

PART I - CLIMATE IMPACT AND INITIAL FINDINGS

CREST CLIMATE HUBS

CLIMATE ACTION REPORT

NEOM
Climate Hub
Saudi Arabia



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CLIMATE ACTION REPORT

FOR NEOM – SAUDI ARABIA BY CREST FOUNDATION

Climate change has enormous impact on survival of all living creatures. Failure to adapt is one major factors for extinction. Studying of endangered species, geological changes and damage causing factors can lead way to define a methodical roadmap in conceptualizing Climate Hubs (which has direct influence on human wellbeing as well).

A consolidation of gross study based on online research from several authentic sources with focus on current situation due to several man-made developments across Tabuk Province boiling down to Neom. This includes mapping of climate and geological changes occurred over period of time and its impact on natural resources. Fact remains that Saudi Arabia ranks 98 of 165 countries in the UN Sustainability Development Goals Index.

Development Report 2021. That makes it even more critical for Climate Hub to design targets based on corrective actions to achieve important Sustainability GOALS specific to Neom, Tabuk, Saudi Arabia.

These considerations are increasingly critical to integrate with planning principles of new age community developments across the modern world for future proof human science. Climate Action Report designed by CREST Foundation is a scientific framework to build Climate Hubs to combat both climate and lifecycle disasters. Part - 1 navigates first step towards Climate and Project Feasibility. Primary focus of this report is to constitute a solution framework to restore ecological balance with broad roadmap towards environmental impact goals of CREST Foundation overlapped and measured in comparison with UN Sustainable Development Goals defined for Saudi Arabia. Evidence and results occurred in this report will get further evolved in Report II – Climate Hub Design and Implementation Roadmap with micro level details based on intense on ground and in person inspection of site location involving several subject matter experts.





PILOT STUDY OF
NEOM
SAUDI ARABIA

ABOUT NEOM

SAUDI ARABIA

NEOM Region is in the upper north-west part of the Kingdom of Saudi Arabia, along the Red Sea and the Gulf of Aqaba.

NEOM has been designated, by the Saudi Government, as an International Commercial and Industrial zone built on available natural and unique components of this region, adding to the economic vision that Saudi Arabia.

The idea of creating NEOM Region was viewed from several different National and International aspects of development.

NEOM has the potential to become the ultimate Smart City by achieving exceptional innovation in business, livability, and sustainability in line with Saudi's vision 2030.

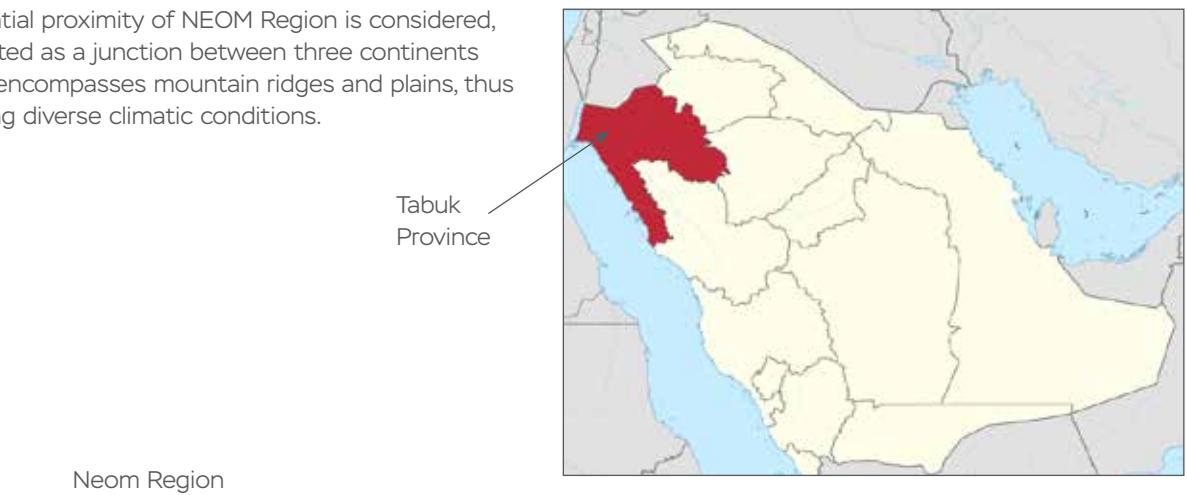
NEOM aims to,

- » Become The Tourist Destination of Saudi Arabia
- » Create 3,80,000 jobs
- » SAR 180B contribution to GDP by 2030
- » Powered 100% by renewable energy
- » 450km+ of coastline
- » 13% of the world's trade passes through the Red sea
- » 170km of reimagined urban development by forming hyper-connected communities called THE LINE



LOCATION

If the spatial proximity of NEOM Region is considered, it is situated as a junction between three continents where it encompasses mountain ridges and plains, thus witnessing diverse climatic conditions.



PROPOSED PROJECT LOCATION

OPTION 1

First option is between the Neom palace and Neom bay Airport. This location does not have a coastal line and takes 2 hours and 16 minutes by road from Tabuk.



CONNECTIVITY

- Major highways that run through the project
- 8784
- Route 55



PROPOSED PROJECT LOCATION

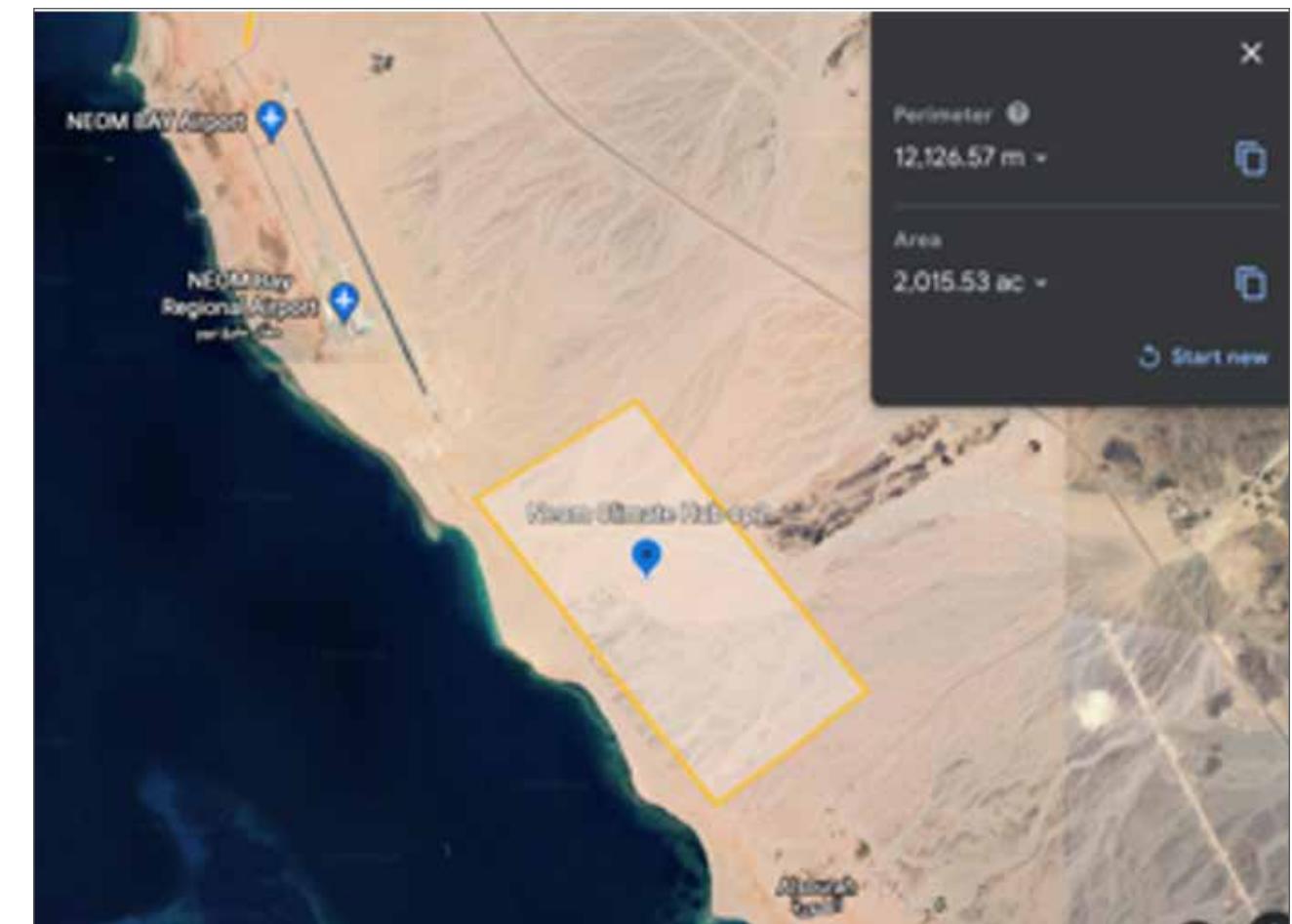
OPTION 2

The second option of the site has been identified in between the Neom Bay airport and Alsourah. This option has a coastal line and a great potential for hospitality projects. 2 hours 38 minutes by road from Tabuk



CONNECTIVITY

- Major highways that run through the project
- 8784
- Route 80



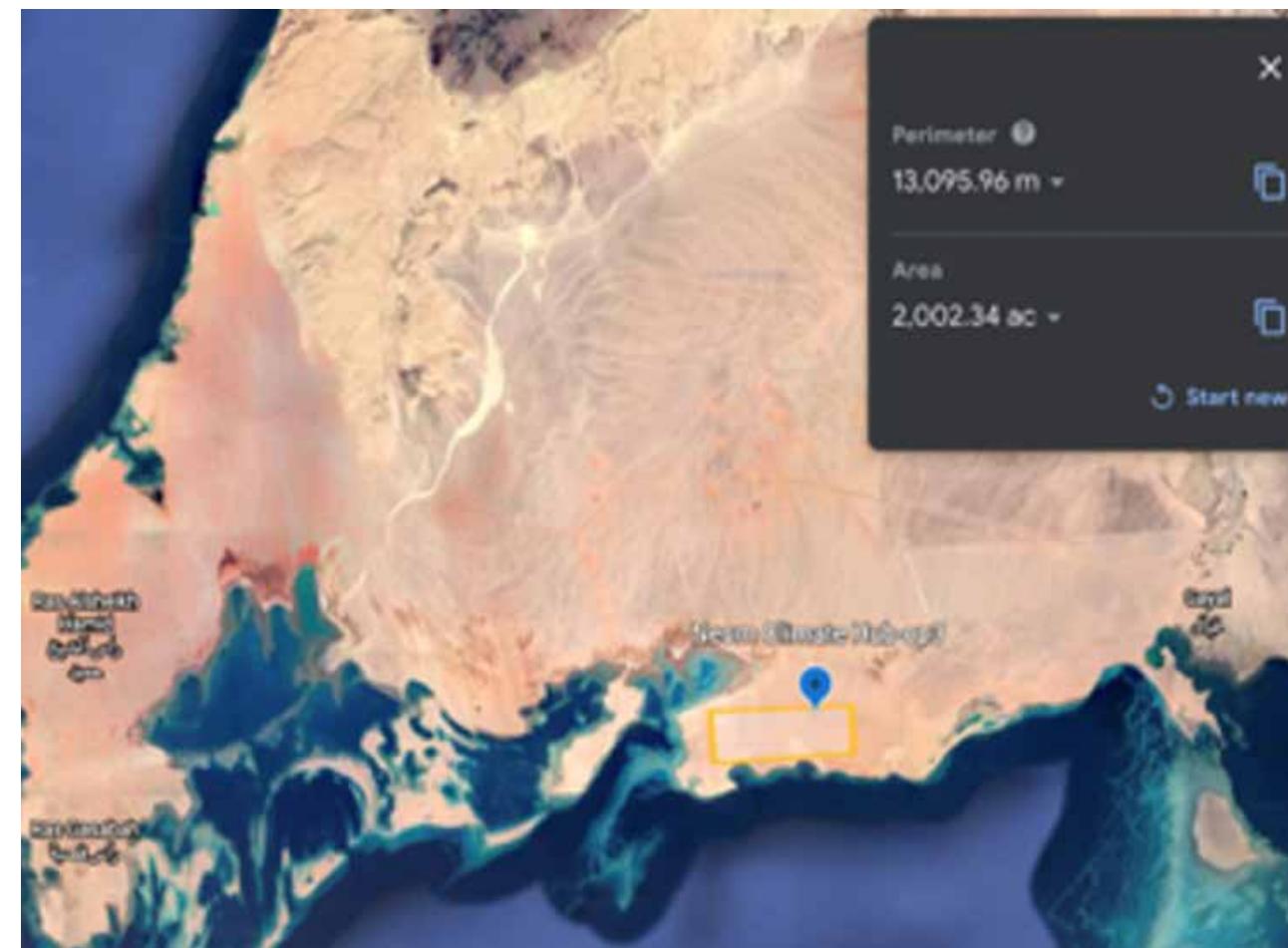
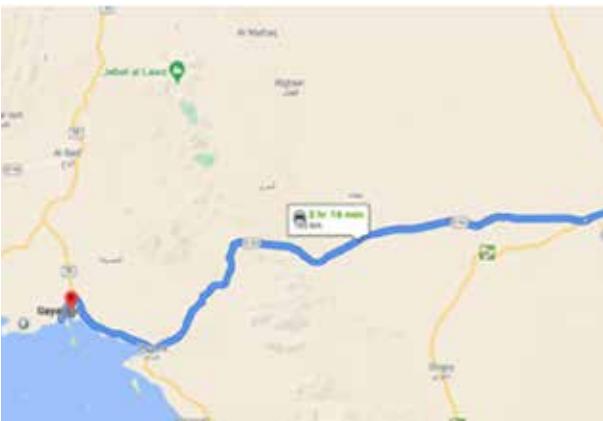
PROPOSED PROJECT LOCATION

OPTION 3

The third option is a site of 2000 acres located beyond Gayal. This site has a coastal line and close to THE LINE proposed by Neom.

CONNECTIVITY

- 2 hours 16 minutes by road from Tabuk
- Major highways that run through the project
- 8784
- Route 55



HERITAGE/ ATTRACTIOnS

A LAND OF ANCIENT RELIGIOUS SIGNIFICANCE

For years, the region of Tabuk has played host to pilgrims, merchants, and travelers. Once an ancient pilgrimage pitstop between Egypt, Jordan, and Madina, Tabuk has also witnessed settlements from the Byzantine Empire. Famous explorers like Charles Doughty have chronicled the region, and to this day, it continues to be a dream expedition site for archaeologists and travelers alike.

Tabuk's history is marked with transitory journeys, encapsulated by the wrecks and artifacts left behind by voyagers who once passed through this historical region.

Tabuk is dizzyingly robust in its Heritage. A sprawling and mystical mountain ensemble, thousands of ancient Kufic Arabic inscriptions dating to the early days of Islam at Jabal Hisma. Off the coast, two more modern wrecks lay silently: the Georgios G. ship and the Catalina airboat (early 1900s).

The place is a land of countless empires, ancient tribes, and prophets. Other notable sites:

- » Tabuk Castle (3500 BC).
- » Qasr Al Hamra castle (700 BC).
- » Old City walls (600 BC).
- » Haddaj Well (before 500 BC).
- » Qasr Al Ablaq castle (600 AD).
- » Qasr Al Bejaidi, Al Hadiqah Mound, and much more.



STUDY OF
BIO-NETWORK AT
NEOM



AIR QUALITY

POLLUTANTS IN NEOM CITY, TABUK REGION

Average AQI Index - 47

PM2.5	- 4 pg/m ³
PM10	- 47 pg/m ³
SO ₂	- 25 pg/m ³
NO ₂	- 40 pg/m ³
CO	- 10 pg/m ³
O ₃	- 64 pg/m ³

Particulates are the most harmful form of air pollution due to their ability to penetrate deep into the lungs and blood stream. It is often caused by burning of fossil fuels or natural sources like dust storms, forest fires, pollen, or sea spray. For parts of Africa and the Middle East, a significant portion of particle pollution originates from dust blowing in from arid areas.

PM10 particles hurt air quality because of their adverse effects on human health. Because PM10 is small enough to penetrate deep into the lungs, these particles can adversely impact your respiratory and cardiovascular system. Coarse particles don't cause inflammation of the brain, as fine and ultra-fine particles do, but they contribute to conditions such as cardiovascular disease, asthma, and allergies.

Spatial distributions of ambient air pollution show highest concentrations in Duba region with noticeable seasonal variants. The NO_x, SO₂, CO, VOC, and PM concentrations are higher during spring and winter, because of lower boundary layer heights during these seasons. The northwest winds are likely contributing to higher air- 21 pollution concentrations over the southern NEOM region, i.e. Duba and adjoin areas.

The predicted NO_x and SO₂ concentrations that are greater than 40 µg/m³ and 25 µg/m³, respectively, persist for about three hours and occur two to three times per season. The predicted CO and VOC concentrations that are greater than 10 µg/m³ and 0.05 µg/m³, respectively, last for less than three hours and occur about two to three times in spring and winter. A PM concentration greater than 4 µg/m³ persists for about two hours and occurs less than three times per season. The maximum values are mainly concentrated at the emitting source locations near the Duba region.

The predicted air pollutant concentrations are well within the national air quality standards recommended by GAMEP and the Royal Commission. Maximum

POLLUTANTS IN NEOM CITY, TABUK REGION

concentrations of NO_x (~40 µg/m³), SO₂ (~25 µg/m³), CO (~10 µg/m³), VOC (~0.05 µg/m³), and PM (~4 µg/m³) are noticed in the Duba region, which is located about 300 km south of NEOM in the three years 2016-2018. These higher concentrations are mainly due to the northwest winds from north of Duba.

This clearly suggests that the air quality in NEOM is good, and pollution is well within the recommended standards. It should be noted that the background emissions (such as dust and vehicle pollution) were not considered as such data was not available for this region and only the estimated emissions originating from eleven major industrial sources were considered. This study assessed the state of the air quality in the NEOM region for the environmental impact assessment and planning in the region.

Ozone and CO are "Moderate to Unhealthy" at NEOM and could become a cause for concern in future.

While ozone causes SMOG, higher levels of CO indicate incomplete burning of fossil fuels.

Breathing ground-level ozone can trigger a variety of health problems including chest pain, coughing, throat

irritation, and congestion. It can worsen bronchitis, emphysema, and asthma. Ozone also can reduce lung function and inflame the lining of the lungs. Repeated exposure may permanently scar lung tissue.

Ozone damages vegetation and ecosystems by inhibiting the ability of plants to open the microscopic pores on their leaves to breathe. It interferes with the photosynthesis process by reducing the amount of carbon dioxide the plants can process and release as oxygen.

Elevated levels of ozone leads to reduced agricultural crop and commercial forest yields, reduced growth and survivability of tree seedlings, and increased susceptibility to diseases, pests and other stresses such as harsh weather

Carbon monoxide (CO) is a toxic air pollutant produced largely from vehicle emissions. Breathing CO at high concentrations leads to reduced oxygen transport by hemoglobin, which has health effects that include impaired reaction timing, headaches, lightheadedness, nausea, vomiting, weakness, clouding of consciousness, coma, and, at high enough concentrations and long enough exposure, death.

EPA's Breakpoints for pollutants							
AQI	PM10 (in µg/m ²)	PM2.5 (in µg/m ²)	SO ₂ (in µg/m ²)	NO ₂ (in µg/m ²)	CO (in µg/m ²)	Ozone (in ppm)	
Good	0-50	0-54	0-12	0-35	0-53	0-4.4	0-54
Moderate	51-100	55-154	12.1-35.4	36-75	54-100	4.5-9.4	55-70
Unhealthy for sensitive individuals	101-150	155-254	35.5-55.4	76-185	101-360	9.5-12.4	71-85
Unhealthy	151-200	255-354	55.5-150.4	186-304	361-649	12.5-15.4	86-105
Very Unhealthy	201-300	355-424	150.5-250.4	305-604	650-1249	15.5-30.4	205-404
Hazardous	301-400	425-504	250.5-350.4	605-804	1250-1649	30.5-40.4	405-504
Hazardous	401-500	505-604	350.5-500.4	805-1004	1650-2049	40.5-50.4	505-604
Hazardous	501-999	605-9999	500.5-9999.9	805-99999	2050-99999	50.5-99999	605-99999



Signs of ozone include flecking , stippling, bronzing and reddening on plant leaves

“ Carbon Monoxide and ground Ozone are at unhealthy levels at NEOM making them a cause for concern in future ”

SOIL

SURFACE MATERIALS IN NEOM CITY IN TABUK REGION

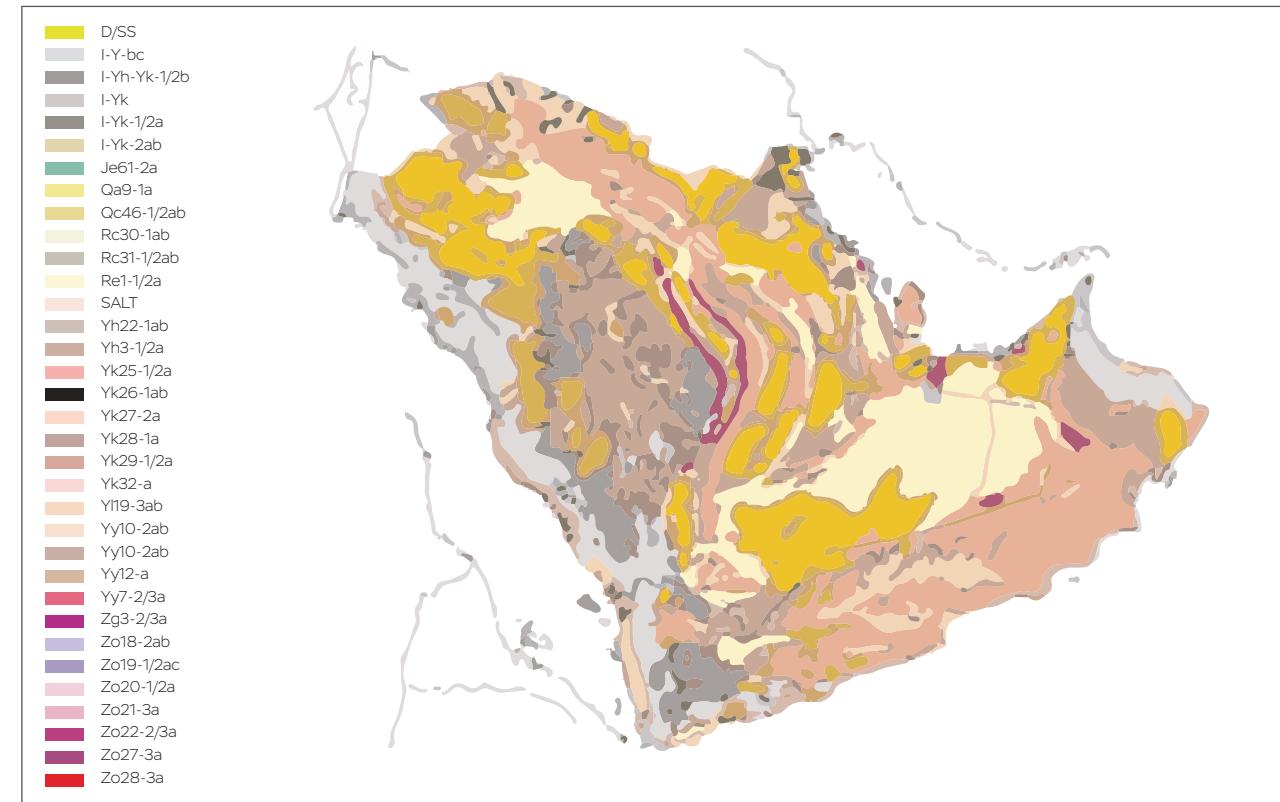
NEOM Region is characterized by intensive structures and tectonic movements which are reflected on the diverse lithological characteristics and distribution. However, surface materials such as rocks and soil are found with tremendous types and aspects.

These materials play a significant role in the distribution of plant species (e.g. soil-related flora), notably the region contains bare rock, sand dunes, alluviums and detrital deposits, salty soil.

Erosion is a physical process where terrain materials are moved by the effect of water, slope or wind and it may occur over vast area. Landslides are common

phenomenon of instable terrain where soft and hard materials of rock and soil move along sliding surfaces. Landslides almost redistribute rock debris, soil and sediments through fast collapses and sliding

The soils of the Arabian Peninsula reflect the general aridity of the climate. Most are poorly developed, shallow, or are enriched in lime, gypsum, or salts. In addition, transported materials, such as sand dunes and sheets, cover large areas. The soils are mostly formed by the physical breakdown of geological materials and their subsequent removal, sorting and deposition by wind and water.

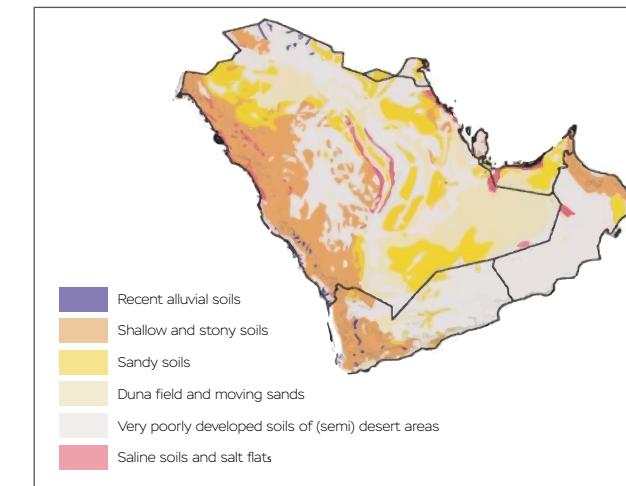


The main soil types that occur in the Arabian Peninsula, classified according to the FAO Soil Map of the World (FAO, 1974), are listed below,

SURFACE MATERIALS IN NEOM CITY IN TABUK REGION

Main soil types of the Arabian Peninsula

Symbol	Name	Summary description
I	Lithosols	Undifferentiated very shallow soils; unsuitable for agriculture
Je	Eutric Fluvisols	Alluvial soils with good fertility status; the best soils for agriculture
Qa	Albic Arenosols	Strongly leached sandy soils, do not retain soil moisture; unsuitable for agriculture
Qc	Cambic Arenosols	Slightly matured sandy soils, retain soil moisture better; suitable for agriculture under sprinkler irrigation
Rc	Calcaric Regosols	Calcareous poorly developed soils, poor physical properties for agriculture
Re	Eutric Regosols	Poorly developed soils with moderate fertility; poor physical properties for agriculture
Yh	Haplic Yermosols	Undifferentiated very poorly developed soils of (semi-) deserts; management properties vary considerably; full irrigation is needed for all agricultural uses
Yk	Calcic Yermosols	Very poorly developed soils of (semi-) deserts with calcium-enriched subsoil; unsuitable for agriculture
Yl	Luvic Yermosols	Very poorly developed soils of (semi-) deserts with clay-enriched subsoil; can be made suitable for agriculture if full irrigation is available
Yy	Gypsic Yermosols	Very poorly developed soils of (semi-) deserts with gypsum-enriched subsoil; unsuitable for agriculture due to poor physical properties and need for full irrigation
Zg	Gleyic Solonchaks	Saline soils with insufficient drainage; unsuitable for agriculture
Zo	Orthic Solonchaks	Undifferentiated saline soils; unsuitable for agriculture



Three textural classes are distinguished:

- 1: Coarse (predominantly sandy)
- 2: Medium (predominantly silty)
- 3: Fine (predominantly clayey)

These distinctions are further defined in the discussion on soil management properties

In addition, the soil associations do consider three broad landform classes:

- a: Flat topography
- b: Undulating topography
- c: Hilly topography

WATER

SURFACE MATERIALS IN NEOM CITY IN TABUK REGION

NEOM is located in Northwest Saudi Arabia with more than 450km of Red Sea coastline has access to a vast supply of seawater, Ground Water Resources and Rainfall. The 450 km of Red Sea Coastline uses its substantial renewable energy resources to produce desalinated water at "extremely low cost". This ensures zero CO2 emissions as well as zero brine effluent discharge. The Ground water resources are common features applied in NEOM Region, and more specifically in the coastal zone where they are wide spread.

Sources of Water:

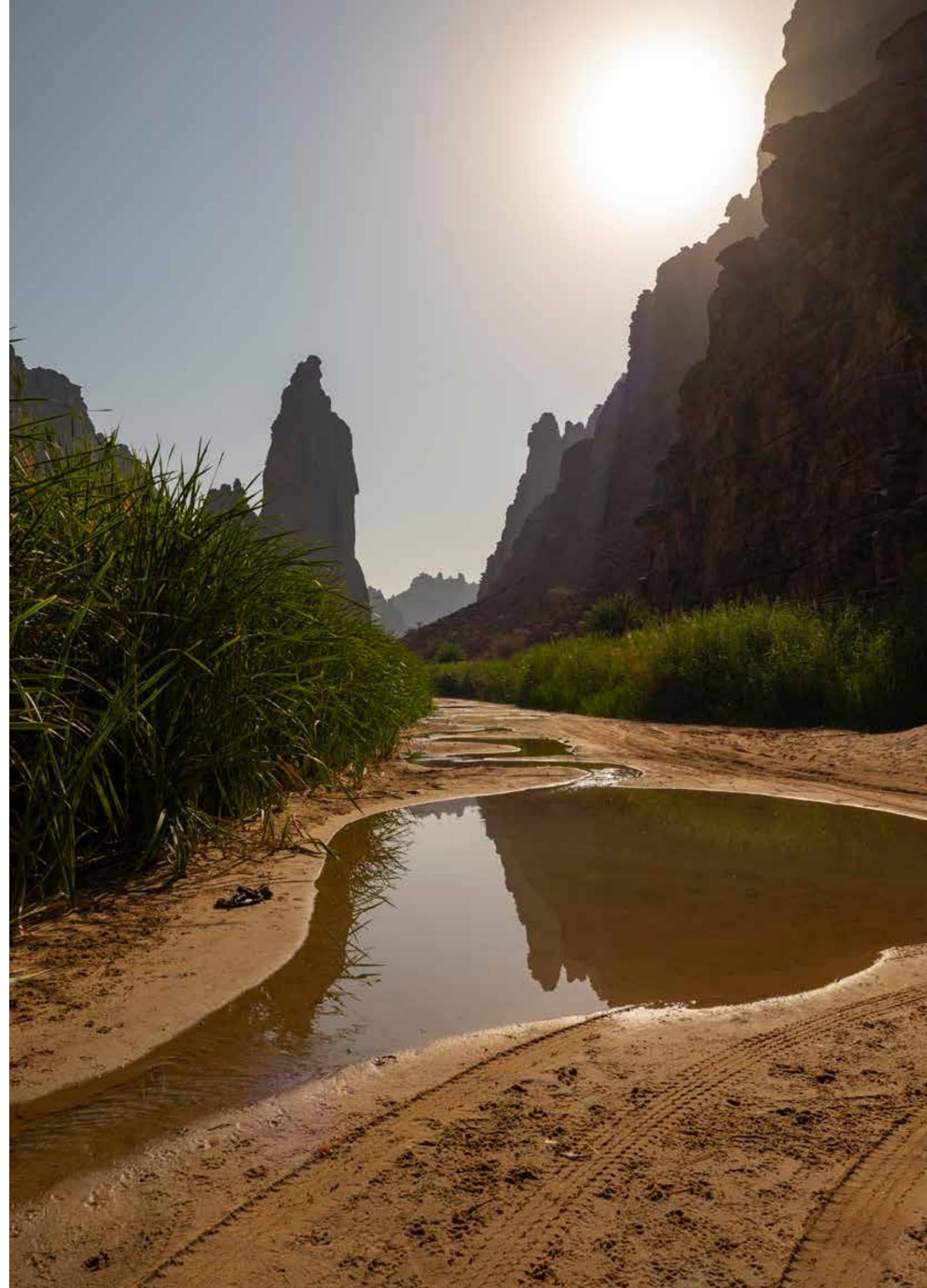
1. 450 km of Red Sea coastline.
2. Ground Water Resources.
3. Rainfall.



Groundwater is water resource that is found in rocks, as aquifers, at different depths below the surface of the Earth, and it is usually considered as one of the most important natural resources. Groundwater in NEOM Region is utmost significant, notably that this region receives very limited rainfall.

The Arabian Shield occupies the west-central one-third of the KSA and is part of the larger Afro-Arabian Shield. It is the geologic base of the central Najd, Hejaz, and Asir regions and extends from 50 to 700 km inland from the Red Sea toward Riyadh. This ancient landmass consists of igneous and metamorphic rocks of Precambrian Era. Basalts of mid-Tertiary and Quaternary Periods are spread over western parts of the Shield and form the harrat. Sedimentary rocks of the Paleozoic Era and

“Groundwater at NEOM is most significant as the region falls under the Arabian Shiled zone which is impermeable while also receiving very limited rainfall”



WATER

SURFACE MATERIALS IN NEOM CITY IN TABUK REGION

modern alluvium partly overlie the Shield itself. A narrow strip of Tertiary to Quaternary Period sedimentary rocks, including alluvium and related surficial deposits, also mantles the Precambrian Era rocks between the base of the mountain and the Red Sea coast, where the structural relationships are complicated by faults connected with the Red Sea rift.

NEOM falls in the Arabian Shield Zone. Shield rocks are relatively impermeable and are not significant aquifers. Locally, however, small yields of water might be found in the heavily jointed or fractured crystalline rock of the shield or in the younger basalt. The Shield influences the water resources in other ways; it forms the highest parts of the Kingdom and substantially controls the drainage and distribution of rainfall, which runs off through the wadis and is then available to recharge groundwater. Because the rocks of the Shield are commonly impermeable, they shed most of the rain that falls on them, shunting relatively large percentages of the rainfall to the adjacent bodies of sedimentary rocks in the Arabian Shelf region which can store water.

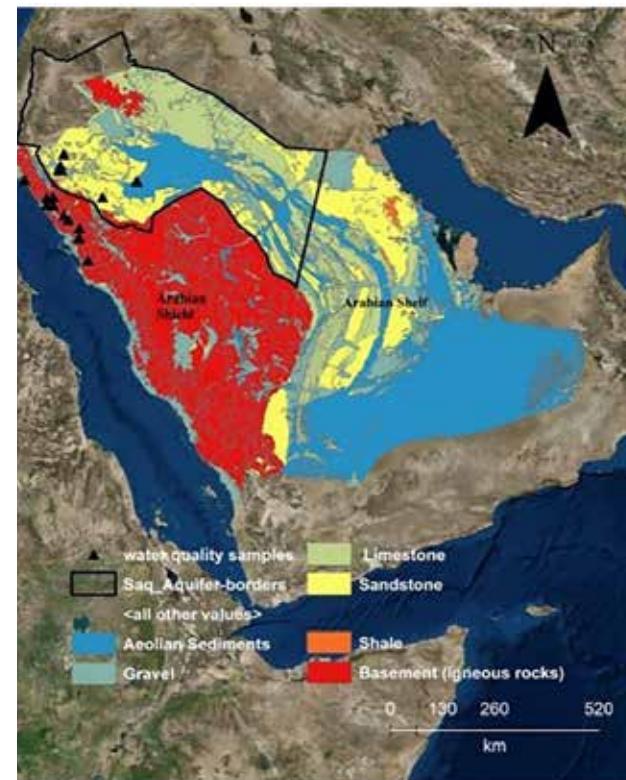
The shallow aquifers mainly restricted to the valleys also constitute a major source of water in Arabian shields and coastal regions. The climate of the region is dominantly arid to semi-arid, and the groundwater resources are under extreme stress because of high temperatures, low and erratic rainfall, and high evapotranspiration.

No studies have been applied on groundwater resources for the extreme northwest of Saudi Arabia where recently NEOM Region has been designated. However, there are some studies obtained on Tabuk Region which is hydro geological like the plateau of NEOM Region, but totally different from the other parts of this region.

Rainfall:

NEOM Region is located above the latitude 27° 43' 00 N which distinguishes it towards more precipitation rate if compared with the largest part of the Saudi Arabia, which does not receive much rain and the average yearly precipitation is approximately 100 mm/year.

The average rainfall rate of Tabuk province is about 57.5 mm/year, but it ranges between 11 and 412 mm, and the average temperature is 22.5°C, where the maximum reaches 44°C and minimum 9°C; in addition, the area is known by high humidity since it is bordered from west and south by the sea. The average rainfall in Tabuk city and the surrounding is about 47 mm/year as recorded from ground station in Tabuk City.



FLORA & FAUNA

ENDANGERED & VULNERABLE SPECIES

Tabuk Province (including NEOM Region) has a variety of plant and animal species forming unique ecosystems & biodiversity typical to the region. Their abundance and distribution are still undefined, notably in the rugged and remote areas due to inaccessibility to reach these areas.

The utility of these species is still limited and can be considered as undiscovered. This is because the region is still characterized by very low population density, and thus limited human activities, and no concerns are given to the region so far.

NEOM Region has several potential natural resources including the geologically related ones, in addition to natural reserves with ecosystem advantages, where unique flora and fauna exist as well as the distinguished landscape and diverse natural components.

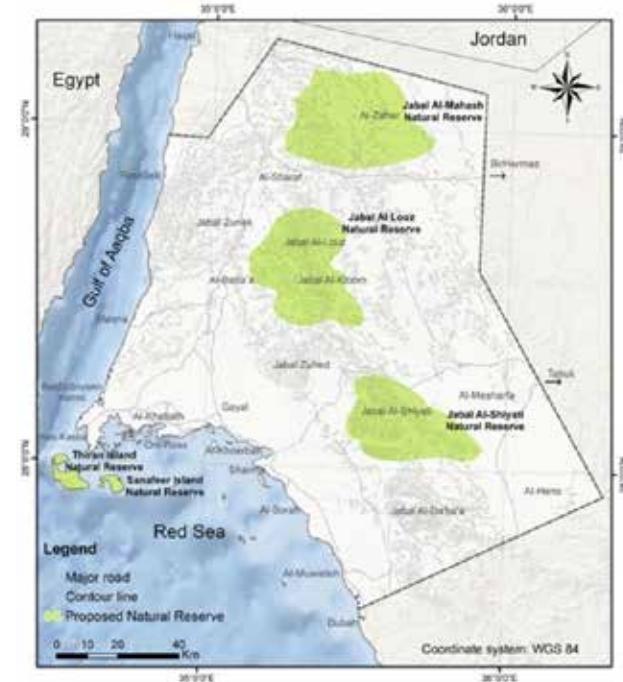
The regions along the northwestern and southwestern regions, however, are densely vegetated and contain the highest number of species. Approximately 70% of the country's floristic elements are reported from these areas. According to the present estimates, Saudi Arabia contains 97 (4.25%) trees, 565 (24.73%) shrubs and about 1620 (71.02%) herbs. Flora consists of all groups of plants such as mesophytes, xerophytes, halophytes, psammophytes, hydrophytes, parasites, neutrophiles and heliophytes.

“ Saudi Arabia contains 97 trees, 565 shrubs and 1620 herbs including 51 plant families and 106 species ”

NEOM Region has distinguished species of fauna and flora where several unique species were reported including 51 plants families with 106 species.

There are five proposed natural reserves in this document include three of terrestrial ones which are mainly located in the mountainous ridges and two marine ones for Thiran and Sanafeer Islands. Such as:

1. Jabal Al-Mahash Natural Reserve.
2. Jabal Al-Louz Natural Reserve.
3. Jabal Al-Shiyati Natural Reserve.
4. Thiran Island Natural Reserve.
5. Sanafeer Island Natural Reserve.



FLORA

The distribution of plants is mainly controlled by their responses to variation in environmental factors, including water availability, topography and soil.

There are 51 identified families of plant species in the NEOM Region.

Families with more than 3 plant species are:

- Amaranthaceae: 24 species
- Poaceae: 18 species
- Asteraceae: 9 species
- Fabaceae: 8 species
- Brassicaceae and Zygophyllaceae: 7 species
- Chenopodiaceae and Poacea: 6 species
- Resedaceae: 5 species
- Lamiaceae: 4 species
- Boraginaceae: 4 species
- Asclepediaceae and Caryophyllacea: 3 species.



FLORA



Acanthaceae



Aizoaceae



Apiaceae



Asclepiadaceae



Asphodelaceae



Avicenniaceae



Capparaceae



Cistaceae



Convolvulaceae



Cucurbitaceae



Euphorbiaceae



Geraniaceae

FLORA



Grassulaceae



Hyacinthaceae



Liliaceae

FLORA



Zygophyllaceae



Cyperaceae



Juncaceae



Mimosaceae



Orobanchaceae



Papaveraceae



Loranthaceae



Malvaceae



Menispermaceae



Plantaginaceae



Salvadoraceae



Scrophulariaceae



Nitrariaceae



Neuradaceae



Nyctaginaceae



Solanaceae



Tamaricaceae



Urticaceae



Polygonaceae



Portulacaceae



Rhumnaceae



Xanthorrhoeaceae

FARMING

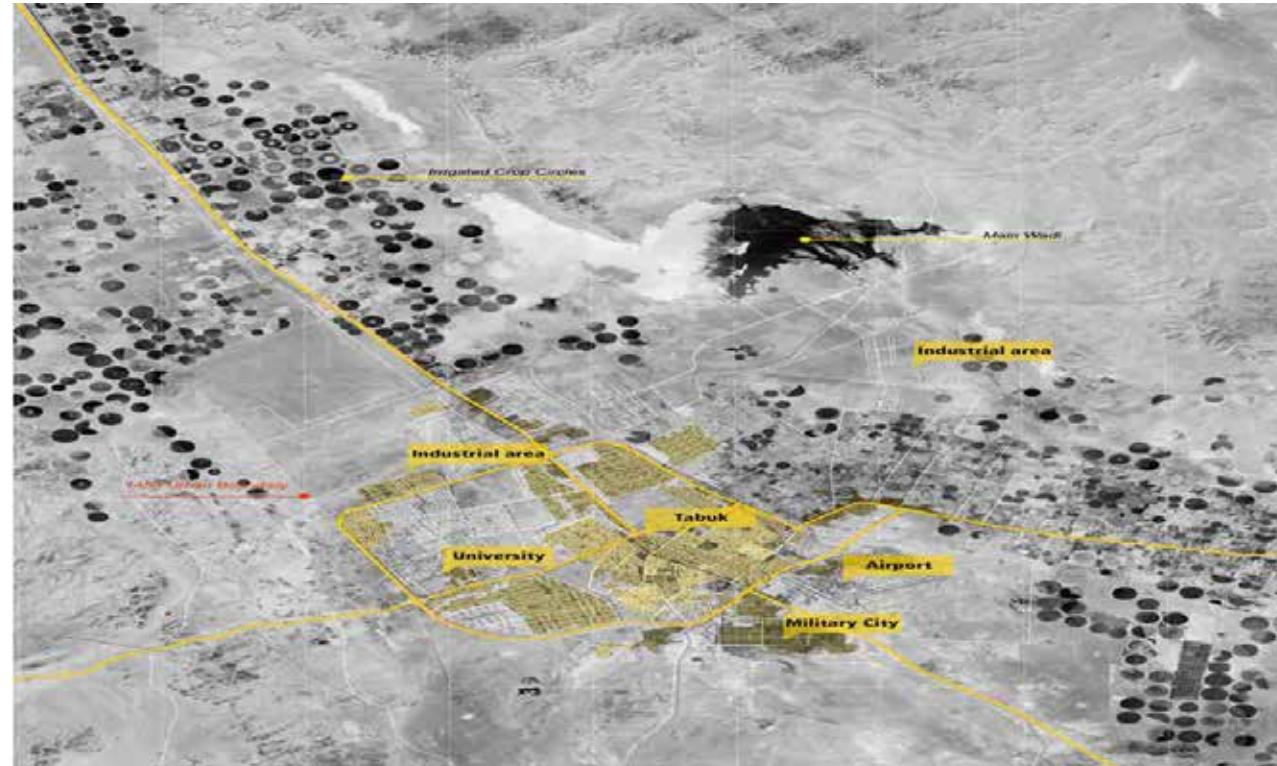
AGRICULTURE IN THE ARABIAN PENINSULA

Agriculture in the Arabian Peninsula was limited to date farming and small-scale production of vegetables and staples; however, serious agricultural development began in the 1970s due to the launch of an extensive program promoting modern farming techniques. Due to which rural roads & irrigation networks were established, storage and export facilities were built, and agricultural research and training was encouraged. Saudi is now completely self-sufficient in production of meat, milk, and eggs etc., while it also exports wheat, dates, dairy products, eggs, fish, poultry, fruits, vegetables, and flowers to markets all around the world.

NEOM, geographically lies at the intersection of the Hejaz Mountain range and the plains of the Northern Region. There are significant underground water

resources surrounded by hills and wadis, and the three important regional wadis are Wadi Al-Akhdar(Green Valley), Wadi Damm, and Wadi Asafir.

The location of farming activities is directly linked to the underground water table. A method called Center Pivot Irrigation in Saudi Arabia is typical of many isolated irrigation projects scattered throughout the arid and hyper-arid regions of the Earth. Nonrenewable Fossil water is mined from depths as deep as 1 km (3,000 ft), pumped to the surface, and distributed via large center pivot irrigation feeds. The circles of green irrigated vegetation may comprise a variety of agricultural commodities from lucerne to wheat. Diameters of the normally circular fields range from a few hundred meters to as much as 3 km (1.9 mi).



AGRICULTURE IN THE ARABIAN PENINSULA

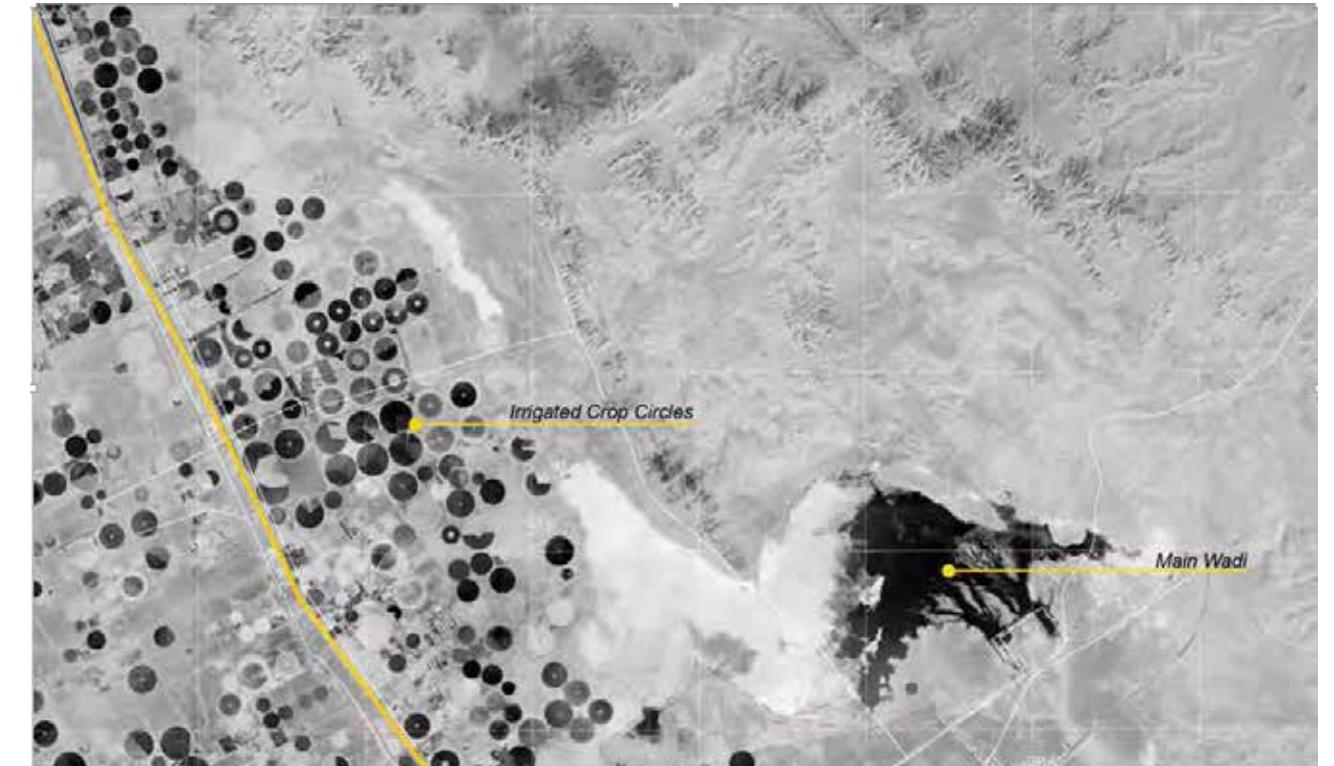
Traditionally, agriculture developed along the wadis makes use of scarce sources of water. Agriculture is one of the most important economic sectors in Tabuk, where the total crop area in 2012 was 489,00 hectares, representing about 6.2% of the total crop area in the Kingdom. Tabuk is well known for flower plantations as it exports flowers to Europe such as gladiolas, lilies, and statice.

The Tabuk Region has remarkable floristic diversity; however, this natural biodiversity hotspot is affected by several human activities, such as woodcutting and development.

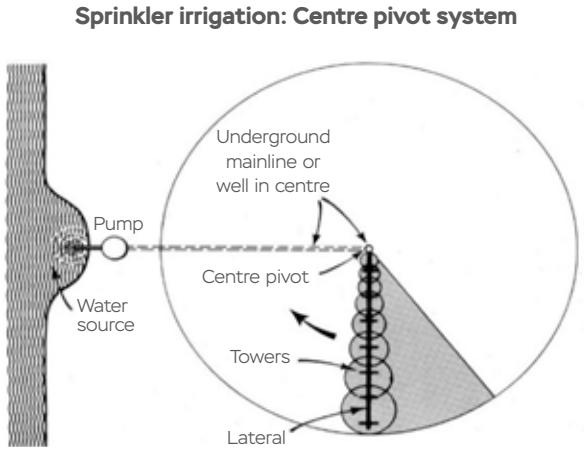
The newly planned areas for Tabuk have been mapped along with the existing productive plots, showcasing

how new development is not respectful or integrating agricultural land. This implies that much of this valuable land is at risk to a change in land-use. It appears that large parts of the agricultural areas are irrigated through sprinkler systems, which have proven to be inefficient in such climatic conditions, due to high evapotranspiration levels, which further impact the loss of freshwater. It is recommended to shift to more sustainable practices, such as drip irrigation systems, that can save up to one fourth of water in comparison to surface irrigation.

“Saudia Arabia is currently self-sufficient in production of meat, milk and eggs”



AGRICULTURE IN THE ARABIAN PENINSULA



“ Sprinkler systems currently used for irrigation is known to cause water losses due to high evapotranspiration making it inevitable to move to sustainable practices such as drip systems that save upto one fourth of water in comparision ”



FAUNA

ENDANGERED & VULNERABLE SPECIES

The Tabuk Region includes the following 7 major animal groups. The biotic factors on animal communities were measured by calculating the diversity index (D_i) which indicates how many different types exist, based on counting the total number of individual (N) and the number of individual of species (n).

Therefore, the following species, with their D_i and were accounted:

- Birds : 72 species
- Mammals : 10 species
- Reptiles : 18 species
- Amphibians : 7 species
- Invertebrates : 13 species
- Insects : 93 species

NEOM and King Abdullah University of Science and Technology (KAUST) have taken it upon themselves to ensure preservation and protection of certain species of Turtles by stopping them from being hunted for their Shells.

“ Tabuk region is the hotspot for human activity which is effecting its natural biodiversity ”



ENDANGERED & VULNERABLE SPECIES



peregrine falcon

The peregrine falcon became an endangered species over much of its range because of the use of organo-chlorine pesticides, especially DDT, during the 1950s, '60s, and '70s. Populations of the peregrine falcon have bounced back in most parts of the world.



Red-Footed Falcon:

A major impact on the red footed falcon's population is loss and degradation of natural nest sites. Pesticides are also a huge threat as they are depleting their natural food sources, making food competitive.



Ferruginous Duck:

The species is threatened by the degradation and destruction of its favoured habitats by anthropogenic causes which are very wide and varied including impoundment, drainage, pollution and mismanagement



Eurasian curlew:

Formerly classified as a species of Least Concern by the IUCN, it was suspected to be rarer than generally assumed. Following the evaluation of its population size, the classification was found to be incorrect, and it was consequently promoted to Near Threatened status in 2008.



bar-tailed godwit

The Eurasian curlew (*Numenius arquata*) is a wader in the large family *Scolopacidae*. It is one of the most widespread of the curlews, breeding across temperate Europe and Asia. In Europe, this species is often referred to just as the "curlew", and in Scotland known as the "whaup" in Scots.



Black-tailed Godwit:

There is an estimated global population of between 634,000 and 805,000 birds and estimated range of 7,180,000 square kilometres (2,770,000 sq mi). In 2006 BirdLife International classified this species as Near Threatened due to a decline in numbers of around 25% in the previous 15 years.



False killer whale:

The false killer whale is covered by the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas. No accurate global estimates for the false killer whale exist, so the species is listed as Near Threatened by the IUCN Red list.



Black-tailed Godwit:

The populations and trends of the species have been considered fairly poorly studied in the past, but a strong declining trend has been detected. As a species, the greater spotted eagle is classified as vulnerable to extinction by the IUCN.



Juniperus turbinata :

Juniperus turbinata resembles *J. phoenicea*. It is a shrub or small tree up to 8 m (26 ft) in height. *Juniperus turbinata* has a native distribution from Macaronesia throughout the Mediterranean to the Arabian Peninsula. It is a nearly threatened Species

ENDANGERED & VULNERABLE SPECIES



White-headed duck:

White-headed duck is considered endangered due to a large reduction in populations in the last 10 years. Most of this decline is due to habitat loss and hunting, but interbreeding of the Spanish population with the introduced ruddy duck is a more recent threat.



Lappet-faced vulture or Nubian vulture:

The lappet-faced vulture's world population is believed to have decreased perceptibly. The declines are almost entirely due to human activities, including disturbances from habitat destruction and cultivation, disturbances at the nesting site and ingestion of pesticides.



Black-tailed Godwit:

The populations and trends of the species have been considered fairly poorly studied in the past, but a strong declining trend has been detected. As a species, the greater spotted eagle is classified as vulnerable to extinction by the IUCN.



Eastern imperial eagle :

The eastern imperial eagle has declined greatly through history. Today, dedicated conservationists and biologists are working extensively to remediate and reverse the decline of eastern imperial eagle. The species was up listed to Vulnerable in 1994 and global protection initiatives were begun around this time



Black-tailed Godwit:

BirdLife International categorises this bird as endangered, due to a rapid population decline, particularly on the central Asian breeding grounds. The United Arab Emirates have been the main destination for thousands of falcons caught and sold illegally for hefty sums at the black market



Bearded Vulture:

The bearded vulture is one of the most endangered European bird species as over the last century its abundance and breeding range have drastically declined. The increase in human population and infrastructure results in the declines of the bearded vulture populations today.



Northern lapwing:

National surveys of England and Wales have shown a population decline between 1987 and 1998, and since 2009 the northern lapwing has had red list conservation status in the United Kingdom. The numbers of this species have been adversely affected by intensive agricultural techniques.



Indo-Pacific bottlenose dolphin

The species is not considered to be endangered; its near-shore distribution, though, makes it vulnerable to environmental degradation, direct exploitation, and problems associated with local fisheries.



Sooty falcon:

It was formerly classified as Least Concern by the IUCN, but has recently been shown to be rarer than formerly believed. Consequently, it was uplisted to Vulnerable status in 2017

ENDANGERED & VULNERABLE SPECIES



Humpback dolphin

It is listed as this species has been categorized as being in danger of extinction throughout all or a significant proportion of its range and CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.



knob coral

This is a common species of coral but it seems to be decreasing in abundance. The main threat it faces is from the destruction of its coral reef habitat, and it is also moderately susceptible to coral bleaching, so the International Union for Conservation of Nature has rated its conservation status as being "near threatened".



Indo-Pacific Humpback Dolphin:

The Indo-Pacific humpback dolphin is listed on Appendix II of the convention on the Conservation of Migratory Species of Wild Animals. There is a population decline of 60% in the last decade. The population continues to be further threatened by pollution, vessel collision, overfishing, and underwater noise pollution.



Eurasian oystercatcher:

It is the most widespread of the oystercatchers, with three races breeding in western Europe, central Eurosiberia, Kamchatka, China, and the western coast of Korea. The extinct Canary Islands oystercatcher formerly considered a distinct species, may have actually been an isolated subspecies or distinct population of the Eurasian.



Hawksbill sea turtle:

Consensus has determined sea turtles, including E. imbricata to be, at the very least, threatened species because of their slow growth and maturity and slow reproductive rates. Humans have killed many adult turtles, both accidentally and deliberately. Their existence is threatened due to pollution and loss of nesting areas because of coastal development.



Egyptian vulture:

Egyptian vulture populations have declined in most parts of its range. In Europe and most of the Middle East, populations in 2001 were half of those from 1980. The exact cause of the decline is not known, but has been linked with the use of the NSAID Diclofenac, which has been known to cause death in Gyps vultures.



Eurasian curlew:

Sperm whales are listed on Appendix I and Appendix II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It is listed on Appendix I as this species has been categorized as being in danger of extinction throughout all or a significant proportion of their range and CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.

ENDANGERED & VULNERABLE SPECIES



Humphead Wrasse:

In 1996, following a decade of rapid population decline, the humphead wrasse was placed on the IUCN Red List of endangered species. The wrasse's genomes must be analyzed to help keep the species alive. Illegal, unregulated and unreported activities have been identified as the major factor for the failure of conservation efforts.



Striped hyena :

It is the only species in the genus *Hyaena*. It is listed by the IUCN as near-threatened, as the global population is estimated to be under 10,000 mature individuals which continues to experience deliberate and incidental persecution along with a decrease in its prey base such that it may come close to meeting a continuing decline of 10% over the next three generations.



Eurasian Nubian ibex :

The International Union for Conservation of Nature has classified the Nubian ibex as "vulnerable" on the basis that fewer than 10,000 mature individuals remain and the population is declining. Threats faced by the animal include competition with livestock for water and fodder, hunting pressure, and habitat destruction.



Arabian sand gazelle:

Today it survives in the wild in small, isolated populations in Saudi Arabia, the United Arab Emirates, Oman, and southeastern Turkey. Small numbers may also be present in Kuwait, Iraq, Jordan, and Syria. The total population of wild sand gazelles is thought to be less than 3,000. Significantly more are held in captivity, reserves, or breeding programs, perhaps more than 100,000.



Leopard:

The leopard is listed on CITES Appendix I, and trade is restricted to skins and body parts of 2,560 individuals in 11 sub-Saharan countries.[3] The leopard is primarily threatened by habitat fragmentation and conversion of forest to agriculturally used land, which lead to a declining natural prey base, human-wildlife conflict with livestock herders and high leopard mortality rates. It is also threatened by trophy hunting and poaching.



Dugong:

Dugong numbers have decreased in recent times. For a population to remain stable, 95 percent of adults must survive the span of one year. The estimated percentage of females humans can kill without depleting the population is 1–2%. This number is reduced in areas where calving is minimal due to food shortages. The IUCN Red List lists the dugong as vulnerable, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora regulates and in some areas has banned international trade.



reticulate whipray:

The International Union for Conservation of Nature (IUCN) has listed the reticulate whipray as Endangered. Its large size, inshore habitat preferences, and slow reproductive rate render it susceptible to overfishing. Although specific data is lacking, significant declines in overall ray catches have been documented within its range. Habitat degradation also threatens this species, while pollution and destructive fishing practices may have also taken their toll.

BIO DIVERSITY

BIODIVERSITY IN NEOM REGION

The region contains abrupt topographic aspects and located dominantly between the desert and the sea.

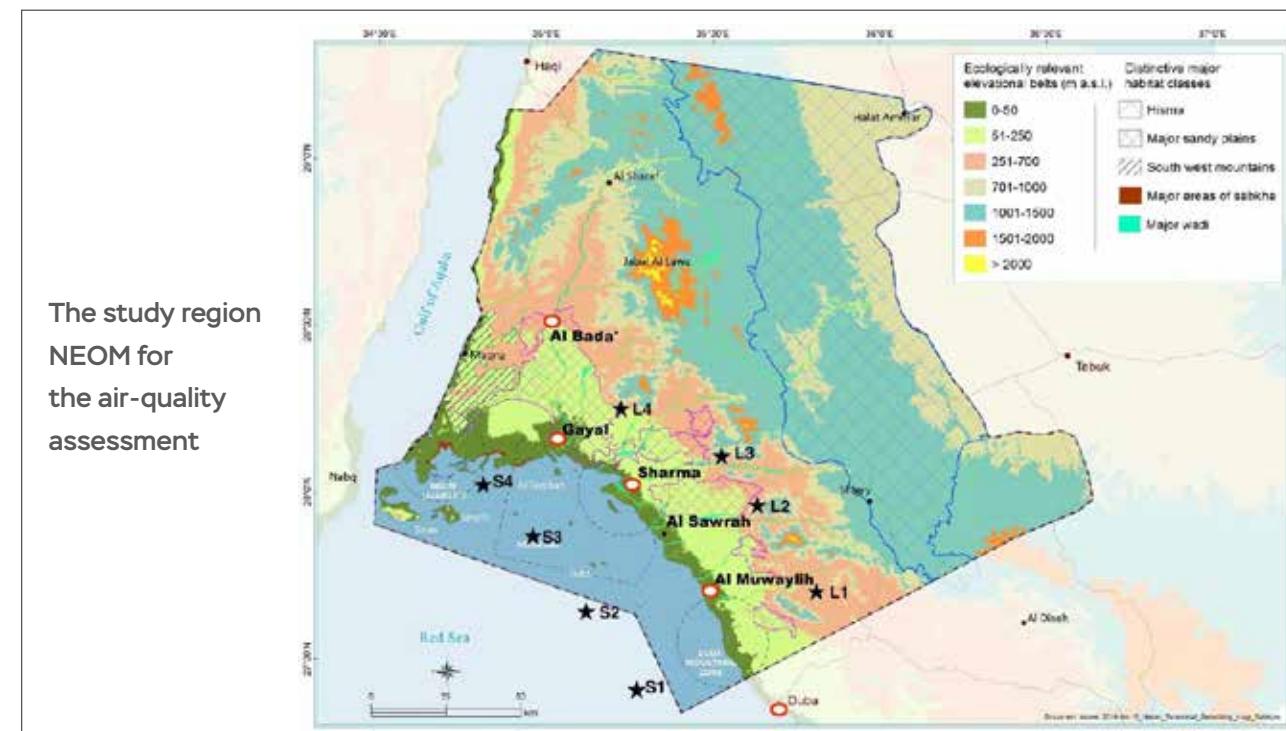
The loss or change in biodiversity and ecosystem services is controlled by certain indirect and direct influencers, such as,

Indirect Influencers:

1. Demographic
2. Economic
3. Socio-political
4. Cultural
5. Scientific and technological

Direct Influencers:

1. Habitat change



BIODIVERSITY IN NEOM REGION

1. **Habitat** represents the natural environment for many species where there is assured presence of food, protection, and mates for reproduction. For NEOM Region, there are diverse habitats occurred largely within the identified geomorphologic units. They exist as large-scale habitats including mountains, desert, dunes, wadis, rocky outcrops, salt pans (sabkhas), coastal plain, tidal flats, littoral zone, and many other habitats. Also, there are small-scale habitats which are included among the large-scale ones, such as: crests, gullies, caves, rock pockets, wetlands, soil intrusions, beach gravel, marine terraces, sandy sea floor, etc., which are dominant habitats in NEOM Region.

2. **The Climate of NEOM** region is distinguished by its topographic setting where coastal plains extend at the foot slopes of mountain ridges in which the latter gradationally tilted eastward. This in turn creates a diverse climatic zone over different topographic units. Hence, the average rainfall rate is about 57.5 mm/year, but it ranges between 11 and 412 mm, and the average temperature is 22.5 °C, where the maximum reaches 44 °C and minimum 9 °C; in addition, the area is known by high humidity since it is bordered from west and south by the sea.

3. **NEOM** Region is characterized by intensive structures and tectonic movements which are reflected on the diverse lithological characteristics and distribution. **Surface materials** (rocks and soil) are found with tremendous types and aspects. These materials play a significant role in the distribution of plant species, notably the region contains bare rock, sand dunes, alluviums and detrital deposits, salty soil.

4. The characteristic of the littoral zone has several aspects including mainly the shoreline characteristics

and materials, as well as seawater properties. In this respect, **shoreline morphology** is important as well as water depth and the located materials. In addition, the chemical and physical of seawater have significant role in the distribution and types of marine species.

5. **The Human Interferes** with the biodiversity at different dimensions. In this respect, the anthropogenic interference is always considered whether for optimal or unfavorable ones. Other than the necessary involvement, there is no remarkable human interference observed in NEOM Region. Thus, except the coastal zone, there is very few number of human settlements in the largest part of NEOM Region, and even in the coastal zone the existing ones are still few.

“
The existing biodiversity
at NEOM is ‘Unique’ as
finding these ecosystems
elsewhere is quite rare
”

GEOLOGY

The geographic location of NEOM Region has diverse geographic features.

It is bordered by the Gulf of Aqaba from west and the Red Sea from south-western part, Al-Muwieleh and Jabal Al-Deba'a from south-eastern, Tabuk City and the surrounding from east, and Jordan from north.

NEOM Region can be classified into three principal geomorphologic units. These are the coastal zone, mountain ridges and the plateau.

Coastal Zone – The shoreline of NEOM Region extends along the Red Sea where the largest part of the shoreline is adjacent to the Gulf of Aqaba.

Thus, the total length of NEOM coastal stretch is about 225 km where it encompasses several coastal portions which are controlled mainly by structural and geomorphological features. The estimated total area of the coastal zone is 8125 km² (31% of NEOM Region).

Coastal plains – Most of coastal plains are located mainly in the south-western part of NEOM Region where they largely compose talus slopes and alluvial fans for miscellany of deposits (e.g. alluvial and colluvial deposits mixed with marine sands and dunes) derived along the existing streams. Therefore, except one coastal plain located along the Gulf of Aqaba, all other plains show V-like shapes and connected with valley courses.



Mountain foot – Slopes – These are the gentle slopes and hill adjacent to the coastal plains of the NEOM Region. They are characterized by diverse slope degree and altitudes, where the average slope gradient ranges between 10 and 40 m/km, while the average altitude ranges between 40 and 120 m above sea level.

Mountain ridges are those mountain chains extending from the hills of the coastal zone upward to the adjacent mountains of NEOM Region. They sometimes form the extension of the mountain hills to the east and north. Thus, the mountain ridges encompass an area of about 12,720 km² (48% of NEOM Region).

Mountain hills – Mountains constitute the main body of NEOM Region where they extend in the NW-SE direction and separate the coastal zone from the plateau. They are characterized by different slope gradients, but they in general represent rugged topography with steep slope where the slope gradient exceeds 120 m/km in many instances. While the average altitude ranges between 800 and 1400 m above sea level.

Crests – These are the highest mountains in NEOM Region where they are distributed within the mountain ridges. These crests, which can be observed from several remote areas, represent the tops of the most abrupt mountains in the entire region. They are almost found with altitudes exceeding 1600 m.

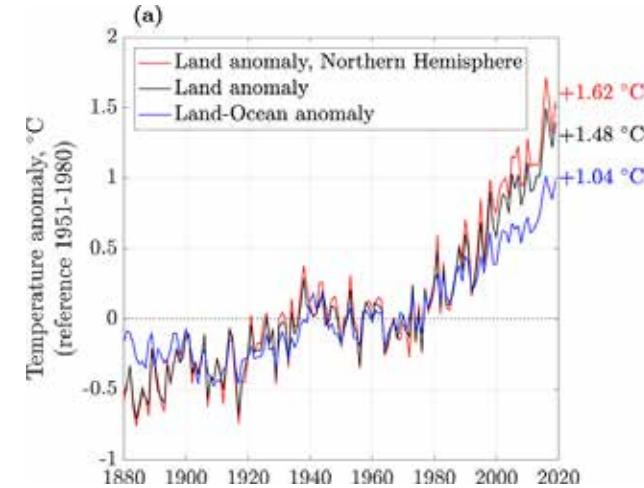
ALARMING CLIMATE INDICATORS

Global temperatures have been steadily increasing since the beginning of widespread instrumental temperature monitoring in the late nineteenth century (IPCC 2013). Temperature changes over land are greater than those over oceans, and land surface in the Northern Hemisphere is warming faster than the Southern Hemisphere. Since the late 1970s, the warming rate has accelerated, and land surface temperature in the Northern Hemisphere has increased by almost 1.5°C (Fig. a).

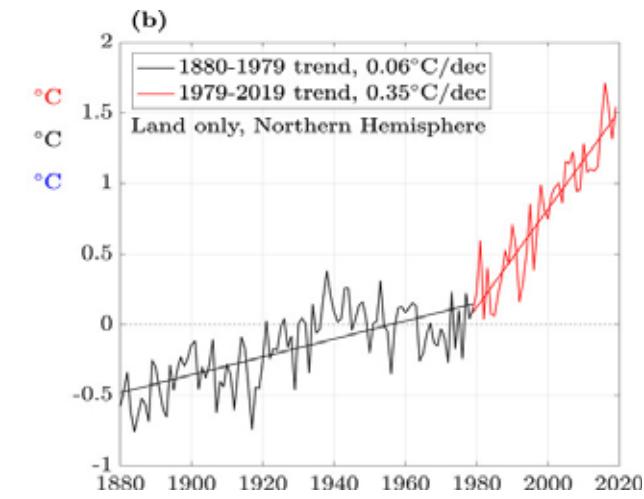
Saudi Arabia is experiencing a strong warming trend and a global hot spot of temperature increase and is experiencing one of the fastest warming rates on the planet. Extreme events are becoming more frequent and pose significant health risks to people and businesses. Between 1979 and 2019, the mean temperature in the kingdom increased by 2.1°C, almost 3 times the global average. Summers warm faster, and average June-August temperatures have risen by 2.5°C over the same time and nights are warming faster than days.

Rapid growth in warm days has resulted in an exponential increase of heat wave duration in most of the studied cities. Coastal locations are less affected by the rise of temperature and the temperature extremes. But these areas are strongly impacted by the elevation of heat index. The magnitude of changes over the Persian Gulf coast is generally higher than over the Red Sea.

Climate change will severely affect the kingdom's economy and make the population vulnerable to extreme weather. Today, per capita electricity consumption in Saudi Arabia is already among the highest in the world, with air conditioning making up a record high 70% of household consumption. Rising temperatures will further increase demand for electrical power. Each 1°C of temperature increase in Saudi Arabia is associated with nearly 2.5%-4% increase in power generation in different regions of the country. In



“ Saudi Arabia is experiencing one of the fastest warming rates and would soon go on to become the global hot spot of temperature increase ”

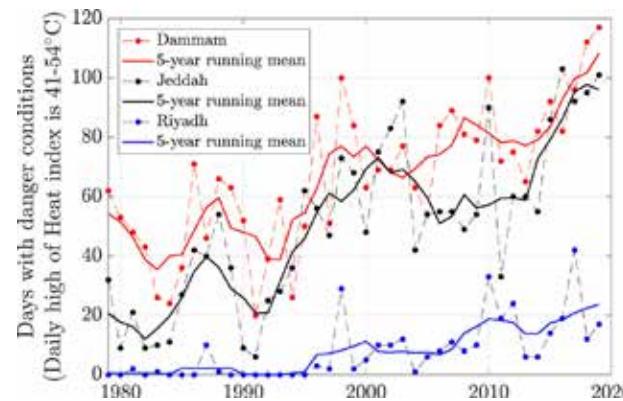


ALARMING CLIMATE INDICATORS

agriculture, temperature increase impacts the demand for freshwater, a scarce resource in Saudi Arabia. It also changes thermal limits of crops and decreases yields.

The rise of all-cause mortality is about 20%-30% when ambient temperatures exceed 40°C. An increase of ambient temperatures would cause an increase in geographical distribution of some vector organisms (e.g., malarial mosquitoes) and transmission of numerous vector-borne diseases such as malaria and dengue fever. The total duration of heat waves in a year (prolonged periods of maximum temperature records) is growing exponentially in most of the big cities in Saudi Arabia. These waves are the most significant weather-related cause of mortality in the world. As for minimum temperatures, nights are warming far more rapidly than days in Saudi Arabia. This increase of daily minimum rather than maximum temperatures is far from innocuous. The night is a time to release thermal stress accumulated during the day, which is important for people, as well as animals and ecosystems. Warmer nights mean buildings and their occupants do not have much chance to cool down. This situation is exacerbated in the cities, where concrete and asphalt accumulate heat during the day and release it at night. This accumulation increases the demand for air conditioning during the night and early morning time, raising the need to increase baseload power production.

The effect of heat index on public health is divided into four categories (Table 2). In Saudi Arabia, days with "extreme danger" conditions are already present, although rare. For example, across the Persian Gulf coast, these conditions are recorded a few times per year. Days with danger conditions are far more frequent, and their occurrence since 1979 has broadened significantly (Fig. 12). Heat poses greater risk for people in coastal cities than those who are inland. The universal thermal comfort index has also increased over the past four decades.



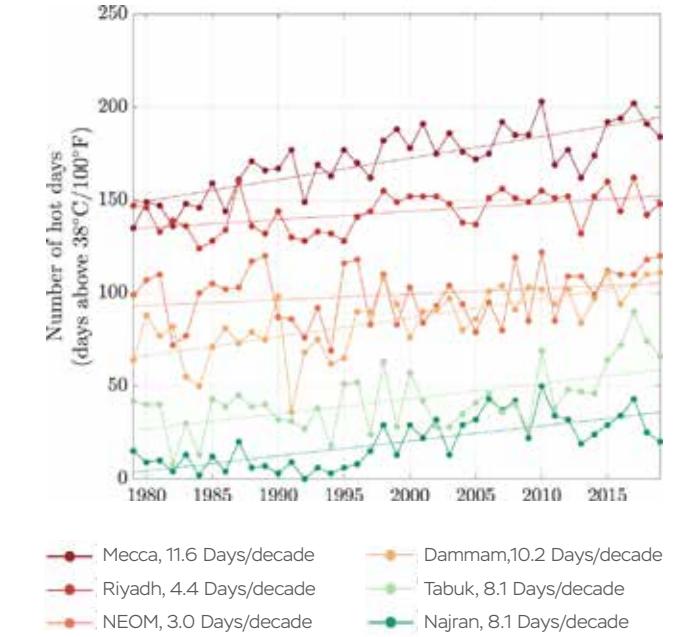
Increase in ambient temperatures causes rise in population of mosquitoes and other insects transmitting Dengue and Malaria

Heat Index	Category	Dangers
26°-32°C	Caution	Fatigue is possible with prolonged exposure and activity; continuing activity could result in heat cramps
32°-41°C	Extreme caution	Heat cramps and heat exhaustion are possible; continuing activity could result in heat stroke
41°-54°C	Danger	Heat cramps and heat exhaustion are likely; heat stroke is probable with continued activity
Over 54°C	Extreme danger	Heat stroke is imminent

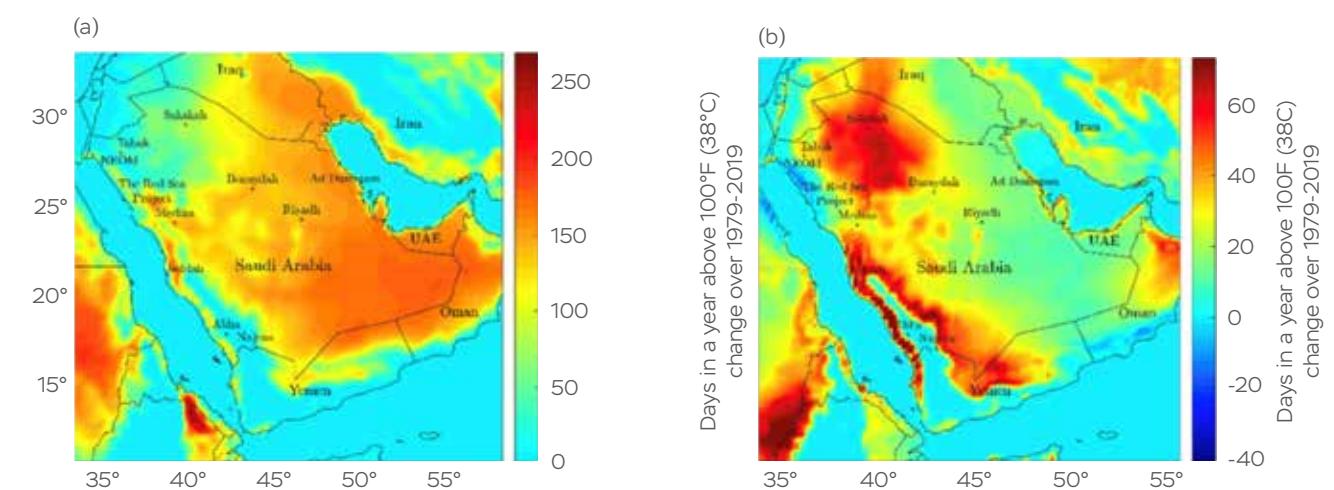
ALARMING CLIMATE INDICATORS

Another way to describe a changing climate is to count the number of days per year when a certain temperature threshold is reached. The parameter "hot days" (HD) is an annual count of days when Tmax reaches 37.8°C (or 100°F). 100°F is a common threshold in literature defining very hot conditions. The map of the average value of this parameter across the kingdom is shown in Fig.a. The highest number of hot days is observed in the southeast of the country.

Fig.b shows the change in the HD parameter over the last 41 years on a country scale. The southeast is not showing a significant change in the trend, because the number of HD per year is already very high there. Conversely, this parameter increases very fast in the areas with less severe climate, such as the capital Sakākah and the entire Al Jawf province, which are well known for their oases and agricultural activities. The fact that the increase in the number of HD does not impact the area along the Red Sea coast stretching from NEOM down south until the Red Sea Project is noteworthy. The Red Sea plays an important role for coastal locations, contributing to a milder climate and delaying the effects of climate change. In NEOM, the rate of warming has remained low, although weak warming trends are observed in non-summer months.



Change in the number of hot days in a year over 1979–2019 and linear trends. These are days with maximum temperature exceeding 100°F (37.8°C).



ALARMING CLIMATE INDICATORS

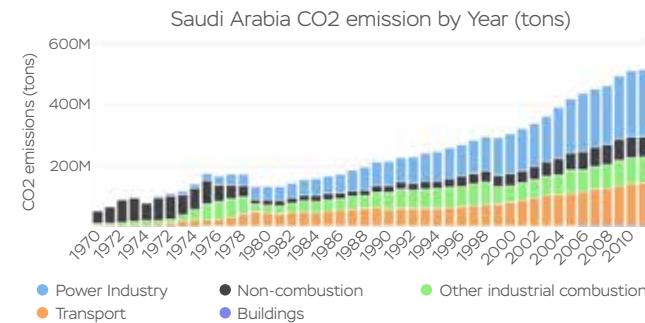
NEOM has one of the most favorable strategic locations. The future megacity has not only a milder climate, but also stands out as a region with perhaps the lowest rate of temperature and temperature extremes increases. Application of the best construction design practices for new buildings and measures to mitigate heat island effect is necessary to ensure safety of city dwellers amid a fast-warming climate. Early planning of resource recycling—water, waste, and materials—would contribute to a decrease of primary power consumption and reduction of emissions. In addition, it will generate local supply chains and secure jobs.

Energy consumption per capita is among the highest in the world. Further demand reduction via price signals, carbon tax, and consumption awareness campaigns may facilitate a transition to alternative energy sources. This transition could result in distributed generation and utility-scale renewable energy sources that have not been cost effective or feasible in the past. Grid stability

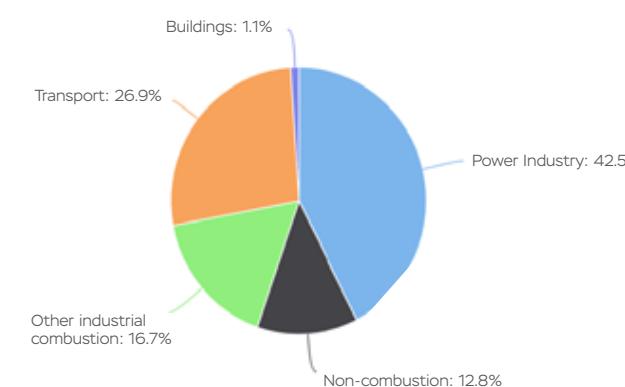
with fluctuating power from renewable source will be of vital importance in Saudi Arabia. Energy storage as hydrogen and thermal storage could enhance the use of Saudi Arabia's rich renewable energy potential. Hydrogen might be also advantageous for alternative transportation, electricity generation, and various energy intensive industrial processes. Thermal power plants produce nearly all the kingdom's power [Electricity & Cogeneration Regulatory Authority (ECRA) 2018] and must use water for cooling. This means that energy and water security go hand in hand and are equally important. Saudi Arabia is one of the most water scarce regions of the planet, and to accommodate its needs, the country relies on nonrenewable groundwater and desalination, which at present is 100% fossil powered. Water must be treated and not wasted. It can be reused for power generation and agriculture. Solar-heat desalination might help to decarbonize freshwater production and might be more appropriate in Saudi Arabia than photovoltaics that deteriorate quickly with dust agglomeration and extreme temperatures.



Fossil CO2 Emissions (2016)	Yearly Change	Global Share	Tons per capita
517,079,407 tons	+0.92%	1.45%	15.94



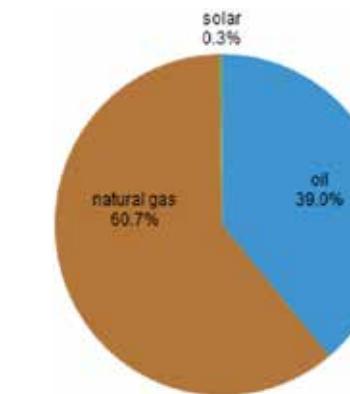
Fossil CO2 Emissions by Sector



ALARMING CLIMATE INDICATORS

# ↓	Country ↑	CO2 Emissions (tons, 2016) ↓↑	1 Year Change ↓↑	Population (2016) ↓↑	Per capita ↓↑	Share of world ↓↑
1	China	10,432,751,400	-0.28%	1,414,049,351	7.38	29.18%
2	United States	5,011,686,600	-2.01%	323,015,995	15.52	14.02%
3	India	2,533,638,100	4.71%	1,324,517,249	1.91	7.09%
4	Russia	1,661,899,300	-2.13%	145,275,383	11.44	4.65%
5	Japan	1,239,592,060	-1.21%	127,763,265	9.70	3.47%
6	Germany	775,752,190	1.28%	82,193,768	9.44	2.17%
7	Canada	675,918,610	-1.00%	36,382,944	18.58	1.89%
8	Iran	642,560,030	-2.22%	79,563,989	8.08	1.80%
9	South Korea	604,043,830	-0.45%	50,983,457	11.85	1.69%
10	Indonesia	530,035,650	6.41%	261,556,381	2.03	1.48%
11	Saudi Arabia	517,079,407	0.92%	32,443,447	15.94	1.45%
12	Brazil	462,994,920	-6.08%	206,163,053	2.25	1.29%
13	Mexico	441,412,750	-2.13%	123,333,376	3.58	1.23%
14	Australia	414,988,700	-0.98%	24,262,712	17.10	1.16%
15	South Africa	390,557,850	-0.49%	56,207,646	6.95	1.09%

Saudi Arabia's electric power generation by fuel 2020

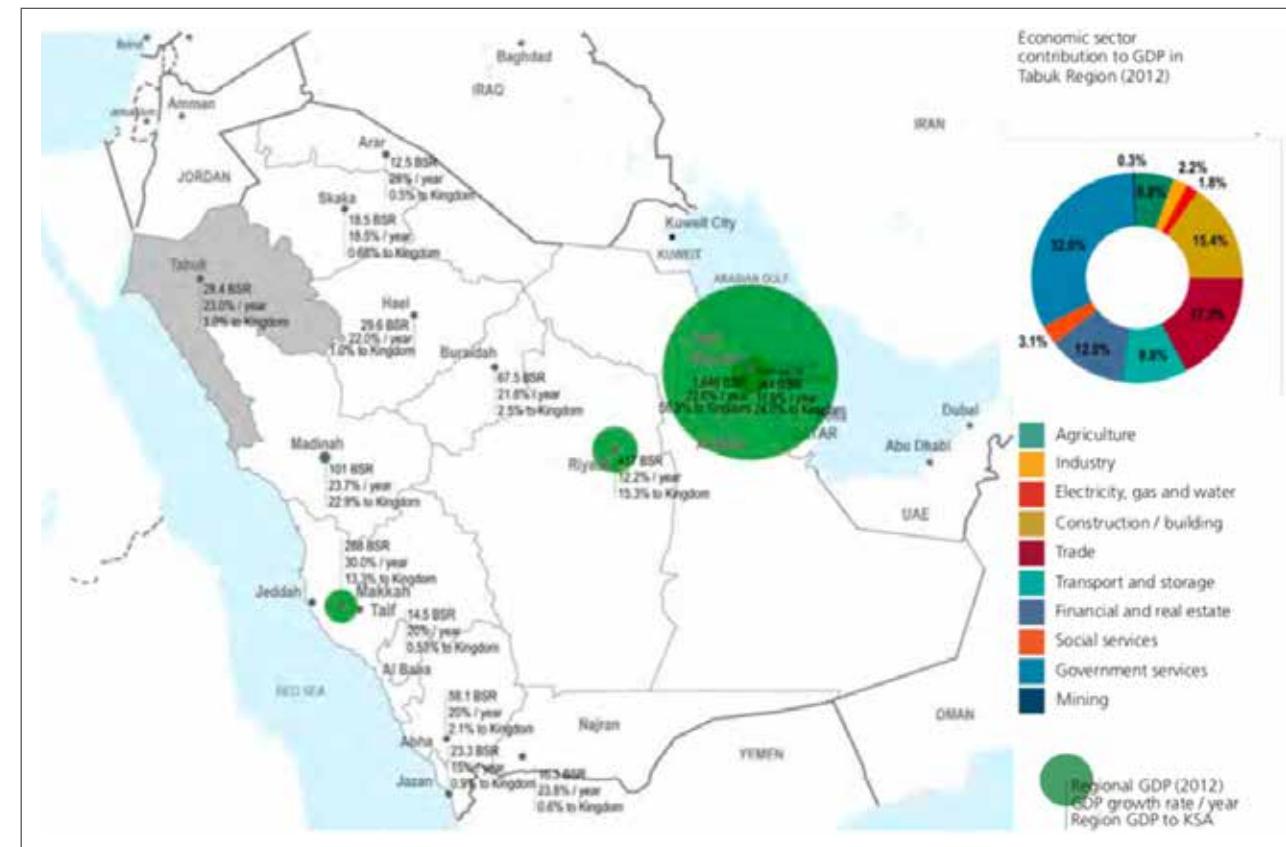


ECONOMY

THE REGIONAL PLAN FOR THE TABUK REGION

The Gross Domestic Product (GDP) of the Tabuk Region, in 2012 was 28.4 billion riyals, representing 1.03% of the GDP of the Kingdom, and 1.99% of the GDP of the Kingdom without crude oil and gas. The trade sector ranks first in terms of contribution to the GDP with 17.3%, followed by the construction and building sector with 15.4%, financial and real estate services sector with 12%, transport and communications sector with 9.8%, agriculture with 6%, and industry with 2.2%.

“Tabuk’s annual growth rate of GDP was 23% during 2009 and 2012”



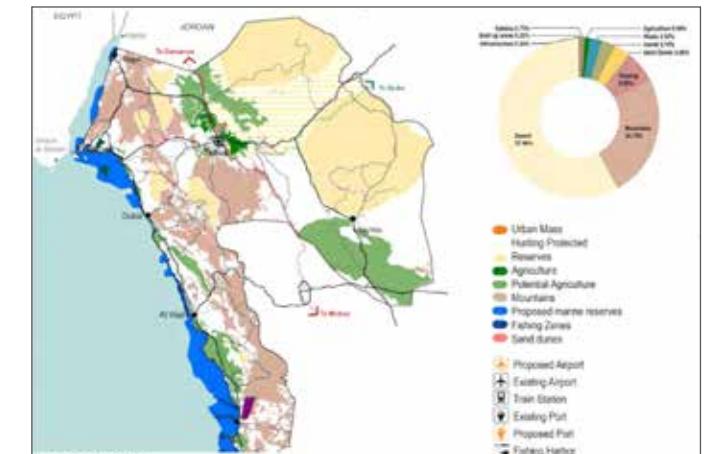
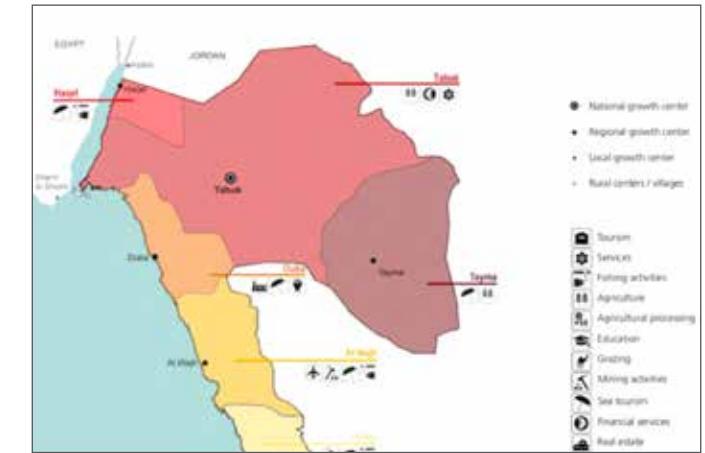
THE REGIONAL PLAN FOR THE TABUK REGION

The city of Tabuk plays a very key role in the Kingdom as it's a focal for many of the new mega projects scaled for the Kingdom's Vision 2030; the Neom City and the Red Sea Project among other expansion projects. The regional plan of Tabuk and the NSS have placed a lot of importance on the hierarchical development of most of the centres in the region as a way to balance the foreseen growth.

The Regional Plan of Tabuk Region for the year 1450H proposes a unique set of functions for the different governorates that draws on the existing strengths and potentials for each governorate, with Tabuk City as a National Services Centre, while the cities along the coastline shall capitalise on tourism, fishing activities, and mining.

The central idea is to emphasise the role of Tabuk as a National Growth Centre and focus on its development while spreading development to other growth centres, especially along the coastal corridor. Additionally, it will distribute and spread development in a balanced manner to the Regional and Local Growth Centres, and rural communities.

Emphasising the linkage between the Tabuk Region and the neighbouring areas through the corridor of Duba/Tabuk/Skaka/Arar and the internal corridor of Tabuk/Tayma/Madinah, in addition to the corridor of Wajh/Ula/Hael, and the coastal corridor of Madinah/Yanbu/Tabuk, will draw focus to economic activities along these axes



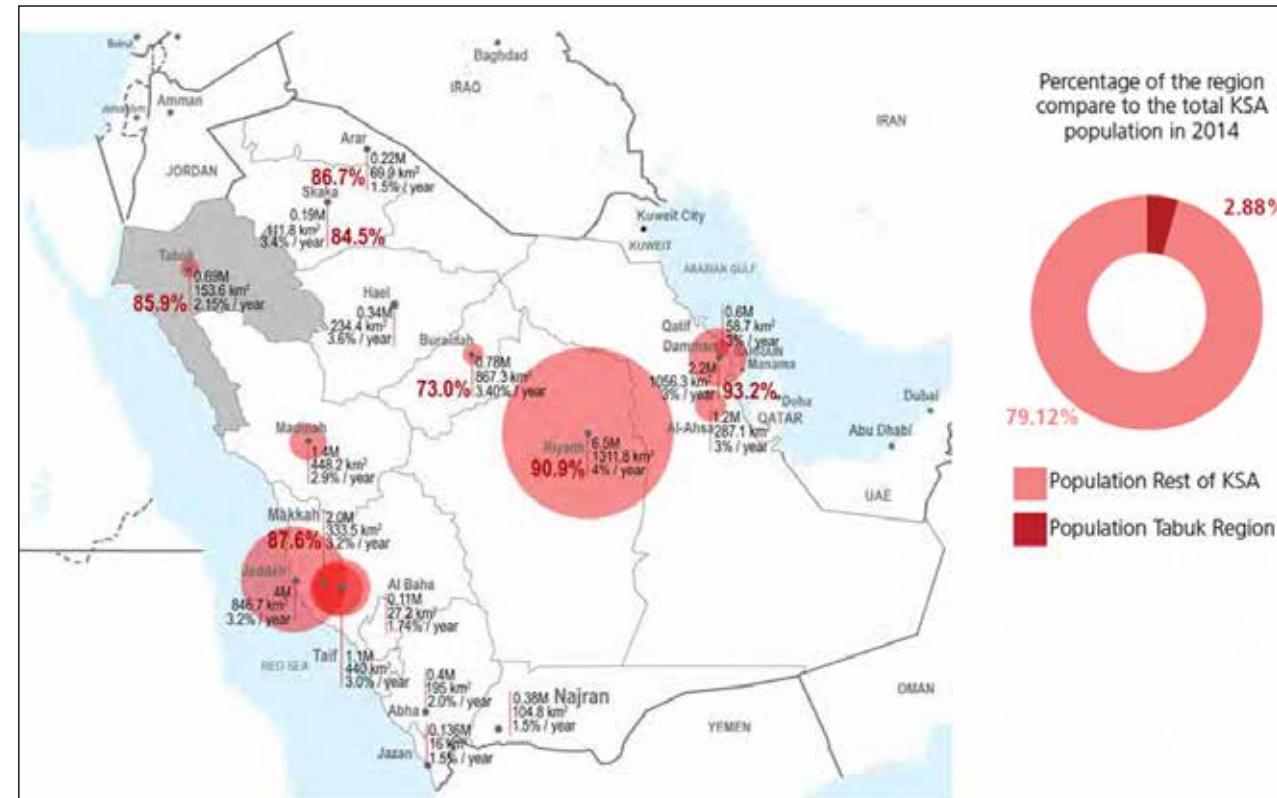
POPULATION

The area of the Tabuk Region is 139,000 square kilometers or about 6.2% of the total area of the Kingdom. The Tabuk Region stretches from North to South covering over 580 kilometers and extends over 480 kilometers from East to West. According to the estimations of the Central Department of Statistics and Information, the total population of the region was projected at 887,000 people, representing about 2.88% of the total population of the Kingdom, in 2014.

The Saudi population in the region is estimated to be 732,000 and 155,000 are made up of non-Saudis. The Tabuk Governorate has 72% of the total population of the region, followed by Amlaj with 7.7%, Diba with 6.6%, Wajeh with 5.6%, Taima with 4.6%, and finally Haql Governorate with 3.5% of the total population.

The Tabuk Region extends over an area of 117,000 square kilometres, or 11.7 million hectares, corresponding to 5% of the total land area of the Kingdom.

“
Tabuk’s population is approximately 2.7% of the kingdom’s population
”



URBAN DENSITY

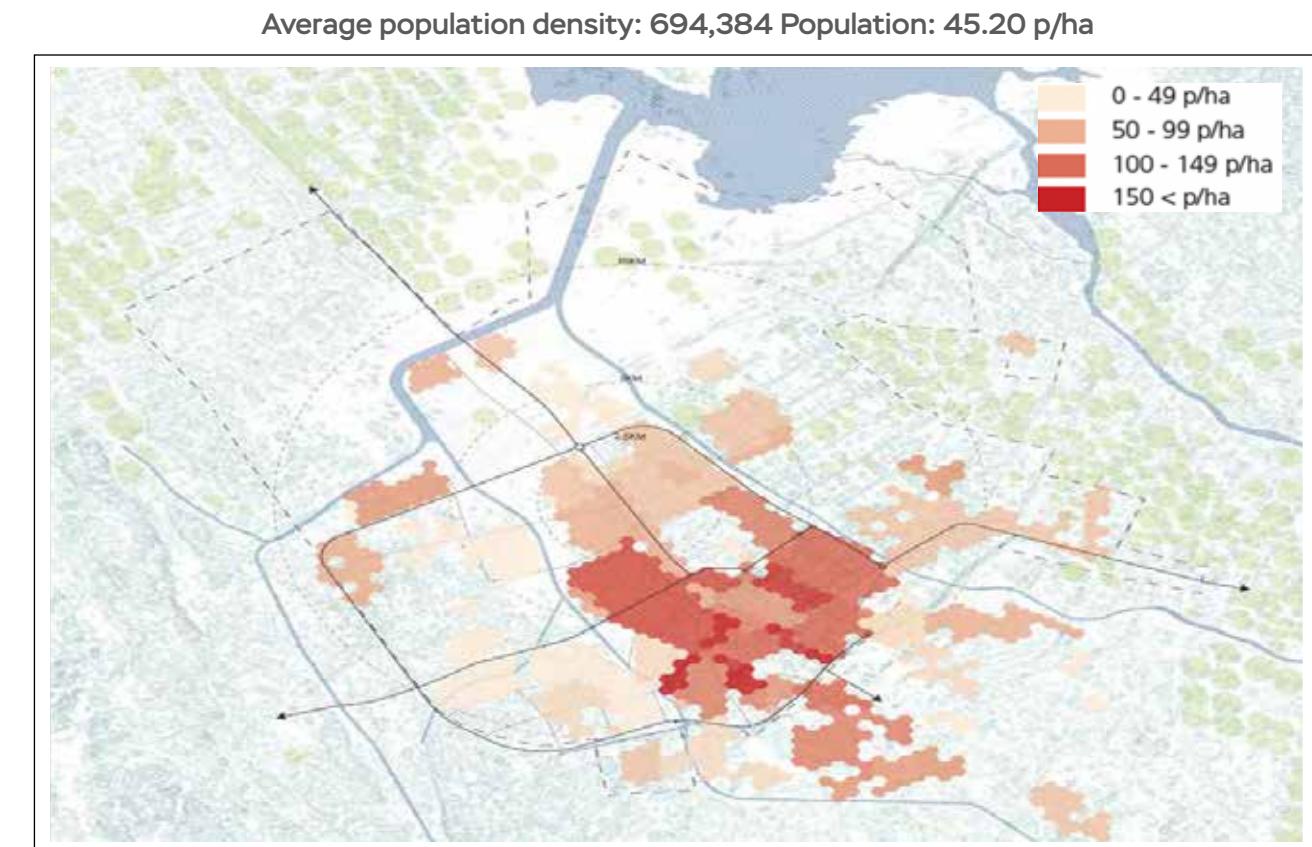
Considering Tabuk total population of 694,300, and calculating the average population density of the built-up area (15,360 hectares), Tabuk has an average density of 45.2 inhabitants per hectare.

The highest density is in the core of the city, where the old city centre is located, and is estimated to bearound 170-310 p/ha, in line with the UN-Habitat recommended density for a compact and sustainable city. The urban fabric in this area is compact, with buildings that are generally three to five stories high, sited with mostly zero lot setbacks and some mixed-use.

The population density in transitional areas located between the old city centre and the most recently developed areas continue to register a high-density

population, in comparison to other cities in the KSA. The density in these areas ranges from 40 to 90 p/ha. Moving further outward from the high-density zones, density is registered at an average of 30-40 p/ha, which, compared to other Saudi cities, is considered to be medium-density

“
Tabuk’s population is approximately 2.7% of the kingdom’s population
”



PUBLIC TRANSPORT

NEOM Region has only three main highways span from Tabuk Region (NE-SW direction) towards the coastal zone where these three transport routes join connect Saudi Arabia with Jordan at the Gulf of Aqaba.

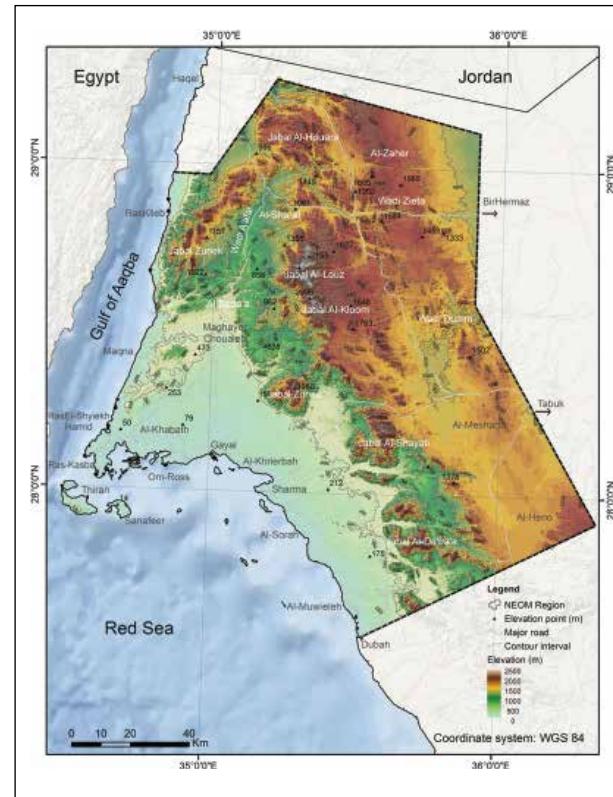
The Proposed Transportation for NEOM Region:

For roads network, there should be a detailed transportation scheme made specifically for the entire NEOM Region, and this can be done within a context of an integrated planning and land management approaches.

Rail transport: This represents a safe, most dependable and comfortable land transport system if compared to



“
There are no railway or flight ports that are present in NEOM region except for two runways, one of which is proposed to be the airport for the region
”



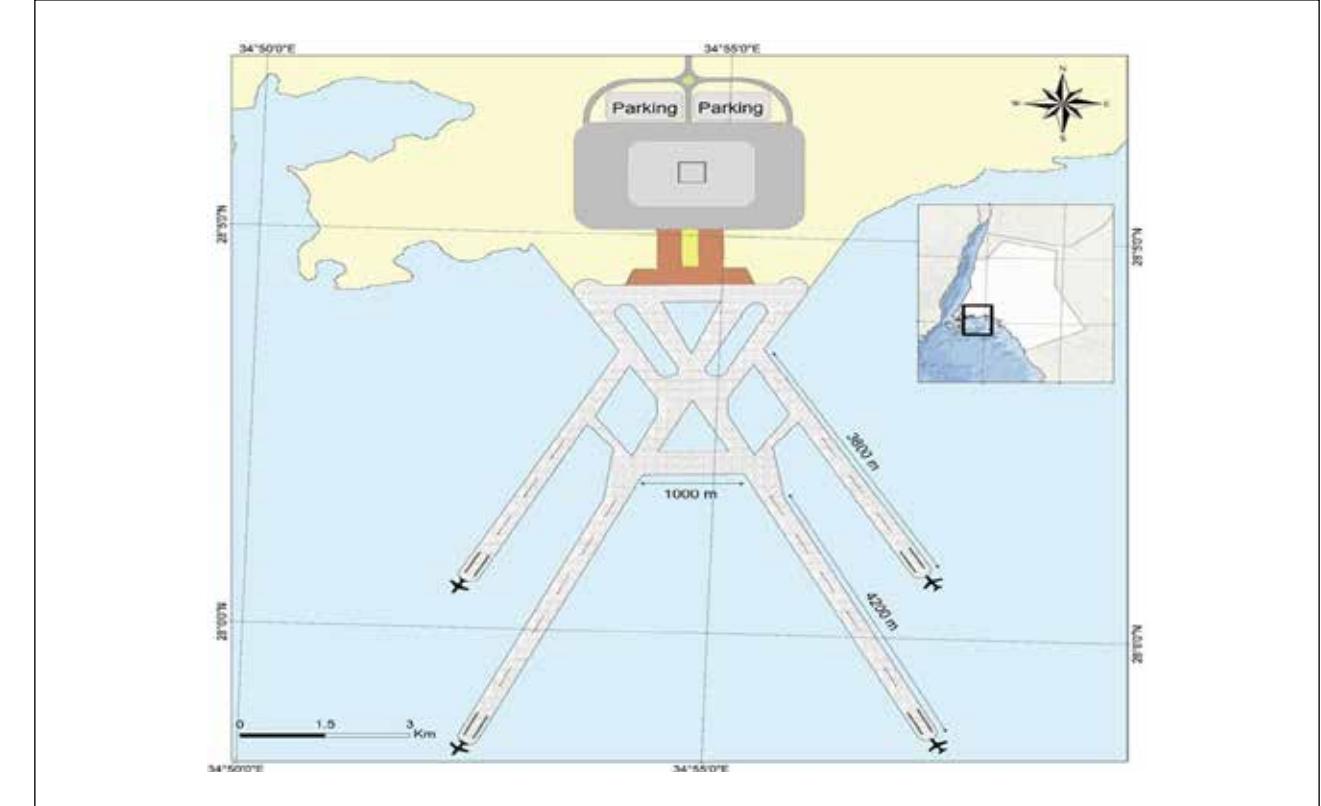
RAIL TRANSPORT

other forms of transportation. It covers large distance at high speed and with cheaper mode of transport. However, three aspects of rail transport can be proposed as shown below:

High-speed railway The proposed route of this railway is showed in the attached picture. It is about 200 km long, where it has one coastal route with 11 stop-stations along its entire way. Thus, it can continue after NEOM Region for more than 45 km along Haqel, and then to the Jordanian border at Al-Durrah border crossing.

Light train is used for short to moderate distances and usually its stations are connected with the high-speed trains. The total proposed distance of the light-speed train for NEOM Region is about 165 km where 22 stop-stations were proposed.

Sub-marine train are used when a train route is cut by water. However, sub-marine train can be also used as a touristic tool to reach marine places and to enjoy observing underwater views and this is the compound objective of proposing sub-marine trains for NEOM Region. The proposed train connects between land and near Ras -Kasba, Ras El-Shyiekh Hamid with



AIR TRANSPORT

Thiran and Sanfeer Islands where a round route of about 30 km is proposed including 3 stop-stations.

Air transport: The proposed air transport in this document implies proposing landing sites and not flight routes. Hence, for NEOM Region there must be a major airport and helicopter landing sites.

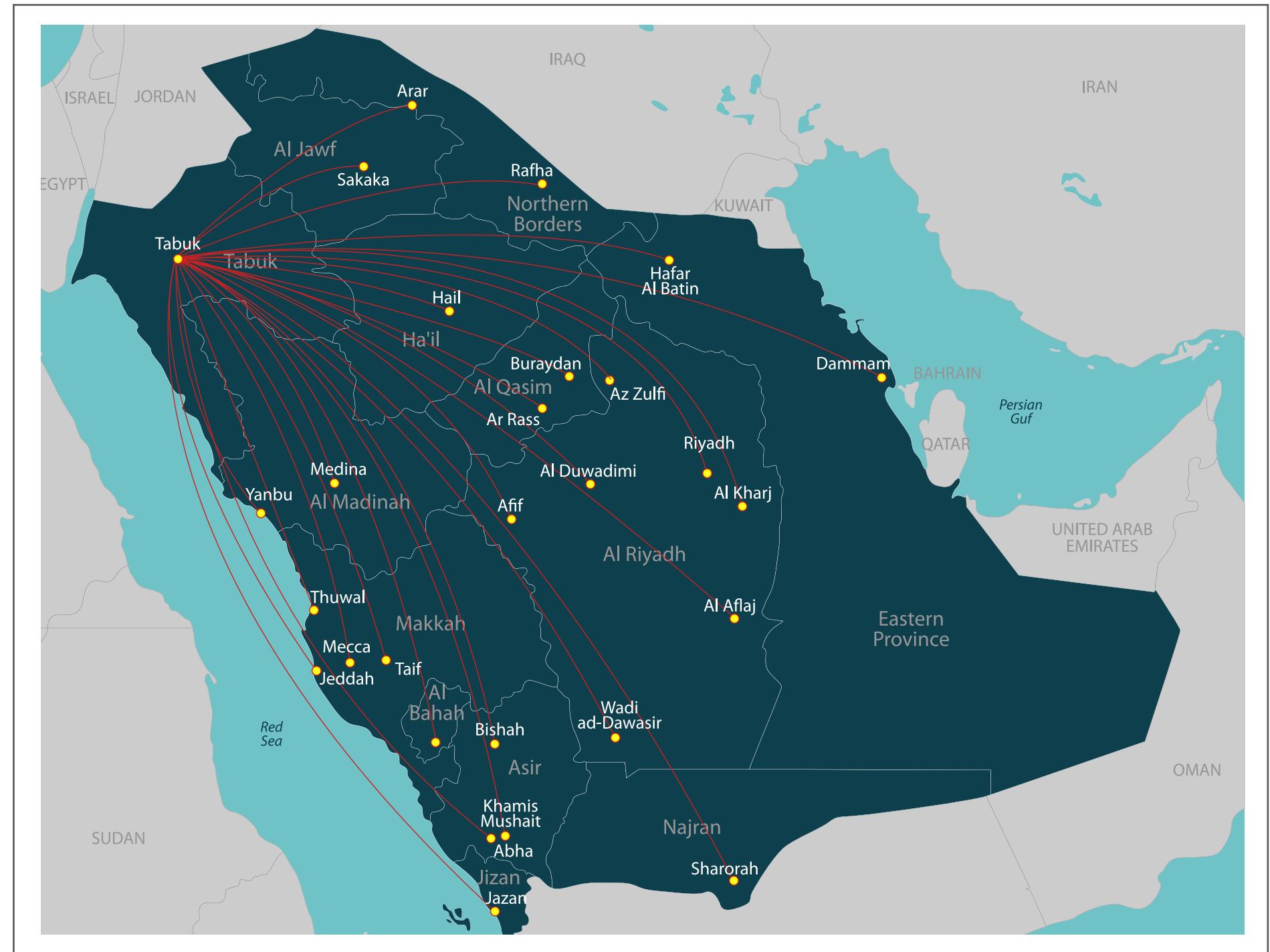
International airport: As mentioned previously there are two runways; one in Wadi El-Masier (2.1 km) and the other one near Sharma (3.25 km) and both are located along the coast. A schematic figure has been illustrated for a proposed international airport for NEOM Region as shown beside. The proposed airport occupies four runways with international dimensions, as well as a giant airport compound.

Helicopter landing sites: Using low-flight aircraft has become widespread and essential in many smart zones. This can be a transport tool used for many purposes.

Thus, in NEOM Region, there are 8-12 helicopter landing sites can be proposed and they can be attributed to at least 4 equipped landing stations.



AIR TRANSPORT





CLIMATE HUB

Buildings consume 40% of the energy worldwide as 21% of the greenhouse gases originate from them. This is the time to rethink about the way we are building homes.

Climate hub is “the solution” in the current scenario. Climate hubs are closed ecological systems which do not rely on matter exchange with anything from outside of the system. The waste generated by one species is used by another species forming closely knit biological communities within themselves.

New ecosystems are created by making the place conducive for various organisms thereby increasing the biodiversity of the place. Climate hubs enhance the quality of bionetworks such as soil, air and water including the surrounding neighborhoods & environment.

Climate hubs are group of homes built & integrated with nature. They are highly energy efficient, low on resources, self-sustainable communities relying completely on renewable sources for energy, food production through natural ways of farming, near zero waste projects etc.,

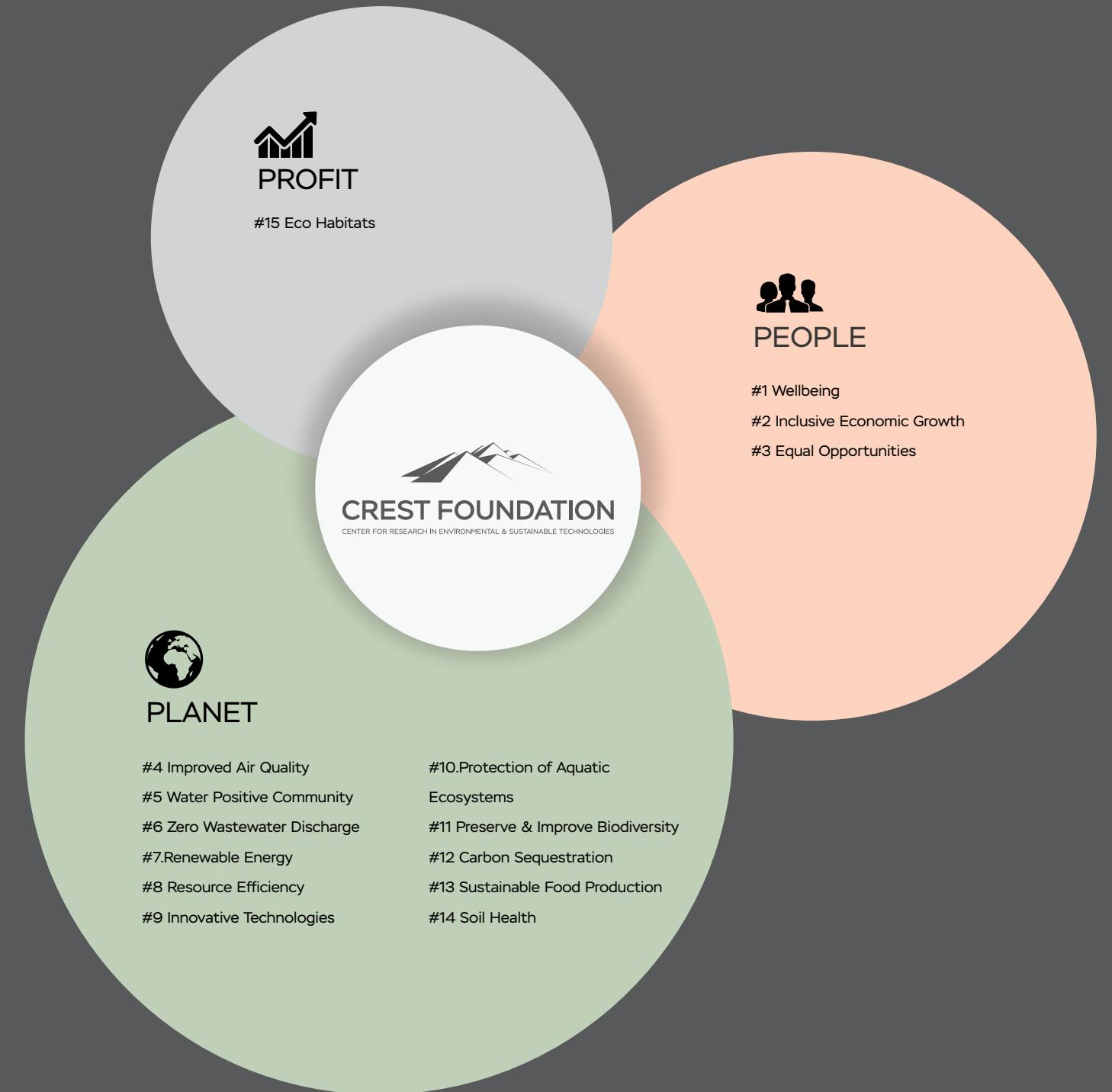
Neom climate hub is a self-sustainable project. The residential community of three categories has 700 homes with 3400 occupants will generate their own power, water and produce their own food.

A photograph of a large, layered rock formation under a dark, star-filled sky. A prominent, naturally occurring archway is visible in the center-left of the frame. The rock face has distinct horizontal sedimentary layers. In the background, more rock formations and a flat landscape are visible under a pinkish-orange horizon.

CREST CLIMATE ACTION TARGETS

NEOM,
SAUDI ARABIA

CREST FOUNDATION'S #15 CLIMATE ACTION TARGETS FOR NEOM, SAUDI ARABIA





KEY CLIMATE ACTION TARGET **#1 WELL-BEING**

People and the way they live are important aspects of the community along with their interactions within and outside. Their involvement in social welfare is an essential criterion for the wellbeing of a Climate Hub. To ensure healthy interaction within the community, Climate Hub incorporates the below elements into its design,

Amenities for active spaces for physical wellbeing of the occupants: Specially designed spaces to conduct Social, Financial, Physical & Community Level events will be an essential part of design. The project will assign common activity spaces for community events, parties and get togethers etc., to bring people from different walks of life together for a healthy social interaction. Thereby also addressing several psychosomatic medical disorders in humans such as depression, sleep disorders, social isolation etc., and enhances overall well-being.

There will be cycling and jogging pathways and other relevant infrastructure through such routes to ensure and increase the use of bicycles within the community.

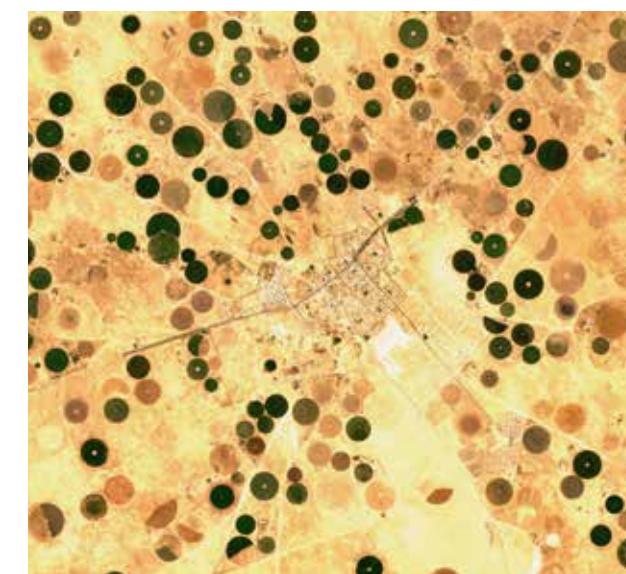
The farm buffer area that is continuous and uninterrupted throughout the farm is designed to promote passive

health with pebble walkways, semi covered spaces to practice yoga or just plain meeting and conversation spaces

Climate Hub will also have its very own Medical Spa where one can relish leisure with ayurvedic massages, well equipped body care salon, at the luxury of their community spaces itself.

Congregated spaces for discussions and awareness programs: Tie ups with NGOs and rehabilitation centers etc., is part of the wellness plan of a Climate Hub. Help from these organizations by conducting workshops to promote healthy lifestyles contribute in supporting overall wellbeing of the community.

Health benefits of taking organic food: Climate Hub is a community driven by "The Greenculture" who respect nature's way to lead a life of self-sustenance through completely sustainable methods of farming. Community members get to witness firsthand the design, execution and maintenance of Witnessed, unadulterated organic food cultivated without the use of harmful chemicals, antibiotics or growth hormones.



“Community at NEOM Climate Hub promotes passive health through active amenity spaces and witnessed farming practices”

KEY CLIMATE ACTION TARGET **#2 INCLUSIVE ECONOMIC GROWTH**

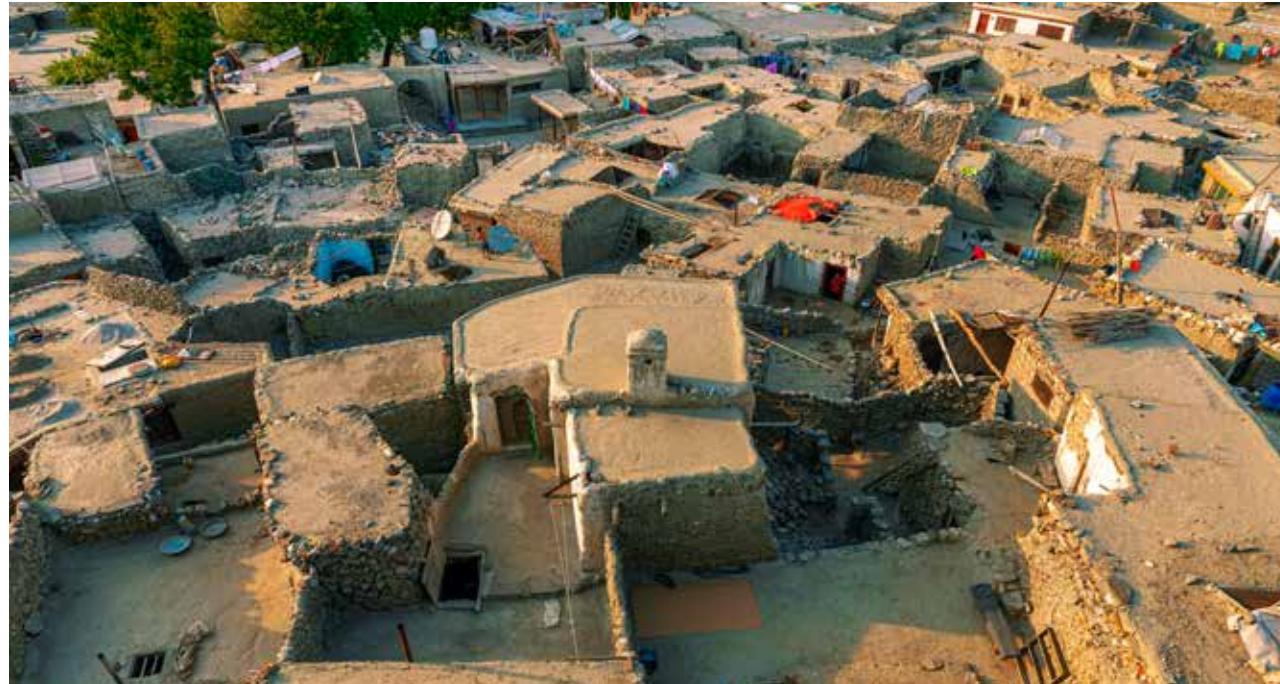
Employment to people from surrounding rural areas thereby increasing their income levels: A Climate Hub will need several personnel for service roles such as Construction, Administration, Security, Housekeeping, and many more. CREST would identify staff required from people in surrounding villages and provide them with skill development training to eventually hire them as part of the maintenance team for the whole property. So, the employment needs are locally fulfilled.

Apart from opportunities within the community, there would be an increase in auxiliary job opportunities because of the development such as, road maintenance, kitchen support, waste management, marketplaces etc., creating a spillover effect by also improving the property prices. Climate Hub will have the capacity to provide employment to approximately 1050 support staff without any discrimination based on religion, sex, race, nationality, age.

This in turn positively contributes to the per capita income levels and decreases the unemployment rate of the region.

Helping people de-urbanize: Simple living standards such as waste management starting at home, letting go of redundant spending habits, becoming one with nature, exploring possibilities of a minimalistic lifestyle would all become part of everyday life at Neom Climate Hub.

“ NEOM Climate Hub would create around 1000 jobs within and several indirect growth opportunities to nearby communities ”



KEY CLIMATE ACTION TARGET **#3 EQUAL OPPORTUNITIES**

Zero discrimination as the motto, NEOM Climate Hub will provide equal Opportunities irrespective of Gender, Religion, Caste & Color. It is important to create a community that is fair, inclusive, and builds a workforce which reflects diversity. A diverse community allows all contributors to contribute their knowledge, skills, and abilities to the community regardless of background, religion, race, gender, sexual orientation, or any grounds for discrimination and eliminating barriers to participation.

Climate Hub follows a Diversity Policy that provides a framework for the organization to achieve the following.

- Diversity in context of employment primarily refers to the equal employment opportunity provided to everyone.
- Challenge unacceptable behaviors and create a climate where complaints can be raised without the fear of reprisal.



KEY CLIMATE ACTION TARGET

#4 SUSTAINABLE FOOD PRODUCTION SYSTEMS

Water is the key to agriculture. However, Saudi Arabia is predominantly desert with no permanent rivers or lakes and very little rainfall. Water is extremely scarce and with the increased growth, demand for water is also increasing.

Underground aquifers are one of the major sources of water in Saudi Arabia. Second major source being the sea. Kingdom of Saudi Arabia has implemented a successful program to provide water necessary for agriculture by,

- a network of dams to capture and utilize water after seasonal flash floods.
- desalination of seawater to provide potable water
- use of recycled water for domestic purposes and irrigation of farm fields and urban parks is an expanding source of water

AT NEOM Climate Hub, we would make use of recycled water from the community along with existing groundwater resources for agricultural purpose.

Climate is the primary determinant of potential biomass productivity of plants and crops. This is because pf assimilation (the capture of CO₂ from the atmosphere and its conversion into carbohydrates) is determined by radiation energy and water availability. Apart from radiation and moisture, rate of assimilation of biomass is strongly determined by crop characteristics

According to the response of assimilation rate to temperature, FAO (1978-81) has proposed four crop groups. Each crop group has a different response function, or adaptability range, to temperature.

Adaptability ranges of different crop groups

4 Crop group	Crop types	Optimal mean temperature range	Examples
1		15-20	Barley, bread wheat, chickpea, lentil, olive, sunflower, cabbage, oats, rye, grape, sugar beet; temperate grasses; almost all trees
2	C3 adapted for higher temperatures	25-30	Cotton, groundnut, cowpea, soybean, tobacco, sunflower, sesame, rice, fig, grape, olive
3	C4	30-35	Maize, sorghum, sugarcane, all millets, fonio rice; tropical grasses
4	C4 adapted for lower temperatures	30-35	Maize, sorghum, millets



SUSTAINABLE FOOD PRODUCTION SYSTEMS

There are three types of growing period in the arabian peninsula,

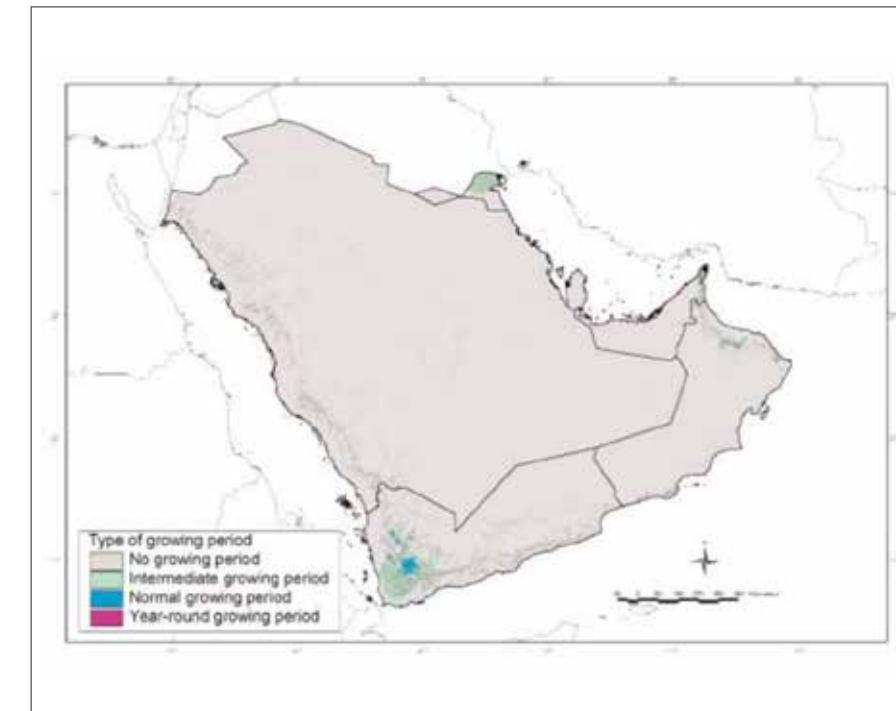
- Normal growing period
- All-year-round dry period
- Intermediate growing period

Comprehensive cropping patterns would be followed where, we cultivate all vegetables suitable for the type of soil present. These will ensure, community is self-reliant on the produce from the farm. However, we need to bear in mind that the farm is subject to natural disasters.

NEOM Climate Hub would have a holistic farm, where

Farming is practiced at various levels. This establishes the sanctity that is maintained and governed by the members themselves with expert advice. Community Farming, Personal farming, Animal husbandry, Aqua farming, etc., are just a few components of farming at Neom Climate Hub.

The community farming comprises majority of the essential farm produces based on the water availability. We need approx. 200 acres to be dedicated to fruits and vegetables with diverse cropping patterns designed to benefit the plants nutrient supply in such a way that it also promotes passive health care. The plant care and nutrient supply in the farm is done using predominantly animal manure prepared from the animal husbandry unit.



“NEOM Climate Hub strives to accommodate all food needs of the community through its 200 acre collective community farm spaces”

SUSTAINABLE FOOD PRODUCTION SYSTEMS

Few important aspects of farming at NEOM Climate Hub would be,

Use of native tree/plant species which need less or no water

Improve Biodiversity by introduction of a small percentage of diverse plant species

Promote overall wellbeing from consuming safe food.

Witnessed and unaltered produce

Reduction in food miles because food required by the community is locally grown as per the need.

Moisture preservation techniques are employed to reduce water dependency of the farm by at least 50% using,

1. Live mulch, garden waste and coconut waste to cover the surface.

2. Soil breeding-live organic mulch as a continuous farm cover



SUSTAINABLE FOOD PRODUCTION SYSTEMS

3. Active farmland manure from the animal husbandry unit

The farm is designed to be water independent; all water systems are designed based on the rainwater available and the recycled water capacity at NEOM.

Irrigation techniques will be designed in consultation with experts in the field. Scientific methods would be used to calculate the sizes and placement of the storm water trenches that channelize the water falling on the site in a controlled way without any soil erosion.

Other essential Steps to improve farming at Neom Climate Hub include,

- Companion cropping techniques
- Natural pest control methods using locally available substances, Bio control Agents, Herbal Concoctions, trap crops etc.,
- Compost preparation: Large quantities of waste material is available as vegetable refuse, farm litter such as weeds, Sewage sludge and animal waste from home units and common areas. Excreta can be converted into useful compost manure by conserving and subjecting it to a controlled process of anaerobic decomposition. Compost is used in the same way as Farmyard Manure and is good for application to all soils and all crops

Vermicompost: Organic manure produced by the activity of earthworms that generally live in soil, eat biomass and excrete it in digested form. It is generally estimated that 1800 worms are an ideal population for one sq. meter and have the capacity to feed on 80 tons of humus per year. These are rich in macro and micronutrients, vitamins, growth hormones and immobilized microflora. The average nutrient content of vermicompost is much higher than that of Farmyard Manure. It contains 1.60%

N, 5.04% P2O and 0.80% K2O with small quantities of micronutrients. Application of vermicompost facilitates easy availability of essential plant nutrients to crop.

- Crop rotation
- Grid-free power sourcing
- Pooling of knowledge systems & regular hassle free up-keep and maintenance
- Sharing of profits and loss
- Water security ensured as water is harvested, and conservation works effectively for large areas.
- Expert care for the farm, energy, water and every aspect of the farm and living
- Active community that is run by professionals with a process driven approach.
- Reliable work force in the farm due to the structured incentivized employment with proper growth ladders.

“
The first ever farming community of Saudi Arabia to witness & consume organic food produced within the community”

KEY CLIMATE ACTION TARGET #5 EFFICIENT WATER MANAGEMENT

Saudi Arabia is the world's third largest consumer of water per capita after the US & Canada. With water consumption rate twice the world average.

Average water consumption per capita in Saudi Arabia is 263L per day. Demand for water by households is growing at the rate 7.5 percent annually. This increasing demand seems roughly three times the population growth rate in the Kingdom

"The Kingdom receives very little rain, has no permanent rivers or lakes and has limited groundwater reservoirs, which are depleting at an alarming rate. In such a situation, it seems imperative to come up with the best water conservation measures and methods."

The water demand for the project is primarily domestic and farming. The project intends to have a highly efficient desalination plant powered by solar coupled with rain water harvesting to meet the water demands of the project. The Annual water demand of the project is 40,25,866 KL out of which domestic water demand is 6,28,846 KL and farming water demand is 33,97,020 KL

The average mean precipitation of Neom is 100mm with an average of 16 days of precipitation. The site has a rainwater harvesting potential of 1,56,501 Cu.m of water. The rainwater from rooftops will be collected in underground water tanks and shall be used for farming along with the treated waste water from STP of 5,03,077 KL

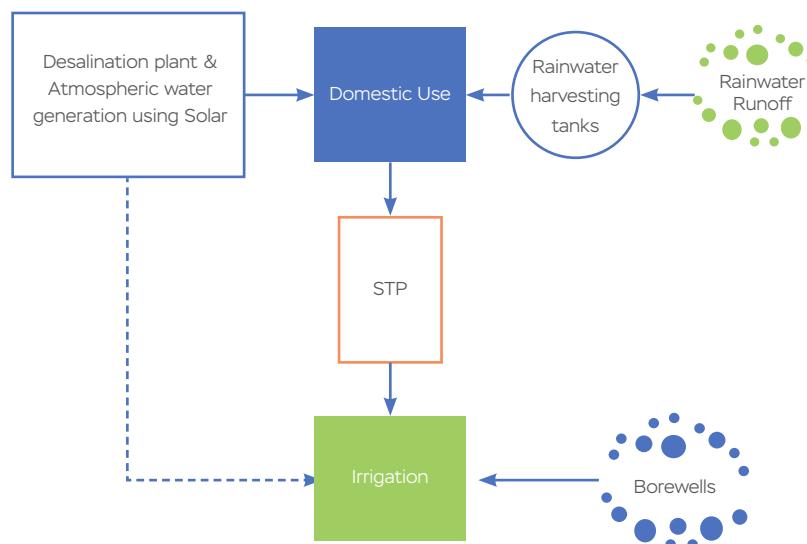
Water Use Reduction

Water consumption would be further controlled/reduced by atleast 35% with the help of water efficient plumbing fixtures.

Desalination plant & Atmospheric water generator plants will be installed to meet the majority of the water demand of the project.

Strategy:

Water use reduction → Reused of treated waste water
→ Harvest Rain water → Zero carbon/sustainable technologies



“ Water demand for the project is reduced through use of Water efficient fixtures, reuse of treated waste water, harvesting rain water, and water captured through sustainable technologies ”

KEY CLIMATE ACTION TARGET #6 ZERO WASTEWATER DISCHARGE

When wastewater is released into the environment, it contaminates the waterbodies and their ecosystems. Reusing treated water reduces demand for fresh water.

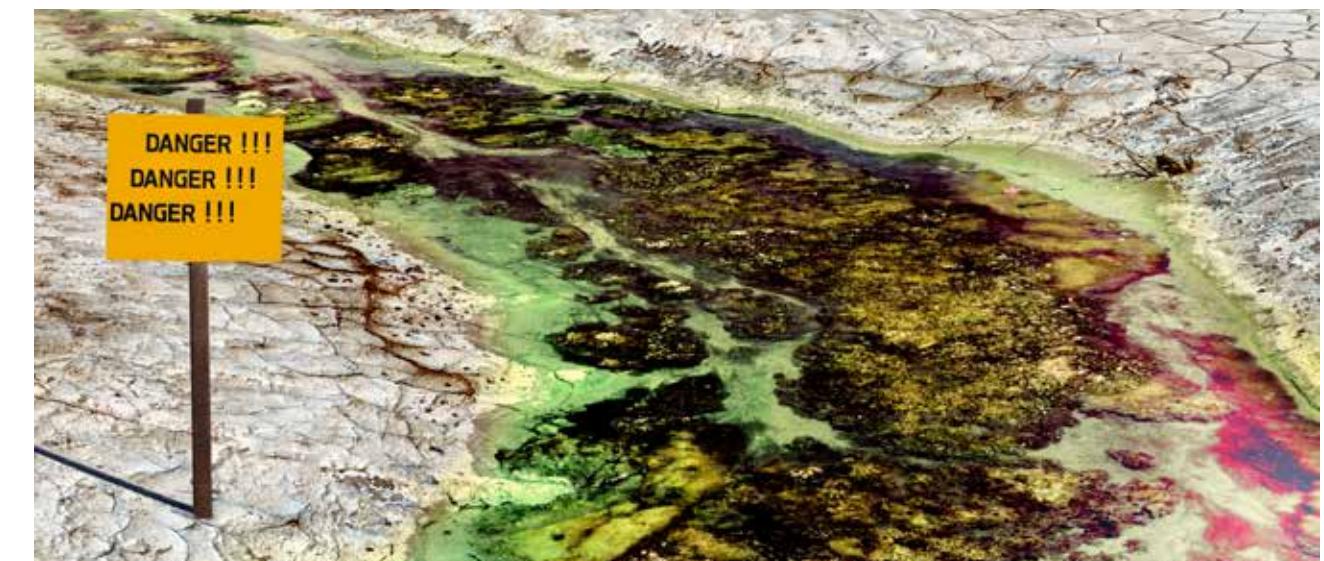
Neom Climate Hub will be a zero-wastewater discharge site.

Zero wastewater discharge is an ambitious wastewater management strategy to purify wastewater by subjecting it to a chain of treatments so that 80-90% of wastewater is recovered and recycled within the site. Thus, preventing the risk of environmental pollution associated with wastewater discharge and maximizes the efficiency of water usage, thereby striking a balance between exploitation of freshwater resources and preservation of aquatic environment.

The project will have an onsite wastewater treatment facility to treat the black and grey water and the treated wastewater will be used for farming and landscaping purposes. There is no discharge of contaminants to the surface water which minimizes impact on local ecosystems and the climate.

By treating the wastewater on site, the burden on the local bodies to handle the sewage is reduced along with the associated costs of transport & sewerage system.

“ A Wastewater treatment facility is critical to keep water contamination under control ”



KEY CLIMATE ACTION TARGET #7 RENEWABLE ENERGY

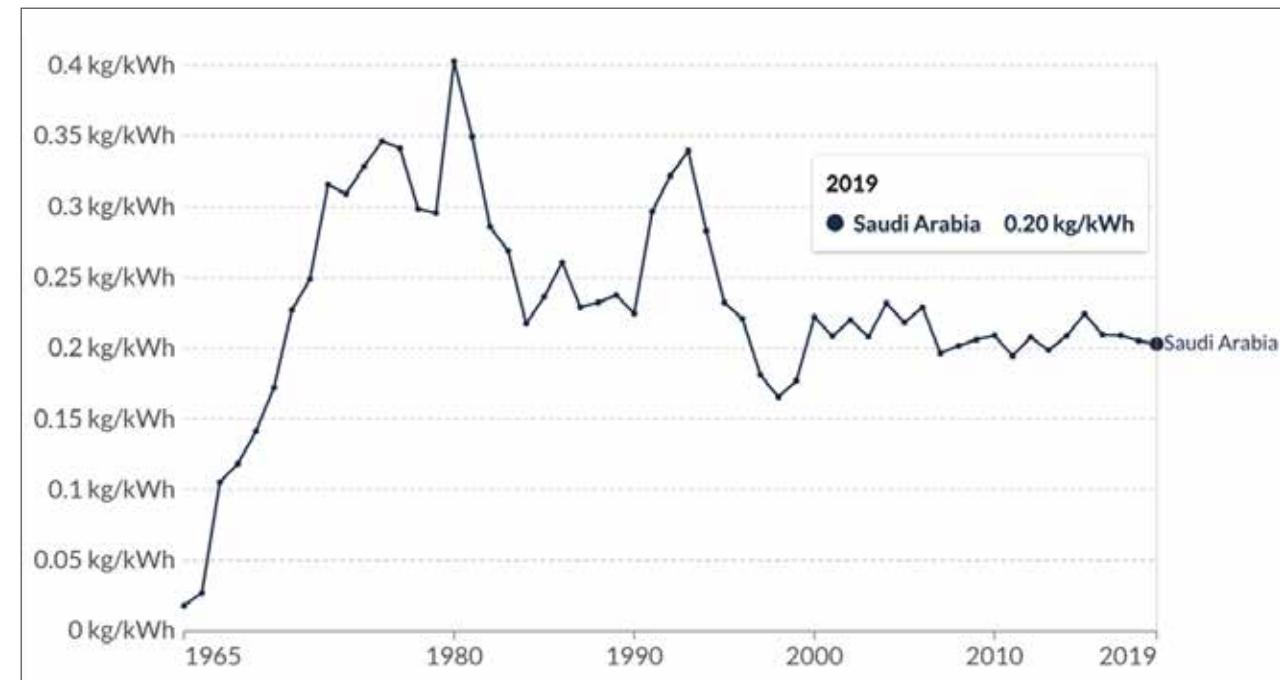
Climate Hubs are net zero-energy positive communities which produce renewable energy through solar and wind energy systems to meet 100% of the energy demand loads.

The total energy demand for the project including Residential, Commercial and amenities would be approx. 59,865,500 kwh.

A solar wind hybrid energy system of 35 MW capacity shall be installed.

Renewable energy has a key role to play in the decarbonization of the energy sector and the resulting mitigation of climate change effects.

“ 35 MW of energy would be produced through renewable energy technologies at NEOM Climate Hub ”



Carbon intensity is the amount of CO₂ emitted per unit of energy.

We can reduce emissions by using less energy and/or using lower-carbon energy.

This metric monitors the second option. As we transition our energy mix towards lower-carbon sources (such as renewables), the amount of carbon emitted per unit of energy is reduced.

This chart shows carbon intensity – measured in kilograms of CO₂ emitted per kilogram of oil equivalent consumed.

KEY CLIMATE ACTION TARGET #8 INNOVATIVE TECHNOLOGIES

WASTE TO ENERGY

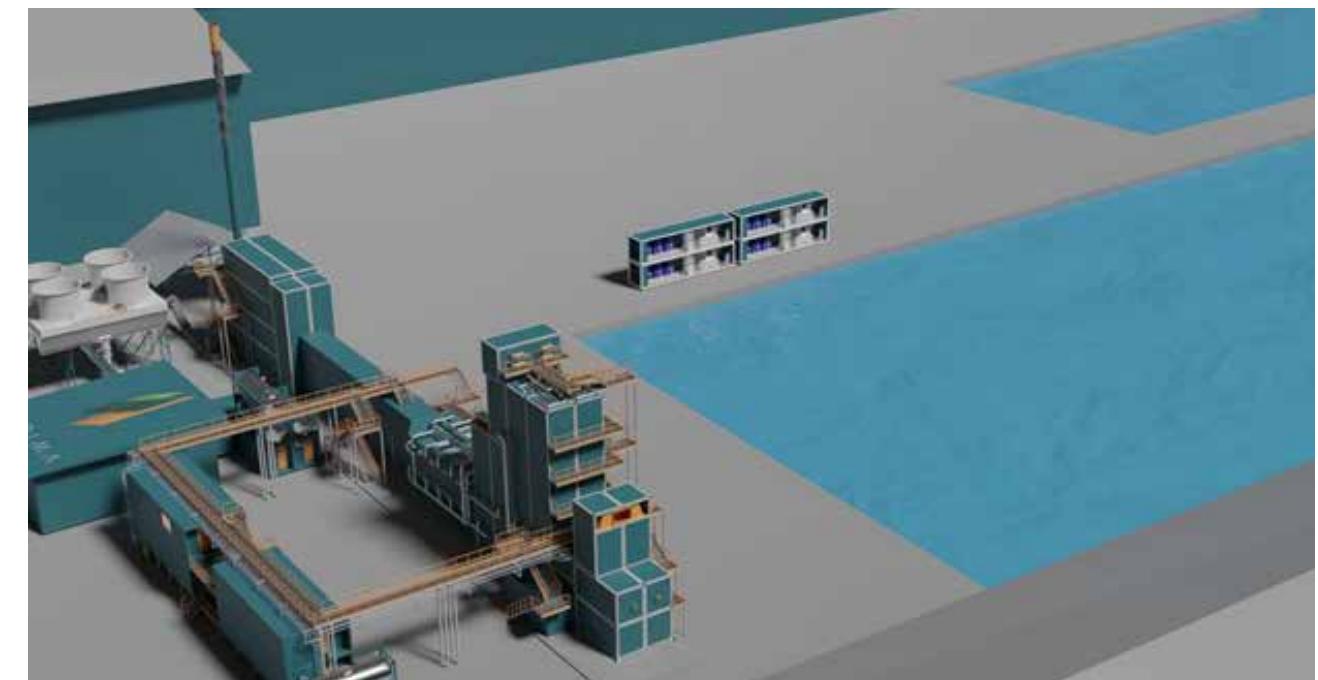
Currently, Saudi Arabia generates 17 million tons of MSW annually with an average of 1.4 kg/capita/day which is more than the global average of 1.2 kg/capita/day. The current practice for waste disposal in Saudi Arabia includes collecting unsegregated waste from several residential and commercial areas and sending it to open desert landfills. Even though it is expected that most of the landfills will exceed their capacities within a few years, disposal of waste in open landfills is still the dominant method due to good land availability and the relatively low cost of resources. Less than 15% of the collected MSW is recycled informally by scavengers who manually extract paper, metals, and plastics.

The best strategy is to maximize clean disposal of waste and reducing the waste generation rate. Waste-to-energy practices will serve this target and the need of waste disposal.

WASTE-TO-ENERGY-TO-WATER CONCEPT

The wasteto-energy-to-water concept makes use of the abundantly available, but underutilized, energy hidden in every-day trash in the potable water production.

The main technologies used to produce potable water are Reverse Osmosis (RO) using membranes and Multi-Effect Distillation (MED) using a steam and a series of evaporators. Together these enable the use of the full thermal power output of the wasteWOIMA® plant in the waste-to-energy-towater concept. The technologies are most efficient in desalination, i.e. purifying sea water, but are applicable to contaminated water as well. The beauty of the concept lies in the use of locally available free fuel to create high value for local people; potable water. A single WOIMAline wasteWOIMA® plant with a thermal output of 13MW is capable of producing over 500m³ of potable water per hour. This serves the needs of up to 200,000 people, coincidentally the same



INNOVATIVE TECHNOLOGIES

number of people generating enough waste to feed the plant. Capacity can be easily increased with additional WOIMAlines. Both new waste and landfill-mined waste are acceptable fuels for the plant. Landfill-mining requires a waste presorting facility that also supports the recycling of e.g. metals, glass and plastics.

The wasteWOIMA® waste-to-energy power plant, as well as the water treatment facility, design is based on standard 20' and 40' container-sized modules, which simultaneously act as · easily transportable units · secure enclosures · installation platform for technical solutions · protective housing on-site There is no buildings in the design causing additional costs or slowing down the erection process. The modules are simply bolted together to form the operational waste-to-energy-to-water, or waterWOIMA plant. All the modules have been designed with efficient and fast transportation, erection, dismantling and relocation in mind.

One WOIMAline uses some 30,000 to 50,000 tons of waste fuel per annum. Different waste streams, including MSW, RDF, agrowaste, industrial waste, landfill-mined waste and similar can be mixed. This translates to over 500m³/h in potable water production, i.e. ~100m³ per ton of waste. Up to four WOIMAlines and water treatment modules can be interconnected to form a larger waterWOIMA plant. The plant is easily delivered, quick to install, cost-efficient to run and simple to maintain offering all stakeholders significant benefits. Relocation to a close-by site can be done within four-to-six months.

“ Waste to Energy strategies would be implemented to maximize clean disposal of waste ”

BENEFITS

Waste Management

- Creating new business potential
- Simplifying waste logistics
- Reducing environmental impacts
- Matching future regulations
- Postponing landfill investments
- Green image benefits

Power & Utility

- Decentralizing power generation
- Enabling off-grid solutions
- Offering fuel & production flexibility
- Harnessing endless fuel source
- Utilizing carbon credit schemes
- Fast plant delivery

Investors

- Excellent return on investment (ROI)
- Scalable business model
- Diversified investment portfolio
- Vendor arranged funding
- Fast project roll-out
- Plant relocation option

Other Stakeholders

- Turning waste into local welfare
- Health & environmental benefits
- Local reliable energy supply
- Educational & job opportunities
- Improving living conditions
- Implementing development funding

INNOVATIVE TECHNOLOGIES

Water from Air

An atmospheric water generator (AWG) is a device that extracts water from humid ambient air. Water vapor in the air can be extracted by condensation - cooling the air below its dew point, exposing the air to desiccants, or pressurizing the air.

Unlike a dehumidifier, an AWG is designed to render the water potable.

The goal is to reclaim that condensation, filter it, and then store it in a carafe or other holding tank. The reclaimed water is filtered a number of times to take out airborne particles and bacteria as part of the process.

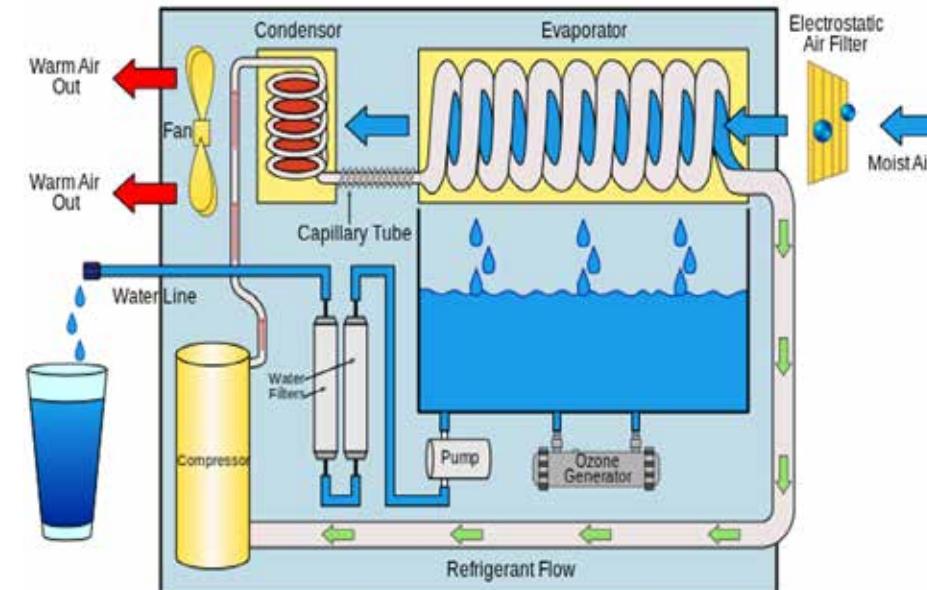
Since a greater quantity of water is found in humid air, the machines work efficiently in NEOM for most of the year, with temperatures of 35 degrees and a humidity of 60% - relative to the temperature being normal between April and October each year.

SKYH2O AWS Maximus 4.10

SkyH2O effectively combines up-stream (IP/technology + products) with down-stream (projects + financing) to provide communities, utilities, and large commercial and industrial water users with fresh potable water. SkyH2O AWS MAXIMUS 4.10™ system is rated for a production capacity of approximately 10,500 liters per day.

SkyH2O Uses state-of-the-art variable speed airflow and cooling controls to ensure reliable operation in a wide range of atmospheric conditions. Web-based internet of things (IoT) industrial controls continuously monitor all operating parameters utilizing graphical and remote interfaces, which may be also viewed remotely. Filters are designed with industrial holding capacity for maximum efficiency during long operating time ranges.

Engineered for to fit within existing 40' ISO container logistics systems, with efficient onsite “plug & play” installation.



“ Extracting Water from Air will meet the demand for potable water for the community ”

INNOVATIVE TECHNOLOGIES

AWS Maximus 4.10 Specifications:

Water production: 10,500 liters/day (2,780 gallons/day)

Installed Electrical Power: 132 kW

Energy consumption: 0.29 kWh/liter, (1.1 kWh/gallon)

Size (W x H x L): 2.19m x 2.54m x 11.30 m

Dry Weight: 13,200 kg (29,000 lbs)

Operating Temperature Range: 5 to 50 degrees Celsius

Operating Relative Humidity Range: 25% to 100% RH

Refrigerant: Environmentally Accepted 410

Air filters: MERV 15, 95% heavy-duty industrial filters.

WATER TREATMENT:

Water is collected in a UV-protected chamber and is filtered and passes through an in-line ultraviolet light treatment system. Water filtration for potable water.

Solar Wind Hybrid Systems

PowerMill™ designed and built by WindStream Technologies and solves the problem of deploying utility scale wind power devices where conventional Horizontal Axis Wind Turbines (HAWT) do not meet the geographical or resource needs of the area. Built to harness lower wind speeds than are required by large HAWT, the PowerMill™ utilizes WindStream' proprietary Vertical Axis Wind Turbine (VAWT) technology with a system of solar panels making up a true hybrid renewable energy solution. Packaged into a convenient turn-key solution, the PowerMill™ is uniquely designed to be installed where traditional utility scale devices cannot provide a compelling return on investment for the owner/operator.

Features

All in one micro-grid ready system.

Deploys straight out of container.

Flexibility with wind, PV and battery inversion.



“ Solar Wind Hybrid System enhances power generation to 24 hours 365 days a year making it most efficient ”

INNOVATIVE TECHNOLOGIES

Containerized battery storage and control system.

Off-grid capability.

Container acts as stabilizer for mounting and installation.

Advantages – On Grid/Off Grid

- » More Power
- » Highly Scalable
- » More reliable
- » Fast Installation
- » Improved Generation Stability
- » Less Space

SAND STOCK

Renewable energy sources like solar and wind are changing how we power our buildings, industries, and grid. However, they are intermittent - we need continuous power even after the sun sets or the wind dies down. As such, energy storage is critical to ensuring continuous power and allows energy producers to take full advantage during times of overgeneration on sunny (or windy) days.

When it comes to short-duration energy storage, lithium-ion batteries are considered the front-runner, but batteries are not the whole story. Our buildings, businesses, industries, and grid need more storage, at lower cost, for longer durations, and at larger capacities than batteries can provide to displace fossil fuels for a sustainable future.

To meet this energy storage challenge, a prototype which is game-changing new thermal energy storage technology that uses inexpensive silica sand as a storage medium known as “**PROJECT STOCKSAND**”. Economic Long-Duration Electricity Storage by Using Low-Cost Thermal Energy Storage and High-Efficiency Power Cycle (ENDURING) is a reliable, cost-effective, and scalable solution that can be sited anywhere.

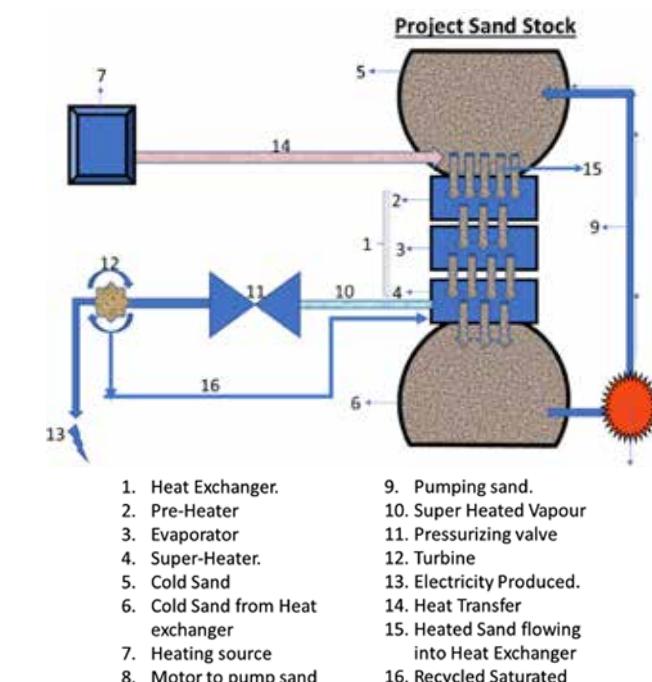
The research project, called “**Sandstock**,” was launched

to develop a sustainable and low-cost gravity-fed solar receiver and storage system using sand particles as the heat collector, heat transfer and thermal energy storage media.

The project involved analysis of UAE sand chemical composition using X-ray fluorescence and X-ray diffraction techniques. These revealed a preponderance of quartz and carbonate materials. Analysis further revealed that the desert sand can be used as a TES material up to 800°C -1,000 °C.

The sand's radiant energy reflectiveness was also measured before and after a thermal cycle, as it may be possible to use desert sand not only as a TES material, but also as a direct solar absorber under concentrated solar flux.

Unlike traditional storage devices like synthetic oils and molten salts that are used for thermal energy storage systems, Sand is quite abundant in Saudi Arabia with plenty of sunshine and quite inexpensive to obtain.



INNOVATIVE TECHNOLOGIES

DESCRIPTION

The availability of this material in desert environments allows for significant cost reductions in novel CSP plants, which may use it both as Thermal Energy Storage (TES) material and solar absorber. The success of the Sandstock project reflects that usability and practical benefits of the desert sand.

The main components of the project include a container which holds the sand collected from the Desert, this will be used as medium to store the Heat Energy which is generated through a external heating source or direct heat absorption. A Heat Exchanger which consists of three parts such as Pre-Heater, Evaporator and Super-Heater, which will be used in collecting the Thermal Energy present in the heated sand and then converting it into a Super-Heated Vapour, which is used in running the Turbine to produce the Electricity. A Pump which will shift the cooled down Desert sand into the Container collecting the cold sand collected from the Desert.

The baseline system is designed for economical storage of up to a staggering 26,000 MWh of thermal energy. With modular design, storage capacity can be scaled up or down with relative ease. (<https://cleantechnica.com/2021/08/31/using-hot-sand-to-store-energy/>)

OPERATIONAL PROCESS

Step 1: The Desert Sand is collected and then transferred into a Container, which can absorb the heat from the external heating Agent.

Step 2: An external agent is used to transmit the heat to the Sand in the container to temperatures which can reach up to 800 to 1000 degrees Celsius.

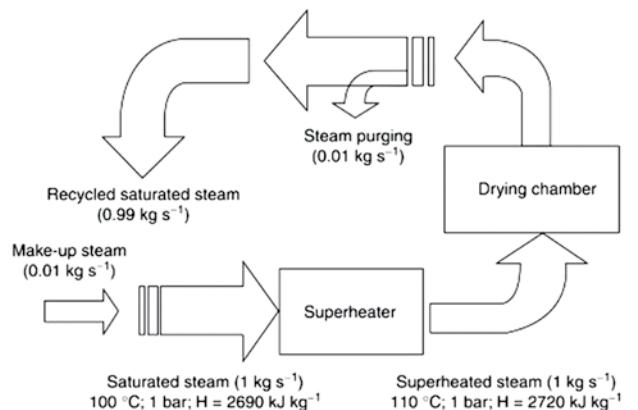
Step 3: This heated sand will be transferred to an Heat Exchanger, which collects the heat present in the Heated Sand, then converts it into Super-Heated Vapour. The cooled Sand will be transferred into the Container below.

Step 4: The Collected Sand will be transferred back to the top container which has the sand collected from the Desert. This process is continued in loop.

Step 5: The Super-Heated Vapour is then transferred into a pressurizing valve.

Step 6: From the pressurizing valve the Vapour is forced onto a Turbine which converts the rotational energy into electric energy.

The recycled saturated steam is then sent back to the Super-Heater to achieve maximum efficiency for the Super-Heated Vapour.



Projects Pursuing this Technology:

Currently, the research team at Masdar Institute Solar Platform is busy developing the first large scale prototype for the commercial market. The technology they are using is a beam down concentrator.

A laboratory-scale prototype also was successfully tested at the CNRS' 1MW solar furnace, in Odeillo, France. A pre-commercial-scale prototype using a beam-down solar concentrator is slated for testing at the Masdar Institute Solar Platform, potentially in collaboration with an industrial partner.

INNOVATIVE TECHNOLOGIES

Earth Air Tunnel System

Earth air tunnel system as a natural ventilation system is increasingly used in modern buildings

to minimize the consumption of non-renewable energy and reduce the harmful emissions.

Natural ventilation has been a fundamental approach to the design of low energy buildings and it is well known that in low-rise buildings this is mainly achieved by wind-driven air flow through windows and openings. Purposefully designed and positioned openings are able to draw in and expel air.

A wind catcher or wind tower is a single device to facilitate the supply and extract of air. They have been used in the Middle East countries for centuries to produce natural ventilation and passive cooling in buildings.

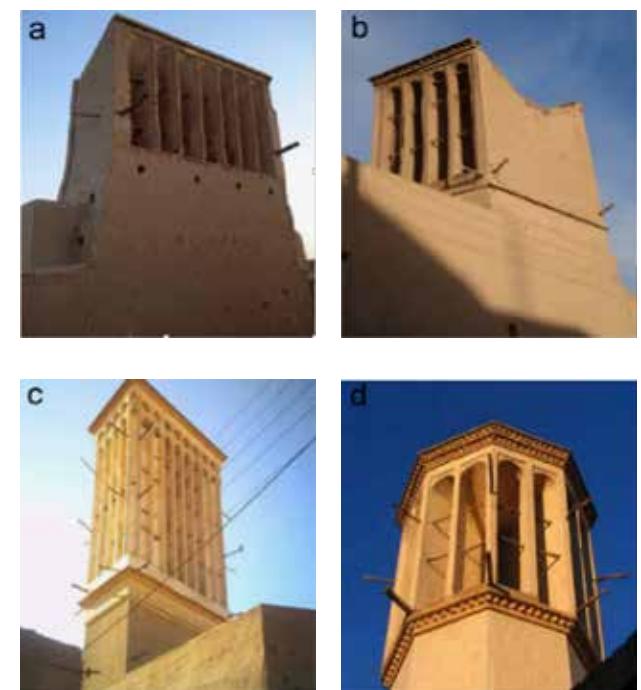
A wind-catcher functions as a solar chimney in an environment with no significant wind or available water, which creates a pressure gradient, is a vertical duct or passage employing solar energy to heat up the air. Thus, the air rises through the passage as a result of convection. This convection of heated air is able to improve the natural ventilation of buildings and create Passive Cooling and Natural Ventilation.

Working Process Passive heating and cooling systems are known for their advantage of consuming negligible or very less energy as compared to active heating and cooling systems.

Earth to air heat exchanger (EAHE) as Indirect Ground Air Cooling systems mainly depend on the high thermal capacity of the soil allows the temperature below a specific depth to remain constant throughout the year which is near the annual average ambient temperature.

The concept of Wind catcher is normally a tall structure with the height from 5 to 33 m mounted over the building

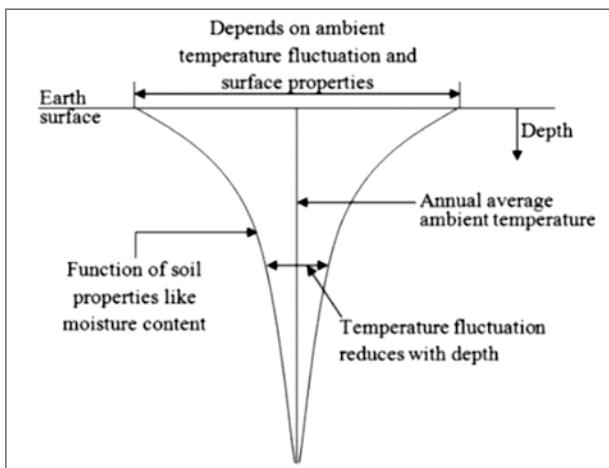
roof. With taller tower capturing winds at higher speeds and with less dust. The number of directions in which Wind catcher face is different; therefore these towers are often classified to the number of their openings. The following are One-sided, Two sided, four sided and octahedral-wind catchers.



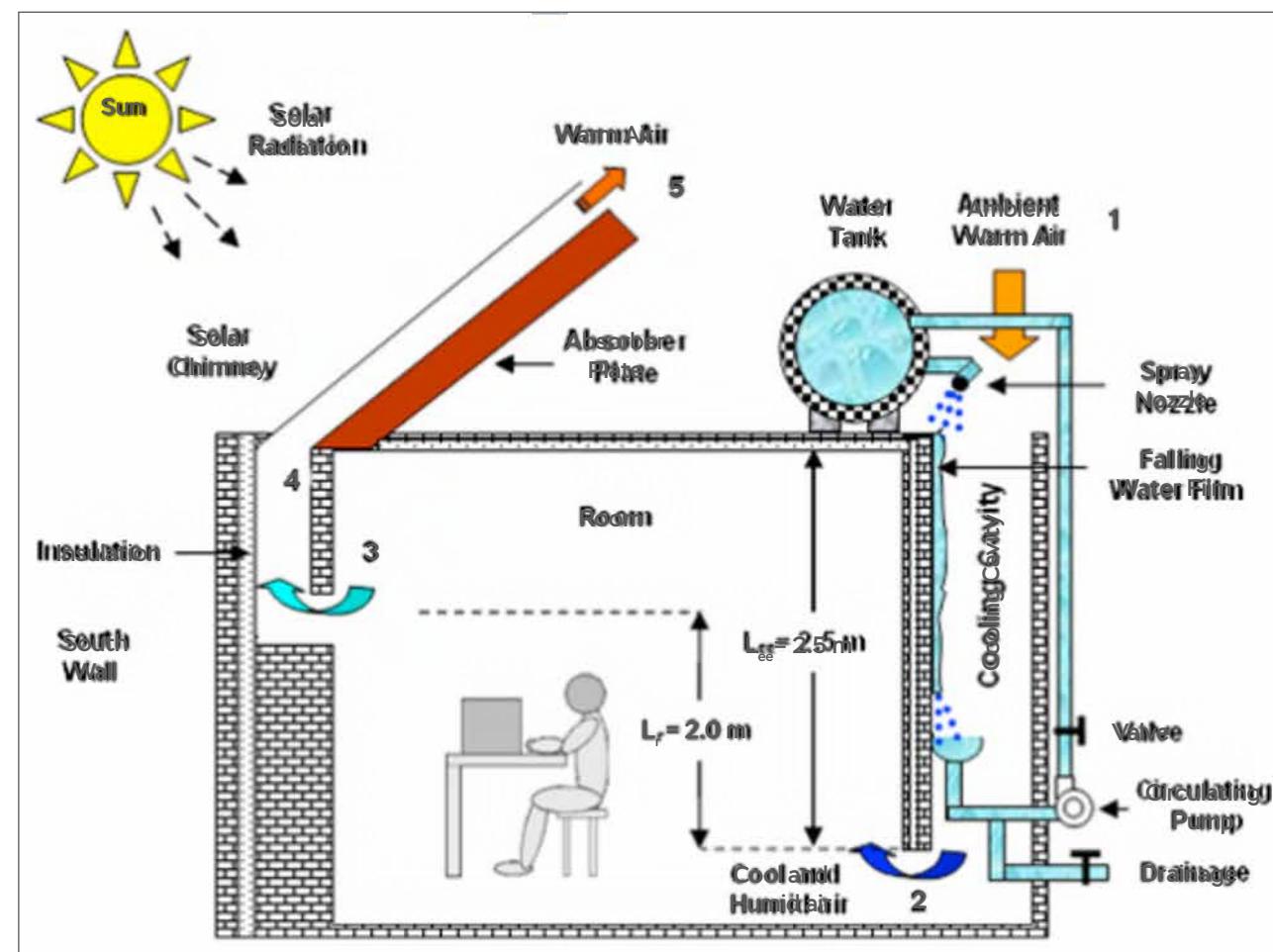
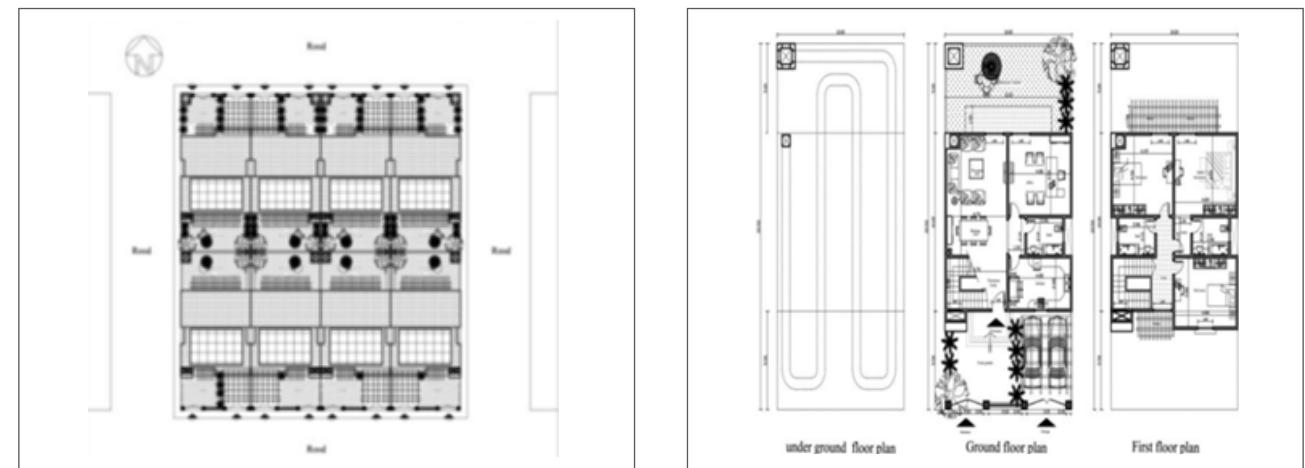
The earth temperature fluctuation reduces with depth and almost dies down at about 4 m. The temperature at this depth approximately equals annual average ambient temperature.

A solar chimney on the other hand, is a good configuration to implement natural ventilation in buildings where solar energy is available. An appropriate design of a solar chimney for cooling includes providing an air gap in a south facade or in the roof of the building that causes stack effect exists between the solar chimney and the inlet of the building. The stack effect operates between the high temperature and high pressure developed in the

INNOVATIVE TECHNOLOGIES



INNOVATIVE TECHNOLOGIES

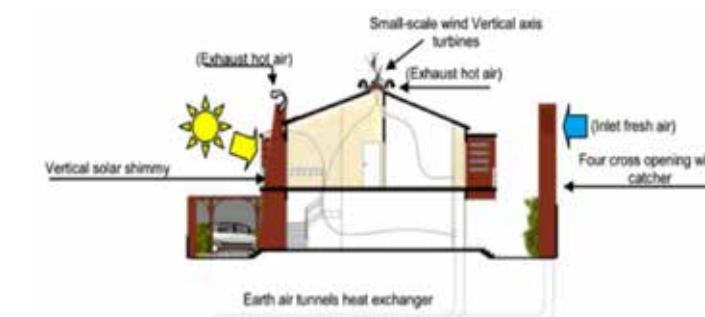


solar chimney and the low pressure and low temperature at the inlet. If the openings are provided at the inlet of the building and at the outlet of the solar chimney, air will enter into the building due to the difference of air densities and pressure gradient and move through the building before exit from the outlet of the solar chimney.

Wind catcher earth air tunnel:

Passive cooling is being employed as a low-energy consuming technique to remove undesirable interior heat from a building in the hot seasons.

A tunnel in the form of a heat exchanger buried at a depth of about 4 m below the ground level will acquire the near temperature as the surrounding earth. Therefore, when the ambient air passes through this tunnel, it will be cooled in summer and warmed in winter seasons.



KEY CLIMATE ACTION TARGET

#9 RESOURCE EFFICIENCY

Population explosion, coupled with improved lifestyle needs of people, results in increased solid waste generation in urban as well as rural areas of the country.

All wastes become hazardous if not carefully disposed of resulting in irreversible damage to earth overtime. But what is equally important is that all waste is recyclable.

Recycling reduces the demand of virgin materials, consumes less water and energy. There is a need to look at the waste not merely as an environmental polluter but a recyclable material of great potential and energy saver.

The primary goal is to ensure **ZERO WASTE TO LANDFILL**

Strategies for Waste Management & Reduction:

Types and quantity of waste generated by community will be monitored. Residents, staff and vendors would be educated on how to reduce the waste



Waste hierarchy shows the best way to avoid shrinkage of valuable resources by preventing waste from getting generated in the first place. The goal is to maximise efficiency and avoid unnecessary consumption through behaviours such as

- selecting items with the least packaging or that require the fewest resources to produce
- avoiding disposable goods or single-use materials
- buying products that are recycled, recyclable, repairable, refillable, re-usable or biodegradable
- using leftover food rather than throwing it away

Key Objectives:

- To take all reasonable steps to ensure that waste management controls are observed.
- To minimize the amount of waste generated and maximize the amount of waste reused and recycled.
- To reuse and recycle as much waste as possible on-site. Where on-site reuse is not possible, identify the most appropriate waste management option in line with the waste hierarchy.
- To manage waste as close as possible to the site location.
- To provide training to improve awareness of waste management issues with all residents, staff and vendors and to improve waste management practices on-site.

Types of Waste:

Domestic waste can be broadly classified in to 5 types

1. Dry Waste (paper, plastics, tetra packs, cardboard, glass, thermocol, etc)
2. Wet Waste (food leftovers, rotten fruits, eggshells, tea leaves, flowers, etc.,)

RESOURCE EFFICIENCY

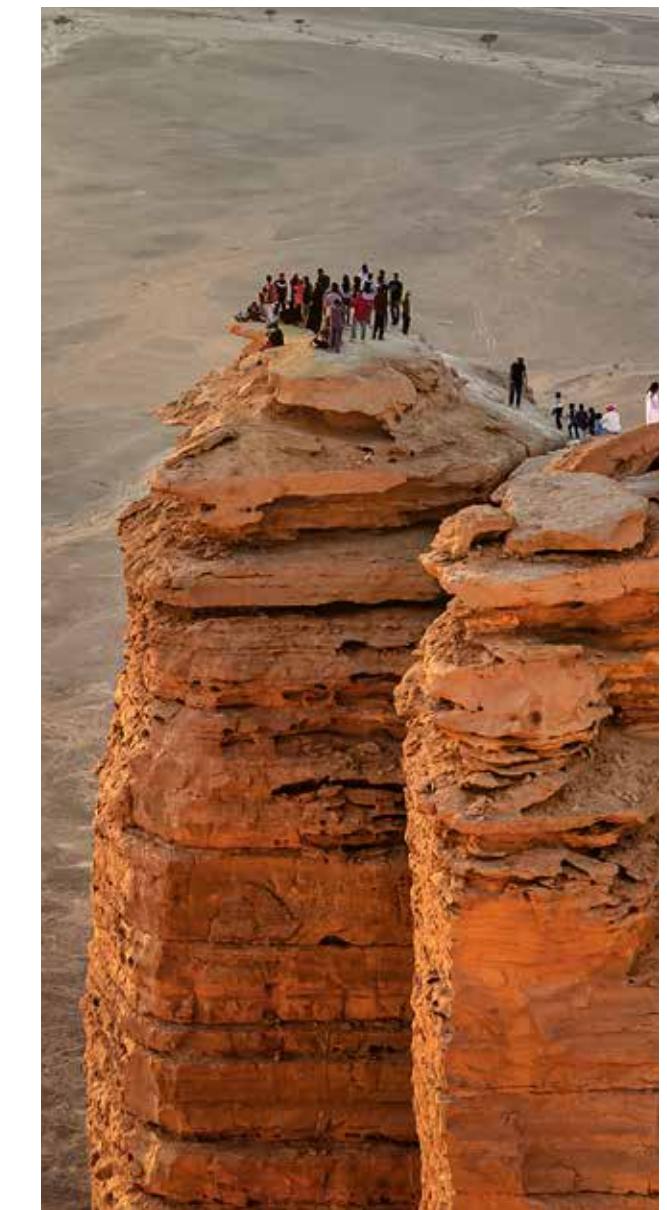
3. Sanitary Waste (sanitary napkins, diapers, bandages, condoms, etc)
4. E- Waste (all electronic waste like batteries, phones, chargers, computer parts, appliances, etc.,)
5. Hazardous Waste (chemicals, cosmetics, paints, oils, medicines, syringes, razors, broken glass, etc.,)

Segregation of Waste at Home Level:

For simplification and ease of segregation for residents, there would be three bins only at home level

- Dry Waste
- Wet Waste
- Reject Waste – Sanitary & Hazardous Waste.
- Wet waste would be transferred to the Biogas plant for power generation & compost
- Dry waste would be transferred to central waste storage facility where it will be further segregated into papers, cardboard, plastic, metals, rubber, thermocol, etc.,
- All recyclable materials will be sent to Recycling facility and non-recyclable plastics will be used as raw material in Waste to Energy systems to recover energy.
- Sanitary waste like diapers and sanitary napkins must be covered fully in newspaper and marked with a red cross. They will be incinerated within the site.
- E-waste is collected quarterly by the housekeeping team and stored centrally and will be picked up by E-waste recycling vendors
- Hazardous waste like chemicals, paints, oils, pesticides will be separately stored in the HHW bin at the central waste storage facility and will be handed over to permitted Hazardous waste treatment facility.

“ NEOM Climate Hub is a zero waste to landfill project ”



KEY CLIMATE ACTION TARGET #10 IMPROVED AIR QUALITY

EPA's Breakpoints for pollutants							
	AQI	PM10 (in µg/m ³)	PM2.5 (in µg/m ²)	SO ₂ (in µg/m ²)	NO ₂ (in µg/m ²)	CO (in µg/m ²)	Ozone (in ppm)
Good	0-50	0-54	0-12	0-35	0-53	0-4.4	0-54
Moderate	51-100	55-154	12.1-35.4	36-75	54-100	4.5-9.4	55-70
Unhealthy for sensitive individuals	101-150	155-254	35.5-55.4	76-185	101-360	9.5-12.4	71-85
Unhealthy	151-200	255-354	55.5-150.4	186-304	361-649	12.5-15.4	86-105
Very Unhealthy	201-300	355-424	150.5-250.4	305-604	650-1249	15.5-30.4	205-404
Hazardous	301-400	425-504	250.5-350.4	605-804	1250-1649	30.5-40.4	405-504
Hazardous	401-500	505-604	350.5-500.4	805-1004	1650-2049	40.5-50.4	505-604
Hazardous	501-999	605-9999	500.5-99999.9	805-99999	2050-99999	50.5-99999	605-99999

It is observed that though the average AQI is good. Ground level ozone is moderate & Carbon monoxide levels prevalent are unhealthy for sensitive individuals when exposed to longer periods.

Vehicular pollution is reduced within the community by introducing safer means of commuting e.g., e-bikes, cycling, other sustainable commuting options etc.,

All farming and afforestation activities in the property will be chemical free ensuring the end users have zero exposure to pesticides.

Use of low VOC compounds: VOCs are only one of several toxic compounds that can be found in paints.

VOCs are crucial pollutants because of their contribution to the formation of ground-level ozone. When VOCs are released into the atmosphere, they react with nitrogen oxides (NOx) to create ozone molecules. Ground-level ozone can have many impacts on human health and is the key pollutant that causes smog. Low VOC refers to volatile organic compounds that are not harmful to the environment and humans as they contain a lower amount of VOC content than conventional paints and create no impact on the ozone layer.



“Species for plantation are carefully chosen to mitigate Air pollution risks for the community”

KEY CLIMATE ACTION TARGET #11 PROTECTION OF MARINE ECOSYSTEMS

United States Environmental Protection Agency (USEPA) bases aquatic life criteria on how much of a chemical can be present in surface water before it is likely to harm plant and animal life. The strategy to protect both freshwater and saltwater organisms from short-term and long-term exposure is crucial to conserving aquatic ecosystems.

Contaminants of concern (CECs) such as pharmaceuticals and **Personal Care Products (PPCPs)** are being detected in low levels in surface water which might have an impact on aquatic life.

These CECs and PPCPs act as Endocrine Disruptors that alter the normal functions of hormones resulting various health defects predominantly reproductive effects in aquatic organisms.

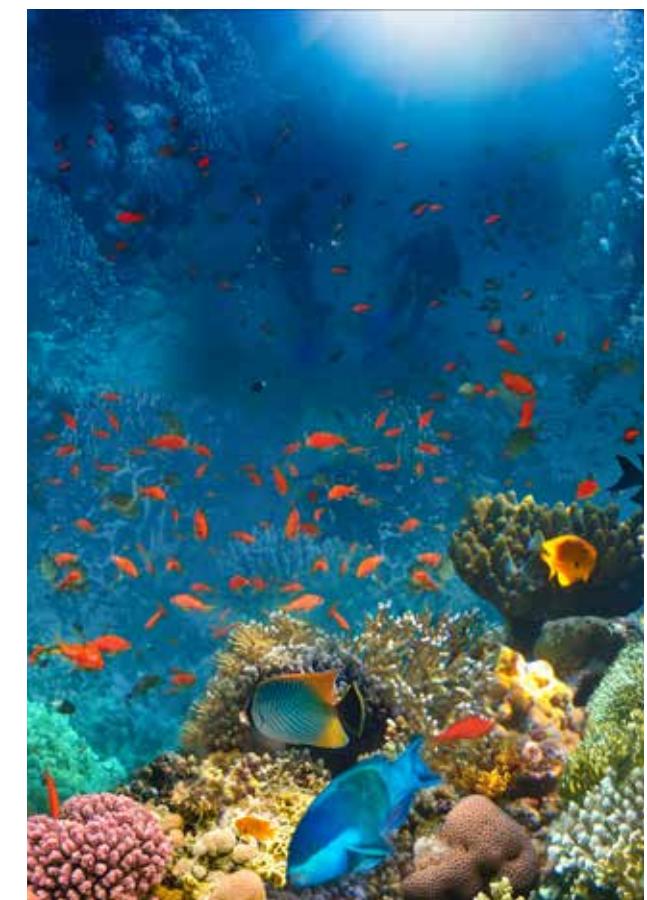
Phytoremediation

“The process of planting trees and other plants to clean up contaminated soil and water. Due to recent advances in plant microbiology, phytoremediation has increasingly become more cost-effective and feasible than traditional remediation approaches for a wide range of polluted sites, while providing communities with the host of co-benefits inherently offered by trees—shade, carbon sequestration, watershed health, and habitat for wildlife”

Use of natural materials for cleaning and housekeeping:

Replacing harmful cleaning chemicals with natural materials reduces the flow of toxic waste into wastewater. Seepage of toxic substances into water streams kills organisms which are essential for maintaining the natural ecosystem while also making it unsafe for consumption. The conventional chemical substances have a terrible impact on our waterways, air quality, soil health, and wildlife habitats.

“Protection of freshwater and saltwater organisms is crucial for maintenance of healthy ecosystems. This is achieved through use of chemical free/natural cleansing agents for upkeep”



KEY CLIMATE ACTION TARGET

#12 PRESERVE & IMPROVE BIODIVERSITY

AFFORESTATION

The Arabian Peninsula is an arid zone

The government aims to plant 10 billion trees in Saudi Arabia and 40 billion in the Middle East and eliminate more than 130 million tons of carbon emissions in the Arab country, reducing it by more than 60% in the region. The launched projects provide for the restoring 40 million hectares of degraded land in Saudi Arabia and 200 million in the Middle East.

Trees play an important role in creating safer, healthier, and more connected communities. Cleaning the air, filtering water, and protecting soil from run off while also providing shade and cooling our homes.

Healthy forests are critical to conserving some of the complex ecosystems of the planet by supporting the habitats of wildlife and aquatic life and keeping the waterways healthy.

An average homeowner can save up to 20% on energy bills but just having the right trees in the right place. Trees improve air quality, protect soil from runoff, sequester carbon and many more

In one year, an acre of mature trees absorbs the amount of CO₂ produced by a car driven 26,000 miles i.e., 48 pounds before releasing Oxygen in exchange.

A concerted effort to create forests through Afforestation is one of the primary goals of Climate Hub. It helps in Carbon Capture by reduction of atmospheric CO₂ resulting in conducive habitats for wildlife, improving water quality, enhancing soil health, and creating natural wind breaks.

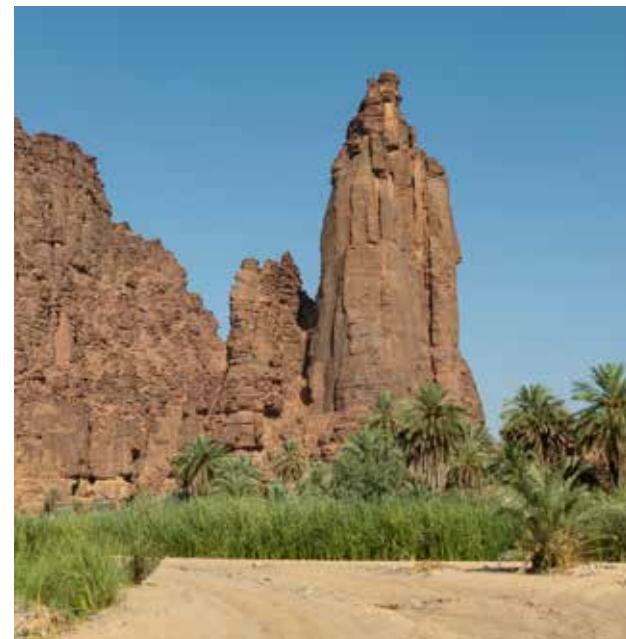
Reforestation will be done in places where the trees have been damaged or dead due to natural calamities or man-made disasters.

Plantation of native trees, such as, *Acacia tortilis*, *Maerua*

crassifolia, *Moringa peregrina*, *Ziziphus spina-christi*, *Hyphaene thebaica*, and *Vachellia seyal* would be key to the success of Climate Hub at NEOM

For e.g., *Acacia tortilis*, commonly called the Umbrella thorn is an important species for rehabilitation of degraded arid land; it tolerates drought, wind, salinity and a wide range of soil types, and has the additional benefit of fixing nitrogen, an essential plant nutrient, in the soil via its interaction with symbiotic root bacteria.

“ NEOM Climate Hub has the potential to sequester 250 tons of Carbon annually through afforestation activities ”



KEY CLIMATE ACTION TARGET

#13 CARBON SEQUESTRATION

Climate Hub aims to plant a minimum of 30,000 plants in Neom which would sequester approximately 250 tons to CO₂ annually.

Heat from the earth is trapped in the atmosphere due to high levels of carbon dioxide (CO₂) and other heat-trapping gases that prohibit it from releasing the heat into space. This creates a phenomenon known today as the “greenhouse effect.”

Trees help by removing (sequestering) CO₂ from the atmosphere during photosynthesis to form carbohydrates that are used in plant structure/function and return oxygen back into the atmosphere as a byproduct. Roughly half of the greenhouse effect is caused by CO₂. Therefore, trees act as carbon sinks, alleviating the greenhouse effect.

On average, one acre of new forest can sequester about 2.5 tons of carbon annually. Young trees absorb CO₂ at a rate of 13 pounds per tree each year. Trees reach their most productive stage of carbon storage at about 10 years at which point they are estimated to absorb 48 pounds of CO₂ per year. At that rate, they release enough oxygen back into the atmosphere to support two human beings. Planting 100 million trees could reduce an estimated 18 million tons of carbon per year and consequently save American consumers \$4 billion each year on utility bills

There are certain methods employed to improve carbon sequestration, they are,

» **Plantation of shrubs/cover crops, Improved plantations:** Shrubs are a necessary part of landscape for carbon sequestration. Carbon sequestration opportunities in croplands include the use of cover crops and improved cropland nutrient management. Cover crops, grown when fields are normally bare, provide additional carbon inputs to soils. Use of cover crops such as corn, soy, wheat, rice, and cotton

» **Reforestation & Urban Reforestation & Natural Forest Management:** Additional carbon sequestration in above- and belowground biomass and soils gained by converting non-forest to forest.

- » Biochar
- » Alley Cropping
- » Cropland nutrient management
- » Improved manure management
- » Windbreaks
- » Grazing optimization
- » Grassland restoration
- » Peatland restoration
- » Avoided seagrass loss
- » Seagrass restoration

Maximum carbon sequestration occurs when multiple species of plants with similar cultural needs form a community with each other, with other organisms, and with the living soil micro climate in which they grow. The complex ecological relationships and interactions among these community members literally create and maintain the conditions they themselves need to flourish. These interactions also enable short and long-term carbon sequestration.

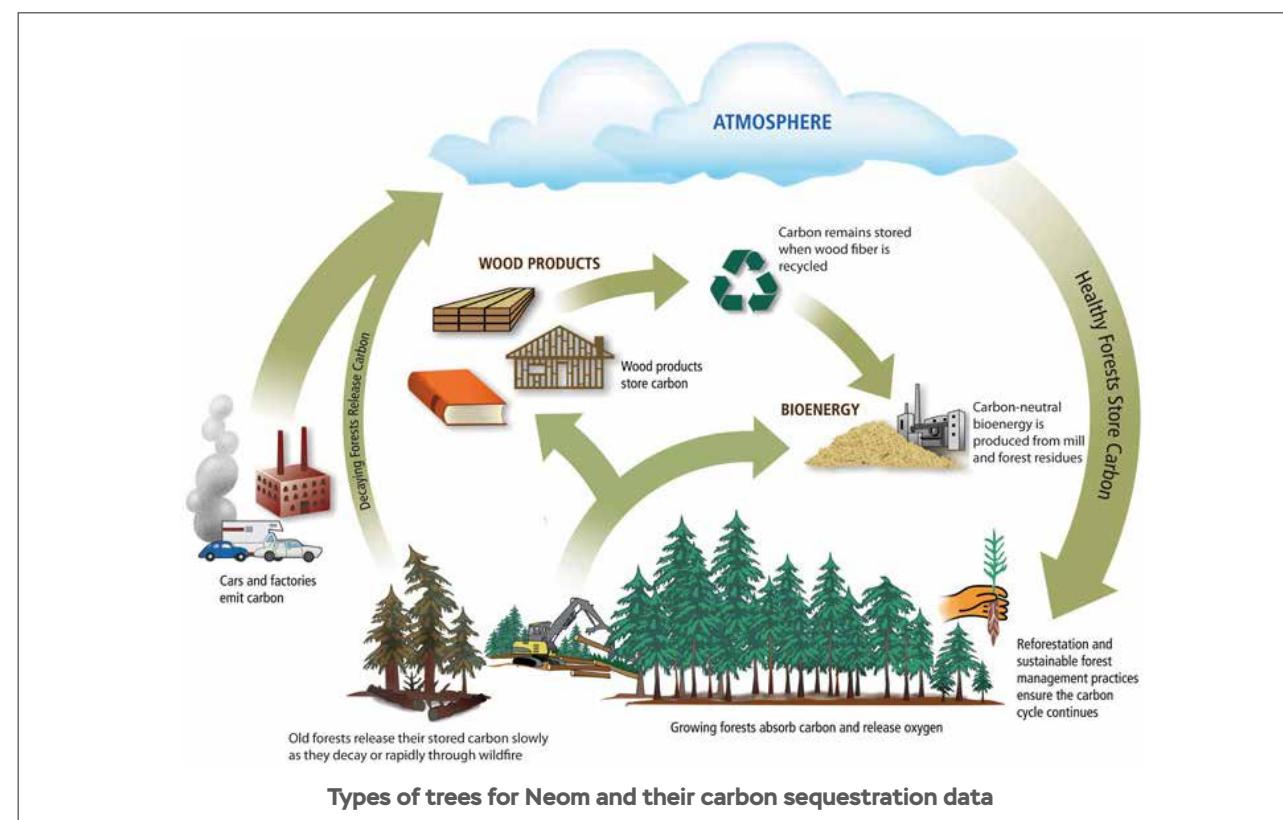
Crucial to carbon gardening is choosing plants with similar cultural requirements that suit the site and the existing soil and will not require high-carbon inputs such as synthetic fertilizer, weekly mowing, frequent edging and hedge trimming or the use of leaf blowers. Nor would a carbon-storing design call for conservation-inappropriate practices such as weekly watering, leaving soil bare through the winter, or growing water-dependent exotic ornamentals in arid regions.

CARBON SEQUESTRATION

Further, any plant mix should aim for at least 80% native plants. Every region has guilds of native plants—natural companions—that might be suitable for the soil and light conditions of the region's gardens. And if starting with an established garden, there is no need to rip everything out and start over. Careful assessment and thoughtful changes such as adding native trees and bushes and surrounding them with a mixed understory/groundcover of low-growing perennials—a living mulch—so they can

form a community, rather than isolating them in mulch islands, will improve carbon sequestration remarkably soon, though sequestering significant amounts of carbon is not a quick, do-and-done project. While soil will start improving rapidly near the surface, the downward percolation of soluble organic matter and its conversion to stable soil carbon takes longer; but this is what we should strive for.

“ Mix of native plants with their natural companions/low growing perennials form a community that is suggested to improve Carbon Sequestration ”



CARBON SEQUESTRATION



Vachellia tortilis, widely known as Acacia tortilis but now attributed to the genus Vachellia, is the umbrella thorn acacia, also known as umbrella thorn and Israeli babool

The Umbrella thorn is also an important species for rehabilitation of degraded arid land; it tolerates drought, wind, salinity, and a wide range of soil types, and has the additional benefit of fixing nitrogen, an essential plant nutrient, in the soil via its interaction with symbiotic root bacteria.



Maerua crassifolia is a species of plant in the Capparaceae family. It is native to Africa, tropical Arabia, and Israel, but is disappearing from Egypt.



Moringa peregrina is a species of flowering plant in the family Moringaceae that is native to Arabian Peninsula Horn of Africa and Southern Sinai, Egypt and can be found throughout Arabia, Egypt and as far north as Syria. Moringa peregrina grows on rocky wadis and on cliffs in drier areas.



CARBON SEQUESTRATION

Ziziphus spina-christi, known as the Christ's thorn jujube, is an evergreen tree or plant native to northern and tropical Africa, Southern and Western Asia. It is native to the Levant, East Africa, Mesopotamia and some tropical countries.

In the Levant and wider Middle East it is called sidr (associated with the lote tree of the Quran) and is common in the Jordan Valley and around Jerusalem, as well as in the Hajar Mountains of the United Arab Emirates.

Hyphaene thebaica, with common names doum palm



“
Trees selected for NEOM
can grow in any soil
condition, thrive in hot
climates, hardy against
pests and diseases
while also being low on
maintenance ”

CARBON SEQUESTRATION

Vachellia seyal, the red acacia, known also as the shittah tree (the source of shittim wood), is a thorny, 6- to 10-m-high (20 to 30 ft) tree with a pale greenish or reddish bark. At the base of the 3-10 cm (1.2-3.9 in) feathery leaves, two straight, light grey thorns grow to 7-20 cm (2.8-7.9 in) long. The blossoms are displayed in round, bright yellow clusters about 1.5 cm (0.59 in) diameter.

In *Vachellia seyal* var. *fistula*, which is more common on heavy clay soils, some of the thorns are swollen and house symbiotic ants.

It is distributed from Egypt to Kenya and west Senegal. In the Sahara, it often grows in damp valleys. It is also found at wadis on the Arabian Peninsula.

Vachellia seyal is, along with other *Vachellias*, an important source for gum arabic, a natural polysaccharide, that exudes from damaged stems and solidifies.

Note: The data might differ after a complete on ground survey is conducted to understand local ecosystem and soil biology before determining the type of plantations suitable.



KEY CLIMATE ACTION TARGET #14 SOIL HEALTH

Fertility status of the soil can only be determined with an on-ground survey; however, based on the studies present for the region, it is determined that the soils are relatively low on organic carbon which is even an optimistic number for the area.

Soil pH hovers around neutral or above in the region controlled due to the presence of free calcium carbonate and is not limiting to plant growth, except where it is due to high soil salinity.

Soil patterns in the Arabian Peninsula are controlled by the interaction of climate, landforms, and geological parent materials. There is no shortage of good agricultural soils; the obvious limitation to put them into production is water availability. Where irrigation water is available, standard fertility management practices are required, and, if provided, will allow maintenance or enhancement of soil quality. Gypsiferous soils require careful irrigation management, but they can be made productive

Climate Hub employs soil conservation techniques involving the use to animal manure, soil from nearby creeks, and wet waste compost for soil fortification. Other techniques include,

a. Trenches across the slopes

b. Contour Bunding: Contour farming or Contour bunding is the farming practice of ploughing and/or planting across a slope following its contour lines. Contour bunding is a proven sustainable land management practice for marginal, sloping, and hilly land where the soil productivity is very low. It consists of narrow based trapezoidal bunds on contours to impound runoff water behind them so that it can gradually infiltrate into the soil for crop use. Spacing between two bunds is commonly expressed in terms

of the V.I. (Vertical interval) which is the difference in elevation between two similar points on two consecutive blinds.

c. Cover crops: Good ground cover by canopy protects the soil like an umbrella besides conserving soil moisture and minimizing soil erosion. These crops hold those soluble nutrients, which are lost by leaching. The advantage of legumes as cover crops is the addition of organic matter.

d. Mulching: Use of available plant residues as mulch reduces the soil loss considerably by protecting the soil from direct impact of rain and reducing sedimentation. A minimum plant residue cover of 30 per cent is necessarily carried with runoff. Vertical mulching to keep runoff and soil loss within the acceptable limits also reduces soil loss particularly by increasing infiltration.

“
Soil is relatively low on organic carbon hence, several proven soil fortification methods would be employed for improvement of soil ecosystems”

KEY CLIMATE ACTION TARGET #15 ECO HABITATS

The climate of the desert is arid, not tolerated by man, but the desert organisms can tolerate, and even have the ability to survive and evolve, because desert organisms were created with physical and biological characteristics to withstand the difficult conditions of the desert. In addition, these characteristics help them moderate the difficult conditions of hot and arid zones.

Hot and arid areas suffer from high temperatures, direct solar radiation, drought, and many difficult climatic conditions, where facades are the primary shield to face climatic conditions. Also, studies have shown that the heat gained through the walls is larger compared to the rest of the building envelope in the desert areas, due to direct sunlight falling on the walls during long periods of the day. Nevertheless, nature can inspire us with outstanding strategies to solve these problems in desert environment and consequently improving the thermal performance of the building, increasing human comfort and decreasing energy consumption in buildings. One of these strategies, is a self-shading strategy that exists in many desert organisms.



The self shading cactus:

In nature, one can also find smart examples of surface design that prevents overheating. One example is the Peruvian Torch Cactus (*Trichocereus peruvianus*). The cactus has developed cooling ribs that gives it a self shading surface. When sunlight hits one side of the rib it automatically shades the other side of it. A smart way of avoiding overheating!

Many studies have analyzed the ability of cactus to adapt to high temperatures and solar radiation. In addition, some studies mentioned that the cactus surface can provide 16% more shade than on a spherical surface. The cactus ribs affect in changing the cactus skin's thermal performance, through shading the exterior surface from sun rays. Cactus' ribs of surface could protect other parts from direct sunlight, this technique called self-shading.

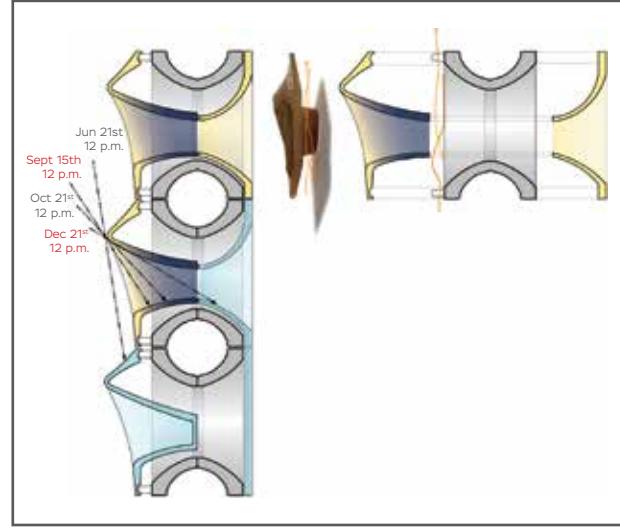
The self-shading of the walls reduces the temperature of the surface exposed to direct sunlight, thereby reducing the amount of heat transmitted through them. This feature presents a solution rendered by nature to reduce temperature in hot areas, the fact that inspires the possibility of reducing building temperature and thus reducing energy consumption used in cooling as the walls represent the largest area exposed to solar radiation, in order to improve the thermal performance inside buildings.

Habitats of Termite Settlements:

Termites that are spread in hot zones and forests of high temperate areas apply the self-shading concept efficiently in forming its habitat from the outside. The termite settlement looks like branched towers at a height reaching four meters. The mass of the termite settlement is differentiated by its prominent buttresses, which increase the space of its external

TYPOLOGY & AREA STATEMENTS

ECO HABITATS

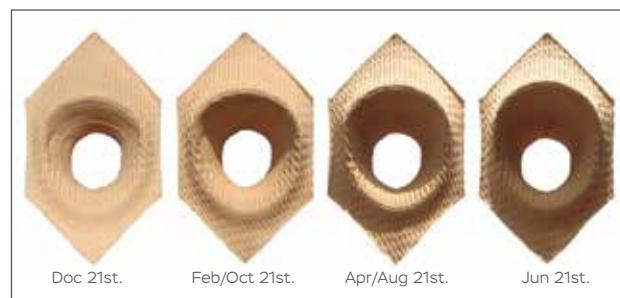


surfaces and support its stability. These buttresses help in creating shade on the surface and facilitate the cooling process by the movement of air on the settlement external surface.

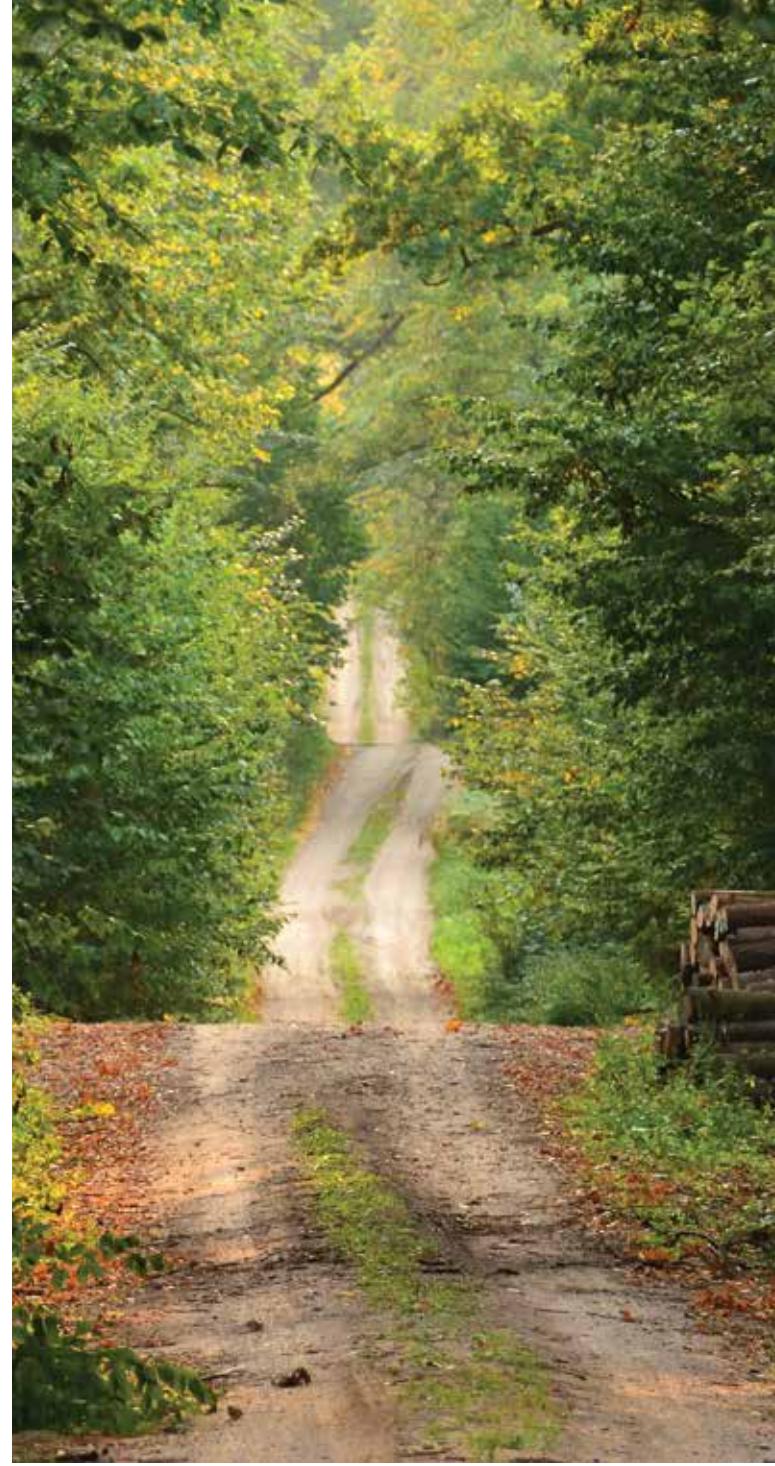
Optimum thermal performance in buildings in hot areas can be achieved by reducing heat gain, which in turn reduces cooling requirements and provides thermal comfort to the occupants.

Heat is transferred from air to the building walls by convective which is created by temperature differences between the wall and air surround the building. The layer near the surface of the wall is different, where heat is transmitted by conduction through layers of air moving parallel to the wall, beside some convection.

Both cacti and termite respond to solar radiation as the primary thermal gain, and secondly to convective thermal gain. As termites construct their mounds in response to radiation and convection, we can develop high performance masonry units that are responsive to climatic fluctuations.



Prototype of face tile. Over the course of the year the face tile either shades itself or receives full sun.



“ Taking inspiration from desert organisms like self shading cactus and termite hills, NEOM Climate Hub employs techniques that ensure better protection from heat and optimization of energy ”

TYPОLOGY & AREA STATEMENTS

RESIDENTIAL		COMMERCIAL	
500 Acres	Luxury Climate Homes 100 Homes with each plot of 5 acres & Built up Area of 10,000 sft	100 Acres	Responsible Enterprise 10 units with each Built up Area of 1,00,000 sft
400 Acres	Aspirational Climate Homes 200 Homes with each plot of 2 acres & Built up Area of 6,000 sft	30 Acres	Responsible Small & Medium Enterprise 10 units with each Built up Area of 30,000 sft
50 Acres	Eco Townhomes G+3 Town houses with 400 Homes & Built up Area of 2,500 sft	20 Acres	Shopping Streets & FPO Exports 20 acres & Built up Area of 50,000 sft
SPORTS		HEALTH & WELLNESS	
200 Acres	Entertainment & Sports Village 200 acres & 1,00,000 sft Built up area	100 Acres	Eco Resorts & Cafeteria 100 acres & Built up Area of 1,00,000 sft
EDUCATION		Eco Hospital & Wellness	
20 Acres	Green School 20 acres & 30,000 sft Built up area	50 Acres	50 acres & Built up Area of 1,00,000 sft

TYPОLOGY & AREA STATEMENTS

Wellness is a salutogenic and proactive approach, focused on prevention, healthy lifestyles and the pursuit of optimal wellbeing. Ultimately, a solid foundation for wellness helps us prevent and overcome disease, both at present and in the future. Wellness is an active process of growth and change to reach your fullest health and well-being. It is associated with actively pursuing activities, making choices and lifestyle changes, controlling risk factors that can harm a person, focusing on nutrition, having a balanced diet, and following spiritual practices that lead to holistic health. Lack of physical activity (25% of adults and 80%

of adolescents) makes a huge impact on health expenditures and lost productivity costing over \$67.5 billion each year. There is more awareness being brought to mental health. Rightfully so, as depression, a leading cause of illness and disability, increased 18% from 2000-2015 worldwide. There should be no more evidence needed to understand that our home should be considered an extension of our self-investment regarding wellness.

The design, construction, facilities, amenities, and services in the Climate Hub are planned to address and enhance individual wellness across all dimensions.



RELATIVE IMAGERY - HOUSING



LIGHT

The prayer room is placed in the southern corner of the house and experiences a constant change in its lighting. One experiences a dramatic play of light as the lighting quality of this space keeps altering throughout the day due to the shadow cast by the skylight with the wooden pergola above it.



EARTH

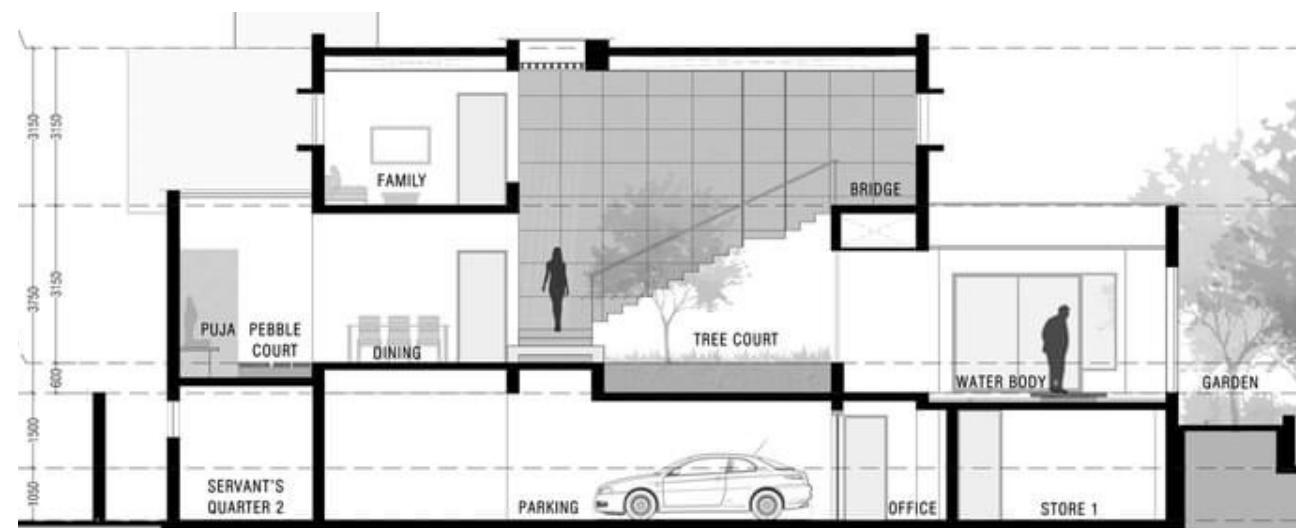
Earth being the only element connected to our five senses. It is considered as an important element of Vastu. The double-height central courtyard is the heart of this residence which is embellished with lush green flora. The Green space is not limited to the exteriors of the building only but also dominates the spatial structure of the interior layout.



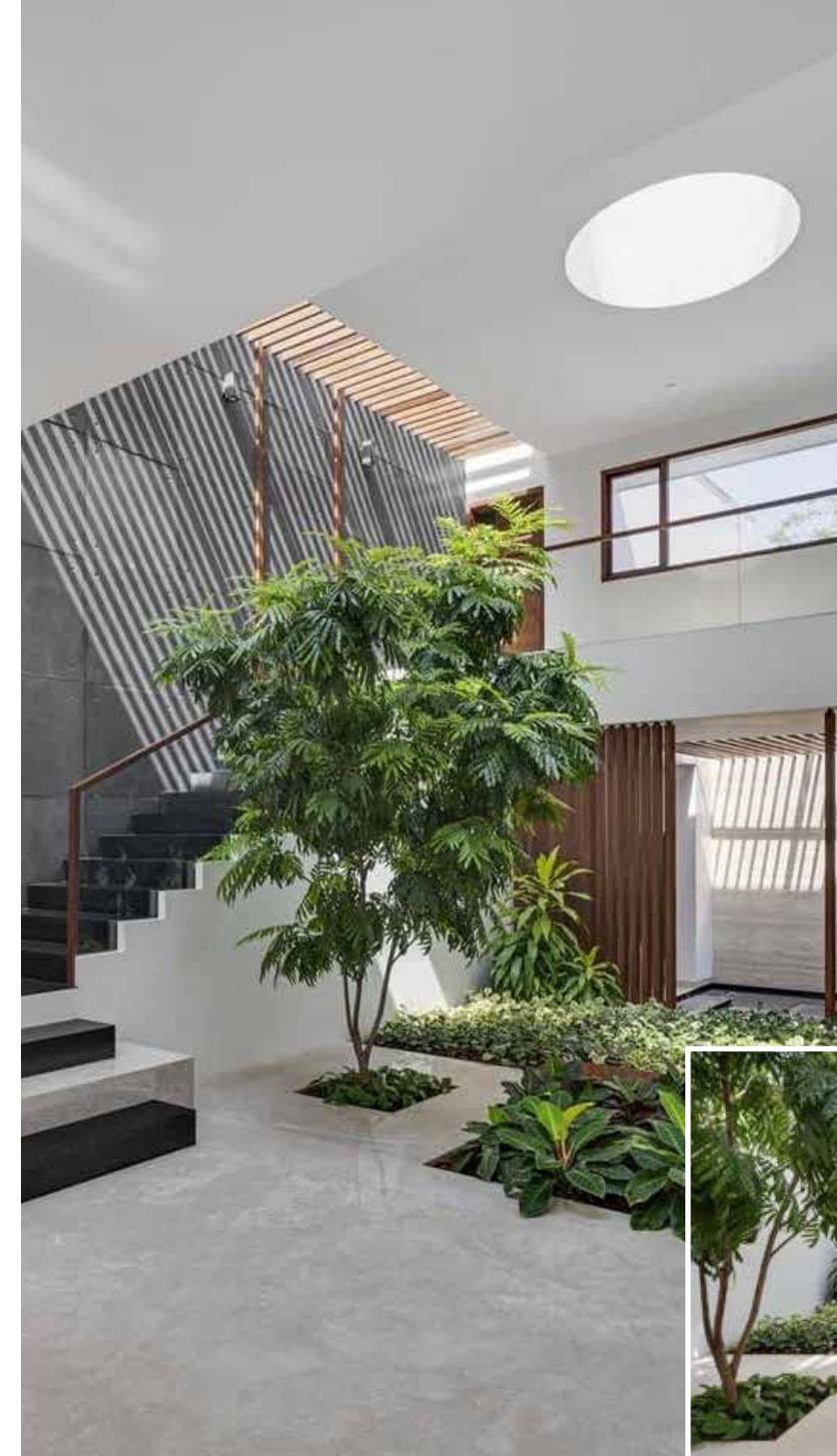
WATER

Water has long been celebrated icon of purity and peace. While it has traditionally been associated with magical outdoor settings, its harmonious effects inside the home can cast a spell of equal proportion.

Here a long, gleaming waterbody acts as a pause point before one explores the other spaces. The jet-black stepping stones highlight it as the focal point against the pure white and travertine cladded walls.



LUXURY CLIMATE HOMES



“The project promotes wellness through all inclusive living”

ASPIRATIONAL CLIMATE HOMES

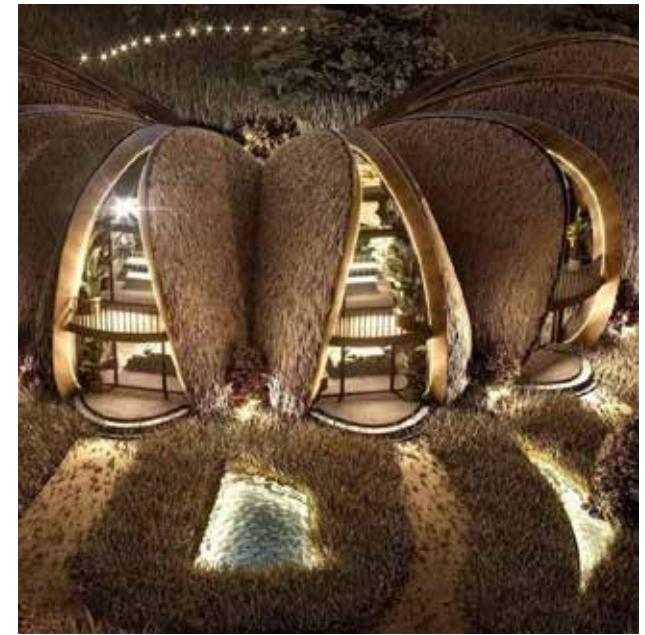
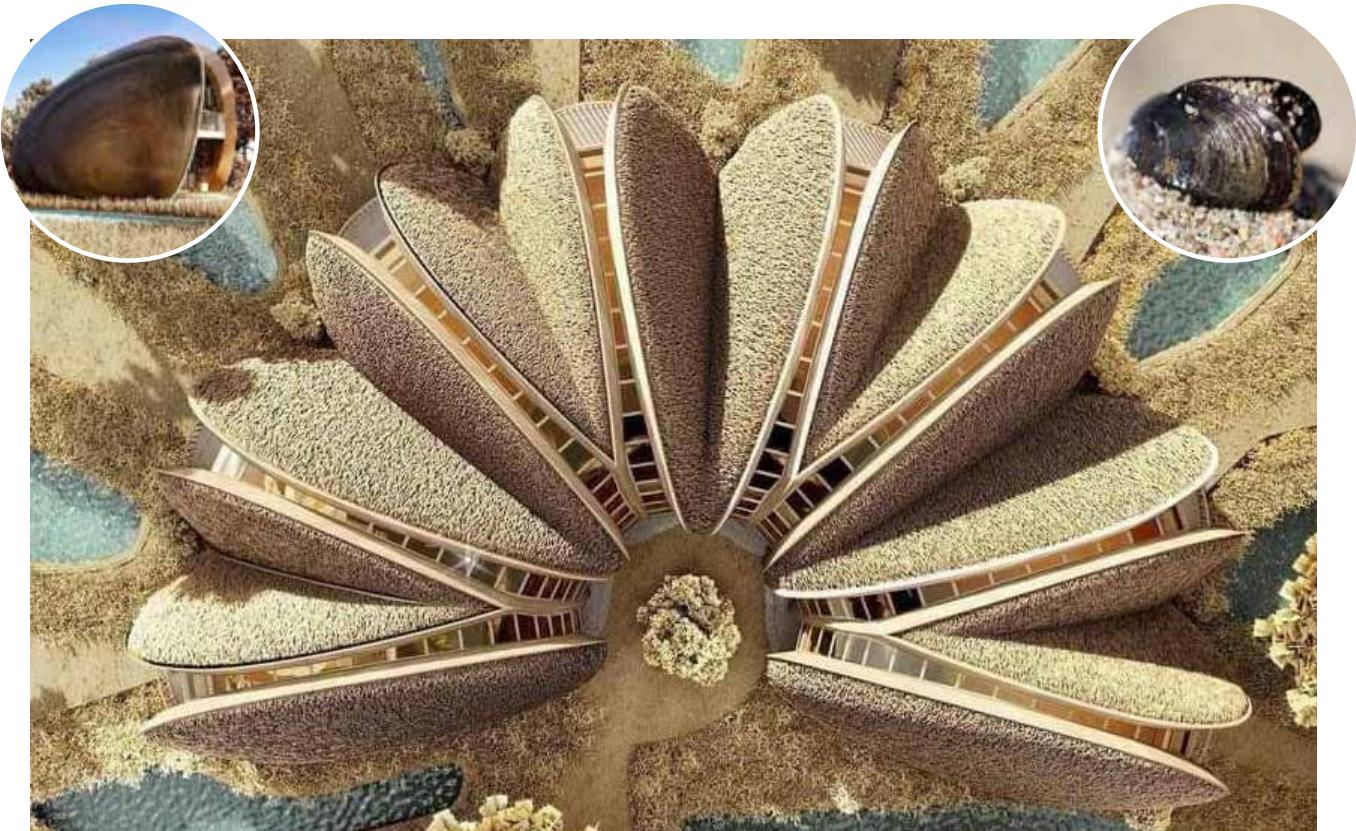


ASPIRATIONAL CLIMATE HOMES



“The architecture of homes in harmony with regional elements—like roomy, muted landscapes, sprawling rock formations and harsh climates—to capture the essence of the desert’s quietude, seclusion, and grand beauty”

RELATIVE IMAGERY - ECO RESORTS & WELLNESS

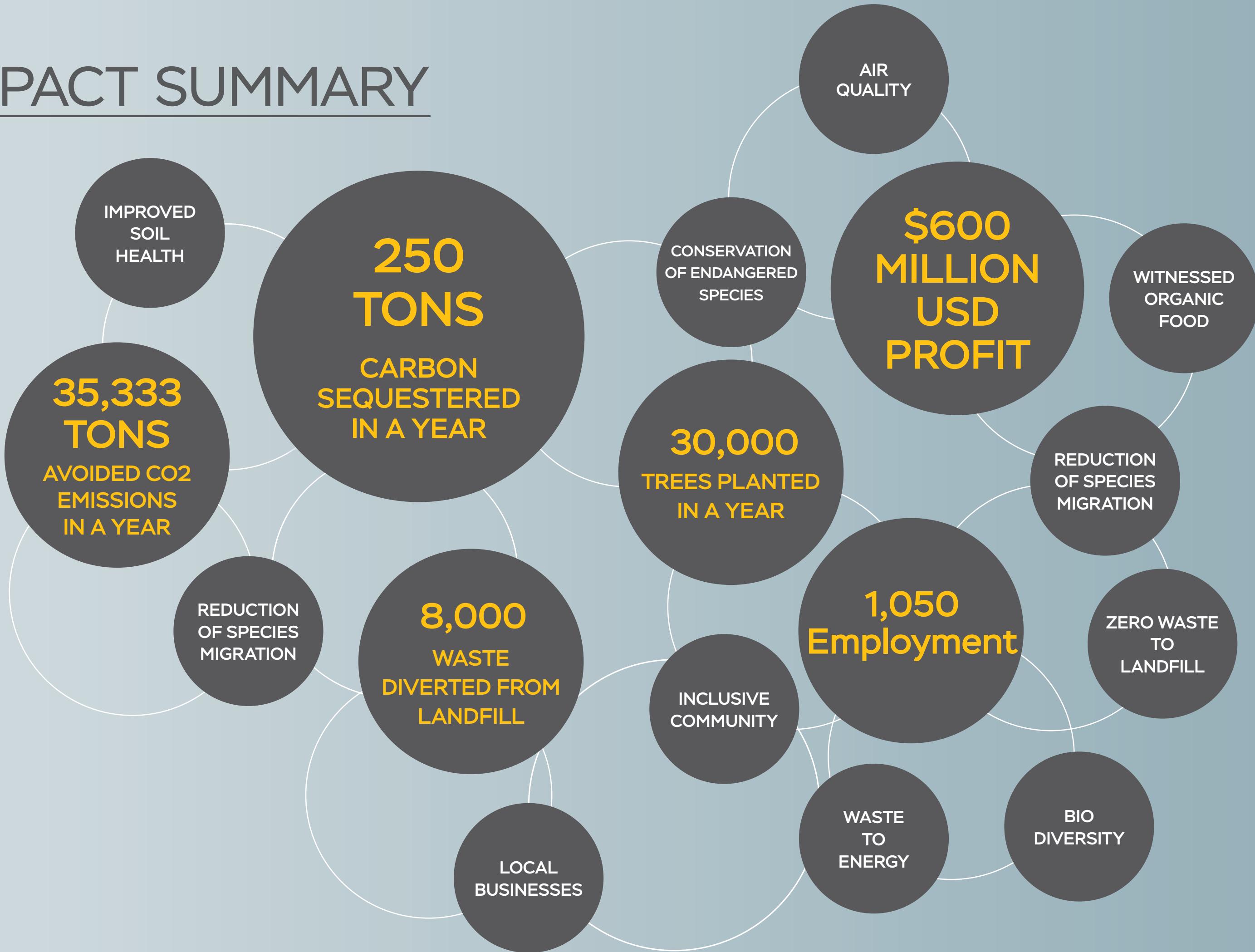


RELATIVE IMAGERY - DESERT CAMPING



“Studies have shown that one night spent in the desert will reset the body’s clock. Deserts are unique, beautiful places unlike any other geologic feature making it the most desirable as a camping destination”

IMPACT SUMMARY



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“ We do not inherit the earth from our ancestors;
We borrow it from our children ”
- David R. Brower

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