

TOWARDS DEVELOPING A BUILDING TYPOLOGY FOR SUDAN

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Problem Statement

- Hard summer in Sudan.
- The technical solutions in buildings for protection against solar radiation and overheating are beyond reach.
- Insufficient information on the characteristics of the building stock, building physics and energy use of buildings in Sudan.

Objectives:

- Create a building typology for Sudan.
- Building typology can be used for building stock modelling, planning and designing building retrofit.

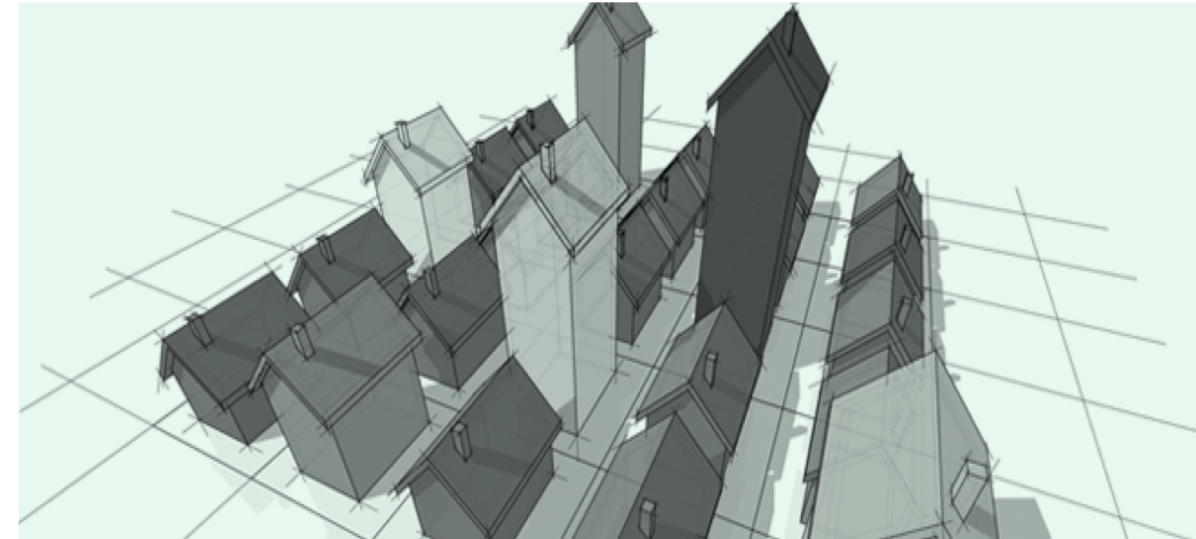
	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	England	... 1918	generic	 GB.ENG.SFH.01.Gen	 GB.ENG.TH.01.Gen	 GB.ENG.MFH.01.Gen	 GB.ENG.AB.01.Gen
2	England	1919 ... 1944	generic	 GB.ENG.SFH.02.Gen	 GB.ENG.TH.02.Gen	 GB.ENG.MFH.02.Gen	 GB.ENG.AB.02.Gen
3	England	1945 ... 1964	generic	 GB.ENG.SFH.03.Gen	 GB.ENG.TH.03.Gen	 GB.ENG.MFH.03.Gen	 GB.ENG.AB.03.Gen
4	England	1965 ... 1980	generic	 GB.ENG.SFH.04.Gen	 GB.ENG.TH.04.Gen	 GB.ENG.MFH.04.Gen	 GB.ENG.AB.04.Gen
5	England	1981 ... 1990	generic	 GB.ENG.SFH.05.Gen	 GB.ENG.TH.05.Gen	 GB.ENG.MFH.05.Gen	 GB.ENG.AB.05.Gen
6	England	1991 ... 2003	generic	 GB.ENG.SFH.06.Gen	 GB.ENG.TH.06.Gen	 GB.ENG.MFH.06.Gen	 GB.ENG.AB.06.Gen
7	England	2004 ... 2009	generic	 GB.ENG.SFH.07.Gen	 GB.ENG.TH.07.Gen	 GB.ENG.MFH.07.Gen	 GB.ENG.AB.07.Gen
8	England	2010 ...	generic	 GB.ENG.SFH.08.Gen	 GB.ENG.TH.08.Gen	 GB.ENG.MFH.08.Gen	 GB.ENG.AB.08.Gen

EPISCOPE / TABULA example

Methods

- Collect the data from:
 - Population and housing census
 - Scientific research paper
 - Reports
- Collect the data on:
 - Geographical features.
 - Climate zones.
 - Population.
 - Building materials

Building Typology Table



Sudan (Geographical Features)

- Located in North- East Africa
- Current area is about 1.886 million km²
- Resources of water, livestock, fertile lands, diverse forests, minerals (gold and copper), and oil production.
- Soil classified into: desert, semi-desert, sand, alkaline catena, alluvial, and ironstone plateau



Sudan map

Source: Food and Agriculture Organization(FAO)

Sudan Climate Zones

- Composite climate:
 - Hot
 - Cool
 - Rainy
- Three climate zones:
 - Warm desert climate
 - Warm semi-arid climate
 - Tropical savanna climate

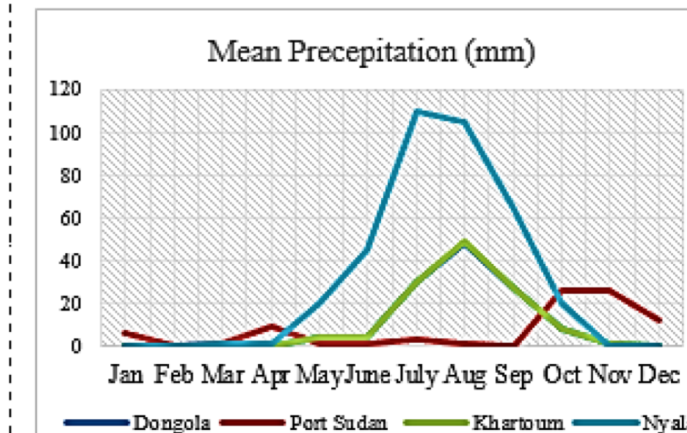
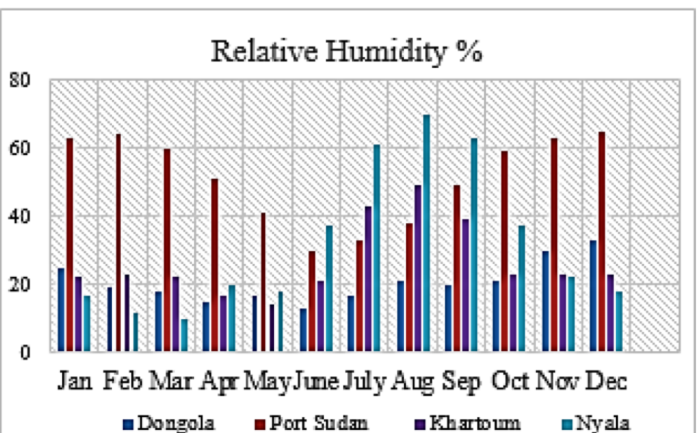
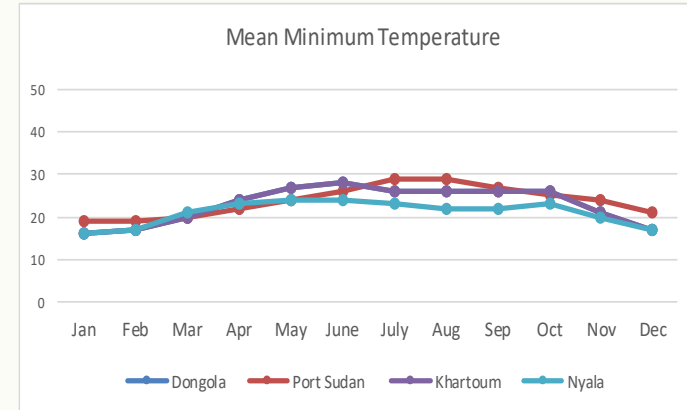
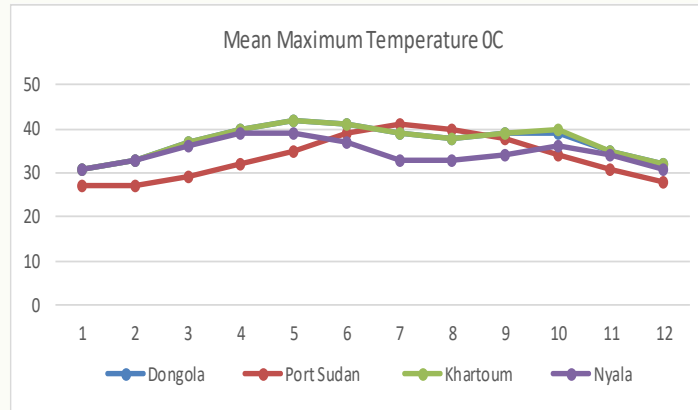


Sudan Climate Zones

Based on Koppen, and Sudan Meteorological Authority (SMA)

Sudan- Weather Data

Source: World Metrological Organization, Sudan Metrological Authority and Central Bureau of Statistics



43,3 °C
26,7 °C
Dongla, Khartoum
Nyala

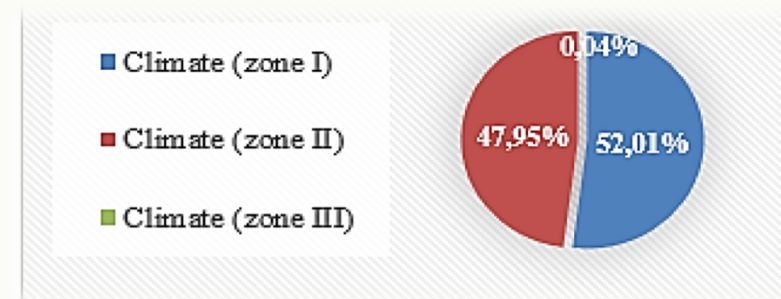
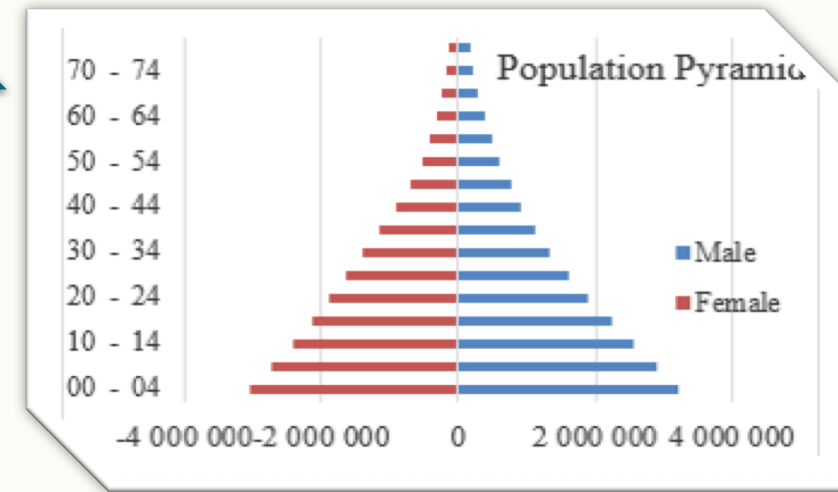
26,7 °C
17 °C
Nyala
Dongola,

Port Sudan,
Nyala
Khartoum
Dongola

Nyala,
Khartoum
Port Sudan,
Dongola

Demographic

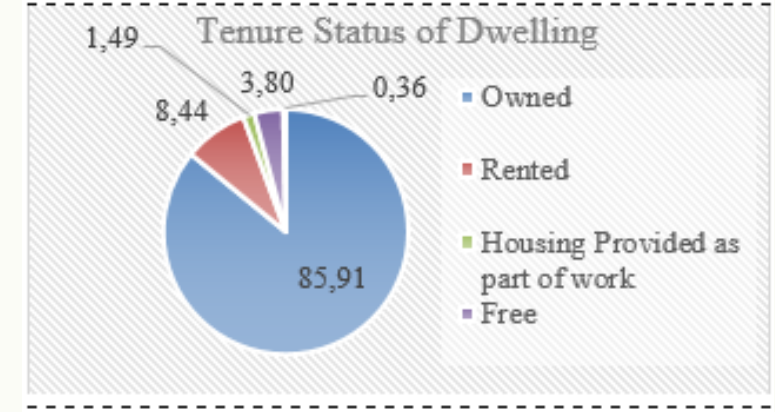
- Total population 41 511 526 million in 2018
- Growing rate 2.8% per annum
- Urban population 34.6% (one – third of the total population)
- 52% lives in warm desert climate zone.
- 48% in the warm- semi arid climate zone.
- Only 0.04% live in the tropical savannah climate zone.



Source: Annual Health Statistics Report 2017

Tenure status of dwellings

- Housing can be classified into four types according to tenure status:
 - owned,
 - rented,
 - provided as part of work and
 - free dwelling

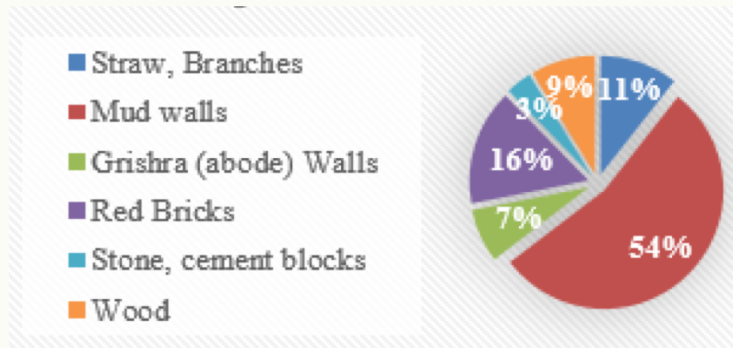


Tenure status of dwelling

Source: Central Bureau of Statistics Census 2008

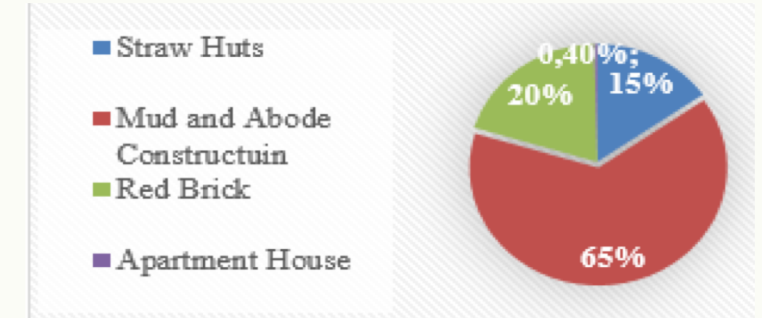
Building materials in Sudan

- The building materials in Sudan are classified into three types:
 - modern materials: concrete, red brick with cement mortar, cement bricks and corrugated iron sheets;
 - traditional permanent materials: red bricks combined with mud bricks for wall construction, mud construction for walls and roofing made from sticks, thatch and mud; and
 - traditional materials: thatch used for roofing and for walls.

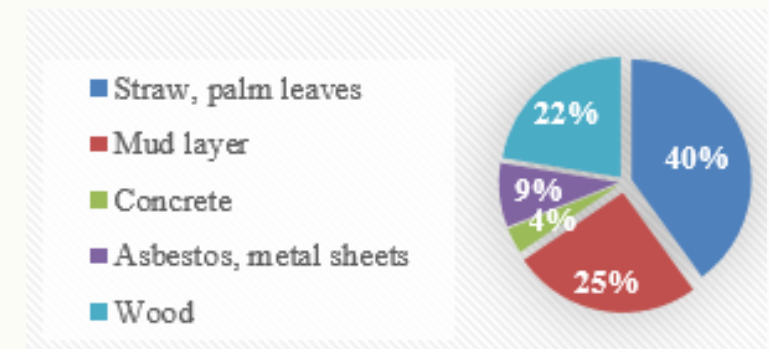


Source: Household Sample Survey 1968

Percentage of household and population according to the wall construction of the house



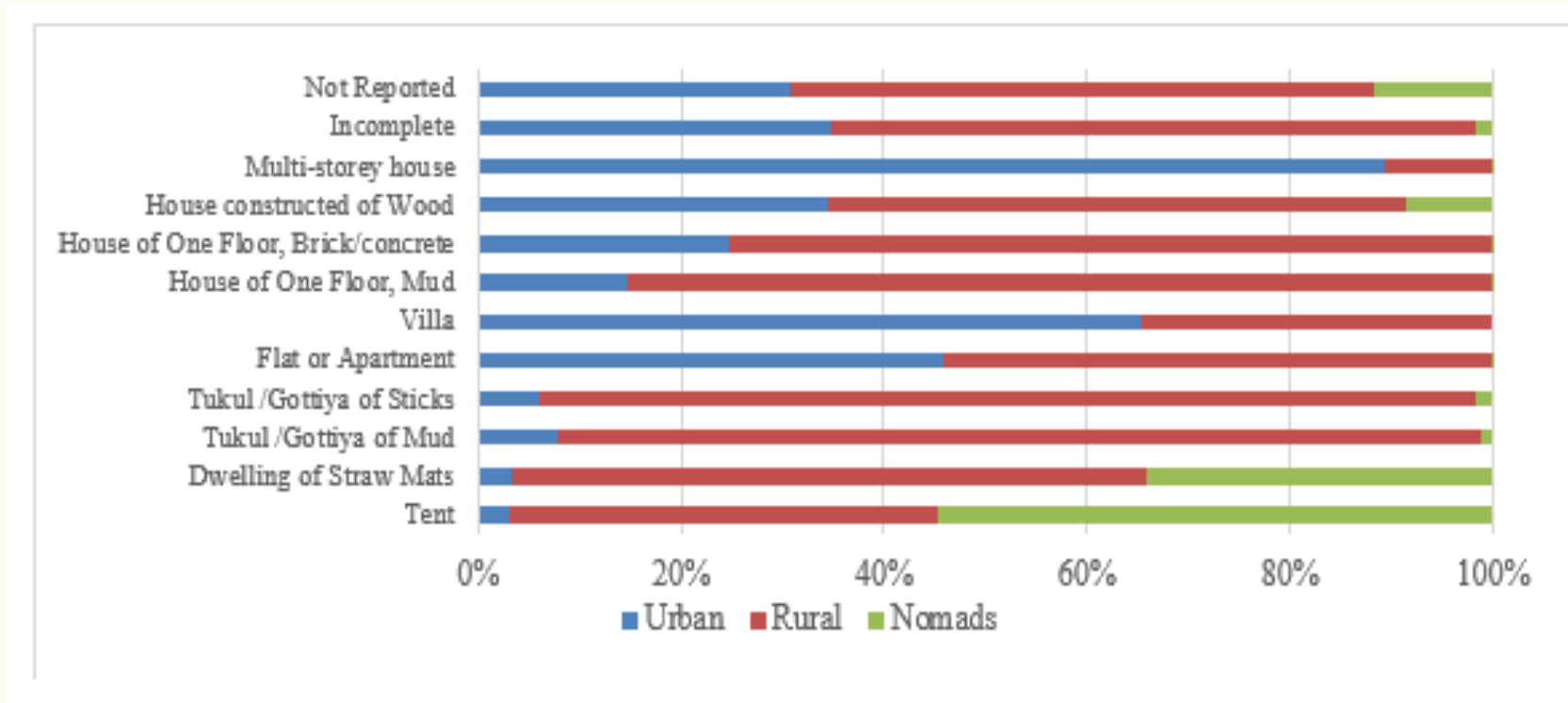
Type of house according to the building materials



Percentage of household and population according to roofing material of house

Source: Household Sample Survey 1968

Household and population by type of dwelling



Source: Central Bureau of Statistics Census 2008

Heating and cooling devices

Percentage of fans and air coolers of the total population (census 2008)

Item	Households%		
	Total %	Urban %	Rural %
Fan	18,17	40,22	9,3
Air Cooler	3,94	11,05	0,77

Fan

Air Cooler

- Multi storey house.
- House of one floor- brick concrete
- House of one floor- Mud
- Villa
- Flat or apartment

Results – Building typology table

Construction Time	Temporary	Single Family Dwelling Detached			Multi-family Dwelling
		Climate Zone I (warm desert climate)	Climate Zone II (warm semi-arid climate)	Climate Zone III (tropical savanna climate)	
Very old (1900-1950) ^{1,2}		 House of One Floor Mud (Adapted)		 Tukul/Gottiya Mud	
Old (1956-2000) ³	 Tukul /Gottiya Sticks	 Tukul/ Gottiya Mud	 House of One Floor Brick/Concrete	 Dwelling of Straw Mats	 Flat Apartment or
				 Wooden Dwelling	
Modern (2000- till now) ⁴	 Tent	 House of One Floor Mud	 Villa		 Multi Storey House
	 Tukul /Gottiya Sticks				

¹ Early Colonial Architecture (1900–1920)

² Late Colonial Architecture (1921–1956)

³ The Post-Independence Era (1956–2000)

⁴ Architecture from 2000 onwards [19]

Results – Building typology (descriptions)

Temporary



Local Materials



Sticks



Straw/ Sticks

Results – Building typology (descriptions)

Single Family Dwelling

Zone I (warm desert)



Mud (adapted)



Mud (adapted)

Zone II (warm semi - arid)



Single floor brick



Villa

Zone III (tropical)



Mud



Wooden

Multi- Family Dwelling



Flat or Apartment



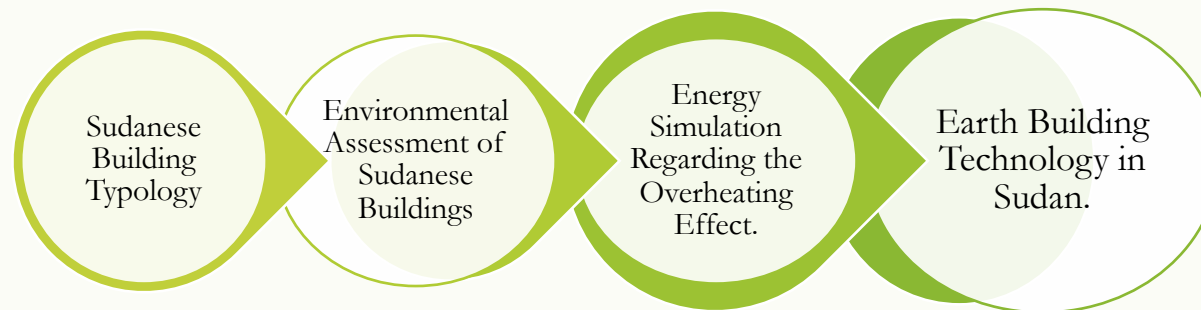
Multi Storey

Conclusions

- Because of the climate we should focus more on the building construction system in Sudan and improve it in order to face the summer overheating issue.
- Air-conditioning **V**s cost and the low income of the majority of the urban population.
- There are some limitation and scarcity in the collected data, it should be improved and updated for further research.
- Building typology was a starting point. These typology results should be improved and transferred into practical results.



Future Plans



Thank you for your attention!

Acknowledgments

Project FK 128663 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary, financed under the FK_18 funding scheme. The research reported in this paper was also supported by the FIKP grant of EMMI in the frame of BME-Water Sciences & Disaster Prevention (BME FIKP-VÍZ).