

## Ancient city gates and modern checkpoints of Nicosia for the morphological theory of attractors

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*“Premesso che per città non possa intendersi né  
l'aggregato di un insieme di strutture edilizie,  
né la società che ne dispone, ma le due cose  
contemporaneamente” [1]*

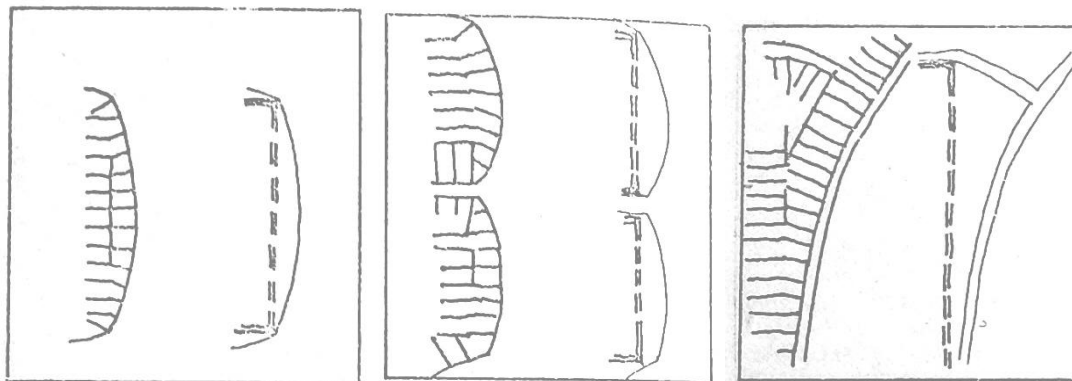
### Abstract

The analysis of a city in its diachronic evolution provides a tool for the development of the theory of attractors. The paper analyses the case study of Nicosia, interpreting the 'medievalisation' process, in continuity between the Conzenian approach [2] and the Italian School of Urban Morphology [3], [4]. The theory should cover in a more analytical manner what Muratori called 'medievalisation' [5], [6], a term generically describing the transformation of urban routes occurring during the Middle Ages. The paper analyses the diachronic changes of routes in the city of Nicosia, Cyprus, and other multi-scalar occurrences of the attraction phenomenon [7] applying attractors and repellers, already used in archaeological studies to interpret such changes. Checkpoints across borders share some properties with ancient city gates: both of them are a *passage obligé* across a 'dividing line'. Even though the 'dividing line' could pre-exist the route, new routes may appear after the establishment of the passing point and the 'dividing line'. A diachronic perspective on the morphology of routes can show this passing point as an 'attractor' in regards to the routes. Only few routes change by attraction as revealed by the inflection analysis, other routes are instead bifurcated. The attractor causes the diachronic deformations of routes by pulling them away from their configuration, while the 'repeller' acts in the opposite direction. The path of the medieval walls of Nicosia, now disappeared, could be traced using the inflection analysis of urban routes, inferring the attractors and the dividing lines. Also the Venetian city wall, determining a new dividing line and new gates acting as point attractors, can be analysed with the same methodology. The openings through those walls introduced in modern times, also seem to follow the very same morphological rules. Other modern elements, such as the presidential palace, introduced a different configuration of the city by attracting the new streets, and finally the check point opened in 2008 in Ledra street is acting today in a similar way by attracting along that route the commercial functions of the city.

*Keywords: urban morphology; attractors; repellers; urban history.*

## 1. THEORETICAL PREMISE:

Recent urban morphology studies consider urban tissues as living organisms changing in time [8], the attractor theory is a new experimental tool of analysis in the urban morphology field following this assumption and is mainly based on the notion of *attractor* as already used in archaeology. Archaeological studies already do consider *attractors* and *repellers* as a tool to interpret some territorial transformations, following the assumption that “the trajectory that a system follows through time is the result of a continuous dynamic interaction between that system and the multiple 'attractors' in its environment” [9]. The notion of *attractor* is also used in mathematics as a set of numerical values toward which a system evolves in the long term. There is a number of studies in urban planning deriving the notion of *attractor* from the mathematic concept and applying it to the statistical study of settlement patterns. [10]. Some archaeologists have borrowed the theory of attractors from mathematics to explain cyclical or “strange” transformations using the point, limit cycle, toroidal, strange attractor division [11], [12]. Space Syntax has introduced the term *attractor* to name an element attracting pedestrian movement, also the concepts of *spatial layout attraction*, *land use attraction* and *transport attractions* are defined therein. In that discipline an *attractor* is a building or any other feature with the potential of generating trips to and from. A *negative attractor* is instead an element decreasing the natural movement rates. [13]. The *attractor* as defined in Space Syntax differs from the notion we are introducing, but it is useful for the explanation of the theory, as the attraction phenomena used in Space Syntax refers to pedestrian movement, it should be considered as pedestrian movement, and traffic in general, happens usually before the street itself is built, the built shape can thus be influenced by the configuration of its traffic as attracted in time.

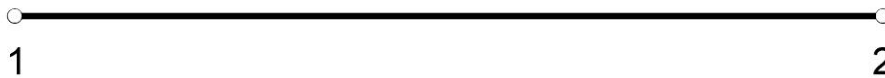


**Figure 6.** The *medievalisation* and *diagonalisation* processes according to Caniggia.

## 2. THE THEORY OF ATTRACTORS AND REPELLERS: DEFINITIONS

The route, street or lane is a human artefact and it can be studied just like buildings and urban tissues. The level of permanence of routes is in general higher than that of buildings, also while the most buildings are private (base buildings) and only few of them are collective (special buildings), routes instead are in general public and should be considered as collective artefacts. In the long duration streets can tell much more history than buildings. The object of

this research is analysing the planimetric configurations of the streets, by recognising typical configurations of the road form in urban environment and its diachronic changes due to the effect of the *attractors*. This method can be useful for different disciplines, such as archaeology, urban history, and urban planning. The *attractor* theory considers the deformations occurring in time to streets considered as artefacts. So an *attractor* could be defined as an element that deviates a route from its previous configuration by attracting its traffic. A *repeller* is the inverse of an *attractor*, an element deforming the configuration of a path by repelling its traffic. The presence of an *attractor* now not existing any more can be inferred with the formal analysis of the configuration of routes that have been attracted by it, determining a sort of diachronic urban stratigraphy, it is therefore possible to infer the presence, type and position of a former *attractor* by recognising the deformations of the routes that were attracted by it. Considering that the route pre-exists the settlement [14] the planimetric form of the route depends on a number of elements attracting and repelling its course from the shortest path. These elements, defined here as *attractors* and *repellers*, can appear, disappear, or even change position in time, determining through history the complex configuration of the route itself. The changing positions of the attractors and the changing strength of attraction can be recognised and used to interpret the phases of an urban settlement. Once an *attractor* ceases to exist or ceases to attract, it may happen that the route returns to its unattracted configuration, but in urban areas this elasticity is reduced by the presence of urban tissues that tend to limit the possibility of reversing the attraction phenomena, freezing therefore the attracted configuration. Attractors can be, point, linear, or shaped/areal.



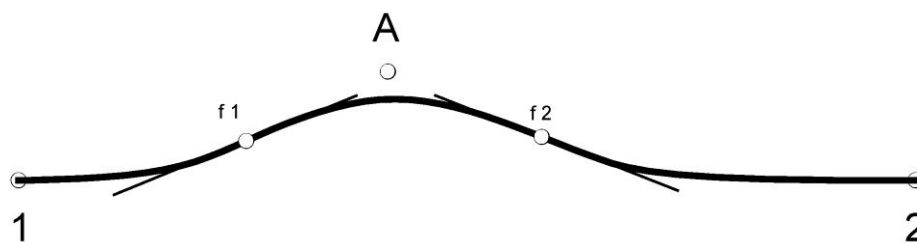
**Figure 1.** Trajectory of a route from pole 1 to antipole 2 as the shortest path.

Examples of point attractors are wells, city gates, bridges, fords, springs, and passes. Examples of linear attractors are instead city walls, rivers, seashores, lakeshores, canals, while shaped/areal attractors are buildings, infrastructures, rock formation, lakes. *Attractors* can be territorial or urban: some special buildings or urban functions may act as *attractors*, typically, markets, power seats (government buildings, local administration buildings), churches, monasteries, other religious buildings. The difference between a territorial and an urban *attractor* is only the urban environment, considering that the city, can change in time, so a territorial attractor can in a subsequent phase find itself inside a city, and on the other hand what was once an urban attractor could today be in an abandoned territory becoming thus territorial. Distinguishing between *nodal* and *polar* attraction, includes the notion of *pole/antipole* and *node* as defined in the Muratorian theory [15]. The *attractor* itself is not *nodal* or *polar*, but the attraction point can be *nodal* or *polar* in relation to how the different routes are converging there, a *nodal attractor* is determining a branching between two or more routes, while a *polar or antipolar attractor* determines the origin or destination of a route. Attraction can be *deformed* or *undeformed*, where a deformed attraction is visible in the local modified configuration, while routes that don't have local curvatures converge in an *undeformed attractor*. Attractors and repellers can be *simple* or *complex* depending on how the effects of their action can be classified, either in a simple form or as the result of more

forms merged together. Finally attractors and repellers can be *anthropic* or *natural*, depending if they are determined or not by human action. This classification is tentative, and is based on the observation of the attraction phenomena in the urban and territorial environments. The classification is useful to build a taxonomy of attraction cases, based on a binary set or parameters, to be used to recognise the type of attractor. So following the classification there could be an *anthropic point nodal undeformed simple attractor*, as well as a *natural continuous deformed complex attractor*. The mean character to be recognised in the road network, besides the road curvature and inflection, are the discontinuities in the track, the bifurcations, the intersections and the convergences.

### 3. NATURAL ATTRACTORS AND ANTHROPIC ATTRACTORS

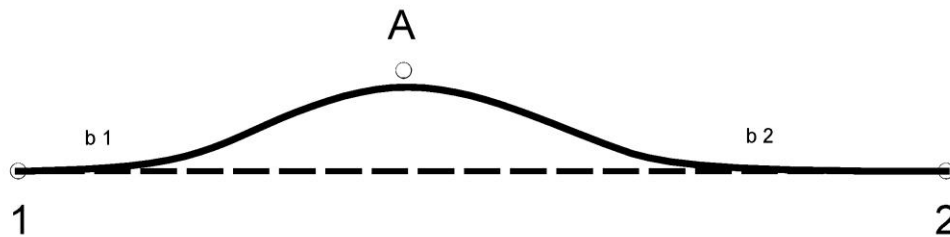
The shortest path from one point to another is a straight line if the surface is flat, instead if the surface has a complex form it is not the shortest path, but the minimum energy path. In this case it is the morphology of the site to act as an *attractor* to the route, deforming it from its theoretical straight line shape. The first step in the construction of the theory consists in the classification of the natural attractors. The theory is based on the assumption that every *anthropic attractor* has an equivalent *natural attractor*. There are different elements that can act as attractors in an urban environment, such as bridges, city walls, city gates, water systems, markets, special buildings, and it is possible to consider each of these anthropic attractors as equivalent to a morphological attractor at the geographical scale. We can even interpret the ridge-top theory [5] as the result of attraction and repulsion of geographic features on anthropic routes. The territorial scale analysis is the methodological base of the theory, but the attractors herein considered operate at the urban scale, deviating locally across time from a rectilinear trajectory and defining therefore a specific urban fabric.



**Figure 2.** The point attractor A inflects the linear trajectory of the shortest path determining inflection points f1 and f2.

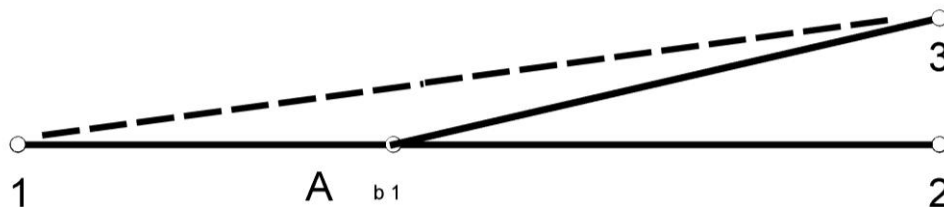


**Figure 3.** The point repeller R along the path deflects the linear trajectory of the shortest path determining the inflection points f1 and f2.



**Figure 4.** The diachronic evolution of a path for the appearance of a point attractor A close to the path, the old shortest path (dashed line) is bifurcated in b1 and b2.

A natural point attractor is as an example a ford: the position of the ford, which is in general independent from the morphological configuration of the territory, will deviate the routes following the ridge top theory so to cross the river in that specific point. The equivalent anthropic attractor is a bridge. While the ford in the human time scale probably does not change, and the deformation of the route from its theoretical shape is stable, in the case of the bridge, its existence and position can vary in time, so the deformation of the routes can be dynamic. Recognising these deformations can help us to reconstruct a disappeared bridge. Other natural point attractor is the mountain pass, and its anthropic equivalent can be the city gate. The linear attractor is instead a continuous structure deforming a route to follow it. Natural continuous attractors are mountain ridges, riversides, lake and seashores. By generalising the ridge top theory, we can say that routes within certain conditions take the shape of the continuous attractors. In some case the same element attracting can act as a repeller in certain parts. As an example we can consider the ridge top that attracts the route, but if too sharp and steep, deviates the route from its edge (repeller) keeping it though close to it (attraction).

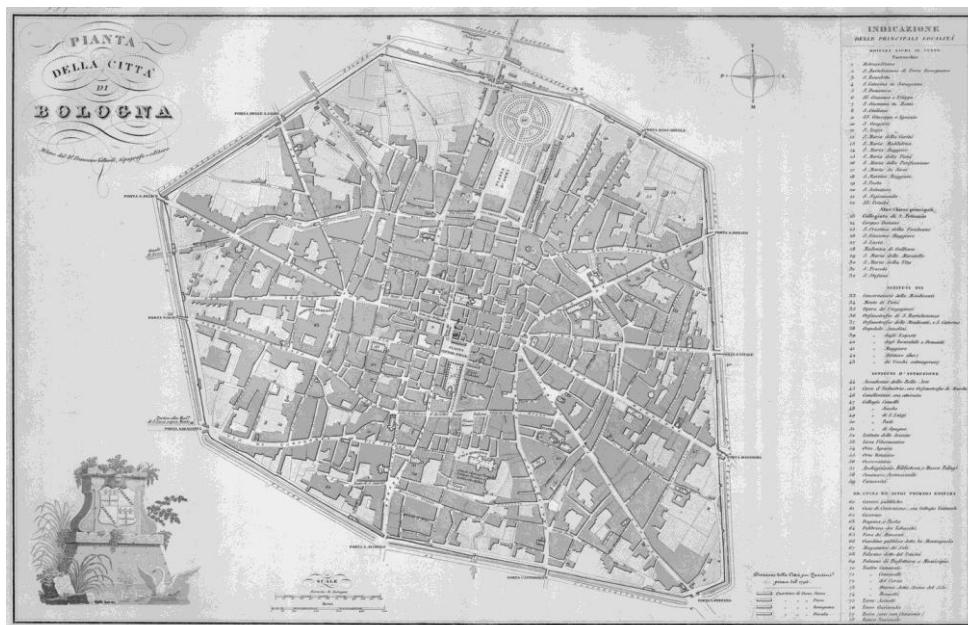


**Figure 5.** The insertion of a point attractor A along the path 1-3 merges the path 1-3 into the path 1-2, determining the bifurcation b1.

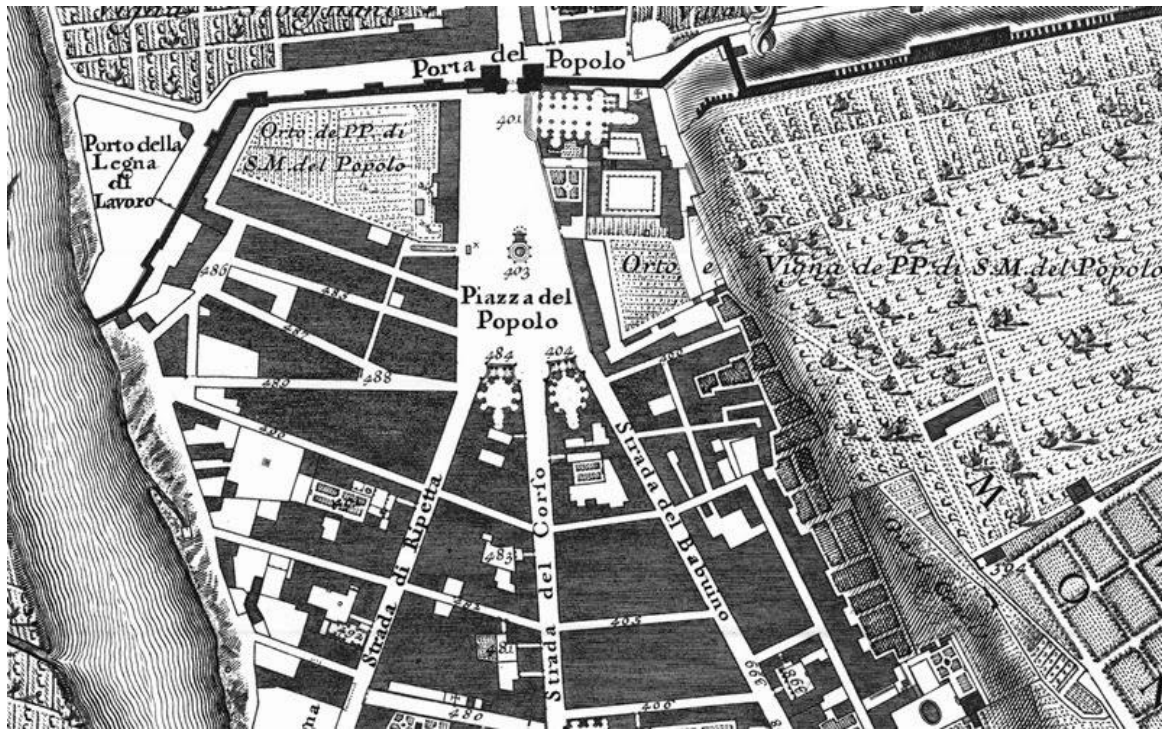
#### 4. ANALYSIS OF THE DIACHRONIC EVOLUTION OF URBAN ROUTES

The research interprets and reads the effects of attractors on urban routes and fabrics as a method for the reconstruction of Nicosia's medieval city walls. An ongoing research is aimed at the reconstruction of the different phases of Nicosia City walls, from the byzantine "circla", to the later *teichokastron*, and the walls built by the Lusignans in the XIV century, comparing them with coeval cases for each phase, such as *Bononia* [16], the territorial routes around Cagliari [17], and the city of Como [14]. The reconstruction is based on the cross matching of historical sources, archaeological evidence and the Muratorian [18], [19], [20] urban morphology analysis methods: this case study is was experimentally proposed for the

development of the theory of attractors. The research on the medieval walls is not finished yet, so cannot be presented here. Some preliminary considerations on the topography of Nicosia can be discussed as a first application of the theory. Following the analogy between the mountain pass and the city gate, it is possible to recognize the typical feature of the bifurcation of routes converging from the territory in the city gate. This Y shaped bifurcation (cfr. Fig. 5) happens when the construction of new city walls and gates, forces a pre-existing street leading to the city centre to abandon its former configuration and merge outside of the city entrance with the other route that attracted the construction of the gate in that position. In this case one of the routes is acting as an attractor for the position of the gate, and subsequently it is the gate acting as point attractor to the other routes. So it is possible to distinguish an undeformed route merging into the bifurcation, and a deformed one. We can recognise this configuration in the bifurcations outside of *Porta Ravennana* in the medieval Bologna, in this case the *Kardo* of the roman *Bononia*, *via Aemilia*, continues undeformed outside of the roman city walls, while the other routes were attracted converging in the gate. The same phenomenon can happen inside the city, either because the urban tissue is not consolidated yet or with the restructuring of the former urban tissue. A good example of an inner bifurcation of routes for the city gate acting as attractor, may be found in Rome with the *Porta del Popolo* and the three streets *via del Babuino*, *via Lata* and *via Ripetta*. In this case the *via Lata* is the unattracted route, the other two, as determined in the XVI century with the *Piano Sistino*, were designed to converge in the square facing the city gate inside the city. By finding typical configuration of road bifurcations, branchings, intersections, and deformations from the straight form, interpreted diachronically, it is possible to construct an abacus of the attractors and repellers, and the deformations caused on the urban routes. With the analytical understanding of a very large number of cases and their explanation in theoretical terms, it will be possible to provide a substantial aid to the study of the history of cities in the middle ages: a historical phase of history that usually lacks documentation for the reconstruction of the urban environment.



**Figure 6.** Typical street bifurcations outside of *Porta Ravennana* in medieval Bologna. *Pianta della Città di Bologna*, Atlante Geografico dell'Italia, Francesco Vallardi Editore, Milano 1868.



**Figure 7.** Typical street bifurcations inside of Porta del Popolo in Rome, G.B. Nolli, *Pianta grande di Roma*, Rome 1748.

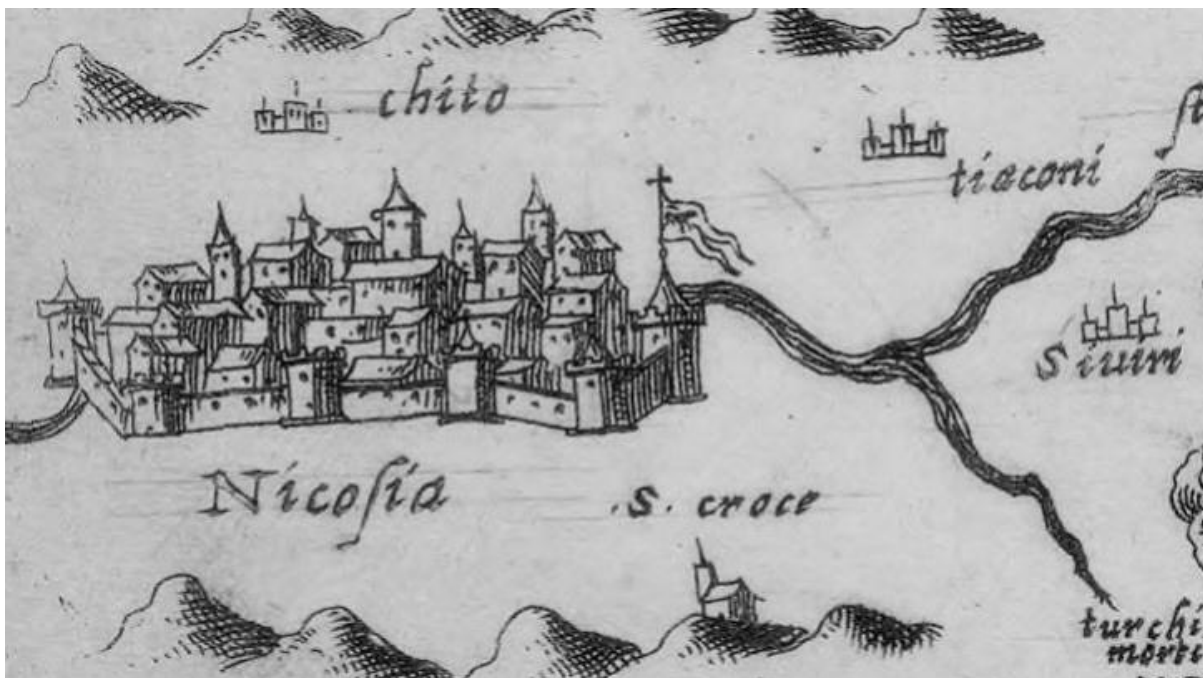
## 5. THE POINT ATTRACTORS OF NICOSIA

The urban settlement of Nicosia started as Ledra in Bronze Age on the top of Agios Georgios hill, next to the river Pedeios (Kanlı Dere), along the intersection of the valley route following that river, and the cross-valley route connecting the Pentadaktylos ridge and the Troodos ridge, and developed as an exchange point between the two sides of the river. Only in Byzantine times, in the X century, the city became the capital of the island, and a surrounding wall was added. After becoming archbishopal seat in 1212, the city grew larger. Nicosia was protected since Byzantine times by a walled enclosure of which very little is known. Later the city was defended by a castle built by Henry I in 1211. A complete city wall surrounding the city was started in 1368 by Peter I and completed by Peter II in 1380. Further works were accomplished by Janus I in 1426, and planned in 1450 following Nicholas V decision. The urban area reached a circumference of four miles, before the Venetian transformation of the city, reduced it to three miles [21]. In 1567 new walls, designed by the Venetian engineers Giulio Savorgnano and Francesco Barbaro, replaced the medieval ones. The construction of the new walls implied the destruction of the older walls, and the infilling of the river, moving its waters into a new moat surrounding the new city walls. A new urban tissue gradually replaced the riverbed, flanked by the sinuous streets that followed its former course inside the ancient city. In Nicosia the three existing bridges, where crossroads connected the two sides of the city, maintained their polar role after the river infilling. The Venetians might have not completed this urban transformation, hence the Ottoman siege of the city in 1570, but in continuity with the precedent administration the Ottoman renovation of the city, used some of the areas above the infilled river. Since then, this area become the city centre. The three bridges disappeared from the urban landscape once the river was

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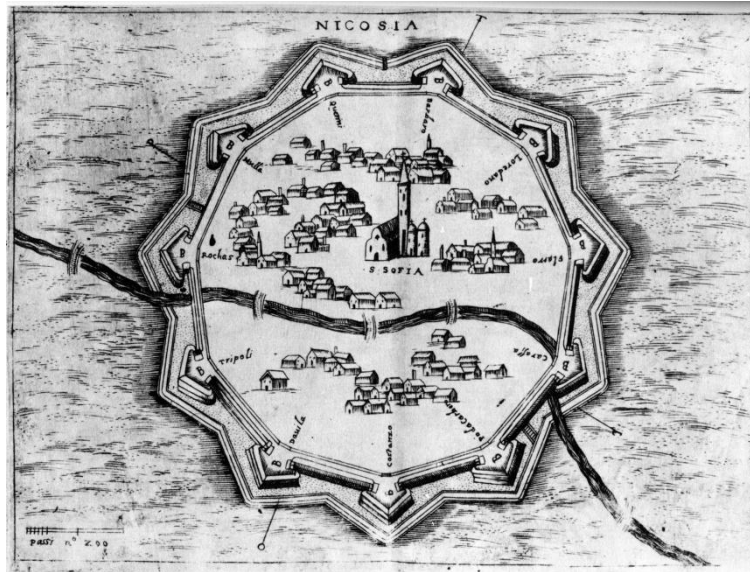
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infilled, but their trace is still readable in the network of urban routes. The bridges acted as attractors for the urban routes. The crossing point of a river determined by a bridge or a ford, acts definitely as a *point attractor* for the surrounding existing routes. What is singular is that the Ledra Street check point, the only crossing point of the buffer zone within the walled city of Nicosia, was opened in the same point where in ancient times one of the three bridges was; so the permanence of urban traces acted as a guide for the modern design process. After the opening of the check point in 2008, in the same position of the ancient bridge, all the commercial activities of the walled city of Nicosia were attracted along that same urban axis of Ledra Street, showing a singular cyclical continuity in the attraction phenomenon. In the plan of Nicosia it is possible to recognise through the inflection and bifurcation analysis a number of meaningful cases. We will propose just a few here, due to the lack of space. The construction of the Kyrenia gate in the end of the XVI century, seems to have attracted the urban axis stemming from the third Royal Palace built in Lusignan times. Maybe in that time the urban tissue was not complete in that zone, and the palace within a fringe belt, was built at the limit of the built area. What is clearly visible in the plan is the attraction of the gate in relation to the urban route, as if the direction of the route was determined by the gate, so to infer that the route developed after the XVI century. In the same area it is possible to hypothesize the presence of a continuous attractor, surrounding the urban tissue, such as a city wall or a moat. On the western side of the city walls, the now called Paphos gate, inflects and bifurcates the outer routes, where the southern one is also deformed by the bastion, acting in this case a repeller. The opening of the Limassol gate in modern times the southern part of the Venetian city walls, attracted the outside routes, and was attracted by the internal ones (Fig. 12)

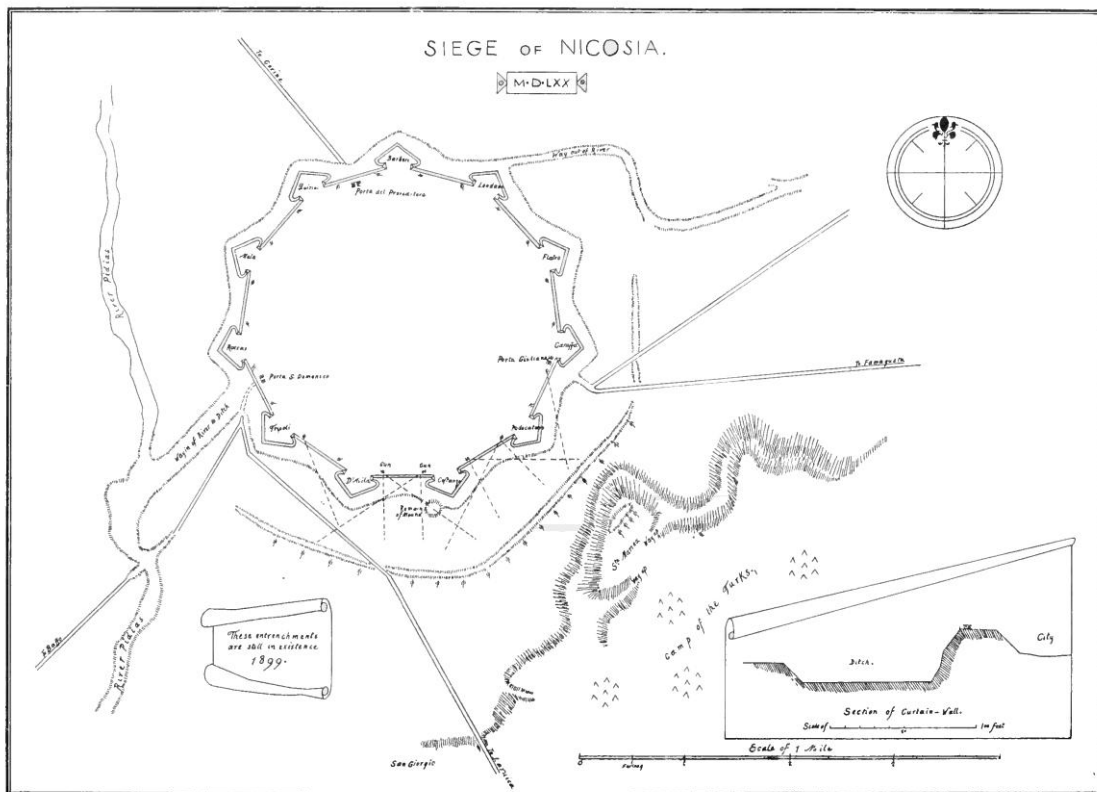


**Figure 8.** F. Bertelli, J. F. Camotii, *Partie orientale de Chypre*, Venetiis, Romae 1562-1570, Bibliothèque Nationale de France, Département Cartes et plans, GE D-13952, detail.





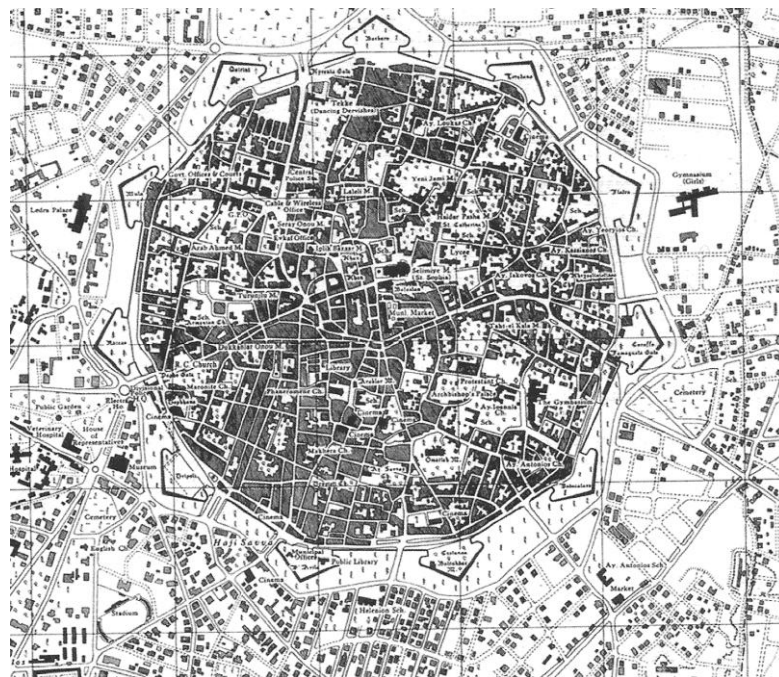
**Figure 9.** G.F. Camocio, *Nicosia, Isole famose porti, fortezze, e terre marittime sottoposte alla Ser.ma Sig.ria di Venetia, ad altri Principi Christiani*, alla libreria del segno di S. Marco, Venetia 1574, n. 72.



**Figure 11.** The attraction of the three Venetian city gates of Nicosia on the external routes. (Cobham, 1908, p.87).



**Figure 12.** Kitchener map of Nicosia, 1881. The opening of Limassol gate in the southern part of the Venetian city walls, attracts the outside routes, and is attracted by internal ones.



**Figure 12.** Department of Lands and Survey, Topographical map of Nicosia and Environs, 1958. It is possible to read the attraction of the Venetian gates and the modern openings in the Venetian walls on the modern street network.

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## FORWARD

The 1st international conference on 'Changing Cities', which was hosted on Skiathos island, 18-22 June 2013, had started as an idea in 2012. The initial concept was to organise an academic event creative, inspiring, stimulating, and above all, international. There had been a belief that such an academic event may contribute in revitalizing academia and promoting tourism in Greece - hit by the economic crisis of public debt in the Eurozone. Given that during the last years, both societies and cities in Greece have been dramatically changing, shrinking in economic, spatial and demographic terms, we have chosen Changing Cities as the main theme of this series of conferences. Our aspiration had been to provide an international forum for transaction of ideas on cities and bring together architects, urban designers, landscape designers, urban planners, urban geographers, urban economists, urban sociologists and demographers, to investigate new challenges. This goal became a reality since the 1st Changing Cities conference gained strong interest of academics and researchers from many countries and regions around the world; Greece and the Balkans, south Europe and Mediterranean countries, northwest Europe, Middle East and Asia, Far East, North America, Latin America and Africa. A total of about 460 abstracts and 320 papers had been submitted in the conference – most of them, about 60% from abroad.

The 2nd Changing Cities conference, Porto Heli, Peloponnese, Greece, 22-26 June 2015, was also fruitful academically since it attracted the attention of scholars, not only from Greece, the Balkans and Europe, but also from far-away countries like USA and Canada, Brazil, Chile, Colombia in Latin America, and China, Japan and Australia in the far-east. We received about 500 abstracts and more than 350 papers. Among the scholars participating, there were about 185 Greek academics and researchers. This indicated that despite shortage of research funds, salary cuts, and broken morale, university teachers and researchers in Greek state universities were trying hard to keep a high-level academic status. Besides, the number of contributions by scholars from abroad (63%) emphatically pointed the international character of the conference.

The results of the 3rd Changing Cities conference, Syros Island, Greece, 26-30 June 2017, points that the series of conferences on Changing Cities is getting established in the international academia as a significant bi-annual international forum. We have received 485 abstracts and 200 papers from many countries around the globe – honouring our efforts as Organising Committee. The contribution by Greek researchers and scholars is 27.42% while that of foreign academics reaches 72.58%; this indicates the international character of the conference. Regarding foreign academics, many of them are from neighbouring countries such as Italy (69), Turkey (37), Cyprus (11), and

Serbia (6); but also many are from distant countries such as Brazil (27), USA (16), UK (16), Poland (11), and Netherlands (10).

The strong interest for this conference by academic communities allows us to have thoughts about organising the 4th Changing Cities conferences in two years' time, spatially hosted in a different Greek sea resort – probably Santorini Island, or Crete.

I would like first to thank the Organising Committee, the keynote speakers, and the members of the international scientific board who supported enthusiastically the academic organization of this conference. I would especially like to thank those colleagues of the Scientific Committee who have also pre-organized special sessions in this conference. I would like to thank all the academic, political and scientific organisations which supported this conference in many different ways: University of Thessaly; The Municipal Authority of Syros Island; the Greek Ministry of Tourism; The Greek National Tourism Organisation (GNTO); Finally, I would like to thank the shipping companies 'Blue Star Ferries' and 'SuperFast Ferries' which sponsored sea travel to and from Syros Island.

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& the International Scientific Board*

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