

## PROTOTYPE FOR AN AXIALLY CONNECTED *LINEAR ROUTE* IN THE ANCIENT CITIES OF SINDH- PAKISTAN

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### Abstract

*The grid is an orthogonal framework that is an innovative system in the history of spatial configuration. In addition, it is an important algorithm in the practice of urban engineering as it can be found along the entire history of urban planning. The most powerful characteristic of the urban grid framework is that it creates a foundational map amenable to producing efficient use of space. However, not much research has been done on the primary origins of the urban grid. This paper examines the chronological history of the orthogonal grid in planned cities in an ancient civilization where the grid pattern was used for designing human settlements. The aim of the current paper is to present the spatial configuration for the most primitive prototype of a prehistorically evolving city. In short, the aim here is to call for a redefinition of the notion of the "city" based on an axial grid.*

*There is a vacuum about the first grid planned city using grown along the linear datum as a spatial navigating device since the early Stone Age and prehistoric era. The grid configuration has several historic-geographical attributes witnessing the evolution of four dimensional temporal- spatial forms. None of the studies have examined the role of the grid according to the topographical constraints of prehistoric cave morphologies such as the Devils Mouth, the first (Rakas jo Roon the first and the second) at Rohri, Lusbella Gundrani caves and the Seven caves. Here cave dwellings are embedded (carved out spaces) hence they are reverse mould i.e. subtractive space rather than additive. This typology provided complete enclosure to hunters and gatherers against the threats from wild animals. It also facilitates a variety of public and private spaces as well as congregational meetings space. To diminish the imbalance in research approaches towards urban settlements; Cozen (2004) suggested that the need is all the most urgent because townscapes are assets of society. The documentary and pictorial evidence based on field surveys included in this paper supports the need for an earlier city theory of the townscape grounded in intensive spatial analysis work. Thus, there is an urgent need for a multidisciplinary approach toward redefining the first planned city.*

**Keywords:** *Ancient Cities, Indus Valley Civilization, Architectural linear grid, Urban Morphology, Space Syntax.*

**Theme:** *Historical Evolution of Built Form*

## Description of the back ground information

In continuation with Childe's vision of city evolution, and Soja's attempt of putting cities first, the hypothesis here is that: the evolution of grid planning is a qualification for first city which occurred at caveman's colony. There is identification for the chronology of compact city plan, where the grid is used to overlap the mixed used settlements. Despite the dominant use of axial grid system in the ancient cities as well as modern cities, urban scholars have not rigorously explored the prototypical origin of grid system in the history of space configuration. Thus here is a potential to expand the understanding of the urban grid pattern during the pre-pottery period (cavemen period) of human history.

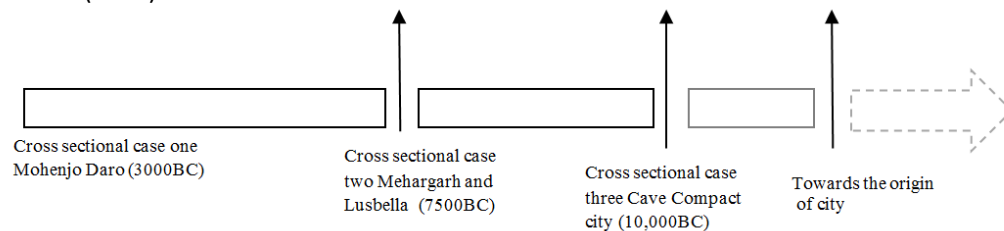
To justify that the grid planning is the most modern as well as the most primitive type of planning approach towards towns, Figure.3 focuses on Mohenjo Daro (BC 3000) which is inferred here as today's Manhattan based on the spatial standards of orthogonal grid. Second, the ancient city of Mehargarh (BC 7000) located at the eastern Baluchistan area, which is contemporary to the Neolithic site of Çatalhöyük (BC 7500), Turkey. Finally, the ancient seven man-made caves, dating back to 12000 BC, the old Neolithic Stone Age sites which shows prehistoric initiative towards the urban grid system, this research is conducted in a retrogressive research model. Space syntax techniques are used here for solving prototypical city design problems. Here it is used as a set of researching the relationship between the way cities are structured and the way they function. It is used here on the long temporal historical model to highlight cultural differences between cities (location Figure2), but increasingly it is able to identify what cities have in common – and so it is helping to build a more general theory of the cities Bill Hillier (2005).

## Introduction

Today grid is common in Mega City design and planners are using grid ubiquitously far and wide universally from Paris to Manhattan. The urban grid system has a long history; in fact the colonial Greek city of Miletus was rebuilt on a grid system around BC 479 by the first recorded town planner Hippodamus. It is well known that the Greek orthogonal planning tradition was influenced by ancient civilizations such as Egypt and Mesopotamia. Consequently, much earlier prototype of grid system has been found in ancient cities such as Mohenjo Daro in the Indus Valley civilization. A few scholars have tried to identify the original location of urban grid system in the history of human being (Stanislawski, 1946; Rose-Redwood, 2008). Since they focused on whether mature form of urban grid system had appeared at multiple locations simultaneously, though they did not address the prototype of urban grid and its origin.

## Grid evolution as a longitudinal temporal model

The Figure1 represents how grid is an axial spine for functioning society. Grid provides physical mechanism within urban space to respond the varied requirement of society and its individual's shelter, rearing children, working transportation, education, the supply of goods, other social and cultural services and recreation. As these essential needs changes over time, so does the character of the grid for the townscape. Hence Grid is subject to historical development. Cozen (2004)



Research Model, A sectional temporal research method model applied at a local scale (micro level grid origin)

## Case Studies

For case study analysis (Figure 1) a similar model of analysis is derived here as an archeologist finds the different grades of layers while excavation. The newest layer is the one which is the top most layers, and as he excavates further the origin is found at latter stages. Hence the conceptual framework used here for the analyses of individual cases is to determine the variables of grid system used at different stages. This is done by analyzing the newest civilization and then retrogressively pushing back the history of cities.

### Ground level

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Layer one: Manhattan (2013)

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Layer two: Mohenjo daro (2500BC)

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Layer three: Mehargarh and Çatalhöyük (7500BC)

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Layer four: cave orthogonal grid (10,000BC)

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A retrogressive longitudinal research method model applied at a global scale (macro level grid evolution)

Since space syntax aids researching cities to understand how social and economic processes shape over time. The analyses patterns of space in the built environment uncover spatial structures in cities and relate them to the way people move, stop, and interact. The Figure 3 represents the axial analysis for analysis of the network of street and walkways and “visibility graph analysis” or VGA is used for analysing patterns of visual fields in Public space.

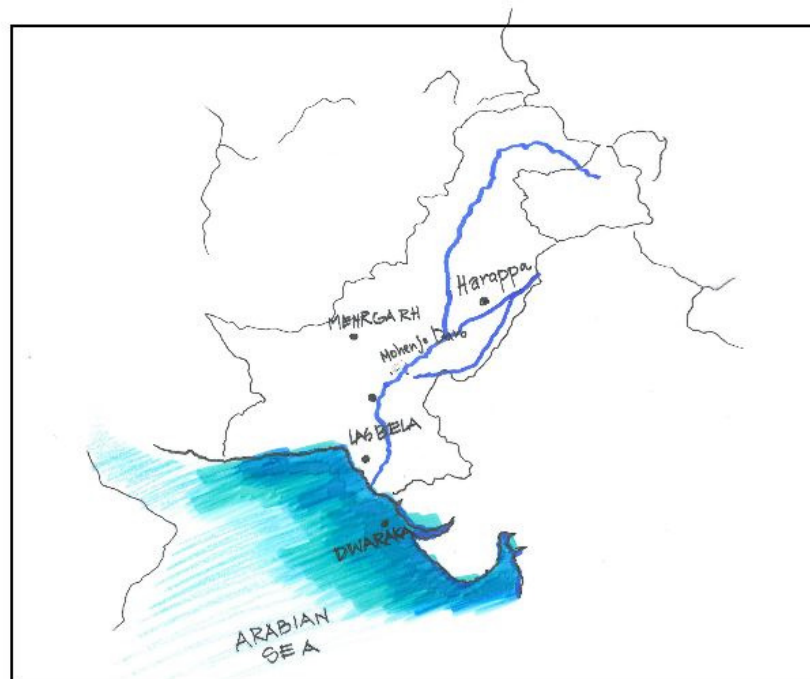
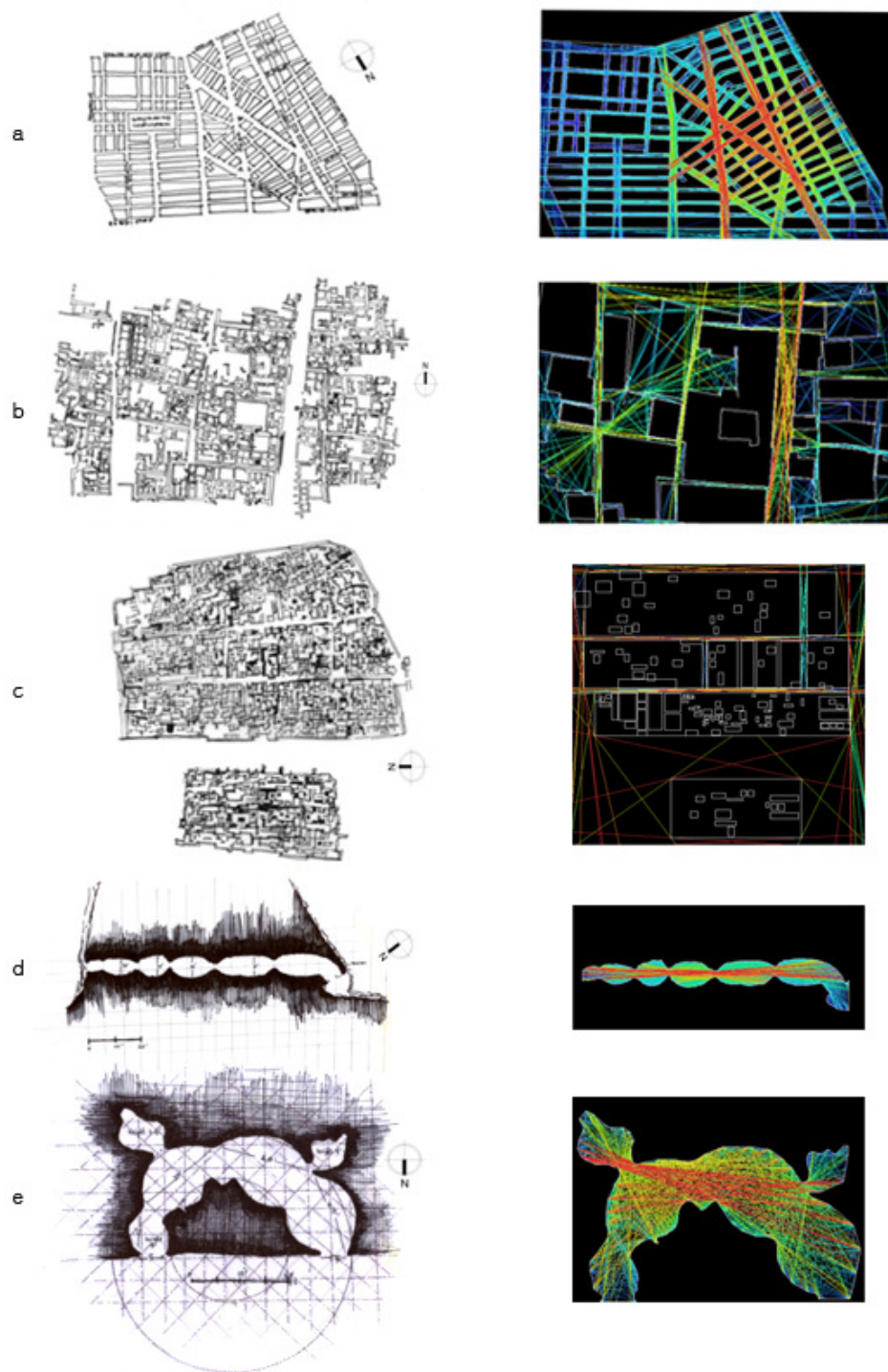
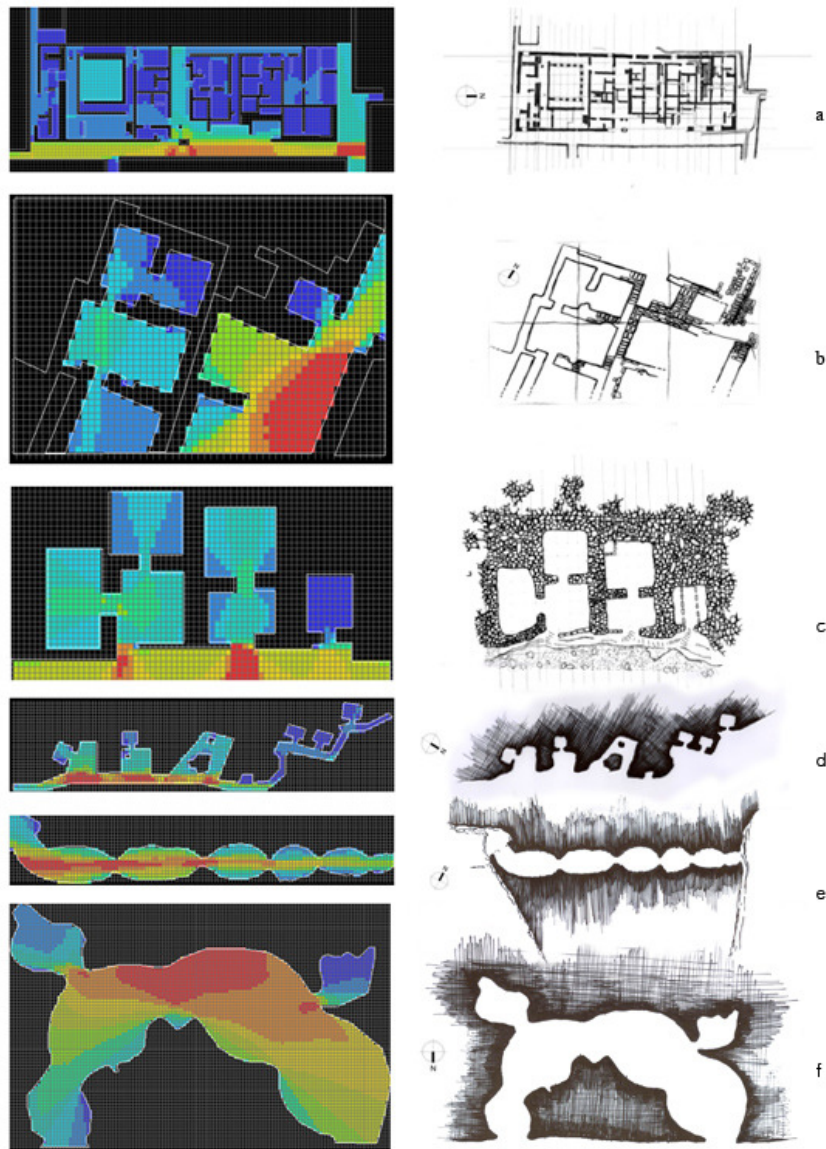


Figure 1 Locations of Case Study Areas



**Figure 2** a. Jane Jacobs' neighbourhood: Manhattan  
<http://www.cyburbia.org/forums/showthread.php?t=12532> accessed 18th April 2013  
b. The HR Area of Mohenjo Daro, Marshall (1922-1927) 'The Indus Civilization', Plate XXXIX  
c. from the film, Schuler, (2010) d and e: Abro (1998) The Man: مائٽهوءَ (used with permission)



**Figure 2** an illustration of possible linkage between cavemen Stone Age and urban grid system in the Indus Valley Civilisation with modern grid. Depth map representation the movement and arrangement of alignments, and the urban grid, supplementing the distribution of built form densities in the historically evolving city.

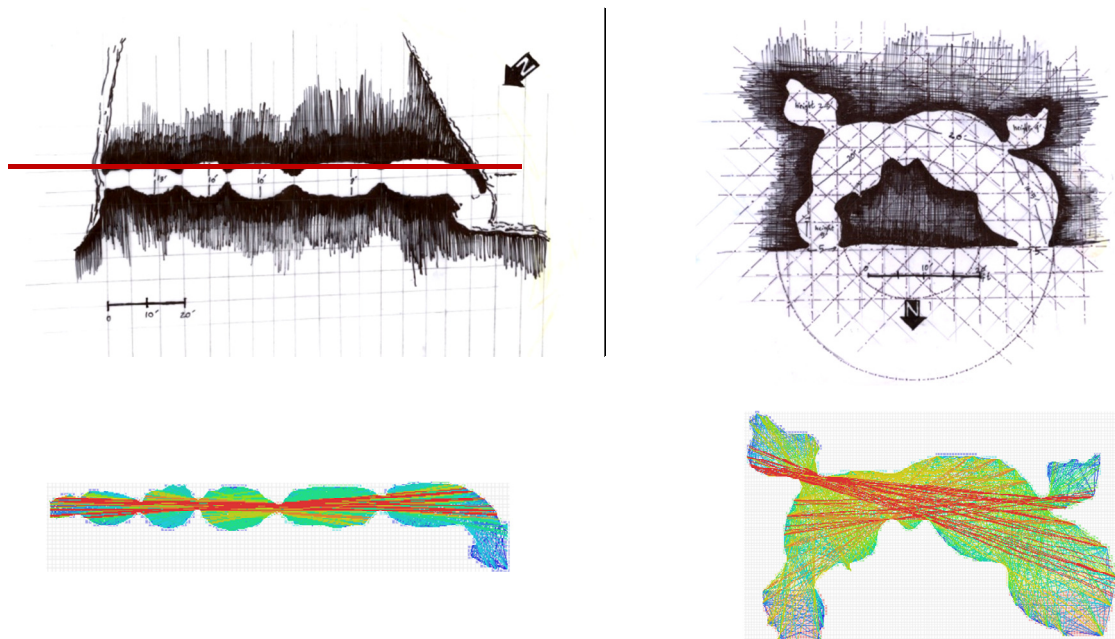
a. Mohenjo Daro(2500 BC), b. Mehrgarh (6500BC) c. Gundrani Cave City (7000BC) Balouchistan, d. Seven cave at Sehwan (10,000BC), e. Devil Mouth first, at Shahdee Shaheed, f. Devils mouth second Rakas jo Rohro, Rohri Hills Sindh.

The figure attempts to bridge the gap between the ongoing studies by making a contribution about the evolution of axial grid system in the history of cities.

## Grid analysis based on the Literature Review

The literature review defines orthogonal grid, by synthesis of four different determinants: first determinant is alignment and distribution of spaces based on public and private activities and mixed used density. Second circulation of people from one point of city to the other and visual connectivity, third determinant is the geometry and the geometrical components which makes the grid i.e. use of right angles and straight lines. Grid supports growth, change and efficient security, of eyes connected. Final determinant is alignment with sun and wind i.e. contextual fringe belts: rivers and hills.

Rose-Redwood argued that the grid facilitates the most complex overlapping phenomena's of settlements that includes politico- economic, historic-geographical, and socio- spatial rationalization of "place". These themes suggested numerous productive lines for inquiring grid origin. Theoretically Stanislawski questioned regarding the primary source of the grid that either the grid was a one-time- invention which is been spread from the source region and the glob till present. He supposed that neither Marshall (1931) nor Mackey (1938) were convinced about the urban grid history prior Mohenjo Daro, though on the other hand Wheeler (1953) believed on the origins of urban history and an obvious prior connections with cities along the Indus. Since Mohenjo Daro was reconstructed over remains of previous civilisation (shown in figure one), and the depth of the entire civilization could unearth further back history Possehl (2003).



**Figure two** Devil mouth the first, near Shahdee Shaheed Rohri Hills and Devel Mouth the second Rakas jo Rohro, Near Rohri Hills (The entrance is 2.4 meters wide diameter, and height is 1.5 meter, the total depth is 12.8 meter. The third chamber is 4 meter high, the second chamber depth is 4 meter long, width is 6 meter, and high is 10 feet. The third chamber is 10 meter deep, 6 meter wide and 4.5 meter high. The 4<sup>th</sup> chamber is 14 meters deep, height, is 3 meter and width is 6 meter).

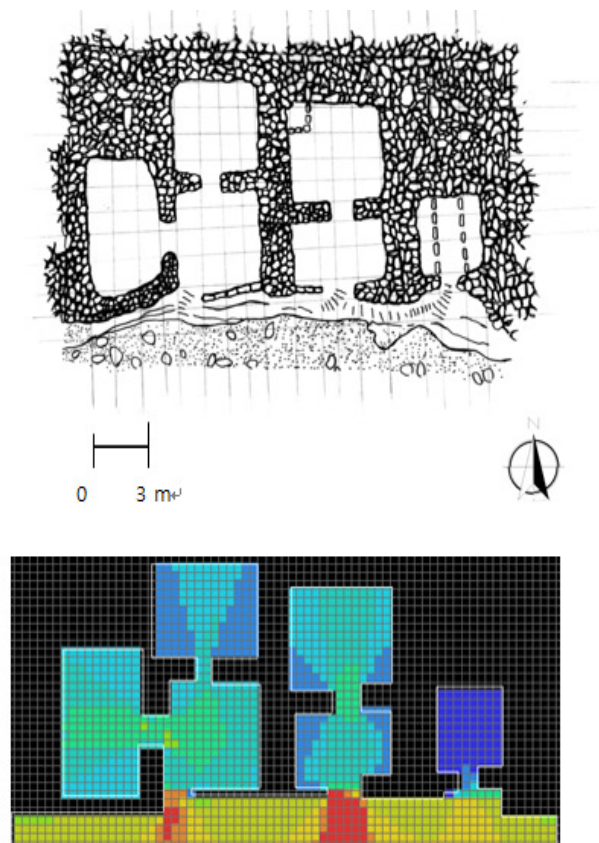
The earlier existing evidence for the grid city were the precedents to the regions directly accessible or associated with the city with grids, this is evidence by the history of distribution of grid patterned cities on the globe, which shows a continuity and a strong link. This is contrary to the contemporary theory that the grid phenomena were a casual automatic pattern of settlements. This study breaks down the grid into its different types, and explains the historical and conceptual relevance of each grid. The grid is classified as point-based (coordinate,

intersection) "The grid, which invades and integrates itself into the land gestures, signifies the rational, impersonal, and inevitable character of natural law, which deterministically controls the structure of the material city and of events within that city". The structure of reason is thus the structure of the grid city, represented in Nature. So, man-made structures are the implementation of this reason found in Nature.

The coordinate, point, or individual hilly zone is no longer our only representation of Nature, and so the grid shifts to a sterile ground. Modernism is a reflection of this universal grid, and Postmodernism becomes its subsequent rejection. Postmodernism rejects the grid as a use of logic, and transforms it into a "decorative element". The grid is then taken to a "mysterious, often nonmaterial dimension" with the discovery of the atom and its explosive tendencies. This research establish hierarchy, focus in, focus out, deconstruct, zoom in, tilt, cut out, explode, suspend, and zoom out to end up finding about what is happening to the grid right now, considering the history of grid.

Recent research by Archeologist and architects have identifies several theories that qualifies cave ancient settlements as capital cities. The first groups of Indus flint quarries were discovered in 1986 near Shrine of Shadee Shaheed by Paolo Biagi(1991) at Rohri Hills and this represented the most intriguing and complex extractive zone. Hence the site of Devil mouth the first, present at this location was habitat for these business men (hunters and gatherers) who were sculpting these stones, and exporting them to far regions. The axial tubular compact settlement of *Rakas jo Rohro* shows the prototypical origins of the primitive grid plan, which was naturally a semi-lattice planned city as shown in Figure 2 (along physical nature, alignment with sun movement, wind, river flow and hill as a fringe belt).

The well calculates, geometrical, and proportionate, architectural feature; represents "elaboration of exact predictive sciences- arithmetic, geometry and astronomy" Smith 2009 and Childe (1950). Figure 3 represents the understanding of the cave dweller intellectual capability and precision of spatial configuration. Moreover the 1:2 rectangular proportions for the room, and the 45 degree parallel with North, show the high precisions of urban design for this earliest city.



**Figure 3** Map of Lusbella Gundrani Cave

Source: Abro (1998) *The Man: مائٿو* Accessed March 23, 2013

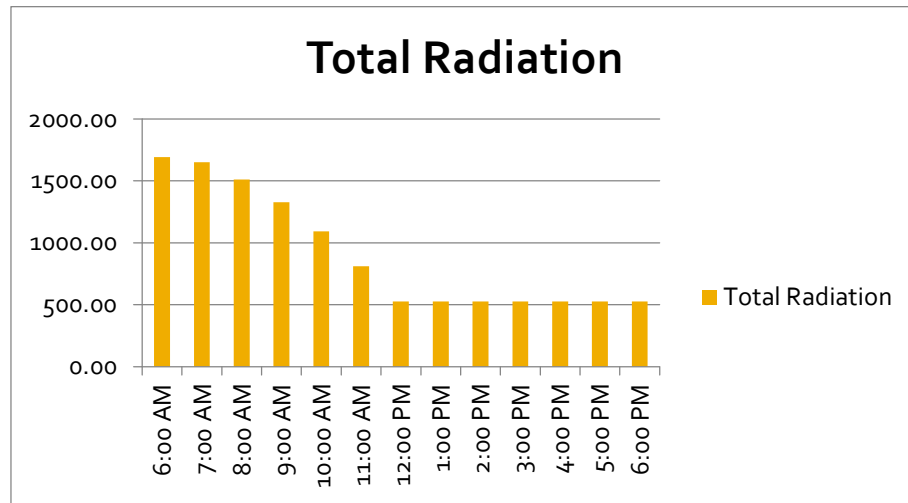
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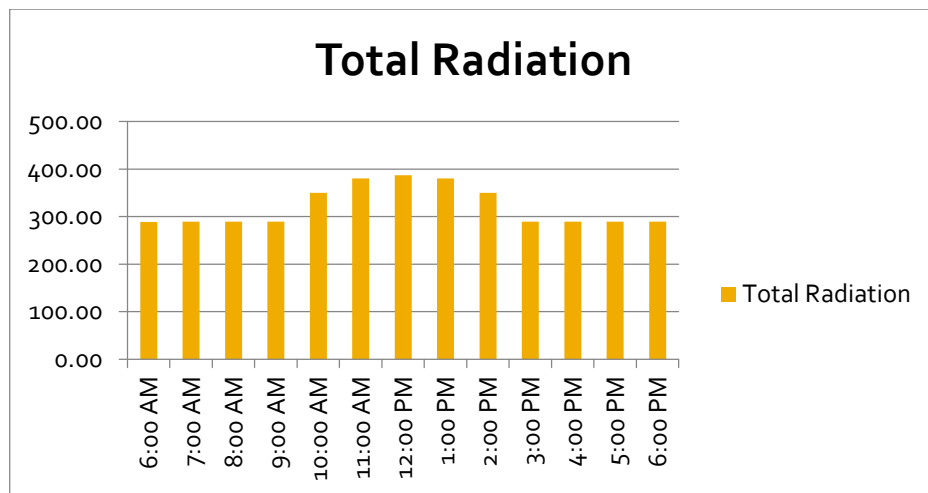
**Figure 4** photo graphs of the Gundrani Caves Baluchistan



**Graph one:** The cave city at Kai, is planned to bring in light early morning, till 11, after the mid day the direct sun light does not enter the caves. Radiation for the 22<sup>nd</sup> December 10000 BC, sun entrance pattern in to the last chamber of seven caves at Kai site



**Graph two:** Shahee Shaheed east elevation Radiation for the 22<sup>nd</sup> December 10000 BC maximum is at mid day



### Evaluation and synthesis of the individual case studies and analysis

The table represents the determinants for the variety of grids from case five to case one. The primary purpose of the origin for grid is accessibility of linear route. Grid evolutions and intricate systems were recorded over time as Seven Caves caters for proportions and density. Continuity and the spatial scale result the grid geometry to grow in complexity by overlapping with primary secondary and tertiary street networks, which is valid for case two Mohenjo Daro plans where space use is more controlled, and grid order is integrated.

**Table one** Evaluation of the individual case studies and analysis

<b>Nature as Determinants Of grids</b>	<b>Case one Manhattan</b>	<b>Case two: Mohenjo Daro priest college</b>	<b>Case three: Mehargarh MR3 Area</b>	<b>Case four: five chamber linear site at Shadee Shaheed</b>	<b>Case five: Devil Mouth the second at Rohri</b>	<b>Case six Seven Caves Sehwan</b>
Movement of people	Main street grid internal linear circulation Avenues	Movement of people in Primary streets secondary street and tertiary street	Accessible street lay out	Very linear connection going through the entire depth of the hill in a straight line	Curvilinear having two entrances opening at the same face of the hill	Linear street, connecting seven chambers, in a row
Movement of sun	Grid parallel to North side	-East west streets for the sun light after mid day	Parallel to North Side	Visibility of sun after mid day	Grid skewed to 45 degrees	The site is designed so that the first ray of light falls perpendicular
Geometry	-Right angle grid -diagonal overlap	-Right angle - Lines -Orthogonal	Orthogonal axis lines	Single straight line	-Semi circular grid -Radial geometry	-45 degree angle -90 degree angle grid
Growth Change Expandability	Vertical High rise	according to a vertical grid the new structures could be added	surrounding space for expansion	The first chamber is smallest and last chamber is biggest, representing the demand for growth	A central chamber which is biggest sculpted over time	The central chamber is larger, earlier it was small but then it was expended when required
Security safety and movement of the eyes for guard and learning	Limited movement of eyes due to high buildings	Grid supports Interaction	Guarding the storage area	Security against wild animals, linear visual contact	Focused view towards the niche	Small chambers Guard from animals and weather

In conclusion we support our hypothesis which has been proved that the typology and topology of the street concept is different from Mohenjo Daro, Mehargarh and Seven Caves nevertheless the morphology is the same. Hence the origin for the grid which is used in all the mega cities today is from the primitive cave man dwellings. Who designed his compact urban form on the basis of the geometric straight line based on natural flows of people movement.

## Conclusions

Redefining a city as a multi-discipline (urban planners, archeologists, anthropologists, architects, geographers and historians) and globally valid grid phenomenon; grid has been with man for a long time. Grid city plan is expected to stay in the vocabulary of spatial configuration further longer. Given that the grid modeling of city will continue to exist the development of further understand is critical. Here the determinant of grids can be simplified as below

1. First determinant is concept of rational alignment of living spaces to smooth the progress of the movement of people and assist their approach.
2. To have a sense of community by connectivity of lines of sight and facilitate cone of vision; as shown in Shahdee Shaheed site
3. Second determinant of grid is alignment with sun path and bringing in calculated sun light.
4. The linkages and alignment of connectivity of public and private places on the grid infrastructure protects security and prevents crime, due to visual harmony
5. The grid facilitated expansion and amendments for the city which grow over time according to economic, social, cultural and environmental prerequisite

This study illustrated that the origin of urban at the Indus Valley Civilization is related with the prototype of urban grid found in the Shahdee Shaheed. Moreover the variables of the grid system are associated with sequence of gradual evolutionary global multidisciplinary phenomena.

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