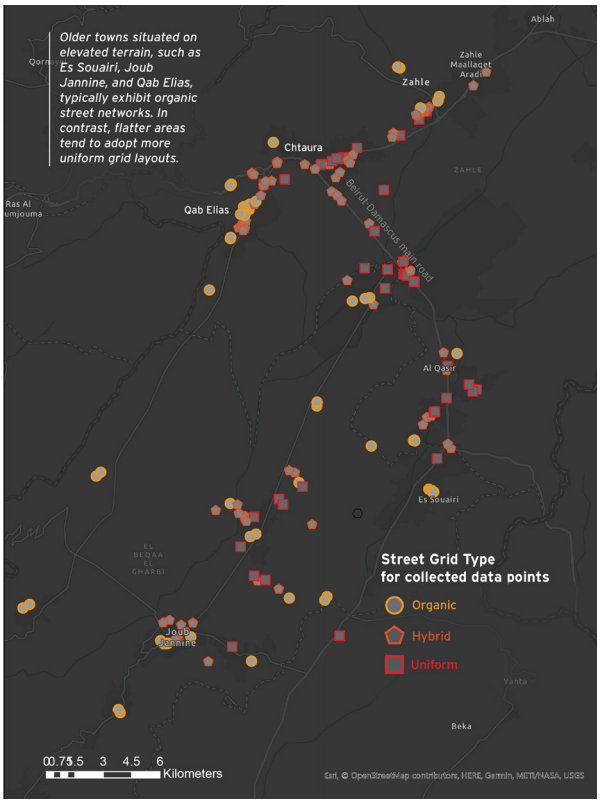

FIG. 11 Distribution of Street Grid in the Beqaa Built Environment. Source: Data points collected by author. Underlying basemap contributions by ESRI, OpenStreetMap, HERE, Garmin, NASA, USGS.

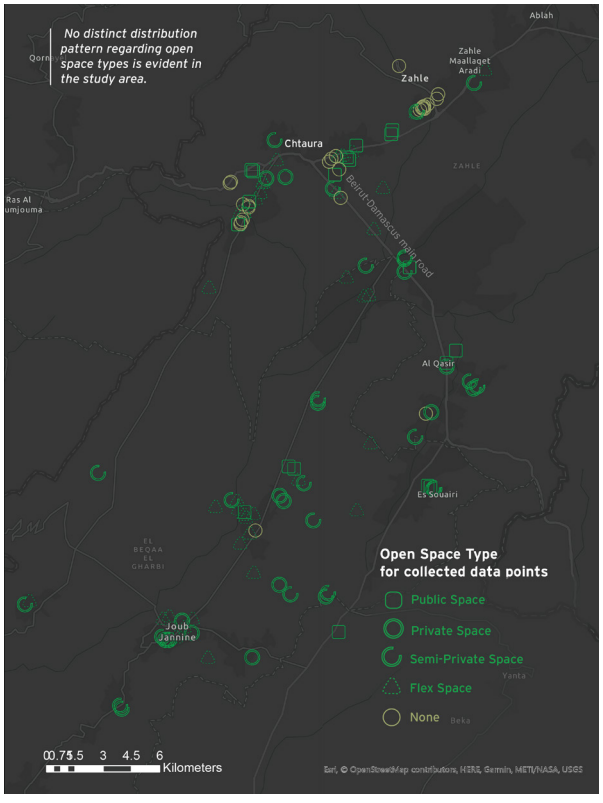

FIG. 12 Distribution of Open Space in the Beqaa Built Environment. Source: Data points collected by author. Underlying basemap contributions by ESRI, OpenStreetMap, HERE, Garmin, NASA, USGS.

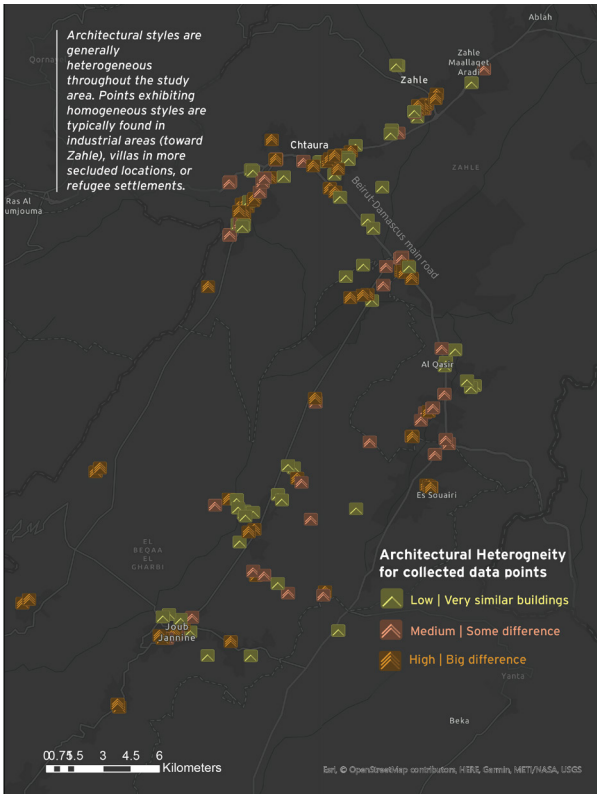

FIG. 13 Distribution of Architectural Heterogeneity in the Beqaa Built Environment. Source: Data points collected by author. Underlying basemap contributions by ESRI, OpenStreetMap, HERE, Garmin, NASA, USGS.

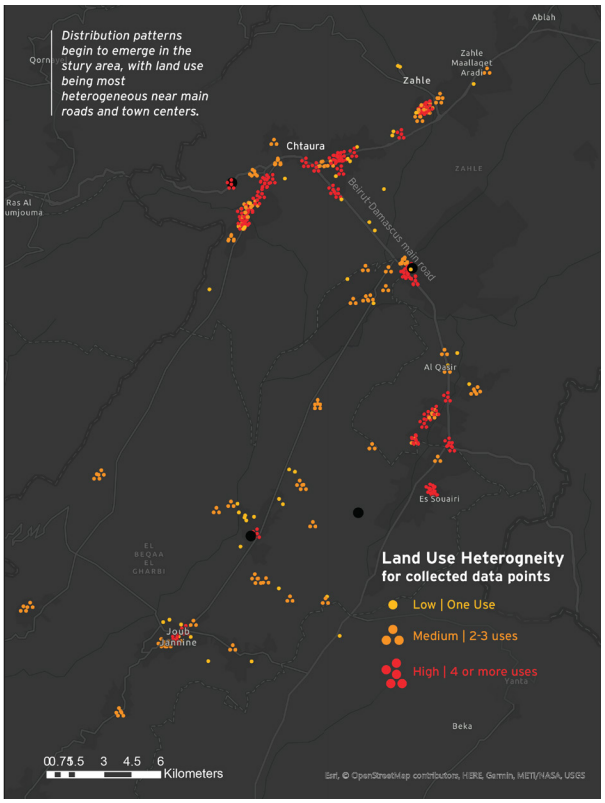

FIG. 14 Distribution of Land Use Heterogeneity in the Beqaa Built Environment. Source: Data points collected by author. Underlying basemap contributions by ESRI, OpenStreetMap, HERE, Garmin, NASA, USGS.

To address the question of how morphological mapping can contribute to regional or national spatial systems, the typo-morphological synthesis (Fig. 6) can be used to synthesize an alternative set of classes to be incorporated into the existing LCLU classification system in use by the National Remote Sensing Center in Lebanon. Fig. 15 delineates how these characteristics can begin to synthesize classes to that goal. The synthesis process and the nomenclature are iterative and easily impacted by participatory planning and the intent driving the production of spatial knowledge. Nevertheless, there is a distinct value in utilizing descriptors that go beyond density, formality and informality (refer to Fig. 4) to bridge the semantic gap between spatial knowledge and actual place.

Typo-Morpological Criterion	Classification	Type 01	Type 02	Type 03	Type 04	Type 05	Type 06	Type 07	Type 08	Type 09
Density	Facility									x
	Very Low	x			x					
	Low	x	x		x	x		x		
	Medium		x	x		x	x	x	x	
	High			x					x	
Street Grid	Organic	x	x				x	x	x	x
	Hybrid	x	x	x		x	x	x	x	x
	Uniform			x	x	x	x		x	x
Open Space	None		x		x					
	Flex		x	x	x	x	x	x	x	x
	Public				x			x	x	x
	Semi-Private			x		x	x	x	x	
	Private	x								
Architectural Heterogeneity	Low	x	x	x	x	x				x
	Medium	x	x	x		x	x	x		x
	High						x	x	x	
Land Use Heterogeneity	Low	x	x	x	x	x	x			x
	Medium			x	x	x	x	x		
	High							x	x	
LCLU Built Environment Classification		Villas	Nomadic or Refugee Settlement	Commercial or Private Developments	Developing fabric	Neighborhood - Apartments	Neighborhood - Apartment + Historic Mix	Neighborhood - Historic	Functional Mix	Campus (Health, Education, etc.)

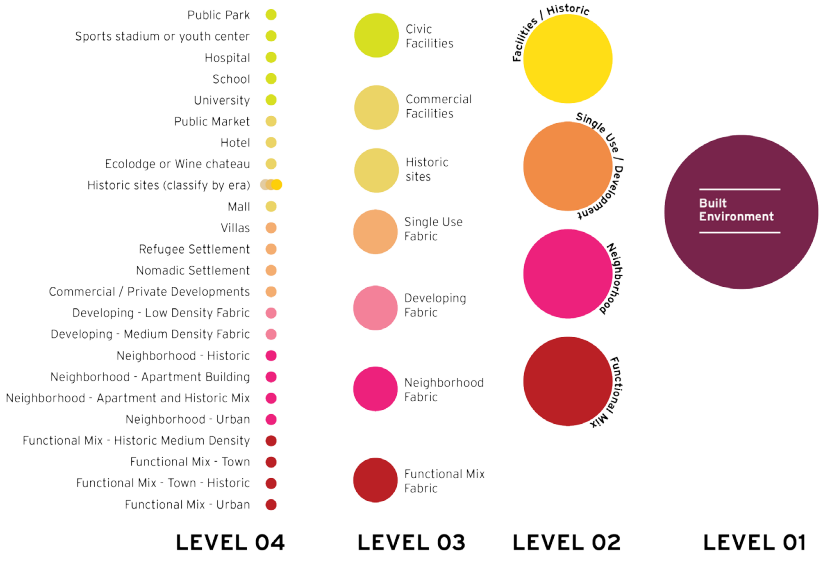

FIG. 15 From Typo-morphological matrix to built environment classification. Source: produced by author.

4. Discussion

The main goal of this research can be summarized as a proposed mapping workflow that translates the built environment into actionable spatial knowledge. It focuses on deconstructing and understanding the commonplace, or vernacular, architecture of the urban environment, which is the outcome of human actions and behaviors.[53] This deconstruction distills criteria of the built environment that are used to identify typologies that can then inform actionable spatial knowledge. Fig. 15 begins to synthesize a classification system that could be used to revise the exiting LCLU system, although more iterations would be needed to finally arrive at a classification system that could be used for Lebanon.

While the proposed workflow in this article was developed for the Beqaa,

53 Thomas Carter and Elizabeth Collins Cromley, *Invitation to Vernacular Architecture: A Guide to the Study of Ordinary Buildings and Landscapes, Vol. 20* (Portland: Ringgold, Inc, 2005),

it is easily transferable to other rural or small-town regions in the Middle East especially if the built environment is described as 'informal' or 'vernacular'. When the built environment is weaved from community-based and traditional construction techniques and is barely hindered by a stringent regulatory framework, it is a testament to the dwellers' adaptability in negotiating material, economic, and environmental constraints to meet their aesthetic and cultural desires. This proposed workflow would inform a mapping process where the 'vernacular' language is transformed into spatial knowledge.

The five phases of this iterative workflow (reconnaissance, establishing a baseline, data collection, synthesis, interpretation) permit the researcher to suspend their normative urge and interrogate the built environment from a site-specific lens that could challenge existing preconceptions on the region. In the case of Lebanon, this would question the perceived role of the Beqaa as an agricultural resource, thus inviting a more complex and equitable frame. In this vein, the value of spatial knowledge and its production is directly tied to its ability to reconceptualize the narrative of place from 'regional value' to 'places of the everyday' while building agency for the built language – the vernacular – and the dwellers who have constructed it. To further build on this, participatory input can easily be integrated in this workflow. Crowdsourced data combined with dweller observations can serve as a foundation for public workshops aimed at pinpointing the key elements of the built environment that hold cultural significance and for devising typologies that orchestrate a form of spatial identity capturing both similarities and distinctions.

This workflow can also be integrated into existing spatial knowledge systems to reflect the complexities of the built environment, thus closing the semantic gap between place and spatial representation. In this case, the established spatial knowledge baseline is the Land Cover Land Use dataset. The same process could be followed to remap a neighborhood, town, city using multiple scales such as buildings, building blocks, or others.

5. Limitations

The stratified random sampling strategy of data points for this study were collected from Central Beqaa and some parts of West Beqaa. Data collected from all of the Beqaa, and perhaps from all of Lebanon, would alter the resulting classes or categories and would be more readily integrated into national GIS classification systems. The question of scale would also be relevant to refine the study's outcomes. While this iteration began to distill density, architectural and land use heterogeneity, open space, and street type composition of each fabric, future iterations could integrate neighborhood boundaries and parcel level data to identify areas more distinctly. Continuing this workflow with other geospatial methods such as classification efforts using remote sensing data can also expedite the

process to attach typo-morphological values to fabric footprints rather than individual points.

Finally, broadening the application of this method, whether by incorporating remote sensing data or by acquiring additional field data points, could provide more precise insights into the interconnectivity of towns and neighborhoods. This can shed light on various aspects such as transportation networks, land use patterns, and the socio-spatial relationships within the Beqaa region.

Lynn Abdouni, Ph.D., is an Associate Research Scientist at the University of Georgia's College of Engineering, specializing in geospatial analysis for city and regional planning. Her research addresses the intersection of the built and natural environment, emphasizing resilience and data production in the context of the Middle East and rural regions in the Southeast U.S. Lynn's expertise spans landscape ecology, infrastructure, urban morphology, and digital spatial data. As an educator, she teaches courses on urban infrastructure systems and sustainable building design.

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