SOCIALCARBON®

Protecting nature through wastewater treatment

A methodology to accelerate the implementation of wastewater treatment plants.

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About SOCIALCARBON

SOCIALCARBON is an international Greenhouse Gas (GHG) standard focused on Nature-Based Solutions. Utilising leading technology and science, it facilitates the restoration and conservation of natural ecosystems through embedding local communities into projects to ensure lasting sustainable development. www.socialcarbon.org

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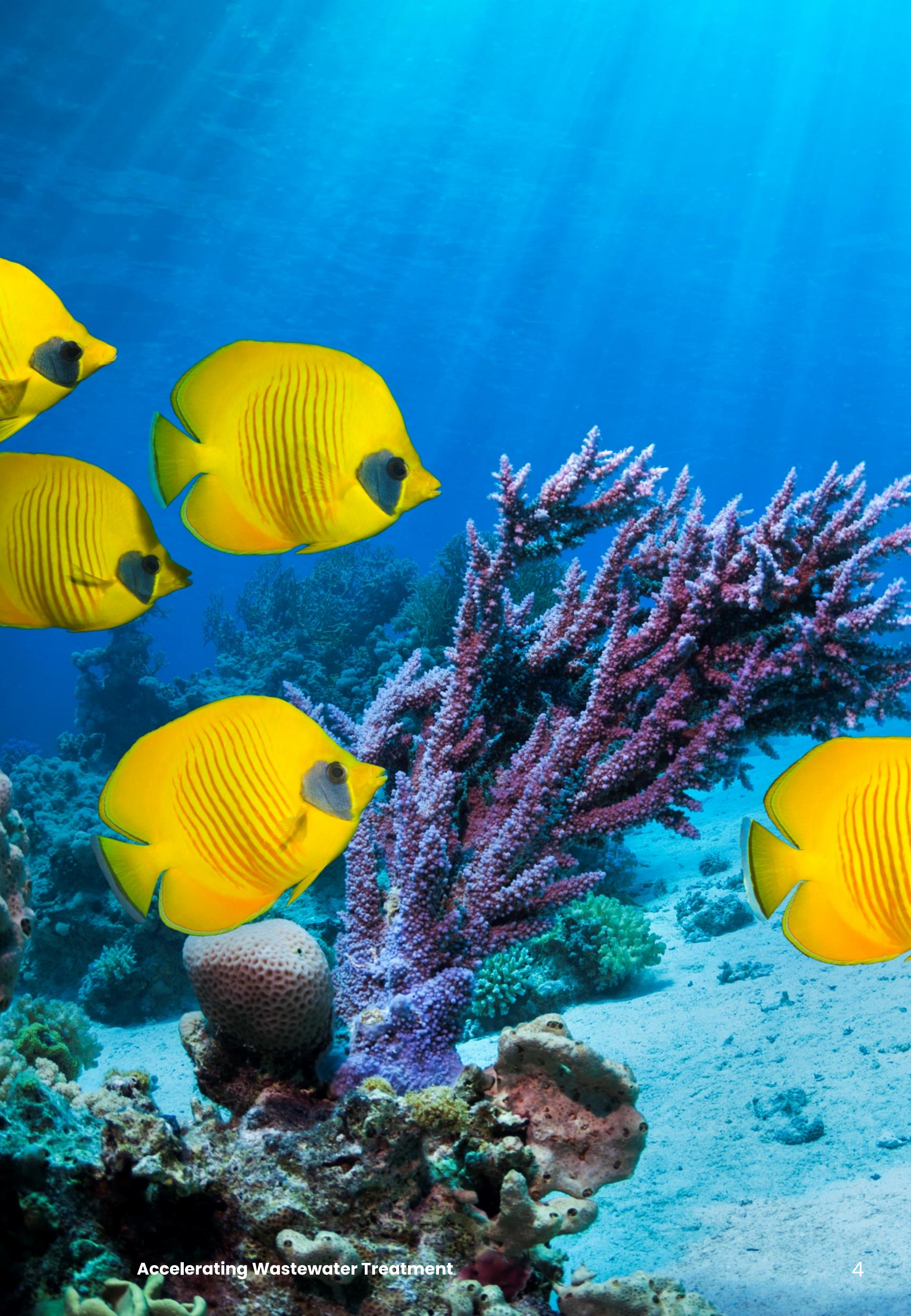
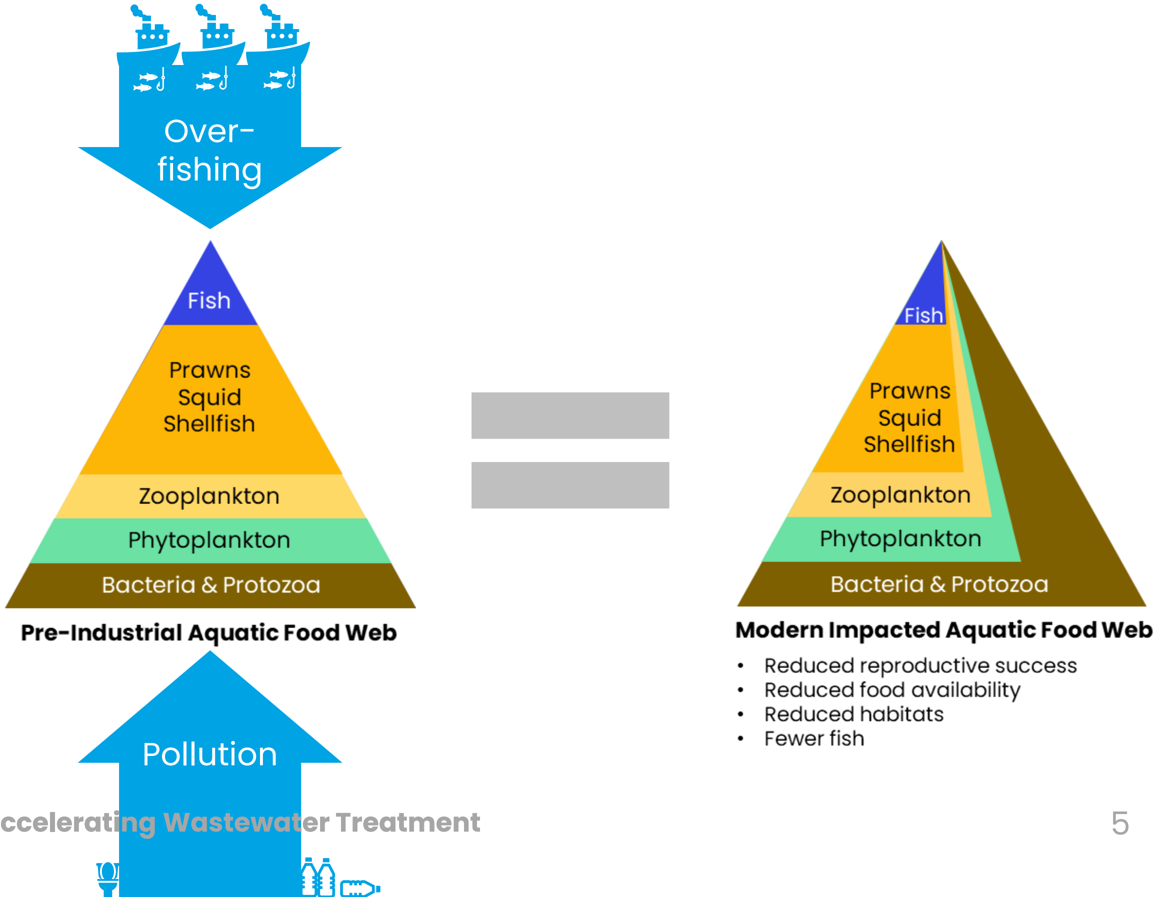


Executive Summary.

Untreated wastewater is threatening our freshwater sources, ocean ecosystems, and undermining climate actions. New financing models are required to scale the development of wastewater treatment plants at pace.

Today, an estimated 80 percent of global wastewater is being discharged untreated into the world's waterways[1]. This affects the biological diversity of aquatic ecosystems and disrupts the fundamental web of our life support systems, on which a wide range of sectors from urban development to food production and industry depend.

With only 8 percent of the required capacity to treat wastewater effectively, low-income countries are the hardest hit by contaminated water supplies. The impact of which includes: a loss of ecosystem services and economic opportunities; spreading of "Dead Zones" impacting fisheries, livelihoods and the food chain; and health impacts due to waterborne diseases[2]. In addition, anthropogenic pollution has been linked to disruptions in the aquatic food web, reducing reproductive success and reducing food availability. Since 1950, 50 percent of all marine life has been lost[1]. Whilst over-fishing is impacting the top of the food chain, pollution is having a significant impact on all aquatic animal immunity, fertility, development, and survivability. Ultimately, we are attacking marine ecosystems from both sides.



Pre-Industrial Aquatic Food Web

Modern Impacted Aquatic Food Web

- Reduced reproductive success
- Reduced food availability
- Reduced habitats
- Fewer fish

It is paramount that marine life be protected and regenerated. Phytoplankton contribute at least 50 percent of all oxygen to our atmosphere and capture an estimated 40 percent of all CO2 produced, yet their global populations have declined on average 1 percent annually. This has implications on climate change and the broader ocean ecosystems; if the decline is not halted and reversed, ocean acidification will intensify resulting in further declines in marine life populations and undermining global climate action initiatives.

The carbon markets offer a new financing option to fund the development of aerobic wastewater treatment plants. This offers an opportunity to stem a primary source of global ecosystem degradation through a cost-effective and low carbon emission approach.

This paper proposes a new methodology under the SOCIALCARBON Standard to quantify the carbon reductions achieved through the implementation of aerobic wastewater treatment plants, whilst realising broader social and biodiversity co-benefits. This methodology has the potential to change how wastewater treatment plant investments are analysed and financed. It will enable private and public organisations to directly finance wastewater treatment plants that deliver lasting benefits towards local communities, natural ecosystems and climate mitigation.

We welcome all feedback on this paper. To share your comments with us, please submit them through our website here:
https://www.socialcarbon.org/contact-us

1.

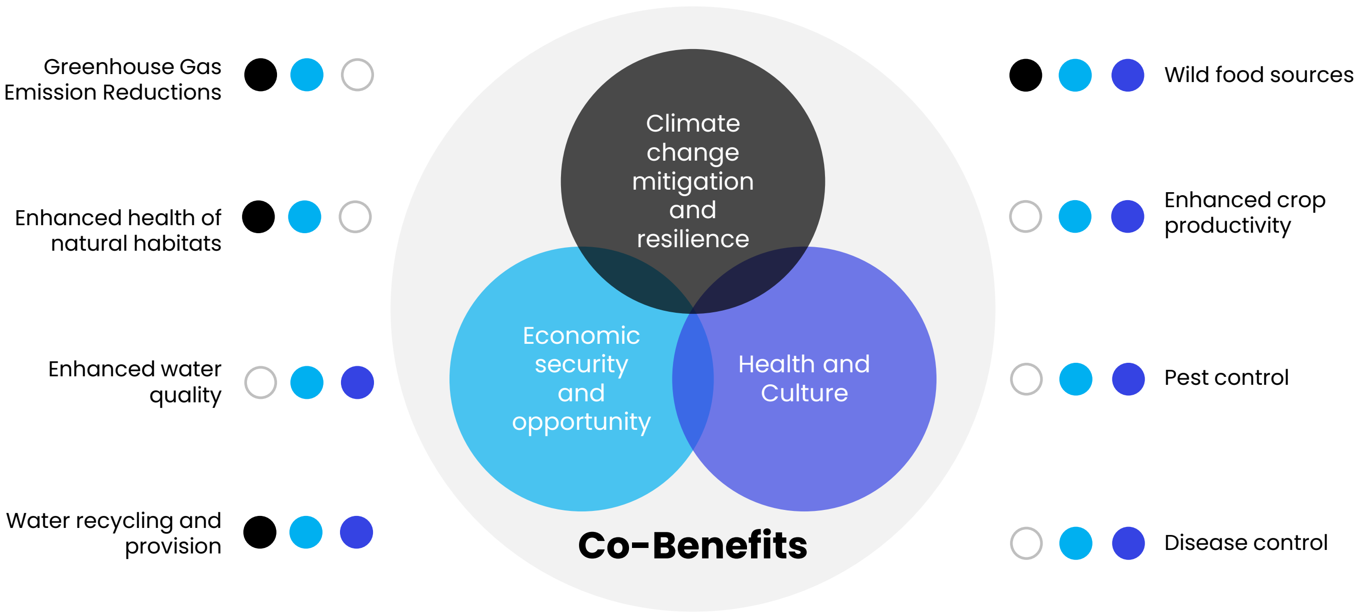
The case for expanding wastewater treatment

The holistic benefits of wastewater treatment.

Investing in wastewater treatment yields significant environmental and social benefits that drastically outweigh the costs.

Wastewater treatment is an essential component of humanity's sustainable co-existence with nature. Without it, we experience health impacts due to waterborne diseases, increased greenhouse gas emissions, disruptions to biological aquatic ecosystems and so much more. A 2015 report by the United Nations Environment Programme (UNEP)[2] explored the economic value of wastewater treatment, assessing the cost of action and the cost of no action. Through analysing peer-reviewed literature on the broad benefits and costs of wastewater, its treatment and impact, it was concluded that wastewater treatment should be invested in, especially in developing countries. The public benefits of wastewater management are both socially desirable and economically rewarding.

The following diagram summarises a non-exhaustive list of co-benefits delivered by wastewater treatment.



Environmental Benefits

Untreated wastewater has been linked to several environmental impacts. When discharged into water supplies it has been linked to increased methane emissions and nitrous oxide[2], whilst also stimulating algae blooms which starve the ecosystem of nutrients[3] and can result in dead zones – areas where very few organisms can survive. Effective wastewater treatment can significantly reduce, and even eliminate discharge of fertilisers and chemicals later discharged into local water supplies, directly addressing the potential environmental costs associated with no action.

Health Benefits

Wastewater treatment has several health benefits. It reduces the burden of disease due to increased drinking water quality, reduces food contamination, reduces waterborne diseases and the financial burden of healthcare.

A study by Grangier et al. (2012)[4] compared the health impacts of wastewater-irrigated agricultural land in the pre-urban area around Aleppo, Syria. Analysing farming communities under similar agroclimatic conditions and farming practices in 12 villages, the study found that the prevalence of waterborne diseases was 75 percent higher in children living in wastewater-irrigated areas. In addition, annual health costs were 73 percent higher per child in wastewater-irrigated areas.

Economic Benefits

Water pollution not only impacts the health of local communities, but also negatively impacts food sources; it reduces fish and shellfish catches and market values, whilst also reducing crop productivity.

Khai and Yabe (2013)[5] conducted a study on the impacts of water pollution of rice cultivation in Vietnam. They surveyed over 300 farmers in two areas in the Mekong River Delta and found that water pollution reduced rice productivity annually by 0.67 tonnes per hectare. This resulted in a total annual economic loss per household of over $100 as a result of the water pollution.

Effective wastewater treatment also creates broader economic benefits. If treated enough to meet local regulatory standards, local communities can benefit from water recycling, either for agriculture or drinking water. This not only reduces pressure on the local freshwater sources but reduces costs of water supply. If treated to the required drinking standard levels, the recycled water may also offer a new source of income.

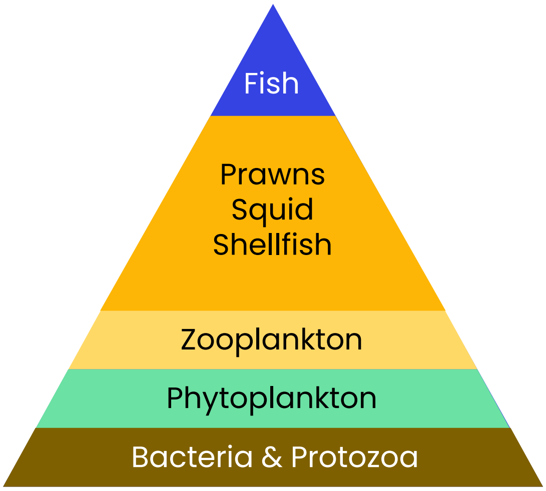
The impact of wastewater on our freshwater sources and oceans.

Wastewater has significant impacts on freshwater habitats and marine life. It must be treated to preserve biodiversity and ensure healthy ecosystems.

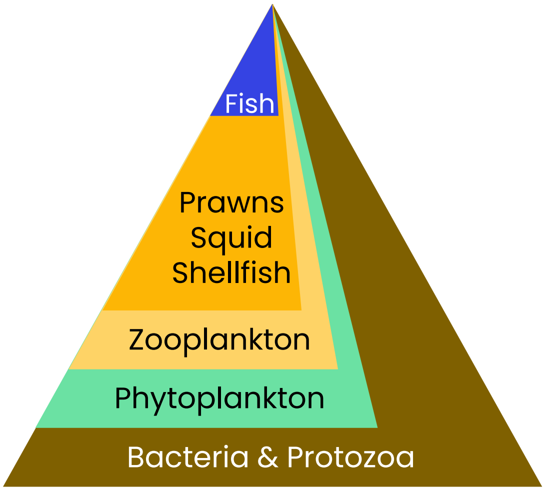
Pollution is having deleterious effects on all parts of aquatic food webs[6]. It causes declines in populations of fish and other aquatic organisms by affecting their survival and ability to reproduce. Fishery declines are occurring amid the perfect storm of habitat destruction, loss of healthy food resources within aquatic food webs, draining and damage to nursery areas, as well as the impacts on water quality caused by pollution and climate change.

Prior to industrialization, the aquatic food web had a healthy abundance of fish, prawns, squid, and shellfish built off a broad base of zooplankton, phytoplankton, bacteria, and protozoa. However, this is no longer the case; the integrity of the post-industrial aquatic food web has been seriously compromised, with fewer and fewer fish at the top, losses of invertebrates in the sediments and water column, losses of marine algae, coral, and other primary producers, as well as the proliferation of bacteria and toxic algae. While overfishing is a key cause of fish stock declines, pollution is having a significant impact on aquatic animal immunity, fertility, development and survivability[6].

As stated by Landos et al[6] in their IPEN report on aquatic pollutants in Oceans and Fisheries, the pre-industrialisation aquatic food web has changed considerably due to increased pollution levels.



Pre-Industrial Aquatic Food Web



Modern Impacted Aquatic Food Web

- Reduced reproductive success
- Reduced food availability
- Reduced habitats
- Fewer fish

Ocean Acidification

The decline in Ocean ecosystem health and biodiversity has broader implications. Phytoplankton contribute at least 50 percent of all oxygen to our atmosphere and capture an estimated 40 percent of all CO2 produced[7]. This is the equivalent to the amount of CO2 captured by 1.70 trillion trees—four Amazon forests' worth[7]. However, Phytoplankton populations have been declining by 1 percent annually[8]. This has significant implications for climate change and ocean acidification. A declining Phytoplankton population reduces the ability of the ocean to sequester excess greenhouse gases in our atmosphere, whilst also further reducing the pH of our oceans and re-enforcing the downward trajectory of Phytoplankton populations.

The oceans have, to date, taken-up around 30% of all anthropogenically produced carbon dioxide[1]. The dissolution of carbon dioxide into surface seawater results in the creation of carbonic acid which in turn reduces the pH of the Oceans. In the 1940's, ocean pH was 8.2, but in 2020, the pH had dropped to 8.04, indicating that the oceans are becoming more acidic[1]. This has had an impact on marine life; most marine life and all plants live in the top 200 m, which is also the most sensitive to climate change and acidification[1]. When the water chemistry becomes more acidic, the ability of the plants and animals to form or maintain their calcium carbonate shell or body structures is affected[9]. Many marine plants and animals have carbonate shells and body structures which are aragonite based, including phytoplankton and coral reefs. Aragonite not only starts to become unstable in ocean surface waters at a pH of 8.04 (2020) but its solubility increases with water depth. At 200 m below the ocean surface aragonite will dissolve completely at pH 8.04[10], and this is referred to as the "dissolution compensation depth". What this means is that the environment for these plants and animals to thrive is gradually reducing because as the ocean surface pH drops, the dissolution compensation depth approaches the surface.

The BIOACID report in 2021[11] stated that:

(i) mineral forms of calcium carbonate have started to dissolve;

(ii) Ocean pH was predicted to drop to 7.98 in less than 25 years; and

(iii) 30 to 50% of all molluscs, echinoderms and calcified macro-algae will be negatively affected.

The IPCC[11] states that at pH 7.98 half of all remaining carbonate-based marine life will be negatively impacted and an Ocean pH of 7.95 will have more serious consequences. The same report forecasts that by 2045, pH will drop to 7.95. If this becomes reality, an ecological cascade effects will occur; Phytoplankton populations will collapse, resulting in the entire food web that relies on them also collapsing. At this tipping point, climate change will become uncontrollable and it is estimated that 80% to 90% of all remaining marine life will be lost[1].

Given the time criticality and impact Ocean Acidification poses to our planet and our future, it must be a priority focus for climate action. Wastewater treatment offers an effective measure to address this threat, mitigate climate change, whilst also offering benefits far beyond just environmental.

Reducing pollution would enable marine life to naturally regenerate, which in turn will sequester significant amounts of carbon and gradually restore marine populations to pre-industrial levels.

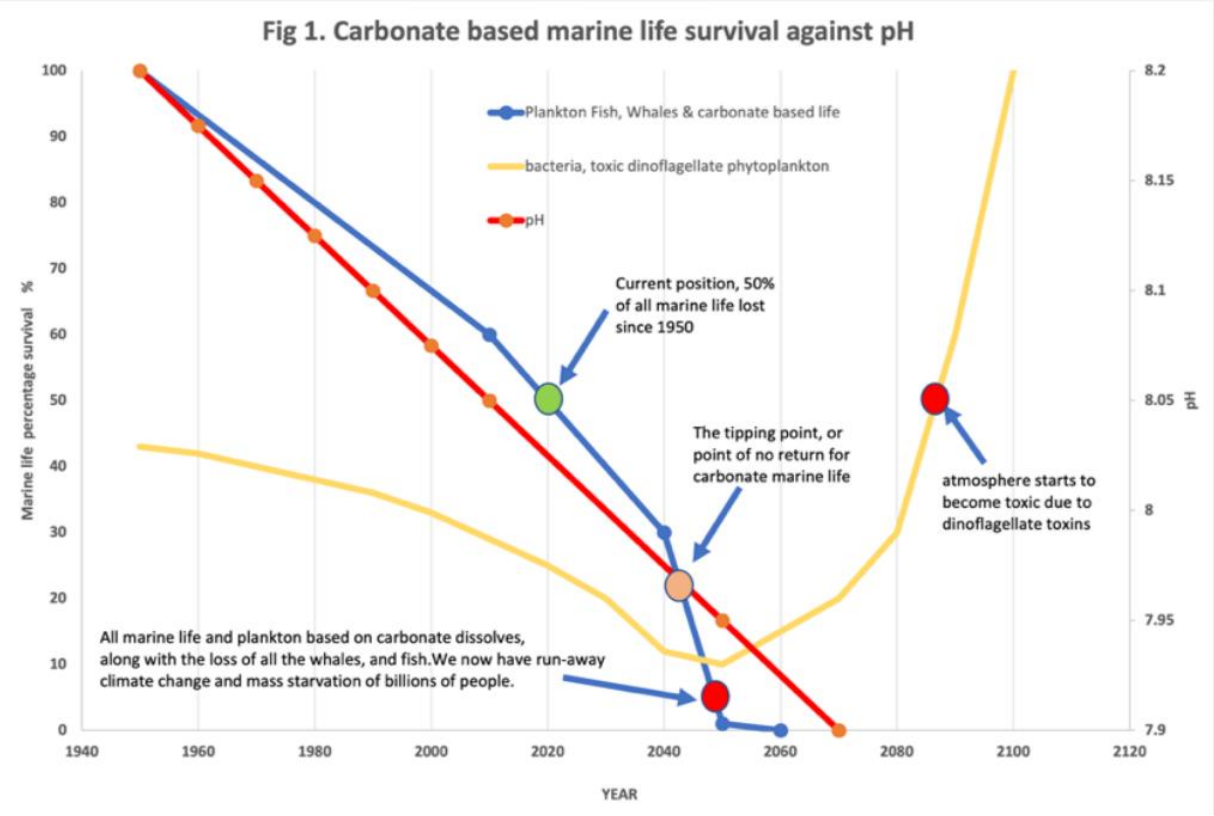


Fig 1. Carbonate based marine life survival against pH

The inequality of wastewater treatment distribution.

With only 8 percent of the required capacity to treat wastewater effectively[2], low-income countries are the hardest hit by contaminated water supplies.

At present, only 20 percent of global wastewater is being treated, of which the majority is in developed countries. The impacts of wastewater on health, the environment and economic activity disproportionally affect the low income countries and local communities. Challenges associated with sewage infrastructure and the distribution of communities has resulted in wastewater treatment investment being under funded, particularly for rural communities. As a result, these communities typically discharge their wastewater directly into local water sources or on agricultural land. Both of these approaches generate significant health and environmental costs; according to the 2014 Economics of Sanitation Initiative, the global economic losses associated with inadequate water supply and sanitation are estimated at US$260 billion annually[12].

Due to the costs associated with sewage infrastructure and large scale treatment plants, there is a need to develop decentralised wastewater treatment plants that can support entire communities (ranging from 500 to over 10,000 people) without the need for extensive sewage infrastructure. This will offer the most cost effective solution that is capable of being implemented at pace.

2.

Financing wastewater treatment plants

The conventional approach.

Existing approaches to financing wastewater treatment plants are not suitable for rural communities and are unable to support deployment at the pace required.

According to the World Bank, in 2007-2017 global spending on water and sewerage projects exceeded $22 billion, with 84% of investments in wastewater treatment being in greenfield projects[13]. ESFC Investment Group states that the average cost for the construction of a wastewater treatment plant was $16 million in 2014, and in 2017 this figure quadrupled, reaching $64 million for a medium-sized facility[14].

Medium and large scale wastewater treatment plants are typically financed either through public funding, public-private initiatives, or through private investment. The challenge with rural-based wastewater treatment plants is that they do not offer substantial returns for private investment given there limited size; rural communities typically need wastewater treatment plants capable of supporting a maximum of 10,000 individuals. This, alongside the high conventional costs for plant construction, means that wastewater treatment in rural communities, particularly in developing countries, has been under funded.

An alternative approach to financing rural wastewater treatment plants is required. One that offers alternative sources of income and attracts a new set of financiers. Based on open-source aerobic wastewater treatment plant designs, treatment plants capable of supporting 10,000 people can be constructed for less than $2 million. A single four lagoon system that uses natural processes has the potential to offer effective wastewater treatment at a fraction of the cost. The methodology proposed in this document has the potential to bring climate finance into the water and sewage sector, changing the dynamic of wastewater treatment finance.

Using nature throughout the process.

Wastewater treatment is best managed through natural processes without the use of chemicals.

Natural processes exist that should be harnessed to manage wastewater. Doing so will not only be more cost effective, but also reduce the environmental footprint of wastewater treatment i.e. by eliminating the use of chemicals to enhance the removals of suspended and dissolved solids. Through the use of at least four connected ponds or lagoons, there is an ability to treat the wastewater purely through natural processes through the increase in the species diversity of bacteria and other organisms in the water.

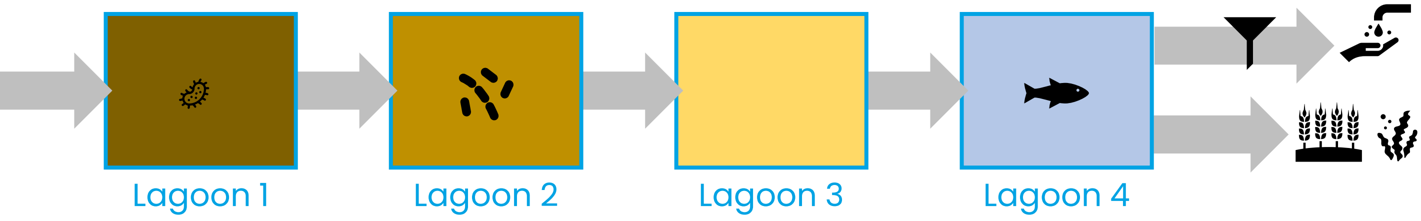
Lagoon 1: This will consist of high concentrations of ammonia and organic matter. When aerobically treated by bacteria, the water will be ready to enter the second lagoon within 4 days.

Lagoon 2: By this stage the lagoon water will appear light brown in colour and the bacteria will be forming large stable bacterial floc. The concentration of protozoan, rotifers and many other organisms will become established. The wastewater will have been digested and converted into bacterium cell biomass.

Lagoon 3: Water entering this lagoon will have a low Biochemical Oxidation Demand (BOD) and ammonium level, but a high concentration of solids in the form of bacteria and, both singled celled and small, multi-cellular organisms. The organisms now have no food to eat, so they start attacking and eating each other. This is called endogenous respiration, and the bacterial cell biomass and other organics are converted to water, carbon dioxide and nitrogen gas - meaning no sludge is produced that would then require expensive transport or disposal.

Lagoon 4: By this stage the water in the lagoon will be of sufficient quality to permit the cultivation of fish such as tilapia. These fish are not for human consumption as there may be some toxins and plastic in the fish, so they are left to breed and to produce juveniles. These will be harvested from the system and transferred, as required, to the aquaculture part of the process.

After lagoon 4, the water can be discharged into the environment at zero impact, used for irrigation or aquaculture / aquaponics, or filtered and chlorinated for consumption.



3.

A new approach to funding wastewater treatment plants

Our approach.

SOCIALCARBON is proposing a new methodology to quantify the environmental and social benefits achieved through aerobic wastewater treatment.

There is a clear need to scale wastewater treatment plant investments in rural communities. An innovative new approach is required to overcome the existing investment barriers preventing action. The proposed methodology has been designed to fill this gap in a flexible manner, facilitating the creation of two types of environmental asset depending on the geographic location of the rural community.

Eligible project areas

Projects shall quantify the emission reductions achieved through avoided disposal of wastewater into local water sources. This will be eligible for communities that dispose of their wastewater into rivers, lakes, reservoirs, or wetlands, which as a result will result in anaerobic decomposition and methane emissions. In these scenarios projects will be able to generate carbon credits.

Coastal communities that dispose of their wastewater into the ocean will not be able to generate carbon credits. This is because the wastewater is not expected to decompose anaerobically, thus not generate methane emissions. Under this scenario, the project will only be able to generate SOCIALCARBON payment for ecosystem services units. These assets will not be eligible for use for carbon offsetting.

Embedding local communities

Local communities must be embedded into the implementation and management of the wastewater treatment plant. It is expected that the plant will generate a small, but important number of jobs in the community to maintain the plant whilst operational.

Inclusion of local stakeholders will also incentivise the enhancement of the treatment plants for wider use and benefits; if managed appropriately the treatment plants can be used for aquaponics, aquaculture or further filtered for drinking water. These broader uses of the treatment plants offers additional income generation opportunities for the community and will increase climate resilience.

Additionality

Additionality will be determined on a project method basis. Projects will need to demonstrate that the project meets all the requirements for additionality applied by the CDM Additionality assessment.

Conservative estimates

The carbon reductions quantified under this methodology will be extremely conservative and likely multiple factors less than the real emission reductions achieved by a project. Chemical and organic pollution have significant negative impacts on natural habitats which have corresponding emissions. However, at present it is not possible to quantify the direct emission reductions achieved through avoided degradation of natural ecosystems resulting from wastewater treatment.

Scenario-based environmental assets

Projects utilising this methodology will be eligible to generate different environmental assets dependent on their geographic location and baseline disposal of wastewater.

- **Carbon credits** – these can be created when wastewater is disposed of in local water sources other than oceans. As per other SOCIALCARBON methodologies, SOCIALCARBON Units can be generated based on emission reductions. These can be used for carbon offsetting purposes.

- **Payment for ecosystem services units** – these can be created when wastewater is disposed of direct into oceans. The value of these units are based on the broader co-benefits of the project, including but not limited to forecasted health and economic benefits.

This hybrid approach will facilitate the implementation of projects across a range of geographic regions, ensuring coastal communities are not excluded from project financing.

Accessing upfront funding.

Wastewater treatment requires upfront investment to be implemented.

The set up costs requires to implement wastewater treatment plants means that upfront funding is required. Working with our technology provider Biodiversity & Ecosystem Futures and their new fundraising instrument Green Impact Units, projects will be able to access the funding needed and in exchange share 100 percent of the environmental assets generated by the project with funders. The following example outlines how this would work in practice.

Example

Investment required to build and run the plant for 21 years: $1,400,000

Size of community: 10,000 individuals

Estimated annual emission reductions: 4,000 tCO2e

Duration of project: 21 years

1. Sell 84,000 Green Impact Units, each valued at $16.66. Set the funder allocation rate to 100% so they receive all environmental assets generated.

   Note: this is calculated by dividing the investment required by the total estimated number of environmental assets to be generated over a 21 year period (84,000).

2. Develop the wastewater treatment plant and begin monitoring the environmental benefits.

3. Each year, monitor the environmental benefits of the project and issue the environmental assets (4,000). All of these environmental assets will be automatically transferred to the funders who can then offset their own environmental footprint.

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