Jean-Édouard Buchter

Greening of the Sahara

FAVRE

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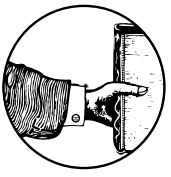

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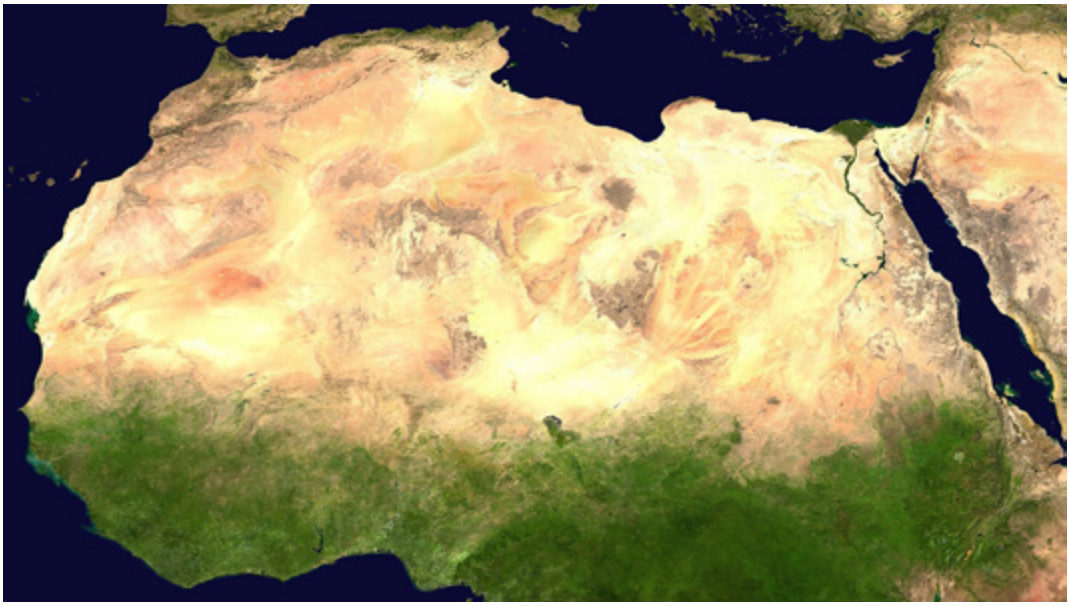

Satellite photo of the Sahara

Alamy Stock Photo

As much rain falls annually in Gorom Gorom as in Colmar.
As much rain falls annually in Ouahigouya as in Paris[1]

1 Annual average rainfall (google data) Gorom Gorom 566 mm, Colmar 530 mm
Ouahigouya 627 mm, Paris 637 mm

A blinding reality

We are in Plato's cave[1]. We run after shadows while reality is luminous. We deal with current affairs, epidemics, wars, telecommunications. It's unavoidable, but in the meantime, climate degradation and its consequences will catch up with us. The time is no longer to wonder if the climate is changing, but above all how to prepare to save our ecosystem and the populations that inhabit in[2]. But there is a reality so enormous, so brilliant, that we do not see it:

The immense luminous spot of the Sahara dominates satellite views. The current possibility of reversing its desertification on a large scale by involving the populations bordering this desert is ignored, as this undertaking is so feasible. The societal and civilizational implications of such an undertaking are exciting.

An immediate life-saving action is largely ignored: zaï.

Its current form, which is powerfully effective, is almost unknown: the motorized zaï[3].

This desert, by far the largest in the world (sixteen times the size of France), is quite special in terms of hydraulic and agricultural opportunities. It is potentially a major factor in solving the environmental, societal and migratory problems of the world.

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1 Allegory of the cave according to Plato: men are chained in an «underground dwelling», in the form of a cave. They have been so since their birth, so that they have never seen directly the source of daylight, that is, the Sun; they know only the feeble radiation that manages to penetrate to them. If one of them is freed from his chains, and accompanied to the exit, he will be dazzled by a light that he is not used to bearing. He will be able to see the Sun. Man will then return to the cave, to his fellow men, to bring them his knowledge. But the latter, unable to imagine what has happened to him, will receive him very badly and refuse to believe him.

2 250 million people will be displaced by climate change by 2050 according to UN forecasts in 2019.

3 Exposition of the method of zaï, explanations see further

We are encouraged to migrate to Mars, to capture carbon dioxide by huge machines, to plant trees galore in unlikely regions. But the most natural solutions, the ones closest to the populations and based on ecological agriculture, are seen too little. In our still temperate countries, young people ready to invest in developing agroecology cannot find land. The mountain peasantry witheres away in the face of the new constraints. But in hot countries, there is something more violent: the shepherds and farmers of the Sahel are dying in the face of the polluting rush from all over the world towards growth that is not that of quality of life, but that of consumption. Forecasts for the Sahel speak of temperature increases of the order of 5 to 6 °C.

However, there is an immense territory on this planet that was fertile only 5000 years ago. Unlike Mars, it has a normal atmosphere, normal gravity, and a considerable supply of water in its southern part. This water is just waiting to be retained and the vegetation will begin to reclaim the lost land with spectacular efficiency. In a few years, the Sahel will be greened, in a few decades the south of the Sahara will be refertilized, in one or more centuries the habitable lands will far exceed the Tropic of Cancer, as in the past.

The beginning of this process, the regreening of the Sahel, is within reach. But the rest of this reconquest, the rise of humidity and greenery to the north, will be slower and more complex. We will see that in this phase the new climatic conditions will be decisive, but that human intervention will also be decisive.

We will analyse later why such a plan does not take off. The reasons for this are mainly excessive specialisation, civil servant inertia, and national withdrawal. This book only claims to indicate the feasibility of this project, with simple technical means, financing that has already been decided and a decisive societal investment.

- Holding back the rains, the «zaï»

The rains brought from the south by the African monsoon are not retained in the ground. They run off and ravine the land. The method of zaï, developed on a very large scale, would make it possible to fix this water. The greened land would in turn retain moisture, which would gradually rise northwards. Similarly, the rains that run off the mountains are to be retained in the ground. The Atlas, Hoggar, Tibesti and Aïr massifs generate rainfall that should not carry away the soil, but fertilize it.

- Exploiting rivers

The Sahara benefits from an extraordinary benefit: the water of four great rivers that flow directly from the rainy areas of the south to the desert areas of the north. These are Senegal, Niger, Chari and Nile. Their irrigation potential, particularly that of Niger, is largely under-exploited and deserves ambitious plans (note: in. Jean-Edouard Buchter, Reverdir le Sahara, Ed. Favre 2019 p.100 et s.).

That said, the amount of rain that falls annually on the Sahel is double the amount of water carried by the Sahelian rivers of Niger, Senegal and Chari. However, rainwater arrives directly on the ground and does not require canals, pumps or irrigation systems. It only asks to be welcomed by basins dug once. It can fertilize the soil rather than wash it away and gully it.

One can imagine the fabulous amounts of fresh water that return to the ocean at the mouths of rivers. All this water is lost to agriculture. We could plan to pump it on the continents by pharaonic technical means. On a very large scale, it would become complicated, senseless from an energy point of view. However, this water can be diverted before the mouth by directing it towards canals. This is called irrigation. But the simplest, most effective, is to retain rainwater directly in the ground, before it runs off into a watercourse. This is called «zaï».

- Rely on local people

The people of herders and farmers of North Africa are said to be at the base of a gigantic project to reconquer the land. Until today they have only lost land. The aim is to assist them in this work of refertilizing their lost soil, by means of agroecology and agroforestry. The rural exodus will be reversed. The industrial West can provide the necessary technical equipment. The experiments described in this book illustrate the realism of this approach. Then there will be the possibility of creating land for displaced and refugee populations.

- Security is an essential prerequisite in many Sahelian territories. It is a military problem, which requires an enormous commitment, which can only be taken up by the African state powers, supported by the industrialized countries. It is a major front in the defense of the free world.

- The pacification that will follow depends essentially on the living conditions of the Sahelian populations on their soil. It is an agricultural and societal problem.

- Global warming aid

A striking climatic opportunity, for several decades, it seems that the climate of the Sahel has been getting wetter. Rainfall is increasing. However, climatologists remain cautious about interpreting this phenomenon. However, some of them modelled the climate of the Sahara and were surprised to see a likely significant increase in rainfall during this century. Global warming would bring a humidification of the Sahara!

- Testimony of a fertile past

An astonishing historical reality: the Sahara was green and inhabited in most of its surface, only 5000 years ago. Its sudden drying up was caused by a slight climatic cooling, which caused a tipping over. This shift was probably aggravated by the populations of this period, which was in the midst of the Neolithic expansion. (cf. J.-E. Buchter, op.cit., p. 29.)

- Promises of the motorized zaï

This book presents an extraordinarily effective regreening process: **motorized zaï with goat droppings**. This method combines the know-how of local populations, agroforestry and modern motorization. Its promotion as a prerequisite for cropping and grazing should be done on a gigantic scale and benefit from financial support commensurate with this challenge. Time is running out, because this process requires the full and complete support of the pastoralists and farmers who will do the work. However, these inhabitants will only do so if they are convinced of it. This conviction is passed on from one person to another, thanks to the work of local facilitators. The spread of this process is therefore exponential, but the beginning cannot be brutal. Hence the urgency to start immediately, and to benefit very quickly from capital for the local training of facilitators and for the first material investments. This is what the Regreening the Sahara Foundation is committed to (note: Regreening the Sahara Foundation, see appendix at the end of the book).

Vision

To say that the Sahara can be greened often plunges the interlocutor into an abyss of perplexity:

«- Wait... We have time, we are in the process of resolving the issues of wage inequality, the revival of consumption, the preservation of jobs, etc.

«And wait... It's just impossible, where do you go to get the water? And then, if you have any, these immensities of sand will swallow it up without having been able to germinate a single seedling!»

...

The Sahara is too big, too blinding in satellite photography, too ignored in its green and civilized past. The monstrosity of this no man's land between blacks and whites does not even question us, so fatal and inexorable does it seem. Yet it is there, waiting, a land surface offered, the future homeland recovered by the Sahelians and North Africans, the future lung of greenery and a refuge for the displaced.

If in the Sahel the abundant, heavy and seasonal rains are held back in the field, in a few years all the recently abandoned land will be reclaimed by the inhabitants of these regions. Then, in a few decades, the clay and lateritic plateaus would be greened, which could accommodate displaced populations. Then, in a few centuries, the rise of humidity towards the north would inexorably conquer the desert as far as beyond the Tropic of Cancer, as in prehistoric times. A new civilization, made up of emigrants fleeing wars, persecutions, famines, economic crises and climatic upheavals, would settle there. A new America would be organized, totally original, without the genocide of any indigenous population. The few nomads who roamed these deserts would gradually see their conditions improve, their wells revitalized, and the harshness of their way of life lightened.

«The African continent is in its initial phase of development. But in the end, it is fortunate: this disadvantage of African countries is a huge advantage on the path to transition. We must integrate the climate emergency into development policies and avoid the trap of mimicry with Western and industrialized countries. We don't have the same problems, the same approaches, or the same narratives on climate issues. No other continent has this range of choices available to us, African leaders can opt for a totally different mode of development. But for this to happen, we need a real political will, and an ability to mobilise intellectual and scientific resources.»

Youba Sokona[1]

[1] Youba Sokona, Mali, is Vice-Chair of the IPCC. He was Director of the African Center for Climate Policy (2010-2012). One of the pioneers in the fight against global warming on the African continent, he joined the Intergovernmental Panel on Climate Change (IPCC) in the 1990s. (Jeune Afrique, Maher Hajbi, April 16, 2022.)

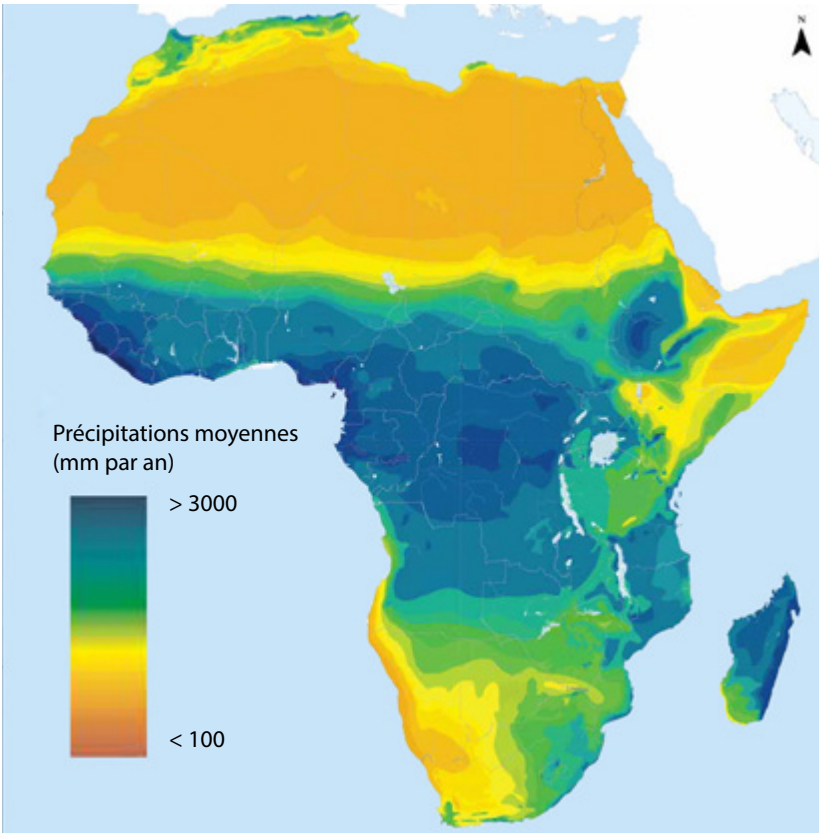
Why the Sahara?

Why not focus on greening other deserts as a priority?

The following maps and images clearly show the unique opportunities of the Sahara.

The description, the opportunity and the dangers of exploiting all water resources are detailed in the book Regreening the Sahara (see bibliographical information).

Opportunity of rainwater resources



UNEP Atlas de l'eau en Afrique

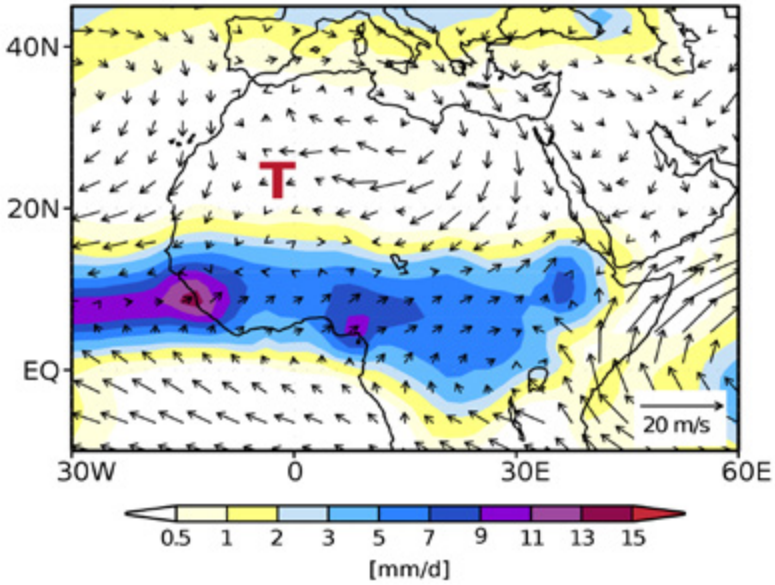
Average rainfall per year

Moving northwards, we notice the decrease in rainfall from the rainy zone of the equator to the Sahelian band, which is still well endowed, and then to the total drying up of the hyperarid Sahara.

The challenge is to bring this wetland up to the north by fixing the moisture in the soil and vegetating.

We also see the influence of the Atlas Mountains on rainfall.

African monsoon opportunity



Martin Claussen , Geographische Rundschau, 11-2020

Map of rainfall during the African monsoon from mid-June to mid-September.
The colours indicate the average quantities of water in mm/day.

There is an abundance of rainfall throughout the southern Sahelian strip, and in particular in the Guinean forest area.
The Guinean coast receives more water than the wettest points in France.

Conakry: 3775 mm/year Mont Aigoual (maximum in France): 2280 mm/year

The Sahelian strip receives as much rain as areas as fertile as Alsace.

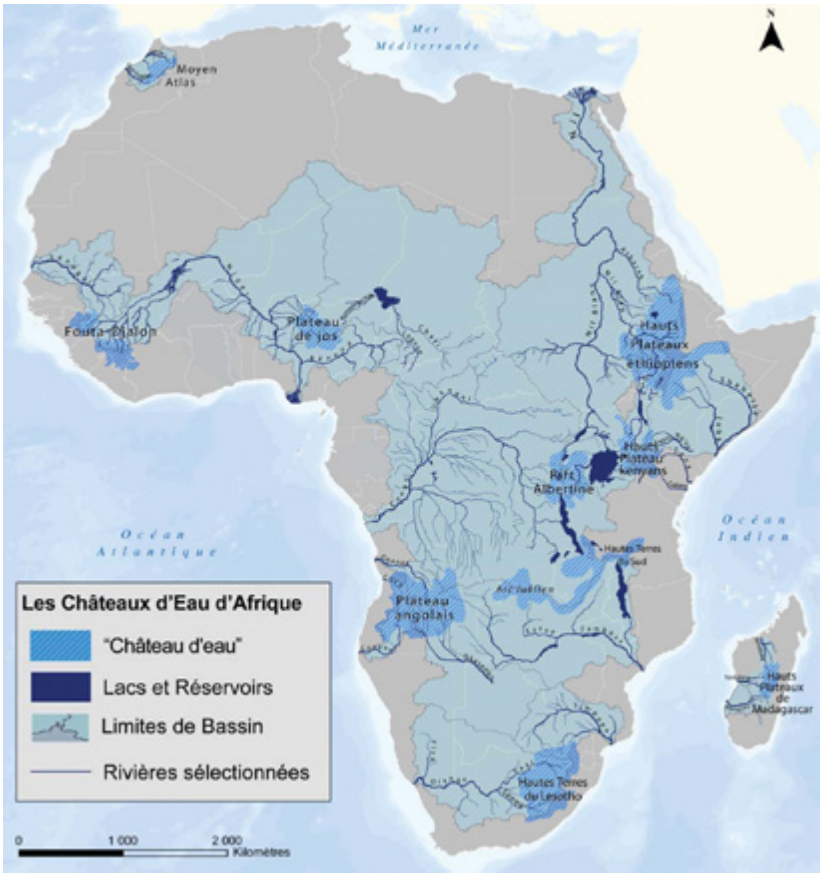
Gorom Gorom (nord du Burkina): 566 mm/an. Ouahigouya: 627 mm/an

Colmar: 530 mm/an Paris: 637 mm/an

But all this rain falls in two months on a ground that does not absorb it!

So the whole problem is in the retention of water in the land.

River resources opportunity



UNEP Atlas de l'eau en Afrique

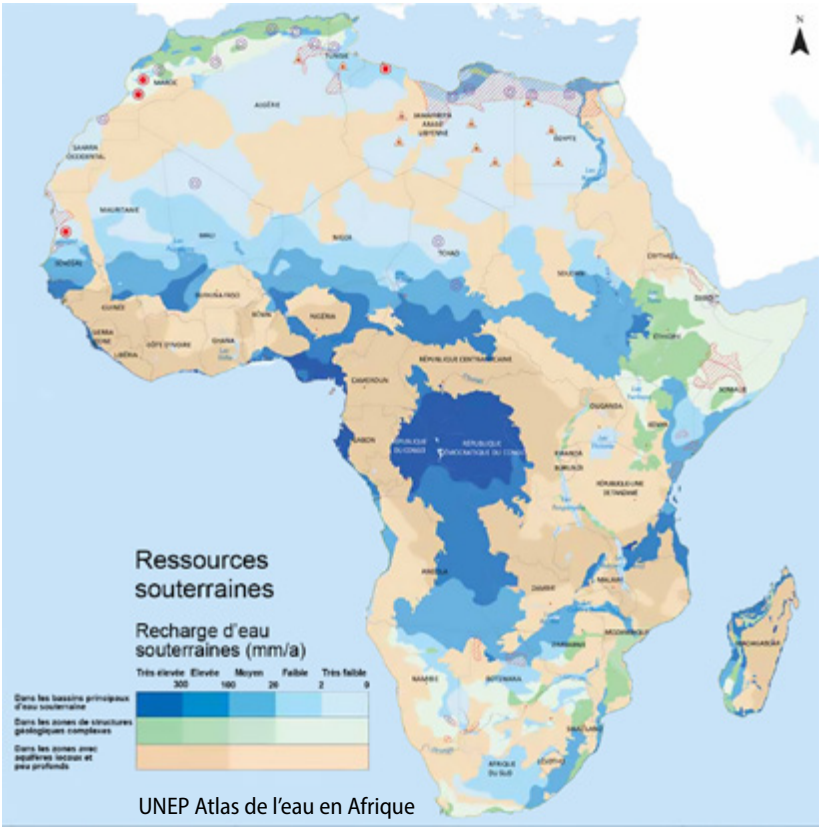
Tropical rivers

Four major rivers carry water northwards, all the way to the Sahel. From west to east, Senegal, Niger, Chari and Nile.

The challenge is to make maximum use of these water vectors[1]

1 Irrigation potentials of these rivers, cf. J.-E. Buchter *Regreening the Sahara*, op.cit.

Groundwater opportunity



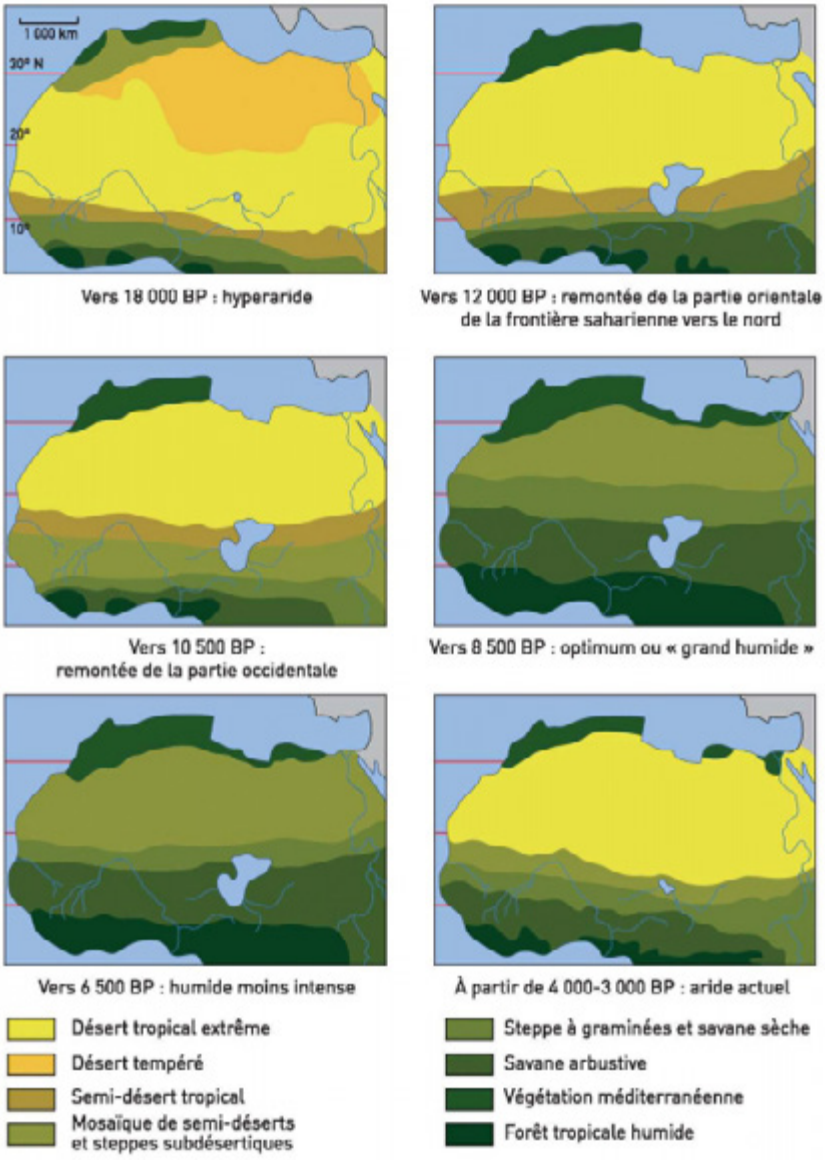
UNEP Atlas de l'eau en Afrique

This map shows the richness of the Sahelian zone in groundwater. These are fed by monsoon rains and retained in porous soil. We also see the effect of the mountainous areas, Atlas, Hoggar, Tibesti, Aïr.

North of the Sahara are the fossil aquifers whose water dates back millions of years and is not renewed. Excessive pumping from these aquifers lowers the water level, which causes the oases to dry up and the influx of underground salt water. They are therefore to be prohibited for intensive agriculture.

Pumping into aquifers is subject to technical constraints. It must be monitored by hydrogeology specialists in order to avoid the decline of the aquifers and their salinization.

Climate cycles opportunity



BP = before present
Source : IRD/D. Paugy *et al.*, 2011, adapté d'après Le Quellec, 1998 + lien OpenEditions Books.
Référence biblio : D. Paugy, C. Lévêque, I. Mouas, 2011 – *Poissons d'Afrique et peuples de l'eau*. Marseille, IRD Éditions, coll. Focus, 320 p.

Legend of previous maps

18 000 BP
Corresponds to the last ice age.

12 000 – 10 500 BP

Beginning of the «Holocene». End of the Ice Age. Vegetation resumes. The surviving humans are multiplying. The Neolithic civilization undertook agriculture and animal husbandry.

8500 – 6500 BP

Peak humidity. Saharan rock art is at its peak. Lake Chad reaches the extent of the Caspian Sea.

4000 – 3000 BP

Brutal aridity transforms the Sahara into a hyperarid desert. It corresponds to a slight global cooling. This cooling is due to an evolution of the Earth's orbit (precession of the equinoxes). It has caused a shift in the Saharan climate. According to some scientists (Wright), desertification has been accentuated by human development.

Several scientists (see bibliographical notes below) have noted the influence of global warming on humidity in the Sahara (see the book Regreening the Sahara). The explorer and geologist Nicole Petit-Maire notes a powerful and systematic humidification during the successive global warmings that have occurred over the last few million years. Kröpelin observes this effect by sampling Lake Yoa in Chad. Jakob Schewe and Anders Levermann have modelled the climate and humidity of the Sahara. Their observation is that humidity will increase significantly in this century. Martin Claussen predicted an increase and then a switch to humidity in the course of this century or at the beginning of the next century. His research is now focusing on the beneficial effect that the abundance of carbon dioxide will have on the growth of Saharan vegetation. Moreover, Wright links the sudden desertification of the 5th millennium BP to the human development of the time.

Notes on the scientific authors cited

Nicole Petit-Maire, Emeritus Research Director at the CNRS, was Vice-President of the International Union of Geological Sciences from 1989 to 1996 and directed two UNESCO International Programmes. His book accessible to the public is: *Sahara, Les grands changements climatiques naturels*, Éditions Errance, 2012.
Nicole Petit-Maire is a geologist. During expeditions to some of the most desert regions in the heart of the Sahara, she discovered very large territories that were covered with lakes. These enclose the remains of lake fauna in sometimes enormous quantities. The dating of these remains has made it possible to situate them in relation to the geological eras. The Earth, and consequently the Sahara, has lived through hot eras alternating with cold eras. The last warm periods (interglacial) occurred 10,000 years ago (beginning of the Holocene), 125,000 years ago, 240,000 years ago, 325,000 years ago, 430,000 years ago...
By dating these witnesses to the wet ages, Nicole Petit-Maire found that each cold period corresponds to a drying out of the climate, and that each warm period corresponds to humidification. This corroborates observations that the Sahara became humidified after the last glaciation (early Holocene). The brutal desertification that occurred 5000 years ago, following a cooling, also obeys this principle. Will the current global warming therefore lead to an increase in humidity? It seems that the trend has indeed been towards an increase in rainfall since the beginning of this century. This would be consistent with Claussen, Schewe-Levermann, and Kröpelin surveys.

Martin Claussen, Victor Brovkin, Andrey Ganopolski, Claudia Ku-batzki, Vladimir Petoukhov, *Climate Change In Northern Africa: The Past Is Not The Future*, Potsdam Institut für Klima-forschung, Institut für Meteorologie, FU Berlin, Climatic Change 57, pp. 99-118, Kluwer Academic Publishers 2003).
M. Claussen, S. Bathiany, V. Brovkin, T. Kleinen, Simulated Cli-mate-Vegetation Interaction In Semi-Arid Regions Affected By Plant Diversity, Nat. Geosci. 6 2013.

Jacob Schewe, Anders Levermann, *Non–linear intensifi-cation of Sahel rainfall as a possible dynamic response to fu-ture warming*. Earth Syst. Dynam., 8, 495-505. [DOI: 10.5194/esd-8-495-2017.

David K. Wright, *Humans As Agents In The Termination Of The African Humid Period (AHP)*, Frontiers in Earth Science, 26 Jan. 2017.

The Sahara around 8500 BP

Lake Chad is as big as the Caspian Sea. Another lake, Lake Adrar, is fed by rivers flowing from the Atlas and Hoggar massifs.

d'après Henri J. Hugot, 1974

Cave paintings in Tassili N'Ajer

© iStock – muha04

Opportunity of contemporary global warming

Paleontological past

We have already seen that the Sahara has gone through dry eras when the climate was cool and wet eras when the climate was warmer. The work of Nicole Petit-Maire is particularly enlightening on this subject.

Recent past

The 70s and 80s saw a dramatic drying up of the Sahel. Global warming is not enough to explain this phenomenon. Scientists remain uncertain about the explanations for this phenomenon, which could be related to the evolution of ocean currents and solar activity.

Looking at the last few years, the following diagram clearly shows an upward trend in rainfall since the mid-80s.

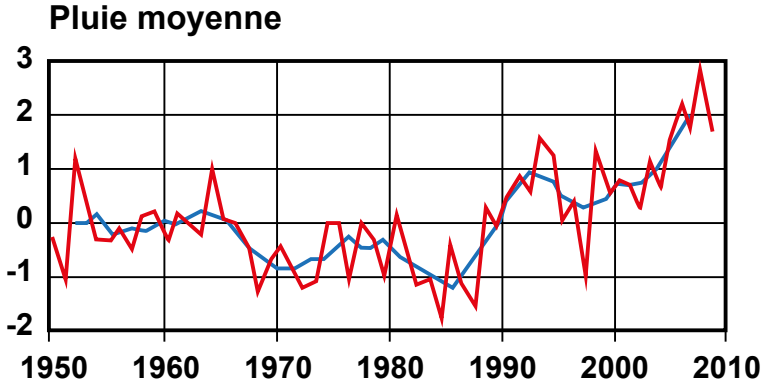


Diagramme selon: IRD *Le retour d'une période humide au Sahel*
https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers19-05/010068392.pdf
page 9.

Future

Numerical models of the Saharan climate undertaken by two climatological institutes indicate that we are heading towards a marked increase in humidity, which will probably take the form of a powerful shift in rainfall patterns.

According to Jacob Schewe and Anders Levermann, researchers at the Max Planck Institute in Potsdam[1].

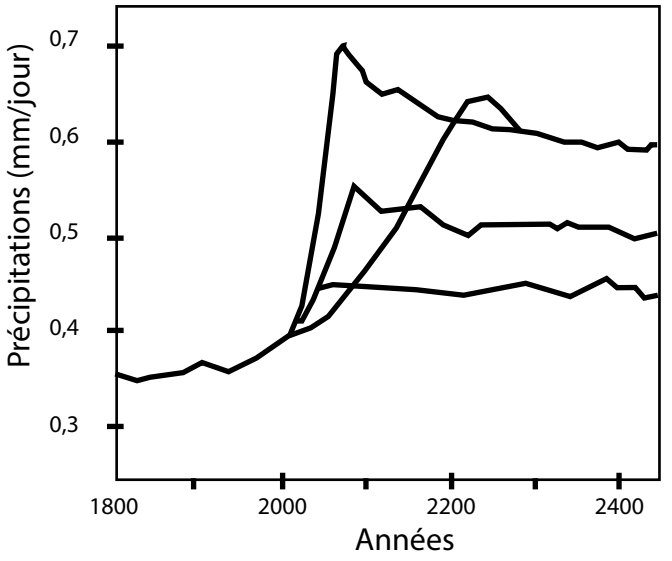
Schewe: «In the dry Sahel, there seems to be a possibility that warming will improve the availability of water for agriculture and grazing.»

A. Levermann: «The scale of the possible change is astonishing. It is one of the few elements of the Earth system whose tipping we could soon witness.»

According to simulations by Martin Claussen and his collaborators at the Max Planck Institute in Hamburg, the rainfall scenarios would take different possible forms according to different basic assumptions. They are schematized in the diagrams in the following figure. After a prolongation of the present increase in rainfall, all point to a burst of humidity which should already occur in the middle of this century[2].

1 See the bibliographical information at the end of the book.

2 Diagram after Martin Claussen, Victor Brovkin, Andrey Ganopolski, Claudia Kubatzki, Vladimir Petoukhov, *Climate Change in Northern Africa: The Past is Not the Future*, Potsdam Institut für Klimaforschung, Institut für Meteorologie, FU Berlin, *Climatic Change* 57, pp. 99-118, Kluwer Academic Publishers 2003).



Recently, Mr. Claussen put into perspective a close link between global warming and the humidification of the Sahara. According to him, the current warming has a human cause. It is therefore not due to the evolution of the Earth's orbit, which weakens the comparison with the previous phases of humidity in this desert. On the other hand, Claussen sees a positive relationship between the increase in carbon dioxide in the atmosphere and the greening of the Sahara (see next page).

Opportunity for the increase in carbon dioxide (CO_2)

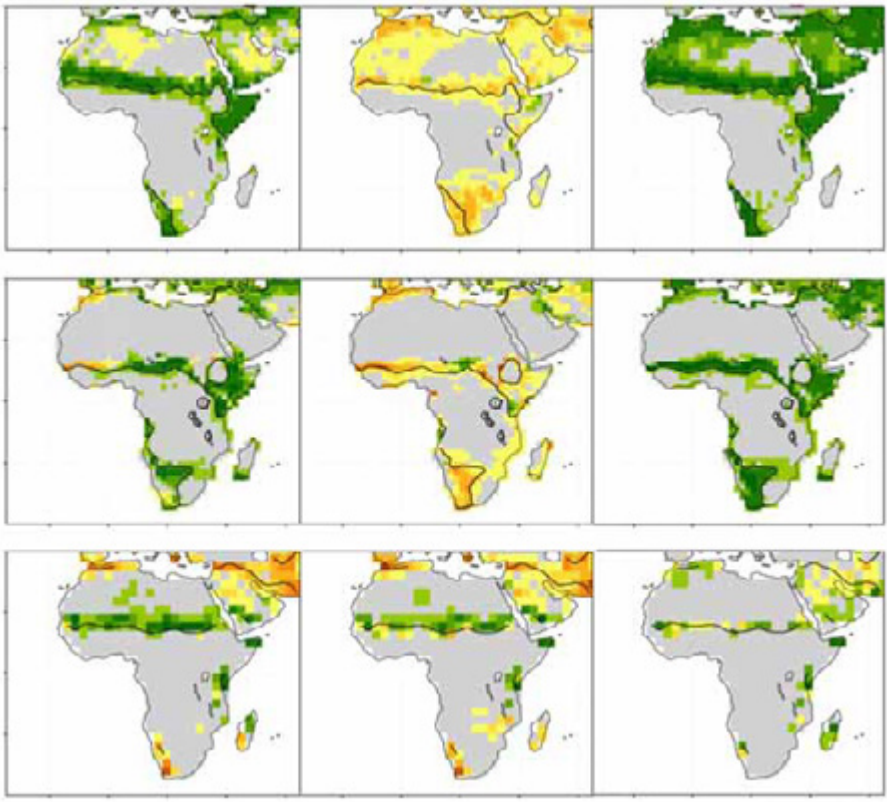
Recently, Martin Claussen and his team modelled the influence of the increase in the carbon dioxide content of the air on the greening of the Sahara in the 21st century. It is well known that CO_2 is the main food for plants. Its abundance promotes their growth. This is the phenomenon modelled by the Max Planck Institute in Hamburg.

The three strips of diagrams correspond to three different calculation models.

The right-hand column shows the revegetation under the effect of CO_2.

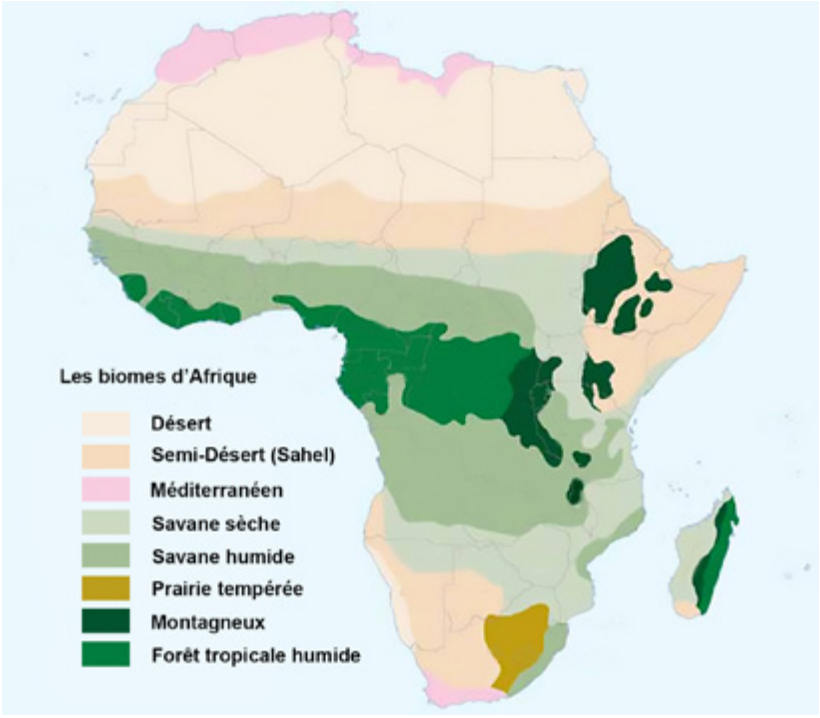
The middle column shows the effect of climate.
The left column shows the overlap of the two effects.

Despite a large difference between the predictions of the three models, there is a significant increase in vegetation cover, mainly due to the abundance of carbon. However, this is in no way the result of human intervention. It is obvious that if humans intervene to retain water and to put the land under agriculture, the effect will be multiplied.



Martin Claussen, *Mögliche relative Änderung der Vegetationsfläche im 21. Jahrhundert. Die grüne Sahara*, Geographische Rundschau 11-2020.

Opportunity and fragility of Guinean and equatorial forests



UNEP Atlas de l'eau en Afrique

The forests that receive the water of the monsoon store it and give it back as the season progresses through their transpiration. Thus accumulations of clouds are formed, which the winds carry to the continent, where they fall as rain. These are what Donato Nobre calls the «aerial rivers»[1]. Their existence is obviously threatened by deforestation.

The Guinea Forest in West Africa affects Guinea, Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria and Cameroon.

1 D. Nobre has extensively studied above-ground rivers. It demonstrates their involvement between the Amazon rainforest and the South American continent. The same approach can be imagined, all things considered, in relation to African forests and African deserts. For more details, see the appendix at the end of the book: «The Guinean equatorial forest, the heart of pumping towards tropical rains».
« Antonio Donato Nobre, *The Future Climate of Amazonia*, translation American Journal Experts, Sao José dos Campos, SP :ARA :CCST-INPE :INPA, 2014.

In a century, Côte d'Ivoire has lost 82% of its forest cover. The regeneration of this Guinean forest is an essential condition for Sahelian and Saharan regreening.

Demographic Opportunity

Photo : L. Grandi

Even if it will subside, the current African demographic wave will be part of the solution. The rural exodus must be reversed. As the driving force behind the fertilisation of the Sahara, agroecology will employ millions of farmers, who will implement and develop the know-how of Sahelian livestock and farmers. The limited and sustainable energy motorization will serve to avoid the extreme arduousness of agricultural work in the past. A single initial pass of a «dolphin» plough will allow this evolution.

All the advantages of regreening are in our hands. If we remain inactive and purely declarative, the water will gully and destroy the land, rather than refertilizing it

Successive stages of the reconquest

- Zaï: this is the attack on the sterile layer of the soil by the creation of basins, retention of rain and the first formation of plants by sowing. In the Sahel, even in years with very low rainfall, if the basins are made with sufficient care, at a depth of 60-70 cm, the water retained is sufficient to go until the next rainy season without the vegetation dying.

- Grazing: the role of livestock is important in the reconquest of the territory. The Fulani herdsmen can return to their former lands very soon. This is even desirable from a plant point of view. From the first year, according to L. Grandi, cattle can be introduced with moderation on the sites worked by the zaï. Damage to seedlings is low. Droppings and the mixing of the soil by the hooves are two favourable effects. Livestock farming, as it has been practiced for centuries, does not have the negative greenhouse effect produced by industrial fattening.

- Cultivation: Crops can expand from year to year as humus is formed by vegetation and protected by growing trees. The action of farmers for the improvement and use of the humus layer will be decisive.

Progress of the reconquest

- Phase of recovery of the land that was green until the end of the 20th century. This is the Sahelian strip, about 200 km wide and 7500 km long. The technique for carrying out this phase of work is currently mastered. It must be urgently activated on a massive scale!

- Fertilization phase of clay and lateritic plateaus located further north. The rise in humidity towards the north will allow us to enter this phase. The zai will play a decisive role. The identification of these plateaus and the development of working methods specific to the fertilization of each of them constitutes a very large field of study, which must be developed on the basis of what is already known. A scientific agency will have to follow up on this programme. It will mainly employ agronomists, hydrogeologists and rural engineers. This agency must be created and put into operation urgently!

- Greening phase of hyperarid areas. This phase can be considered as the humidity rises to the north. The revitalization of the oases will be a starting point, as will agriculture on the slopes and at the foot of the mountain ranges. The use of the effects of the increase in humidity will be fundamental.

The Zaï, the royal road to reconquest

Yacouba Sawadogo, the pioneer

It exists deep within the hearts of humans
the thousand and one founding wisdoms of a pacified planet.
Yacouba is living proof of this.

Damien Deville[1]

Born in 1940, Yacouba Sawadogo lives in the Ouahigouya region of Burkina Faso. A peasant and merchant, he owned, among other things, sterile laterite land. In 1974, he gave up the business and undertook to rehabilitate a traditional method of fertilization: zaï.

Zaï consists of digging a hole in the ground with a hoe and introducing compost. Then it is a question of promoting the access of termites of the genus trinervitermes. These termites have at least two functions: they dig galleries that will retain water and they promote fertility through their droppings. They also store the grass, just below the surface of the soil. A tree is planted in this hole. The water is then retained beyond the rainy season and the tree can grow in this previously desert land.

Yacouba Sawadogo began to dig holes by hand under the mockery and even the depredations of his neighbors who did not believe in the effectiveness of this method, believing that it was an exception to tradition. But forty years later, they realized that a forty-hectare forest had grown, that crops were thriving and that wildlife inhabited these places. Their attitude was reversed and they put this process into practice. The

1 Damien Deville is the author of a book on Yacouba Sawadogo: *L'homme qui arrêta le désert*. Tana éditions 2022.

Photo : Moussa Ouedraogo

Yacouba Sawadogo

success was such that the rural exodus in the village ceased and was even reversed. Yacouba then began to teach his technique, which has spread from one to the next to the other countries of the Sahel, to the point that we are talking about three million hectares reforested.

On 24 September 2018 in Stockholm, he received the Right Livelihood Award, better known as the alternative Nobel Prize, for his process which is now recognised by the UN Commission against Desertification.

The manual Zaï in half-moons

The half-moon zaï, with its water reservoir and with an addition of organic matter, is the effective starting point for market gardening and arboreal crops.

WFP-Evelyn Fey

Half-moon field in Senegal

©FAO/Giulio Napolitano

Sahelian woman practicing manual zaï in half-moonss

At the end of the international conference of the United Nations Convention to Combat Desertification (UNCCD COP-15), which was held in Abidjan in May 2022, the fight against desertification was symbolized by the heroic commitment of women, digging the ground with their pickaxe.

Is this really what we want? Should the desert be greened up under the blows of women's pickaxes?

What can and should machinery be used for?

If the industrialized countries, which are responsible for climate imbalances, only provide tractors, the work of greening would be done 700 times faster than by hand. The dug basins would reach a depth of 60-70 cm, and would retain water for the duration of the dry season. It would therefore be a question of a massive greening of the desert, of a profound transformation of the soil.

The «dolphin» plow

Photos L. Grandi

The motorized zaï with dolphin plough

The Deserto Verde Burkinabe project

Dauphin plough (delfino) of the engineer Vallerani. The hard, sterile and clayey soil is loosened and dug into basins that retain water in the rainy season.

The illustrations of the Burkinabe Deserto Verde experience are reproduced with the kind permission of Lindo Grandi.

The following pages present the approach of the motorized zaï through the Burkinabe Deserto Verde experience. Other companies such as Reach Italia and Hommes et Terre also use the Vallerani-type dolphin plough in the Sahel.

Northeast of Gorom-Gorom, in the north of Burkina Faso, the desert is greening as far as the eye can see. In 2003, Lindo Grandi, a forest ranger from Ticino, undertook with Amadou Boureima, a Burkinabe agricultural technician, the sowing of resistant vegetation in arid environments. For this purpose he used the «dolphin» plough (delfino) developed by the Italian engineer Venanzio Vallerani. 3700 hectares have been transformed from a desert to an agroforestry landscape. In 2015, this extraordinary experience was unfortunately stopped by insecurity, which is particularly strong in this region.

Vallerani's Dauphin Plough

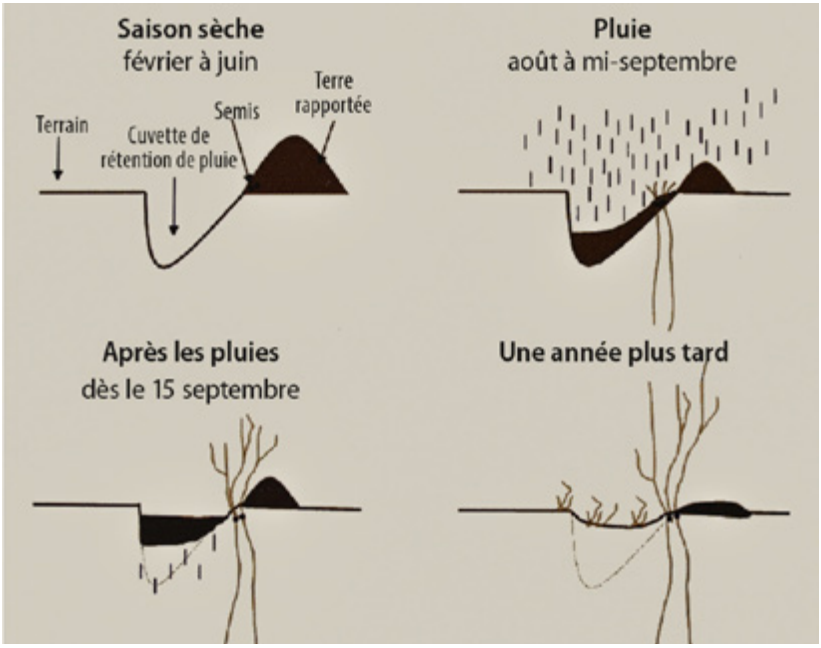
In a single pass, the dolphin plough digs deep pockets that retain water in the rainy season, in which the local inhabitants directly sow the seeds. A single basin absorbs about one cubic meter of water, which maintains humidity throughout the dry season.

Photo: Nardi Group

The hydraulic cylinder used to give the oscillatory diving movement can be distinguished. You can also see under the chassis the blade of the «ripper» which fractures the ground along the entire length of the furrow.

The rest of the operations, i.e. grazing and cultivation, is carried out entirely by the local inhabitants.

Trees are not planted, but sown. Sowing is done in the dry season without any artificial fertilizer, mainly by depositing goat droppings on the side of the basins dug by the plough. The droppings contain the seeds that will give rise to the trees of local species. Grass seeds are brought by the breath of the harmattan, an almost constant wind in the Sahel.



Operation over a year. Sowing is done at the level of the land, on the edge of the basin.

Sowing with goat droppings

Goat droppings contain the seed of a local species, coated with fertilizer.

The village sows in the furrows of the dauphin plough.

Youth join in the action

This sowing does not require preparation, maintenance, watering or fencing

When the seedlings have emerged well, the cattle are allowed to graze in the rows, without restrictions! The animals graze on the grasses that are already growing around thanks to the retained water. Their droppings fertilize the land. The young acacias (tortilis, senegal, seyal and nilotica) and the Faidherbia, Balanites aegyptica, jujube trees that have grown are little damaged by the animals and continue to develop. Acacia tortilis is the species that grows best using this method. For other tree species, a supplement must sometimes be produced by seed companies.

This operation of ploughing in basins and sowing by excrement takes place only once. In the following years, the basins will still capture the grass seeds blown by the wind. But the trees that will be born by the sowing of goat droppings will continue to grow. The vegetation will green up during the rainy season and rest during the dry season.

Initiated in 2003, this work has revegetated three thousand seven hundred hectares of desert land with the help of tractors and ploughs, which is the equivalent of five thousand football fields. By the end of 2013, the Vallerani system had enabled the revegetation of one hundred and sixteen thousand hectares in thirteen countries in Africa and Asia.

In Gorom Gorom, one million five hundred thousand trees are growing thanks to the Burkinabe Deserto Verde project initiated by Lindo and Verena Grandi. The local host was Amadou Boureima. They were supported by the NGO Reach Italia with its head for Africa Allain Long. The cost per hectare worked was on average 100 euros.

A scientific evaluation of the Burkinabe Deserto Verde programme was published in 2010.(Note)

A program as effective as Deserto Verde Burkinabé can multiply almost infinitely in the Sahel and other regions of the Sahara.

It requires:

1. A plateau whose soil still contains a certain amount of clay;
2. Seasonal rainfall from 200 mm per year;
3. A local community that is committed to the project and committed to its implementation;
4. Financing for the purchase, operation and maintenance of the tractor and plough.

Lindo Grandi instructs an intern in front of a pile of goat droppings

Aerial view of a portion of the desert prepared with a plough.

One year after sowing.

Four years after sowing.

As soon as the vegetation greens, a controlled return of livestock is beneficial.

The facilitator, at the heart of the process

The concrete, societal and agricultural implementation of a regreening process essentially involves activating the local agricultural society. The work of persuasion, training and monitoring of farmers, from village chiefs to implementers, is carried out by an essential figure: the «facilitator». Without it, ploughs and tractors are inoperable.

This person must possess an impressive number of qualities. The emergence of this actor or actress is not simply the result of training, but of a deep personal commitment. His desirable skills are:

- Agricultural training
- Knowledge of the terrain
- Knowledge of the country's way of life, especially ethnicities and habits that can be very different from one village to another
- Knowledge of local languages (which may differ from village to village)
- Knowledge of French
- Interpretive skills
- Negotiation and teaching skills
- Mechanical and hydraulic skills

All this makes such a key character highly sought after.

Training of facilitators

The training of animators does not depend only on professional instruction, but on transmission from master to student. That's why people who currently have the experience and ability to do so are very valuable. A multi-year shutdown in their operation would mean the loss of these essential skills. It is therefore in order to perpetuate and multiply as much as possible the training of these people that an organized training

course was envisaged by Amadou Boureima, former leader of Deserto Verde and Sabina Vallerani, daughter of the engineer Venanzio Vallerani. Such a school is the first condition for the large-scale development of greening by motorized zaï.

Photo : L. Grandi

Amadou Boureima, facilitator and designer of the Burkinabe Deserto Verde project with two village chiefs from the Gorom Gorom region.

The current operators of the Vallerani system

© Sabina Vallerani

Venanzio Vallerani (1924-2012), the engineer and inventor of the dolphin plough, behind the hydraulic cylinder used to give the plough its oscillatory diving movement.

The current operators of the Vallerani process in the Sahel are:

- Reach Italia, an association based in Italy (about ten ploughs)
- Hommes et Terre, an association based in Burkina Faso and Belgium (about ten ploughs)
- Deserto Verde Burkinabé (association based in Switzerland, currently on standby)

These three associations have worked mainly in Burkina Faso. The security situation is currently severely disrupting

their operations, to the point that Deserto Verde had to cease its activity in 2016. However, the core team remains available for a restart in a safe region. Contacts are made, particularly in Senegal.

To ensure that the quality of work is maintained while drastically increasing the amount of surface area worked, it will be essential to keep several companies in operation and to have a periodic evaluation of their efficiency.

Urgent concrete actions

The urgency of launching both motorized zaï projects and simultaneously the training of their socio-agricultural animators is subordinated to obtaining the funds to allow this dual approach.

Evaluation

At the same time, a new study[1] must be undertaken to justify the extension of this action. The aim is to encourage the support of Sahelian states and their citizens, as well as that of international institutions, societies and individuals likely to support this action.

Topic of study:
Evaluation of a motorized zaï site with

- Dolphin plough of the Vallerani type
- sowing goat droppings.

This study would document any company planning to implement the motorized zaï with a dauphin plough in a secure territory.

The parameters to be measured would be:

- mass of grassland produced.
- developed forest mass.
- absorbed carbon mass.

The measurements made on the construction sites of the last twenty years exist and are available. Measures on the current state of the vegetation are possible.

1 A scientific evaluation of the *Burkinabe Deserto Verde project* was made and published in 2010:
M.Conedera, N. Bomio-Pacciorini, P. Bomio-Pacciorini, S. Sciacca, L. Grandi, A. Boureima, A. M.Vettraino, *Reconstitution des écosystèmes dégradés sahéliens*, CIRAD-revue / Bois et forêts des tropiques No 304(2) 2010.

The restart of a construction site in a safe country is extremely urgent.
The team of local technicians and animators is available.
Local contacts are current.
All that's missing is the financial contribution.

Billions are promised to the climate cause. Let them be invested as soon as possible in what saves massively!

Why is concrete, ecological and profoundly social action still largely ignored, even in specialized circles, and why does it not find its way to its realization on a very large scale?

Where is the money promised to save the climate and the people who depend on it immediately?

At the end of the COP-15 in June 2022 on drought and desertification in Abidjan, Macky Sall, President of the African Union and Mohamed Bazoum, President of the State of Niger, stepped up to the plate to express their disappointment at the inadequacies of the international community's responses to the challenges facing African countries[1]. The annual aid of 100 billion dollars to help the countries of the South deal with the climate crisis, promised at COP-15 in Copenhagen, was confirmed at COP-21 in Paris. But it was delayed at COP-26 in Glasgow and never fully materialised[2].

Only a small part of these sums would allow a powerful start of the motorized zaï. This would then grow exponentially thanks to carbon finance and the careful monitoring of global

1 *At the closing of the Africa CEO Forum, the Presidents of Senegal and Niger pointed out the inadequacies of the international community's responses to the challenges facing the countries of the continent.*
Jeune Afrique, June 14, 2022, Joël Té-Léssia Assoko.
2 *Ten years ago, developed countries pledged $100 billion to help developing countries cope with climate change. But the promises have not been kept.*
Jeune Afrique, November 4, 2021, Marie Toulemonde.

finance. But the strong support and enthusiastic support of the public for this project will be as important as its funding.

Causes of the current stagnation of motorized zaï

Why is it that the symbol of the fight against desertification is a woman with a pickaxe and not a dolphin plough?

- National and international civil servants

The offices concerned with the allocation of funds to combat desertification are not getting started. Symposia with thousands of people lead to general declarations, pious wishes and ecological truisms.

- Cultural compartmentalization

The dolphin plough was invented and launched in Italy. It is ignored in the French-speaking sphere.

- Specialization

We are in a world of specialists. To be respected today, you have to be a «great specialist». However, it takes generalists to understand the multiple facets of a subject such as the regeneration of the world's largest desert, and to make a synthesis of them. Analysis is the virtue currently prized. The synthesis is lost. It is not enough to be a great climatologist, a great geologist or a great political scientist. Moreover, no one is paid to work on subjects such as the greening of the Sahara, and anyone who does so would risk being taken for an enlightened person, which would harm his professional career.

-Slogans

The planting of billions of trees in uninhabited territories is announced. However, the seedling is effective in soil that has already formed. In a hyper-arid land far from water sources, without the constant assistance of a population, he dies. This has been observed in Australia, China, Algeria, the Sahel, etc.

Planting away from a population that will benefit from and care for this greenery is an abstract vision. It is like launching an army at great expense without ensuring its stewardship.

- Baudruches

A number of balloons will deflate as quickly as the Graf Zeppelin.

Technological monsters from the 20th century will turn out to be giants with feet of clay. In the field of irrigation, gigantic canals have already demonstrated their inexorable ageing, their exorbitant environmental cost and very often their catastrophic inadequacy to the conditions of agriculture and local society.

More generally, we will perceive that the societal effort that is now deliriously moving towards telecommunications and entertainment will have to be urgently shifted to more vital and natural activities.

Conversely, the tendency towards the «small» at all costs can slow down an efficient process, but one that is «motorized». Wokism can banish the engine, invented, developed and manufactured by «Westerners». We would then like the basins of the zaï to be dug with a pickaxe.

-Rural exodus

In Africa as in Europe, the current trend is towards urban concentration and commuting. Greening the territory requires a reversal of the desertion of the countryside. The encouragement of a return to the land is not sufficiently envisaged by the popular, governmental and economic authorities, neither in Africa nor in Europe.

-Terrorism

The eradication of terrorism is the first bet to be won. It also has the dimension of a war effort, involving close collaboration between Africans and Europeans. In some Sahel countries, this takes precedence over any other goal. This war is of existential importance. At present, the few existing motorized

zai sites operating in the Sahel are severely disrupted, if not annihilated by terrorism. Of course, it is the Sahelian governments that must have the upper hand in protecting their territory and their populations. But the effort is such that they cannot do without the support of industrialized countries.

In Burkina Faso, the Deserto Verde association created by Lindo Grandi from Ticino, who worked in the north-east of the country, had to protect its construction sites by military guards, then was forced to cease all activity since 2015. The Swiss foundation Regreening the Sahara is looking for capital to relaunch its activity in Senegal with the still existing work team.

The associations Reach Italia and Hommes et Terre (Belgian), which each operate with about ten dolphin ploughs, are forced to migrate to the southern part of Burkina Faso or Senegal.

Disturbing is the anti-French sentiment, which we see goes as far as anti-Westernism. Manipulated by a great power, this feeling gradually penetrated popular thought throughout French-speaking Africa. It finds through social networks a privileged channel of propagation. But doesn't this feeling still have some reason to exist? Doesn't the Westerner have good reasons to improve his attitude and his ways of proceeding? It is high time to meditate with lucidity on what is repulsive in our behavior, without falling into naivety. Angelism, moreover, is not lifesaving. Security is done by weapons. It will be painful. But pacification was achieved through agriculture.

Financing

Private donations and sponsorship

Financing is, as in any company, the sinews of war. Private donations and patronage are almost always the financial starting points for highly beneficial actions that are undertaken around the world and whose motives are disinterested.

Sponsoring

Sponsorship can then strengthen these actions, by bringing a commercial perspective, if only for an image need. However, it often accommodates itself to greenwashing. In addition, risk-taking is a disruptive factor, especially in projects involving unstable geographical areas.

International Finance

To achieve the firepower needed for an enterprise to re-green desert areas, the financial investment must reach the level of what it should be: a war effort. This is why it must be state and supra-state. This is why **the preservation and consolidation of entities such as the African Union, the European Union and especially the UN is fundamental.**

COP-15 in Copenhagen in 2009 provided for the allocation of 100 billion dollars per year to counter the effects of drought in the countries of the South. This resolution was confirmed at COP-21 in Paris. For comparison, the United States' military budget is $700 billion annually. This means that we are still far from the climate and societal effort that will have to be made at the end of this century. In 2022, it is estimated that only 50 to 80% of these sums were actually paid.

Carbon Finance

Paying the absorbed carbon to the person who has managed to capture it is an excellent way to finance the regreening of territories. UN and EU bodies are working tenaciously to develop this vital concept. The essential problem is to make this principle escape from all forms of commercialism and the many loopholes that are not unfailingly to be invented.

However, it is still necessary to be able to evaluate this capture. It is also necessary to be able to prove that we are dealing with a new form of capture, otherwise we would be disproportionately enriching all the owners of existing forests.

It turns out that the price of a tonne of carbon guaranteed by the European Union or the World Bank is subject to speculation. Its price is traded on international markets. It is increasing dramatically.

Since 2018, there has been an **almost constant increase in the price of carbo**n from €7 per tonne to more than €28 in May 2020, and we are approaching €100 per tonne in May 2022. This sounds like a great encouragement for the developers of new green areas.

One criticism of carbon finance is that some large companies use this financing to engage in mega-crops that are inadequate, unsustainable or unsuitable for local populations. This is obviously not the case with processes based on zaï, local seed and indigenous work.

The attempt to revive the Deserto Verde Burkinabé operation has shown that even if such an undertaking promises a brilliant profitability in terms of carbon finance, the donors for its revival will not willingly want to take the risk of the operation. There are buyers for the tons of carbon that will be produced when the experiment works. On the other

hand, we have not found financing that advances the funds for the few years that will allow the vegetation to develop to a sufficiently lucrative carbon absorption. This departure from the construction sites must therefore be launched by other bodies.

Allowance price in the EU Emissions Trading System.

(€ per ton CO2)

We are at the heart of the Mediterranean migration debate

- Should we welcome absolutely all those who wish to migrate and offer them the best possible living conditions?

- Should we push back waves of migrants, bring them back to their starting point and pay for inhumane camps?

In view of the two political camps that are clashing on the subject of immigration, neither of these two options is sustainable. The outcome lies in a large-scale entrepreneurial and societal vision, the result of a partnership between North and South:

To create a land, a cultivable country with a pleasant climate, where all volunteers for a healthy and active life can find refuge in dignity.

My astonishment comes from the fact that we have not yet seen that it is within reach, while some pioneers have been showing the way for more than twenty years.

The financing of a sufficiently ambitious plan for regreening by motorized zaï must essentially go through international public bodies or national bodies. The industrialized countries have a great responsibility to assume in this regard. However, at this stage, we come up against the blockages inherent in these institutions: bureaucratism, national and cultural reflexes, concealment by current events (pandemics, wars, social crises, populism, nationalism). Wars and terrorism, in particular, are becoming major obstacles. The investment in technical and military means is such that only state and interstate organizations are able to provide it. They will have to do so, otherwise no plan for the regreening of the Sahel and the Sahara is possible. And the fight against deforestation must

involve the armed forces. It's a war!

We are hearing more and more about not hundreds of billions a year, but trillions. In fact, we have no control over the long-term forecast of what awaits us in several decades, or rather what awaits our children and descendants. Not long ago, such reflections made us accuse us of being killjoys, but today the majority of young people are becoming aware of what awaits them and what awaits their children. We will have to change our way of thinking and living. Should we wait for «the old people» to leave?

Motorized zaï is, however, among the least expensive, the most effective, the most natural and the least utopian things that can be done... but we don't know. Or we don't want to know.

COP and global efforts

COP-15 in Copenhagen in 2009 provided for the allocation of 100 billion dollars per year to counter the effects of drought in the countries of the South. This resolution was confirmed at COP-21 in Paris. At the end of 2022, it is estimated that only 50 to 80% of these sums had actually been paid.

At the end of the Africa CEO forum on the sidelines of the COP-15 symposium in May 2022 in Abidjan on the fight against desertification[1], we will recall the position taken by Mohammed Bazoum (President of the Republic of Niger) and Macky Sall (President of the African Union and the Republic of Senegal) both deploring the fact that the promised international aid is not arriving.

Major general resolutions were drafted in Abidjan. However, no mention of any kind could be detected about the mo-

1 This is COP-15 of the UNCCD (United Nations Convention to Combat Desertification)

torized zaï. This concrete solution seems to be completely ignored by international decision-makers.

Of the countries supporting dolphin plough projects in the Sahel, only Italy, Belgium and Luxembourg are currently active. It seems that this action of Italian origin is struggling to convince the French-speaking world.

The point

The consequences of the climate crisis are already visible and the damage caused cannot be denied, but we still have the opportunity and the resources to overcome this crisis.

Excerpt from the youth statement. Lausanne Charter 2019.

The information and experimentation campaign promoted by the Regreening the Sahara foundation has come up against the media polarization that was captured for two years by covid, and then recently by the war in Ukraine. The longer we wait to know and start this gigantic project, the more we are distracted by balloons such as immigration to Mars, telecommunications inflation or self-driving cars. In this way, possible solutions to climate, agricultural and migration problems will be delayed. These will affect us all the more violently because we have spent time resolving war quarrels, due to the current return of barbarism to European territory, in the Sahel and potentially across the Atlantic.

This book was published at a time when, in the East, Russia, led by a bloodthirsty despot, wanted to reconstitute its former empire. In the south, so-called religious fanatics want to establish a medieval caliphate. In the West, a superpower from across the Atlantic is hanging on an election that could lead to a civil war.

Surrounded by these dangers are Africans and Europeans.

Faced with the upsurge of the struggle between the colossal empires of the planet, the free world is threatened with shrinking. In this fight for survival, it is essential that Africa and Europe join forces and protect each other. Because in the south, hunger and thirst trigger jihadism, rural exodus and economic exodus. In the east, Asian giants covet markets and territo-

ries. In the West, across the Atlantic, the economic powers are at the mercy of elections that could tip them into institutional chaos and violence. In this situation, collaboration between Saharan-Sahelian Africa and Europe becomes essential. The management of our climate, agricultural and migratory problems is urgent. In this sense, the relevance of the Euro-African partnership is obvious. In the middle of this couple lies one of the most beautiful seas, but also the largest desert in the world. A desert that, until recently, was not a desert! A desert which, as we will see, will benefit, if we know how to do it, from global warming in the sense of an increase in humidity.

The geopolitical Sahara belongs to twelve sovereign African countries. But the ecological Sahara conditions the entire planet, an immense regulator of the global climate, as is the Amazon forest, as are several biotopes in the world. The Sahara and the Sahel are also at the heart of the Euro-African migration phenomenon. However, the Sahara and the Sahel are the problem, but also the solution. This immense territory is a lifeline for the local populations, but also potentially for some of the 300 million people who, according to the OECD, will be displaced by the year 2050.

If the fight against deforestation is a primordial battle, the fight for the greening of deserts is all the more so because it creates welcoming land.

From then on, the idea of «Eurafrica» resurfaced. In our Africa-Europe relationship, we are at the heart of a couple problem. The more different partners a couple is, the richer their productions. A pair of clones is not fertile. However, a major condition is the understanding of our respective roles. The resolution of our inevitable quarrels is a primary task, while respecting our identities. On the one hand, the essential regeneration of the African territory is the business of Africans. They are the ones who have the human resources to cultivate and regenerate their immense territory through agroecology. On

the other hand, the industrialized countries are called upon to provide the technical means to achieve this. There is a natural and fruitful partnership here, from which any remnant of neocolonialism is a priori absent.

But our aridity is also the desert of our modernism, our digitalization, our unbridled rationalism. A drought that we are withstanding less and less, but that Africans are enduring even less than we Westerners. This will lead us to consider a phenomenon of burning topicality: the brutal rejection of France, and then of Europe, which has been developing in the Sahel since 2020. This movement is the catalyst for two other current dangers: jihadism and the open door to totalitarian empires. These evils, which primarily attack Mali, the geographical, cultural and «hydraulic» heart of the Sahel, have a cause that is directly related to the evolution of Western culture.

This is why I wanted to put in first place the work of a Burkinabé, who was the first and most emblematic of the re-conquerors of the desert: Yacouba Sawadogo.

It is urgent to fight for the climate, biodiversity, life in harmony between humans, animals, plants and the whole universe. But it is even more urgent to see that we will not prevent climatic, biological and societal disruptions. They are already taking place. We must foresee that the nature will be different and that we must urgently organize the rescue to a changed world. Leaving such a surface of the earth as it is, when the possibility of fertilizing it is blinding, is also a sign that we have an obvious mental dryness. This emergency was obscured for two years during which covid diverted our attention. In the coming years, we will probably also be absorbed by the Ukrainian issue, by the production of fossil-free electricity necessary for all heat pumps, all air conditioners and all electric vehicles. The upper middle class will be absorbed by everything that may require it to make efforts to be sober. And the lower middle class will be absorbed by the difficulty of making

ends meet. However, we are currently on an ocean liner that has already touched the iceberg.

Urgency does not mean haste. It is counterproductive to plant billions of trees artificially, without symbiosis with nature, without the agreement and conviction of the indigenous populations. Obviously, it is even more childish to think of taking refuge on other planets, even if we spend a lot of billions and a huge media support on it.

Growth is intimately linked to human nature. How can we treat the current schizophrenia between growth and a reduction in the environmental footprint? How can we transfer the concept of consumption growth to that of quality of life growth? How can we devote the work of humans to the urgent tasks of preserving their future and their descendants?

Issues

Realizing the low level of environmental intergenerational altruism that
constitutes a major threat to our future...

Excerpt from the youth statement of the UNCTAD COP-15 symposium.
mai 2022, Abidjan

The aim of this book is, as with the one that preceded it, to grasp the theme of refertilisation from its concrete side. This aspect will bring us to the societal aspects.

Since the publication in 2019 of my book Regreening the Sahara, so many events have impacted society, whether in Africa, Europe or around the world, that the need is now felt to update this concept.

The challenge is twofold: on the one hand, to spread the urgency of regreening the Sahara, and on the other hand, to demonstrate the feasibility of such an undertaking.

- The first goal will be mainly carried out by publications that can reach a wide audience. This book is one of them.
- The second goal will be achieved by promoting an agroecological fertilization project of striking efficiency, perfectly adapted to the land and the society that lives from it: the dolphin plough.

It is now urgent to strengthen the promotion and therefore the financing of this dual action. A decisive initial support was the constitution of the Reverdir le Sahara Foundation under the aegis of the publisher Pierre Marcel Favre[1].

The Paris 2015 climate agreements are one thing. Another

1 *Reverdir le Sahara Foundation*: see Appendices

is the implementation of survival and rescue operations that are already urgent. They will become immense. Because climate change is here to stay. Its effects are already catastrophic and will be even more so in the future. And it's not just the climate that's the problem, there are also all the effects of heavy agrochemicals on health and biodiversity, the problems of urban concentration, conflicts, etc.

The results of major hydraulic projects are harsh. Dams and canals are 20th century technologies. Time very often reveals their techno-scientific and megalomaniac drift. Between the monsters that are America and China, Eurafrica can be, we must hope and believe, the axis of balance and ecology. It can and must impose itself as such, for the good of the whole planet.

It is now urgent to strengthen the promotion and therefore the financing of this dual action. A decisive initial support was the constitution of the Reverdir le Sahara Foundation.

In concrete terms, where do we start? How to secure first? In the pile of «old» notions thrown away and lost are a few treasures that will have to be sorted out and searched for. Among them is the notion of chivalry, which is often presented to us in caricature form, in films about the Middle Ages or Star Wars. However, we can see an impressive current manifestation of this in the commitment of the troops of Sahelian and French soldiers in the desert, in the courage of Ukrainian fighters in the face of the madness of one man. But in our consumerist society, very few are willing to take a mortal risk. However, the fight against jihadism will require individuals ready to sacrifice. It goes as far as our vision of death, the return of a chivalrous ideal.

Then, after having secured, it will be necessary to pacify.

First of all, by reconciling farmers, shepherds and hunters. And also by reversing the rural exodus. This immense population resulting from the African demographic boom can become the actor in the construction of a lung of the planet. All this will happen naturally if we regenerate and recreate fertile territories. The rise of the rains to the north will once again fill the water points that the nomads need. Their difficulties will be relieved and their commercial activities will be possible again. Little by little, the greened land will become cultivable and the nomads will be able to settle down. The book Regreening the Sahara considered the multiple opportunities offered by the Saharan environment. This book focuses on the most realistic, simple, and effective way to move greenery and agriculture up from the southern wetland to the arid northern vastness, and from the mountains to the lowlands. African populations will find a vocation and motivation that will reconnect them with nature. The industrialized countries will provide the machine that frees them from the extreme arduousness of this work. Global warming will in itself provide the antidote to desertification, provided that the water it brings is not lost in destructive torrents. Thus will return the trees, pastures, animals and humans that disappeared five thousand years ago.

Yes, there is reason to believe in the possibilities that humans have to get out of it, and there is reason to rely on the real opportunities that modern technology can offer us.

Eurafrica

Un partenariat transcontinental entre l'Europe, le Maghreb et l'Afrique subsaharienne pourrait enrayer la dérive de nos deux continents et nous permettrait de retrouver, ensemble, le chemin de l'action.

Dominique de Villepin[1]

L'Afrique n'a personne à rattraper. Elle ne doit plus courir sur les sentiers qu'on lui indique, mais marcher prestement sur le chemin qu'elle se sera choisi.

Felwine Sarr[2]

We are no longer in the 20th century. The quarter of the 21st was soon crossed. The challenge can no longer be that of growth in consumption, but that of growth in the quality of life. However, this is decreasing. The destruction of our natural environment, the despair of a large part of the inhabitants of the south, but also the moral misery of the suburbs of our megacities are eating away at the achievements of modernism. In the east and west, giant powers threaten the achievements of citizens, culture and humanists. It is time for the north and the south of the old world to come together, unite, strengthen and set out on missions of survival, but above all of life. With the last energy! Let us build the future and not dwell too much on the fatal events of the past. Colonization was inscribed in the destiny of humanity. The atomic bomb was to be discovered. We had to succumb to the abuse of fossil fuels. Consumerism was supposed to undermine our ideals. But what this century and the following will demand of us must involve us to the highest degree. To maintain our serenity in the coming turmoil, Africa and Europe have no choice but to support each other and to put their respective qualities at the disposal of the construction of a new area of civilization. A crucible of Chris-

[1] Dominique de Villepin, *Mémoire de paix pour temps de guerre*, Grasset, 2016, p. 388.
[2] Felwine Sarr, *Afrotopia,* Éd. Philippe Rey, 2016.

tianity for two millennia, Europe has largely lost the rising arm of the cross. This is now just a capital T. Only the human brain is worshipped, except for the artificial «brain». A destiny assumed in partnership with Africa has the potential for therapy.

An action that brings people together

Fighting on the level of ideas, ethics, politics, is essential. But that doesn't trigger the movement. Joint action sets everything in motion. It is both the goal and the starting point. There is nothing like a common struggle against a common enemy. And we have this enemy: climate change. He uses all kinds of decoys: personal and national selfishness, climate denial, greenwashing, bureaucratism. Secondary battles polarize all our attention and energy: pandemics, risks of new world wars. The path is increasingly narrow between the risks of autocracies and demagogic chaos. But a common struggle for a common goal is actually a gift. Of course, there are other challenges to be met, not the least of which is the fight against deforestation. Of course, there are other deserts. But the Sahara is the one where the evidence of a possible action is the most striking. This project combines the fight for the climate and the rescue of the population. What we need are entrepreneurs, workers and financial backers.

Greening our desert

Si actuellement les espaces s'urbanisent, bien plus dangereux en est le corollaire : l'urbanisation de nos propres esprits.
Damien Deville[1]

L'épuisement de la raison technoscientifique ainsi que les conséquences civilisationnelles de ses impasses appellent de nouvelles métaphores du futur, un renouvellement des sources des imaginaires, la pensée d'un ailleurs. Celles-ci passent pour les Africains par une meilleure intégration de leurs propres univers de références dans la quête de leurs équilibres sociétaux.
Felwine Sarr [2]

Le XXI^e^ siècle sera-t-il donc celui du triage et de la sélection par le biais des technologies de la sécurité ? Des confins du Sahara en passant par la Méditerranée, le camp est-il en passe de redevenir le terminus d'un certain projet européen, d'une certaine idée de l'Europe dans le monde, sa marque funeste, comme Aimé Césaire en nourrissait il n'y a pas longtemps l'intuition?
Achille Mbembe [3]

The fight against drought is a global fight. Its climatic component is only one facet. It is not enough to arrive on a plot of land with tractors, ploughs and a preconceived technical plan. If we think we can fight drought only by irrigation, basins or silver salts in the atmosphere, we have not put our finger on the root of the problem.

Analysis and digitization have killed synthesis and analogy. But digitalization, rationalism, scientism, specialization, are drying up. This argument may seem incongruous at first glance. And yet it is by entering into communion with the

[1] Damien Deville, *L'homme qui arrêta le désert*, Éd. Tana, 2022, p. 72.
[2] Felwine Sarr, *Afrotopia*, Éd. Philippe Rey, 2017, p. 111.
[3] Achille Mbembe, *Brutalisme*, Éd. La Découverte, 2020, p. 74.

spirit of a country and the culture of its inhabitants that one puts oneself in the right disposition for a saving action. This approach is essentially fusional and not digital.

The peoples who live in this nature are an integral part of itself. The West is astonished by the growing and increasingly organized mistrust of it. Of course, this mistrust, which becomes distrust, is manipulated by an external power. The latter makes maximum use of grievances against the former colonizers to obtain a destabilizing effect. But we must realize that the discourse of Westerners on the virtues of democracy and the defense of human rights cannot accommodate a lifestyle whose environmental footprint is ten times that of the world average. Their conscience must no longer tolerate that, through its carbon pollution, populations like that of the Sahel see their lands desertified. Wanting to park migrants in inhumane camps is not sustainable.

Knowing that realistic means can stop these phenomena is essential. Those who have access to the knowledge of these processes, who have the means and the position to put them into action and who do not, bear an overwhelming responsibility.

The Westerner is astonished that the whole world does not applaud his civic and humanitarian self-righteousness. He is surprised by the emergence of terrifying and retrograde ideologies such as jihadism, Trumpism, or tsarism. He believes that he belongs to a Judeo-Christian civilization, but in fact, in his great majority, he no longer believes in it. He believes in his brain. And this is understandable, as Judeo-Christian pedagogy lags behind reality, often based on the repetition of texts whose essentials are not understood. The cross has lost its vertical branch. It has become a capital T. Certainly we have had the lights, but now we need the Light.

To get out of it, cosmologist Hubert Reeves urges us to

rediscover gratitude and veneration. But more than ever, we have the means to realize that creation is a permanent miracle, and not a pure emanation of chance and necessity. It is this mental dryness that stuns the nationals of other cultures and causes blockages in our mutual understanding. This is not a trivial detail.

Some will find that these considerations go beyond an «objective» framework which should be that of a plea in favor of a project as concrete as the re-fertilization of the desert by the dolphin plough. I think that, on the contrary, if we neglect cultural aspects and good manners, we are not moving towards solutions, but towards conflicts. Industrial rationalism is causing cultural desertification in the suburbs of megacities. This desertification is visually illustrated by the architectural levelling of urban districts around the world. To speak to Africans, Asians and South Americans, the language of our industrial revolution is less and less convincing.

It is certain that many peoples have an organizational leap to take. But the Westerner has a cultural leap to make, with all due respect. There are elementary things that he ignores and that others feel deeply... For example, in France, we don't know that blaspheming is not a question of law, but a shocking lack of life ethic.

Possessions

Words of Fulani shepherds[1]:

«Thanks to Lindo's work, our countryside has become greener. From then on, even those from Dori (a neighboring region) can come to these lands to graze their flocks.»

1 Heard in the film *Deserto Verde Burkinabé* directed by Jonathan van Lamsweerde, illustrating Lindo Grandi's project. See on https://reverdirlesahara.org/

Reparation requires the renunciation of exclusive forms of appropriation, the recognition that there is the incalculable and the unappropriable and that, therefore, there can be no exclusive possession and occupation of the Earth.

Achille Mbembe[1]

[1] Achille Mbembe, *Brutalisme*, op. cit., p. 237.

Why green the Sahara and not only the Sahel?

I am often told that the Sahel is already big enough and difficult to regreen. It would therefore be reasonable to plead for the regreening of the Sahel, which we know that motorized zai can overcome, with a considerable effort, and which will last several decades. I am rightly told that the sand of the Sahara does not retain water.

These judicious remarks prompt me to provide the following arguments:

Many Saharan lands are suitable for re-fertilization:

- In emergency, oases.
- Then the sides of the mountains that condense the water. At the foot of the Atlas Mountains, the Hoggar, Tibesti and Aïr massifs.
- The Sahara is not only made of sand. Some plateaus are clayey or lateritic. They deserve in-depth studies on their possibilities of gradual re-fertilization, from the south from where the water will arrive when it reaches these regions.
- When the wetland shall move northwards, we will certainly be surprised at the way the sand will be «colonized» by vegetation, and we will probably be surprised by the inventiveness of the agronomists of this future era. Because humans will have to use this progression of rainfall to multiply its effect. Already today we know and develop the «water retainers « which, mixed with sand, accumulate and retain rainwater.

The use of vermiculite is being perfected. A company develops a liquid clay that, in a microscopic layer, envelops the grains of sand[1].

It is essential that agricultural research be invested on a large scale, now, in preliminary studies on the greening of currently hyperarid areas.

1 *Desert Control* is a company that has developed a process called LNC (Liquid Nano Clay). This technique makes it possible to coat the grains of sand in a microscopic layer of clay, so as to retain water. This process, which works by spreading, uses much less clay than a traditional mixture with clay. It is still very expensive, but is slated for development that will make it more accessible. *Desert Control* is a Norwegian company that operates in the United Arab Emirates.

Why the 2050 horizon?

Because this is the last choice. Or the repair, or the funeral. There will be no leakage into any exoplanet. The Earth will be the oasis from which «all humanity» will undertake the gigantic work of regenerating life. Or it will be the universal tomb, its mausoleum, in the continuity of the geological period of the history of the universe.
Achille Mbembe[1]

The political and technical worlds are planning the «2050 horizon». Generally, we think we are visionary enough if we consider this future quarter of a century. Moreover, some are worried about the 5 billion year deadline! Indeed, cosmologists predict a significant change in the Sun's functioning for this horizon. Everyone will judge the merits of this concern...

On the other hand, the end of this century and the following centuries unfortunately do not inspire many people, except for the authors of «science fiction» based on spaceships and star wars. And these times depend dramatically on what we do now! We have a responsibility for the future of our grandchildren and their descendants. And that future has much more to do with agriculture than with high technology.

This century will see the regreening of the Sahel, the next century will see the regreening of the Sahara.

You have to be in Plato's cave not to see that the future is bright! Let's stop depressing young people, let's reverse the statistics, which every year flood us with figures on the increase in drugs and suicides. Let us see and show that a new America is emerging, which will be neither a field of genocide, nor a meadow for the slaughter of bison, nor an empire of mercantilism, but a land of welcome, of miscegenation and,

[1] Achille Mbembe, *op. cit.,* p. 237.

it is to be hoped, of citizenship. It will be the laboratory of the new socety. This territory will house the most courageous refugees from the climate, from wars and, in a word, from «brutalism» as defined by Achille Mbembe. Brutalism of the objectification of the human and the «humanization» of the machine. The stupidity of the nonsense of the 20th century: deconstructivism, artificial «intelligence», «immortality» of bodies. A vastness that is currently deserted can truly become a promised land, without bloodshed, but by retaining water. Physically, it's as simple as that. But it's just too simple to be believed! This is not the result of gigantic scientific studies and global symposia. This can be grasped by the common sense of everyone, and that is why we do not see it and why we do not do it. Plato's sun is not believed by the inhabitants of the cave in which we are all confined.

This fight for the regreening of deserts can be started immediately and last a few decades, or even a few centuries. Other struggles will probably take millennia, such as the struggle to ensure that the resources of the subsoil belong to the international community. Some urgent battles will be very hard and will probably require force, such as the fight against deforestation, against ocean pollution, against atmospheric pollution. The fight against desertification, on the other hand, immediately convinces the states that owne the concerned territories. Wish that this immense wealth, which will be created, can participate in the rescue of humanity.

Strategy

How can we trigger the phenomenon that will lead society into peaceful wars against drought, against deforestation, against the poisoning of the air, water and land? Will these wars be able to remain unarmed? How will society take charge of the effort that awaits it in the struggles that are taking shape on all fronts? We are heading towards a time when the efforts to be made will be colossal. It will be the end of luxury for all. Is waiting any longer, procrastinating, the right strategy? Financing will have to be taken in hand by international powers, which will mandate efficient entrepreneurs. Because wars are too heavy and too serious to be supported only by private individuals or NGOs. However, the fight against drought will be the equivalent of a war effort.

Let the media take up this subject!

The first resort is media. Everyone must know that regreening certain deserts is possible, sometimes on a gigantic scale, by simple and natural means. Everyone must know that this is a big part of solving climate and migration problems. It is as important as the fight against deforestation, the fight against autocracies, against the old theocracies, against the oppression of women.

Let all media players get involved, whether they are journalists, publishers, painters, singers, filmmakers, videographers, cartoonists, futuristic novelists, playwrights! They can be much more mobilizing than numerical studies and the reports of commissions and symposia.

This is how this subject will reach the ears of citizens, politicians and finally on the desk of decision-makers. We have to short-circuit the administrative monsters!

Spread the word!

And what about us?

The fertilization of the Sahara will create a lot of jobs, life opportunities, mainly for Africans, then for the displaced, and then for all those who want to participate in the construction of a society in new lands. It may even reverse the migratory flows, but it is obviously not for tomorrow morning. The urgency is for the refugee camps to disappear. That tensions are lowered, in Europe and Africa, on the coasts of the Mediterranean and the Channel. To melt the camps and the suburbs by building a new land, which will require quantities of organic farmers and all the active voluntary society that will accompany this work. To be aware of this, to ardently support it in our society and our citizenship, to advance the idea, will already be participating. Ensuring that the international and national administrative monsters do not run on empty will be a noble civic commitment. To fight with young people by opening realistic perspectives of fusion with nature, of faith in the Creative Power, to prove that it is indeed towards new horizons that we are going, through the collapses that are coming.

Annexes

An impetus to be transformed: the Great Green Wall

Create a fifteen-kilometre-wide strip of vegetation from the west coast of the Sahel to its east coast. This strip of greenery would be seven thousand six hundred kilometres long, and an effective surface area of about 80,000 square kilometres, or nearly three times the area of Belgium. In this way, we would stop the progression of desertification, we would recreate arable and habitable land. This strip would extend from northern Senegal to Djibouti. It would cross the desertified area of the Sahel on the territories of Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria, Chad, Sudan, Eritrea and Djibouti.

Proposed in the eighties by Thomas Sankara, then president of Burkina Faso, the Great Green Wall was mentioned in 2002 at the N'Djamena summit on the occasion of the World Day to Combat Desertification. It was then approved by the Conference of African Heads of Government of the Commu-

nity of Sahel-Saharan States in Ouagadougou in 2005. In 2007 in Addis Ababa, eleven Sahel-Saharan States supported this initiative. Currently, the GGW project is an African Union (AU) programme. The partner countries are: Algeria, Burkina Faso, Benin, Cape Verde, Chad, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Libya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan, Tunisia.

The GGW obtained the support in principle and financial support of the international community at the Bonn summit in 2017. The condition for this aid is that each region has «a precise plan, based on consultations and collaboration with the local populations».

The GGW is supported by global organizations such as:

- The UN Convention to Combat Desertification (UNCCD);
- The World Bank;
- The Sahara and Sahel Observatory (OSS);
- The Food and Agriculture Organization of the United Nations (FAO);
- The United Nations Development Programme (UNDP);
- The United Nations Environment Programme (UNEP);
- The European Union (EU).

Of the eight states directly concerned by these projects, only one has made significant progress: Senegal.

In Senegal, the GMV project began in 2008. The political and territorial stability of this country has allowed for a steady advance, despite the initial scepticism of some observers.

Senegal plants two million trees per year, or an annual area of five thousand hectares. In 2017, 42,500 hectares had been reforested out of a final target of eight hundred thousand hectares. At first, the site was a large expanse of rows of trees, then we realized that it was better to create scattered, inhabited plots of about six hundred hectares each, surrounded by

fences. This allows the cattle to move between the plots, without grazing on the young shoots. The installation of the plots was accompanied by a long work of awareness-raising. A pact between farmers and Fulani herdsmen has been implemented. The fodder produced on the protected plots is mowed and made available to the herds.

But the question of water supply is crucial. In many parts of Africa, this contribution will require extensive piping, pumping and water transport facilities.

Future of the Great Green Wall: An extension to the entire territory

A visit by the board of the Regreening the Sahara Foundation to Senegal in February 2020 allowed its members to see first-hand the concrete evolution of the project.

We have seen the implementation of the concept of harmonization between agriculture and pastoralism as well as the sedentarization allowing the schooling of children. On the other hand, due to a lack of resources, the supply of irrigation water is lacking. In the area visited, the water pumped by the current boreholes is barely enough to water the herds, and does not allow the new vegetation to progress sufficiently. Many more boreholes would be necessary, under the supervision of hydrogeologists.

Mr. Abdou Karim Sall, Minister of Environment and Sustainable Development of Senegal, informs us that:

«The concept of the Great Green Wall is no longer limited to a strip of land located in the north of the country, but consists of working on the entire surface of the country. The effort of the population must become general. «This is not a utopia, but a strong ambition for the whole country. It is the benchmark of our social policy.»

The opinions of Minister Abdou Karim Sall and Ali Haïdar, Director of the National Agency for Reforestation and the Great Green Wall, indicate how regreening is a central issue in Senegal. This Sahelian country, which is the only one to be protected from terrorist violence, is experimenting with ways to stop and then reverse desertification. The approach is experimental, ecological and above all societal. Under current conditions, we can see that the technical concept of the «wall», ratified in 2007, is gradually giving way to a much broader vision than that of row plantings. The current approach is that of a regreening of the entire territory through a popular and diversified effort.»

In this context, it seems to us that methods using direct rainfall capture in the field are particularly judicious.

From the «Great Green Wall» to the «Great Green Tide»

A «Green Tide» that would invade the Sahel from the Gulf of Guinea, from the south, is a realistic vision[1].

Many agricultural and climate experts have doubted the effectiveness of a barrier that would hold back the desert. But the desire to stem and reverse desertification is very present in the Sahel countries. The concept of a simple wall of planted trees has given way to a concept of inhabited, protected agricultural sites, living in symbiosis with the herders.

The strategy now is to massively increase the humidity from the south, by ruthlessly fighting against the deforestation of the Guinean forest, by replanting it, and at the same time by retaining rainwater further north, in the land.

The widespread application of a powerfully motorized zai acting deep in the soil will allow this water retention. Not only do the means exist to achieve this, but they are tested and documented. The question is not so much to equip oneself with ploughs and tractors, but to train the actors of this work, which requires a lot of know-how. It is also a question of convincing the inhabitants of these territories of the feasibility of this process. Only a tiny part of the hundreds of billions pledged to combat desertification will be enough to give strength to this action. The will of the locals to survive will ensure the success, as has been experienced so far in the Great Green Wall project, and in Burkina Faso before the current period of insecurity.

1 https://www.nigerdiaspora.net/a-la-une/32-politique-niger/16290-la-grande-muraille-verte-mirage-sahelien

As described earlier, well-trained professional teams are already in action. They can constitute the starting core of a movement that gradually increases in strength, to achieve all the necessary effectiveness.

Regeneration of existing root systems
Tony Rinaudo

© Word Vision – Silas Koch

Australian agronomist Tony Rinaudo is nicknamed the «maker of forests». Having lived for several decades in Africa, he has developed and practiced an astonishing and very effective method for reforesting formerly green territories. His technique is to revitalize the old root system, if it has survived for decades. This root system, which he calls «underground forest», still gives a few bushes that emerge on the surface. By choosing the right plants, pruning and protecting them, Tony Rinaudo rebuilds healthy trees and the forest is reborn from its ancient roots. Trained in his technique, the inhabitants of the country thus reconstitute their own living environment. His formula is: «those who have deforested can reforest». In Niger alone, Rinaudo has already regenerated an area of 50,000 km2, more than the area of Switzerland, by regenerating 200 million trees. The regeneration potential of this process is of the order of the equivalent of the surface area of India. More than an agricultural

method, T. Rinaudo has founded a vast peasant movement that carries his practice, the «farmer-managed natural regeneration (FMNR)».

Like many Australian agro-ecologists, T. R., born in 1957 in the state of Victoria, lived through the surge of agrochemicals in his country. At a very young age, he noticed the destruction of local tree species and replaced them with the monoculture of pine. After graduating as an agricultural engineer from Armidale University, he became involved in the missionary organization «Serving in Mission» and was sent to Niger, where he arrived in the extreme drought conditions that followed the 1970s. Imported monoculture methods had completed a disaster of deforestation and degradation. Like most agronomists of the time, he began to develop nurseries and replant the territory. He bitterly noted that only 10% of the seedlings survived drought, sandstorms, goats and wild cutting for fuelwood. Ready to give up, he fixed his gaze on one of the small bushes that grew in the grounds. As he approached, he realized that it was in fact the suck of a large tree that had been cut down. He discovered that the entire territory covered the living roots of an ancient forest. It was therefore a question of regenerating it rather than planting a new one. And those who had deforested could become the ones who would regenerate this forest! And that's how he had the idea of founding the FMNR movement.

Tony Rinaudo has received a number of prestigious awards:

- Interaction 2010 Best Practices and Innovations Initiative
- Word Vision Global Resilience Forum, 2011
- Arbor Day Award for Education Innovation, 2012
- UNCCD Land for Life Award, 2013
- Right Livelihood Award, 2018 (prix Nobel alternatif)

Water from tropical rivers

Four great rivers carry immense quantities of water to the middle of the desert. Senegal, Niger, Chari and Nile[1].

The Niger River

©Getty Images-George Steinmetz

The immensity of the water rubs shoulders with the immensity of the desert

1 cf, § *Opportunité des ressources fluviales*

The Niger River has a tremendous untapped potential[1]. It is an average of 6000 m^3 of water per second that arrives at the level of the desert. This river borders the south of the desert area for more than a thousand kilometers. It feeds a huge wetland from Ségou to Timbuktu, the inland delta, which is an extremely prosperous area for fishing, agriculture and livestock. Its surface area of thirty thousand square kilometers is equivalent to the area of Belgium. Its functioning is complex, and its delicate balance must be preserved[2].

Wikimedia commons

Niger River Basin

1 cf., J.-E. Buchter, *Reverdir le Sahara*, op.cit., p.100-106

2 Marie–Laure de Noray, *Delta intérieur du fleuve Niger au Mali – Quand la crue fait la loi : l'organisation humaine et le partage des ressources dans une zone inondable à fort contraste, sociologie et communication appliquées au développement* . Montpellier, Vertigo, vol. 14 no 3, déc. 2003.

The Guinean equatorial forest, the heart of the pumping towards tropical rains

The large equatorial forests benefit from heavy rainfall fed by rising evaporated water in the hottest areas of the globe, near the equator. The main forests of this type are those of the Amazon, the Congo and Indonesia. The Guinean forest of West Africa is watered by humid winds from the Gulf of Guinea. It is of paramount importance in the production of rainwater that will be conveyed by the monsoon winds to the arid territories of the Sahel, further north[1]. Guinea receives in its mountains the water that feeds the sources of the great rivers, which carry it to the north, to the Sahel: Niger, Senegal, Gambia. Moreover, the considerable evaporation due to the transpiration of its vegetation is carried by these same winds towards these same arid countries.

The preservation and reforestation of these forests is therefore a top priority. The uncontrolled deforestation that is rampant there is a crime against nature and against humans, which must be repressed with the greatest energy by local administrations, and if necessary by the international community. This is a crucial point in the global politics of the future.

In the same fight, the creation of new greenery, then new forests, is an essential driver of humidification. It is not only for the local climate, but for the neighbouring regions. This is a self-amplifying phenomenon: rainwater produces greenery, which in turn will lead to an increase in rainfall. Conversely, deforestation will lead to a decrease in rainfall, which in turn will cause an even more severe death of the forest. We are then in a death spiral.

The analysis of the forest as a rain-generating power has functions that are detailed by Professor Antonio Donato Nobre[2]. This scientist has particularly studied the role of the Amazon rainforest in the climate of South America. But his observations apply to other equatorial forests, such as the

1 cf., §: Opportunity of the African monsoon

2 Antonio Donato Nobre, *The future climate of Amazonia*, translation American Journal Experts, Sao José dos Campos, SP :ARA :CCST-INPE :INPA, 2014

Guinean forest of West Africa. The five main rain-generating functions are listed below:

1. Recycling and humidity regulation,
2. The nucleation of condensation,
3. The humidity pump,
4. Aerial rivers.

1. Moisture recycling

This is ensured by the transpiration of the foliage. The water evaporated on the oceans and carried by the winds is precipitated on the continents. It accumulates in the spongy subsoil of forests. From there, the plants gradually pump it to their leaves, which return it to the atmosphere, from where it is carried to other regions. In the case of the great Guinean forest, winds from the Gulf of Guinea pour their water into the Guinea Mountains. From there, they are taken to the Sahel during the rainy season, and could carry the humidity much further north, if it were abundant enough. Because of the large surface area of foliage, the evaporation of a dense forest area is greater than that of the same area of the ocean.

2. Condensation nucleation

Studies carried out on the Amazon rainforest have highlighted the effect of organic substances secreted by trees on water condensation, leading to the formation of raindrops. These substances, whose scientific name is «biogenic volatile organic compounds (BVOCs)», are commonly likened to perfumes. Since these discoveries, it has become clear that the presence of trees has an effect on the formation of rainfall. This explains why recreating forest has a multiplier effect on regreening. The moisture carried by the winds from the ocean or the equatorial forest pours more heavily into green areas than into desert areas.

3. The Humidity Pump

The condensation of water vapor on the forest acts as a powerful pump, sucking moist air from the ocean to the main-

land. This is because the volume of vapour in the atmosphere is reduced to that of condensed water, which is about a thousand times smaller. This creates a powerful air intake, which, if it comes from the ocean, brings a renewal of humidity. This also explains the multiplier effect of afforestation, and the very current effect of what remains of the great forest.

4. Aerial Rivers

The quantities of water evaporated above the forests are transported by air currents that Nobre calls «flying rivers». These phenomena have been particularly studied in Brazil, where the aviator Gérard Moss and his wife Margi took atmospheric samples over the Amazon and throughout Brazil. The map of flying rivers was thus established. The result is the certainty that if the Amazon rainforest weakens, almost all of Brazil's agricultural land will dry up. All things considered, we can, by analogy with the great Amazon forest, compare the Brazilian flying rivers with the flows of moisture from the African equatorial forests and the Guinean forest.

An agency

For the planned and international development of greening by motorized zaï, the creation of a competent agency is essential. This must be mandated by the UN bodies.

A certain number of people with recognized skills must be hired on a permanent basis.

People in the field

- For the launch and monitoring of zaï projects.

Professionals in the field, with a high level of practical qualifications.

Scientific

- For the prospection of land suitable for refertilization by zaï.
- For the scientific monitoring of construction sites, the evaluation of the quantities of carbon absorbed.
- For the quality control of the work carried out by the companies operating the dolphin ploughs. In particular, the depth reached by the plough and the fixed blade (ripper) must be checked and guaranteed .

Skills of soil scientists (soil specialists), agronomists, geologists, hydrogeologists, rural engineers.

Local negotiators

- -For contact, negotiation and collaboration with the communities living in the territories concerned.

People who are very familiar with the local societies and

their languages. These people will need to be familiar with territorial, customary and legal rights.

Administrators

- For the financial, accounting and administrative aspects, as well as relations with financial supporters.

Administrative and accounting skills.

All these skills are necessary and work in synergy. This is why an entity that encompasses **and energizes the whole is necessary.**

The *Regreening the Sahara Foundation*

Created in 2019, this foundation aims to promote the concept of regreening the Sahara.

Founder: Pierre-Marcel Favre
Godfather: Bertrand Piccard

Address:
Rue de Bourg 29
CH-1003 Lausanne

Site: https://www.verdir-le-sahara.ch
e-mail: info@verdir-le-sahara.ch

A few figures

Motorized Zaï

The following figures relate to a projection on a site that would include 10 ploughs over 10 years since its commissioning, including initial investment. (The databases are drawn from the Deserto Verde Burkinabé.)

- Cost per hectare: between €65 and €160 depending on the conditions of the land
- These values do not take into account the expected benefit of carbon credits. This contribution depends on the status and price of carbon finance in the coming years. It should make the operation profitable, and therefore self-amplifying)
- Mass of CO^2 sequestered per year and per plough, 10 years after passage: 145 000 t/year
- Area worked per plough per year: 1650 ha
- Annual local maintenance fee after the plough: €0
- Water mass captured for rainfall of 500 mm/year: 5,000,000 litres/year per hectare

Miscellaneous data

Sahara area: 9.2 million km^2

Average flow of the Niger at Sokoto (Bamako region): 6000 m^3/s
Average discharge from Senegal to St Louis: 640 m^3/s

Price per tonne of CO_2 sequestered on the European market (end of October 2022): €60-80/t

Annual rainfall[1]

Averages in different locations in mm/year: (The sites mentioned go, roughly, from the shore of the Gulf of Guinea to the north)

Conakry	3775
Freetown	2946
Abidjan	1545
Lagos	1540
Fouta Djalon	1600
Bamako	990
Ségou	760
Mopti	500
Tombouctou	185
Niamey	540
N'Djamena	726
Dakar	515
St Louis	338
Nouakchott	160
Agadès	282
Kidal	706
Taoudenni	707
Bobodioulasso	900
Ouagadougou	745
Ouahigouya	627
Gorom-Gorom	566

For comparison, rainfall in different parts of Europe and the Arabian Peninsula:

Colmar	530 (minimum en France)
Mont Aigoual	2280 (maximum en France)
Paris	637
Madrid	415
Cologne	795
Riyad	112

1 Google data

Acronyms used

UNCCD: United Nations Convention to Combat Desertification.

COP: Conference of the Parties. The Conference of the Parties (COP) on climate change brings together all the states that signed the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro in 1992.
UNFCCC COP-26 was held in Glasgow in 2021.

Other COPs:

COP of the United Nations Convention to Combat Desertification UNCCD.
UNCCD COP-15 was held in Abidjan in 2022.

COP of the Convention on Biological Diversity (CBD).
CBD COP-15 was held in Montreal in 2022.

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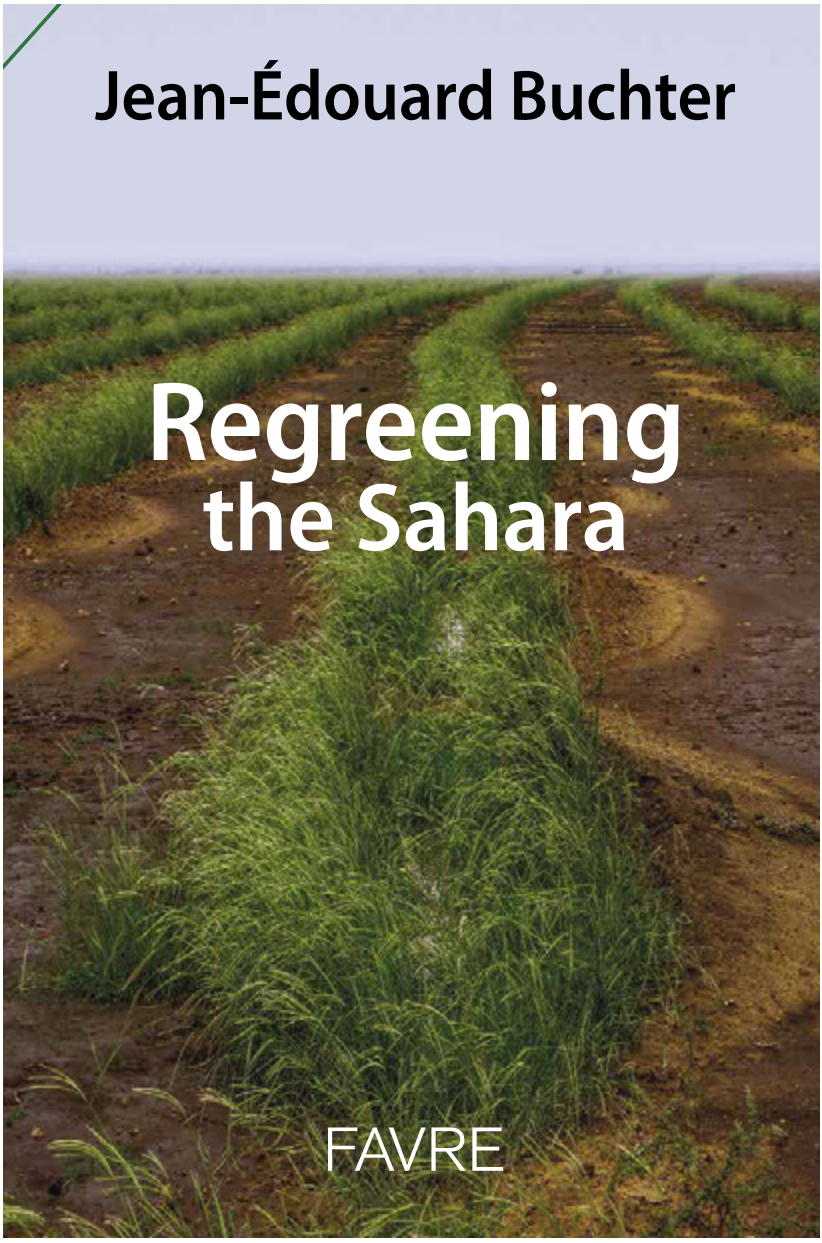

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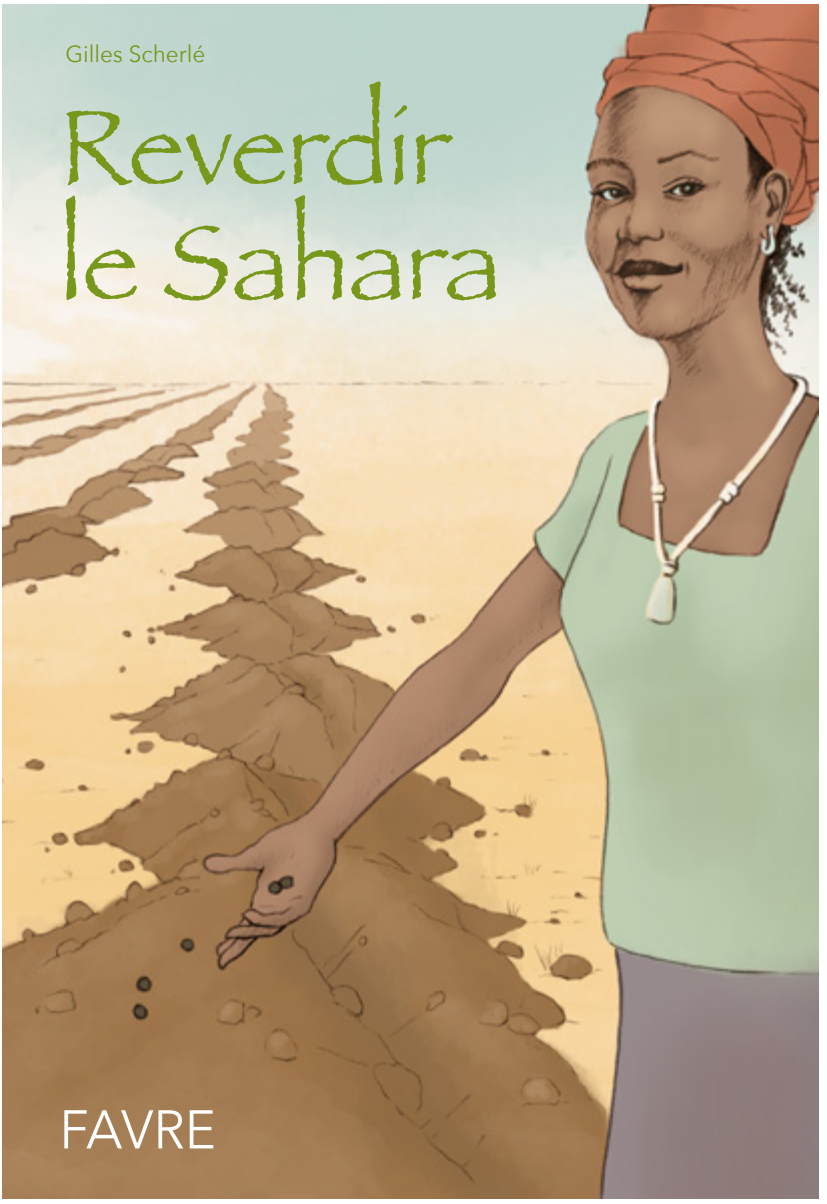

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