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Knowledge-based-ness and synthesis of indigenous knowledge with climate in traditional architecture: Evidence from Naeen city

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A B S T R A C T

Application of indigenous knowledge is an example of knowledge-based-ness considered as the main agenda in most current urban and climate planning as well as geographical studies. It is one of the interesting topics in research on the role of climate on human dwelling and immediate environment. Indeed, building ecology emphasizes the ability to combine climate and environmental factors and rendering them to spatial qualities and structural comfort. This paper investigates the application of indigenous knowledge and the correspondence between traditional texture of Naeen city and its climate. In this regard, the climatic conditions in Naeen were studied in terms of temperature, humidity, wind and tourist comfort index (TCI) of climatourism. The data was collected from Isfahan Meteorology Website over the period 1985-2005. Subsequently, the traditional texture of Naeen, construction materials and building styles were studied through considering the special architectural conditions and compatible materials. Eventually, the correspondence between architectural styles and climatic conditions was studied. The results show that traditional architecture based on indigenous knowledge was consistent with climatic conditions. In this regard, using such materials as mud bricks and thatch with suitable heat capacity as well as using wind catchers, high walls around houses, dome construction, southward direction of houses were consistent with east-west wind direction. In addition, concentration of the traditional texture of the city, wall thickness, corridors, long hallways, courtyard ponds and roofed alleys are evidence of the effect of climatic conditions on urban texture in order to provide comfort in different seasons.

1. Introduction

Knowledge-based development is the offspring of the new millennium, which may bring about changes in future perspectives (Garcia, 2008:45; Brown et al., 2005). Knowledge asset of a country is considered as the fuel to its growth engine in the modern era. Thus, it is vital to understand the knowledge capital of nations (Passerini, 2007:89).

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Brokensha et al. (1980) defines indigenous knowledge as the methods of learning, understanding and worldview in terms of epistemology, which is the result of trial and error experiences of groups of people who have used and experienced with available resources in their environment. They believe that indigenous knowledge is the unique local knowledge of a particular culture or society, which is different from the academic knowledge developed in universities and scientific centers (Saidi, 2008:373). In different urban development eras, human has created clever architectures consistent with climatic conditions and natural facilities in order to provide the best environmental and living conditions in the buildings (Tavasoli, 2008). Rulers and governors have always sought to create urban environments since the dawn of human civilization (Bell, 1972:227). The construction of dwelling loci followed certain requirements based on different agendas. The development of cities based on certain agendas dates back to over four thousand years ago (Manori, 1994). Evaluation of environmental potential as one of the aspects of sustainable development is a crucial issue in all local development plans, both urban and rural, so that any new idea for development is incomplete unless it addresses the concept of sustenance (Badri & Eftekhari, 2010:2). Nowadays, climate and geographical studies are the basis of operations in urbanism and accommodation (www.s.vahdat.com). Climate is one of the most important factors in the construction of buildings in which climatic conditions are studied in order to use the built environment more appropriately. Even in primitive eras, human sought methods to prevent harmful climatic conditions so that he developed designs derived from climatic conditions (Saligheh, 2004:147).

Traditional and local methods of construction as well as indigenous knowledge are the best way to understand the environmental conditions. Nature-friendly construction means respecting the environment, understanding climatic conditions, considering territorial status and natural elements, wind direction, sunshine and other local characteristics (Zandi & Arabi, 2010:49). Architectural climate is an area of study in research on the effect of climatic conditions on human accommodation. In the past, architects knew the effect of wind, sun and rain on houses and buildings through experience and developed interesting techniques to decrease adverse climatic effects. In contemporary architecture, changes due to bioclimatic criteria and sustenance are gaining more and more importance. Indeed, building ecology emphasizes the building capacity to incorporate environmental and climatic factors and render them to spatial qualities and the comfort of the form (Jodat, 2001:5).

If necessary measures are not taken in a building to incorporate climatic conditions, the building may create inappropriate temperature conditions in the outside even though it has natural interior temperature comfort. Interior building conditions that are inconsistent with climatic conditions may not be made comfortable even through spending reasonable costs on heating and cooling systems (Kasmaie, 1988:2). Although human is exposed to natural factors, he has applied his intelligence, competence and artistic ability to move toward development over the course of history because human has succeeded to use architecture consistent with climatic and temperature conditions to create comfort (Ghareh Nezhad, 2002:31).

Intensive studies have been conducted on determining climate-friendly conditions or the effect of climate on housing. Ding et al. (2001) studied the correspondence of Middle-Eastern architecture with climate. Olgay (1973) and Givoni (1997) developed bioclimatic models of buildings in order to study and identify the conditions required for thermal comfort. In Iran, many researchers have addressed this issue. Asayesh (1999) studied the bioclimate and building thermal requirements in Tabriz city. Ghaemi (2000) investigated the effect of climatic factors on human. Asiaie et al. (2004) studied climatic characteristics and their effect on compatible architecture to optimize fuel and energy consumption in Iran. The present study investigates the correspondence between traditional architecture of Naeen city and climatic conditions and application of indigenous knowledge.

2. The geographical location of the region

Naeen is one of the cities located in Isfahan Province in central Iran. It is the capital city of Naeen County and lies at 32.8 degrees north latitude and 53 degrees east longitude. The city is enclosed by Dasht-e Kavir (Great Salt Desert) and has arid climate. It lies on a relatively level plain with 1600 meters altitude. It lacks appropriate vegetation and is enclosed by a few single, isolated mountains to the north, south-west and east. The city has arid, desert climate (Fig. 1) (www.majarajoo.com).

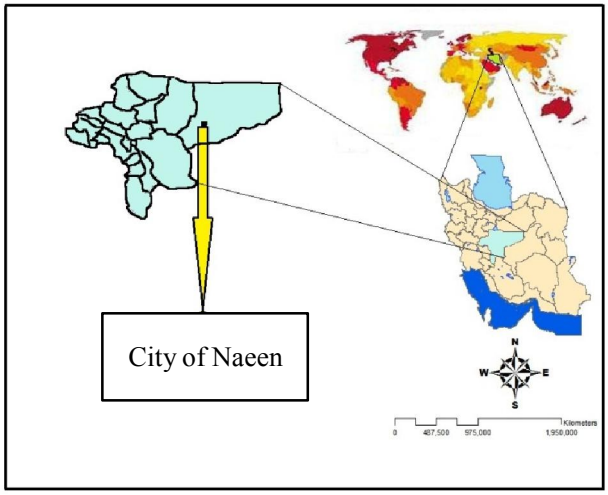

Fig. 1. Geographical location of Naeen

3. Method

The present study was conducted to investigate the correspondence between traditional texture of Naeen city with its climatic conditions as well as to address the attention to climatic and environmental issues in urban development and application of indigenous knowledge. In this regard, climatic conditions of the city were examined in terms of temperature, humidity, wind and climatourism. The data was collected from Isfahan Meteorology Website during 1975-2005. The information was then extracted and the necessary figures were drawn. Subsequently, the traditional texture of Naeen was studied based on special architectural elements of the city and necessary construction materials. Eventually, the construction styles and materials used in buildings were studied in terms of their correspondence with climatic conditions.

3. Climatic conditions of Naeen

Naeen is a desert city in Isfahan province, located at the heart of desert. It suffers difficult, severe climatic conditions. In this study, climatic elements including wind, minimum and maximum temperature, relative as well as minimum and maximum humidity were studied along with climatourism conditions. Subsequently, architectural elements were examined consistent with climatic conditions.

4. Temperature

According to Table 1, Fig. 1 and Fig. 2 that show mean, minimum and maximum temperatures, a comparison between mean daily temperature and mean maximum temperature shows a considerable difference between them. Moreover, the difference between mean minimum and maximum temperatures indicates acute environmental conditions, which is due to desert climate and lack of vegetation. Considering insufficient rain and low relative humidity, there are sharp fluctuations in circadian temperature. As the ground is mainly sabulous and since stone has lower heat capacity than

soil, which heats fast in the daytime, it loses its temperature quickly at night and cools down the environment. As the sky in the region is often void of clouds, the released heat exists the atmosphere and does not return to the earth, which helps cool down the environment. Therefore, the construction materials need to be used that prevent rapid heating in days and cooling down at nights. Besides, the buildings should be made so that they provide the residents with comfort across different circadian hours.

Table 1
Mean, minimum and maximum temperature in Naeen

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Minimum Temperature	-1.7	0.3	4	10	14.2	18.9	21.7	19.9	16	10.4	4.3	0.1
Maximum Temperature	9.7	12.8	16.5	23.4	28.2	33.9	36.2	35.4	31.5	24.8	17	11.9
Mean	4	6.6	10.2	16.7	21.2	26.4	28.9	27.7	23.7	17.6	10.6	6

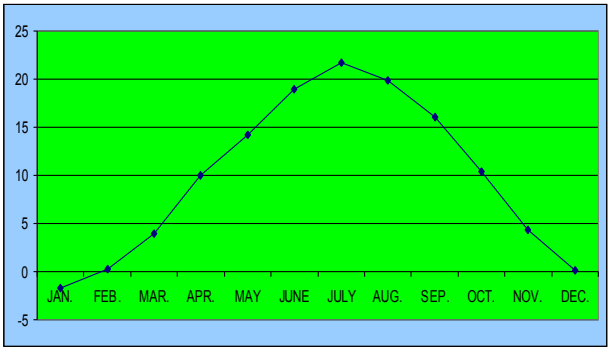

Fig. 1. Mean minimum temperature in Naeen

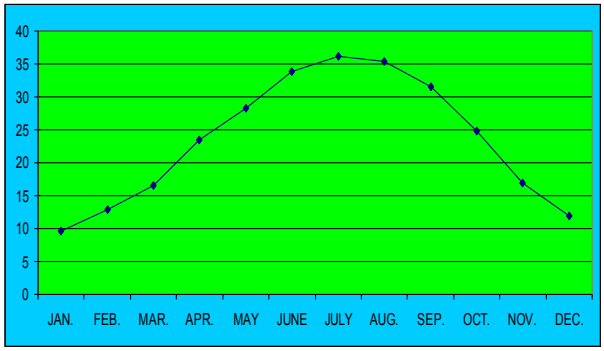

Fig. 2. Mean maximum temperature in Naeen

5. Wind

Wind is one of the climatic variables that exerts a significant effect on accommodation comfort based on its speed, direction and percentage. Table 2 illustrates the speed and direction of wind in Naeen. As shown in the table, the wind blows from west in most of the year and it only blows from northeast in summer. Besides, the data shows that wind blows at high speed throughout the year. Thus, the houses need to be built in east-west direction; that is, the buildings should stand either to the north or to the south. The houses need to be built so that they protect the residences against adverse effects of these winds.

Table 2
Wind direction and speed in Naeen

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC
Wind direction	270	270	270	270	270	270	45	45	45	270	270	270
Wind speed/Knots	8	8.8	9.9	10.2	10.3	9.3	9.3	8.8	8.3	8.3	7.9	7.3

6. Climatic comfort of Naeen

Since application of indigenous knowledge of architecture, urbanism, and climatic comfort of buildings in terms of energy efficiency is one of the important planning decisions in many countries, we will study climatic comfort of Naeen using Tourism Climate Index (TCI). Although this index is originally used to examine tourism climate conditions, it may also be used with architecture.

7. Tourism Climate Index (TCI)

TCI is one of the indices used to estimate climatic comfort in tourism planning, which was introduced by Meicskowski (1985). It contains seven parameters three of which are used independently and two of which are used in relation to bioclimatology. TCI is computed using the following equation:

$$TCI = 8\times Cld + 2\times Cla + 4\times R + 4\times S + 2\times W$$

In this equation, CID is comfort index of the day, which includes average maximum anemometer temperature (TAMAX) and relative humidity. CIA is circadian comfort index that includes mean daily temperature and mean relative humidity. R is the amount of precipitation in millimeters, S is the sunshine hours and W is the average wind speed in m/s. Despite other climatic indices, all climatic factors are addressed in this equation, and each factor may reach up to weighted number of 5. The seven variables of TCI entail five sub-indices. Every sub-index is measured based on a standard scoring system ranging from 5 (ideal) to 3 (extremely unfavorable). These sub-indices are as follows.

Precipitation (P): precipitation typically exerts an adverse effect on recreation and tourist activities. This sub-index may affect TCI as much as 20 percent.

Sunshine hours (S): sunlight generally has a positive effect on tourist activities. It has positive mental effects and affects the quality of photos that tourists take. However, it has also adverse effects in hot climates and may cause sunburn.

Airflow (Mean speed of wind) (W): this variable depends on temperature. In hot climates, it has positive effects due to evaporation and cooling down. However, in cold climates, wind exerts an adverse effect on human thermal comfort due to its cooling effect (Sari Sarraf et al., 2010:67-68).

Comfort index of day (CID): the variables covered by this sub-index include TAMAX and average of daily minimum relative humidity. This index shows thermal comfort conditions during maximum human activities. It may affect TCI as much as 40 percent. In order to measure thermal comfort the value of which represents physiological and mental feelings, temperature and relative humidity are used based on a comfort factor figure and the values are computed. The values are derived from the cross-section of temperature and relative humidity. In comfort index, the most optimal region is the 20-27 ^{0}C temperature range in terms of thermal comfort and 30-70 percent in terms of relative humidity. This range has optimal thermal comfort, and TCI value is measured on a scale of 5 that gradually decreases with TCI fluctuations.

Circadian comfort index (24 hours) (CIA): the variables covered by this sub-index include mean daytime temperature and mean relative daytime humidity. This sub-index shows circadian thermal comfort conditions. It has a share of 10 percent in TCI. A specific figure is used to calculate CID and CIA. Both factors have a 50 percent share in TCI altogether, with CID having a 40 percent share and CIA having a 10 percent share. CID is computed by inserting TAMAX and minimum relative humidity. CIA is computed using daily temperature and mean daily relative humidity. Since CIA covers the mean circadian temperature comfort and includes the time when people are at rest inside buildings, it is less important than CID so that it only takes a 10 percent share in TCI. In order to calculate these indices, mean values of the associated variables should be inserted into a specific figure. The value of TCI ranges from 0 to 100 so that every region obtains a value within this range consistent with its climatic conditions. Table 3 illustrates a classification of this index.

Table 3
TCI classification

Classification in the map	The numerical value of the index	Classification in the map	The numerical value of the index
Ideal	90-100	Low	40-49
Excellent	80-89	Unfavorable	30-39
Great	70-79	Quite unfavorable	20-29
Good	60-69	Extremely unfavorable	10-19
Acceptable	50-59	Unbearable	0-9

Source: (Sari Sarraf et al., 2010:74)

7.1 Climatourism conditions of Naeen in different months

Considering the data obtained from Isfahan Meteorology Website illustrated in Table 4 and based on the calculations conducted using TCI method, the climatourism conditions of Naeen city is illustrated in Table 5.

Table 4
Descriptive data to compute climate comfort index of Naeen city

Month	Wind	Rain	Max. Temperature	Mean Temperature	Sunshine	Mean Humidity
Jan.	4.6	22.8	9.7	4	199.1	39
Feb.	6.6	12	12.8	6.6	221.2	28
Mar.	6.5	20.3	16.5	10.2	224.6	24
Apr.	7.1	12.1	23.4	16.7	249.7	19
May	6.8	10	28.2	21.2	303.2	16
June	6.8	1.1	33.9	26.4	348.4	13
July	6.7	0.6	36.2	28.9	348.1	15
Aug.	6.3	0.2	35.4	27.7	351.9	13
Sep.	5.9	0.1	31.5	23.7	313	14
Oct.	5.3	1.8	24.8	17.6	285	18
Nov.	5.1	5	17	10.6	221.5	26
Dec.	4.5	12.7	11.9	6	207.7	34

Table 5
Naeen climatourism conditions in different months

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Condition	Good	Great	Great	Ideal	Ideal	Excellent	Great	Excellent	Ideal	Ideal	Excellent	Great

As shown in Table 5, Naeen city has ideal climatourism conditions in April, May, September and October. However, appropriate measures should be taken to provide comfort conditions in other months in order to deal with non-ideal conditions.

7.2 Comparison between traditional texture of Naeen and its climatic conditions

Being designed based on such factors as environment, weather, urban needs and safety against enemy invasion, Naeen traditional texture has a closed, introvert architecture. Therefore, architectural structures and historic buildings are densely constructed close together. The city was designed so that residential spaces were built adjacent to other urban elements such as the Central Mosque, Governor's Mansion, Bazaar, Hosseinieh, schools and public bathrooms without any functional problems. The traditional texture of Naeen constitutes seven districts each of which has a number of Hosseinieh. They are as follows:

- Kelvan district
- Chehel-Dokhtaran district
- Panjahe
- Nowgabad or Nowabad
- Babul Masjed or Dar-e Masjed
- Saray-e Now
- Koy-e Sang or Godalu

The results showed that the temperature varies dramatically across different seasons of the year so that the difference between minimum and maximum temperature is considerable. The days are typically hot while the nights are cool, particularly in winter. Thus, architectural texture needs to adjust these conditions. The materials used in traditional texture of Naeen consist of mud brick and thatch. When soil is mixed with straw and water to make thatch, it gains the ability to adjust hot, desert summers so that it functions as an insulator in Naeen houses (Organization for Design Services

of Municipalities in Isfahan Province, 2005:25). Naeen houses are constructed quite densely so that they would prevent the penetration of heat, wind and cold into houses and urban areas. Since Naeen has hot summers, the physical structure of the traditional texture is compact and full shade to prevent the penetration of sunshine into the built environment. The houses are enclosed by high walls intended to resist sunshine and strong winds. As the winds often blow from west and east, houses are made toward south.

Old houses typically have domes, small doors and high curved roofs. Spectacular windcatchers are occasionally made on dome roofs. These types of houses constitute over 80 percent of the houses. However, they are more compact toward the east side of the city so that they reach their maximum density in the traditional texture of Naeen, particularly in Mohammad Abad district. Dome roofs prevent the heating of the building in hot seasons as they cast shadow on the one side of the building in daytime. Moreover, they prevent excess cooling of the house at night in cold seasons. This type of construction is exactly consistent with climatic conditions and hinges on the indigenous knowledge of the region.

As discussed, measures needed to be taken in order to provide climatic comfort across different seasons of the year in Naeen. Through the application of indigenous knowledge, Naeen traditional buildings are made so that they are enclosed by high walls to provide shadows in hot days, and furnished by courtyard ponds with stone fountains to moderate the weather. The houses have open, wide spaces called hall (Tallar in Farsi) that was used mostly in the morning and afternoon in summer when sunshine attenuates. In old houses, rooms are made across all four geographical directions so that residents lived in southward rooms in summer and northward rooms in winter. Southward rooms catch shadow in hot seasons preventing excess heating while northward rooms catch sunshine in winter and thus providing appropriate conditions.

Overall, one may conclude that the traditional texture of Naeen is made based on indigenous, empirical knowledge as it has a compact structure made of mud brick and thatch. The houses have dome roofs and high walls with small doors and limited number of windows. The hallways are roofed and narrow. The climate of Naeen is the main reason why the urban texture is compact and dense (Organization for Design Services of Municipalities in Isfahan Province, 2005:31).

8. Conclusion

Over the past decades, researchers have sought to use methods in order to both preserve the environment and satisfy current global needs. Indigenous knowledge is one of these methods addressed by many researchers over the last years. Considering the attainment of past generations to this knowledge and application of it in urban areas, one may contend that revival of indigenous knowledge can be an important step toward sustainable development. However, through providing opportunities for discussion and exchange of ideas among researchers and using predecessors' knowledge, the development may be made sustainable.

Naeen is a city lying at the heart of desert with dramatic temperature fluctuations across both the seasons of the year and circadian cycle. The temperature fluctuations are associated with acute desert climate with hot summers and days and cold winters. The application of indigenous knowledge in Naeen has made traditional architecture consistent with climatic conditions, which is the result of indigenous knowledge and experience. The architecture of Naeen has also incorporated limited elements of Islamic culture; however, climatic factors play the dominant role in architecture of the city. In this regard, using mud brick and thatch with good heat capacity, windcatchers, high walls around houses, dome roofs, southward direction of houses consistent with east-west wind direction, density of the traditional urban texture, thick walls, hallways, long corridors, courtyard ponds, roofed passageways and alleys are evidence of the influence of climatic conditions on urban texture, which aimed to provide comfort in different seasons of the year.

References

Asiaie, M., et al. (2004). The role of climate-friendly architecture in optimization of fuel consumption. *Scientific Bulletin Attached to Nilvar Magazine*, 4 (4).

Badri, S.A., & Rokn uddin Eftekhari, A. (2003). Sustenance evaluation: theory and method. *Geographical Research Quarterly*, 18 (2-69), 9-34.

Bell, G. (1972). *Human identity in the Urban Environment*. Penguin Book, 227.

Brokensha, D. W., Warren, D. M., & Werner, O. (1980). *Indigenous knowledge systems and development*. University Press of America.

Brown, M. A., Southworth, F., & Stovall, T. K. (2005). *Towards a climate-friendly built environment*. Arlington, VA: Pew Center on Global Climate Change.

Garcia, B. C. (2008). Global KBD community developments: the MAKCi experience. *Journal of Knowledge Management*, *12*(5), 91-106.

Ghaemi, A. (2000). A new perspective in application of weather and climatology. *Geographical Research Quarterly*, 5.

Ghareh Nezhad, H. (2002). Human, nature and architecture. Isfahan: Gol-hay-e Mohammadi Publications (In Persian).

Givoni, B. (1998). *Climate considerations in building and urban design*. Wiley. com.

Jodat, M.R. (2001). Sustainable architecture. *Iran Architecture Quarterly*, 5.

Ding, Y. D. J. G., Griggs, D. J., Noguer, M., van der LINDEN, P. J., Dai, X., Maskell, K., & Johnson, C. A. (2001). *Climate change 2001: the scientific basis* (Vol. 881). Cambridge: Cambridge University Press.

Kasmaie, M. (1997). Khuzestan climate and architecture. Khoramshahr Center for Accommodation Research.

Manori, M. (1994). Geographical and environmental consideration in site selection of new cities. Proceedings of International Conference on Urban Development and New Cities, Ministry of Accommodation and Urbanism.

Mieczkowski, Z. (1985). The tourism climatic index: a method of evaluating world climates for tourism. *The Canadian Geographer/Le Géographe canadien*, *29*(3), 220-233.

Olgay, V. (1973). *Design with climate*. Princeton University press.

Organization for Design Services of Municipalities in Isfahan Province. (2005). Strategic plan and revival of historic texture of Varzaneh city, Varzaneh municipality.

Passerini, K. (2007). Knowledge-driven development indicators: still an eclectic panorama. *Journal of Knowledge Management*, *11*(5), 115-128.

Saidi, A. (2008). Encyclopedia of urban and rural management. Publications of the organization for Municipalities and Community Council of Villages.

Saligheh, M. (2004). Modeling accommodation consistent with climate in Chabahar. *Journal of Geography and Development*, 147-170.

Sari Sarraf, B., et al. (2010). Climatourism zoning of Arasbaran region using TCI. *Geographical Space Research Journal*, 10 (30).

Tavasoli, F. (2008). Adjustment of environmental conditions. Course handout of architecture, Islamic Azad University.

Zandi, D.,& Arabi, Sh. (2010). Designing with nature (Niknam village, Lawasan). *Architecture and Building*, 22-23.

www.chaharmahalmet.ir/iranarchive.asp

http://www.majarajoo.com

http://s-vahdat.com/post-29.aspx