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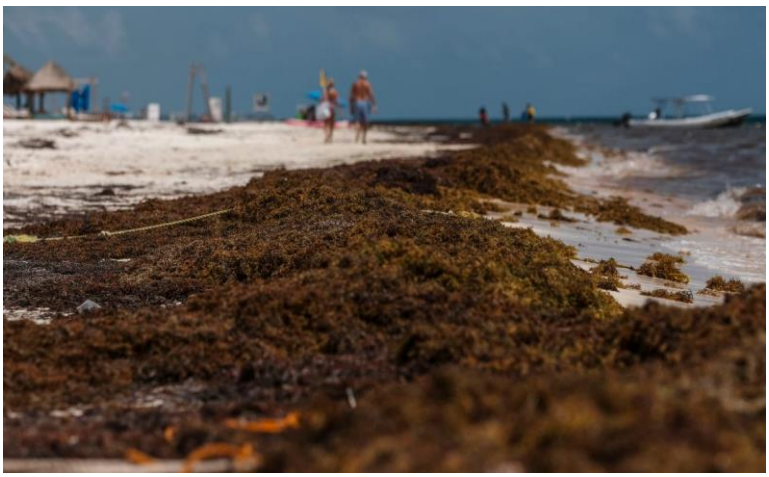
Mahahual, Quintana Roo, Mexico: Turning Sargassum into Eco-friendly Biodegradable Soluble Non-Plastic Bags.

Two important matters have affected directly marine and terrestrial life and tourism in the area of Quintana Roo. One is Sargassum and the other one is trash or residues that end up in the bottom of our seas. Some species of **Sargassum** - a group of **seaweed** - live on the ocean's surface, where they attract fish, birds and turtles. ... However, too much of the seaweed can smother corals and seagrasses, and end up on beaches, releasing gas that smells like rotten eggs. Some 1,000km (621 miles) of Mexican beaches have been impacted this year. Removal is time-consuming, expensive, and not always effective.

Three out of five preferable beach destinations to visit nationally happen to be in Quintana Roo according to a study made by Expedia. (Forbes, 2019).
Two out of ten internationally preferred beach destinations are in Quintana Roo as well. (*Lopéz Dóriga*, 2016).
This makes it an especially important issue to discuss since Quintana Roo received 16 million 911 thousand tourists in 2017; growing a 5.3% in relation to 2016 and making a total profit of 8 million, 810.38 thousand US dollars, this is, 207.9 million more than in 2016. (SEDETUR, 2017).

Photograph 2-Sargassum at Cribbean seas



V. R. (2018, November 26). *La Secretaría de Medio Ambiente de Quintana Roo solicitó recursos adicionales para combatir el sargazo en 2019*[Photograph found in, El Financiero, Mexico]. Retrieved July 15, 2019, from https://www.elfinanciero.com.mx/peninsula/sargazo-sera-el-dolor-

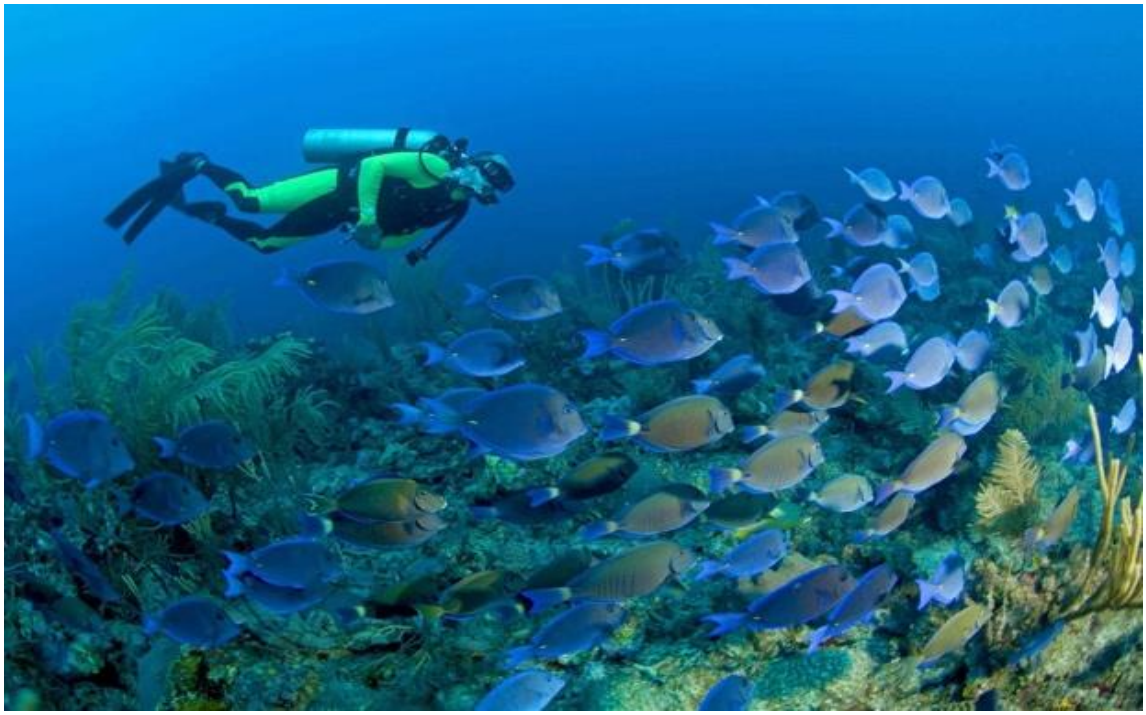
Photograph 2- Trash at 500 meters under sea

EFE. (2017, November 23). *Bajo los mares mexicanos la basura llega a los 500 metros*[Photograph found in Excelsior, Mexico]. Retrieved July 15, 2019, from https://www.excelsior.com.mx/nacional/2017/11/23/1203096(Originally photographed 2017, November 23)

Quintana Roo's main income sources are tourism, fishing and the industry (petroleum production), while livestock and agriculture are mostly for self-consumption.

Quintana Roo is the state with most income from the touristic sector in the country making a total worth of 4.954.36 million dollars in 2006. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).
One of its most popular activities is scuba diving, with more than 70 different reefs to dive into; it is definitely, tourists´ favorite to practice in the Riviera Maya.

Photograph 3-Scuba diving in Quintana Roo



Scuba Reef, & Universidad La Salle. (2016, October 4). *BUCEO EN MAHAHUAL*[Photograph found in Scuba Reef, Mexico]. Retrieved July 15, 2019, from https://www.scubareef.com.mx/buceo-en-mahahual/(Originally photographed 2016, October 4)

Snorkeling, Scuba Diving and visiting the subterranean Mayan natural pits or sinkholes *Cenotes,* are the most demanding activities along with tours to the reserved biosphere of Sian Ka'an, Cozumel Island, Cancún and Cobás archeological zone. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).

Fishing made in 2006 147 tons of fish for direct consuming registered. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).

In the same year (2006), there was an 11.874.655.0-ton petroleum production making a value of 712.000.000.00 Mexican pesos equivalent to 13.528.000.000 US dollars. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).

Self-consumption sectors such as livestock and agriculture are based on raising bovine and porcine cattle. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).

Photograph 4- Livestock

Servicio de Información Agroalimentaria y Pesquera. (2018, February 01). *Producción Ganadera*[Photograph found in *Servicio de Información Agroalimentaria y Pesquera Acciones y Programas, Secretaría de agricultura y desarrollo rural,* Mexico]. Retrieved July 15, 2019, from https://www.gob.mx/siap/acciones-y-programas/produccion-pecuaria
(Originally photographed 2018, February 01)

Basic crops that are grown in the area are beans, corn, pumpkin, tomatoes, and peppers for self-consumption. (*Agencias de competitividad de los destinos turísticos de México 2013-2018* translated to Competitivity Agencies of Touristic Destinations of Mexico 2013-2018).

According to INEGI, in 2015, out of 30.174.901 homes; 22.683.498 families were directed by a masculine figure and 9.420.238 by a feminine figure.
In Quintana Roo the average family consists of 3-4 members per home unit.
In 2017 out of those families 71.7% of them were nuclear, 2.5% compound and 25.8% extended, 53.8% of those were two-parent households, and 18% were single parented and 28.1% another type. (INEGI, 2015-2017).

Mahahual is located at a region known as "*Costa Maya*". It has an average altitude of 5 meters above the sea level and can go up to 10 meters southbound.
The weather is sub-humid and has a very warm with a rainy season in summer and humidity originating from the Caribbean. The average annual temperature is of 28ºC, with a maximum of 35ºC and a minimum of 14ºC. (SEMAR, 2012).

Mahahual belongs to the municipality of *Othón P. Blanco* (Quintana Roo) and according to data by the CONEVAL (National Council for the Evaluation of Social Development Policy) in 2010, poverty percentage in said municipality was at 42.9%, making 109.361 thousand people live under below standard conditions. 8.6%, 21.980 people lived under extreme poverty conditions. (CONEVAL, 2010).

Mahahual has telephone coverage with line services provided by *Telmex* and mobile service by *Telcel* and *Movistar* with antennas based at Chetumal. Their economy is based on tourism and fishing. Hotel infrastructure has been distributed along 120 kilometers of the coast between *Punta Herrero* and *Xcalac*. One of Mahahual`s principal touristic attractions is the *Banco Chinchorro* natural reserve, the second largest reef barrier in the world, making it incredibly attractive for scuba diving and sport fishing. Fishing is based on lobster and is regulated by the species ban periods. (SEMAR,2012).

Mahahual went through a drainage system crisis in 2017 according to *La Jornada* (a Mexican newspaper) as described by the newspaper, *Holbox*, Mahahual had an insufficient drainage services supply making their growing population suffer from a sewage leakage. (*Maldonado Joana*, 2017).

Its total population is of 282 habitants, out of whom 156 are male and 126 female, 90 are minors, 192 adults out of which 11 are over 60 years. 54 Mahahual inhabitants live in indigenous households. Only 85 Mahahual inhabitants have access to health care given by the government. (*Nuestro Mexico*, 2001-2019).

Mahahual`s health sector counts with 2 health clinics, one of the private sector and the other one of the public sector. Mahahual has 20 mini markets, 10 drugstores, 55 restaurants, 20 tour selling locals, 2 boutiques and approximately 55 hosting centers with, 27 hotels, 4 hostels, 6 cabins, 8 camping zones and 92 Airbnb's. (*Gobierno del Estado de Quintana Roo*, 2018)

There are 90 households out of which, 17 have soil-based flooring and 24 have only one room. 77 of those households have sanitary installations, 76 are connected to the public service, 63 have access to electricity, 9 have a computer, 29 a washing machine and 59 have a TV.
There are 16 illiterate citizens over 15 years of age, of those between 6 and 14 years of age only one does not assist to school.
Of the population ranging on 15 years of age, 17 have no scholar background, 76 have attended school but haven't finished their studies, 39 have a basic scholarship level and 74 have a post-basic scholarship. (*Nuestro Mexico*, 2001-2019).

Mahahual is considered the second most important Caribbean cruise port, making tourism of extreme importance to Mahahual's economy, being estimated that it yearly receives more than 500.000 new visitors and can sustain more than 300 cruises.
According to the Integral port administration of the STC (Transport and Communication Ministry), in 2006 Mahahual received 348 cruises with 811 thousand 287 passengers. This year, Mahahual hosted only 180 cruises with 417 thousand 849 tourists. (*Aviña José Carlos*, 2019).

-Problem-

Sargassum has massively arrived at the Quintana Roo coasts proceeding from Jamaica, ranging approximately 550 kilometers of diameter. It´s currently a severe and risky situation. (Forbes, 2019)
It is damaging urban, rural and even touristic populations as it is affecting the seas and marine life killing fish, which happens to be one of the principal food consumption for Mexicans and tourists while in Quintana Roo. It`s killing marine life, affecting the oceans and tourism as it scares tourists away from the affected beaches making an important resource such as tourism, decay.

Sargassum is a marine macroalgae, it can grow a few meters long. (*Zúñiga Ortiz Laura*, 2019). It can be greenish or blackish and some species have vesicles full of gas to keep them floating on the surface of the sea and promote photosynthesis. These provide a specialized environment for marine organisms yet unknown. They generally grow near the coast and this is mainly the reason why they're called *maleza del engaño* which in English means deception weed. (*Naturalista, 2019 & El Universal, 2019*).

Sandra Laso Jácome, a former Greenpeace Mexico worker in the program of agriculture and feeding reportedly said that the Mexican government should not only invest in getting rid of Sargassum but actually study what is causing its propagation. Some of the most relevant causes to this phenomenon happen to be global warming and climate change as the sea's temperature keeps rising and the poles and glaciers keep melting, this favors Sargassum´s massive reproduction. (*Méndez Ernesto,* 2018)

Being originally from Mexico, and knowing this particular algae has started to attack our coasts and beaches (especially in Quintana Roo, Cancún, Playa del Carmen, Puerto Morelos & Tulum) killing many species along its way, affecting negatively both tourists and habitants as well as the biodiversity, becoming a huge threat to marine life, such as turtles fish, shrimp, and crabs, I want to take action.

It has been announced that sargassum has taken 300 kilometers of Quintana Roo's southern beaches covering them in their totality with the before mentioned algae, now reaching 1000 km of diameter, practically covering all marine surfaces from Jamaica to Yucatán. Tourism workers have had to spend from 100 thousand to 900 thousand Mexican pesos monthly to try and keep Quintana Roo clean and while it has partially helped, they claim it has profoundly affected their economy and daily lives.

Different hotel owners have openly spoken about the economic damage Sargassum has caused since it became a plague.

David Ortiz, Tulum´s hotel association president, claims hotels have been cleaning the ocean for five years now and since sargassum´s invasion, their efforts both monetary and physical have had to double and even with such labors the economy has kept decreasing. (*Reza Abraham & Meraz Fernando*, 2019).

Gilberto de la Cruz a *San Martín* beach commission agent declared, "Cozumel depends on tourism, if there is none, the family won`t eat, and if you`ve realized the state of the situation everything is in horrible conditions, for example, tourists come, if they see ugly beaches they just take pictures and leave". (*Vázquez Fátima*, 2019).

Arturo Pérez a *Chetumal* merchant said, "Tourists came, as they arrived and realized how stinky *Chetumal* was they`d leave…and they have stopped coming precisely because of Sargassum". (*Vázquez Fátima*, 2019).

Raquel Cervera a *Mirador* handicraft seller claimed, "If we clean it up today and there`s bad weather it`s as if we had done nothing, Sargassum comes back". (*Vázquez Fátima*, 2019).

Brigitta van Tussenbroek, an investigator for the Marine Sciences and Limnology Institute *Puerto Morelos* Unit, in Quintana Roo for the *UNAM* (National Autonomous University of Mexico) has pointed that the main culprit on tourisms decay is Sargassum. (*La Jornada & Vanguardia*, 2019).

According to data by the SEMA (Quintana Roo's Department of Ecology and Environment) between June 19th and July 29th, 2018 multiple cleaning services picked more than 106.000 cubic meters of Sargassum in 41 beaches of *Cancún, Puerto Morelos, Solidaridad, Cozumel, Tulum,* and *Othón P. Blanco*. (*De la Torre David & Gutiérrez Guadalupe*, 2019).

My proposal to the issue has been inspired by David Christian, who created an eco-friendly alternative to plastic bags using seaweed (which is another type of algae).
His company´s name is Evoware, and it helps both the environment and Indonesian farmers as to them this (the seaweed) is a plague just as Sargassum in Mexico.
His solution to an environmental issue (our plastic contribution to the oceans) is great since it unites forces with Indonesian farmers to help them financially. Helping the rest of the world as well, due to this being soluble in water and edible, giving it an alternative use to conventional "plastic" (now non-plastic) bags only with benefits to both human and marine life, which, to this day, has killed 72 different species going from fish to crustaceans.

His company creates an algae-based product and buys the algae from Indonesian farmers that are currently in extreme poverty. His product is a food-based packaging that uses natural and halal materials making it high in fiber, vitamins, and minerals. It has 2 years of shelf life without preservatives, it's biodegradable and can become fertilizer, it's printable and heat sealable and can be customized for taste, color, and even brand logo. (Evoware,2017).

My idea is to recreate this project with sargassum by producing it through the usage of the newly implemented tax imposed by *Costa Maya* hotel chains, claiming to be used as an ecologically purposed tax. As I investigated about the chemical processes that algae goes through to be turned into sustainable products I realized that I`m not sufficiently prepared to actually execute them, with that in mind and my determination for this idea to be produced under a different countries circumstances I found an Industrial Plant based in *Cancún*, Quintana Roo that is working on Sargassum`s recycling in order to both give it a better use and clean the oceans, just as David Christian is doing with Indonesian seaweed and as I intend to do too. Their company (*Alquimar*) has won the Green Latin America prize and is conformed by 11 *UNAM* students, financed by *CONACYT*.
What they do is extract Sargassums components to produce food additives, fertilizers, fish food and even antioxidants, still they have no proposal to turn Sargassum into a non-plastic eco-friendly bag, that`s when David Christians idea turns relevant to *Alquimar* and for Mexico's current situation, as we could unite forces to both reduce sargassum, plastic waste and making sure that Mahahual`s population can improve their living conditions by making tourism grow. We would be giving them an extra advantage to call people's attention to the area and address the community`s problem by making them producers of an eco-friendly product that could not only help them but also the whole state of Quintana Roo.

This is mainly the reason why I consider that adapting David Christian`s idea to this community will help improve Mahahual´s and Quintana Roo´s overall conditions.

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