GOVERNMENT OF ASSAM

ONE MAN ENQUIRY COMMITTEE

(ORDER No. FRW.6/2020/1 Dt. 12th June, 2020)

REPORT

ON

DAMAGES TO
ENVIRONMENT, BIODIVERSITY, WILDLIFE, FORESTS
&
ECOLOGY

ON ACCOUNT OF

BLOW OUT AND EXPLOSION AT OIL WELL No. BGN-5

BAGHJAN, TINSUKIA

ASSAM (INDIA)

BY

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ADDITIONAL PRINCIPAL CHIEF CONSERVATOR OF FORESTS (WILDLIFE)

&

CHIEF WILDLIFE WARDEN, ASSAM

10th February, 2021

CORRIGENDUM

GOVERNMENT OF ASSAM

OFFICE OF THE ONE MAN ENQUIRY COMMITTEE

(ORDER NO- FRW.6/2020/1 DATED.12/06/2020)

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No. OMEC/MKY/BGN-5/2020/L01/50 **Dt. 23rd June, 2021**

From: M.K. Yadava, IFS,
Addl. PCCF (WL) & CWLW and
One Man Enquiry Committee

To
The Commissioner & Secretary to the Govt. of Assam,
Department of Environment & Forests, Dispur,
Guwahati-781 006, Assam

Sub:- Submission of Enquiry Report of the One Man Enquiry Committee
Ref:- OMEC Letter No. OMEC/MKY/BGN-5/2020/L01/49 Dt. 10th February, 2021
Meeting Dt. 9th April, 2021 &
Emails Dt. 20th April, 2021 & 3rd May, 2021 from the Env & Forest Deptt.

Sir,

With reference to the subject cited above, and the meeting held to review the One Man Enquiry Committee Report on the on damages to environment, biodiversity, wildlife, forests & ecology on account of blow out and explosion at OIL Well No. -5 at Baghjan, Tinsukia District, Assam, and the decisions taken thereof to reassess the cost of environmental damages from a more rigorous point of view of "Social Cost of Carbon" in the Indian context, and accordingly revise the relevant portions of the Report with scientific inputs and references, I wish to bring to your kind notice that a set of corrigenda have accordingly been proposed. These may be treated as a part and parcel of the Report. This includes the typographical error corrections in the Report as well. Therefore, this Corrigendum to the Report has been divided into two Parts:-

1. Corrigendum Part I deals with the Social Cost of carbon in view of the damages to environment, biodiversity, wildlife, forests & ecology on account of blow out and explosion at BGN#5 with additional write-up and compilation of literature review on the subject matter

2. Corrigendum Part II lists Errata of the Report along with an additional list of references.

However, no change either in the cost of ecological damages or in the budgetary prescriptions have been made. However, the manner in which prescribed payable cost of damages may be realized has been suggested. Cap and Trade System using Emission Trade System has additionally been suggested as an alternate environmental policy of the Government of Assam to regulate pollution overshoot.

The Report, in three volumes and additionally with this Corrigendum, shall be available for download at the following address: http://baghjan.amtron.in/omec.

Hope the Report is accepted, and action initiated accordingly, if deemed fit and proper.

Yours faithfully,

(Mahendra Kumar Yadava IFS)

ADDITIONAL ABBREVIATIONS & ACRONYMS

CAT	Cap and Trade
CCDF	Climate Change Damage Function
CGE	Computable General Equilibrium
DICE	Dynamic Integrated Climate Economy
EDF	Environmental Defense Fund
EKC	Environmental Kuznets Curve
ETS	Emissions Trading System
GMM	Generalized Method of Moments
GTAP	Global Trade Analysis Project
IAM	Integrated Assessment Model
IWG	Interagency Working Group
INDC	Intended Nationally Determined Contributions
IPO	Initial Public Offering
ML	Maximum Likelihood
NBP	Budget Trading Program
NZE	Net Zero Emission
RICE	Rapid Integrated Climate Economy
SAM	Social Accounting Matrix
SCAR	Social Cost of Atmospheric Releases
SCC	Social Cost of Carbon
SDR	Social Discount Rate
UNFCCC	United Nations Framework Convention on Climate Change
USG	United States Government

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CORRIGENDUM PART-1

1 REVISITING SOCIAL COST OF CARBON & OTHER COSTS

1.1 Need For Revision

The One Man Enquiry Report on the on damages to environment, biodiversity, wildlife, forests & ecology on account of blow out and explosion at OIL Well No.5 at Baghjan, Tinsukia District, Assam in the Chapter 8, Para 8.7.1 [Page 224, Vol. I], the cost of carbon emissions, also known as Social Cost of Carbon, was estimated based on average US based social cost of carbon. Similarly in Chapter 10, Para 10.9.3 [Page 284, Vol I], the cost of waste heat was deduced indirectly. Thirdly, in Chapter 11, Para 11.13.2 [Pages 352-3, Vol I], the loss of ecosystem services was estimated based on Costanza et al (2014)[1] directly. Further, in Table 16.1, 16.2 & 16.3 in Chapter 16, Para 16.3 [Pages 456-9, Vol I], the cost of damages and liabilities of the polluter have been assessed. If the costs of carbon, entropy (waste heat) and ecosystem services change, these three tables may need to be changed. Accordingly the 'Net Share of Liability' described in Para 16.3.2 may also need to be revised.

A fresh literature review was conducted, and based on the latest inputs, it shall be examined whether any changes in the assessment of the countable damages would be made. The discussion on social cost of carbon, entropy tax and cost of ecosystem services was initially avoided, and appropriate costs were used directly without citing much reason. In the paragraphs to follow a more detailed discussion and latest trends would be laid down, and a decision arrived at as to whether there was any need to change the original assessment or not.

1.2 The Economics Of Climate Change

The current understanding is that anthropogenic activities causing emissions of greenhouse gases in large quantities are causing climate change. CO_2 concentrations in the atmosphere were 280 ppm in 1750 and stood at 415 ppm in 2020. About 7.7 $GtCO_2$ (~ 2.12 GtC) equals 1 ppm of CO_2 in the atmosphere. A concentration of 415 ppm in the atmosphere would mean an accumulation of 3225 $GtCO_2$ in the atmospheric sink[2]. It is predicted that atmospheric CO_2 concentrations will reach 700-900 levels 2100. This would, in turn, trigger a global warming of 3^0-5^0 C[3].

Economy vs ecology has been dominating the intellectual debate more prominently after the Rio Earth Summit in 1972. Without going into the details of all the debates that have been raging since then till date, it can be only said that definite contours have now started to emerge. There are many threads of intellectual debate, and we shall pick here only one of them and that too partially. The topic of social cost of carbon and other emissions in particular and impact of carbon emissions on

1 Costanza Robert, de Groot Rudolf, Sutton Paul, van der Ploeg Sander, Anderson Sharolyn J, Ida, Farber Stephen, Turner R. Kerry, 2011, Changes in the global value of ecosystem services, Global Environmental Change 26 (2014) 152–158

2 Turner Mathew A, Brown University, 2019, carbon cycle, emissions and consumption and emission levels and trends, EC140 Topic #2, Fall 2019

3 Nordhaus William, 2019, Climate Change: The Ultimate Challenge for Economics, American Economic Review, 2019, 109(6): 1991–2014 https://doi.org/10.1257/aer.109.6.1991

economy have been a matter of research for long, may even be aptly termed as the Economics of Climate Change, and even a review on the subject matter is out of scope. However, studies in respect of economic growth, wellness and emissions are rather limited. A brief of the subject matter is being presented in the next section with a view to get an overall perspective.

1.2.1 Economy, Wellness and Emissions

CO_2 emissions are considered as a logical consequence of industrial activities, and while they add value, pollution is a direct consequence of it; and the question to be addressed is whether such polluting industrial activities and their hazardous consequences (such as Baghjan accident) can be considered as part of the sustainable development, and how much is the loss of social welfare and well-being. A recent research by Luzzati & Rughi (2018) found that incidence rate of cancer at all the sites studied was found to increase linearly with per capita income, even after discounting factors such as population ageing, improvement in cancer detection and omitting spatially correlated variables. The researchers concluded further that If higher incidence rates in developed countries were merely due to such factors alone, and not due to **life-styles and environmental degradation**, we would have found a flat or even an inverted-U pattern[4] between per capita income and cancer incidence[5]. Stern (2006) had stated that Global warming due to accumulation of Green House Gas (GHG), the main one being CO_2 was the main threat to humanity[6]. The World Bank estimated in 2010 that the cost of pollution constitutes upto 7.4 % of GDP in the Middle East and North African countries. The cost of oil spill alone is 2.4% of the GDP[7]. Similarly, another World Bank Study in 2015 found that about USD 50 billion was the cost borne by Alexandria alone due to annual flood damages. The Report concluded that "A warmer, drier, and more variable climate with

4 The inverted U pattern is normally called the Environmental Kuznets Curve (EKC), which is a hypothesized relationship between various indicators of environmental degradation and income per capita and is empirical in nature. According to Stern D. I. (2015), "*The EKC is an essentially empirical phenomenon, but most estimates of EKC models are not statistically robust. Concentrations of some local pollutants have clearly declined in developed countries but there is much less clarity about emissions of pollutants. Studies of the relationship between per capita emissions and income that attempt to avoid various statistical pitfalls find that per capita emissions of pollutants rise with increasing income per capita when other factors are held constant. However, changes in these other factors may be sufficient to reduce pollution. In rapidly growing middle-income countries the effect of growth overwhelms these other effects. In wealthy countries, growth is slower, and pollution reduction efforts can overcome the growth effect. This appears to be the origin of the apparent EKC effect. These econometric results are supported by evidence that, in fact,pollution problems are being addressed in developing economies. However, there is still no consensus on the drivers of changes in pollution.*" While EKC shows, a sper the presumed policy implications as presented in the 1992 World Development Report and elsewhere, that development is the best cure for environmental problems, in effect, "*It is clear that the levels of many pollutants per unit of output in specific processes have declined in developed countries over time with increasingly stringent environmental regulations and technological innovations. However, the mix of effluent has shifted from sulfur and nitrogen oxides to carbon dioxide and solid waste so that aggregate waste is still high and per capita waste may not have declined. Economic activity is inevitably environmentally disruptive in some way. Satisfying the material needs of people requires the use and disturbance of energy flows and materials. Therefore, an effort to reduce some environmental impacts may just aggravate other problems*". Stern David. I., 2015, The Environmental Kuznets Curve, Reference Module in Earth Systems and Environmental Sciences, Elsevier, 2018, ISBN 9780124095489, https://doi.org/10.1016/B978-0-12-409548-9.09278-2

5 Luzzati T & Rughi Pareti T, 2018, Economic growth and cancer incidence, Ecological Economics, Volume 146, April 2018, Pages 381-396

6 Stern Nicholas, 2006, *The Economics of Climate Change: The Stern Review, Government of UK, 2006*

7 World Bank, 2010, The Cost of Environmental Degradation Case Studies from the Middle East and North Africa, 2010. Ed: Croitoru Lelia and Sarraf Maria

greater frequency of extreme events (floods, heat waves, dust storms) will put increasing pressures on scarce water, forest and arable land resources, compounding food security concerns”[8]

On the other hand, Parikh et al (2007)[9] argue that historically the carbon foot print of India has been very small compared to the developed world. The authors ran a model from which it emerged that enforcing a 20% cut in CO2 emissions in the long run(34 years) would adversely impact GDP by 2.87% compared to BAU. Nevertheless, India had made strong commitments in respect of the Intended Nationally Determined Contributions (INDCs) to the UNFCCC[10]. India has pledged to improve the emissions intensity of its GDP by 33 to 35 per cent by 2030 below 2005 levels. It has also pledged to increase the share of non-fossil fuels-based electricity to 40 per cent by 2030. It has agreed to enhance its forest cover which will absorb 2.5 to 3 billion tonnes of Carbon Dioxide (CO_2) by 2030. In the Net Zero Emission (NZE) scenario, India’s 90% of the energy would have to come from renewable sources and by 2030, India would have to migrate to a strong Green Hydrogen economy. Green hydrogen can be obtained from electrolysis of water for which energy can come from renewable sources again[11]. ***Therefore, in event of India becoming a hydrogen economy, fossil fuels, especially oil and gas would get reduced to 10% of the energy by 2030-2050***. Currently, the contribution of renewable sources of energy to the energy mix of India comes only to 21.25%[12].

1.2.2 Understanding Climate Change Damage Functions

In almost all models of working out the social cost of emissions and climate change invariably adopt one or other relationships of climate change to well-being and economy. It is to be well understood that climate change could ultimately affect our society and the well-being of current and future generations requires an evaluation of the complex interplay between human and natural systems. According to Tol RSJ (2015), “There are so many and so different effects: crops hit by worsening drought, crops growing faster because of carbon dioxide fertilization, heat stress increasing, cold stress decreasing, sea levels rising, cooling energy demand going up, heating energy demand going down, infectious disease spreading, and species going extinct. It is hard to make sense of this. Therefore, aggregate indicators are needed to assess whether climate change is, on balance, a good thing or a bad thing and whether the climate problem is small or large relative to the many other problems that we have”. In order to correlate some of these or all of these, a Climate Change Damage Function (CCDF) is required. Damage functions are required to translate physical impacts in terms of economic variables inside CGE, IAM and other numerical economic models; and these functions define one or more relationships between climate variables, typically average

8 World Bank, 2015, The Middle East and North African Region, Maximizing the World Bank Group’s Impact in the Middle East and North Africa, April, 2015

9 Parikh Jyoti, Kiran Chandra & Krishnamurthy, 2007, Economic impact of carbon emission restrictions: The case of India, Energy Security, Climate Change and Sustainable development Ed. Mathur Jyotirmoy, Wgner H. J., Bansal N. K, Anamaya Publishers, New Delhi, 2007

10 http://www.indiaenvironmentportal.org.in/content/419700/indias-intended-nationally-determined-contribution-working-towards-climate-justice/

11 TERI & SHELL, 2021, India: Transforming to a net-zero emissions energy system, Scenario Sketch, teriin.org, https://www.teriin.org/press-release/net-zero-emissions-indias-energy-system-2050-technologically-possible-highly

12 https://en.wikipedia.org/wiki/Renewable_energy_in_India

temperature, but sometimes also humidity or heating days, and economic variables such as potential income, productivity, resource endowments, etc.

As per the Policy Research Paper 7728 of the World Bank (2016)[13], a set of five impact parameters were adopted to arrive at a comprehensive damage function for climate change. These are:-

1. Sea level rise
2. Variation in crop yield (agricultural productivity)
3. Heat and labour productivity
4. Human health
5. Tourism
6. Household energy demand

All the six parameters were evaluated and aggregated based on 1^0,2^0,3^0,4^0, & 5^0 rise in the global surface temperature. For India, the losses arrived at in % terms of the economy are listed below:-

Table No. 1.1: Scenarios of Climate Change Damages on Economy

Climate Change Impact Parameters	Description/ nature of loss	% Variation Due to Rise in Temperature (Degree Celsius)*				
		+1	+2	+3	+4	+5
Sea level rise	Loss of land (2050)	0.0002	0.0003	0.0004	0.0006	0.0007
	Loss of land (2100)	0.0003	0.0006	0.0009	0.0011	0.0014
Agricultural production	Maize	2.31	5.19	6.63	9.19	12.31
	Wheat	1.06	5.13	12.69	19.38	24.31
	Rice	2.25	2.56	2.88	6.56	12.50
	Multi-factor production	2.13	4.53	9.10	9.86	12.82
Heat & labour productivity	Agriculture	5.21	10.84	16.71	23.06	29.08
	Manufacturing	2.47	5.44	8.83	12.44	16.21
	Services	0.74	2.36	4.79	6.52	9.25
Human Health	Loss of productivity	0.7468				
Tourism	Loss in net inflow (2011 GDP)	0.21	0.40	0.58	0.76	0.93
Household energy demand	Electricity	0.26	0.51	0.76	1	1.24
	Gas	0.10	0.20	0.29	0.39	0.47
	Oil	3.42	6.76	10.02	13.21	16.33

* *Red numbers indicate Loss, Black numbers indicate Gain*

Who will take the hit most?: As described by Tol 92015), by and large, the negative impacts of climate change will fall on the developing economies. The author sees three reasons for this:-

13 World Bank, 2016, Estimation of Climate Change Damage Functions for 140 Regions in the GTAP9 Database, Policy Research Paper 7728, June, 2016

1. The poorer countries are more exposed. Richer countries have a larger share of their economic activities in manufacturing and services, which are typically shielded, to a degree, against the vagaries of weather and hence climate change. Agriculture and water resources become far more important in poorer countries.

2. The poorer countries tend to be in hotter places. ***This means that ecosystems are closer to their biophysical upper limits and that there are no analogues for human behavior and technology***. For example, the future climate of the UK may become like Spain's current climate. The people of the UK would, therefore, adopt some of the habits of the people of Spain and benefit from them naturally. If the hottest climate on the planet gets hotter still, there are no examples to copy from; new technologies will have to be invented, and behaviour will have to be adjusted by trial and error.

3. The poorer countries tend to have a limited adaptive capacity which is the ability to adapt. It depends on a range of factors, such as the availability of technology and the ability to pay for those technologies. Adaptive capacity also depends on human and social capital. An ounce of prevention is worth a pound of cure, but prevention requires that one is able to recognize problems before they manifest themselves, i.e. the ability to predict the future; and the capacity to be able to act on that knowledge. In other words, the analytical capacity is connected to policy implementation. Furthermore, the governance systems need to care about the potential victims. The country's rich may be aware of the dangers of climate change and have the wherewithal to prevent the worst impacts, but if those impacts would fall on the politically and economically marginalized and weaker sections, the rich may chose to ignore the impacts. This brings us to the last topic of debate before we go to actual costs i.e. granularities in climate change in India.

Granularities of Climate Change in India: This section is largely based on the works of Lee et al (2021)[14]. The authors studied carbon footprint of 203313 households in 623 districts of India. The study brought out the variation in the carbon footprint by economic, cultural and demographic factors. The study showed that while eradication of extreme poverty did not conflict with ambitious climate change mitigation in India, but the analysis suggests that carbon footprint reduction policies within India need to target high expenditure households, which are roughly 20% of all households, which are responsible for nearly seven times the carbon emissions than low expenditure households (living on $1.9 consumption a day). These vast disparities between the carbon footprint of citizens in India highlights the need to differentiate individual responsibilities for climate change in the national climate policy perspective.

Thus, it can be suggested that "Carbon Tax" and or "Entropy Tax" may work well to supplement the poor in adopting clean and green technologies. The Baghjan blowout is a case in point which brought out the stark vulnerabilities of the rural poor and of the damage of the highly productive ecosystems in view of a large scale ecological disaster.

14 Lee Jemyung, Taherzadeh Oliver, Kanemoto Keiichiro, 2021, The scale and drivers of carbon footprints in households, cities and regions across India, Global Environmental Change 66 (2021) 102205

1.2.3 Climate Change Social Discount Rates (SDR)

Social Discount Rates (SDRs) are a way to look at the present value of goods and services as they would occur at a later date in future[15]. If one examines the questions as to how much we need to invest today in order to safeguard the future of our next generations tomorrow to limit the impacts of climate change in the future, this would give rise to two broad scenarios. If we assume that it is very important to invest for climate change now or never, one would apply very low discount rates. However, *Homo economicus* does not always think like that. For him, returns today are more attractive than returns in future. This describes people's propensity to prefer income today rather than tomorrow. In such a scenario, the discount rates would be high for the future generations.

William Nardhaus, the Nobel Laureate in Economics (2018 awarded for for integrating climate change into long-run macroeconomic analysis), a Sterling professor at Yale University, in his paper [Nardhaus (2019)[16] opines that the economic theory of discounting assumes a great significance in Integrated Assessment Modelling of climate change due to long delays in investment in abatement of climate change and associated returns in averted damages. Nardhaus further classifies discount a 'discount rate on goods' which is a market based concept and measures the relative price of the goods at different points of time; and 'generational discount rate' as the relative weight of the economic welfare different generations or households over time, and refers to discount in future welfare but not in future goods. According to Nardhaus, there is a prescriptive view in which a low discount rate is taken for ethically just investments in mitigating global warming is taking, and it amounts to about 1% per annum. On the other hand, in the descriptive approach, it is assumed that investments in climate change mitigation, which are slow on return, must compete with other investment opportunities, and thus, reflect a kind of opportunity cost. This is often taken as about 5% per annum.

Which SDR to be used?: Goulder & Williams (2021)[17] have provided a very good exposition as to which type of rate to be used in a given policy paradigm for mitigation of climate change. In order to evaluate a climate change policy wrt future benefits and current investments let us assume that the future benefit is ΔC_T i.e. it avoids a loss of ΔC_t in future consumption in the year t. The discount rate r_{SW} could be used to show how much how much current consumption could be sacrificed without lowering social welfare. The authors suggest if $\frac{\Delta C_t}{(1+r_{SW})^t}$ is greater than the current consumption, the said policy would raise social consumption. The authors further argue that if the two types of discount rates be r_{SW} and r_F, then, assuming both are different, resources (and associated consumption) are not allocated across different periods of time in a way that maximises social welfare. Assuming $r_{SW} < r_F$, would mean that resources are being transferred to future time periods by consuming less now which would imply increase in capital stock, say by reducing government budget deficit, and thus would raise social welfare. Reducing consumption by 1 unit today and increasing the capital stock would increase the amount of consumption for next period by

15 https://www.lse.ac.uk/granthaminstitute/explainers/what-are-social-discount-rates/

16 Nardhaus William, 2019, Climate Change: The Ultimate Challenge for Economics, American Economic Review, 2019, 109(6): 1991–2014 https://doi.org/10.1257/aer.109.6.1991

17 Goulder Lawrence H. and Williams III Roberton C, 2012, The choice of discount rate for climate change policy evaluation, Discussion paper, RFF DP 12-43, September 2012, Resources For the Future, www.rff.org

$1{+}r_{F.}$ If $r_{SW} > r_{F,}$ then, implies the reverse logic- consuming more now would decrease the capital stock but increase the social welfare. In effect, the choice would be whether to increase the social welfare now or transfer capital stock to future generations. Consuming less now and saving more for the future would mean $r_{F,}$ exceeds r_{SW}. At the social welfare optimum, one should attempt for $r_{SW} = r_F$. Therefore, one would need optimization models to generate realistic behaviour responses and have a good social welfare function too. Further, it needs to be stated that there are uncertainties associated with the discount rates. If one deploys r_{SW}, there is an uncertainty about growth rate. With r_F, there is an uncertainty about future opportunity cost of capital.

1.2.4 Climate and Economy Models

Several mathematical models and relationship function groups have been worked out by a host of scientists and researchers across the globe who have been seized of the issue of linking economic activities, well being and climate change and work out ways to quantify an economic evaluation of the societal cost of climate change. Integrated Assessment Models (IAMs), which can be defined as approached that integrate knowledge from several domains into a single framework. Two strong candidates that need mention are the DICE/RICE models developed by Nordhaus, and Computable General Equilibrium (CGE) Models originally pioneered by Wassily Leontief descending from his famous input-output tables and Social Accounting Matrix (SAM). Carbon Tax, energy tax and energy security are some of the outcome of the various CGE models. Several recent studies on carbon tax have studied impact of carbon tax, either in percentage or in absolute terms of dollars per tonne of CO_2 emitted, on economy and suggested optimum levels of taxation[18,19,20]. The Climate Framework for Uncertainty, Negotiation and Distribution (FUND) is another IAM developed by Richard S. J. Tol. Panel Data Analysis (with variations such as static, dynamic and cross-legged) is another powerful technique to study impacts of climate change on economy. In panel data analysis, time series data for long periods of time (repeated observations on the same cross section, observed for several time periods, also called Longitudinal data,) are used to arrive at conclusions using methods such as Generalized Method of Moments (GMM) and Maximum Likelihood (ML) classifiers. Some of the research works have studied global as well as country wide impact

18 Liu Lirong, Huang Charley Z, Huang Gouche, Baetz Brian & Pittendrigh Scott M, 2018, How a carbon tax will affect an emission-intensive economy: A case study of the Province of Saskatchewan, Canada, Energy, 159 (2018), p817-826

19 Guo Zhengquan, Zhang Xingping, Zheng Yuhua & rao Rao, 2014, Exploring the impacts of a carbon tax on the Chinese economy using CGE model with a detailed disaggregation of energy sectors, Energy Economics, 45 (2014), p455-462

20 Allan Grant, Lecca patrizio, McGregor Peter & Swales Kim, 2014, The economic and environmental impact of a carbon tax for Scotland: A computable general equilibrium analysis, Ecological Economics, 100 (2014), p40-50

of CO_2 emissions on the economy[21,22,23,24,25]. The research of Singh Ajay et al (2015) shows that Kharif productivity in India would decrease by 5.17% with 1^0 C rise in actual average maximum temperature.

1.2.5 Cap and Trade Model

Unlike the models discussed so far, Cap And Trade (CAT) model is a market driven mechanism to limit carbon emissions and pollution of the sinks, wherein the Government sets an upper limit on pollution, and companies that are either crossing the limit or just below it, would buy credits from the those that are far below the limit. This way, the cleaner industries get incentivised in the market, and the polluting industries get penalized. This mechanism would require a very high degree of monitoring by the regulators. However, companies can buy and sell permits on an exchange. The initial allowances could be priced or given for free by the regulator. Its origin can be seen in the SO_2 trading program of the USA under the Acid Rain Program in 1990, and subsequently NO*x* Budget Trading Program (NBP) launched in 2003[26].

The European Union (EU) established the first cap-and-trade system for CO_2 emissions in the world starting in 2005 to meet its obligations to reduce GHG concentrations under the Kyoto Protocol. While it was proposed in October 2001, the EU's Emissions Trading System (EU ETS) ran in trail mode from 2005-2007. In 2020, the value of the EU ETS was estimated at €201 Billion. In December, 2020, the carbon prices ended at €33.44/t[27]. China, which is responsible for burning half of the coal of the world, and produces 25% of all the emissions, has gone ahead with creating a national carbon market in December, 2017 with advisory assistance from the Environmental Defense Fund (EDF), USA. About 2000 power companies are a part of it, and it is likely to expand. The value of the Chinese ETS stood at €257 million by 2020.

In India, Gujarat became the first State to launch a cap and trade system for curbing air pollution. It launched a pilot project in Surat to curb Particulate Matter (PM) emissions in 2019. It is limited to the textiles industry as of now. This is world's first PM Emission Trading System. The scheme aims to lower the cost of compliance for industries, while meeting the State's air pollution targets.

21 Saidi Kais & Hammami Sami, 2015, The impact of CO_2 emissions and economic growth on energy consumption in 58 countries, Energy Reports, 1 (2015), p 62-70

22 Aye Goodness C & Edoja Prosper Ebruvwiyo, 2017, Effect of economic growth on CO2 emission in developing countries: Evidence from a dynamic panel threshold model, Cogent Economics & Finance, 5:1, 1379239, 2017, DOI: 10.1080/23322039.2017.1379239

23 Tokunaga Suminori, Mitsuru Okiyama, Ikegawa Maria, 2015, Dynamic Panel Data Analysis of the Impacts of Climate Change on Agricultural Production in Japan, Japan Agricultural Research Quarterly, 49(2): p149-157, April, 2015, DOI: 10.6090/jarq.49.149

24 Singh Ajay K, Sharma Pritee, Joshi Surabhi, 2015, Effects of Climatic Factors on Agricultural Productivity in India: A State-wise Panel Data Analysis, International Journal of Basic and Life Sciences, Vol 3 (2015), Issue No. 1, p 48-67, ISSN(Online): 2320-515X

25 Palanisami K, Ranganathan C.R, Kakumanu K. R, Nagothu Udaya Sekhar, 2011, A Hybrid Model to Quantify the Impact of Climate Change on Agriculture in Godavari Basin, India, Energy and Environment Research Vol. 1, No. 1; December 2011, DOI: 10.5539/eer.v1n1p32

26 https://en.wikipedia.org/wiki/Emissions_trading

27 Berntsen Jon, Fjellheim Hæge, Kolos Maria, Liao Cathy, Rihel Aje Singh, and Zelljadt Elizabeth, Review of Carbon Markets in 2020, 26th January, 2021, Refinitiv

Several other countries have launched their own cap and trade emission trading system, notable among them being UK in 2021, New Zealand in 2008, South Korea in 2015.

1.3 Social Cost Of Carbon And Other Emissions

Under this section, we shall briefly discuss the social cost of carbon, methane, carbon monoxide and NOx.

1.3.1 Social Cost of Carbon

As already discussed in detail, researchers show that there is definite impact of global warming or even local rise of surface temperature. Surface temperatures are expected to rise faster on land as because oceans absorb heat. Further a small rise in surface temperature can drastically increase the probability of extreme heat. Temperature changes also have indirect effects. Warmer oceans are associated with rise in sea level, increase in humidity, tropical storms and higher frequency of floods. Higher temperatures also impact the ecosystems adversely. Chi et al (2020)[28] opine that "costs related to damages to existing physical capital as well potential future damages are one channel through which climate change affect the economy". Nordhaus (2019) opines that potential damages of climate change would be most heavily concentrated in natural ecosystems and spread in geographic regions such as low income and tropical areas of Africa, Latin America, Indian subcontinent and coastal regions of the world. According to him, the vulnerable regions would include rain-fed agriculture, seasonal snow peaks, coastal people that would be impacted by sea level rise, high river run-offs, degradation of forests, raging wild fires and damaged natural ecosystems. He further goes to say that many of the earth systems operate at scales that are effectively unmanageable by humans with existing technologies; and important global tipping points include 'rapid melting of large ice sheets (Greenland or West Antartic) and large scale changes in the ocean circulation systems such as 'Gulf Stream'; and these are particularly dangerous because they cannot be easily reversed once triggered. Therefore, there is a huge uncertainty around modelling of future costs of climate change and the manner of discounting them, even though a grim future awaits us.

The Social Cost of carbon (SCC) is a direct outcome of the IAM/DICE model. The Dynamic Integrated Climate & Economy (DICE) model estimates the path of the economy by optimizing consumption, emissions and climate change. According to Nordhaus (2019),

$$\max_{c(t)} W = \max_{c(t)} \left[\int_{0}^{(\infty)} U\left[c(t)\right] e^{-pt} dt \right] \qquad 1.1$$

subject to

$$c(t) = M(y(t);z(t);\alpha;\varepsilon(t)) \qquad 1.2$$

28 Chi Joseph, Pellerin Mathieu, Rodriguez Jacobo, 2020, The economics of climate change, Chi, Joseph and Pellerin, Mathieu and Rodriguez, Jacobo, The Economics of Climate Change (October 20, 2020). Available at SSRN: https://ssrn.com/abstract=3715848 or http://dx.doi.org/10.2139/ssrn.3715848

where In the two equations above, c(t) is consumption; y(t) are other endogenous variables (such as global temperature); z(t) are exogenous variables (such as population); α are parameters (such as climate sensitivity); ρ is the pure rate of time preference; and ε(t) are random variables in the stochastic versions. According to Nordhaus (2019), the equation 1.1 is a highly simplified representation that shows an optimization of the path of consumption subject to complex constraints of equation 1.2 which itself is represented by almost 20 equations (not shown here), which is the most challenging part of the DICE model construction. These equations take into account the economic production functions and carbon cycle constraints. There is also an estimation of the impact on optimized consumption of an extra ton (tCO_2) of emissions. Thus, according to Nordhaus (2019), this is a shadow price that the DICE model produces as a mathematical variable associated with carbon emissions in an optimized framework. To internalize the carbon externality, this has been termed as carbon tax or carbon price or most aptly the social cost of carbon.

Therefore, according to Nordhaus (2019), the Social Cost of Carbon (SCC) is the economic cost caused by an additional ton of CO_2 emission. The SCC estimates vary anything from USD 10 to 275 per ton of CO_2. The standard DICE Model yields a price tag of $36 /$tCO_2$.For less ambitious temperature targets, it could vary from $43-108/$tCO_2$ for 2020. For temperature targets of 2^0C and below, the SCC could vary from $158-279/$tCO_2$ for 2020.

The **Interagency Working Group (IWG) on the Social Cost of Greenhouse Gases**, US Government, brings regular updates on the social cost of the atmospheric pollutants. The latest Technical Support Document brought out in February, 2021[29], is worth quoting here as to its purpose and mandate,"*On January 20, 2021, President Biden issued E.O. 13990 which re-established the IWG and directed it to ensure that SC-GHG estimates used by the U.S. Government (USG) reflect the best available science and the recommendations of the National Academies (2017)[30] and work towards approaches that take account of climate risk, environmental justice, and intergenerational equity. The IWG was tasked with first reviewing the SC-GHG estimates currently used by the USG and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including taking global damages into account. In this initial review, the IWG finds that the SC-GHG estimates used since E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways. First, the IWG found previously and is restating here that a global perspective is essential for SC-GHG estimates because climate impacts occurring outside U.S. borders can directly and indirectly affect the welfare of U.S. citizens and residents. Thus, U.S. interests are affected by the climate impacts that occur outside U.S. borders. Examples of affected interests include: direct effects on U.S. citizens and assets located abroad, international trade, tourism, and spillover pathways such as economic and political destabilization and global migration. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. Second, the IWG found previously and is*

29 IWG, 2021, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, US Government, February, 2021

30 National Academies, 2017, National Academies of Sciences, Engineering, and Medicine, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide. Washington, D.C.: National Academies Press

restating here that the use of the social rate of return on capital to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continues to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context". As per the IAWG (2021), the Social Cost of CO_2, from 2020 to 2050 (in 2020 dollars per metric ton of CO_2) is reproduced below:-

Emissions Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th Percentile
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

Fig. No. 1.1: IWG Social Cost of Carbon Emissions 2020-2050

It can be seen that the rate used in the Report to assess Social Cost of Carbon is US$ 66.60, arrived at by another means, is very close to the SCC at 3% SDR in 2035.

Ricke et al (2018)[31] carried out a study of country level social cost of carbon, deploying four distinct components: a socio-economic module including projected emissions of CO_2, a climate module depicting the response of the earth system to the CO_2 emissions arising out of the economy, a damage module wherein economic response to the changes in the earth systems are quantified, and a discounting module under which a time series of future damages is compressed into a single present value. The study found that the **SCC for India was the highest at US$ 86/tCO_2**. India is followed by USA with US$ 48/tCO_2, and China at US$ 24/tCO_2. The study found that Northern Europe, Canada and the former Soviet Union have negative SCC values as their current temperatures are below the economic optimum.

1.3.2 Social Cost of Methane

As it is well known, methane (CH_4) has 28 times more Global Warming Potential (GWP) than CO_2. The social cost of methane emission as worked out by IWG (2021) is given in Fig. No. 1.2. Another study by Shindell (2015)[32] has worked out the Social Cost of Atmospheric Release (SCAR), extending the SCC analogy further to other atmospheric pollutants. According to him, the median SCAR for CH_4 comes to US$ 2700, 4600 & 6000 per tCH_4 at 5%, 3% & 1.4% SDR. The

31 Ricke katharine, Drouet Laurent, Caldeira Ken, Tavoni Massimo, 2018, Country-level social cost of carbon, Nature Climate Change, Vol 8, October 2018, p895-900

32 Shindell Drew T, 2015, The social cost of atmospheric release, Climate Change, DOI: 10.1007/s10584-015-1343-0

median values take into account the additional climate induced health impacts. We can assume a social cost of US$ 4600 at 3% SDR with climate-health impact.

	Discount Rate and Statistic			
Emissions Year	5% Average	3% Average	2.5% Average	3% 95th Percentile
2020	670	1500	2000	3900
2025	800	1700	2200	4500
2030	940	2000	2500	5200
2035	1100	2200	2800	6000
2040	1300	2500	3100	6700
2045	1500	2800	3500	7500
2050	1700	3100	3800	8200

Fig. No. 1.2: IAWG Social Cost of CH_4 Emissions 2020-2050

1.3.3 Social Cost of CO

As per Shindell (2015), the social cost of CO emissions, at median values values taking climate health impacts, comes to US$ 410, 630 & 820 per tCO at 5%, 3% and 1.4% SDR respectively. We can assume a social cost of US$ 630 at 3% SDR at median value.

1.3.4 Social Cost of NO_2

NOx are a group of indirect green house gases which by way of catalytic action help in producing ozone in the troposphere. According to Shindell (2015), the median cost of NOx is US$ 67000 for all the discounting rates of 5%, 3% and 1.4%.

1.3.5 Social Cost of Particulate Matter

Particulate matter impacts public health immensely, especially in the surroundings of the flame plumes. A study by Heo et al (2016)[33] estimates social costs of $PM_{2.5}$ to be between US$80,000 to 130,000 per ton of $PM_{2.5}$ emitted into the atmosphere. However, since tonnage of particulate emissions was not worked out, this point has been brought here for academic interest and future reference.

1.3.6 Combined Cost of Damages

With the above social costs of various damages described in the previous sub sections, one can arrive at the total cost of damages from CO2, CH4, CO and NOx emission from Baghjan blowout as per Table given below:-

33 Heo Jinhyok , Adams Peter J. and Oliver Gao H, 2016, Public Health Costs of Primary PM2.5 and Inorganic PM2.5 Precursor Emissions in the United States, Environmental Science and Technology, University of Birmingham, DOI: 10.1021/acs.est.5b06125

Table No. 1.2: Combined Social Cost of Baghjan Emissions

Emission Entity	**Emissions Quantum (MT)**	**Social Cost @ 3% SDR (US$/ton)**	**Social Cost (Mil US$)**	**Exchange Rate (INR/US$)**	**Social Cost (Cr INR)**
CO_2	7.451+0.005=7.456	67	499.55	74	3696.68
CH_4	0.362	4600	1665.2	74	12322.48
CO	1.649	630	1038.87	74	7687.64
NOx	0.539+0.793=1.332	67000	89244	74	660405.6
TOTAL			**92447.62**	**74**	**684112.4**

1.4 Final Views On Cost Of Damages

The Report estimated the cost of ecological damages arising due to the Baghjan blowout, explosion and fire at Rs. 25,000.00 cr. It was suggested to the author to re-examine the social cost of the damages, as it was expected that social costs would be still on higher side. However, as already discussed in detail in the paragraphs above, the uncertainties in cost estimation of damages to the natural systems, variation in discounting rates and the various ways in which these costs could be modelled including just the cost to the economy, cost of public health or cost of damages to the natural systems, one could arrive at any figure from Rs. 25,000 cr to Rs. 100,000 cr, purely depending upon the evaluation pathway taken. In the considered opinion of the author, Rs. 25,000 cr is a very reasonable bottom-line.

1.4.1 How to Look at the Cost of Damages from ETS Point of View

Assuming that the newly created department of Climate Change in the Government of Assam starts to toy with the idea of creating a global ETS in which an attempt is made to raise Rs. 25K cr worth of capital by raising an internationally tradable IPO of Carbon Bonds @ US$ 10 / tCO_2, one can offer ~ 350 million such bonds globally. Of these, MoPNG as owner of M/s OIL should buy 27% of the total offer (of which ~ 14% should be purchased by M/s OIL). This assumes trading period of 10 years over which the IPO shall be valid, and the parties could buy at any point of time at the initial offer rate from the Government of Assam. However, MoPNG and M/s OIL would have to buy one tenth of the shares annually for 10 years.

The Government of Assam could use the earning to plough back two thirds of the fund raised in greening of the oil and gas and other industries in the State in an attempt to make Assam a carbon neutral state in next 10 years.

1.4.2 Shift in Environmental Policy: A Use Case

As per the USEPA (2018)[34], emissions from a passenger vehicle per mile comes to 404 grams (or ~250 gm per km). Assuming it runs about 6000 km per year, its total emissions would come to 1.5 tons. Further assuming that a vehicles road life is 10 years, and in order to run next 5 years, the owner needs to invest in green bonds worth 7.5 tons of CO_2, and twice that amount for next 5 years after which the vehicle would have to be off-road compulsorily. Thus, the owner, in order to run for

34 USEPA, 2018, Green House Gas emissions from a typical passenger vehicle, Office of Transportation and Air Quality EPA-420-F-18-008, US Environmental Protection Agency, March 2018

next 10 years on the road, needs to invest in about 22.5 tons of Carbon Bonds. If he is futuristic, he may buy at IPO rate of US$10 per ton i.e. by investing a total of Rs. 16650.00. If he buys the Carbon Bond from the market, he may have to actually spend thrice that amount.

Further, Assam has registered about 1.5 million vehicles till 2011. Each such vehicle, which is 10 years old, would require at least 22 Carbon Bonds to be on road for next 10 years. Therefore, approximately 30-35 million Carbon Bonds can be sold off straight away only in one use case.

Every case of pollution overshoot can be effectively handled in this manner without taxing the citizens much. However, such innovative environmental policy schemes would require a buying politically at the highest level and on-boarding all stakeholder involved in a given scheme of things. Then, these carbon Bonds could be sold and purchased at market rates by one and all including industries, enterprises and citizens alike.

1.4.3 How Much M/s OIL is Liable to Pay?

M/s Oil India Limited (OIL) is an enterprise of repute having its origins in the soil of Assam and a Navaratna enterprise of the Government of India. The intension of this Report is not to kill M/s OIL or penalize it so heavily that may die one day. The Report ought to be seen in its entirety, and at the root of it, it is the MoPNG that needs to introspect, and act like a good owner.

As per Para 16.3.4 of the Report, the share of M/s OIL has been fixed at Rs. 92.21 cr per annum for 10 years and that of MoPNG at Rs. 587.79 cr per annum for 10 years as a cost of damages to be paid to the Government of Assam, which, in turn, has been suggested to have the funds spent in the prescribed manner. In addition, payment of royalties to the Govt. Of Assam has been recommended to the tune of Rs. 489 cr with additional 14.5% VAT on the royalties.

However, acceptance of the above recommendations is subject to approval of the Government of Assam. The Govt. Of Assam may have its own views on the matter, and may decide to compound the damages or reduce the same or even waive it off fully or partially even or seek equivalent equity in M/s OIL by way of reducing the equivalent shareholding of MoPNG. The Government of Assam may raise the entire cost of damages or part thereof in Carbon Bonds as explained earlier and invest the same in making Assam carbon neutral.

The cost of the Report as mentioned in Para 17.5.1 of the Report is required to be defrayed by M/s OIL.

1.5 The End Word

This Report is a humble attempt to bring about a departure from the business as usual methods and systems for assessment of ecological damages and environmental impact assessments, and align a new thinking in terms of ecological disasters. Ecological disasters are likely to be more frequent and damages may rise at compounding rates. Therefore, this Report may be discussed openly, researched upon and newer methods may be worked upon, so that we may not be seen by the future generations as not even having given a try to put our best foot forward. A true scientific temper is needed while assessing natural systems without thinking who would pay for that. Eventually, it shall neither be M/s OIL or MoPNG, we all shall all have to pay heavily, including future generations.

1.6 Public URL Of The Report

The Report, in three volumes and additionally with this Corrigendum, shall be available for download at the following address: http://baghjan.amtron.in/omec.

CORRIGENDUM PART-2

2 ERRATA TO VOLUME I OF THE REPORT

2.1 Errata To Volume I Of The Report

Several grammatical and other errors in sentence formation (due to accidental erasing while typing in the computer) and erroneous typing of certain numerical values have come to light while revisiting the Report (Volume I). All such errors that have caught the eyes of the author of this Report in this round of reading have been listed here Chapter No, Para No and Page No wise serially in a tabular format. Line No. is the line count on a given page (and additionally referenced by the corresponding Para No. While line numbering, tables, figures with their titles, equations with their expressions and definitions of quantities and parameters (mostly starting with 'where' in one or more lines but not mixed with another running sentence), and paragraph headings have not been counted as lines.

Table No. 2.1: Errata

Chapter No.	Para No.	Page No.	Line No.	Corrections
1	1.2	52	8	Replaced 'discussions' with 'discussion'
1	1.3	53	16	Inserted 'was' after the word 'strategy'
1	1.4	55	8	Replaced 'the from' by 'our front'
1	1.4	55	15	Replaced 'were' with 'was'
1	1.4	55	16	Replaced 'them' with 'their missing colleagues'
1	1.4	55	21	Deleted the second occurrence of 'water'
1	1.8	59	25	Replaced 'were with 'was'
3	3.1	71	1	Replaced 'areas' with 'area'
3	3.2.2	74	5	Inserted 'sight' after 'rare'
3	3.4	82	17	Replaced 'Joolock' with 'Hoolock'
3	3.8	92	1	Deleted the second occurrence of 'even'
4	4.3	97	9	Capitalized 'm' of 'm/S'
4	4.5.3	104	6	Replaced 'definitions' with 'definition'
4	4.6.2	107	Table 4.9	(inserted '(MMT)' after 'Share of OIL in Production'; and inserted '(BCM)' after 'Share of OIL in NG Production'
4	4.9.1	115	3	Inserted 'is generally considered rare' after 'explosion'
5	5.1	124	10	Deleted the first occurrence of 'were'
5	5.1	124	15	Replaced 'to fully understand' by 'to

Chapter No.	Para No.	Page No.	Line No.	Corrections
				understand fully'
5	5.4	126	14	Deleted the first occurrence of 'to'
5	5.4.4	131	1	Inserted 'be' after 'should'
5	5.4.4	132	6	Deleted the first occurrence of 'the'
5	5.5	132	20	Replaced 'practice' with 'practices'
5	5.10	141	17	Replaced 'in' with 'is'
5	5.10.1	142	19	Capitalized 'c' of 'collector'
6	6.3.2	153	18	Inserted 'heavier hydrocarbons were present' after 'meaning'
6	6.3.4	154	2	Replaced 'needs' with 'need'
6	6.5.1	157	18	Deleted 'not'
7	7.2.5	171	12	Replaced '1292' with '1509'
7	7.2.8	173	3	Replaced the sentence 'The radiative power.... total power of the flame' with 'The radiation emissions from natural gas jet fires arise mostly from water vapour and CO_2, and the fraction of heat radiated from jet fires of natural gas and crude oil varies from 0.13 to 0.50'
7	7.2.8	173	13	Deleted the first occurrence of 'now'
7	7.4	193	23	Replaced '158' with '160'
7	7.4	193	25	Inserted ', and condensate chemical composition to be $C_{8.2808}H_{18.5582}$.' at the end of the sentence
8	8.4	200	12	Replaced 'Rs. 1.00 lakh' with 'one lakh'
8	8.5.1	202	12	Replaced the first occurrence of 'PM' with 'AM'
8	8.6.3	213	1	Replaced 'in depth' with 'in-depth'
8	8.6.6	218	12	Deleted 'seen that'
9	9.6	231	20	Inserted ',' after '... the atmosphere'
9	9.6.1	231	26	Capitalized 'r' of 'rate'
9	9.6.1	232	7	Deleted 'and'
9	9.6.3	234	23	Replaced 'change' with 'vary'
9	9.7	236	13	Replaced 'has' with 'have'
9	9.7.3	238	13	Inserted 'in' after '...Defense,'
9	9.7.3	239	6	Replaced 'fall' with 'falls'

Chapter No.	Para No.	Page No.	Line No.	Corrections
9	9.7.3	240	6	Replaced ‘As for’ with ‘For’
9	9.7.3	241	1	Replaced ‘are’ with ‘were’
9	9.7.4	243	3	Replaced ‘vibration’ with ‘vibrations’
9	9.8.2	250	20	Inserted ‘, and’ after ‘... this purpose’
9	9.9.1	254	27	Deleted ‘below’
9	9.10.3	260	12	Inserted ‘due to large scale turbulences in the flame’ after ‘... site’
9	9.10.7	263	18	Inserted ‘in Para 9.7.4 at Page 242 with Footnote 141,’ after ‘stated, ’ and replaced ‘building’ with ‘only a few buildings’
9	9.10.7	263	25	Replaced ‘about’ with ‘dBA’
9	9.11	265	29	Inserted ‘ground’ before ‘velocity’
9	9.11	266	17	Replaced the sentence ‘The findings of ... in this Report’ with ‘The conclusion of IIT Guwahati expert team that in respect of vibrations and noise, the gas blowout was not responsible for formation of cracks in the buildings, has not been accepted by this Committee.
10	10.1	267	2	Replaced ‘variable’ with ‘variables’
10	10.2	268	21	Replaced ‘atmospheric’ with ‘atmosphere’
10	10.3	268	29	Replaced ‘givea’ with ‘give a’
10	10.6	271	19	Inserted ‘secondly,’ after ‘’... subsequently),‘
10	10.8	279	36	Inserted ‘, though the thermal measurements by IIT Guwahati expert team tally with the theoretical values arrived at in this Chapter subsequently at 10.9.6’
10	10.9.3	282	17	Replaced ‘a year’ with ‘six months’
10	10.9.3	282	18	Replaced ‘1’ with ‘4’
10	10.9.3	282	19	Replaced ‘3800’ with ‘15200’
10	10.9.3	282	20	Deleted the line ‘With a population of 1.68 cr ... per annum.’
10	10.9.3	282	Eq. 10.12	Replaced ‘0.46’ with ‘0.45’
10	10.9.7	285	24	Replaced ‘137’ with ‘136’
10	10.9.11	293	3	Replaced ‘137’ by ‘136’
10	10.9.11	293	13	Inserted ‘absorbed most of the waste heat’ after ‘National Park’

Chapter No.	**Para No.**	**Page No.**	**Line No.**	**Corrections**
10	10.9.11	293	15	Replaced ‘137’ with ‘136’
10	10.11	300	3	Deleted ‘creates’ and inserted ‘is created’ after ‘heat island’
10	10.11	300	13	Replaced ‘137’ with ‘136’
10	10.11	300	20	Replaced ‘137’ with ‘136’
10	10.11	300	26	Inserted ‘which is chargeable on M/S OIL as ‘Entropy tax’
10	10.11	300	27	Replaced ‘has’ with ‘had and ‘spewed’ with ‘spewing’
11	11.1	302	4	Inserted ‘subsequently’ after ‘were done’
11	11.2	304	19	Inserted ‘are’ after ‘We’
11	11.6	310	10	Deleted ‘the continue’
11	11.8.3	330	6	Inserted ‘to’ after ‘resorting’
11	11.8.4	331	8	Replaced ‘119’ with ‘115’
11	11.8.8	337	6	Inserted ‘such’ after ‘under’
11	11.9	338	1	Inserted ‘for soil quality’ after ‘prescribed’
12	12.3	363	3	Inserted ‘be’ after ‘would’
12	12.3.1	363	12	Replaced ‘,’ after ‘[224]’ with ‘[,]’
12	12.3.1	363	13	Replaced ‘o’ of ‘one’ with capital ‘O’
12	12.3.1	363	16	Deleted ‘as’
12	12.4	366	13	Replaced ‘wave’ with ‘waves’
12	12.5	369	12	Replaced ‘waters’ with ‘water’
12	12.5.4	371	5	Replaced ‘60’ with ‘6’
12	12.7	373	1	Inserted ‘of’ after ‘indicators’
12	12.8	376	13	Deleted ‘be’
12	12.11.5	384	24	Inserted ‘efficient’ after ‘36%’
12	12.11.5	384	27	Replaced ‘falls’ with ‘would fall’
13	Facing Photo Plate	390	1st Title	Replaced ‘rds’ with ‘Birds’
13	13.2	392	21	Replaced ‘And’ with ‘and’
13	13.3.5	394	27	Inserted ‘been’ after ‘have’
13	13.3.7	396	4	Deleted ‘giving’
13	13.3.7	396	4	Inserted ‘shown’ after ‘is’
13	13.3.7	396	5	Replaced ‘Chart that’ with ‘The Chart below’

Chapter No.	**Para No.**	**Page No.**	**Line No.**	**Corrections**
13	13.4	396	8	Inserted 'is' after 'This'
13	13.6	402	13	Deleted 'the sighting of'
14	14.3.2	409	Fig. Title	The Fig Title of Fig No. 14.1 moved to the previous page
14	14.3.2	409	6	Inserted 'is' after 'scarcely'
14	14.3.2	410	Fig Title	The Fig Title of Fig No. 14.2 moved to the previous page
14	14.4.3	411	15	Inserted 'be' after 'to'
14	14.5.3	416	2	Replaced 'attenuation' by 'amplification'
14	14.6	417	12	Replaced 'a' with 'an'
14	14.6.4	422	3	Inserted 'in the fauna' after 'abnormalities'
14	14.10.1	426	7	Deleted the first occurrence of 'together'
14	14.10.2	426	13	Replaced 'is' with 'in'
14	14.10.2	426	20	Inserted 'June' after '26^{th}'
14	14.10.2	426	21	Inserted 'July' after '18^{th}'
14	14.10.2	427	11	Deleted 'were caused'
15	15.2.3	440	25	Replaced 'inasmuch' with 'in as much'
16	16.2.5	454	10	Replaced '70%' by '60%'
16	16.3	456	10	Inserted 'possess' after 'not'
16	16.6	462	10	Replaced 'GtCO2e' with '$GtCO_2e$'
17	17.1	465	11	Replaced 'assessment' with 'assessments'
17	17.2	466	16	Inserted 'for' after 'issued'
17	17.2	466	17	Replaced 'has' with 'have'
17	17.2.1	466	32	Deleted the first occurrence of 'has'
17	17..2.2	468	2	Replaced 'to' with 'and'
17	17.2.2	468	3	Deleted 'are'
17	17.2.2	468	19	Inserted 'be' after 'may'
17	17.2.3	468	30	Replaced 'waters' with 'water'
17	17.2.4	470	3	Inserted 'for' after 'proposed'
17	17.2.5	470	13	Inserted 'not' after 'does'
17	17.2.8	472	4	Replaced 'assessment' with 'assessments'
17	17.2.8	472	5	Replaced 'One' with 'We'
17	17.2.9	473	11	Inserted 'and' after 'accidents,'

Chapter No.	Para No.	Page No.	Line No.	Corrections
17	17.2.10	473	12	Inserted ‘the’ after ‘part of’
17	17.2.11	473	27	Replaced ‘regulators’ with ‘Regulators’
17	17.3	476	17	Deleted the third occurrence of ‘the’
17	17.3.1	480	17	Replaced ‘158’ with ‘160’
17	17.3.1	480	20	Inserted ‘, and condensate chemical composition to be $C_{8.2808}H_{18.5582}$.’ at the end of the sentence
17	17.3.1	483	2	Inserted ‘ground’ before ‘velocity’
17	17.3.1	483	24	Replaced the sentence ‘The findings of ... in this Report’ with ‘The conclusion of IIT Guwahati expert team that in respect of vibrations and noise, the gas blowout was not responsible for formation of cracks in the buildings, has not been accepted by this Committee.
17	17.4.1	492	15	Inserted ‘stress analysis’ after ‘thermal’
17	17.4.2	494	2	Replaced ‘disaster’ with ‘disasters’
17	17.4.2	494	11	Replaced ‘baghjan’ with ‘Baghjan’
17	17.4.2	494	24	Replaced ‘who’ with ‘that’
17	17.4.2	494	29	Replaced ‘appear’ with ‘appears’
17	17.4.2	494	31	Replaced ‘park’ with ‘Park’
17	17.4.2	495	19	Replaced ‘site’ with ‘sites’
17	17.4.2	496	31	Inserted a new line ‘PCBA infrastructure and manpower should also be upgraded’
17	17.5	498	Table 17.3	Inserted ‘& Upscaling of PCBA infrastructure & manpower’ at the end of line at sl 8 in the Table 17.3
17	17.5.1	499	18	Replaced ‘to learn’ with ‘to be learnt’

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