EXPLAINING SARGASSUM

A GUIDE ANSWERING ALL YOUR QUESTIONS ABOUT THIS PHENOMENON

1. Where does the sargassum that washes up on our coastline come from?

Sargassum is a brown seaweed of the family Sargassaceae, comprising a large number of species worldwide. Sargassum is commonly found on coastal seabeds, except for two species growing on the ocean surface and drifting freely with ocean currents in the form of slicks: the pelagic Sargassum fluitans and Sargassum natans. These two algae have always been present in the North Atlantic Ocean and the Caribbean region, with a well-known circulation system between the Gulf of Mexico and the Sargasso Sea, with the presence of scattered algae in the rest of the region. On the other hand, the massive strandings of Pelagic Sargassum that have been affecting the Caribbean Sea since 2011 seem to be originating in a new area: the North Equatorial Recirculation Region, a circular marine current located between the coast of Brazil and the Gulf of Guinea.

2. Why are there strandings on our coasts? Is this a long-term phenomenon?

While the understanding of the phenomenon is still the subject of research to scientifically prove certain hypotheses, it seems that the North Equatorial Recirculation Zone has temperatures and nutrient concentrations favourable to the rapid development of Sargassum. Seasonal currents, influenced by the wind regime and the more global oceanic dynamics in the Atlantic, direct a large part of the algae accumulated in the area towards the Lesser Antilles archipelago and the Caribbean basin.

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Martinique, because of its very rugged and urbanised Atlantic coastline, is particularly vulnerable to this and because of its geographical position, very exposed to the arrival of sargassum.

The size of the area concerned, the variability and complexity of the combined phenomena that encourage the growth of algae do not yet allow us to predict with certainty the long-term evolution of the phenomenon. Nevertheless, the worsening of the 3 episodes of mass stranding since 2011 as well as satellite observations leave little doubt today that the phenomenon is here to stay.

3. Where does the smell of Sargassum come from?

The characteristic rotten egg smell is that of Hydrogen Sulphide (H2S). H2S is a gas that comes from the natural decomposition of Sargassum in lack of oxygen, especially when seaweed (like all biodegradable organic matter) lies in thick layers on beaches and rocks. Our olfactory system is able to detect this substance in very small quantities (0.02 to 0.03 ppm).

A HEALTH ISSUE

4. What does breathing H2S (Hydrogen Sulphide) or NH3 (ammonia) affect our health?

H2S and NH3 are toxic gasses, but the severity of poisoning depends on the quantity inhaled and the time of exposure. On the coast, the gas is diluted in the air and concentration is lower. This is why the authorities are taking precautionary measures and recommending that vulnerable and sensitive people avoid exposure to Sargassum. An expertise conducted by the High Council of Public Health in June 2018 allows to better understand the health effects related to chronic exposure (low levels of H2S and NH3 concentration). You can consult the latest HCSP opinion at https://www.hcsp.fr.

5. What are the symptoms of exposure to H2S and NH3?

H2S gas can cause breathing difficulties, eye irritation, dizziness and headaches. High concentration must be reached to cause serious health effects with the risk of loss of consciousness and cardiac arrest, particularly in confined spaces. This level of concentration had never been reached during measurement campaigns carried out. Most of the concentration measured near the coast is usually below 1 ppm.
Similarly, NH3 gas can cause eye irritation (lacrimation) and respiratory irritation (coughing, breathing difficulties, etc.) when breathed in.

6. What should I do if I experience these symptoms?

When you experience symptoms, stay away from areas affected by rotting strandings. Contact your doctor or pharmacist and tell them where you have been exposed to Sargassum.

7. Who are the sensitive and vulnerable people?

Pregnant women, infants and young children, people over 65 years old, people suffering from cardiovascular pathologies, heart or respiratory insufficiencies and asthmatics, are the most vulnerable population. People also who identify themselves as sensitive during pollution peaks and/or whose symptoms appear or are amplified during peaks (e.g. diabetics, immunosuppressed people, people suffering from neurological diseases or at risk of heart disease, respiratory disease or infection).

8. Are there any reported serious health consequences for humans from exposure to Sargassum?

To date, there have been no reports of serious health impacts from exposure to Sargassum seaweed.

9. Where can I inform myself about H2S and NH3 measurements and health risks?

H2S and NH3 measurements are monitored by Madininair which has set up a continuous monitoring network. The concentrations are transmitted daily to the ARS and put online on the ARS Martinique website in the form of a press release consisting of a map of average concentration over 24 hours, accompanied by an information table and health recommendations. These maps are public.

MADININAIR website: http://www.madininair.fr/ Mesures-du-reseau-Sargasses

Martinique ARS website: http://www.ars.martinique.sante.fr/Situation-regionale-des-algues.176365.0.html

10. How is the monitoring of H2S concentration carried out?

In conjunction with the Prefect of Martinique, ARS Martinique with the support of Madininair, has set up a network to monitor Hydrogen Sulphide and Ammonia concentration in urbanised areas affected by algae strandings. This network is financed by funds from ADEME, CTM, ARS, Espace Sud and Cap Nord. It allows real-time and continuous monitoring of H2S and NH3 concentration. It meets the needs of the partners in terms of expanding knowledge of H2S and NH3 concentration and assessing the combined health impact.

The 3 main objectives of this network comprising 14 fixed and 7 mobile sensors are the following:

- Estimating population exposure
- Alerting authorities as soon as concentration approaches 1ppm to better anticipate the phenomenon. In addition to the measurement network provided by the Cairpol infrastructure, Dräger X-am 5000 devices (mobile sensors) can be used to measure H2S and NH3 concentration for example, to scan an area during mass stranding episodes and thus potentially assess the dispersion of the phenomenon. The monitoring of H2S and NH3 emissions is carried out in accordance with the decision of the High Council for Public Health of June 2018. Automatic sensors continuously measure H2S levels in the field and provide permanent measurements. The devices are self-contained and equipped with a telephone communication system that sends the data in real time to the Madininair computing centre. The data is then processed to produce 24-hour average values.

11. How is health surveillance organised?

Health surveillance is organised in Martinique through the network of sentinel doctors who can be reinforced if necessary. The latter have been given a procedure to follow and they transmit the number of consultations that may be linked to exposure to Sargassum on a weekly basis. There is also a procedure for reporting serious cases from hospital emergency services, SAMU or SOS Médecins.

A follow-up of all spontaneous declarations from individuals or other health professionals is also ensured by ARS.

MANAGING THE PHENOMENON

12. How do you collect Sargassum and what precautions should people take when collecting Sargassum?

In order to prevent the risk of hydrogen sulphide (H2S) formation, the seaweed must be removed from the shoreline as soon as possible after it has washed up.
This is the responsibility of municipalities, which are supported by the State in the acquisition of mechanised collection equipment, subsidies for contracting private companies and setting up manual collection brigades, as well as seeking advice and assistance in the implementation of the project. They also receive advice and technical support for the management of collection sites. The collection of seaweed must be carried out under the control of trained and equipped professionals. The wearing of a gas detector throughout the collection operations on foot is mandatory. Emergency teams likely to intervene in the event of an accident have also been trained.

13. What management measures are implemented at local level?

Under the coordination of the Prefect, State services intervene in the following areas:

- ARS measures the population's exposure, ensures health surveillance and communication campaigns with the general public and health professionals.
- The Department for the Environment, Planning and Housing (DEAL) is responsible for scientific monitoring, forecasting efforts, cartographic monitoring of strandings, participating in the development of mechanised technical solutions for collection, and providing methodological and technical support to municipalities and communities to manage seaweed collection and disposal.
- The Directorate of the Sea provides technical support and expertise for dams.

14. Who organises seaweed collection?

The regular collection of this algae in less than 48 hours allows to avoid health issues within the local population, to reduce the impact on nautical activities, and to limit the consequences in terms of beach use.
Collection on the coast is the responsibility of the mayors as part of their general policing powers in terms of public health. A number of actions have been carried out in partnership with the communes network, CTM and ADEME.

To accompany and support them, the Prefecture informs mayors, supports the communes in terms of technical assistance, investment and possible reinforcement of human resources in conjunction with other local authorities and develops a policy to deal with this problem in the long term. State aerial resources are also mobilised for reconnaissance to map the phenomenon and monitor its evolution and identify the most exposed sites. Innovative collection machines and techniques are also being developed and tested to improve collection performance on the beaches or at sea.

Ministerial announcements
-Being able to set up collection in less than 48 hours
-Developing a Sargassum plan
-Strengthening the H2S/NH3 sensors' network
-Providing financial assistance for communities to get equipped
-Setting up green brigades
-Strengthening the research programme
-Supporting companies and individuals who have suffered damage due to Sargassum

15. Who pays for collection, machines, barricades? How much does it cost?

The State is the main funder for the fight against Sargassum. Since April 2022, the Prefecture has deployed 2.2 million euros to ensure the collection of seaweed in the most affected communes: 9 communes on the Atlantic coast and one on the Caribbean coast. The sub-prefectures of Le Marin and Trinité collect information from work sites on a daily basis, where 80 to 100 people have been mobilised. The Prefect and State services meet every week to coordinate actions and prioritise resources in the areas where the population is most affected. In 2015, the State financed municipalities with more than 200,000 euros to acquire the first local equipment, such as skips and shovels. In 2018, this equipment grant more than doubled, ie 540,000 euros were earmarked for the acquisition of heavier equipment, such as trucks and construction machinery.

Martinique Prefecture has decided to subsidise up to €540,000 for the equipment of communes through the acquisition of machinery:
Marigot: 1 watercraft - Truxor, already acquired
Robert: 2 watercraft being acquired Cap Nord: one watercraft being acquired Vauclin: quad bike acquired, adaptations underway
Diamant: truck being acquired
The State finances the installation of booms to limit the amount of seaweed washed up on shorelines.
8 booms have been installed and 17 others are being installed or tested for it.

16. Why dams?

Certain coastal configurations (bottom of the bay, weak current...) have the effect of concentrating and retaining Sargassum which, as a result, cannot be surfaced by the sea. This is where the degradation phenomenon begins. Hence the idea of protecting these particular areas with booms to limit the amount of Sargassum washing ashore and reduce nuisance. However, a boom can also be useful to divert Sargassum to an easily accessible collection point on the shore.

17. Where should dams be installed?

The site and the technique used ("grillage" or "polmar" boom, "fixed" boom or fluctuating or "pocket" boom) are determined after expertise by the Direction de la Mer, according to sea and wind conditions, the nature of the seabed (installing the booms must not deform seabeds), which stakes are to be protected, the capacity to collect on land, the need to 'trap' the Sargassum in order to better collect it. Thus, the installation of a barrier makes sense when collection from the shore is difficult or impossible. On the other hand, it will not be possible to lay booms on a windward coastline that is too directly exposed to the sea.

18. How to install a dam?

Several dams have been installed on the initiative of local residents' associations or town halls after technical validation by the DM, which relies on the expertise of fishermen or sea users. The project leader must apply for or an authorisation to occupy the public maritime domain (AOT). The State and ADEME, its operator, participate in the financing of dam projects carried out by local authorities. Work is being carried out by the State and the municipalities to identify all sites suitable for the installation of a dam and the most appropriate technique. These elements will be integrated into local protection plans.

19. Can we already conclude that the dams are effective?

Boom monitoring has been put in place which, at this stage, shows the effectiveness of the booms installed: they resist the sea, keep the seaweed away with reduced levels of H2S on the coast protected by them, or direct it in the desired direction for collection. In addition, environmental monitoring has been set up to study the medium- and long-term impact of Sargassum blocked by the booms in the marine environment (water and submarine soil).

RESEARCH AND EXPERIMENTATION

20. The various calls for projects have insured subsidy trials for collection and recovery of algae. Where do we stand?

ADEME, in consultation with local authorities and government departments, is involved in various areas. Since 2016, nearly €4.8 million have been mobilised to address the subject. In addition, 4.9 M€ have been invested in structures for valorization able to receive Sargassum.

ADEME is supporting a study to cross-reference current and satellite data carried out by the Observatoire du Milieu Marin Martiniquais. The results are expected in the last quarter of 2018 and will improve our knowledge of the phenomenon. These results will be optimised by an image acquisition network to be installed on the coast by BRGM.

•Developing collection techniques

The trials funded under the calls for projects have been evaluated, and the evaluation sheets are available on the ADEME website. In brief:

Rake, claw bucket and seaweed rake: A tractor with various additional collection tools (rake, claw bucket, seaweed rake) from the company SEEN.

The rafter (evaluated with the Barber brand): The main advantage of this technique is the output of 30m3/h, which allows a large length of beach to be treated quickly on a daily basis. However, its low storage volume (2.5m3) forces the machine to make a large number of return trips. In addition, the machine becomes ineffective with important stranding thickness.

The claw bucket is suitable for collection of thicker beach strandings. However, the large number of return trips makes it a troubleshooting tool in the absence of collection means with perfectly adapted storage.

The seaweed rake: Not suitable, it reaches saturation after a few metres and mixes algae with sand.

Self-propelled collection vehicle: A prototype based on the adaptation of a beet machine for Sargassum collection has been tested. An output of 50 to 100m3/h, an internal storage volume of 20m3, the ability to unload directly into a truck, the ability to collect less than 1% of sand and the possibility of working in thick layers make this a promising tool. However, the imposing size of the machine does not allow access to all sites and can cause problems of entrapment.

Green Brigades: The system via an Association Chantier d'Insertion is very satisfactory. Manual collection allows to remove minimum sand, it is usable on sites that are not easily accessible and it preserves the natural aspect of sites. It also provides employment. However, it is quickly overwhelmed in the event of a mass stranding.

Amphibious collection: Amphibious tool carriers (Truxor, mobitrac...) are very useful at the bottom of accessible bays, but the yields are much lower than on land and therefore costs grow higher. It is recommended for small areas of stagnant algae or as a complement to a long arm shovel to push the algae towards collection point.

Towed net: The technique consists of towing Sargassum from near-shore to land where it is easier to collect the seaweed. Trials show some difficulty in pulling the net out of the water. It is possible to use this technique to tow the seaweed to a collection area.

•Identifying recovery means, in a circular economy perspective

Solutions that allow large volumes to be treated in the short term, by improving existing treatment units, are favoured. Trials on innovative processes with higher added value are also supported. Land application :

A study coordinated by the Institut Technique Tropical (IT^2) in partnership with CIRAD, CTCS, the Chamber of Agriculture and the Collectivité Territoriale de Martinique is analysing the effects of direct spreading of Sargassum on main tropical crops.

Results show low agronomic contributions. A leaflet on the precautionary use of Sargassum is being published.

A composting platform Holdex is accepting seaweed free of charge in Le François (100t/week). An extension of the platform and the implementation of a process in a confined environment is planned by the company to be able to receive more Sargassum (and agricultural waste if necessary). Total announced capacity of algae treatment: 30,000t of fresh Sargassum. ADEME is supporting this project overall to expand the composting platform (not only for Sargassum) with a 4.95 M€ investment. 2 complementary projects are being supported on composting tests in existing installations in order to improve the process, to define acceptable quantities on the units and possible extensions: the Terra Viva platform in Ducos (first testing phase has started, the first two Sargassum batches have been composted), the Centre de Valorisation Organique (CVO) in Robert (adaptation work has been carried out and the experimental protocol has been established by the operator).

Recovering energy: A study of Sargassum pyrolysis has shown low energy potential and high ash production, which is detrimental to the facilities. However, energy recovery is interesting, if the Sargassum is pyrolysed at high temperature with co-products. A study of the methanogenic potential of Sargassum is showing a tendency of degrading methanation performance.

Agri-food valorisation: Arsenic a priori calls into question this possibility of recovery.

Recovery into bioplastic: A study is underway in Brittany for a project to use Sargassum as a natural filler in the manufacture of plastics.

IT IS STRONGLY RECOMMENDED :

- To avoid contact with algae clusters
- Talk to your doctor or pharmacist if you have any of the following symptoms: itchy eyes or throat, watery eyes, headache, difficulty breathing, cough, itching, vomiting, dizziness.

112 Emergency number

More information on health risks:
www.martinique.ars.sante.fr
0596.39.42.43

Mapping of measurements:
Daily publication of H2S and NH3 measurements:
www.martinique.ars.sante.fr
www.madininair.fr

Also available at the town hall.
Martinique Prefect
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FORBIDDEN TO

Approach collection sites within 50 m of collection sites
Enter areas affected by strandings of decomposing decaying algae
Enter areas of areas of algae accumulation where there is risk of sinking