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SAHARA DUST NOURISHES THE SOIL - ROLE OF FLOODS IN THE FERTILIZATION OF PALM GROVES

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ABSTRACT

This article addresses a very particular meteorological phenomenon. This is the diffusion of desert dust from the Sahara into the atmosphere. Based on satellite images taken by NASA during the period 2001-2021, the Sahara desert sends millions of tons of fine particles out of its territory every year. Thus, during the period from June 4 to July 14, 2020, dust from the Sahara flowed over more than 12,000 km to reach Florida in the United States of America. The Sahara exported a quantity of fine sand from March 25 to 29, 2022 to Europe and more particularly to countries such as France, Portugal, Spain and Switzerland. Despite the problems they cause, such as air pollution, health and the environment, Saharan dust is a very good natural fertilizer. In the Algerian Sahara, for centuries, farmers have exploited the floods drained by the River to feed the soils of the palm groves. With each flood, millions of tons of dust and nutrients are picked up by runoff. This water loaded with fine particles is shared between the farmers by an engineering hydraulic system. The relationship between the Amazonian forest and the Sahara Desert is a good example to justify the contribution of these fine particles to the soil.

Keywords: Dust, Flood, Oasis-Palm grove, Sahara, Soil fertilization.

INTRODUCTION

In recent years, the population of northern Algeria has realized that the presence of desert dust in the air during the summer season is increasingly important and annoying. This particular phenomenon of air pollution by dust particles is a consequence of very active wind dynamics in the Sahara Desert. With an adequate layout of approximately ten mega-obstacles occupying 10% of the total area of the desert, the Sahara offers the best wind system of the eleven hot deserts on the planet. The Sahara annually releases more than 180 million tons of fine particles outside (Borunda, 2020). However, the large and medium particles move by saltation and thrusting inside the Sahara, thus forming zones of erosion and deposits. Thanks to the dominant direction of the trade winds and the arrangement of the mega-obstacles, the dust once lifted leaves the Sahara in a westerly direction through Mauritania and Western Sahara. This does not prevent the sand from flying out of the Sahara across the other borders. Following the decreasing order of magnitude, the solid particles fall on the over flight path. Only light particles can reach the most distant places in the Sahara. This is how during the large dust storm that lasted from June 4 to 26, 2020, the largest sand voyage ever recorded in history, a plume of dust that originated in the region of Tanezrouft (Algeria) and reached South America, the Caribbean and the southern United States. For 3 weeks, an air bridge between Tanezrouft and the American continent was created to dust the soil and the ocean with millions of tons of desert dust from the Sahara (Remini, 2020). Considered a natural fertilizer, Saharan dust sprinkles the Amazon forest several times a year. On average, 27.7 million tons per year of dust from the Sahara reaches the Amazon basin. This amount contains approximately 22,000 tons of phosphorus (Remini, 2017). Few studies have been performed on migrating dust and nutrients picked up from the soil of the Sahara. However, the uplift mechanism of these fine particles has just been resolved in recent years (Remini, 2018; Remini, 2022a; Remini, 2022b). This article addresses the contribution of migratory dust to soil fertilization while evoking the use of the oasis population to flood waters to feed their palm groves.

STUDY AREA AND WORK METHODS

Study region

Covering an area of 9 million km^2, the Sahara is considered the largest hot desert on the planet. It is located in the northern part of the African continent (Fig. 1). With a perimeter of 13,000 km, the borders of the Sahara are the chain of the Saharan Atlas to the north, the Sahel to the south, the Atlantic Ocean to the west and the Red Sea to the east (Remini, 2001). This area is occupied by eleven countries, namely, Algeria, Tunisia, Libya, Egypt, Chad, Niger, Mali, Mauritania, Western Sahara, Sudan and Morocco. The Sahara, an arid to hyperarid territory, is known for its low rainfall of 60 mm/year and a temperature that can exceed 45°C in periods of drought. Certainly, the Sahara is the most beautiful and the largest desert in the world, but it is not the most arid, since it is the Atacama Desert in Chile, which is considered the number 1 desert in the world in terms of aridity. In northern Atacama, one may observe an average of 0.1 mm of rainfall per year. It is more than 250 times drier than the Sahara (Meyer, 2019). For example, the city of Arica holds the world record for the longest period of drought: 172 months (from October 1903 to January 1918), i.e., more than 14 years (Geoclimat, 2011). There are regions in the Atacama Desert that have recorded zero rain for 4 centuries (Meyer, 2019).

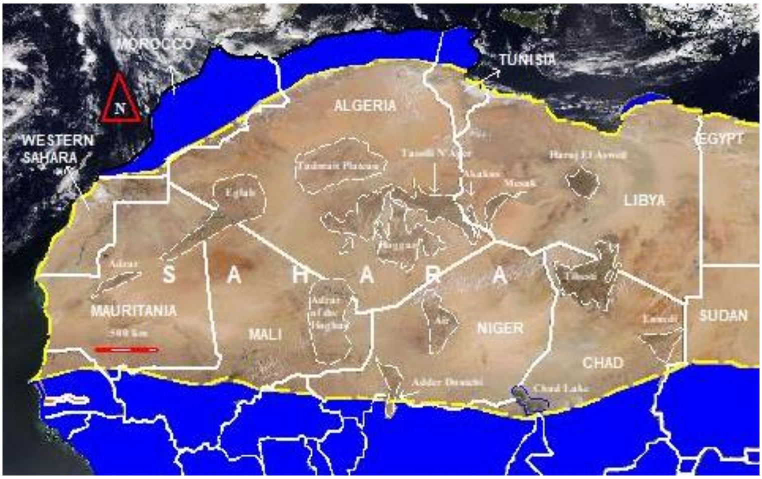


Figure 1: Situation of the hot Sahara desert (Remini, 2018)

The Sahara Desert differs from other deserts by its large surface area, which is approximately 9 million km^2, 20% of which is occupied by sand dunes and 10% by rocky massifs. Breathtaking landscapes exist only in the Sahara: Rivers, Guelta, lakes, Reg, Ergs, oases, Chott, Sebkha, rocky plateaus and Rocky Mountains (Figs. 2 and 3). These different landscapes form the most beautiful desert in the world.

Figure 2: Chott Erraneb (Ouargla) (Photo. Remini, 2008)

Figure 3: Rocky massif and sand dunes, one of the landscapes of Tassili N'Ajjer (Photo Remini, 2021)

Unlike other deserts in the world, the Sahara is animated by a very active wind dynamic (Remini, 2001). There are approximately ten mega-obstacles in the Sahara. These are Hoggar – Tassili N'Ajjer (Figs. 4, 5 and 6); Ennedi, Tibesti, Air, Adrar Ifoghas, Eglab, Tadmait Plateau, Ader Doutchi, Harruj Aswad, Adrar. The proper arrangement of these topographic reliefs by forming corridors and Venturi creates exceptional wind dynamics (Fig. 7).

Figure 4: A view of the Tassili N'Ajjer mega-obstacle with an area exceeding 70,000 km^2. Tassili N'Ajjer is a set of volcanic massifs whose maximum altitude is more than 2100 m. (Photo Remini, 2021)

Figure 5: The Hoggar mega-obstacle is essentially composed of volcanic rocks. Its highest peak is Mount Tahat in the center of Atakor, whose altitude exceeds 2900 m. (Photo Remini, 2006)

Figure 6: A view of the mountain ranges of the Hoggar mega-obstacle with an area of more than 50,000 km^2 (Photo Remini, 2008)

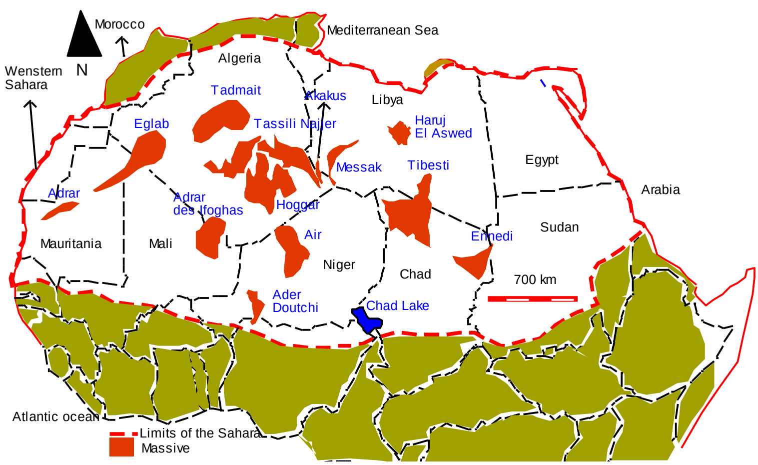


Figure 7: Sahara with these mega-obstacles; the originality of an exceptional desert (Remini, 2022)

In the presence of sand from the mountain ranges following the phenomenon of erosion that has worked for millions of years, the meeting of the Harmattan winds coming from the East with the rocky massifs creates an impressive wind dynamic. This causes the appearance of deposition areas, erosion areas, wake areas, pass areas and detachment areas. This is how Ergs are formed in the deposit areas upstream of obstacles such as the Grand Erg Occidental (Fig. 8). Ergs can also form in convergence areas. In the absence of obstacles, in flat areas, Ergs form in rough areas such as the Grand Erg Oriental (fig. 9). Generally, sandy particles form dunes and Ergs. On the other hand, for fine particles, whether in an area in the presence of obstacles or in a flat area, the detachment of the air streams from the obstacles or the rough zone generates the appearance of vortices that are accompanied by the lifting of dust in the air.

Figure 8: Grand Erg Occidental with an area of 80,000 km^2. The Erg was formed upstream of the Eglab obstacle (Photo Remini, 2015)

Figure 9: Grand Erg Oriental occupies an area of 120,000 km^2 and has dunes that exceed the height of 200 m (Photo Remini, 2018)

RESULTS AND DISCUSSION

The Consequences of Animated Wind Dynamics in the Sahara Desert

The particularity of the Sahara lies in the number and perfect arrangement of mega obstacles that generate a very active wind dynamic (Remini, 2018). This is how the topographic reliefs influence the wind currents carrying sand. This led to a new wind diagram composed of deposition areas, erosion areas and wake areas. Heavy particles generally move in saltation according to the speed of the wind and can thus travel several kilometers from an erosion area to a deposit area (Figs. 10 and 11). It is the geometric shape of the mega-obstacle that sizes the dunes and the Ergs. The sandy particles, thanks to their own weight, cannot escape from their territory of the Sahara.

Figure 10: A sample of sand taken in the capital of Tassili (Djanet) during a sandstorm (Photo Remini, October 2021)

Figure 11: Movement of sand particles by saltation, the most common means of sand transport (Remini, 2021).

Generally, during the dry period, these sandy particles move in large concentrations in the form of sandstorms called sandstorms. This meteorological phenomenon often occurs in the wilayas of southern Algeria and can sometimes reach the wilayas of the gateway to the desert, such as Biskra, Msila, Boussaâda, and Djelfa located between 300 and 400 km from the capital. The extent of the damage resulting from this meteorological phenomenon depends on the violence of the wind and the duration of the storm episode. On the health side, the sand in the air irritates the eyes and causes serious respiratory diseases. For example, the infectious disease, known as "valley fever", which is spreading at high speed in the American West? According to several scientists who claim that the disease comes from the Coccidioides fungi present in the dust carried by the sandstorms, which are frequent in the American desert (Durand, 2022). This disease has the symptoms of a flu (fever, fatigue, cough, headache, muscle aches), which can last up to three weeks. However, this disease can lead to more serious cases; the infection can lead to irreversible lesions on the lungs and to the death of the patient (Durand, 2022). On the environmental side, sandstorms pose many problems, especially the invasion of gardens by sand. Despite the closed windows and doors, the sand enters the houses. The sandstorm reduces visibility to zero, and vehicle traffic becomes difficult and often causes fatal accidents. Sand deposits scattered on the roads are generally in the form of dunes hampering the circulation of vehicles and the movement of people (Figs. 12 and 13).

Figure 12: Sand deposits (large particles) in the middle of a road during the sandstorm of January 30, 2022, which affected the Souf region – Algeria (Miloudi, 2022)

Figure 13: Formation of sand dunes (large particles) in the middle of the Touggourt-Chegga road with each sandstorm (Photo Remini, 2021)

When sandstorms occur, human activity decreases, few people circulate outside, and the population takes shelter in the houses. Vehicle traffic becomes very difficult and can even cause engine failures. Sand is everywhere; in our hair, in our plates, in our clothes and in our homes. In very rare cases, state institutions and, more particularly, schools close their doors for the duration of the sandstorm episode. After the end of a sandstorm, life resumes again, and the sand hunts clean the roads and squares. The population sweeps the sand in front of the doors of their houses and in the gardens. In return, the wilayas of northern Algeria receive dust from the Sahara and not sand. Dusts are grains of matter whose thickness ranges from a few hundred nanometers to a few hundred micrometers (Hamanou, 2018). Having become a usual meteorological event, the dust rises from the Sahara to the north of Algeria each year and more particularly during the hot season. Due to their size, the sandy particles cannot make a trip of approximately 2000 km; they generally fall at the level of the wilayas of the highlands. Only dust particles can reach the coast, and they can even fly over the Mediterranean and Atlantic Oceans. These very fine particles deteriorate air quality and are harmful to human health and can even cause respiratory diseases, which are a main cause of disability and death throughout the world (Burunda, 2020). Additionally, these very light dust grains easily penetrate the eyes, but they are beneficial for soils and oceans.

The Sahara desert fertilizes the planet's soils

The 9 largest hot deserts on the planet send millions of tons of dust into the atmosphere. Covering an area of 18 million km^2, the 9 hot deserts of the world are in decreasing order of area as follows: Sahara (9 million km^2), Arabian Desert (Rab El Khali) (2.3 million km^2), Australian Desert (1.4 million km^2), Gobi Desert (1.3 million km^2), Kalahari Desert (0.9 million km^2), Atacama Desert (0.8 million km^2), Central Asian Desert (Karakoum Kizil Koum) (0.65 million km^2), North American Desert (Somora) (0.3 million km^2), and Taklamakan Desert (0.3 million km^2) (Fig. 14).

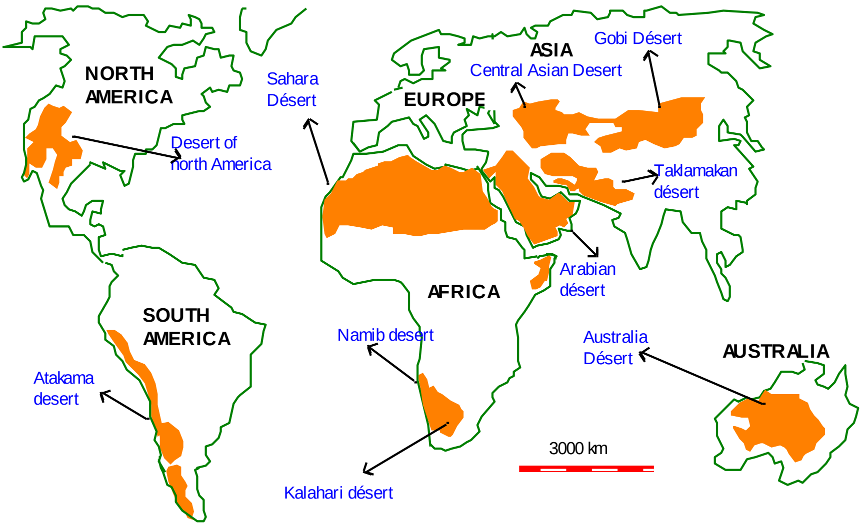


Figure 14: Deserts of the world (Remini, 2022)

In each desert, a very active wind dynamic is manifested by the movement of sand particles by saltation. This type of transport results in the formation of dunes and Ergs as well as the silting up of oasis areas. However, the fine particles are transferred due to violent winds outside the arid territory. The Sahara, Arabian and Central Asian deserts are the largest and most consistently active sources of sand and dust storms (ONU, 2020) (Figs. 15 and 16).

Figure 15: A sample of fine particles collected after the passage of the dust storm of March 29, 2021 (Photo Remini, 2022)

Figure 16: A sample of fine particles collected after the passage of the dust storm of March 29, 2022 (Photo Remini, 2022)

In view of its particularity, which resides in an adequate organization of mega-obstacles that accelerate the winds to raise the dust in the atmosphere, the Sahara remains the most important source of desert dust on the planet. More than 55% of all global dust emissions are produced by the Sahara, the effects of which are strongly felt in the North Atlantic Ocean, the Caribbean Sea, the Mediterranean Sea, the Red Sea and the Sahel (ONU, 2020). Dust plumes end up sprinkling the seas, oceans and continents. Obtained by a centuries-long erosion process, this dust from different types of rocks is very rich in nutrients. During the travels of these dust plumes, significant amounts of nutrients accompany the fine particles. In descending order, the sediments fall according to their sizes from the point of uplift until the plume fades. However, the intervention of rain is likely to stop the journey of clouds; dust will eventually fall on the ground or on the sea in the form of muddy rain. Our clothes are stained with very fine mud (Fig. 17). Cars stained with dust cause jostling in car washes (Fig. 18).

Figure 17: Muddy rain stains our clothes (author's jacket) after the passage of the dust storm of March 29, 2022 (Photo Remini, 2022)

Figure 18: Vehicles (author's car) marred by muddy rain during the March 29, 2022 storm (Photo Remini, 2022)

Figure 19: Dust storm of March 29, 2022 with an orange color invading the town of Blida (Photo Remini, 2022)

On the other hand, water erosion by the force of runoff tears fine particles from their initial positions, which end up being deposited in dams or at the bottom of the oceans. For this reason, the land becomes increasingly depleted of nutrients, while trees and forests continue to grow normally. This is explained by external inputs of fertilizers that compensate for the deficit in fertilizers. These are arid environments with very strong winds that send millions of tons of dust and fertilizers into the atmosphere each year. Of an orange, grayish and even yellowish color, the clouds of dust in the 4 corners of the world sprinkle the soils, the forests and the oceans. What water erosion causes soils to lose nutrients, wind erosion compensates; the two erosions help each other. For example, approximately 5 billion tons of dust are emitted each year. The Sahara sends 2 billion tons of dust into the atmosphere per year (ConsoGlobe, 2022). The dust stays in the air from a few minutes for the largest ones to a few weeks for the smallest ones (Hamanou, 2018) (Fig. 19).

The oases, a story with the dust of the Sahara

For centuries, the fine particles drained by floods have been considered a godsend. In addition to the large volume of water that they drain and which are necessary for feeding the population and irrigating the gardens, the sediments they carry are considered a natural fertilizer par excellence. These inputs of silt and nutrients are of great interest for the development of plants and palm trees. For these reasons, oasis dwellers cultivate their gardens in the major beds of the rivers (Fig. 20). Throughout the year, these gardens are irrigated by well water. However, during periods of flooding, the water laden with silt floods the gardens, and consequently, the soil is enriched with nutrients; it is a natural soil amendment (Fig. 21). This is the most important moment in the life of an oasis dweller. An annual dust-laden flood that submerges the palm grove is largely sufficient for the success of an agricultural year.

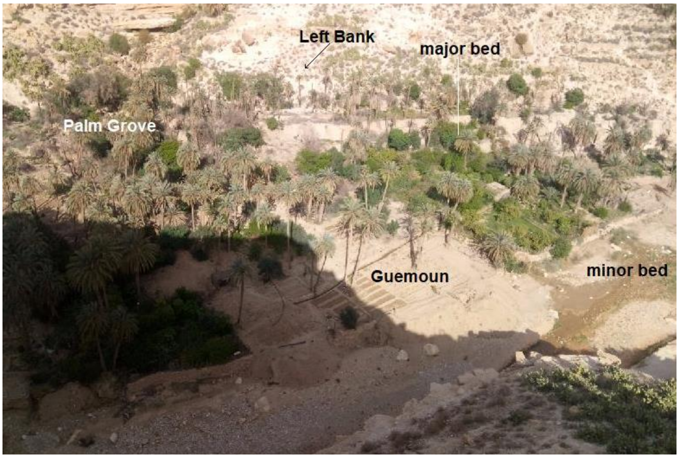


Figure 20: Gardens on the major bed of the Labiod River (Commune of Ghassira) (Photo. Remini, 2017)

Figure 21: Flooding of the palm grove located on the N'Tissa wadi by floodwaters, a technique used by farmers in the M'zab valley (Photo. Remini, 2015)

In the M'zab valley, the Mozabite population is well aware of the value of floods and, more particularly, the dust carried by the M'zab, Zegrir and N'tissa Rivers. Farmers give a lot of importance whether it is for water or for sediments drained by floods. The mud is used as a fertilizer for the soils of their gardens or as building materials for their ksour (City of the peasants) (Figs. 22 and 23).

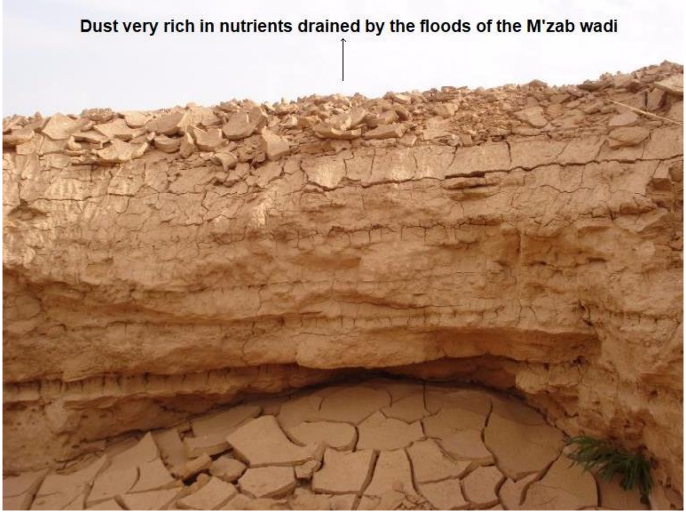


Figure 22: Mud stored in Ahbas N'Bouchen and recovered by farmers to reuse it as an amendment for poor soils (or to combat soil salinization) (Photo Remini, 2010)

Figure 23: Dust obtained after drying and grinding of the mud (Initial dust) (Photo Remini, 2016)

The entire Mozabite population stands up on the banks of the river to welcome the flood. It is a special event that is celebrated by the population each time a flood arrives. This population, which has lived in harmony with the floods for more than 7 centuries, has developed the rivers of the valley to properly manage and take advantage of the water and sediments. The population of the M'zab valley has highlighted hydroagricultural development at the level of each oasis, taking into account the geomorphology and configuration of the river. This development is based on the division of the river into 3 parts according to priority, which we call the IRS system: flood irrigation, groundwater recharge and population security (Remini, 2020a; Remini, 2020b; Remini, 2020c). Depending on the importance of the flow of the flood, the first part of the flow is intended for the flood irrigation of the gardens. Once this task has been completed, the second part is intended for groundwater recharge. The remaining flow will be discharged into the river downstream of the oasis. The Mozabite population attaches great importance to the waters charged with the flood. For this reason, a system for sharing this fertilizing water has been highlighted. It is based on a network of Seguia that channels the fertilizing water from the Wadi to the gardens (Fig. 24). The share of water of each individual depends on his contribution to the realization or maintenance of the hydraulic installation.

Figure 24: A seguia carrying water from a flood toward the various gardens for temporary flooding (Photo M'zab Valley Archives)

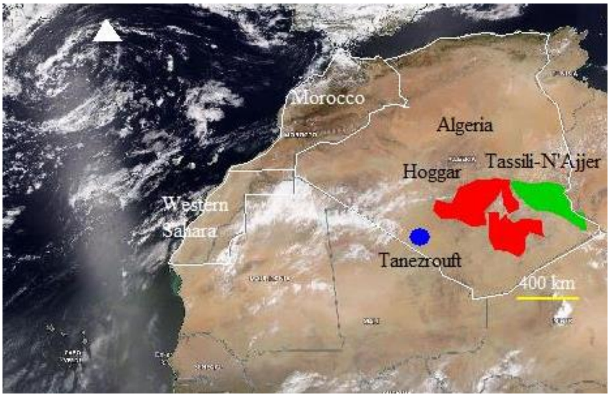
The role of Saharan dust in preventing phosphorus depletion

Starting from the idea that a rosebush planted in a vase is fed daily by a glass of water. After a few days, the mass of earth contained in the vase will be emptied of nutrients following periodic washing. In this case, the plant sees its development limited because of the lack of nutrients. On a large scale, for example, in a watershed, considerable sediment losses are recorded each year as a result of water erosion, which pulls these lands out of the ground. Then, they are carried by the rivers toward the sea. Nutrients such as phosphorus and potassium accompany these quantities of solid particles toward the coast to enrich aquatic life. However, the different types of plants continue to develop at the level of the watershed despite the departure of the chemical elements! This can only be explained by an external supply of fertilizers. Due to water erosion, more than 180 million tons of sediments are torn annually from the watersheds of northern Algeria and drained by rivers to the sea and dams (Demmak, 1980). Such a large quantity can give an idea of the volume of nutrients discharged annually into the sea and into reservoirs. Despite this deficit, the forests of northern Algeria develop normally, which can be explained by annual inputs of fertilizers from the Sahara through the transfer of desert dust. Throughout the year and more particularly during the summer season, several million tons of sand and dust rise from the Sahara toward the northern regions.

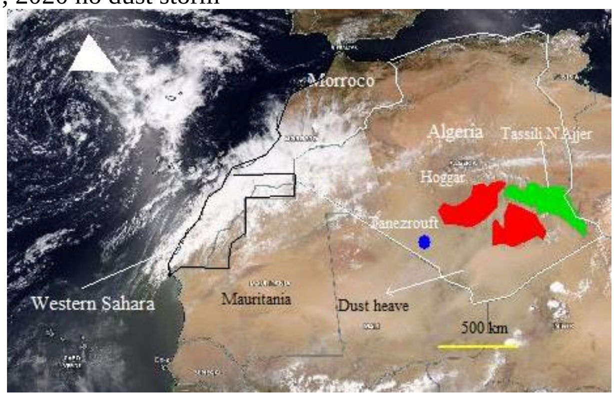
The Amazonian forest is fertilized by Saharan dust

Covering an area of 6.7 million km^2, the Amazon forest is shared between 9 South American countries: Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Suriname and French Guiana. Nicknamed the lung of the planet, the Amazonian forest is a vast plain where the Amazon flows, the longest river in the world at 7000 km long. The Amazon River drains an average flow of 209,000 m^3/s at its mouth, i.e., 20% of the total volume of fresh water on the planet (Guyot et al., 1994). According to the work of Callede et al. (2010), the interannual inputs from the Amazon to the ocean for the period 1972-2003 would be 206,000 m^3/s.

The Amazonian forest holds more than 390 billion trunks of more than 16,000 species of different types of trees (Vey, 2013). This huge forest, despite having 50 times more trees than human beings on the whole planet, grows on poor soil. What a paradox, a green desert that was born on land lacking nutrients such as phosphorus, potassium, calcium and magnesium (Haug, 2015), is its productivity is limited by the availability of these nutrients. The heavy rainfall that falls on this tropical region accentuates soil erosion, and consequently, a significant quantity of these nutrients escapes from the soil to reach the Atlantic Ocean. It should be noted that the Amazon watershed receives an average of 2710 mm of rain per year (Molinier et al., 1996). Sediment transport in the Amazon River records average values of approximately 500 to 600 million tons/year (Olivry et al, 1988). At the outlet of the Amazon, the sediment flow reaches a rate of 600 to 800 million tons/year (Filizola, 2003). In this large amount of dust released into the ocean, a significant amount of nutrients, such as phosphorus and nitrogen, feed aquatic life. As a result, the soil of the Amazon watershed lacks nutrients, particularly phosphorus. In addition, as if by chance, these losses in chemical elements are compensated annually by phosphorus inputs from the dust of the Sahara. Indeed, each year millions of tons of dust are transported by the winds from the Sahara to southern Europe, the Amazon, the Caribbean, the Gulf of Mexico and even to the southern United States. Crossing the Atlantic Ocean, more than 182 million tons of dust can reach the territory of the Amazon Basin. A significant amount of particles fall into the ocean along the Sahara-Amazon route for more than 400 km. Only 27.7 million tons of dust land on the Amazon basin, while the rest, or 132 million tons of dust, continues its way to the Caribbean and the southern United States. Of the 27.7 million tons of dust that dustes the equatorial forest, 22,000 tons of phosphorus fall throughout the Amazon River watershed (Gentside, 2015; Haug, 2015). Therefore, we can say that phosphorus losses due to water erosion are compensated by phosphorus inputs due to wind erosion. The Amazon, the lung of the planet, develops thanks to the desert dust coming from the Sahara. More precisely, more than 95% of dust comes from the homes of Tanezrouft (Algeria) and Bodélé (Chad) (Remini, 2017; Remini, 2018; Remini, 2020; Remini, 2022). For example, during the period from June 4 to July 14, 2020, the American continent was invaded by a large cloud of dust from the Tanezrouft Desert (Algeria) (Fig. 25a, b, c and d). During this dust storm, the Amazon rainforest was dusted for 5 episodes: from June 20 to June 24 (5 days), from June 25 to June 28 (4 days), from July 7 to July 9 (3 days) and from July 12 to July 14 (3 days); thus, there was a total of 15 days. It is immense as a mass of dust and the nutrients that accompanied these fine particles. These satellite images were taken by the NASA/NOAA Suomi NPP satellite. It should be noted that this dust cloud even reached the cities of Mexico City (Mexico) and Florida (southern United States), a distance of more than 12,000 km. Called Godzilla, this huge dust storm has not been recorded for more than half a century; a natural air bridge has been created between the two deserts, yellow and green, to transfer millions of tons of fine particles for two weeks nonstop.

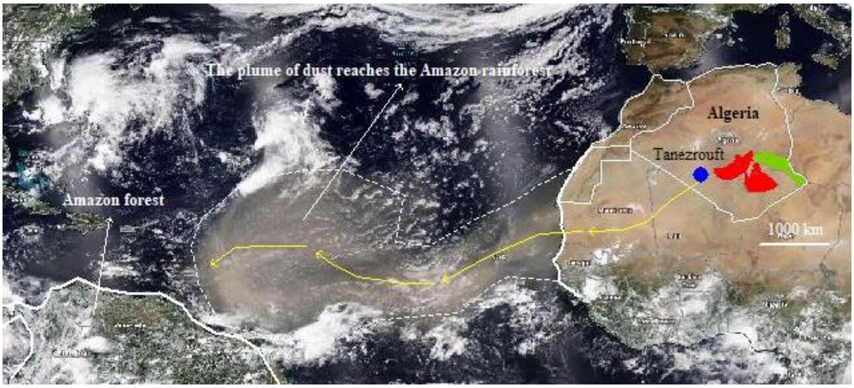


a) June 4, 2020 no dust storm



b) On June 5, 2020, dust rising in the Tanezrouft desert

c) On June 7, 2020, the highly concentrated dust plume leaves the western border of the Sahara



d) On June 20, 2020, the dust plume (first episode) reached the eastern border of the Amazonian forest after two weeks of flying over more than 7000 km from Tanezrouft (Algeria) (@NASA Erath worldview).

Figure 25: The largest dust storm recorded in over half a century. It lasted 40 days in 5 episodes (from June 4 to July 14). Millions of tons of dust were transferred from Tanezrouft (Algeria) to the Amazon, the Caribbean, Florida and Mexico (@NASA Erath worldview).

Sahara desert dust sprinkles Europe

The dust emanates from the Sahara and more precisely from Tanezrouft. Trade winds from Libya bypass the Hoggar-Tassili N'Ajjer mega-barrier by two northern and southern branches to meet in the Tanezrouft. It is in the wake area that the air streams are detached, causing the formation of vortices. Such a phenomenon generates a lifting of dust in the atmosphere, which will then be driven by wind currents. These dust plumes drain with them nutrients and organic matter and fly over the Mediterranean. They will sprinkle the entire surface of their runs. These are the northern part of Algeria, Spain, France, Switzerland and Italy. During the period March 15 to 18, 2022, a high concentration dust storm lasting from March 15 to March 18, 2022 originated in Tanezrouft (Algeria) and crossed all of northern Algeria as well as the Mediterranean Sea to reach the European countries on the other shore (Fig. 26). The dust plume occupied an area of 3.5 million km^2 during these 4 days. The soils and part of the Mediterranean Sea were dusted by a plume of dust very rich in nutrients and organic matter. The chemical elements lost by water erosion at the level of these soils have been compensated.

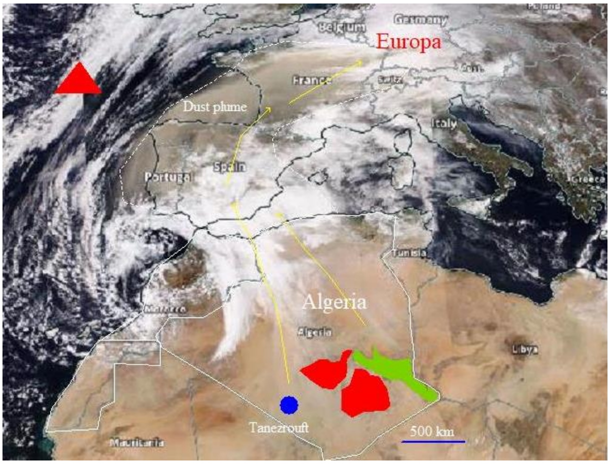


Figure 26: Transfer of desert dust from Tanezrouft (Algeria) to Europa by flying over the Saharan Atlas chain and the Mediterranean Sea - Case of the dust storm from March 15 to 18, 2022 (@NASA Erath worldview)

The dust storm may take another path. This time, it can leave the western borders of the Sahara by flying over part of the Atlantic and return via Portugal, Spain, France, Switzerland and Italy, as was the case with the storm of dust from February 15 to 20, 2021 (Fig. 27).

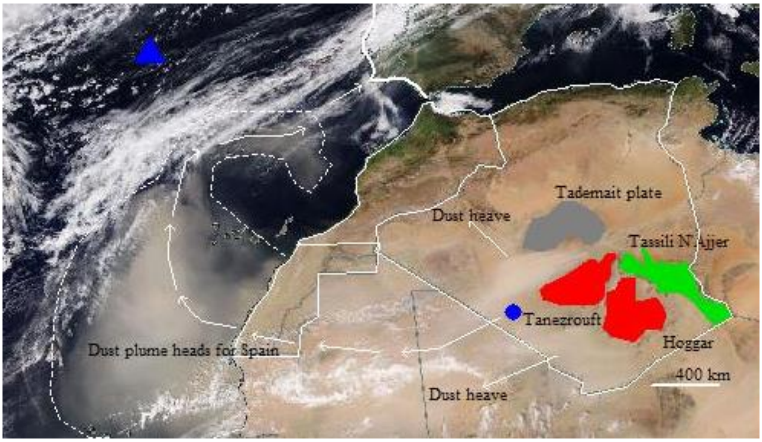


Figure 27: Transfer of dust from Tanezrouft (Algeria) to Europe by flying over the eastern part of the Atlantic to reach Portugal and Spain - Case of the dust storm from February 15 to 20, 2021 (@NASA Erath worldview)

Dust plumes sprinkle the oceans and seas

A significant amount of minerals accompanies the dust plume from the Sahara on the transatlantic journey to reach the American continent or even cross the Mediterranean to dust southern Europe. These dust clouds are very rich in iron, phosphorus and potassium. Plants and phytoplankton both need these nutrients to grow. Along the path of the dust plume on the ocean, the particles, according to their weight, land on the sunny surface of the ocean, allowing living organisms to draw the nutrients necessary for photosynthesis. More than 70% of the iron available to photosynthesize in the Atlantic Ocean comes from dust from the Sahara (Bourunda, 2020).

CONCLUSION

As we mentioned at the beginning of this article, the desert dust of the Sahara has yet to leak all these secrets. Although fine particles degrade the quality of the air and the environment, the benefits of these dust storms have proven to be very important for soils and oceans. This is how the nutrients lost under the effect of water erosion are compensated by the contributions of desert dust from the Sahara. Two places are preferred by the desert dust of the Sahara. Every year, millions of tons of fine particles visit the Amazon basin and the mountain ranges of the Pyrenees to fertilize their soils. The population of the oases, the only one who knows the value of these sediments coming from different types of rocks under the effect of erosion. In the M'zab valley, the population has invented a system of sharing flood waters just to take advantage of these charged waters. Indeed, each garden is flooded by a share of water, which is a function of the contribution of each farmer to the maintenance of the development.

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