Vernacular Ecology: Environmental Recreation of Ancient Dwellings in Southeastern Turkey

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ABSTRACT

“At the beginning of the 21st century, in a time of rapid ecological degradation, globalization and destruction of much vernacular architectural heritage, concerns for the maintenance of the local, cultural identities, and an awareness of the need to provide sustainable built environments are set to raise an interest in the vernacular traditions” (Asquith & Vellinga, 2006) for a culturally-embedded environmental design future. This paper investigates the Southeastern Turkey’s vernacular architecture with the aim to partake in the development of a New Hasankeyf proposal by investigating design guidelines for the new dwellings of the future city. The basis of the explored guidelines relies on the concept of ‘recreating the vernacular’ with the primary goal to enhance the environmental performance of the proposed dwellings; through passive means and without compromising the cultural/geographical premonitions that it originally derived from by implementing 1) compact form, 2) adapted space layout and 3) improved building elements.

INTRODUCTION

In an era, in which archeological sites are preserved with utmost diligence, Hasankeyf - a declared conservation area in Southeastern Turkey - is left at its destiny, which would be determined by the Turkish Government that attempts to flood the region with its Ilisu Dam along Tigris River as a part of an “integrated irrigation and agricultural project” (Demirbilek, 1997) called GAP.

It is not only the inconceivable truth of inundating such an ancient city which results in a homeless population and ever lost heritage, but also the insensitivity of the government’s new construction proposal set forth that both encourage a need to offer construction and design guidance for a sustainable, long-lasting, culturally-familiar and aesthetically-amalgamated design approach.

Over the last century, the region has faced a “rapid and uncared growth” as observed by (Demirbilek, 1997) due to fast population increase, changes in the social context and economic restrictions. This has encouraged an incongruous, fast-pace construction without any considerations for (cultural) modern era notions. The main goal of the current research is, therefore, to understand and explore the limitations of the vernacular sustainable strategies in Hasankeyf and learn how the local approaches could be implemented in and further adapted to a new development within the region. Considering this, the paper at this stage, adamantly envisions the ‘recreation of the vernacular’ as an integral aspect of long-term sustainability by investigating potential passive measures, which could provide annual occupant comfort.

The recreation of the vernacular concentrates on exploring a design of mostly self-sustaining dwellings embedded within an environmentally-responsive enclosure without compromising elements that define the region’s unique architecture but enabling it to adapt to the contemporary family needs.
REGIONAL INFLUENCES

Climate & Topography

Hasankeyf is a hillside settlement with an altitude reaching up to 495m perched within a valley in the hot and dry Southeastern region of Turkey. The great temperature difference of about 32°C between the hot summer and relatively cold winter months made it “imperative to adopt to the natural forces from the early days” of the region’s history (Alioglu, 2000).

The climate analysis of the closest city of Batman obtained from the climate software, Meteonorm indicates that the area faces two annual extremes with a minimal amount of rainfall and a good amount of global radiation: fairly hot summers and cold winters with a large diurnal temperature difference. Based on this climate analysis, two different comfort bands can be determined by following de Dear’s formula calculations as outlined by (Szokolay, 2004): the resulting comfort band for summer ranges between 24°C and 29°C, and for winter, the band falls between the temperature range of 17°C and 22°C.

Culture & Architecture

The historical perspective reveals that in the vernacular architecture of Anatolia, human beings built dwellings based on a specific region’s geographic and climatic provisions along with the religious premonition of orienting the main façade towards Qibla - to Mecca, which is the direction of the Holy Land of Islam (Demirbilek, 1997).

Hasankeyf is an exceptional precedent to such a hypothesis: the city’s settlement on hillside topography with introverted house layouts, not only accentuates the region’s cultural privacy, but also represents the environmental benefits such a settlement and layout provide (Demirbilek, 1997). Moreover, the formation of semi-open (Eyvan & Revak) and open (courtyard & terrace) spaces along with enclosed areas forming the typical 2-level construction, differentiation of rooms for solely male and female occupancy, and small openings to outside mimic the characteristics of the area’s closed-in lifestyle (Alioglu, 2000).

The region houses three building typologies: the U-type (- most commonly encountered within the vernacular city fabric), the L-type and the Linear Type. The building forms portray the family status and size, ranging from the most prestigious house with the largest family in the U-type to medium size in the L-type and to the smallest building form of the Linear Type. Despite the difference in their size and form, all the building typologies have traditional flat roofs, same treatment of architectural features and closely related program allocation and space layouts.

CASE STUDY FIELDWORK & ANALYTIC STUDIES

A fieldwork is conducted and measurements are taken in a precedent dwelling - the Gozuoglu House - in Mardin (- a nearby city to Hasankeyf) with the aim to investigate the vernacular building’s performance.

The prestigious Gozuoglu House represents region’s emblematic, architectural features within its 2-level construction of 90cm-thick, non-insulated, locally-sourced stone walls with single-glazed, small windows and a U-type layout of varied open, semi-open and enclosed spaces.

The house consists of ‘living units’ as described by (Alioglu, 2000) which include bedroom areas (within Haremlik and Selamlik living rooms) and the most esteemed men (Selamlik) and women (Haremlik) living rooms at the upper level. These spaces are commonly occupied during the summer season due to their high volume with ceilings reaching up to 5m (Demirbilek, 1997). The external shutters supplement indoor comfort within these spaces by providing protection against (direct) sunlight during the peak hours of the day.

The winter season targeted lower level, on the other hand, embraces daily ‘service areas’ (Alioglu, 2000) including an office (live/work room) and a study room along with a kitchen across a storage space, and an earth-dug room, which is most commonly used during the summer season as it stabilizes the indoor temperature and maintains the space cooler.
Fieldwork

The fieldwork of the Gozuoglu House is completed using Tiny Tag data loggers (for room dry-bulb temperature) on the sunny days of 4th - 6th of July 2011, during which the average outdoor temperature ranged between 30.1°C and 31.2°C. The intent of the fieldwork is to understand the temperature performance of two similar spaces at different levels based on solar radiation impact. A living room - Haremlik and a live/work room - the office space are chosen due to their comparable layout and size (28m² of floor area in Haremlik and 25m² in the office) along with analogous window-to-floor ratios (13% in Haremlik and 11% in the office), occupancy pattern and ventilation rates. (Note: Both spaces were not occupied during the fieldwork period).

The obtained data logger results indicate that thermal mass maintains both spaces’ internal air temperatures at a fairly stable level (with a 2°C fluctuation) throughout the day despite the large 20°C diurnal fluctuation of the external temperature as seen on Figure 1.

Figure 1  Fieldwork measurements’ graph of two rooms in the vernacular Gozuoglu House

The 5°C internal air temperature difference between the upper level Haremlik and the lower level office highlights that solar radiation potentially plays an influential role in the increase of the internal air temperatures - a theory that needs to be confirmed by the subsequent analytic studies: the unobstructed Haremlik’s east and south facing windows increase solar access, whereas the lower level office’s only east facing, overshadowed (by terrace above) windows limit it.

Hypotheses

Analyzing the climatic characteristics of the city including S-SW wind flow pattern and high solar angles along with observing the case study fieldwork results, a series of strategies are formulated based on initial environmental hypotheses, which focus on passively improving the indoor comfort within such a vernacular enclosure:

- Increase of solar access into spaces
- Compact spaces of airtight, thermal mass construction
- Shading elements
- Night time ventilation (with additionally openable, upper pane windows and/or skylights)
- Maintenance of the vernacular’s semi-open and open spaces that further contribute to the indoor
comfort enhancement: during winter, these spaces provide buffer from the cold outdoor temperature while during summer, they offer a shaded microclimate environment (Fathy, 1986; Koch-Nielsen, 2002), extending the daily family life.

Analytic Studies

At the conclusion of the obtained fieldwork, analytic studies are conducted using Thermal Analysis Software (TAS) for calibration, understanding of the dwelling’s annual performance and confirmation of the proposed strategies in relation to the formulated environmental hypotheses.

The created base case model complies with the vernacular case study precedent in terms of building form, layout and inputs. The completed TAS model is examined for building’s performance of levels, orientation, solar radiation access and internal heat gains throughout a typical summer (7th - 13th of June) and a winter week (1st - 7th of December). The analysis and comparison of each simulation are evaluated against the comfort bands (24°C - 29°C for summer and 17°C - 22°C for winter) calculated according to de Dear’s formula.

Four rooms are selected for the simulations: Haremlik (the upper level living room with south and east facing windows), Selamlik (another upper level living room with south and west facing windows), office (the lower level live/work space with east facing windows) and Antre (a lower level living room with west facing windows). Both of the lower level rooms as well as the upper level ones are given the same window-to-floor ratios of the vernacular (13% on the upper level and 11% on the lower level) to minimize the parameters that would influence the outcome.

Similar to the fieldwork measurements, the summer simulation results for both orientations indicate that solar radiation has a valid influence on increasing spaces’ internal air temperatures: the more exposed upper level portrays approximately 4°C warmer temperatures (before the internal heat gains are applied) compared to the lower level rooms as indicated on Figure 2.

Figure 2 The east and the west facing summer temperature graphs of the free-running Gozuoglu House Base Case simulations – Influence of solar radiation

Infiltration: 1ach
Ventilation: Haremlik: 0.6ach, Office: 0.3ach, Selamlik: 0.6ach, Antre: 1.4ach

Despite the impact of solar radiation, the influence of orientation (East vs. West) is minimally observed due to the U-type building form that overshadows itself: two same level rooms portray a fairly close temperature range. Nonetheless, it can be clearly identified that the impact of internal heat gains is the most direct: the temperatures of both levels initially increase following the external temperature
pattern, however, with a time-lag due to the dwelling’s heavy-mass construction. Once the internal heat gains (i.e., mainly occupancy and some lighting) are applied into these spaces, the internal temperatures reach their peak approximately at a 1°C - 2°C higher level as highlighted with \(\square\) on Figure 3. When the internal heat gains are removed as spaces become unoccupied, the internal temperatures decrease following the pattern of the external temperature. Nevertheless, the internal temperature levels do not necessarily mimic the external temperature drop if the internal heat gains are continuously applied within these spaces as highlighted with \(\square\) on Figure 3.

Reassuring the previously formulated hypotheses, the free-running (without heating or cooling) Gozuoglu House Base Case exhibits a much poorer performance during the cold winter season with internal temperature levels falling below the calculated comfort band of 17°C - 22°C, following a fluctuation line of 7°C - 14°C as highlighted on Figure 4 (a) and (b).

Moreover, the winter season simulations highlight the better performance of the lower level spaces (- the office to the West and Antre to the East) due to their less exposure to the interchanging outdoor temperature. Following this line of thought, it is not only the higher volume of the upper level with taller ceilings and a larger window-to-floor ratio, but also the exposed surfaces further contribute to the heat losses that occur at this level, in return diminishing its performance.

### Critical Review

The conducted fieldwork and current analytic studies confirm the initially formulated environmental performance hypotheses for the investigated vernacular dwelling, in which the heavy-mass stone construction and small window-to-floor ratio maintain the internal temperature levels stable during both winter and summer months, however, passively achieving indoor occupant comfort during the hot summer period, but not providing it for the cold winter season. Considering this, the focus of the future analytic studies in this paper is to enhance the vernacular building’s performance during winter while reducing the Annual Heating Load Demand and maintaining the summer indoor comfort.

Following the pattern of the previous section, a new hypothesis is formulated stating that the building scale manipulations such as improving the construction (i.e., implementing double-glazing and insulation) and increasing window-to-floor ratio along with defining a layout that is proportionate to the targeted occupants (in terms of floor area for the resulting internal heat gains) would increase the building’s performance during the winter season while also maintaining the desired summer comfort.
Vernacular dwellings of the region (especially the U-type building form) were meant for large families because traditionally married males never left their family home (Alioglu, 2000). Nonetheless, current married generation prefers to privatize their individual, core family life from the extended relatives. Considering this, guidelines are presented for the ‘recreation of the ‘modern’ vernacular’ with the New Hasankeyf Base Case being created following the reiterated parameters:

- Compact dwelling size proportionate to a single family of 4 people, which corresponds to the Linear Type encountered within the vernacular fabric (Note: Per the previously completed analytic studies, the U-type building depicts the worst performance among all the typologies due to its form, which limits solar access and enables heat loss via large amount of exposed surface area. It is also due to this reason that the Linear Type is chosen to represent a new dwelling prototype for the future city of Hasankeyf).
- Reduced stone wall thickness from 90cm to 30cm for ease of transport, labor and cost reduction
- Adequate space layout to accommodate the modern era adaptation of programs (i.e. identification of programs for the vernacular model). (Note: Separate bedroom and bathroom spaces were not a part of the vernacular dwelling layout; instead they were a part of a ‘shared space’ system. However, with the increasing need of individual privacy within a dwelling, the locals of the region are encouraged to redefine some rooms to provide for the needs of those ‘unidentified’ programs. This ‘forced’ process often takes away from the function and the proposed layout of another vernacular space in the building, posing contradiction to the traditional occupancy pattern and space layout).

The created New Hasankeyf Base Case has the input values as shown on Figure 5, deriving from the region’s precedent characteristics.

![Figure 5](source: TAS)
The New Hasankeyf Base Case’s simulations conducted using TAS restate the previously encountered outcome: the model exhibits a good performance during the summer period with temperature patterns (for both levels) falling within the target comfort band, whereas it suffers throughout the cold winter season. As hypothesized earlier, the following building scale manipulations are additionally considered for the enhancement of the proposed dwelling’s annual performance:

- Addition of insulation along the exterior of structure (from the vernacular none to 5cm thickness)
- Change of glazing type (from the vernacular single to double-glazing)
- Increase of window-to-floor ratio (from the vernacular 11% (at lower level) and 13% (at upper level) to 15% (at lower level) and 25% (at upper level) both with insulated, external shutters)
- Reduction of terrace depth (from the vernacular 4m to 2m depth)

A architectural approach combining the considered parameters along with an optimum South (Qibla) orientation has been established based on a balance of Annual Heating Demand reduction and increase of Solar Gain, and it is reflected within the design prototype for the New Hasankeyf dwellings. To quantify the proposed prototype’s performance, a set of a typical summer and a winter week simulations has been completed comparing an upper level living room (Selamlik) to a lower level one (living room/office). The obtained summer simulation results of the free-running (without heating or cooling) New Hasankeyf Base Case as seen on Figure 6 (a), indicate a stable profile for the lower level living room/office, whereas it portrays a bigger fluctuation pattern for the upper level Selamlik due to increased ventilation strategy applied in order to maintain the internal temperature levels within the set comfort band with newly increased window-to-floor ratio.

The New Hasankeyf Base Case’s internal temperature profiles portray significant improvements of approximately 20-25% for the winter model performance when compared to the vernacular Gozuoglu House Base Case: both the upper level Selamlik and the lower level living room/office display a more regulated temperature pattern with a daily fluctuation reaching up to 4°C as indicated on Figure 6 (b). The obtained results highlight both levels’ potential for achieving comfort range with increased occupancy and/or minimal heating input: it has been observed that when there is constant solar radiation above 500 W/m² and the external temperature exceeds 10°C, the lower band of the comfort zone can be achieved during the occupation hours under free-running conditions. Moreover, there is an evident improvement in the lower level space’s internal temperature levels from the Gozuoglu House Base Case condition. The improvement also applies to the upper level Selamlik’s internal performance with a 3°C higher temperature range compared to the vernacular Gozuoglu House Base Case model. Considering this, the band in which the heating system would operate in order to reach the comfort range would be much smaller and therefore, significant savings can be achieved.

**Figure 6** (a) The summer temperature graph and (b) the winter temperature graph of the free-running New Hasankeyf Base Case simulations (source: TAS)
Despite the prototype dwelling passively not achieving a complete annual range within the calculated comfort bands, the proposed guidelines relay an achieved summer comfort and an enhanced winter performance without compromising the origins of the vernacular’s architectural existence: the primary focus of the research is to offer guidelines to design for inhabitants who are devoted to meticulously preserve their cultural traditions mirrored onto the region’s architecture and lifestyle.

The conducted research of the previously formulated hypotheses via supplementary analytic studies in this section, reassures the set theory in regards to the ‘recreated’ vernacular dwellings’ performance. More importantly, this research leads to an outcome that can provide guidelines for the New Hasankeyf dwellings’ passive design approach, through which not only current, but also future builders, designer and occupants can dwell upon, learn and grow, carrying on the precedents. The primary scope of this study has been to investigate the limits of the localized vernacular passive measures in order to enhance the environmental performance of dwellings within the Hasankeyf area. Nonetheless, further studies that are based on alternative performance metrics would explore useful measures that not only ‘recreate’, but also assist in achieving a more efficient and improved sustainable design by ‘redeveloping’ the vernacular lessons learned in this initial research.

ARCHITECTURAL DESIGN

The New Hasankeyf proposal derives from the architectural syntax of the vernacular, which is based on a 4mx4m grid layout (Ozbek, 2004). It represents housing units that achieve desirable indoor living conditions throughout varied seasons. The premise of the units’ design lies on maintaining the vernacular language based not only on its space layout, usage and building form, prolonging the roots of the cultural lifestyle and traditions, but also on its architectural aesthetic that smoothly amalgamates with the existing surrounding.

In addition to preserving the vernacular’s space layout and function, the bathroom and the bedroom spaces are compensated in the new proposal, all with either standard or high-level windows. Reiterating the transitional spaces, the New Hasankeyf proposal consists of terraces forming Revaks (semi-open spaces) below, which lead to a sheltered, private courtyard, in which comfort is enhanced with water elements and vegetation.

The varied façade treatment evident in materiality, scale and ornament application along with diverse opening sizes (15% on the lower level and 25% on the upper level) and ceiling heights (2.5m at the lower level and 5m at the upper level) visually contribute to the seasonally desired transition of the two levels: the linear patterned, local wood finish with smaller windows encapsulated with minimal, insulated, wood shutters on the lower level reflects the simplicity of the ‘service areas’ it encloses behind; whereas the elegant, local stone arrangement and the larger windows with ornate, insulated, wood shutters highlight the prestigious ‘living areas’ of the upper level.

The beneficial reconsideration from the vernacular example in the New Hasankeyf prototype is the secure extension of family life onto the flat rooftop enabled by the elaborate railing design, which, in addition to the terrace’s, defines the perforated, horizontal framing of the building’s overall façade.

CONCLUSION

The New Hasankeyf proposal depicts the pictogram of a vernacular ecology harmonized with the deeply rooted cultural texture of Hasankeyf in Southeastern Turkey. It presents an improved but closely paired to vernacular design that provides guidance for designers and builders who would partake in building dwellings for the soon-to-be-submerged city.

The proposed guidelines simply do not dwell upon a novel design; they instead focus on the ‘recreation of the vernacular’ with an enhanced environmental performance. It is nonetheless, acknowledged that the vernacular model faces constraints as passive design approaches are enforced. Considering this, design alterations to the vernacular model such as providing a glazed enclosure at terrace level to pre-heat the air to be supplied indoors and/or active systems would additionally need to be integrated to achieve full comfort.
All the unifying elements of the proposal are created to respond to the current family needs and environmental conditions for a building scale enhanced performance as discussed by (Yannas, 1994) along with finding a balance within the traditional composition of the area. It is through these considerations that the guidelines highlighted within this paper can be followed for a sustainable modern era adaptation of the new and soon-to-be emerging Hasankeyf dwellings.

REFERENCES