The Exploration of Algae as Biological Environmental Sustainable material and their impact on the society and the different industry sectors

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Abstract:

Recently, there has been a continuous increase in environmental pollution rates in many areas due to the lack of societal awareness and gross neglect of the general environment including neglecting our water resources of fresh and salt water and sewage (which can be recycled) and living organisms that we view as waste. They are burned, while these objects can be exploited massively in various sectors. There are environmental areas of a special nature such as natural reserves, in which construction is done with materials that are harmful to the environment, or the use of materials that result in enormous waste that cannot be utilized and is difficult to recycle. Uprooting of trees and palm trees commonly used in environmental friendly structure without being careful that we are reducing the cultivated areas and changing the environmental character of the place.

In term of specialization, the architectural and interior design of public and private facilities and the selection of raw materials especially in those important areas or in general for users in urban cities, there is no following idea of sustainability and its standards to a large extent due to the lack of many options for renewable and natural raw materials.

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Therefore, researchers, scientists, manufacturers, designers, and consumers; since it is a new thought and direction for countries in all their governmental sectors; must pay attention to the environment in order to secure and improve the life of the individual in terms of food, drink, climate, and many other aspects. Since the world began to notice the new climate developments that pose a global threat, two things have become necessary: first, to secure our resources, raise their efficiency, and exploit them to the fullest extent. Secondly, spreading constructive awareness about sustainability quickly addressing the emerging problems. Thus, the aforementioned topics could be summarized as follows:

- Scarcity of raw materials that improve environmental quality and reduce energy consumption.
- The increasing environmental pollution on the coasts, represented by algae and plastic materials, and in urban areas in terms of air pollution and emissions resulting from the increasing exploitation of fossil energy (Freon and carbon dioxide) and sewage.
- The percentage of cultivated areas of trees and forests worldwide has decreased due to drought or to save them for industrialization or civilizational expansion.
- Not exploiting coastal resources and neglecting them as waste.
- The high costs of environmental materials in the field of interior design due to the lack of diversity in materials and alternatives and the lack of incentives for investors to establish factories for them and to spend on scientific research to develop them or discover what is newer.
- The use of materials that are harmful to the environment in coastal areas, represented by quick dismantling and assembly of exhibitions, furniture, and construction.
- The use of many harmful materials in urban areas and on the coasts results in huge waste that is difficult to recycle because it contains materials harmful to the environment or whose life cycle is incomplete for optimal exploitation.

Keywords:

Sustainable Buildings; Sustainable Design; Sustainable Material; Algae Products.

Introduction:

The particular kind of algae categorized as green macro algae (seaweed) is the subject of our research for algae material investigation and proof. Seaweed, also known as green macro algae, that may grow year-round and is commonly found in a variety of maritime habitats. It can filter water in its natural condition, and when it gets sunlight, it becomes a lot more potent natural oxygen source than trees because it absorbs carbon dioxide and produces ten times as much oxygen. It is very simple to cultivate and harvest in a controlled setting.

Its applications are always being explored and found. Its current applications are mostly found in the food and bioenergy sectors. In order to expand our perspectives and knowledge and work toward integrating various factors and sciences to develop and reach powerful, innovative products and materials that can suit our needs throughout green solutions, we concentrate on investigating its various chemical and physical properties through the various product types that have reached worldwide. Collecting and harvesting green macro algae was through hand harvesting methods, on the Mediterranean coastline starting from Rafah till Salloum and on the Red sea coastline from Taba to Marsa Alaam. There are 9800 species of algae and some of them are harmful and undesirable. All species of algae share similar physical properties and our research aims to observe alternate uses for seemingly undesirable material, which means that we can offer many jobs for the coastal occupants specially women sector and young men in many sectors that increase the income for such poor and delicate families or occupants.(Rashad & Elchaghaby,2020)

Green macroalgae are naturally existing material within our environment and can be found near wet environments with the right growing conditions. They require light, carbon dioxide, moisture and simple nutrients to grow.

In addition, its fast growth allows collection for ample research and manipulation.

Observing their physical properties, it possesses an attractive natural coloring both in their wet or dry state. Wet state provides an increase of density that allows an easier way for sculpting the material. In dried state,

it can be easily utilized in coloring methods. Due to its natural presence, green algae able to be integrate into the ecosystem if needed.

The research is aiming at the economic and environmental use of the huge quantities of Egyptian coastal seaweeds in different industrial sectors especially interior design and furniture purposes to replace the materials that have negative impact on the environment or to reduce the demolition of natural raw materials like trees. Many foundations and design offices started to try using such a material and co-operate with some labs to reach environmental sustainable material for daily life usage products with severe impact on the user such as Furniture pieces in closed zones in different spaces as we consume 90 % of our time in closed spaces during the day, using Clothing fabrics and materials on our skin and catering and drinking items… etc. All the previous items and sectors are of a big percentage of industries especially in Egypt of a direct contact with the human. On the other hand, worldwide all countries facing an economical issues to afford those materials for its markets and fortunately, Egypt is endowed by a variety of water resources between seas, River, Lakes and groundwater. So, we have to make use of this biological material which survived from the beginning of the universe with the bacteria too.

As mentioned previously, moreover, Egypt has more than 20 thousand tons of algae wastes annually not used and burnt. So, my duty as researcher was to inform the society and whom it may concern and broaden our knowledge of what we can make use of throughout using such a material which can invade a lot of industrial sectors that improve our environment and make positive differences in our economic power.

Green Algae Research:-

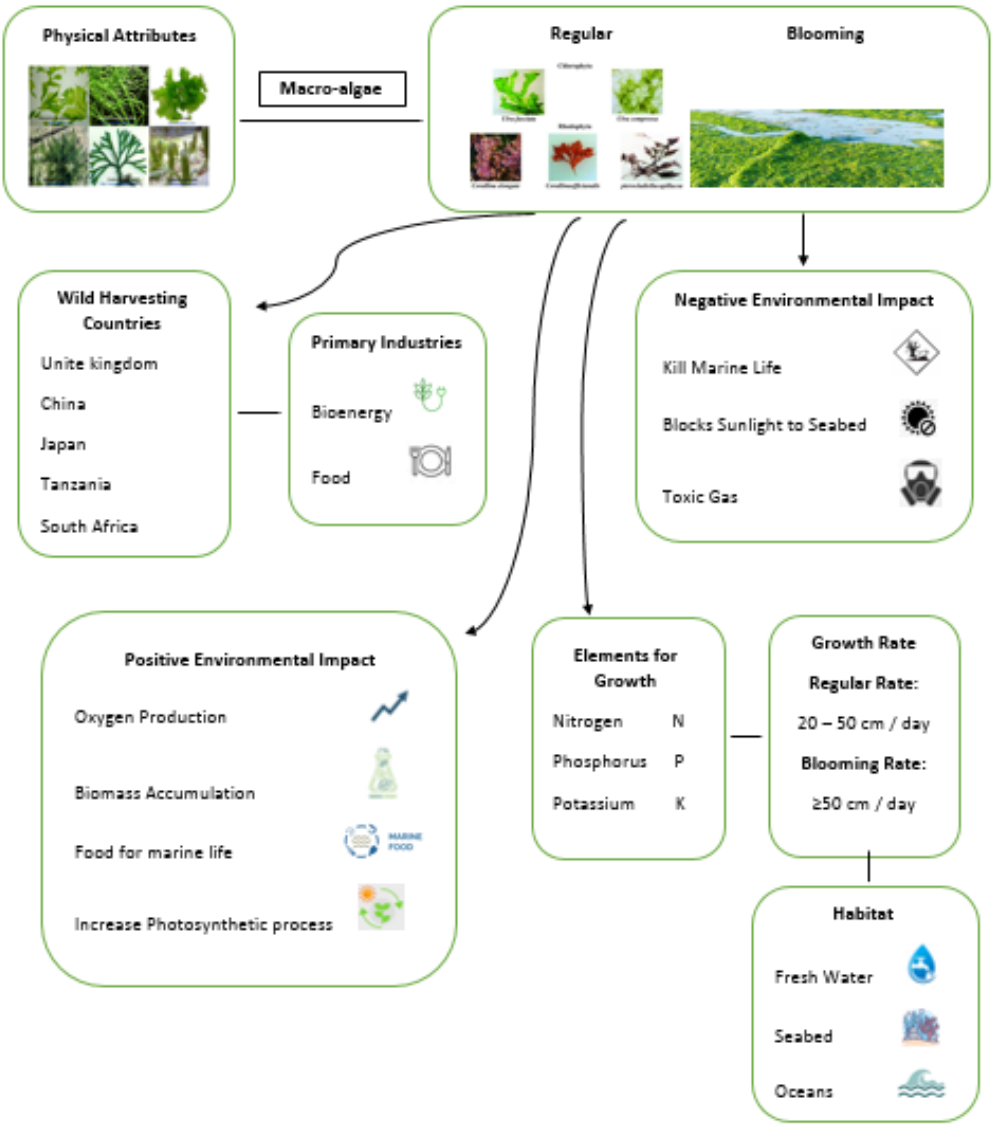


Diagram (1) partly explains the life cycle of algae, its advantages and disadvantages, the main types of industry that affects it, and the most important countries that produce it.

Statement of the Problem:

- Excessive use of environmentally polluting materials, such as plastics.
- Cutting trees continuously and quickly, which harms the environmental balance and increases pollution.
- Poor use of some construction and interior design elements in coastal and environmental areas such as natural reserves.
- Misuse of rapidly renewable natural resources to manufacture environmentally friendly materials instead of cutting down trees, which have a significant impact on the environment.

Objectives:

The current manuscript was consent in a) explaining the importance of algae as a resource for the green economy and the idea of environmental sustainability, b) Introducing environmental design and its role in employing algae-based products and c) Employing algae products within interior design elements, functionally and aesthetically.

Research hypotheses:

The current study assumes the following points:

• Relying on the use of algae products as elements of interior design as an alternative to industrial products with harmful compounds reduces pollution and works to improve the quality of the indoor environment.

• The diverse use of algae products in interior design elements produces interior spaces with aesthetic and functional values.

As we are talking about environmental and sustainable material in the track of design processes we have to know some definitions for some terms that can let us know the vision and criteria needed to be selected or deal with it to improve our societies from our background as interior designer:

Sustainable Building:

Sustainable building defined as the process of designing and constructing buildings with resource-efficient materials and methods that won't endanger the environment's health or the health and welfare of building occupants, construction workers, the general public, or future generations

(kumar.B & Saha.B, 2012). Textiles are the primary use for the biodegradable product. Therefore, organic raw materials are crucial industrial inputs that help create a circular economy that is environmentally beneficial and doesn't generate plastic trash. Textiles are the primary use for the biodegradable product. Therefore, organic raw materials are crucial industrial inputs that help create a circular economy that is environmentally beneficial and doesn't generate plastic trash.
Recycling, energy efficiency, alternative construction materials, and small-scale experimentation served as the foundation for the first wave of sustainable design. The second wave of sustainable designers started to see that the best outcomes for sustainable design may come from integrating all the variables.

Green Design was defined by the U.S. Green Building Council (2003) as design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants in five broad areas (Site, Water, Energy, Materials & Resources and Indoor Environmental Quality.

Sustainable Design:
Sustainable design has emerged as a guiding paradigm / model in the creation of a new kind of built environment one that "Meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987)

Research Field:
Interior Design, Furniture Design, Sustainable Materials, Sustainable Buildings, Green Economic, Algae Explorations.

Research Methodology:
The study adopts an exploratory research design to investigate the effectiveness of a sustainable environmental material that is widely found in Egypt, to enhance the industry sectors by proofing how it is used world wide and how we developed the material here in Egypt to inline with our weather conditions.

Earth is the only known planet in our universe capable of sustaining life, yet we choose to abuse the environment that supports us carelessly.

Environmental pollution resulting from smoke and waste quickly began to have permanent effects on our environment that are increasing temperatures and harm the human health - the focus of all things due to carbon dioxide - leading to the dehydration of many regions. Environmental sustainability is a topic that most people choose to ignore. This is because we indulge in short-term comfort, and we make choices ignoring the long-term consequences of our selfish choices on the environment, humans have become the environment's worst enemy. This is how countries and societies feel the poorest in our world are most affected by these long-term consequences.

Therefore, there is a global trend - especially in Egypt - to achieve sustainability standards in many sectors due to the problems that countries are witnessing regarding miss consumption of resources and evacuating the public interest, the measures Egypt is taking to control infringements on the environment and paying attention to providing solutions that ensure the provision of food and water, their proper consumption, purifying the air, and setting laws that guarantee following environmental standards requires us, as researchers in every field, to put forward scientific ideas that help achieve that constructive approach.

Here, as specialized researchers, it seems that the designer has a tremendous impact on environmental sustainability because he is the one who decides on the materials and products that will be used and how to interact with all of it and provide design systems and methods that restore ecological balance. It is our job to solve problems, finding intellectual solutions to what the country faces, and exploiting everything around us with a vision and thought that follows functional and aesthetic rules for users.

In this research, the researcher is proofing the power of combining different sciences to provide completely environmental compounds, substances, or raw materials without introducing any harmful substances into the environment in their manufacture, so that they do not have harmful emissions and the life cycle of those compounds, materials, or raw materials is a closed cycle; we benefit in the interior design specialty as a research topic or in other design departments.

After its lifespan, it can achieve sustainability through recycling it for other products or decomposing it environmentally. This material is moss, which is available on the coasts Egypt, water desalination sites and other areas. Therefore, this plant was chosen because of its many benefits. Including purification of Air and water in huge proportions and in various fields, including medicine, food, and renewable energy. But, too much of it is a burden on me Countries, some of them burn them and some of them cannot exploit them - their rapid reproduction without exploitation threatens fish life in the seas, the movement of ships, and obstructing transactions in ports, which harms the economy and food security - and this is considered by countries. Advanced as one of the elements of the green and blue economy, which is a new concept that calls for benefiting from the seas as an environment that can be cultivated and benefited from. From its outputs, Environmental sustainability is the ability of a country, the people living in that country, and businesses to preserve and protect highly valued resources in the physical environment.

Algae Exploration

First of all, we have to know that Algae is classified into many specific types. We will deal with specific type of it called "Kelp" mainly as an example, which is considered as one of the Macro-algae, Seaweeds. It is typically found in many different marine environments and can grow year around. In its natural state when exposed to light it acts like plants as a natural source of oxygen but by 10 times the efficiency of any other plants and it is able to filter water too by absorbing any toxic substances in water. Additionally, it is easy to grow and harvest within a controlled environment.

Secondly, its uses are continually being discovered and developed. Currently, its uses are primarily rooted in bioenergy and food industries. But, some foundations are working on finding other usages that can be done by algae in different scientific departments to substitute the artificial materials that harm our planet as Plastics … etc.

In our project, we are exploring a new chemical and physical properties through extraction and manipulation of the material using other types of macro-algae. We already examined how it can be used as a natural dye and its potentials as an individual material examining its structural integrity and its ability to be formed in molds or sheets. As we are working on

architectural and interior applications, so we are taking into consideration that some additives and aggregates will be integrated into our material in order to sustain and contribute its strength and ability to carry various weight loads.

Algae Farming:

- Here we will see different countries from Africa and Asia mainly working on algae agriculture and making use of their algal blooms in their countries and how they benefit from it.

• Micro-algae Farms (WorldWide)


New Mexico


Florida


Random Picture

Form (2) shows examples from different countries worldwide that works on Microalgae farms.

(https://scarcityzero.com/scarcity-zero/what-it-does/indoor-farms-biofuels)

In Egypt: National Research center – Algae Technological Lab, Algae Dept.

Form(3) shows the Micro Algae Farms at the National Research Centre, Egypt.

• Macro-algae Farms

- Here we will see how it is harvested easily from the coastal lines with no effort for any gender, if it is cultivated with logical curriculums.

Form (4) shows different types of Macro algae Farming & how easily harvested by simple labor.
Random Pictures from Tanzania and South Africa

Algae Cleaning and Water Filtering:

We can propose to collaborate with the desalination centers to supply the algae we need to benefit from the filtering algae that has no other use after it is used as a filter. We propose to utilize this unable algae as our primary material.

Form(5) shows: ***Algae cleaning / processing in laboratory to filter water (Random Pictures - China)***

MATERIALS AND METHODS:

ALGA SOURCE

The Macro-alga "Kelp"was obtained from the seas of those different countries that are going to be shown later, using hand harvesting. Alga was in situ washed by sea water and kept on ice box till drying. In the laboratory, alga was re-washed by tap water and hand screening then dried using circulated oven at a moderate temperature or by spreading it out in the open air. (Emam, Mansour, Shabana & Moustafa, 2014)

ADHESIVES MATERIALS

Different natural adhesives material were used in their trials till they have reached the perfect composite formula and sequence in preparing the composite or by extracting it from the algae itself. They also started to work with team of chemists to make synthetic environmentally friendly adhesive materials.

(1) PRECEDENTS:

- **Pavilions:**

The designer "Julia Luhmann" department of seaweeds showed some organic pavilions in London 2013, made of Kelp (macro-algae seaweeds) and Rattan structure.

The color of the kelp panels change from yellow to orange to brown, depending on the light and the time of day. It also gives off a salty scent of the sea. (https://glasshousehelsinki.com/julia-lohmann-made-an-imaginary-craft-a-reality-with-the-help-of-seaweed/, Niipola, 2021)

Form(6) shows an Administrative building in London – Julia Luhmann's Project

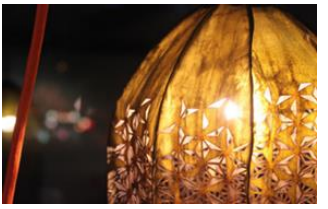
- **Decorations:**

London-based designer " Julia Lohmann " thinks dried strips of seaweed could replace leather, paper and plastic to make everyday-objects like these laser-cut kelp lampshades.

She used a laser cutting machine to create patterns in pieces of kelp before sewing them together, or stretched them into shape while wet to dry into new forms.

(https://www.iconeye.com/design/department-of-seaweed-julia-lohmann, Design, 2019)



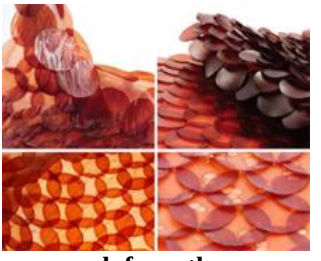


Form(7) shows how easy to work on Algae after drying and make different unique decorative items that are environmentally sustainable. - Julia luhmann's decorating project – London. www.iconeye.com

- **Fabrics:**

- Woven Fabric: The fabric on her deck chair-like seat, is created using cellulose extracted from kelp. It has similar properties to that of viscose – a compound used in synthetic textiles – but with much softer fibers.
- Bioplastic Fabric: Algae bioplastic fronds are sewn onto a biodegradable base layer made of plant fibers. This makes the dress free of crude-oil derivatives such as synthetic fibers.





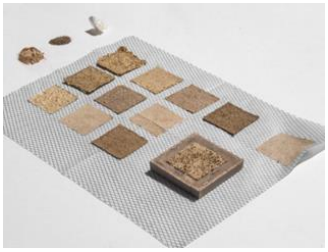
Form(8) Different types of algae and the colors we can reach from them

Form(9)shows the different types of algaewith their different textures & colours that can be extracted & manufactured by algae as an environmental sustainable fabrics that can be used in different functions. – www.Dezeen.com

- **Stamps:**

Spanish-Italian designer Pablo Dorigo Sempere has extracted algae polluting the Venetian Lagoon and used it to make paper postage stamps for the Italian City.

Dorigo Sempere learnt to make the paper from scratch with the raw ingredients, including thin powdered algae, coarse powdered algae and cellulose fibers. (Favini, 2018)



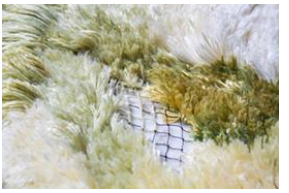
This form (10) shows how the italian designer made use of an environmental material that affected the tourism & usage of stairs in Venice, Italy by turning algae into a unique souvenirs as stamps. ***Favini, 2018***

- **Rugs:**

This rug is woven using yarn made from algae harvested from the sea and designed by the Dutch designer "Nienke Hoogvliet".

The yarn is created using cellulose extracted from kelp, a large seaweed that is one of the biggest types of algae.

The kelp is harvested in South Africa and purchased from a specialist



Form(11) shows how algae transformed from a plant into yarn forming rugs and much more. Dezeen – Nienke Hoogvliet Project *supplier. (Howarth, Dezeen, 2014)*

- **Claddings:**

The world's first building to work as bioreactors for increasing or affording algae biomass and the panels itself work as natural shutters during the day and the building is being piloted in Hamburg, Germany, by engineering firm ARUP.

The "bio-adaptive facade", which ARUP says is the first of its kind, uses live microalgae growing in glass louvres to generate renewable energy and provide shade at the same time.

form (12)Picture shows the first building that has bioreactor facades for microalgae. Hamburg - Germany

Installed in the BIQ building as part of the International Building Exhibition, the algae are continuously supplied with liquid nutrients and carbon dioxide via a water circuit running through the facade.

When they are ready to be harvested they are transferred as a thick pulp to the technical room inside the building and fermented in a biogas plant. (Orchid.M, Orchid.P & Amidpour, 2019)

- **3D Printing Products :**

A Dutch design firm that experimented with 3D Printing and green algae. They developed an algae polymer that is able to be used in 3D Printers. They explore the implications of using algae as a way to 3D print objects emphasizing its sustainability and potential in completely replacing plastics in the future. (Dezeen, Morris, 2017)

form (13) shows the transformation of algae into a paste used in 3D printing to substitute plastic products & much more.
3D Printing lab for a Dutch design Firm at Dezeen

- **Furniture:**

Royal Danish Academy of Fine Arts graduates have produced home products based on kelp and paper mixture. This mixture is ground and molded into a variety of geometric forms and heated to create a rigid material.

The colors of the end products are directly derived from the natural appearance of the brown seaweed.

Form (14) picture shows a seating form picked out of a form made of a rigid material from algae – Algae Furniture Trial.

(https://www.designboom.com/design/terroir-project-jonas-edvard-nikolaj-steenfatt-04-03-2015/)

Form (15) shows how algae after drying can be transformed into a rigid material forming Furniture pieces to decrease as much as we can the usage of woods.
Jonas edvard & Nikolaj Steenfatt Project – www.designboom.com

CONCLUSION:

There are several benefits of using algae. Algae have several beneficial qualities that make them useful in a wide range of applications. They are steadily gaining traction as plastic substitutes. Their ability to absorb excess CO2 and remain renewable and biodegradable is their strongest feature. Therefore, whole marine aquaculture companies that cultivate seaweed are providers of raw materials. One major benefit of these seaweed farms is that they are good for the environment. In addition to giving the living beings a place to live, they also create oxygen through photosynthesis, which is necessary for all life. If the oxygen content of the ocean dropped too much, all organisms would go extinct.

Therefore, when it comes to furniture created from renewable raw materials, algae are fascinating drivers of innovation. Alginate is a biopolymer found in them that has elastic, robust, and stable properties. Algal furniture feels good to the touch and has a very organic appearance.

The usual smell of algae is eliminated upon manufacture. For instance example, eucalyptus wood and brown seaweed extracts are used to make "Sea-Cell fibers". The fibers are biodegradable, odorless, silk-like in texture, and naturally antimicrobial and as it was proved previously by the products done by some Architectural and interior design offices worked on that recently.

RESULTS AND DISCUSSION

Algae-based new materials are being developed by the textile and interior design sectors, taking it from sushi ingredient to fashionable raw resource. These materials are ecologically friendly and inventive. These goods might promote sustainable lives and aid in the reduction of the mountains of plastic garbage that surround the globe. We examine the distinctive qualities of algae and how they might be used to create furniture.

For Product designers and manufacturers, the climate catastrophe and resources shortages present ongoing problems with no easy answers. For this reason, furnishing, packaging and fabrics deprived from algae are highly relevant to the interior design sector.

It is a material that replenishes itself, preserves resources, creates oxygen in the ocean and doesn't leave any plastic garbage behind.

In addition to helping the environment, anyone who manufactures their products with sustainable materials is also adhering to a cutting-edge sustainability trend that is highly appealing to consumers. Consumers want to spend fewer resources and lead better, more conscientious lives, after all.

The environment is harmed by plastics, particularly if they aren't recyclable. Food, textile, and furniture manufacturers have long realized that consumers will look for sustainable solutions in the future. Herein lies the application of a materials trend that offers several advantages. Seaweed and other algae are nutritious dietary components because of their mineral content, but they may also be processed to make a variety of products.

Algae-based furniture, textiles, and packaging already exist. Novel, algae-based polymers may now entirely dissolve and replace plastics because of their exceptional strength and ability to do so, thanks to unique production techniques. Textiles are the primary use for the biodegradable product. Therefore, organic raw materials are crucial industrial inputs that help create a circular economy that is environmentally beneficial and doesn't generate plastic trash.

If interested to the topic and need much more information and knowledge about the algae based products and raw materials that are ecofriendly and sustainable nowadays you can refer to the students master's thesis.

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استكشاف الطحالب كمواد بيولوجية بيئية مستدامة وأثرها على المجتمع وقطاعات الصناعة المختلفة

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المستخلص:

في الآونة الأخيرة، هناك تزايد مستمر في معدلات التلوث البيئي في العديد من المناطق بسبب قلة الوعي المجتمعي والإهمال الجسيم للبيئة العامة بما في ذلك إهمال مواردنا المائية من المياه العذبة والمالحة ومياه الصرف الصحي (التي يمكن إعادة تدويرها) والكائنات الحية فيها.

ما نعتبره نفايات يتم حرقها، بينما يمكن استغلال هذه الأشياء على نطاق واسع في قطاعات مختلفة. وهناك مناطق بيئية ذات طبيعة خاصة مثل المحميات الطبيعية، حيث يتم البناء فيها بمواد ضارة بالبيئة، أو باستخدام مواد ينتج عنها نفايات هائلة لا يمكن الاستفادة منها ويصعب إعادة تدويرها. وأيضاً، اقتلاع الأشجار والنخيل الشائع استخدامه في البناء الصديق للبيئة دون الحرص على تقليص المساحات المزروعة وتغيير الطابع البيئي للمكان يسبب ضرراً هائلاً. من حيث التخصص، التصميم المعماري والداخلي للمرافق العامة والخاصة واختيار المواد الخام خاصة في تلك المجالات المهمة أو بشكل عام للمستخدمين في المدن الحضرية، لا توجد فكرة متبعة للاستدامة ومعاييرها إلى حد كبير بسبب عدم توفر العديد من

الخيارات للمواد الخام المتجددة والطبيعية الصديقة للبيئة، ولذلك فإن الباحثين، العلماء، المصنعين، المصممين والمستهلكين يجب عليهم المشاركة بينهم وبين بعض لأنه فكر واتجاه جديد للدول بكافة قطاعاتها الحكومية و هو وجوب الاهتمام بالبيئة من أجل تأمين وتحسين حياة الفرد من حيث الطعام والشراب والمناخ، والعديد من الجوانب الأخرى. منذ أن بدأ العالم يلاحظ التطورات المناخية الجديدة التي تشكل تهديداً عالمياً، أصبح من الضروري أمرين: الأول، تأمين مواردنا، ورفع كفاءتها، واستغلالها إلى أقصى حد. ثانياً، نشر الوعي البناء حول الاستدامة وسرعة معالجة المشكلات الناشئة. ومن ثم يمكن تلخيص المواضيع المذكورة أعلاه فيما يلي:

- ندرة المواد الخام التي تعمل على تحسين جودة البيئة وتقليل استهلاك الطاقة.
- تزايد التلوث البيئي على السواحل ممثلاً بالطحالب والمواد البلاستيكية، وفي المدن من حيث تلوث الهواء والانبعاثات الناتجة عن زيادة استغلال الطاقة الأحفورية (الفريون وثاني أكسيد الكربون) ومياه الصرف الصحي.
- انخفاض نسبة المساحات المزروعة بالأشجار والغابات على مستوى العالم بسبب الجفاف أو حفظها للتصنيع أو التوسع الحضاري.
- عدم استغلال الموارد الساحلية وإهمالها كنفايات.
- ارتفاع تكاليف المواد البيئية في مجال التصميم الداخلي بسبب عدم التنوع في المواد والبدائل وعدم وجود حوافز للمستثمرين لإنشاء مصانع لها والإنفاق على البحث العلمي لتطويرها أو اكتشاف ما هو جديد.
- استخدام المواد الضارة بالبيئة في المناطق الساحلية والمتمثلة في سرعة تفكيك، وتجميع المعارض والأثاث والإنشاءات.
- يؤدي استخدام العديد من المواد الضارة في المناطق الحضرية وعلى السواحل إلى نفايات ضخمة يصعب إعادة تدويرها لاحتوائها على مواد ضارة بالبيئة أو التي تكون دورة حياتها غير مكتملة للاستغلال الأمثل.

الكلمات المفتاحية: المباني المستدامة؛ التصميم المستدام؛ المواد المستدامة؛ منتجات الطحالب.