



ARCHITECTURE IN EXTREME CLIMATE CONDITIONS

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Abstract

During his studies at the Faculty of Architecture in Sarajevo, the Author met several students who came to study there, from the Middle East (Jordan, Syria, Yemen, Palestine/Israel) and from Africa (Libya, Sudan, Ghana). In their projects-student works, he noticed visible traces of their geographical origin and autochthonous culture. This observation of his was even richer when, as a young assistant professor, he mentored the preparation of graduate theses of several students (from Jordan and Palestine/Israel). It was interesting their experience that they passed on to the Author, after they, as architects with some design experience in their country, came to Sarajevo again. Instructed in the knowledge of architectural physics at the Faculty of Architecture in Sarajevo, they were confused that in their countries 'calculations from architectural physics are not made', or more precisely, that the problem of thermal protection and parodifusion in their native countries is not a problem (it is not treated in projects), but it is the problem of 'thermal stability in the summer regime', the solution of which is a basic matter in architectural design solutions. The author was lucky enough to get to know directly those parts of the Earth whose architecture is the subject of this work: an area with a polar climate (the vicinity of Innsbruck in Austria), an area with a desert climate (Mecca, Jeddah and Riyadh in Saudi Arabia) and an area with a tropical rain forest climate (Penang and Kuala Lumpur in Malaysia). And while his stay in the Alps represented one of the most beautiful life experiences for him, he experienced the desert and tropical conditions as, for him, extremely unfavorable natural environments. Even then, he had the idea of researching these environments, that is, architecture as a framework for the lives of the people who live in these environments. More than fifteen years have passed since his travels in these three climate-specific, different natural environments, when they became the subject of his interest. The study of architecture, both vernacular and contemporary (author's), seemed to him like solving the most difficult mathematical problems. The Author teaches this and similar topics at the Faculty of Architecture of the University of Sarajevo through several courses: Architectural Physics, Bioclimatic Architecture, Architecture as an Energy System, Conceptualization and Materialization of the Boundaries of Architecturally Defined Space (ADS).

Keywords: extreme climatic conditions, society, man, architecture

1. Introduction

Considering the title of this paper, in considering the environment (as one of the four basic components of Architecturally Defined Space, ADS), attention will be focused on the climate. At the same time, a clear distinction should be made between the terms 'climate' and 'weather', since their consequences on the conceptualization and materialization of architecture are different. Climate is a long-term average of weather, usually averaged over a period of 30 years^[1]. In considering the climate, as an important feature of the natural environment, we will use its concept and systematization

of climates on Earth taking, as the main criteria, the two most important climatic elements - air temperature and precipitation - based on their accurately measured monthly and annual values. The vegetation of a certain area also played a big role in this. Köppen established five basic climate classes^[2]:

- A. Tropical rainy climates,
- B. Dry climates,
- C. Moderately warm rainy climates,
- D. Snow-forest (boreal) climates,

E. Snowy (polar) climates.

At the same time, climate types B and D are predominantly continental, and climate types A, C and D – climates of geographical areas with forests.

The variety of climate on Earth is shown in Figure 1.

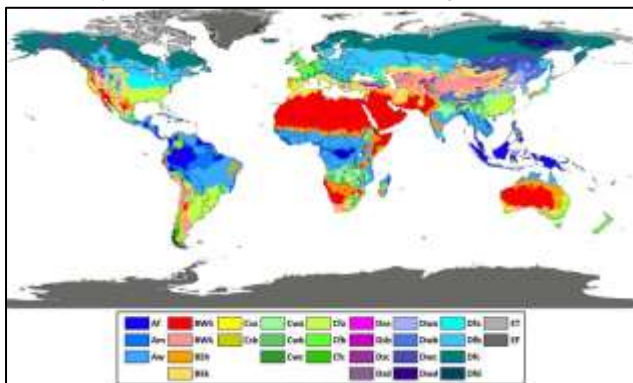


Figure 1. Köppen climate classification map

Source:

https://commons.wikimedia.org/wiki/File:K%C3%B6ppen_World_Map_High_Resolution.png, Accessed: July 6, 2023.

Weather is the state of the atmosphere, describing, for example, the degree to which it is hot or cold, wet or dry, calm or stormy, clear or cloudy [3]. On Earth, most weather phenomena occur in the lowest level of the Earth's atmosphere, the troposphere, just below the stratosphere. Weather refers to daily temperature and precipitation activity, while climate is a term for averaging atmospheric conditions over longer periods of time. Weather is conditioned by air pressure, temperature and humidity differences between one place and another. These differences can occur due to the angle of incidence of the Sun's rays at any given location, which varies with latitude. The strong temperature contrast between polar and tropical air leads to the largest atmospheric circulations. Mid-latitude weather systems, such as extratropical cyclones, are caused by current flow instabilities. Because the Earth's axis is tilted relative to its orbital plane (the ecliptic), sunlight falls at different angles at different times of the year. On the Earth's surface, temperatures usually range from ± 40 °C per year. Over thousands of years, changes in Earth's orbit can affect the amount and distribution of solar energy received by Earth, thus influencing long-term climate and global climate change. Extreme weather or extreme climate events include unexpected, unusual, severe or unseasonal weather. Often, extreme events are based on the recorded time history of a place and are defined as the condition in the most unusual 10% of that historical time [4]. Extreme weather is a weather event such as snow, rain, drought, flood or storm that is rare for the location where it occurs. For example, normal temperatures at the equator would constitute a heat wave if they occurred at the North Pole. Because extreme weather events have always occurred, even before anthropogenic (human-caused) climate change became unequivocally present starting around 1980, it was impossible to attribute any extreme event to climate change. Climate change will probably increase the frequency of heat waves or other extreme weather events, but it will never be possible to point to one such event and say that it was caused by climate change. On the other hand, it is possible to assess the effects of climate change on the frequency and average strength of extreme weather events. There is evidence that some weather extremes have already shifted: the number of cold nights has decreased, for example, while the number of warm nights

(associated with heat waves) has increased. Droughts, storm intensity and heat waves have increased and will continue to do so. Most categories of extreme weather events, with the exception of cold waves, are projected to continue to increase with global warming.

Therefore, in this paper, the architecture in the Pojasevimia will be considered:

- Polar climates (climate type E according to Köppen),
- Dry climates (climate type B according to Köppen) and
- Tropical rainy climates (climate type A according to Köppen).

It is understood that extreme conditions can occur in all types of climate (such as very limited climatic conditions, i.e. the weather), but the considerations in this paper do not apply to them.

2. Environment

The environment is a fundamental feature of an Architecturally Defined Space (ADS). As a complex expression of human struggle, architecture is simultaneously a strictly defined empirical phenomenon that is always realized in a concrete natural environment in which it must survive as a physical structure, resistant to more or less aggressive natural influences. At the same time, many inputs from the social environment give architecture the characteristics of a concrete society in a historical-temporal context.

2.1. Natural environment

When we talk about the natural environment, we mean "those parts of the visible world that were not created by man and that we can discern with our senses" [5]. The term 'nature' refers to all physical phenomena, from microscopic to macroscopic dimensions, from matter and energy to the Universe. As Architecturally Defined Space (architecture, ADS) is always realized in a concrete natural environment, mutual dependence of nature on the architectural object and the architectural object on nature is understood. This mutual dependence is sometimes so obvious that architecture (built objects) resembles a living, natural organism that is in a symbiotic relationship with its natural environment. There are cases when the built environment (architectural object) imposes itself on the natural environment with its artificiality to the extent that it more than obviously represents a 'foreign body' in the concrete natural environment. From the beginning of his existence on Earth, similar to other living organisms in nature, man made his shelter in the best understanding of the respective natural environment, exclusively from materials found on the spot. Every human intervention in the natural environment is basically the creation of an artificial world that lives in parallel with nature. The world created by man, initially only as a shelter, over time imposed itself on nature, with a more or less recognizable aspiration towards its autonomy, often with a visible aspiration of superposition over nature. Man understood this aspiration by his immanent need to master nature, and later, to create a world wherever he wanted, better, more beautiful and more pleasant than any place in the natural environment.

2.1.1. The natural environment of the polar climate

The climates of polar land areas vary depending on their latitude, proximity to the sea, altitude and topography (Figures 2-4). Due to the high latitudes, solar energy is limited to the summer months. Although it can be considerable, its effectiveness in increasing surface temperatures is limited by the high reflectivity of snow and

ice. Only in the central polar basin does the annual net radiation fall below zero. In winter, radiation cooling on the surface is associated with extreme cold, but at altitudes of several thousand meters, you can often find places with high temperatures, from 11 °C to 17 °C. Temperature inversions like this occur more than 90% of the time in the middle of winter in northwestern Siberia and most of the Polar Basin. They are common over the Greenland ice cap and in the sheltered mountain valleys of the Yukon and Yakutia [6]. The lowest surface temperatures ever recorded in North America were in Snag, Yukon (-63 °C), and even lower temperatures were recorded in Yakutia (-68 °C) and northern Greenland (-70 °C). Summer temperatures are more uniform throughout the Arctic. On the southern border, the monthly mean temperature reaches 10 °C, and in the continental areas short-term heat with temperatures up to 32 °C (in the 1980s), continuous sunny weather and calm weather are not uncommon. In the maritime climate, along the coast and on the northern islands, when there is open water in the sea ice, the summer is relatively cold. In the south, temperatures are around 7 °C, decreasing in the north to 4 °C or less. A maximum of 16 °C is almost never reached, except at the heads of fjords like in the southwest of Greenland, where the marine influences are less pronounced. Fog and low clouds are widespread in the sea areas, and at this time of the year these areas are the most attractive in the world. In areas with continental winters, precipitation is heaviest during the summer months. Light rain and snow showers are common, but average precipitation is low. Summer is a time of sudden changes everywhere. Calm, clear weather with sunny rays and temperatures of around 10 °C will be followed by sudden winds, which often cause the temperature to drop from 11 °C to 17 °C, accompanied by clouds and fog.



Figure 2. Areas on Earth with a polar climate

Source:

https://upload.wikimedia.org/wikipedia/commons/0/0a/Koppen_classification_worldmap_E.png, Accessed: July 6, 2023.



Figure 3. Left: Greenland. Right: Antarctica

Source:

https://lh5.googleusercontent.com/p/AF1QipN0ML7erf2YxI4F9-Yzo5vm2wT_cpXXIaOmdRp1=h1440, Accessed: July 6, 2023.

Source:

<https://lh5.googleusercontent.com/p/AF1QipOHHO6bhcx00mBiF-ApLk7ul5LmIz9Dg-Bqi3LLO=h1440>, Accessed: July 6, 2023.



Figure 4. Left: Himalayas. Right: Andes

Source:

<https://lh5.googleusercontent.com/p/AF1QipNkEntgjMb2W81qyT-NpksWucmNH2VEzOvqlbXsh=h1440>, Accessed: July 6, 2023.

Source: <https://lh5.googleusercontent.com/p/AF1QipNTJibDWF-63SgrXP7NfCUkPmCtVL5Tw6BuOrzN=w2560-h1440-pd>
Accessed: July 6, 2023.

Resources in the polar climate environment.

The most important natural resources in the environment of the polar climate are: snow (as a building material), water (the sea, as a habitat for fish and various mammals that are the basis of human nutrition and raw materials for making clothes and shoes: humpback whale, walrus, narwhal, seal), terrestrial mammals (polar bear, polar fox, polar wolf, polar rabbit, polar deer-reindeer, elk (...), some of which are used for food, while clothes and rugs are made from the fur of all the mentioned animals, and birds (whose eggs are used for food), (Figure 5). Mineral resources in

the polar climate include: coal, ores (iron, zinc, lead, nickel, precious metals, diamonds and other precious stones), building materials (stone, sand and gravel). In recent times, large reserves of oil and natural gas have been found under the seabed. The representation of plants is scarce, but there is a wide variety of lichens, mosses and algae (which are food for arctic deer). Some plants can grow in the tundra region : sedge, grass and dwarf woody shrubs and miniature flowering plants (Figure 6).



Figure 6. Flora in the polar climate environment

2.1.2 Natural environment of desert climate

Desert climate or dry climate (in the Köppen climate classification BWh and BWk) is a climate in which there is an excess of evaporation compared to precipitation^[2]. Typically bare, rocky or sandy surfaces in desert climates retain little moisture and evaporate what little rain they do receive. Covering 14.2% of the land surface, hot deserts are the most common type of climate on earth after the polar climate. Although no part of the Earth is known to be absolutely rain-free, in the Atacama Desert in northern Chile, the average annual amount of rain over a period of 17 years was only 5 millimeters. Some places in the Sahara desert, such as Kufra in Libya, record only 0.86 millimeters of rain per year. The official weather station in Death Valley in the USA reports 60mm per year, but in the 40-month period between 1931 and 1934, a total of 16mm of rain was measured. There are two variations of desert climate: hot desert climate (BWh) and cold desert climate (BWk), (Figure 7). There are three widely used isotherms to demarcate a 'hot desert climate' from a 'cold desert climate': the most common mean annual temperature is 18 °C, or sometimes a mean temperature of 0 or -3 °C in the coldest month, so a place with a climate of type BW with a corresponding temperature above any isotherm used is classified as 'hot dry' (BWh), and a site with a corresponding temperature below the given isotherm is classified as 'cold and dry' (BWk). Most areas with a desert and arid climate receive between 25 and 200 mm/m² of rain annually.

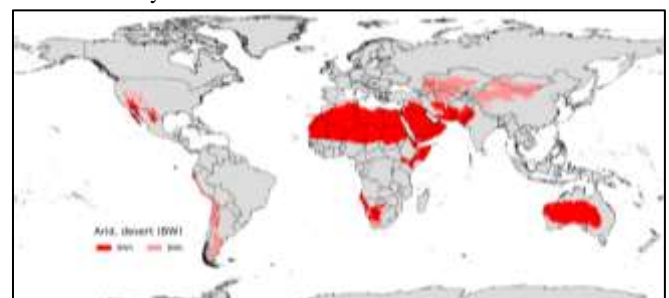


Figure 7. Regions with a desert climate: BWh (hot desert climate) BWk (cold desert climate)

Source:

https://upload.wikimedia.org/wikipedia/commons/4/48/BW_climate.png, Accessed: July 6, 2023.

Hot desert climates (BWh) are typically found below the subtropical ridge in the lower midlatitudes, often between 20° and 33° N and S latitude (Figure 8). In these places, stable descending air and high pressure above them create hot, dry conditions with strong solar radiation. Hot desert climates are generally hot, sunny, and dry year-round. They are found in vast areas of North Africa, the Middle East, northwestern parts of the Indian subcontinent, inland Australia, smaller areas of the southwestern United States, and Chile. Hot deserts present on all continents except Europe and Antarctica, although Almería in southern Spain has such a climate. In the time of the high Sun (summer), scorching and drying heat prevails. Average temperatures in the hot months are usually between 29 °C and 35 °C, with midday readings of 43-46 °C common. World records of absolute high temperature, over 50 °C, are mostly in hot deserts, where the thermal potential is the highest on the planet. This includes a record of 56.7 °C in Death Valley, which is currently considered the highest temperature recorded on Earth. In some desert places, very high temperatures occur continuously throughout the year, even during winter. These places have some of the highest annual average temperatures recorded on Earth, exceeding 30 °C. This last feature can be seen in parts of Africa and Arabia. During colder periods of the year, nighttime temperatures can drop to freezing or below because of the extreme loss of radiation under clear skies. However, very rarely do temperatures drop far below freezing. Hot desert climates can be found in the deserts of North Africa, such as the vast Sahara Desert, the Libyan Desert, or the Nubian Desert. The deserts of the Horn of Africa are the Danakil deserts or the Grand Bara deserts. The deserts of South Africa are the Namib deserts or the Kalahari deserts. The deserts of the Middle East are the Arabian deserts, the Syrian deserts or the Lut deserts. The deserts of South Asia are the Dasht-e Kavir or the Thar deserts of India and Pakistan. The deserts of the United States and Mexico are the Mojave Desert, the Sonoran Desert, or the Chihuahuan Desert. The deserts of Australia are the Simpson deserts or the great deserts of Victoria and many other regions.

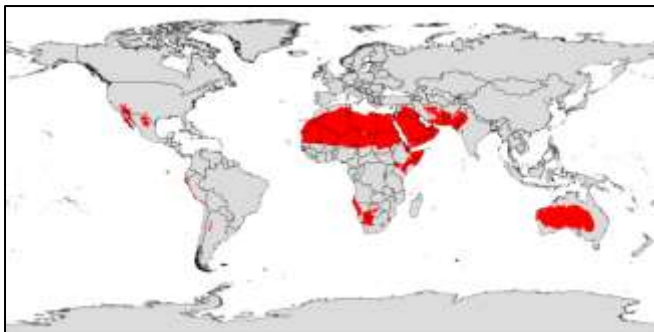


Figure 8. Regions with a hot desert climate

Source:

https://upload.wikimedia.org/wikipedia/commons/b/bf/Koppen-Geiger_Map_BWh_present.svg, Accessed: July 6, 2023.

Famous arid deserts include the Sahara Desert, which covers most of the African continent, and the Mojave Desert, located in the southwestern United States. Semi-arid deserts are slightly cooler than hot and dry deserts (Figures 9, 10). Long dry summers in semi-arid deserts are followed by winters with little rain. Semi-arid deserts are found in North America, Greenland ('ice desert'), Europe and Asia. Coastal deserts are slightly wetter than other types of deserts. Although strong fogs blow from the coast, rains are still rare. The Chilean Atacama Desert in South America is an

example of a coastal desert. Cold deserts are still dry, but have extremely low temperatures compared to other types of deserts. Antarctica is an example of a cold desert.



Figure 9. Lijevo: Dolina smrti (Death Vally), SAD. Desno: Pustinja Atacama, Čile

Source:

<https://lh5.googleusercontent.com/p/AF1QipNr8PMTFdL7DVxt4zqldCzSxJmurKFc9m4huEFt=w2560-h1440-pd>

Accessed: June 26, 2023.

Source: <https://www.livescience.com/64752-atacama-desert.html>,

Accessed: June 26, 2023.



Figure 10. Left: Sahara desert. Right: Namibian desert

Source:

https://lh5.googleusercontent.com/p/AF1QipOFL8Qwp1FXFETTgkHk8BAhAogfHnqyG0G8P_vj=h1440, Accessed: June 26, 2023.

Source:

https://lh5.googleusercontent.com/p/AF1QipNuCpKo3XfuVSfu6ToZeYQqG_zRPgWK1bR0okfd=h1440, Accessed: June 26, 2023.

Cool desert climates (BWk) usually have hot (or in a few cases warm), dry summers, although summers are usually not as hot as in hot desert climates [2]. Unlike hot desert climates, cool desert climates tend to have cold and dry winters. Snow is usually rare in regions with this climate. The Gobi Desert in Mongolia is a classic example of cold deserts. Although hot in summer, it shares very cold winters with the rest of Central Asia. Cold desert climates are usually located at higher elevations than hot desert climates and are usually drier than hot desert climates (Figures 11-17). Cold desert climates are usually found in temperate zones, usually in the rain shadow of high mountains, which limit precipitation from westerly winds. An example of this is the Patagonian desert in Argentina, bordered by the Andes in its west. In the case of Central Asia, mountains limit monsoonal precipitation. The Kyzyl Kum, Taklamakan, and Katpana deserts of Central Asia and the drier parts of the Great Basin Desert in the western United States are other major examples of BWk climates. The Ladakh region and the city of Leh in the Great Himalayas of India also have a cool desert climate. The Hautes plains are another prime example of a cold desert climate, located in the northeastern part of Morocco and in Algeria. This type of climate is also found in Europe, primarily in the Bardenas Reales near Tudela, Navarre, Spain and parts of the high altitude Tabernas Desert in Almeria, Spain. Arctic and Antarctic regions also receive very little precipitation during the year due to extremely cold, dry air. However, both are generally classified as polar climates, as they have average summer temperatures below 10 °C.

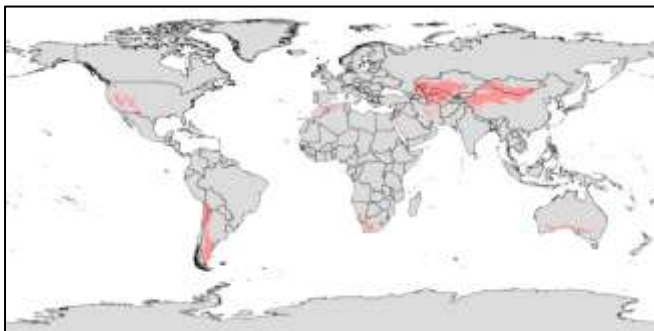


Figure 11. Regions with a cold desert climate

Source:

https://upload.wikimedia.org/wikipedia/commons/0/07/Koppen-Geiger_Map_BWk_present.svg, Accessed: June 26, 2023.



Figure 12. Left: Death Valley National Park in the Great Basin, southeastern California (USA). Right: Black Rock Desert in Nevada. Minerals, algae and cyanobacteria give this geyser a wide range of colors

Source:

<https://www.britannica.com/science/desert/Biota>,

Accessed: June 27, 2023.

Source:

<https://www.nationalgeographic.com/environment/article/deserts>,

Accessed: June 27, 2023.



Figure 13. Left: Patagonian desert, Argentina. Right: Gobi Desert (Mongolia)

Source: <https://www.askqotd.com/thepatagonian-desert/>, Accessed: June 27, 2023.

Source: <https://www.audleytravel.com/ca/mongolia/places-to-go/the-gobi-desert>, Accessed: June 27, 2023.



Figure 14. Left: Lüt Desert, Iran. Right: Desert landscape near Riyadh (Saudi Arabia)

Source: <https://www.britannica.com/science/desert/Biota>,
Accessed: June 27, 2023.



Figure 15. Left: Ergs are vast expanses of sand dunes like this area in Oman. They are sometimes called the sand sea, because the dunes look like ocean waves. Right: Hindu pilgrims gather at Pushkar, in the Thar Desert, Rajasthan state, India

Source:

<https://www.nationalgeographic.com/environment/article/deserts>,
Accessed: June 27, 2023.

Source: <https://www.britannica.com/science/desert/Biota>,
Accessed: June 27, 2023.



Figure 16. Left: Sahara Desert, near Merzouga, Morocco. Right: An oasis in the Libyan desert (Libya)

Source: <https://www.britannica.com/science/desert/Environment>,
Accessed: June 27, 2023.

Source: <https://www.britannica.com/science/desert/Biota>,
Accessed: June 27, 2023.





Figure 17. Left: The sand dunes surrounding Sossusvlei, the termination of Tsauchab, an intermittent stream in the south-central Namib, Namibia. Right: Simpson Desert (Australia)

Source: <https://www.britannica.com/science/desert/Biota>,

Accessed: June 28, 2023.

Source: <https://www.pinterest.com.au/pin/441141725979338673/>,

Accessed: June 28, 2023.

Resources in the desert climate environment. In any natural environment, water is the fundamental basis for life. In some deserts, there are sporadic places (oases) where water comes to the surface from underground reservoirs, creating extremely rich habitats for people, flora and fauna. There are such places in deserts: Sahara (Arabic: الصحراء الكبرى/as-ṣaḥrā' al-kubrā = great desert), Arabian Desert (Arabic: الصَّحْرَاءُ الْعَرَبِيَّةُ), Huacachina Lagoon in Chile, for example. In the Gobi desert, there are occasional rivers and lakes that are formed by the melting of snow from the surrounding mountains and can be sustained for a long time. In some deserts, more or less deep below the surface of the ground, there are reserves of thermal water (in Jordan, for example) [7]. Solar radiation is a huge resource in some deserts, which, along with water and soil, is the prerequisite for the life of green plants - food for animals, including domestic animals (camels, goats, sheep, goats, llamas...). A special resource of the desert is wind, which has recently been used as a renewable energy source. Although deserts are geographical areas with little precipitation during the year, there is still a relatively wide range of flora and fauna there (Figures 18-20). All deserts are rich in mineral resources, stone and sand (as building materials for the construction of dwellings where people live a stationary life, such as the Atacama desert in Chile), various ores (copper-in the deserts of the USA, Chile, Peru, Iran, iron, lead and zinc - in the deserts of Australia, Algeria and Mauritania, gold, silver and uranium - in Australia and the USA, phosphate - in Morocco and the Western Sahara). There are huge deposits of oil and natural gas in the Sahara desert and the Arabian desert. Today, sand dunes are a huge resource where tourists from all over the world come to practice the extreme sport of sandboarding.



Figure 18. Some major resources in deserts



Figure 19. Flora of the desert



Figure 20. Fauna of the desert

2.1.3 Natural environment of rain forests

Tropical rain forests are forests that occur in areas of tropical rain forest in a climate where there is no dry season (all months have an average amount of precipitation of at least 60 mm), and can also be called lowland equatorial evergreen rainforest (Figure 21). True rainforests are usually found between 10 degrees north and south of the equator. They are a subset of the tropical forest biome that occurs within 28 degrees of latitude (in the equatorial zone between the Tropic of Cancer and the Tropic of Capricorn), (Figures 21-23). Within the World Wildlife Fund's biome classification, tropical rainforests are a type of tropical moist broadleaf forest (or moist tropical forest) that also includes broader seasonal tropical forests [8]. Tropical rainforests can be characterized as hot and humid. Average monthly temperatures exceed 18 °C during all months of the year. The average annual rainfall is not less than 1680 mm and can exceed 10 m, although it is usually between 1750 mm and 3000 mm. This high level of precipitation often results in poor soils due to leaching of soluble nutrients in the soil. Tropical rain forests show a high level of biological diversity. About 40% to 75% of all biotic species are indigenous to rainforests. Rain forests are home to half of all living animal and plant species on Earth. Two thirds of all flowering plants can be found in rainforests. One hectare of rainforest can contain 42,000 different species of insects, up to 807 trees of 313 species and 1,500 species of higher plants. Tropical rain forests have been called "the world's largest pharmacy", because more than one quarter of natural medicines have been discovered in them. Tropical rainforests are one of the most threatened ecosystems globally due to large-scale fragmentation resulting from human activity. Habitat fragmentation caused by geological processes such as volcanism and climate change has occurred in the past and has been identified as an important driver of speciation. However, rapid human-managed habitat destruction is suspected to be one of the main causes of species extinction. Tropical rainforests have been subject to heavy logging and agricultural clearing during the 20th century, and the area covered by rainforests worldwide is rapidly shrinking.

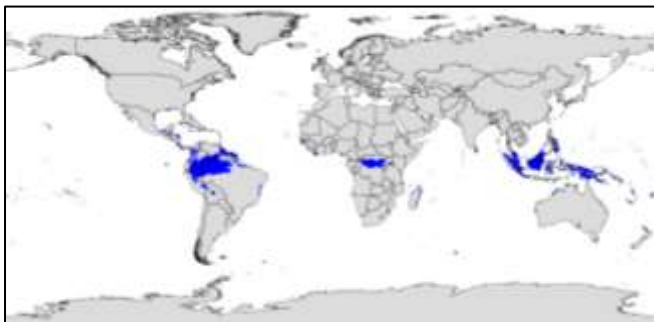


Figure 21. Climatic zones of tropical rainforests (Af)

Source:

https://upload.wikimedia.org/wikipedia/commons/c/c4/Koppen-Geiger_Map_Af_present.svg, Accessed: June 28, 2023.



Figure 22. Left: Amazon rainforest. Right: Rainforest in Africa
Source: <https://greenstarsproject.org/2019/09/08/save-amazon-rainforest-wwiiethical-consumerism/>, Accessed: June 28, 2023.

Source: <https://www.shutterstock.com/video/clip-29525767-africa-rain-forest-aerialview>, Accessed: June 28, 2023.



Figure 23. Left: Rainforest in Malaysia. Right: Rainforest in Indonesia

Source: <https://depositphotos.com/271160332/stock-video-aerial-footage-tropicalrainforest-malaysia.html>, Accessed: June 28, 2023.

Source: <https://iphndefenders.net/indonesiastill-behind-indigenous-peoplesland-recognition/>, Accessed: June 28, 2023.

Resources in the rain forest climate environment. Tropical rainforests support the greatest diversity of living organisms on

Earth. Although they cover less than 2% of the Earth's surface, rainforests are home to more than 50% of the planet's plants and animals. Rain forests are located in tropical regions, where they receive a lot of sunlight. Plants convert sunlight into matter and energy through the process of photosynthesis. Energy is stored in plant vegetation, which is eaten by animals. An abundance of energy supports an abundance of plant and animal species. The structure of the rainforest canopy provides plenty of room for plant growth and animal life. Tree canopies ('canopies') offer food sources, shelter and hiding places, enabling interactions between different species. For example, in the canopy there are plants called bromeliads that store water in their leaves. Frogs and other animals use these 'pockets' of water to hunt and lay eggs. Although there is a lot of energy in the rainforest system, life is not easy for most of the species that inhabit the biome. The rainforest is, in fact, an intensely competitive place, with species developing specific strategies and innovations for survival, encouraging specialization. Many species are known to use symbiotic relationships with other species to survive. There are four main layers (floors) in the rain forest: emergent, canopy, understory and forest floor (Figures 24-28). Each layer has unique characteristics based on different levels of water circulation, sunlight and air. Although each layer is different, they exist in an interdependent system where processes and species in one layer affect those in another. Dozens of countries have tropical forests. The countries with the largest areas of tropical forest are: Brazil, the Democratic Republic of the Congo (DRC), Indonesia, Peru and Colombia.



Figure 25. Tall tree trunks in the rain forest

Source: <https://www.nationalgeographic.com/books/article/7-us-national-parks-with-incredible-trees>, Accessed: July 6, 2023.



Figure 26. A symbiotic way of life in a tropical forest

Source: <http://trop rains.weebly.com/biotic-interactions.html>, Accessed: July 6, 2023.



Figure 27. Flora of tropical forests

Source: <https://www.activewild.com/tropical-rainforest-plants-list/>, Accessed: July 6, 2023.

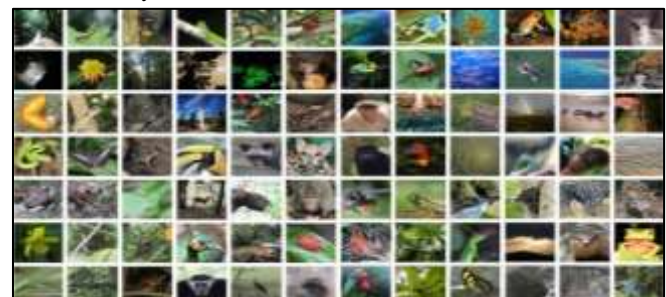


Figure 28. Fauna of tropical forests

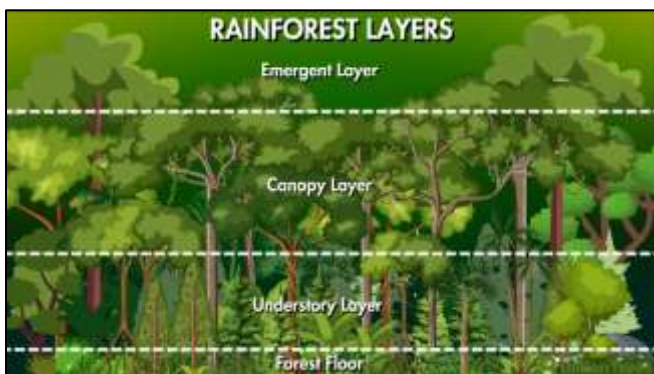


Figure 24. Slojevi kišne šume (lijevo) i emergentni sloj (emergent layer) u okolini Maya Rio Azul u Gvatemali (desno)

Source: <https://8billiontrees.com/animals/tropical-rainforest-animals/>, Accessed: July 6, 2023.

Source:

<https://rainforests.mongabay.com/kids/elementary/201.html>,

Accessed: July 6, 2023.

2.2 Social environment

The social environments of the space on Earth that are the subject of this paper are specific, in everything different from the social environment as we know it, not the space of 'European civilization' and as is usually taught in school. However, these specific social environments can also be observed through the general theory of the social environment (society), so before looking at the social environments of the space-subject of this work, we will provide basic information about society in general. A social environment (society) is a group of individuals involved in more or less permanent social interaction or a large social group sharing the same geographic or social territory, usually subject to the same political authorities and dominant cultural expectations. Societies are characterized by patterns of relationships (social relations) among individuals who share a distinctive culture and institutions. A given society can be described as the sum of such relationships between its constituent members. In the social sciences, the larger society often exhibits patterns of stratification or dominance in subgroups. Societies construct patterns of behavior by considering certain actions or speech as acceptable or unacceptable. These patterns of behavior in a certain society are known as social norms. Societies and their norms are subject to gradual and constant changes. By being collaborative, a society can enable its members to benefit in ways that would not otherwise be possible on an individual basis. In this way, individual and social (joint) benefits can be distinguished, or in many cases they overlap. According to the anthropologist Maurice Godelier (1934-), one critical innovation in society, unlike man's closest biological relatives (the chimpanzee, for example), is the parental role assumed by men, which would supposedly be absent in our closest relatives for whom paternity is mostly it is not possible to determine. Sociologist Peter Ludwig Berger (1929-2017) defines society as ...“a human product and nothing but a human product, which continuously acts on its producers“. According to him, „society was created by people, but this creation turns back and creates people or shapes every day“^[9]. Sociologist Gerhard Lenski (1924-2015) distinguishes societies based on their level of technology, communication and economy^[10]: hunting and gathering societies (primitive type), simple horticultural societies, characterized by the cultivation of simple tools (hoes and digging sticks) - appear around 8000 BC, advanced horticultural societies, characterized by copper and bronze metallurgy, simple agrarian societies, characterized by the use of the plow - appear around 3000 BC, advanced agrarian societies, characterized by iron metallurgy, industrial societies, characterized by the use of machines powered by non-living forms of energy - appear around 1750. This is similar to the system developed earlier by anthropologists Morton Herbert Fried (1923–1986), a conflict theorist, and Elman Rogers Service (1915–1996), an integration theorist, who created a classification system for societies in all human cultures based on the evolution of social inequality and the role of the state. This classification system contains four categories: hunter-gatherer bands (categorization of duties and responsibilities), tribal societies in which there are a few limited instances of social rank and prestige, stratified structures led by the elders of that civilization, with complex social hierarchies and organized, institutional governments. Over time, some cultures progressed toward more complex forms of

organization and control. This cultural evolution has a profound effect on community patterns. Forms of consciousness (philosophy, religion, science, technique and technology) are essential characteristics of every society, which have a strong influence on the primary characteristic of society - socio-economic relations^[11,12,13,14,15,16]. Non-prescribed forms of behavior and values (morality, tradition...) are important features of every society, although they are not prescribed. They are inherited (and changed) from generation to generation and thereby confirm their strength.

2.2.1 Social environment in areas with a polar climate

As areas with a polar climate are located around the North Pole, three continents, North America, Europe and Asia, 'meet' there. There are smaller distances between these continents, in relation to the North Pole, as the center of gravity (Figure 29). The peoples inhabiting this area had social relations, both along the lines of the Earth's parallels (which here are relatively short compared to the equator and moderate latitudes), and along the meridian lines, towards the depth of North America, Europe and Asia. The result of these circumstances is reflected in the ethnic diversity of the peoples who live there, as well as in the richness of their cultures.



Figure 29. Areas of the Earth with a polar climate

Source: <https://www.zarkanderson.com/2012/12/the-arctics-energy-reserves.html>, Accessed: July 6, 2023.

Arctic indigenous peoples include: Saami (in the circumpolar areas of Finland, Sweden, Norway and northwestern Russia), Nenets, Khanty, Evenki and Chukchi (in Russia), Aleut, Yupik and Inuit/Inupiat (in Alaska), Inuit/Inuvialuit (in Canada) and Inuit/Kalaallit (in Greenland), (Figures 30-41). The basic characteristics of Inuit societies are:

- Family groups were the most important social unit in Inuit culture,
- They usually lived in family groups of about 5-6 people,
- Each family lived and hunted together with 6-10 other families,
- Marriage was important for the Inuit people. Some marriages were arranged, but most were by choice,
- In marriage, there was an obvious division of labor: men built houses and hunted, while women cooked, dressed animal skins, made clothes and took care of children.

In traditional Inuit households, children were treated with patience and gentleness, and in response, children were rarely disobedient (Figure 30). Slapping and scolding were not considered acceptable

forms of child control. Generosity, gentleness and tenderness were considered very good qualities by the Inuit. Since their society relied on the cooperative effort of all its members, these qualities became indispensable. Losing your temper, on the other hand, was considered shameful. Moreover, hasty anger could endanger the well-being of the community. Today, many Inuit follow either the Catholic or Anglican faith. Missionaries from these two denominations came to the Arctic in the early 1900s, bringing medicine, technology and faith. The Inuit were impressed and would buy the whole package. The older Inuit still believe in shamans, and their ideology is a blend of traditional beliefs and modern theology.



Figure 30. Inuit families from Alaska

Source: https://firstpeoplesofcanada.com/fp_groups/fp_inuit6.html,

Accessed: July 6, 2023.

Source: <https://www.britannica.com/topic/Eskimo-people>,

Accessed: July 6, 2023.



Figure 31. Left: An Inuit family in front of a tupik (a tent made of animal skins and used in the warmer months), Pond Inlet, Canada (1906). In the middle and on the right: Children of the Inuit people in Alaska (beginning of the 20th century)

Source: <https://allthatsinteresting.com/inuitpeople#1>, Accessed: July 6, 2023.

Source: <https://www.pinterest.co.uk/pin/445926800593443610/>, Accessed: July 6, 2023.



Figure 32. Left: Dog sleds were key to the traditional Inuit way of life until the 1950s. Center and right: An Inuit preparing to throw a harpoon from his kayak while hunting in the Bering Sea, left (1929) and an Alaskan Inuit next to a shot polar bear

Source: <https://www.britannica.com/topic/Eskimo-people>,

Accessed: July 6, 2023.

Source: <https://www.dailymail.co.uk/news/article-2253029/Historic-photographsdocument-Alaskas-Inuit-Eskimosurvived-worlds-coldest-winters.html>, Accessed: July 6, 2023



Figure 33. Left: Inuit woman fishing in Nome, Alaska (early 20th century). In the middle: The Inuita hunting party hunts

the beluga whale, which can provide food for an entire community for a long period of time. Right: Inuit on a traditional sleigh after a hunt, Cape Dorset, Nunavut, Canada

Source: <https://www.britannica.com/topic/Eskimo-people>, Accessed: July 6, 2023.

Source: <https://allthatsinteresting.com/inuitpeople#1>, Accessed: July 6, 2023.



Figure 34. An Inuit with a large drum made of walrus stomach or bladder, left (Nunivak Island. 1929) and a girl and an adult man playing a drum in a tent (1949), center and right

Source: <https://www.britannica.com/topic/Eskimo-people>, Accessed: July 6, 2023.

<https://allthatsinteresting.com/inuitpeople#1>, Accessed: July 6, 2023.



Figure 35. Left: Larry Griswold got the idea for the trampoline from a game invented by the Inuit. They would use the skin of a sea seal to repel each other into the air. Right: Inuit Winter Festival (Quviasukvik)

Source: <http://larrygriswold.weebly.com/history-of-trampolines.html>, Accessed: July 6, 2023.

Source: <https://arctickingdom.com/quviasukvik-the-inuit-winter-festival-andchristmas/>, Accessed: July 6, 2023.

Within reindeer breeders, every individual, regardless of age and gender, owns livestock. Inheritance among the Sámi is limited by various practices of the dominant society. Following tradition, the inheritance of parental dwellings, plots of land, livestock, locations for the use of resources and other wealth, as well as the responsibility and care of elderly parents, will usually fall to the youngest child.



Figure 36. Left: Sámi people, Northern Sweden (around 1880). Right: Sámi people, Lavvu (around 1900)

Source: <http://www.whitewolfpack.com/2015/12/rare-old-photos-of-indigenoussami>, Accessed: July 6, 2023.

Source: <http://www.whitewolfpack.com/2015/12/rare-old-photos-of-indigenoussami.html>, Accessed: July 6, 2023.



Figure 37. Sámi woman and child, Enare, Finland (left, around 1900) and Sámi mother and child (right, 2000)

Source: <https://www.flickr.com/photos/28772513@N07/3581787874>, Accessed: July 6, 2023.

Source: <https://www.discover-the-world.com/blog/yoiking-with-the-sami-near-bodo-norway/>, Accessed: July 6, 2023.



Figure 38. Left: Sámi people in collective fishing (circa 1900). Right: Contemporary Sámi reindeer herders, Sweden (2000)

Source: <https://www.quora.com/How-did-the-Sami-people-organize-their-society-What-were-their-social-rules>, Accessed: July 6, 2023.

Source: <https://sweden.se/society/sami-insweden/>, Accessed: July 26, 2022.



Figure 39. Handicrafts of the Sámi people

Source: <https://www.hurtigruten.com/excursions/norway/6c-sami-culture/>, Accessed: July 6, 2023.

Source: <https://nordnorge.com/en/tema/thesami-are-the-indigenous-people-of-the-north/>, Accessed: July 6, 2023.

Source: <https://visitsweden.com/where-to-go/northern-sweden/swedishlapland/sapmi-and-sami/>, Accessed: July 6, 2023.



Figure 40. Society of contemporary Sámi people

Source: <https://lauklines.no/en/activities/explore-the-sami-culture/>, Accessed: July 6, 2023.

Sámi allaskuvla/Sámi University of Applied Sciences/University of Applied Sciences Sámi is an autochthonous institution that preserves and promotes the Sámi language, culture and community life (Figure 41). At this university, the Sámi language is the main teaching, research and administrative language. All studies have a Sámi or indigenous perspective, and strong links with other indigenous institutions have been built. The Sámi University of Applied Sciences has national responsibility in Norway for Sámi teacher training, journalist education and higher education, and also has an important role for higher education in Finland and Sweden. Promotes the Sámi perspective in research and teaching. This university has two faculties, both competent for circumpolar and arctic cooperation: the Department of Language, Duodji, Animal Husbandry and Social Sciences and the Department of Sámi Teacher Education and Indigenous Journalism.



Figure 41. Sámi allaskuvla/Sámi University of Applied Sciences/University of Applied Sciences Sámi, Kautokeino, Norway. The university building (left), a young Sámi girl next to an exhibit of clothes in the Sámi tradition (right)

Source:

<https://www.uarctic.org/memberprofiles/norway/8710/sami-universityof-applied-sciences>, Accessed: July 16, 2021.

2.2.2 Social environment in areas with a desert climate

People have lived in the desert for thousands of years and have adapted to its extreme conditions. The Chinchorro culture developed in the Atacama desert area from 7000-1500 BC. These peoples were stationed fishermen who inhabited, mainly, coastal areas. Their presence has been confirmed by archeological finds near the present-day cities of Ilo, in southern Peru, to Antofagasta in northern Chile (Figure 42). The presence of fresh water in the arid area on the coast facilitated the settlement of people in these areas. The Chinchorro were known for their elaborate mummification. The Atacama people, also called Atacameño, are indigenous people from the Atacama desert and the Altiplano region (Spanish: llanura alta = high plain) in northern Chile and Argentina and southern Bolivia. According to the 2010 Argentine census, 13,936 people identified as first-generation Atacameño in Argentina [17], while Chile was home to 21,015 Atacameño people as of 2002. Other names include Kunza and Likanantaf. The Tiwanaku people were the first known invaders. In the early 15th century, the Atacameño was conquered by the Inca emperor Topa Inca Yupanqui, who introduced a new social order, the cult of the Inca Sun, and various customs, including coca leaves. The Inca regime built roads from the Salar de Atacama to present-day northeastern Argentina. In 1535, the first Spanish conquistadors arrived in the area and it was finally annexed under Spanish control in 1556. In the 18th century, the Atacameño Tomás Paniri joined the uprisings led by the Peruvian Túpca Amaru II and the Bolivian Túpca Katar. In 1824, the region became part of Bolivia, and in 1883, it became a Chilean possession. In 2007, the Atacameño population was estimated at 21,015 people [18]. The Atacameños protected their villages with strong stone walls known as 'pukara'.

They developed ceramic crafts, copper work (using copper mined from Chuquicamata) and goldsmithing. Many historic villages still exist today with the same names, including Quito, Chiu-Chiu, Lasana, Turi, Topayín, Susques, Calama, Toconao, Antofagasta de la Sierra and one of the most important settlements in the region, San Pedro de Atacama. The original language of the Atacameños was the recently extinct Kunza language. The photograph (Figure 43) documents some features of the social life of the people living in the Atacama.



Figure 42. Left: Remains of an ancient settlement in Atacama (photo taken by drone). Right: Pukará de Quito (Pucará de Quito), a pre-Columbian archaeological site in northern Chile. This stone fortress is located 3 km northwest of the city of San Pedro de Atacama, overlooking the valley of the San Pedro River. Declared a national monument in 1982.

Source: <https://theconversation.com/how-a-preincan-civilisation-thrived-in-theatacama-desert-thanks-to-seabird-poo-fertiliser-153759>

Accessed: July 6, 2023.

Source:

https://upload.wikimedia.org/wikipedia/commons/a/a3/Pukar%C3%A1_de_Quito_o_Pucar%C3%A1_de_Quito_02.JPG

Accessed: July 6, 2023.



Figure 43. People of the Atacama people at a church ceremony

Source: <https://www.youtube.com/watch?v=4LZJhywvgH0>, Accessed: July 6, 2023.

The Gobi (meaning 'desert' in Mongolian) is located in Central Asia. It is the fifth largest desert on Earth and the largest cold-winter desert in the world. It lies north of the Himalayan mountain range which blocks rain clouds traveling north from the Indian Ocean. This is why it is also called the 'rain shadow' desert. One of the driest parts of the Gobi desert is the eastern steppe of the Gobi desert, which has no trees, only low hills, and vast flat areas dominate. Wind-blown dust fills dry surfaces, and the temperature ranges from -40 °C in winter to even 50 °C in summer. Animal husbandry ('pastoral nomadism') has been going on in the Gobi desert for centuries. One animal more than any other has shaped the human history of Central Asia, including the Gobi Desert, and that is the horse. Horses have been used by people for about 5000 years. This enables the nomads to travel far and fast, as well as to obtain milk and meat for food. The horse is an important part of the history of the Gobi, the wars. Other animals such as goats and camels are also raised. Throughout history, the nomadic tribes of the Mongolian steppe formed empires to rule vast areas of Central Asia, including the Gobi Desert. The first of these was the Xiongnu, who fought many battles with the Chinese Han Dynasty more than 2,000 years ago. The use of horses to fight in wars and travel long distances in the desert and steppe became a normal part of life in Central Asia. The harsh environment of the Gobi desert and the Mongolian steppes created a way of life that by the 13th century helped Genghis Khan (Genghis Khan, 1158-1227) and his descendants to establish the mighty Mongol Empire, the largest land empire ever. Even the harsh desert steppe of the East Gobi was no longer an obstacle. Nomads and traders used horses and camels to establish trade routes across the Gobi Desert between Mongolia and China. Even today, almost a third of Mongolian households earn their living by raising livestock, and many of them spend at least part of the year as nomads, traveling across the steppe in search of the best pastures. They still get meat and milk from their horses. The main religion in Mongolia is Buddhism with about 90% followers of the Mongolian population. The rest are Islam, shamanism and a few Christians. The oldest religion of Mongolia is shamanism, since it originated within the clan structure. Archaeological findings suggest that shamanism has existed there for more than 40,000 years. The photographs (Figures 44,45) document the main features of the religion, culture and social life of the people living in the Gobi desert.



Figure 44. Lijevo: Ovoo, tradicionalni mongolski žrtvenik. Desno: Mongolska kaligrafija

Source: <https://www.selenatravel.com/mongolian-culture>,
 Accessed: July 6, 2023.



Figure 45. Left: Local tolbo artist, Uligii. Right: Mongolian traditional musicians

Source: <https://www.selenatravel.com/mongolian-culture>,
 Accessed: July 6, 2023.

The Tuareg (a large Berber ethnic confederation; mostly inhabiting the Sahara in a vast area stretching from extreme southwestern Libya to southern Algeria, Niger, Mali, and Burkina Faso.) have traditionally adhered to Berber mythology. Archaeological investigations of prehistoric tombs in the Maghreb revealed skeletal remains that were painted with ochre colors. Although this ritual practice was known to the Iberomaurians, it appears that the custom was largely derived from the succeeding Capsian culture. Megalithic tombs were also erected for religious and funerary purposes. In 1926, one such tomb was discovered south of Casablanca. The monument was inscribed with funerary inscriptions in the ancient Libyan-Berber script known as Tifinagh, which the Tuareg still use. During the medieval period, the Tuareg adopted Islam after coming into contact with the Umayyad Caliphate in the 7th century. In the 16th century, under the influence of El Maghili, the Tuareg embraced the Maliki school of Sunnism, which they now primarily follow. The Tuareg helped spread Islam further into western Sudan. Although Islam is the religion of the contemporary Tuareg, historical documents suggest that they initially resisted Islamization efforts in their traditional strongholds. They also retained elements of pre-Islamic cosmology and ritual, especially Tuareg women. For example, Tuareg religious ceremonies contain allusions to matrilineal spirits, as well as to fertility, menstruation, the earth, and ancestors. The Tuareg are one of the influential ethnic groups that helped spread Islam and its heritage in North Africa and the neighboring Sahel region. Timbuktu, an important Islamic center known for its ulema (religious scholars), was founded by the Imasheghen Tuareg in the early 12th century. It flourished under the protection and rule of the Tuareg confederation. In 1449, the Tuareg ruling house established the Tenere Sultanate of Air (Sultanate of Agadez) in the city of Agadez, in the Air Mountains. 18th-century Tuareg Islamic

scholars such as Jibril ibn 'Umar later preached the value of revolutionary jihad. Inspired by these teachings, Ibn 'Omer's disciple, Usman dan Fodio, would go on to lead the Fulani Jihads and establish the Sokoto Caliphate. The photographs (Figures 46-50) document the main features of Tuareg culture and society.



Figure 46. Left: Touaregs at a festival in the desert near Timbuktu, Mali. Right: Tuareg celebration in Sbiba, western Tunisia. Most people own a takouba, the Tuareg sword

Source: <https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023.



Figure 47. Ghat Festival in Libya (December 2013). In an annual event, the Tuareg tribes of the region and tourists come together to celebrate the traditional culture, folklore and heritage of the Tuareg in the ancient city of Ghat located in the southwest corner of Libya

Source: <https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023.





Figure 48. Tuaregs perform their traditional music as well as contemporary (world) music

Source:

<https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023.



Figure 49. Tuareg jewelry

Source:

<https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023.



Figure 50. Scholars of the Qur'an treat mostly men with verses from the Qur'an and some psychological counseling techniques. Female herbalists treat mainly women and children with leaves, roots, bark and some holistic techniques such as verbal spells and laying on of hands. Practitioners called bokawa (Hausa term; sing. Boka) treat with perfumes and other non-Kuranic methods. In addition, 'spirit possession' is cured by drummers

Source:

<https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023.

The first human communities in Arabia date back to about 20,000 years ago. Nomadic families and tribes moved across the fertile land in the center of the region, first hunting and gathering other foods in nature and then raising their own livestock. In the Arabian desert oases, the green areas around the springs helped the nomads to explore the harsh desert conditions by traveling from one oasis to another. The largest oasis on Earth is Al-Ahsa'a in eastern Saudi Arabia. 1000 years ago it was one of the largest population centers in the world. The many natural water sources in the area meant that

people could grow crops and fruit. Al-Ahsa'a is still famous for its dates, as well as for the cultivation of rice, corn, wheat, lemons and other fruits. Until 50 years ago, most people in Saudi Arabia (a country that contains much of the Arabian Desert) were nomads. They traveled across the desert with their camels, goats and sheep using wadis (desert rivers that only fill when it rains) and oases to grow their crops. Since the 1960s, the number of nomads has declined rapidly and less than 5% of the population of Saudi Arabia is now nomadic. Beneath the desert are trillions of barrels of oil and gas that have provided enormous wealth to many countries around it. Large cities were built, especially in the northwest of the region. In the desert, 'artificial oases' of concrete, steel and glass have grown. The tallest building in the world is the skyscraper Burj Khalifa in Dubai, which is 829.8 meters high, built in 2009 (according to the project of architect Adrian Smith, SOM group). This is a contrast never seen in the history of mankind, achieved in a time of only one hundred years. Many people in the Sahara keep livestock and form small farms where they grow as much food as possible to feed themselves and their families. This breeding is called 'natural breeding'. The photographs (Figures 51-54) document the way of life, culture and social life of the Bedina people.



Figure 51. Left: Bedouins raising goats. Right: Meeting (conversation) of men in a Bedouin tribe tent

Source:

<https://www.oddizzi.com/teachers/explore-the-world/physicalfeatures/ecosystems/deserts/what-can-you-find/people/>

Accessed: July 6, 2023.

Source:

<https://egyptianstreets.com/wpcontent/uploads/2018/11/sinaiphoto-1.jpg>, Accessed: July 6, 2023.



Figure 52. Lunch in a Bedouin tribe

Source: <https://www.pinterest.com/pin/513551163730992774/>,

Accessed: July 6, 2023.

Source: <http://discoversinai.net/english/abedouin-feast/4548>,

Accessed: July 6, 2023.



Figure 53. The Bedouins (Rashaida people of Massawa, Erire) dance at their wedding ceremonies

Source:

<http://kwekudeetripdownmemorylaneyou.blogspot.com/2014/02/rashaida-people-ancientbedouin-arabs.html>, Accessed: July 6, 2023.



Figure 54. Camel and horse race, a favorite pastime among Bedouins

Source: <https://www.flysaa.com/it/26-degreessouth/celebrating-desert-lifeinternational-festival-of-the-sahara>, Accessed: July 6, 2023.

The Bantu communities that engaged in animal husbandry were particularly influential in that area (Figure 55). Livestock was their source of movable wealth. People who owned cattle gained political power by lending cattle to neighbors, who in turn were obliged to provide support and assistance to the lender. In this way, cattle lending created new political relations and included outsiders in existing political and social groups. Pastoral Bantu communities spread their religion as they traveled, introducing new spirits and beliefs to the communities they visited. Their media established new centers of spiritual and political power that competed with and often replaced local spirit worship. Between 1000 and 1500, new forms of economic, political, religious and social life, which arose under the influence of the Bantu, completely transformed the Great Lakes region of Africa. Hundreds of societies in central and southern Africa trace their roots to Bantu, and about 150 million Africans speak one of nearly 600 Bantu languages. However, regional differences in environment, livelihoods and history made each society and Bantu language unique. Bantu languages are so different that people who speak one language usually cannot understand their neighbors who speak another. Bantu patterns of social organization, forms of government, and ways of seeking kinship vary greatly.



Figure 55. A village of the Himba people in Namibia

Source: <https://www.afar.com/places/himbavillage-kunene>,

Accessed: July 6, 2023.

The San people do not have an official figure or head of government, but govern by collective consensus. Disputes are resolved through protracted discussions in which all involved have the opportunity to express their opinions until an agreement is reached. Certain individuals may assume leadership in certain spheres in which they excel, such as hunting or healing rituals, but cannot achieve positions of general influence or power. This was very confusing to the white colonists when they tried to establish treaties with members of the San people. The leadership among the San is retained by those who have lived in that group for a long time, who have reached a respectable age and good character. San people are generally egalitarian and share things like meat and tobacco. Land is usually owned by the group, and land rights are usually inherited bilaterally. Kinship ties are the basic framework for political models. Membership in the group is determined by residence. As long as a person lives on the land of his group, he retains his membership (Figure 56).



Figure 56. A village of the San people in Namibia

Source: <https://jitp.commons.gc.cuny.edu/tag/san/>, Accessed: July 6, 2023.

Aboriginal people believe that body, mind and spirit are not separate, but interconnected. Feelings and thoughts create emotional and physical manifestations that become an integral part of who we are. They believe that emotions that deal with fear or avoidance result in illness or “discomfort”. Blockage or numbing of thoughts and feelings takes us away from well-being and promotes disease. Known for their powerful healing methods, Aboriginal people understand that within each person lies the knowledge and ability to heal and create a state of well-being through balanced thoughts and feelings. Recognizing our emotions and universal spiritual connection, we move towards a state of good health, while enriching ourselves by meeting life's inevitable challenges and lessons. Through their example, Aboriginal people show the interconnectedness that nature shows us every day - pure connections waiting to be discovered, the connections between

each other and the world around us. If we truly listen and allow our hearts and souls to guide us, rather than our chaotic, overcomplicated minds, we can understand and live what Aboriginal people have lived and understood for thousands of years: love is everything. The photographs (Figures 57-59) document the specifics of Aboriginal culture and social life.

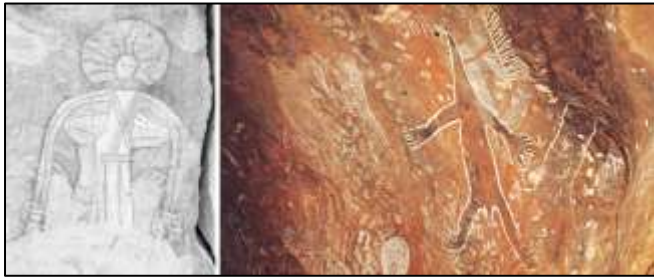


Figure 57. Aboriginal cave painting. Spirit figures associated with the meeting of legendary kangaroo and snake heroes in a dream, left (Northern Territory, Australia). Picture of a hawkler lizard on a cave wall (South Australia), right

Source: <https://www.britannica.com/topic/Australian-Aboriginal/Leadership-and-social-control>, Accessed: July 6, 2023.



Figure 58. Left: Aboriginal rock art on Nourlangie Rock in Kakadu National Park (Northern Territory, Australia). Right: Ocher, traditionally used by Aboriginal Australian peoples to decorate objects, create art and adorn the body

Source: <https://www.britannica.com/topic/Australian-Aboriginal/Leadership-and-social-control>, Accessed: July 6, 2023.



Figure 59. Left: An Australian Aboriginal man plays the didgeridoo. Right: Australian Aboriginal singer-songwriter Ruby Hunter (2008)

Source: <https://www.britannica.com/topic/Australian-Aboriginal/Leadership-and-social-control>, Accessed: July 6, 2023.

2.2.3 Social environment in areas with a rain forest climate

The Amazon has a long history of human settlement. Contrary to popular belief, large and sedentary societies of great complexity existed in the Amazon rainforest. These societies produced pottery, cleared parts of the rainforest for agriculture, and managed forests to optimize the distribution of useful species. The notion of a virgin Amazon is largely the result of population decline after the arrival of Europeans in the 16th century. Studies suggest that 11.8% of Amazon forests are anthropogenic in nature, resulting from the careful management of biodiversity by indigenous people. However, unlike those using current farming techniques, these Amazons were adapted to the ecological realities of their environment over five thousand years of experimentation and understood how to sustainably manage the rainforest to suit their needs. They saw the importance of maintaining biodiversity through a mosaic of natural forests, open fields and forest patches managed to be dominated by species of special interest to humans. Many of these populations lived along rivers where they had good means of transportation, excellent fishing, and fertile floodplains for agriculture. However, when the Europeans arrived, these were the first settlements to be affected as the Europeans used the main rivers as highways to the interior. In the first century of European presence, the American indigenous population was reduced by 90%. Most of the remaining peoples lived in the interior of the forest where they were pushed out by Europeans or traditionally lived there in smaller groups. Indigenous groups such as the Yanomamo and Kayapo have lived in the Amazon for thousands of years, accumulating detailed knowledge of the rainforest and ways of survival. Amazon is the largest rainforest in the world. It is the ancestral homeland of 1 million Indians. They are divided into about 400 tribes, each of which has its own language, culture and territory. The Yanomami move every three to four years to find more fertile soil for their crops^[19]. Today, despite the decimation of the population, the natives still live in the American rain forests. Instead of wearing traditional clothing, most Americans wear Western clothing, and many use metal pots, pans, and utensils for daily living. Some groups make handicrafts to sell to tourists, while others routinely travel to the city to bring food and produce to the market. Almost no local group obtains most of its food from traditional nomadic hunting and gathering of forest fruits. Almost everyone grows crops, and hunting, gathering, and fishing serve as a secondary or supplemental source of food.

African forest peoples live in groups ranging in size from 15 to 70 people, mostly depending on external factors (availability of game, trade relations with outside communities, prevalence of disease and

extent of forest area). These groups are traditionally nomadic, moving to new parts of the forest several times a year and carrying their entire possessions on their backs. Their nomadic lifestyle allows the group to move in response to resource availability (Figure 60). This approach, along with low population density and a lack of alien encroachment, has historically allowed wildlife populations to recover after a group has left an area. When African forest peoples set up a temporary camp, they usually remove all undergrowth, small trees and saplings, leaving the trees that form the canopy intact. Under the cover of the canopy, the inhabitants of the forest are protected from intense tropical solar radiation and maintain the habitats of wild game and honey-producing bees. By leaving the canopy intact, the area can quickly return to a healthy and productive forest once they are gone. Their huts, at first glance, resemble the igloos of the Central Arctic Inuit, with a domed lattice formed of saplings and walls of tree leaves on shingles. Most African forest people traditionally spend most of the year near villages where they trade meat, honey and labor for cassava, vegetables, metal goods and cloth. According to anthropologists who have studied the dynamics between forest peoples and villagers, it is common for a forest family to establish a symbiotic relationship with a settled village family. These relationships between one forest family and one village family can last for generations. The roles of individuals in a community of African rain forest people are different and over time have been established as routine. Women collect forest fruits in baskets that they carry on their backs. Men concentrate on hunting and collecting honey. Honey is often the forest product most valued and sought after by the Mbuti and other forest peoples. Mbuti can climb more than 30 meters into the canopy to reach the honeycomb. When they reach the comb, the climbers light wood that produces smoke that stuns the bees, allowing the Mbuti to collect the honey. African forest peoples rely on hunting to provide their primary source of protein.



Figure 60. Ljudi kišnih šuma u Kongu love ribu

Source: <https://www.worldwildlife.org/places/congo-basin>, Accessed: July 6, 2023.

Tropical rain forests have been the framework of life since ancient times. Although forest life cannot be described as easy, these people have built their lives around the surrounding forest and its systems. Therefore, they are a great repository of forest knowledge. They know the healing properties of plants and understand the value of the forest as an intact ecosystem. As forests disappear, these indigenous peoples lose their homes and culture. Conflicts with settlers, who bring disease and domestic animals, have resulted in the reduction of the native population in many areas. In the past, commercial companies, settlers and governments expanded forest land without the permission of indigenous people. Even today, in countries like Brazil and Bolivia, private interests are illegally encroaching on the lands of indigenous peoples. Sometimes tribal groups are given the choice of allowing their lands to be developed or left in their natural state. If developed, the indigenous population expects to receive some of the benefits of

'civilized' life, including better education for their children, access to health care and infrastructure such as roads and electricity. Other times, a group may choose to maintain their more familiar, natural way of life in the forest by refusing development.

3. Man

Man has been dealing with a wide range of questions about the Universe, about himself, and especially questions about his essence and place in the Universe since his inception. Hence, the arrangement of the Universe, no matter how objective it may be, from the point of view of man makes sense only in relation to man. No matter how well researched the question of 'the origin of man' (the evolution of the living world) is, science has established the time of the creation of the living world on Earth, where the appearance of man as we know it today is placed at the very end of the evolution of the living world. However, since 'something' cannot arise from 'nothing' or turn into 'nothing', the biggest question remains: what is this 'something' at the beginning of life? People, rare individuals who achieved enormous power (power and influence over the lives of a large number of people) during their lifetime, had an expressed need to be 'immortal' and they expressed this need in a visible, material way, and their efforts remained visible to this day. Other people, on the other hand, have achieved their 'immortality' through the power of their spirit and immaterial deeds that will be useful and a source of spiritual wealth for generations of people who will live on Earth. Hence, over time, the question of 'something' and 'nothing' became complicated to the extent that the former 'something' (materially visible and physically stable) became 'nothing', and the former 'nothing' (values of the human spirit) became 'something', and increasing as time passes [20].

3.1. Man in the polar climate zone

Indigenous peoples have inhabited the Arctic for thousands of years. It is estimated that the share of indigenous people is about 10% of the total population living in the Arctic regions. Over 40 different ethnic groups live in the Arctic. According to Figure 61, the indigenous Arctic peoples are:

1. Inuit. Languages: numerous dialects of the Inuit language, English, Danish, Russian. Population: 180,000. Territory: Alaska, Canada, Greenland and Chukotka,
2. Russian and American Aleutian (Unangan). Languages: English, Russian, Unangan Tunuu, Niigugim Tunuu. Population: 15400. Territory: Alaska and the Russian Federation,
3. Inuits. Languages: numerous dialects of the Inuit language, English, Danish, Russian. Population: 180,000. Territory: Alaska, Canada, Greenland and Chukotka,
4. Athabaskan. Languages: 23. Population: 45,000. Territory: Alaska (United States), Yukon and Northwest Territories in Canada
5. Gwich'in. Languages: Gwich'in (Dinju Zhuh K'yuu), one of the 47 Athabaskan languages. Population: 9000. Territory: Alaska (United States), Yukon and Northwest Territories in Canada,
6. Inuits. Languages: numerous dialects of the Inuit language, English, Danish, Russian. Population: 180,000. Territory: Alaska, Canada, Greenland and Chukotka,
7. Saami. Languages: Southern, Ume, Pite, Lule, Northern, Inari, Skolt, Kildin and Ter Sami (nine). Population: 50000 - 80000. Territory: Finland, Russian Federation, Norway and Sweden,
8. 41 Indigenous groups living in the Russian Federation, see the map of the groups at the link. Languages: Numerous languages. Population: 270000. Territory: Russian Federation.



Figure 61. Map of the distribution of autochthonous peoples living in the polar climate

Source: <https://www.arcticcentre.org/EN/arcticregion/Maps/Indigenous-Peoples/Indigenous-Peoplesorganizations>, Accessed: July 6, 2023.

There are great differences in cultural, historical and economic background between the groups (Figures 62-66). A common feature of most indigenous communities in the Arctic is that they have already undergone significant changes due to the globalization of the Western way of life, state policies, modern transport and the introduction of a mixed economy. In general, indigenous people have a specific connection with the land they inhabited. Other features, for example a different language, culture and traditional way of life, such as reindeer husbandry, fishing and hunting, are characteristics of the indigenous people of the Arctic. However, industrialization, social change and environmental problems such as climate change pose a threat to the continuity of these livelihoods and cultures. Recently, the political organization of indigenous peoples has led to the international recognition and clarification of human and political rights concerning indigenous peoples. Rights to land and natural resources are an important part of the culture and survival of indigenous peoples in the Arctic.



Figure 62. Inuit in Alaska, 1929 (left) and contemporary Inuit (right)

Source: [https://en.wikipedia.org/wiki/File:Inupiat_Family_from_Noatak_Alaska,_1929,_Edward_S._Curtis_\(restored\).jpg](https://en.wikipedia.org/wiki/File:Inupiat_Family_from_Noatak_Alaska,_1929,_Edward_S._Curtis_(restored).jpg)

Accessed: July 6, 2023.

Source: <https://acedtranslations.com/wpcontent/uploads/2017/02/art63.jpg>

Accessed: July 6, 2023.

The Sámi people are an autochthonous Finno-Hungarian people who inhabit the Sápmi, and which today includes large northern parts of Norway, Sweden, Finland and the Kola Peninsula within the Murmansk region of Russia (Figure 63). The Sami were known in the past (in English) as Lapps or Laplanders, but some terms are considered offensive by the Sami who prefer the name of the area in their language 'Sápmi'. The ancestral lands of the Sámi are located along the Volga River, in today's Russia, like other Uralic peoples. Their traditional languages are Sami languages, which are classified as a branch of the Uralic language family. Traditionally, the Sami engaged in a variety of livelihoods, including coastal fishing, fur preparation (from reindeer-reindeer) and sheep herding. Their best-known means of livelihood is semi-nomadic reindeer herding. Currently, about 10% of the Sámi are associated with reindeer herding, from which they obtain meat, fur and transport. For traditional, environmental, cultural and political reasons, reindeer husbandry is legally reserved only for the Sámi people in some regions of the Nordic countries.



Figure 63. Left: A Sámi family in a typical living environment (1870s). Library of Congress Archives. Right: North Swedish Nomad Sami (around 1880)

Source: <https://owlcation.com/humanities/Native-American-Nations-Part-XXII>, Accessed: July 6, 2023.

Source: <https://www.flickr.com/photos/28772513@N07/3585253220>, Accessed: July 6, 2023.



Figure 64. Left: A Sámi family in a typical living environment (first half of the 20th century). Right: A Sámi man with a herd of reindeer

Source: <https://prospectjournal.org/2016/10/31/the-sami-a-disappearing-indigenousminority-in-scandinavia/>, Accessed: July 6, 2023

Source: <https://www.npr.org/sections/pictureshow/2011/10/31/141858323/photos-thelife-of-real-reindeer-herders>, Accessed: July 6, 2023.



Figure 65. Left: Reindeer harnessed to a sled is the main means of transportation among the Sámi people. Right: Arrangement of a traditional Sámi tent

Source: <https://www.visitnorway.com/placesto-go/northern-norway/land-of-sami/>, Accessed: July 6, 2023

Source: <https://arcticcoast.no/en/tours/sami-life>, Accessed: July 6, 2023



Figure 66. Left: Traditional costume of the Sámi people. Right: Norwegian Sámi Parliament 2017-2021

Source: <https://arcticcoast.no/en/tours/sami-life>, Accessed: July 6, 2023

Source: <https://www.lifeinnorway.net/famoussami-people/>, Accessed: July 6, 2023

3.2 Man in the desert climate zone

Although the desert is a very unfavorable climatic environment, many ethnic groups live in it. These are people who have to move in search of places with water and food, despite the greatest risks. Some of these peoples are the Berbers of North Africa, which include the Kabyles and Tuaregs, the Bedouins of the Arabian Deserts, the Bejas of Namibia, the Sans of the Kalahari Desert, and the Australian Aborigines.

The Quechua are indigenous peoples of South America who speak some of the Quechua languages (Quechua). The majority of Quechua speakers live in Peru, Ecuador, Bolivia, Argentina, Chile and Colombia. The most common dialect of Quechua is Southern Quechua. The Kichwa people in Ecuador speak the Kichwa dialect. In Colombia, the Inga people speak Inga Kichwa. The Quechua word for a Quechua speaker is 'runa' or 'nuna' ('person') and the plural is 'runakuna' or 'nunakuna' ('people'). Some historical Quechua peoples are: the Chanka people (who lived in the Peruvian regions of Huancavelica, Ayacucho and Apurímac), the Huanca people (from the Peruvian Junín region, who spoke the Quechua language before the Incas), the Incas (who established the largest pre-Columbian empire), the Cañari of Ecuador (who adopted the Quechua language from the Incas), the Chíncha (an extinct trading kingdom of the Ica region of Peru). The photographs (Figures 67-92) illustrate the physiognomy of the people living in the Atacama desert, their way of life, and their culture.





Figure 67. Atacama people breed alpacas (2000s)

Source: <https://www.earthcultures.com/cultures/people-of-theatacama-chile>, Accessed: July 6, 2023



Figure 68. A family of the Quechua people in the Atacama desert

Source: <https://www.pinterest.com/pin/71353975335414661/>, Accessed: July 6, 2023

The people who inhabit the Gobi desert are mostly Mongolians, but due to the overpopulation of Han Chinese in Inner Mongolia, more and more Mongolians are forced to move to the less developed areas of the desert. In the Gobi desert, summer temperatures reach 45 °C, and -40 °C in winter. Endless sand dunes, heat or freezing cold, scarce water resources and dry months without a single drop of rain... Dominated by sand dunes as high as 800 meters, a clear sky where you can easily count stars, wild animals, dinosaur fossils millions of years old and harsh climate, desert shepherds with herds who still intend to maintain their nomadic way of life. The photographs (Figures 69-71) illustrate the physiognomy, way of life in an authentic natural environment, value system, culture and social life of the people living in the Gobi desert.



Figure 69. Mongol nomads in the Gobi desert

Source: <https://www.skylife.com/en/2017-05/anomadic-life-in-the-gobi-desert>, Accessed: July 6, 2023



Figure 70. Mongol-nomadic people in the Gobi desert

Source: <https://www.skylife.com/en/2017-05/anomadic-life-in-the-gobi-desert>, Accessed: July 6, 2023



Figure 71. Mongolian traditional house ger (yurt)

Source: <https://www.selenatravel.com/mongolian-culture>, Accessed: July 6, 2023

The Tuareg people (Twareg or Touareg) are a large Berber ethnic confederation. They mostly inhabit the Sahara in a vast area that stretches from extreme southwest Libya to southern Algeria, Niger, Mali and Burkina Faso. Their total population in that territory exceeds 2.5 million, with an estimated population in Niger of about 2 million (11% of the population) and in Mali another 0.5 million (3% of the population). They are traditionally nomadic herders. Small groups of Tuareg live in the north of Nigeria. They traditionally speak Tuareg languages, also known as Tamasheq, Tamachen, Tamashekin, Tomacheck and Kidal. These languages belong to the Berber branch of the Afroasiatic language family. The Tuareg are called "blue people" because of the indigo-colored clothes they traditionally wear. It is one of the ethnic groups that have historically influenced the spread of Islam and its legacy in North Africa and the neighboring Sahel region. Tuareg society traditionally lives in the way of clan membership. They controlled several trans-Saharan trade routes and were an important party to conflicts in the Saharan region during the colonial and post-colonial eras (Figures 72-75).



Figure 72. Touaregs in their authentic living environment

Source: <https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023



Figure 73. A group of Tuareg women (left) and a young Tuareg (right)

Source:

<https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023



Figure 74. Tuareg women (left and center) and a young Tuareg girl (right)

Source:

<https://kwekudeetripdownmemorylane.blogspot.com/2014/02/tuareg-people-africas-bluepeople-of.html>, Accessed: July 6, 2023

Bedouins are nomadic Arab tribes that historically inhabited the desert areas of the Levant, the Arabian Peninsula, Upper Mesopotamia and North Africa. The English word 'bedouin' comes from the Arabic word 'badawī', meaning 'dweller of the desert'. Bedouins are traditionally divided into tribes or clans, and historically share a common culture of herding camels and goats. The vast majority of Bedouins are followers of Islam, and a smaller part are Arab Christians. Although many Bedouins have abandoned their nomadic and tribal traditions for a modern urban lifestyle, many retain traditional Bedouin culture such as retaining the traditional 'aṣā'ir clan structure, traditional music, poetry, dances (such as saas) and many other cultural practices and concepts. Urbanized Bedouins often organize cultural festivals, usually held several times a year, where they gather with other Bedouins to participate in and learn about various Bedouin traditions, from reciting poetry and traditional sword dances to playing traditional instruments and even lectures on traditional weaving of tents. Traditions such as camel riding and camping in the deserts are still popular leisure activities for the urban Bedouins who live in close proximity to the deserts. The photographs (Figures 76-78) illustrate the physiognomy, the authentic natural environment in which they live, the value system, culture and social life.



Figure 75. A Bedouin family in their authentic living environment in the Sahara desert

Source: <https://www.britannica.com/topic/Bedouin>, Accessed: July 6, 2023



Figure 76. Bedouin tent

Source: <https://www.pinterest.com/pin/641270434413536848/>, Accessed: July 6, 2023



Figure 77. A girl and a boy of the Bedouin people

Source: <https://www.pinterest.com/annettebarrow1/the-beauty-of-bedouin-girls/>, Accessed: July 6, 2023

Source:

<https://web.stanford.edu/~siegelr/jordan/wadirum2008.html>, Accessed: July 6, 2023



Figure 78. A modern Bedouin tent

Source: <https://www.picfair.com/pics/06640825-interior-of-a-traditional-bedouin-tentin-madaba>, Accessed: July 6, 2023

Source:

https://www.reddit.com/r/CozyPlaces/comments/85yk4b/bedouinstyle_tent/, Accessed: July 6, 2023

The Bantu, a large group of related peoples, originated along the present-day border between Nigeria and Cameroon and spread throughout central and southern Africa. The term Bantu is sometimes used to describe all Africans and African culture in general. This usage of the term is incorrect. Namely, the Bantu peoples make up only a third of the population of Africa. Bantu is also the name of a family of related languages spoken by these people. Over time, many Bantu-speaking peoples began to

differentiate themselves from each other. All Bantu languages arose from a single language known as Proto-Bantu. About 4000 BC people who spoke this language developed a culture based on the cultivation of root crops, diet and fishing on the West African coast. Over the years, Bantu became more and more prevalent among the languages of the nomadic peoples who lived in the same area. Its spread was probably helped by the unique social organization of the early Bantu, based on a system of cooperation between villages. Each village consisted of several 'houses', and each 'house' established working relations with 'houses' from other villages. This strong but flexible social network may have helped the Bantu language to migrate across the continent. Today, Bantu peoples are as diverse as the countries they inhabit (Figure 79).



Figure 79. Bantu people, in Nigeria (left) and in Namibia and Mozambique (right)

Source: <https://moscsp.ru/en/korennye-zhitelistrany-narody-bantu-narody-afriki.html>, Accessed: July 6, 2023

Source: <https://onlinenigeria.com/content/templates/?a=365>, Accessed: July 6, 2023

The Himba people, some of whom now inhabit the northern Namib Desert in Angola and Namibia, are one of Africa's most skilled herders (Figure 80). Their livestock strategy is based on seasonal mobility and their ability to cooperate and coordinate with each other. Therefore, it can be said that although the Himba are known as pastoralists, their success as pastoralists is not only in their knowledge of livestock (goats and sheep), or even in their ecological knowledge. Their vitality rests on social relations and their socio-cultural organization.



Figure 80. A family of the Himba people in their authentic living space, Namibia

Source:

<https://www.ourworldforyou.com/wpcontent/uploads/2016/09/Gifts-for-sale-from-the-Himba-Damaraland-Namibia.jpg>

Accessed: July 6, 2023



Figure 81. Women (left) and a young girl (right) of the Himba people in Namibia

Source: <https://namibiaturism.com.na/blog/Insearch-of-the-Himba-in-Namibia>, Accessed: July 6, 2023

Source: <https://www.flickr.com/photos/57999689@N02/36697023005>, Accessed: July 6, 2023

The Herero (also known as Ovaherero) are an ethnic Bantu group that inhabits parts of southern Africa (Figure 82). Most live in Namibia, and the rest in Botswana and Angola. There were an estimated 250,000 Herero people in Namibia in 2013. They speak Otjiherero, a Bantu language. In Botswana, the Hereros or Ovaherero are mainly found in Maun and some villages surrounding Maun. These villages are, among others, Sepopa, Toromuja, Karee and Etsha. Some of them are in Mahalapye. In the southeastern part of Botswana, they are located on Pilane. There are several of them in the south of Kgalagadi, namely the villages of Tsabong, Omawaneni, Draaihoek and Makopong. The Ovaherero are known as courageous guardians of culture. A large dress and headdress are the main attire for women, while men are mostly seen with leather caps and walking sticks.



Figure 82. A married couple with a child from the Herero people (late 19th century, left) and a young Herero woman in traditional costume (2000s, right)

Source:

https://en.wikipedia.org/wiki/Herero_people#/media/File:Herero_woman.JPG, Accessed: July 6, 2023

The San or Basarwa, as they are called in most of the region, are a people whose members are employed by Bantu-speaking herders who work for support or are employed by rich herders. Few San still follow their traditional pattern of hunting and gathering (Figures 83-87).



Figure 83. A young man from the San people with a scorpion (which is his food, left) and lights a fire in the traditional way

Source:

https://en.wikipedia.org/wiki/%C7%83Kung_people#/media/File:San_Schmuck.JPG, Accessed: July 6, 2023



Figure 84. Khoisan/Bushman (San group) hunting

Source: <https://geography.name/khoisan/>, Accessed: July 6, 2023

Source:

<https://robbyrobinsjourney.files.wordpress.com/2020/01/kalahari-desertbushman.jpg>, Accessed: July 6, 2023



Figure 85. A San (!Kung) woman makes jewelry next to a child

Source:

https://en.wikipedia.org/wiki/%C7%83Kung_people#/media/File:San_Schmuck.JPG, Accessed: July 6, 2023



Figure 86. Left: Bushmen from the Kalahari Desert, Namibia. Right: San people in an authentic living environment

Source:

<https://robbyrobinsjourney.files.wordpress.com/2020/01/bushmenancing.jpg>, Accessed: July 6, 2023



Figure 87. A typical house of the San people in Namibia

Source:

<https://twitter.com/ExploreNamibia/status/899536711264370688/photo/1>, Accessed: July 6, 2023

The Tswana (Figure 88) are the smallest cultural group in Namibia, numbering about 6,000 people, and they live mainly in the Gobabis district near the Botswana border (Hereroland). They are divided into three sub-groups known as the Tlharo, Tlhaping and Kgalagadi (Figure 89), who have intermixed to some extent with the Kalahari Bushmen. The ancestors of the Tswana tribe moved to the area south of Limpopo from East Africa during the 14th century in several separate migrations. Today they settled in more modern Namibia, and most of them adopted Christianity.



Figure 88. Members of the Tswana people, Namibia

Source:

<https://www.arebbusch.com/tswanapeople-namibia/>, Accessed: July 6, 2023

Source:

http://www.thetravelboss.com/articles_detail.php?aid=1382, Accessed: July 6, 2023



Figure 89. People of the Kgalagadi people

Source:

<https://www.tourismupdate.co.za/article/new-camp-kgalagadi-transfrontierpark>, Accessed: July 6, 2023

Aborigines (Figures 90-92) are the first inhabitants of the Australian continent, thought to have arrived more than 60,000 years ago. The arrival of European settlers from England in 1788 brought enormous challenges to the simple native way of life. Nevertheless, the ancient culture of the Aborigines is still maintained today, despite the harsh desert climate and few material goods. Far from a primitive society, this special group of people is rich in community, gratitude, spirituality, simplicity and, most importantly, love. The basis of this simple way of life is the Aboriginal understanding of the powerful connection between

mind, body and spirit and their belief in universal consciousness (One Consciousness or All That Is). They believe that everything is One and cannot be separated. Aboriginal people believe that close alignment with the land is of the utmost importance. They also feel a strong connection with their ancestors.



Figure 90. Aboriginal people in their authentic living environment

Source: <https://www.pinterest.co.uk/pin/539235755360298894/>,

Accessed: July 6, 2023

Source: <https://holzwellness.com/remotaustralian-aborigines/>,

Accessed: July 6, 2023



Figure 91. Left: Young men over two meters tall (1920s) and a young Aboriginal woman (2000s)

Source: <https://www.pinterest.com/curhuggi/aboriginal-woman/>,

Accessed: July 6, 2023

Source: <https://www.pinterest.com.mx/pin/304837468514526668/>,

Accessed: July 6, 2023



Figure 92. Left: Aboriginal warrior with traditional body paint and ritual scars (1923s). Right: An Australian Aboriginal warrior preparing to throw a boomerang (2000s)

Source: <https://www.britannica.com/topic/Australian-Aboriginal/Leadership-and-social-control>, Accessed: July 6, 2023

3.3 Man in the rain forest climate zone

Rain forests have been home to thriving and complex human communities for thousands of years, from Africa to the Pacific Northwest. The temperate rain forest of the northwest coast of North America is home to the Tlingit (who belong to a group of American Indians), (Figure 93). The Tlingit enjoy a varied diet, relying on both marine and freshwater species, as well as game from the interior of the forests. Thanks to the abundant Pacific bays, rivers and streams, the traditional Tlingit diet consists of a wide range of aquatic organisms: crabs, shrimp, clams, oysters, seals and fish such as herring, shellfish and salmon. Kelp and other

seaweed can be harvested and eaten in soups or dried. A famous Tlingit saying goes: "when the tide goes out, our table is set". In more inland areas, historical Tlingit hunters hunted deer, elk, rabbits, and mountain goats. Plants collected or harvested include berries, nuts and wild celery.



Figure 93. Tlingit, Northwest Coast of North America

Source: <https://www.britannica.com/topic/Tlingit>, Accessed: July 6, 2023

The Yanomami (Figure 94) are a people and culture native to the northern Amazon rainforest, which straddles the border between Venezuela and Brazil. Like the Chimbu, the Yanomami engage in both hunting and agriculture. The Yanomami hunt deer, tapirs, monkeys, birds and armadillos. They have hunting dogs that help them search the underground and forest floor for game. The Yanomami practice agriculture to clear the land of vegetation before cultivation. Crops grown include cassava, banana and maize. In addition to food crops, the Yanomami also grow cotton, which is used to make nets and clothing.



Figure 94. Yanomami, the rainforests of the northern Amazon

Source: <https://www.survivalinternational.org/tribes/yanomami>,

Accessed: July 6, 2023

The Waura are the indigenous people of Brazil (Figure 95). Their language (Waura) is the Arawa language. They live in the region near the upper Xingu River, in the Xingu Indigenous Park.



Figure 95. Waura people in the Brazilian Amazon

Source: <https://www.pinterest.com/pin/287174913709232768/>,

Accessed: July 6, 2023

The Secoya (also known as Angotero, Encabellado, Huajoya, Piojé, Siekopai) are indigenous peoples living in the Ecuadorian and Peruvian Amazon (Figure 96). They speak the Secoya Pai Coca language, which is part of the Western Tucano language group.



Figure 96. Secoya people, Ecuador

Source: <https://www.amazonfrontlines.org/who/partners/secoya/>, Accessed: July 6, 2023

The Waorani (Figure 97) were the last to be contacted of all Ecuadorian indigenous peoples, first discovered by an American missionary group in 1958. From the first contact, the Waorani experienced a rapid and difficult integration into modern society. Their territories have shrunk considerably, and their remaining lands have been affected by logging, oil extraction and colonial settlement, among other things. Several Waorani groups have so far refused contact and continue to move deeper into the forest.



Figure 97. Waorani from the Ecuadorian part of the Amazon

Source: <https://www.indiatodayne.in/visualstories/webstories/waorani-tribe-the-last-savage-tribe-of-the-amazon-43085-17-06-2023>
Accessed: July 6, 2023

Pygmy peoples (Figures 98,99) are ethnic groups whose average height is unusually small. The term pygmy is used to describe the phenotype of endemic short stature for populations in which adult males are on average less than 150 cm tall. The term is primarily associated with African pygmies, hunters and gatherers from the Congo Basin. The terms 'Asiatic pygmies' and 'Oceanic pygmies' have been used to describe negrit populations in Southeast Asia and Austro-Melanesian peoples of short stature. The Taron people of Myanmar are an exceptional case of a 'pygmy population' of East Asian phenotype.



Figure 98. Pygmies of Central Africa

Source: <https://infocongo.org/en/whats-the-plaint-and-exact-population-of-centralafrican-pygmies/>, Accessed: July 6, 2023



Figure 99. Baka Pygmies (left) and Cameroonian Pygmies (right)

Source: <https://www.sciencesource.com/CS.aspx?VP3=LoginRegistration&L=True&R=False>, Accessed: July 6, 2023

Source: <https://archive.shine.cn/sunday/Cameroon-pygmies-caught-in-forestfeud/shdaily.shtml>, Accessed: July 6, 2023

The Mbuti (Figure 100), an indigenous community of the Ituri rainforest in Central Africa, were traditionally foragers. Their diet consists of plants and animals from every layer of the rainforest. From the forest floor, the Mbuti catch fish and crabs from the Ituri River (a tributary of the Congo), and gather berries from the low bushes.



Figure 100. Mbuti people, Central Africa

Source: <https://www.mindenpictures.com/stock-photo-mbuti-pygmy-initiation-huntwith-two-boys-in-traditional-bluebody-naturephotographyimage90410891.html>, Accessed: July 6, 2023

Sama-Bajau is the name for several Austronesian ethnic groups of maritime Southeast Asia. The name refers to related people who are usually called Sama or Samah, or are known by the exonym Bajau (Badjao, Bajaw, Badjau, Badjaw, Bajo or Bayao). They usually live a sea lifestyle and use small wooden sailing boats such as perahu (layag in Meranao) and djenging (balutu). There is a Sama-Bajau ethnic group originating from Sabah in Malaysia called Samah (West Coast Bajau). They are known for their unique heritage that is authentic only to the Kota Belud district of Sabah, the traditional horse culture. In Malaysia, they are called the Cowboy from the East. The Sama-Bajau are the dominant ethnic group in the Tawi-Tawi Islands in the Philippines. They are also

found on other islands of the Sulu Archipelago, coastal areas of Mindanao, in the Malaysian state of Sabah, Sulawesi and several parts of the East Malay Archipelago/Indonesian Archipelago. In the Philippines, they are grouped with the religiously similar Moro people. In the last fifty years, many Filipino Sama-Bajau have migrated to neighboring Malaysia and the northern islands of the Philippines, due to the conflict in Mindanao. As of 2010, they were the second largest ethnic group in the Malaysian state of Sabah.

The Sama-Bajau were sometimes referred to as 'sea gypsies' or 'sea nomads', terms also applied to unrelated ethnic groups with similar traditional lifestyles, such as the Moken of the Burmese-Thai Mergui Archipelago and the Orang Laut of southeastern Sumatra and Riau Island in Indonesia (Figure 101). The modern expansion of the Sama-Bajau from older inhabited areas appears to be related to the development of the sea cucumber (trepang) sea trade. For most of their history, the Sama-Bajau were a nomadic, maritime people, living off the sea by trading and fishing. The Sama-Bajau, who inhabit the boats, see themselves as a non-aggressive people. They stayed close to the coast by building houses on sticks, and traveled using beautiful, hand-made boats in which many lived.



Figure 101. Sama-Bajau people in the Philippines (above) and Sama-Bajau women in traditional dress, Semporna, Sabah, Malaysia (below)

Source: <https://www.unhcr.org/ph/15041-theplight-of-the-sama-bajau.html>, Accessed: July 6, 2023

Source: https://en.wikipedia.org/wiki/Sama-Bajau#/media/File:Sabah_West_Coast_Bajau_women_in_traditional_dress.jpg

Accessed: July 6, 2023

The term 'Papuan' is used in a broader sense in linguistics and anthropology. In linguistics, 'Papuan languages' is an umbrella term for the diverse, unrelated, non-Austronesian language families spoken in Melanesia, the Torres Strait Islands and parts of Wallacea. In anthropology, 'Papuan' is often used to refer to the highly diverse indigenous populations of Melanesia and Wallacea prior to the arrival of Austronesian speakers and the dominant genetic traces of these populations in the current ethnic groups of these areas (Figure 102).



Figure 102. Papuan in Papua New Guinea

Source:

https://aminoapps.com/c/languageexchange/page/blog/papua-the-peopleand-theculture/moeb_rzxIkuRXa54lZNjokKZVXK7Dj3d24

Accessed: July 6, 2023

Source: <https://jakartaglobe.id/movement/giving-hope-to-the-children-of-papua/>, Accessed: July 6, 2023

The Huli are an indigenous people who live in the Hela province of Papua New Guinea (Figure 103). They speak primarily Huli and Tok Pisin. Many speak some of the surrounding languages, and some also speak English. They are one of the largest cultural groups in Papua New Guinea, numbering over 250,000 people (based on the 2011 national census).



Figure 103. People of the Huli tribe (Papua New Guinea)

Source: <https://jaytindall.asia/story/hold-ontoyour-wigs-days-of-wild-in-tari/>, Accessed: July 6, 2023

The Chimbu people live in the montane rainforest on the island of New Guinea (Figure 104). The Chimbu practice shifting cultivation. This means that they have gardens on arable land that has been cleared of vegetation. Part of the plot may remain uncultivated for months or years. Conspiracies are never abandoned and are passed down within the family. The Chimbu grow sweet potatoes, bananas and beans on their plots. The Chimbu raise livestock, especially pigs.



Figure 104. Chimbu people, New Guinea

Source: <https://www.dailymail.co.uk/news/article-6285875/Papua-New-Guineaskelton-tribe-dress-corpse-scareenemies.html>

Accessed: July 6, 2023

Source: <https://www.looppng.com/content/chimbu-province-gears-tourism-boost>, Accessed: July 6, 2023

There are many tribes in the rainforests of the Malaysian state of Sarawak. Sarawak is part of Borneo, the third largest island in the world. The most famous tribes in Sarawak are: Kayani, Kenya, Kejaman, Kelabit, Punan Bah, Tanjong, Sekapan and Lahanan. They are collectively called Dayaks or Orangulu, which means

'inland people'. Anthropologists are of the opinion that most Dayaks are of mainland Southeast Asian origin, and their mythologies support this (Figure 105).



Figure 105. Dayak people, Borneo, Malaysia

Source: <https://authenticindonesia.com/blog/know-more-aboutborneo-dayak-tribe/>, Accessed: July 6, 2023

The Dani people (also spelled Ndani) are a people from the central highlands of western New Guinea (Indonesian province of Papua), (Figure 106). It is one of the most populous and well-known ethnic groups in the mountains.



Figure 106. Dani Man, Indonesia

Source: <https://www.wowshack.com/the-11-things-that-have-changed-the-danitribe-of-papua/>, Accessed: July 6, 2023

Source: https://www.trekearth.com/gallery/Asia/Indonesia/Irian_Jaya/Papua/Wamena/photo278624.htm, Accessed: July 6, 2023

The Yafi of Indonesia (of which there are about 350) are no longer accessible to 'civilized' people. They are part of the cluster of peoples of New Guinea within the block of the Pacific Islands (Figure 107). This group of people is found only in Indonesia (Figure 108).



Figure 107. Warrior of the Papuan Yafi tribe in traditional clothes, decorations and colors. Island of New Guinea, Indonesia (02.02.2009)

Source: https://www.123rf.com/photo_55768796_new-guinea-indonesia-2-februarythe-warrior-of-a-papuan-tribe-of-yafiin-traditional-clothes-ornamen.html, Accessed: July 6, 2023



Figure 108. Rain forest people in Indonesia

Source: <https://www.nytimes.com/2016/12/02/world/asia/modern-world-tugs-at-anindonesian-tribe-clinging-to-itsancient-ways.html>

Accessed: July 6, 2023

Even today in the world (in rain forests) live a large number of tribes 'outside civilization', that is, 'uncontacted tribes'. Among them are: Sentinelese (a people living on North Sentinel Island in the Bay of Bengal), Jarawa (indigenous people living on the northern side of South and Middle Andaman in the Bay of Bengal), Chút (a hunter-gatherer people, first observed by North Vietnamese forces during the Vietnam War), the Pintupi (discovered in 1984 in the Gibson Desert in Western Australia)... Today, about 44 uncontacted tribes live on the western Indonesian part of the island of New Guinea. You believe in some of those tribes of cannibals.

4. Boundaries

Boundaries are those places in the environment where the situations encountered are controlled according to very specific human needs. Conditions are all those discovered and undiscovered phenomena in space that have a stimulating or degrading effect on humans. Borders, therefore, have the task of enabling the selection of influences. In the architectural sense, they enclose, but also include a person in the conditions of a certain environment ^[11,15].

4.1. Architecture in a polar climate environment

The polar climate has cool summers and very cold winters, resulting in treeless tundra, glaciers and permanent or semi-permanent ice sheets. Hence, in the range of (vernacular) architecture, there are buildings (dwellings, mostly) in which to stay during the short summers and buildings (dwellings) in which to live in the winter.

Architecture in the polar climate environment from the aspect of architectural physics. The study of architecture from the aspect of architectural physics in polar climate conditions was done on the example of a traditional dwelling, the igloo, and author's architecture created on the basis of empirical analyzes of spatial concepts (including design), concepts of the materialization of ADS boundaries and the use of renewable energy sources on site. It should be borne in mind that the temperature of the outside air in polar climate conditions throughout the year does not exceed the value of +10 °C, and that in most of the year it has values from -20 °C to -40 °C, and even lower. The basic materials in the creation of traditional architecture in the conditions of the polar climate are taken from the site, and depending on the specific geographical area, they are: packed snow, stone, sod, wood (sticks and more or less massive logs), whale bones, furs of indigenous animals (seal, elk, reindeer, reindeer...). A house made of blocks of packed snow, an igloo, is a typical dwelling in the Arctic region (Figures 109-111). Spatial concept igloo (horizontal and vertical plan) are the result of formative and thermotechnical performances of packed snow (which condition suitable „building technology“) and finding

the most optimal form of construction whose conditions of internal comfort will have minimal effect on the external environment (low temperatures and wind). The circular base and dome in the vertical plane is the most efficient geometric form that ensures the most favorable (smallest) relationship between the outer surface of the igloo and its volume. By burying the igloo in the surrounding compacted snow (sometimes in the ground) and by the deliberate disposition of the horizontal plan (where a more or less long and narrow access corridor is made), the influence of the wind on the basic living chamber of the igloo is reduced, and thus on the heat losses of the entire architectural structure. Blocks made of compacted snow (whose structure is quite loose due to low ambient temperatures, i.e. filled with voids with air) have relatively high values of thermotechnical performance - thermal conductivity coefficient (λ)^[14] is about 0.4-0.8 W/mK, with a volumetric mass of about 50-400 kg/m³. Achieving thermal comfort inside the igloo is the result of thousands of years of long life and experience in polar climate conditions. The main means of heating people in the igloo is themselves, since they release a significant amount of heat through their metabolism^[14]. At the same time, they stay inside the igloo dressed in their traditional clothes and shoes with extremely high values of thermotechnical performance. As a means of lighting inside the igloo, people use seal fat. Burning fat also releases heat. Thus, it is possible to very easily reach the air temperature inside the igloo up to +15 °C, and the air temperature of the external environment below -20 °C. In this way, the value of the PMV parameter reaches -3, i.e. the state of comfort, which is rated as 'a little cold, but pleasant'. Artificial lighting inside the igloo was almost not even necessary, since the snow during the day (and clear nights) lets in (diffuse) natural light from the outside environment. As for ensuring the quality of the indoor air in the igloo, it is achieved by effective ventilation of the indoor space, whereby fresh air enters the igloo through an access tunnel and exits through an opening (which, if necessary, also closes it) in the crown of the dome of the main living area.

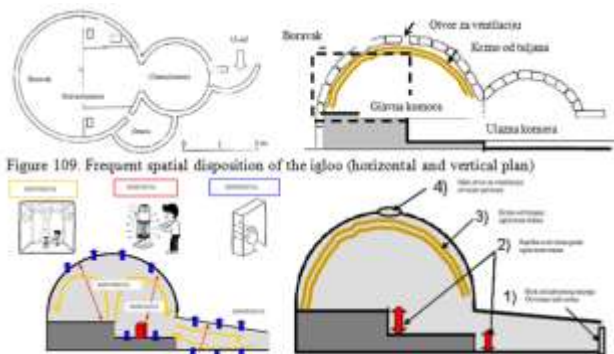


Figure 110. Left: Heat spread at the igloo (inside the igloo and the igloo-vein environment). Right: Basic elements of an igloo

Source: <https://www.semanticscholar.org/paper/EVALUATION-OF-INDOORENVIRONMENT-INVERNACULAR-%E2%80%95-OFMurakami-Eng./6bf47640787b410c1a45203f103fb6a6d98be7c3>, Accessed: July 4, 2023

When it comes to author's (contemporary) architecture in polar climate conditions, checking the validity of the concept and the materialization of the boundaries (envelope) of the Architecturally Defined Space (ADS) from the aspect of architectural physics (as well as the influence of wind on the structural stability and form of the architectural structure), designers have access to many

software- and with which the real conditions of the natural environment and their effects on the comfort of people within the ADS can be simulated relatively simply, but quite convincingly. The use of new tools in architectural design implies a new approach in the complex design process with a clear understanding of how different performances of an architectural object, in different circumstances, should be generated, both within the boundaries of ADP and outside, from its environment. The natural environment of the ADP must be studied in order to raise the level of utilization of the benefits of natural resources in achieving the comfort expected by people with their specific way of life. For the Commerzbank Headquarter building in Frankfurt (1997), a series of performance tests were conducted (natural lighting, ventilation, energy consumption...). Such tests have never been done before. By combining computerized fluid dynamics (Computational Fluid Dynamics, CFD) and advanced energy simulation, it is possible to realize new possibilities in the design of architecture aligned with environmental conditions. CFD is a suitable tool for modeling smoke migration and can significantly reduce the number of installed smoke control units in the building.

4.1.1. Vernacular architecture in a polar climate environment

Central (Canadian) Inuit made winter houses of stone and sod (Figures 111-120). In the middle of the nineteenth century, they lived in snow houses (igloos) made of snow blocks. Inuit winter settlements consisted of several domed buildings and could support several dozen people. Snowflakes varied throughout the central Arctic. The Inuit in Labrador lived in semi-subterranean stone or wooden houses covered with sod during the winter. An average of 20 people lived in these apartments. The Sallirmiut winter dwellings on Southampton Island were made of whale bones and limestone slabs. Approximately two to four families could live in these houses. There are two types of transitional seasonal houses (qarmaq), which the Inuit inhabited in the fall. The usual form of a qarmaq was a semi-permanent small structure made of stone walls, whale bones, sod, a stone platform and a skin roof. Housing during the summer months consisted of different variations of tents. Arctic winter houses of any construction method consisted of a network of intimate locations where private activities took place and communal and public spaces where community activities took place. Sleeping places were at the back or on the edges of the net, separated and regulated by wooden partitions, passages and thresholds. Entrance porches, tunnels and alcoves in tunnels, kitchens and tanks were common components of the community.

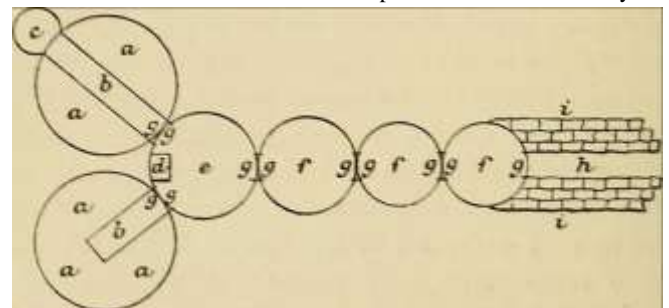


Figure 111. Family rural apartments. Floor plan of two Inuit snow houses (1904)

Source: <https://www.thoughtco.com/paleo-andneo-eskimo-houses-169871>, Accessed: July 4, 2023

The history of the American Arctic regions is long (about 5000 years) and follows numerous climatic and technological changes

and challenges. The extreme cold and limited access to building materials such as wood and clay bricks led to innovations in this area, using wood (brought ashore by water), marine mammal bones, sod and snow as building materials. The basic forms used and developed by the first people in the American Arctic still exist, with new developments and innovations as justified by time and climate change: Tipis or Tent Houses, Snow Houses - Innovative Architecture of Eskimo People, Whale Bone Houses - Thule Culture Ceremonial Structures, Semi-Subterranean Winter Houses, Qarmat or Transitional House, Ceremonial Houses/Dance Houses, Chief's Houses, Men's Houses-Kasigi, Tunnels. The photographs (Figures 112-120) show a wide variety of vernacular architecture in the polar climate zone.



Figure 112. An Inuit family next to a tent-summer house (tupiq), around 1915.

Source:

https://en.wikipedia.org/wiki/Tupiq#/media/File:Eskimo_family_w_ith_Malamute_from_1915.JPG, Accessed: July 4, 2023

Source: https://firstpeoplesofcanada.com/fp_groups/fp_inuit6.html, Accessed: July 4, 2023



Figure 113. The construction of a half-buried Inuit house (left) and the archaeological remains of one such house (right)

Source: <https://www.thoughtco.com/paleo-andneo-eskimo-houses-169871>, Accessed: July 4, 2023

Source: <https://www.nps.gov/articles/analyzing-early-driftwood-houses-of-coastalalaska.htm>, Accessed: July 4, 2023



Figure 114. A group of Inuit on the island of St. Lawrence in front of their house (1897). Walrus meat is dried on a rack above the entrance to the house

Source: <https://www.thoughtco.com/paleo-andneo-eskimo-houses-169871>, Accessed: July 4, 2023



Figure 115. The Inuit build a snow house (igloo) from blocks of snow

Source: <https://www.britannica.com/topic/Eskimo-people>, Accessed: July 4, 2023

Source: <https://www.theguardian.com/artanddesign/gallery/2017/feb/15/geraldinemoodie-douglas-moodiephotographers-1900s-canada-inuit>, Accessed: July 4, 2023



Figure 116. Drawing of the snowy village of Twerpukju near Nunivak Island, Bering Sea (1865)

Source: <https://www.thoughtco.com/paleo-andneo-eskimo-houses-169871>, Accessed: July 5, 2023



Figure 117. Qarmaq (house with a construction made of whale bones)

Source: <https://www.newberyphotoarchives.ca/en/photos/5-qarmaq>, Accessed: July 5, 2023

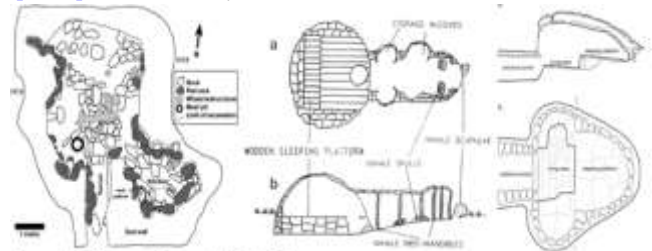


Figure 118. Houses of the early Thule Inuit

Source: https://www.researchgate.net/figure/Plan-of-Early-Thule-Inuit-house-15-Skraeling-Island-after-McCullough-1989-55_fig2_264004582, Accessed: July 5, 2023

Source: <https://www.erudit.org/en/journals/etudnuit/2006-v30-n2-etudnuit1994/017569ar/>, Accessed: July 5, 2023

Source: https://www.researchgate.net/figure/Illustration-of-an-Inughuit-winter-house-a-cross-section-b-plan-Imagemodified-from_fig3_256464063, Accessed: July 5, 2023



Figure 119. Half-buried winter houses of the Inuit community „Indian Point“ (1897)

Source: <https://www.thoughtco.com/paleo-and-neo-eskimo-houses-169871>, Accessed: July 5, 2023

Lavvu (parallel names, Northern Sami: lávvu, Lule Sami: lávdagoahte, Inari Sami: láávu, Skolt Sami: káávas, Kildin Sami: koavas, Finnish: kota or umpilaavu, Norwegian: lavvo or sametelt and Swedish: káta) is a temporary Sámi dwelling - the peoples of the northern extremes of Europe (Figure 120). It has a design similar to Native American teepees, but is less vertical and more stable in strong winds. It allows the indigenous cultures of the treeless plains of northern Scandinavia and the high arctic of Eurasia to follow their reindeer herds. The Sámi people still use this dwelling as a temporary shelter, and more and more other people use it for camping. It should not be confused with 'goahti', another type of Sámi-stan, or Finnish 'laavu'.



Figure 120. Lijevo: Obitelj Sámi ispred goahtija u prvom planu i lavvua u pozadini (oko 1900. godine). Desno: Sámi-ljudi pored kuće od drvenog skeletal prekrivenog busenjem, Norveška (konac 1800. godine)

Source: https://en.wikipedia.org/wiki/Lavvu#/media/File:Saami_Family_1900.jpg, Accessed: July 5, 2023

4.1.2 Newer and contemporary (author's) architecture in a polar climate environment

At the end of the 19th and the beginning of the 20th century, the polar region of the Earth, traditionally inhabited by Eskimos (Inuit), began to be visited by explorers, and later by people engaged in hunting and fishing with modern, efficient tools and weapons. With that, due to contacts with newcomers, the transformation of the traditional Inuit way of life began. The construction of permanent settlements on the shores of the sea begins, with facilities suitable for modern settlements. In addition to residential buildings, these settlements have various service facilities, schools, buying stations (for furs of polar animals, meat and fish) and fish processing plants (Figure 121).



Figure 121. Left: New Inuit settlement. Right: Colorful houses in the remote Greenlandic settlement of Ittoqqortoormiit

Source: <https://oceanwideexpeditions.com/blog/the-world-is-changing-for-the-native-inuit-people>, Accessed: July 5, 2023

Arctic architecture emerges from its limitations. Few places in the world have such extreme ecological, socio-political and material demands. Although vernacular projects have been designed throughout the region for centuries, the Arctic is currently experiencing intense, newfound attention, especially in architecture, planning and infrastructure. Shrinking polar ice has opened up the Northern Sea Route, and now the shipping, oil and gas industries are rushing to establish a stake in the area's future. Driven by both environmental conditions and pecuniary interests, Arctic architecture has found a new place in modern design discourse.

Monte Rosa Hut (German: Monte Rosa Hütte) is a mountain building ('hut') located near Zermatt on the Monte Rosa massif (altitude up to 4634 m), above the Grenzgletscher, which is situated on a rocky part without glaciers called Untere Plattje at an altitude of 2883 meters. It is owned by the Swiss Alpine Club. The hut is the start of the usual route to the summit and other mountains in the area. The first hut was built (1894-1895) right next to the still much higher Border Glacier at an altitude of 2795 meters (Figure 122).



Figure 122. Old stone hut (1895-2010)

Source: https://en.wikipedia.org/wiki/Monte_Rosa_Hut#/media/File:Monte_Rosa_Hut_01.jpg, Accessed: July 5, 2023

The new mountain hut was designed by the architect Andrea Deplazes from ETH Zürich (Eidgenössische Technische Hochschule Zürich), and was officially opened in September 2009 (Figure 123). The project of the Swiss Alpine Club, on the occasion of the celebration of the 150th anniversary of ETH Zurich, was launched in 2003. The finished building elements were transported by train to Zermatt and 3,000 helicopter trips were required to transport 35 workers and material to the glacier. The new building is a high-tech, energy almost self-sufficient, environmentally friendly mountain hut whose materialization is based on wood and a cover (facade covering) made of profiled aluminum sheet.



Figure 123. Monte Rosa Hut in a natural environment

Source: <https://www.uniqhotels.com/the-newmonte-rosa-hut>, Accessed: July 5, 2023

Rothera Research Station was built in 1975 on a small peninsula on the southeast coast of Adelaide (Figure 124). It is home to well-equipped biological laboratories and facilities for a wide range of research. The station has a 900-meter-long runway with an associated hangar and bulk fuel storage and a dock for transshipment of cargo from supply ships. With the commissioning (1991/1992) of a gravel runway and hangar, air operations became more reliable and access to Rothera was greatly improved by a direct air link from the Falkland Islands. Dash 7 will make approximately 20 flights to Stanley over the summer, bringing scientists, support staff, food and equipment. A rotating summer population of scientists and support staff arrive at Rothera by boat or de Havilland Canada Dash 7 aircraft flying from the Falkland Islands. Rothera welcomes up to 130 people in summer, and an average of 21 in winter. The station is named after John Rothera, a surveyor in the British program in the 1950s ^[21].



Figure 124. Rothera Research Station in Antarctica (Architects: Hugh Broughton Architects, 1977, 1997)

Source: <https://ramboll.com/projects/ruk/british-antarctic-survey-rothera>, Accessed: July 5, 2023

Source: <https://www.archdaily.com/934706/construction-works-begin-on-hughbroughtons-discovery-building-at-rothera-research-station-in-antarctica>, Accessed: July 5, 2023

Jang Bogo Antarctic Research Station is a research station at the South Pole (Figure 125). The design of the station was done by a South Korean team of architects from the SPACE group. Since the beginning of 2014, this research institute, in Terra Nova Bay, has endured temperatures of up to minus 40 degrees Celsius and wind speeds of up to 234 km/h. Scientists there test devices, equipment and new materials in extreme conditions. The center was built in a modular form over two consecutive summers - of only 65 days at a time ^[22].



Figure 125. Jang Bogo Antarctic Research Station (Architects: SPACE, 2014)

Source: <https://blog.allplan.com/en/building-in-extreme-climate-zones>, Accessed: July 5, 2023

The cultural center of Greenland is located south of the Arctic Circle in Nuuk (Figure 126). The building features an undulating, floating wooden screen facade. A metaphor for the Northern Lights, a golden larch skin wraps around the core of the building as it opens up through narrow glass slits ^[23].



Figure 126. Cultural Center of Greenland (Architects: schmidt hammer lassen architects, 1997), Nuuk, Greenland

Source: <https://architazer.com/blog/inspiration/collections/arctic-architecture/>, Accessed: July 5, 2023

Source: <https://www.pinterest.com/pin/184999497170489514/>, Accessed: July 5, 2023

In Longyearbyen, Svalbard, 78° north of the Earth's equator, Snøhetta designed a visitor center called The Arc, citing its location in the Arctic and its function as an archive of seeds for world memory (Figure 127). Commissioned by Arctic Memory AS, the visitor center will present contents from the Svalbard Global Seed Vault (the world's largest secure seed storage and Arctic World Archive), a vault that aims to preserve the world's digital heritage. Access to the exhibition building takes place via a glass access bridge that serves to organize visitors into smaller groups. On the access bridge, one is exposed to the environment and from one vantage point one can experience high geological formations in the south, spectacular views in the north and the exterior of the exhibition building. Contrasting volumes are designed to give visitors the experience of walking away from the familiar entrance to a vault within the permafrost ^[24].



Figure 127. The Arc, Longyearbyen, Svalbard, Norway (Architects: Snøhetta, 2019-2022)

Source: <https://snohetta.com/project/469-the-arc-a-visitor-center-for-arctic-preservation-storage-in-svalbard>, Accessed: July 5, 2023
 Source: <https://www.dezeen.com/2019/11/06/svalbard-global-seed-vault-snohettaarctic/>, Accessed: July 5, 2023

Halley VI British Antarctic Research Station is a mobile polar research station (Figure 128). It is the southernmost scientific research station operated by the British Antarctic Survey (BAS), and is located on the 150-metre-thick floating Brunt Ice Shelf, which is moving 400 meters a year towards the open sea. The snow level increases every year by 1 meter, and the sun does not rise for 105 days during the winter. Temperatures drop to -56 °C, and winds blow more than 160 km/h. Access by boat and plane is limited to a three-month summer window. The research station has been continuously occupied since 1957. There, in 1985, scientists first noticed a hole in the ozone layer. Halley V was completed in 1992. As the legs of the station were fixed in the ice, it could not be moved, so in 2004 BAS and RIBA organized an international competition to select a designer for the new station [25].



Figure 128. Halley VI British Antarctic Research Station (Architects: Hugh Broughton Architects, 1992)

Source: <https://hbarchitects.co.uk/halley-vibritish-antarctic-research-station/>, Accessed: July 5, 2023

Princess Elizabeth Antarctica (Figure 129). The International Polar Foundation has signed Belgium's return to Antarctica with the first zero emission station ever, Princess Elizabeth Antarctica. Ever since the days of Belgium in 1898, Belgium has maintained strong ties with Antarctica. An original signatory to the Antarctic Treaty, Belgium continued to build the King Baudouin Research Station, which closed its doors in 1967. Four decades later, the International Polar Foundation launched Belgium's return to Antarctica, conceiving, designing and building the 'zero emission' Princess Elizabeth research station as a legacy project of the 2007-2008 International Polar Year [26].



Figure 129. Princess Elizabeth Antarctica (Architects: Philippe Samyn and others, 2009)

Source: http://www.polarfoundation.org/news_press/press_pictures/princess_elisabeth_antarctica, Accessed: July 5, 2023

4.2 Architecture in the environment of a desert climate

Hot (BWh) and cold (BWk) desert climates are reflected in the conceptualization and materialization of (vernacular) architecture. Some peoples in both types of desert climate (Bedouins and Mongols, for example) live a nomadic way of life, so their dwellings (tents and yurts) are 'mountable-dismountable', i.e. portable. People in the Atacama Basin live a stationary way of life (although they are primarily engaged in animal husbandry), they have stationary dwellings, built from stone taken on site.

Tents whose fabric is made of camel, sheep or goat wool (hair) is a suitable solution for creating the borders (envelopes) of ADS. It is light, does not accumulate and, therefore, does not radiate a significant amount of heat into the inner space of the tent. During the day, it creates a comfortable shade in the interior space, and efficient ventilation improves the shade effect [27]. For the purpose of preparing food, socializing and (eventually) warming up (during the night), the people of the desert light a fire in an open area (Figure 130).



Figure 130. Left: Tent of nomadic Bedouins in the UAE. Right: Bedouin tent in Wadi-Rum, Jordan

Source: <https://gulfnews.com/entertainment/arts-culture/know-the-uae-life-under-thetent-1.1915952>, Accessed: July 5, 2023

For the conditions of the cold desert climate (BWk) and the overall living conditions of people in these areas, the ger (yurt) is the best architectural solution. It is a construction made of elements that nomads carry (on camels or horses) threatening their herds (Figure 131). The architectural-constructive concept of a yurt implies the construction of a circular or polygonal contour with a base diameter of 5-10 m along which prefab walls (lattices) are placed, which are connected to each other at their highest point. A roof structure made of wooden sticks is added to the walls, which form the contour of the sloping (conical) roof. At the crown of the roof, the rods of the roof structure rest on a central wooden ring, which is supported on the ground inside the yurt by two rods. The canvas-covered ring can be opened/closed to ensure the exhaust of smoke from an open hearth or stove (which is in the very center of gravity of the base). The skeletal construction of the walls and roof is covered with several coverings (rugs) made of sheep, goat or camel hair. Sometimes the wall filling (roof covering) is done as a 'quilt', where felt is added between two layers of the covering.



Figure 131. Mongolian ger (yurt)

Source: <https://www.pinterest.co.uk/pin/382383824590438253/>, Accessed: July 5, 2023

Source:

<https://livingnomads.com/wpcontent/uploads/2017/06/02/mongolia-yurt-334.jpg>, Accessed: July 5, 2023

When the author's (contemporary) architecture is on Wednesday, the verification of the validity of the concept and the materialization of the boundaries (envelope) of the ADP can be done using a computer and appropriate software, where the input assumptions can be quickly changed, i.e. the requirements of the cryptoclimate (climate of the interior space) and environmental climate parameters.

4.2.1 Vernacular architecture in the environment of a desert climate

Every desert in the world has some specifics, as well as the people who live in it. Architecture expresses this with 'its own language' - different programs (type of objects, i.e. their function), concept and materialization. The photographs (Figures 132-144) present some examples of vernacular architecture in the Atacama desert in Chile.



Figure 132. Left: A typical house in the village of Machuca in the Atacama Desert, Chile. Right: San Pedro de Atacama, a city in the Atacama Desert, Chile

Source: <https://www.picfair.com/pics/06531404-atacama-desert-chile-typical-houses-in-the-village-of-machuca-in-the>

Accessed: July 5, 2023



Figure 133. Church, San Pedro de Atacama, Atacama Desert, Chile

Source: <https://www.pxfuel.com/en/free-photojctcw>, Accessed: July 5, 2023

Located 265 km as the crow flies southeast of Peru's capital Lima, or five hours by car, Huacachina is a stunning desert oasis surrounded by steep and towering sand dunes. It is considered one of the most attractive places in the world for sandboarding. Nowadays, this oasis has become an extremely visited place where several hotels have been built. It is an example of how the social environment (at the global level) can turn a desert into a great economic resource (Figure 134).



Figure 134. Oasis of Huacachina

Source: <https://www.surfertoday.com/surfing/the-best-sandboarding-dunes-in-the-world>, Accessed: July 5, 2023

The photographs (Figures 135-138) present several examples of vernacular architecture from various parts of the Sahara desert, and from the Rub Al Khali desert (Saudi Arabia).



Figure 135. Left: Tuareg tent, Morocco. Right: A traditional village of the Tuareg people in Libya

Source: <https://blog.ferrovial.com/en/2017/07/traditional-architecture-energyefficiency/>, Accessed: July 5, 2023



Figure 136. Bedouin tents, Sahara

Source: <https://www.oddizzi.com/teachers/explore-the-world/physicalfeatures/ecosystems/deserts/what-can-you-find/people/>

Accessed: July 5, 2023

Source: <https://www.pinterest.at/pin/481603753903926518/>, Accessed: July 5, 2023

Source: <https://www.pinterest.com/pin/396879785888314293/>, Accessed: July 5, 2023



Figure 137. A Berber 'tent village' in the Sahara, Morocco

Source: https://www.tripadvisor.com/LocationPhotoDirectLink-g293732-d4323559-i118550363-Best_Morocco_Tours-Casablanca_Casablanca_Settat.html, Accessed: July 5, 2023



Figure 138. Bedouin reed 'house' (Arish House), Liwa Oasis, Rub Al Khali Desert, United Arab Emirates

Source: <https://www.architecturalreview.com/awards/ar-emergingarchitecture/arish-house-by-2-ideasarchitecture-liwa-oasis-rub-alkhalidesert-united-arab-emirates>, Accessed: July 5, 2023



Figure 139. Underground house, Gharyan, Libya (left) and Tunisia (right)

Source: <https://www.pinterest.es/pin/497366352574719388/>, Accessed: July 5, 2023

Source: <https://www.pinterest.com/pin/258042253620795479/>, Accessed: July 5, 2023



Figure 140. Kerzaz Oasis on Wadi Saoura, Western Sahara, Algeria

Source: <https://www.britannica.com/science/desert/Biota>, Accessed: July 6, 2023

Bhunga houses in the desert areas of Kutch, western India, are houses built of mud (adobe) and decorated with various things, inside and out (Figure 141). They are, in fact, real museums of the people of Kutch. They are mostly found in the desert islands in the northern parts of Kutch like Banni and Paccham.



Figure 141. Bhunga houses in the desert areas of Kutch, Gujarat state, western India

Source: <https://www.kutchtourguide.com/blog/wp-content/uploads/2015/10/Bhunga-Kutch.png>, Accessed: July 6, 2023

The Mogao Caves are located at a strategic point on the Silk Road, at the crossroads of trade, as well as religious, cultural and intellectual influences. The stations (492 of them) and cave shrines in Mogao are famous for their statues and wall paintings, testifying to 1000 years of Buddhist art (Figure 142). Carved into the cliffs above the Dachuan River, the Mogao Caves, southeast of Dunhuang Oasis, Gansu Province, contain the world's largest, richest, and longest-lived treasury of Buddhist art. It was built for the first time in 366 and represents a great achievement of Buddhist art from the 4th to the 14th century. Currently, 492 caves have been preserved in which there are about 45,000 m² of frescoes and more than 2,000 painted sculptures.



Figure 142. The Mogao Caves are carved into the face of a sandstone cliff in Dunhuang (China) on the edge of the Gobi Desert

Source: <https://www.artnews.com/art-in-america/features/triple-canopy-bosnia-58893/>, Accessed: July 6, 2023

Source: <https://claralieu.wordpress.com/2008/07/07/the-caves-of-dunhuang-china/>, Accessed: July 6, 2023

Ger (yurt, yurt) has a circular base (diameter 3-5 m). The walls of the yurt are made of a type of single-layer lattice (when developed on site) made of wooden sticks, parallel stacked next to each other, in a package, during transport. Stronger wooden frames are built into the walls of the yurt, which carry the doors (Figure 143). Instead of the usual door construction, a curtain is often used that opens upwards, like a 'ventus window', or just deflects to the side, like a curtain. The roof of the yurt is in the shape of a compartment, and it is made of specially shaped sticks that are placed radially, resting at their base on the wall of the yurt, while at the top of the roof they are fixed in a central, rigid, wooden hoop. Sometimes the wooden hoop is free, stabilized by the pressure

forces generated by the radially placed rods of the roof structure, and sometimes it is supported on two vertical wooden columns. The horizontal forces generated by the circular shape of the roof base are absorbed by thicker woolen rope or strips of woolen mesh, which are exposed to tensile stresses. The central ring at the crown of the roof is exposed to compressive stresses, and its form is stabilized by wooden rods placed crosswise within the contour of the beam. The top of the conical roof is the highest point of the yurt space, and through it the smoke and waste are removed air from the yurt, and introduces natural daylight into the space.



Figure 143. Mongolian ger (yurt)

Source: <https://www.pinterest.com/pin/317433473715803100/>,

Accessed: July 6, 2023

Source: <https://www.pinterest.com/pin/467881848758352908/>,

Accessed: July 6, 2023

Many variations of Aboriginal shelters are related to the changing needs of a particular time, temperature and part of the country (Figure 144).



Figure 144. Aboriginal Houses, Hermannsburg, Northern Territory, Australia (1923)

Source: https://www.wikiwand.com/en/Herbert_Basedow,

Accessed: July 6, 2023

4.2.2 Newer and contemporary (author's) architecture in the environment of the desert climate

The desert roses (Figure 145) that bloomed for a long time under the hot Qatari sun have been immortalized in the form of the new National Museum of Qatar. With its curved discs and consoles, the museum 'blooms' in the middle of the Doha landscape, a symbol of humble beginnings and the spectacular rise of a nation whose story is revealed in the institution's 11 galleries. During the opening ceremony (March 27, 2011), which was attended by the Emir of Qatar, Sheikh Tamim bin Hamad Al Thani, his Kuwaiti counterpart, Sheikh Sabah al-Ahmad al-Jaber al-Sabah, and French Prime Minister Edouard Philippe, the desire of the emirate to become the main cultural force. On a usable area of 53,000 m², in addition to 11 permanent and temporary exhibition rooms, there is an auditorium with 220 seats, restaurants, cafes and a high-design souvenir shop. And while trying to project into the future, the museum incorporates the past into its structure, and the famous palace of Sheikh Jassim bin Mohammed Al Thani, the emir of Qatar from the 19th century, has been restored and integrated into the museum as a central exhibition site ^[28].



Figure 145. National Museum of Qatar, Doha, Abu Dhabi (Architect: Jean Nouvel, 2005)

Source: <https://www.dw.com/en/qatars-newnational-museum-inspired-by-thedesert-rose/a-48093214>, Accessed: July 6, 2023

Source: <https://www.designdiffusion.com/en/2019/07/09/doha-the-national-museumof-qatar-by-ateliers-jean-nouvel/>, Accessed: July 6, 2023

Ski Dubai Snowpark is an artificially arranged ski center in desert climate conditions. It was built according to the project of the architectural firm Thinkwell Group from Los Angeles, and was opened in 2005. The ski center with the Mall of Emirates, one of the largest shopping centers in the world, forms a unique business complex built by its owner, Majid Al Futtaim Group. Considering the natural environment, sand skiing, or sand boarding, can naturally be expected in the area of Dubai. The construction of a ski center, at first glance, looks like an adventure and an exhibition, however, it is a financially justified job for its investor and owner. The very idea of building a ski center in the climatic conditions of Dubai, in its beginning, looks like a mathematical-physical task that needs to be solved (a task) in an architectural space characterized by two key data:

- Indoor air temperature: $t_i = -20\text{ }^\circ\text{C}$,

- Air temperature of the outdoor space (environment): $t_e = +40\text{ }^\circ\text{C}$.

The temperature difference (60 °C) to which the boundary of the architecturally defined space (building envelope) is exposed should be noted. 6000 tons of artificial snow was artificially produced in the ski center. The area of the center is 22,500 m² and it is in operation all year round. The temperature inside the object is from -1 °C to -20 °C, while the temperature in its surroundings rises to +40 °C. Inside the building, there are five ski slopes with excellent technical performance, with the longest one being 400 m. The building is 85 m high and 80 m wide. A special attraction of the ski center is the snow cave, with an area of 3000 m², snow bullet (flying down a 150 m long slope) and penguins (Figure 146).



Figure 146. Ski Dubai: a Ski Resort in the Desert (Architects: Thinkwell Group, 2005)

Source: https://www.youtube.com/watch?v=xIX9ju_ZbAY,
Accessed: July 6, 2023

The King Abdullah Petroleum Studies and Research Center is located in Riyadh, Saudi Arabia (Figure 147). The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit institution for independent research into policies that contribute to the most efficient use of energy to provide social welfare worldwide. KAPSARC develops policies and economic frameworks that reduce the environmental impact and overall costs of energy supply, enable practical technology-based solutions for more efficient energy use. Collaborating with international research centers, public policy organizations, world government institutions and global industry, KAPSARC brings together leading experts from around the world to address energy challenges. They freely share their knowledge, insights and analytical frameworks. The 70,000 m² KAPSARC campus includes five buildings: the Energy Knowledge Center, the Energy Computing Center, the Conference Center with an exhibition hall and a 300-seat auditorium, the Research Library with archives for 100,000 volumes, and the Musalla, an inspiring place for prayer on campus. The architectural concept of KAPSARC has strong technical and ecological considerations at its heart, drawing the five elements of the campus into a unified whole (Fig. 3.66). This project was awarded LEED Platinum certification by the US Green Building Council, as it was designed in response to the environmental conditions of the city of Riyadh to reduce energy and resource consumption.



Figure 147. King Abdullah Petroleum Studies and Research Centre, Riyadh, Saudi Arabia (Architects: Zaha Hadid Architects, 2017)

Source: <https://www.archdaily.com/882341/king-abdullah-petroleum-studies-andresearch-centre-zaha-hadid-architects>
Accessed: July 6, 2023

Designer Tomas Osinsk and Los Angeles film producer Chris Hanley have created a house of mirrors near Joshua Tree National Park. The Invisible House (the envelope of which is made of mirrors) is located on the site, a 10-minute drive from the center of Joshua Tree, California (Figure 148). The property can be rented for filming, photography and events. Mirrored glass walls provide expansive views of the 90-hectare private setting. The house was developed on an area of 551 m², and was conceived as one long, continuous entertainment area around a 30-meter-long indoor pool.



Figure 148. Invisible House, edge of Joshua Tree National Park in California (Architect: Tomas Osinski, 2019)

Source: <https://www.dezeen.com/2020/06/12/invisible-house-mirrored-chris-hanleyjoshua-tree-national-park-desert/>, Accessed: July 6, 2023.

The French architect Jean Nouvel presented (2020) a hotel project (Sharaan) that will be carved into a sandstone hill in the AIUla desert in Saudi Arabia, about 350 km north of the city of Medina, and is located in the Madâin Sâlih world heritage area under UNESCO protection, the cultural achievement of the Nabatean people (Figure 149). The Nabateans occupied the Arabian Desert between the second and fourth centuries BC, and are known for a series of rock-cut architectural works (including Petra in Jordan) [16]. The development of the resort is part of the AIUla Royal Commission's plan to boost global tourism in the area. "Foreseeing the future is a constant obligation that requires us to be fully alive with places in the present, as well as to conjure up the past" (Jean Nouvel) [28].



Figure 149. Cave hotel (Sharaan), AIUla desert, Saudi Arabia (Architect: Jean Nouvel, project, 2020)

Source: <https://www.dezeen.com/2020/10/27/sharaan-jean-nouvel-aiula-desert-saudi-arabia/>, Accessed: July 6, 2023.

4.3 Architecture in the environment of the rain forest climate

As the rain forest climate area is developed on land along the Earth's longest parallel (the equator), in America, Africa, Asia, Australia and Oceania, a wide variety of architecture, both vernacular and contemporary (author's), is encountered there.

4.3.1 Architecture in the environment of rain forest climate from the aspect of architectural physics

As already mentioned, rain forests are located in a climate zone where there is no dry season (all months have an average amount of precipitation of at least 60 mm). In addition, mean monthly temperatures exceed 18 °C during all months of the year, the average annual precipitation is not less than 1680 mm, although it is usually between 1750 mm and 3000 mm. The average annual temperature is between 21 °C and 30 °C.

As the levels of the main parameters of human comfort (temperature and air humidity) of the environment throughout the year are higher than the levels that are optimal for human comfort within the ADS ($t_i = 20-22\text{ }^\circ\text{C}$, $\phi_i = 60-75\%$), then the basic task of the concept and materialization of the boundaries of ADS to make the house a "colder and drier environment" than the outside environment. Heat and moisture transport is from the outside to the inside (boundary) of the ADS. This is exactly the opposite of the situation we have in all other natural environments on Earth (on the ground). The picture shows the architectural concept and materialization of ADS in the conditions of the rain forest environment, which successfully solves the mentioned problem from the aspect of architectural physics. This concept is generally applied to a number of vernacular architecture in the rain forest environment. Specific characteristics in a wide range of solutions are the result of the influence of the social environment and man (Figure 150).

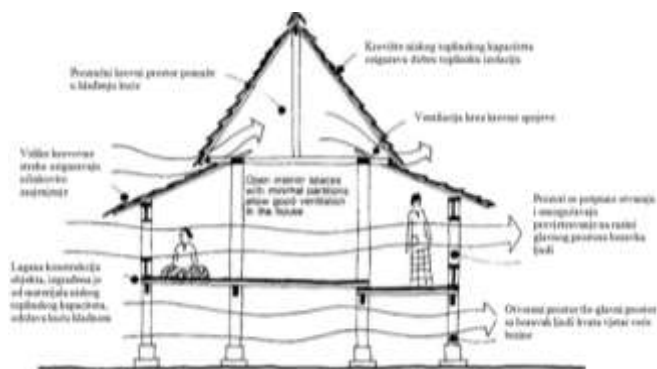


Figure 150. A typical vertical plan of (vernacular) construction in a rain forest environment (Adapted from: Yuan L. J.)

Source: https://cambodiarchitecture.files.wordpress.com/2010/06/vernacular_architecture_cooling.pdf, Accessed: July 6, 2023.

The solutions of author's architecture more or less follow the solutions of vernacular architecture. Here, too, complex computer software is used, such as computerized fluid dynamics (Computational fluid dynamics, CFD), (Figure 151).

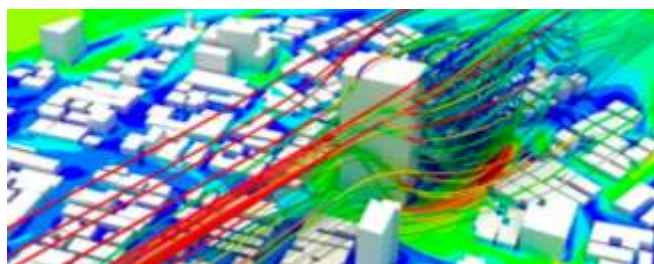


Figure 151. Computational Fluid Dynamics (CFD) simulation of wind around buildings

Source: <https://www.mdpi.com/2071-1050/12/23/10173/htm>, Accessed: July 6, 2023.

4.3.2 Vernacular architecture in the environment of the rain forest climate

As already mentioned, the rain forest climate area is developed on land along the Earth's longest parallel (the equator), in America, Africa, Asia, Australia and Oceania. In addition to the many common features of vernacular architecture along the entire circumference of the equator (horizontal), each individual geographical area receives cross-cultural influences from the area

along the meridians (vertical). The result is a wide variety of architectural concepts and materialization (Figures 152-164).



Figure 152. Residential colonies of the Yanomami tribe in the Amazon

Source: <https://www.flickr.com/photos/27555022@N05/2575305538>, Accessed: July 6, 2023.
Source: <https://www.pinterest.com/pin/438678819929833913/>, Accessed: July 6, 2023.



Figure 153. Left: Traditional houses in the Amazon rainforest. Right: Traditional houses in the Orinoco River Delta, Venezuela

Source: <https://www.pinterest.co.uk/pin/471400285973004898/>, Accessed: July 6, 2023.
Source: <https://www.lastfrontiers.com/imageview/933>, Accessed: July 6, 2023.



Figure 154. Ifugao huts in the Philippines
Source: <https://www.pinterest.com/pin/575194183635224014/>, Accessed: July 6, 2023.



Figure 155. Traditional dwellings in Burundi, Africa
Source: <https://www.pinterest.com/pin/616289530229068256/>, Accessed: July 6, 2023.



Figure 156. Traditional architecture of the Zulu people, Africa
 Source: https://www.researchgate.net/figure/The-ecological-beauty-of-traditional-beehive-huts-of-Zulu-people-South-Africa-left-and_fig1_335960050, Accessed: July 6, 2023.



Figure 157. Traditional dwellings in Rwanda, Africa
 Source: <http://www.africavernaculararchitecture.com/rwanda/>, Accessed: July 6, 2023.
 Source: <http://www.africavernaculararchitecture.com/wpcontent/uploads/2015/04/Rwanda-Kings-Hut-interiorsubmitted-by-Larsen-Pay%C3%A113.jpg>, Accessed: July 6, 2023.



Figure 158. Traditional architecture in Liberia, Africa
 Source: <https://www.pinterest.com/pin/110760472063868683/>, Accessed: July 6, 2023.



Figure 159. Left: A traditional house in the Democratic Republic of the Congo, Africa. Right: Houses of the Korowai tribe Indonesia
 Source: <https://www.pinterest.com/pin/572801646340982770/>, Accessed: July 6, 2023.
 Source: <https://www.thesun.ie/news/4910382/inside-indonesias-cannibal-korowaitribe-that-live-in-trees-and-consider-westerners-white-ghosts/>, Accessed: July 6, 2023.



Figure 160. Traditional architecture in Indonesia
 Source: <https://www.pinterest.com/pin/51580358209406445/>, Accessed: July 6, 2023.



Figure 161. Sumbanese traditional houses in Indonesia
 Source: <https://archeyes.com/sumbanesetraditional-houses-in-indonesiavernacular-architecture/>, Accessed: July 6, 2023.



Figure 162. A traditional Batak house in Sumatra (left) and a traditional Tongkonan (Torayan people) house on the island of Sulawesi, Indonesia
 Source: <https://www.pinterest.cl/pin/472526185885255692/>, Accessed: July 6, 2023.
 Source: <https://www.pinterest.com/pin/247698048238839681/>, Accessed: July 6, 2023.



Figure 163. Traditional architecture in Vietnam
 Source: <https://www.pinterest.ca/pin/827747606491054059/>, Accessed: July 6, 2023.



Figure 164. A settlement of the Bajau people

Source: <https://tobyforreal.wordpress.com/2015/10/21/the-awesome-bajau-tribe/>, Accessed: July 6, 2023.

Source: <https://thejupital.com/people-of-thesea/>, Accessed: July 6, 2023.

Source: <https://authentic-indonesia.com/blog/8-unique-facts-of-the-bajau-indonesiasea-gypsies-tribe/>, Accessed: July 6, 2023.

4.3.3 Newer and contemporary (author's) architecture in the environment of the rain forest climate

Specially designed to solve a series of demands of the natural environment, tropical architecture focuses on issues of ventilation, integration with the environment and its climate. Made to blend into their natural surroundings, these projects demonstrate the tension between functional structures and organic context. This is where the concept and materialization of architecture comes to the fore, primarily the concept and materialization of the envelope of an architectural object.

Casa Branca is located in São Sebastião, Brazil, along the beach on the north coast of Sao Paulo (Figure 165). The White House project in its tropical context is a response to the requirements of comfort and building maintenance over a long period of time in a tropical area by the sea, where high temperatures and the effect of sea air determine extreme local conditions. Perforated wooden doors combine with an elegant staircase that climbs to the upper living room. Casa Branca (White House) is located on a beautiful Brazilian beach on the north coast of Sao Paulo, which was the main input for organizing the plan and choosing the materials to be used. The spaces of the house have large sliding window screens, from floor to ceiling, which create a pleasant feeling of warmth, erasing the boundary between interior and exterior. In the living room, glass doors measuring 3.0 x 2.5 are built into the walls and integrate the interior space with the balcony, thus generating cross ventilation with the aim of reducing the room temperature. In the same space, wooden perforated doors, like large musharabi, shade the interior without blocking the breeze. On the ground floor we

find the social area of the house, even the kitchen, which overlooks one of the side gardens. There are bedrooms on the first floor. There is a garden with a terrace on the roof deck which can be accessed by a staircase. The combination of wood, concrete and white aluminum (resistant to the influence of sea air) gives the impression of 'tropical minimalism' architecture.



Figure 165. Casa Branca (Architects: StudioMK27 – Marcio Kogan, 2014)

Source: <https://architizer.com/blog/inspiration/collections/tropical-modernism/>, Accessed: July 6, 2023.

Source: <https://architizer.com/idea/1465732/>, Accessed: July 6, 2023.

Casa Bahia in Miami, Florida (USA), is located in the tropical environment of Coconut Grove (Fig. 3.94). Seemingly floating above the water, this construction explores spatial experience through timelessness, simplicity and light. Casa Bahia is a tropical retreat in the heart of Miami. It's a framework for living, with a design philosophy that prioritizes our humanity and well-being. The house serves as a solid, restorative sanctuary of everyday life. It seems that the designer adhered to the principle: 'beauty is in simplicity, and luxury is in restraint'^[29].



Figure 166. Casa Bahia (Architect: Alejandro Landes, 2015), Miami, USA

Source: <https://architizer.com/blog/inspiration/collections/tropical-modernism/>, Accessed: July 6, 2023.

Ha Long Villa is located along the coast of Vietnam's Ha Long Bay - a UNESCO World Heritage Site known for its high limestone islands and emerald waters (Figure 167). The main concept of the house is to create a space where people can live in the forest. The building is characterized by multiple rectangular openings in the concrete walls, from where trees of green trees emerge. The house has a pentagonal base in the contour of which there are closed and semi-open spaces with greenery. This concept creates deep shadows as part of a green facade with a double skin against the hot tropical climate. This buffer between indoor and outdoor space protects the house from hot climate and noise. Each semi-open space is connected by a main spiral staircase. There is a spatial sequence from the outside to the inside, from the ground to the roof, and through a semi-open space with large windows and

plenty of greenery to experience the rich natural landscape and view of the city from different angles ^[30].



Figure 167. Ha Long Villa (Architects: VTN Architects, 2020)
Source: <https://www.stirworld.com/seefeatures-vtn-architects-packs-aconcrete-villa-with-trees-on-its-doubleskin-facade-in-vietnam#gallery-2>, Accessed: July 6, 2023.

Kuala Lumpur International Airport (KLIA), (Bahasa Malaysia: Lapangan Terbang Antarabangsa Kuala Lumpur) is Malaysia's main international airport and one of the largest airports in Southeast Asia and worldwide (Figure 168). It is located in the Sepang district of Selangor, about 45 kilometers south of Kuala Lumpur city center and serves as a conurbation of the Greater Klang Valley. KLIA is the largest and busiest airport in Malaysia. In 2018, it transported 59988409 passengers, 714669 tons of cargo and 399827 aircraft takeoffs. It is the 23rd airport in the world in terms of total passenger traffic. The airport was designed by the Japanese architect Kisho Kurokawa. The building of the main terminal 1 and contact Pier was opened in 1998, and terminal 2 in 2014. Today it stands alongside the Petronas Towers as one of Malaysia's architectural gems. Japanese architect Kisho Kurokawa's vision of the airport's form and materials incorporated influences from the natural and cultural environment. The design represents an interesting example of his concept of 'symbiosis', which Kurokawa described as 'an airport in the forest'. It is also a compelling example of sensitive architectural design in the midst of Asia's explosive growth. The first indication that reflects Kurokawa's concept of 'symbiosis' is the building's roof, which is made as a series of hyperbolic paraboloid shells that float above an almost flat place like a set of Islamic domes (in Malaysia, more than 60% of the population is Muslim).



Figure 168. Kuala Lumpur International Airport (KLIA), (Bahasa Malaysia: Lapangan Terbang Antarabangsa Kuala Lumpur). (Architect: Kisho Kurokawa, 1998)

Source: <https://www.klia2.info/klia/klia-layoutplan/>, Accessed: July 6, 2023.

After the realization (2001) of the Eden Project in St Blazey, England (architects: Grimshaw Architects), (Figure 169) and the Tropical Islands Resort in Berlin (2004), Germany (architects: CL MAP GmbH), (Figure 170), the project (2014) Heart of Africa Rainforest Biome is another visionary project in which, in the conditions of a relatively cold climate, an artificial structure is designed and realized, the concept and materialization of the envelope generating conditions suitable for the climate of tropical rainforests.



Figure 169. Eden Project in St Blazey, England (Architects: Grimshaw Architects, 2001)

Source: <https://www.edenproject.com/edenstory/about-us/our-funding>, Accessed: July 6, 2023.

Source: <https://www.sciencefocus.com/planetearth/conservation-creating-edens/>, Accessed: July 6, 2023.



Figure 170. Tropical Islands Resort in Berlin, Germany (Architects: CL MAP GmbH, 2004)

Source: <https://www.bloomberg.com/news/articles/2018-12-11/parques-reunidos-saidto-near-deal-to-buy-german-tropicalresort> Accessed: July 6, 2023.

Source: <https://www.businessinsider.com/thetropical-islands-resort-in-germany-2013-3>, Accessed: July 6, 2023.

5. Conclusion (Perspectives)

According to the theory of Architecturally Defined Space (ADS), perspectives are an immanent dimension of architecture, in all historical periods and in all possible environments. At the same time, the perspectives of the architecture seen in the period of antiquity (Mesopotamia, Egypt or Greece, for example) are different from the perspective of the architecture of the Middle Ages or the perspectives of the architecture of the Modern period. Perspectives of architecture seen today, on the threshold of the third decade of the 21st century, are different from the perspectives of architecture in the past, and therefore also from the perspectives of architecture that will be seen in the future, in a hundred, five hundred or a thousand years. However, perspectives in architecture, regardless of which historical period it is about, and which specific geographical area, have their constant as well as a number of more or less variable dimensions appropriate to the specific time and space, that is, to the natural and social environment. The constant perspective in architecture is related to man, that is, confirmation of his true values. At the same time, some requirements of architecture according to human needs are

universal and timeless and, as such, are prescribed by standards at the world, regional or national level. It is about the so-called definition area of human comfort in the field of thermodynamics, acoustics and lighting. Looking at the perspectives of architecture, which is the subject of this book (Architecture in extreme climatic areas), should be followed through the simultaneous monitoring of the other three fundamental elements of architecture - environment, man and borders. At the same time, the mutual influence of these three elements of architecture does not have to be linear and in the order as listed, but intricate, complex and controversial. According to the way individual elements of architecture are treated in this book, it is obvious that the natural environment is directly reflected on the social environment and man, and all together on architecture. With just a cursory look at people's physiognomy, for example, we can unmistakably tell from which natural environment (on Earth) they come. In the (current) perception of natural environments with polar and desert climates, they are scarce, harsh, and therefore sparsely populated. Until now, we have mostly perceived the natural environment of rain forests (where the richest biodiversity of plant and animal life is) as 'wild', where 'civilization lags behind', so we called it a jungle. When we talk about the perspectives of life (and therefore also the perspectives of architecture) in any geographical area of the Earth, we must have an insight into what resources (and what amounts of them) that area has: drinking water, fossil and renewable energy sources (coal, oil, gas, Solar radiation, geothermal energy...), mineral wealth... The presence of people (from the world of 'known civilizations' of which we are a part) in the northern polar area (Arctic) and in the southern polar area (Antarctic) is more recent. The arrival of people from the 'European cultural circle' to these areas happened at the beginning of the 20th century. At first, these visits looked like adventures of curious people, and later they had different purposes - installing military bases and scientific research stations. The battle for the hidden mineral wealth of the Arctic is likely to intensify following research that has confirmed vast reserves of fossil fuels (oil and oil) under the ice. A map of potential oil and gas reserves in the region, recently published in the prestigious journal Science, shows that about 30% of the world's untapped gas and 13% of oil lie under the sea around the North Pole. Billions of barrels of oil and trillions of cubic meters of gas lie within the Arctic Circle, where until now permanent ice has prevented drilling. The latest research has shown that under the Sahara desert (which until now we have perceived as a vast and water-scarce area on Earth) lie the largest reserves of fresh water on Earth (Figure 171).

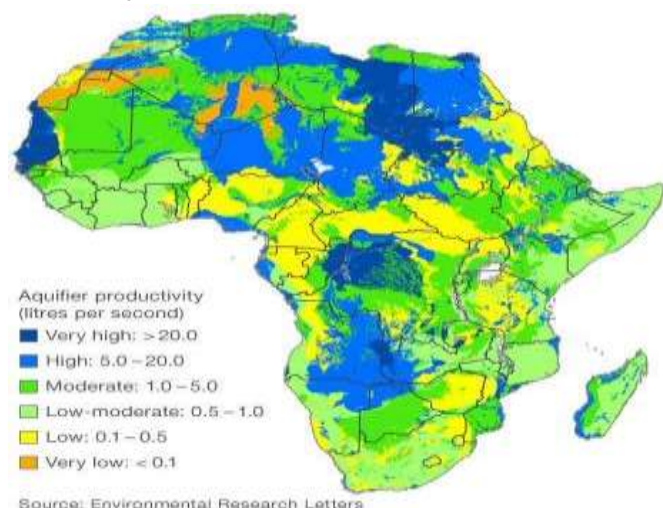


Figure 171. Underground supplies of fresh water in Africa

Source: <https://www.bbc.com/news/scienceenvironment-17775211>, Accessed: July 6, 2023.

Some richer countries from the Sahara area (Libya, for example), thanks to the huge income from the exploitation and sale of oil, arranged very ambitious water pumping systems under the Sahara, turning this desert into a vast space with modern agriculture. Through an extensive system of built pipelines, they provide the country with water for consumption and agriculture. The so-called "Great Man-Made River" (English: The Great Man-Made River, GMMR, Arabic: *العظيم الإذثار النحر*) is the world's largest irrigation project (Figure 172). GMMR currently has a flow of almost 2.5 million m3 of water per day. It runs through an underground network of pipelines from the Nubian Sandstone Aquifer System in the Great Sahara Desert to coastal urban centers, including Tripoli and Benghazi. The distance is up to 1600 kilometers. GMMR currently provides 70% of the total fresh water used in Libya.



Figure 172. Model of the „Great Artificial River“ irrigation project in Libya

Source: <https://www.dandc.eu/en/article/libyahas-worlds-largest-irrigation-project>, Accessed: July 6, 2023.

People have lived in rainforests since ancient times. Rain forest areas seem to be the most vulnerable in the future, given their intensive deforestation. Deforestation threatens numerous plant and animal communities and indigenous human communities. About 17 percent of the Amazon rainforest has been destroyed over the past 50 years, and losses are steadily increasing. The Amazon rainforest is already seeing a 25% decrease in rainfall in some regions. When rainforests are lost, an important natural resource will be lost. Tropical rainforests are centers of biodiversity, home to approximately half of the world's plants and animals, many of which have not even been cataloged yet. Rain forests produce, store and filter water, protecting the soil and the area from floods and drought. Many plants found in rainforests are used to produce medicines (including anti-cancer drugs) and cosmetics and food. Rain forests are home to endangered or protected animals such as the Sumatran rhinoceros, orangutan and jaguar. Forest trees absorb carbon dioxide, an important function required by climate change caused by human emissions of greenhouse gases. Bearing in mind the facts presented, especially the resource potential, the Author predicts that the areas with a polar and desert climate (especially the area of today's Shara desert) will be densely populated. The project of a city in the desert - Masdar City (Arabic: *مصدر مدينة*) in Abu Dhabi (UAE) has already been released (2006) according to the project of one of the leading design firms in the world, Foster + Partners. The Arctic City project (1970) by architects Otto Frei and Ewald Bubner envisages the construction of a city in polar climate conditions. The realized Masdar City project (Figure 174) as well as the unrealized The Arctic City (Figure 173) function using solar energy. The framework for a large population will be a new, sophisticated architecture that will use clean energy sources

(natural gas) and renewable energy sources (solar radiation and geothermal energy).



Figure 173. The Arctic City (Architects: Otto Frei and Ewald Bubner, project, 1970)

Source: <https://www.pinterest.com/landOfEcodelia/ideal-city-utopianarchitecture/>, Accessed: July 6, 2023.

Source: <https://www.iconeye.com/architecture/features/item/10164-freiotto-s-arcticcity>, Accessed: July 6, 2023.



Figure 174. Masdar City (Arabic: مصدر مدينة), Abu Dhabi (Architects: Foster + Partners, 2006)

Source: <https://transsolar.com/projects/abudhabi-masterplan-masdar-city>, Accessed: July 6, 2023.

On the other hand, the Author is concerned about the future of areas with a rainforest climate (Figure 175).



Figure 175. Soil erosion due to deforestation (Brazil)

Source: <https://www.nationalgeographic.org/encyclopedia/rain-forest/>, Accessed: July 6, 2023.

Perhaps the centers of the future development of the world will be in today's Sahara desert and the Arabian desert, and today's world of areas with a temperate climate will become the cultural heritage of mankind.

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