Projekt

oneWater

The concept of the research group **oneWater.earth**

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The problems and challenges

of the 21st century are world-wide and gigantic. Among them, the heating of the Earth under the terms climate crisis, climate change or greenhouse effect clearly stands out as an existential threat to human civilization as the greatest challenge of this century. To master it requires tremendous efforts.

The research group *oneWater.earth* has joined forces in this project to offer **concrete solutions** to the anthropogenic threat.

The goals of the project

is to focus on preserving planet Earth as a habitable planet. Because humans as well as fauna and flora have only one (single) Earth at their disposal.

We want to reforest the deserts of our Earth, make them urbanized and arable, so that the global rise in temperature can be stopped and even reversed in the long term.

The project is not a one-time measure but is designed to last. It will span many generations and is based on the awareness that all natural and national boundaries will be overcome. Concrete solutions for the future as well as inevitable repairs require a bio-cybernetic understanding of the system with the goal of keeping the biosphere in its natural balance[1].

Water

is the source of all life.

With the irrigation of the deserts, the basis for the cycle of the vegetation is established, so a new life develops for fauna and flora.

Accomplished by targeted planting and specific irrigation of suitable plants, humus must first be produced, which in turn is a prerequisite for the cultivation of trees[2] and crops[3].

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1 The tasks cannot be solved with a linear "cause-effect theory".

2 Through photosynthesis, trees remove the greenhouse gas carbon dioxide from the air, serving as CO2 absorbers, so to speak, and can thus slow down global warming. Trees have other influencing factors: they release oxygen, moisten the air and filter it of pollutants.
Albedo values can also improve significantly. Albedo values: Desert: 0.30; Forest: 0.05 to 0.18.

3 In addition to multiple economic benefits, large-scale forests form a massive CO2 reservoir. A forest area of 3 million km2 (about ⅓ of the area of the Sahara) can - planted with suitable trees - store about 70 billion tons of carbon, which corresponds to almost ¼ of the 300 billion tons of carbon that have been released into the atmosphere by human activities since the industrial revolution.

Circulation effect of water on ecology and economy

oneWater

oneEarth **onePlanet** **oneLife**

Water

is the basic element. Water is essential to the concept in the long term, its use triggers overwhelmingly positive, profound, complex and interlinked cycles, but above all, it enables the concept to have sustainable side effects and consequences, which result in manifold additional benefits[4]:

- new "green lungs" (forests) are created for the world climate,
- CO_2 is massively absorbed and permanently bound,
- in the long term, global warming will be stopped,
- in the long term, global warming will be reversed,
- in the long term, a global climate balance is achieved,
- new temperate climate zones and ecosystems are created,
- the polar ice caps and glaciers (permafrost) stabilize,
- the rising sea water level decreases,
- groundwater is rising again,
- the global "water stress" will end,
- deserts and urban centers receive an unlimited supply of water,
- the unequal distribution of water on Earth is counteracted,
- living space for the growing world population is created,
- lifelines to stabilize the food chain will be created,
- global migration is significantly curbed,
- foundations for growth and prosperity are laid,
- millions of jobs are created as a basis for livelihood,
- business areas and growing markets are developed,
- compensation for the clearing of rainforests is created,
- time is gained for the metamorphosis (transformation) of people to adapt their previous ways of life and behavior to new ones.

[4] Exemplary, non-exhaustive list

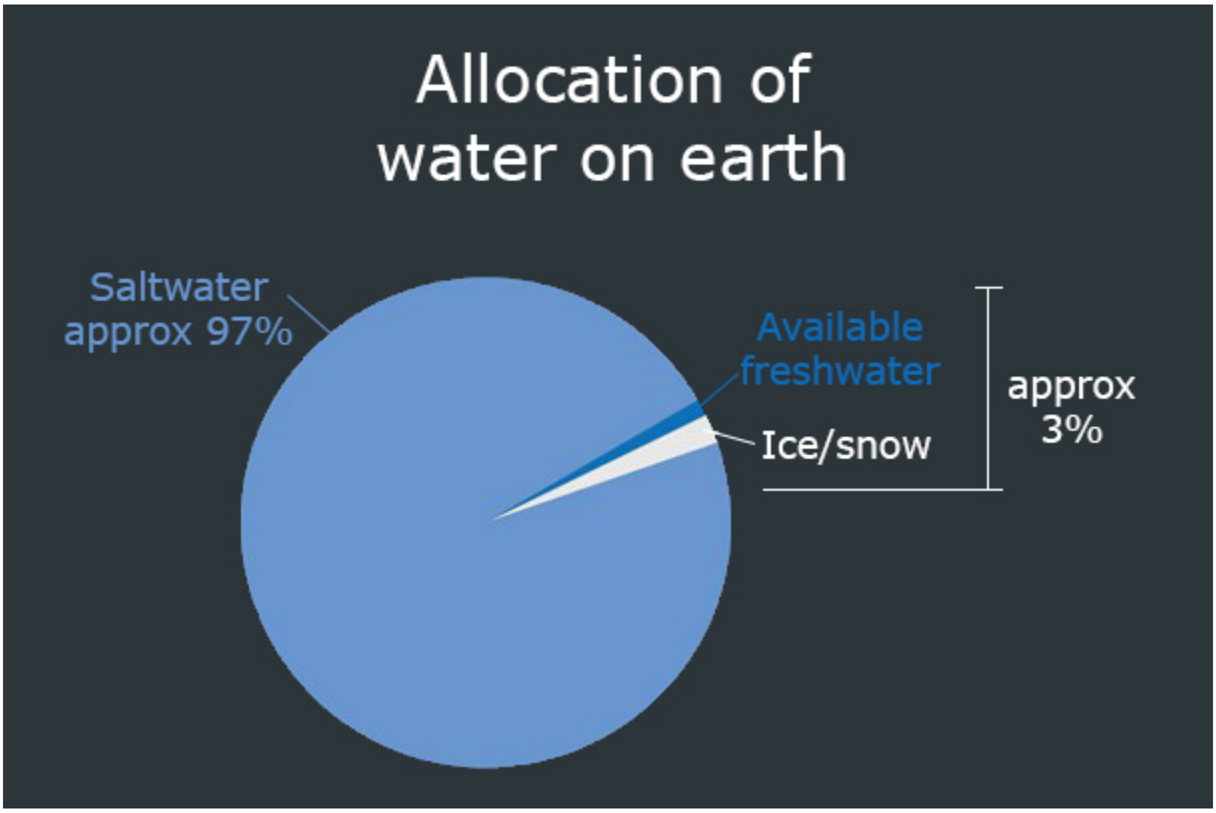
Water

is the most valuable raw material on Earth and as an eternal element, the "golden" key and an answer to the challenges of our time, but above all of the future.

The total area of the Earth is divided into water and land areas:

Water area	360.570.000 km²	70,7 %
Land area	149.430.000 km²	29,3 %
Total area of the Earth	510.000.000 km²	100 %

Sea or salt water are available in inexhaustible quantities but can only be used to a limited extent and in a few sectors.



In order to make the surplus of saltwater usable for humans, fauna and flora available in land, seawater must be desalinated and converted into fresh drinking water.

This requires seawater desalination plants.

A large part of the survival of future generations depends on the success of this enormous task.

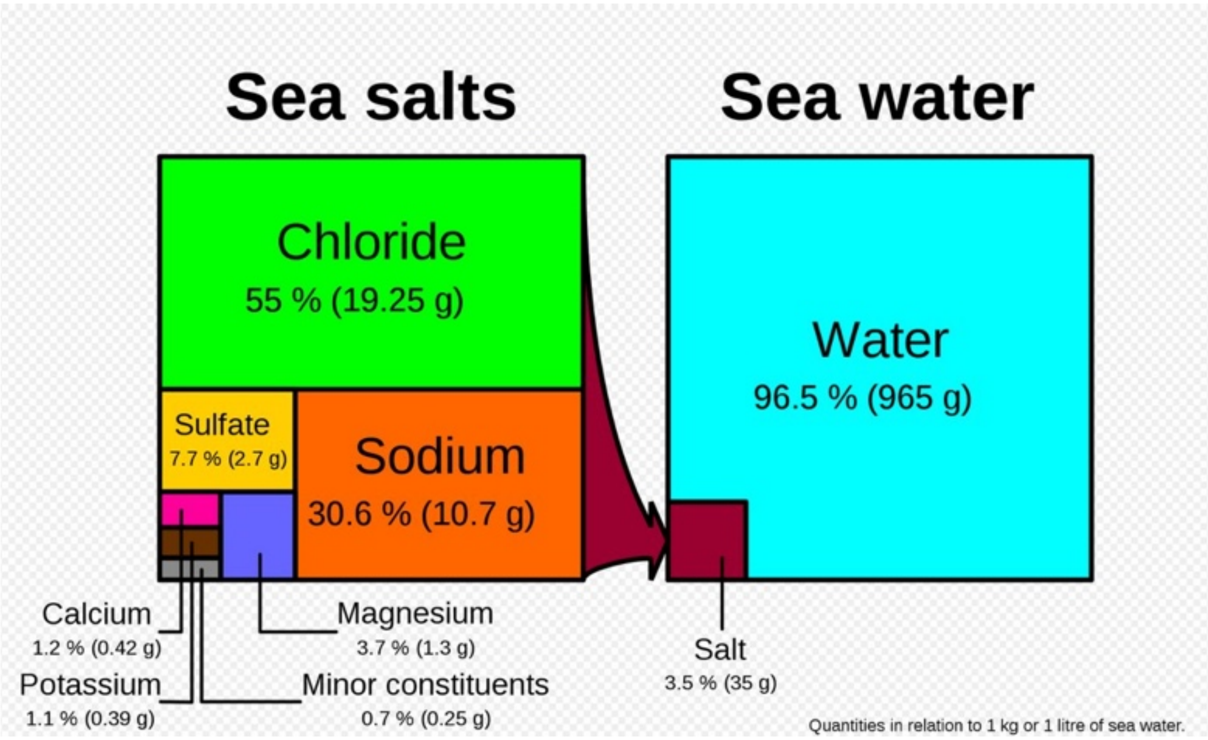
Seawater Desalination Plants

Deserts and other arid/semiarid areas of the world do not have (or have insufficient) natural freshwater resources (from precipitation, surface water, spring water, or groundwater) to maintain sufficient quantities for safe bases of human and animal life, and vegetation.

Furthermore, rising seawater, sinking groundwater, lacking or excessive precipitation as well as drying up surface waters represent potential dangers for civilization, which can - and must - be prevented as well as compensated by the realization of this project: the sensible use of desalinated seawater!

Seawater is the raw material, which is inexhaustible by its eternal cycle. In the long run, the use of desalinated seawater is the most efficient, sustainable and, surprisingly, economical method[5] to achieve the multiple goals mentioned at the beginning.

Seawater has an average salt content (salinity) of 3.5% mass fraction (corresponding to a salt content of 35 g/kg seawater). The total salinity varies from sea to sea and depends on many factors but need not be considered in detail here.



5 According to the World Health Organization, for every US $1 invested in water, there is an economic return of US $4.

Established techniques / technologies for desalination[6]

Selective Vaporization / Evaporation due to Vapor Pressure Difference between Water and Salt		Selective Crystal Formation under Rejection of Salts	Selective Membrane Permeability for Water and Salt	Selective Movement of Ions according to their Charge	Selective Exchange of Ions on Surfaces
Addition of Heat (from outside the System*)	Addition of Heat (from inside the System*)	Pressure Elevation	Pressure Elevation	Electric Potential Difference	Selective Exchange of Ions on Surface
Multi-Effect Distillation (MED)	Humidification-Dehumidification (HD)	Hydrate - based Desalination (HBD)	Reverse Osmosis (RO)	Electrodialysis (ED) / ED Reversal (EDR)	Ion Exchange
Thermal Vapor Compression (TVC)	Membrane Distillation (MD)		Pressure Reduction and / or Addition of Heat	Electrodeionisation (EDI)	
Mechanical Vapor Compression (MVC)	Rapid Spray Evaporation (RSE)		Pervaporation (PV)	Capacitive Deionisation (CDI)	
Adsorption Desalination (AD)					
Vacuum Membrane Distillation (VMD)					
Flashing (under Addition of Heat from inside the System*)		Removal of Heat	Osmotic Pressure Difference	Bio-Electric Potential Difference	
Multi-Stage Flash (MSF)		Freeze Desalination (FD)	Forward Osmosis (FO)	Microbial Desalination Cell (MDC)	
Direct Spry Distillation (DSD)					
Ocean Thermal Energy Desalination (OTED)					
Vaporization	Evaporation				

The processes commonly used today in the order of their economic importance:

[6] www.DME-ev.de; Mapping according to the separation principle of water & salt

1. the MSF Multistage Flash Evaporation process (thermal evaporation) is the most widely used and is also operated on a large industrial scale (e.g., Jabal Ali in Dubai).

2. In reverse osmosis, the medium (seawater) is forced under high pressure through a semi-permeable membrane to overcome the osmotic pressure.

3. In membrane distillation, a microporous membrane retains saline liquid water and allows only desalinated water vapor to pass.

4. experimental techniques

   a) Plastic evaporation tubes
   b) Freezing process (failed)
   c) electrodialysis (only economical at very low salt levels)
   d) Ion power (Siemens operates a pilot plant in Singapore)
   e) bio-fuel cell (application for brackish water)
   f) multistage solar photovoltaic membrane distillation.

In different weighting, almost all large-scale plants in operation have in common that until today an enormous technical and energetic - and thus cost-intensive - effort has to be made to separate the relatively small amount of salt from the seawater and to obtain human-grade drinking water from it. Costs and benefits are not yet in a balanced relationship. In addition, they affect the CO_2 balance to a high degree and cause further environmental pollution.

Due to these negative components, one of the oldest dreams of modern civilization, to have sufficient fresh water everywhere and in unlimited quantities, can only be fulfilled by conventional methods at the cost of systemic disadvantages[7].

Generations of scientists and technicians are already working on the use of seawater desalination plants. In this respect, the ideas underlying this project are by no means new.

Low-emission or, even better, zero-emission technical innovations must therefore be placed at the beginning of the project, so that precisely those economic cycles are set in motion that are best suited to sustainably and extensively halting global warming and reducing it in the long term. This is the central and elementary demand, because this is the only element this project can influence.

With regard to the implementation of the project, the tasks are to compile all accumulated and available knowledge, all expertise as well as the latest findings from all relevant research and specialist areas as well as overlapping fields, to coordinate them in an unbiased manner and to coordinate them with each other in a system-related manner.

[7] Seawater desalination plants have been in use for over 100 years. Of the approximately 19,000 plants currently in operation, most are already in use in regions such as the Persian Gulf and many MENA countries. The acronym MENA stands for Middle East & North Africa. The term refers to the region from Morocco to Iran and is largely congruent with the Arabic-speaking world.

1. Innovative **seawater desalination plants** must be designed, constructed and operated in such a way that they result in a new production process for the production of drinking water. The plants must - as far as possible and feasible - operate with the greatest possible avoidance of emissions (goal: completely emission-free), cause no upstream or downstream damage and be fed exclusively from regenerative energy sources.

   The above-mentioned conditions also refer in particular to the fact that during operation:

- interference with marine ecosystems is prevented, and that no marine animals are sucked in and destroyed,
- avoiding the use of chemicals for the purification of drinking water, and
- corrosion and dissolution of metals is largely prevented by the use of suitable materials.

   The useful, valuable and harmful substances contained in the salt water (salt, magnesium, copper, aluminum, lithium, etc.) are to be dissolved out before or during desalination and, wherever possible, returned to economic use as raw materials.

   Focusing in operations and infrastructure, these requirements extend to the extraction points of the seawater via pumps and the wide network of pipelines, as well as the routing to the irrigation systems, as well as to the new cities, municipalities and enterprises.

2. likewise, the exclusively **renewable energy sources** are to be operated according to the same requirements. Primarily <u>wind</u> and <u>solar</u> energy (photovoltaic and solar thermal power plants) come into consideration here, if necessary, also <u>geothermal</u> energy and innovative sea waterpower plants.

3. As far as possible, feasible and financially viable, the production of storable and transportable **hydrogen** should be integrated into the regenerative energy production. The wind and solar energy available in deserts guarantee an enormous conversion potential[8] for this and enable a sustainable hydrogen economy. In general, investments in the hydrogen economy are very likely to open up global future markets and new value chains. In addition, the energy stored in hydrogen enables the operation of desalination plants even at night (or in the event of a temporary loss of energy sources).

In order to be able to fulfill the maximum possible environmentally friendly conditions, the necessary upstream and downstream sectors and their infrastructure must be included.

4. A widespread network of **pipelines** must be set up to transport the water to where it is needed. Topography, soil formations, differences in altitude and depths must be taken into account, and above all, long distances must

[8] In 1994, the German Aerospace Research Institute (DLR) looked into hydrogen production in the desert. At the time, the 350-kW electrolyzer powered by solar cells provided proof that it was possible to produce hydrogen that could be stored and transported. The available solar resources could provide the same amount of energy on one percent of Saudi Arabia's land area (equivalent to about 2,150 km2) as is exported annually as crude oil. The land area of Saudi Arabia is approximately ¼ of the land area of the Sahara.

be covered with the help of suitably powerful pumps. The optimal routes are to be worked out.

5. With regard to the **reclamation of deserts**, the task is to establish test areas for large-scale agricultural and forestry field trials in the wild under real conditions on sufficiently large areas (if possible, in the vicinity of an initial desalination plant). There, suitable plants are to be planted, irrigated in species-specific doses and their characteristics, growth and vegetation cycles, long-term effects and contributions to maintaining or stabilizing the ecological balance as well as their economic benefits are to be tested intensively.

Common to all areas must be that **economic aspects** are always considered in addition to technical feasibility. If all the above-mentioned conditions are met, the operating, maintenance and upkeep costs must yield an economic return, even if only in the long term. Drinking water must become an inalienable part of the basis of every existence and must be affordable at all times, even for the poorest[9].

Cost efficiency[10], **energy efficiency**[11] and **ecological efficiency**[12] must be taken into account.

The tasks are overwhelming, complex and very multilayered. This is the result of the cycle-consequence-effects described at the beginning and further cycle-consequence-effects, which are associated with the management of the climate crisis in relation to the ecological and economic areas as - quite possible and desirable - side-effects and consequences.

oneWater.earth will be the collection point, the hub, where all strands from all areas of knowledge and expertise converge and are made available to everyone involved and interested in a special database. It will also be the point where information growth and information exchange will take place.

oneWater.earth will be the independent, transparent, if possible, with a mandate from the EU and/or UN, and led by experts from all relevant fields, coordination and planning center for all measures for the implementation and realization of the project.

[9] The right to access to clean water was recognized as a human right by the United Nations General Assembly in Resolution 64/292 on July 28, 2010. However, it is not legally binding and cannot be enforced. However, the enshrinement of the human right to water has a high political priority. Occasionally, a human right to water is also derived from Article 11.1 of the International Covenant on Economic, Social and Cultural Rights.

[10] A measure of the return on investment, taking into account the costs incurred. The more cost-effective a technology, the higher its economic efficiency.

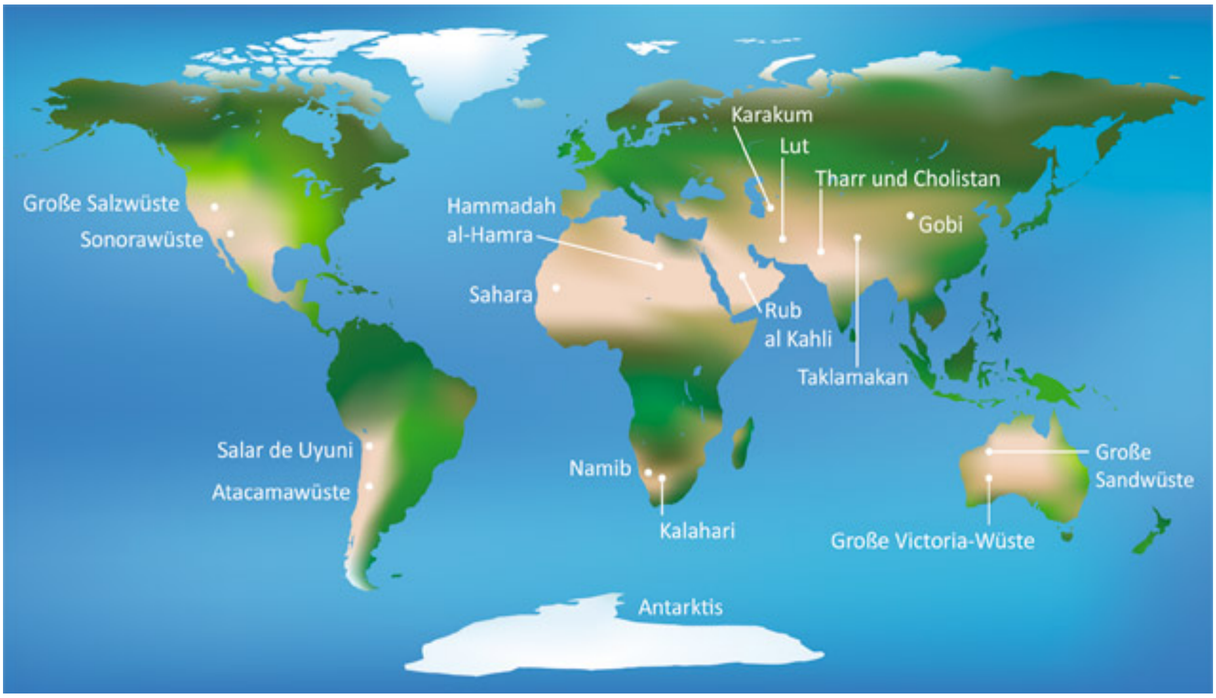
[11] Is a measure of the energy yield, taking into account the energy applied. The more energy-efficient a technology, the higher its efficiency.

[12] Is a measure of sustainability and environmental compatibility. It is calculated on the basis of CO_2 emissions from combustion when, for example, fossil fuels are used in production.

Deserts

About 50 million km² of deserts and semi-deserts cover the Earth's land surface - with an increasing tendency due to the so-called desertification. After balancing the subpolar and subnival regions (cold desert, ice desert, especially Arctic and Antarctic) about 20 million km² of deserts remain for the considerations of this project. The term characterizes areas without vegetation or vegetation-poor areas of the Earth, in which clearly less rain falls than could evaporate (dry desert, heat desert).

The following diagram gives a rough overview of the global distribution of desert regions:



The ice deserts (Arctic, Antarctic, glaciers) are to be protected and preserved as climate factors essential for survival. In this project they play a role insofar as a cooling of the global temperature contributes to their preservation.

All other deserts add up to an area of about **20 million** km².

In this project, we will initially deal with only one of the largest contiguous desert areas on Earth: **the Sahara**.

It is used exclusively as an **example** and is brought to the fore because of its extent and the importance of its eco-strategic location as well as its socio-economic development and growth potential.

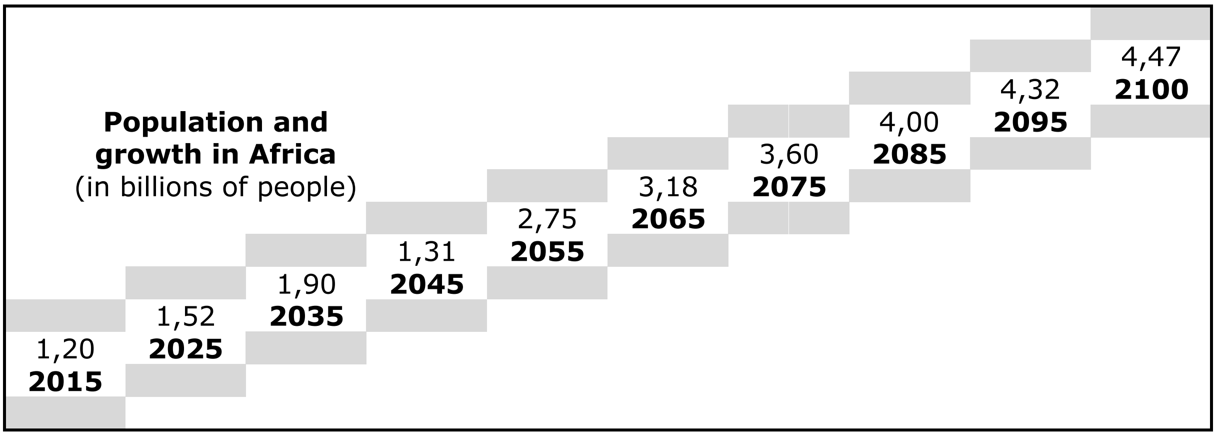
Africa

The population of the riparian states of the Sahara and Sahel zones:

Country	Area (in km²)	Population	Population density per km²
Senegal	196.722	16.710.000	81
Mauretanien	1.030.700	3.850.000	4
Westsahara	266.000	600.000	3
Marokko	446.550	36.500.000	81
Algerien	2.381.741	42.973.000	18
Tunesien	163.610	11.721.000	71
Libyen	1.775.500	6.800.000	4
Ägypten	1.001.450	100.400.000	100
Sudan	1.861.484	42.800.000	20
Eritrea	117.600	5.100.000	53
Tschad	1.284.000	15.900.000	12
Niger	1.267.000	23.300.000	18
Mali	1.240.192	19.550.000	16
Burkina Faso	267.950	20.488.000	75
	ca. 13,3 million km²	**ca. 347 million people**	

The continent of Africa consists of an area of about 30.2 million km^2 and is habitat for about 1.3 billion people. About 44% of the area and 26.7% of the population are distributed among the Sahara riparian states. The remaining area of 16.9 million km^2 (56%) is home to 73.3% of Africa's population.

Africa's population is expected to nearly double to approximately 2.5 billion by 2050. By 2100, the population in Africa will have grown by almost two billion to approximately 4.4 billion people.



In its projections, the United Nations assumes that the fertility rate in Africa will also fall to 2.1 children per woman by 2100. However, because of the very young age structures, populations in Africa will still grow for some time.
The forecast published by the UN (assuming constant conditions) literally forces us to create living, working and food space as a basis of life for Africa's growing population!

The oneWater project also creates the indispensable basics.

Drinking water: consumption, demand, production of a number of seawater desalination plants

Water consumption[13] includes:

- the immediate, essential coverage of needs, as well as the consumption of drinking water,
- consumption for everyday life (personal hygiene, household, washing, cooking, etc.),
- added to this is the amount of water used for agriculture, commerce, industry (process water) and
- as well as the virtual water quantity. "Virtual water" is required for the production of a product (independent of the place of production).

Both demand and consumption vary greatly and depend on many circumstances, the detailed description of which can be disregarded here for the time being. However, the **determination of demand** will be the subject of geological, geomorphological, biological, hydrogeological, sociological, agricultural, constructional and other research and investigations even before the actual irrigation begins.

Of fundamental importance are the questions and considerations of what types of shrubs, trees and plants will be grown, what animals (including population) will be kept, and ultimately how many people will settle. Multi-layered questions have to be clarified, in which the constant feedback effects between humans and nature have to be taken into account, and the suitability and yield of the cultivated food and plants have to be weighed up very carefully.

To illustrate the relationship between water consumption and the number of desalination plants required, consider the following[14]:

Assuming an average water consumption of 3,800 liters a person per day, this results in a corresponding water consumption of 1,385,000 liters (or 1,385 m³) of drinking water per person a year[15].

Assuming a daily production of a desalination plant of 500 million liters (or 500,000 m³) of drinking water per day[16], such a plant will produce 175 million m³ of drinking water per year[17].

Under these assumptions, one plant can meet the drinking water needs of about 125,000 people. To cover the demand of one billion people, about 8,000 corresponding plants would be needed under these assumptions.

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13 Water is not consumed, but only used. Here, however, the usual terminology is used, and water consumption is spoken of.

14 The assumptions and calculations made here are for illustrative purposes only and are intended only to give a sense of orders of magnitude. They are subject to inaccuracies and systemic interactions and depend on a large number of - open, varying and ultimately yet to be determined - factors.

15 Calculated by the World Resources Institute.

16 The Jabal Ali Power Plant and Desalination Plant, currently the world's largest seawater desalination plant, desalinates 2.135 million cubic meters of seawater per day.

17 A year here calculated with 350 days (approximately to account for maintenance days and the like).

If, however, only the factor of the assumed daily water demand per person changes from about 3,800 liters to about 6,800 liters[18], then, with otherwise unchanged assumptions, more than 14,000 corresponding plants are needed to cover the water demand of one billion people.

The range of variation shown here has a direct effect on investment and maintenance costs, and influences the number of jobs at the plants, amortization and return on investment.

However, it has a decisive influence on the continuous course of **drinking water production.**

If the area of the Sahara is habitable, theoretically several billion people can live and work there. However, habitability and usability are dependent on the supply of drinking water.

The time needed to build the necessary plants and supply the areas with water also plays a decisive role.

If only one plant were built and connected each year, it would take 8,000 years to meet the needs of one billion people. If, on the other hand, one plant could be commissioned per week, it would still take more than 150 years.

Even with highly effective production methods and maximum compression of the time it takes to build a plant and start supplying, it is clear that this project will take generations to complete, even with a global effort.

[18] This would be according to A. Y. Hoekstra and A. K. Chapagain, in: "Water footprints of nations: Water use by people as a function of their consumption pattern", Water Resource Management (2007) 21:35-48, page 39, correspond to the average per capita water consumption in southern European countries such as Spain or Greece.

Call for cooperation from the global community

Climate change threatens all of humanity. No state alone can avert this danger. Likewise, the implementation of such a project can neither be accomplished by individuals nor by single sciences alone. It requires the intensive cooperation of all conceivable fields of research, science, industry, technology as well as outstanding engineering achievements. It requires an unbiased, international, interdisciplinary exchange, the bundling of all accumulated knowledge, and should produce new insights, new materials, new technologies, new techniques and new knowledge.

Ideas, concepts and plans only ever lead to success and results if they are also realized through appropriate implementation.

With the help of the concentrated knowledge of this world, driven by tremendous research and innovation power and an energetic will to perform with just as much power, the project can be implemented.

A success finds then best conditions, if it is accompanied by responsible motivation, by ethical, philosophical and empathic, from visionary to utopian thought and remains selfless. If it does not lose sight of the big goal:

To preserve the well-being of the people living today, but above all that of future generations.

Last but not least, it must be supported and sustained by a stable political framework and the provision of appropriately sized financial resources.

While scientists provide political decision-makers with hardly countable proposals for solutions besides enumerating information and facts, the question remains unanswered:

WHO should solve the existing problems and HOW.

This project shows concrete solutions.

Therefore, we call upon all researchers and scientists worldwide from all fields of research and knowledge, all institutes, laboratories and universities, all engineers and technicians to participate in a concerted action for the realization of the project and to take an active part in it.

Attachment 1

To find solutions to the climate crisis, representatives from around the world have met more than twenty times under the auspices of the United Nations. In four decades of committed speeches and dashed hopes, much has been achieved, especially in the minds of the people. However, mankind has not yet made decisive progress towards the goal of stopping global warming.

Thus, the progressive rise in temperature due to natural disasters continues to take a devastating toll in human lives, societal and social upheavals, and enormous (repair) costs.

This project aims to decide the race against time and the race against the greenhouse effect in favor of all inhabitants of the Earth:

1. technical innovations solve the question of water production
2. the preservation of the ecological balance as a self-regulating ecosystem will be restored.

The clear goal of this project should be repeated once again: It is directed at keeping planet Earth habitable for all living beings. To achieve this, CO_2 emissions must be reduced, and carbon dioxide already emitted must be recaptured.

This way is only one solution among many and cannot stand alone as a problem solution. The dimensions and manifold positive consequences, however, which develop from this and open up a multitude of subsequent possibilities, assume a magnitude that cannot be compared with anything that has been set in motion so far.

The sheer mass of available data must be analyzed, and recognizably relevant areas must be connected in such a way that practicable, implementable solutions with avoidable or solvable risks result from it.

In addition to all the theoretical knowledge and all the models and simulations, a great deal of engineering skill is required for implementation in order to lay the foundations for achieving the ambitious goals.

This does not affect the belief that **changes** and **adaptations** in human behavior are inevitable. But before that can happen, attempts must be made to ensure that **active intervention** will meet the needs of achieving the goal.

This paper largely avoids source citations and references. The access to the information of the key findings on the causes and consequences of global warming, which have been worked out on a scientific basis, is available to interested and understanding people of the community of nations almost at any time and almost without restrictions.

From the already immense flood and abundance of reports, forecasts and projections, opinions and scenarios on specific topics of climate change, the special report (the 1.5 degrees report) of the IPCC[19] is nevertheless mentioned here in particular[20] and as well as the publication of the Leopoldina[21] from July 2019: STATEMENT "CLIMATE TARGETS 2030: PATHWAYS TO A SUSTAINABLE REDUCTION OF CO_2 EMISSIONS".

There is a great deal of talk in the scientific and political communities, meaningful and justifiably controversial, about the ways and means to counteract global warming. Worldwide, many measures have already been taken and initiatives launched that focus on this indispensable goal. Nevertheless, not enough is being done - and too often the exact opposite is happening - to stop or reverse global warming.

In the meantime, it has become high time to stop the eloquent invocation of the apocalypse and to take further initiatives. This is exactly what this project is intended to do. The mental penetration of the project leads fast to the (at first frightening) realization that no comparison can be put to the dimensions of this project from the recent history of mankind. Nevertheless, it must expose itself to the race with the remaining time and be realized. Now and without delay!

Seriously undeniable, the climate crisis is a real global threat, affecting all of humanity and all living beings. Concretely, it affects every individual and has an impact on every individual.

Accordingly, the *oneWater.earth* project is of global significance.

In the direct context and in direct interaction with global warming, **water** (in all its manifestations) has a far more prominent, even central, importance. Therefore, the world community must reach a consensus on all stages of this project. Only with a clear majority it will lead to the many predicted successes. Therefore, it takes a lot of courage to make the future possible!

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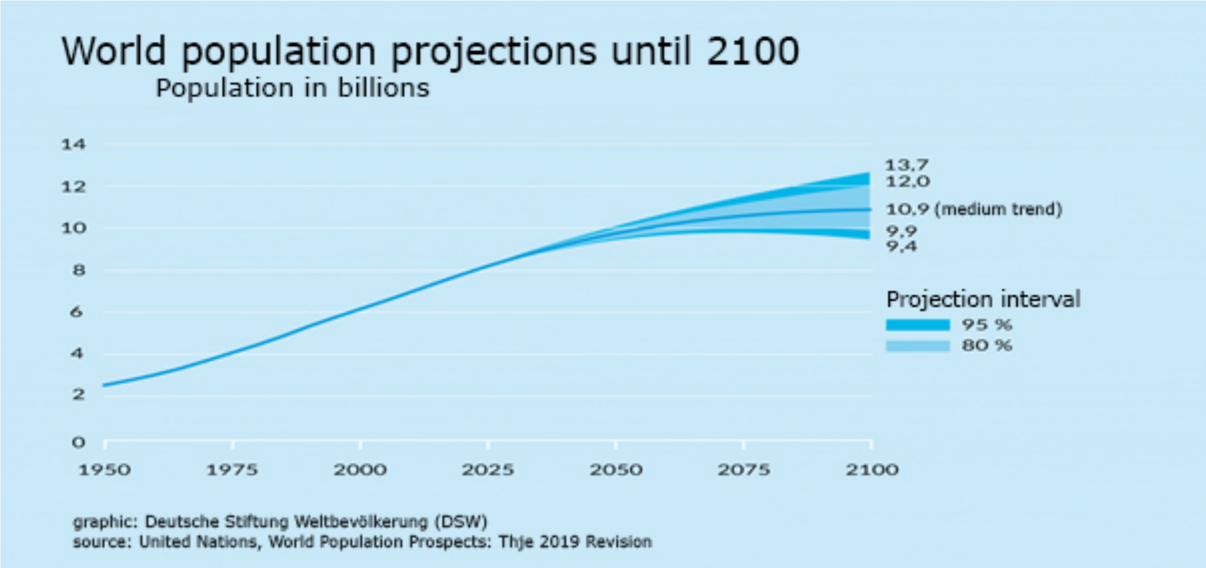
19 The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body that assesses the scientific evidence on climate change.

20 https://www.ipcc.ch/sr15/

21 The National Academy of Sciences of the Federal Republic of Germany, Leopoldina, provides independent advice to politics and society on important issues for the future.

Forecasts

According to a **forecast** by the United Nations, the world's population may still grow significantly by the year 2100.



All over the world, people are naturally confronted with the element of water as the cornerstone of life. Nevertheless, water cannot be taken for granted. Without having to go into the geographical locations here, nearly 1.5 billion people (with an increasing tendency) are struggling with water scarcity.

Reports, models, simulations and forecasts must always consider and include the element water. Both in terms of its performance as an elixir of life and in terms of its potential for danger and destruction. Inevitably, water is a central component of the climate and thus also of its change.

Serious scientific **forecasts** name six systems which are moving towards critical points (so-called tipping points), which can be compared to ticking time bombs and which, without exception, contain water as their core element. Each of them can accelerate the rise of temperature, lead to chain reactions and ultimately to irreversible, fatal consequences for all living beings on Earth:

1. thawing permafrost
2. dwindling sea ice at the poles
3. deforestation and slash-and-burn of primeval and rain forests
4. methane hydrates on the ocean floor
5. carbon uptake of the sea
6. the slowing Gulf Stream

The aforementioned forecasts, many of which are already perceptible, noticeable and even visible, mean horror scenarios with catastrophic, irreversible consequences for the world population, as well as for fauna and flora. Nobody knows whether they will actually occur. We deliberately refrain from describing possible consequences here, although they are considered very likely if the climate continues to warm.

The central obligation of our time is to contain and stop global warming, not to exceed the 1.5-degree target in the medium term and, if possible, even to reverse it.

The realization of the *oneWater.earth* project provides significant solutions with the construction and use of seawater desalination plants, which are directly related to the aforementioned problem circles. In the long term, they counteract global warming.

The *oneWater.earth* project is also initially a **projection** whose effectiveness and penetrating power must be proven.

Construction of a prototype plant

In order to be able to prove that a seawater desalination plant as well as its upstream and downstream sectors and components can function and be operated according to the required criteria under technical and also economic aspects,

- exclusively operated with renewable energies
- completely emission-free
- as well as residue-free, environmentally friendly disposal or economic utilization of useful and harmful substances produced

the construction of a prototype plant is necessary.

Such a plant, which is also highly efficient, is to be used to test the relevant technologies under real conditions and to achieve a lasting economic benefit. To what extent established technologies can be used, modified if necessary, coupled or combined, or to what extent a completely new, to some extent revolutionary innovative technology can be developed through synergies in order to achieve all the targets, must be set as a task for the relevant experts and designers and solved by them.

According to the present state of knowledge, none of the established process technologies seems to meet the deliberately high demands in such a way that they can be used. Tried and tested techniques often remain at a status quo and undergo only limited further development, but this is not evaluated here.

If necessary, other materials, new or to be newly developed for the specific use, as well as new, possibly modular construction methods with low land consumption, can be used, which can be tested on such a model plant by unbiased experts.

The primary goal of the *oneWater.earth* project is to make a substantial contribution to reduce global warming, must not be lost sight of at any point.

Agricultural Experimental Fields

It is known from studies and soil samples that deserts, especially the Sahara, were fertile thousands of years ago. Statements about how this condition can be restored and how deserts can be transformed into landscapes that are both beneficial to the climate and productive to the economy cannot be made in general terms.

Reasonable answers are directly related to the particular soil conditions and the artificial supply of fresh water, natural rainfall and vegetation cycles. Even in deserts, one must assume that soil characteristics, hydrogeological conditions, other environmental conditions, and interactions will differ. Not every arid area will be suitable for renaturation (scree deserts, mountains, etc.). Therefore, regional strategies need to be developed, exploring which diverse plant species can thrive at which dosage of water supply.

This requires appropriately sized experimental areas to conduct suitable field trials, ideally located in the immediate vicinity of desalination plants to keep infrastructure costs low. Priority should be given to researching which plant species are best suited to form humus and withstand sand drifts through deep root development.

In addition to the construction (development) of a prototype plant for seawater desalination, it is no less important to establish experimental fields at the same time as the first drop of water from this plant, with the aim of transforming the deserts back into fertile landscapes.

Water scarcity, water stress

The total amount of water in the world cannot be used. On the other hand, the amount of potable water is decreasing and has already reached its maximum worldwide. In many regions, water resources are being used more intensively than is sustainable in the long term. As a result, one third of the world's largest groundwater systems are under threat.

In addition, human demand for water has increased six-fold since 1930 and is forecast to continue to rise. This is mainly due to the fact that the world's population has grown - more people require more water, not only for drinking and washing, but also for consumption and economic development. Since the 1980s, water consumption has been rising worldwide by about one percent per year for these reasons. This trend is estimated to continue until 2050.

Over the past 50 years, population growth and economic development have led to a huge increase in freshwater demand, primarily for crop irrigation. About 70% of the world's pumped groundwater is used for irrigation. Nearly half of agricultural irrigation depends on groundwater. The problem is that in many places more water is withdrawn than can be replenished by rainfall, which endangers the ecosystem: if groundwater levels fall, extraction costs rise, and ultimately crop failures due to drought lead to an increase in food prices. When wells (up to 300 meters deep in the U.S.) dry up, it can threaten food security locally and up to the global level.

Riverbeds around the world are in danger of drying up, especially in regions where groundwater has been pumped for years and decades. This has dramatic consequences for ecosystems: It is visible that fish and plants die when there is no more water in the river. Even drinking water supplies are at risk. Freshwater ecosystems are sensitive to even a relatively small drop in groundwater levels, although the extent of groundwater depletion often only becomes apparent decades later.

Population growth is accompanied by increasing demand for water, making it almost impossible to encourage agriculture to use water sustainably. After all, plants - and water - are always at the beginning of long food chains.

Of course, an unlimited supply of desalinated seawater should not only serve the renaturation and reforestation of deserts. Seawater desalination plants can also be used in other regions of the world to end the precarious situation not only for agriculture, but also for industry and all other consumers that need water to survive. Up to possibilities to not only extinguish forest fires (e.g., California, Australia) but to prevent them by seasonal or preventive humidification of the soil.

After all, under the aspects mentioned above, the widely branched and powerful pipeline systems can and should supply all areas that require drinking water: agriculture, industry and municipalities up to large cities. The extraction of groundwater can be eliminated, and groundwater levels can rise again, which contributes to a sustainable recovery of endangered ecosystems and restores the balance.

Another not insignificant aspect is that conflicts over water supply among people, groups and nations do not arise in the first place but are prevented by the availability of water.

Rising seawater, sinking groundwater, lacking or excessive precipitation (which the soils can no longer absorb or store) as well as drying up surface waters represent potential dangers for people, which can be counteracted, both prevented and compensated by the realization of this project, namely the sensible use of desalinated seawater.

Societal, economic and socio-economic Components

The achievement of the primary goal is accompanied by or results in a number of secondary and consequential goals. New green lungs (forests) and lifelines (water, pipelines) for the world's climate also give rise to a variety of business sectors.

National and global political dimension

Deserts belong to the territorial possessions of sovereign states and are subject to their respective sovereign rights. They are therefore not directly at the free disposal of the global community. Against this background, it is essential to obtain consent for their use as climate projects.

Utilization in this context means first of all the long-term, permanent and sustainable, fundamentally positive impact on climatic conditions and the global living conditions of people.

At the same time, the realization of the project also creates a number of value chains from which the countries concerned can derive economic benefits.

From the very beginning, the project has been shaped by national and global political dimensions. It is thus the task - and at the same time the obligation - of the (political) world community and community of values to create the appropriate conditions for implementation and thus to create space for those willing and able to act.

This project offers politics an almost unique opportunity to achieve a historically outstanding feat in an unprecedented act of solidarity. This chance must now only be used.

A realization of the project is therefore also dependent on corresponding political will formations and must be supported by a common, permanently stable, project-related integrative political will power when it comes to those countries that do not have their own access to marine waters. Neighboring countries must allow "transit routes" for the pipelines.

Thus, an undertaking of this magnitude necessarily requires consensus among all stakeholders. It is conceivable that it will not be easy to negotiate bi- or multilateral agreements, ownership and usage rights, and consistent supply obligations, and to conclude them in a resilient manner with lasting legal force even in crisis or conflict situations. It may be necessary to establish protection zones to secure the "waterways" (the pipelines) on one's own territory and for foreign territory.

Disadvantages/negative experiences. No intervention without side effects.

Part of the effort to provide objective information in connection with the project is that failed projects are not concealed and/or downplayed. Lessons as well as opportunities to gain useful experience and to exclude repetitions open up from failures suffered.

On the one hand, desert sand soaked by precipitation is surprisingly fertile because the mineral nutrients have not been washed out. On the other hand, minerals dissolved in water remain as salts and prevent vegetation.

Continuous irrigation can therefore cause damage, but drip irrigation can provide the exact amount needed for the plant to thrive and grow.

Decisive reforestation with deep rooting should prevent sand movement due to strong winds and storms so that land can be made arable in the first place. As a result, less iron-rich and phosphate-rich desert dust can fertilize phytoplankton in the oceans, which form the base of the food chain for all marine life. At the same time, lots of plankton binds lots of carbon dioxide. Nutrient "supplies" due to sandstorms are also diminishing for the Amazon rainforest.

The desalination process produces toxic residues and harmful substances, e.g., vast quantities of highly concentrated so-called brine (brine solution). The way of "disposal" so far poses an enormous, reckless threat to marine ecosystems. Science and research are already recording initial successes in solving these problems and may even be able to turn unavoidable by-products into useful economic assets in this project.

These few examples illustrate the intensive systemic interactions that must be considered and researched. Therefore, the latest knowledge from all fields must be incorporated into the realization of this project.

Man-made reclamation (renaturation, revitalization) can be described as relatively harmless "remedial work" if indispensable imperatives are placed before all thoughts and actions:

Any intervention in nature must anticipate feedback effects as well as interactions of all kinds. Every measure must be carried out extremely carefully and cautiously. Wherever impairments, damages and disadvantages are unavoidable, they must be compensated for with the greatest possible efficiency. In any case, the aim is to prevent catastrophes - even if these may only be in the distant future.

The implementation of the project raises not only purely scientific and technical questions, but of course also moral ones. It must be left to the countries and nations concerned to weigh up values that are perishing against possible values that are emerging, according to their own points of view - and then to decide.

Migration

Not only in terms of mitigation and long-term reversal of global warming, but also in terms of

- the **growing population**,
- the **stabilization of the food chain** as a basis for national and international supply,

and

- **migration**, a geopolitical problem that urgently awaits geopolitical action,

the implementation of the project enables many positive consequential effects.

By greened desert areas solid, exceptionally sustainable jobs are created as bases of life in an almost unimaginable dimension, which in turn cause out of themselves complete chain reactions of again positive changes.

First of all, jobs are created at the individual seawater desalination plants as well as the associated plants for energy production. Workers, engineers and scientists will be employed there (and junior staff will be constantly trained) for the construction, ongoing operation, maintenance and further development of these plants and their associated laboratories for controlling the water.

If the number of people working at the new, efficient desalination plants is [arbitrarily] estimated at 50 employees per plant, then an assumed 8,000 plants would create 400,000 secure jobs, corresponding to 1.2 million in a three-shift operation.

As a result of the settlement of this stately number of people (and their families), localities with a lively community and everything that naturally develops from it are created.

A very wide network of pipelines and efficient pumping stations, even finely branched in its extensions, has to be built, monitored, controlled, managed and maintained - and requires countless jobs. Long distances [up to approx. 2,500 km] have to be reached and great differences in altitude overcome. At the same time, pipeline construction can integrate important elements of currently non-existent [or inadequate] new infrastructure: Roads, railways, supply networks and media (power and communication lines, fiber optic cables, etc.).

The extracted fresh water will be directed through the aforementioned pipeline system to currently barren areas. The subsequent irrigation will create landscapes and agriculture with fertile fields and diverse vegetation, which will provide many people [and their families] with work, bread and a decent living.

The project, which is not limited to the Sahara, will considerably reduce or even eliminate the causes of worldwide migration [destabilization of societies; also, to be included are environmental refugees as a result of desertification].

As a result of the aforementioned measures, diverse job opportunities and lively infrastructures are emerging in landscapes that are now still barren:

Urbanization requires schools and a comprehensive education system, hospitals and a solid health care system, administrative offices, production facilities, industrial plants, trade, handicrafts, markets, stores, hotels, restaurants, etc. (each with apprenticeships) that provide people with a sustainable source of income and livelihood[22].

The water supply as well as the importance of the quality of the water must therefore also include future urbanization in all considerations. After all, drinking water must be carried to the last tap.

It only makes sense to produce water of a consistently high quality: Drinking water[23]. Producing different water qualities requires a disproportionate effort, especially with regard to the huge network of pipelines and their associated infrastructure.

Jobs will also be created [or preserved] at the sites or production facilities of the industries involved in the execution of the project.

While a number cannot yet be precisely quantified, it can be assumed that a significant number of crisis-proof jobs will be created.

In conjunction with the high demand for equipment, correspondingly high production capacities will have to be built up, which could create jobs and training positions in the order of hundreds of thousands.

- Ongoing research and development in all areas
- Prefabrication of desalination plants (for on-site assembly)
- Prefabrication of energy-generating devices
  [wind turbines, solar cells, etc.] (for on-site assembly).

Conclusion: infertile soils not only deny people their habitat and livelihood. They affect the entire economic performance. Conversely, where there is no livelihood, people look elsewhere for their livelihoods.

oneWater.earth project shows possible solutions to reverse these processes. Soil must not be exploited at any price, but high-quality topsoil must be built up and preserved through more sustainable soil management. Where appropriate awareness is lacking, it must be developed through general and specific education and teaching. Targeted research and extension in these areas can help preserve soils for future generations.

Particularly valuable areas must continue to be protected in the future and must not be used for intensive agriculture or settlement areas.

Halting global warming by sequestering greenhouse gas emissions in trees will help improve environmental conditions for these areas.

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[22] With corresponding tax revenue for the individual countries.

[23] It cannot be estimated to what extent the seas are already so contaminated by dumping (garbage, pharmaceuticals, plastics, toxins, heavy metals, etc.) that conversion to drinking water and its further use could be endangered. It must be examined whether the existing analytical methods are sufficient to identify and neutralize all hazardous substances that endanger humans, fauna and flora, so that the water obtained in this way can also be introduced into the food cycle as drinking water without hesitation. This is an important additional field of research. Dealing with and avoiding waste is a task and an appeal to mankind that can only be remembered in this context.

Attachment 2

Financing 1

Before presenting an overview of the costs of the prototype plant, the experimental fields and the actual project, in each case including the upstream and downstream facilities and associated infrastructures, and discussing financing issues, payback and return on investment, it is necessary to address considerations of a fundamental nature, which are due to the special nature of this extraordinary project and must be put first.

The ecological balance of our planet has undoubtedly been destabilized by human activity. For the sake of constant economic growth, the Earth has been and is being exploited, the atmosphere and the oceans are being polluted, the climate is still being heated up and the extinction of species is being further promoted. Despite all knowledge of the devastating consequences of CO_2 emissions, their increase has still not been reduced to meet the 1.5-degree target. The extent of the danger is known and predictable: it threatens the very existence of mankind.

Again, it is in the hands of human beings to protect themselves and the fragile biosphere, to initiate the end of destruction and to change things, conditions and situations in favor of ecological stability.

- All investments that promise a "more" (in growth, in profit) for today and possibly a short period of time, ignore the possibility or danger that a "less" (at worst "nothing") remains for following generations[24].

- Conversely, investments in the future (here specifically in the greening and reforestation of deserts[25]) take part of the burden of inheritance off the shoulders of future generations, for which they are not responsible, but which they will very well have to bear if the decision-makers responsible today fail to act. Whoever finds the formulation "generation" too distant and too abstract, may replace it by naming his own children and grandchildren. Who would not want their children and grandchildren to fare well or even better than oneself? If, on the other hand, the possibility or danger of an ecological apocalypse is ignored, then their future is endangered to the highest degree.

- What is the use of all the knowledge, all the vast amounts of data, all the ever more precise forecasts, realistic horror scenarios and the daily reports of catastrophes, if the inevitable consequences are not finally and immediately drawn, indispensable initiatives are not taken and implemented? Were all the researches, investigations, expeditions, efforts and privations of all the scientists and engineers - and the costs spent on them - wasted, are they useless?

[24] Example: What (economic) future lies ahead for oil-producing countries when finite sources have dried up or oil is no longer needed (or not in today's quantities)?

[25] Example: For the countries bordering the Sahara and for countries on the Arabian Peninsula, an almost ideal opportunity to become a guarantor of food security for the world's population.

- Should we really watch and wait for the polar ice caps to continue melting until "land under" is reported? Both have long since become visible and tangible reality. The human imagination should be sufficient and one should not have to wade knee-deep in water oneself - even as an inhabitant of high-altitude Earth formations who is not directly affected - in order to be able to recognize that the time pressure alone requires unprecedented, quite enormous efforts and investments in technology and infrastructure to avert the heating of the Earth with all its destructive consequences - with luck perhaps not already for us, but certainly for the children and grandchildren.

- According to many voices, a further rise in temperature can only be prevented by immediate and radical changes in behavior. Radical cuts in human behavior (and in the economy) to achieve climate change are probably difficult to imagine because they involve significant sacrifice (of actual or perceived wealth, privilege). They are unlikely to be implemented without considerable resistance. They must be brought about with patience and caution (even in the case of political majorities) and can only take effect slowly. What profound and very expensive consequences radical influences entail is illustrated to mankind by the Corona pandemic. One does not wish to look into its grimace again. In its radical manifestations, the change of human behavior is also not necessary, because the implementation of the project grants a period for gradual adaptation.

For the paradox of this project is that, in equal parts, neither radical social nor economic or political sacrifices need to be made to prevent ecological collapse, nor do opportunities arise to restore the Earth's ecological balance.

Opportunity 1

Greening up to 20 million km^2 of the Earth's surface will slow, stop and eventually even reverse the greenhouse effect. This will keep the Earth habitable.

Opportunity 2

At the same time, up to 20 million km^2 of surface area will be created for people to settle and find their jobs and living space.

Opportunity 3

Where people can live and work, purchasing and economic power, consumption and thus markets are created.

Opportunity 4

Up to 20 million km^2 mean an enormous, a last remaining, naturally developing economic space and growing market on Earth.

Opportunity 5

Implementation of the project requires patience and time. A period of at least two to three generations will allow people to adapt to the necessary changes in previous lifestyles and behaviors in such a way that no further damage is done to the biosphere and then no radical measures need to be taken.

Instead of taking the axe to growth and jobs, the project creates jobs and growth. To quote figures would be speculative, nevertheless both areas will reach significant sizes in the long term.

Of course, the caveat must be made that this is a long-term project, and the projected effects will take impact with a corresponding time lag. This does not apply to the industries directly involved in the project, which are certainly significant, but it does apply to all those areas for which the numerous existences of people (in the sense of consumers) are a prerequisite.

Against this background, questions about the financing of the project[26] are basically self-answering: It is the natural responsibility of the global community. It also has the necessary instruments and financial resources[27] at its disposal. Neither the containment nor the reduction of the world's climate can be negotiated any longer. The attempt to regulate the climate in such a way that the Earth remains habitable is first and foremost a global task and effort. So, there is significantly more at stake than "just" money. We must not lose sight of the goal, nor allow it to be obscured.

In view of the importance and urgency of the matter, the key points should be briefly summarized once again. It must also be repeated that if we fail to act, global warming will accelerate at perhaps breathtaking speed, and the resulting consequences will restrict people's lifestyles far more than any environmental regulation or moderate measure could achieve now.

- The primary goal is to stop the global temperature increase. Thereby, a multitude of positive consequential effects result, according to which numerous people find manifold possibilities to build up their livelihood.

- It is imperative that the implementation is designed in such a way that the biosphere is not disturbed but restored and kept in balance.

- The project itself can only be started after all ideas, thoughts, considerations, experiments and findings have been checked in the testing phase of science and technology in respect to the project suitability and with regard to compatibility with the interrelationships and effects of the biosphere and have been illuminated and weighed up to the last corner.

- From a (classical) investor's point of view, a purely economic return only begins to take effect after a few years. The seawater desalination plants are, as basic requirements, the instruments that enable uncounted (also economic) benefits and advantages for the whole mankind in the long run.

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[26] From the prototype plant to the test fields and the actual implementation of the project

[27] World Bank and IMF. Another example is the UN Convention to Combat Desertification, UNCCD (1996), which imposes binding financial obligations on signatory countries. In fiscal year 2012, the World Bank provided US$53.5 billion for projects in developing countries. There should be no question that an informed global public will mandate the aforementioned institutions to finance, promote and support these projects through appropriate funding. But also funds from national resources can/should be used. As an example, a German commitment is to serve: The Moroccan DESERTEC project is supported by the German Kreditanstalt für Wiederaufbau (KfW) with 800 million Euros. Furthermore, a pre-pandemic announcement from the Federal Ministry of Finance of the Federal Republic of Germany dated 08/08/2019 indicates that "substantial financial resources are available" in the Energy and Climate Fund to finance possible measures.

The predicted results serve uniformly the world community and achieve - apart from the climatic and many other effects - in the long run also private and/or economic benefits. Thus, new areas of competence are responsibly developed for the future and jobs are preserved or created.

To recognize this and to finance it for a certain period of time, which can certainly be calculated when reliable data and figures are available, is the duty of politics - in cooperation with the sciences, industry and technology. Strong political commitments have already been published for the global community. It will be crucial for politics to work hand in hand with private actors in industry. If the project were to fail solely because of the question of financing, it would be tantamount to a political oath of disclosure, an unjustifiable declaration of bankruptcy.

The steadily increasing use of seawater desalination in itself proves that this technology is a costly and complex, but entirely practicable water resource that is available in unlimited quantities, free from the fluctuations of precipitation.

The previously formulated demands, requirements and conditions are prerequisites that undoubtedly present themselves as high hurdles for the tasks with regard to the consequential effects of the overall project. They can only be coordinated, overcome, solved and achieved in an intensive, ambitious, committed, highly motivated, appropriately funded and goal-oriented cooperation of research, science and technology.

From the Leopoldina, a recommendation [related to the transformation of the energy system] may be quoted and may well be transferred and extended to the overall project, because it is of course fully valid for this project as well:

"A key partner for the execution [of the energy system transformation] is industry. However, no single industry currently exists to handle this task. Therefore, a cross-industry dialogue is necessary. This process, as well as the mobilization of the necessary substantial capital, are tasks that policymakers must now shape directly. Otherwise, the conversion could come to a standstill beyond experimental plants."

The financing of such a solidarity pact in favor of the living beings of this Earth can become a gigantic task and very probably mean an enormous, never known expenditure of energy, stretch over generations and only in generations "pay off", i.e., amortize themselves only time-delayed according to purely economic criteria.

Even if it is not possible to come up with a (conventional) financing model right from the start, because unknown costs still have to be determined and only approximate or estimated values can be provided at this point in time, there must be no doubt that even a ludicrously high investment will pay off in the end. It can be taken for granted that enormous investments will be cheaper for the world community in the end and economically more sustainable than all the repair measures to the damage that has already been done and will almost certainly be done in the future.

In addition, everything has to be financed step by step, is not due all at once and, of course, is linked to the corresponding feasibility or its success, which can essentially be determined and then calculated from the prototype plant and the test fields. This ultimately makes financing predictable and calculable.
In view of the tasks and goals, the question of raising money may not be a minor matter, but it must become a self-evident fact[28].

But even if financing according to conventional market-economy models should not pay off[29], one must raise at least two, perhaps decisive questions:

- whether financing and calculation models are appropriate at all in considerations of a safer continuance of man and nature,

and

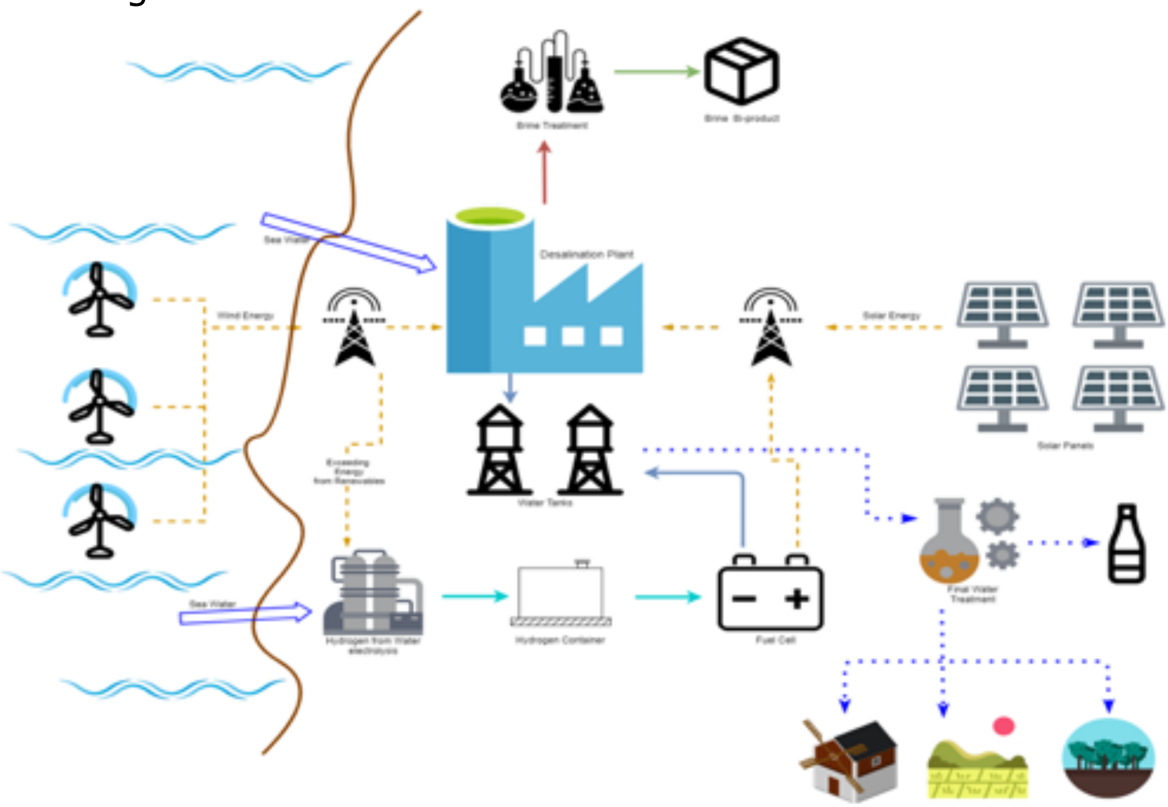
- which rapid alternative means, and ways are available, if one wants to exclude or prevent destruction and annihilation of the basis of life of a large part of the Earth's population and of future generations.

Money can flow into a trust fund exclusively created for this purpose. The money will be spent according to certain criteria, which have yet to be defined in detail, and primarily for targeted investments in research and development of new desalination plants and energy sources to companies that are demonstrably willing to innovate and act, and at the same time qualified.

The project is certainly very big, but in view of the pressing problems and the dwindling ecological carrying capacity of the Earth, it is certainly not too big. The implementation of the project is such a gigantic task that one can indeed shy away from it. However, this would be too short-sighted and would not help future generations and the growing world population any more than it would solve water stress, world hunger and migration issues.

[28] The "Green Deal" announced by the EU could be a powerful lever to use for this project.
[29] Appropriate experts should feel called upon to prove the opposite.

Financing 2



Schematic representation of a plant complex and its consequential effects (Cesar Meneses).

As mentioned before, an exact cost calculation cannot yet be performed, since a large number of still unknown factors are not yet available, some of which have to be determined more precisely at the prototype plant and the agricultural test fields.

Nevertheless, an overview of the costs and an outlook on the economic prospects of success will be attempted. Only rough figures, approximations, estimates and (if available) comparative values can be used.

Investment / added value

Three cost sectors can be assigned to the project, each sector being independent.

With regards to

- the respective one-time investments and ongoing operating costs
- as well as with regard to continuous value creation

they are to be regarded as a unit. They are mutually dependent and largely draw on the same sources, also with regard to possible debt service[30].

[30] Interest and redemption payment of a debtor for its liabilities

Cost sectors				
1	2	3		
Desalination plants	**Energy**	**Pipelines**		
		a	b	c
Intake stations, Desalination and wastewater treatment plants, delivery to Pipelines	Solar & Wind Power, Geothermal Power, Hydro power, Hydrogen	reforestation	Municipal, industrial and private use	Agriculture economy

Cost sector 1: Desalination plants

The one-time investment costs (in each case) for a plant with a daily capacity of 500 million liters can be estimated[31].

Capacity:	624.000.000 liters/day; 26.000.000 liters/hour
Technology:	Reverse Osmosis (RO)
Power consumption:	2 bis 3 kilowatts/1.000 liters (estimated)
Service life:	26,5 years

The investment cost of the SOREK plant was about US $ 500 million (about € 450 million). It should be possible to reduce the costs significantly by using an emission-neutral and energy-saving plant designed from scratch (claim/requirement for the technology).

Without taking into account the (one-time) research and development costs for a prototype plant (later under **cost sector 0**), an amount of **€400 million** per plant[32] with a useful life of 25 years should be estimated here.

In very simplified terms, the economic efficiency or value added from the costly desalination process is as follows:

1	Revenue	generated from the sale of drinking water
2	./. Expenses	for construction, operation and production costs
3	=	revenue (defined here exclusively to cover the fixed and calculable variable costs)
4	plus	markup / margin
5	=	Profit

It is inherent to every production process that production takes place before sales. Drinking water must first be produced as a product before it can be sold to customers. Therefore, before revenues flow, there are expenses that have to be financed.

In the implementation of this project, the special feature is that, with the help of suitable plants and specific irrigation, topsoil must first be created, which in itself does not yet produce any yield (at least if it is not marketed as such, which would, however, contradict the objective of the project).

31 An approximate value is provided by the SOREK plant, a highly efficient desalination plant commissioned in Israel in August 2013: https://www.hutchisonwater.com/projects/sorek/

32 This value refers to the construction costs and components, not to the construction of the pipelines.

Only after a time delay trees (forests) do grow on it, which in turn form the basis for new ecosystems by binding CO_2, producing oxygen, releasing moisture and in this way having a regulating and temperature-lowering effect on the climate, as well as serving as protective walls against sand drifts. It remains to be decided to what extent these are useful woods that will only yield a return after decades, or whether a primeval forest will develop on the topsoil that will serve exclusively as a green lung for the biosphere and only yield indirectly, or whether deforestation-free agriculture can be practiced there - or a combination from whose various components ecological and economic benefits will arise.

In other areas, however, agricultural land or agroforestry can be created, which also require topsoil, whose plants must be irrigated and go through the growth and vegetation cycle, and - albeit in a shorter period of time than trees - lead to a correspondingly delayed yield through harvesting and sale of the fruits (or via food for animals).

A third area for traffic routes and settlement areas must be considered. Water is also needed for these, even if not initially in the form of irrigation for plants.

Roughly divided, there are three potential "consumers" for desalinated water:

Nature	Agriculture & Forestry	State / Community
Trees, forests, CO_2 sequestration, Oxygen production. Guarantor for life, but itself destitute.	probably classical form, but "new land"; money flow only after revenue is generated.	The "state", which provides roads and building sites for people, industry, handicrafts, hospitals, schools etc. Financing only later via tax revenues.

Depending on the prioritization of a target parameter (e.g., global warming requires the most extensive reforestation possible), the weighting changes to the detriment of another target variable (e.g., settlement, jobs, food production). This will depend on one hand on the advice and forecasts of science, on the other hand on the parties involved, i.e., the financing world community on one hand and the ideas or utilization plans of the respective sovereign on the other hand. In the course of time, the weightings can also shift.

According to the statements made under "Financing 1", the world community finances the project on the premise that global warming will be halted and reversed in the long term. If the predicted successes materialize, repayment becomes obsolete because the world community will also receive long-term financial inflows from the greened areas.

Consequently, the purchaser "nature" must be exempted from repayment of the financing. It has already been pointed out elsewhere that water demand or water consumption cannot yet be represented. Very probably the quantities will vary, so that also arithmetically an imputed allocation is not possible from the outset.

Depending on the allocated or available area for the other consumers, it is possible to consider in which ratio and in which order of magnitude capital service is to be provided. Over what period of time and with what quantity irrigation has to be carried out until the first yields from harvests (or tax revenues) flow and water consumption can de facto be paid for, can only be assumed here, but not reliably represented.

The basic prerequisite is always that revenues are generated that are higher than the contribution margins, i.e., that they result in profits. This can be assumed, as existing desalination plants provide impressive evidence to this effect.

It is not necessary to decide here on the amount of the surcharges on the revenues, which then result in the profit. Determining this remains a matter for the operators of the plants or the sovereign. Profits are always subject to market economy laws (mostly represented by competitive prices), depend on competition and also on whether the customers/buyers can pay the price.

Cost sector 2: Energy

The energy costs are part of the production costs. Only renewable energy sources can be considered for the project. In desert regions, photovoltaic, solar and wind power plants are the primary options.

The question arises whether each desalination plant needs its own energy plant or whether several desalination plants can be supplied simultaneously.

This is then followed by other questions concerning land use, capacity (the power required by the desalination plants and the pumping stations for the pipelines and the maximum possible power level), location[33], safety, and distances and routing, each of which form separate cost centers.

As with desalination plants, capital costs (construction costs) are incurred only once in each case. Apart from low operating costs (for personnel, maintenance and repair), no other costs are incurred. This is because wind and solar power, the actual energy suppliers, are available permanently and free of charge. They cause neither waste nor emissions.

Depending on power requirements and performance, surplus or free energy can also be supplied or sold to customers other than the desalination plants and their peripherals.

Based on current knowledge, energy costs represent the highest single item within operating costs, accounting for approximately 44% of the total. The same demands that are made on the development of desalination plants in terms of efficiency and cost reduction must also be made on energy producers. It would have to be possible to reduce energy costs by at least half.

The more the costs of production are reduced, the more consumption-friendly and favorable the sales prices can be.

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[33] If possible, energy sources should be built on terrain that is less suitable for other uses (e.g. in mountainous regions or offshore).

Cost sector 3: Pipelines

As previously stated, water must be delivered to points of consumption via pipelines. Pipeline systems must be designed so that their intake and capacity are commensurate with the volumes of water that must be transported and distributed.

Here, questions have to be clarified, e.g., concerning the material: What is the appropriate material in terms of durability (wear, service life, multilayer composite pipes), compressive strength, load-bearing capacity and flow properties; what are the optimum dimensions that the pipes must have (length, diameter, transport); stockpiling, storage and replacement also play a role, as do the issues of above-ground or underground installation (maintenance, repair).

No comparative data are available for the parameters mentioned, so they can only be estimated very roughly. Of course, the routes (the distances), subsidiary branches as well as the number and required power of the pumps become essential cost factors.

Total cost sectors

Despite the large number of unknown parameters, the financing (or pre-financing) world community should at least be given an order of magnitude, the amount of which is calculated somewhat above the sum to be raised but can be regarded as close to reality.

Whether or not the plant complexes themselves have to generate profits makes sense in view of, e.g., the running times, so that a subsequent complex can finance itself, but may be left open for the time being.

However, it will take years before financial returns are generated through real sales from the supply of fresh water, the product of the plants, to the customers.

So that the world community is not additionally burdened with the running production costs apart from the unique construction costs, this not yet more exactly definable period should be bridged.

The plant complexes actually have possibilities at their disposal, which (at least) cover the running production costs.

One-time **expenses** per plant complex			
Cost sector 1 Desalination plant	Cost sector 2 Energy plant	Cost sector 3 Pipelines/Pumps	**Total**
each one-time construction costs (free area)			
	- 1 billion €		
	(provides 4 plants)		
- 400 Mio. €	- 250 Mio. €	- 200 Mio. €	**- 850 Mio. €**

ongoing **maintenance and operating costs** = **production costs**			
per 1.000 liter			
(Calculation basis: 500 million liters daily production)			
- 0,300 €	- 0,075 €	- 0,010 €	**(= - 0,385 €)**
per year[34]			
- 55 Mio. €	- 13,7 Mio. €	- 1,9 Mio. €	**- 70,6 Mio. €**

Revenue[34] from water sales	
per 1.000 liter	0,40 €
per year	**73 Mio. €**
Surplus (income less expenses) **per year**	**2,4 Mio. €**

The sales price per 1,000 liters of water is deliberately calculated at only 1.5 €cents above the cost price.

This price takes two aspects into account: As already mentioned, the "Nature" customer must be supplied free of charge on a permanent basis.

In the case of the "agriculture and forestry" customers, it is taken into account that, in the long term, significantly more food can or should be produced than is required to meet national demand. This "surplus production" is then to be made available to the world community in order to be able to secure global food requirements. However, the products must also be offered at competitive prices.

From this point of view, low production prices acquire their fundamental importance. The lower these prices are, the more favorable the selling prices can be.

With regard to the general financing of production costs (and also for debt service), several alternatives are available as sources of income.

If additional withdrawal facilities (filling or dispensing plants) are attached to the **desalination plants** from the outset, then drinking water (possibly refined) can be filled into suitable containers (bottles, etc.) and distributed on a large scale either to or via an independent distribution network, e.g., under the "*oneWater*" brand.

If only 0.25% of the annual production (around 400 million liters) is sold in suitable containers at, for example, €0.20/liter (which of course then also includes the costs of the filling plant and water itself), then this could be used to build up an additional source of income with a gross profit of around €100 million per year[35]. (The pure production costs amount to 0.0004 €/liter).

[34] The costs are based on a plant with a daily output of 500 million liters and 365.25 days/year; the revenues, on the other hand, are based on 350 days/year (see footnotes 16 and 17). The amounts are rounded up for costs and down for revenues.

[35] For the calculation, see the assumptions in footnote 34.

If the **energy plants** are dimensioned from the outset in such a way that additional customers can be supplied via the desalination plants and pumps, this can also result in a lucrative source of income.

Ultimately, a correspondingly profitable **hydrogen** economy can be established with a hydrogen production plant. Hydrogen could also be used as a battery system to store energy, that could be used to power the desalination plant whenever other renewable sources of energy are low or missing.

The cost calculation does not yet take into account a debt service. Under the unfavorable condition that the financing does **not** include lost grants and subsidies, but only long-term, low-interest loans, another € 2.125 million must be added to the investment sum of € 850 million at (e.g.) 0.25 % interest. These would already be covered by the surplus.

Cost sector 0: Prototype

The primary objective in the construction of a prototype desalination plant is to develop a novel, emission-free, energy-saving and highly efficient plant, which has already been described in detail. To avoid having to incur additional costs for a dedicated power complex, the prototype should ideally be built near an existing power complex[36] and draw power from there.

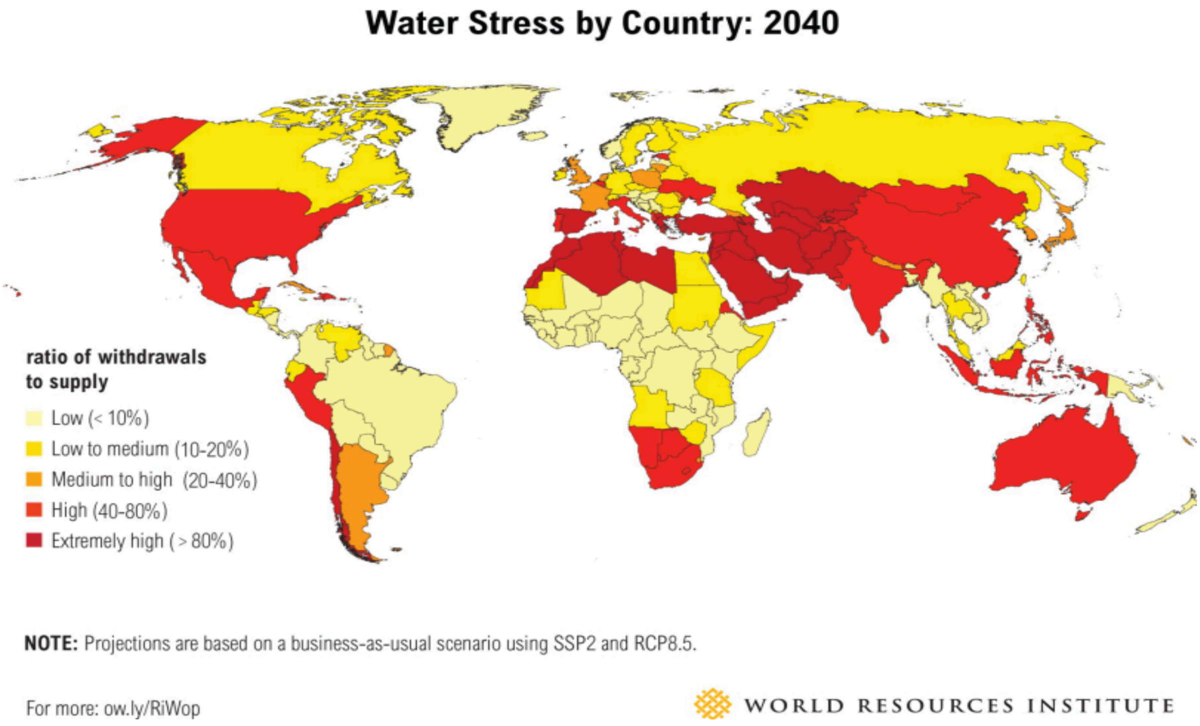
The costs of a prototype plant, which don't need necessarily to be designed on an industrial scale and could therefore cost less than the actual plants, would ultimately have to be covered by the revenues from the individual plants. It must be taken into account that the full number of plants needed to cover the costs of the prototype will not be available immediately (but only after many years or perhaps only after several generations). Therefore, the costs of the prototype plant cannot easily be put in relation to the number of plants needed. Nevertheless, even over a comparatively short period of time, they are unlikely to be significant.

For example, if we assume that the prototype will cost €5 billion and that only 500 plants will be built in ten years, which is rather low in view of the total number of plants required, the amount that would have to be generated by each individual plant to cover the costs of the prototype would be €10 million - an amount that is not very significant in relation to the assumed construction costs of €850 million.

Costs for the hydrogen production plant are not yet taken into account here. This complex represents an option that requires further elaboration. Reference is again made to footnote 8 in this context.

[36] Suitable for this purpose would be, for example, the solar power complex near Quarzaate in Morocco (but about 300 km away from the North Atlantic) or the wind farm near Zafarana in Egypt (on the Gulf of Suez).

Outlook / Additional business areas / Water stress[37]



In addition to the reclamation of deserts, a considerable number of other desalination plants may develop as an expanded area of application for new plants that will most likely be required to meet the increasing demand for drinking water in large urban centers due to "water stress".

Existing and further anticipated urbanization is producing this "water stress." If, as required, a new plant can be developed, it will be in competition with other plants, will be able to bring its advantages to bear, and will be able to successfully intervene in the growing market of "water stress".

Whereas in 1950 more than 70% of people lived in rural areas and less than 30% in urban areas, the ratio will be almost mirrored in 2050 due to the expected continuing urbanization: only about 34% of mankind lives in rural areas and 66% in urban areas[38].

It is not possible to predict which urban centers or metropolises will need a seawater desalination plant, but if the groundwater shortage continues, 30 to 50 plants can be expected[39]. About 40 metropolitan areas each serve more than 10 million people[40].

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37 According to UNESCO, the people of a region or state suffer from "water stress" if the renewing water resources are less than 1,700 m³ per capita and year. Water scarcity exists when the corresponding value falls below 1,000 m³ per capita. If the renewing water resources are less than 500 m³ per capita and year, UNESCO speaks of absolute water scarcity. The global differences in renewing water resources per year are enormous.

38 The survey was conducted by the World Population Foundation.

39 According to a World Resources Institute estimate: https://www.wri.org/our-work

40 Of which 2 with over 30 and 10 with over 20 million inhabitants.

Elsewhere in this project description, a modular design has already been suggested. If this can be realized (in the prototype plant), the sizes of the desalination plants can be adapted to the needs of potential customers, smaller units can also be produced, and new or additional customers can be acquired in this way. Thanks to its outstanding features[41], the new plant would become a unique selling point, which should keep the number of efficient competitors in check.

Finally, simplified plant variants can also be used to fight large-scale fires (or for preventive drenching of the soil).

Conclusion

At first glance, the aforementioned investment costs swallow up significant amounts of money. With a corresponding number of desalination plants per year, the figures can quickly add up to €40 billion[42] or more. In view of the financial resources available to the world community, however, these are reasonable and justifiable sums, especially since they serve to balance the preservation of the biosphere, keep the Earth habitable and, in the long term, produce a respectable series of positive social and economic consequences.

At a certain point, the project becomes self-financing, as revenue is generated through the sale of drinking water.

Financial resources cannot only be understood as cash or credit accounts and loans. Financial instruments in the form of sureties, guarantees or also increased depreciation possibilities for participating companies and/or tax-exempt, at least tax-privileged donations or other incentives for private support can be subsumed under it.

It should be clear from the project description that those scientists, institutions, technicians and companies are called upon to participate who not only have a corresponding fundamental will to act, but are also demonstrably and purposefully capable and competent, with largely legal commitment, to undertake the required developments, including technical ones.

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[41] These include parallelization, automation of work processes, their simplification and standardization, digitalization and electrification as elementary factors for increasing the efficiency of seawater desalination plants, as well as continuous innovation and increasing productivity and best quality over the entire life cycle of the plants.

[42] The International Bank for Reconstruction and Development (IBRD/World-Bank) has allocated US$55 billion in funding in 2019.

Personal remarks

It is important for the authors of this paper to point out that they consider the ideas, thoughts, proposals and visions of the presented project as a mission for the immediate future. The concept arises from the clear insight and deep conviction that the inevitability of fundamental changes (improvements) can no longer be left to the political leaders alone but must be taken into their own hands.

We see our most urgent obligations and tasks in helping to shape our future, and above all that of our children and grandchildren, to the best of our knowledge and conscience, so that our Earth remains habitable. To this end, this project shows realistic solutions and, if implemented, can counteract the climate changes that threaten our very existence. Based on available scientific forecasts, we have gained a clear idea of the global impact of the climate crisis and what the fatal consequences will be if we do not act.

By choosing the Sahara as an exemplary project, as a model in a sense, we are taking into account the fact that this region (and, in its wider extension, the Sahel zone) represents one of the largest contiguous areas of desert. Its extent, its geo- and eco-strategic location, its socio-economic development and growth potential, and its enormous natural capacity for renewable energy sources, give it an exposed importance.

For maximum impact, we believe it is imperative to consider the Sahara in its entirety, so that all riparian states are fully involved in the project from the outset and can identify with it. It is highly probable that serious political considerations will arise in connection with all of the promising consequential effects that have been pointed out, which exclusively concern the respective state sovereignty.

The achievement of the clearly defined, primarily climate-related goal, which the project triggers through its effects and must dominate everything as a permanent signpost, could quickly be pulverized if desires arise that make a value chain tangible with the reclamation of the desert areas.

The project may well come into conflict with the interests of individual nations. A decision to participate in the project and lead the country to prosperity in the long term will then be up to the leadership of the country in question and cannot be achieved by coercion or force under any circumstances.

Behind the project itself there are no political or neo-colonialist intentions of white Europeans on the part of the authors and not the slightest endeavor to want to influence in any way social, cultural and/or social conditions or to influence the sovereignty and the sovereign rights of the individual states. These should and must be protected from influences of any kind, especially from outside.

Basically, we do not want to appear politically and do not want to be taken over by any political direction. The concept itself should be understood unencumbered by any - even unintentional - political or party-political position, statement or opinion.

In the future, positive climatic changes will emanate strongly from this region and generate both regional and global impact. In this context, the inevitable economic consequences[43] must exclusively benefit the riparian states. It is conceivable that North Africa will also gain global political significance by becoming one of the guarantors of food security for the world's population.

The emergence of jobs and gainful employment, from which people generally derive their self-esteem and identity, creates the basis for life and livelihood. It may well be trusted that the inhabitants of this continent will no longer be forced into migration. Migration movements have many causes, but above all they are caused by environmental influences. Global warming and the desertification of vast areas of land in Africa are leading to migration on an unprecedented scale. The perilous journey across the Mediterranean is also being risked by people who can no longer survive in their homeland because environmental conditions have fundamentally changed.

The more people are convinced that this mission can be achieved, the greater the chances that the climate crisis can be overcome.

Earlier, we pointed out that this is a very complex and multi-layered project. It may be that not everything that needs to be considered was considered at the initial conceptual development stage. In this respect, gaps may have arisen here, which may be left to the experts to fill, close and complete. It will be interesting to see what else can develop from this project.

The increasing importance of hydrogen for the general energy supply was mentioned. The chlor-alkali process and a multitude of new process technologies that can be specifically considered for the project, on the other hand, have not yet been mentioned so as not to go beyond the scope of the project description.

We are aware that implementation of the project will involve significant intervention in the desert ecosystem and that the resulting changes may suppress evolutionary adaptations. Despite any urgency, caution is warranted because the consequences of these interventions will linger for centuries.

One final question must be asked:

Who will stand up and say that such a project, however gigantic, cannot achieve the predicted effects? Who would want to shoulder that responsibility?

Berlin, August 2018/June 2021; Antonius Schmid (DE)

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[43] These are presented in the concept as the principles of consumption and the logic of consumption, i.e., capitalism and the market economy, which no one is forced to follow.