
No
Solid
Ground
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No Solid Ground

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Content

Abstract

Nature has been the first designer on this Earth, adjusting and reshaping the environment to its needs. Over time, humans have taken over this design process, using nature's design tools and developed them even further to adjust nature to their needs and imagination. Lately, the human impact on Earth is transforming the landscape through desertification and rising sea water so drastically that the consequences will force humans out of their homes and on the move to find new places to call their home. What if the answer to prevent all of this from happening lays in nature's design and we just need to understand how to embrace it?

Based on the analysis of the two case studies of the island Sylt in Germany and Kolmanskop in the Namib Desert in Namibia, this thesis is an attempt to question the way we are building in times of climate change, to create awareness about this urgent topic and to suggest how we as humans can build in unison with nature instead of fighting against it.

Introduction

Visiting the Isle of Sylt for the first time, I was driving all the way up to Northern Germany and boarding the car train for the remaining part of this long journey. The train made its way past dykes and wetlands. Leaving the small town of Niebüll on the main land, the narrow train tracks became one with the water, leading to the island which took me back in time with its romantic little houses and their huge thatched roofs, enchanted gardens and old timers parked in the driveways.
Ever since, these journeys to the northern-most island of Germany have always been fascinating. With the island feeling so familiar, almost like coming home, a seemingly endless amount of travelers proudly keep showing off their Sylt-shaped bumper stickers on the cars, a symbol of their owners' bond with the island for all those well-spent summers at the local beaches in the past decades.

Sylt is very well known for the distinctive shape of its shoreline, and especially to tourists, has become famous for its kilometer-long sand beaches. Each year, an increasing number of new visitors get in line to board the car train together with the loyal island lovers who feel as if they had spent their whole childhood between the dunes of List and Hörnum.

How would those devoted „half-islanders" react to news stating that, in the future, their favorite North Sea island may not be the same due to climate change, and that their bumper stickers with their beloved and distinct shoreline may be outdated soon?

Research shows that the shape of Sylt has been shifting for the past 125.000 years. It went from being part of the mainland to becoming an island. Since Sylt has nowadays turned into such a visitors' hotspot, everybody insists on being able to take a seat in one of those blue and white-striped beach chairs which have become such a

popular symbol of the island. The residents of Sylt as well as the Republic of Germany itself started advertising and praising the island as a scenic dream to tourists, and this dream needs to prevail, not shift.
Therefore, Sylt is kept in a man-made time capsule which is supposed to resemble to the good old days: The iconic nature with its wetlands and shorelines is kept the same while the beaches are being flushed with sand from the ocean to keep the familiar silhouette. In times of climate change, the islander's fate in nature's design became brittle. Hence, nature will have to be improved to ensure that Sylt will remain above sea level even though the water around it is rising.
The environmental engineers and designers' chosen tool to preserve the shape of Sylt is sand. Sand is part of every product, every process and everything built on that land, thus it is an integrated part of the island's DNA.

Experts say that even considering the climate changes as well as the rising sea levels, the current generations will not experience the sinking of the island. Sylt and its visitors are facing uncertain times though, not knowing if their favorite beach will still be the same the next summer they return.

Climate change is not just affecting favorite local beaches but entire shorelines, food supplies, towns, and homes due to rising sea levels and intense droughts which leads to the desertification of giant territories. We may not feel the effects of climate change today as we sit in our beach chairs and gaze at the calm ocean of the North Sea, but elsewhere in the world people are already affected by its consequences. Over time, these consequences will spill over to the now safe North Sea Island of Sylt.

A country that has been massively suffering from these effects and already today is experiencing the indirect consequences of the climate change is Syria. The Syrian civil war was ignited by many factors, one of them being the tremendous drought that preceded the outbreak of the war. It resulted in many people leaving their homes in the arid areas of the countryside to move to the cities. Rather than helping with local aid, the Assad regime responded with cuts in support services, fueling the rebelliousness which then resulted in a war (H.Welzer, 2018), leading to even more Syrians leaving their country to escape the war and start over a new life in safety abroad, for example in Germany.

A designer might not be able to have a significant positive influence, for the better, on the climate change, but could help adapt to its consequences through architecture. The current way of building is based on the belief that buildings will stay in the same space for 50 to 70 years (K.Olthuis, 2014). It is not taken into account, though, that our surroundings are changing throughout this time span and that the ground we are building on is not solid anymore, neither physically nor metaphorically. Stiff buildings, resting on concrete layers which try to anchor themselves on a shifting ground, are created. Those buildings will end up being evicted by nature if the way of building is not re-designed.

Nature has been a successful designer for far longer than human mankind, using elements such as sand, wind and water like its tools and helpers to its design versus considering them as enemies. Humans need to start working with nature's tools to design a new typology and create an architecture which is not trying to restrain nature but is able to move with it.

In order to use nature's design tools, the ground we are building on, with all of the changes it will go through in the future, needs to be understood first.

The recent climate reports offer an overview of the challenges nature and therefore architecture will face in the future. Due to climbing average temperatures around the world, glaciers and sea ice keep melting, which results in rising sea levels. Nowadays, strong floods, leaving whole neighborhoods and people's homes under water, are being experienced in cities such as Miami and Katmandu, but also in Westerland on the island of Sylt, all located close to the coastlines. By the end of the century, the sea levels will have risen between 26 and 82 centimeters, or even more, and put the majority of the world's biggest cities located on the waterfront in danger (K. Olthuis, 2014). Besides resulting in sea level rises, the increase in temperatures will also lead to extreme weather shifts, affecting other parts of the world as well. Arid regions will experience stronger, long-lasting droughts and hurricanes which will lead to the desertification of huge parts of land, turning them into fruitless deserts. People in these areas will experience the loss of crops, shortage of drinking water as well as an increase in wild fires which will evict them from their homes and will set them on the move to find shelter in the already overcrowded and endangered cities on the waterfront. Thus, climate change is slowly evicting houses and whole neighborhoods

through rising sea levels, floods and erosion while also destroying inhabited areas in arid regions inland through droughts, hurricanes and moving sand dunes. Instead of offering shelter, today's architecture is failing and will continue to fail as it is not able to adapt to those changes. Today's construction will become the ruins of the future, creating temporary zones which will be inhabitable just for a limited period of time. Only if architecture accomplishes to become flexible and move with the changes of the climate instead of holding against it stubbornly, can it offer safety in times of change.

Looking at the recent climate reports, one could think that the world is transforming faster than ever before. But instead, nature has been changing and redesigning our environment since the beginning of time, always using the elements as its tools to create new spaces.

Sylt

In the case of Sylt, nature chose to use sand as its tool to design the space, and together with wind and water, it is grinding down layers of the island's earth, with every storm tide smoothing out bumps along its coast line. Long before Sylt appeared on a map for the first time as „Isola Syltae" more than 1.000 years ago (E.Klatt, 2012), the island was redesigned over and over again through nature. Simulated maps indicate that around 1.300 BC, Sylt was not one big piece of land which was slowly sanded down by nature over time into today's shape, but that instead nature's strong forces must have pressed a group of several individual islands together (Figure 01), separating them from the mainland and designing them into two big islands (Figure 02). Villages which used to be divided from each other by the sea, were now only a walk over dry land apart. But at that point in time, Sylt was still shaped way differently from the actual shape that people today recognize in a heart beat. Maps dating back to 1662 show the island for the first time as one in the T-shape which we know today (Figure 05). It can be assumed that the map is not accurate in details, but the general shape of Sylt known today was documented here for the first time after the former two islands had been embanked by humans a few hundred years prior. Over time, the strong currents of the North Sea continued designing the island in the West, thinning out the axis of Sylt from North to South, elongating it more and more. The erosion from this process was then used to further advance the growth of the Wadden Sea in the East, sand sedimenting in the area and the land growing steadily over the years until it was able to keep itself over water during strong storm tides (Figure 14).

Nature was designing well: With the West coast as the weather side of the island, each strong storm tide hit this part of the island the hardest. The East was barely affected by these winds due to its advantageous positioning in the lower laying part of the island and behind the Geests

which, as highpoints of the island, also acted as wind breakers. Every strong storm tide hitting the West coast of the island meant new material for the East, slowly piling up sand and building new land. While the sea was eating away some layers of earth, a thick layer of marsh acted more like a sponge. Instead of eroding this layer of earth, the water was only absorbed by the ground, which made the marsh aggregate and rise over the water.

Nature was not the only designer on the island anymore. After loosing several villages such as Eidum and Bydum during storm tides hitting the Western part of Sylt and sand-drift burying the provincial towns of Alt-List and Alt-Rantum, islanders understood that the safest place to inhabit was the highpoint of the island, the so called Geest. Even though they had not recognized yet how the marsh land of the Wadden Sea was rising with the water, and how to use this circumstance as a design tool for their homes, they had already understood that this area of the island provided shelter from the west winds and the storm tides. The Wadden Sea was located on the lower part of the island, only partly above sea level. Hence, they began building their houses on top of man-made Geests, artificial piles of clay to secure their homes against rising sea levels. This was the first cut into nature's design on the island. The villages started growing and soon the sparse landscape was not able to provide enough food for all inhabitants anymore. Humans decided to design the island further by altering its appearance through dykes around the Wadden Sea which would prevent the area from being flooded on a regular base and were supposed to turn the moist ground into useful agricultural land. This meant only a short-term solution, though. It provided the islanders with additional fruitful space to generate food while, at the same time, cutting off the steadily growing Wadden Sea from its nurturing current coming from the West Coast of the island as well as from the sea current which used to help rise the marsh land irrupting the ground. As a result of this interference, the whole area began sinking gradually over the years, leaving it underneath sea level today.

The dykes, as man-made activators of this vicious cycle, are now the sole protectors making sure the water is not reclaiming this undernourished part of the island. Once this cycle was put in motion, there was no way out of it.

Numerous other consequences regarding the change in design of the island were to follow.

Strong storm tides were still hitting the island

every winter, making the cliffs in the West decline constantly. With the installation of the dykes, though, the erosion of the cliff missed its purpose of continuing to nourish the Wadden Sea.
The sand was just passing the West of the island while being transported onward into the ocean which began creating sandbanks in the sea. Simultaneously, humans started construction on the cliffs for its good view over the ocean. With the permanent natural decline of the cliff, the ground underneath those houses was being eroded with every tide, eventually threatening the houses to fall into the sea (Figure 16). As a countermeasure, the islanders began building so-called Buhnen into the sea to hold on to the shoreline in the West, hoping to protect the endangered houses built too close to the cliff (Figure 20). These man-made design tools, in addition to the dykes, were supposed to keep Sylt in a strong corset to prevent the island from shifting more with nature. It worked only for a short period of time and worsened the situation over the years. Instead of keeping the sand in place, the Buhnen eroded the beaches and cliffs even faster that nature had done before. The remains not only became a huge danger for tourists while swimming and surfing but also an ugly sign of human failure in Sylt's coastal preservation (Figure 21). In their misery of preventing the island from eroding any further, the islanders and the government tried adapting new design tools which had worked previously on similar beaches during storm tides in France.
They began covering their beaches with huge piles of concrete tetrapod barriers (Figure 22), but didn't consider that this design was only working on the unique pebbly shoreline of the French beach and not on the sandy beaches of Sylt. Instead of keeping the sand on the beach, the water was getting into the gaps between the tetrapod barriers. The sand was swept away and the concrete monsters dug themselves deep into the layers of the island (Figure 23). The islanders stopped using tetrapod barriers as a tool to protect the coast when the disaster reached its peak: The current of a particularly strong storm washed away whole concrete barriers, pushing them into a protective wall which led to flooding the whole city center of Westerland.

After this long-lasting fight against the storm tides, the islanders gave in to the erosion of their coastline. Instead, they began collecting the sand which had previously been washed away during storm tides by means of dredgers in order to put the sand back onto their beaches. This process of beach renourishment was introduced in 1972 as a

new human design tool and has been conducted each year ever since to compensate for the island's loss through erosion (Figure 24).

So far, the above mentioned technique has been the only flexible human design tool to keep the island's shape and it can even be adapted in case the beaches lose more sand than usual during one storm season. While experiencing weak winds, sand dredging can even slow down Sylt's sand loss with fordunes which were shaped over time from windblown dispersal over the island, while nurturing these dune chains even further (Figure 25).

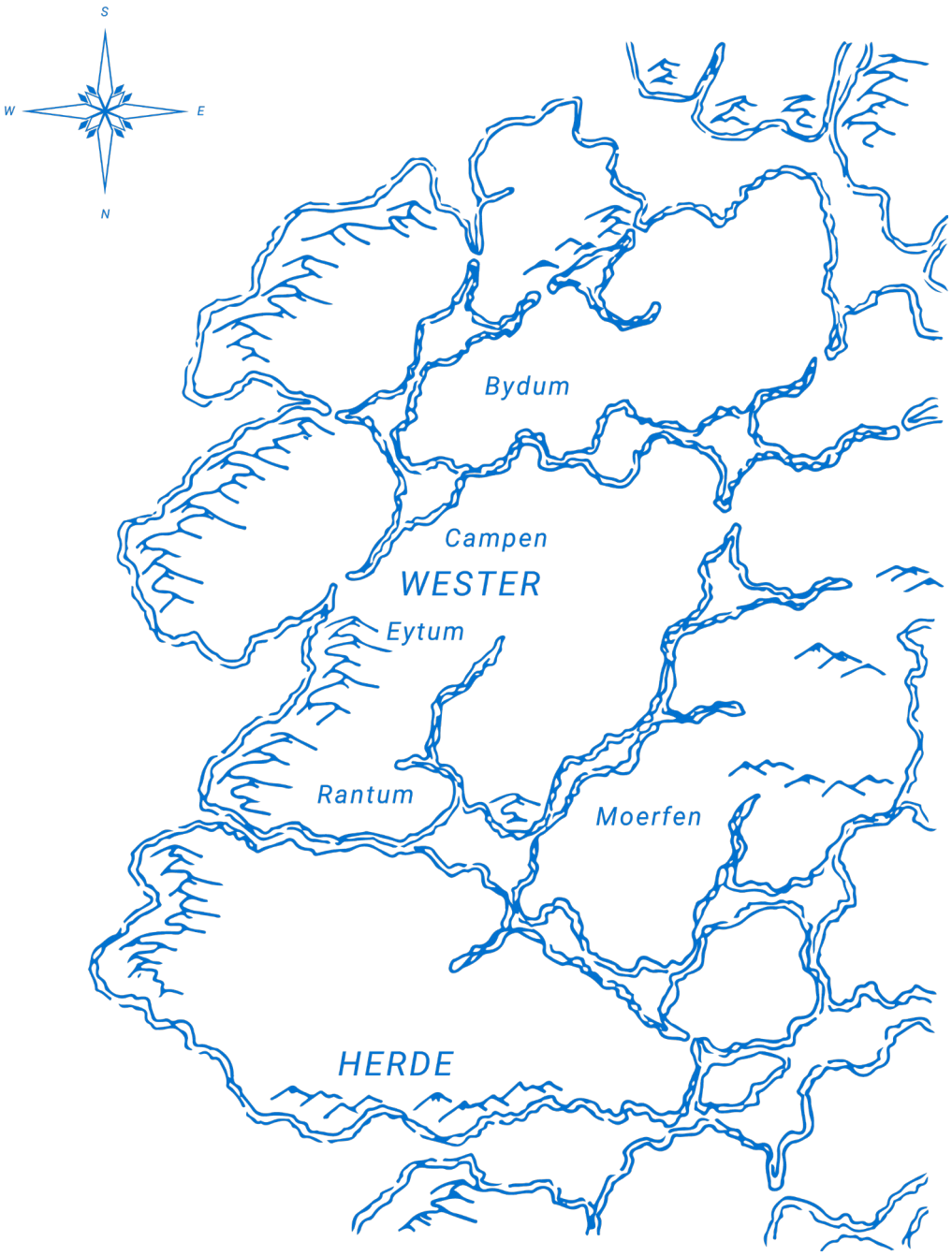
Humans are learning from nature by recreating and accelerating one of its processes of supplying sand for the beaches. Later on, this process is again handed over to nature to create natural dunes which will weaken the storm tides hitting the island. This natural consequence of the teamwork between human sand flushing and nature's distribution of sand leads to additional problems on the island. The newly created dunes need space to move. Sylt, though, being a luxury resort attracting more and more visitors every year, has no such thing as space. There is only building ground available.

This is why the city started handing out permits to build new hotels, restaurants and housing for tourists, their construction cutting into the natural movement of the dunes. To stop the movement of the sand once and for all, and to prevent the newly-built houses from being buried underneath the shifting masses, the islanders stabilized the dunes with deep-rooting sand-sedge and pines. But the plants' need for water dried up the dunes even further. This makes it easier for the wind to pick up the grains and spread them further across the island. The stabilized dunes stay behind, slowly being stripped away by the wind and unable to move (Figure 26).

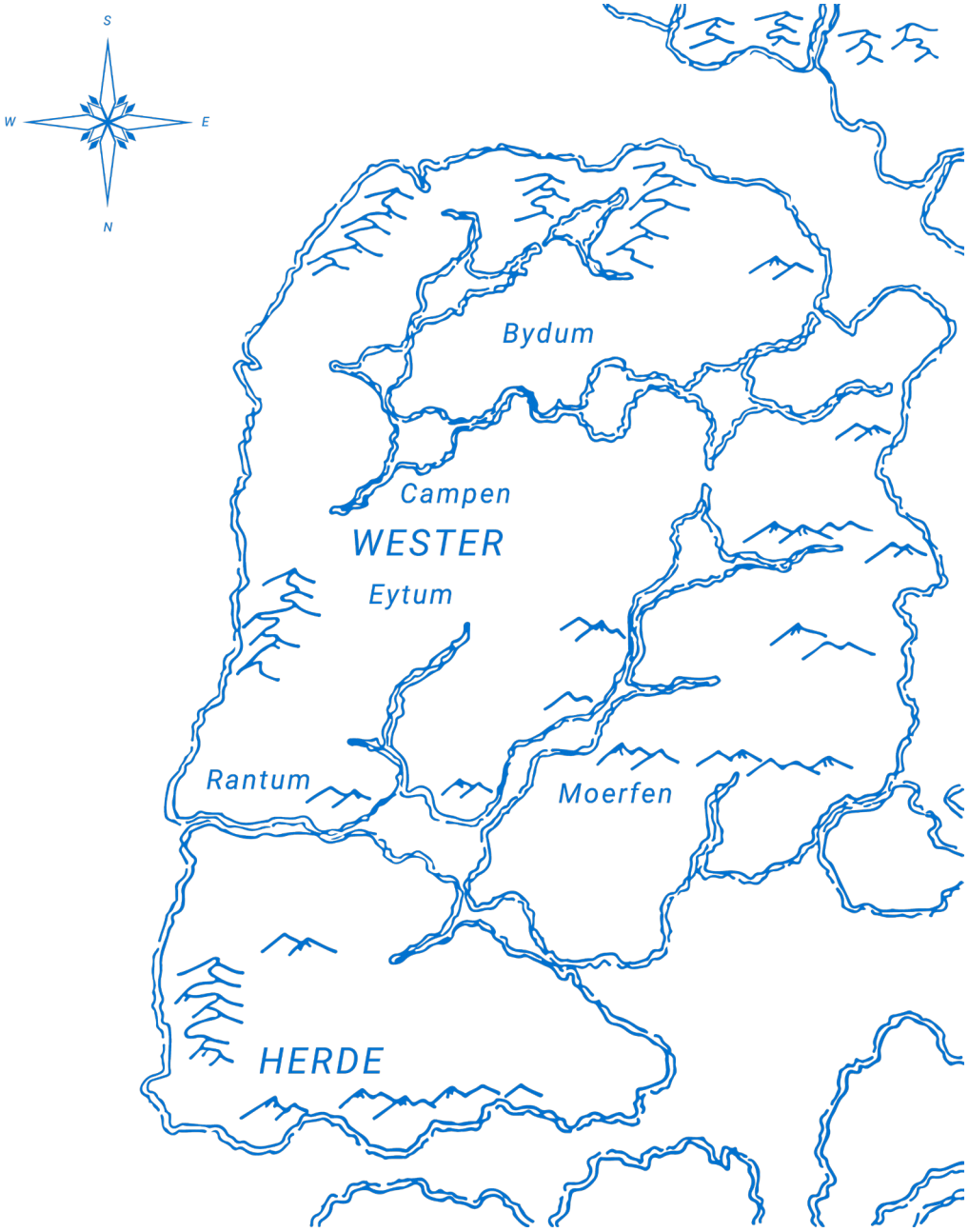
Architecture can learn from the design tools nature is using in Sylt. Looking at the island as one organism, it is eroding in the West to further grow in the East, which leads to a movement of the whole island towards the East and closer to the mainland. While moving with it, the marsh land in the East is further absorbing water to hold the island over water and rise with the sea level, functioning almost like a life jacket to prevent the island from drowning in the sea.

A look into the future shows that the island will keep eroding and the cliffs will continue to break off. The sand flushing, if continued, will only be able to slow down the reduction of the Geest area, but never stop it permanently and it needs

to be kept alive. The reinforcement of the dykes is necessary, otherwise there is a threat of the marshes flooding and the island being divided into a West Sylt and an East Sylt. If all these measures are taken, Sylt will continue to break the waves off the coast as an undivided island even in the centuries to come, but it will continue to change (E.Klatt, 2013).

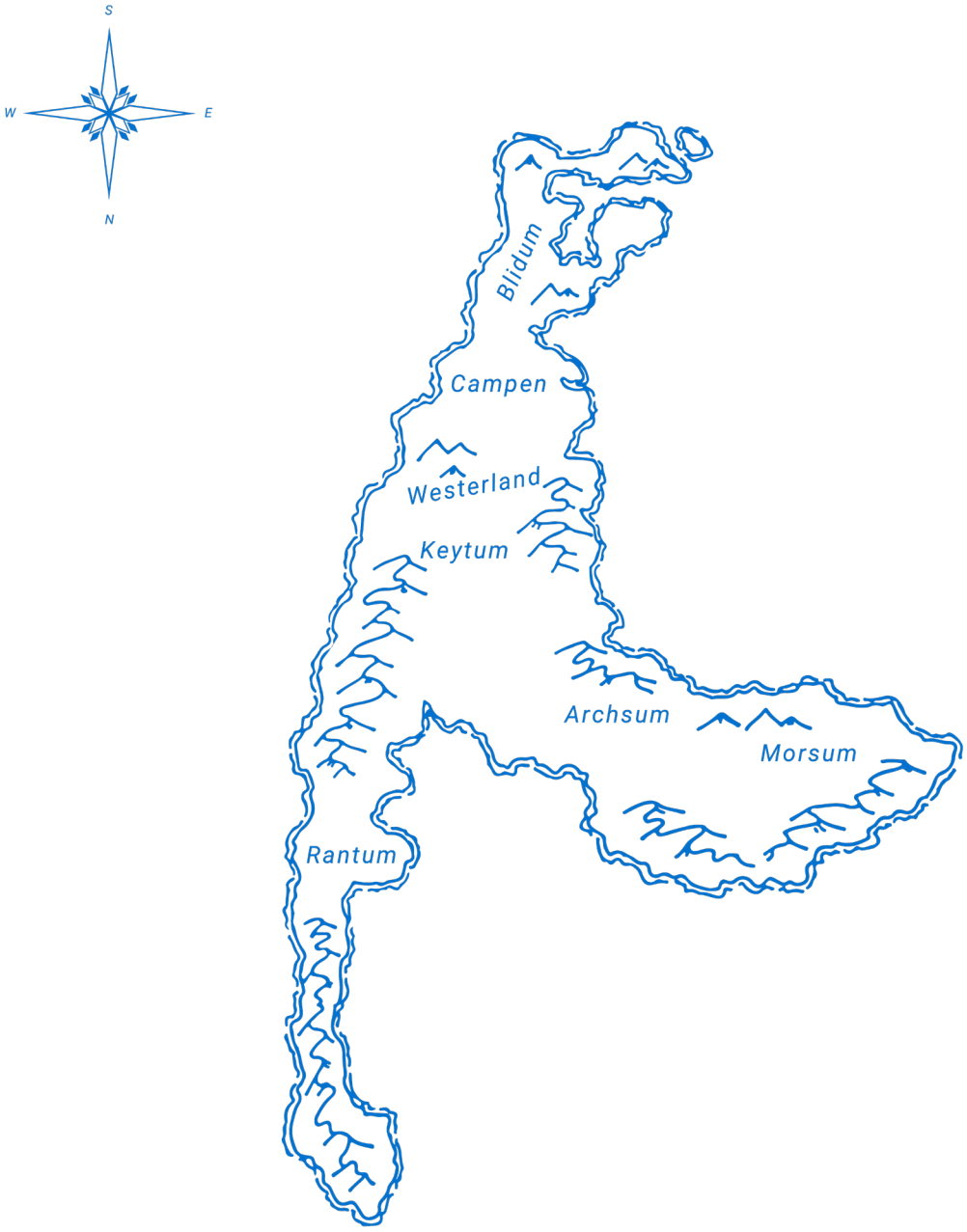


01 // Isola Syltae 1.300 BC



02 // Sylt after 1.300 BC

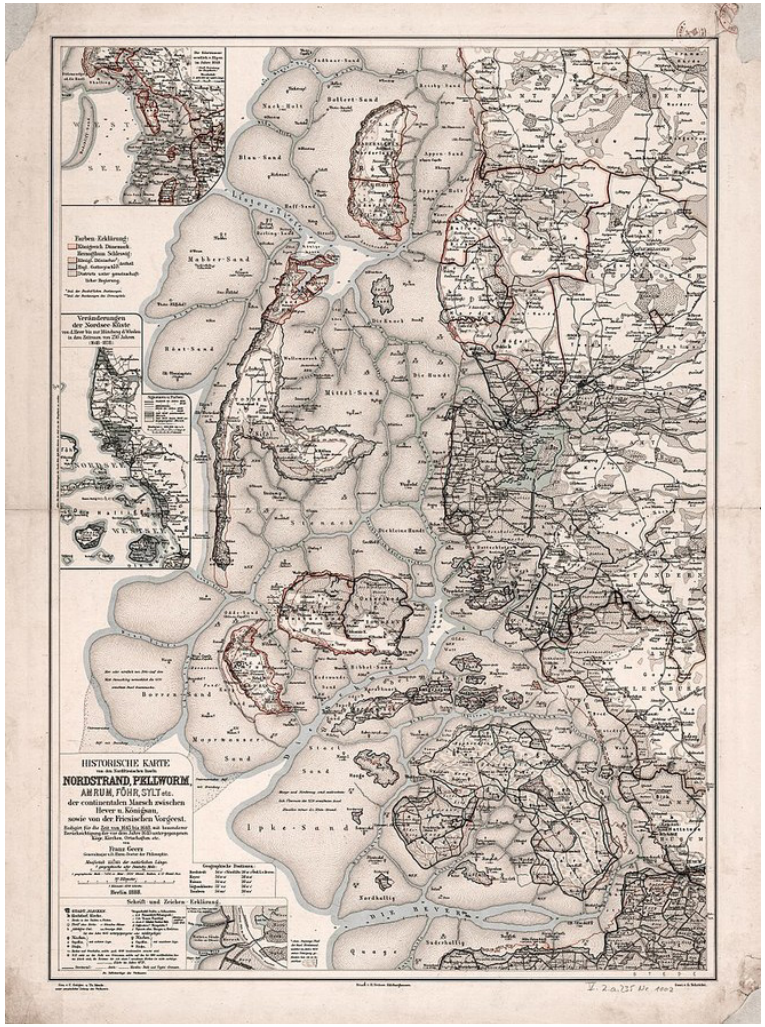
03 // Sylt around 1.000 BC



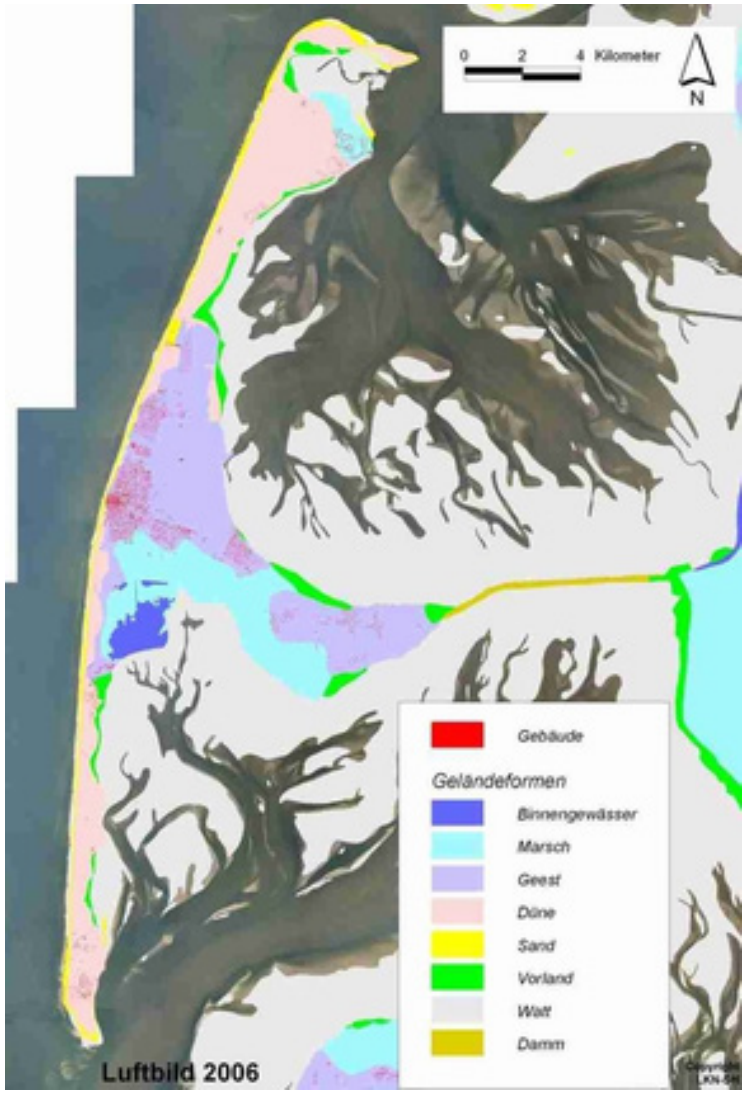
04 // Sylt ca.1650


S
W
E
N
List
Kampen
Westerland
Keitum
Archsum
Morsum
Rantum

07 // Map of Sylt (1888)

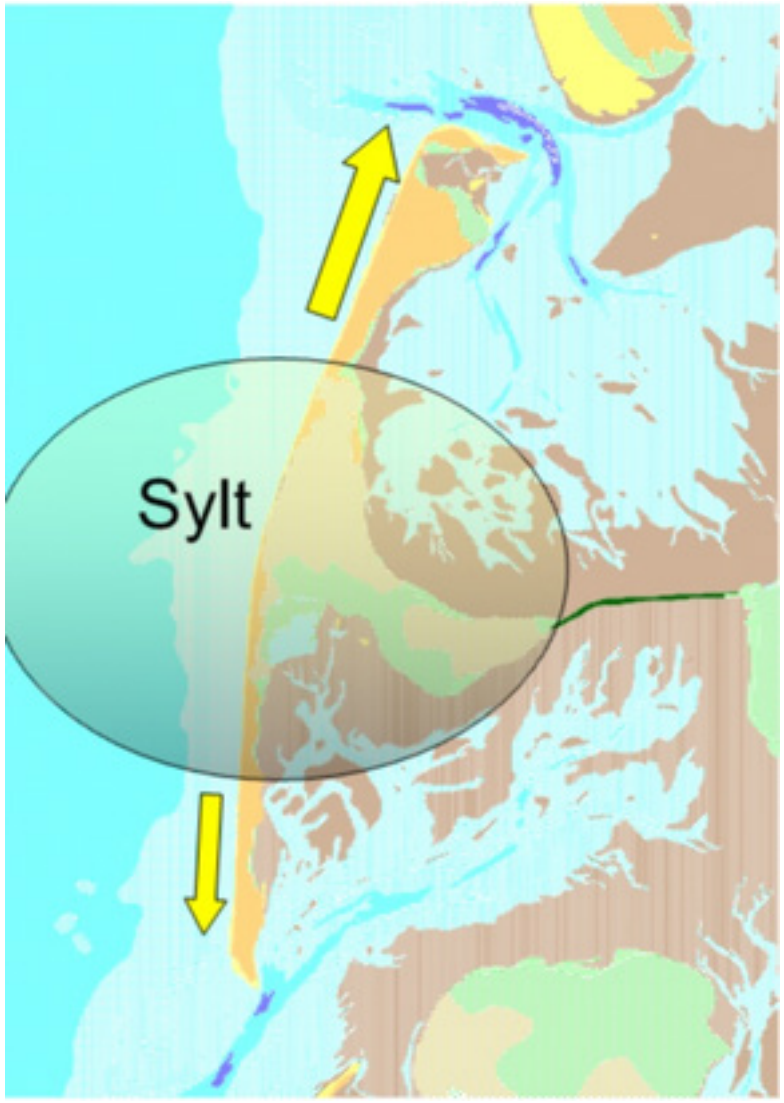


06 // Map by Johannes Meyer

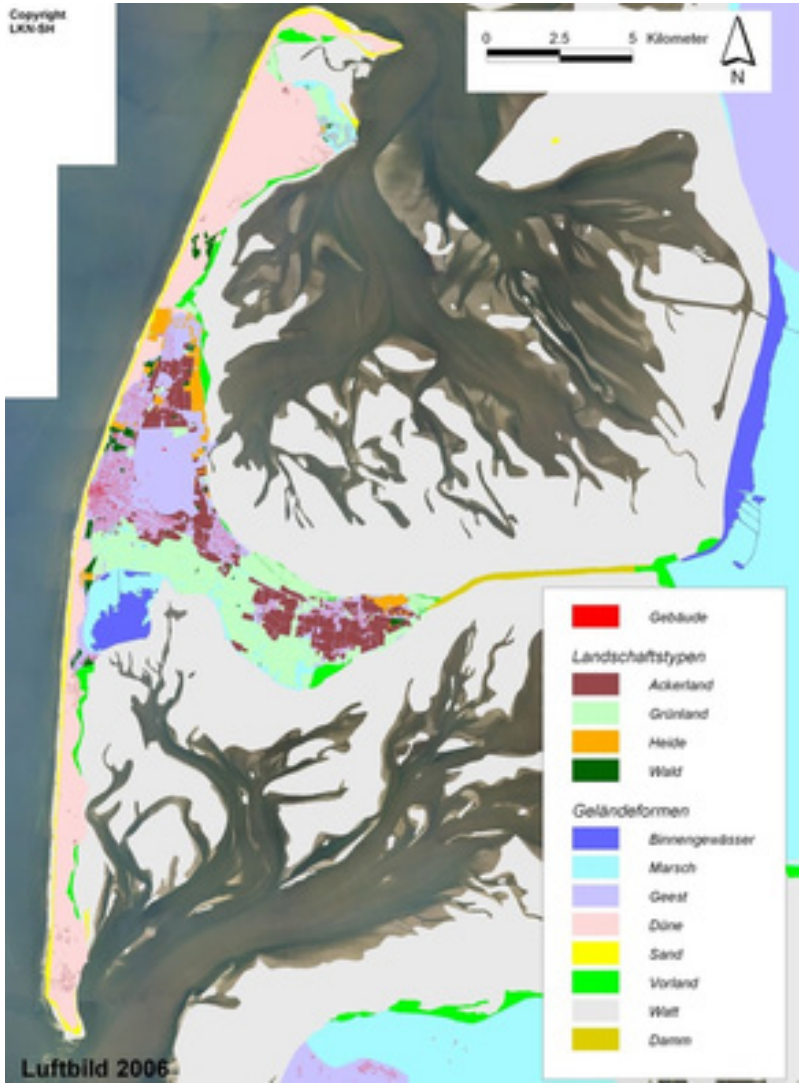


09 // Terrains of Sylt part 01

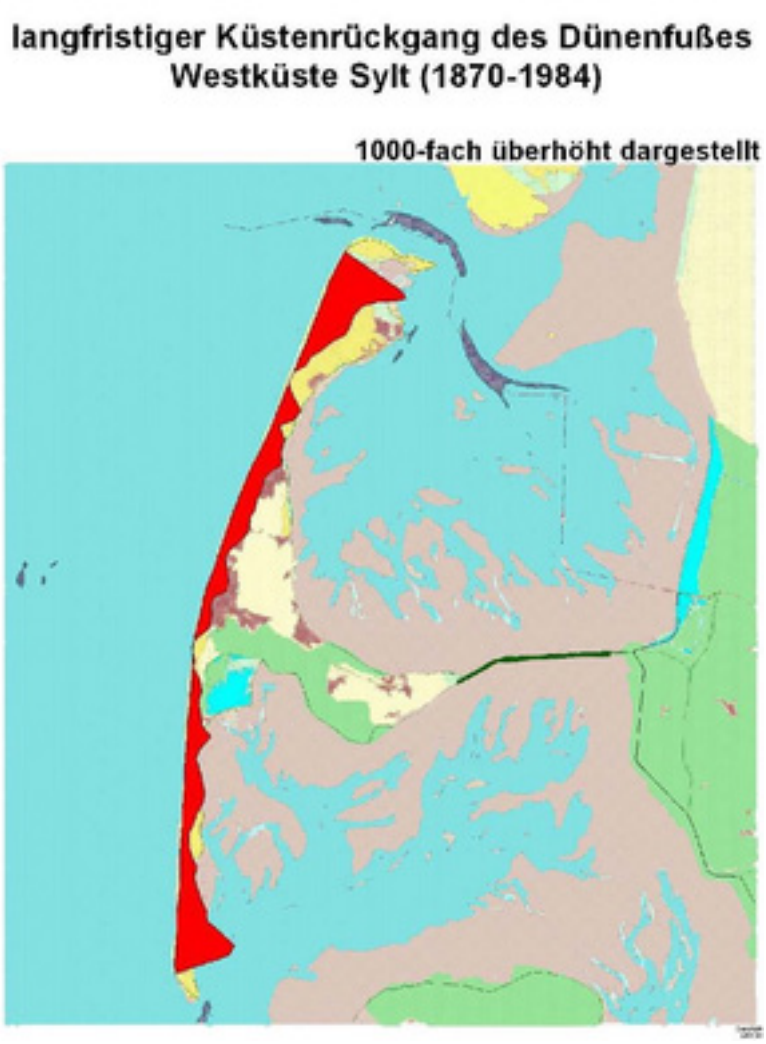
08 // The shape of Sylt today



11 // Sylt's current movement



10 // Terrains of Sylt part 02



13 // Sylt's coast decline in the West from 1870 to 1984

12 // Populations on Sylt

15 // Train tracks through the Wadden Sea

14 // Sylt's Wadden Sea

17 //Morsum during floods (1920)

16 // Sylter beach café at the cliff

18 // Sylter hotel built on the cliff

19 // Orientation of the houses in an easterly direction

21 // Leftovers of Buhnen at the beach

20 // Buhnen at the beach

22 // Tetrapod barriers

24 // Beach renurishment

23 // Tetrapod barriers eroding the beaches

25 // Fordunes Sylt

26 // Stabilized dunes

Kolmanskop

In Kolmanskop, a former German settlement in the Namib Desert which covers the whole coastal region of this African country, nature already broke free from the manmade corset into which it was forced. But before humans took over this part of one of the driest deserts in the world in 1905 (M.Antrag) to adjust it to their needs after diamonds where found in the area (Figure 27 & 28), the sand sea around the later Kolmanskop was designed by wind as a design tool of nature. The high velocity winds lead to extensive yarding development, rock fluting and deflation (Lancaster 1984; Corbett 1993 in A.Goudie and H.Viles, 2015, p.6), shaping the land over the years and producing new material for the desert.

The eroded widespread sand grains gather themselves together into piles which turn into new dunes over time, using their impressive power of self-accumulation by moving with the energy of the wind (M. Welland, p. 31). These dunes move on a sandy ground, stretching from the famous skeleton coast in the West of the country far inland like a elongated beach (Figure 29).

In comparison to Sylt, there is no layer of earth or clay that can function as an anchor in a desert which is acting more like a turbulent sea than a solid ground. In order to prevail in this sea of sand, it is essential to adjust to and move with versus fight against the natural surrounding. Nature designed the native vegetation specifically for these circumstances by giving the plants short roots which allow them to sit on top of the shifting dunes and move with them (Figure 30). This adaption also enables them to take in their needed water from the thick coastal fog that is transported inland by the winds and then settles in the upper layers of the sand dunes.

If the native plants had deep-growing roots instead of their short ones, they would be anchored well in the sand but not be able to reach the water reservoirs in the upper part of the dunes, risking to dry up. In addition, considering a constantly shifting environment, staying in one place

becomes dangerous. Plants that cannot float on top of the dunes and shift with them would be buried by the flying sand over time.

However, plants are not the only living creatures in the Namib Desert which were specifically designed for their surrounding and move with the sand. Different lizards, spiders and ants are light enough to either walk or even swim through the fine desert sand without much resistance, turning the deathly desert into one of nature's well-designed ecosystems.

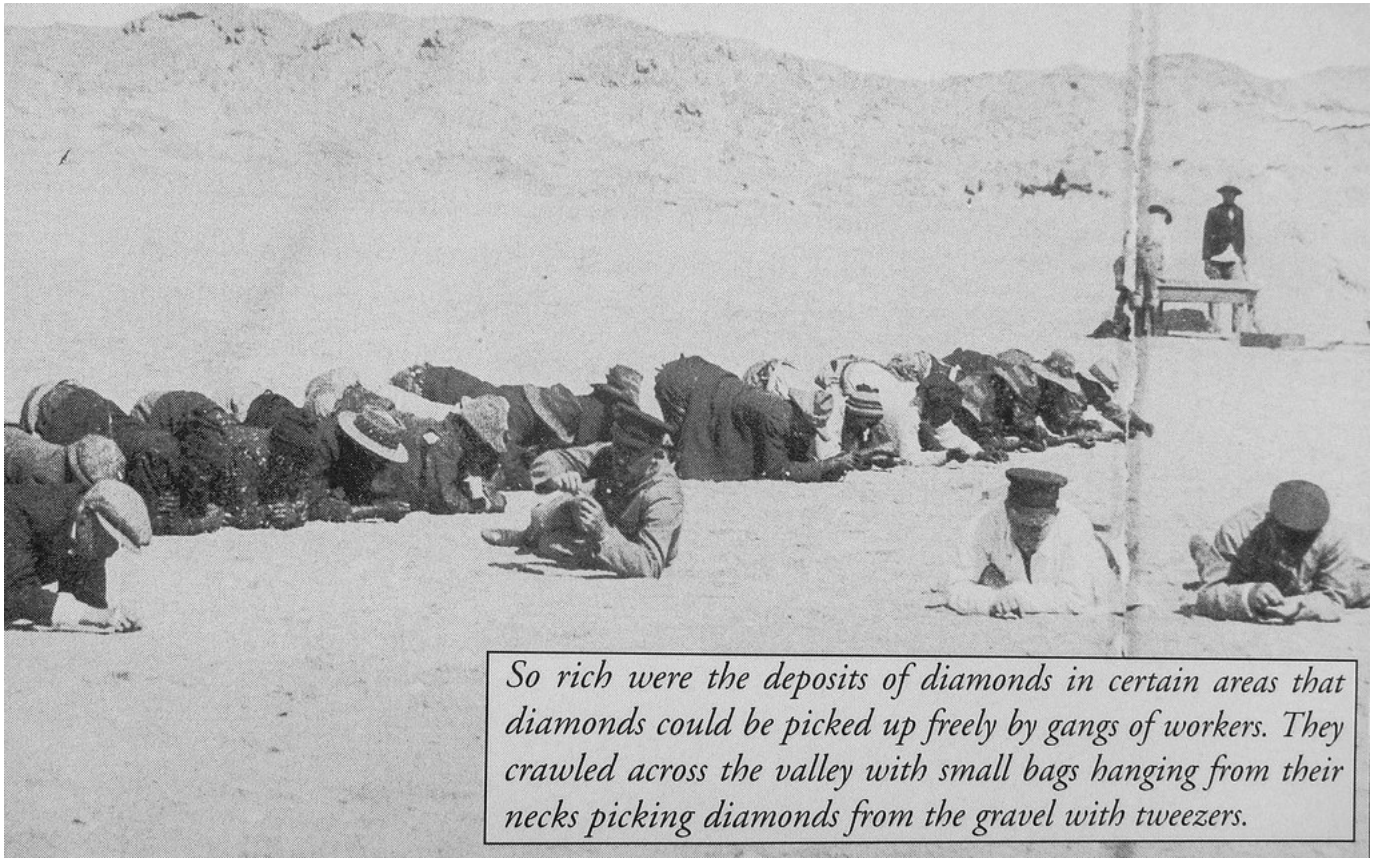
Humans were the one species that was not supposed to be part of nature's design of the Namib Desert: Their skeletons of ships as well as stranded sailors at the West coast of the country still bear witness to this fact, turning the desert into the now famous Skeleton Coast (Figure 31).

When the first colonizers discovered diamonds floating on top of the sand dunes, humans forgot about the hostility of the desert and their poor adaption to it. Instead, the discovery of diamonds lured the German settlers in 1905 out of their safe bay in Lüderitz and into the volatile desert leaving their known ground. With the distance between the diamond area and the settlement of Lüderitz being 15 kilometers, humans started building the new town of Kolmanskop in the desert. Living in the desert, though, was not supposed to mean leaving the comfort of the urbanized city. The settlers began building a village based on the same techniques know from home with materials directly shipped from Germany to the colony. Amenities the inhabitants were used to were provided, putting their houses on heavy concrete beds in the sand. All the materials were shipped to Lüderitz from where a newly-built train connection transported the commodities further into the desert. Soon, the new settlement started blossoming in its sparse surrounding. Simple private houses as well as luxurious villas, a bakery, a meat shop, hotels, a public school, pubs and even a casino, as well as a ballroom, a bowling alley and a hospital were built between the dunes to provide everything the settlers needed for their new life.

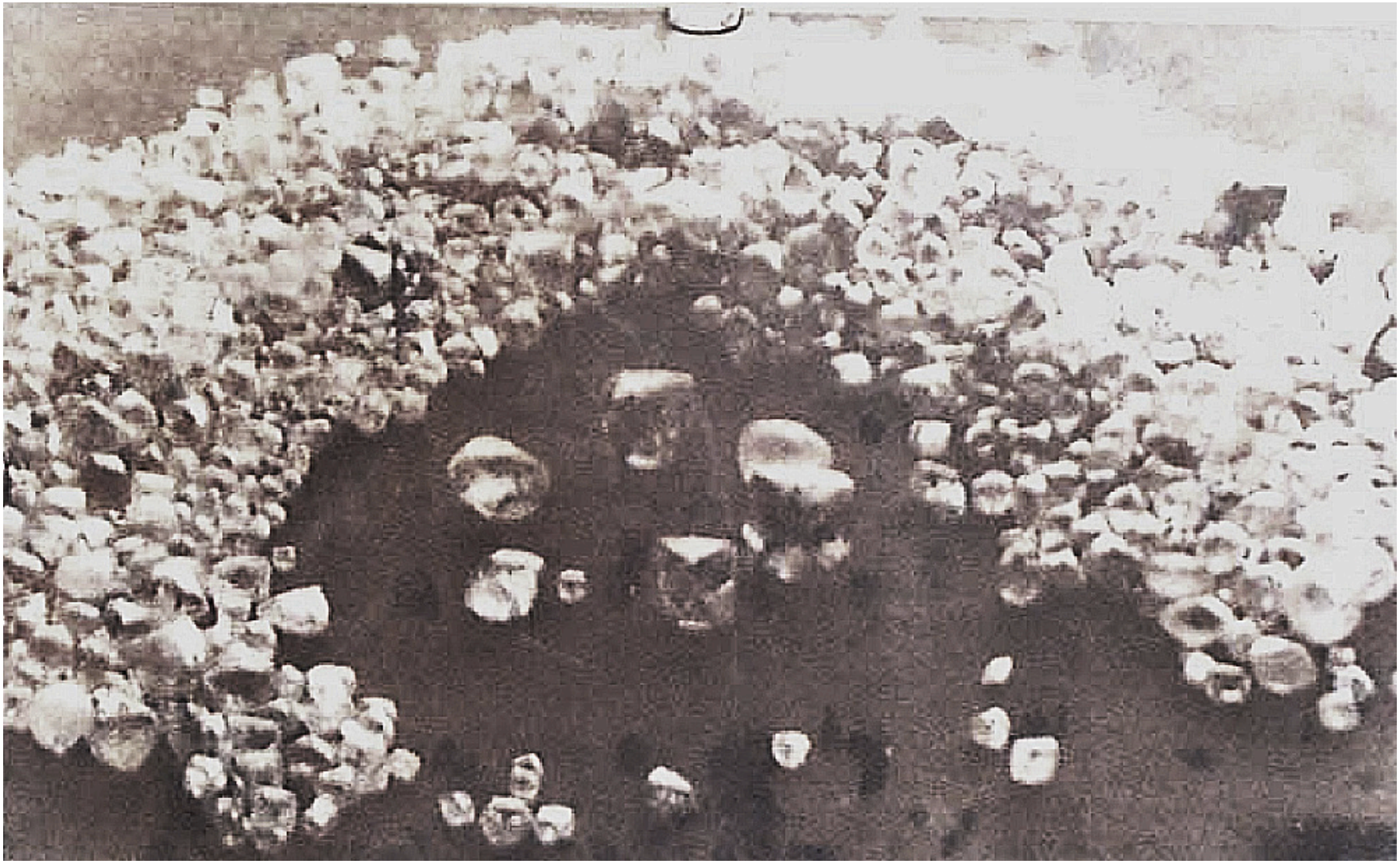
But just as years later, in the case of Sylt's beaches and the tetrapod barriers, building on concrete would become a feasible option, it did not work out on the ever changing ground of sand in the desert. Germany's trusted architecture failed the settlers on this unknown ground and migrating dunes kept on burying their houses while sand grains creeped into every crack of their homes. To

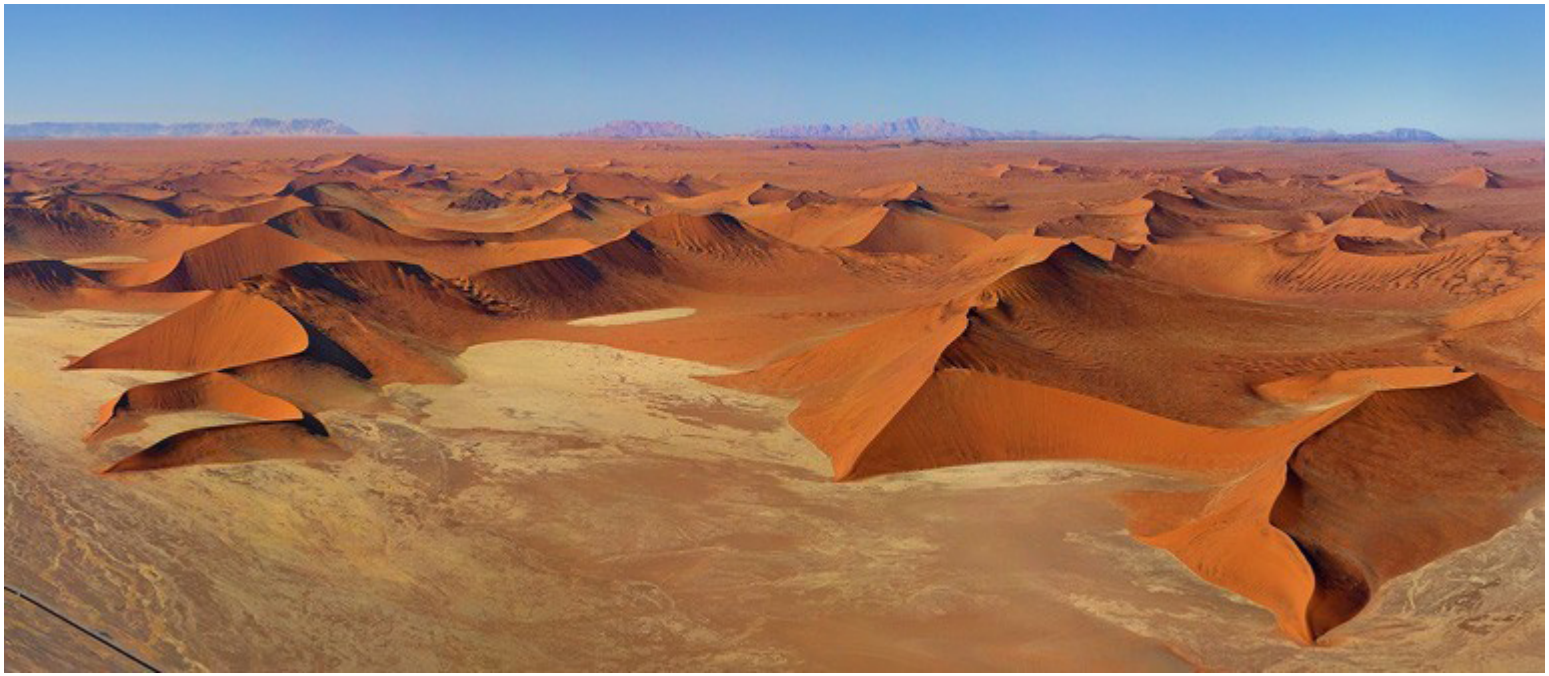
stabilize the dunes and keep the dry sand grains from being picked up by the strong velocity winds, the settlers planted lush gardens which also brought a tropical new vegetation to the desert. But while the native plants were taking their needed water from the dense fog which the wind transported from the coast inland, the manmade vegetation was not able to survive under these extreme conditions and the lush gardens were either buried underneath the flying sand or died from the lack of water. Without hardly any rain and he coastal fog as their only direct source of water in the desert , the settlers were not able to survive under these harsh conditions. Additional water had to be transported by ship from the 1.000 kilometers distant city of Cape Town to the settlement of Kolmanskop. It was needed not only to provide sufficient resources for the settlers' basic needs but also for their precious ice and soda company as well as the swimming pool (Figure 32).

The intentions of not just surviving but starting an entirely new existence were extremely hard to realize and did not work together at all with life in the desert. Still back home in Germany, the government was not tired of selling the African colony as a dream under the sun with desert diamonds as its new currency (Figure 51). The propaganda attracted even more people back home to set out to Kolmanskop and join the settlement in the desert town, turning it into the richest city in Africa at that time. After exploiting nature's treasures the colonizers saw no reason to stay any longer, and set out to new diamond fields, like a hive of grasshoppers, swarming from one place to another leaving places of destruction behind. The last settlers left the town in 1956 (M.Antrag, 2019), leaving behind a dead body of accumulated houses for the nature to take over again. Without its human opponent to fight back, nature continued shaping the ground. Burying abandoned houses underneath moving dunes and using the wind to cover the whole city under a thick layer of sand, nature was acting almost like a sandy version of a snow globe, slowly erasing any human trace that the German colonizers had left behind during their occupation of the desert. Over the years, Kolmanskop turned into a man-made time capsule of 20th century Germany just like Sylt, filled with everything that could provide the feeling of "home away from home' to the German settlers. As time went by, nature began to slowly open this time-capsule, creeping into it, grinding it down and merging with its leftovers until it began disappearing in the dunes.

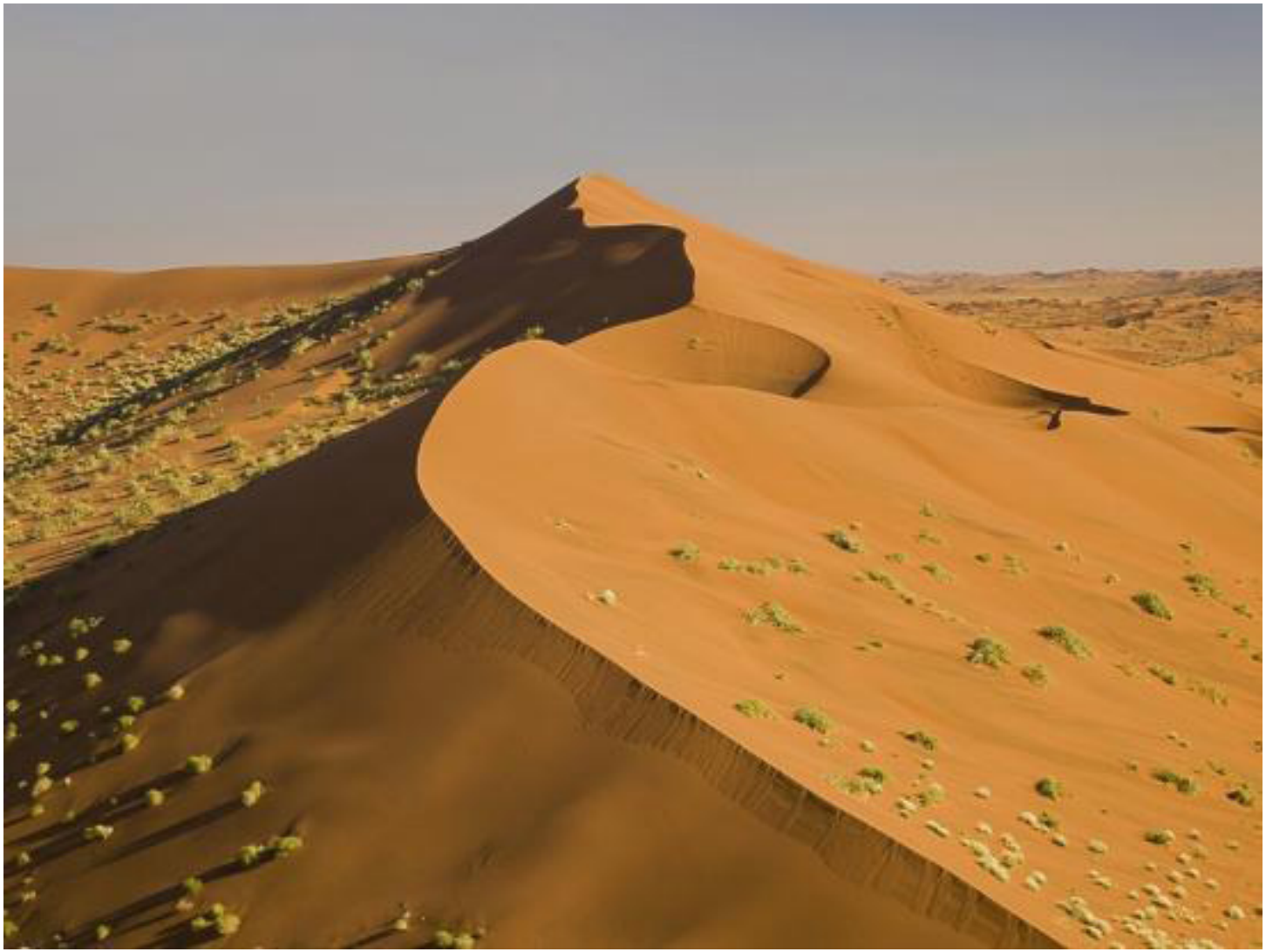


27 // Miners searching for diamonds in the sand





29 // Namib Desert



30 // Desert vegetation

31 // Skeleton Coast

33 // Ghost town Kolmanskop

32 // Swimming pool in Kolmanskop

35 // Kolmanskop kitchen interior

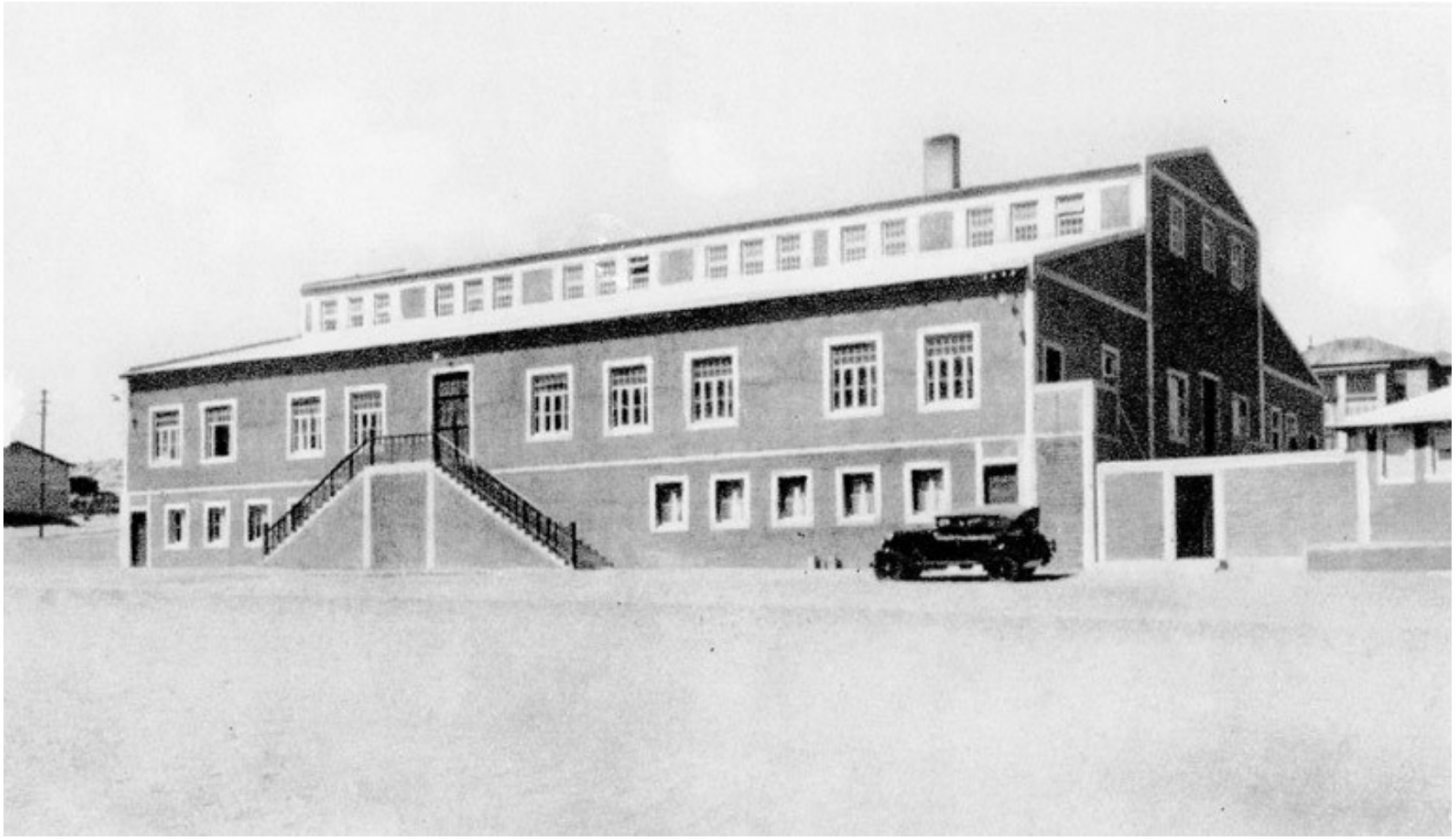
34 // German ruins in the desert

37 // Kolmanskop bowling alley

36 // House interior in Kolmanskop

38 // Sand dunes in the interior

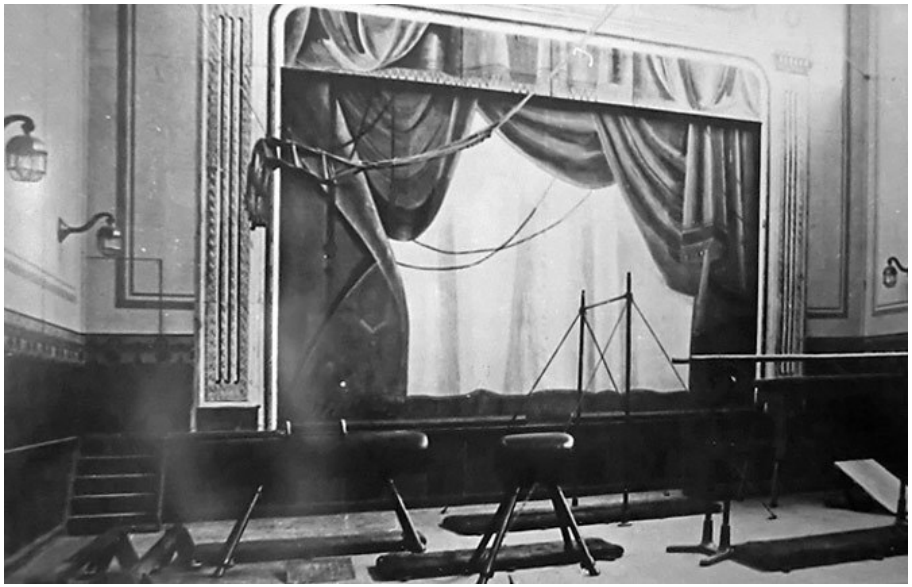
39 // Kolmanskop (1914)



40 // Casino of Kolmanskop

41 // School of Kolmanskop

43 // Bakery in Kolmanskop



42 // Kolmanskop's public gym

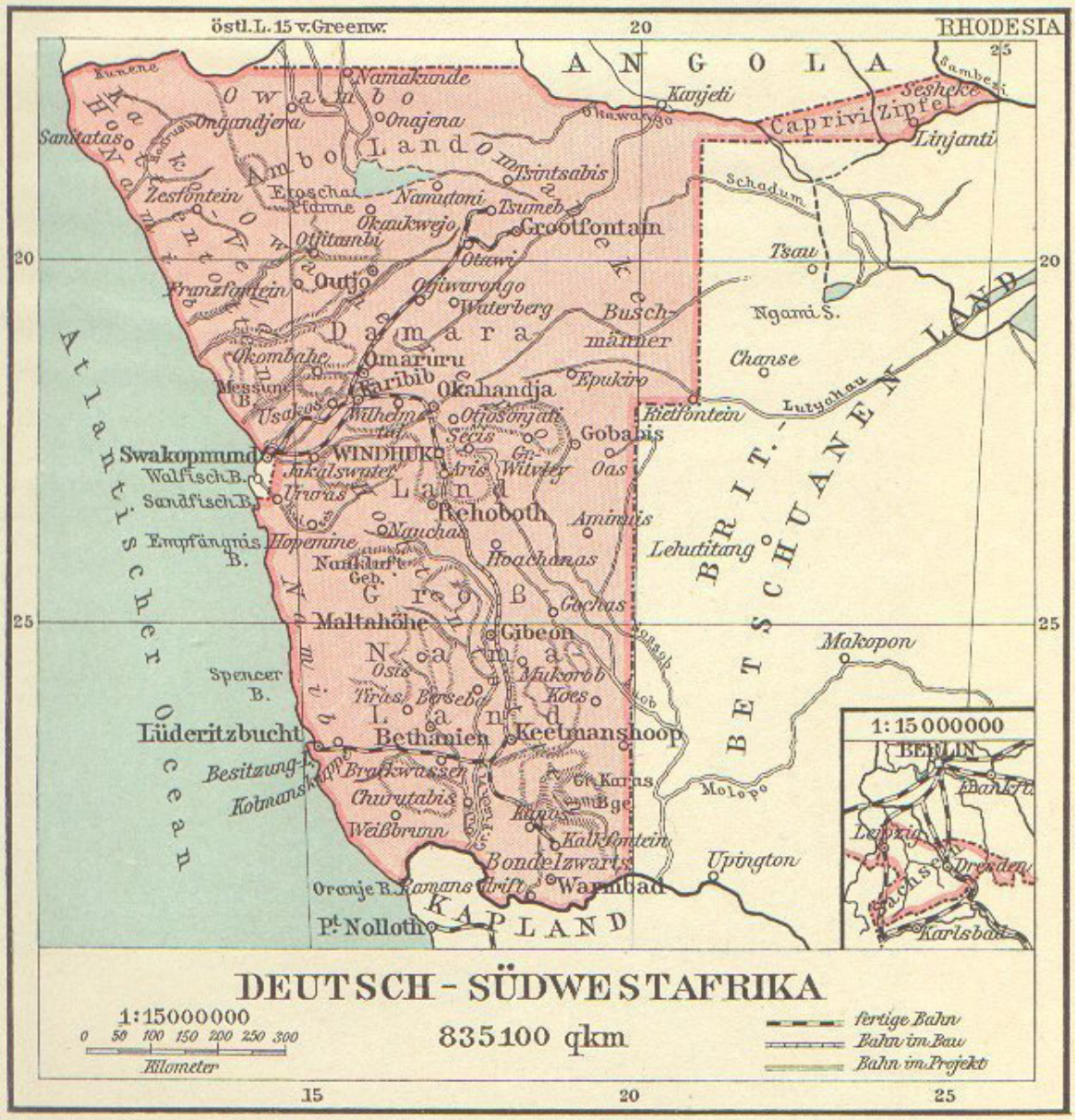
45 // Ice fridge

44 // Inside of Kolmanskop‘s ice factory

46 // Hospital of Kolmanskop

48 // Sand evicting a house

47 // Inside the hospital



50 // Map of Germany South-West Africa (1912)

49 // Train tracks buried under sand

51 // Postcard from Germany South-West Africa

52 // Postcard Diamond mining

53 // Postcard Kolmanskop

Common ground

As Sylt is surrounded by an ocean of water and Kolmanskop by a sea of sand with comparable liquid qualities as water, they both can be considered islands. Both these seas are calm and quiet, but nature's winds put them in motion, creating waves in the water as well as dunes in the sand. Climate change causes both of these seas to rise, one due to the melting of glaciers and sea ice, the other due to desertification. The precipitation pattern change, storms and hurricanes become more common, and their full power hits the islands of Sylt and Kolmanskop. Humans are using architecture to anchor themselves on their islands, digging deep into the ground and filling it with concrete as a foundation to put their houses on. But the ground these houses are built on is not solid, and the ocean of sand as well as the ocean of water is chipping away the material around the concrete, wiggling the houses out of their foundations like a loose tooth, ready to engulf them completely.

Sylt and Kolmanskop turn into representatives for similar regions, and instead of standing against these shifting grounds and stormy seas, the architecture in these regions needs to act flexible and ready to adapt to changes if humans want to continue living in them.

Floating homes

Looking at the parallels between the two case studies and the design tools nature is using to shape them, I am convinced that a similar type of architecture should be applied in both areas to hold houses over the water as well as over the moving dunes.

Over the years humans have already explored several architectural types to set themselves apart from the unsteady ground. Treehouses, for example, are an age-old tool to provide housing up in the save treetops, unreachable for approaching enemies or any dangers on the ground. Even though treehouses used to be seen only as a childhood dream and a quirk in architecture for a long time, they evolved over the last few years from their do-it-yourself character and became a part of the respectable architectural scene of the twenty-first century which led to a lot of architects such as Anthony Gibben (Figure 54), Andreas Wenning (Figure 55), and Simon Storey of Anonymous Architects (Figure 56) to jump on this new trend of adult treehouse architecture (Unger, A. 2018). In areas closer to the water and without forests to built in, stilts provided extra height and safety for humans and their belongings. Compared to treehouses, building on stilts made it possible to unlock extensive areas which so far had been inaccessible for humans, and it allowed bay areas to further grow into the sea as the cluster of stilted villages in Kampong Phluk in Cambodia shows (Figure 57). The stilt architecture gave humans the feeling of building on a solid ground instead of water. While the body of water was being punctured by stilts, the villages seemed to be enthroned on top of it. Whereas treehouse architecture needed to adjust its design to the tree it was built in, stilts only affected the construction underneath the water. This enabled humans to build, just in the way they were used to, on top of the stilts and allowed the development of whole cities such as Venice with a consistent architectural style.

In the lower-laying areas of Northern Europe with its strong storm surges, humans used a similar technique to adjust their traditional way of building to the conditions of their surroundings. Mimicing nature's design of highpoints, they constructed huge piles of earth, so called terps or Geests, to give their houses and farms extra height and safety during storm tides (Figure 58). This technique enabled humans to secure not just single households during storms, but entire villages, too, and even meadowland which made it possible to provide secured food sources in these unstable circumstances.

Still all of these architectural types have one problem in common: Over time and with rising waters, they will have to grow taller if they don't want to drown in the sea as Kunio Katō's illustrates in a simplified manner in his animation movie „The House of Small Cubes" (2008). If we insist on keeping our traditional building techniques, we will have to build higher and higher to escape the rising water.

In certain areas of the world, humans have already outgrown the traditional way of building their houses on the ground. The Uros, a native tribe in Peru, migrated out of the Amazon and established sixty floating artificial islands on Lake Titicaca (Figure 59). After being oppressed by the local population and being unable to find their own land, the Uros found retreat in the middle of the lake and began building their own floating islands as their new ground for existence. The chosen tool to keep their houses over water is the native Totora reed which is cut and layered to create a thick pontoon-type floating structure (Figure 60). It is also the material of everything built on the islands: The fishing boats, the houses, and all of the interior pieces as well as souvenirs for tourists who visit the village (Figure 63). Each island offers housing to the belonging members of a single extended family, and all together the village is the home of some 1,200 Uros (Foer, J. 2011). Similar to Sylt's flexible sponge layer which absorbs water in order to expand and stay over water, the thick reed layers of the lake village are also able to absorb water like a sponge. In the future, this specific ability of a sponge layer might be a potential architectural tool which can not only be used in water regions but also in the desert areas. If sand masses are acting similar to water masses, this principle might help to prevent houses from being buried by sand.

On water, the Uros technique of floating houses has already been used and developed for more

than one hundred years and countries like the Netherlands are working on whole cities which will be located on water (Figure 64 & 65). They combine a steady foundation of concrete with a light structure of foam to keep the buildings over water. Examples such as Richard Sowa's Do it yourself island made from plastic bottles on the coast of Mexico even prove that it is possible to plant vegetation on those islands already today (Figure 65).

So far, there is no development like that existing in extreme environments like the deserts yet because stability is not the only problem humans inhabiting these areas are facing. Continuity is problematic, too. Traditionally, people inhabiting these areas solved those problems by using tents and yurts (Figure 67 & 68). These mobile houses offer more flexibility and can be adjusted to the existing weather conditions. The black tents of the Bedouin tribes for example are well designed to be lightweight, portable, foldable and easy to adjust to fit their lifestyle (Figure 69). Their woolen fabric also provides dense shade during the hot daytime and is able to protect the inhabitants against the cold during the night. The positioning of the tent should always be adjusted to favor the climatic conditions. During the hot summers, for example, the tent opening is oriented towards the prevailing wind direction which allows for a cooling wind circulation on the inside of the tent (Attia, S. 2016). For nomadic tribes, this housing style in accordance with the surrounding nature has worked for hundreds of years, and architects around the world see potential in these lightweight building constructions. The Beijing based office of PLaT architects, for example, tries to use the principle of the Bedouin tent to create minimal interventions with nature and preserve the sensitive environment, combining lightweight structures with textile roofing in their design for the desert hotel (Figure 71).

However, the steel plate base with its design resembling the star shaped fortifications of the late fifteenth and early sixteenth century in Italy is still designed to hold back the high-flow sand and to stabilize the hotel's platform which is standing strongly against the intruders, the grains of sand. Over time, this will still result in moving sand dunes swallowing the resort if no additional precautionary measures are taken. Combined with a lightweight base which allows sand to move through it instead of holding it to the ground, desert architecture might be able to float on top of moving sand dunes without any further design interventions.

Using similar techniques as we already know them from house boats, architecture would rather explore the desert like a ship sailing on top of a sea made from sand while creating minimal interventions with nature. Instead of trying to conquer these extreme environments of moving sand masses, architecture would help humans to live in unison with nature and further explore the huge potential floating dwellings can provide in these areas in the future.

The United States have already been using this technique as part of their border fence between their country and Mexico. The so-called „Sand Dragon" is a construction which is floating on top of the dunes, its shape shifting with the formation of the sand (Figure 74 & 75). This kind of architecture is a great approach to a flexible way of building, but as a border fence, its capability of shifting has one huge disadvantage: It results in the actual border line to shift with it. To correct this design flaw, the border fence still needs humans to put it back in place every other month.

Another design tool humans could adopt from nature is sand's power to self-accumulate. So far, this has not been explored any further in architecture. In Sylt's case, nature's design tools, wind and water, are slowly eroding the cliffs in the west to nourish the lower laying Wadden Sea in the east of the island. They are spreading the eroded sand, but it accumulates again in the East and results in the whole island constantly shifting towards the mainland. The same is happening in the deserts: Strong winds are moving single sand grains which start accumulating in piles. These piles turn into sand dunes and are put in motion by winds from different directions, moving them several meters per year. Architecture geared towards not just standing stiffly against nature, but able to erode over time and self-accumulate again after its particles were moved by the elements of nature, would allow us to move along with the changing environment. Houses in the desert would be moved and shaped like the wind dunes, and buildings on the island would be able to move with its shifting ground towards the mainland.

54 // Inhabit Treehouse by Anthony Gibben

56 // House in Trees by Anonymous Architectrs

55 // Djuren Treehouse by Andreas Wenning

57 // Stilt houses in Kampong Phluk in Cambodia

58 // House built on a terp in Northern Europe

59 // Floating village of Uros on Lake Titicaca

61 // Uros boat

60 // Structure of the floating village

63 // Housing on the island

65 // Floating neigborhood by Waterstudio.nl part 02

64 // Floating neigborhood by Waterstudio.nl part 01

66 // Richard Sowa's DIY island at the coast of Mexico

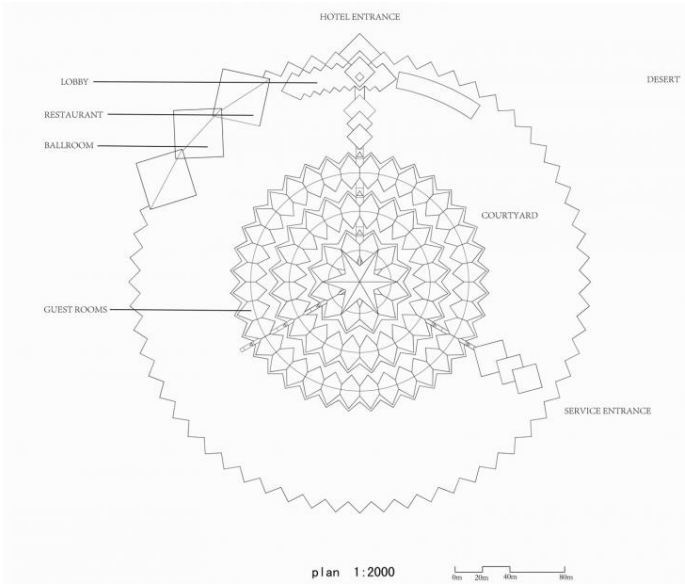
67 // Desert tent

69 // Traditional Bedouin tent

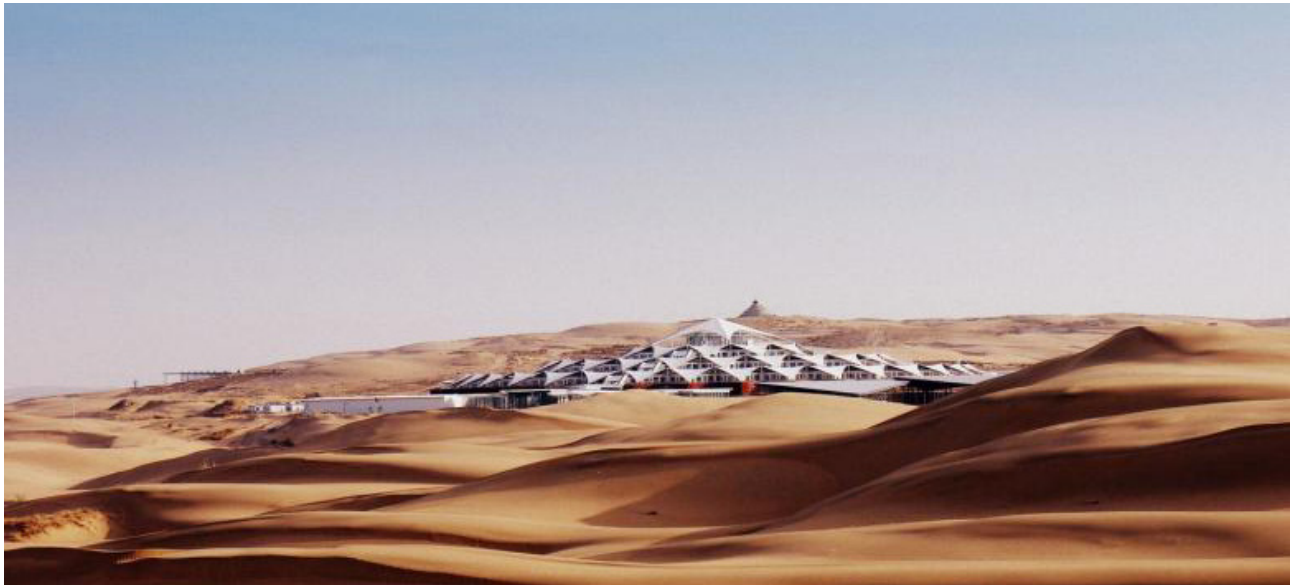
68 // A traditional Kazakh yurt in 1860 in the Syr Darya Oblast

71 // Desert hotel by PLaT Architects

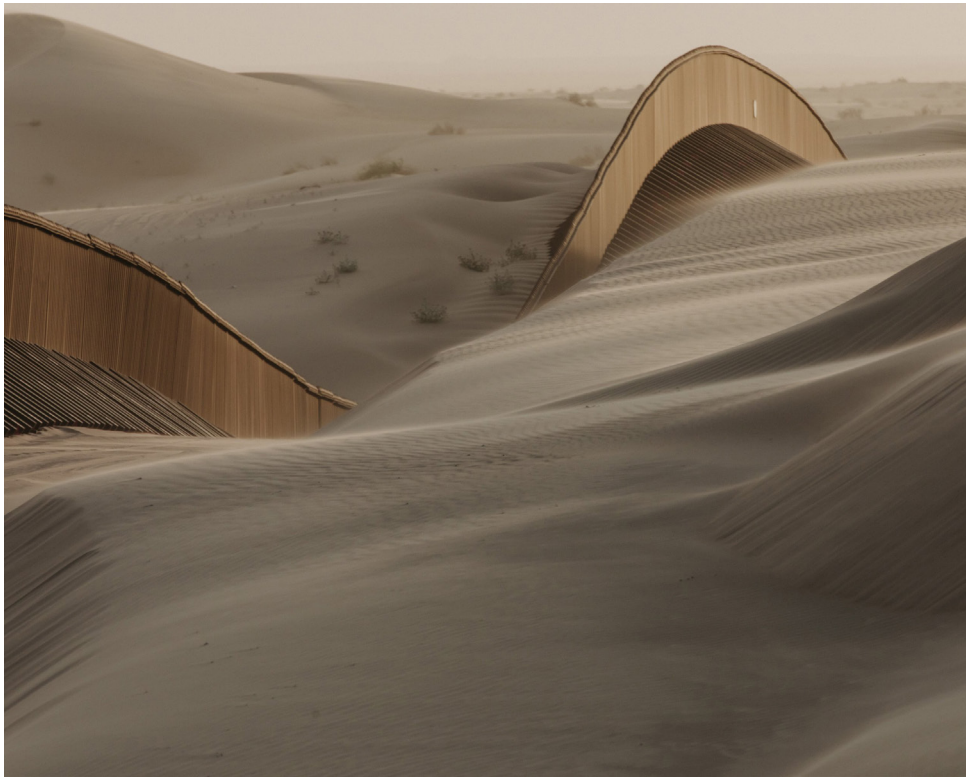
70 // Children sitting in the shadow of a Bedouin tent



73 // Floor plan of the Desert hotel by PLaT Architects



72 // The Desert hotel by PLaT Architects between the dunes



75 // The Sand Dragon US border part 02

74 // The Sand Dragon US border part 01

Conclusion

The possible ways of using nature's design tools for our architecture elaborated in the above thesis prove the high potential there is in a flexible kind of architecture which is able to shift with its surrounding. As a next step in the evolution, this kind of architecture would help provide additional living space for people accumulated in dense cities, i.e. by building on water or setting up highly engineered crop farms floating in the desert and not risking of being buried by sand dunes. Climate change is already happening and will continue to happen, but humans have always been able to adapt to these new changes. Therefore architecture, as a tool of humans, needs to adapt as well. To do so, we have to let go of the belief that our houses and cities need to be built from static elements in order to allow an architecture which is floating on the ever changing sea of nature. On a small scale people might not be able to get to Sylt by car and train in the future anymore, but they might be able to take their water or sand house with them. But on the big scale with increasing desertification all around the world this new type of building might provide safe housing for millions of people who are being affected by rising sea levels and increasing aridity already today.

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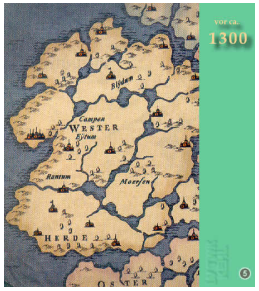

01 // Isola Syltae 1.300 BC

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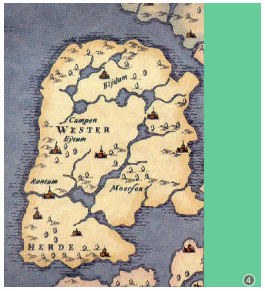

02 // Sylt after 1.300 BC

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03 // Sylt around 1.000 BC

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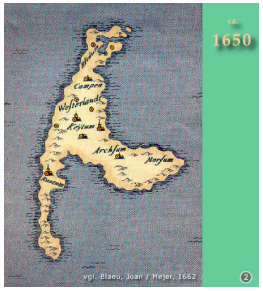

04 // Sylt ca.1650

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05 // Sylt 1920

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06 // Map by Johannes Meyer

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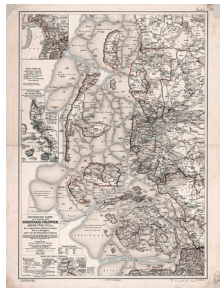

07 // Map of Sylt (1888)

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08 // Sylt today

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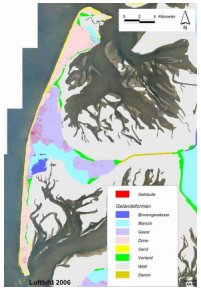

09 // Terrains of Sylt part 1

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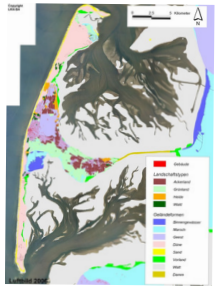

10 // Terrains of Sylt part 2

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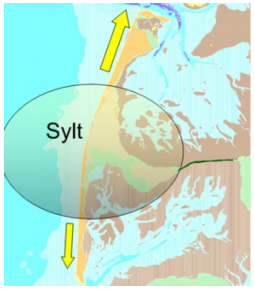

11 // Sylt‘s current movement

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12 // Populations on Sylt

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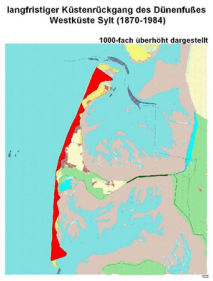

13 // Sylt‘s coast decline (1870-1984)

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14// Sylt‘s Wadden Sea

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15 // Train tracks through the Wadden Sea

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16 // Sylter Houses at the Cliff

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17 // Morsum during floods (1912)

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18 // Sylter hotel built on the cliff

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19 // Orientation of the houses in an easterly direction

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20 // Buhnen at the Beach

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21 // Leftovers of Buhnen

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22 // Tetrapod Barriers

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23 // Tetrapod barriers eroding the beaches

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24 // Beach Renurishment

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26 // Stabilized dunes

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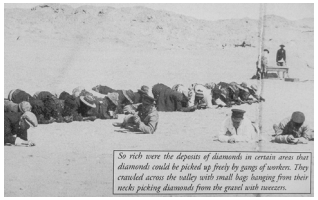

27 // Miners searching for diamonds

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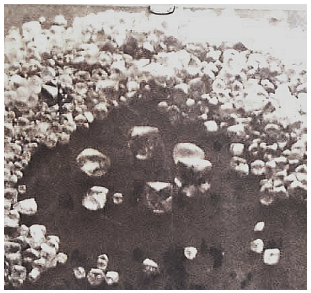

28 // Desert diamonds

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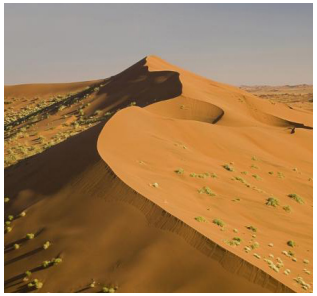

30 // Desert vegetation

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31 // Skeleton Coast

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32 // Swimming pool in Kolmanskop

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33 // Ghost town Kolmanskop

https://d2w9rnfcy7mm78.cloudfront.net/4096929/large_29938e83b-dfd7837e1df7fc45bbbae06.jpg?1555488686

34 // German ruins in the desert

https://d2w9rnfcy7mm78.cloudfront.net/4096934/large_5e87d1107a3e-8580c72179a10321accf.jpg?1555488803

35 // Kolmanskop kitchen interior

https://freewheely.com/2015/02/kolmans-kop-ghost-town-and-the-namibian-dia-monds-history/

36 // Inside of the ghost town

https://freewheely.com/2015/02/kolmans-kop-ghost-town-and-the-namibian-dia-monds-history/

Visual references

37 //Kolmanskop bowling alley

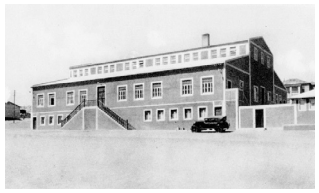
https://freewheely.com/2015/02/kolmanskop-ghost-town-and-the-namibian-diamonds-history/

38 // Sand dunes in the interior

https://freewheely.com/2015/02/kolmanskop-ghost-town-and-the-namibian-diamonds-history/

39 // Kolmanskop (1914)

https://d2w9rnfcy7mm78.cloudfront.net/4097078/large_1ea9946c0c2299ddd068d89ee57d1a5c.jpg?1555490519

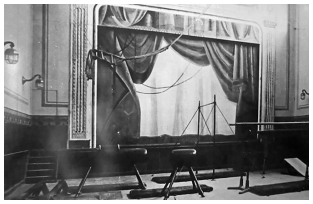


40 // Casino of Kolmanskop

https://d2w9rnfcy7mm78.cloudfront.net/4097080/large_a1cda7626c2bb0f6abceed7e242daae1.jpg?1555490531

41 // School of Kolmanskop

https://d2w9rnfcy7mm78.cloudfront.net/4097084/large_a2bc56514adac94170147bd95d454c58.jpg?1555490547



42 // Kolmanskop‘s public gym

https://d2w9rnfcy7mm78.cloudfront.net/4097089/large_8bb3ef543a1db00c3df0f106b794c751.jpg?1555490566

43 // Bakery in Kolmanskop

https://d2w9rnfcy7mm78.cloudfront.net/4097099/large_ac73d00e66e65d00e4c14f4201e39efa.jpg?1555490592

44 // Inside Kolmanskop‘s ice factory

https://d2w9rnfcy7mm78.cloudfront.net/4097101/large_e1c32b2ef7b740a3ffe9ee7b4b4a8da5.jpg?1555490598

45 // Ice fridge

https://d2w9rnfcy7mm78.cloudfront.net/4097106/large_49af58f53fcc3547f348055d49fbe7c4.jpg?1555490615

46 // Hospital of Kolmaskop

https://d2w9rnfcy7mm78.cloudfront.net/4097109/large_945492dbc18d053a40a063ebdf965e18.jpg?1555490625

47 // Inside the hospital

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48 // Sand evicting a house

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49 // Train tracks buried under sand

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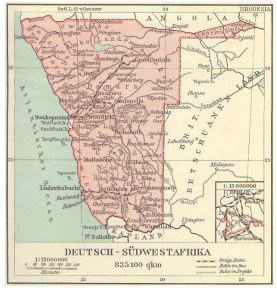

50 // Map of Germany South-West Afrika (1912)

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51 // Postcard from Germany South-West Africa

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52 // Postcard diamond minning

https://deutsche-schutzgebiete.de/wordpress/projekte/kolonien/deutsch-sued-westafrika/

53 // Postcard Kolmaskop

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54 // Inhabit Treehouse by Anthony Gibben

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55 // Djuren Treehouse by Andreas Wenning

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56 // House in Trees by Anonymous Architects

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57 // Stilt village in Kampong Phluk in Cambodia

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58 // House on a terp in Norther Europe

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59 // Floating village of Uros on lake Titicaca

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60 // Structure of the floating village

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61 // Uros boat

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62 // On the floating island

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63 // On the floating island

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64 // Floating neigborhood by Waterstudio.nl part 01

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65 // Floating neigborhood by Waterstudio.nl part 02

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66 // Richard Sowa‘s DIY island

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67 // Desert tent

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68 // A traditional Kazakh yurt in 1860 in the Syr Darya Oblast.

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69 // Traditional Bedouin tent

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70 // Children sitting in the shadow of a Bedouin tent

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71 // Desert hotel by PLaT Architects part 01

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72 // Desert hotel by PLaT Architects part 02

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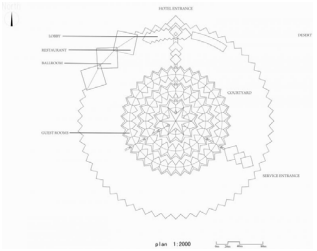

73 // Desert hotel by PLaT Architects part 03

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74 // Sand dragon US border

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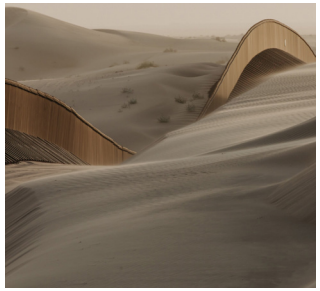

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