SEAWEED HOUSE 2.0: METHODS AND TECHNIQUES TO HARMONIZE AND IMPROVE THE LIVING AND URBAN OF FUTURE CITIES, IMITATING NATURE

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Abstract

The project questions the solutions currently available that can bring immediate benefits in mitigating climate change within homes and human settlements. Among the proposed solutions, Spirulina seems the most promising one. This single-celled microalga has great adaptive capabilities and allows different applications in the field of construction, attempting to merge Architecture, Urban Planning and Nature, generating sustainable and recyclable environments.

Keywords: Seaweed House, Urban environmental sustainability, Break down climate change, Natural based solution, Cultural based solution**.**

1 Framing of the scientific problem with reference to the state of the art

As defined by the Italian Ministry of the Environment, "air pollution" means any change in the normal composition or physical state of the air, the presence of one or more substances in quantities and characteristics liable to alter the normal environmental conditions and the health of the air. The pollutants emitted into the atmosphere by human activities are responsible for various environmental problems: from acid rain to the greenhouse effect, to the depletion of stratospheric ozone, to the degradation of air quality.

"Air pollution is the most important environmental risk factor for the health of the population, particularly in urban areas. In Italy, in the last ten years, vehicular traffic, especially diesel vehicles, and the combustion of biomass for heating (wood and pellets) represent the main sources of pollution from $PM_{2.5}$ with an important impact on health especially in urban areas."[1]

Due to changing lifestyles and thermal and meteorological anomalies, much more time is spent indoor and consequently the exposure time to pollutants in the indoor air, which partly originate from the external atmospheric air and partly from internal sources. Of great concern is the contribution of $PM_{2.5}$ to the original indoor pollution from biomass used for domestic heating. A study conducted by Elemens for Legambiente and Kyoto Club in April 2021 points out that domestic heating contributes to the pollution of cities, portraying polluted metropolises beyond measure, in which methane is one of the primary types of fuel.[2] Pollution is a global environmental problem, posing a threat to nature, which becomes contaminated nature. Lowering the threshold for environmental pollution requires an effort

[1] Gard-I, (2017), 7-13.
[2] Infobuildenergia, (2021).

to regulate the processes of production, recycling, and waste disposal, with a clear shift towards a circular economy, based on maintenance and recycling, rather than on the production of new consumer goods.

Our focus must be on the use of renewable energy, such as air, water and soil, and self-sustaining buildings and local communities. There is talk of building being one of the sectors responsible for a significant number of emissions into the atmosphere and excessive energy consumption.

Specifically, according to data from Global Alliance for Buildings and Construction:

The construction sector would be responsible for 36% of final energy consumption and 39% of the world's total carbon dioxide emissions, 11% of which would come from the production of building materials such as steel, cement, and glass. "Significant improvements are needed, especially in the design and construction phases".[3]

It emerges the importance of reducing the environmental impact from the beginning, that is, from the production of the materials with which it is built, since the environmental impact of a building material or product depends on the energy used to extract, transport, and process it, the CO_2 emitted during this process and the production of any other pollutants. Choosing natural materials, coming from the local territory, and using recycled materials from the treatment of building waste, wood, glass and plastic, are actions that reduce the environmental impact. Architecture and construction, therefore, can improve and change to combat pollution and respect the environment, from design to materials, to energy production, moving towards a more sustainable architecture. A first step to reduce the environmental impact is a correct and careful design. A necessary path in the transition to a greener future involves the decarbonisation of heating systems. The architectural design is directed towards a path that communicates more and more with nature, tightening a real intimate bond, rediscovering the vital and powerful side of natural force.

2 Objectives and expected results

Recent studies have discovered excellent solutions in the use of algae, not only for their ability to eat carbon dioxide present in the air and water in which they live, but also as an alternative source of energy used for the creation of biofuels through their production of biomass.

The alga becomes a metaphor for a new model of design reference, linked to the unveiling of its natural intelligence, to study it, copy it and transfer it to the practices of managing urban events: from construction to the city, useful to mitigate climate change and create an even more developed circular economy in several sectors: food, pharmaceuticals and agriculture. The alga, which is best suited to this study, recognized and subjected to various research, is Spirulina, having the ability to convert carbon dioxide into lipid-rich carbon molecules, to reduce CO_2 emissions and other greenhouse gases, acting as real carbon tanks. Amply demonstrated by experimental research:

"Spirulina can fix up to twice its weight of carbon dioxide"[4], demonstrating a fixation capacity per hectare/ year greater than other types of crops. "For each Kg of spirulina, about 1.9 Kg of CO_2 are

[3] 'GlobalAbc, (2020).
[4] Cecchini, (2021).

subtracted from the environment"[5]. Atmospheric scavengers that absorb carbon preventing the release into the atmosphere for very long periods of time. In addition to being real sponges in capturing carbon dioxide, they contribute to the food emergency response.

Microalgae, such as spirulina, are primitive autotrophic microorganisms capable of independently producing the substances necessary for their growth, exploiting solar energy, CO_2, and water, returning oxygen. Their growth is continuous, unlike for terrestrial vegetables in temperate climates, with a vegetative activity that often does not cover more than a few months of the year. This natural behaviour means that the microalgae adapt also to narrow or not very fertile environments, with large artificial basins or sealed reactors (called photobioreactors).

"Sustainability" is one of the key words of our time. In this case, the cultivation of Spirulina, reflects this behaviour, as it does not deplete the soil in which it is grown, ensuring a water balance, because the water is used by Spirulina only to move, absorb the nutrients in the water and collect solar waves. In essence, Spirulina grows by means of natural nutrients on narrow marginal surfaces.

Its cultivation represents a model of sustainable agriculture that can be easily pursued because it requires a reduced effort in economic terms, technology, and natural resources, increasingly oriented towards a low environmental impact.

3 Methodology and activities

The research that we want to conduct in this study is to combine Architecture and Nature, to build a new habitat where we can live in contact with nature, surrounded by vegetation, a primitive domestic landscape to return to our origins. Seaweed house is the product that we intend to carry out in this research, a new home where new solutions of ways of living are experimented, based on the naked beauty of the materials used and the organic forms that express the new spaces of living.

By linking several houses in a new urban design, the second step of the research is to compose a new neighborhood where the urban space responds to natural logic of coexistence with nature and its rhythms, so as to affect the culture of living in the city, evolving the Natural Based Solutions approach into Natural and Cultural Based Solutions. To tackle in an innovative way the problems that we must respond to, approaching and exploiting all possible currents, returning animals that live in the forests, in habitats on a human scale, built and based on the technology of the spirulina algae. An eco-sustainable and recyclable house, made with waste, vegetable materials that combine with the technology that algae offer, giving health, environmental and food benefits. A home of human health and environmental sustainability. Algae will become an essential and fundamental element in this new way of living a house, one hundred percent a living plant, exploiting all its capabilities, from a purification filter, a CO_2 tank, a bio-energetic battery, and dye.

Imagining and testing algae in new urban configurations: a neighborhood that behaves like a living vegetable organism, in which everyday realities are assembled. An ecodistrict divided into housing units, represented by Seaweed house, commercial, exploiting the technology of spirulina algae, but also green areas and agricultural cultivation in which to experiment with the union between agricultural parks and tropical forests where algae cultivation is established. Bringing the design back to a contemporary neighborhood where it is expected to create a network of public spaces, integrating green

[5] Cecchini, (2021).

and built in an environmental key, regenerating the existing spaces thanks to the use of algae and increasing the natural strength

The seaweed will be used as a dye, biodegradable and applicable to the fabric, combined with cellulose fiber, gives anti-inflammatory benefits, toning properties and a source of protection against free radicals. Useful discovery to introduce these factors in the architectural field, working on the furnishing materials of an indoor environment, such as curtains, effective at shielding UV rays, composed of living algae, applied inside transparent tubes, exploiting the biofuel produced as a source of heating for the home. In addition, the algae combined with bacteria and water, develops a bioenergetic battery from which to obtain energy, necessary for lighting and heating systems.

On the theme of the circular economy, the alga will be introduced and used in plants serving the internal environment as a purification filter, trying to recover and recycle the water used, after being treated in tanks by an oxidation plant combined with one of reverse osmosis, for new use. At the end of life, Spirulina will be pressed, extruded and dried, used in food, energy, or fertilizers for the fields, while water will be used to irrigate green social spaces and gardens. With algae it is possible to obtain bioplastics thanks to 3D printers that create new sustainable products, eliminating synthetic plastics.

4 Social and cultural interest

The originality of the research lies in exploiting the algae in vertical tanks or, better, vertical walls that contain algal fluid, combined with the membrane or glass, improving the release of carbon dioxide, stored by spirulina, performing the function of photobioreactors that purify grey water.

These walls will divide the interior, connecting with the outside in an indirect way, thanks to chimneys, exploited both as filters to reduce contamination with the outside, and to capture the air that will exert pressure, so that the alga, through the flow of water, releases oxygen and continues to grow, absorbing nutrients and capturing solar waves, producing biomass for different destinations.

An accommodation built following natural rules, reproducing architectural elements with natural components. This study of algae, reproduced within a small domestic environment, is designed to be expanded to urban artificial intelligence systems. The research starts by analyzing the aspects of algae in agreement with other materials to lead to an improvement in environmental quality. For example, replace the common cement that we know, with a biogenic limestone cement, where limestone is produced by algae, called coccolitofori, covered with limestone scales. A new method of cement production, sustainable and carbon neutral. In addition, to combat air pollution, it is possible to introduce in cities bioreactors to purify the air, performing the function of a real plant, containing microalgae immersed in water that can reduce carbon dioxide through a photosynthesis process. It is useful to introduce them where there are no spaces for real plants, between parking lots and close-up architecture, urban furniture, columns at bus, train and tramway stops, filtering and cleaning the surrounding air, giving oxygen. Once their life cycle is over, microalgae will be converted into biogas and biomethane to heat cities, which are useful for heat pumps and district heating and cooling systems. In addition, algae can help in urban lighting, thanks to the production of fuel oil resulting from the cultivation and squeezing of algae, which will serve to power the electricity plant. In a sustainable city, attentive to climate change, it is instinctive to insert urban gardens, gardens, vertical agriculture, green walls and roofs, radically introducing green to cities. In this process of urban forestation, algae and other types of plants can be useful to ensure agricultural sustainability, such as inserting algae into

gardens, thinking of nature as part of a new bio-intelligent infrastructure. A project developed in Warsaw recreated a playground, containing glass reactors with live cultures of microalgae Chlorella. This new digital bio composite technology combines aesthetic and material qualities, with the natural ability of microalgae to capture solar radiation and absorb CO2. With this sustainable economic system, it is possible to change the way of doing and thinking about construction, reduce pollution, restore energy in the economy of our country and regenerate our heritage, both public and private. The result will be a new urban environment designed with nature, an ecosystem of plants, algae and fungi, lived according to its rhythms, which teaches us to behave sustainably, in contact with nature. Bacteria, algae and fungi are organisms capable of transforming pollutants into nutrients, an indispensable process in cities made up of architectures capable of integrating these organisms in the sustainable urban environment. Microalgae reveal a collective intelligence when it comes to urban planning. The city is no longer an anthropocentric living space, but a synthetic, artificial and natural landscape, in which only with the collaboration of multiple forms of life, we can take care of the planet. Learn new design indicators, mixing ecological and human needs. Nature must be understood as technology and productivity, teaching us a new language and learning from it a culture of regenerative development.

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