TITLE: Implementation of Green Credit System

Forest cover is known to reduce AQI. Trees use Carbon to grow, and they break down the CO2 to take the carbon from it for their own growth. This gives us oxygen in return.

Different trees are better for different climates, hence different forest types would need different trees to offset the same amount of carbon.

Within every forest type, certain trees are better than others at consuming CO2. These types of trees must be identified for each region of the country.

The topic is chosen as recently, the government has announced a plan for green credit system which it aims to implement to create market based mechanisms for climate change[17]. This scheme falls under many national and global targets, such as LiFE program, 30 by 30 and Net Zero by 2070.

Objective:

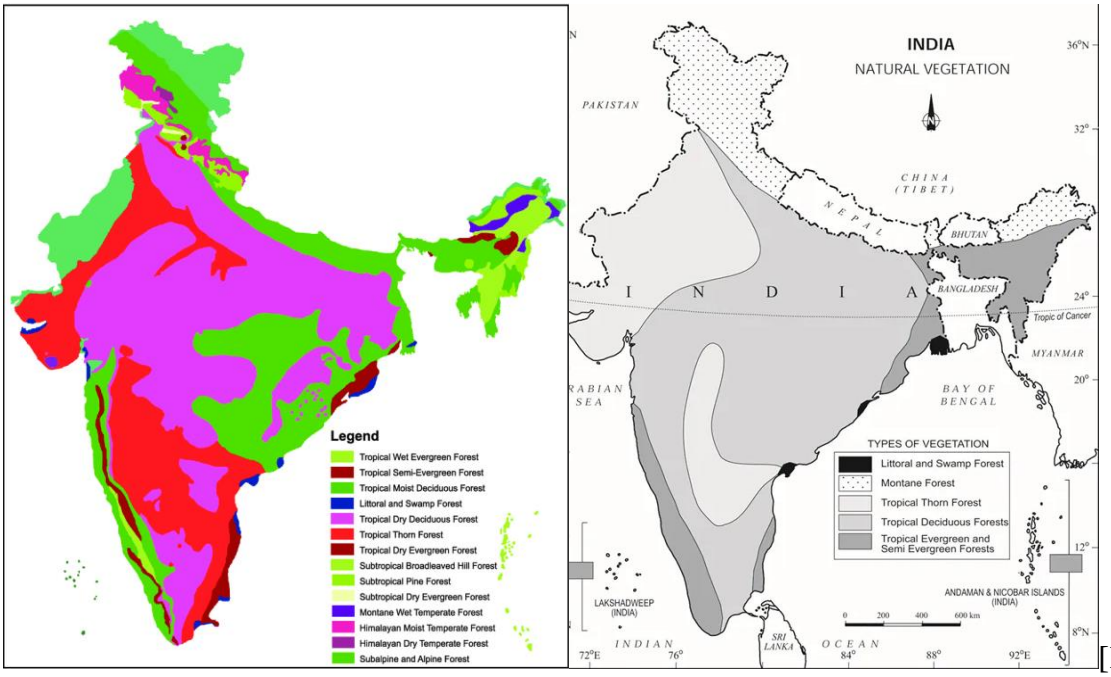
To hypothesize how the "Green Credit System" would work in practice through the specific case of carbon offsetting in Delhi by increasing forest cover.

Research Question:

How much does forest cover reduce carbon emission in empirical terms?

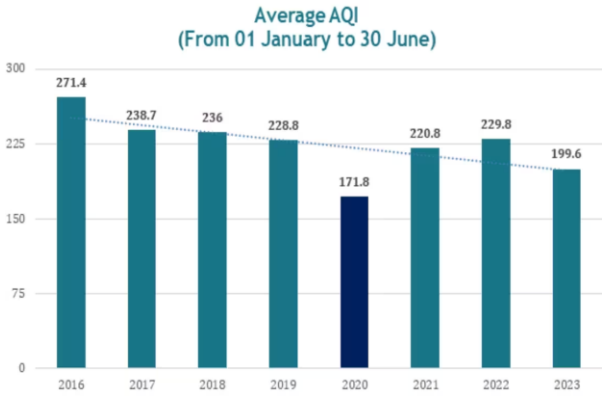
Literature Review:

Bharat is a land of many forests and climates. In different climates, different types of trees thrive and work differently when it comes to reducing carbon. The more efficient a tree's growth the more carbon it will offset. Therefore, it is important to consider the climate and the vegetation type of an area before proceeding with a plan to plant trees to offset carbon.



[Map 1 and 2]

This research would require us to select an area to study. Delhi is a Tropical Thorn Forest, and this is common to several parts of the country such as haryana, rajasthan, gujarat, karnataka, etc. Trees such as Oak trees, Neem trees, etc are the best for this climate.
Bharat has the third largest increase rate of forest cover in the world after China and Australia. Within this growth, it would be poignant to know which trees were planted the most to facilitate their growth, how much increase in each tree type was created and how much AQI did this offset.

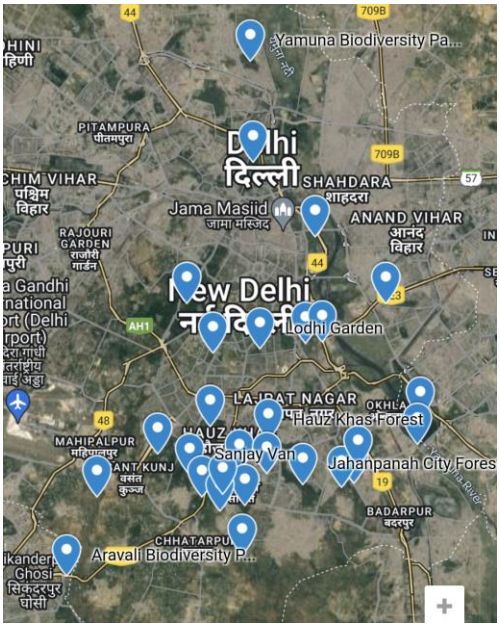


Delhi has also seen improvement in AQI in the past 8-10 years. How much of this can be directly correlated with an increase in forest cover is also interesting.

Delhi has 30 Green Zones. These Green Zones include:

- Lodhi Garden
- Nehru Park
- Jahanpanah City Forest
- Tughlakabad Diversity Park
- Sanjay Lake
- Sanjay Van
- Rajghat - Shanti Van - Shakti Sthal
- Hauz Khas Forest
- Buddha Jayanti Park
- Deer Park
- Sunder Nursery
- Aravalli Biodiversity Park (Gurugram)
- Mehrauli Archaeological Park
- Aravalli Biodiversity Park, Vasant Kunj
- Vijay Mandal Park
- Hauz Rani Forest
- Garden of 5 Senses
- Tilpat Valley Biodiversity Park
- Mangar Bani Forest
- Millenium Park
- Satpula Park

- Lado Sarai Forest
- Mahavir Vanasthali
- Rajokri Forest
- Yamuna Biodiversity Park
- Okhla Bird Sanctuary
- Kamala Nehru Ridge
- Green Vibes Farm
- Vasant Kunj Park
- Kalindi Biodiversity Park [4]



(Link to map: https://www.google.com/maps/d/u/0/edit?mid=142eswfLibYMtYUJ-d6at_oC7FjAneBg&usp=sharing)

Most of these systematic forests are concentrated in South and Central Delhi, with lesser focus and attention paid to the other and more industrial areas of the Delhi UT.

Within Delhi's forests, there is a predominance of Thorn Forests (Group 6). Yet, in some parts we see Tropical Dry Deciduous Forests (Group 5) as well [5]. In Map 1, we can see them in Red and Purple, respectively. The third type of forest in Delhi is Plantation Forest [5].

The forests of Delhi fall into the Monsoon Forest category. This category of forests flower between March and May, which is usually Delhi's spring time.

The Delhi Ridge, was at some point, a continuous ridge, but deforestation in the last 600 years has caused it to fracture. The British were the first one to begin Afforestation, but their reasons were to create an aesthetically pleasing backdrop to a city sandwiched between the forest and the Yamuna river. The ancient site of the Hanuman temple of the Mahabharata Era was chosen by the

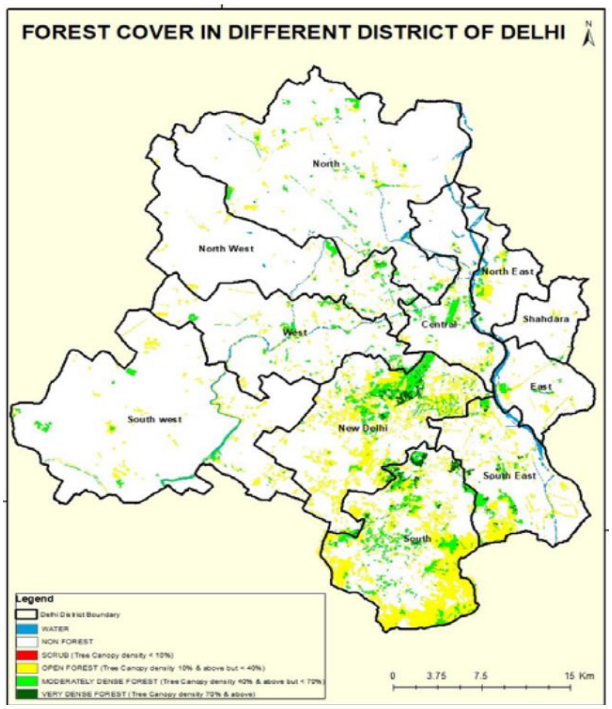
British to build Connaught Place (today Rajiv Chowk) in. Many alien species were introduced to these ridges, including the Mexican Prosopis Juliflora, which got the name of Vilayati Kikar (foreign tree). Today, we consider this tree an Invasive Alien Specie [6] which is harmful to the environment. This is because Mexico houses a Low Thorn Forest, whereas Bharat houses a Ravine Thorn Forest. Such examples from history show us why it is important to choose regional and local trees to have efficient and productive afforestation, which has a net positive impact on the flora and fauna.

The Forest Survey of India's ISFR report 2021 said that the forest cover of Delhi has more than doubled in the last 20 years, increasing from 151 km^2 to 342 km^2 [7]. The Very Dense Forests within this expansion have remained constant, while Medium Dense forests have increased mostly. Open Forests have been reduced with time from 0.62 km^2 to 0.44 km^2.

As per the FSI classification, the classification is as follows:

- Very Dense Forest: Any land with tree cover of 70% or above.
- Medium Dense Forest: Any land with tree cover between 40% and 70%
- Open Forests: Any land with tree cover between 10% and 40%
- Scrubs: Any land with tree cover less than 10% (Small or stunted trees) [8]

As we can see, efforts to protect the Very Dense Forests have kept their number constant. Meanwhile, Open Forests have seen a decline, in place of which the Medium Dense Forest has been the most suitable for the densely populated capital city.



[Map 3]

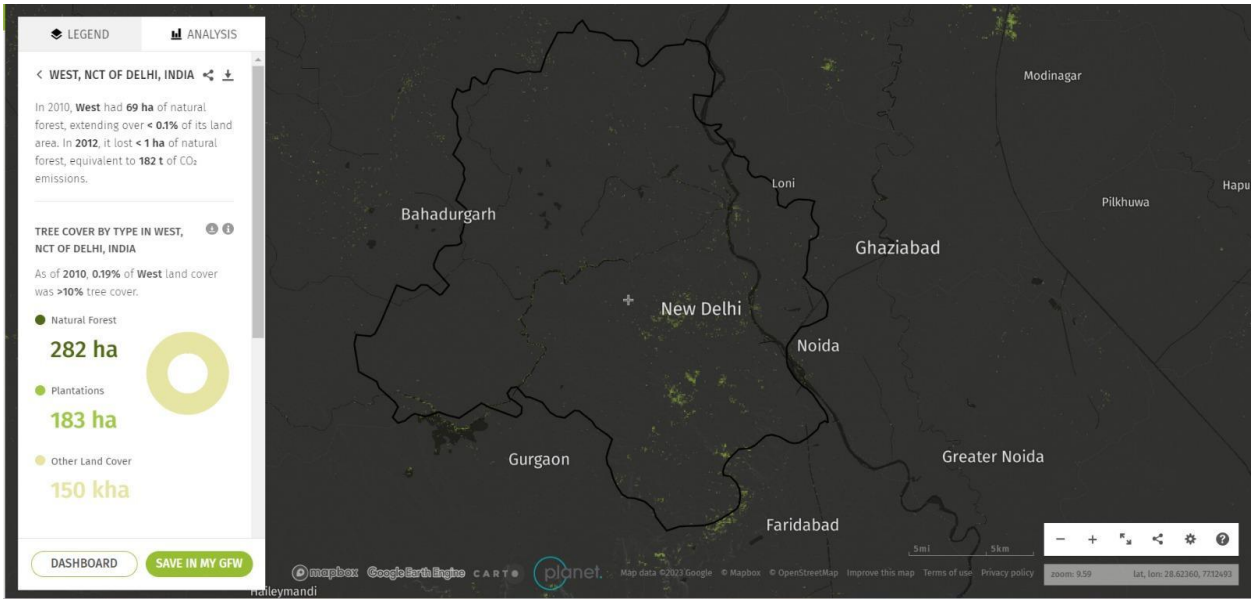
We also see a plethora of forests in New Delhi, South Delhi and somewhat in adjoining areas of South East Delhi. Yet, South West and West Delhi, East Delhi and North Delhi, Shahdara etc have very little forests in them. Most of the forests there are Scrub Forests. How can this be improved?

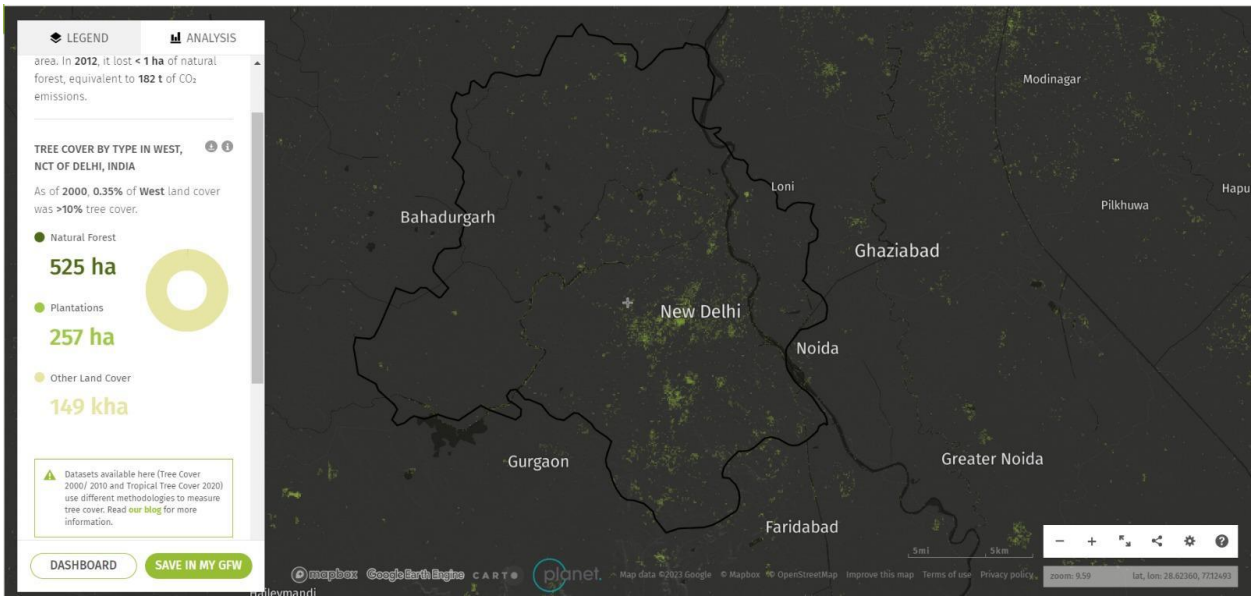
We wanted to study the improvement of forest cover in the UT of Delhi so far first.

As we discussed, Bharat has the third largest forest increase in any country in the world[10]. The Greenest Capital in the world in 2013 was Delhi as well [11], in the very middle of this cover doubling period of 2001 to 2021. While today Delhi is the 63rd Greenest City globally, it also is the Greenest city for Real Estate as of 2021 [12].

Keeping all this context in mind, we delve into finding empirical research on this topic regarding the AQI and carbon emission.

In this study, we have relied primarily on government data, of the FSI and the IFSC reports of every year. From this data we have determined that the forest cover has definitely increased, the AQI over time has reduced, and now we seek to find a method to make a point system from this data.





[Map 4 and 5 show the change in forest cover and dense forest cover, as per the interactive maps of Global Forest Watch]

We also have to consider economic considerations while doing our research. Since the aim of the Green Credit System is to use a market based mechanism, we need to understand how a market works.

In a market, the stock exchange works on supply and demand. When a stock is in more demand since the time we bought it, the same number of shares sell for more per share. When demand is lower than the time we bought the share, the shares sell for less per share. This basic concept is what the Green Credit System is based upon.

As the pollution by a certain pollutant goes up, the demand for green credits that curb this pollutant would also go up. Hence, to maintain a net zero output, companies will be directed to buy these points from entities engaged in green-positive action[13]. As pollution of certain pollutants

increases, so will the demand for a certain green credit point, and hence the price. This would make green-positive action profitable for entities engaged in environment conservation. It would also encourage companies to keep a stock of their environmental impact beforehand and buy these points beforehand.

There is also a concept of benchmarks such as NIFTY50. In this, the average of a number of stocks (in case of NIFTY it is 50) is taken and an average value is given. BY buying a "single NIFTY Stock", you are buying shares in all 50 companies listed and hence are getting a more broad exposure to the market as a whole[14].
Using this, we can understand the "Green Credit System" as a whole as a NIFTY index of sorts, with each pollutant (like NOx, SOx, COx, NH3, O3, etc) as a separate company share.

There is also a concept in economics of a "sector". Different sectors have a collection of stocks in them which are all related to similar industries. Having this sectoral grouping makes it easier for investors to diversify their portfolio into a collection of related and inter-related industries at once. With a diversity of sectors, there are different stocks that add value to different industries, differently. Some of the same stocks are given higher weightage in some sectors as compared to other sectors.

Similarly, with different states, and floral/faunal diversity in each of our states, it may be wiser to look at each state as a collection of "Cultural zones". The cultural zones are better at dividing the forest types in separate zones as well. Similar to how different stocks of a specific industry have a "grouping" or "sector" [16]. Different pollutants, and how they react with different zones, can be seen as different "sectors" of the economy, and this "sector" may be totally independent from the boundaries of each Pradesh or "State". For example, "Tropical Wet Evergreen Forest", "Himalayan Moist Temperate Forest" and "Tropical Thorn Forest" all 3 can be considered different "sectors" regardless of their placement in the border of states. Nature herself does not care about these artificial borders.

Considering these elements of stocks, baseline and sector, we can draw parallels and make our own version to create our own market-based mechanism for Bharat.

This mechanism can allow a more flexible structure, as well as more concentrated action with certain pollutants over others.

One limitation of this is what I may term as "intangible environment-positive action", such as increasing the Mangrove Cover to reduce damage of Earthquake or Tsunamis. How can one measure this directly? Instead, a different mechanism must be adopted for this work, such as an ideal base level of Mangrove that should be there and the seasonal chances of a tsunami.

- Base Level: Could be based on what the original mangrove forest was in a fixed year and how much the value has deviated from that value in km^2.
- Season of Tsunami: The prices for Mangrove Covers can increase when there are low chances of a tsunami and hence a good time to plant trees.

Besides the Mangrove Cover, it is best for the "tangible environment-positive action" to follow a "gold standard" system of measuring the respective CO2 points, NOx points, SOx points, NH3 points, O3 points, etc, with their value pegged on their emission, and to have a single "NIFTY" stock which allows investors to invest in all of these simultaneously.

For this study, to limit our scope and scale, we will only focus on CO2 emissions, and only in the region of Delhi NCR. We will study the change in forest cover and analyze the methodologies for calculating the carbon they offset.

We will also verify these readings with experts, whom we quizzed and asked for their opinion, and identify if certain trees and their plantation can yield us more carbon to offset, and hence, yield the "entity engaged in environment-positive action" more profit for their planting choices.

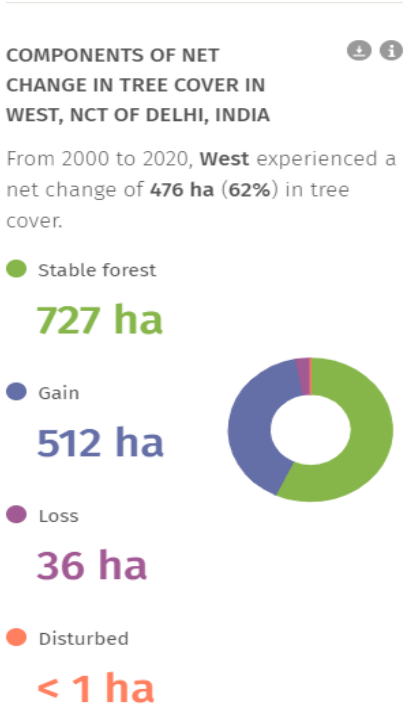
Setting this study as the blueprint, we hope that other emissions can have points derived for them also to be included in our Benchmark Green Credit System.

Methodology: For our research, we will be using the data from Global Forest Watch, which not only monitors the increase and decrease of forests globally (their data is consistent with government data) but also gives us how much carbon is offset per unit area of Carbon.

We would do this by:

1. Identify the type of forest. In our case we are going to study the forests of Delhi, which is a Tropical Thorn Forest.
2. Identify the trees that are the most suitable for that climate, and the ones that would offset the most carbon.
3. Identify the percentage or concentration of these trees in the forest
4. Find how much the forest area has increased in the last 2 years, 5 years and 10 years
5. Find out which tree was used the most for the expansion, and how much increase in the most carbon offsetting tree.
6. Compare these numbers to the decrease in AQI
7. Find the ratio of these
8. Use this to calculate a point system

According to Global Forest Watch dot Org, there has been a net increase in forest cover between 0.5% to 2% in all of Bharat, including Delhi. Delhi has gained a net 5.12 km^2 of area, and has a 7.2 km^2 area forest as stable forest. There is a Gross Increase of roughly 70% of forest area. This offsets 1,82,000 kg of Carbon in the environment.



[Table 1][9]

By this metric, we can conclude that roughly:

1,82,000 / 1,239 (kg/km^2)
= 146 kg of Carbon offset per km^2 area of forest, or
= 0.000146 kg of Carbon offset per m^2 area of forest
= 1 Carbon Point

By this, we can conclude that for every m^2 area of forest we increase, we are offsetting 0.146 grams of Carbon.

This implies that 1 m^2 of forest increased = 0.000146 kg of Carbon Offset = 1 Carbon Credit Points. The price of these points will fluctuate as more Carbon is emitted into the environment, and fall as more carbon is either offset or less carbon is emitted into the environment.

Similar points can be devised for other pollutants such as NOx, SOx, etc.

Next, we need to make a scoring system to ensure that our carbon offsetting exercise does not lead to plants that are bad for the environment, or add to the carbon. Let us take the example of Tropical Thorn Forest, in Delhi.

While there are no "best trees" for any forest for carbon sequestration, there are a few factors that can reduce the desirability of certain trees in certain forests for carbon sequestration. These factors include:

- Short lived and fast growing grasses
- Invasive Plant species
- Seasonal plants with shallow roots
- Plants with a low biomass
- Plants with short growing seasons [18]

Indigenous plants that grow, are perennial, are heavy and have deep roots are usually the best.

Some examples of good trees in Tropical Thorn Forests (which are indigenous, grow for long periods of time, are perennial, have a high mass:volume ratio and good growing seasons) species are:

1. Acacia
2. Prosopis
3. Anogeissus
4. Boswellia
5. Tamarind [19]

Considering these 10 on a scale of 1-10, we can count backward. Which trees live shorter than these? Which trees are seasonal? Which ones are lower in biomass in comparison? Which ones

have shallower roots? Which ones have short growing seasons? Whether a plant is an invasive specie or not.
Let us consider the Eucalyptus plant, comparing it to a Tamaring tree.

Factor considered	**Score given**
Short lived or fast growing grass	Same as Tamarind (200 years) - 10
Invasive species	Yes - 0
Is the plant seasonal	Some leaves of Eucalyptus dry (Tamarind is evergreen)- 8
Score of biomass	Eucalyptus is 0.478g/cm3, almost half of Tamarind (0.85 g/cm3) - 6
Length of growing season	10 years (Tamarind is 13-14 years) - 7
Length of root	1.5-2 meters depth (Tamarind tree is usually 13 meters depth) - 1

As we can see, Tamarind ranks at 32/60. Meanwhile, any tree that is indigenous to Delhi's forests would easily rank in the higher 50s out of 60. Most trees would get full or close to full marks, unless they have certain undesirable features.

Similarity, trees in different forest types of Bharat can be identified, taken as the standard, and other trees can be compared to these trees.

This method of ranking trees can help disqualify the trees that perform poorly in carbon sequestration, or at least have them classified as “poor investments” for investors looking to buy Green Credits.

The rankings of different trees would also change according to different pollutants in question. Different scores for different pollutants can be made, attracting different investors with different needs accordingly.

As we can see from the above discussion, certain plants are very good for Tropical Thorn Forests, and some factors make certain plants bad for carbon sequestering in this forest type.

This information can be used by the steering committee to award specific points for specific trees (instead of simply giving points for forest area increase).

This way, a plantation of Acacia Plants, for example, would be worth more Carbon Points than a plantation of Eucalyptus trees (a known invasive species in Delhi forests).

Result and Discussion:

With this study, we have found a simple yet effective way to count pollutants in the environment and make a point system based on a valuation that is tangible and pegged on a quantifiable value. We asked experts on how these values can differ for different trees and which trees are best; this exercise can be used to give different points for different trees.
We also discussed how these tangible values can be used to calculate a baseline value to create a baseline called "Green Credit System.Some scope for further study can include:

- These discussed the limitations of this method for certain intangible actions, like increasing the mangrove cover. Further study to well define how these points can be calculated, keeping the season patterns and a baseline area in mind, or any other parameters, can be done.
- On the basis of this, we can recommend similar methodologies for other pollutants such as NOx, SO gas, O3, etc, and recommend different point systems for different pollutants.
- Different trees, according to how much carbon they can offset, will be awarded points in proportion to how much carbon they can offset in their sector, or forest type.

This, along with a compulsion of companies to maintain a net zero environmental pollution contribution, can compel both citizens and companies to pay for promulgation of a net zero emission. This aligns with Bharat's goals on environment, such as LiFE program, 30 by 30 and Net Zero by 70.

Different regions of Bharat, 75-80 cultural/geographical regions in total[15], even within states there is a diversity of nature, and hence having different exchanges for different regions based on forest type, on pollutant concentration, on population density and developmental goals, a precise exchange of different "categories" of investing groups can be made. This would be used to push action towards where it is needed.

Future scope:

- Different trees would also give us different points in different forest types. This can help us in discriminating against those trees which are good in one forest type but not in another. A methodology can be used to identify trees that exist in an environment. Factors like shallow roots or invasive species origin can be seen as factors which reduce the preferability of certain trees. Further study can be done here.

- The above exercise, in some places more in depth, can be dealt with by the Steering Committee to help determine the approximate carbon offset by certain trees in certain forest

types. The steering committee can also better calculate how “intangible activities”, like Mangrove Forest Covers or Ecomark Development Label or Sustainable Building and Infrastructure, need to be formulated more laterally. The last two can be seen as measures to reduce a “green credit debt” for factories and for big building owners respectively. They can be seen as ways to “reduce one’s green debt”. Further study can be done here.

- The above exercise will also have to be investigated on the ground level. Whether this would be done directly under the steering committee, or on a contractual basis, or if the people deployed for investigation will be government servants or private entities or both, will also have to be deeply formulated. This aspect of the green credit program’s policy can also make for another research paper.

Conclusion:

Our study goes over the Green Credit System, notified by the government on 13th October 2023, and in accordance with the LiFE Mission and EcoMark Scheme, proposes to use market based mechanisms to formulate a system to reduce our emissions of various pollutants.

In this study, we drew parallels to market mechanisms like “baseline” (like NIFTY), bullish and bearish trends and various sectors in a stock market. We used this to define a market system for different pollutants in the environment which would constitute Credit Points for individual pollutants, an overall baseline grouping for it called the “Green Credit”, and a grouping of different forests as different sectors. We also discussed that the valuation of different offsetters can change according to which trees they are planting and whether they suit the environment they are grown in or are slowing down the sequestration process. We discussed all of this in the context of Delhi alone, where the sector (ie forest type) is a Tropical Thorn Forest type, the industry (ie the pollutant) is the carbon offset industry and the best stock (ie carbon credit) is determined by us studying the various factors of the stock (which trees constitute the forest or plantation, does it have any invasive species or shallow roots which may harm our investment and be negative factors, etc) to conclude whether we should buy this stock or not.

We also made a distinction between “tangible” and “intangible” credit points and how lateral solutions for their calculation can be used for further studies.

Finally, we concluded that these calculations for all the systems, whether tangible or intangible, can be calculated by the steering committee. They would have to review and update their methodologies with time, as well as deploy agents to check if their evaluation is correctly being done without irregularities on the ground level, and keep the value of the points pegged and updated.

Several dimensions of this system can make for future research as well.

This way, we use market mechanisms for offsetting carbon and achieving the government goals like LiFE, Ecomark Program, 30 by 30 and net zero by 70.

Bibliography:

[1] https://www.hindustantimes.com/cities/delhi-news/delhi-air-quality-index-best-ever-during-first-half-of-2023-in-past-8-years-since-2016-101688127398875.html

[2] https://unacademy.com/content/bank-exam/study-material/general-awareness/rajasthan-tropical-thorn-forests/#:~:text=This%20type%20of%20tropical%20thorn,Shrubs%20are%20also%20common.

[3] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=19674760

[4] https://www.ndns.in/wp-content/uploads/2023/10/October-Newsletter-2023_compressed.pdf

[5] http://forest.delhigovt.nic.in/sites/default/files/Delhi%27s%20Forest%20at%20a%20Glance.pdf pg 37

[6] https://wii.gov.in/images/images/documents/publications/rr_2018_invasive_species_tamil_nadu.pdf

[7] https://indianexpress.com/article/cities/delhi/delhi-increase-in-denser-forest-area-between-2001-2021-a-welcome-sign-centre-to-hc-8495381/#:~:text=The%20Centre%20said%20that%20as%20per%20ISFR%202021%20published%20by%20Forest%20Survey%20of%20India%2C%20the%20green%20cover%20of%20Delhi%20shows%20a%20manifold%20increase%20from%20151%20sq%20km%20in%202001%20to%20342%20sq%20km%20in%202021%2C%20which%20depicts%20gradual%20improvement%20in%20percentage%20share%20of%20the%20geographical%20area%20of%20the%20state%20from%2010.2%25%20in%202001%20to%2023.06%25%20in%202021.

[8] https://fsi.nic.in/scheme-of-classification#:~:text=Classification%20Scheme-,Very%20dense%20Forest,Open%20forest

[9] https://www.globalforestwatch.org/map/

[10] https://pib.gov.in/PressReleasePage.aspx?PRID=1894898#:~:text=India%20ranks%20third%20globally%20with%20respect%20to%20the%20net%20gain%20in%20average%20annual%20forest%20area%20between%202010%20and%202020.

[11] https://economictimes.indiatimes.com/delhi-emerges-as-the-greenest-capital-city-in-world-sheila-dikshit/articleshow/21959960.cms

[12] https://www.business-standard.com/article/current-affairs/delhi-greenest-city-for-real-estate-in-india-ranks-63rd-globally-report-

121092900897_1.html#:~:text=Delhi%20is%20the%20greenest%20city%20for%20real%20estate%20in%20India%20but%20ranks%2063rd%20globally%2C%20according%20to%20a%20study%20by%20property%20consultant%20Knight%20Frank.

[13] https://www.drishtiias.com/daily-updates/daily-news-analysis/green-credit-program-1#:~:text=Green%20Credit%20refers%20to%20a,environmental%20preservation%20and%20sustainable%20practices.

[14] https://www.indiainfoline.com/knowledge-center/share-market/how-to-invest-in-nifty-tips-and-strategy#:~:text=By%20investing%20in%20Nifty%20index,you%20with%20broad%20market%20exposure.

[15] https://www.reddit.com/r/IndiaSpeaks/comments/yqc2ur/proposed_75_states_of_india_in_prof_gautam/

[16] https://www.5paisa.com/stock-market-guide/stock-share-market/what-is-portfolio#:~:text=A%20portfolio%20is%20a%20grouping%20of%20several%20types%20of%20financial%20investments%2C%20such%20as%20closed%2Dend%20funds%20and%20exchange%20traded%20funds%20(ETFs)%2C%20as%20well%20as%20securities%20like%20stocks%2C%20bonds%2C%20commodities%2C%20cash%2C%20and%20cash%20equivalents.%20Most%20people%20think%20that%20a%20portfolio%27s%20core%20consists%20of%20equities%2C%20bonds%2C%20and%20cash.

[17] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=19674760

[18] https://www.frontiersin.org/articles/10.3389/fpls.2020.570001/full

[19] https://scholar.google.co.in/scholar_url?url=https://epubs.icar.org.in/index.php/IJA/article/download/96514/38401&hl=en&sa=X&ei=Y9WUZefKFtqs6rQP04mLyAg&scisig=AFWwaeZhurl-IMIKXFoQnOvKW96g&oi=scholarr