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GIS and the Future of Humanities – An Archeological Case Study in Madurai, India

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A B S T R A C T

The "Spatial Turn" is an academic trend that emphasises the importance of studying place and space in the Humanities and Social Sciences. In this "Spatial Turn," researchers are particularly interested in looking into how the terrain has evolved. For one thing, the landscape acts as a bridge between the past and present, linking geographical locations with their respective eras. Studying a "Spatial Turn" necessitates looking at history, literature, and mapping all at once. Madurai City, in the state of Tamil Nadu, is home to several important Hindu and Buddhist sites, including the Meenakshi Amman Temple, the ThirumalaiNayakkar Palace, and the Rani Mangammal Palace. With the help of a technique called "Mapping with GIS," this article aims to investigate the "Spatial Turn" alongside the Landscape alteration study of these three distinct monuments. It is abundantly clear that the geo-cultural and geo-political actions that led to the demolition, destruction, and reconstruction of the buildings of those sites in the Madurai region were largely responsible for the "Spatial Turn" along those monuments.

Keywords: GIS, Spatial Turn, Madurai, Meenakshi Amman Temple, ThirumalaiNayakkar Palace, Rani Mangammal Palace

1. Introduction

Beginning around the end of the Middle Ages, historians have shown a growing propensity (dubbed the "spatial turn") to prioritise the geographical dimension in their study, forging closer relationships with geohistory and cultural geography specialists as a result.

Historians who are concerned about the globalisation of information have proposed a number of methods to foster sociological and geographical narratives that are responsive to the movement of science, and they have also proposed methods to raise philosophical problems regarding the allegedly reductionist nature of symmetrical social research. The concept that there is a distinct boundary between scientific endeavours and other fields of cultural production has been brought into question by insights from the sociology of science. The development of scientific culture beyond epistemic norms and cognitive processes has been brought about as a direct result of the dissemination of accounts of the broader cultural implications of scientific results. Studies that focus on the social construction of scientific credibility within the confines of the laboratory or studies that are concerned with the epistemic challenges of transmitting science from place to place may not always reveal the broader cultural geography of science that has been brought to light by such descriptions of the "active traffic" between scientific endeavour and other cultural endeavours. [(Knorr, 2007)]

Research on the "Landscape Turn" and the "Spatial Turn" is conducted in relation to the Geographic Information Systems (GIS) and Neo-geography revolution, both of which include mapping into its core fabric. Even though the most pressing issues (landscape versus worldview, palimpsest, the commons versus community, and panopticism versus territoriality) predate GIS and Neo-geography, the histories of these issues can be incorporated into the modern underpinnings of the latter, and they can be visualised in a way that makes it simpler for future generations to understand what is left of the past. Alterations to land use and the historical significance of the land go hand in hand with one another. They combed through historical records, proposed theories of spatial experience, and promoted terminology such as "commons," "palimpsest," and "pseudo environment" in an effort to coin a universal language for describing spatial experience and its artificial manipulation. Ultimately, they were unsuccessful. These intellectuals consisted of people like the history of the law Henry Maine, the philosopher Ernst Cassirer, the historian of cities Lewis Mumford, the journalist Walter Lippmann, and the professor of religion Mircea Eliade.

In a progression of changes that have gradually elevated geospatial tools and technologies to the status of authority in the study of human behaviour, the name change from GISystem to GI Science represented a de-reification. This change was one of a series of shifts that have gradually elevated geospatial tools and technologies to the status of authority. It is no longer reasonable to presume that every application of geographic information systems (GIS) to study in the fields of science, culture, politics, or economics is part of some positivist plot to colonise (and hence degrade or destroy) geographic research for good. By analysing two recent volumes published by the University of Indiana Press (The Spatial Humanities and Toward Spatial Humanities), it is shown that the response (though less automatic) is genuine, and it is shown that the reification of geospatial technology

commonly develops because of this reaction. It has also been said that a focus on geospatial activities is required for the ongoing de-reification of GIS and the consequent fruitful uptake in specialised areas of geography, geology, and other fields that are related to these [(Wittgenstein, 2009); (Hanna & Harrison, 2004)].

In geography, there is a de-reifying movement that wants to bring geospatial thinking into the concerns of humanists, historians, cultural and political geographers, and others who are part of the shift to geo-humanities [(Crang, 2015); (Rossetto, 2014); (Delyser& Sui, 2012)]. Humanistic research on (geospatial) technology is now seen as not neutral, full of values, and shaped by corporate and market interests (Pasquale, 2015). This is like the early "social implications" critiques of GIS, which pointed out the possible social effects of search, sorting, and algorithm-based platforms that could use geospatial information. Humanistic inquiry is being changed to be more value-laden, non-neutral, and structured by corporations (Pickles, 1995). Because of the growth and transformation of history, geographic shifts have taken place, which sparked our interest in the concept of a "Spatial Turn" and the role that spatial tools have had in evaluating shifts in focus throughout the course of time. This research aims to chronicle the development of the city's limits as the city evolved and changed over the course of time. This is one of the key purposes of this investigation. To promote and examine the identity of the city in the context of its artistic creation, architectural landmarks, and cultural heritage. Third, we will make use of a Geographic Information System (GIS) and other statistical tools in order to track the development of three significant landmarks that are vital to the identity and standing of the city.

The city of Madurai, which is located in the Indian state of Tamil Nadu, has a recorded history that dates all the way back to the year 2500 C.E., and it is still operating as a contemporary metropolitan area to this day. Over the course of history, both the ruling classes, such as the Pandyas and the VijayanagaraNayakkas up until the British, and the ordinary people changed the attitudes they held about their communities and the methods in which they made use of the urban legacy they inherited. However, the rapid expansion of the city has required modifications to historic landmarks such as the Meenakshi Amman temple, the ThirumalaiNayakar Mahal, Puthu Mandapam, Raya Gopuram, the Streets, and the temple ponds. These modifications have prompted a call for a greater public understanding of the significance of striking a harmony between the city's past and present. The old city of Madurai is the subject of this research project so that its history and the heritage buildings there can be uncovered.
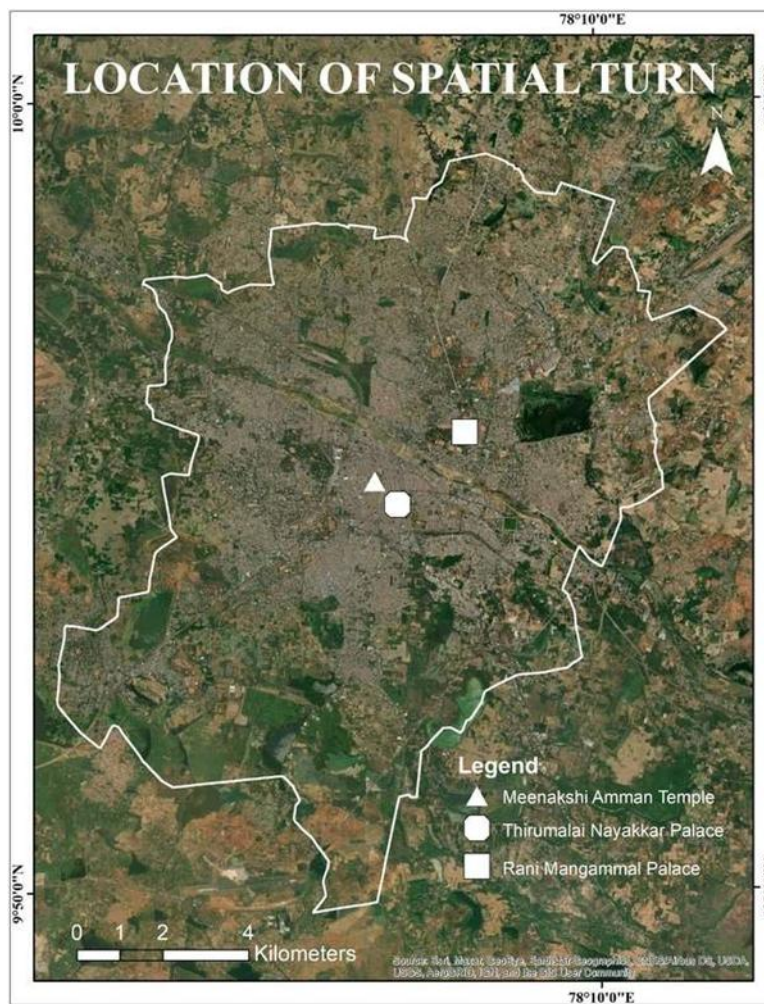

Fig. 1 : Location of Study

2. Literature Review

(Gregory & Healey, 2007):- -The use of geographic information systems (GIS) in historical research has seen a meteoric rise in the number of initiatives over the course of the past decade. Because of this, a new field of research known as "historical GIS" has emerged. This change was first observed in the quantitative aspect of the discipline, but in years that are more recent it has made its way over to the qualitative side as well. Not only have historians who self-identify as historical geographers benefited from the rising popularity of historical GIS, but the study of history as a whole has grown a greater awareness for the role geography has played throughout history because of these advancements.

(Knowles, 2000):-Three different quotations from Anne pertain to historical GIS.

1) When conducting studies that take place in space, having precise geographic limits is necessary

2) Be uninformed on the spatial aspects of human history, such as the shifting significance of physical geography as a restricting and enabling element to the territorial expression of social structures. For example, this lack of knowledge could lead to a misunderstanding of how the importance of physical geography changed over time.

3. Data mapping is the only mode analysis that discloses the genuine dimensions of reality and change in the past. This brings us to our final point.

3. Materials and Methods

In this study the historical analysis (context analysis with eye to Spatial Humanities) for "Spatial Turn" has been carried out firstly for the change of Madurai region (from Madura to Madurai – the geo-political change in the area) and secondly for important heritage sites (for analyzing the implications of both geo-polity and geo-culture attributes over such historical monuments) ie., Meenakshi Amman Temple, ThirumalaiNayakkar Palace, Rani Mangammal Palace (Gandhi Museum). For all these the "Spatial Turn" are analysed from the Pandyas Period to Current Period (Post Corona) with various Literatures available, Blogs and Pattrikas and through Field observation (for mapping the current scenario). For Meenakshi Amman Temple, ThirumalaiNayakkar Palace and Rani Mangammal Palace it has been analyzed from Pandyas Period and only the drastic changes occurred during periods has been mapped.
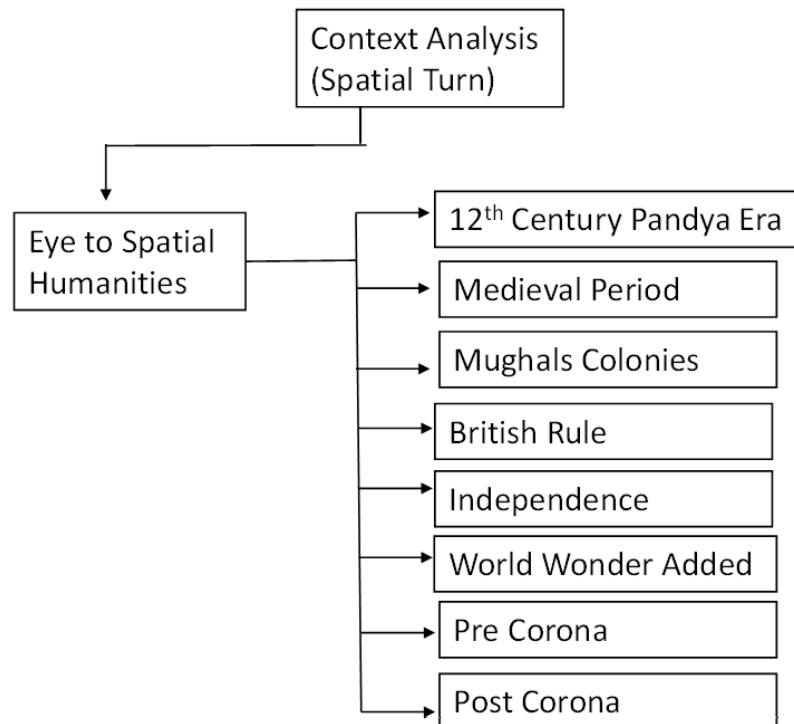
4. Results and Discussion

Spatial Turn:-

The Spatial Turn is studied to analyse the changes in boundary of Madurai from old years to till date and changes in Historical Monuments from the earlier period when it is built to till date (ie., in context to study the spatial changes with eye on Spatial Humanities).

Journey From Madura to Madurai

Madurai District Extent changes mapped for years from 1854 to Current but the earlier periods hasn't been mapped since there is indefinition of details.

During 1854

The imagery of map is obtained from the Source – https://searchworks.stanford.edu/view/12089476 (1854 Pharaoh and Company Map of the District of Madura, Tamil Nadu, India (Including Madurai)). It is then georeferenced and digitized using ArcMap 10.4. Madurai District was in the name as District of Madura during 1854. The Madura District then had a large areal extent covering important towns as DindigulThencurray (Theni), MurrGaupoory (Dindigul), Madura (Madurai), Pudukkottai is a princely state merged with Madura during 1810 and called in the name of Poodoocottah (Pudukottai), etc., and revenue villages as Shevaganga Zamindary (Shivaganga), Ramnad Zamindary (Ramanathapuram) etc., which is present today as six different Districts in Modern day Tamil Nadu.
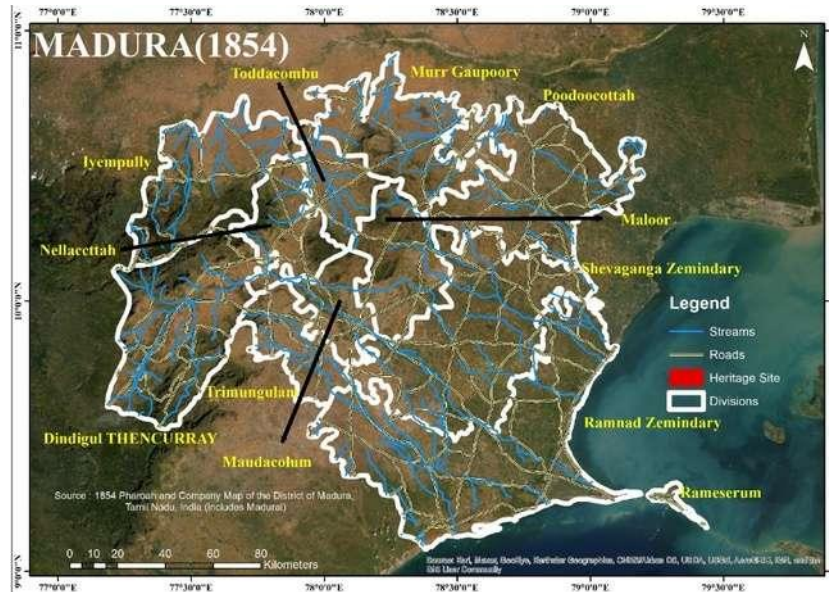

Figure 1: Madurai during 1854

During 1932:

The imagery of map is obtained from the Source – Atlas of Madras Presidency. It is then georeferenced and digitized using ArcMap 10.4. The district then had 30 different subdivisions which including towns, villages & zamindaries. The District of Ramnad (ie., Earlier Ramnad&Shevaganga) got separated from Madura during 1910. The Pudukkottai District also got separated from Madura. During 1932 the three districts ie., Madurai, Dindigul& Theni of modern day Tamil Nadu are together as District of Madura.
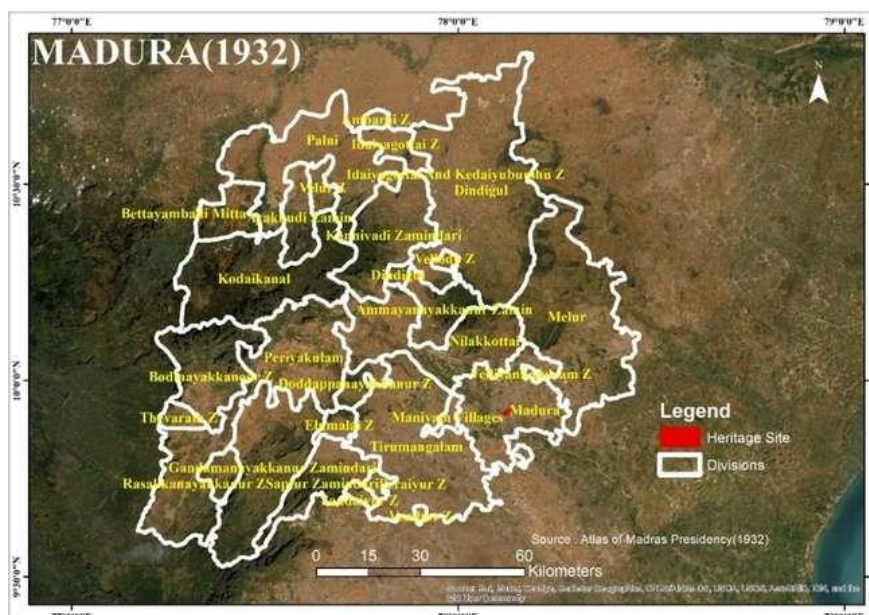
Figure 2: Madurai during 1932

During 1961

The image is obtained from Census of India 1961 & digitized in ArcMap 10.4. After Independence the Madura District doesn't has changes in the Areal extent but the Taluk names are changed from Todikkombu, Nilakottai, Modakkulam, Melur, Aiyampalle, Tenkarai&Tirumangalam to Dindigul, Nilakkottai, Madurai, Melur, Palni, Periyakulam&Tirumangalam + Kodaikanal.
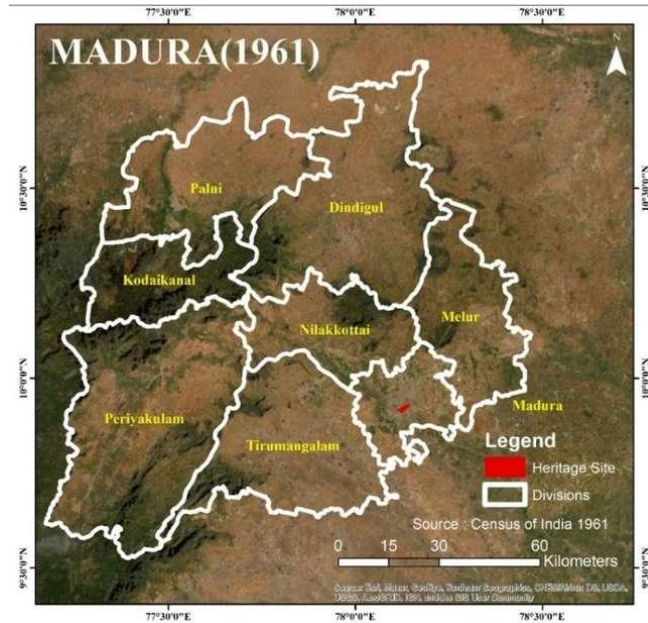

Figure 3: Madurai during 1961

During 1991

The image is obtained from Census of India 1991 and digitized in ArcMap 10.4. The Dindigul District was carved from Madurai during 1985 and Madurai has become 2 different district one as Madurai (which is present day Madurai & Theni) and another as Dindigul. Then Madurai had 9 different taluks namely Uttamapalayam, Periyakulam, Usilampatti, Tirumangalam, Vadipatti, Madurai South, Madurai North &Melur.
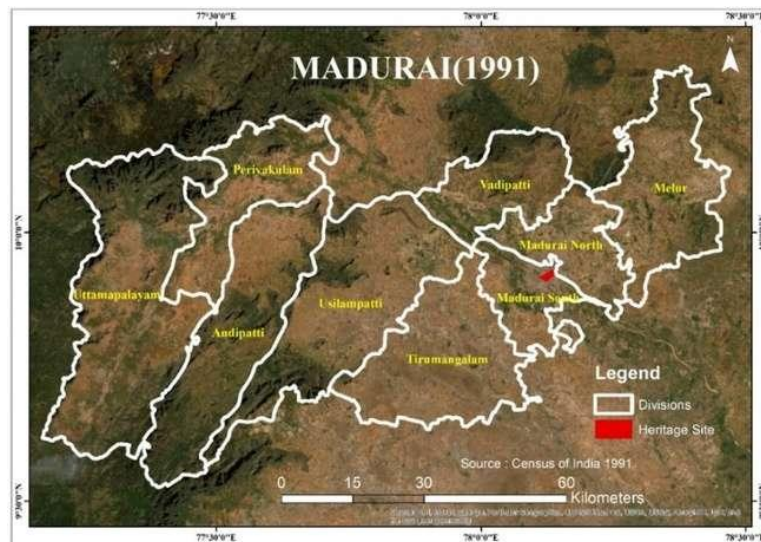

Figure 4: Madurai during 1991

During 2001

The image is obtained from Census of India 2001 and digitized in ArcMap 10.4. The Theni District has got segregated from Madurai during 1994. After that Madurai has divide into 7 taluks as Peraiyur, Usilampatti, Tirumangalam, Madurai South, Madurai North &Melur.

Figure 5: Madurai during 2001

At Present(2022)

The image obtained from the source TWAD Board, Chennai. At present Madurai is divided with 11 taluks as Peraiyur, Usilampatti, Tirumangalam, Madurai South, Madurai North, Madurai East, Madurai West &Melur.
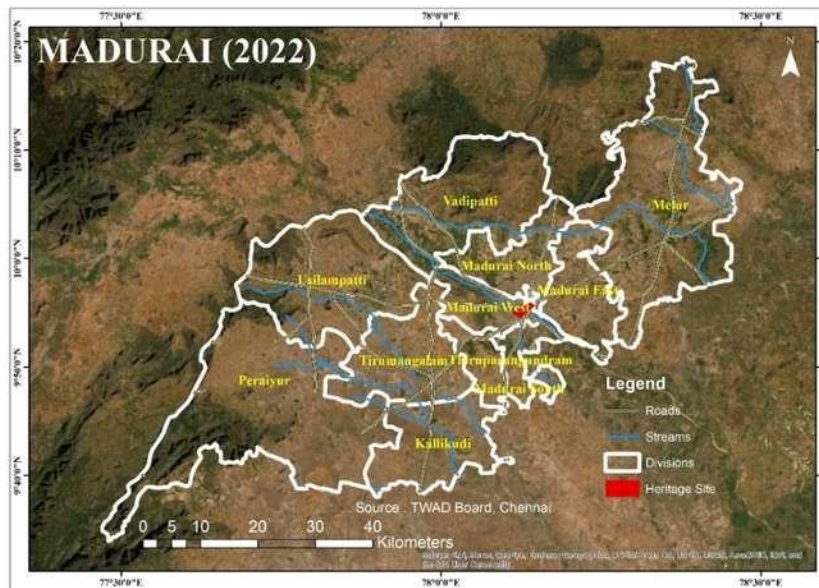

Figure 6: Madurai during 2022

Meenakshi Amman Temple

According to legend, Kulashekara Pandya (a Pandya Dynasty ruler between 1190 and 1216 CE) erected the Meenakshi Temple in adherence to the prophecy of Lord Shiva in his dream. However, the current temple was constructed during the Nayakkar era. The temple is mentioned in a few religious texts from the first to fourth centuries C.E., which characterise it as the city's focal point. In documents dating back to the early sixth century, the temple was mentioned as a location where scholars gathered to discuss significant issues. On the other hand, the temple as it is today was rebuilt in the 16th century after being destroyed by Muslim invaders.

Meenakshi Amman Temple was among the temples that Malik Kafur, a general of the Delhi Sultanate, destroyed during his 14th-century invasion of South India. The Meenakshi Amman Temple's buildings were rebuilt when the Vijayanagara Empire conquered Madurai. In the late 16th and early 17th centuries, the temple was significantly extended by VishwanathaNayakar, a ruler of the Nayaka dynasty. When restoring the temple, it is stated that the

Nayaka dynasty rulers used the "Silpa Shastras" architectural style. The "Silpa Shastras" are a body of ancient texts that contain a set of building guidelines.

Some of its components deteriorated under British rule, and the entire temple underwent restoration in the 20th century.

The Sundareshwarar Shrine and its entrance tower, Meenakshi Shrine and its tower, Chithra Tower in front of Meenakshi Shrine, SundaraPandiya Tower between Sundareshwarar Shrine (i.e., between the present-day Marriage Hall and Mangayarkarasi Mandapam), and Raja Tower and Raja Tower were the only parts of the temple when it was first constructed in the 12th or 13th century. The SundaraPandiya tower was destroyed by Malik Kafur during his invasion because it provided numerous places to shelter during disasters (like War).

The Nayakkars then rebuilt the entire Structure during 16th to 17th century and some by 18th Century. The Ashta Sakthi Mandapam, which was used as a location for several stores prior to 2018 and was constructed by the Thirumalai Nayak King and his Wives RudrapathiAmmal&Tholimamai during the 18th Century, must be entered upon entering the Eastern Gateway. AriyanathaMudaliar constructed the 1,000-pillared hall in 1569, using his creative and engineering skills to replace the original 15 pillars with 985 pillars and two sculpted Shrines. The Kambathadi mandapam was erected by Krishna VirappaNayakkar (H) (1572- 1595). Muthu VeerapaNayakkar constructed Kilikoondu Mandapam in 1623. Pudumandapam, also known as Vasantha mandapam (bottom of the plan), was finished in the 17th century by Thirumalai Nayak. It is in front of the eastern tower, outside the currently walled compound. It takes you to the Eastern gopuram, which is still under construction. The Mandapa Nayaka Mandapam, a 100-pillared building on the northeast corner of the second courtyard, was constructed in 1526 by ChinnappaNayakkar. In 1611, Muthu VeerappaNayakar I finished the Viravasantharaya mandapam (R), which is located south of the mandapam with 1000 pillars. The Pudu Mandapam was finished in the 17th century by Thirumalai Nayak. In 1565, a commoner named ThittiyappaChetti constructed the Golu mandapam under the reign of Krishnappa Nayakkar.

The main temple, which is where Goddess Meenakshi resides, is reached through the enormous doorway known as the Kadaka Gopuram. The gateway was rebuilt in the middle of the 16th century by TumpichiNayakkar. The Sundareswarar Shrine Gopuram is the oldest "gopuram" in the temple and was constructed by Kulasekara Pandya. You enter the Sundareswarar (Lord Shiva) shrine via the "gopuram." A gopura built by MaravarmanSundaraPandyan I in 1231 was later expanded, renovated, and given the new name Sundara Pandya Thirukkopuram. Chitra Gopuram, built by MaravarmanSundaraPandyan II (1238–1251), symbolises the religious and secular nature of Hinduism. This "Nayaka gopuram" was built in 1530 by VisvappaNayakkar. The 'gopuram' and another entryway, the 'Palahai Gopuram,' have a striking resemblance. Vembaturar Ananda Nambi built the first three-tiered gopuram in 1227. It was destroyed and rebuilt in the 14th century, same as previous gopurams. This gopuram is located between the Kilikuttu (parrot) mandapam and the Meenakshi shrine. Vembathurar gopuram is how it is referred as in some inscriptions.

The majority of these buildings are still standing today; only a small portion were demolished during British rule and afterwards repaired.

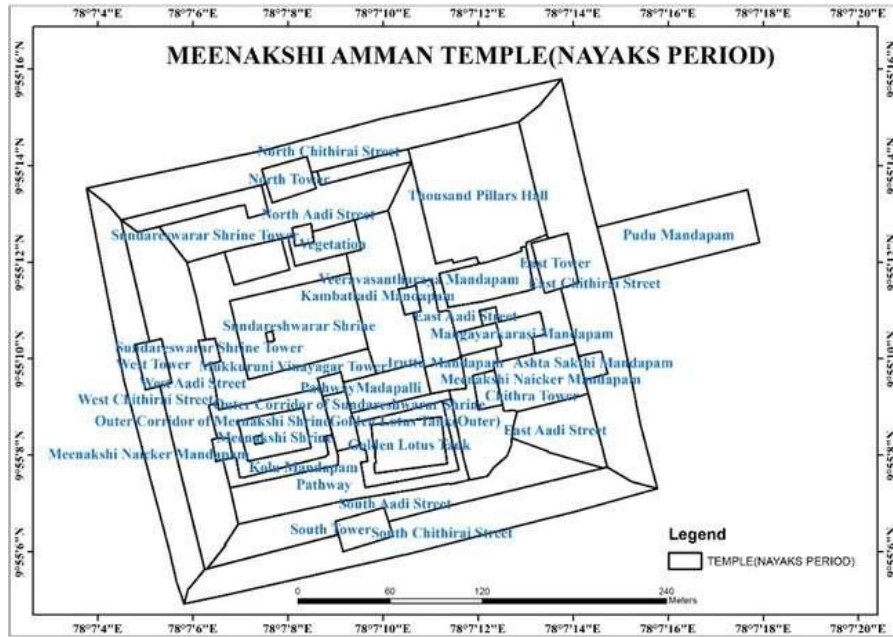**Figure 7:** Meenakshi Amman Temple During 12th to 13th Century

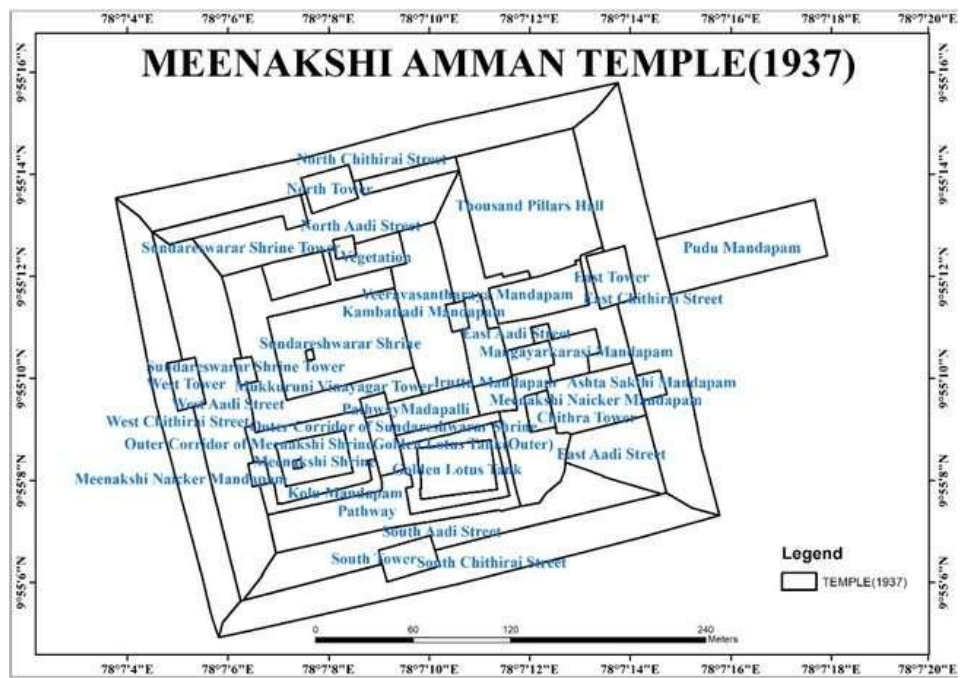**Figure 8:** Meenakshi Amman Temple During Nayaks Period

Figure 9: Meenakshi Amman Temple During 1937

Figure 10: Meenakshi Amman Temple At Present(2022)

ThirumalaiNayakkarPalace :-

One of the Nayakkar's king Thirumalai built the ThirumalaiNayakkar Palace during his reign 1623-1659. The Palace was built with combination of Italian and Mughal's architecture. His Grandson Chokkanatha itself destroyed much of its structure for taking the ornamentation while shifting the capital to Tiruchirappalli during 1665.

When Thirumalai Nayak Built the Palace during 17th century it had Main Entrance on East side and entering into it is divided into 3 portions and there would be Rajeswari Temple at straight to the entrance gate and opposite to that there is Rangavilasam and an ornamental Palace is attached to it , in the right side to that there would be the Northern Entrance is placed. In the centre portion there is Sculptural Yard and Palli Arai and a portion of Dancing Hall. In the Southern side of the Palace there is a Courtyard, while heading West from Courtyard there is a round shaped Central Pavilion (Sorgavilasam) and further towards West there is Ornamental Place and Pooja room was placed. The Dancing Hall is placed at the Western Side from all the above said Halls and further the Relatives and Servant's Palace in the Western side and finally there was a Flower Garden at the Western end.

During the Mughal's period, all the other structures are remained the same, but only the Ornamental place was changed to Harem (by Anwar - Mughal Sultanate).

During the British period (ie., when they came to Madurai for trading) only a small part has been left for Dancing Hall and the other regions are converted into 4 different parts as ChandragaiMedai, Sports Yard,Vasantavavi and Armoury.

The Palace is then got destroyed due to various factors like Heavy rains, occupied by weavers as paper factory and for government activity during the early 19th Century.

Only after 1860 the then governor of Madras Mr. Christholmtook action regarding the restoration of the Palace. At Present only one-fourth portion of this palace is remaining with the parts as Courtyard, Celestial Pavilion (Sorgavilasam), Harem, Pooja Room, Dancing Hall, Palli Arai and Sculptural Yard.
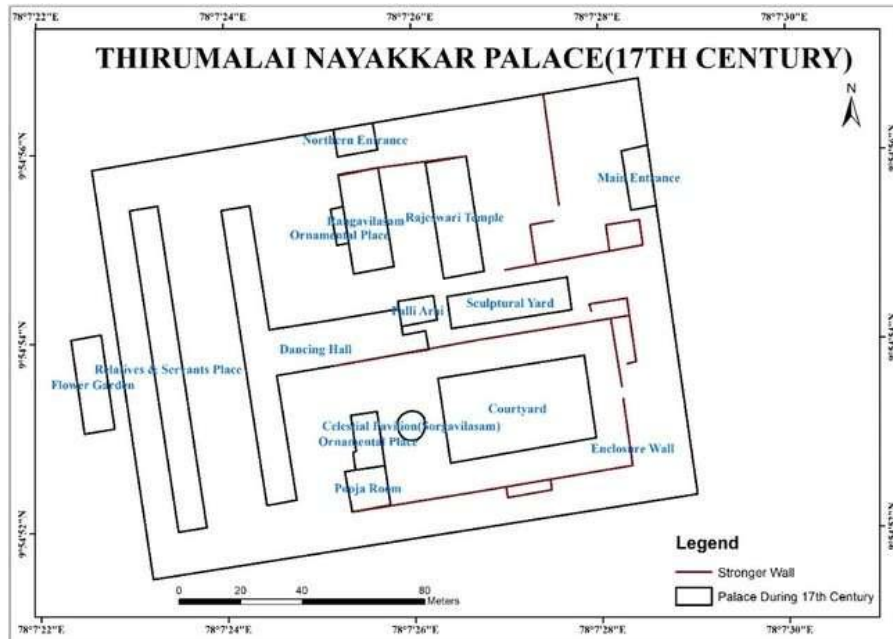
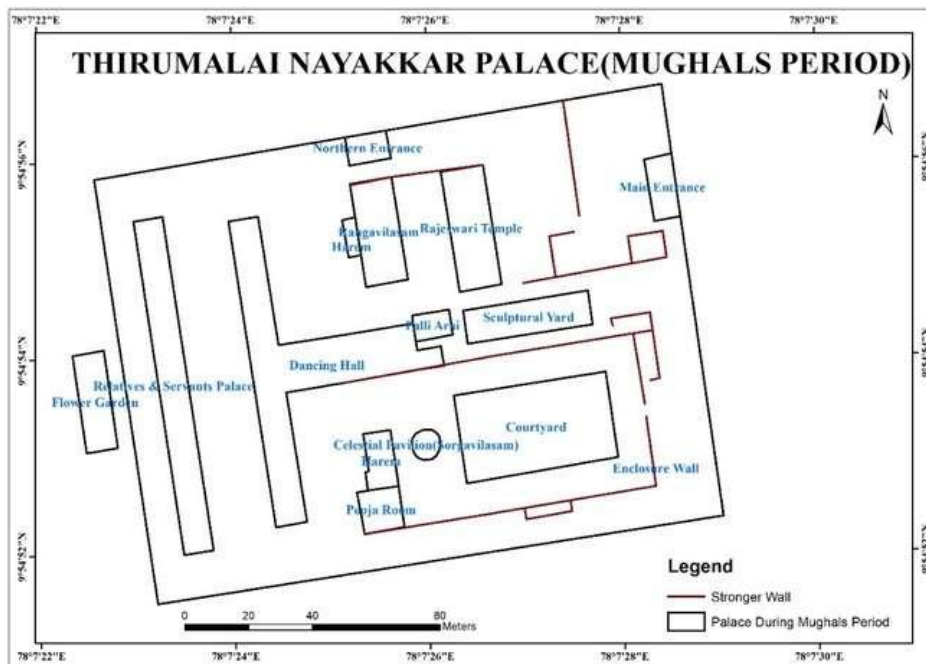**Figure 11:**ThirumalaiNayakkar Palace during 17th century

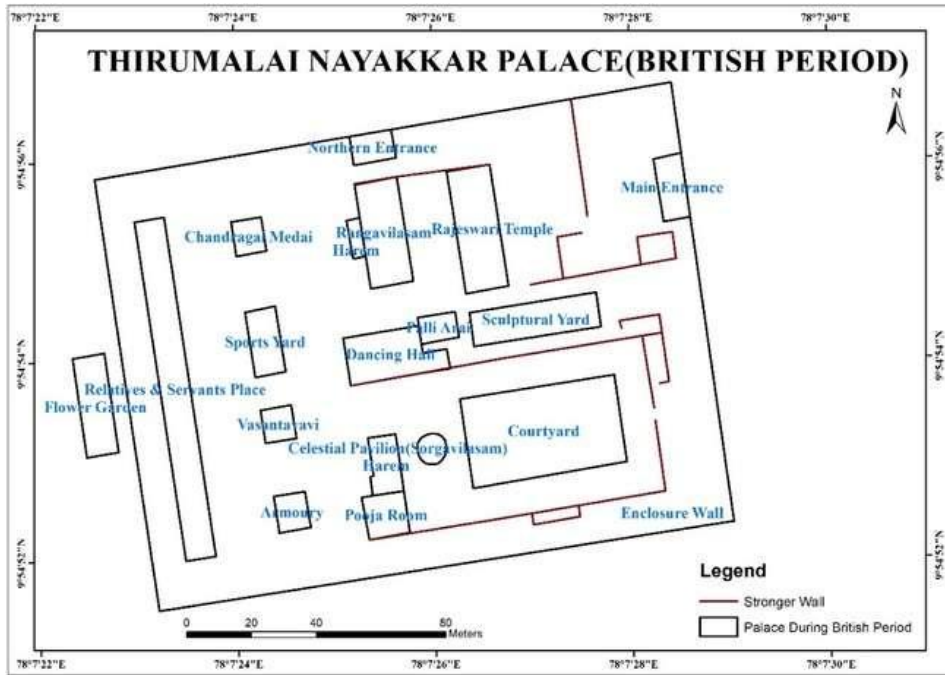**Figure 12:**ThirumalaiNayakkar Palace during Mughals Period

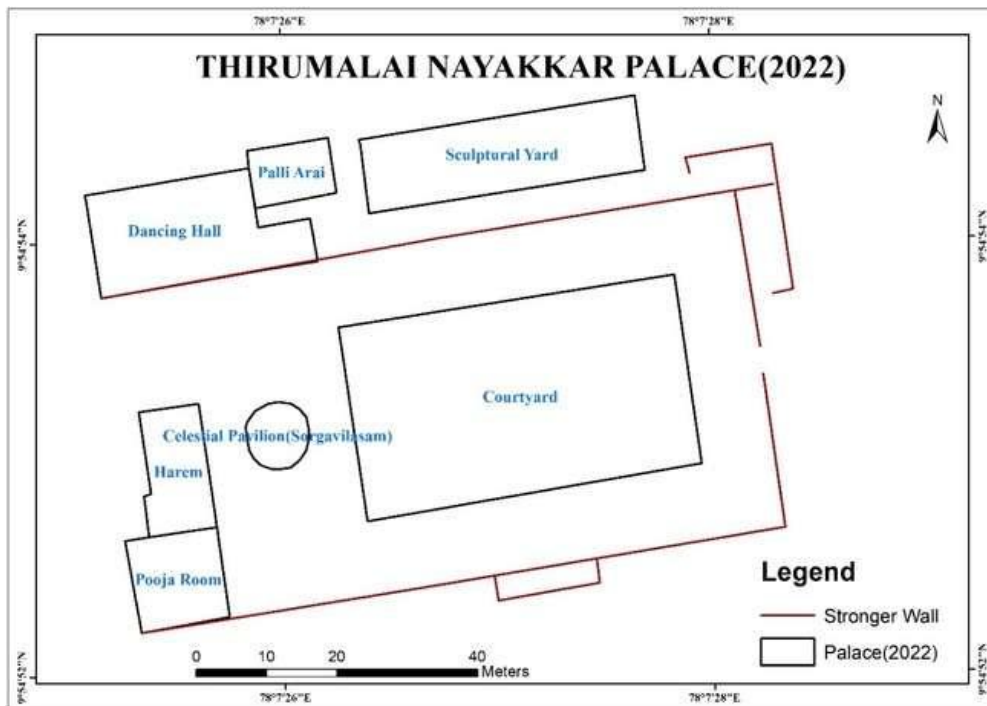**Figure 13:**ThirumalaiNayakkar Palace during British Period

Figure 14: ThirumalaiNayakkar Palace At present (2022)

Rani MangammalPalace :-

The Rani Mangammal Palace was built during 1700 AD. Since it is not marvelous like ThirumalaiNayakkar Palace but it acted as a glory of the Madurai city. The Rani Mangammal Palace then had a huge area covering number of Halls and rooms. The Darbar Hall is the only portion that it is remaining today, which built during 1700 AD. The left side of the current building is extended during British period and the right side is extended after Independence. The speciality of this building is that, it doesn't looks like the extension, since it has been created with adopting the same architecture that used as earlier building architecture. Earlier this Palace has said to located on the Northern Bank of river Vaigai. Now the building has moved far from the river course which represents the changes in river course.

The Rani Mangammal Palace is now used as Gandhi Museum in which the part extended during British Rule is used for Library and the part extended after Independence has been used as place for Showcasing the Replica of Gandhiji things.
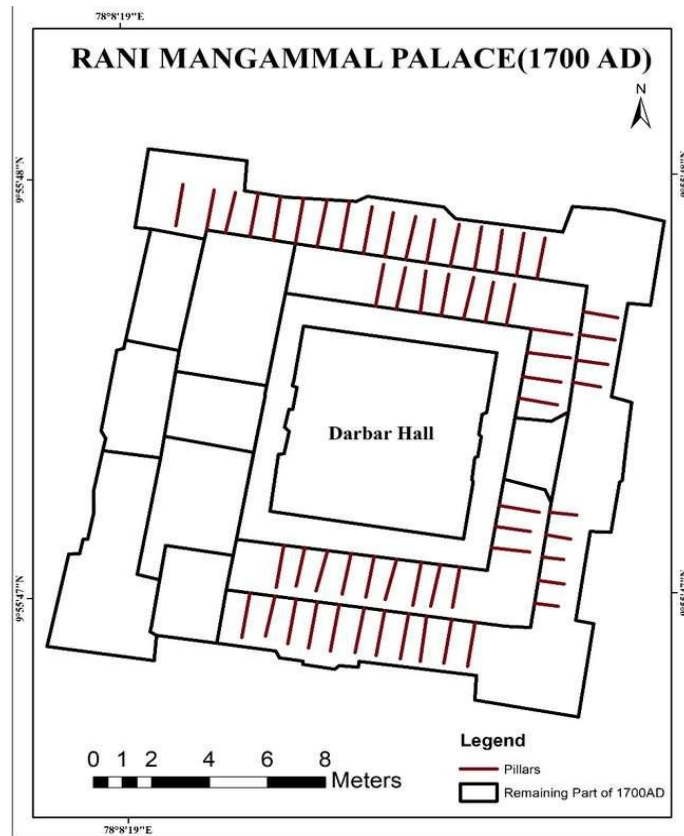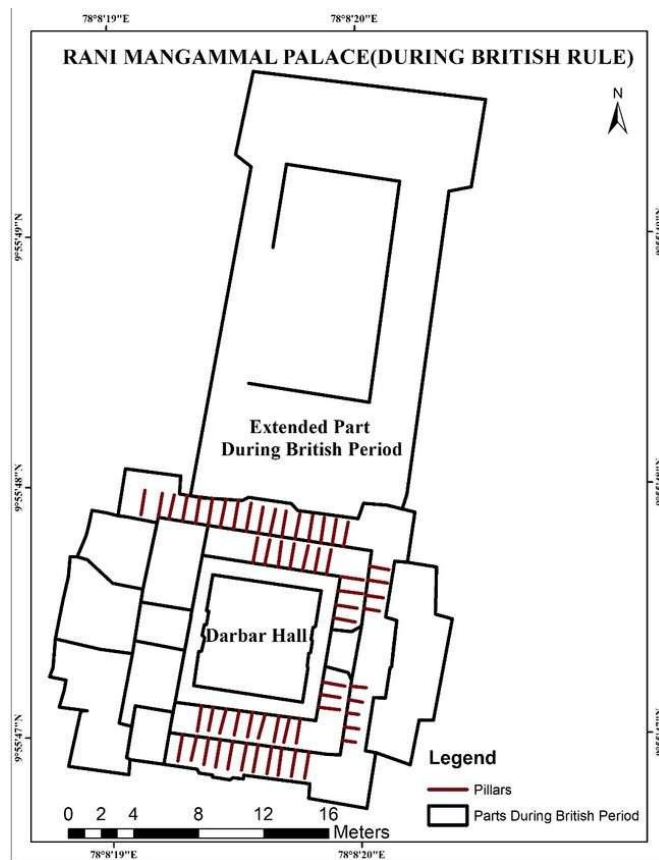
Figure 15: Rani Mangammal Palace during 1700AD
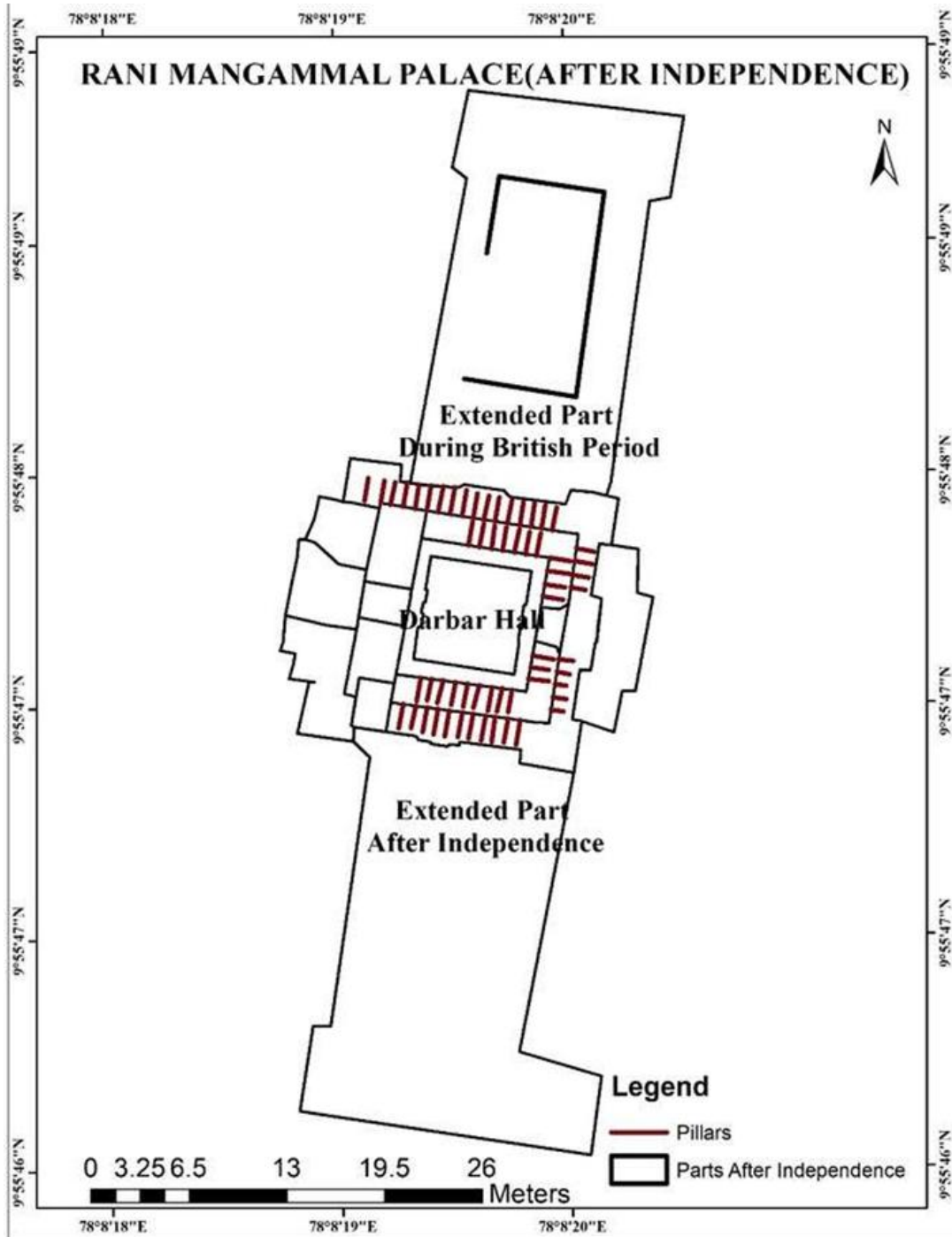

Figure 16: Rani Mangammal Palace during British Period

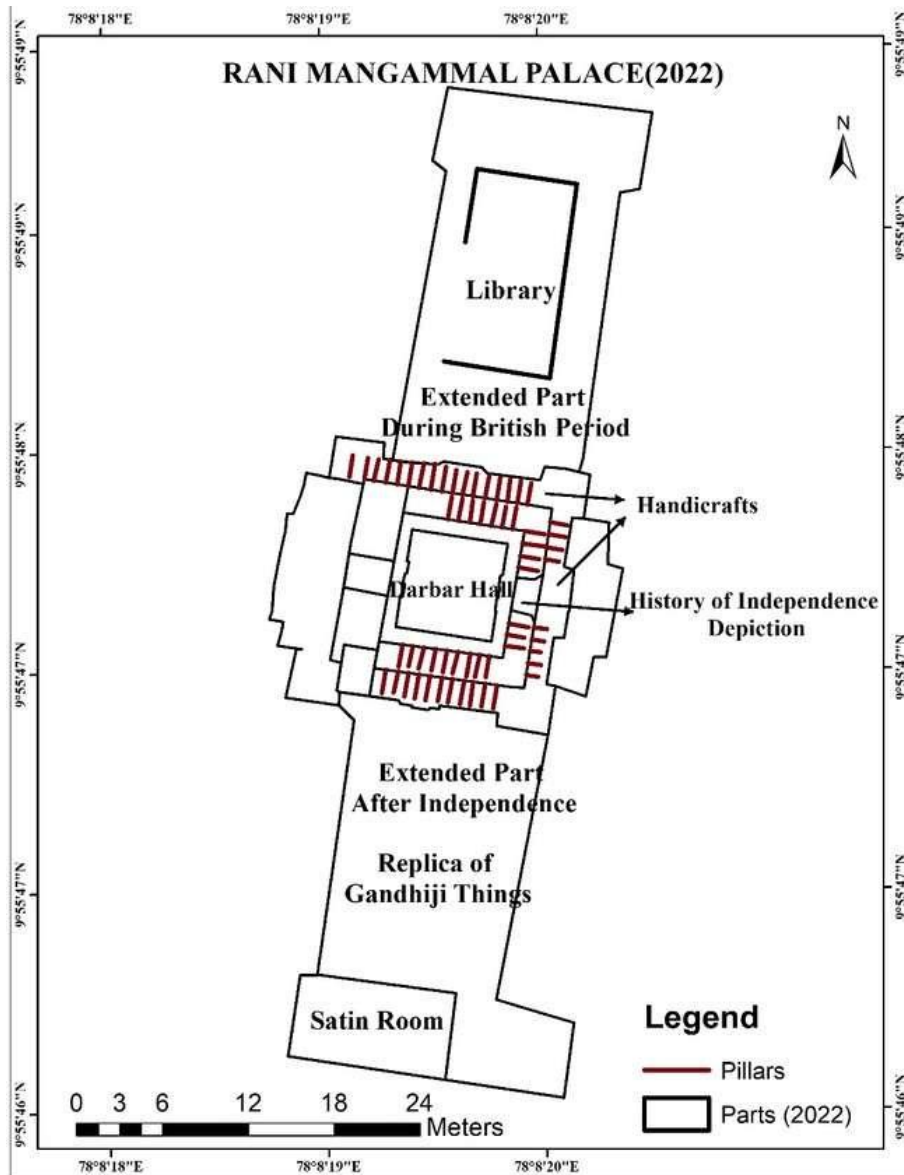**Figure 17:** Rani Mangammal Palace After Independence

Figure 18: Rani Mangammal Palace At Present(2022)

Syntactic Measures :-

- Integration is the main idea of space syntax. Using this method, integration can be expressed as numerical numbers.

- The integration of a space depends on the average number of lines and direction changes required to connect it to every other space in the settlement system. Therefore, integration is about syntactic accessibility rather than metric accessibility, and depth rather than distance is employed to define how far a space is.

- It is also feasible to determine whether a new design plan fits into the existing structure of an area by calculating integrated and segregated areas of a settlement. (Thilagam& Banerjee (2016))

Table 1-A: The morphological characteristics of medieval temple towns of Tamilnadu. (Thilagam & Banerjee, 2016)
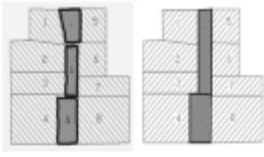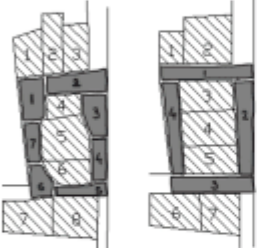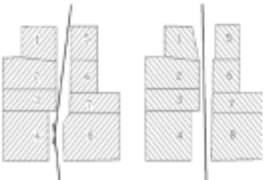
Terms	Schematic diagram	Definition	Formulae
Measures of convexity			
Convex articulation		The degree to which the open space of an urban system is broken up into convex space is indicated by the convex articulation value. Convex articulation is measured by dividing the number of convex spaces by the number of buildings. Lower values indicate lesser break up and therefore more synchrony.	*Convex articulation = C*/number of buildings, where *C* is the number of convex spaces
Convex deformation		The degree of convex deformation of the grid can be measured by dividing the number of convex spaces by the number of islands. (wherein an island is defined as a block of continuously connected buildings completely surrounded by open space).	*Convex deformation = C/I* where *C* is number of convex spaces and *I* is the number of islands.
Convex ringiness		The ringiness of the convex system *R* convex is the number of the rings in the system as a proportion of the maximum possible planar rings for that number of spaces.	$R\ convex = I/2C-5$ where *I* is the number of islands and *C* is the number of convex spaces
Measures of axiality			
Axial articulation		The degree of axial articulation can be measured by dividing the number of axial lines by the number of buildings. Low values indicate a high degree of axiality and high values indicate a greater break up.	*Axial articulation = L*/number of buildings where *L* is the number of axial lines

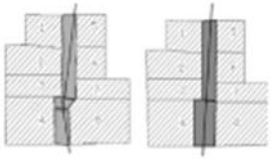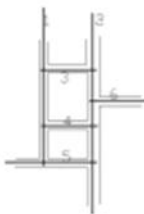**Table 1-B:** The morphological characteristics of medieval temple towns of Tamilnadu. (Thilagam & Banerjee, 2016).

Terms	Schematic diagram	Definition	Formulae
Measures of axiality			
Axial integration		The degree of axial integration of convex spaces can be measured by dividing the number of axial lines by the number of convex spaces. Low values indicate a higher degree of axial integration of convex spaces and vice versa.	*Axial integration = L/C* where *L* is the number of axial lines and *C* is the number of convex spaces.
Axial ringiness		The ringiness of the axial map is indicated by (*R* axial).	*R axial* = ½*L*−5 where *I* is the number of islands and *L* is the number of axial lines.
Mean connectivity		Connectivity is a significant measure of an axial map which describes the number of lines connected to or intersecting a given line. The connectivity index is indicative of the pattern of an urban grid.	Lower connectivity value is attributed to a nonorthogonal grid prevalent in naturally growing cities (Raman, 2003).
Mean global integration		A key measure of the axial map is integration the value which tells us "how the line is positioned with respect to the system as a whole" (Hillier, 1996). The highest number is the most integrated space in the system, the lowest the most segregated space in the system.	Integration measured to the full radius (radius *n* integration) of the system under consideration is called global integration. When the radius is restricted to 3 steps away from a line (radius 3 integration) it is called a local integration.

Table 2: Characteristic measures for comparison of the morphology during periods

Parameters	Medieval Time(Chola Period 920AD-13th Cen)	Era of Silpathikkaram	Mughal Sultanate	Tughlaks	Vijayanagar Dynasty	Nayaks	British & French Rule	After Independence	2K Era
No of Buildings	9614	11545	20799	50111	67000	251000	347783	650000	1161947
No of convex spaces	1655	1545	1211	8600	5431	2345	1234	967	321
No of Islands	416	512	306	270	270	111	53	50.5	
No of axial lines	814	906	1567	2347	4583	7634	14031	21345	52312
Percent of Open Spaces	20%	15.6	12	10.1					
Mean convex space unit	399.48	401.39	273.11						

Table 2: Measures of Convexity Parameters

Analysis	Medieval Time(Chola Period 920AD-13th Cen)	Era of Silpathikkaram	Mughal Sultanate	Tughlaks	Vijayanagar Dynasty	Nayaks	British & French Rule	After Independence	2K Era
Convex Articulation	0.1721448	0.1338242	0.058224	0.171619	0.0810597	0.0093426	0.0035482	0.00148769	0.00027626
Convex Deformation	3.9783654	3.0175781	3.9575163	31.851852	20.114815	21.126126	23.283019	19.1485149	0
Convex Ringiness	0.1258699	0.1659643	0.1266032	0.0157022	0.0248687	0.0236926	0.0215185	0.02617937	0

Table 3: Measures of Axiality Parameters

Analysis	Medieval Time(Chola Period 920AD-13th Cen)	Era of Silpathikkaram	Mughal Sultanate	Tughlaks	Vijayanagar Dynasty	Nayaks	British & French Rule	After Independence	2K Era
Axial Articulation	0.0846682	0.0784755	0.0753402	0.046836	0.068403	0.0304143	0.0403441	0.03283846	0.04502099
Axial Integration	0.4918429	0.5864078	1.2939719	0.272907	0.8438593	3.2554371	11.37034	22.073423	162.965732
Axial Ringiness	0.2563155	0.2833426	0.0977948	0.0575816	0.0294728	0.0072725	0.001889	0.00118309	0

Conclusion

The 'Spatial Turn' caused through era were studied in the sequence as "The journey from Pandiya Nadu to Madura and now Madurai" clearly shows that it is due to Geopolitical and Geocultural activities. Preservation of Meenakshi Amman Temple's heritage. The Tirumala Nayak palace is today a tourist destination and a shooting location for movies and wedding picture shoots, with more than 50% of it demolished. Queen Place was severely damaged (mainly deteriorated and rebuilt), but the government has now taken possession and turned it into the Gandhi Museum. Hence it is proved that the GIS is acting as a better environment for conveying the Geo-Historical events through maps.

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