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An Augmented Approach to Sustainable Financing in an Indian Road Project

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Abstract

This paper aims to provide an alternative approach to sustainably finance a 65 km road project in Karnataka, India. As per the reports, a total of 30,000 trees is being cut down to accomplish this project. Studies have stated that a mature tree can produce approximately 118 kg of oxygen in one year. Using this data, loss in oxygen from the affected area is estimated and provided in this paper. NASA earth observatory claimed that 70% of earth's oxygen is produced by phytoplankton present in the ocean. Mathematical calculations carried out in this research reported that Phytoplankton produces 133.34% more oxygen than trees. Considering previous studies and observations construction of six phytoplankton ponds, one after every 10 km is proposed in the paper. This article also provides a list of materials required to produce phytoplankton along with pricing of each product. Moreover, a comparison between forest plantation (30,000 trees) and construction of six phytoplankton ponds is carried out. As, this comparison involves graphical representation reflecting the amount of O_2 produced by trees and phytoplankton, it also provided an overview of funds required for forest plantation and constructing six phytoplankton ponds. Considering every essential factor and material requirement, a financing report is an important asset of this research.

Keywords: Phytoplankton, Green Bonds and Sustainable Financing (SF)

1. Introduction

In the past few years, sustainability has become the spotlight for researchers as it is a medium that enables overall financial and environmental development without harming natural resources. The entire globe is currently facing the problem of intense climate change, which is causing severe damage to environment. Consequences of climate change involves high intensity storms, floods and excessively hot winds which are causing melting of some important glaciers. Some significant findings such as IPCC 2018, IPCC 2019a and IPCC 2019b have reported increase in temperature by 1.5^{o}C above preindustrial levels, and intense climate change enveloping the land and ocean area, respectively. Apart from outlining the effects of climate change across the globe, these reports (UNFCCC 2015) also states that some particular sectors are immensely contributing into the reduction of global warming by minimizing temperature up to 2^{o}C.

According to the article 2.2(c), Chenet et al. 2019 and Whitley et al. 2018, it is reported that the finance sector has been emerged as an important sector in dealing with the implementation of a zero-carbon transition. Moreover, as stated in United Nations 2015a and UNFCCC 2018, a total of US$100 billion is estimated to fulfil Paris Climate Agreement as well as UN 2030 Sustainable Development Agenda. Climate policy Initiative 2018 reported that a total funding of US$ 2 – 3.6 trillion every year starting from 2020 till 2050, is required to limit the temperature rise below 1.5^{o}C in order to mitigate climate change. These data numbers implies that more efforts might be required to overcome this global problem, and current investment would not suffice to perform necessary tasks in the road of mitigating climate change.

As per the data provided by Son and Louati 2016, and Louati et al. 2018, air pollution is an issue of concern in every country as it affects the lives of many peoples every year. Moreover, WHO also reported that more than 25% of deaths can be directly associated with air pollution. In 2015, more than 35% of deaths recorded in Asia was due to extremely poor quality of air. City areas are more affected by air pollution when compared to small towns. India specifically is typically suffering from air pollution. As stated by Guttikunda et al. 2019, out of 640 districts in India, 173 districts crossed the yearly standard value of 40 $\mu g/m^3$ in 1998. Whereas, this number reached to a total of 288 districts by 2010. A report from the World Health Organization in 2019 claimed that among the top 10 cities, there are nine Indian cities which have extremely harmful air quality indexes. Table 1 below shows top 10 Indian cities with highest level of AQI as of December 2021.

Table 1. Air Quality Index of 10 Indian Cities

CITY	US AQI
Kanpur, Uttar Pradesh	550
Jaunpur, Uttar Pradesh	503
Varanasi, Uttar Pradesh	498
Nanpara, Uttar Pradesh	495
Ghatampur, Uttar Pradesh	493
Faridabad, Haryana	446
Gurugram, Haryana	446
Noida, Uttar Pradesh	446
Sitapur, Uttar Pradesh	446
Chakapara, West Bengal	442

Source: iqair.com

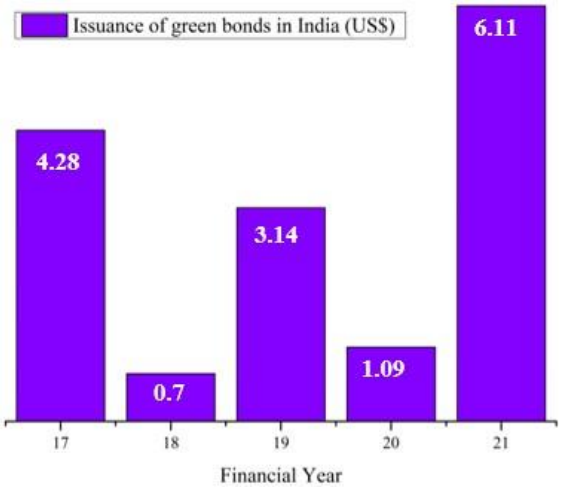
It is widely known that air pollution increases when concentration of various harmful gases such as nitrogen oxide, carbon dioxide, and carbon mono oxide etc, increases in the atmosphere. These gases are often emitted by industries, automobiles and airplanes. An increase in amount of carbon dioxide in earth's atmosphere results in a decrease in air quality. While presence of these gases in the atmosphere leads to air pollution, reduction in oxygen levels from air is equally responsible for poor air quality in a particular area. In today's world it is extremely necessary that every major or minor investment should be carried out sustainably. The term used for such type of financing which does not involve degradation of environment, is "Sustainable Financing (SF)". While other countries such as Japan, US and Indonesia are finding solutions to implement SF in various projects across the country (Setyowati 2020; Schumacher et al. 2020), it is still an issue of concern for India. In this paper, we have tried to provide feasible solution to bring sustainable financing by considering a case of 65 km road project which involves immense deforestation.

2. Literature Review and Methodology

It is widely known that every road or railway project involves clearing of enormous amount of land. This clearing process mostly includes cutting down of trees. Tress not only emit oxygen in atmosphere, but also absorbs ample amount of carbon dioxide. When a tree is cut down, carbon dioxide (CO_2) stored in that tree is disposed into the atmosphere, which as a result may leads to increase in CO_2 levels and this process of emission of CO_2 is known as "sequestration". This road project involved enormous deforestation of 30,000 trees in western ghats. (Bangalore mirror/Times of India). Studies have reported that, while an average mature tree can produce nearly 260 pounds (~118 kg) of oxygen in one year, it can absorb 48 pounds (21.7724 kg) of CO_2 annually. Two of these trees can provide ample amount of lifetime oxygen for a family with four members. Considering the above details, we can estimate the enormous amount of loss in oxygen level in atmosphere due to cutting of 30,000 trees. Therefore, a term named

"green bonds" is introduced in each country to financial support these types of projects. The funding amount present in green bonds is often used to take necessary measures in order to compensate for any environmental loss which is faced while accomplishing the project. As India stands at number three when it comes to world's largest CO_2 emitter, huge volumes of green bonds were issued in India in last five years. As per the reports of GBTA (green bond tracking agency) – U.K, a total of US$6.11 billion is issued in India in 2021. Fig. 1 provides green bond issuance details from Financial Year (FY') 20172021, in India.

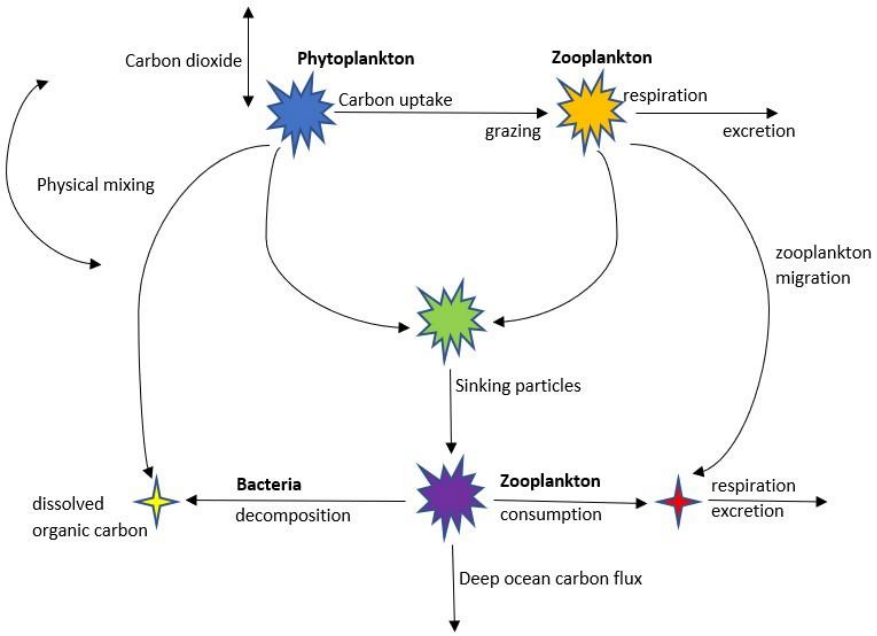
Fig. 1 Green bond issuance in India from FY 2017-21



Source: spglobal.com

Lindsey et al. 2010, from NASA earth observatory claimed that phytoplankton present in oceans are responsible for the 70% of earth's oxygen. It is also reported that every second human being inhales oxygen which is produced by phytoplankton. These are generally microscopic organisms which can survive in both salty and fresh water environment. Similar to plants, phytoplankton also absorbs sunlight with the help of chlorophyll inherited in them and produces chemical energy using the process of photosynthesis. The amount of carbon dioxide consumed by Phytoplankton is equal to the carbon dioxide consumed by land plants. Upon the death of phytoplankton while some carbon moves deep into the ocean, remaining carbon is distributed in different layer of the ocean. A detailed schematic of the cycle is given in fig. 2.

Fig. 2 Schematic of Carbon Cycle

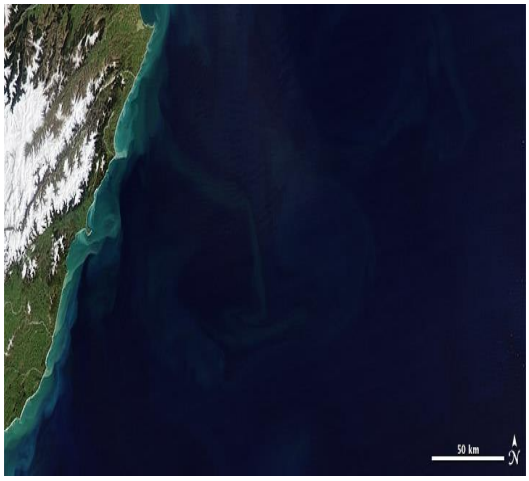


Source: NASA Earth's Observatory

Growth of phytoplankton depends on various factors such as carbon dioxide, appropriate nutrients and sunlight. The nutrients required phytoplankton to grow involves silicate, phosphate, nitrate and calcium. These are the same nutrients which are required by a normal land plant to grow. It is also reported by NASA, that some phytoplankton can even fix the concentration of nitrogen. Figure 3 and 4 shows the growth of phytoplankton on the east of New Zealand from date 11th October, 2009 to 25th October, 2009.

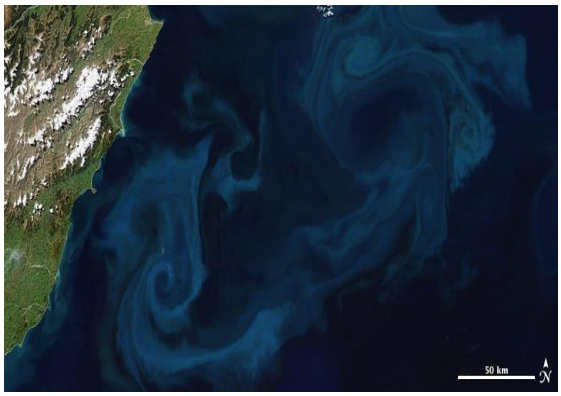
In this paper, we have tried to provide a feasible solution to sustainably finance a 65 Km of road project by introducing six phytoplankton ponds, one after every 10 Km. Funds from green bond can be effectively utilized in the manufacturing of these ponds. Requirement of materials for the construction of phytoplankton along with the price of each material (in INR) are explained in detail in this article.

Fig. 3 East of New Zealand on 11th October, 2009



Source: Lindsey et al. 2010, NASA earth observatory

Fig. 4 Growth of Phytoplankton on 25th October, 2009



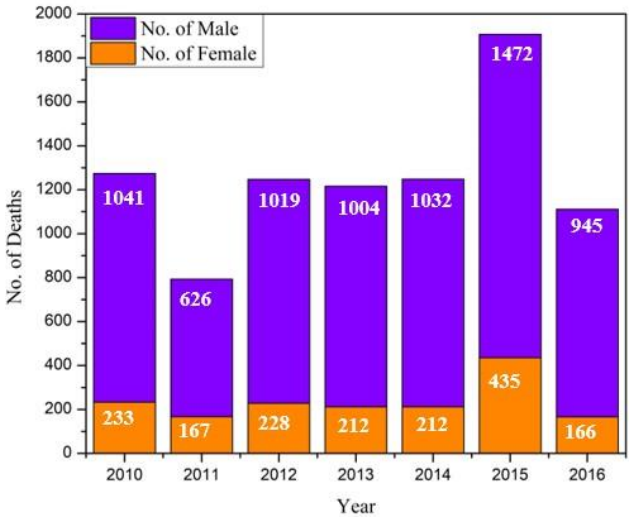
Source: Lindsey et al. 2010, NASA earth observatory

3. Results and Discussion

According to the reports, 30,000 trees was cut down in this road project and a mature tree produces approximately 118 kg O_2 per year. This implies that 30,000 trees will produce 35.4 x 10^5 kg oxygen per year. This amount of loss in oxygen from atmosphere can cause severe damage to the deforested and its nearby area as it may leads to increase in local temperature when compared to initial conditions. This increase in temperature and reduction in oxygen levels can cause serious health related illnesses which may further leads to deaths. Fig. 5 shows number of deaths in India due to heat related illness from 2010 to 2016. It was observed that death percentage of female is less as compared to that of male. This is due to more exposure of males to the sun when compared to females. In order to compensate for the environmental loss, government bodies are funding various forest plantation projects. Studies have reported that it

takes nearly 10 years for a tree to get mature and deliver the same amount of oxygen (~118 kg/year). However, researchers are untiringly aiming to provide more financially efficient and less time consuming solution in order to mitigate harmful effects of climate change.

Fig. 5 Death count of male and female in India from 2010-2016



Source: NDMA, New Delhi, India

This paper provides an alternative approach by sustanably financing a road project by introducing six phytoplankton ponds in an entire 65 km highway span, one after every 10 km. After scrutinizing every aspect of this proposal, it was decided that each pond will be rectangular in shape with dimensions 10m x 10m x 5m, which will accomodate 10^5 litres of water. Production of phytoplankton is the most important factor in this research as its production is more financially feasible when compared to forest plantation. Materials required to develop phytoplankton are: LED light, On/Off timer switch for lights, air pump, flexible airline tubing, rigid airline tubing, multi-outlet airline splitter/valve, salt mix, fertilizer f/2 formula and phytoplankton starter culture. Significance of every listed material/product along with required quantity and price (INR) are provided in detail. Quantity requirement of each material/product is decided on the basis of excessive numerical analysis and approximations (Jones et al. 1998).

A. LED Light bulb

To carry out the photosynthesis process, it is highly recommended to use to white light as it produces extremely strong outputs in red and blue wavelength. For the production of phytoplankton, a total of 20 pieces of 100W high bay lights will be required. Table 2 shows the requirement of bulbs along with estimated amount.

Table 2. Pricing and requirement details of light source

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
100-Watt led light bulb	20	38,000 INR (10 pieces)	76,000 INR

B. On/Off timer switch.

These switches are required in order to save the man power and electricity. Coding can be done manually for each switch which will provide the provision to set a desired working time of each switch. Table 3 provides the requirement details of the same. *Table 3. Pricing and requirement details of timer switch*

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
On/Off timer switch	20	650 INR/piece	13,000 INR

C. Industrial Air Pump

This air pump will push air into the pond using mechanical energy. Air forced into the water will develop bubbling phenomenon which will result into providing appropriate amount of oxygen in the water. This added oxygen will create ambient conditions for the production of phytoplankton. Product details are given in the table 4 below. *Table 4. Pricing and requirement of air pump*

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Heavy duty industrial air pump	3	15000 INR/piece	45,000 INR

D. Flexible Airline Tubing

These types of tubes are especially designed to transfer industrial water, cooling water, sewage, etc. These tubes will be served in this project for the purpose of transferring water and other liquid materials, as composition of flexible airline tubing consists of rubber PVC, and other reinforced materials which increases its stress holding capacity. Details of the required product is provided in table 5.

Table 5: Pricing and requirement of flexible tubing

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Flexible airline tubing	~40 meter	550 INR/meter	22,000 INR

E. Rigid Airline Tubing

This will be used in that stage of phytoplankton production which will involve the transfer of hight pressure air from the pump into the pond. These tubes have high tensile strength and are specially designed for industrial air pumps. Quantity requirement along with pricing is given in table 6.

Table 6: Pricing and requirement of rigid tubing

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Rigid airline tubing	~40 meter	400 INR/meter	16,000 INR

F. Stainless Steel Multi-Outlet Splitter Valve

This product is used to evenly spread the air into the pond. Specifically, a stainless-steel air pump tube splitter with regulatory valve and 18-way outlets would be an ideal product as per the project requirement. This product is chosen on the basis of its high tensile strength and stress bearing capacity. Product details and its pricing is provided in the table 7. *Table 7: Pricing and requirement of splitter valve*

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Stainless steel 18-way outlet air valve	5	1200 INR/piece	6,000 INR

G. Salt Mix

In order to support the phytoplankton culture and its growth, salt mix is added into the water. This salt promotes the growth of algae and bacteria which is the backbone of a phytoplankton. Product details are given in table 8.

Table 8: Pricing and requirement of salt mix

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Bacterial salt mix	~50 Kg/pond	700 INR/Kg	2,10,000 INR

H. Fertilizer f/2 formula

It is the most important and expensive material among the others. This formula is green in colour and develops ambient conditions for effective production/growth of phytoplankton. As per the standard usage, only 3 ml of f/2 formula should be dissolved in 2 litres of water in order to achieve efficient results. Calculations were carried out according to the required amount of water and it was observed that 750 litre of f/2 formula is required for the construction of one pond. Quantity requirement of f/2 fertilizer is given in table 9. *Table 9: Pricing and requirement of f/2 formula*

Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
f/2 formula	750 liters/pond	1500 INR/liter	67,50,000

I. Phytoplankton Starter Culture

Starter culture provides appropriate amount of nutrients, vitamins, phosphates, and silicates which are essential for the production and growth of phytoplankton. The one which can be used in this project is "Bioplankto". One litre of starter culture can be effectively used in 100 m^3 of water. Details of the same is provided in table 10.

Table 10: Pricing and requirement of phytoplankton starter culture

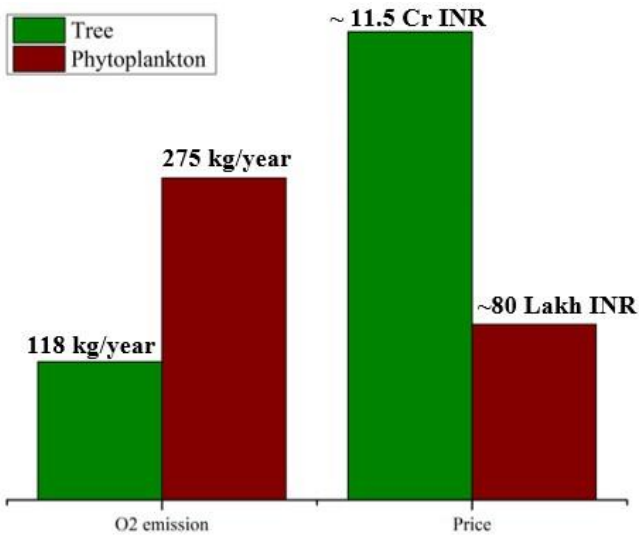
Product Type	Total Quantity Required	Price (INR)	Total Price (INR)
Plankton starter culture	5 liters/pond	540 INR/liter	16,200

Totalling the entire amount, it is found that a 71,54,200 INR will be required for the construction of six phytoplankton ponds. Presence of these ponds will surely compensate for the oxygen loss caused due to excessive deforestation. Further calculations showed that approximately 80 lakh INR (including labour cost, land cost, electricity charges, maintenance cost and other miscellaneous charges) will be required for the constuction of six phytoplankton ponds.

3.1 Comparison Analysis

According to NASA earth observatory, ocean phytoplankton is the source of 70% of earth's oxygen. This implies that the composition of 100 kg atmospheric oxygen will consist of 70 kg phytoplankton oxygen and 30 kg tree oxygen. On carrying out mathematical analysis of this data, it was found that phytoplankton can produce 133.34 % more oxygen when compared to trees. While it requires approximately 37 acres of land the plantation of 30,000 trees, only 0.24 acre of land will be required to accommodate six phytoplankton ponds. Moreover, the price of per acre agricultural land is nearly 30 lakh INR which reflects that total cost of land for forest plantation will be extremely high when compared to land cost for the construction of ponds. A detailed comparison of O2 emission from trees and phytoplankton along with price analysis for the construction of phytoplankton ponds and forest plantation is given in fig. 6. It was observed that while a mature tree can produce 118 kg oxygen in an year, this value can rise upto 275 kg in case of phytoplankton. Moreover, fig. 6 shows that cost for the construction of six phytoplankton ponds is approximately 93 % less cost consuming than forest plantation. Therefore, based on entire analysis, it was found that the solution provided in this research against forest plantation is more financially and sustainably feasible.

Fig. 6 Comparison of O2 emission and fund requirement for phytoplankton pond and forest plantation



4. Conclusion

This paper provides an unique approach to sustainably financing an Indian road project by introducing phytoplankton ponds. This research considered a 65 km road project in Karnataka, India which involved cutting down of approximately 30,000 trees in the western ghats. Graphical representation of green bonds issuance rate in India from year 2017 to 2021 and number of deaths due to heat related illness from year 2010-16 was also studied in this paper.

It was noticed that the death count of males are extremely higher when compared to that of females. It was also seen that India issued an enormous amount of 6.11 billion US$ as green bonds to support sustainable financing. Green bonds are used to provide financial supports to compensate for the environmental loss caused due to similar type of road/rail projects which involves excessive deforestation. This paper also provided a financial report which shows list of materials and total funding required for the construction of six phytoplankton ponds. Moreover, a detailed comparison between trees and phytoplankton is carried out on the basis of their O_2 emission and investment costs which showed that the construction of six phytoplankton ponds are more ecnonomically and sustainably feasible when compared to forest plantation.

References

Bangaloremirror.indiatimes.com/bangalore/cover-story/more-than-30000-trees-will-be-axedfor-65-km-road-between-chikkamagaluru-dakshina-kannada-is-it-ecologicaldisaster/articleshow/55588569.cms

Chenet, H., Zamarioli, L., Kretschmer, B., & Narvaez, R. (2019). From Transformational Climate Finance to Transforming the Financial System for Climate. Deliverable D4. 3a. COP21 RIPPLES Project (Horizon2020).

Guttikunda, S. K., Nishadh, K. A., & Jawahar, P. (2019). Air pollution knowledge assessments (APnA) for 20 Indian cities. Urban Climate, 27, 124-141.

IPCC. 2018. IPCC Special Report: Global Warming of 1.5°C. Geneva: Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf.

IPCC. 2019a. Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas Fluxes in Terrestrial Ecosystems. Geneva: Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/2019/08/Fullreport-1.pdf.

IPCC. 2019b. Special Report on the Ocean and Cryosphere in a Changing Climate. Geneva: Intergovernmental Panel on Climate Change. https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/SROCC_FinalDraft_FullReport.pdf

Iqair.com/Air-Quality-Index/India/top-10-cities/

Jones, R. I. (1998). Phytoplankton, primary production and nutrient cycling. In Aquatic humic substances (pp. 145-175). Springer, Berlin, Heidelberg.

Schumacher, K., Chenet, H., & Volz, U. (2020). Sustainable finance in Japan. Journal of Sustainable Finance & Investment, 10(2), 213-246.

Lindsey, R., Scott, M., & Simmon, R. (2010). What are phytoplankton? NASA Earth observatory.

Louati, A., Son, L. H., & Chabchoub, H. (2019). Smart routing for municipal solid waste collection: a heuristic approach. Journal of ambient intelligence and humanized computing, 10(5), 1865-1884.

Setyowati, A. B. (2020). Governing sustainable finance: insights from Indonesia. Climate Policy, 1-14.

Louati, A. (2016). Modeling municipal solid waste collection: A generalized vehicle routing model with multiple transfer stations, gather sites and inhomogeneous vehicles in time windows. Waste Management, 52, 34-49.

UNFCCC. 2015. The Paris Agreement. Bonn: United Nations Framework Convention on Climate Change. https://unfccc.int/process-and-meetings/the-paris-agreement/the-parisagreement.

UNFCCC. 2018. UNFCCC Standing Committee on Finance: 2018 Biennial Assessment and Overview of Climate Finance Flows: Technical Report. Geneva. https://unfccc.int/sites/default/ files/resource/2018 BA Technical Report Final Feb 2019.pdf.

United Nations. 2015a. The 2030 Agenda for Sustainable Development. New York, USA. https:// sustainabledevelopment.un.org/content/documents/21252030 Agenda for Sustainable Development web.pdf.

Whitley, S., Thwaites, J., Wright, H., & Ott, C. (2018). Making finance consistent with climate goals: insights for operationalising Article 2.1 c of the UNFCCC Paris Agreement.

Making finance consistent with climate goals: insights for operationalising Article 2.1 c of the UNFCCC Paris Agreement.