Sustainability of houses in Sahara

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PREFACE

This dissertation is part of the final examination for the Bachelor of Architectural Technology and Construction Management Education.

The project is proposed as an overall reflection of temporary settlements to resolve the problem of people displaced by situations resulting from natural disasters, armed conflict or otherwise trigger a forced relocation of a large group of people.

Nevertheless we used a particular case, a situation of political exile to do it more real.

Obtain information has not been too easy; if it considers that the place was going to be temporary.

In addition, some data could be different according to sources.

ABSTRACT

The report contains urban analysis from Algeria refugee camps and solutions to improve its urban organization to reduce as far as possible the level of instability.

To be conditioned by climate, resources, materials and habits from the desert. But, at the same time, taking benefits from them.

Build from sustainable way and follow the steps thinking about the desert in a place to protect.

Furthermore, behind urban level, the dissertation shows a small part of this world, that sometimes we forget. It contains:

- Brief introduction about refugee camps.
- Western Sahara conflict. To know its history, understand why they leave their country and in which conditions they are.
- Refugee Camps Analysis. Geography, climate, resources, organization, urban planning… each of them affects in great changes.

From my point of view, in these conditions, the architect's work will be more appreciated if provides the involvement of the population to achieve the highest degree of self-learning and self-sufficiency.

KEY WORDS:

sustainability, environmental, social, cultural, resources, economic, international aid, urbanism, infrastructure, provisional, improvement, self-sufficient

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1. PROBLEM STATEMENT

In my dissertation I am going to analyze one part of the world which sometimes is being forgotten. A country, where a lot of people were exiled and were forced to live in Algeria's desert, knowing as Sahara.

Those people live in the refugee camps where the summer temperature exceeds more than 50 degrees in the shade and in winter it is freezing cold.

I would like to show how to improve their habitability in a sustainable way, in a place where they can not find anything else besides sand.

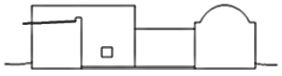
I'm going to use different research methods:

- my own observation, I was there twice and I think it could be an important reference,
- analysis of what other people have researched or documented,
- facts

To achieve my main goal, I will focus on some relevant issues:

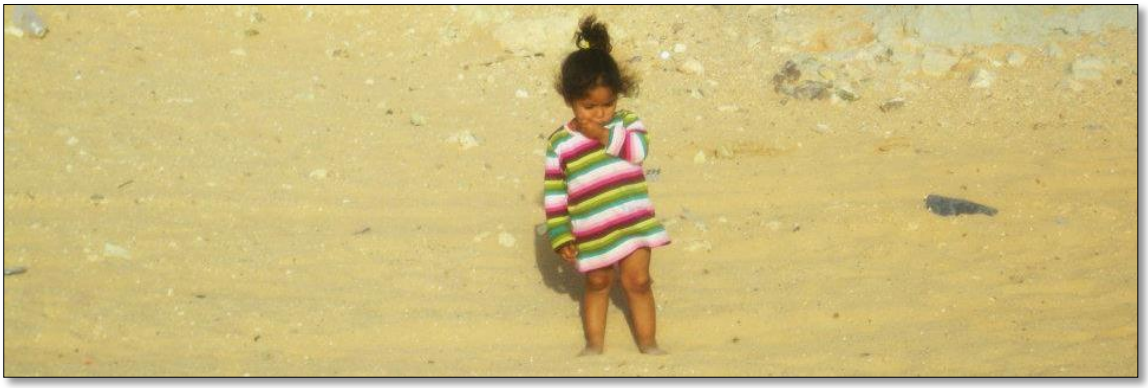
- History of the territory and its people, to understand why are they living in the desert? And why aren't they in their country?
- Actual Situation
    - Area analysis
    - Everyday life (People, their culture, how do they live?)
- Urbanism analysis
    - How do the villages look like?
    - How they are organized (districts, villages, quarters…)?
- Houses analysis
    - Materials
    - Shapes
    - Services
    - …

Once I have analyzed their habitability I will try to improve self-construction habits of the camps and urban service networks from a point of view sustainable and thinking about the desert environment as a place to protect.



2. MAIN SECTION

2.1. REFUGEE CAMPS



Picture 1. Child in 27th of February camp, Tindouf

A refugee camp is a human settlement where a group of people live, for an indeterminate period of time, forcibly displaced from their habitual residence. There is international humanitarian aid, mainly in the form of food, shelter and medical care but possibly there is not clean drinking water or access to health care that prevents outbreaks of cholera, dysentery, hepatitis, malaria, and other diseases. There are about 20 million refugees worldwide, and 9 million of them are children. Data, as always, might be different depending on the source you are checking. Also, the time spent in the camps is very variable. In Albania, Kosovo refugees lived in camps for only three months, while the Somali refugees have been living in camps in Kenya since 1991. The of Jallozai, Pakistan, was formed from the Soviet invasion in the 80s. And Tindouf, in Sahara, was formed over thirty years ago.

And thirty years is a long period of time.

I will sum up with a quote from millionsoulsaware.org: **"This is a refugee camp, a place that not one of us would willingly choose to inhabit."**

Picture 2.

Daadab camps, Kenya.
The biggest refugee camp in the world, more than 450.000 refugees

Picture 3.

Daadab camps, Kenya.
Thomas Mukaya

Picture 4.

Somali refugees drink water

Picture 5.

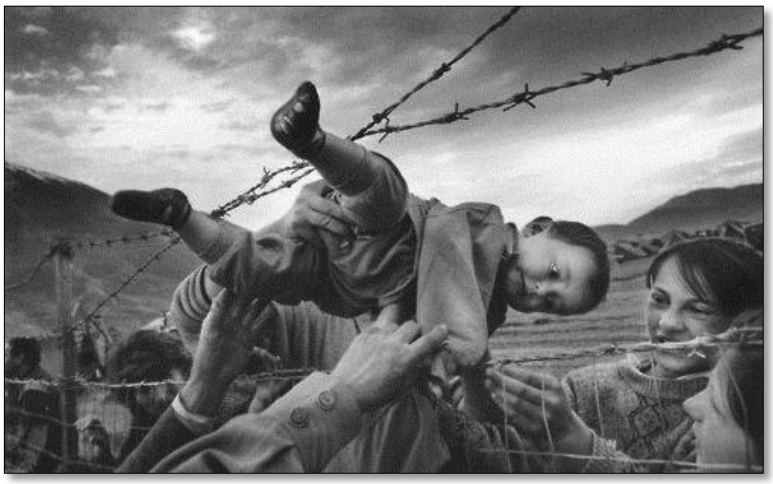
Jallozai, Pakistan.

Picture 6.

Peshawar, Pakistan.

Picture 7.

27th of February, Tindouf.



Picture 8.

Child meets with his parents.
Carol Guzy.

This is the picture winning Pulitzer Prize, taken (in May 99) in refugee camps in Kosovo, by Washington Post reporter Carol Guzy. Guzy's camera caught the moment when a two year old child, Agim Shala, met with its parents on Albania border.

2.2. WESTERN SAHARA GEOGRAPHY

Western Sahara is an African territory, located in the horizontal edge of the Sahara Desert, along the Atlantic Ocean.

Western Sahara includes Saguia el-Hamra in the north and Wadi ed Dahab (Rio de Oro) in the south. Its area with around 280.000 Km². Is one tenth the size of Algeria, half the size of France and just a little bit smaller than Italy. It lies between the 20th and 30th parallel in the Tropic of Cancer. It is bordered by Morocco to the north, Algeria to the northeast, Mauritania to the east and south and the Atlantic Ocean to the west.

Figure 1. Africa Map

RESOURCES

- MINING INDUSTRY
  It is known that in 1947 the discovery of phosphates in Bou Craa gave then Spanish Sahara great economic importance.

  Phosphate mines Bucraa, open, are the largest in the world.

  It has detected uranium, oil, gas, lead, titanium, gold and zinc.

- FISHING
  Its Atlantic coastline is among the richest fishing areas in the world.

Figure 2. Western Sahara Politic Map

2.3. HISTORY

The history of the people who inhabit Western Sahara goes back hundreds of years. In XIth century, a confederation of tribes, "veiled Sanhaja", formed the Almoravid State. The Almoravids left the Sahara to go north where they conquered Morocco. Then one part of them crossed the Mediterranean, invaded Andalusia, settling in large parts of Spain. They founded Marrakesh and other cities and there was a great flowering of culture during their reign. However they lost contact with the country of their origin and their former way of life.

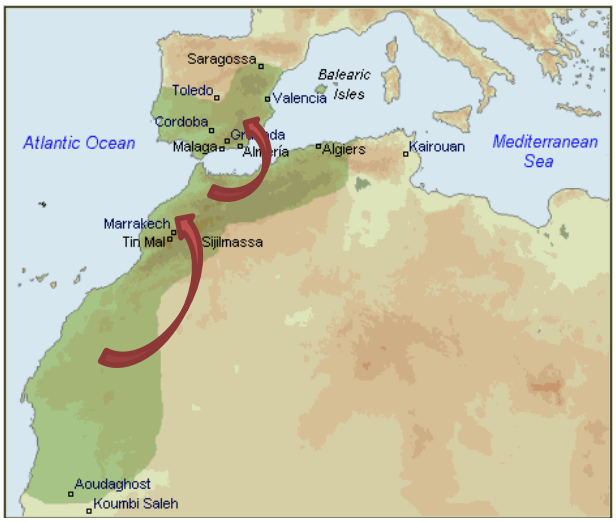


Figure 3. Large extent of the Almoravid Empire

Direct ancestors of the present-day Saharawi were tribes which came from the Yemen in the XVth century. They crossed North Africa and established themselves in the region of Western Sahara.

Because of low, irregular rainfall, the region was inhabited basically by nomadic tribes. They lived by pasturing animals and growing crops where possible. Their religion was Islam, their law was based on custom and the Koran. Ethnically and culturally they were different from the populations around them, they moved across the desert on more or less regular routes, dictated by seasons, wells, waterholes.

Saharawi society, like many others in Africa at that time, was a tribal society, but it had some specific characteristics. For example, it was governed by an Assembly of Forty, each of whom represented one of the Saharawi tribes (in contrast with his neighbours, for example Morocco, where there was a hereditary monarch with absolute powers, or Mauritania, where it was the strongest tribe which imposed tribute on the weaker tribes and, in general, dominated them).

During XIXth century, relationships with Spain were mostly limited to questions concerning fishermen from the Canary Islands: in fact Spanish interest in the territory was principally determined by desire to protect the Canary Archipelago. From time to time Spain was forced to negotiate with the chieftains of the area to obtain the restitution of its sailors. In 1884, to ensure its domination, Spain proclaimed a protectorate from Cape Blanc to Cape Bojador. In the Berlin Conference, which set led the partition of Africa between the European powers, ratified this proclamation and Spain seized the control of The Western Sahara. The Saharawi people opposed the Spanish forces.

Figure 4. Canary Islands, Cape Bojador and Cape Blanco

In the meantime, France had become the dominant power in North-West Africa and wished to extend its possessions still further. In 1886, negotiations were started, to define frontiers between French and Spanish zones. These continued until 1900, when the first Franco-Spanish secret treaty was signed, to be followed by further secret agreements in 1904 and 1912.

In 1934, Western Sahara was established as a Spanish colony.

During the 1950s and 1960s, when so many African countries began to accede to their political independence, the question of the Spanish Sahara was first on the agenda of the United Nations. The argument for the liberation of the territory was based on the UN General Assembly Resolution 1514 (XV) of 1960, the Declaration of the Granting of Independence to Colonial Countries and Peoples.

After Morocco independence, this claimed Sahara territory. And also Mauritania joined territorial claims.

In 1966, United Nations recommended the Western Sahara decolonization.

While that, started the nationalist agitation. It was in 1967 that struggle began to take organized form with the creation of the Movement for the Liberation of the Sahara.

An intensive campaign to mobilize Saharawi people on behalf of their independence led to a massive demonstration in 1970. Spaniards reacted by massacring the demonstrators and dissolving the liberation movement.

On 10 th of May in 1973, Constitutive Congress for the Front for the Liberation of Saguia el Hamra and Rio de Oro, known as the POLISARIO Front, was held. And it started the fight against Spain.

On 6th of November in 1975, Green March into Western Sahara began when 350.000 unarmed Moroccans converged on the city of Tarfaya in southern Morocco and waited for a signal from King Hassan II of Morocco to cross the border in a peaceful march. A few days before, on 31st of October, Moroccan troops invaded Western Sahara from the northwest.

In the waning days of General Franco's rule and after Green March, Spanish government signed with Morocco and Mauritania as it moved to transfer the Territory on 14th of November in 1975, "Madrid Accords".

On 26th of February in 1976 Spain left Sahara territory, and then Polisario Front (supported by Algeria) proclaimed Sahrawi Arab Democratic Republic (SADR) and started a liberation war for his territory against this two countries.

In 1979, following Mauritania's withdrawal due to pressure from Polisario, including a bombardment of its capital and other economic targets by the Polisario, Morocco extended its control to the rest of the territory. Morocco bombed Saharawi people with napalm and white phosphorous in order to commit genocide, which caused the flight of many Sahrawi to the desert.

In 1980 it was conducted setting up the extensive sand-berm in the desert (known as the Border Wall or Moroccan Wall).

Since then Western Sahara territory is divided by a wall or berm over 2,000 km long from north to south. It is formed by a series of sand barriers of two or more meters protected by minefields. Every 5 km there is a fortification. The wall remains guarded by more than 150,000 Moroccan

Figure 5. Border Wall

soldiers, all that for a cost of over a million and a half euros per day. Area west of the wall is militarily occupied territory by Morocco, while area east of the wall is territory administered by the Polisario, over which it exercises sovereignty SADR.

Picture 10. Border Wall

In 1991, Morocco and Polisario Front signed a “ceasefire” sponsored by the UN that it established Mission by United Nations for the Referendum in Western Sahara (MINURSO), to be held in February 1992. The aim was to "organize and conduct a referendum in which people of Western Sahara had the opportunity to decide the future status of the territory”.

In 1992 it hasn’t celebrated the Referendum.

To break the deadlock in peace process, United Nations appointed James Baker as Personal Envoy of the Secretary General of the United Nations for Western Sahara, with the aim of establishing a dialogue with the warring parties to proceed with the immediate implementation of the "Plan of Arrangement" and hold the referendum provided for therein. Fruit of the encounters are signed Houston Agreements, establishing a specific timetable for various stages of the process of decolonization of Western Sahara.

To this day it hasn’t concluded the Referendum. While the Polisario understands that people should vote in 1975 over their descendants, Morocco wants to include people who migrated to the area (encouraged by the government itself) which is why referendum is pending.

However, as it has been described some organizations, pressures of the kingdom of Morocco which is considered strongest part in both the military and the political, have prevented the referendum on self-determination for Saharawi people.

According to a report commissioned by Security Council to the Legal Counsel of United Nations, “Madrid Accords” didn't become Morocco or Mauritania like territory administering powers, so this is still, in law, a dependent territory.

Legal status of the territory and the sovereignty issue are still to be resolved. It is mostly under Morocco control. The rest is controlled by Sahrawi Arab Democratic

Republic (SADR). SADR is recognized by the African Union and 81 countries around the world, mostly in Africa and Latin America.

Saharawi population is separated in three different areas:

A) Occupied Territory

B) Liberated Territories

C) Refugee Camps

Territory between sea and wall, controlled by Morocco, is called "occupied territory". Sahrawi population living there suffer constant abuse and human rights violations by Moroccan government.

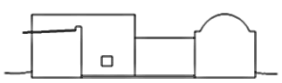
Beyond the wall, and to the border with Mauritania, territory is under control of Polisario Front, in what they call "liberated territories".

Refugee camps are on Algerian territory, and are managed according to international aid.

Why a normal decolonization process turned into a desperate struggle for survival, both of the people and of their country?

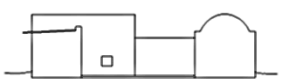
Main reasons are, as so often happens, economic and strategic. Western Sahara is rich in mineral deposits, especially phosphates, uranium, iron, natural gas and oil. The fishing grounds are also very rich.

Seen in this perspective it’s easier to understand all the obstructions, both open and concealed, that are being put in the way of the Saharawi struggle for self-determination.



2.4. CHRONOLOGICAL SCHEME OF WESTERN SAHARA HISTORY

DATE	FACT
1884	Spain proclaims a protectorate from Cape Blanc to Cape Bojador Start Spain colonization in Western Sahara
1934	Western Sahara is established as a Spanish colony
1950-1960	African countries begin to accede political independence
1960	UN General Assembly Resolution 1514 (XV) Declaration of the Granting of Independence to Colonial countries and People
1966	United Nations recommend Western Sahara decolonization
1973	Constitutive Congress for the Front for the Liberation of Saguia el Hamra and Rio de Oro (POLISARIO Front)
1975	Green March Moroccan troops invade Western Sahara from northwest
	"Madrid Accord" Secret accord, Spanish government sign with Morocco and Mauritania to transfer the territory
1976	Spain leaves Sahara territory
	RASD POLISARIO Front proclaims Arabian Republic Democratic Saharawi
1979	Follow Mauritania Morocco extends its control to the rest of the territory
1980	Border Wall – Moroccan Wall Western Sahara is divided by a wall from north to south
1984	RASD is recognized by African Union
1991	"Ceasefire" UN establishes Mission by United Nations for the Referendum in Western Sahara (MINURSO) to date in 1992
1992	No Referendum
1997	James Baker as Personal Envoy of the Secretary General of the United Nations for Western Sahara to proceed "Plan of Arrangement"
…	Negotiations Any accord between Morocco and POLISARIO front
2012	It hasn't concluded the Referendum



2.5. SAHARAWI REFUGEE CAMPS

2.5.1. GEOGRAPHY

Moroccan invasion forced most of the Saharawi people to flee into exile. Brutally persecuted, established in territory ceded by Algeria. There they wait 35 years to return to their land.

Refugee camps are located in south-western Algeria, in Hamada of Tindouf, the most inhospitable Sahara desert. Refugees are mostly women and children. An estimated 200,000 people live in refugee camps, but the exact number varies depending on the source.

Picture 6. Africa Map, Algeria

2.5.2. CLIMATE

In this area of the desert summer temperatures in the shade can reach 55ºC. And frequent sand storms disrupt normal life.

It is classified as desert climate. Warm temperatures and very low and erratic rainfall.

To further define the climatic characteristics of the area it has been used data from a study by Galician and Asturian associations of EWB from Spain.

Picture 7. Tindouf, Algeria

There are monthly and annual climatic values from 1994 to 2004.

The main data are summarized in Table 1, which represent the monthly average values of the following parameters:

- T = monthly and annual average temperatures (º C)
- P = total monthly and annual rainfall (mm)
- V = monthly average wind speed m / s)
- I = monthly average sunshine (hours)
- K = correction factor in potential evapotranspiration function of latitude (Viers and Vigueau, 1990)

- ETP = potential evapotranspiration (mm)

	Ene.	Febr.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sept.	Oct.	Nov.	Dic.	Anual
T (ºC)	13.20	15.9	19.5	22.2	25.2	30.1	34.7	34.4	29.8	24	18.1	14.3	23.45
P (mm)	1.02	5.78	2.94	0.15	0.50	0.27	0.21	3.86	1.65	20.62	0.75	4.59	42.35
v (m/s)	4.3	5	5.4	6.5	6.8	6.5	5.5	5.2	5.6	4.9	4.1	4.3	5.34
I (h)	8.7	9.3	9.4	10.9	11.7	10.9	10	9.7	8.9	8.8	8.8	8.2	9.39
K	0.87	0.93	1	1.07	1.14	1.17	1.16	1.11	1.03	0.96	0.89	0.85	
ETP (mm)	14.13	17.13	21.16	24.72	28.71	33.23	36.29	34.52	29.06	23.39	17.90	14.57	294.81

Table1. Climatic values from 1994 to 2004 in Tindouf (Algeria).

As shown in Gaussen diagram (Figure 8), the low rainfalls in the area are concentrated in the autumn and winter, especially in the months of October and February.

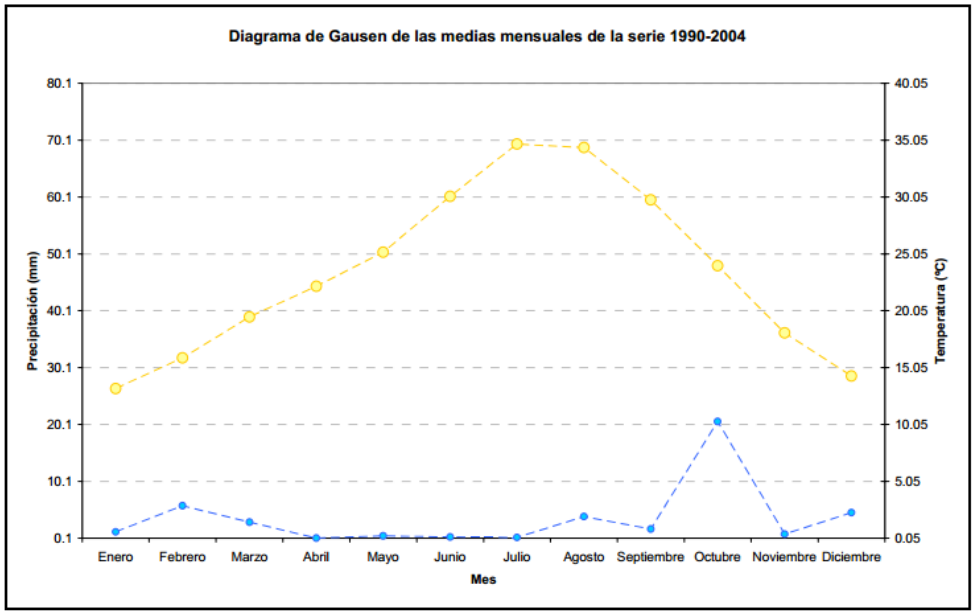


Figure8. Gaussen diagram, average temperature data (yellow) and precipitation (blue) of the series from 1990 to 2004 in Tindouf.

Dry months are considered those in which the rainfall in mm is less than twice the value of the average temperature in °C (Gaussen, 1954). So every month of the year is dry in Tindouf (Figure 8).

Figure 9 shows the monthly average precipitation from 1994 to 2004, great irregularity between different years.

Strangest rainfalls were in October of 1994 (173.5 mm) and 2004 (74 mm). To these are added heavy rains between February of 2006, and in October of 2008. These torrential rains caused extensive damage in the Saharawi refugee camps.

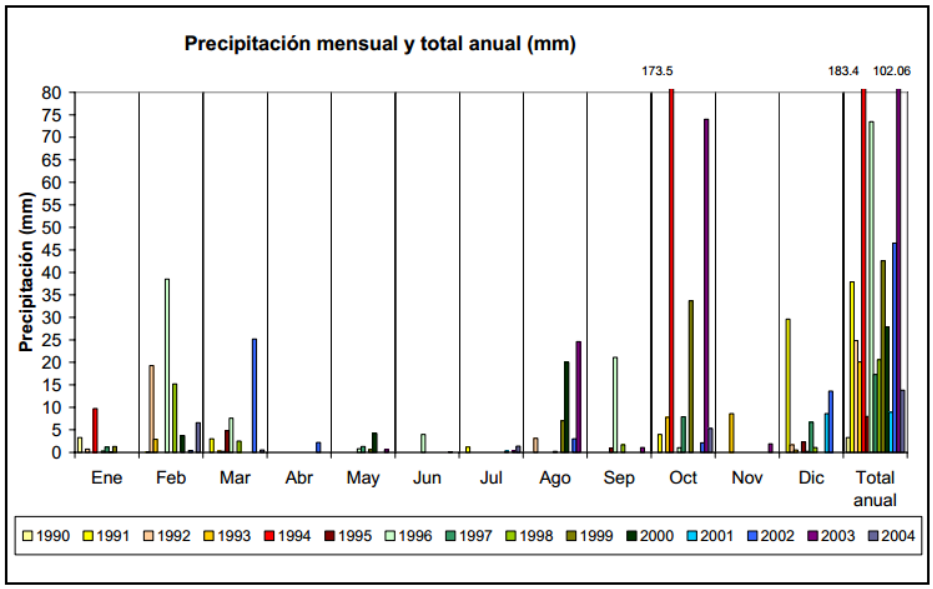


Figure9. Monthly average precipitation (mm), from 1990 to 2004 in Tindouf.

2.5.3. LIVING IN REFUGEE CAMPS

2.5.3.1. URBAN ORGANIZATION

Nowadays, Saharawi population refugee in Tindouf camps are divided in 4 districts (WILAYA) bearing the name of El Ayoun, the capital of Western Sahara; Smara, the sacred town; Dahla, the largest port and Aousserd, a little town in the interior of the country.

Each camp is subdivided into 6 or 7 villages (DAIRA), each village into 4 quarters.

WILAYA	EL AYOUN	AOUSSERD	SMARA	DAHLA
DAIRA	Amgala	Zug	Farsia	Bir- enzaran
DAIRA	Dchera	Miyec	Mahbes	Ain- beida
DAIRA	Daora	Bir- ganduz	Bir- lehlu	Gleibat- elfula
DAIRA	Hagunía	Lagüera	Tifariti	Bojador
DAIRA	Guelta	Tichla	Meheriz	Um-dreiga
DAIRA	Bucraa	Agüenit	Hausa	Argub
DAIRA			Ydería	Yerefía

Around 40,000 refugees live in each district (WILAYA), and between 5,000 and 7,000 in each village (DAIRA).

There are two general hospitals, two secondary schools (12th of October and 9th of June), a school for women (27th of February) and a poultry-farming complex.

Actually, 27th of February (day which proclaimed SADR), began as a school but now forms a large camp with settled population and it grows for be the only one district with electricity.

The central administrative complex is located in Rabuni (ministries, police, managing international cooperation organizations…).

All camps and centers are located near the Algerian city of Tindouf, between 20-50 km distance, except Dahla is located 200 km further south.

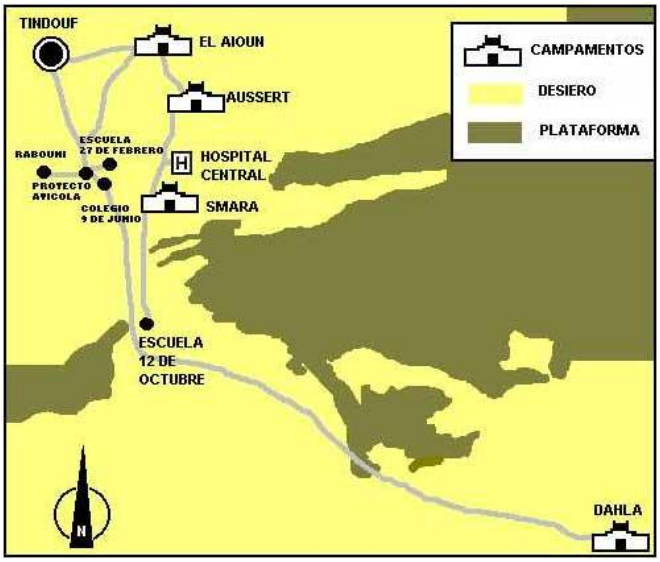


Figure 10. Refugee Camps Organization

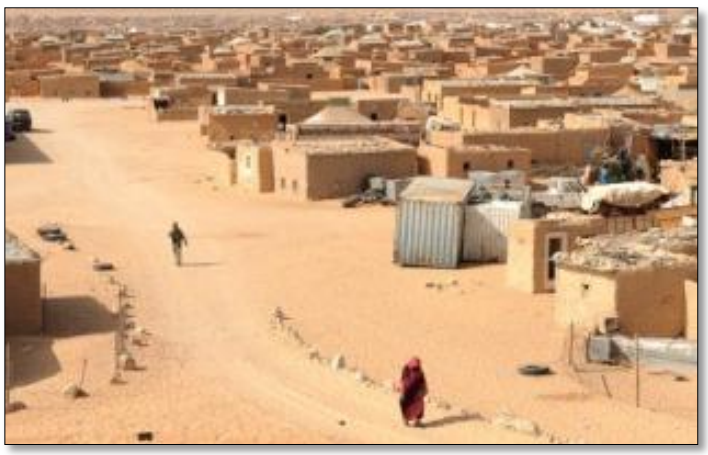
Each district has a regional hospital, a regional school and a

small orchard (except Aousserd, there aren't orchard). They also have a health centre and a nursery for village.

Communication between districts and villages are tracks and paths. There is only one road between Tindouf and Rabuni central reception, and between this and Smara district. There is a military airport in Tindouf.

Picture 11. Communication to Rabuni

Picture 12. Communication between districts



Picture 13. Communication inside districts

Refugee camps were created by hard women work. When Saharawi people fled to Algerian, men were fighting in war, so it was women who took over raising the camps and a whole operating structure.

From an organizational point of view, all adults living in the camps have to belong to one of the five committees. These committees are:

1. Health Committee: It is composed of two subcommittees, one of professional assistance function and other preventive health; it is responsible for issues related to drinking water, the environment, etc.

2. Education Committee: A turn is divided into two subcommittees, one is responsible for issues of nursery and primary schools and one is responsible for issues related to the welfare of children and adult literacy.

3. Supply Committee: It deals with the distribution of food, clothing, tents, gas, etc.

4. Committee for Economic Development or Production: Responsible for overall production, mainly crafts.

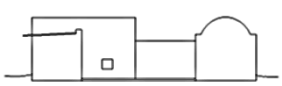
5. Committee on Justice and Social Affairs: Addresses social problems in the village (marriages, divorces, etc..).

2.5.3.2. POLITICAL ORGANIZATION

The Saharawi Arab Democratic Republic (SADR) created Ministries to manage the camps.

Currently there are the Ministries of Transport, Development, Health, Education, Justice, Commerce, Foreign Affairs and Defence, responsible for handling all aspects of daily life in the camps.

1. At Daira level: In each Daira exist Councils that are responsible for the administration of the Daira and consists of: a President (Mayor), a judge, a deputy and the presidents of the five committees (women fully).
2. At the level of the Wilaya: There is a Popular Council composed of Presidents of the Councils of Daira, the Directors of the Departments Specializing in Health, Education, Supplies, Production Justice and Social (appointed by each ministry), and Governor (Wali) appointed by the Minister of Interior.



2.5.3.3. POPULATION

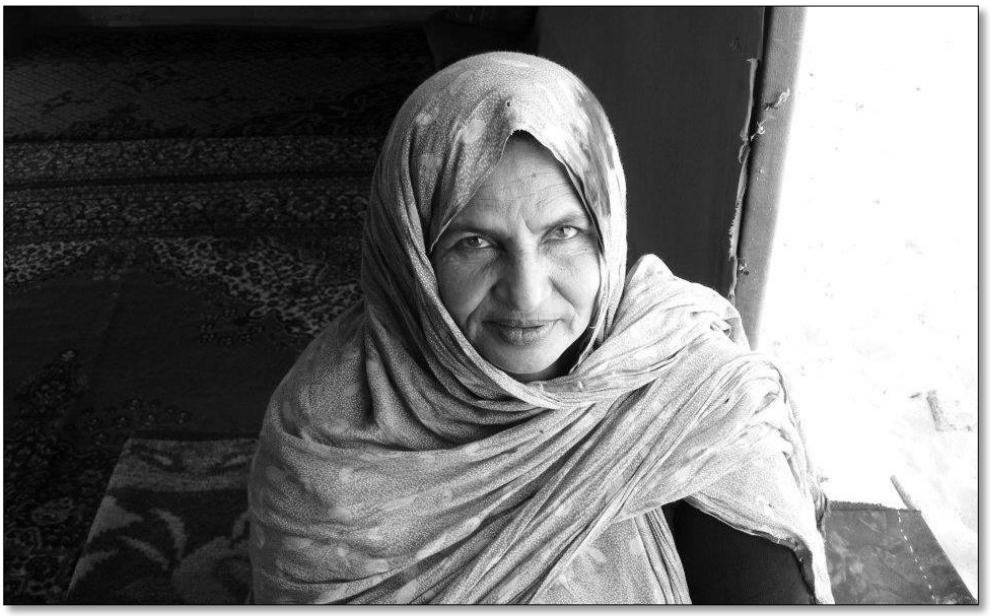
An estimated 200,000 people live in refugee camps, but exact number varies depending on the source.

Camps are inhabited mostly by women, children and elderly, because most of men are in charge of the liberated territories, a few kilometres from the walls.

Woman is foundation of this society.

This is a population who gives special importance to women training. For example, learning about agriculture and production, women take charge of almost all social and economic life of the camps. Many have been trained to become assistant nurses for helping in clinics, and a significant number of students are being trained abroad.

They have an exclusive school for women, with training programs, short-term for camp management and long-term for future requirements of the Saharawi state.



Picture 14. Saharawi woman

2.5.3.4. EDUCATION

Schooling rate: In ten years it has gone of illiteracy rate of 73% to the total schooling of the population between 3-16 years.

Educational structure:

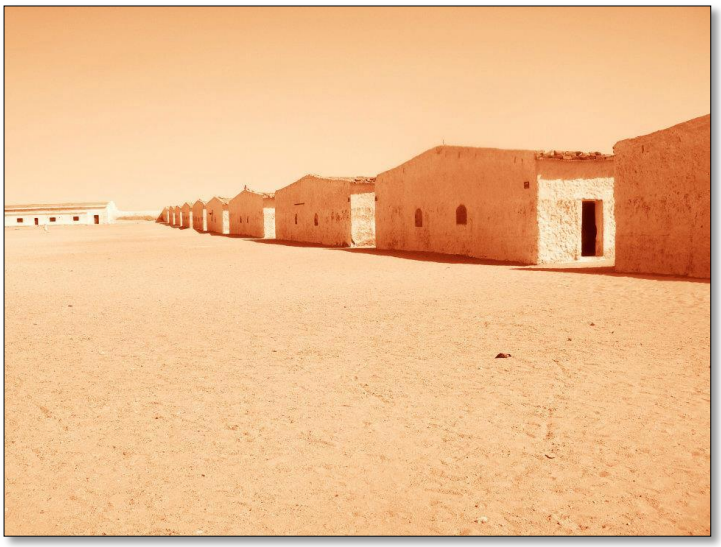
- Nursery: 3-6 years, there are in each village (DAIRA)
- Elementary School: 7-13 years, there are in each district (WILAYA)
- Secondary School: 13-16 years, there are two boarding schools, 9th of June and 12th of October
- University education and higher education: in countries as Algeria, Libya or Cuba. They welcome Saharawi students. It depends on international agreements.
- Special Education: A boarding school for physically handicapped youth, mostly victims of bombings or polio.
- 27th of February School for female education.

Picture 15. Children in Elementary School

Picture 16. Girl in 9th of June Secondary School

Picture 17.

9th of June Secondary School



Picture 18. Classrooms

9th of June Secondary School

Picture 19. Dining room

12th of June Secondary School

2.5.3.5. HEALTH

Health structure:

- Health Committee: three main functions
  - Monitoring maternal and child health
  - Prevention of environmental hygiene
  - Dispensary dependent group (10 women supervised by a nurse) is responsible for visiting the sick in his tent and control the medication.

- Health Centre: There is one in each village (DAIRA) and each internee. They consist of a waiting room, a consultation room and a pharmacy store. Lack of diagnostic tools and have few medicines.

- Regional Hospital: One in each district (WILAYA) and is organized into three units
  - general medicine
  - pediatrics
  - obstetrics and gynecology

  They have a capacity of between 30 and 50 beds

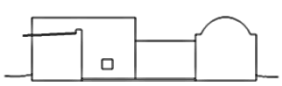
- National Hospitals: “Martir Bachir Salah” coordinated with Wilaya hospital. It is 10 km from the El Ayoun, Smara and Aousserd. It offers services in pediatrics, general medicine, gynecology, obstetrics and surgical ward. Military hospital "Bal-La" from the 1991 ceasefire, was made available to civilians. The major specialties are serving traumatology and rehabilitation.

- Health Ministry: Its main functions are planning and control of the activity and health structure at various levels. It is divided into five divisions: prevention, care, management, evacuation and cooperation.

Population health condition:

Main problems faced are maternal and child malnutrition, high prevalence of iron deficiency anaemia in pregnant women, poor delivery care, and difficulties of maintaining the cold chain and preserve vaccines.

Major reasons for admission to hospital of districts (Wilaya) are diarrhea, respiratory infections and childbirth.



National Hospital revenues frequently are due to disease respiratory, or abdominal surgical, but highest percentage of income are women with complicated deliveries and children with severe diarrhea and severe dehydration.

Picture 20. Aousserd Regional Hospital

Picture 21. Aid worker visits sick people

Deserted rooms, rusty stretchers, outdated equipment... Nor severe cases can be addressed here. In an emergency, the only hospital ambulance must transport the patient to the Algerian city of Tindouf.

Picture 22. Martir Bachir Salah National Hospital

2.5.3.6. LIVING CONDITIONS

Living conditions are hard. No resources, there is practically no food and the population is almost entirely dependent on international aid.

a) Feading

In each village (DAIRA) exist food supply Committees. Each family receives a monthly amount of basic foods depending on the number of members (sugar, tea, flour, rice, lentils, milk powder, ...). The cast is made by the elderly and female heads Supply Committee each Daira.

Saharawi Red Crescent organizes and directs all international aid from UNHCR, World Food Programme, EU, NGOs.

The daily diet is established:

- 300 grams of flour per person per day.
- 50 grams of barley.
- 50 grams of pulses.
- 30 grams of milk, 20 pastas, 7 tea.
- For children: 100 grams of milk and 50 grain

They also consume goat milk products as ordered by them, goat and camel meat, and have a poultry farm that supplied eggs and chicken meat.

Furthermore each district has small orchard (except Aousserd)

Picture 23. Poultry farm

Picture 24. Dahla orchard

b) Drinking water

Domestic water, from wells (which has drinkable process), is distributed through tankers which leave in small metal tanks located scattered in the camps. However, it's recommended to Europeans that don't drink it.It has well bottled mineral water from the city of Tindouf that mainly used to feed babies.
(More information 2.5.3.8.)

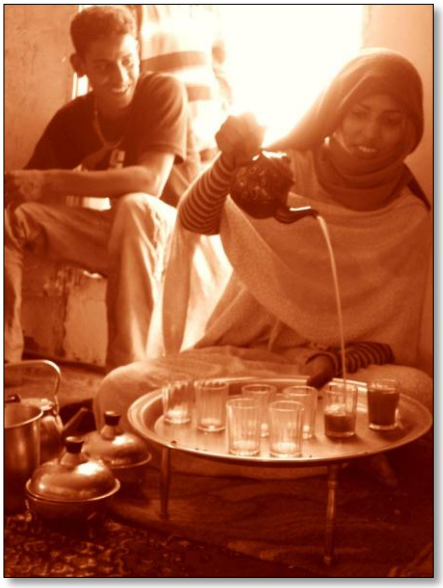
Picture 25. Metal tanks

c) Energy sources: PhotoVoltaic Solar Panels

Some families have plates (present in many cases of Spanish families) that collect solar energy which is then used to light their homes and other activities.

2.5.3.7. NORMAL DAY

Normal woman day starts with prayers and then kneaded bread or preparing tea. Children under twelve attend classes at school and older are enrolled in some of the internees.
Many women leave the tents when the kids and head to the many tasks assigned to them: kindergartens, schools, clinics, work on committees, etc.. Just around dealing with food preparation.
Carrying water for domestic use is one of the tasks assigned to women. Water is transported in drums to tents. In general, the camps are managed by women.



Picture 26. Women preparing tea

Picture 27 and 28. Man taking care goats

2.5.3.8. WATER

Contrary to what it could be expected a priory, the amount of available water does not represent a major problem for the water supply system. Main problem relies on water quality aspects.

Water consumed by the refugee population is groundwater obtained by pumping in boreholes located on the outskirts of the camps.

Given the extreme climatic conditions of the area, the survival of the population depends directly on the groundwater supply. This work is undertaken by the Department of Hydraulics of the Saharawi Arab Democratic Republic (SADR).

The groundwater in the area has been taken since the arrival of refugees in 1976, reaching a finding of 15 boreholes of exploitation, of which 11 are used at present. And has been verified existence of at least four different aquifer units.

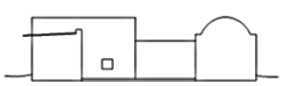
Until 2001 water exploited from wells was distributed to populated areas by tankers crossing the desert, carrying the water directly from the wells to family tanks. Over the years and given the political stalemate in conflict resolution, this system has been gradually replaced by more efficient methods, by storing water in larger capacity removable tanks communicated to extraction wells in buried pipelines. And by tankers water is distributed to the village.

Of the 11 wells exploited in the camps, 6 are used for human consumption and the remaining 5 to irrigate orchards or hygiene in schools and hospitals. To supply human consumption, there are three main centers to pumping and supply:

3. To supply water to Aousserd and Al Ayoune (Figure x).
   These camps are supplied together from wells LF-3, LF-4, HT-13 and HT-12-Bis located in Al Ayoune.

4. To supply water to Smara, 27 of February and Rabouni.
   There are supplied from SA-10 well, located in the proximity of Rabouni (Figure X).

5. To supply water to Dahla by OBL-2 well (Figure X) that captures deep water outside the camp.



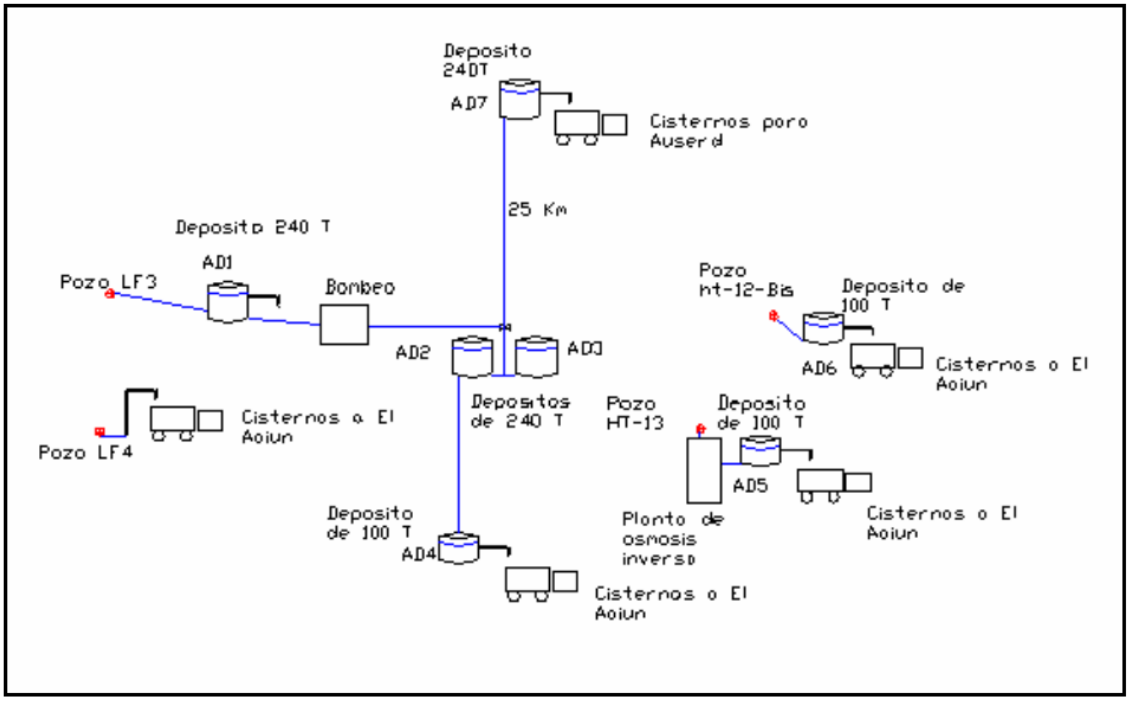


Figure 11. Operating and supply water sketch for Al Ayoune and Aousserd wilaya.

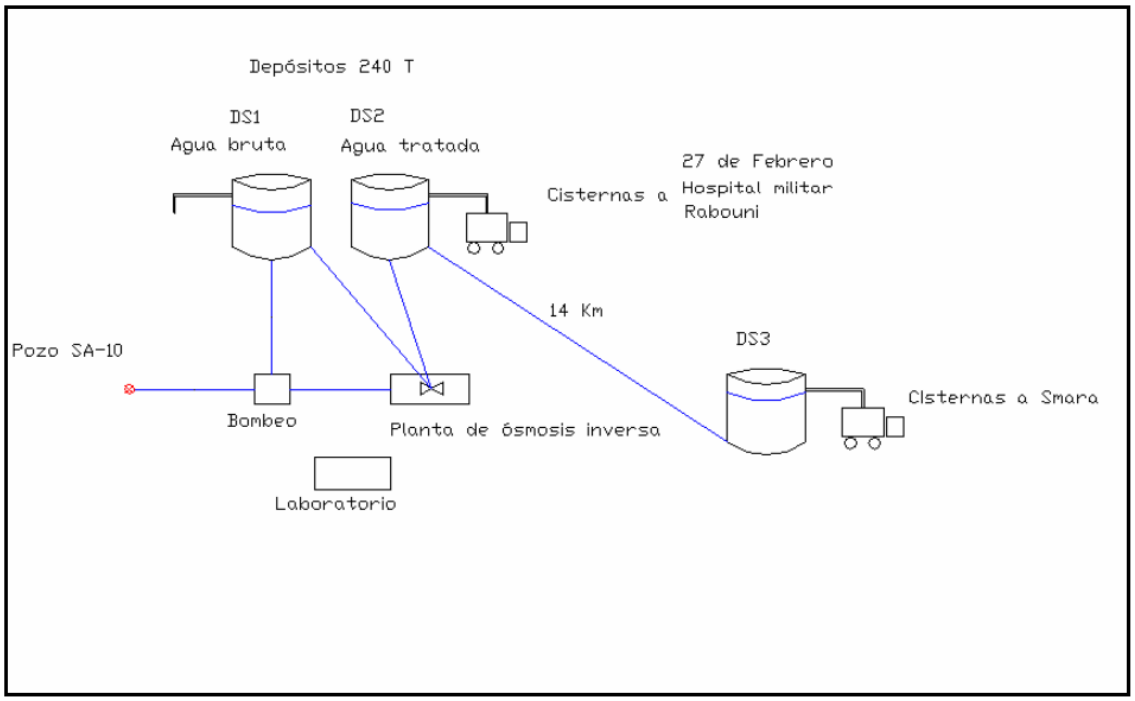


Figure 12. Operating and supply water sketch for Smara, 27th of February and Rabouni.

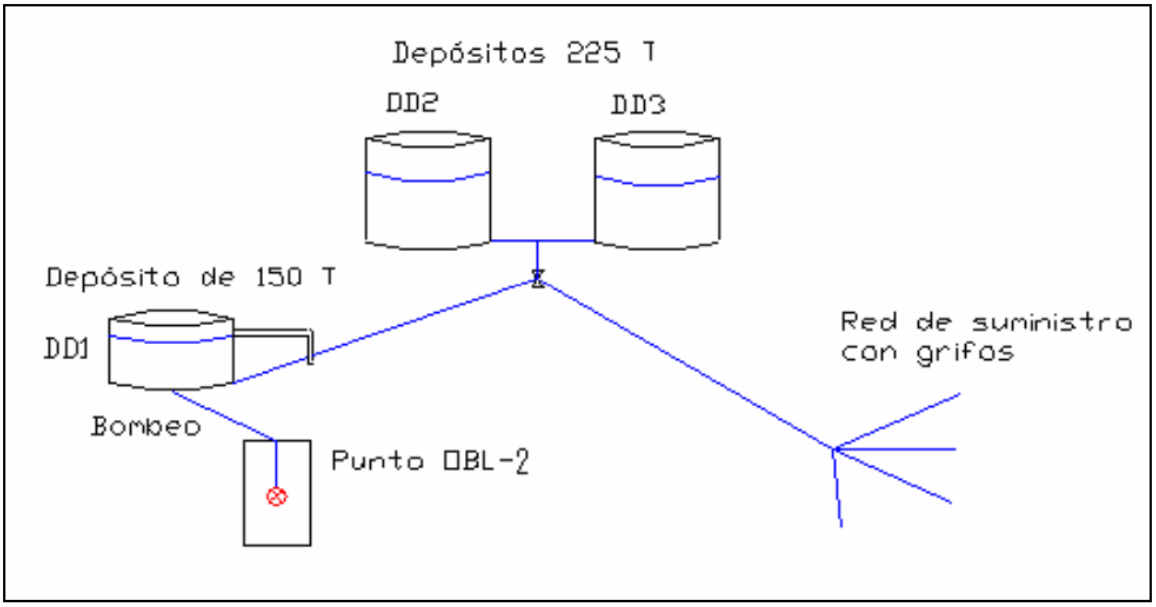


Figure 13. Operating and supply water sketch for Dahla.

According to a study by Galician and Asturian associations of EWB from Spain "Study on the groundwater resources assessment in the vicinity of Tindouf city (Algeria)" with current endowments exist water reserves for several thousand years .

The main problem of supplies with groundwater quality is the same. North aquifers have high salinities and some wells exceed concentrations of fluoride recommended by international health regulations. This is cause responsible for the high incidence of cardiovascular disease, as well as cases of dental fluorosis.

There are high concentrations of nitrates in the aquifers more exploited.

Furthermore the permanence of the refugee population without adequate sanitation systems for over 30 years has ended up contaminating groundwater.

2.5.3.9. DATA COLLECTION

Next drawings show schematically the organization of camps.

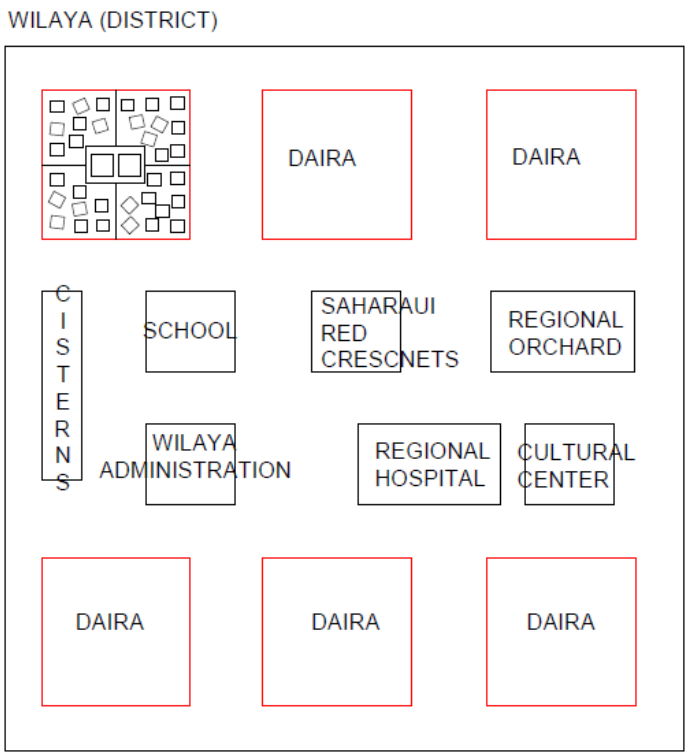


Figure14. District scheme

Tindouf camps are divided in 5 districts (WILAYA).

Each camp is subdivided into 6 or 7 villages (DAIRA).

There are several smaller fields instead of one massive.

In addition, each district has:

a) Elementary school
b) Regional Hospital
c) Regional Orchard
d) Wilaya Administration Place
e) Saharawi Red Crescents Place (Organizes and directs all international aid)
f) Cultural Centre
g) Public Toilets

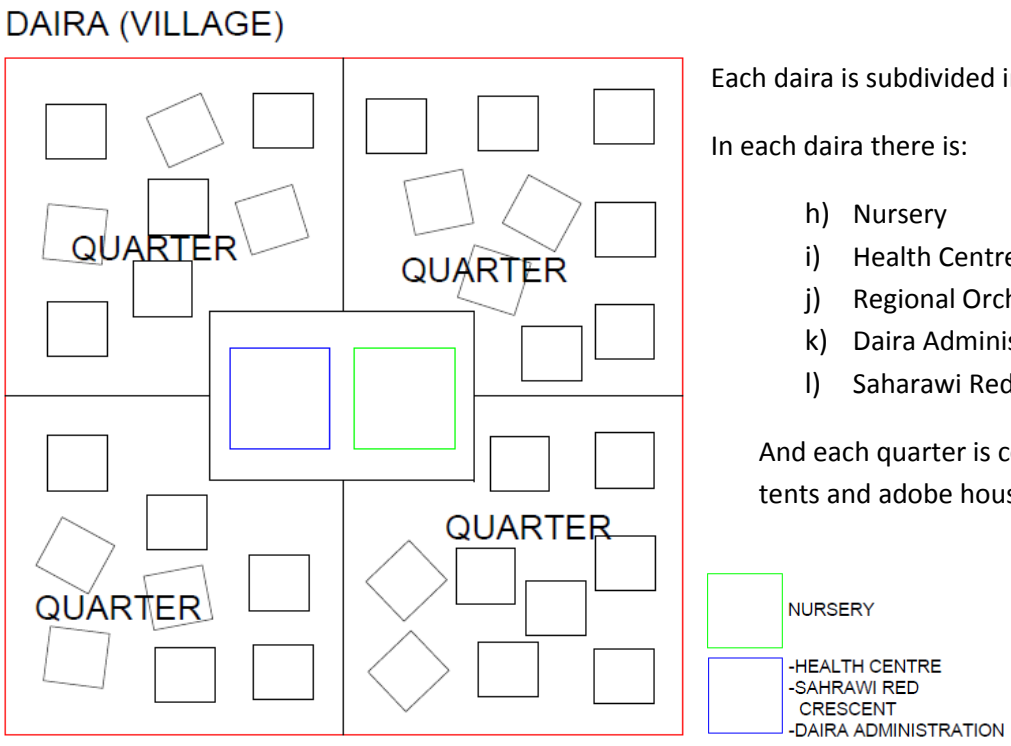


Figure15. Village scheme

Each daira is subdivided into 4 quarters.

In each daira there is:

h) Nursery
i) Health Centre Place
j) Regional Orchard
k) Daira Administration Place
l) Saharawi Red Crescents Place

And each quarter is composed by tents and adobe houses.

2.5.4. HOUSE'S ANALYSIS

2.5.4.1. HAIMA. TENT TRADITION

Figure 16. Haima drawing

Abadila Hasanna poet, who writes in Saharawi dialect Hasaniya, says " man of the desert has a strong link to the tent, which symbolizes the generosity and that has always meant a visual reference point for migrants crossing the vastness of the desert".

It is considered as the first social unit Saharawi, according to history. Is the accommodation, and the set of relations that unite the members of the same family.

Traditionally it was women who were responsible for making the tent, who sewed using canvases made of goat hair and camel.

The tent is spread by two opposing pillars, bound with a rope tied to the ground by means of rings, and wrapped in cloth.

The shape is triangular to prevent the arid wind.

Inside it is divided into two parts: one for women and one for men, where they usually receive guests.

2.5.4.1 TENT CAMPS

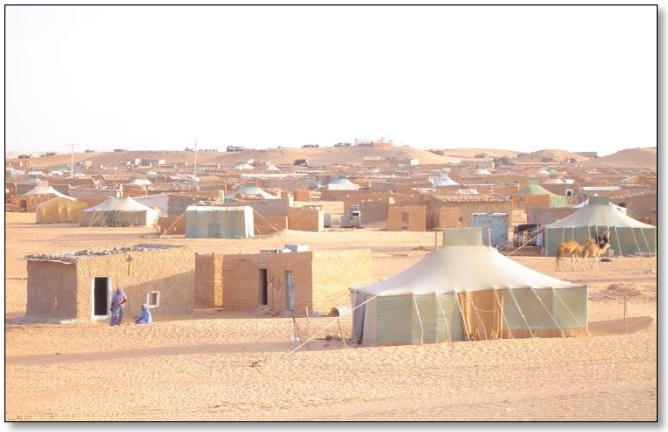
They live in tents provided by UNHCR.

Each canvas tent (HAIMA) which is the family home, he often adds a small adobe building that functions as a kitchen, and a small construction that is the toilet room.

Picture 29. Haima

Toilet rooms are simple square with a hole (latrine), where there is a bucket full of water next to a metal or plastic container to pour the water.

Picture 30 and 31. Toilet (Latrine)



Picture 32. Refugee camp, Tindouf

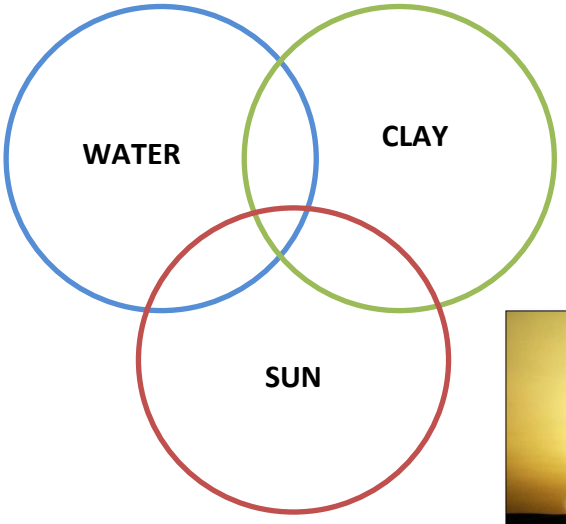
But fewer and fewer there are less haimas and more “adobe” houses.

2.5.4.3. ADOBE HOUSES: Adobe is one of the oldest building materials still in use.

This piece construction made of a mass of mud molded as bricks and sun dried.

The water used in the Saharawi refugee camps is groundwater.

The main problem of supplies with groundwater is quality of this one.



No shortage of sun and land in the desert.

With the union of these two resources and reusing water, it has got the base piece to build their houses.

WHAT ELSE THEY USE?

- Wood doors
- Wood windows
- Wood beams
- Zinc plates (for roof)
- Lime (for interior)

Picture 33. Roof: wood beams and zinc plates.

Picture 34.

Wood window.

Picture 35.

Small windows placed near ground level.

Picture 36.

Men at work, mud bricks process construction.

Picture 37.

Drying process

Picture 38.

Leveling bricks.

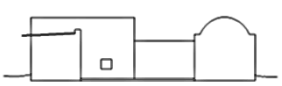
2.6. IMPROVE THEIR HABITABILITY

2.6.1. ¿HOW IMPROVES THEIR HABITABILITY?

Provisionality has determined the building in the camps, also conditioned by physical environment and limited resources. The highlight in the field of construction in the camps is the lack of qualified intermediate and the lack of professional training in this area.

We must overcome the concept of tentativeness in the field of construction and urban to reduce as far as possible the level of instability.

Build from sustainability, understanding from point of view: environmental, social, economic... Creating habitats adapted to the environment, at the household level but also at the city, from the proper use of indigenous materials and techniques and through housing improvements and urban.



2.6.2. URBAN ASPECTS TO CONSIDER

Before establishing improvements in the camps there are some points to consider. There are some organization aspects of the camps that I have read. I offer it from urbanism point of view, and as a reference for urban planning.

- SIZE, measured by population: When number of refugees is in hundreds of thousands, aid agencies are trying to establish several smaller fields instead of one massive, so that population of each of them not exceeding 20,000. Smaller fields are easier to handle in case of fire, or in relation to safety, disease control, etc…

- STRUCTURE: Geometric simplicity, probably the only way possible, given the urgency with which it must work and the economy.

- STREETS and ROADS: Within the field Should be Established good road routes at medical centers, food storage, school, common toilets, etc. .. Between streets houses but usually are not designed for vehicle but footpaths.

- HOMES, SHELTERS: Recommended minimum size for housing (usually uses the term "shelter") is 3.5 m2 per person, if we are in hot climates where cooking is outside.
  Minimum distance between shelters should be two meters.
  Usually is used local materials (wood, branches, and also metals and plastics available). But in emergencies, or if there are no materials available, are provided tents.

- SERVICES: Reception center and administrative
  Space about 15-20% of the total field area.
  One of the main equipment is the Reception Centre. When new refugees arrive, they should know where to go. They should be able to rest and shelter, pending registration.

- MEETING PLACE: In the fields usually set one or more meeting places, for different purposes. For example, there are meeting leaders or representatives of the refugees. It consists, generally, in a store or in a simple shaded porch.

- SERVICES: Medical equipment. It is one of main facilities, obviously. The UN recommended standards are: one regional hospital every 20,000 people

and one hospital per 200,000. Medical center provides primary care, coordinated from a central or main center.

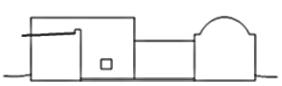
- HEALTH CENTER: (one for each 3-5000 refugees). There, nurses provide treatment for sore throats, fevers, cuts, or similar.

- SERVICES: Food distribution. Food deposits should be located near the administrative offices (for security reasons) and not far from the main entrance (for functional reasons, to prevent trucks admitted into populated areas at risk of abuse). For distribution are arranged several "food distribution points", around a point for every 5,000 inhabitants. There, the refugees haven't to go every day, but once a week or every two or three weeks.

- SERVICES: EDUCATION. Also for this equipment standards are important. Initially, one school from each sector, it means for every 5,000 rural residents. According to Save the Children is important to keep the school service in refugee camps because children must "maintain a sense of normalcy". Education helps to keep a sense of normalcy in the child's life, which in turn contributes to their recovery and reduces the possible traumas.

- INFRASTRUCTURE: WATER. Water supply is an important problem. According to Sphere project, minimum amount of water required is at least 7 liters per person and per day (for use in cooking, personal hygiene, washing dishes and clothes). Although Handy Guide to UNHCR sets 15-20 liters/ person/ day.
  Also, wells are made to supply from aquifers. And in any case the water must be treated to ensure it is not contaminated. If it can't get any water source itself, the water is carried by tanker to the distribution point field.

- INFRASTRUCTURE: SANITATION AND WASTE. The ideal is one latrine per family. But if not possible, at least have one for every 20 people. Must be located downstream and away from sources of supply. They should not be more than 50 m apart of shelters, because otherwise it discourages their use. Criterions build for latrines are: accessibility, not contaminate water, to avoid attracting insects, provide a minimum level of intimacy and adapt to local habits. They should be placed in well-lit areas, and provide certainty in night.
  According to Maria Chalaux (Oxfam) "water projects, sanitation and hygiene are based on three axes. Access to water, sanitation (measures to ensure



that you capture the water is not contaminated) and sensitization, defined as transmitting hygiene. Not enough to provide drinking water, or to make a latrine, people have to understand the usefulness of this and that the ultimate goal is to reduce water-related diseases".

- INFRASTRUCTURE: ENERGY. Arranged for generating electricity with diesel engines or gas supply producing current single phase alternating or three phase. The power output is very variable: from 8 to 500kW. It tends to use energy-saving lamps or fluorescent (with the added benefit of longer life than incandescent). Use is also made, in some cases, solar and biomethane.

- SUSTAINABILITY AND ENVIRONMENT: It's necessary to protect the environment. Prevent overexploitation, pollution and environmental degradation.

2.6.3. URBAN IMPROVEMENT

SANITATION AND WASTE INFRASTRUCTURE

Main problem is infrastructures moreover a bad sanitation and waste infrastructure lies in people health.

In this case, it has ended up contaminating groundwater, furthermore in 90 decade there was a cholera outbreak in Dahla.

If you think about it, toilets are very important to public health and even to human dignity. Those who live in developed countries often do not realize its value.

Beyond that is a matter of human dignity, lack of access to health conditions also put at risk the lives of human beings besides pose a health and economic burden for the poorest communities and damage to environment.

Water and food contaminated with fecal matter cause diseases as diarrhea that kills 1.5 million children each year, more than the annual deaths from AIDS and malaria combined. Chronic diarrhea can have consequences on brain development and immune system.

These substances cause problems, but on the other side, they would be valuable for agriculture purpose. Especially the macronutrients nitrogen (N), phosphorus (P) and potassium (K) in urine and faeces can be utilized instead of artificial fertilizer.

Here it could found the first improvement, focus in SANITATION and WASTE INFRASTRUCTURE.

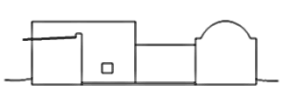
As solution, replace latrines, and place public toilets in every quarter, in every daira and in turn in each wilaya.

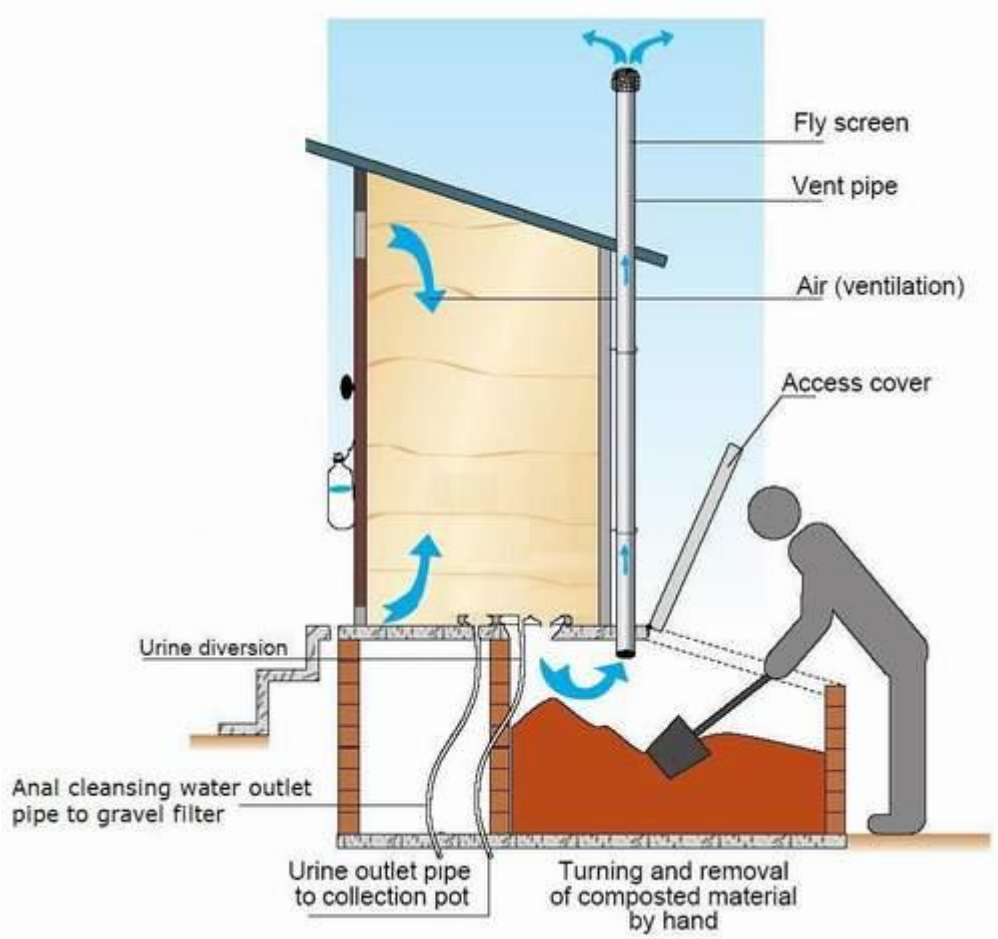
Place toilet in a specific area provides facilities to build sewer installations. Also means better maintenance of this installations and ease to future enhancements.

To collect human waste use dry toilet (toilet that collects urine and faeces separately and has the capability to dry the faeces).

The purpose is reuse this substances as fertilizer and stop to pollute the soil.

Also, waste water collection and purification for garden irrigation.





Picture 17. Dry toilet system

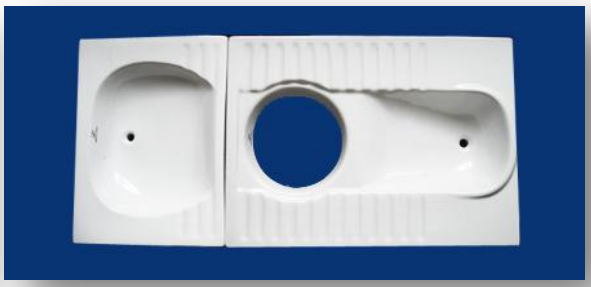


Figure 18 and 19. Different dry toilet types

COMMON HOUSE

Supply each family is really difficult, for that reason the proposed solution is a common improvement.

The main idea is based on building a common house in every quarter.

Its equipped by kitchen, laundry washing room, showers and living room/multipurpose. All rooms conect into a central garden.

Showers separated for men and women. Also shower room is divided in shower area, changing area and sink area.

It could also establish an area for prayer

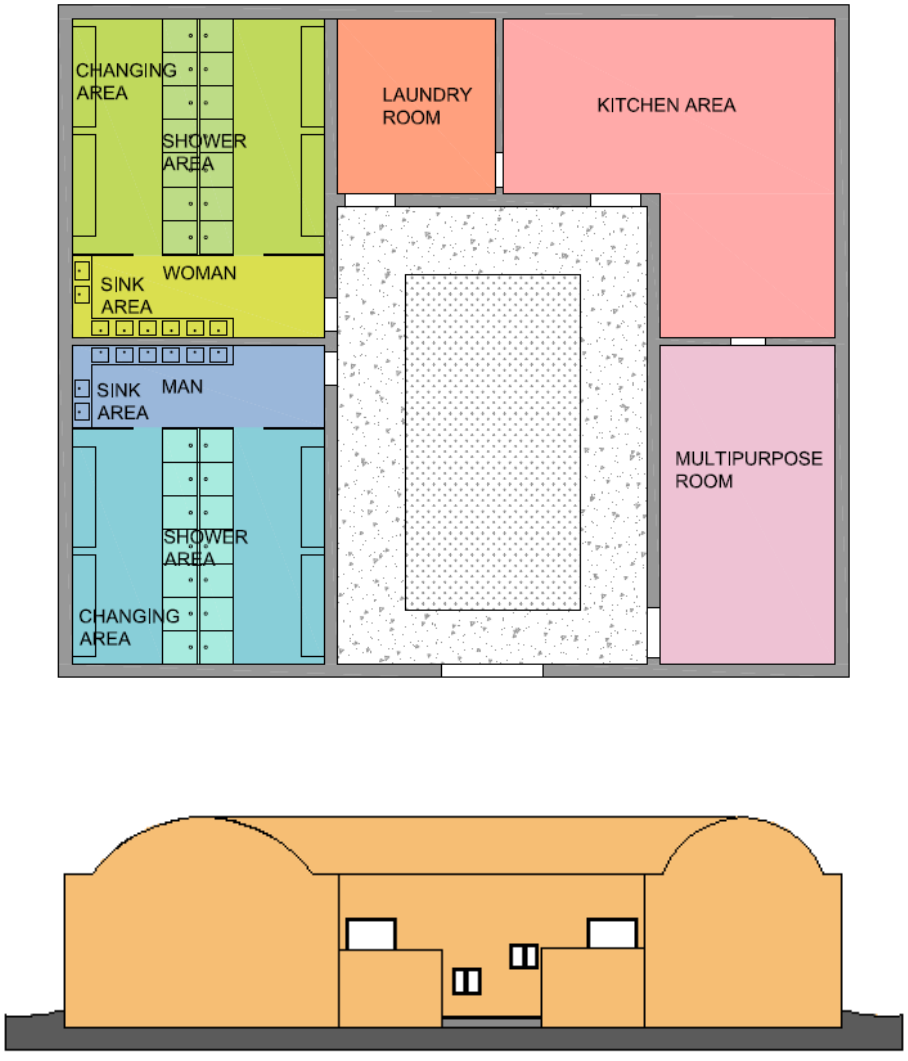


Figure 20. Common house

Materials and elements:

- Adobe is shaping rigid and tight spaces interrelated through garden.
- Roofs covered with vaults. It improves natural climate and ventilation of the building, warm air is on the top of the building.
- Trench in perimeter foundation and under walls where support decks.
- Capping beam of the walls.
- Vaults recessed in capping beam.
- To considerer, structurally, it could use a stronger material, just in trench and beam, such as reinforced concrete.
- Wood carpentry. It has no glass because fragility and maintenance problems.

WATER INFRASTRUCTURE:

Kitchen, showers and laundry washing place connect to a sewer system.

Sewer and suitable installations to create a purification and distribution network water.

Greywater is collected directly from the kitchen sinks, showers and the wash hand basins for treat and reuse.

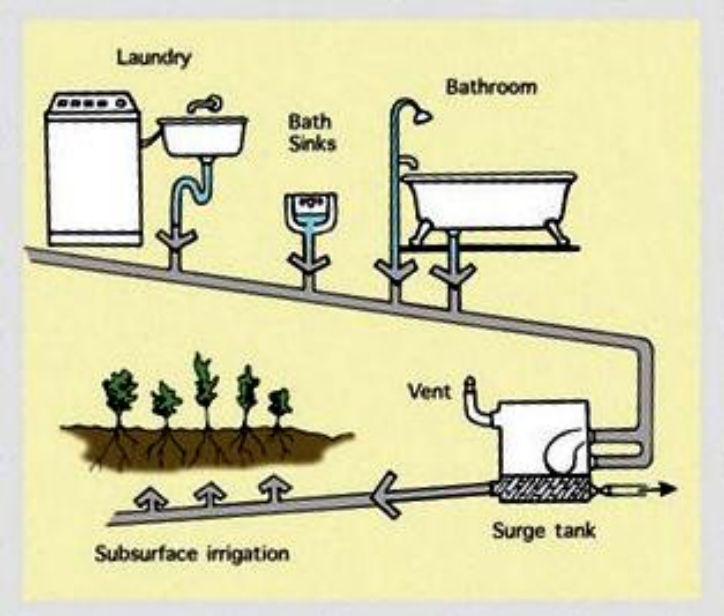


Figure 21. Greywater reuse

Water reuse has a lot of possibilities; it could be destined to garden, to wash clothes, to construction, etc.

ENERGY INFRASTRUCTURE:

Construction in the common house a solar garden equipped by photovoltaic panels to provide electric service to the building.

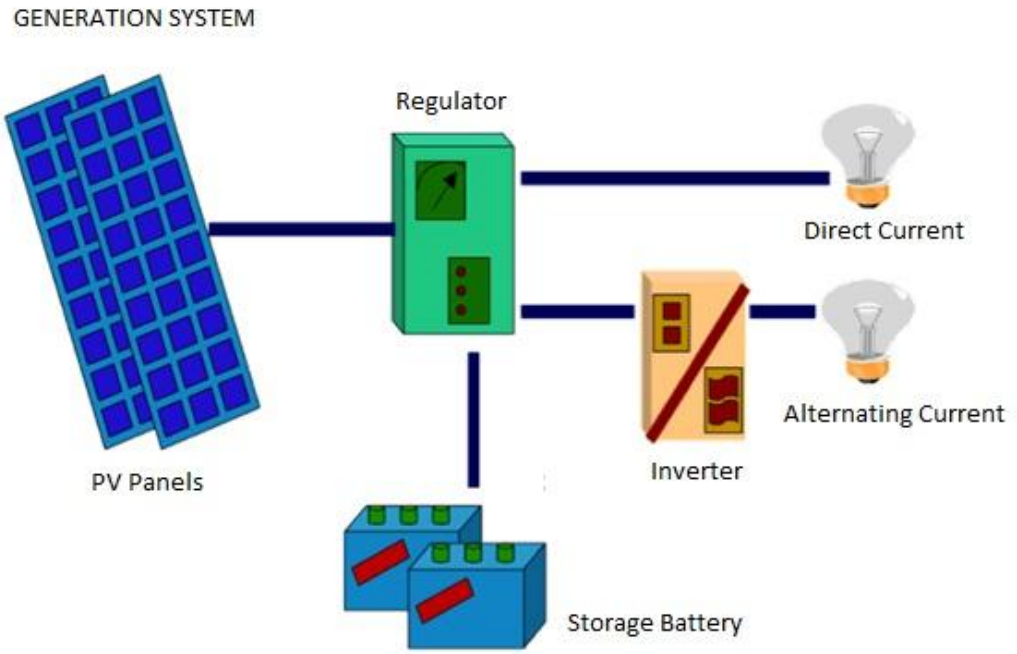
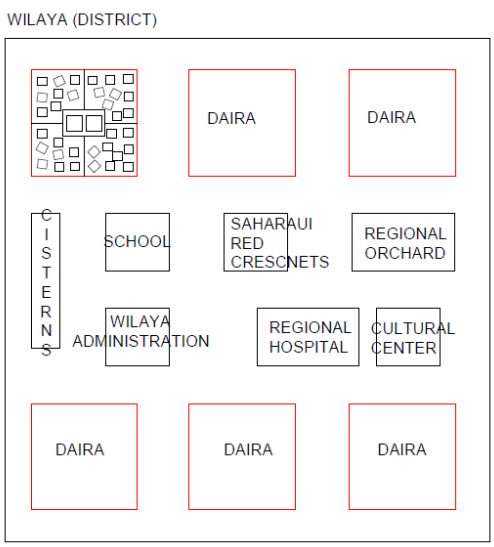


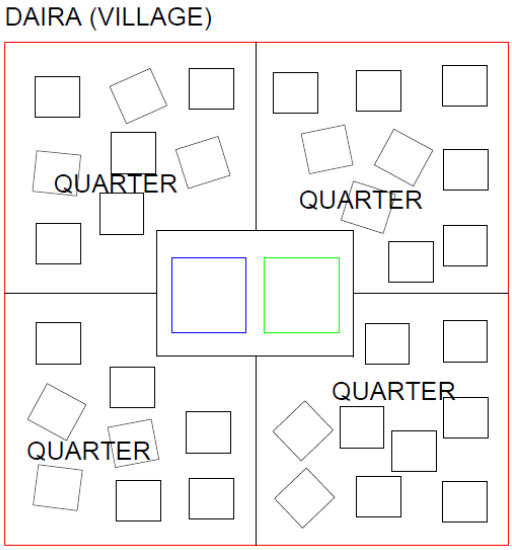
Figure 22. Photovoltaic panels system

Worth mentioning then are the key elements of an isolated photovoltaic system:

- Photovoltaic Modules: will be responsible for electricity generation.
- Regulator: Responsible for controlling the battery charge and discharge and avoid unnecessary or excessive discharge. In a simple way, a regulator can be understood as a switch, closed and connected in series between panels and battery charging and open when the battery is fully charged
- Batteries: They manage to accumulate the energy generated by the photovoltaic generation system in order to have it and use it during the night hours.
- Inverter: it's an equipment that transforms the direct current coming from the regulator into alternating. This is its function.

As a starting point, camps planning:





After changes, placed common house and cisterns, daira planning:

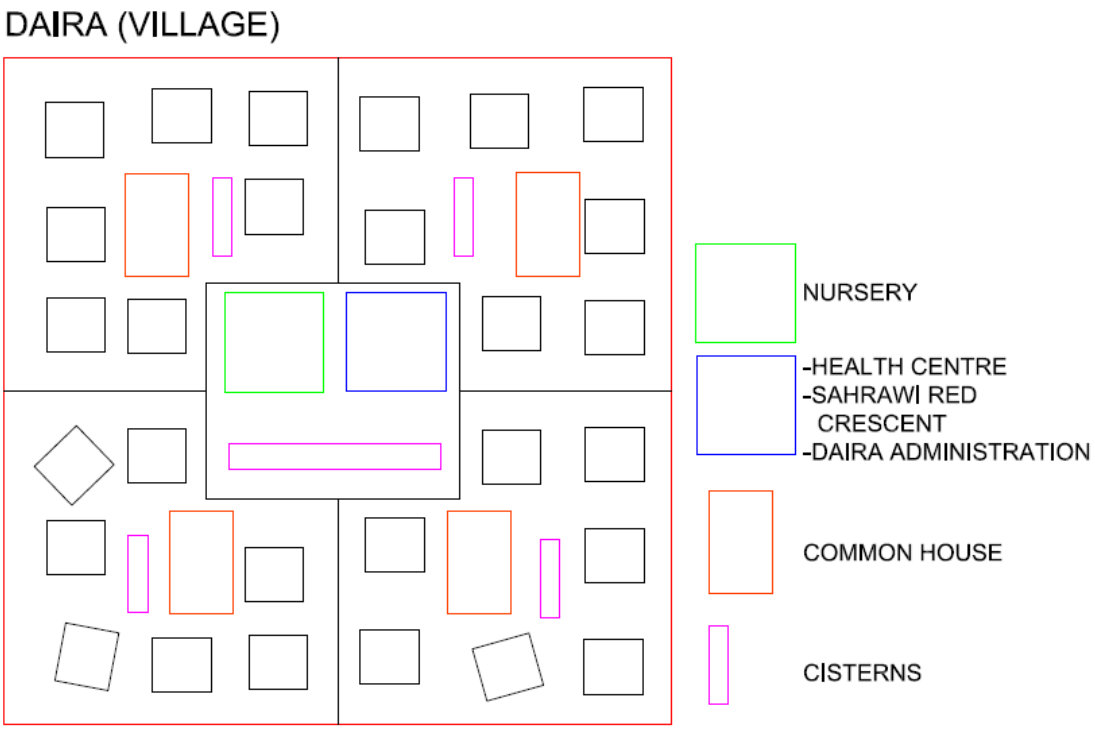


Figure23. Village scheme after changes

2.6.4. HOUSEHOLD IMPROVEMENT

Adobe buildings in Saharawi camps have many shortcomings.
One of the main causes is lack of material Knowledge, both in production and in his use. Through organizations, it could do workshops for learn materials properties and improve adobe production and placement.

ADOBE PRODUCTION:

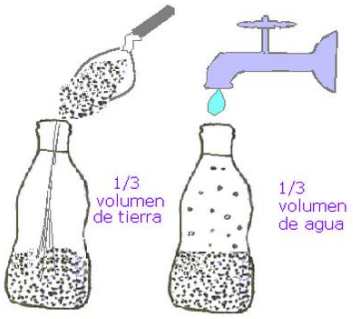
Best soil for adobe production should be between 15% and 30% clay to unite the material while the rest can be sand or coarser aggregates. Excessive clay can produce fissures, whereas a lack of this one could produce fragmentation by lack of cohesion.

What kind of land we can use?

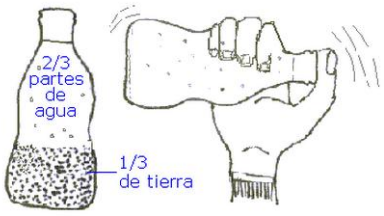
Land from the region, but there are three simple tests that can serve as a guide.

- "Sedimentation test" - gives an idea of the proportion of each component

Mix the land in a bottle with 2/3 of water



Then the bottle should be shaken vigorously and let stand bottle for 20 minutes



Finally, observe different layers separated from the ground. Sand should not exceed 75% of the total.

Figure 24. Sedimentation test

- Clay "dry strength test" - make at least three mud balls of about 2 cm in diameter. Once they have dried (after at least 24 hours), flatten each ball between your thumb and forefinger. If any ball is broken, the soil contains enough clay to be used in the construction of adobe. If some of the beads may be crushed, the soil is not suitable, because it lacks enough and should be discarded.

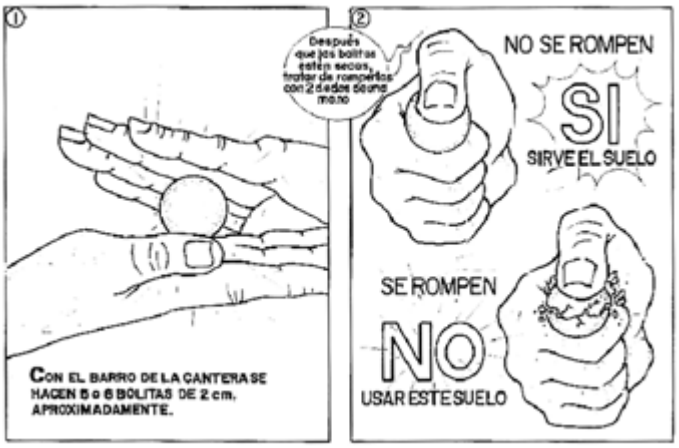


Figure 25. Dry Strength Test (PUCP/CIID, 1995)

- "Roll test" Make a cylinder about 25 cm length (a little thicker than a thumb)
  - If the length of the roll without breaking produced is between 5 and 15 cm, the ground is appropriate.
  - If the length without breaking the roll is greater than 15 cm, too much clay, add sand.
  - If the roll breaks with less of 5 cm, the soil should not be used, too much sand.

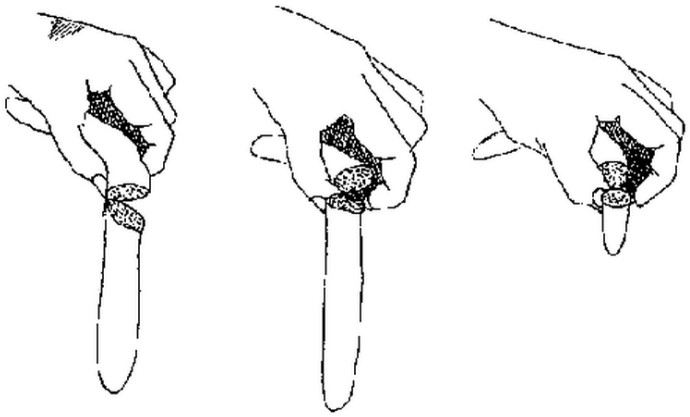


Figure 26. Roll Test

ADDITIVES: introduce some kind of fibrous (straw, rice husk or other vegetable fiber) to improve control of microcracking.

PREPARATION:

- Key to a good adobe is clay (beaten land)
- Mix dry ingredients and add water. The right consistency is when the beat mud will not stick on the feet at the end of beat.
- If possible step on the mud at least 10 minutes intensely.
  The adobe has maximum bond strength and resistance to beat it by 10 minutes. Perhaps it should be made smaller loads and thus ensure that it is well beat.
- Gets wet the mold with water and place the mixture strongly inside the mold.
  As stronger more compressed and thus improves the final adobe strength. Push mixture to corners.
- Lift the mold with a sharp movement upwards so that adobe is removed from mold.
- Adobe drying time: allowed to dry until it reaches a strength that it can be lifted without breaks (one day)
- Then lie down the brick for dry the side that was in contact with the ground. Let dry the adobe pieces for one or two days.
- During the first 5 days cover the bricks with canvas or straw to prevent cracking by drying too fast.
  10-14 days to wait before to be used in construction.

Picture 39. Adobe Wood mold

Picture 40. Adobe. Mix and beat

Picture 41. Filling the mold

Picture 42. Filling the mold. Pushing mixture

Picture 43. Drying time. Step 1

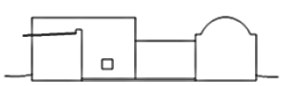
Picture 44. Drying time. Step 2

ADOBE BUILDING FACING:

The coating is essential to limit the effects of weather and prevent moisture affecting the strength of the adobe buildings. Therefore consideration should be given to protect the walls with plaster resistant to the action of erosion and weathering.

Process:

- Surface preparation: roughened to secure gripping of the mortar.
- Wait at least 4 weeks after build the walls to apply the coatings, as it is necessary to produce the settling of the structure so that these movements do not cause cracks in the terminations.
- Wet both sides of wall and start plastering both sides to the same time.
  If it's not executed in this way, the part of wall that is not wet will absorb water from the other face and this from water of mortar so that wall will crack.
- Apply first mortar layer, which must be between 3 and 5 mm thick, using same dosage that was used to make the bricks but with hydrated lime and without fibers.
  It improves the properties as workability, adhesion, waterproofing and aesthetic aspect.
- First layer concluded, then spend a wire brush on fresh mortar and make a scraping to allow adherence of second layer and decrease cracking of the first.
  Wait at least 7 days between applications of layers.
- Second layer is applied, which is a dosage 1:3, it means 1 of quicklime (calcium oxide) and 3 of sand.
  This proportion is well mixed dry and then mixed with water.
- This layer provides esthetics and termination of wall and has a thickness between 2 and 7 mm. It should rest several days for complete drying before starting to paint walls.

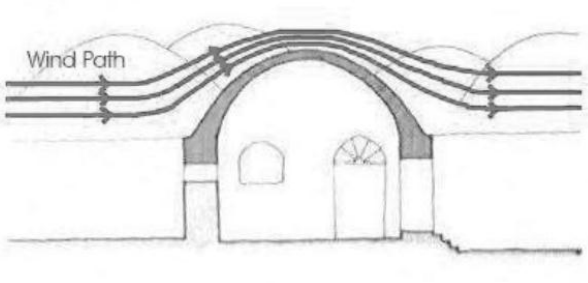


PATHOLOGIES

Conditioned by climatic factors of the region, the ideal way would be using circular lines.

On the one hand, it deflects the wind and thus the erosion of the sand.

On the other hand, it improves natural climate and ventilation of the building. Using dome or vault, the warm air is on the top of the building.



But this involves skilled labor and increase the project economically.

As a starting point, as had been previously analysed, houses are simple adobe walls with zinc layers on wood beams as roof.

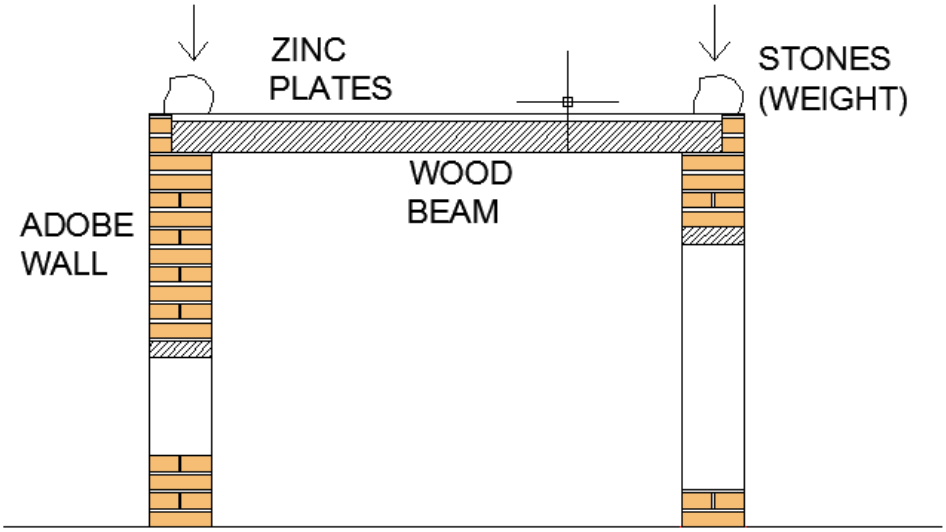


Figure 27. Current adobe house

So, what do we find?

- Poor thermal insulation through roof.

  High temperatures warm zinc layers, and heat is transferred inside.

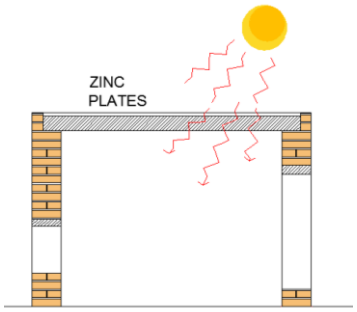


Figure 28. Sun effects, roof without insulation

Solution: Adobe mud on top roof as insulation, putting it on zinc layer.

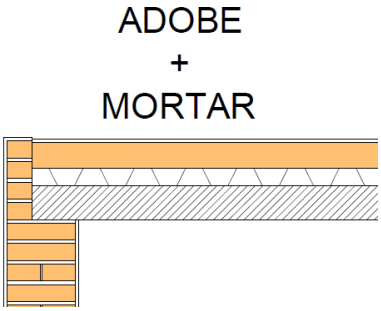


Figure 29. Mortar as insulation

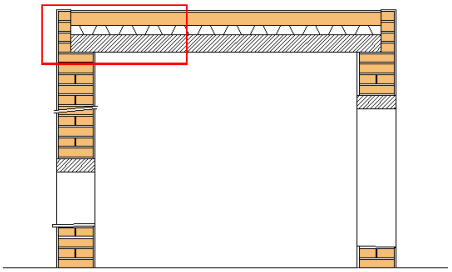


Figure 30. Mortar as insulation in roof

In case of wood beams have not provided, use zinc layer as a structural element.

Houses have about 4 meters light, therefore a zinc plate with more edge and trapezoidal section would be enough.

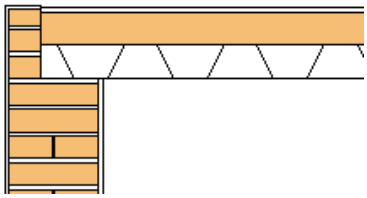


Figure 31. Zinc plate as structural element

Picture 45. Zinc plate

- Floods, in case of torrential rains

  Solution: Raise ground level inside house by compact earth blocks.

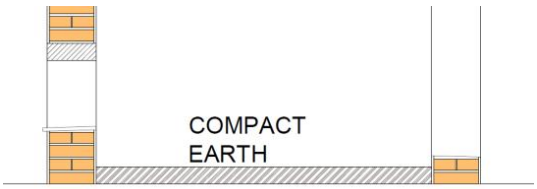


Figure 32. Compact earth

Picture 46. Flood

- Wood lintels in window and door holes.
  In some houses we can see cracks in the facade because short length of lintels, or there are weak.

  Solution: Reinforce holes area by wood lintels or adobe bricks.

  Adobe bricks lintel needs more work, but material will be always disposal.
  This will require a wooden recoverable formwork as this:

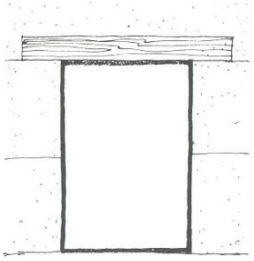


Figure 33. Wood lintel

Picture 47. Wooden formwork

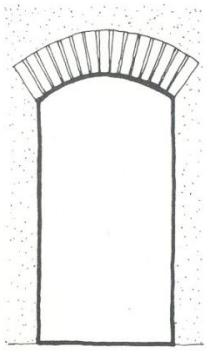


Figure 34. Adobe bricks lintel

- Waterproofing, covering face.
  Mortar layer which must be between 3 and 5 mm thick, using the same dosage that was used to make the bricks but with hydrated lime and without fibers.
  Apply mortar in walls and roof.

  Moreover, build the roof with slope to water flows and it does not acumulate on deck.

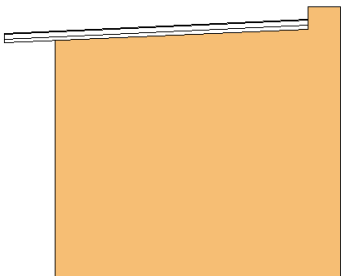


Figure 35. Slope Roof

- To prevent condensation in wall.
  Make small perforations in the wall,
  from side to side, and staggered
  placing pieces of plastic with small holes at the top, making it easier for water to seep through these channels and it be expelled to the outside

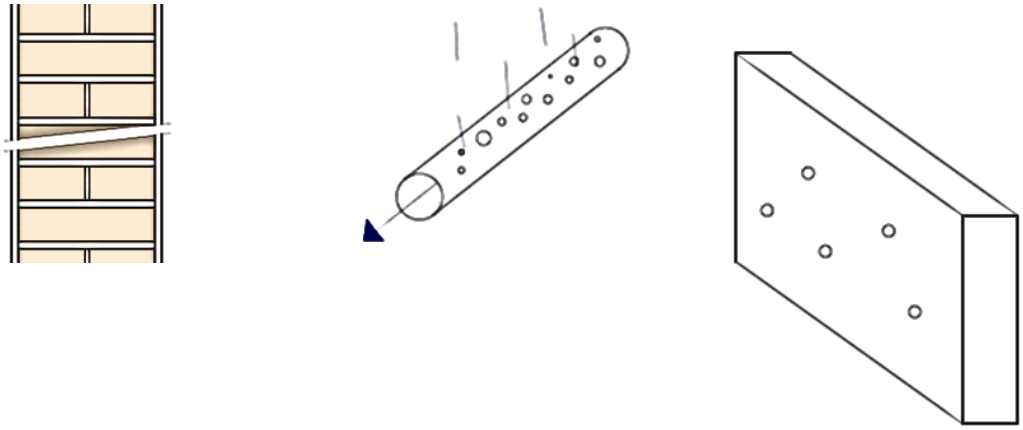


Figure 36. Prevent condensation system

MAINTENANCE:
Wall and above deck will become more vulnerable without coating, for this reason it must always keep in good condition.

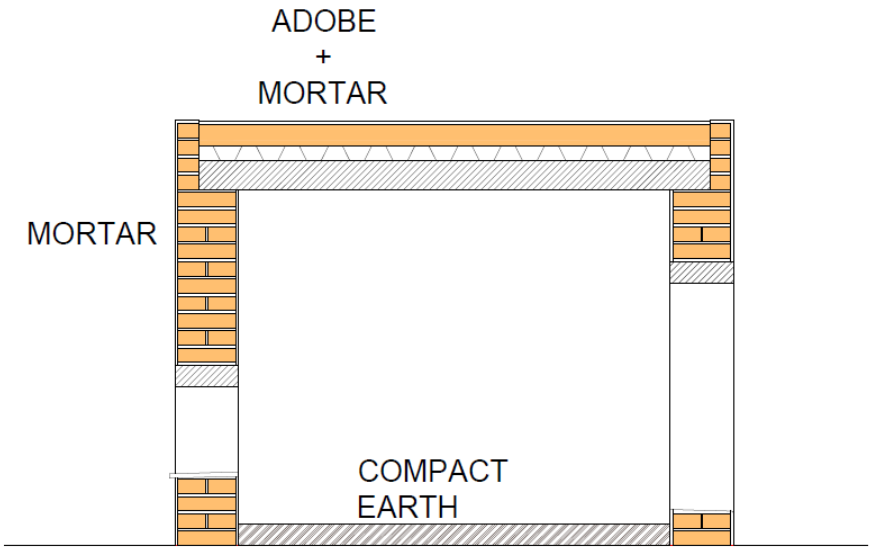
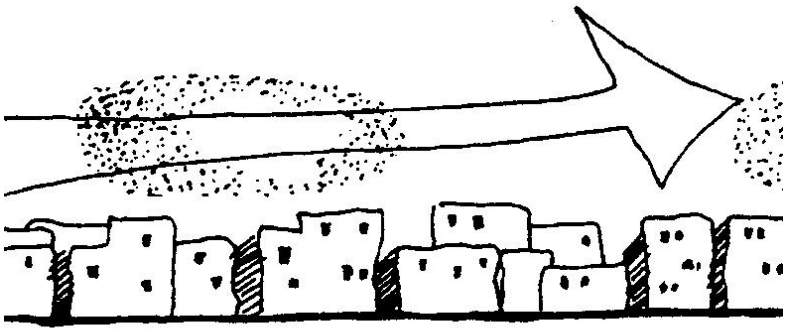


Figure 37. Adobe house

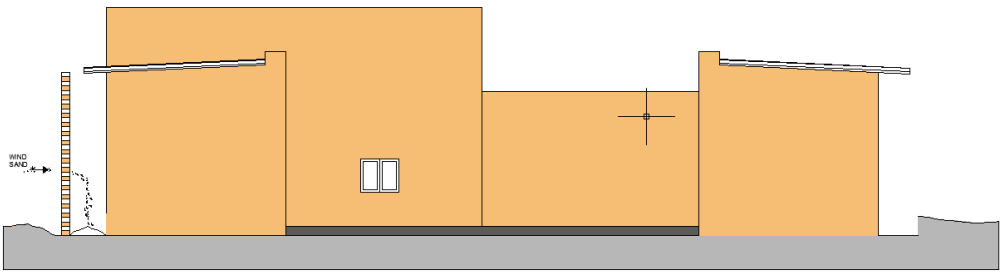
- Protection against wind

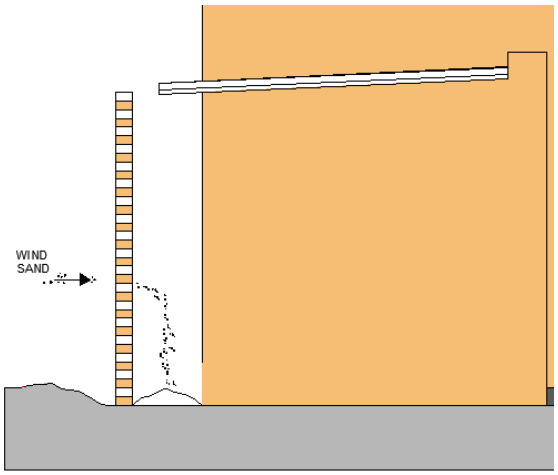
  Houses located close to each other and narrow streets prevent penetration of sand-storms in the traditional development.

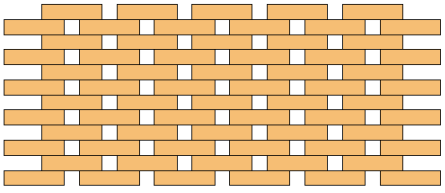


But some isolated houses or in periphery are more threatened against the wind.

In these cases, build adobe walls to mitigate wind effect.
Walls oriented to south (where the wind comes) at a distance between houses around 1.5 - 2 m to allow circulation.







Wall protection: Adobe bricks wall, to decrease wind action.

Figure 38. Prevent wind system

3. CONCLUSION

3.1. TECHNICAL DATA

- Country: ALGERIA

- Region: Hamada of Tindouf, southern Algeria (Sahara Desert)

- Area/ Village: Saharawi refugee camps

- Action field: Planning and housing

- Current situation: People exiled by Morocco illegal occupation of its territory

- Demographic data: 200,000 people in several camps

- Social and cultural data: Arab and Muslim society. Family organization structure still reflects the tribes

- Official languages: Arabic and Spanish as a second official language

3.2. HISTORICAL CONTEXT

After decades of Spanish colonization of Saharawi territories, Hague International Court, in report 16 of November 1975, finds that the arrival of the Spanish in the Western Sahara territory was inhabited by tribal populations organized in autonomous and there was no tie of territorial sovereignty between Western Sahara and Morocco or Mauritania. That same day, Morocco announces occupation of the territory in so-called Green March. On 14th of November, Spain delivers Western Sahara to Morocco and Mauritania, through “Madrid Accords”.

Thereafter events rush, Moroccan and Mauritanian troops invade the territories ignoring UN condemnation. In the night from 27 to 28 February, in 1976, is created in Tindouf the Saharawi Arab Democratic Republic (SADR) as a state.

From 1975 until now, 200,000 refugees, mostly women and children, have been installed in Tindouf camps in a very precarious condition because these camps were conceived as a temporary solution to the problem of Saharawi exile.

3.3. DIAGNOSIS

The initial intentions of this type of provisional reception facilities for displaced populations, in many cases, tend to consolidate, with consequent problems of insecurity and poor constructive urban structure.

Provisionality has determined the building in the camps, also conditioned by the physical environment and limited resources. This reinforces importance of considering on construction and implementation ways.

Sahrawi people, after 37 years, must be overcome concept of tentativeness in the field of construction and urban to reduce as far as possible the level of instability. Three decades is not considering as provisional period.

3.4. SYNTHESIS

Having analyzed the planning in refugee camps and considered urban aspects, as conclusion, main problem is infrastructures.

Build from sustainability, understanding from point of view environmental, social and economic.

PROPOSED SOLUTION:

- Sanitation and Waste Infrastructure Improvement
  Place public toilets around the center of districts, villages and quarters.
  Typology: dry toilet (toilet that collects urine and faeces separately and has the capability to dry the faeces).
  Urine and faeces can be utilized as natural fertilizer and stop to pollute the soil.

- Water Infrastructure
  Basically supply each family is difficult, from a point of view economic and time. For this reason, it arises to build a common house to cater families from same quarter.
  Its equipped by kitchen, laundry washing room, showers, living room/ multipurpose and a central garden. And use adobe as main material.
  Greywater is collected directly from the kitchen sinks, showers and the wash hand basins for treat and reuse.

- Energy Infrastructure
  Construction in the common house a solar garden equipped by photovoltaic panels to provide electric service to the building.

  On the other hand, adobe buildings in Saharawi camps have many shortcomings. One of the main causes is lack of material Knowledge, both in production and in his use.

Through organizations, it could do workshops for learn materials properties and improve adobe production and placement.
Furthermore, having analyzed their houses it collected some pathologies that it could have easy solution (poor thermal insulation through roof; floods, in case of torrential rains; short length of lintels…).

3.5. ONE STEP MORE

Saharawi people possessed a subsistence economy, they were nomadic shepherd.

Thirty years ago it could be one way to live. But things happen, time pass and nowadays a self-sufficiency economy could be better way.

Western Sahara is rich country in natural resources but not its people who take advantage of it.

In refugee camps its economy is Incipient and precarious. Population depends totally on foreign aid.

"How they could be self-sufficient in a place that there aren't anything else than sand?"

It is an open question, I have not the answer, but as curiosity,

Sahrawi Craftsmanship

Sahrawi art is an art of miniaturists, it is an art of apparent simplicity with geometric patterns that are difficult to decipher hidden meanings for non-experts.

Handicraft industry lies in the transformation by the artisans of the skins of goat and camel, silver, ivory color and local clay into useful products, instruments and artworks (jewelry, copper products, ...).

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