Modeling of Carbon dioxide Emission and Control Through Forestation

A Dissertation Submitted to
Nanjing Forestry University
For the Academic Degree of Masters
of Science

By
Uzma Shaheen Najam

Supervised By
Prof. Dr. Li Ping Ping

Nanjing Forestry University
May 2016

Contents

Abstract

Researches on the emissions and source of carbon dioxide (CO_2) and other GHG are becoming hot topics in the field of environment in recent years. How to absorb carbon dioxide, as well as control GHG emissions through reforestation techniques are even more important environmental issues which need further studies .The research is conducted for Karachi city as it is the financial and commercial capital of Pakistan and is also a significant sea-port. The tool employed (Vensim) in this work, is a latest software for modeling system dynamics. All the data observed and collected was put into this tool, which eventually demonstrated the situational analysis with graphical results to simulate the emissions and major sources of carbon dioxide and GHG, as well as estimate how much trees per hectare are required to overcome the hazardous gases / radiations emitting from different resources. The main results are as follows:

1. It was observed that the carbon dioxide discharge in climate has come to up to 151 million metric tons in 2006 that was only 39 million metric tons in 1980. This 287% increase in carbon dioxide amid 1980 to 2007 is the aftereffect of mass urbanization and vitality utilization in Karachi. The simulation results showed that carbon dioxide emission was comprised of a few areas in terms of GHG emission, but mostly three sectors were very important and so discussed in detail i.e. energy, transportation and industry sector. Vitality, similar to power, was a huge wellspring of vitality in Pakistan and is utilized to power homes, business, and industry. The burning of fossil energizes to create power, is the biggest single wellspring of CO_2 emanations in the country. The emissions grew slowly during the 1990 and 2000. After 2005, it increased with a rapid growth rate which was almost a linear growth until 2010 to 2015.The ignition of fossil fuels was the second biggest wellspring of CO_2 emanations. This classification incorporates transportation sources, for example, thruway vehicles, air travel, marine transportation, and rail. The rapid development of transportation had formed a web of 9500 km roads and 1,810,000 ranges of vehicles, which made the transportation, keep in exponential growth. Numerous modern procedures in Karachi emanated CO_2 through fossil fuel burning. A few procedures likewise created carbon dioxide outflows through compound responses that didn't include ignition, for instance, the generation and utilization of mineral items. As a result, it was obvious that the industrial emissions increased by nearly three times within 1990 to 2015. Besides, agriculture, land-use change and deforestation could also result in CO_2 emissions.

2. From Vensim, for controlling CO_2 in Karachi, a minimum of 1537 trees per hectare should be planted in the city to overcome these situations. The analytical part was simulating the current emission of oxygen and the absorption of carbon dioxide, as well as the increase of CO_2 emission through the forestation on the basis of characteristics of important tree species in Karachi. This thesis has also presented the type and distribution of the annual area of afforestation.

Chinese Abstract

对城市中CO2等温室气体的排放数量以及来源的研究，是环境领域近些年研究的热点问题；而如何通过植树造林技术来吸收CO2、控制温室气体则更是环境领域需要研究的一个重要问题。本文以巴基斯坦的金融、商业中心及重要的港口城市卡拉奇市为研究对象，采用最新的Vensim系统动力学模型和软件，将收集所得的数据放入软件中运行之后，综合图形化结果和形势分析，对该城市的CO2及温室气体的数量和主要排放产业来源进行了模拟计算，对吸收和控制温室气体所需要的植树面积进行了估算。主要研究结果如下：

1. 卡拉奇的CO2排放在1980年为3900万吨，而到了2006年已达到15100万吨，这与卡拉奇的城市化何工业化密切相关。模型的模拟结果表明，排放量最大的三个行业部门分别为：能源、交通和工业。燃油、天然气等能源作为巴基斯坦巨大的生命力源泉来为家庭、商业和工业供电。通过燃烧化石燃料来产生电力是二氧化碳排放的第一大来源。其排放在1990至2000年期间增长很慢，但是2005年后增长加快，2010至2015年则近乎直线的增长。交通运输是二氧化碳排放的第二大来源，包括高速公路车辆、航空、海运和铁路等交通资源。交通的快速发展，已形成了9500km的网状公路和181万辆各式各样的交通工具，使得交通的排放量在呈现指数式增长（表3.10）。卡拉奇的许多现代化的生产流程通过燃烧化石燃料释放二氧化碳。一些类似的流程即使没有燃烧同样也可以通过复合反应释放出二氧化碳，因此工业排放在1990年至2015年间增加了近3倍（表3.14）。此外，农业部门、土地利用的变化及森林砍伐等也产生CO2排放。

2.在对卡拉奇地区的重要树种特性进行分析的基础上，对如何通过植树造林来释放 O2、吸收 CO2 并对 CO2 排放量的增加进行了模拟。从运行结果可以看出，面对现实的情况，每公顷至少种植 1537 棵树才可以控制卡拉奇市的二氧化碳浓度的含量从而控制 CO2 浓度上升。文中同时还提出了植树造林的类型及年度面积分布。

Abbreviations

CO_2	Carbon dioxide
GHG	Greenhouse Gas Emission
LULUCF	Land-use Land-use-change Forestry
Gt	Giga-tons
mtons	Metric Tons
MMT	Million Metric Tons
ha	hectare
ft	feet
mtoe	million tons proportionate to oil

List of Figures

List of Tables

Chapter 1

Introduction

Managing environmental change is no more a decision for the city - it is a basic necessity which needs to be adapted and adjusted to within a reasonable time-frame. The city does not have the advantage of a "way out" procedure with regards to confronting up to the atmospheric challenges. The expenses connected with this association should be evaluated to a sensible level of precision to permit a city to arrange, strategize and get ready for this test.

Some of the previous studies have applied a variety of modeling tools and some parametric equations or expressions in terms of vehicle stock (transportation), fuel efficiency, travel distance, GDP, road area and population. In our simulation process, we will ignore the upstream factors like generation of fuel, electricity produced in city, time and other resources involved [1].

This study endeavors to demonstrate the outflow of harmful gasses through the aforementioned sources and how these gaseous outflows can be minimized. Effort has been made in this dissertation to estimate the forest/plantation area required in the biggest city of Pakistan (Karachi) to control carbon dioxide emission.

1.1 Motivation

A major task in any research project is to stimulate public acceptance of the responsibility to take some kind of action. This study was conducted to analyze and simulate how threatening the environmental situation, in terms of carbon dioxide/greenhouse gas (GHG) emissions, is. At this stage if efforts to counter the disastrous effects of GHG emissions are not boosted up, then the present state may become worse in coming future.

Self-inspiration is most likely imperative yet the thing which is more vital is to picture, appraise and mimic the conditions keeping in mind the end goal to spur others battle the environmental change.

In this manner, a noteworthy undertaking in any examination venture is to fortify open acknowledgment of the obligation to make some sort of move. This study was directed to investigate and recreate how undermining the circumstances are. What's more, at this level if the watering system won't help, the present state may turn out to be more regrettable in coming future.

Leading reviews is one of my enthusiasms which likewise persuaded me to step ahead and perform reenactment. Else it would not be so natural to make a model without legitimate confirmed information. Henceforth my inspiration is specifically identified with element of aptitudes i.e., Achievement = (Motivation x Skill).

One can't be inspired unless there is an issue that should be comprehended. As examined before about the city of Karachi populace benchmarks, unmistakably an expansive territory in the middle of the living society is without still and accessible for an estate or development. Since my objective is to make everybody of mindful what could happen more terrible in the event that this is expanding quickly, and on same pace, propose an answer.

Open division foundations of Pakistan is another element for my inspiration particularly Environmental Protection Agency (EPA) Pakistan and Survey of Pakistan (SoP), where I found a decent kind of information that can be effectively prepared.

1.2 Organization of Research

This research proposes the minimum number of trees that can be planted, in terms of per hectare, to control GHG emission that mainly cause absorption and emission of radiations. Carbon dioxide is another major factor that needs to be calculated in terms of per year. The number of trees must emit more oxygen then the negative radiations from GHG. And all these workings should possess a model base design. We shall start with climate conditions of Pakistan

at a very basic and brief level and then will move towards the conditions for its economic capital Karachi.

1.2.1 Data Collection

Information gathering includes primarily the vitality segment, the horticulture part, modern procedure, waste administration, and LULUCF (land use, land-use change and forestry) area. Karachi happens to be the biggest city of Pakistan; however due to poor administration of the local government, the task of information gathering proved to be quite difficult. It was an incredible test for me and by one means or another I figured out ways of gathering data by visiting various local government offices and finally accomplished my objectives, which helped a great deal in my modeling procedures.

1.2.2 Data Analysis

The very first part of project include the data collection which involves mainly the energy sector, the agriculture sector, industrial process, waste management, LULUCF (land use, land-use change and forestry) sector. As discussed earlier in detail that Karachi is quite a big city with improper management of traffic control, so data collection for emission of carbon dioxide was another great challenge and somehow managed to achieve those results which helped a lot in proceedings.

1.2.3 Modeling and Simulation

Modeling and simulation is a very important part to present the idea. And nowadays much of the research is conducted on this platform. This easily communicates the idea of a researcher and the corresponding presentation is also very easy to understand.

The software platform where we will be designing model and conducting simulation is Vensim. Vensim rich feature set emphasizes model quality, connections to data, flexible distribution, and advanced algorithms, configurations for everyone from junior researchers to professionals. This software basically works on formula based principles but on the other hand also supports optimization to sensitivity levels.

A stochastic (random) data using any variable is easily seen in a flow and that is how the benefit of this software is taken. The data collected from different resources for Karachi was given a graphical flow and a gradient formula was opted to simulate it on this software tool. The graphical flow from the year 1990 to 2015 eventually presents the picture how situation is changing. The change that needs to be improved is overcome through another proposed model which consists of oxygen emission through single year duration.

Chapter 2

Country Profile with Climate Context

Pakistan is arranged between the scopes of 24 °and 37 °north and longitudes of 61 °to 75 ° east, extending more than 1600 kilometers from north to south and 885 kilometers from east to west shaping a rectangular mass covering around 880,000 square kilometers with a coastline of 1046 kilometers. Because of its profoundly differing physiographic and climatic conditions, Pakistan has been arranged into 11 topographical, ten agro-ecological and 9 noteworthy environmental zones. The nation's great helplessness to environmental change is a sensible sureness inferable from its geographic area, height and also demographics. Pakistan lies on a lofty slope, dropping forcefully from just about 8500 meters down to ocean level inside a separation of under 3000 km. This circumstance is increased by the nearness of enormous frosty stores in the north of the nation which soften and course through the nation, supplying more than 70% of the waterway streams. This solidified "blue gold" is the nation's most valuable save and maintains the agro based economy helped by the erratic storm downpours of the mid-year. The cold melt and the storm downpours cover in the three month summer period giving the watering system water expected to the bone-dry nation additionally, humorously, hazardously raising the danger of glimmer surges in the streams. The thick populace base which lives along these surge fields and is, in this way, specifically affected duplicates the nation's defenselessness. This is built up exploratory information. Environmental Change is presently starting to include another sporadic and unstable fixing into this water mixed drink. It is not just enlarging the dissolving of the icy masses in the north additionally improving the flightiness of the storms [2].

While there is a worldwide investigative civil argument going ahead about the level and timing of the frigid melt, the signs in Pakistan are unfavorably clear. As indicated by a late research report (ICIMOD) the nation has an incomprehensible chilly zone which covers around 15000 square km including 5000 ice sheets which are in fast withdraw. The rate of this retreat, as indicated by the report, has gone up by 23% in the earlier decade. The high quantum of icy lakes shaping in the North (2500 have been recorded in Pakistan speaking to half of the nation's ice sheets) and additionally the expanded downstream water surges, even in low rainstorm years, are

evident confirmations of the frigid melt. A related stressing part of this atmosphere incited marvels are the 52 lakes which are ordered as "possibly unsafe". In these lakes, which are inalienably shaky, the capability of a sudden upheaval bringing about a quick surge of the put away water remains amazingly high. Such a frosty lake upheaval stream has been additionally termed as a "mountain torrent" because of the wave structure in which a gigantic volume of water is all of a sudden discharged. This can prompt cataclysmic demolition and flooding up to several kilometers downstream. Reports propose that the recurrence of such frigid dangers in the Himalayas and Hindu-Kush area of Pakistan has expanded significantly in the previous decades.

Out of Pakistan’s aggregate zone 24% is developed out of which 80% is flooded by water moving through the, prevalently, icy mass encouraged streams of the area. The nation gloats the biggest infectious watering system framework on the planet. Woods and touching grounds spread around 4% and around 31% is unfit for farming with expansive patches of waterlogged and saline terrains.

In this setting, environmental change influences every one of the divisions of the nation especially affecting upon its water assets, vitality, wellbeing, ranger service, biodiversity and with a noteworthy effect on horticultural efficiency. Any expansion in temperatures modifies the bio-physical connections by changing developing times of the harvests, adjusting booking of editing seasons, expanding crop stresses (warm and dampness stresses), changing watering system water necessities, modifying soil attributes, and expanding the danger of nuisances and sicknesses, consequently gravely influencing the agrarian efficiency.

While being forced to bear atmosphere affects the nation is, unexpectedly, one of the most minimal supporters to the issue both in noteworthy and in addition current terms. At present, Pakistan contributes 0.8 for each penny of the aggregate worldwide GHG discharge and positioning 135th all inclusive on a per-capita premise. In spite of the fact that Pakistan's per capita vitality utilization and aggregate carbon dioxide emissions are greatly low, the carbon dioxide emissions per unit of vitality utilization are generally high. Pakistan’s complete GHG outflows were 310 million tons of carbon dioxide equivalents (MtCDE) in 20083 as appeared in the similar Table 2.1. These outflows contained carbon dioxide (54%), methane (36%), nitrous oxide (9%), carbon monoxide (1%) and Non-Methane Volatile Organic Compounds (0.3%). As far as sectorial dispersion, the vitality division (counting transport) is the most critical giver to

GHG discharges in Pakistan totaling 157 million tons carbon dioxidein year 2007-08 which represents more than 51% of country's aggregate emanations (0.45 % of world's aggregate). Different divisions incorporate Agriculture and Livestock - 39%, Industrial Processes - 6%, LULUCF - 3%, and Wastes - 1%. Thus very nearly 90% of Pakistan's GHG discharges originated from the Energy and Agriculture-Livestock areas and, along these lines, this is the region where the push of Pakistan's alleviation endeavors should be engaged. In spite of the fact that, the outflows in the LULUCF area are a little rate, it is an issue of worry that right now Pakistan has a to a great degree low woods spread (4.8%) which is combined with a high rate of deforestation of around 0.2%- 0.4% per annum. This, be that as it may, gives a chance to the use of worldwide money related instruments to dodge and turn around deforestation [3].

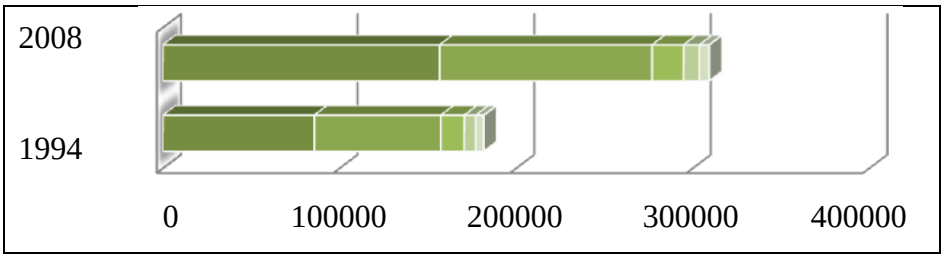


Figure 2.1 GHG Emission in Pakistan from 1994 - 2008

Table 2.1: GHG emissions of Pakistan (1994 - 2008)

	1994	**2008**
Energy	85,816	156,821
Agriculture	71,632	120,284
Industrial Process	13,297	17,866
LULUCF	65,27	8,920
Wastes	4,454	5,505

The twentieth century saw fast urbanization all through the world. The worldwide extent of urban populace expanded from 13% in 1900 to 29% in 1950 and, as per the 2005 Revision of

World Urbanization Prospects, it has achieved 49% in 2005. Since the world is anticipated to keep on urbanizing, 60% of the worldwide populace is required to live in urban communities by 2030. As per the most recent United Nations populace projections, 4.9 billion individuals are relied upon to be urban occupants in 2030 (Figure 2.2) which was 3.2 billion in 2005. Principally, the development towards the urban areas is a direct result of the use of new techniques for development that empowered a substantial creation of nourishment from little land, making a part of the country populace to go to towns to discover open doors for livelihood. Besides, the development of trade and industry in the towns and urban areas offered better chances of work. Today urbanization is an overall marvel. Each country, city and presumably individual on the planet is specifically or in a roundabout way included in the proceeding with procedure of urbanization which is quickly developing. The level of urbanization in Pakistan has gone up from 17.8, 32.5 and around 40%, in 1951, 1998 and 2008, individually.

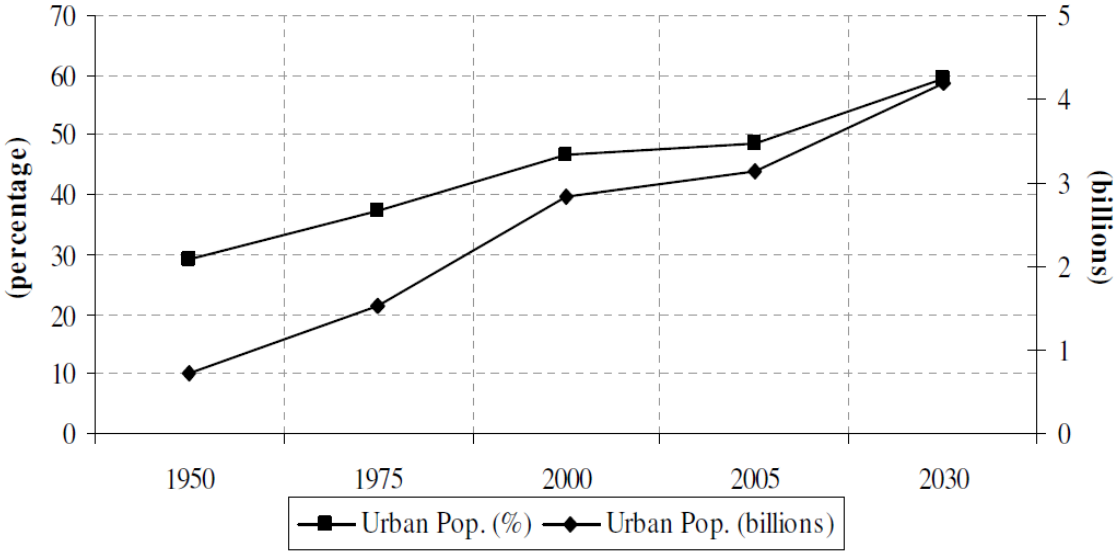


Figure 2.2 World urban populace in rate and in addition altogether since 1950 to 2030

2.1 Karachi City

Karachi is the common capital of Sindh area of Pakistan. It had a territory of 3,640 km ²in 2008 and is situated on the Arabian Sea coast in the amazing south of Pakistan (Figure 2.3). Its land co-ordinates are 24°45′ north and 66°37′ east. Geologically, it can be partitioned into two noteworthy parts; the uneven regions in the north and west and an undulating plain and beach

front range in the south-east. The slopes in Karachi are the off-shoots of the Kirthar Range (mountain range situated in Balochistan and Sindh regions of Pakistan which reaches out from north to southward for around 300 km). The most noteworthy purpose of these slopes in Karachi is around 528 m in the amazing north of the city. All these slopes are without vegetation and have wide mediating fields, dry waterway quaint little inns channels. Karachi has a long coastline in the south. Far from the shoreline are little islands including Shamsh Pir, Baba Bhit, Salehabad and Monora (the nearby names). Karachi has tolerably calm atmosphere with a general high relative mugginess that fluctuates from 58% in December (the driest month) to 85% in August (the wettest month). In winter, the normal temperature of the city is around 21 ℃ while in summer it comes to up to 35 ℃. Karachi gets around 256 mm of normal yearly precipitation[4].

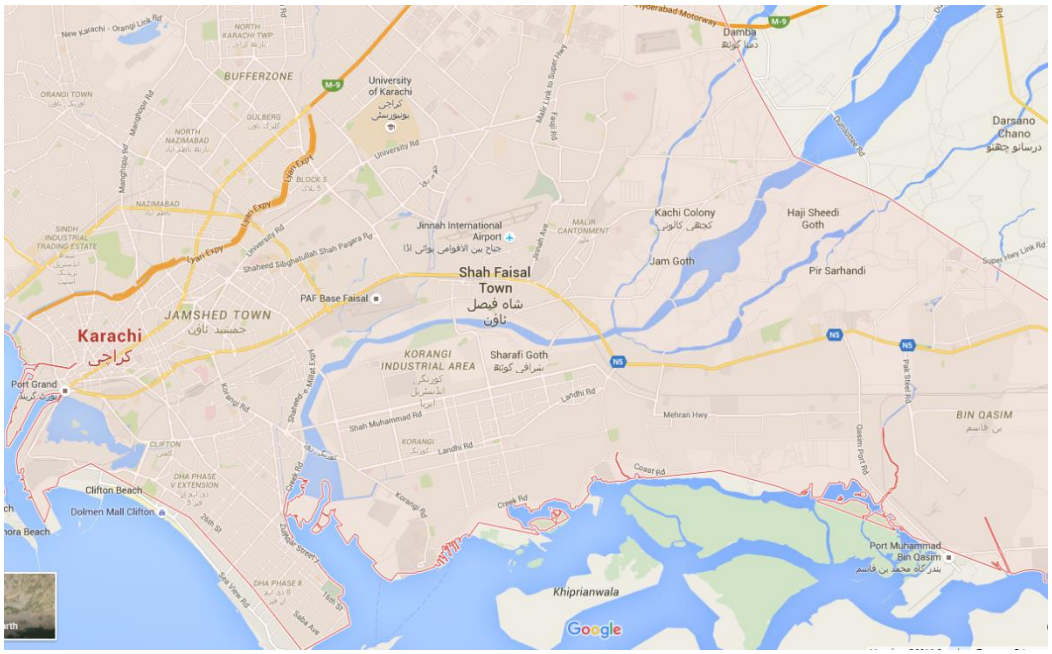


Figure 2.3 View of Karachi on guide

Karachi has a few vast modern zones, for example, Karachi Export Processing Zone, SITE, Korangi, Northern Bypass Industrial Zone, Bin Qasim and North Karachi, situated on the edges of the principle city.

2.2 Environmental Issues of Karachi

Karachi has numerous ecological issues, seriously influencing its biophysical surroundings and in addition human wellbeing. The industrialization and careless natural oversight have added to the issues. The different types of contamination have expanded as Karachi which has brought on boundless natural and wellbeing issues. Air contamination, absence of appropriate waste administration framework and debasement of water bodies are the major natural issues in Karachi.

The Air contamination is the arrival of chemicals and particulates into the air. Regular vaporous contaminations incorporate carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides created by industry and engine vehicles. Photochemical ozone and exhaust cloud are made as nitrogen oxides and hydrocarbons respond to daylight. Particulate matter, or fine tidy is portrayed by their micrometer size PM10 to PM2.5. The air in Karachi is quickly dirtied via car smoke, particularly Rickshaws and Busses, modern emanations, open smoldering of rubbish, house fires, and different particles yet the legislature and environment associations appears non-genuine to handle the issue opportune[5].

The Two-stroke motor on rickshaws and cruisers are one of the real polluters of air in Karachi and rest of Pakistan. The two-stroke motors and in addition imperfect or unturned vehicles are significant polluters with carbon dioxide emanations. Two-stroke motors and also faulty vehicles utilizing substandard grease are significant emitters of sulfur dioxide and smoke. Cars working on packed regular gas and melted petroleum gas are real air polluters.

2.3 GDP of Karachi

The Gross Domestic Product (GDP) in Pakistan was worth 243.63 billion US dollars in 2014. The GDP estimation of Pakistan speaks to 0.39 percent of the world economy. Gross domestic product in Pakistan found the middle value of 59.54 USD Billion from 1960 until 2014, achieving an untouched high of 243.63 USD Billion in 2014 and a record low of 3.71 USD Billion in 1960. Gross domestic product in Pakistan is accounted for by the World Bank Group.

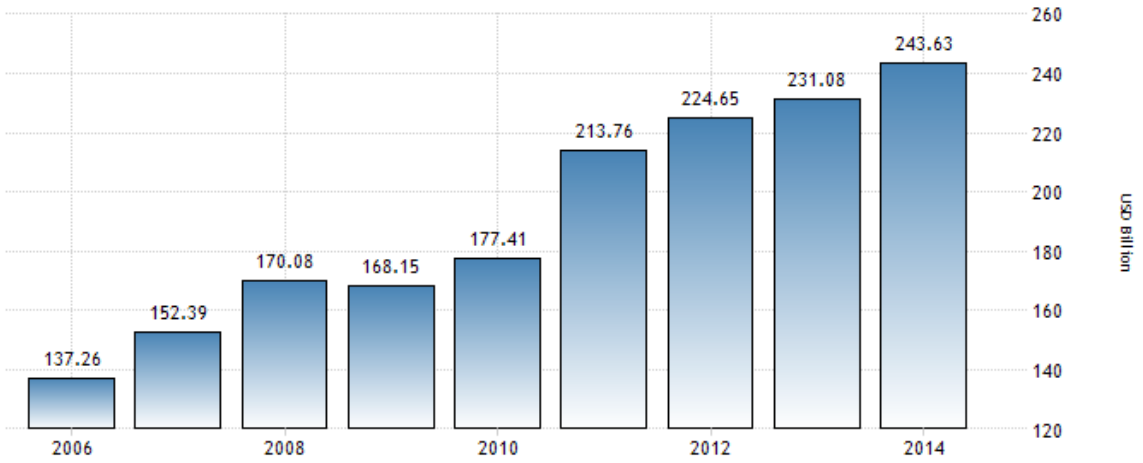


Figure 2.4 GDP of Pakistan (2006 – 2014)

A significant lump of Sindh's GDP is ascribed to Karachi (the GDP of Sindh as a rate of Pakistan's aggregate GDP has customarily drifted around 29%/30%). Karachi's GDP is around 20% of the aggregate GDP of Pakistan. A Price-water-house-Coopers study discharged in 2009, which studied the 2008 GDP of the top urban areas on the planet, figured Karachi's GDP (PPP) to be $78 billion (anticipated to be $193 billion in 2025 at a development rate of 5.5%). It affirmed Karachi's status as Pakistan's biggest economy, well in front of the following two greatest urban areas Lahore and Faisalabad, which had a reported GDP (PPP) in 2008 of $40 billion and $14 billion, separately. Karachi's high GDP depends on its vast mechanical base, with a high reliance likewise on the money related administrations division. Materials, bond, steel, overwhelming hardware, chemicals, sustenance, keeping money and protection are the major modern divisions adding to Karachi's GDP[6].

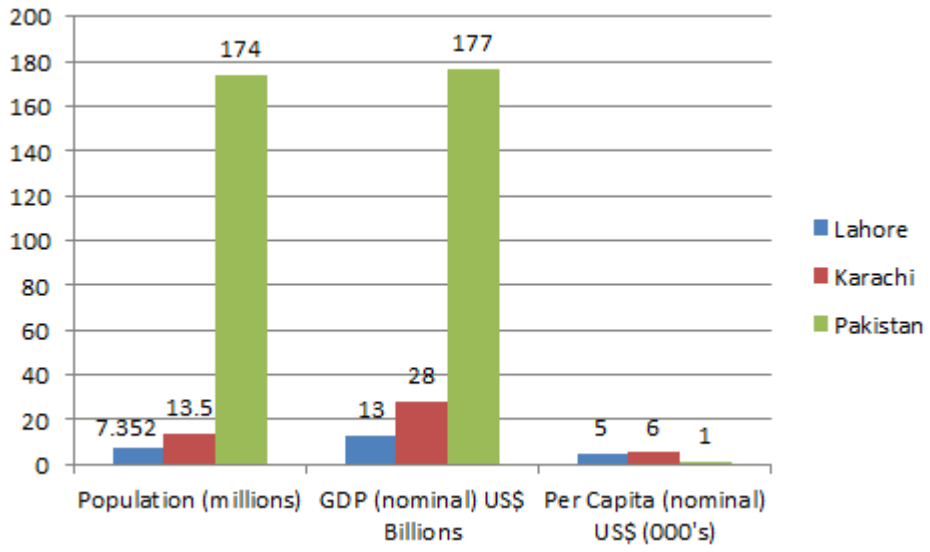


Figure 2.5 Comparison of Karachi's GDP with city Lahore and overall analysis

In accordance with its status as a noteworthy port and the nation's biggest city, it represents a large portion of Pakistan's income era. As indicated by the Pakistan Federal Board of Revenue's 2006-2007 year book assessment and traditions units in Karachi was in charge of 46.75% of direct expenses, 33.65% of government extract duty, and 23.38% of local deals charge. Karachi additionally represents 75.14% of traditions obligation and 79% of offers duty on imports. In this manner, Karachi gathers a noteworthy 53.38% of the aggregate accumulations of the Federal Board of Revenue, out of which 53.33% are traditions obligation and deals charge on imports. Income gathered from Karachi incorporates income from some different territories since the Large Tax Unit (LTU) Karachi and Regional Tax Offices (RTOs) Karachi, Hyderabad, Sukkur and Quetta spread the whole area of Sindh and Baluchistan. Karachi's indigenous commitment to national income is 25%.

2.4 Energy Sector

The Energy segment is not just the single biggest wellspring of GHG emanations in nation contributing right around 51% of these discharges additionally a part where a critical future development in outflows is expected attributable to the need to fuel the nation's advancement needs. Given the critical commitment of the vitality segment in the aggregate stock

of GHGs clearly this part ought to likewise be the focal center of environmental change moderation in nation[7].

In 2008-09 nation's vitality utilization was 37.3 million tons proportionate to oil (mtoe) which was met from a supply blend of gas (43.4%), oil (29%), power (15.3%), coal (10.4%), and LPG (1.5%) of all of which aggregately represented very nearly 51% of the national GHG discharges. Contrasted with the past ten years, petroleum utilization has expanded by 0.5% for each annum, gas by 6.8%, and power by 5%, and coal by 12.5% for every annum. While in the previous five years, gas utilization has ascended by 9%, coal by 1.5% and oil utilization has declined by 9.5%.

This pattern recommends that vitality supply blend is moving far from petroleum items towards gas, coal, and other vitality assets. As a large portion of coal and gas assets expended are indigenous this has permitted impressive investment funds in remote stores. The expanded dependence upon normal gas, in any case, can't be required to keep inferable from the quick exhaustion of nation's regular gas assets. In addition, the choice for managing or expanding dependence upon characteristic gas by importing from Iran or Central Asian nations is being investigated however stays dubious attributable to political and additionally financial limitations. The main sizable fossil fuel asset accessible in Pakistan remains its limitless coal saves assessed at 185 billion tons or around 2% of the world coal resources. Considering the above elements, expanded dependence on coal is by all accounts the main and most suitable choice accessible for Pakistan to fuel its future vitality needs[8].

As far as vitality request, the nation is in the blink of an eye confronted with a circumstance of unmet interest. Nation's present introduced power limit is 20,000MW which is insufficient to meet the nation's present power demand prompting incessant load-shedding particularly amid top utilization times. The vitality setback is at present evaluated to lie in the 2500-5000MW range and, as per appraisals, the vitality emergency cost the nation $6 billion in 2008 while bringing on misfortunes upwards of 2% of GDP in 2009-10. Likewise, this circumstance has additionally driven residential and modern clients to depend upon wasteful power generators running either on regular gas or heater oil which, thusly, has expanded normal vitality use costs and also GHG outflows[9].

Interestingly, Pakistan has one of the most elevated rates of transmission and conveyance misfortunes on the planet while the non-productive residential/living arrangement part (42.15%) is in charge of more power utilization than the mechanical area (23.92%) or the agrarian division (14.03%).All of this point towards a significant potential for the protection of vitality in Pakistan evaluated to, conceivably, set aside to $4 billion through a large group of measures.

2.5 Future Scenario

The GHG stock of nation demonstrates that vitality area outflows were 157 MtCDE (50.7% of aggregate discharges) in 2008 and these were relied upon to grow 17 fold by 2050 to 2730 MtCDE (64% of aggregate emissions).The motivation behind why these emanations are required to become noteworthy by 2050 is on account of the measure of the vitality part is relied upon to increment impressively because of higher populace, industry needs and expected development over all divisions of economy. Discharges are likewise anticipated that would increment drastically by 2050 as the nation will be taking care of the expanded vitality requests through an expanded dependence upon coal assets - which are allegedly identical to the joined oil stores of Saudi Arabia and Iran.

2.6 Agriculture and Livestock

The Agriculture and Livestock segment is a standout amongst the most critical segments of economy in Pakistan. It is in charge of 21% of the GDP, utilizes 45% of work constrain, and wins profitable remote trade for the country.44. Also, in 2010, the domesticated animal's area contributed 53.2% of aggregate rural income, more than 10% of fares, and 11.4% of GDP. Over late years, offer of animals has expanded in agrarian value-addition while offer of products has slowly declined. Domesticated animals populace has additionally expanded drastically as of late. This could be ascribed to populace development, increment in per capita pay and expanded income from fares. The Table 2.2 underneath points of interest the quick ascent in animal's populace[10].

Table 2.2 Pakistan Livestock Population from 1996 to 2006

Pakistan Livestock Population 1996-2006 (in millions)									
	Cattle	Buffaloes	Sheep	Goats	Camels	Horses	Mules	Asses	Total
1996	20.4	20.2	23.5	41.1	0.82	0.33	0.13	3.56	110.2
2006	29.6	27.3	26.5	53.8	0.92	0.34	0.15	4.26	142.8
Percentage Increase (%)	44.72	34.84	12.50	30.65	12.95	3.09	18.09	19.93	29.58

GHG emanations from horticulture and domesticated animals in Pakistan have beforehand developed at a rate of around 3% for each annum and this could go up if the aforementioned elements are represented later on. In this manner, there is a squeezing need to contain these outflows or if nothing else moderate down their development rate. There are various regions that could be focused in the agribusiness and animals division with a specific end goal to alleviate Pakistan's GHG emanations. These are recorded beneath:

2.6.1 Cattle encourage changes

Enteric maturation happens in animals when they can't process their nourishment legitimately. Discharges from this source can therefore be decreased through a system to enhance the edibility of animal’s food. This should be possible by presenting a food supplement, for example, multi-nutrient nourish pieces (MNB). Utilization of such bolster supplements is relied upon to diminish CH4 discharges by a normal of 23 percent for every creature. Likewise, raising limited cows on concentrated high-protein bolster comprising of corn and soybeans can bring about scope of sicknesses, lead steers to discharge 40% more GHGs, and devour 85% more vitality than raising steers naturally on grass and other forages.52 The utilization of suitable feedstock blends and added substances can lessen methane creation from enteric maturation/assimilation in steers and should be supported in an educated way.

2.6.2 Cropland administration

Nitrous oxide emanations can be lessened through cropland administration. This should be possible through better soil, water, and manure administration. Practices, for example, enhanced seepage, limited munching, gushing usage, maintaining a strategic distance from compaction, manure administration, waste administration, disintegration control, crop blend change, meadow transformation, diminishment or disposal of neglected periods, and agro-forestry can essentially lessen nitrous oxide emanations[11].

2.6.3 Reducing methane outflows from rice development

With a specific end goal to diminish discharges from products, there is a requirement for more effective watering system procedures, better administration of natural manures, plant deposit administration and better waste administration. There is likewise a requirement for improvement of rice assortments that diminish the creation of methane [12].

2.6.4 Increasing profitability

Milk is one of most imperative wares from the domesticated animals. Pakistan is one of the biggest milk makers on the planet yet its milk profitability has a tendency to be 33% of that of driving nations, for example, New Zealand. By concentrating on ranges, for example, hereditary qualities, innovation, creature wellbeing administrations, and sustenance, milk profitability could be expanded while dependence would be set upon less ruminants for milk.

2.6.5 Efficiency improvements

Energy proficiency upgrade in running farming tube wells, through review and retrofits, base advancement, limit building, utilization of interchanges vitality innovations and institutionalization. The employments of privately made laser land levelers will diminish horticulture water utilization by as much as a third.

Seeking after these arrangements ought to be less expensive than other moderation alternatives accessible. Usage of these approaches ought not just diminish GHG discharges from the agriculture-livestock segment, it ought to likewise in a roundabout way advantage Pakistan as expanded soil and water quality, better farming practices, preservation of water and vitality, decreased expense of developing harvests, and lessening of diseases got from sustenance.

2.7 Land use, land-use change, and Forestry (LULUCF)

The LULUCF part in Pakistan is in charge of just 3% of GHG emissions and its offer is required to fall further to only 0.357% by 2050. However the significance of LULUCF is critical in Pakistan, inferable from the potential for atmosphere moderation through carbon sequestration by means of afforestation, reforestation and also evading deforestation.

Pakistan has a zone of 3.3 million ha secured by timberlands and planted trees, which is proportionate to 4.8% of the aggregate area area. This relative timberland spread zone is one of the most reduced on the planet and horrid even inside the connection of South Asia. Also, the timberland assets of Pakistan are breaking down both subjectively and quantitatively and the yearly change rate amid 1990-2000 was -1.8% and amid 2000-2005 was - 2.1%, which again disgracefully emerges as a to a great degree high deforestation rate.

2.8 Industrial Processes

The GHG Inventory demonstrates that modern procedures were in charge of 6% of 2008 aggregate GHG emissions36 however it accounts for 23% of the emanations from the vitality area. It makes up more than a quarter of Pakistan's GDP and since Pakistan is still at the lower phases of improvement, the part is required to develop later on and generously add to the national GHG outflows. Right now however the modern segment's GHG emanations with respect to general GHG discharges stay little and thusly it is not viewed as a need for Pakistan's alleviation procedure. Still there are a few zones in the modern division that give request side chances to GHG relief.

Commercial ventures that have a tendency to be the most contaminating in Pakistan are bond, block oven, metal, materials, petroleum refining, manure, cowhide, mining, sugar and substance businesses. In different businesses, boilers represent 35% of vitality expended and around half of these boilers are transported in second-hand and have a tendency to be very vitality wasteful. In this manner, alternately, there exists a significant potential for carbon moderation through productivity upgrade in these boilers.

2.9 Transportation Sector

The vehicle part in Karachi had been creating with populace development and fast urbanization. Lamentably, Karachi has still poor transportation framework when contrasted with the vehicle arrangement of other urban communities of the world. In the advanced time of innovation and improvement, the city of 18 million populace still has no cable car or tram framework to satisfy the vehicle offices of the occupants of Karachi. All out length of street system in Karachi is more than 8,000 km with a thickness of 219 km for every 100 km ². Figure 2.6 demonstrates the development rate of vehicles versus urban populace. Amid 1990 to 2008, the watched development in vehicles is nearly more prominent than the populace development. The normal versatility of pattern line demonstrates that the development in vehicles is more than the development in populace. The most extreme contrast amongst populace and vehicles development is measured from 2000 to 2008[13].

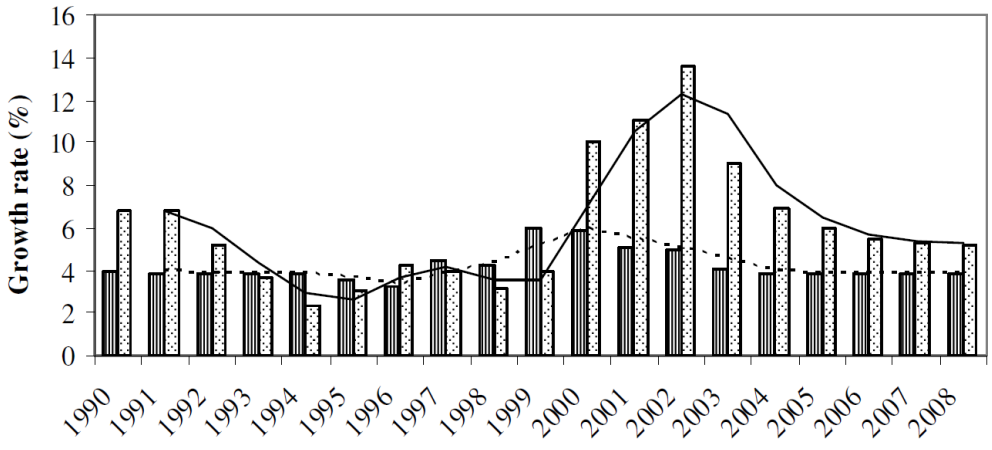


Figure 2.6 Growth rate of vehicles versus population in percentage

Amid this time period, the patterns were in opposition to each other in which populace development declined while vehicles development supported up to 14% every year. It demonstrates that the distinction in development of populace and vehicles is because of expanding interest of transportation in the city. Among the expanding vehicles, the rate offer of individual autos is greatest than alternate vehicles. As per one study, in 2003, there were half autos, 42% bikes, 3% taxis, 3% auto rickshaws and 2% transports and minibuses. Around 98% of the nearby transport is controlled by the private segment while the remaining part is in the hands of general society division. Among all vehicle sources, transports/small scale transports give around half of the travel request. This data plainly highlights that around 92% vehicles are for individual use by the people and just 8% vehicles are utilized as open and private wellspring of transport in the city. The 92% individual vehicles are the real wellspring of vitality utilization and carbon dioxideemission in the city[14].

Table 2.3 demonstrates that there were 1,113,000 enlisted vehicles in Karachi in 2002 and this figure came to up to 8,420,000 enrolled vehicles in 2008. Amid this brief span period, we saw a standard development in vehicles. The watched development amid this time period is around 656% and it is commonly more than the development in urban populace, framework and modern improvement[15].

Table 2.3 Total numbers and per year growth of vehicles in Karachi from 2002 to 2007

Year	Total no of registered vehicles (in thousand)	Total number of vehicles (in thousand)
2002	1113	1113
2003	1177	2290
2004	1280	3570
2005	1431	5001
2006	1610	6611
2007	1809	8420

2.10 Fossil Fuel Consumption

The interest of fossil energizes in Karachi expanded numerous folds than some time recently. It is primarily because of the above expressed reasons of expanding populace, vehicles development and modern advancement. The interest of petroleum items, common gas, power and coal in Karachi has been expanding with time. Absolute per-capita vitality utilization in Pakistan is 12.4 million BTUs and it is assessed that Karachi alone devour around 15% of the aggregate vitality in Pakistan. Figure 3.11 (see next chapter) shows the development in mechanical range and modern units. In this figure, it is seen that the major mechanical improvement in Karachi was amid 1947 to 1969 and amid 1986 to 2009. Amid this time period, we can likewise see the high rate in populace development and urbanization. The processed developments in mechanical units and modern territory in the above figure are 249 and 147%, separately. It unmistakably demonstrates that the extent of expanding patterns between mechanical units and territory is not uniform and the modern zones got to be denser with time.

Figure 3.17 (see next chapter) highlights the utilization of oil and petrol in Karachi. The everyday utilization of oil and petrol hopped from 16000 barrels in 1980 to 51000 barrels in 2007 with an expansion of 219%. Figure 7 expounds the utilization of regular gas that expanded from 40 billion cubic feet in 1980 to 186 billion cubic feet with an expansion of 365%. Figure 8 demonstrates that the coal utilization in 1980 was 262,000 short tons that came to up to 1,009,000 short tons in 2007; with an expansion of 285%. Coal is chiefly utilized as a part of warm electric force stations close Karachi to create power while regular gas, oil and petrol are basically expended for household utilize and to run the vehicle and commercial enterprises.

2.11 Carbon dioxide Emissions

As indicated by report of University College London workshop on environmental change (2005), eleven of the world's worldwide urban areas are in charge of somewhere in the range of 70% of carbon dioxide emanations. Despite the fact that Karachi is excluded among these eleven urban communities but rather the rising patterns of expanding emanation of carbon dioxide are fundamentally demonstrating that it will be one of the significant urban communities which have most extreme outflow of carbon dioxide. All out per-capita vitality utilization in Pakistan is 12.4 million BTUs (1 BTUs = 1,055.055 joules) that contribute 0.7 metric tons for each capita vitality

related carbon dioxide discharge in environment. Being the biggest city of Pakistan, Karachi is the significant purchaser of vitality and the patron of carbon dioxide discharge in environment than some other city of Pakistan.

Figure 3.15 (n next chapter) shows the general increment of carbon dioxide discharge in climate over Karachi. The rate of emanation of carbon dioxide is fast as well as it demonstrates a customary exponential pattern with no noteworthy defeat all through the registered time. It is watched that the carbon dioxide discharge in climate has come to up to 151 million metric tons in 2006 that was only 39 million metric tons in 1980. This 287% expansion in carbon dioxide amid 1980 to 2007 is the aftereffect of mass urbanization and vitality utilization in Karachi.

2.12 City trees cover Area

Karachi's tree spread stands at a minor seven for every penny, with areas falling under different cantonment sheets and the Defense Housing Authority being especially dispossessed of greenery, says another report.

Arranged for the City District Government of Karachi, the report stresses augmentation of the tree spread. Just seven for every penny of the city's aggregate area territory - which comprises of 900,000 sections of land (3,600 sq km) of urban farming and developed region - has a vegetation spread.

For a climatically perfect condition, specialists underline the requirement for no less than one tree for each individual in the city. Karachi's ecological wellbeing is breaking down inferable from untreated private and mechanical effluents streaming into the ocean, air and commotion contamination created by quick and undisciplined transport and spontaneous settlements, business premises and commercial ventures.

Frightened by their discoveries on air contamination, a gathering of researchers at the Pakistan Space and Upper Atmosphere Research Commission (Suparco) in their report of 2006

had asked the legislature to take prompt measures to check the elements in charge of the disintegrating environment.

The researchers expressed "The effect of a diminished oxygen level on streets is now evident from the blood photo of the general population living in or bringing home the bacon at different activity crossing points. Any expansion of a contaminating framework or innovation that may expand the convergence of the toxins by an insignificant 1 miniaturized scale gram for every cubic meter (Âµg/m3) is prone to be cataclysmic."

For Suparco's review, the assigned destinations included 26 movement convergences partitioned into five passageways. The top SO2 convergence of 40ppb (sections per billion) was noted at the Garden Road-Preedy Street crossing point and the Burnes Road convergences, while the most extreme NOx grouping of 239ppb was recorded at the Burnes Road intersection.The greatest CO_2 centralization of 615ppm (sections per million) was found on Korangi Road at the Baloch Colony sidestep convergence, though the greatest CO convergence of 17ppm was noted at Empress Market.

Wellbeing experts have noticed that growth and different infections of the ear, throat and lungs have expanded by 60 for every penny, because of vehicular discharges, basically containing carbon dioxide.

2.13 Production Potential of different types of trees in Karachi

The Corynocarpus is without bother, quickly developing, versatile to even high salt substance, sparing with regards to watering, and is the most mainstream decision of Karachiites since late years.

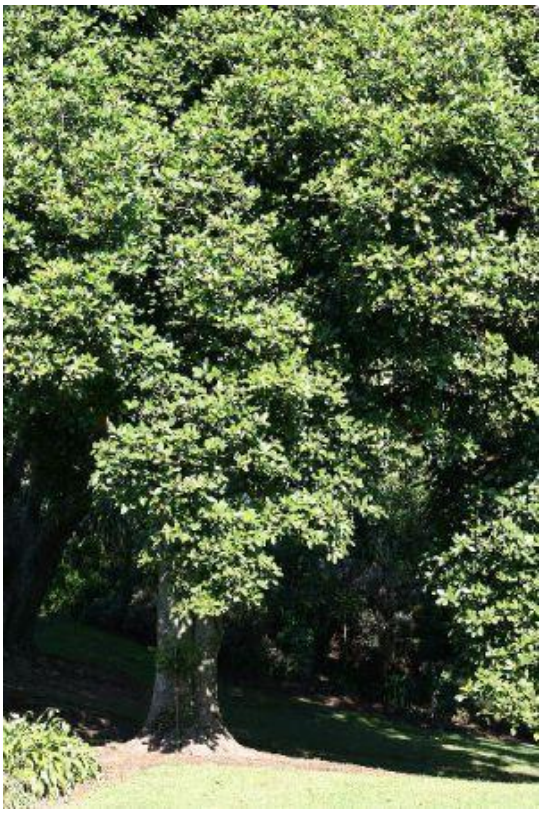


Figure 2.7 The Corynocarpus tree

In any case, it doesn't give shade as it develops straight and vertically. There have been studies that point in the heading that Corynocarpus causes hypersensitivities in people who live close-by. Above all, its roots, when they develop profound underground looking for water, break or stop up Karachi's sewage and water lines.

In this, it takes after the mischief the Eucalyptus trees created the city before. The city acknowledged 25 years after the fact what the Eucalyptus had done. Thus, a pointless exertion was put into removing Eucalyptus trees in the city, and we missed out on the city's greenery too. While it has the benefit of giving shabby wood and develops quick, it truly tosses poisons at different plants and does not permit different plants and trees to develop close by.

Figure 2.8 The Eucalyptus trees

A late pattern is to plant Khujoor (date) trees with full developed tree inserts. Nonetheless, the tree and its organic product are inclined to contagious assaults because of the muggy climate here. The date tree is accordingly a not as much as perfect decision.

The best trees for the city are those that take less water and give shade. The best case is Neem, an extremely brilliant living thing, which sucks in water from underground and gives cool shade. Other sensible decisions are Gulmohar (Flame of the timberland), and Amaltas (Indian Laburnum). These are deciduous trees that shed leaves, which turns out to be exceptionally helpful for Karachi.

Figure 2.9 The Khajoor trees

Indigenous assortments like Laal Badaam (Indian almond) and Jaamun (Syzygium cumini/jambolan) are likewise valuable natural product giving trees that give shade. Lignum is additionally a decent choice; it looks lovely, and uses less water, however requires significant investment to end up a shade giving tree. As it is a medium sized tree, it regards plant in zones where there are power wires above.

(a) (b)

Figure 2.10 (a) The Neem tree (b) the Laal Badaam tree

2.14 Conclusion from the Literature

The super city of Karachi in Pakistan has been confronting numerous social and natural issues. Most of the made issues are because of impromptu augmentation of the city since the making of Pakistan to date. The pitiful arranging and extension of the city with time incredibly influenced the city and its occupants because of contracting open and green space, higher discharge rate of contamination and carbon dioxide in environment and additionally rising urban temperature at disturbing levels. In this exploration, it was found that the quick urbanization, industrialization, populace and vehicles development assumed a basic part in the utilization of fossil powers in Karachi. The speculation of this work was to see whether the fast urbanization in Karachi is boosting up the utilization of vitality assets and how are they influence the emanation of carbon di oxide in environment. In the outcomes, the processed information of Karachi's populace, development in populace, vehicles, mechanical zone and modern units demonstrated a more noteworthy relationship. Decisively, we have seen that there had been consistent development in urban populace. The interest of transport has expanded with time as the populace has likewise expanded. Prior to the 1990s, the development in populace was more than the vehicles development. As we have seen already, after the 1990s, the development of vehicles in the city expanded than the development in populace which was essentially being because of people in general and private banks in Pakistan which offered credit strategies with low loan cost for vehicles and houses. This development in vehicles brought on larger piece of fossil energizes in the vehicle area. Among the investigated information of vehicles, it was seen that around 92% of vehicles are self-claimed which move in the city for individual use (autos and cruisers) and just 8% are utilized for travelers transport (transports, taxis and rickshaws). It demonstrates that individual wellspring of transport has more partake in fossil fills utilization and discharge of carbon dioxidefor the utilization of fossil powers. Numerous methodologies can be embraced and measures can be taken by the neighborhood, common and government to spare the gigantic sum expended as far as usage of oil, petrol and imports of vehicles and their parts. To make Karachi a naturally cordial city by decreasing the vitality utilization and carbon dioxideemission, the most essential activity ought to be to build up the urban transport framework on logical premise. The effective metro prepare or cable car framework like a large portion of the world super urban areas must be begun in the urban communities. It will be the more noteworthy wellspring of transport for the suburbanites of Karachi which will give transport to every one of

those a huge number of suburbanites who utilize their self-transport to travel between different places of the city for their day by day occupations and work places. The venture of Karachi Circular Rail ought to be restarted as it had been working in past. Along these lines, the legislature can lessen up to half activity from the streets. It will lessen no less than 40% of the utilization of fossil powers and carbon dioxideemission. It can likewise assist the administration to diminish the quantity of movement superintendents from the street who control the immense activity. Moreover, to minimize the weight of rustic urban movement to Karachi, the administration ought to create other financial zones in different parts of the nation to give better occupation offices. Neglecting to receive these techniques won't just expand the ecological issues in Karachi yet will bring about financial, social and security fiascos in the coming future.

Chapter 3

Modeling the Situational Analyses

The data grabbed from the situational analyses has brought down to some graphical relationships in terms of energy sector, the agriculture sector, industrial process, waste management, LULUCF (land use, land-use change and forestry) sector, which eventually generates a relation which helped to produce simulation and results on Vensim. It is a tool that helps in building and analyzing system dynamics. A system model is built and Vensim PLE is ready for simulation. Let us discuss and see how each and every block set placed and it worked.

3.1 Modeling the Emission of Carbon dioxide through Transportation

The transportation framework is exceptionally poor in spite of the fact that it has a quick development regarding urban use. Complete length of street system in Karachi is more than 8,000 km with a thickness of 219 km for each 100 km ². The pattern line (all things considered) demonstrates that the development in vehicles is more than the development in populace. 92% vehicles are utilized as private reason (incorporates autos and bikes) and 8% for open source. Open source vehicles (incorporate transports, auto-rickshaws and taxis). 1,113,000 vehicles were enlisted in Karachi as indicated by statistics of 2002 and this figure has come to 8,420,000 in 2008.

3.1.1 Emission through an average Passenger Car

Carbon dioxide emission from an average passenger car is 368.4 g per miles. which goes to:

(368.4 g/mi) x (12,000 mi/yr) x (1 lb/454 g) = 9,737.44 lb per year

19,737.44 lb per year x 0.000453592 = 8.95 Metric Tons per Year

3.1.2 Emission through Light Duty trucks and Buses

Carbon dioxide emission from Light duty trucks and buses are 513.5 g per mile which also goes to:

(513.5 g/mi) x (15,000 mi/yr) x (1 lb/454 g) = 13,572.69 lb per year

13,572.69 lb per year x 0.000453592 = 6.15 Metric Tons per Year

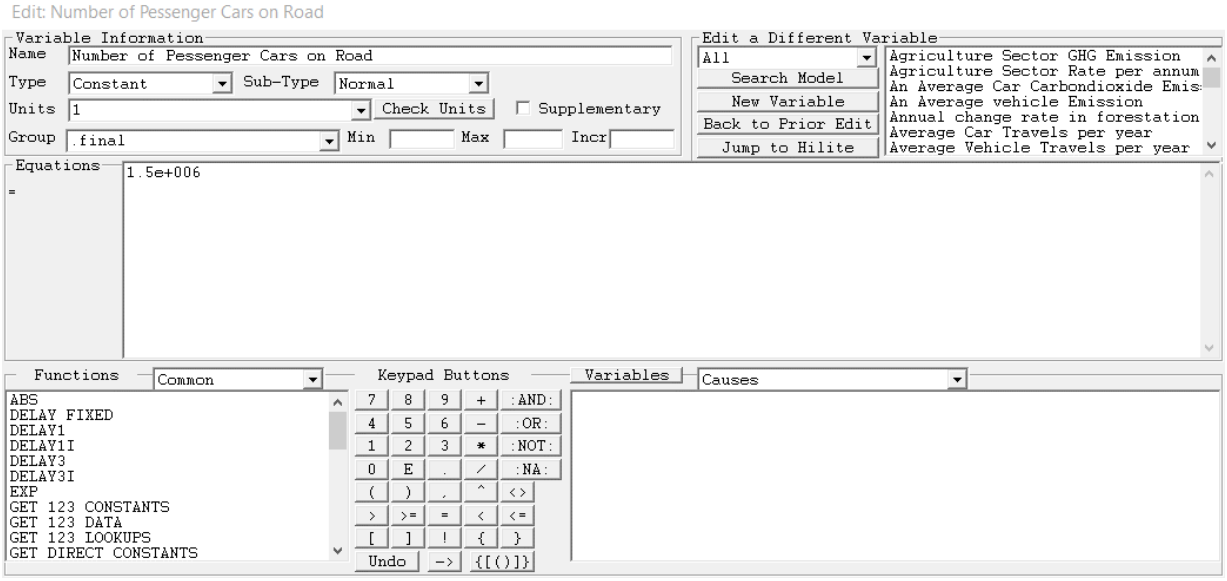


Figure 3.1 Vensim editor for number of passenger cars on road

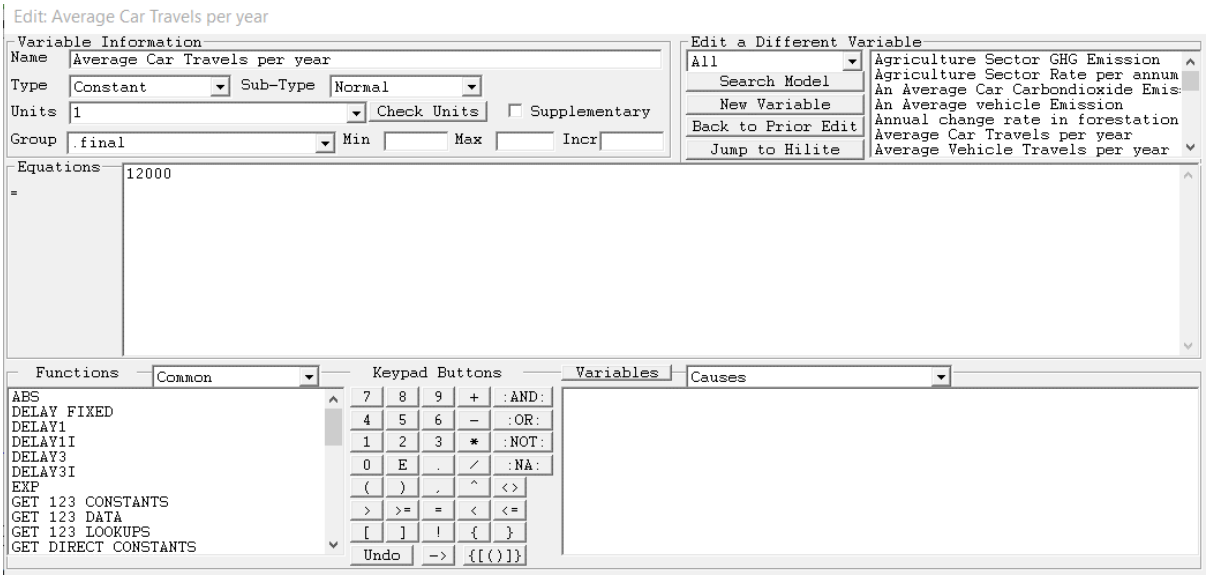
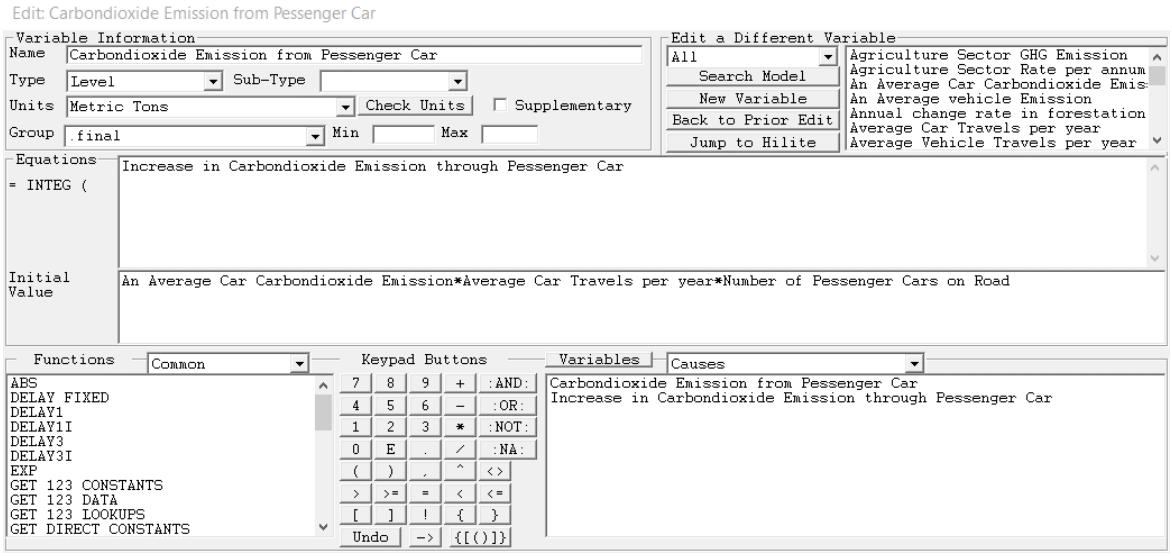
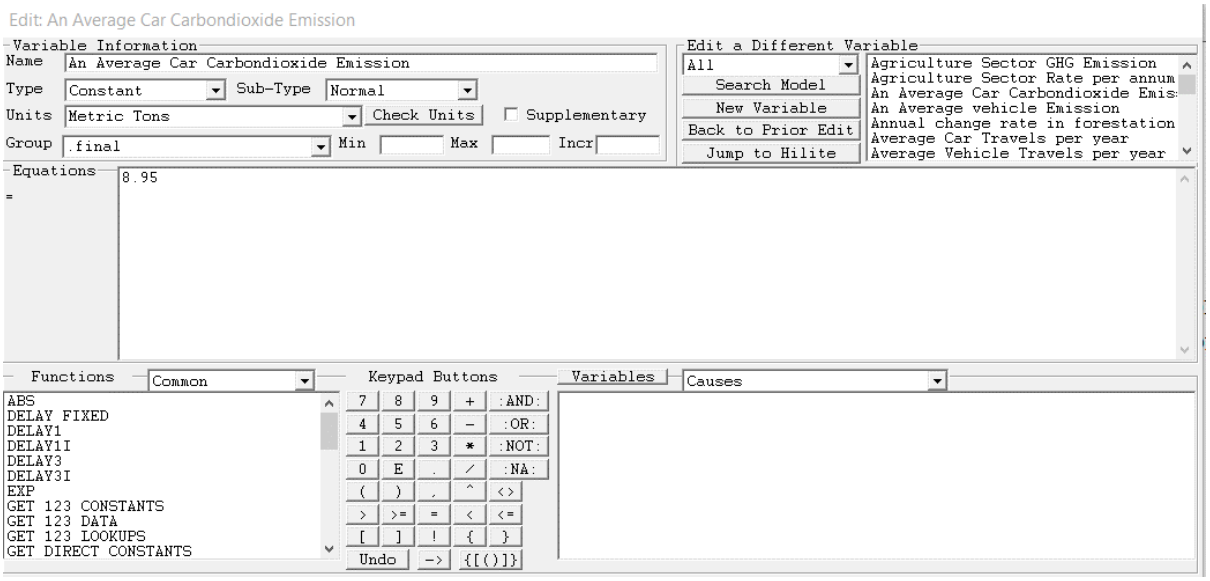


Figure 3.2 Vensim editor for an average car travels per year



(a)



(b)

Figure 3.3 (a) and (b) Carbon dioxide emission from an average passenger car

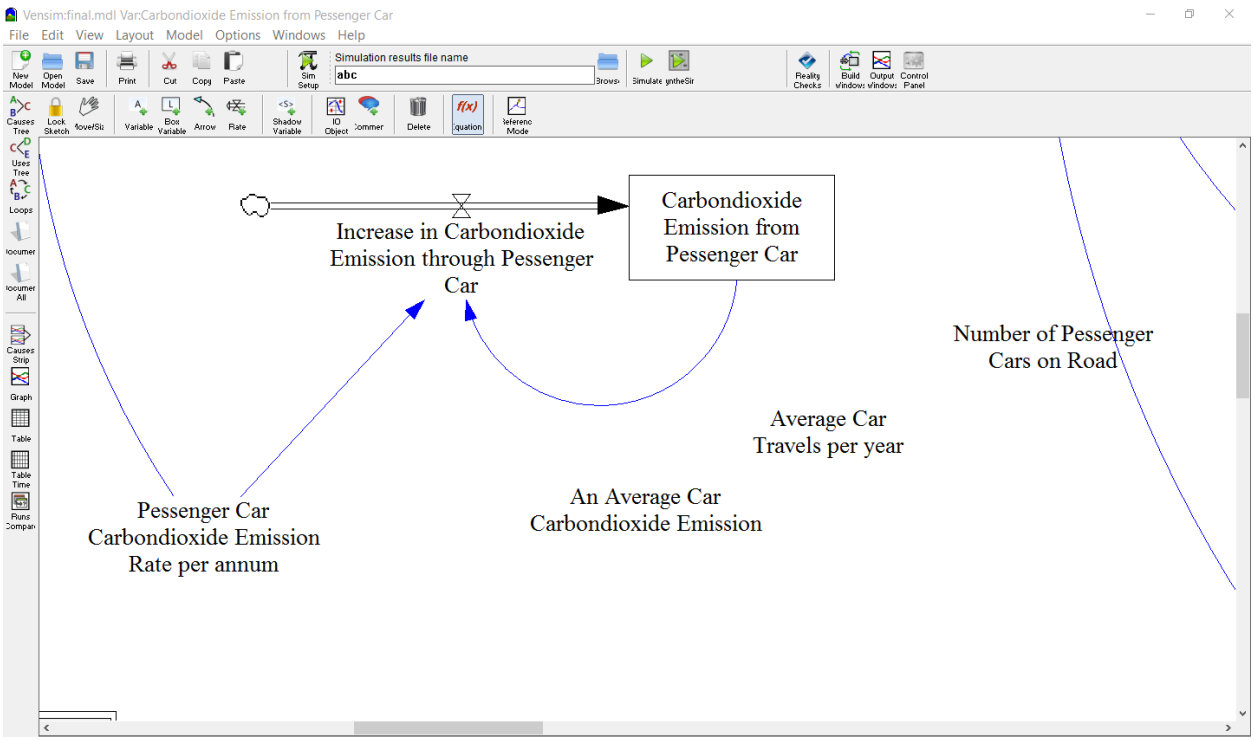


Figure 3.4 Vensim model for carbon dioxide emission from an average car

3.1.3 Vehicle Population and Consumption

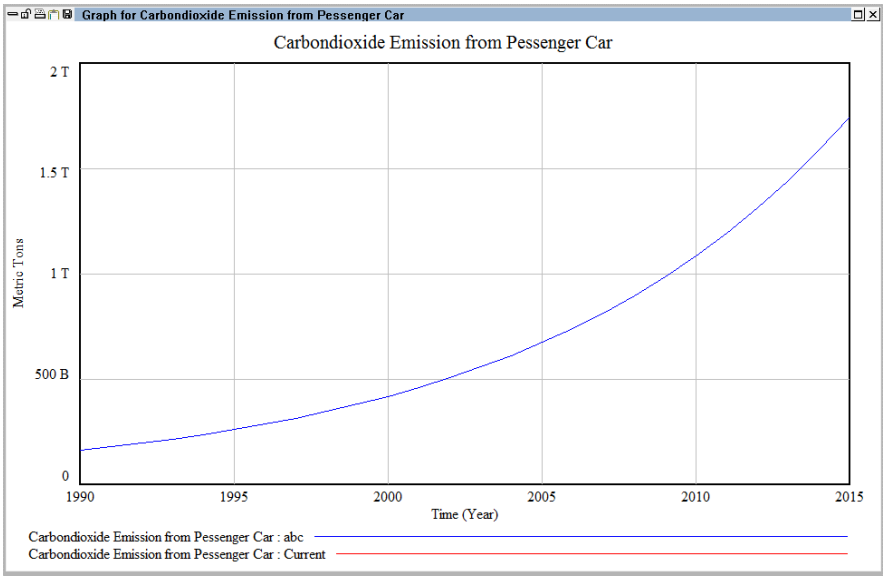


Figure 3.5 Graph for carbon dioxide emission through passenger cars per year

These emanation variables and fuel utilization rates are midpoints for the whole being used armada starting July 2008. More current vehicles by and large transmit less contamination and utilize less fuel, while more seasoned vehicles by and large emanate more contamination and utilize more gas. This is because of a few variables, including the expanding stringency of outflow models after some time and the crumbling (corruption) in the execution of emanation control innovation (e.g., exhaust systems) with expanding age and gathered mileage.

Carbon dioxide, while not managed as an air contamination, is the transportation segment'sessential commitment to environmental change. Carbon dioxide discharges are basically relative to fuel utilization (and conversely relative to efficiency) – each 1% expansion in fuel utilization results in a relating 1% expansion in carbon dioxide emanations. Around 19.4lb carbon dioxide is created for each gallon of fuel combusted. Traveler autos and light-obligation trucks additionally transmit little measures of other nursery gasses (GHGs); in this way, add up to GHG discharges from these vehicles are somewhat more prominent than the carbon dioxide outflow aggregates appeared in this sheet.

Table 3.1 Total numbers and per year growth of vehicles in Karachi from 2002 to 2007

Year	Total no of registered vehicles (in thousand)	Total number of vehicles (in thousand)
2002	1113	1113
2003	1177	2290
2004	1280	3570
2005	1431	5001
2006	1610	6611
2007	1809	8420

Source: Urban resource centre.

The total length of road network in the city is more than 9,500 kms that accommodates about 1.81 million vehicles.

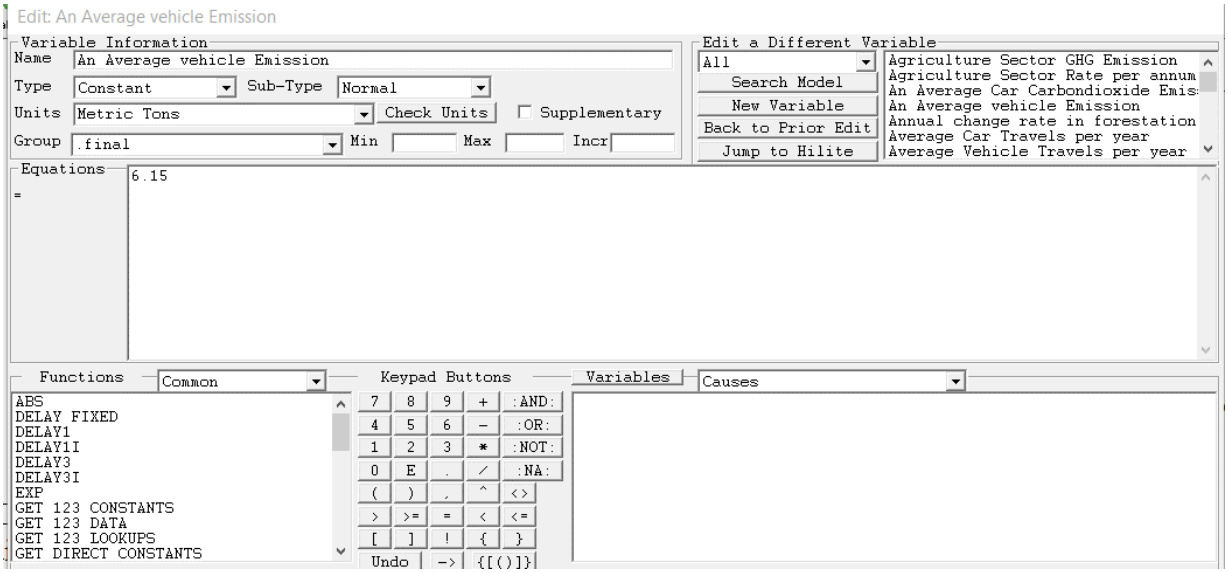


Figure 3.6 Vensim editor for average size vehicle model

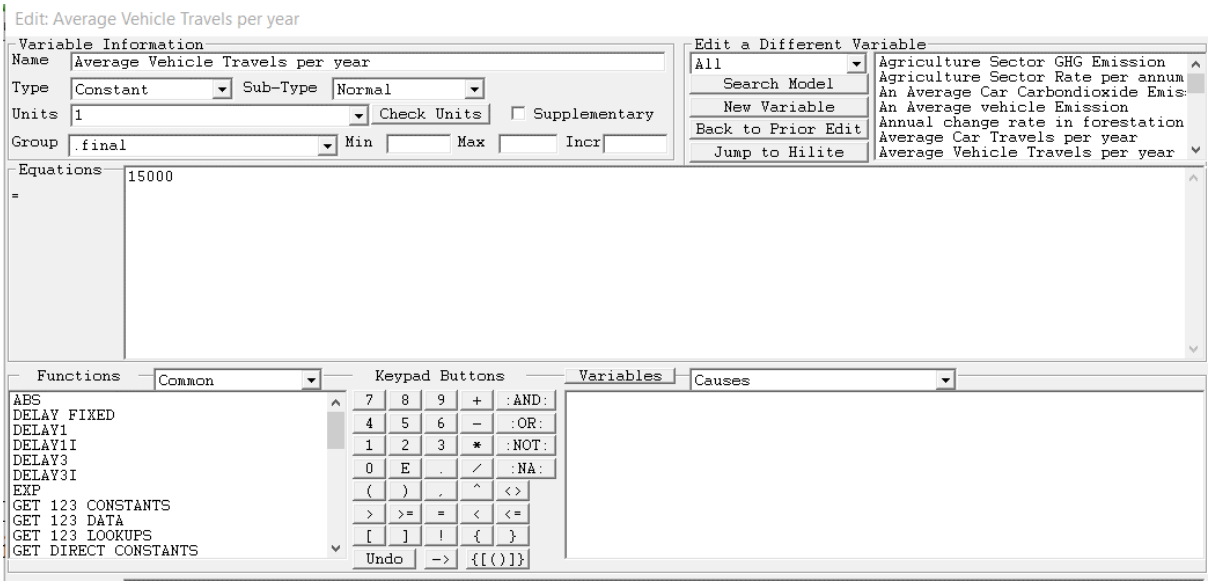


Figure 3.7 Vensim editor for average vehicle that travels per year

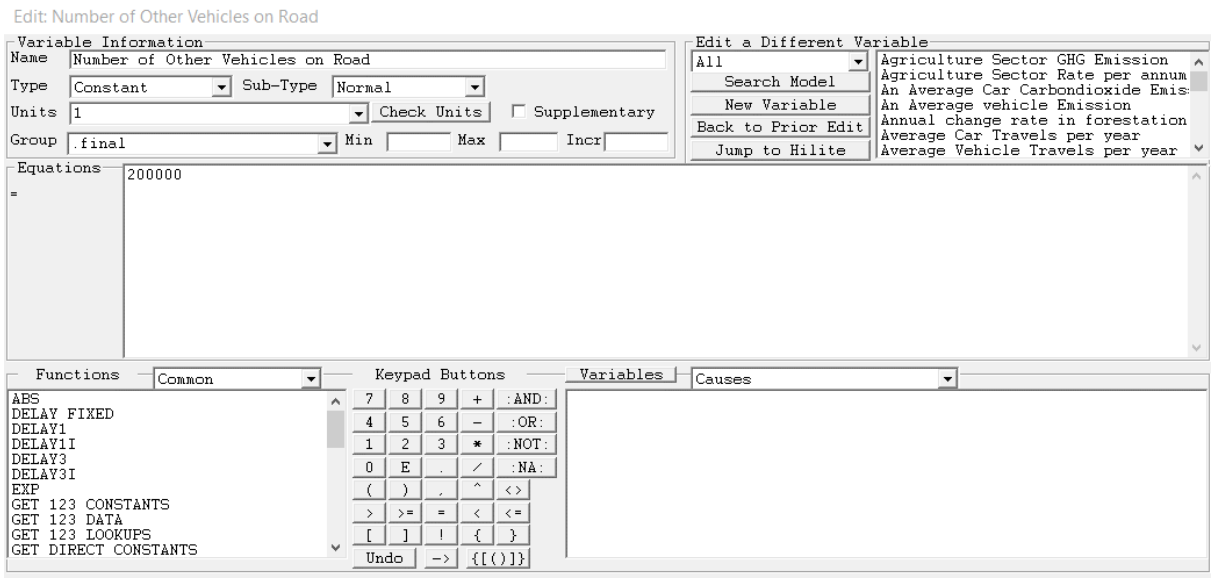


Figure 3.8 Vensim editor for other type of vehicles

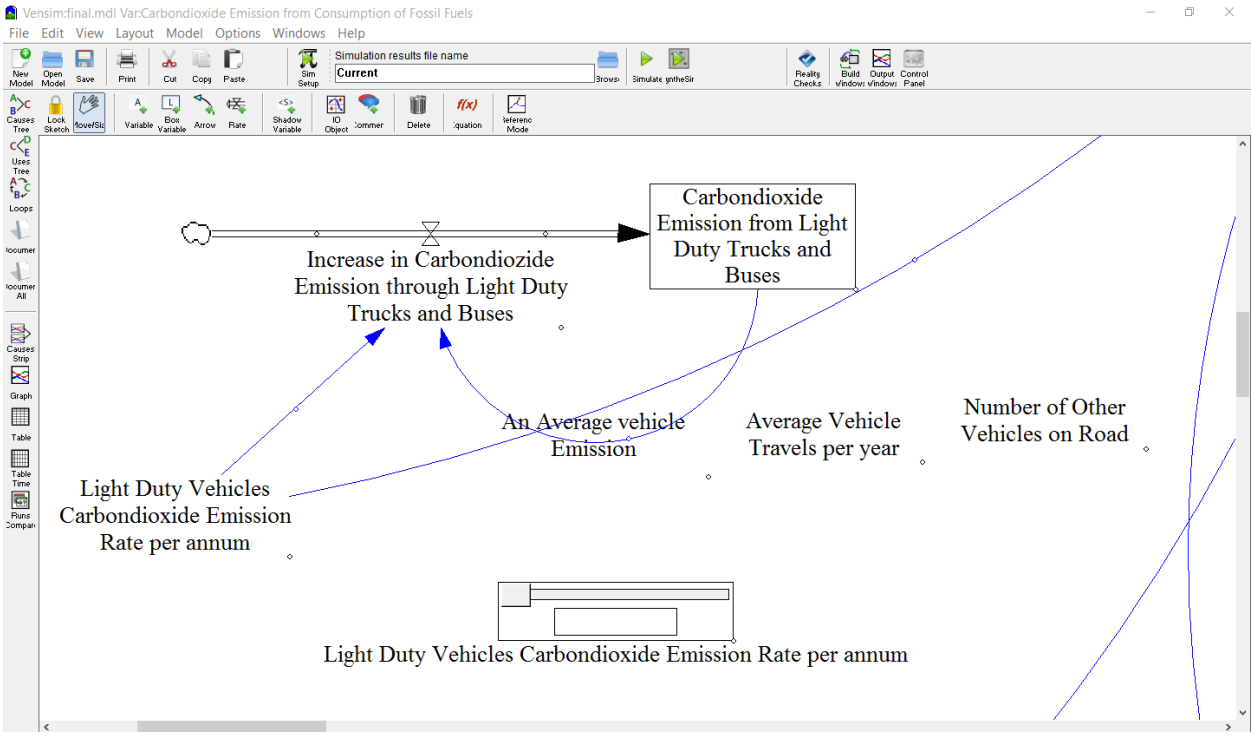


Figure 3.9 Vensim model for light duty trucks and vehicles

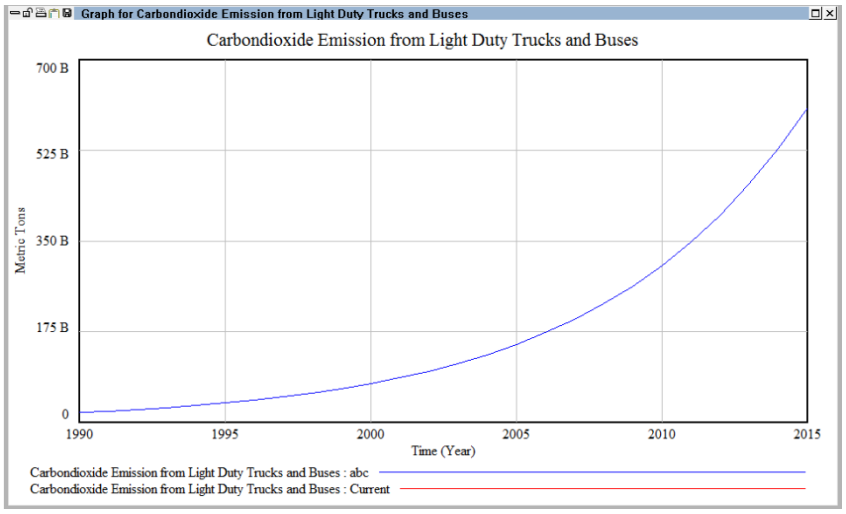


Figure 3.10 Graph for carbon dioxide emission from light duty trucks and vehicles

3.2 GHG emission through Industries

As indicated by report of University College London workshop on environmental change (2005), eleven of the world's worldwide urban areas are in charge of somewhere in the range of 70% of carbon dioxide outflows. Despite the fact that Karachi is excluded among these eleven urban areas but rather the rising patterns of expanding emanation of carbon dioxide are fundamentally demonstrating that it will be one of the real urban areas which have most extreme discharge of CARBON DIOXIDE. All out per-capita vitality utilization in Pakistan is 12.4 million BTUs (1 BTUs = 1,055.055 joules) that contribute 0.7 metric tons for each capita vitality related carbon dioxide outflow in environment. Being the biggest city of Pakistan, Karachi is the real buyer of vitality and the benefactor of carbon dioxide discharge in air than some other city of Pakistan. Figure 3.11 shows the general increment of carbon dioxide outflow in environment over Karachi. The rate of emanation of carbon dioxide is quick as well as it demonstrates a standard exponential pattern with no critical destruction all through the registered time. It is watched that the carbon dioxide outflow in air has come to up to 151 million metric tons in 2006 that was only 39 million metric tons in 1980. This 287% expansion in carbon dioxide amid 1980 to 2007 is the aftereffect of mass urbanization and vitality utilization in Karachi[10].

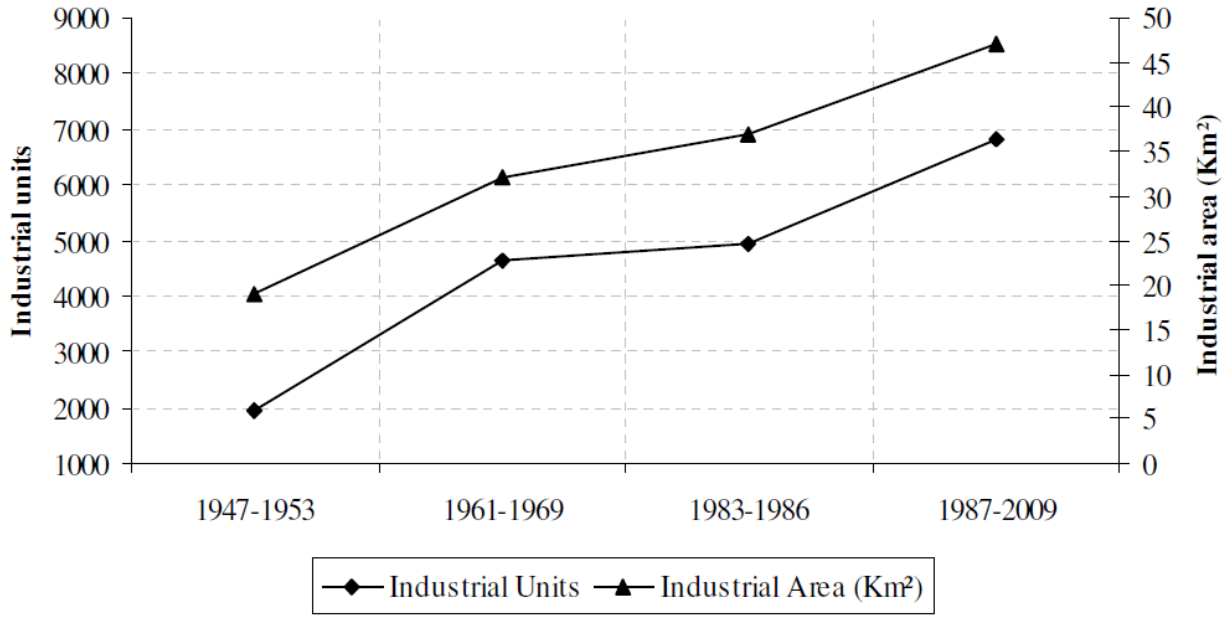
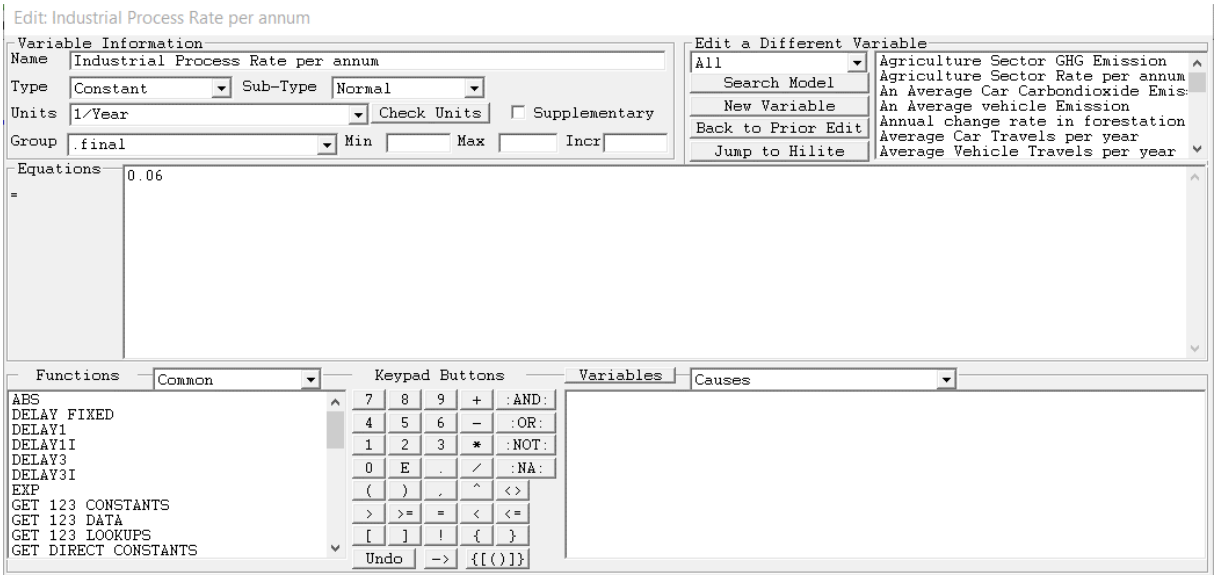
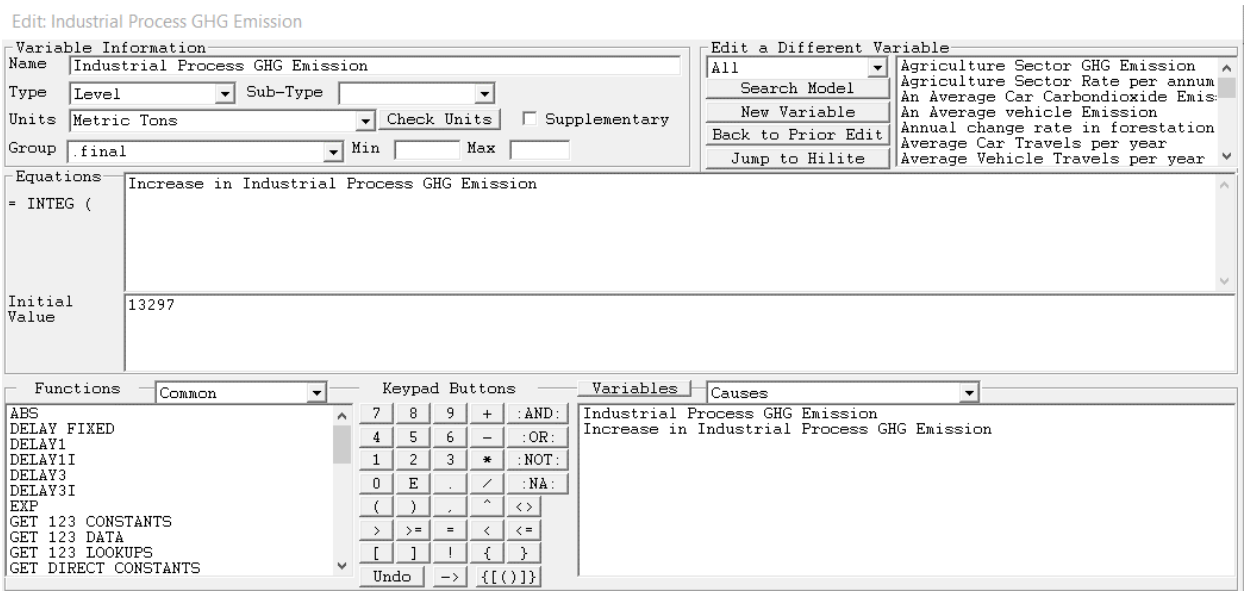


Figure 3.11 The growth in industrial units and industrial area in Karachi since 1947



(a)



(b)

Figure 3.12 (a) and (b) Vensim editor for Industrial process rate and emission of carbon dioxide

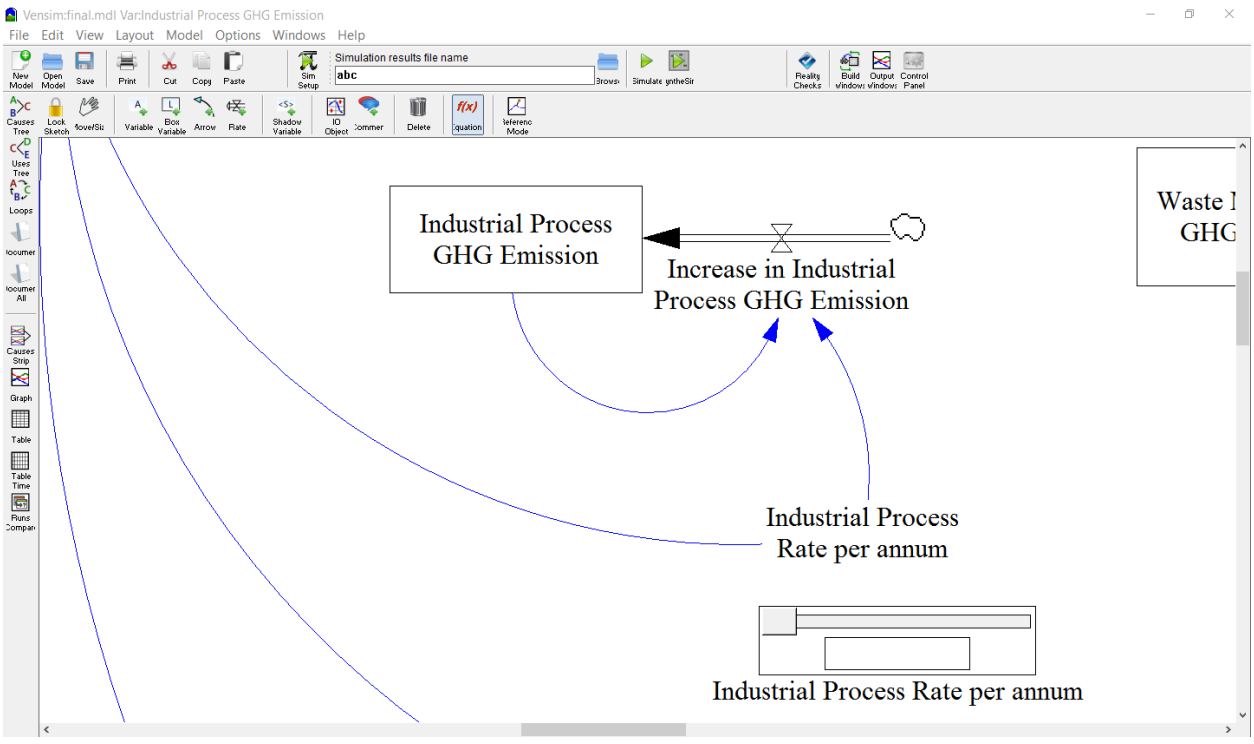


Figure 3.13 Vensim model for Industrial process GHG emission

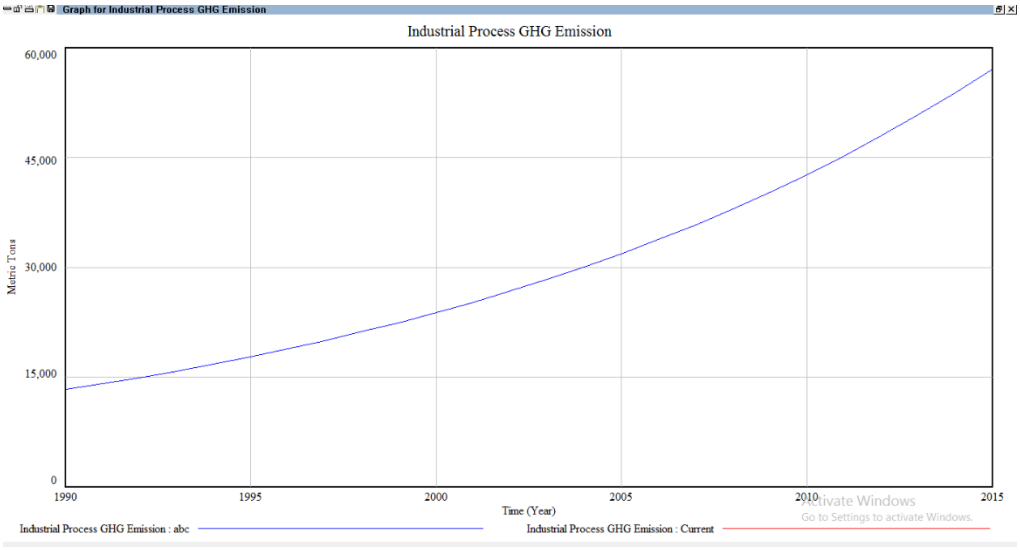


Figure 3.14 Graph for GHG emission through industrial process

3.3 Modeling the Emission of Carbon dioxide through Fossil Fuels

The carbon dioxide emission was just 39 metric tons per year in 1980 but it has reached to 151 metric tons in 2006. This 287% increase in carbon dioxide during 1980 to 2007 is the result of mass urbanization and energy consumption in Karachi.

The emission of carbon dioxide from consumption of fossil fuels in Karachi (million metric tons of CARBON DIOXIDE) since 1980 to 2007.

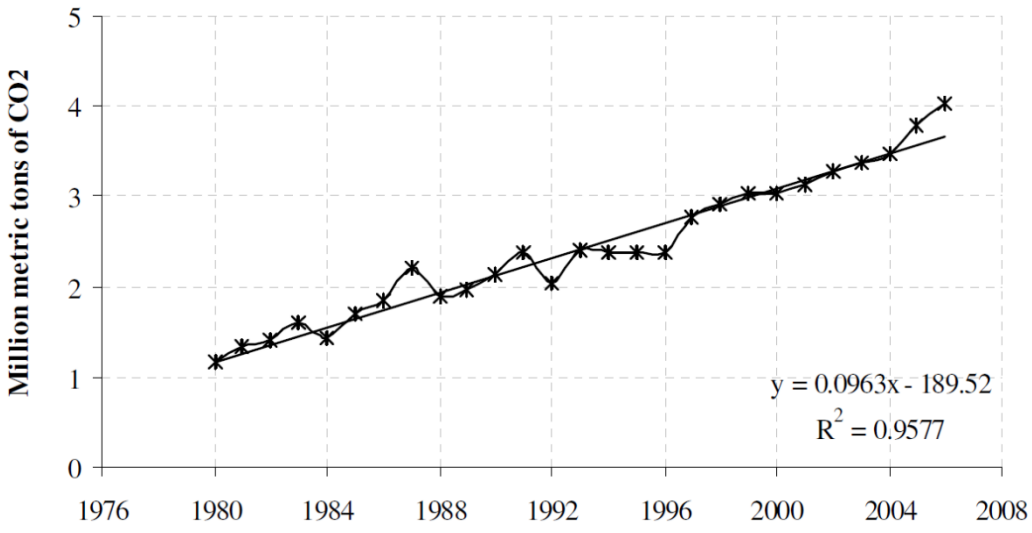
1 metric ton equals 2204.62 pounds. Per year increase in carbon dioxideemission goes 0.5*2204.62 pounds per year

or

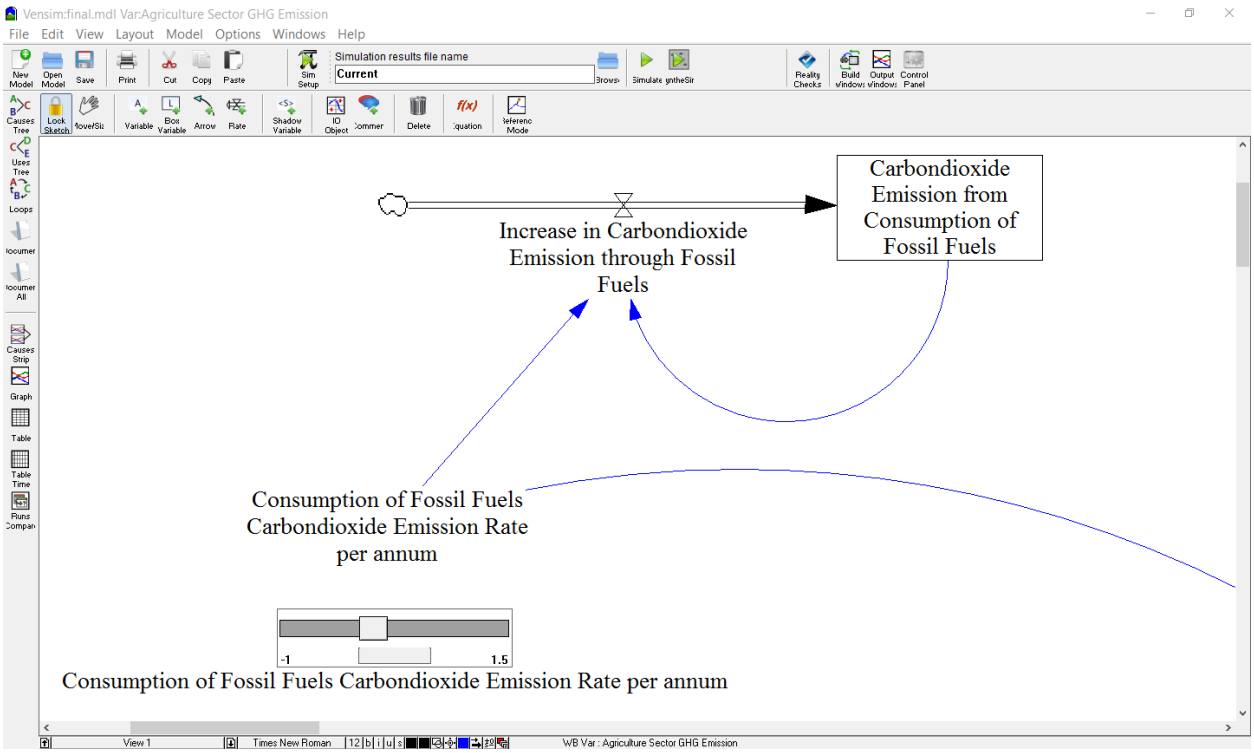
0.5*2204.62*0.000453592=0.499 Million Metric Tons per year

from the equation for the slope of line/ we'll calculate the percent increase:

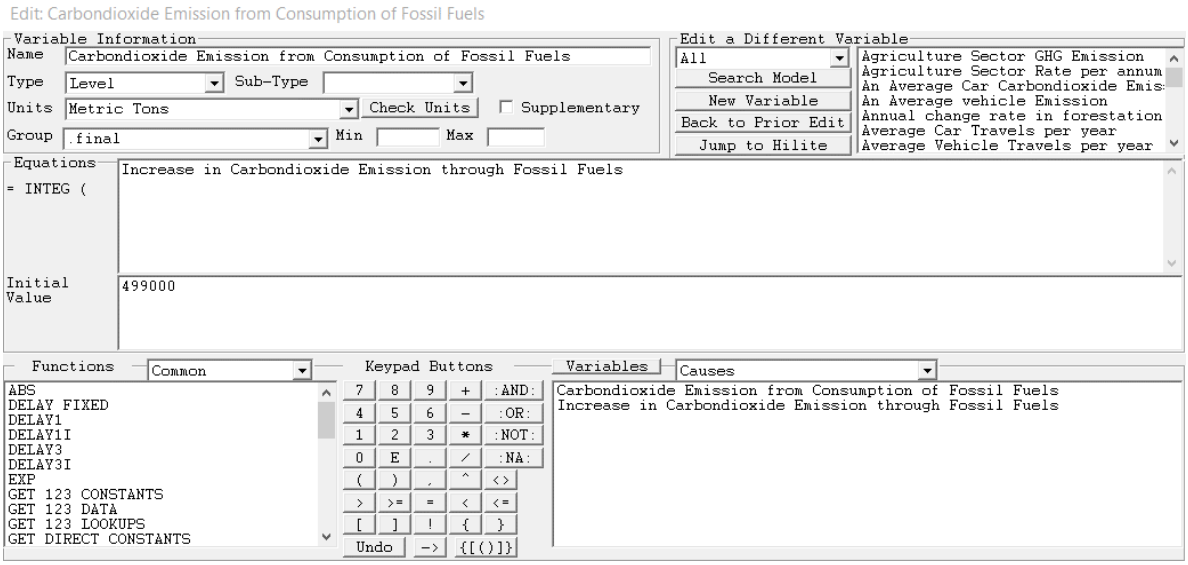
(x1,y1)=(1,1.2) and (x2,y2)=(2,1.5); m=0.3


Million metric tons of CO2
5
4
3
2
1
0
1976
1980
1984
1988
1992
1996
2000
2004
2008
y = 0.0963x - 189.52
R2 = 0.9577

(a)


Vensim:final.mdl Var:Agriculture Sector GHG Emission
File Edit View Layout Model Options Windows Help
Simulation results file name
Current
Carbondioxide Emission from Consumption of Fossil Fuels
Increase in Carbondioxide Emission through Fossil Fuels
Consumption of Fossil Fuels Carbondioxide Emission Rate per annum
-1
1.5
Consumption of Fossil Fuels Carbondioxide Emission Rate per annum
View 1
Times New Roman
WB Var : Agriculture Sector GHG Emission

(b)



(c)

Figure 3.15(a) The emission of CO_2 from consumption of fossil fuels in Karachi (million metric tons of CO_2) since 1980 to 2007 (b) and (c) Vensim structure for carbon dioxide emission through fossil fuels

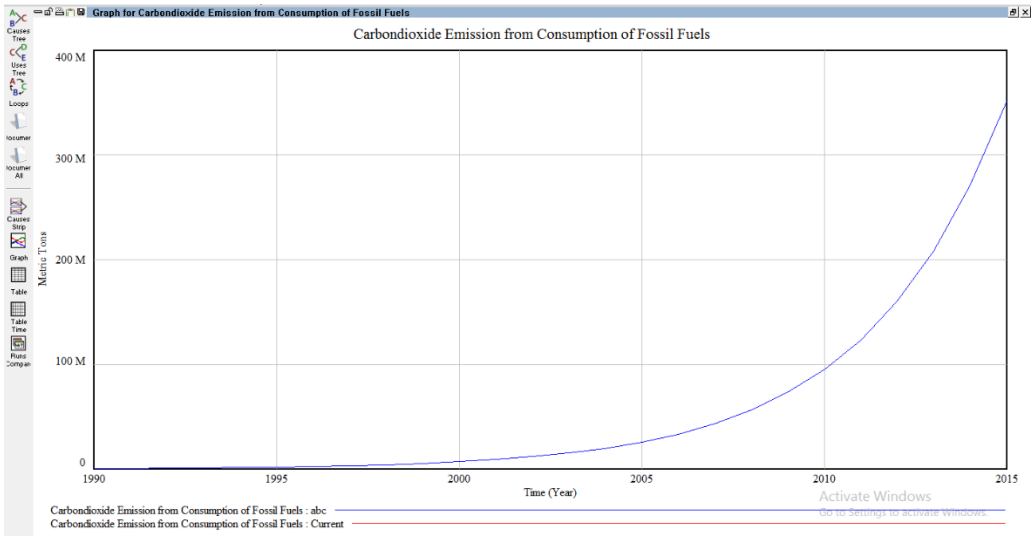


Figure 3.16 Graph for carbon dioxide emission from fossil fuels

3.4 Modeling the emission of carbon dioxide from Oil and Petrol

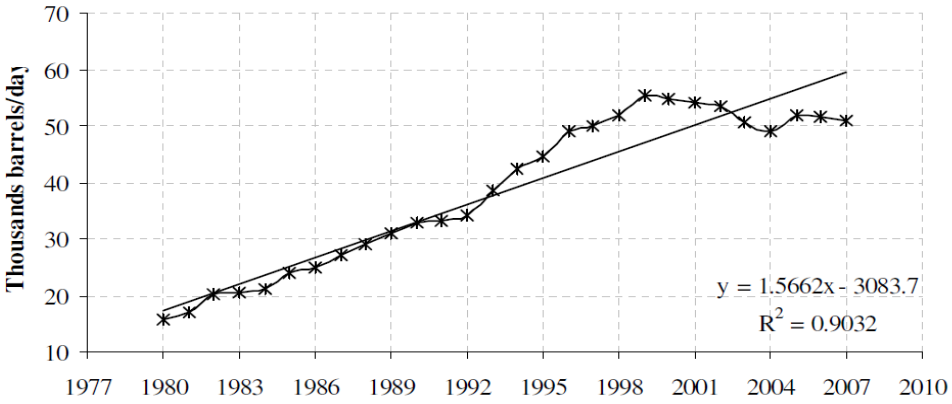


Figure 3.17 The consumption of oil and petrol in Karachi since 1980 to 2007

As we have seen already, after the 1990s, the development of vehicles in the city expanded than the development in populace which was for the most part being because of the general population and private banks in Pakistan which offered credit arrangements with low financing cost for vehicles and houses. This development in vehicles created larger piece of fossil energizes in the vehicle division. Among the investigated information of vehicles, it was seen that around 92% of vehicles are self-possessed which move in the city for individual use (autos and cruisers) and just 8% are utilized for travelers transport (transports, taxis and rickshaws). It demonstrates that individual wellspring of transport has more partake in fossil powers utilization and emanation of CO_2 for the utilization of fossil energizes. Numerous methodologies can be received and measures can be taken by the neighborhood, commonplace and national government to spare the tremendous sum expended as far as use of oil, petrol and imports of vehicles and their parts. To make Karachi a naturally well-disposed city by lessening the vitality utilization and CO_2 emanation, the most critical activity ought to be to build up the urban transport framework on logical premise. The proficient metro prepare or cable car framework like a number of the world urban communities must be begun in the urban communities. It will be the more noteworthy wellspring of transport for the suburbanites of Karachi which will give transport to every one of those a great many suburbanites who utilize their self-transport to travel between various places of the city for their day by day occupations and work places. The venture of Karachi Circular Rail ought to be restarted as it had been working in past. Along these lines, the administration can diminish up to half activity from the

streets. It will diminish no less than 40% of the utilization of fossil fills and CO_2 discharge. It can likewise assist the legislature to diminish the quantity of activity superintendents from the street who control the enormous movement. Moreover, to minimize the weight of rustic urban relocation to Karachi, the legislature ought to create other practical zones in different parts of the nation to give better occupation offices. Neglecting to embrace these methodologies won't just build the ecological issues in Karachi yet will bring about monetary, social and security fiascos in the coming future.

From the volume page we know that:

1 barrel [US, petroleum] = 158.9872972 liter

So 1 barrel weighs:

158.9872972 * 0.88 = 139.908821536 kilograms

1 metric ton is 1000 kilograms:

139.908821536 / 1000 = 7.1475121

So from the date above and calculation for:

3.4.1 Oil and Petrol consumption:

0.8 thousand barrels per year which equals 0.8*1000*158.987*0.88/1000*365 = 40.853.3 metric tons per yearfrom the equation for the slope of line/ we'll calculate the percent increase:

(x1,y1)=(1,0.9) and (x2,y2)=(2.2,1.2); m=0.25

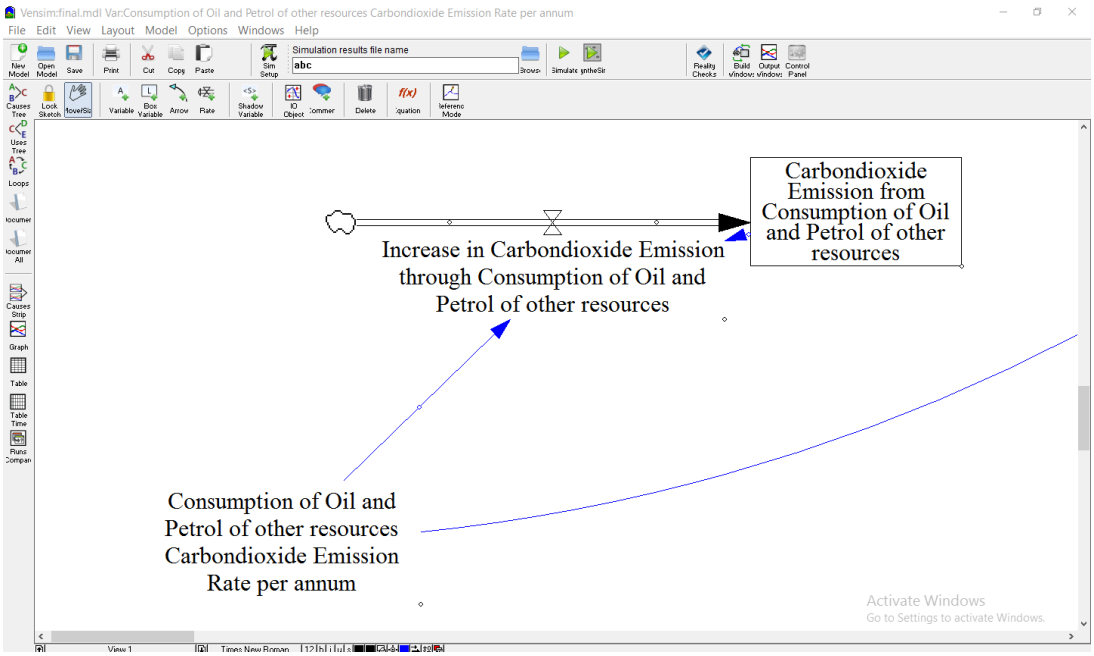


Figure 3.18 Vensim model for carbon dioxide emission from Oil and Petrol

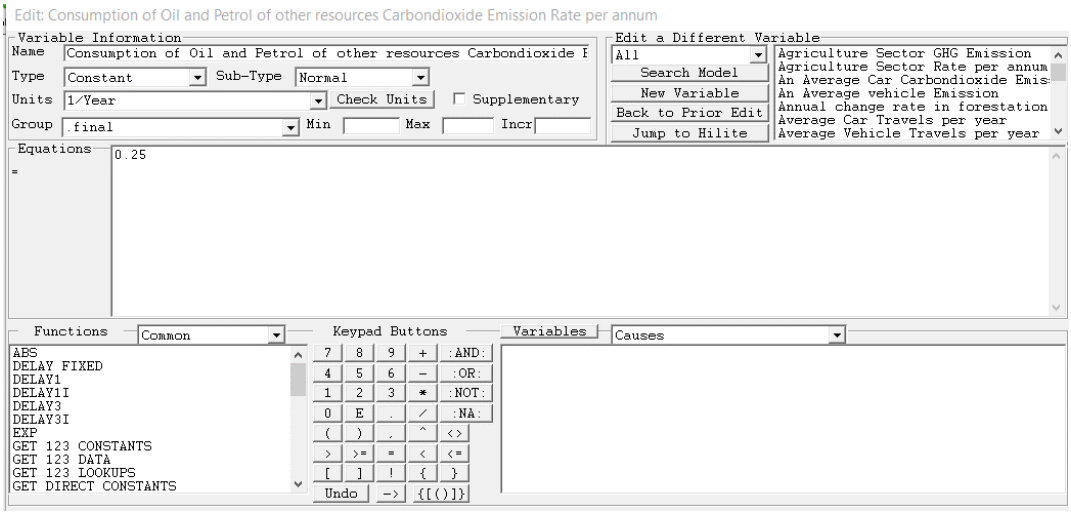


Figure 3.19 Vensim editor for consumption of oil and petrol per year from analysis

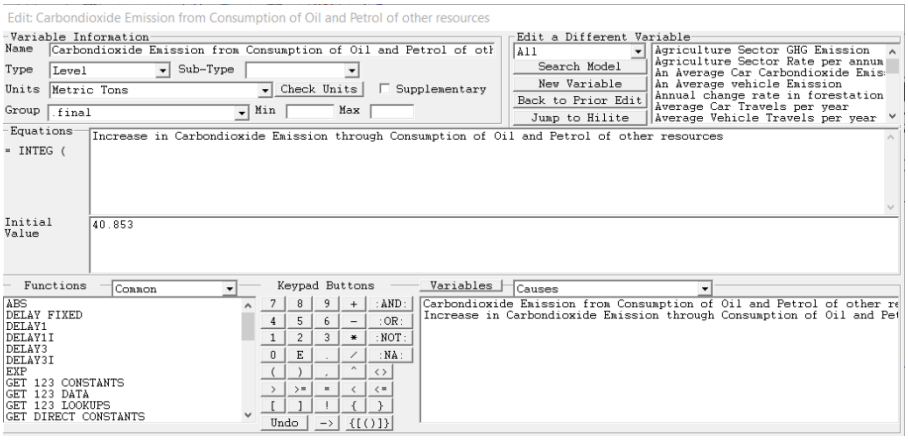


Figure 3.20 Increase in carbon dioxide emission from oil and petrol

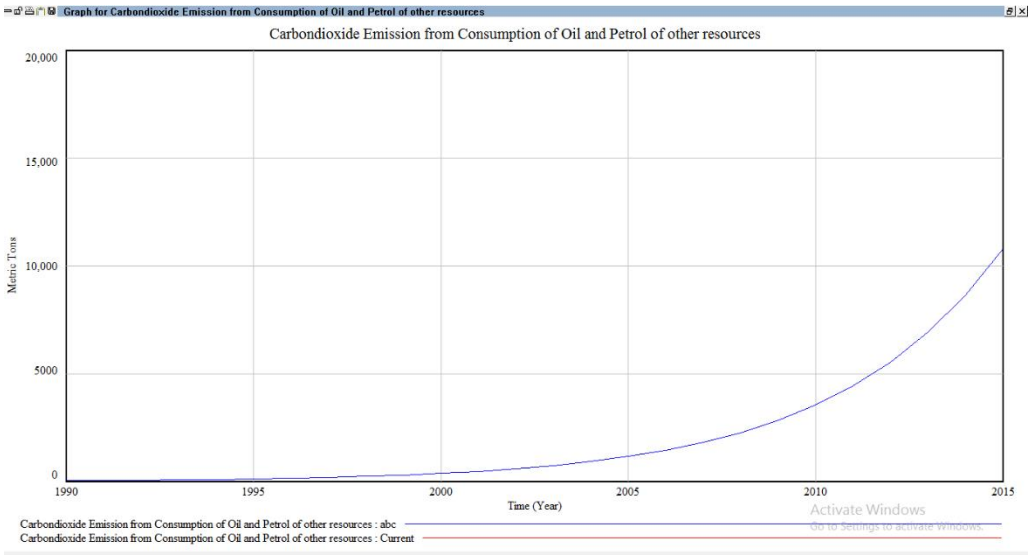


Figure 3.21 Graph for increase in emission of carbon dioxide emission from consumption of oil and petrol

3.5 Modeling for increase in carbon dioxide emission from Natural Gas resources

1 cubic foot = 0.068 Metric tonnes

So for 6 Billion cubic feet per year = 408 872.09 metric tons CO_2 per year

where

mmtbu: Million British Thermal Unit

from the equation for the slope of line/ we'll calculate the percent increase:

(x1,y1)=(1,0.9) and (x2,y2)=(2.2,1.2); m=0.25

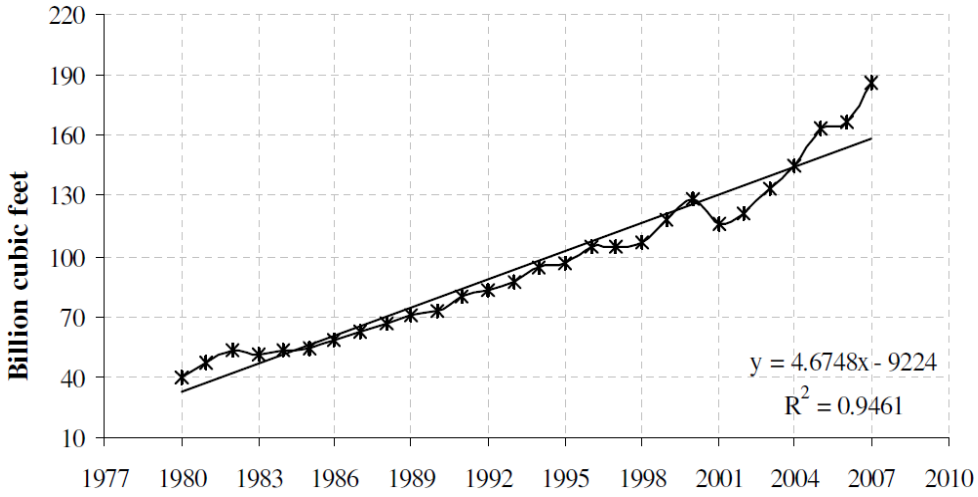


Figure 3.22 The consumption of natural gas in Karachi (billion cubic feet) since 1980 to 2007

Table 3.2 Emission of CO_2 from the industries using Solid fuel, Liquid fuel and Gaseous fuel

Year	CO_2 (MT)	Gaseous Fuel (MT)	Liquid Fuel(MT)	Solid Fuel(MT)
2010	161.3957	0.066695	0.062299	0.01744
2009	157.89	0.067044	0.058357	0.018526
2008	156.6762	0.065808	0.058976	0.018925
2007	158.8948	0.065005	0.057924	0.023128

2006	146.0749	0.063809	0.054264	0.017704
2005	136.6361	0.063549	0.048404	0.016204
2004	131.6013	0.060828	0.046373	0.01692
2003	118.8951	0.054957	0.04425	0.013205
2002	114.084	0.044807	0.053703	0.010088
2001	108.2828	0.037887	0.055133	0.008049
2000	106.4493	0.036399	0.055438	0.008196
1999	100.3841	0.034503	0.052489	0.008599
1998	97.6632	0.032409	0.052621	0.008188
1997	94.7113	0.032244	0.049398	0.008581
1996	94.4473	0.030429	0.05022	0.009366
1995	84.484	0.028133	0.043729	0.008339
1994	84.8397	0.028562	0.043021	0.009215
1993	78.0081	0.026971	0.038415	0.008471
1992	72.79	0.025537	0.035002	0.008368
1991	68.2429	0.024004	0.032339	0.008031

1990	68.5656	0.023135	0.033153	0.008537
1989	60.9565	0.020968	0.029442	0.007088
1988	58.2136	0.018262	0.027352	0.007114
1987	53.5345	0.016799	0.025064	0.006443
1986	49.4532	0.016245	0.022937	0.006274
1985	47.176	0.015486	0.021866	0.005801

Above table shows general outflow of CO_2 in Pakistan which is around 0.5% aggregate emanation on the planet. It can undoubtedly be seen that there is criticalness change in outflow has happened if consider the year 1985 the aggregate discharge was 47.176 million tons of carbon and in the year 2010 the aggregate emanation was recorded as 161.39 million tons [13].

3.6 Modeling the Energy Sector

The GHG stock of Pakistan demonstrates that vitality part outflows were 157 MtCDE (50.7% of aggregate emanations) in 2008 and these were relied upon to grow 17 fold by 2050 to 2730 MtCDE (64% of aggregate emissions).16 The motivation behind why these discharges are required to become critical by 2050 is on account of the extent of the vitality division is required to increment extensively because of higher populace.

Table 3.3 Energy Demand Projections (2005-2030)

Energy Demand Projections by Fuel in Pakistan's Energy Security Action Plan (2005 - 2030)		
	1990 Mtoe	2030 Mtoe
Oil	16.33	66.84
Natural Gas	28.17	162.58
Coal	4.22	68.65
Hydro	6.13	38.93
Renewable	0	9.2
Nuclear	0.67	15.11

In 2008-09 Pakistan's vitality utilization was 37.3 million tons proportionate to oil (mtoe) which was met from a supply blend of gas (43.4%), oil (29%), power (15.3%), coal (10.4%), and LPG (1.5%) all of which in total represented very nearly 51% of the national GHG outflows. Contrasted with the past ten years, petroleum use has expanded by 0.5% for every annum, gas by 6.8%, and power by 5%, and coal by 12.5% for each annum. While in the previous five years, gas utilization has ascended by 9%, coal by 1.5% and oil utilization has declined by 9.5%.

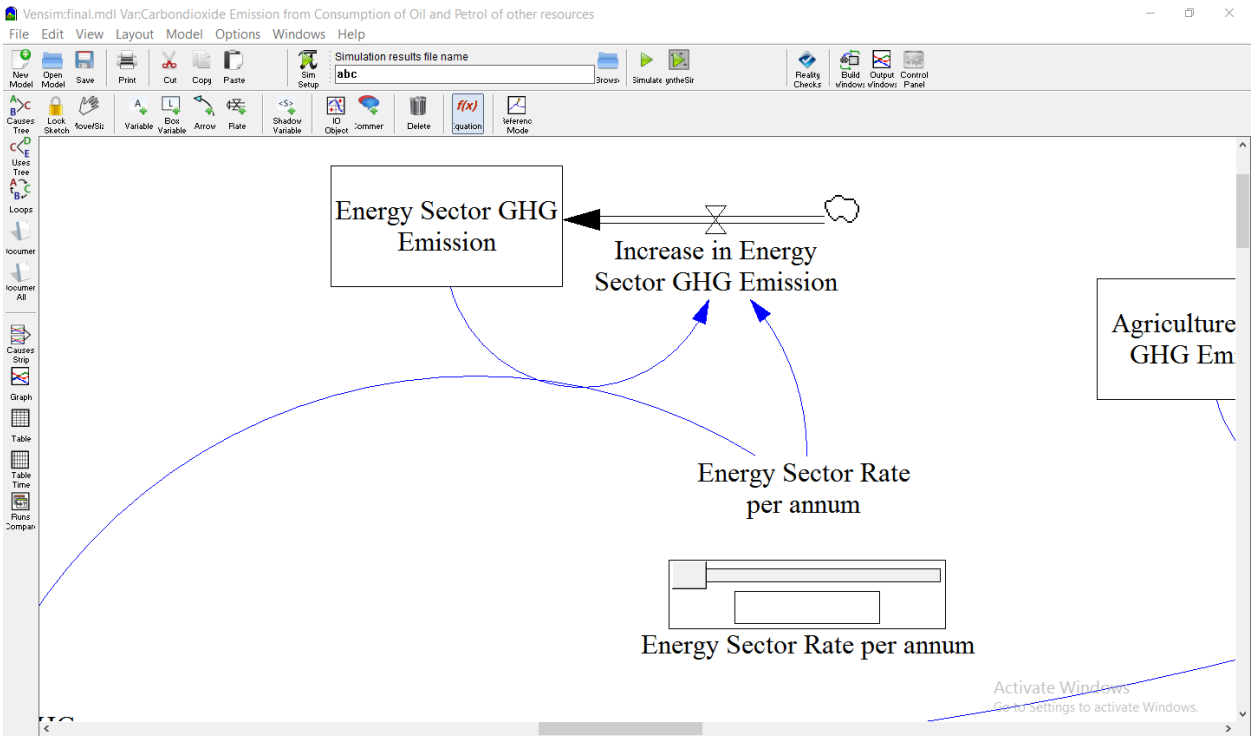


Figure 3.23 Modeling the Energy Sector

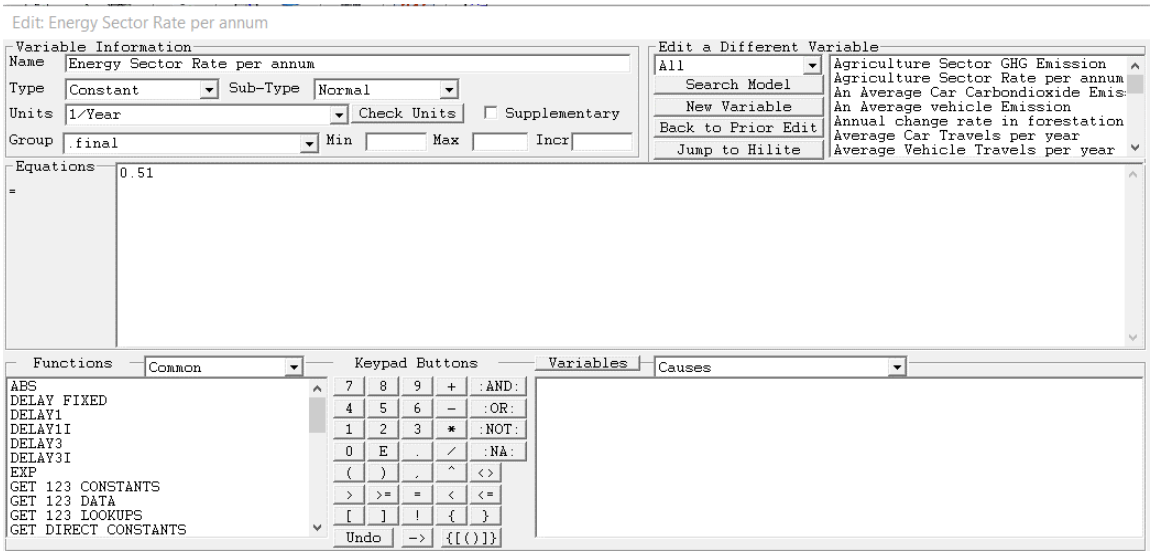


Figure 3.24 The Energy Sector Rate implied on Vensim from data above

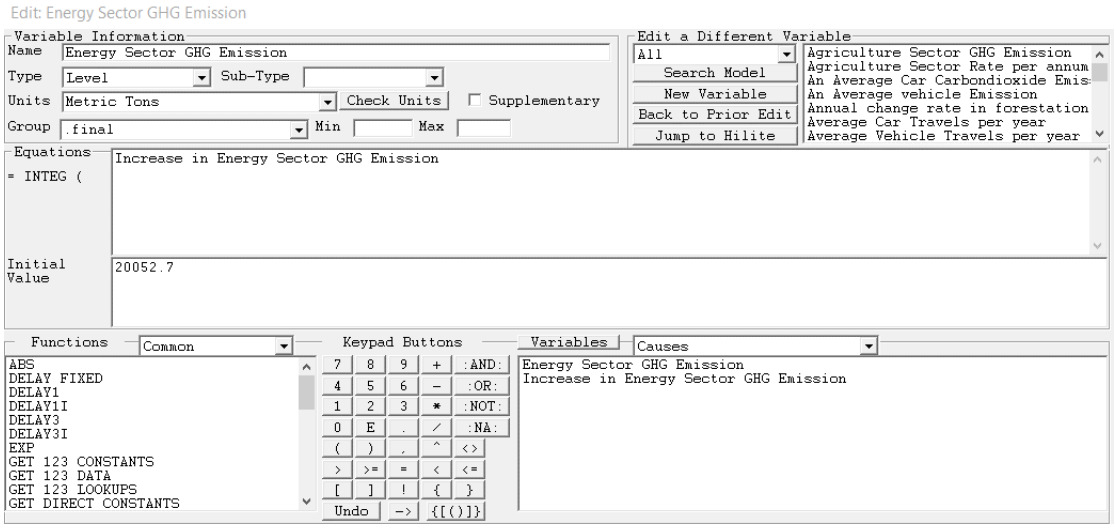


Figure 3.25 Increase rate of GHG emission in Energy Sector

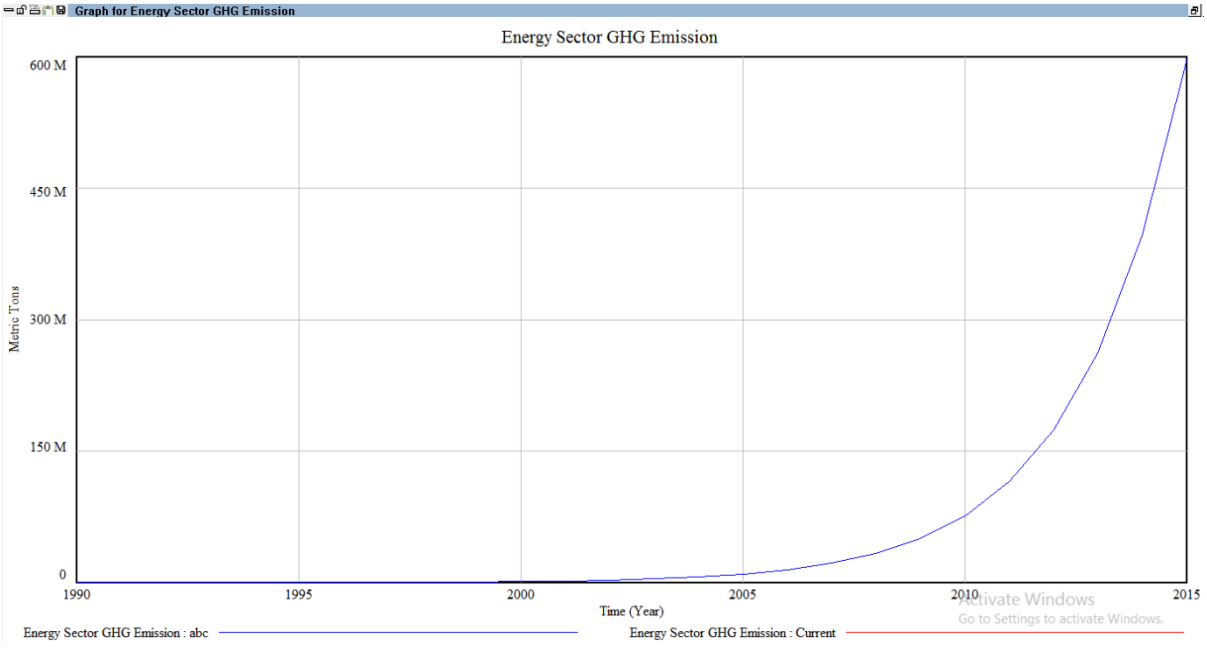


Figure 3.26 GHG emission in Energy sector observed on Vensim

3.7 The LULUCF (Land use, land-use change, and forestry) and Agriculture Sector GHG Emission

The LULUCF part in Pakistan is in charge of just 3% of GHG outflows and its offer is required to fall further to only 0.357% by 2050. However the significance of LULUCF is huge in Pakistan, inferable from the potential for atmosphere relief through carbon sequestration by means of afforestation, reforestation and additionally staying away from deforestation.

In the long run LULUCF has exceptionally positive results seen on Vensim as Pakistan has a range of 3.3 million ha secured by woodlands and planted trees, which is identical to 4.8% of the aggregate area. This relative woodland spread territory is one of the most reduced on the planet and inauspicious even inside the setting of South Asia. Besides, the timberland assets of Pakistan are crumbling both subjectively and quantitatively and the yearly change rate amid 1990-2000 was -1.8% and amid 2000-2005 was - 2.1%, which again dishonorably emerges as a to a great degree high56 deforestation rate.

Figure 3.27 Forest cover in Pakistan

Table 3.4 The Area, Annual change rate and Total change during 1990-2005

	Area			Annual change rate			Total change		
Period and Units	1990 Mha	2000 Mha	2005 Mha	1990-2005 Mha	1990-2000 %	2000-2005 Mha	1990-2005 Mha	1990-2005 %	1990 vs 2000
Plantations	2.3	2.96	3.18	0.006	2.65	0.0044	1.49	0.084	35.9

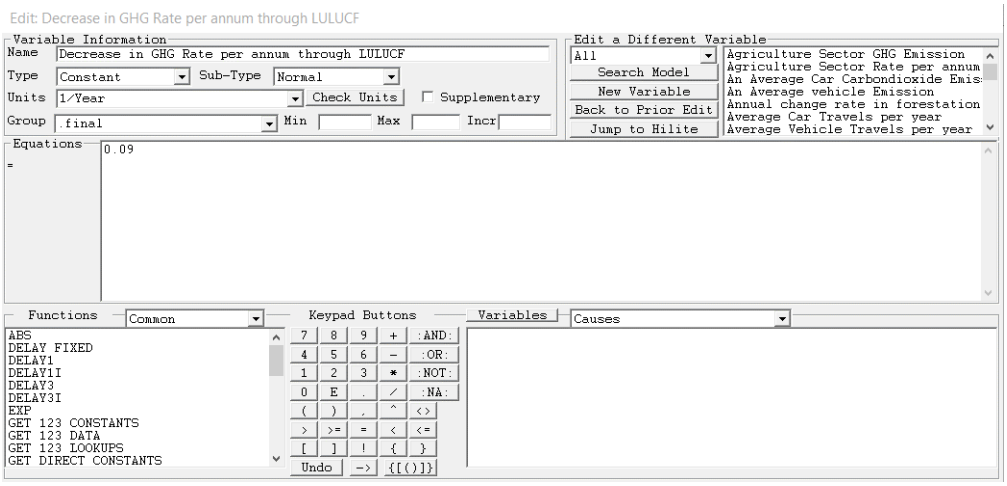


Figure 3.28 The GHG rate through LULUCF on Vensim

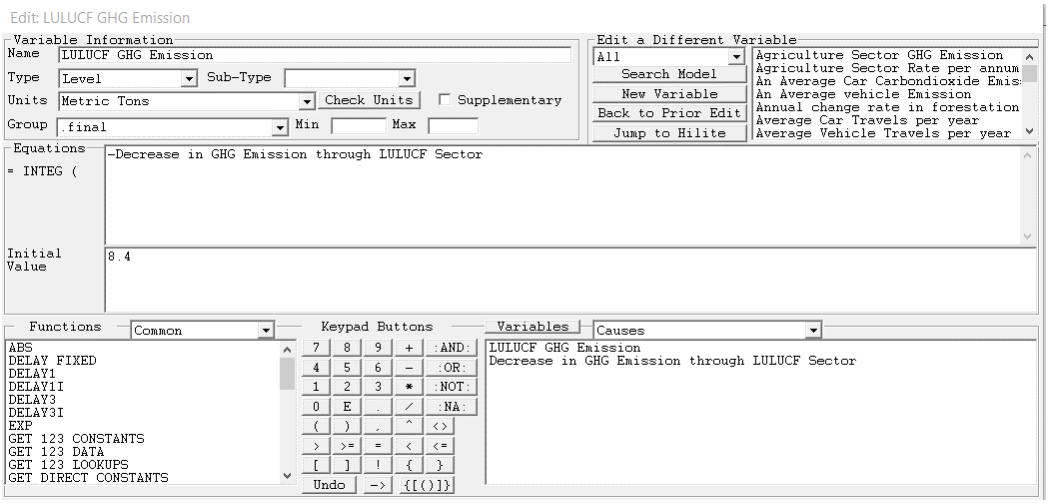
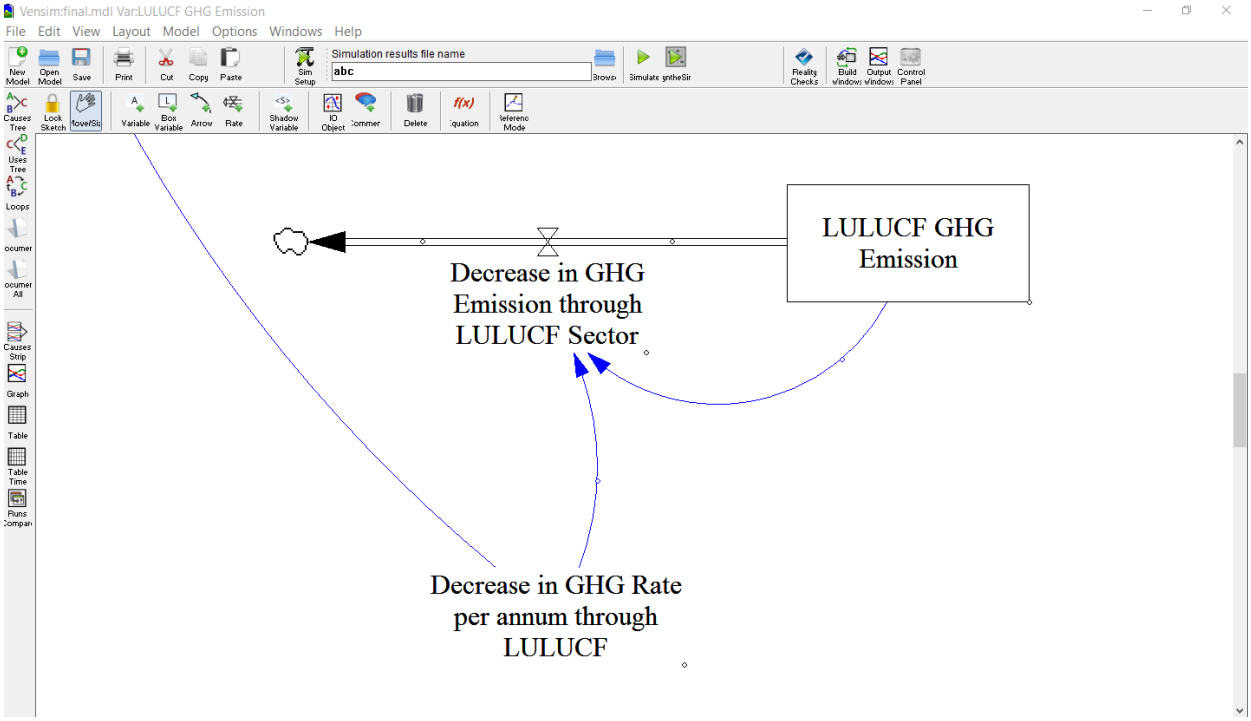
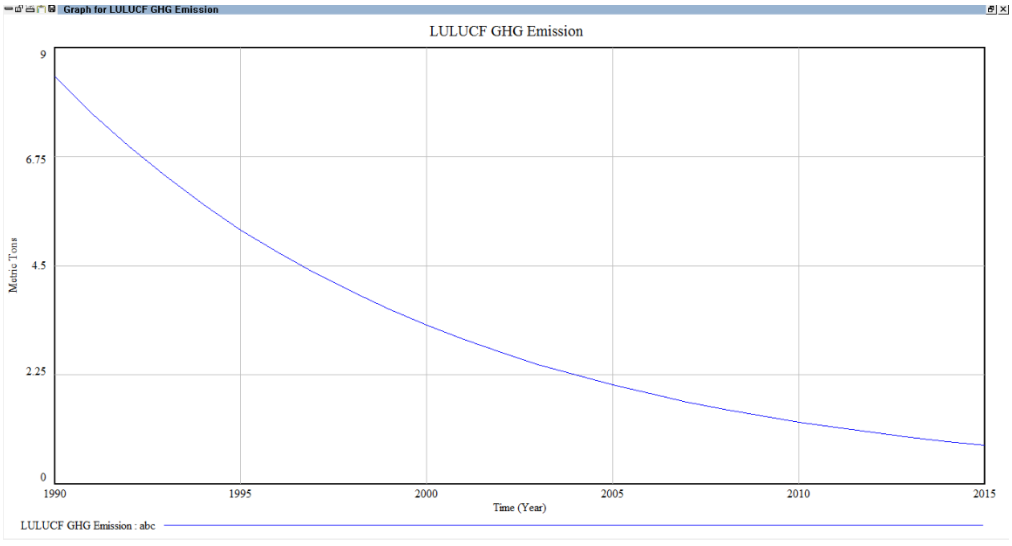


Figure 3.29 The LULUCF Vensim editor initial value

We can observe in Figure 3.30 that the rate arrow is outside as this is the only factor where rate is at decrement producing an opposite result as compare to previous analysis.



(a)



(b)

Figure 3.30 (a) and (b): The Vensim graphical result and flow for LULUCF Sector

Now let us move on towards the Agriculture sector and see the results on Vensim window which are mentioned on figures below.

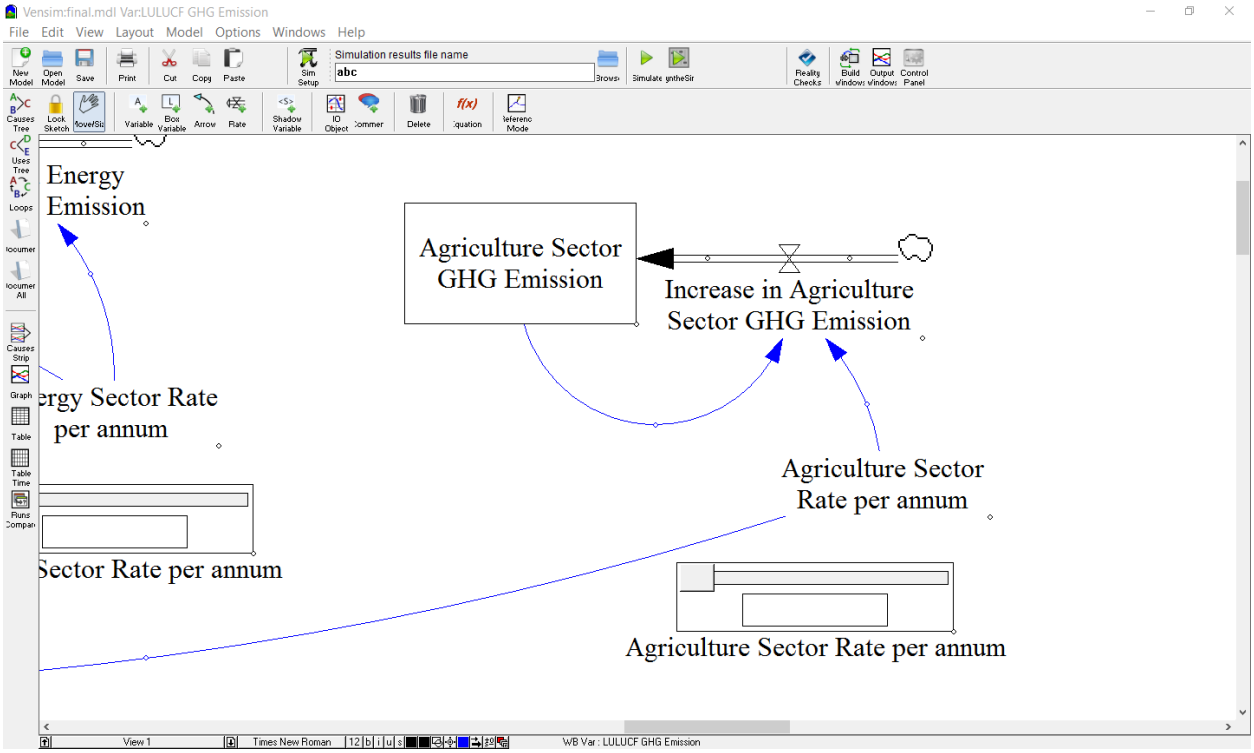


Figure 3.31 Vensim flow model for GHG emission in Agriculture sector

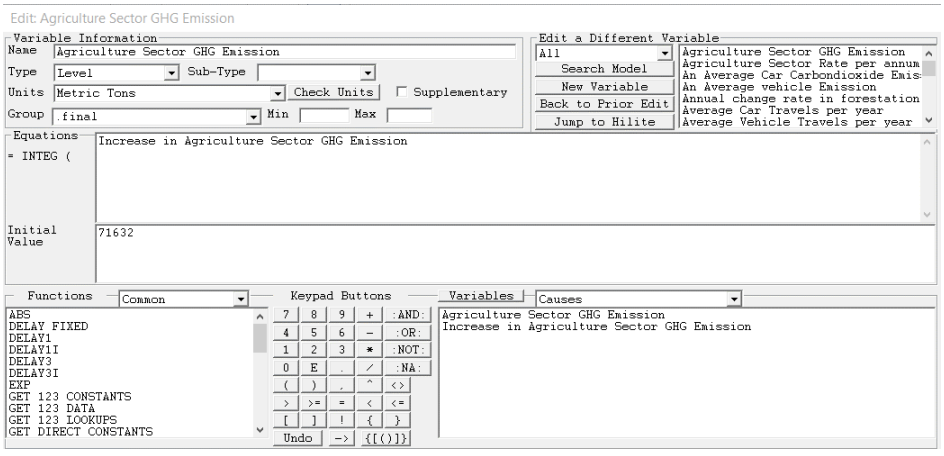


Figure 3.32 Vensim rate applied as per Agriculture and Forestry results

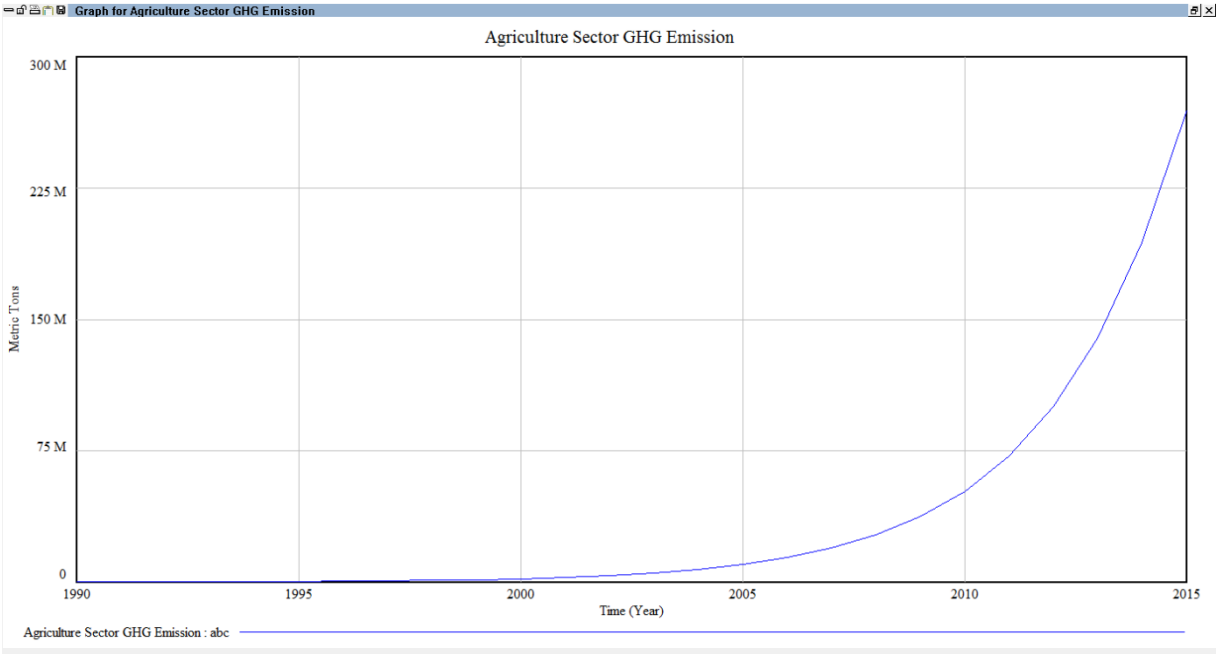


Figure 3.33 Vensim results for GHG emission in Agriculture sector

Chapter 4

Modeling of Forestation area required for control of carbon dioxide

4.1 Single Tree Capacity for Carbon Dioxide absorption and Oxygen Emission

A tree can absorb as much as 48 pounds (0.02177 metric tons) of carbon dioxide per year, and can sequester one ton of carbon dioxide by the time it reaches 40 years old. One large tree can provide a supply of oxygen for two people.

An average lifetime of trees planted in forests for long-term restoration purposes might be 100-150 years. Here are a few examples by region In the Southeast, conifers may live 100-150 years, while hardwoods may live 150-200 years. In the northeast and lake states, some conifers (e.g. white pine and red pine) may live 100-150 years, while Jack pine lives 80-100 years; mixed hardwoods (e.g. maples and oaks) might live beyond 150 years, while aspen and birch might only live 50-70 years. In the Pacific Northwest, conifers may live 200-300 years and longer.

Area of Karachi is 352,700 ha. A 100-ft tree, 18" diameter at its base, produces 6,000 pounds of oxygen [18]. Karachi city has in major of average tree of medium height that are around 40 50 feet which produces 260 pounds (0.117934 metric tons) of oxygen per year.

Table 3.4 Trees that can be planted per ha (Vensim prerequisite)

Spacing (feet)	Spacing (meters)	Maximum Trees can be planted per Hectare
7 x 10	622	1,537 [19]

Carbon emissions from forests go down 25% during 2001-2015. Global emissions from deforestation dropped from 3.9 to 2.9 Giga-tons (Gt) of carbon dioxide (CO_2) per year over the

period of 2001-2015. Deforestation is defined as a land-use change, from forest to other land uses.

4.2 The type of Tree we selected for this project and why

We are working on corynocarpus tree for this project. This type of tree is generally known as Karaka tree.

Karaka or New Zealand shrub is an evergreen tree of the family Corynocarpaceae endemic to New Zealand. It is regular all through the North and South Islands to Banks Peninsula and Okarito, on the Three Kings Islands, on Raoul Island in the Kermadecs, and on the Chatham Islands. It is broad in waterfront environments, frequently shaping a noteworthy part of beach front woods, however it once in a while overwhelms. Most botanists consider it to be local just toward the northern portion of the North Island, having been planted somewhere else by Māori close previous town destinations, and thusly spread by feathered creatures. The basic name karaka originates from the Māori dialect, and is additionally the Māori expression for the shading orange, from the shade of the natural product. In the Chatham Islands, it is called kōpī, its name in the Moriori dialect. It is naturalized and considered intrusive in Hawaii.

Karaka is a verdant overhang tree with erect or spreading branches. It develops to statures up to 15 m and has a forceful trunk up to 1 m in measurement. The thick, rugged leaves are reflexive, dull green above and paler underneath, 50–200 mm long, and 30–70 mm wide with petioles 10–15 mm long. In winter and spring (August to November), karaka produces heavy, erect panicles of small blooms. Singular blossoms are 4–5 mm in distance across and greenish-cream to grayish or light yellow. The organic product is an ellipsoid to ovoid drupe 25–46 mm long, with light yellow to orange tissue, containing a solitary seed.[1] The natural product ages in summer and harvest time (January to April) and the seeds are for the most part scattered by columbiform feathered creatures which eat the natural product.

4.2.1 The Biology of this tree

This evergreen tree is a famous spot for littler feathered creatures to rest amid the winter. It is of awesome quality to flying creatures and other fauna, including spineless creatures that eat their products of the soil their seeds. The capacity to hold up under organic product in winter gives this plant a vital environmental quality, being a decent sustenance hotspot for some species, particularly winged creatures, during an era when assets are rare.

4.2.2 Cultivation

Karaka might be effectively developed from new seed, yet cuttings are extremely hard to strike. Youthful plants are ice delicate and touchy to cool. The tree regularly naturalizes in reasonable environments. It is basic in development and generally accessible available to be purchased both in New Zealand and in appropriate atmospheres elsewhere.[1] It was broadly developed by the Māori.

4.2.3 Uses

The mash of the organic product is consumable, albeit biting, however the crisp portions contain the lethal alkaloid karakin. Accounts from the nineteenth century record that broad preparing was utilized by Māori to change over the bits to a palatable shape, and specify that if the handling was not finished with the best care, harming would come about with side effects including fierce shakings and extreme muscle fits which could leave the appendages for all time settled in bended positions. Passing brought about a couple cases.[2] The berries are poisonous if ingested by pooches and may bring about death.

4.2.4 Culture

On the Chatham Islands this tree (privately known as kopi) has assumed a recognized part ever: the delicate bark of these trees has been utilized for making dendroglyphs. In late 1998, 147 known kopi trees with dendroglyphs remained.

4.3 Simulated Result and Conclusion of Forestation Area Required for Control of Carbon dioxide

The required Oxygen Emission from Karaka tree within this atmosphere on current stats: More than 1.5 million metric tons of oxygen per year to fill the gap. A single (on average height of 60 ft) tree produces 0.02177 metric tons of oxygen at daytime per year which can provide a supply of oxygen for two people. Further can sequester this rate to 1 metric ton per year as it reaches its best height in 40 years. Means it increases at rate of 1.14 in 40 years and reaches upto the production of 1 metric ton of oxygen per year. To cover the gap of 1.5M metric tons;

1,500,000/0.02177 = 68,902,159 of trees in 352,700 ha area

So per ha it goes 68,902,159/352,700 = a minimum of 196 trees per hectare in the busy Karachi city.

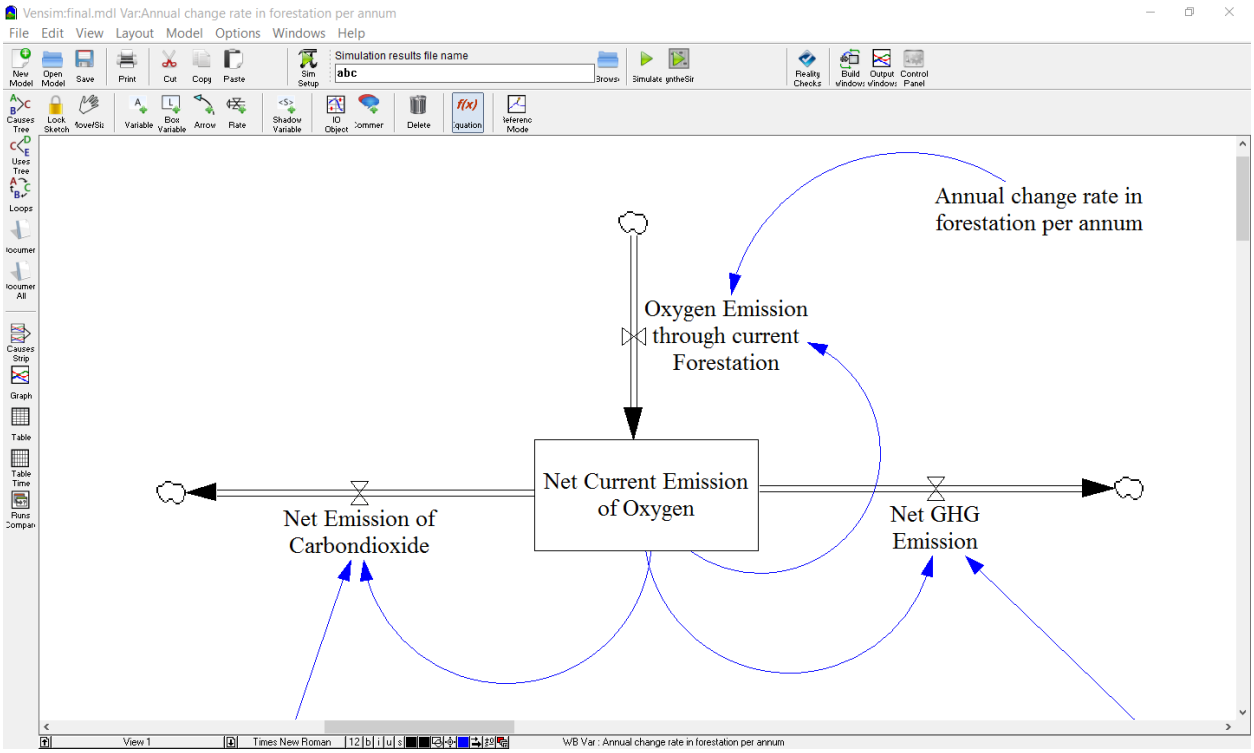


Figure 4.1 The overall Vensim model for Net current emission of Oxygen

We can observe in Figure 4.2 that the annual change rate in forestation per annum is not as sufficient to overcome the emissions and eventually producing a better level of oxygen. The results can be seen next.

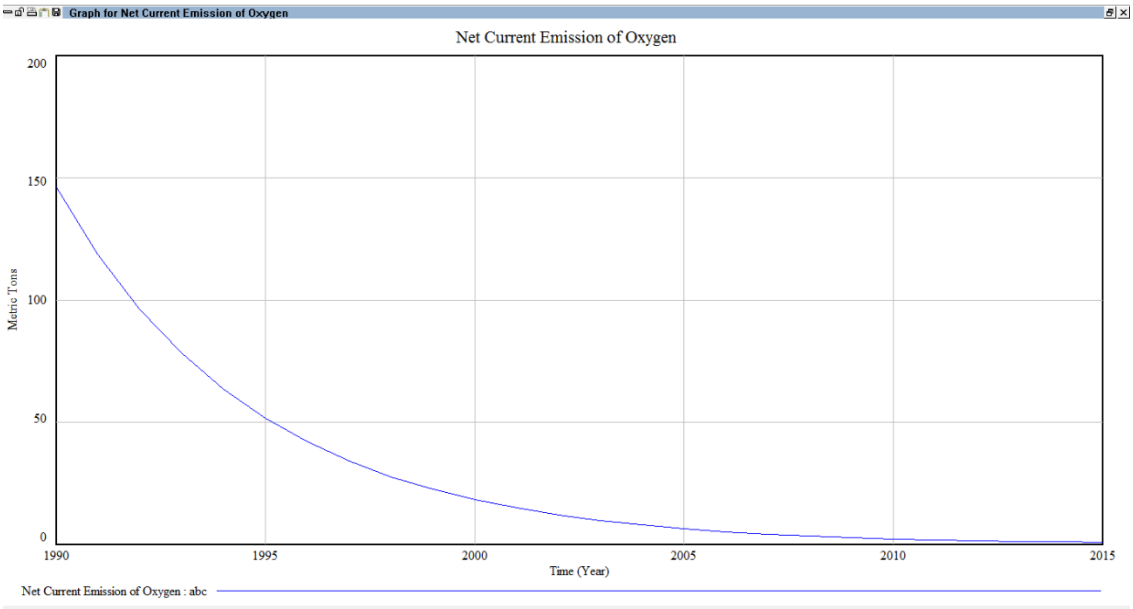


Figure 4.2 The required emission of oxygen needed which is actually going down

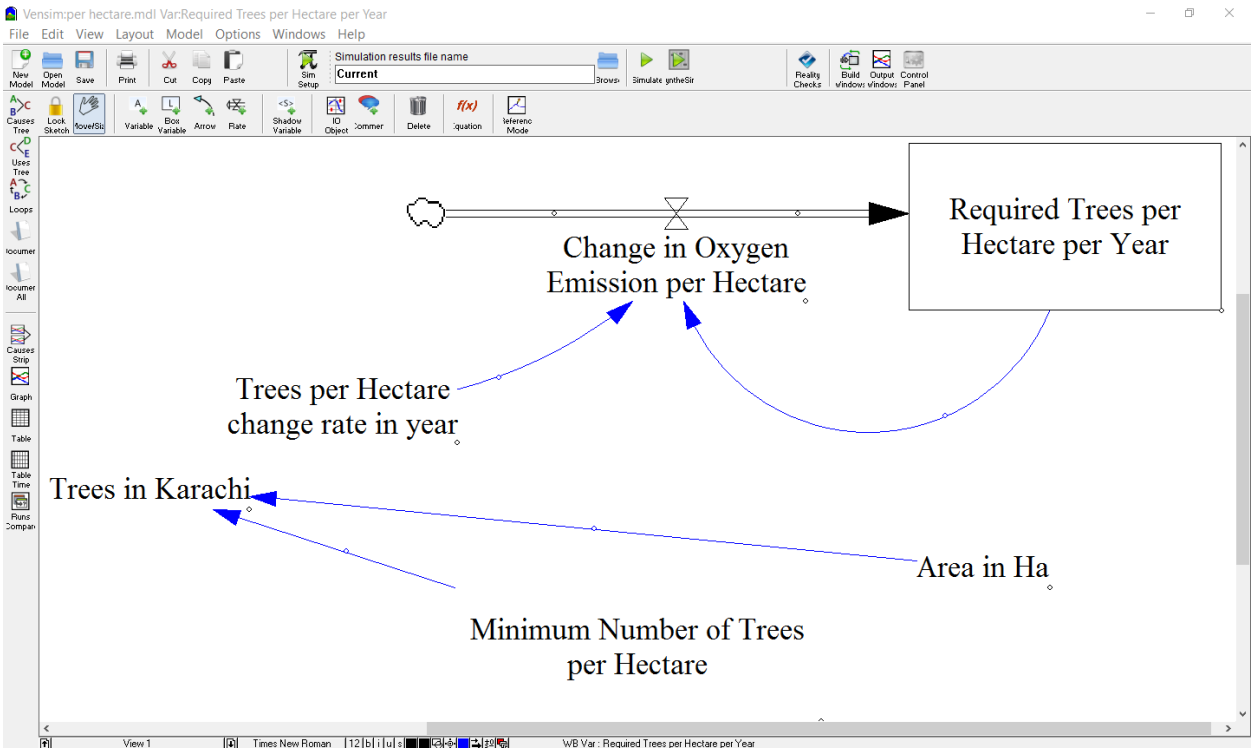


Figure 4.3 Vensim model for the required trees per ha per year to overcome aforesaid results

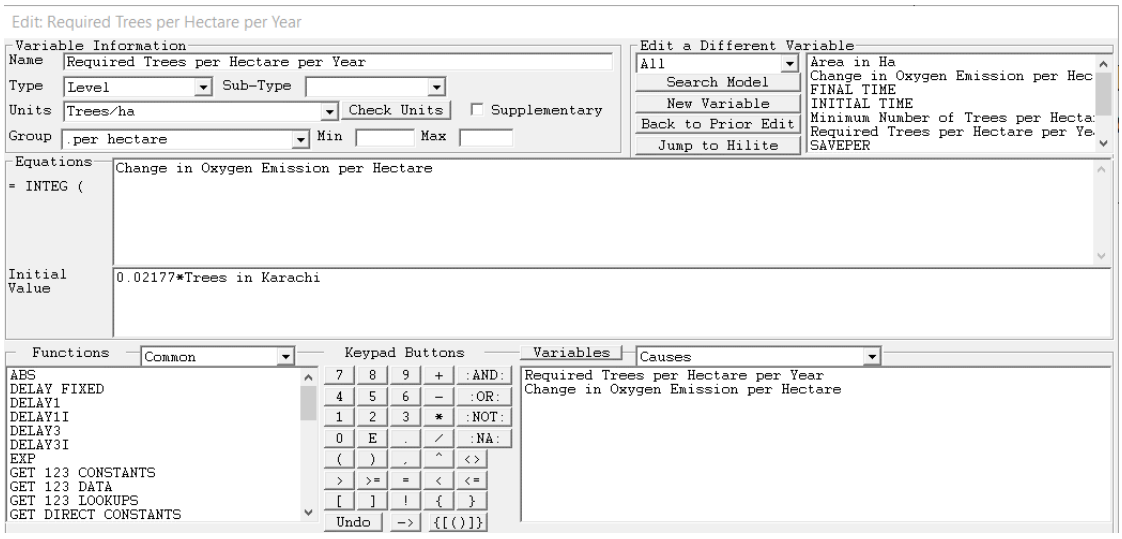


Figure 4.4 Vensim initial rate for required trees from Trees in Karachi and Trees per ha per year models

Planting a minimum of 1,537 trees per ha results an overcome to 1.5 M mtons of oxygen which increases to more good results as they grown up. Figure 4.5 elaborates the results through Vensim graph.

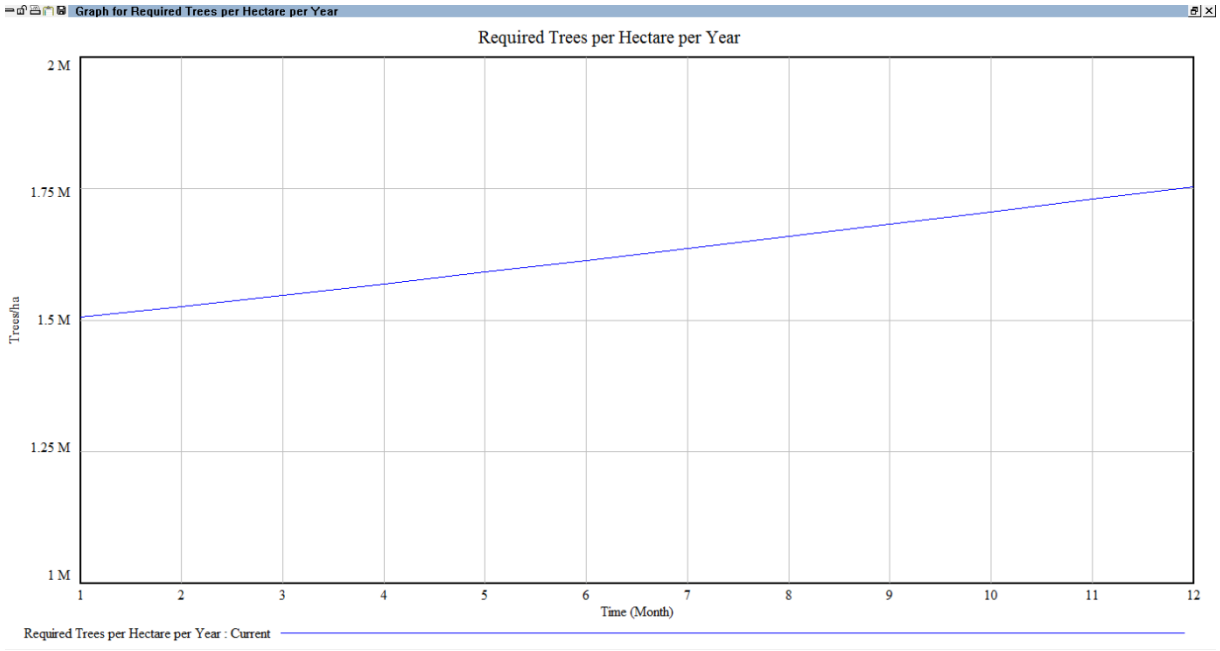


Figure 4.5 Vensim graph for minimum number of trees to be planted per ha per year

Chapter 5

Summary

I have presented in this thesis, the general trend of carbon dioxide and GHG emissions from various sectors particularly energy and agriculture sectors, along with industrial process, waste management, LULUCF (land use, land-use change and forestry) sector with the current emission of oxygen. And finally, it was estimated that how much trees per hectare are required to overcome the hazardous gases / radiations emitting from different resources.

This exploration proposes the base number of trees that can be planted, regarding per hectare, to control GHG discharge that principally bring about retention and outflow of radiations. Carbon dioxide is another main consideration that should be compute regarding every year. The quantity of trees must discharge more oxygen then the negative radiations from GHG. And every one of these workings ought to have a model base outline. We should begin with atmosphere states of Pakistan at an extremely fundamental and brief level then will move towards the conditions for its financial capital Karachi.

The essential bit of undertaking consolidate the data gathering which incorporates basically the essentialness portion, the agriculture part, present day strategy, waste organization, LULUCF (land use, land-use change and forestry) region. As discussed before in purpose of interest that Karachi is really a noteworthy city with offensive organization of development control, so data gathering for outpouring of carbon dioxide was another inconceivable test and by some methods made sense of how to achieve those results which helped an extraordinary arrangement in systems.

The initial segment of undertaking incorporate the information accumulation which includes fundamentally the vitality area, the horticulture segment, mechanical procedure, waste administration, LULUCF (land use, land-use change and forestry) part. As talked about before in point of interest that Karachi is a significant enormous city with shameful administration of

activity control, so information gathering for outflow of carbon dioxide was another incredible test and some way or another figured out how to accomplish those outcomes which helped a considerable measure in procedures.

The GHG sectors which are focused in this research include the energy sector, agriculture and livestock and the carbon dioxide emissions from the transportation sector and fossile fuels mainly.

Karachi has many types of tress that includes The Corynocarpus tree, The Eucalyptus tree, The Khajoor tree, The Neem tree and the Laal Badaam tree. I have chosen the Corynocarpus tree e as this type of tree is generally known as Karaka tree. Karaka is a verdant overhang tree with erect or spreading branches. It develops to statures up to 15 m and has a forceful trunk up to 1 m in measurement. The thick, rugged leaves are reflexive, dull green above and paler underneath, 50–200 mm long, and 30–70 mm wide with petioles 10–15 mm long.

The data grabbed from the situational analyses has brought down to some graphical relationships. The software platform where we will be designing model and conducting simulation is Vensim. Vensim rich feature set emphasizes model quality, connections to data, flexible distribution, and advanced algorithms. Configurations for everyone from junior researchers to professionals. This software basic works on formula based principles but on the other hand also supports optimization to sensitivity levels.

A stochastic (random) data using any variable is easily seen in a flow and that is how the benefit of this software is taken. The data collected from different resources for Karachi was given a graphical flow and a gradient formula was opted to simulate it on this software tool. The graphical flow from the year 1990 to 2015 eventually presents the picture how situation is changing. The change that needs to be improve is overcome through another proposed model which consists of oxygen emission through a single year duration.

The total length of road network in the city is more than 9,500 kms that accommodates about 1.81 million vehicles. Starting from number of passenger cars and their types were taken from the data. They are simulated in Vensim. Then moved towards the heavy fuel vehicles and light transport vehicles. All the data is simulated and so the actual emission of carbon dioxide was noted from Transportation sector. Fossil Fuel Sector was another very major sector. The old fossils emit carbon dioxide and a very few radiated gases. These are so inputted into the software tool and so the emission graph came into being. Energy sector is mainly defined by the electricity production sector in Karachi. The GHG emission through the energy sector has been recorded. Now comes the turn for industrial process. All out per-capita vitality utilization in Pakistan is in millions of metric tons that contribute less than one percent of metric tons for each capita vitality related carbon dioxide outflow in environment. Being the biggest city of Pakistan, Karachi is the real buyer of vitality and the benefactor of carbon dioxide discharge in air than some other city of Pakistan.

The result shows that the emission of GHG and carbon dioxide is more than the emission of oxygen and hence the target was to found out how much trees could be planted in per hectare area to overcome this situation. The required Oxygen Emission from Karaka tree within this atmosphere on current stats: More than 1.5 million metric tons of oxygen per year to fill the gap. A single (on average height of 60 ft) tree produces 0.02177 metric tons of oxygen at daytime per year which can provide a supply of oxygen for two people.

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Acknowledgements

I would like to thank the following:

Almighty Allah for giving me the strength and wisdom to complete this work in the best possible way.

APFnet and Chinese Government for providing an excellent platform for young researchers like me to pursue our research goals and career objectives.

Prof. Dr. Li Ping Ping for being my supervisor, and helping me out not only in my research but also in resolving various other problems which I encountered during my stay in P. R. China. She has always been like a mother figure for me and has showed me great affection and kindness. Thanks to her for supporting me and always being there whenever I needed her.

My mother, who has always tried her best to provide me an excellent education, and has always guided and supported me in every aspect of my life. Thanks to her for making me the person I am today.

My husband for supporting me and always believing in me, despite all the odds and difficulties.

All my colleagues at NFU for endless discussions both technical and fun-related.

Thanks to all the teachers at NFU for being very helpful and cooperative.

Last but not least, my daughter Inaaya Najam and my son Muhammad Mustafa Najam, and to them I dedicate this dissertation.