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Case Study

Building materials in eco-energy houses from Iraq and Iran

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ABSTRACT

Builders from the Western part of Asia are trained to make buildings that can fulfil certain required functions while giving full consideration to all sites and environmental conditions. The research covers the zone between Iraq and Iran. The first investigated region is the "Mesopotamian Marshes" or Iraqi-Iran Marshes, a wetland zone situated in southern Iraq and partially in southwestern Iran. The other region is a desert district, which includes a prominent part of the southern and western parts of Iraq and part of Iran. The last is the centre city of Basra. The building materials were the most important building element that affected the conformation of vernacular habitats from the western part of Asia in general and the Iraq–Iran area in particular. In this study, we needed to focus on the effects of ecological and energy-efficiency processes in creating vernacular habitats and the selection of optimal building systems and materials in this part of the world, which can be an essential point for sustainable environmental building processes in the future. Reeds, clay, straw, bricks, and wood were the most popular building materials used by builders from this region. The impact of building material on the environment embodies the essential method implicitly significant in this research to effectively determine traditional building materials in the environment, in addition to comparative analysis. This presents an essential factor of our analysis, in addition to the impact of environments on building systems. The main target of this study is to benefit designers and building engineers in their pursuit to find optimal and competent solutions suitable for specific local microclimates using traditional methods in the design process that are sustainable and ecological.

1. Introduction

Vernacular habitats developed their individuality by tapping into nearby resources and exploiting them to confront the problems posed by a local environment. If rain is seasonal, the roof structure must also function efficiently in the dry season (Woolley, 2006). When it is warm, large, a high roof space continuum with the living area is practical. Temperature extremes call for thick insulating walls and roofs to maintain a comfortable internal environment (Almusaed, 2004). The most important question that needs to be answered is what is the relationship between the outer conditions of temperature, sunshine and rain and the inside thermal comfort. For different climatic sessions, it is necessary to take into account building, area, orientation, colours, etc. Although it is quite a complicated matter to theoretically solve these problems, it is possible to

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establish an empirical relationship between the exterior and inner environments for any building. In this way, the practical problem can be solved (Ginvoni Man, 1976). Throughout history, the human being has striven to erect shelters that fulfil basic needs relating to his survival, shelter that provides an environment favourable to his physical requirements. During his years of effort to achieve that environment, many local variations in dwellings have evolved (Wenzel, 1996). According to a UN document, the purpose of the habituation process is not to build houses but to ovulate a competent house. In other words, the house should provide the security of technical advice and be involved in acquiring small loans and cheap materials (Stulz, 1981). Climatic conditions compel the builder to find an efficient solution to serve the human being and the comfort of his existence. Building materials have an important impact on the home's functions and inhabitants. Environmental building materials add value to human life and reduce the negative impact on the environment drastically. In West Asia, climates, environmental elements with heavy buildings and shaded courtyards are common. These climates typically have a huge diurnal temperature range, and houses tend to employ an arrangement of these measures, with the particular mix being modulated to suit local micro-climatic characteristics. Selecting and specifying environmental building materials are often complicated processes (Jester, 1995).

Builders from this region created their habitats taking into consideration the above-mentioned question, in an efficient manner and to fit human needs by adapting to local environmental parameters. Each building material displays the different physical characteristics; the structure requires rigid strength to support the dead weight of the roof and walls. If the situation dictates the range of fitting materials, together they command the form. West Asia's vast landmasses are diverse in geology and climate (Almusaed, 1997). This investigation has to find suitable solutions for building materials and then study different building materials from various sources and based on its characteristics of eco-energy house efficiency. The main lesson we can learn from this study is not only to further the conservation and repossession of the form of habitats already in existence, but also to rethink what can form new habitats for the future (Fig. 1).

2. Climate-specific effects

Climate is the main factor that directly affects the construction process and building materials in West Asia. This region is situated in the subtropics' climate zone. It is affected by the subtropics' high-pressure belt, which reaches the farthest north in the summer. The sky in West Asia is bright and glaring, even when thinly clouded. As one goes inland from the equator, seasonal differences in climate become more marked with a wetter wet season, and a drier winter period (Kukreja, 1978). There are many factors that affect building materials of traditional buildings from West Asia. Solar radiation deteriorates organic materials by initiating chemical reactions within the material and causing oxidation. Fig. 2 shows the monthly average temperature and sunshine hours in the West Asia Region. In this region, edifices have to be planned with great attention and thought, and with due respect for climate. Shade and protection from dust storms may have the highest priority in some areas, whereas in other areas, ventilation and the trapping of air streams and breeze are the primary goals. The effect of climate over the building materials is large; high temperatures, for example, can affect all types of materials in general. The speed of a chemical reaction doubles for every 10 °C increase in temperature (Nielsen, 2010).

In addition, increasing levels of humidity can increase the deterioration physically and by creating an environment for harmful fungus and microbial growth as well as insect attacks. Changes in humidity also cause deterioration through changes in volume and stress within the material.

3. Investigation methods

AN environmental profile is achieved on the basis of the SBI (DK) calculation programme, BEAT 2000, which is a standardised technique for classifying and measuring the environmental effects related to building materials in their life

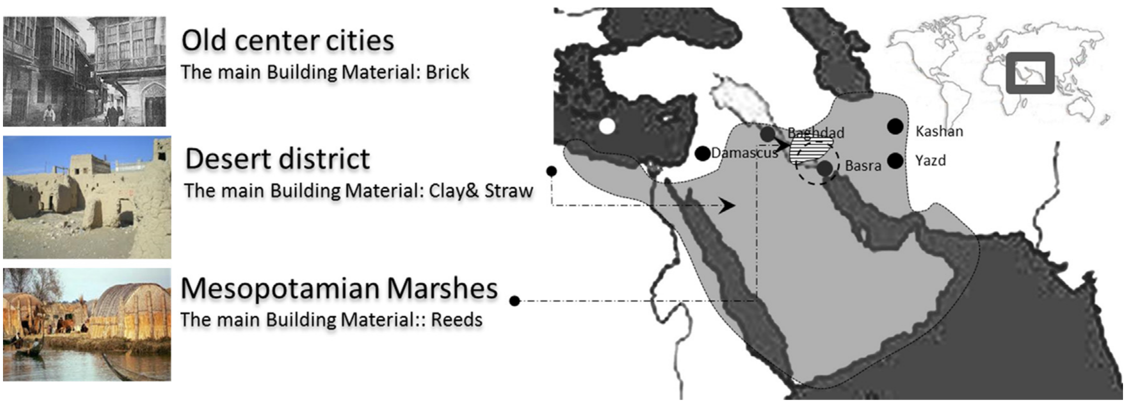

Fig. 1. The different building systems categories from West Asia Region.

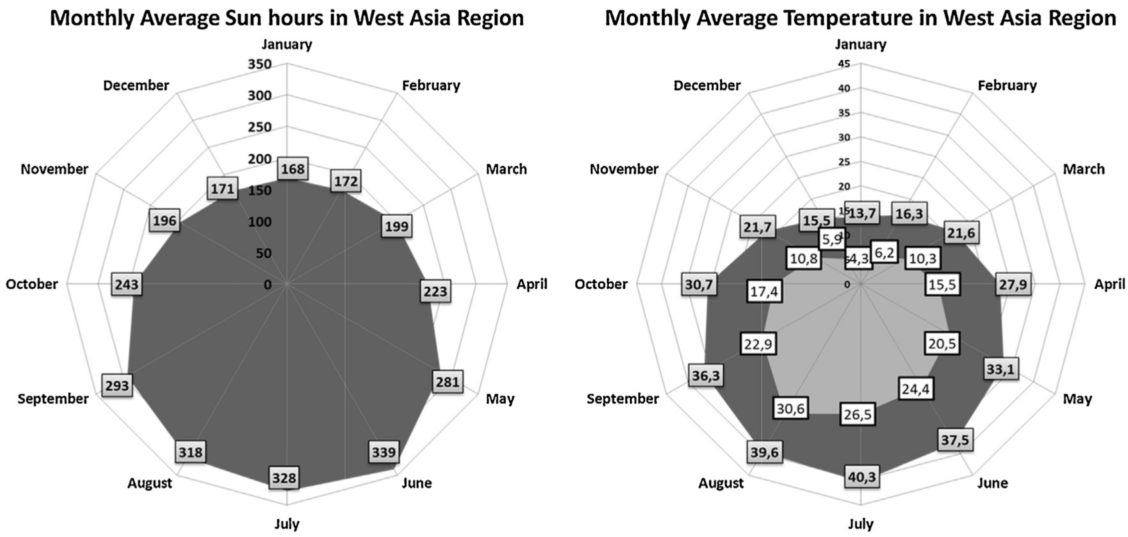

Fig. 2. The average weather in West Asia Region.

cycles (11). It consists of seven parameters that cover all essential physical environmental impacts and effects. It is possible to examine an environmental profile indicator using the same indicator on another one. The first indicator is resource consumption, where the environmental impacts of resource benefits can be composed of a loss of resources and space consumption and risks of gas extraction or a cultivation process. The study will use three circumstances. The first is the ability of the material to engage in a recycling process, where it can provide for the immediate environment by reducing the use of new resources. Knowledge materials are a part of the renewable resource process, such as, in the building of plant materials, mainly wood, or non-renewable resources, such as mineral substances like brick, concrete and metals. The second indicator is the environmental impact of energy consumption. In this situation, the study will use three circumstances: renewable feedstock energy, the heat of combustion of renewable resources, where is wood is the principal base product; non-renewable feedstock energy, such as plastic; and renewable energy, such as energy from wind and hydropower production and biofuels. Last is non-renewable energy, such as coal, oil, gas. These energy sources are characterised by a limited quantity at disposal, and their use gives rise to, among other things, the greenhouse effect. The third indicator is a greenhouse effect, which shows the environmental impact of greenhouse-gas emissions. The anthropogenic greenhouse effect is due to cord gases (including carbon dioxide, methane and other) for the retention traps heat radiation that would otherwise radiate from the earth into space. In this way, they contribute to atmospheric warming. Acidification influence is a fourth indicator that shows the environmental impact of the emissions of acidifying compounds (mainly sulphur dioxide and nitrogen oxides), which attack plant foliage and acidify the soil. Nitrogen impact is a fifth indicator, which shows the environmental impact of the discharge of substances containing nitrogen or phosphorus. They can cause the growth of algae or plants to increase out of balance in relation to, and to the detriment of, the global ecosystem. The toxification effect is a sixth indicator of the environmental profile, showing the environmental impact of the emissions of substances that have acute and chronic toxic effects on humans. Disposability is the last indicator of environmental profiles and shows what happens to a building, structure or material once its life is over. In this situation, the study will use three circumstances: recycling/high-value recycling, the direct reuse of the material in its original form or reuse of the material innovatively through the production of new materials (Marsh, 2000). A low-worth recycling/incineration, the recycling of material for the production of brand new materials of lower quality, or burning the material with energy; and hazardous waste, where the material contains substances that must be disposed of according to law (Table 1).

Comparisons are an instrument of inquiry. Materials related to environmental impacts can be assessed in relation to other factors such as energy consumption and the greenhouse effect, which is divided into the following:

- Materials
- Acclimatisation

A material impact on the environment should not be observed in isolation from other environmental factors. The environmental impact of certain materials or structures can be compared to other factors (Dinesen, 1997). The environmental profile can compare the environmental impact per m^2-floor areas of the house's acclimatisation needs and its building materials. The calculation of housing accumulation requires using the approach developed by SBI for the calculation programme BV95. The calculated cooling & heating requirements are then converted to gross energy consumption and CO_2 emissions.

Table 1
Environmental profiles indicators using in eco-energy buildings materials efficiency analysis.

Environmental profiles indicators	Analysis factors			
Resource consumption	Ability to recycling process (ARP.)	Renewable resources (RR)	Nonrenewable resources (NRR)	
Energy consumption	Renewable feedstock energy (RFE)	Non-renewable feedstock energy (NRFE)	Renewable energy (RE)	Nonrenewable energy (NRE)
Greenhouse effect		GE		
Acidification influence		AI		
Nitrogen impact		NI		
Intoxication effect		IE		
Disposability	Ability to recycling (AR)	Low worthy recycling (LWR)	Hazardous waste (HW)	

4. Specific building materials nominated

A building is built to be occupied by humans. As such, it makes sense that architects, be they Classical, Renaissance, Modern, or contemporary, would use the human body as inspiration or a principle of design (Korydon, 2012). The building envelope is a man's barrier against external atmospheric conditions and their fluctuations. Builders from this zone have chosen three varied categories, in the building material's selecting process. These are mineral materials, organic materials and mixture material.

4.1. Organic building materials

This is the first building material utilised by human beings in the building process. It comes from renewable resources and can be extracted by humans easily; therefore, it is an ecological material with many good proprieties and can be successfully used in the construction process. It is a large part of human life (Brown, 1990). It is a popular building material because of it is specific environmental friendliness and great energy values. The main benefits of these materials are their cheapness, prevalence, and excellent proprieties of thermal and acoustical insulation.

4.1.1. Reeds

Reed is an organic building material; it has good resistance to water actions. It contains a high ratio of silicon substance, which leads to it being durable and flexible in technical action and structures; however, it is a highly flammable material. The high concentration of silica in the reeds makes this material unattractive for insects and other animals. Reed meets all the requirements to be an efficient insulator. The form of the stem allows it to serve all manners of functions (Elias, 1980). It is an excellent thermal and acoustic insulator material. The relative durability and flexibility in construction are the most important proprieties of reeds. The unique properties of reeds have been noted for a long time, in all regions of the world (Lauren, 2000). The influence of reeds on pathogenic bacteria is particularly intense. Reeds from the marshland region consist of several types of plants whose stems differ in thickness, flexibility and chemical composition. The most popular reeds used in the construction process are "Ihdri", the regional name of this type of reed. The building of walls with reeds is much less labour intensive than that with other materials such as brick, adobe, or stone, and requires considerably less skill. Reed building is forgiving, encourages individual creativity, and leads to final structures that are climatically adapted and energy efficient. Reed does have some disadvantages. Its natural durability is lower than wood, and it must be treated with preservatives to last in exposed locations.

4.1.2. Straw

Straw is a material with high thermal efficiency. It has an *R*-value substantially better than those of other traditional buildings, depending on the type of straw; it consists of barley that is 36% cellulose, 26% pentoses, 17% linen, wax, protein and ash – a composition very similar to wood. The straw has excellent insulation properties. Straw's biological functions include its axis for water. Therefore, straw bales are good at transporting moisture and thus regulate interior humidity, provided they bear the diffusion through open screen and coatings. Straw's weaknesses are risk of fire, insects or decay refraction caused by long-term, high moisture content (Gillv, 1970). Straw can provide greatly improved comfort, and dramatic energy savings compared to more expensive traditional building structures because they allow for smaller heating or cooling systems in conventional homes because of the increased insulation. Bale building is of particular value in severe environments where energy is costly.

4.1.3. Wood

Wood is an organic material, a natural combination of cellulose fibres (that are strong in tension) embedded in a matrix that resists compression (Janssen, 1988). The principal components in wood are cellulose (40–50%) and hemicellulose (15–25%), with lignin (15–30%) as well as other material such as sugar, starch and protein. The technical properties of wood are highly dependent on the type and moisture content. It also contains varying other elements depending on the type, which defines its smell, colour and resistance to pest damage. There are two forms of wood, softwood and hardwood, which are subdivided into a number of different types (Edward and Joseph, 2011).

Wood has a high caloric value (between 12.5 MJ/kg and 20.1 MJ/kg). Thermal re-utilisation of untreated and uncoated wood is un-problematic. Re-utilisation is possible if the wood is dismantled without damage. Untreated old wood conventionally can be used as raw material for a number of different applications (Woolley, 2006). The conversion of wood into a sustainable, renewable resource to be used as a main building material could be beneficial in various areas of the world.

4.2. Mineral building material

Mineral materials are made from non-renewable resources dug on land or at sea. They are homogeneous, naturally occurring solid inorganic materials with a clear crystal structure and a definite chemical composition (Damon, 1983). Builders from this zone have found good building materials from the local neighbourhood. Two essential building materials were selected in the building process: clay and brick, which are near the required scale of humans.

4.2.1. Clay

Today, clay offers the only practical prospect for building the five hundred million houses that will be required in the coming years (Anil, 1981). A mass of clay has extraordinary formability and robustness. Excellent adhesion and bonding forces count as the main properties of clay.

4.2.2. Brick

Brick is used as a principal building material from zone "I". The typical house from Sumerian age was a one-story construction made from baked or sun-dried mud-brick. The family house included the following structure functions: a living room, kitchen, open courtyard, servant's residences, etc. A brick-building element has excellent thermal resistance (Barry, 1988).

The material is very efficient in energy consumption and can be accepted as a bio-ecological material, especially in West Asia. Clay bricks are a more thermally inert material, and chemical reactions are relatively low. Thus, the effects of green houses are limited (Manand har, 1983). The recycling of clay bricks can be a difficult process due to the unavoidable mortar, render and plaster residue that tends to adhere to the bricks, particularly when such products have high cement content. However, older brick is easier to recycle because much of it was constructed using lime mortar (Manfred et al., 2006).

4.3. Mixture of building materials

4.3.1. Clay + straw

This is one of the ancient building practices known. Clay is odourless, non-toxic and pleasant to work with in combination with straw, creating a soft to pulpy prepared mix of clay and vegetable fibres (straw) that can be used for filling the panels in timber-framed buildings or pressed in moulds for making clay bricks and boards. Ready-made mixes are now available on the market. The density of the mixture building material of clay and straw is 1200–1700 kg/m^3. A mix of clay and straw is a heterogeneous material, with good thermal properties (Easton, 1996). Fig. 3 shows the environmental profile comparative analytical interpretation of environmental profiles of 1 m^2 of different building materials.

The straw–clay mix creates a unique, breathable combination of high insulation with thermal mass.

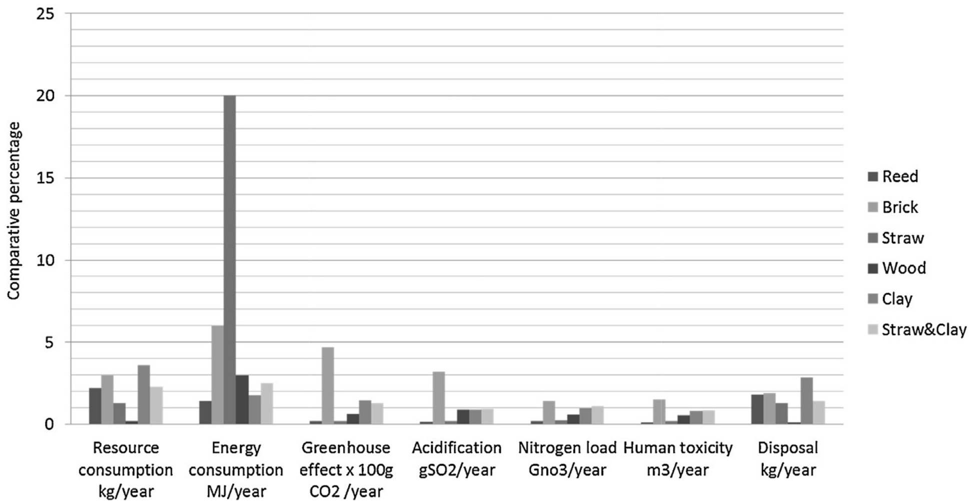

Fig. 3. Comparative analytical interpretation of environmental profiles of 1 m^2 of different building materials.

5. Building systems of heritage practices (case study from Basra habitats)

The city is located in a region of the historic area of Sumer, the hometown of the fictional character Sinbad the Sailor, and a suggested place of the Garden of Eden. It held a significant position in the early regional history and was founded in 636 AD. It includes three different habitat arrangements. The first appeared in the north part of the city in the zone of marshes, Zone III. Another type appeared in the south part of the city in the desert area, Zone II. The last appeared the middle part of the city beside the big-city river Shat Al-Arab, Zone I, as shown in Fig. 4.

From the practical experiences of the building process, specific habitat units from historical experiences were more related to the objective context (Solar Handbook, 1986). One of the most effective interventions of an old building from this region was respecting balances between many environmental factors to create a particular building style, which makes the balances between human life and the milieu condition optimal. The notion of ecological building is not an absolute (Almusaed, 1996; Marsh, 2000). It is, therefore, more correct to use the words more or less environmentally friendly, healthy or willing ecology (Doran and Cather, 2013). However, that is not sufficient in practical experience. Accordingly, old builders of the city and region took into account many other factors. One important factor was the implication of bio-climatic concepts in the building process

- Why a bio-climatic building concept?

  The climate has a primary influence on architectural form, not only in the challenges it poses to the builder but also in the materials it supports. In bio-climatic building conception, the edifice is converted to a subsystem of a vast environmental system that should be examined carefully. The holistic integration of subsystems in the system is critical. There are clear interpretations in native architecture (Houben and Guillaud, 1984). The temperature of the ground or walls can be substantially different from that of the neighbouring atmosphere. In bio-climatic buildings from Basra, the earth is valuable as a shelter, particularly in conjunction with landscaping.
- Specific houses From Basra

  Basra's traditional habitat has evolved within these constraints; it can be defined as architecture without architects: not that it is created without overall supervision, just that it is not in the hands of a sophisticated urban professional. Instead, it is vernacular in that it is the product of well-tried local craftsmen raised in the use of local materials to confront local social and environmental conditions. Glazed windows are not part of the Basra tradition. In the warmer regions, glass inhibits the flow of air in summer. Openings are sealed against the winter cold by opaque shutters or cloth screens. Rural housing often lacks window openings, making for a dark interior (Namdin, 1996). Building materials are convenient, readily available and can be made and used by the city builders to build their habitats. In all housing' models, the allocation of habitat functions in the house resembles the shape of a tree, where the main building element is a courtyard, which is point "zero" in the house structure. The most common characteristic of the houses of the hot and humid regions is their openness. They are constructed to catch every breeze that occurs, for natural air currents are the best relief in humid climates [8-2]. All habitat functions are allocated around the courtyard with a hierarchy approach. The most important is for functions of living, such as a living room. Next come service areas, such as kitchens. In this study, we investigated three different cases where old builders constructed something appropriate for the environmental, climatic and human requirements.

5.1. *"Old Basra Habitat" from zone I*

A high temperature, "*T*", due to the heat island phenomenon is a major risk factor that affects housing configurations and compositions in this zone. The recommendation is to create a habitat unit that adapts to extreme climate with a series of

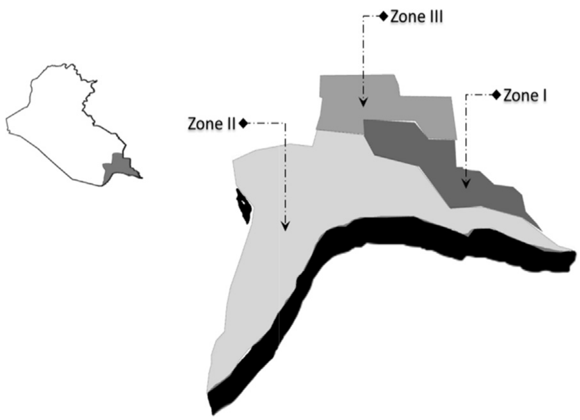

Fig. 4. Building zones from Basra.

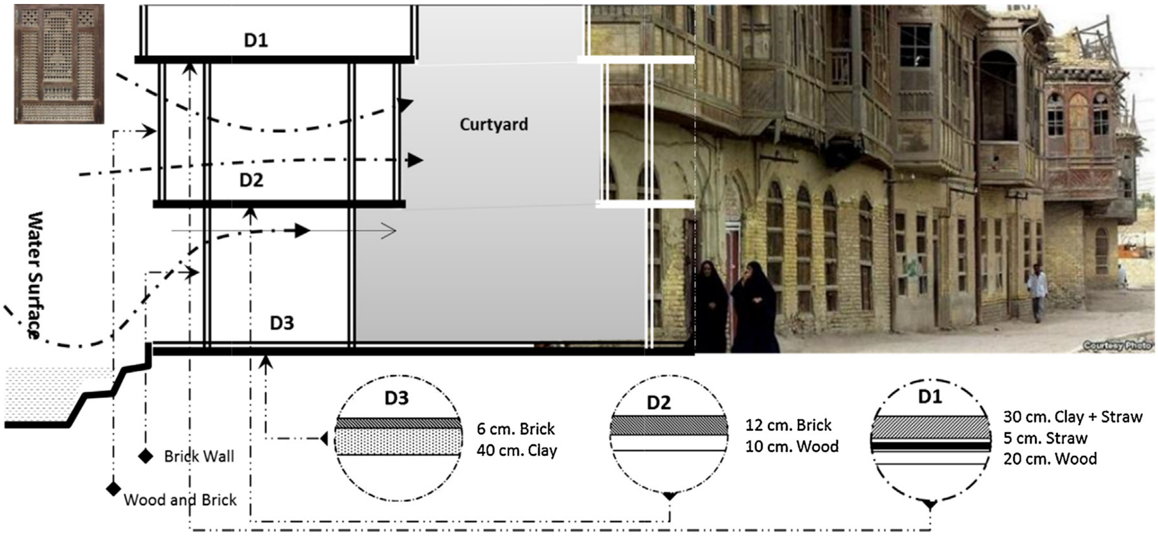

Fig. 5. Traditional house from zone I (Old Basra Habitat).

interferences such as significant thermal insulation, profound shadows on facades, and natural stream ventilations throughout the building functions and structures (Fig. 5).

5.1.1. The house mechanism

In Old Basra, a house is considered beautiful if it is capacious and if the situation is airy and exposed on all sides to the wind, especially to the northern breeze. A healthy house has its courtyards, basins of water, and wooden pieces on the front of the façade "Shanashil." A handsome house is seen without terraces, with "Shanashil" on which the family may sleep during the night (Fathy, 1986). Most of the old Basra distinct habitats are decorated, usually to show invisible spirits and demons and to satisfy local traditions. Building materials have to be strictly respected (see Fig. 10). The habitat area is divided into two functional zones: a social area that includes the living room, kitchen, storage room, and bathroom and a private area that includes bedrooms. Communication between all operational areas occurs throughout the courtyard (Table 2).

5.1.2. Technical house description

The habitat area of this edifice is ca. 125 m^2: the social area is 30%, the private area is 45%, and the courtyard is 25%. The building materials used in the creation of the house are as follows:

- The roof is made of 10 cm of clay and straw, which improves the roof's resistances to waterproofing and high temperature; 3 cm of pressed straw; 10 cm of reeds; 5 cm of pressed straw and 10 cm of wood as a structural element.
- The floor is made of a 40 cm layer of clay and eventually sand as a healthy ground, and a 12 cm layer of brick.
- The exterior wall is combined with an inner wall with 24 cm of brick.
- The upper façade is made of wooden elements (Shanashil unit), with a thermal roll.
- The interior wall is made of 12 cm of brick.
- The estimated life cycle is 100 years.

Table 2
Different material uses in creating and the percentage of material in layers.

External walls (46%) of total areas		Glass panels (1%) of total areas		Roof (10%) of total area		Ground slab (15%) of total areas		Inner walls (13%) of total areas		l level slabs (9%) of total areas		Foundation (6%) of total areas	
Materials	Areas	Mat.	A	Mat.	A	Mat.	A	Mat.	A	Mat.	A	Mat.	A
Brick	69%	Wood	15%	Clay and straw	28%	Clay	100%	Brick	100%	Brick	100%	Brick	100%
Wood	31%	Glass	85%	Pressed reeds	6%								
				Reeds	39%								
				Pressed reeds	6%								
				Wood	21%								

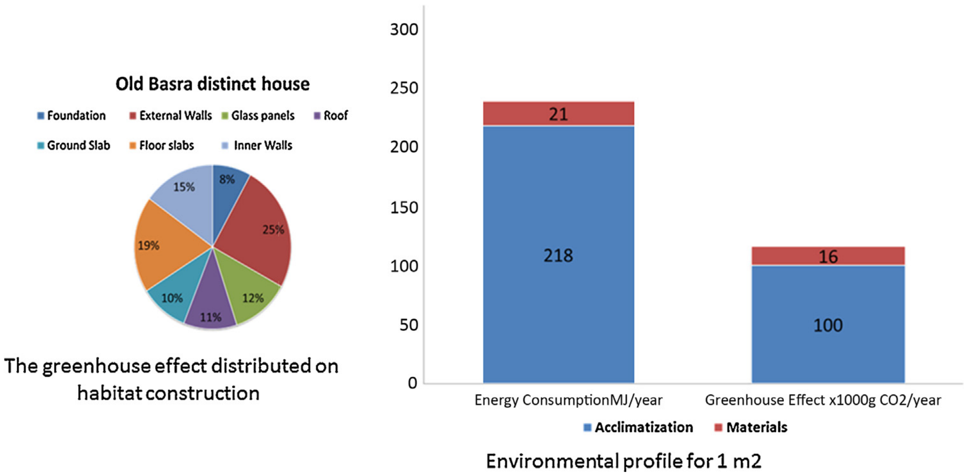

Fig. 6. The greenhouse effect spread on habitat construction and environmental profile for 1 m^2.

5.1.3. House environmental impacts

This is a category of heavy construction. Brick is the main material used in this construction. The impact on the environment by acclimatisation or building materials is limited. The houses are located in row buildings in front of a narrow street, placed directly by the old city river. The houses were built in the beginning of the last century.

The results show that the release of CO_2 is relative low; however, it is higher than other categories of houses. Fig. 6 shows the influence of the greenhouse effect distributed on habitat development and the environmental profile for 1 m^2.

The environmental impact of the materials is a representation of the results shown in the environmental profile of the same house's materials.

5.2. "Marshes House, Unit" from zone II

A high humidity "*H*", due to marsh water, is a major risk factor that affects housing configurations and compositions from this zone. A recommendation is to create a habitat unit with a building material resistant to water and humidity.

5.2.1. The house mechanism

The location is a historic site, from the Sumerian time. The housing configuration was founded for the preliminary time in the "Ur" city, where the initial settlement was founded (Ilay and Barry, 1998). UNESCO recognises the lacustrine region in the north of Basra as a monument of nature, representing one of the largest sites of unique ecosystem types in the world. There is a low density of people living in symbiosis with impressive flora and fauna full of rare species. In the north of Basra, on an "Artificial Island", the house was built in water with a weak current, and the habitat unit is made of reeds and a mixed of clay and straw (Tobias et al., 2009). There are two ways to make the island suitable for the construction process: one is choosing good ground and the other is making it suitable for a particular case. Fig. 7 shows the different procedures for building an artificial island.

5.2.2. Technical house description

The habitat unit area is 147 m^2 (7 × 21) m:

- The habitat entrance is oriented towards the northwest, where the dominant wind originates.

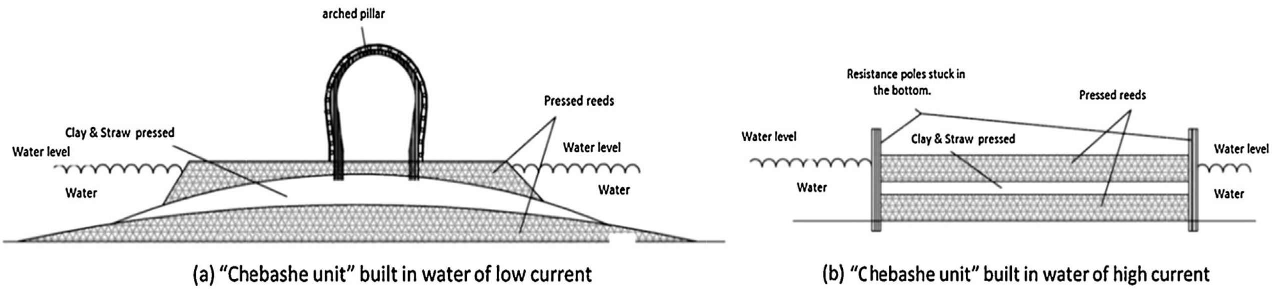

Fig. 7. Different position of artificial island made for habitat unit (Abbas, 2012).

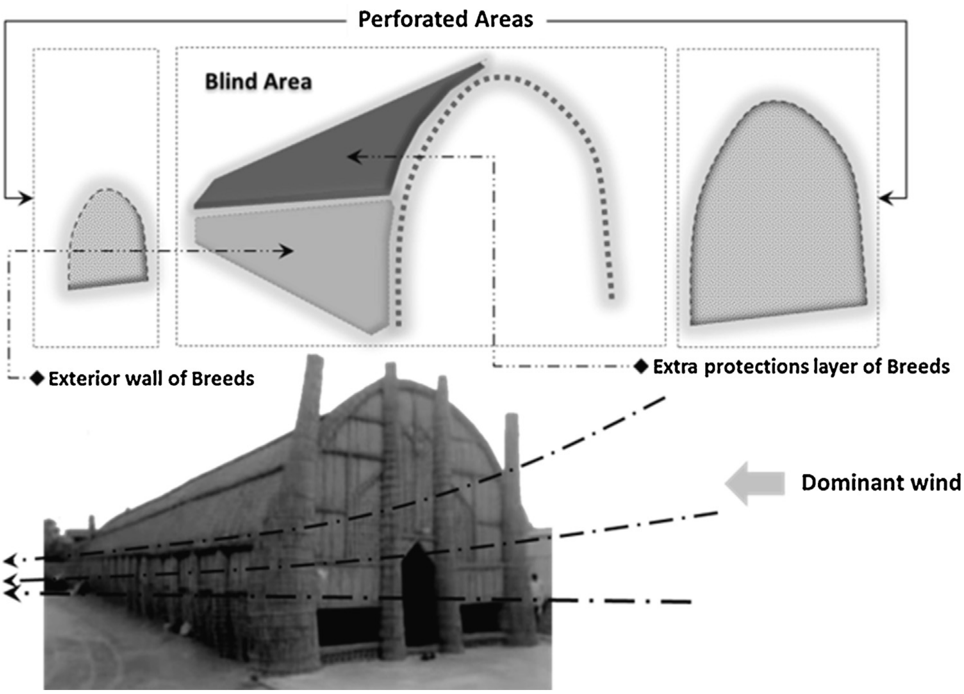

Fig. 8. A habitat envelopes and pattern descriptions.

- The frontal façades on the axis (northwest-southeast) are perforated to allow for permanent natural cross-ventilation (see Fig. 8).
- The minimum distance to the water must be approximately 10 m.
- The roof is always made of a vault form.
- The number of columns on the long side is as follows: seven pillars with the local name of Shabe, with 3 m between 2 pillars.
- The facade has four pillars: the roof pillars framing the entrance and the others located on the corners.
- The estimated life cycle is 25 years.

The habitat site is created from many posts that include closely related strains of reeds between them. The height of the pillar (Shabe) can reach 10 m. The diameter of the pillar (Shabe) is approximately 70 cm at the base and 20 cm at the top (Fig. 9).

5.2.3. The house's environmental impacts

The house is made of lightweight constructions. The principal building material applied is reed. Table 3 shows different material used in the composition and the percentage of building materials in layers.

A demonstration shows that houses made of reeds are friendlier environmentally, with a positive impact on the environment and less energy consumption. A short life cycle material presents negative aspects to a building system. Fig. 10 shows the greenhouse effect for a habitat construction and the environmental profile for 1 m^2.

5.3. The "Al-Zubeir House, Unit" from zone III

The sandy wind "W", which is due to the Sahara Desert environment in the Arabian Peninsula, is a major risk factor that affects house configurations and compositions from this zone. Here, a blind wall is recommended.

5.3.1. The house mechanism

In many ways, the earth is the most prominent material used in natural buildings. Earth can be found everywhere, and, as a result, it used to be said that the majority of the world's population still lived in earth buildings (Keefe, 2005). Of course, concrete and bricks are made of material from the earth, but what will be discussed here are structures that are made of earth in its most natural state, with a minimum amount of treatment or processing (Wenzel, 1996). Strong prevailing sandy winds provoke a builder's response, resulting in lower, blind façades, flatter buildings offering less resistance and thus less prone to building damage and human discomfort. Experiences from the old building process show that malleable building materials can be employed when the climate is humid and are rigid when the climate is dry. Usually wet clay is used directly, mixed with Straw, and perhaps given more body by adding gravel or stone. This is prominent in areas of the world where earth

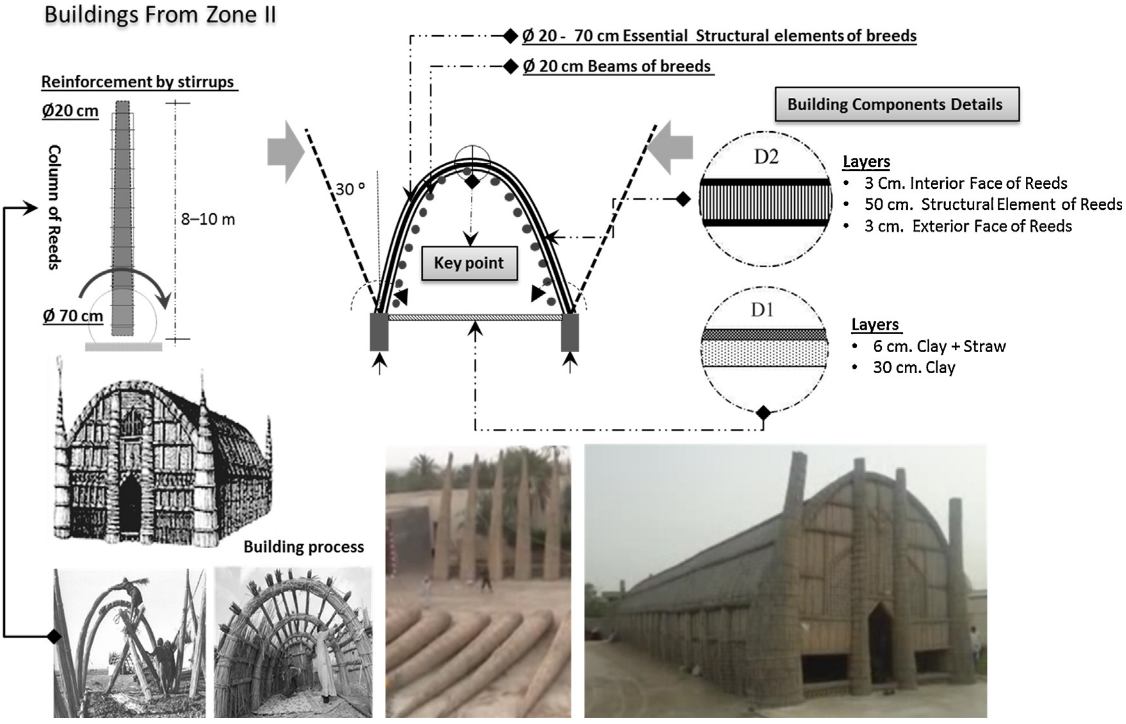

Fig. 9. Compositions Reed's house such principal building materials from northern and Eastern part of Basra.

Table 3
The "Marshes House, Unit" compositions, areas and percentage.

External walls (58%) of total areas		Opening orifice (2%) of total areas		Roof (16%) of total areas		Ground slab (9%) of total areas		Inner walls (12%) of total areas		Foundation (3%) of total areas	
Materials	Areas	Mat.	A	Mat.	A	Mat.	A	Mat.	A	Mat.	A
Reeds	90%	Reeds	15%	Pressed reeds	5%	Clay and straw	80%	Reeds	100%	Reeds	100%
Pressed reeds	10%	Orifice	85%	Reeds	90%	Pressed reeds	20%				
				Pressed reeds	5%						

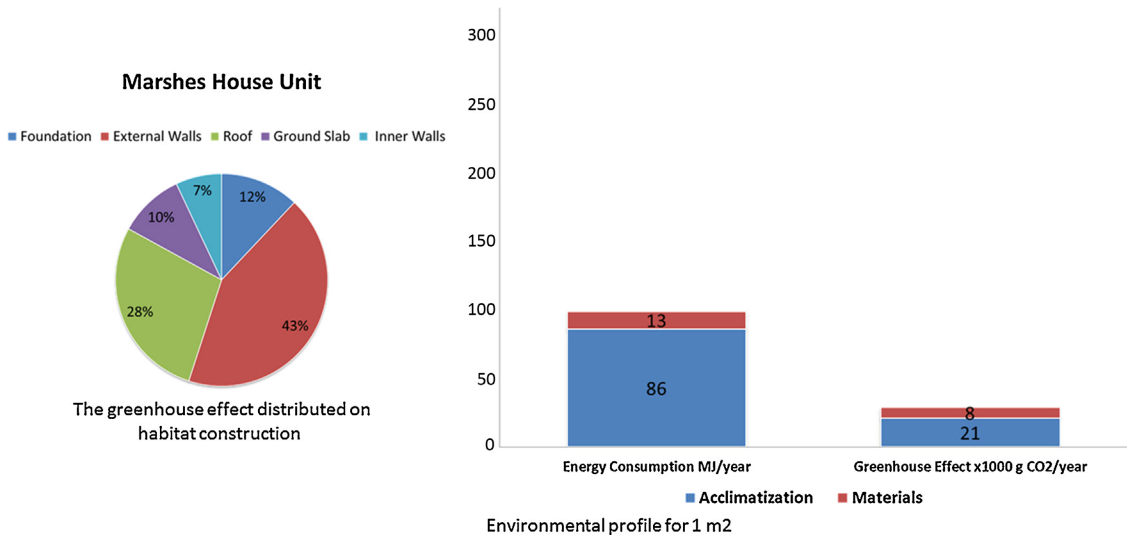

Fig. 10. The greenhouse effect distributed on habitat construction, and environmental profile for 1 m^2.

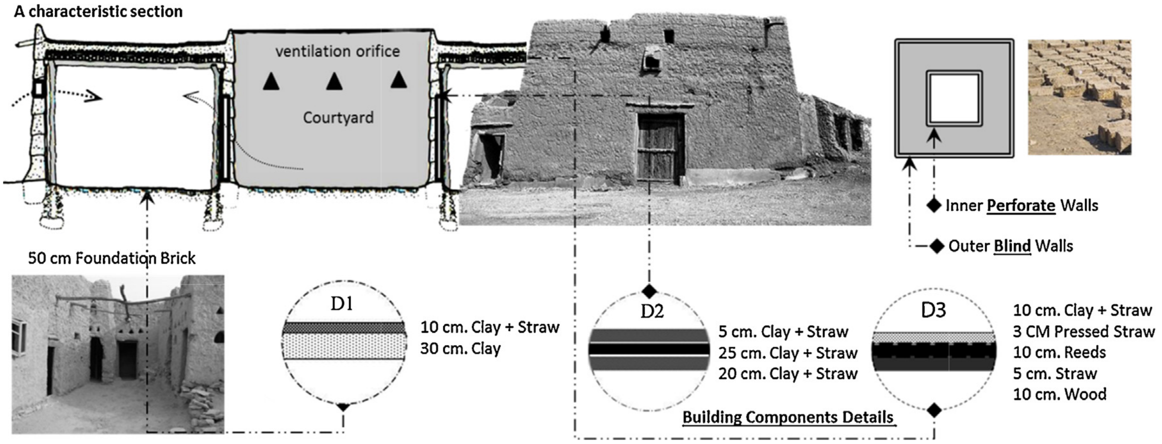

Fig. 11. A compositions clay and straw are main building materials from northern and Eastern part of Basra.

buildings may have a relatively short life as part of a nomadic existence. When abandoned, they will not leave anything unpleasant behind (Wenzel, 1996). The extraction of clay, especially on a site where a house is due to be created, is a zero-carbon solution for construction, and clay and straw walls and floors can be used as a direct substitute for mass concrete (Marchell and Leary, 1974).

The "Al-Zubeir House, Unit" building, in its architecture without architects, notes that inexperienced builders fitted their work to the local environment and topography. Basra's vast variety of environments and local microclimate assures a correspondingly wide range of a reply. The beauty of the "Al-Zubeir House Units" design derives less from self-conscious decorative attempts than from unadulterated, practical outlines produced by adapting regional material to be as economical as possible, resisting aggressive environmental elements and employing beneficial ones. Habitats from an Al-Zubeir district are truly vernacular, utilising only slightly altered material from its immediate surroundings. Rural, desert architecture is remarkable for its sculptural shapes achieved in clay.

5.3.2. Technical house description

In this zone, edifices have to be planned with great attention and thought and with due respect for climate. Shade and protection from dust storms may have the highest priority in some areas, whereas in other regions, ventilation and the trapping of air currents and breeze are the primary considerations (Kukreja, 1978) (see Fig. 11). The courtyard space is an essential element in the habitat from zone III, where all habitat functions are allocated together and are oriented towards the courtyard. Intimacy is necessary in cultural life. All primary functions are oriented towards the house courtyard directly. The unit involves just one level (Fig. 12).

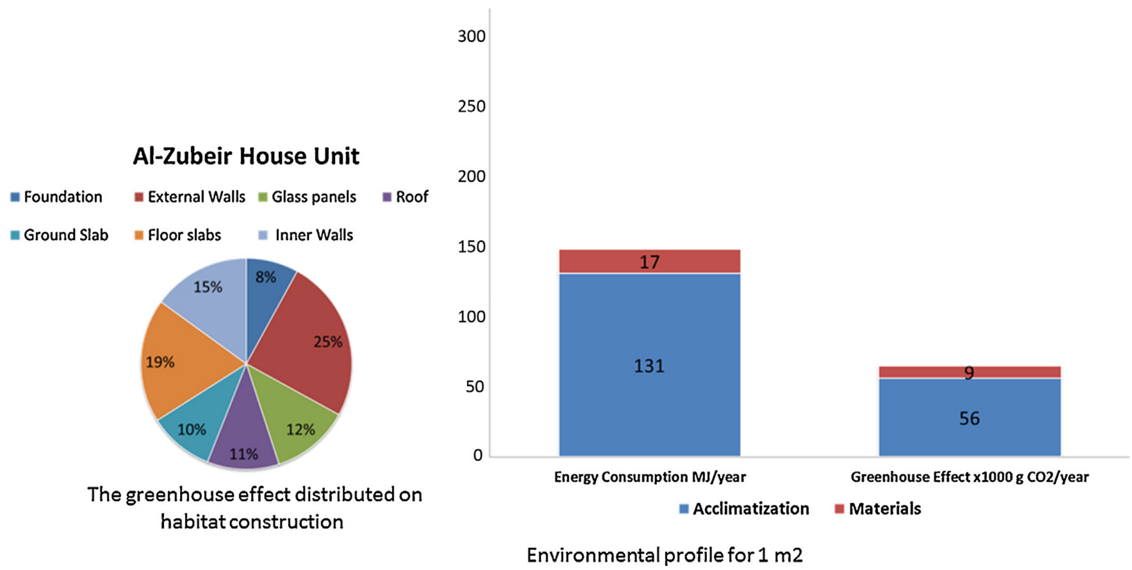

Fig. 12. The greenhouse effect distributed on habitat construction, and environmental profile for 1 m^2.

Table 4
The "Al-Zubeir House, Unit" compositions, areas and percentage.

External walls (52%) of total areas		Glass panels (1%) of total areas		Roof (14%) of total areas		Ground slab (16%) of total areas		Inner walls (12%) of total areas		Foundation (5%) of total areas	
Materials	Areas	Mat.	A	Mat.	A	Mat.	A	Mat.	A	Mat.	A
Clay and straw	100%	Wood	15%	Clay and straw	28%	Clay and straw	100%	Clay and straw	100%	Brick	100%
		Glass	85%	Pressed reeds	5%						
				Reeds	39%						
				Pressed reeds	7%						
				Wood	21%						

The habitat area of this edifice is of ca. 450 m^2, where the social area is 10%, the private area is 35%, and the courtyard is 55%. The building materials used in the conception of the house are as follows:

- The roof is made of the mixture of 10 cm of clay and straw, 3 cm of pressed straw, 10 cm of reeds, 5 cm of pressed straw and 10 cm of wood as a structural element
- The floor is made of a 30 cm layer of clay and eventually sand, as a solid base, and a 10 cm layer of clay and straw.
- The exterior wall is combined with an inner face layer of 3 cm special clay and straw, or 25 cm of clay and straw and the same inner face of 3 cm clay and straw.
- The interior wall is made of 15 cm clay and straw.
- The estimated life cycle is 50 years.

Habitat shapes vary from a rectangular plan and extension to the north to a square one. The conglomeration of buildings creates a progression of private space, which is enclosed by a clay wall; therefore, a courtyard is created by this process (Jensen, 1997). The system was developed for individual utility, free of fixed rules. Each building is oriented in relation to its neighbours.

5.3.3. House environmental impacts

The principal building material applied is clay and straw. Table 4 shows the different material used in house compositions and the percentage of materials in layers.

The house material components are environmentally friendly and better employed in energy-efficiency features.

6. Conclusion

Defining the qualities of an environment is neither easy nor absolute. They vary with time and change as people's expectations and education changes. Moreover, adapting to a new-architectural idea with a vernacular conception is difficult for many architects who have been educated in a culture that despises the aesthetics of what they see as 'twee' vernacular cottages. Incidentally, the aesthetic and functional housing opportunities remain innumerable and fun opportunities. Respect is given a high priority. Strategies to reduce environmental impacts can and should vary depending on the site. The selection of building materials is, overall, crucial because there is little difference in the material's environmental impacts and because they play a vital role both architecturally and in terms of the impact on the external environment near a residential use. For instance, the term "environmentally compatible" suggests that acceptable effects for humans and ecosystems can still be achieved with maximum amounts of emissions and limited contamination. This study discusses the requirements of building materials suitable for bio-climatic building in West Asia, where the meaning of the contemporary building category is an application of the bio-climatic concept, which is very complex. Everywhere, sustainable home thinking about the environmental impacts in the overall processes is implicit in houses.

Basra had three different microclimates (a marshland district, desert region and regular hot climate in the city centre). This study tries to investigate an existing habitat in the Iraq–Iran area that has different microclimates. Vernacular building materials such as clay, brick, straw and wood, are the most popular building materials used in this region. The Ecology of Building Materials is a challenge regarding the possibilities for existing materials and the evaluation of new materials. Nevertheless, a complete ecological structure does not exist. However, a building can always be made more ecological and less environmentally impactful. The principal conclusion of the study shows that:

i. The local microclimate directly influences the conformation of habitat. Therefore, the choice of building materials takes a high priority in the building process. Clay and straw, breeds, and brick are most frequently applied building materials.
ii. Natural materials were used efficiently in vernacular houses. It is clear that when insulating habitats; the interrelated environmental impact of the selection of insulation materials is not relevant compared to the savings in energy.

iii. Acclimatisation has a greater impact on the environment than building materials.
iv. Heavy materials (Bricks) used in the exterior or interior reduce energy requirements. In contrast, clay- and reed-based materials have a lower material-related environmental impact.
v. To support the meaning of the building in the residual value of the primary fabric, maintenance and repairs must be carried out on all components corresponding to their specific renewal cycles.
vi. For future research, the life cycle of building materials by focusing on the experiences of vernacular houses from this zone should be increased the create a creative intervention where innovative material can be used in new buildings with an increasing life cycle of current materials.
vii. Brick, clay and wooden constructions should be improved to occupy a more considerable place in our residential buildings than they do today.

The objective of the study is to assist architects and designers in selecting suitable solutions in terms of building materials. In addition to studying different building materials from various sources and their characteristic, it is necessary to adapt to traditional materials in modern, innovative applications and create a good solution in terms of building materials for West Asia specifically.

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