BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI

ORIGINAL APPLICATION NO. 26 OF 2013 (SZ), 27 of 2013 (SZ), 28 of 2013 (SZ), 51 of 2012 (SZ), 86 of 2017 (SZ)

Janajagrithi Samithi ... Applicant(s)
Versus
The Union of India and Ors. ...Respondent(s)

With

CSI St. Luke's Church ... Applicant(s)
Versus
The Union of India and Ors. ...Respondent(s)

With

BallibettuAlideDeasthana ... Applicant(s)
Versus
The Union of India and Ors. ...Respondent(s)

With

Janajagrithi Samithi ... Appellant(s)
Versus
The Union of India and Ors. ...Respondent(s)

With

Janajagrithi Samithi ... Appellant(s)
Versus
The Union of India and Ors. ...Respondent(s)

INDEX

S. Suresh
2/3/2021

S SURESH
REGIONAL DIRECTOR

Place: Bengaluru

Date: 02/03/2021

Date: 1-3-2021

From

The Expert Committee of the NGT

To
The Honble National Green Tribunal
Principal Bench, New Delhi / SOUTHERN BENCH, CHENNAI

Through:
The Regional Director
CPCB, Bengaluru

Dear Sir

Subject: Submission of final report of the expert Committee
Ref: Hon'ble NGT reconstituted an Expert Committee vide its order (corrected) order dated 08.06.2020:

With regard to the above subject and reference, the expert committee has prepared the report and two copies of the hard copies of the report are enclosed for onward submission to the Hon'ble NGT with intimation to us.

Thanking you,

Yours sincerely

R. Srikanth 1/03/21
Prof. R Srikanth

Prof Krishna Raj 1/3/2021

Encl: The Final Report with Appendix and Annexures (106 Pages)

REPORT SUBMITTED BY THE EXPERT COMMITTEE ON M/s. UDUPI POWER CORPORATION LTD., KARNATAKA TO THE HON'BLE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI, AS PER ORDERS DATED 01.06.2020

1.0 PREAMBLE

In the Original Application Nos. 578/2018, 579/2018, 580/2018, Appeal No 176/2018 and Appeal No. 86/2017, filed by Janajagrithi Samithi V/s The Union of India & Others, the Hon'ble National Green Tribunal (NGT) issued an Orders / uploaded on 14.03.2019 with a direction that .. ***"to explore such measures and steps that would mitigate the harm already caused in addition to ensuring that the plant operates strictly within the environmental norms. We thus invoke the "Polluter Pays principle" under Section 20 of the National Green Tribunal Act, 2010 and hold M/s Udupi Power Corporation Ltd., Project Proponent, liable to pay Environmental Compensation which shall be assessed by a Committee of Experts. ……CPCB shall be the nodal agency to coordinating amongst the Members for taking up task".***

"The Committee shall assess the environmental damages on account of the environmental violations in the area of fly ash management, ash pond, ambient air quality, fugitive emissions etc. which undoubtedly has caused severe damage to the environment and the ecology of the area and submit its report within three months".

Accordingly, the Committee's report was submitted to the Hon'ble NGT on 15.07.2019 by CPCB. On the report submitted, the Counsel appearing for the applicant raised the objection about a member competency, etc. In view of the above, the Hon'ble NGT reconstituted an Expert Committee vide its order (corrected) order dated 08.06.2020 to file a report. The copy of the order is given as **Appendix 1**.

2.0 CONSTITUTION OF EXPERT COMMITTEE & ITS MEETINGS

In compliance of Hon'ble NGT orders, CPCB constituted an Expert Committee. The terms of reference for the Committee is "to ***assess the environmental damages on account of the environmental violations in the area of fly ash management, ash pond, ambient air quality, fugitive emissions etc. which undoubtedly has caused severe***

damage to the environment and the ecology of the area" for the existing 2 x 600 MW Thermal Power Plant (TPP) of M/S Udupi Power Corporation Ltd (UPCL), Udupi. The members of the reconstituted Expert Committee are as follow:

Table 1: Constitution of Expert Committee

No.	Name and Designation	Department
1.	Dr. R. Srikanth, Professor & Dean	School of Natural Sciences and Engineering, National Institute of Advanced Studies (NIAS), Bangalore
2.	Dr. Krishna Raj, Professor	Centre for Economic Studies and Policy (CESP), Institute for Social and Economic Change (ISEC), Bangalore
3.	Mr. G.Thirumurthy Additional Director & Nodal Officer	Central Pollution Control Board (CPCB), Regional Directorate-South, Bangalore

Upon the formation of the Expert Committee ("Committee"), the committee had five rounds meeting i.e. on 16.06.2020, 25.08.2020, 05.11.2020, 12.11.2020 and 27.01.2021. The Committee agreed to adopt the CPCB methodology to assess the Environmental damage caused by UPCL. This methodology includes an assessment of the environmental damage inflicted on Agricultural / Horticultural crops and the Health of the people living in the villages located within 10 km of the UPCL plant. The Committee also agreed on the following terms of reference to assess the environmental damage caused by UPCL.

- The time period for assessing the environmental damage is from the date of commissioning of Unit 1 of the UPCL plant (i.e., from November 2010).
- The data for assessing the environmental damage will be collated by the Committee from different Government Departments such as Health, Agriculture, Horticulture, as well as KSPCB.
- Besides, the observations of the Committee during the field visit to the affected villagers/panchayats, health centres, and the UPCL plant will also be given due consideration.

In view of the above, the Committee obtained the following information from the concerned government departments to estimate the Environmental damage caused by UPCL.

- ✓ The list of affected villages within a 10 km radius of the UPCL plant, considering the predominant wind directions.
- ✓ Details of the total land area affected both irrigated and un-irrigated and its breakup with cropping pattern in the affected villages.
- ✓ Total crop loss, reduction in crop yield, change in cropping pattern before and after commissioning of the first unit of the UPCL plant on 11th November 2010.
- ✓ The total population of villages, information on health statistics of villages w.r.t. air borne and water borne diseases.
- ✓ Operational status of the UPCL plant since 11th November 2010.

Subsequently, the Committee submitted an Interim Report to Hon'ble NGT based on the meetings held and the information obtained from concerned departments. The Committee requested on 4th February 2021 for additional time. Accordingly, the Hon'ble NGT granted additional time and the case is re-posted to **03.03.2021**. In the meantime, the committee undertook a 3-day field inspection and held meetings with concerned Government departments in Udupi district, UPCL, the Applicant, and a few villagers and Panchayat officials in Yelluru village as per pre-planned discussions. The Committee's visit to hold stakeholder meetings and visit the UPCL site was also informed to the District Collector. Accordingly, the Expert Committee conducted meetings with the officers of the District Agriculture and Health departments and the Applicant (over video conference) on 7th December 2020. On 8th December, 2020, the Committee also visited a PHC, some agricultural lands, wells, cattle, Yelluru Panchayat, and held discussions with some villagers in Yelluru village along with the District agriculture department. The inspection of M/s UPCL was conducted on 9th December 2020.

In the meeting held on 7th December 2020, the concerned department officials in Udupi district were requested to provide the following information:

- ✓ Year wise population of identified Villages
- ✓ Air Borne and Water Borne diseases of the 15 villages and Health data of the villages located beyond 15 kms
- ✓ Soil study report of the Agricultural lands
- ✓ Average rain fall during Kharif season and impact due to saline water
- ✓ Change in cropping pattern Village wise statistics on Horticultural crops yield.

- ✓ Reported death of cattle due to Environmental Pollution.
- ✓ Copies of complaints received by the Panchayats against M/s UPCL with respect to Environmental Pollution.

Accordingly, the concerned departments and Panchayats submitted information to the Expert Committee; the same was reviewed for preparation of the final report. However, with respect to data on ecology, environment, loss of fish, agricultural crop loss and cattle deaths, data are insufficient and also requires an independent study and it is time consuming, therefore, the committee decided to estimate the EC for airborne diseases solely based on the information received from the health Department.

3.0 METHODOLOGY FOR ASSESSING ENVIRONMENTAL COMPENSATION

The committee relied on the methodology prepared by the Central Pollution Control Board (CPCB) for assessing the environmental compensation based on the Hon'ble NGT direction in the matter of O.A. 593/2017 (WP) (Civil) No 375/2012, Paryavaran Suraksha Samiti Vs Union of India. Accordingly, the Environmental Compensation (EC) is estimated considering following cases:

a) Discharge in violation of consent conditions, mainly prescribed standards / consent limits.
b) Not Complying with the directions issued, such as direction for closure due to non-installation of OCEMS, non-adherence to the action plans submitted etc.
c) Intentional avoidance of data submission or data manipulation by tampering the online continuous emission/ effluent monitoring systems.
d) Accidental discharges lasting for short durations resulting into damage to the environment.
e) Intentional discharges to the environment – Land, Water and Air resulting into acute injury or damage to the environment.
f) Injection of treated/ partially treated / untreated effluents to ground water.

The earlier Committee estimated the Environmental Compensation considering violations of consented conditions and noncompliance to the directions and notices, accordingly the estimated EC was Rs. 4.89 Crores.

Now, the re-constituted Expert Committee consented that CPCB methodology itself mandates that "in case of (d), (e), (f), the Environmental Compensation may be levied based on a detailed investigations by Expert Institutions / Organizations." Therefore, to determine the EC, the Committee is of the opinion to take into account health data to assess the airborne diseases afflicted to the people in the 10 km surrounding villages from M/s UPCL.

3.1 MECHANISM FOR ASSESSMENT OF HEALTH ISSUES

The Expert Committee had a detailed discussion about the mechanism for Assessment of Health Issues developed by CPCB in O.A. 739 of 2018 (Air Pollution due to Stone Crushers) and requirement of information to arrive / estimate damage assessment of Health Issues. Accordingly, the formula used for assessing the damage to Health due to Respiratory Diseases (Damage H) in Rupees:

Damage H = No of Cases Reported (X) * COI Affected Area

The Committee observed that since there is no separate methodology available to assess the Environmental Damage caused by a Thermal Power Plant. However, the methodology adopted for stone crushers by CPCB may be followed, since both coal-fired power generation and stone crushers create airborne pollution. The methodology demands that the sites/ areas where many types of the industries are co-existing, % contribution of particulate matter from each industry in the ambient air may be calculated based on the Source Apportionment Studies. In such cases, the contribution of the each industry /activity may be calculated by multiplying the **Damage H** with the contribution factor from each source.

On the above point, the Expert Members doubted whether it is possible to carry out a Source Apportionment study on the ground today to record the pollution that may have occurred during the heyday of M/s UPCL during FY 2015-16 and FY 2016-17. Hence, the Committee decided to focus on the assessment of the Environmental Compensation based on the health impacts of airborne diseases recorded by the local health centres..

4.0 STATUS OF OPERATION OF M/s UPCL

M/s Udupi Power Corporation Ltd. (UPCL), a subsidiary of Adani Power Ltd., is established in 264 hectares located in western coastal region at Yelluru Village, Udupi, Karnataka. M/s UPCL has two existing units of 2 X 600 MW thermal power plant based on 100% imported coal as fuel. The Committee was informed that the Unit 1 of 600 MW was commissioned and started commercial operation on **November 11, 2010** while Unit 2 was commissioned and started commercial operation on **August 19, 2012**. The important details of the CFE and CFO granted to UPCL are as follows:

The **Consent for Establishment (CFE)** was issued to the unit under Water (Prevention & Control of Pollution) Act, 1974 ***(WATER ACT)*** and Air (Prevention & Control of Pollution) Act 1981 ***(AIR ACT)*** for establishment of 2 X 600 MW coal based thermal power plant by KSPCB vide Order No. KSPCB/HPI/SEO/EO/UDUPI/CFEx/2009-10/49 dated May 19, 2010. The important conditions are:

- To obtain necessary license / clearance from other relevant statutory agencies.
- Industry shall use imported coal with ash content less than 4.75% and sulphur content less than 0.8%.
- A bi-flue stack of 275 m height each stack for the 2028 TPH boiler shall be provided with continuous online monitoring equipment for SOx, NOx, PM, Hg and exit velocity of flue gas shall not be less than 23.19 m/s.
- High efficiency Electro Static Precipitator (ESP) shall be installed to ensure the Particulate emission does not exceed 50 mg/m^3.
- Wet limestone type FGD unit with 85% efficiency removal of SO_2 shall be installed.
- Industry shall comply with Fly ash notification.

Consent for Operation (CFO) for Thermal Power Plants Unit I & II– 1200 MWH was issued under Water Act and Air Act by the KSPCB vide combined consent order No. KSPCB/SEO/17 Cat/CFO/UPCL/2009-10/98 dated May 19, 2010, with validity up to June 30, 2011 and subsequently renewed every year up to 2015-16. Now, the present combined consent for discharge of effluents under the Water Act and emissions under Air Act is issued by KSPCB vide Combined Consent Order No. AWH-301645 dated

December 15, 2016 for a period from July 01, 2016 to June 30, 2021 (5 Years). The important conditions of present consent are:

- **Effluent:**

  - Total sea water quantity usage shall not exceed 10,000 M^3/Hr for industrial and domestic purpose.
  - To use imported coal with ash content not exceeding 12% and Sulphur content not exceeding 0.8% (average) respectively at any given time.
  - Treated effluent shall be discharged through pipeline in the Arabian Sea ensuring that the differential temperature is maintained within 5°C.
  - Sweet water requirement shall be met from the desalination plant.
  - Storage tank of sufficient capacity shall be provided to hold the untreated effluent in the event of emergency arising.
  - To install online monitoring system at the outlet of Guard Pond to monitor pH, DO etc.
  - To conduct plankton studies to verify whether any heavy metals or any other pollutants are getting accumulated in the vicinity of the discharge and any impact on marine life.
  - To check the submarine pipeline for any damages etc.

- **Emission**

  - Transportation of coal from Mangalore to the site shall be undertaken by rail with adequate provision to control fugitive dust emissions.
  - To maintain stack height of 275 M AGL with twin flue, ESP and FGD to meet the standard of Particulate matter of 50 mg/Nm^3. The exit velocity of flue gases shall not be less than 22 m/s. Low NOx burner shall be installed.
  - To install online continuous emission monitoring system for stack.
  - To operate FGD plant to control SO_2 emissions.
  - To provide adequate dust control measures for coal handling area and coal transfer points.
  - To monitor mercury content on monthly basis in the ash generated and as well as in the emissions.

- Extensive monitoring of air quality in and around the power plant and extending up to Western Ghats.
- Fugitive emission of fly ash shall be controlled so that no agricultural of non-agricultural land is affected. Damage to any land shall be mitigated and suitable compensation provided in consultation with the local panchayat.
- To adhere to the directions contained in fly ash utilisation notifications.
- To maintain the record of quantity / quality of blended coal burnt in the boiler and quantity of ash generated and disposed off.

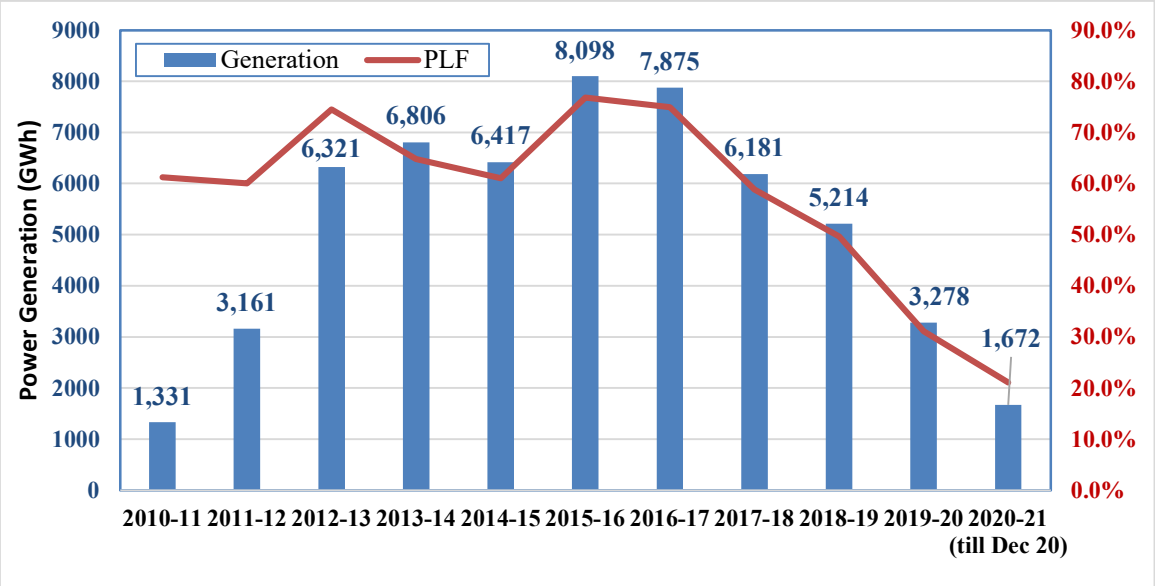
M/s UPCL is operating both the units i.e. 2 X 600 MW thermal power plant for supplying electricity to meet about 11% of its peak electricity requirement under different power purchase agreements to the State of Karnataka. The actual capacity of operation of plants and days of operation and Plant Load Factor (PLF) are shown below:

Table 2: Operation of UPCL over the Years

Year	Power Generation (MU)			Plant Load Factor (PLF) %			Running days	
	Unit 1	Unit 2	Total	Unit 1	Unit 2	PLF	Unit 1	Unit 2
2010-11	1330.7	0	1330.7	61.20	0	61.20	104	0
2011-12	3161.47	0	3161.47	59.99	0	59.99	255	0
2012-13	3960.13	2361.26	6321.39	75.34	73.01	74.46	310	180
2013-14	3652.58	3153.45	6806.04	69.49	60.00	64.75	311	263
2014-15	3013.59	3402.99	6416.58	57.34	64.74	61.04	254	286
2015-16	4088.96	4008.59	8097.55	77.58	76.06	76.82	316	313
2016-17	4352.47	3522.96	7875.42	82.81	67.03	74.92	345	281
2017-18	3046.97	3134.35	6181.32	57.97	59.63	58.80	261	260
2018-19	2376.43	2837.91	5214.34	45.21	53.99	49.60	217	251
2019-20	1445.5	1832.43	3277.93	27.43	34.77	31.10	137	184
2020-21*	794.81	877.5	1672.31	20.07	22.16	21.11	80	88

Note: * Till December 2020

The combined Power Generation of Unit 1 & 2 with PLF over the years is shown in Graph below:



Source: UPCL and Central Electricity Authority (CEA)

Fig.1. Power Generation from UPCL (GWh or MU) and Plant Load Factor (%)

As shown in Table 2 and Figure 1, UPCL's power generation reached a peak during 2015-16 and has been continuously declining in the last 3 to 4 years. Specifically, the power generation from UPCL during 2019-20 was only 40% of the electricity generated during FY 2015-16. During the current FY 2020-21, the UPCL plant has been under reserve shutdown for extended periods as per the requirement of the Karnataka State Load Dispatch Centre (KSLDC). Therefore, power generation by UPCL during April – December 2020 was less than 55 percent of the planned generation for this period and lower by 22 percent compared to UPCL's generation during the same period last year.

Consequently, the Plant Load Factor (PLF) of UPCL during FY 2020-21 was only 21.12 percent which is lower than the record-low PLF of 27.34% achieved by UPCL during FY 2019-20. However, UPCL could increase their power generation during the visit of the Expert Committee i.e. December 07-9, 2020 and the period during which Ambient Air Quality Monitoring (AAQM) was carried out by the KSPCB at selected villages during December 15 – 18, 2020. As shown in Table 3, the PLF of UPCL during the

measurement of AAQM (December 15-18, 2020) varied between 72.53% and 79.97% which is in the same range as the PLF achieved during FY 2015-16 and FY 2016-17.

Table 3: Operation of UPCL during the Field Visit and AAQM measurement

Date	Power Generation (GWh or MU)			PLF (%)
	Unit-1	Unit-2	Total	
07.12.2020	0	0	0	0
08.12.2020	3.93	1.66	5.59	19.41
09.12.2020	10.11	9.83	19.94	69.24
15.12.2020	10.16	11.49	21.65	75.17
16.12.2020	9.84	11.05	20.89	72.53
17.12.2020	10.75	12.29	23.03	79.97
18.12.2020	10.53	11.09	21.62	75.07

Note: MU – Million Unit, PLF- Plant Load Factor

4.1 AMBIENT AIR QUALITY STATUS OF VILLAGES

The Karnataka State Pollution Board (KSPCB) does not have any continuous AAQ monitoring station in the vicinity of UPCL. However, KSPCB arranged to carry out Ambient Air Quality Monitoring at four villages i.e. Mudurangadi, Adamar, Hejmady and Inna located in the vicinity of M/s UPCL as per the decision of the Expert Committee meeting held on December 07, 2020. **The monitoring locations and their distance from the UPCL stack are shown in Google map (Fig 2) below:**

Fig 2: Map showing Location of AAQ Monitoring

The above map reveals that the monitoring location of R&R colony, Admar is at 1.9 km towards NW, Mudurangadi is at 2.8 km towards NE, Inna village is at 4.8 km towards SE and Hejmady is at 7.2 km towards SW from the UPCL stack.

The Ambient Air Quality Monitoring was carried out for PM_{10}, $PM_{2.5}$, NO_2 and SO_2 for two consecutive dates i.e. December 15-16, 2020 (24 hrs.) and December 17-18, 2020 (24 hrs.) by following the standard sampling procedures. The monitoring results reported by KSPCB are summarised as follows:

Table 4: Ambient Air Quality Monitoring Results – 8 Hrs Average

Sl. No.	Parameters (µg/m³)	December 15-16, 2020			December 15-16, 2020		
		1st Shift	2nd Shift	2nd Shift	1st Shift	2nd Shift	2nd Shift
1	**Location : Mudarangadi Village**						
	PM_{10}	40	33	41	64	26	31
	SO_2	7	9	8	11	8	9
	NO_2	12	9	10	13	10	11
	$PM_{2.5}$*	40			29		

Sl. No.	Parameters ($\mu g/m^3$)	December 15-16, 2020			December 15-16, 2020		
		1st Shift	2nd Shift	2nd Shift	1st Shift	2nd Shift	2nd Shift
2.	**Location: R&R Corridor, Admar Village**						
	PM_{10}	37	33	36	72	36	42
	SO_2	9	7	8	10	8	7
	NO_2	11	9	11	12	11	10
	$PM_{2.5}$*	33			26		
3	**Location: Hezamady Kodi Village**						
	PM_{10}	40	38	54	35	71	30
	SO_2	8	10	10	9	8	11
	NO_2	14	13	15	16	14	15
	$PM_{2.5}$*	31			20		
4	**Location: Inna Village**						
	PM_{10}	22	43	50	35	24	27
	SO_2	10	11	12	9	9	7
	NO_2	13	12	14	14	12	12
	$PM_{2.5}$*	38			23		

Note: All values are expressed in 8 hourly basis ($\mu g/m^3$), Where *- $PM_{2.5}$ is 24 hrs. Sampling

The ambient air quality monitoring data of the above locations for 24 Hours (average) are given below:

Table 4A: Ambient Air Quality Monitoring Results- 24 hrs. Average

S. No.	Monitoring Locations	SO_2 $\mu g/m^3$		NO_2 $\mu g/m^3$		PM_{10} $\mu g/m^3$		$PM_{2.5}$ $\mu g/m^3$	
		A	B	A	B	A	B	A	B
1	Mudarangadi Village	8	9	10	11	38	40	40	29
2	R&R Corridor, Admar Village	8	8	10	11	35	50	33	26
3	Hezamady Kodi Village	9	9	14	15	44	45	31	20
4	Inna Village	11	8	13	12	38	29	38	23
3	**NAAQ Standard limit**	**80**		**80**		**100**		**60**	

A – December 15-16, 2020, B – December 17-18, 2020

The ambient air quality monitoring results indicate that the concentrations of SO_2, NO_2, PM_{10} and $PM_{2.5}$ are well within the prescribed limits and comply with

the National Ambient Air Quality (NAAQ) Standards (24 Hours average). This demonstrates the fact that UPCL plant can control airborne pollution within the NAAQ standards if all controls are in place and the plant is complying with all conditions laid down in the Environment Clearance, Consent to Operate, etc. However, it is worth noting that the previous committee has arrived at an Environmental Compensation of Rs. 4.89 Crores due to UPCL's non-compliance with various statutory provisions over a period of 1630 days (15.10.2011 to 08.10.2015 and 10.02.2016 to 04.08.2016).

5.0 WATER QUALITY OF OPEN WELLS IN YELLURU VILLAGE

During the Expert Committee inspection along with other concerned departments to the Agricultural fields, some of the farmers expressed that their open well water is not potable and the colour of the water is changed. The Expert Committee decided to carry out sampling of open wells in Yelluru Village through KSPCB. officials carried out open well sampling at three locations. The data related to the samples collected from three open wells and analysed in the KSPCB Lab, Mangalore are shown in Table 5:

Table 5: Open well (OW) Samples Analysis Results

S No	Parameter	OW 1	OW 2	OW 3	Std*.
1	pH at 25°C	6.6	6.8	6.9	6.5 – 8.5
2	Hardness as $CaCO_3$, mg/L	16	168	100	600
3	Calcium as Ca, mg/L	3	22	14	200
4	Magnesium as Mg mg/L	2	27	16	100
5	Chloride as Cl, mg/L	32	578	294	1000
6	Sulphate, mg/L	1	26	28	400
7	Total Alkalinity mg/L	80	100	76	600
8	COD mg/L	9	22	36	-
9	BOD, mg/L	1	1	2	-
10	TDS mg/L at 180°C	104	824	492	2000
11	Fluoride mg/L	0.020	0.016	0.054	1.5
12	Nitrate as N, mg/L	0.784	11.9	5.21	45
13	Turbidity NTU	BDL	BDL	BDL	5
14	Sulphide, mg/L	BDL	BDL	BDL	0.05
15	Lead, mg/L	BDL	BDL	BDL	0.01

S No	Parameter	OW 1	OW 2	OW 3	Std*.
16	Chromium, mg/L	BDL	BDL	0.016	0.05
17	Iron, mg/L	0.279	0.218	0.08	0.3
18	Cadmium, mg/L	BDL	BDL	BDL	0.003
19	Copper, mg/L	BDL	BDL	BDL	1.5
20	Nickel, mg/L	BDL	BDL	BDL	0.02
21	Zinc, mg/L	2	3	4.7	15

Note: * - Indian Standard for Drinking Water (IS 10500: 2012) permissible limit in the Absence of Alternate Source

Where,

OW1 - Open well water collected from Ganesh Rao House Saje, Yelluru

OW2 - Open well water collected from Ganesh Rao Field Saje, Yelluru

OW3 – Open well water collected from Jaganath Mulya House, Kolachuru, Yelluru

The above table reveals that TDS, Chloride, Hardness etc. are found high in the Open well located in the agricultural field, whereas the Open well located near the houses are found very low, may be due to entry of agricultural runoff in to the open well located in the agricultural field. However, there is no significant ground water contamination since the ground water quality samples collected from the open wells are conforming to the IS 10500: 2012 standards.

6.0 CROP AND SOIL STATUS IN SURROUNDING VILLAGES OF UPCL

The Expert Committee sought clarifications with respect of extent of agriculture land affected due to environmental pollution in villages. In view of this, the Joint Director of the Agriculture Department in Udupi district stated that the total rainfall levels in the area during Kharif i.e. June to September were 2654 mm, 3027 mm, 2685 mm, 2854 mm and 2763 mm in 2015, 2016, 2017, 2018 and 2019, respectively. He also stated that the total rainfall values in the area during Rabi i.e. October to December were 499 mm, 80 mm, 277 mm, 236 mm and 507mm in 2015, 2016, 2017, 2018 and 2019, respectively. There are two major crops i.e. Paddy and Black gram cultivated in the area.

6.1 AREA COVERAGE OF CROPS

Paddy is cultivated during Kharif and black gram is cultivated during Rabi in general. Accordingly, the agricultural area coverage under rain-fed paddy and black gram in Kapu Taluk and Karkala Taluk of Udupi District over the last decade is as follow:

Table 6: Area coverage of Kharif and Rabi

S. No.	Year	Area Coverage Kharif (ha)			Area Coverage Rabi (ha)		
		Kapu	Karkala	Total	Kapu	Karkala	Total
1	2009-10	2214.16	997.64	3211.80	257.09	11.55	268.64
2	2010-11	2182.82	989.46	3172.28	229.42	10.97	240.39
3	2011-12	2202.17	922.35	3124.52	181.36	07.99	189.35
4	2012-13	2030.51	906.75	2937.26	175.23	07.69	182.92
5	2013-14	2003.32	899.32	2902.64	122.56	21.92	144.48
6	2014-15	1955.39	851.83	2807.22	116.61	08.49	125.10
7	2015-16	2037.89	861.68	2899.57	116.68	07.93	124.61
8	2016-17	2075.24	845.20	2920.44	093.13	06.06	099.19
9	2017-18	1966.92	815.58	2782.50	074.73	07.05	081.78
10	2018-19	1511.62	724.62	2236.24	075.90	06.55	082.45
11	2019-20	1448.67	689.96	2138.63	079.83	04.96	084.79

The above table revels that the area coverage of Kharif and Rabi was highest during 2009-10 i.e. 3211.8 ha and 268.64 ha respectively. But, thereafter the area under rain fed paddy during Kharif and black gram during Rabi has shown sharp declining trend till 2014-15. Later, area coverage of Kharif and Rabi increased during 2015 – 2017 and again started reducing. The exact reasons for the decline in area of cultivation could not be ascertained by the Expert Committee since systematic field surveys could be undertaken due to the COVID-19 pandemic. On the other hand, it is observed that there is no remarkable change in the productivity of Paddy & Black gram over the last 11 years as per yield statistics information of Department of Economics and Statistics. The Agriculture Department has ***also reported that the decline in the area of paddy and black gram was not only a trend in the surrounding village of UPCL but also a phenomenon noticed in the entire Udupi District.***

The Agriculture Department has submitted the yield statistic based on the Hobli average crop cutting for a period i.e. 2008 to 2014, whereas for the year 2014 to 2020, the yield statistics were provided based on the crop cutting results of Gram Panchayat level average yield. ***The Department is not having yield statistics for individual farmers since crop cutting studies were not conducted for the same.*** The area coverage, crop yield information, soil health status etc. submitted by the Agriculture Department are given in **Annexure 4.**

During the field visit between December 7-9, 2020, the expert committee met the **Jaganath Mulya farm House, Kolachuru, Yelluru and enquired about the environmental problems due to UPCL. He observed that the paddy yield is reduced by 50% from 40 quintals to 20 quintals per acre while the yield of horticulture crops including the coconut yield is also drastically affected. Further, he stated that the open well water is unfit for consumption and the household vessels are rusted with the pollution. He opined that the agriculture crops are mainly affected due to saltwater deposit on the crops. Another farmer, Ganesh Rao House Saje, Yelluru also confirmed the crop losses in his field and added that his cattle are suffering from skin diseases due to air pollution.**

The Committee also visited Yelluru Panchayat and discussed with the stakeholders. The Yelluru Panchayat submitted copies of complaints received from the villagers against the air and water pollution from UPCL. The main complaints include, air pollution, water pollution, agricultural and horticultural crop loss, health issues, and also salt deposits.

6.2 SOIL HEALTH STATUS

Soil Electrical Conductivity (EC) does not directly affect plant growth but has been used as an indirect indicator of the amount of nutrients available for plant uptake and salinity levels. EC has been used as a surrogate measure of salt concentration, organic matter, cation-exchange capacity, soil texture, soil thickness, nutrients (e.g., nitrate), water-holding capacity, and drainage conditions. In site-specific management and high-

intensity soil surveys, EC is used to partition units of management, differentiate soil types, and predict soil fertility and crop yields. High EC can serve as an indication of salinity (EC > 4 dS/m) problems, which impede crop growth (inability to absorb water even when present) and microbial activity. Soils with high EC resulting from a high concentration of sodium generally have poor structure and drainage, and sodium becomes toxic to plants. EC is expressed in deci Siemens per meter (dS/m). The classes of salinity and EC are shown in Table 7.

Table 7: Classes of Salinity and Electrical Conductivity

S. No.	Salinity Class	EC (dS/m)	Effect on Crop Plants
1	Non - saline	0 < 2	Salinity effects negligible
2	Very slightly saline	2 < 4	Yields of sensitive crops may be restricted
3	Slightly saline	4 < 8	Yields of many crops are restricted
4	Moderately saline	8 < 16	Only tolerant crops yield satisfactorily
5	Strongly saline	>16	Only a few very tolerant crops yield satisfactorily

The Agriculture Department has submitted the analysis results of soil electrical conductivity (EC) conducted as per the Govt. of India Guidelines to the Expert Committee in the surrounding villages of UPCL for the years 2015-16, 2016-17, 2017-18 and 2018-19. The same is tabulated in **Table 8** and given in **Annexure 4**.

Table 8: Soil Health Status of Surrounding Villages of UPCL

S. No.	Taluk	Panchayat	Village	EC	
				2015- 17	2017 - 19
1	Udupi	Yelluru	Elluru	0.7777	0.1025
2		Thenka	Thenka	0.0800	0.1456
3		Mudarangadi	Santhuru	0.0638	0.3984
4			Pilaru	-	0.0937
5		Bada	Bada	0.1175	0.1680
6		Belapu	Belapu	0.0606	0.1226
7		Padubidri	Padebettu	0.1127	0.1124
8			Nadsalu	0.1084	0.1348
9		Palimaru	Nandikuru	0.0971	0.1511

10			Paliaru	0.0870	0.1878
11		Majru	Majuru	0.1538	0.1121
12			Paduru	0.1042	0.1284
13			Heruru	-	0.0578
14		Kapur Purasabhe	Mallaru	0.1260	0.1000
15			Padu	0.3331	0.1804
16			Muluru	0.1193	0.0661
17		Shirva	Shirva	0.0684	0.1065
18		Hejamadi	Hejamadi	0.4847	0.1158
19		Kuthyaru	Kuthyaru	0.0543	0.0850
20	Karkala	Belmannu	Sooda	0.0939	0.1245
21			Belmannu	0.1647	0.3113
22		Inna	Inna	0.1181	0.2563
23		Nandalike	Nandalike	0.0938	0.1837
24		Mundkuru	Mundkuru	0.1117	0.4633

The above table reveals that the EC of the soil in all 24 villages of Udupi Taluk and Karkala Taluk located in the surroundings of M/s UPCL is less than 2 dS/m. This indicates that the salinity effect is insignificant and the soil health complies with the non-saline Class. Hence, it can be concluded that Soil Electrical Conductivity of soil is found to be normal in villages around UPCL, and no noticeable impact due to sea water cooling tower which is provided with drift eliminator (after several years of operation without this vital equipment) to reduce the loss of sea water to the environment due to the evaporative cooling process.

6.4 STATUS OF HORTICULTURAL CROPS

The Deputy Director of Horticulture was requested to provide the status of Horticultural Crops i.e. Coconut, Arecanut, Cashew and Banana grown in the villages of Kapu Taluk and Karkala Taluk of Udupi District. The Horticultural Department informed that only the average yield of taluk is available and individual farmer wise, village wise yield statistics were not available since crop cutting experiments were not conducted by the Department. The village wise horticultural crop yield status submitted by the Horticulture Department is given as **Annexure 5.** The average yields per acre for different crops reported are shown in Table 9:

Table 9: Average Yield of Horticultural Crops

S. No.	Name of the Crop	Crop Yield (Quintal / Acre)
1	Coconut	14.16
2	Arecanut	6.88
3	Cashew	8
4	Banana	92

As per their department records there is no crop loss reported in the surrounding areas between 2008-09 to 2019-20 and with the existing data, there is no drastic change in the cropping pattern before and after commencement of M/s UPCL.

6.5 STATUS OF CATTLE DEATHS

The Deputy Director, Animal Husbandry & Veterinary Services, Udupi district, vide letter 23.12.2020 reported to the Expert Committee that no animal deaths are reported during 2008 to 18.12.2020 due to environmental pollution in the villages / taluks of Udupi located in a 10 km radius from M/s UPCL (**Annexure 6)**.

7.0 HEALTH STATUS OF VILLAGES

Based on the decision of the Expert Committee, the District Health and Family Welfare Office, Udupi was requested to provide the information about the number of patients reported due to Air Borne such as Asthma, Acute Respiratory Infection, Bronchitis, Cancer and Water Borne such as Gastroenteritis, Diarrhoea, Renal Diseases, Cancer for period from 2008-09 to 2019-20 i.e. from before start of the unit till March 2020. Accordingly, DHO, Udupi, has submitted information for identified villages located within 20 km surroundings from UPCL. The villages identified in Udupi Taluk are Palimar, Nandikur, Yellur, Santhoor, Pilar, Tenka, Hejamadi, Padebettu, Nadsal, Bada, Belapu, Kalathuru, Kuthyar, Shirva "A", Shirva "B", Shirva "C", Muloor, Padoor, Mallar, Kaup Padu, Majoor, 92- Heror, and in Karkala Taluk are Belman, Sooda, Inna. Based on the information submitted by the Department of Health, the average increase in population over the period i.e. from 2008-09 to 2019-20 in these villages is about 6%. The village wise population changes over the period is given as **Annexure 1**. The details

of the patients (suffering from Airborne and Waterborne-pollution related diseases) belonging to each of the identified villages located within 10 km, between 11 – 15 km and between 16 - 20 km of the UPCL plant as reported for the years 2008-09 to 2019-20 are given in **Annexures 2, 3A, and Annexure 3B** respectively.

The Expert Committee reviewed the Public Health Data (provided by the District Health Officer, Udupi) pertaining to 33 villages around the UPCL, Udupi based on village location distance from the UPCL. Accordingly, the villages are grouped based on the distances i.e. within 10 km, in between 11 to 15 km and in between 16 to 20 km. The health data are divided in to two groups i.e. before commissioning of Unit 1 and after Commissioning of Unit 1 till March 2020 to assess the air borne and water borne diseases reported by the people to the Government health centres in those identified villages. The analyses of the health data recorded by the Government health centres in these villages i.e. within 10 km, in between 11 to 15 km and between 16 to 20 km of UPCL are shown in **Table 10 (A, B, and C), Table 10 (D, E, and F) and Table 10 (G, H and I),** respectively.

Table 10A: No of Patients Reported in Villages within 10 km (Air Pollution Related Diseases) - 15 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Asthma	120	86	121	112	136	123	55	98	108	174	171	166
2	Acute Respiratory Infection (ARI)	1003	576	542	1935	719	730	5218	5063	4362	2432	2263	1208
3	Bronchitis	1377	1729	1374	907	816	875	955	1139	983	993	1072	1019
4	Cancer	4	4	8	5	6	11	16	14	20	24	34	40

Table 10B: No of Patients Reported in Villages within 10 km (Water Pollution Related Diseases) - 15 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Gastroenteritis	60	85	84	76	67	83	79	93	71	75	74	80
2	Diarrhoea	206	396	211	211	263	212	195	255	206	229	179	181
3	Renal diseases	22	28	27	48	36	47	34	31	56	64	50	70
4	Cancer	10	2	4	12	3	11	12	13	14	19	18	27

Table 10C: Average Prevalence of Airborne and Waterborne Diseases of Villages within 10 km

Airborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Asthma	110	129	**17**
ARI	1014	2749	**171**
Bronchitis	1347	982	**-27**
Cancer	5	21	**293**

Waterborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Gastroenteritis	76	78	**2**
Diarrhoea	256	215	**-16**
Renal diseases	31	49	**55**
Cancer	7	15	**109**

Table 10 D: No of Patients Reported in Villages in between 11 - 15 km (Air Pollution Related Diseases) - 10 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	**Asthma**	63	54	63	66	61	65	42	47	47	59	56	57
2	**Acute Respiratory Infection (ARI)**	580	442	464	827	459	484	1501	1672	1382	933	870	577
3	**Bronchitis**	225	341	237	77	74	76	53	63	45	68	60	59
4	**Cancer**	2	2	5	4	4	3	6	3	10	6	5	7

Table 10 E: No of Patients Reported in Villages in between 11 - 15 km (Water Pollution Related Diseases) - 10 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	**Gastroenteritis**	22	23	24	20	14	21	21	20	22	22	18	16
2	**Diarrhoea**	137	176	129	135	132	118	135	122	122	125	127	119
3	**Renal diseases**	17	16	19	13	24	19	20	18	16	20	23	17
4	**Cancer**	0	0	2	2	0	1	0	2	0	0	5	2

Table 10 F: Average Prevalence of Airborne and Waterborne Diseases of Villages in between 11 - 15 km

Airborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Asthma	62	54	**-12**
ARI	578	985	**70**
Bronchitis	220	62	**-72**
Cancer	3	6	**69**

Waterborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Gastroenteritis	22	19	**-13**
Diarrhoea	144	125	**-13**
Renal diseases	16	20	**21**
Cancer	1	1	**25**

Table 10 G: No of Patients Reported in Villages in between 16 - 20 km (Air Pollution Related Diseases) - 8 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	**Asthma**	13	14	12	12	15	13	13	14	15	10	9	12
2	**Acute Respiratory Infection (ARI)**	52	58	55	55	59	61	70	67	61	60	55	52
3	**Bronchitis**	5	4	8	5	7	6	6	5	4	5	3	5
4	**Cancer**	3	3	5	7	6	3	4	4	7	7	9	2

Table 10 H: No of Patients Reported in Villages in between 16 - 20 km (Water Pollution Related Diseases) - 8 villages

Sl. No.	Disease	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	**Gastroenteritis**	19	23	20	17	25	24	24	25	29	18	24	15
2	**Diarrhoea**	39	49	38	40	39	40	39	39	33	32	33	29
3	**Renal diseases**	5	5	6	2	9	2	4	2	3	5	3	4
4	**Cancer**	0	0	0	0	0	0	0	0	0	0	0	0

Table 10 I: Average Prevalence of Airborne and Waterborne Diseases of Villages in between 16 – 20 km

Airborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Asthma	13	13	**-1**
ARI	55	61	**10**
Bronchitis	6	5	**-7**
Cancer	5	5	**17**

Waterborne Disease	Average Prevalence		Difference (%)
	Before Unit 2	After Unit 2	
	Col (1)	Col (2)	Col (3) = (2-1)/1
Gastroenteritis	20	23	**16**
Diarrhoea	42	36	**-14**
Renal diseases	5	4	**-11**
Cancer	0	0	**0**

The health data of villages i.e. within 10 km, in between 11 to 15 km and in between 16 to 20 km shown in **Tables 10A through 10I** indicates that there is a significant increase in airborne pollution and waterborne related diseases depending on the distance from the UPCL plant. The health data of 15 villages located within 10 km radius reveals that there is increase of 17%, 171%, and 293% in the average annual prevalence of Asthma, Acute Respiratory infection (ARI) and Cancer respectively during the period 2012 to 2020 (**Table 10C**). While normalising to a population of 1000, the reported cases of ARI increased from 14 to 37.

The health data of 10 villages located in between 11 -15 km radius reveals that there is increase 70% and 69% in the average annual prevalence of ARI and Cancer respectively. The other air borne diseases of Asthma and Bronchitis are found negative during the period 2012 to 2020. While normalising to a population of 1000, the reported cases of ARI increased from 14 to 24.

The health data of 8 villages located in between 16-20 km radius reveals that there is increase 10% and 17% in the average annual prevalence of ARI and Cancer respectively. The other air borne diseases of Asthma and Bronchitis are found negative during the period 2012 to 2020. While normalising to a population of 1000, the reported cases of ARI increased from 0.9 to 1.2.

Waterborne renal diseases increased by 55% during the period 2012 to 2020 in the villages located within 10 km, whereas other waterborne diseases i.e. Gastroenteritis, Diarrhoea are found negative. The Committee noticed that the villages are not having a sewage network, and the individual houses are managing their sewage by providing septic tank / soak pit.

From above it is clear that there is air pollution-related diseases are reported significantly in the villages located within 10 km radius from the UPCL, whereas the numbers of cases are found to decrease beyond 10 km. The airborne and waterborne diseases reported in the Government PHCs identified by the District Health Authorities are decreasing with increasing distances from the UPCL.

As per the National Health Profiles published by the Central Bureau of Health Intelligence (CBHI), Ministry of Health and Family Welfare based on the Monthly Health Condition Reports from Directorate of Health Services of State, the state wise cases and Deaths due to Acute Respiratory Infection for a period of 2013 to 2018 for the State of Karnataka is tabulated below:

Table 11: Acute Respiratory Infection of Karnataka for a period of 2013 to 2018

Year	Male		Female		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
2013	811229	171	766125	85	1577354	256
2014	1121196	27	1091963	12	2213159	39
2015	1118437	29	1000542	6	2118979	35
2016	1081104	63	991317	36	2072421	99
2017	1138647	52	1106474	21	2245121	73
2018	1226672	67	1196606	42	2423278	109

The above table reveals that there is decrease in mortality due to acute respiratory infection during 2013 to 2018 in Karnataka while the total number of cases between 2014 and 2018 fall within a narrow range of -6.4% to +9.4% of the mean value. On the other hand, the average number of ARI cases increased by 171% in the 15 villages located within 10 km of the UPCL plant (**Table 10C)**. This increase may have been much higher but for the continuous reduction in UPCL's power generation in the last four years (**Table 1**). Since the reduction in ARI in the buffer zone of the UPCL plant in recent years coincides with the decline in power generation, the health of residents in the buffer zone must be monitored carefully when power demand increases from UPCL.

8.0 Environmental Management at UPCL

The Expert Committee inspected the environmental management practises followed by UPCL with respect coal handling, unloading operations, stacking and reclaiming facilities, fly ash handling system, ash pond, surface runoff management, ground and ambient air quality monitoring, source emission monitoring and fugitive emissions control system etc. The status of the same is tabulated below:

Table 12: Status of Environmental Management

S. No.	Environmental Management	Existing system
1.	Coal Handling	• The unit receives imported coal by sea route through New Mangalore Port Trust (NMPT), Mangalore at Berth 15, which is established and being operated by UPCL. • Coal rack is unloaded at the track-hopper system of Coal Handling Plant (CHP) which consists of track hopper, coal yards with a capacity of 5 Lac tons, closed conveyor system, stacker – reclaimer machine, coal crusher and coal bunkers and rain guns in coal yard, dry fog system at all transfer points and Crusher House, Dust Extraction System at Bunkers to control the fugitive dust emissions. • Provided settling ponds for treating surface run-off water from coal handling plant. • The coal yard is located at a lower elevation of the plant and its surroundings and two sides of coal storage area is provided with wind breakers of Teflon Wind-Shield and also green belt is created on outer boundary of the coal handling plant.
2.	Source Emission	• The unit has provided a single bi-flue stack of 275 M height connected with Online Continuous Emission Monitoring System (OCEMS) for monitoring of flue gas that comes out from boilers of 2028 TPH Boiler 1 and 2028 TPH Boiler 2. • The unit has provided ESP followed with FGD system to handle the flue gas partially about 25% for controlling SO_2 emissions.

		• The CPCB has given them a timeline to meet the new standards of Sulphur dioxide and Oxides of Nitrogen by year 2022.
3.	Fly Ash Handling	• Out of total Ash generation, the fly ash percentage is ranging between 80 to 90% and bottom ash is ranging between 10 to 20%. • The fly ash generated from the ESP is conveyed through pneumatic system to the ash silos which is provided with bag filters for control of dust during loading and unloading operation. Fly ash from the silos is transferred to Bulkers with spout to reduce dust emissions and transported to various industrial sectors i.e. Cement, Ready Mix Concrete, Brick manufacturing etc. to ensure 100% fly ash utilisation. • Bottom Ash generated from the furnace and coarse ash from the economizer hoppers is utilized by Brick and M-sand manufacturers and also disposed to the ash disposal area in dry form in bulkers. The unit has closed a part of the ash dyke and rehabilitated the same with plantation to control dust emissions from the ash ponds. • The unit has a stock of about 2 lac MT ash in ash ponds; the unit started achieving 100% fly ash utilisation. The unit has closed part of the ash dyke and rehabilitated the same with plantation to control dust emissions.
4.	Sea Water Consumption	• The average sea water consumption varies between 5 to 5.9 KL/MW against the permitted limit of 8.57 KL/MW, as per records of UPCL. • The unit has two number of natural draft-cooling tower with a large hyperbolic tower, where sea water is used for cooling. The cooling towers are provided with drift eliminator to

		reduce the loss due to evaporation, drift and blow down. The unit maintains Cycles of Concentration (COC) i.e. the relation between the concentration of minerals in the makeup water and the cooling tower recirculation water above 1.25 at any time. • RO plant reject along with cooling tower blow down (sea water) is disposed to the sea through guard pond and the average of discharge limit of wastewater in to sea is found within permitted limit, as per the records. • The coastal water quality monitoring near the sea water intake and effluent discharge point study carried out by Department of Aquatic Environment Management, College of Fisheries, Mangalore concludes that the study region indicates that the values (pH, DO, BOD) are within the primary water quality criteria and do not pose any threat to the environment under the present condition.
5.	Ground Water Monitoring	• KSPCB is carrying out ground water quality monitoring at 5 Locations and surface water quality at 2 locations in Mulki River to ascertain the quality of ground and surface water. • Also, the unit is monitoring ground water quality at 9 Locations, Surface Water (1 point) within the buffer zone apart from 4 ground water sampling at Ash Pond and 6 ground water sampling wells in the pipe line corridor by engaging NABL accredited Lab and reports are submitted to KSPCB on monthly basis. • The analysis results of ground water quality carried out by KSPCB are found within the permissible limit of ISO 1500 Drinking Water Standards, except marginal exceedance of Iron concentration on a few locations.

6.	Ambient Air Quality Monitoring	• The unit has established Four (04) Continuous Ambient Air Quality Monitoring Stations (CAAQMS) within industrial premises and Nine (09) Manual Ambient Air Quality Monitoring stations in the surroundings. • The unit has continuous meteorological observatory stations at site to observe Ambient Temperature, Humidity, Wind Speed, Wind Direction and Rain fall. • The overall ambient air quality monitoring results reveals that SO_2, NO_2, PM_{10} and $PM_{2.5}$ are found complying with the Ambient Air Quality Standards.

In addition to the above Environmental Management System, M/s UPCL introduced Adani Aarogya Card / Health Insurance scheme to the Villagers of Yelluru and Mudarangadi / Santoor villages. The Committee was informed by UPCL that more than 9500 villagers of above said villages are covered for Rs.50000/- cashless medical treatment in multispecialty hospitals, requiring specialized treatments. This must be verified from the panchayats covered. This coverage must be extended by UPCL to the residents in all 15 villages within the 10 km buffer zone that are affected (**Table 10A-10C**).

9.0 ENVIRONMENTAL COMPENSATION

The earlier Committee estimated the Environmental Compensation considering violations of consented conditions and noncompliance to the directions and notices and estimated the EC based on the following formula:

$$\mathbf{EC = PI * N * R * S * LF}$$

Where,

PI – Pollution Index of industrial sector, R – A factor of Rupees for EC

N – Number of days of violation took place LF – Location Factor

S – Factor for scale of operation

According the **EC = PI * N * R * S * LF**

= 80 * 1630 * 250 * 1.5 * 1

= ` 4,89,00,000/-

The earlier estimation of EC was Rs 4.89 Crores.

Now, the re-constituted Expert Committee agreed to use the CPCB methodology to take into account environmental damage on Agricultural / Horticultural Crops and Health of the people in the 10 km surrounding villages from M/s UPCL, in addition to the above estimate of Rs. 4.89 Crores.

Based on the statistics submitted by the Government Agricultural, Horticultural and Animal Husbandry departments, there is neither a remarkable change in the productivity of paddy & black gram in Udupi district nor is there is any drastic change in the cropping pattern after the commissioning of UPCL. Further, they have no records of any significant increase in the salinity of the soil which is found to be non –saline today. Similarly, these Government departments also submitted that there is no horticultural crop loss reported in the surrounding areas. Also, there is no animal death reported by the concern department. However, the committee is unable to ascertain the facts of the various departments with villagers due to paucity of time and it requires a complete study on the agricultural loss due to air pollution. ***The Department is not having yield statistics for individual farmers since crop cutting were not conducted for the same.***

In view of above, the Expert Committee decided to estimate the EC based on the incidence of airborne respiratory diseases diagnosed in the Government Primary Health Centres in 15 villages identified by the District authorities to be within 10 km of the UPCL plant. As per the CPCB methodology developed in O.A. 739 of 2018, the following formula was used to assess the Environmental damage to Health (Damage H):

Damage H (in Rupees) **= No of Cases Reported (X) * COI Affected Area**

This methodology demands that the sites/ areas where many types of the industries are co-existing, % contribution of particulate matter from each industry in the ambient air

may be calculated based on the Source Apportionment Studies. However, the committee made assumption that the contribution from other sources may be insignificant since there is no other "Red" category industry in the vicinity of the UPCL plant. Further, power generation from UPCL has recorded a steep decline from year to year from FY 2015-16 onwards due to the availability of power from other sources in Karnataka. Therefore, it was not possible to conduct a proper source apportionment study under these circumstances. Moreover, the local villages as well as the Additional District Commissioner of Udupi district (who had also served in this area earlier) recalled specific instances of the impact of pollution caused by UPCL on the villages near the plant. Due to these reasons, the Committee has considered UPCL is as single polluter / source for the purpose of estimating Environmental Compensation since the commissioning of Unit 1 of the plant in November 2011.

Based on the data received from the District Health Officer, the number of patients who received treatment in the Government health centres in the 15 villages located within 10 kms of UPCL for the following air pollution-related diseases between October 2010 and March 2020 are estimated as follows (**Table 10A**):

- Asthma : 1204
- Acute Respiratory Infections : 24,201
- Bronchitis : 9446
- Cancer : 174

As per the study conducted by one of the Experts, the Cost of Illness of Asthma, ARI, Bronchitis, and Cancer are **Rs. 8,280, Rs. 4,248, Rs. 60,000 and Rs. 1,20,000 respectively. This study by Vijayalakshmi and Krishna Raj (2020) is enclosed as Annexure 7.** Accordingly, the EC is estimated as follows:

a) Damage H_{asthma} = 1204 X Rs. 8280 = Rs. 99.65 Lakhs
b) Damage H_{ARI} = 24,201 X Rs. 4248 = Rs.1028.06 Lakhs
c) Damage $H_{bronchitis}$ = 9446 X Rs. 60000 = Rs. 5667.60 Lakhs
d) Damage H_{cancer} = 174 X Rs. 1,20,000 = Rs. 208.80 Lakhs

Total Damage H = Rs. 7004.11 Lakhs

Therefore, the Environmental Compensation (EC) between October 2010 and March 2020 to compensate for the cost of illness caused by UPCL is estimated to be: Rs. 70,04,10,828- (Rupees Seventy Crores, Four Lakhs, Ten Thousand and Eight hundred Twenty Eight only).

However, this compensation is estimated based on the information provided by the Government health centres in the area (up to 10 km from UPCL) and does not include the cost of treatment incurred by the villagers in private health centres/hospitals in Mangalore/Udupi/Manipal or other nearby towns. This amount also does not include any compensation for any deaths caused by the aforesaid diseases when they become incurable or the loss of livelihood due to forced absenteeism caused by these diseases. While the additional costs can be estimated by undertaking systematic field surveys in the 15 villages falling within 10 km of UPCL, it was not prudent to carry out such field surveys during a pandemic.

10.0 OBSERVATIONS AND RECOMMENDATIONS OF THE EXPERT COMMITEE

Based on field inspections, meeting with concerned Departments, monitoring of ambient air quality of villages and review of data submitted, environmental management etc., the overall observations of Expert Committee are:

- The environmental impact on ecology, environment, loss of fish, agricultural crop loss and cattle deaths, data are insufficient and also requires an independent study for estimation of environmental compensation.
- M/s UPCL has started operating Plant Load Factor (PLF) of >70% of its installed capacity i.e. 2 X 600 MW from 2012-13 to 2016-17 and has been continuously declining from 2017 -2018 to till date due to lower-cost power is available in the state. The average PLF during 2019-2020 was just 31.10 % which has further declined to 21 percent during the first nine months (April-December 2020) of the current financial year.

- The Ambient Air Quality Monitoring carried out in four villages i.e. R&R colony, Admar at 1.9 km towards NW, Mudurangadi at 2.8 km towards NE, Inna village at 4.8 km towards SE and Hejmady at 7.2 km towards SW from the UPCL stack at the Plant Load Factor ranging between 72.5% to 79.97% revealed that ambient

air quality monitoring results of SO2, NO2, PM10 and PM2.5 are found well within the prescribed limits and complying with the ambient air quality standards (24 Hours average) of National Standards. This may be due to the improvements in the environmental management system of UPCL in recent years, though the local communities have undeniably suffered major health-related impacts in the past.

- The ground water samples of Open Wells monitored in the villages of Yelluru revealed that the TDS, Chloride, Hardness levels. are high in the Open well located in the Agricultural field, whereas these levels are very low in the Open wells located near the houses. This may be due to entry of agricultural runoff in to the open well located in the agricultural field. However, there is no significant ground water contamination and the ground water quality samples collected from the open wells are conforming to the IS 10500: 2012 standards. This may be due to the improvements in the environmental management system of UPCL or due to the low operation level of the plant in recent years. Nevertheless, these improvements need to be sustained even when the plant generation increases in future.

- As per the records of Agricultural Department, the area coverage of Kharif (Rain fed paddy) and Rabi (Black gram) was highest during 2009-10 i.e. 3211 ha and 268.64 ha respectively. But, thereafter under rain fed paddy during Kharif and black gram during Rabi has shown sharp declining trend till 2014-15. Later, area coverage of Kharif and Rabi increased during 2015 – 2017 and again started reducing. The exact reasons for declining area of cultivation are not evident in the information submitted by the District authorities. On the other hand, it is observed that there is no remarkable change in the productivity of Paddy & Black gram over the last 11 years as per the yield statistics reported by the Department of Economics and Statistics of the Government of Karnataka. Also reported that the decline in the area of paddy and black gram was not only a trend in the surrounding village of UPCL but also this is a phenomenon noticed in the entire Udupi District. The limitation is that the department is not having yield statistics of individual farmers which may be ascertained from the panchayat or through

plot-wise crop cutting surveys. Therefore, a separate study is required to assess the crop yield loss in the 10 km radius of the UPCL.

- The soil characteristic of Electrical Conductivity (EC) in all 24 villages of Udupi Taluk and Karkala Taluk located in the surroundings of M/s UPCL is found < 2 dS/m, concluding that salinity effect is insignificant and complying with non-saline Class. Hence, it can be concluded that Soil Electrical Conductivity of soil is found to be normal in villages around UPCL, and no noticeable impact due to sea water evaporation from the cooling tower which has been retrofitted with a drift eliminator to control the impact of sea water on the crops cultivated in the area around UPCL that was noticeable earlier.

- As per the records of Horticultural Department, there is no crop loss reported in the surrounding areas between 2008-09 to 2019-20 and with the existing data, there is no drastic change in the cropping pattern before and after commencement of M/s UPCL. The limitation is that the Department is not having yield statistics of individual farmers which may be ascertained from the panchayat or through plot-wise crop-cutting surveys. Therefore, a separate study is required to assess the crop yield loss in the 10 km radius of the UPCL.

- The Department of Animal Husbandry & Veterinary Services, Udupi submitted that there was no record of Animal Death due to environmental pollution in the villages/ taluks of Udupi located in10 km radius of UPCL.

- As per the health records of the Government-owned Primary Health Centres in in the 33 villages around the UPCL plant, air pollution-related diseases have increased significantly in the villages located within a 10 km radius from the UPCL. As per the Government records submitted to the Committee, The prevalence of air and water-borne diseases are decreasing with increasing distances from the UPCL which demonstrates the impact of UPCL operations on the health of the villagers living within 10 km of the UPCL plant.

- UCPCL has introduced Adani Aarogya Card / Health Insurance scheme to the Villagers of Yelluru and Mudarangadi / Santoor villages covering more than 9500 villagers for cashless medical treatment (up to a sum insured of Rs. 50,000 per

year) in multispecialty hospitals. This was confirmed by a few villagers in one of the villages visited by the Expert Committee inspection.

- The earlier expert committee estimated the Environmental Compensation (EC) of Rs. 4.89 crores to be paid by UPCL considering the documented violations of consent conditions and noncompliance to the directions and notices issued by KSPCB and/or other Authorities to UPCL. The re-constituted Expert Committee adopted the CPCB methodology and has assessed the Environmental Compensation on the basis of any damage inflicted on Agricultural / Horticultural Crops and the health of the people in the 10 km surrounding villages from UPCL in addition to the EC estimated by the earlier expert committee. Since there is no noticeable loss of Agricultural / Horticultural Crops as per the District Authorities, the committee estimated the EC based on the Health Status of the people in the surrounding villages located within a 10 km distance from UPCL as per the Authorities.

- Accordingly, considering cost of illness related to air borne diseases, the estimated EC is ***Rs. 70,04,10,828- (Rupees Seventy Crores, Four Lakhs, Ten Thousand and Eight hundred Twenty Eight only). To this amount, the Committee has added the EC of Rs. 4.89 Crores assessed by the earlier Committee on account of recorded non-compliance of consents/clearances by UPCL in the past which may have resulted in crop damages to the local communities in the past. Therefore, the total Environmental Compensation to be paid by UPCL is estimated to be Rs. 74.93 Crores (Rupees Seventy Four Crores and Ninety Three Lakhs only).***

The re-constituted Expert Committee suggest the following for the improvement and better co-ordination of people, department and the industry for the sustainable development of the people living in the area surrounding UPCL:

- ❖ All the Environmental Monitoring Data of UPCL shall be made available to the Village panchayats located in the surroundings of UPCL at monthly intervals. This will enable the concerned panchayat to review and discuss these results with the villagers. In case any villager has a specific issue with the data or the pollution

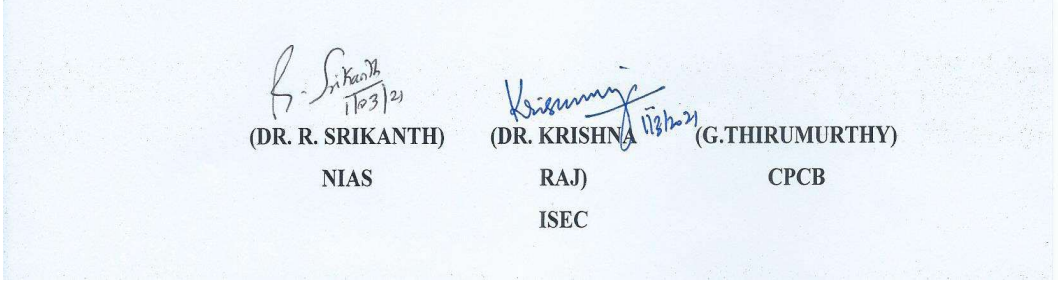
impact of the plant, the concerned panchayat shall communicate the same to UPCL, KSPCB, and the concerned Government department.

- On receipt of disagreement from the village panchayat, UPCL has to clear such issued involving KSPCB and the concerned department as well as the village panchayat

- The Department of Health has to take up community based cross sectional study to estimate the health burden on villagers residing within a distance of 10 km from UPCL. The Adani Arogya Bima scheme must be extended to all villagers residing within 10 km of the UPCL plant to minimise the future health costs (and loss of livelihood) of the local communities.

- The Department of Agriculture and Horticulture must collect the yield statistics and crop cutting data of ***individual*** and shall inform the area coverage, soil study results, crop yield /loss, ground water quality etc. to the local village panchayat for dissemination of information to the villagers.

- KSPCB shall itself carryout monitoring of Ambient Air Quality of Villages located in the surroundings within 10 km as per CPCB norms to cross verify the data of UPCL and also the Ground Water monitoring of open wells located in the villages and share the same to the concern panchayat. A part of the EC paid by UPCL may be used by CPCB (or KSPCB) to set up a continuous Ambient Air Quality (AAQ) monitoring station in a strategic location downwind of the stack. Since this location may vary from season to season, this continuous AAQ monitoring station may be fitted in a mobile van. KSPCB can also identify fugitive dust emission sources and prescribe the standard for the same by amending the consent granted to UPCL under the Air Act and Water Act.



(DR. R. SRIKANTH) NIAS

(DR. KRISHNA RAJ) ISEC

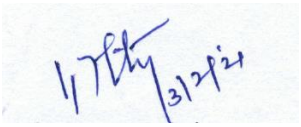
(G.THIRUMURTHY) CPCB

11. DIFFERENCE OF OPINION OF THE COMMITTEE MEMBER FROM CPCB

1. The Committee members from NIAS and ISEC have considered total number of patients in the area during plant operation years (however, since Unit 2 instead of Unit 1) for calculation of health based EC. The Committee member from CPCB is of the view that normal prevalence of the diseases which are expected even if the plant was not there may have been considered and accounted to arrive at the incremental number of patients which may be attributed to air pollution from the plant.

2. The Committee members from NIAS and ISEC have informed that the costs of illnesses are as per the working paper - Vijayalakshmi and Krishna Raj 2020, *"Economic Estimation of Health and Productivity Impacts of Traffic Congestion: A Case of Bengaluru City"* However, it is found that the costs of illnesses considered are not available in the said working paper. The Committee member from CPCB is of the view that the approach used in the reports submitted in O.A.739 of 2018 and O.A. 30 of 2020 (SZ) may have been used.

3. The Committee members from NIAS and ISEC have recommended the health based EC to be in addition to the non-compliance based EC of 4.89 Crores. The Committee member from CPCB is of the view that EC may have been recommended on the basis of only one of the two approaches (the maximum one).



(Dr. Srikanth)	(Dr.Krishna Raj)	(G.Thirumurthy)
NIAS	ISEC	CPCB

Appendix I

Corrected Copy

Item No.1,2,3,4 & 5:

BEFORE THE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

Original Application No. 26 of 2013 (SZ)

With

Original Application No. 27 of 2013 (SZ)

With

Original Application No. 28 of 2013 (SZ)

With

Appeal No. 51 of 2012 (SZ)

With

Appeal No. 86 of 2017 (SZ)

IN THE MATTER OF:

Janajagrithi Samithi ... Applicant(s)

Versus

The Union of India and Ors. ...Respondent(s)

With

CSI St. Luke's Church ... Applicant(s)

Versus

The Union of India and Ors. ...Respondent(s)

With

BallibettuAlideDeasthana ... Applicant(s)

Versus

The Union of India and Ors. ...Respondent(s)

With

Janajagrithi Samithi ... Appellant(s)

Versus

The Union of India and Ors. ...Respondent(s)

With

Janajagrithi Samithi ... Appellant(s)

Versus

The Union of India and Ors. ...Respondent(s)

Date of hearing: 01.06.2020.

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER

HON'BLE MR. SAIBAL DASGUPTA, EXPERT MEMBER

Original Application No. 26 to 28 of 2013 (SZ) &

Appeal No.51/2012 and 86/2017 (SZ)

For Applicant/

Appellant(s): M/s. A. Yogeshwaran.

For Respondent(s): M/s. M.E. Saraswathi for

M. Sumathi and

Mr. G.M. Syed Nurullah Sheriff for MoEF&CC.

38

M/s. Dharpan for State.

M/s. P.N. Rajeshwaran represented on behalf ofMr. Vijay Narayanan &

Mr.H.R. Narayana Rao for UPC.

Mr. R. Thirunavukarasu for CPCB.

ORDER

Original Application No. 26/2013

1. As per order dated 20.02.2020, this Tribunal had considered the request for the change of certain committee members constituted by the then benches by Judgement dated 14.03.2019, and we permitted the Central Pollution Control Board to co-opt a person of their choice in the place of Dr. Zareena Begum, and we have substituted Dr. S.K. Satheesh in the place of Dr. H.N. Chanakya and posted the case to 26.05.2020 for filing a report. On 26.05.2020, the matter was adjourned to 17.06.2020 by notification. As per order dated 26.05.2020, this Tribunal had advanced the case to today on the basis of the oral submission made by Sri. Thirunavukkarasu counsel representing Central Pollution Control Board to consider the affidavit filed by them and also panel of experts submitted by them for the purpose of substituting the person for Dr.Zareena Begum and Dr. S.K. Satheesh.

2. When the matter was taken up today through Video Conference, We heard Sri. Yogeshwaran counsel represented the applicants as

well as the appellants in all the matters. Smt. Sumathi and Sri. Syed Nuruallh Sheriff represented for themselves and Smt. M.E. Saraswathi on behalf of the other counsel for Ministry of Environment Forests and Climate Change (MoEF&CC) Sri. Dharpan learned counsel for State of Karnataka was submitted that he has been appointed as standing counsel Government of Karnatakain the place of Sri. Devaraj Ashok, Sri. P.N. Rajeswaran represented on behalf of Sri. Vijay Narayanan and Sri. H.R. Narayana Rao for Udupi Power Corporation and Sri. R. Thiruvavukarasu represented for Central Pollution Control Board.

3. The Central Pollution Control Board had filed an affidavit wherein they have stated that they requested for Dr. Krishna Raj Professor of Economics from Indian Institute of Social and Economic Change (ISEC), Bangalore to join a committee in the place of Dr. Zareena Begum and he had expressed his willingness to join and he will have to be substituted .

4. Though they have suggested Dr. N.P. Shukla, Former Chairman of Madhya Pradesh Pollution Control Board (MPPCB) and Member of Expert of Appraisal Committee (Thermal Power/Coal Mines/Infrastructure), Ministry of Environment Forests and Climate Change (MoEF&CC), as an expert member in the place of Dr. S.K. Satheesh, Indian Institute of Science, Bangalore as he also expressed his inability to join the committee who has been substituted in the place of Dr. H.N. Chanakya as per the earlier order, but we have directed the Central Pollution Control Board to submit a panel of experts in order to substitute Dr. H.N.

Chanakya or Dr.S.K. Satheesh. Accordingly, they have submitted a panel of experts out of which we select Dr. R. Srikanth, Professor & Dean, School of Natural Sciences and Engineering, National Institute of Advanced Studies Indian InstituteofScienceCampus, Bangalore 560 012 to substitute Dr. S.K. Satheesh who was ordered to the substituted by us in the place of Dr. H.N. Chanakya as per earlier order.

5. The committee is reconstituted with Dr. Krishna Raj, Professor of Economics from Indian Institute of Social and Economic Change (ISEC), Bangalore and Dr. R. Srikanth, Professor & Dean, School of Natural Sciences and Engineering, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore 560 012. So, the committee is reconstituted including above officials accordingly.

6. The committee is directed to conduct the inspection during non-monsoon period as requested by the counsel for the applicantas according to him, it is not possible to take E.I.A. report during monsoon period as the climatic conditions will be different and it will not show the actual picture

7. The learned counsel appearing for State of Karnataka submitted that they had already issued a notification requesting the *State of Karnataka to conduct the carrying capacity which has also directed to be conducted as per the judgement mentioned above. The learned counsel submitted that steps have been taken for this purpose. They also directed to submit the report

41

independently in this aspect before the next hearing date.

8. The Registry is directed to communicate this order to the committee members including the newly added expert's members in the committee immediately through e-mail, so as to enable them to comply with the direction.

9. Four months' time is granted to the committee to file the report. The Committee is directed to submit the report through e-mail or e-filing at ngtszfiling@gmail.com within above mentioned time

10. For consideration of report post on 06.10.2020.

(*) Corrected as per order dated 08.06.2020

.....J.M.

(Justice K. Ramakrishnan)

O.A.No.26,27,28/2013 and
Appeal 51/2012, 86/2017
1st June 2020. Sr.

.....E.M.

(Shri. Saibal Dasgupta)

42

Annexure 1

YEAR WISE POPULATION DETAILS OF VILLAGES LOCATED WITHIN 20 KMS FROM M/s UPCL

Taluk	Sl. No.	Village	Year wise Population											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Udupi	1	Palimar	3397	3408	3427	3449	3472	3496	3517	3547	3598	3598	3635	3675
	2	Nandikur	3309	3331	3348	3369	3381	3390	3402	3416	3424	3424	3492	3525
	3	Yellur	7204	7216	7252	7267	7283	7296	7301	7308	7335	7355	7059	7165
	4	Santhoor	2859	2870	2894	2901	2916	2932	2919	2946	2993	2993	3011	3062
	5	Pilar	2995	3302	3319	3324	3364	3387	3408	3417	3456	3455	3305	3308
	6	Tenka	4591	4617	4630	4638	4642	4662	4665	4680	4685	4691	4695	4707
	7	Hejamadi	8282	7314	8360	8391	8425	8421	8425	8440	8466	8476	8480	8547
	8	Padebettu	2160	2168	2188	2215	2228	2315	2228	2230	2380	2415	2431	2446
	9	Nadsal	10612	10686	10828	11118	10983	11006	11086	11105	11128	11652	11698	11780
	10	Bada	8210	8253	8289	8291	8485	8520	8567	8617	8650	8720	8919	8996
	11	Belapu	4041	4061	4072	4154	4172	4191	4290	4395	4591	4743	4767	4909
	12	Padubelle	2044	2063	2201	2410	2441	2469	2455	2460	2451	2460	2471	2486
	13	Kalathuru	3097	3114	3135	3150	3178	3197	3178	3178	3190	3206	3212	3240
	14	Kuthyar	3153	3170	3160	3168	3159	3177	3105	3095	3085	3090	3085	2938
	15	Mattar	3021	3055	3106	3156	3231	3250	3247	3280	3310	3325	3271	3253
	16	Shirva "A"	4142	4165	4210	4315	4354	4374	4301	4310	4317	4327	4344	4395
	17	Shirva "B"	4061	4098	4124	4152	4163	4182	4230	4285	4352	4480	4517	4558
	18	Shirva "C"	1645	1661	1683	1702	1728	1755	1755	1770	1776	1782	1814	1831
	19	Moodabettu	4998	5008	5038	5075	5015	5125	5142	5155	5165	5169	5176	5180
	20	Kurkal	5370	5379	5388	5495	5535	5595	5602	5605	5607	5609	5610	5610
	21	Muloor	3306	3362	3369	3376	3381	3384	3386	3389	3401	3407	3411	3433
	22	Padoor	1721	1621	1720	1618	1620	1700	1712	1800	1855	1861	1668	1676
	23	Uliyargoli	6020	6500	6300	6300	6250	6300	6500	6300	6300	6040	6020	5612
	24	Mallar	6510	6600	6660	6770	6880	6995	7110	7195	7208	7212	7056	7288
	25	Kaup Padu	5302	5309	5341	5254	5259	5339	5063	5089	5279	5465	5720	5123
	26	Pangala	2500	2500	2400	2500	2300	2400	2500	2300	2300	2402	2400	2200
	27	Majoor	2565	2361	2318	2400	2365	2230	2240	2235	2218	2108	2233	2373

Taluk	Sl. No.	Village	Year wise Population											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
	28	Innanje	2750	2800	2300	2780	2800	2665	2700	2600	2750	2891	2922	2537
	29	92- Heror	1520	1532	1518	1420	1525	1520	1505	1542	1545	1547	1276	1326
Karkala	30	Nandalike	3324	3354	3374	3393	3418	3448	3464	3489	3502	3514	3552	3570
	31	Belman	379	394	398	395	408	402	414	412	392	936	380	389
	32	Sooda	17	16	17	14	17	23	22	19	13	24	22	25
	33	Inna	3210	3243	3254	3652	3610	3515	3781	3869	3874	3837	3867	3874

Annexure 2

NUMBER OF PATIENTS REPORTED FOR EACH IDENTIFIED VILLAGES LOCATED WITHIN 10 KMS

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Nandikur / Udupi	**Air borne Diseases**												
		Asthama	5	6	5	4	6	6	8	11	12	15	16	18
		ARI	45	35	36	38	41	46	80	82	76	68	63	84
		Bronchitis	152	131	130	148	132	142	178	198	184	182	203	184
		Cancer	0	1	2	0	0	2	2	2	4	5	5	6
		Water borne Diseases												
		Gastroenteritis	8	14	13	13	10	12	12	8	2	10	12	13
		Diarrhea	12	19	13	13	16	11	10	28	13	17	13	10
		Renal diseases	4	5	5	8	6	9	4	5	10	12	10	13
		Cancer	1	1	1	2	1	2	2	2	3	3	3	4
2	Yellur / Udupi	**Air borne Diseases**												
		Asthama	5	9	6	6	9	5	8	7	12	20	18	20
		ARI	52	40	38	42	45	42	79	85	82	70	68	85
		Bronchitis	152	130	138	162	143	156	180	225	196	178	193	189
		Cancer	1	1	1	1	2	2	4	3	4	4	8	10
		Water borne Diseases												
		Gastroenteritis	12	15	16	15	12	13	14	19	13	11	13	14
		Diarrhea	10	21	13	9	16	11	8	31	13	16	13	12
		Renal diseases	2	5	4	8	6	9	5	4	10	12	10	13
		Cancer	1	1	1	2	1	3	2	3	3	5	4	4
3	Santhoor / Udupi	**Air borne Diseases**												
		Asthama	4	5	4	6	7	6	7	6	11	19	16	18
		ARI	48	36	36	41	43	40	78	82	80	68	65	84
		Bronchitis	146	125	138	160	145	152	175	220	190	180	192	192
		Cancer	1	0	1	0	2	3	3	2	3	4	5	6

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	9	14	15	14	10	12	13	18	12	10	12	12
		Diarrhea	11	21	12	8	16	10	8	30	12	15	13	10
		Renal diseases	4	4	6	8	5	9	5	5	10	12	9	13
		Cancer	1	0	1	2	0	2	3	2	4	3	3	4
4	Pilar / Udupi	**Air borne Diseases**												
		Asthama	5	4	4	6	7	6	6	7	12	18	15	18
		ARI	45	35	34	40	42	45	80	84	70	65	68	85
		Bronchitis	148	130	135	158	130	150	180	200	185	188	205	182
		Cancer	0	1	2	0	1	2	2	3	4	4	5	8
		Water borne Diseases												
		Gastroenteritis	8	15	14	13	11	13	13	18	12	20	15	10
		Diarrhea	12	20	10	12	18	8	12	25	14	18	10	11
		Renal diseases	2	5	4	8	6	9	4	5	10	12	10	12
		Cancer	1	0	1	2	0	2	2	3	2	4	2	4
5	Palimar / Udupi	**Air borne Diseases**												
		Asthama	5	6	5	6	7	5	5	7	12	19	16	18
		ARI	46	36	35	41	43	46	78	85	71	64	67	84
		Bronchitis	140	128	132	160	128	148	178	196	186	183	201	190
		Cancer	0	0	2	1	0	1	2	2	3	3	5	8
		Water borne Diseases												
		Gastroenteritis	8	15	14	13	11	12	13	19	12	10	12	13
		Diarrhea	12	20	10	12	17	8	12	26	14	17	12	12
		Renal diseases	4	5	5	8	5	8	4	5	10	12	9	13
		Cancer	0	0	0	1	1	1	1	2	2	3	2	4
6	Tenka / Udupi	**Air borne Diseases**												
		Asthama	13	8	15	10	15	15	1	7	8	9	10	8
		ARI	165	49	43	237	65	66	679	655	565	289	267	101
		Bronchitis	116	168	101	17	19	21	9	12	4	11	10	13
		Cancer	0	0	0	0	1	0	0	0	0	0	0	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	15	35	13	15	15	14	14	8	8	8	8	11
		Renal diseases	0	0	0	0	0	0	0	0	1	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
7	Nadsal / Udupi	**Air borne Diseases**												
		Asthama	24	21	42	34	37	32	3	17	13	29	31	15
		ARI	266	128	108	699	177	174	1915	1926	1651	855	801	293
		Bronchitis	272	453	292	44	55	49	25	31	14	31	27	25
		Cancer	1	0	0	2	0	0	2	0	0	2	1	1
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	32	103	39	39	37	25	24	23	23	27	31	26
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
8	Bada / Udupi	**Air borne Diseases**												
		Asthama	24	13	21	18	23	23	3	14	10	22	20	13
		ARI	145	89	101	491	121	123	1488	1340	1120	584	530	200
		Bronchitis	136	292	202	32	41	29	12	34	11	23	22	22
		Cancer	0	0	0	0	0	1	0	0	2	2	1	1
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	23	56	19	23	25	20	21	15	18	23	15	13
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
9	Mallar / Udupi	**Air borne Diseases**												
		Asthama	8	2	2	4	4	2	5	7	4	6	8	6
		ARI	3	10	8	5	4	6	6	5	5	4	5	3
		Bronchitis	0	0	1	2	0	2	0	4	0	0	2	2
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	3	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	3	1	0	2	2	0	1	0	4	4	0	0
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	3	0	0	0	0	0	0	0	0	0	2	4
10	Majoor / Udupi	**Air borne Diseases**												
		Asthama	3	1	2	2	4	3	1	2	2	3	5	4
		ARI	5	8	7	10	15	11	12	8	9	15	4	10
		Bronchitis	1	0	1	1	0	1	1	1	2	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	10	12	8	5	10	18	9	7	15	10	5	12
		Diarrhea	11	14	10	7	18	25	12	10	17	12	7	15
		Renal diseases	3	2	1	6	5	0	8	3	2	1	0	2
		Cancer	1	0	0	2	0	0	1	0	0	1	0	0
11	Kaup-Padu / Udupi	**Air borne Diseases**												
		Asthama	6	3	3	4	5	2	2	3	3	2	2	2
		ARI	4	4	2	2	2	3	2	3	4	2	3	2
		Bronchitis	0	1	0	0	1	0	0	1	0	0	1	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	4	2	1	2	1	0	1	0	0	2	0	0
		Diarrhea	0	3	0	0	0	0	1	0	0	0	2	0
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	1	1	0	0	0	1	0	0	2	2
12	92 Heror / Udupi	**Air borne Diseases**												
		Asthama	4	1	1	2	2	1	2	4	2	3	4	2
		ARI	2	4	4	2	2	4	4	2	4	2	2	2
		Bronchitis	0	2	2	1	1	1	1	2	1	1	2	1
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	2	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	2	2	1	2	2	1	1	2	2	1	2	2
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	2	0	0	1	0	1	1	1	0	0	2	3
13	Padoor / Udupi	**Air borne Diseases**												
		Asthama	2	1	0	1	0	2	2	2	2	1	1	1
		ARI	1	1	0	2	1	1	2	2	1	1	1	0
		Bronchitis	1	2	1	1	1	0	1	1	1	1	1	2
		Cancer	0	1	0	0	0	0	0	1	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	2	1	1	2	2	2	2	2
		Diarrhea	0	0	0	0	0	0	0	0	0	0	0	0
		Renal diseases	0	0	0	2	2	1	2	2	1	2	2	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
14	Belapu / Udupi	**Air borne Diseases**												
		Asthama	1	0	0	0	0	1	0	0	1	0	0	7
		ARI	28	28	25	31	30	27	20	35	38	24	25	38
		Bronchitis	2	1	2	2	1	2	2	1	2	2	3	2
		Cancer	0	0	0	0	0	0	0	1	0	0	3	0
		Water borne Diseases												
		Gastroenteritis	0	0	1	1	0	0	1	0	2	0	1	1
		Diarrhea	21	23	32	33	38	30	27	27	25	29	16	18
		Renal diseases	0	0	0	0	0	0	0	1	1	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
15	Kuthyar / Udupi	**Air borne Diseases**												
		Asthama	0	0	3	2	1	2	3	2	1	2	2	3
		ARI	28	30	28	20	27	35	29	19	33	31	28	32
		Bronchitis	3	2	2	2	3	3	4	3	2	3	2	4
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years										
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	5	4	5	3	2	3	1	1	2	1	1	2
		Diarrhea	19	21	30	28	22	31	28	25	19	32	17	16
		Renal diseases	0	0	0	0	0	0	0	1	1	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

ARI - Acute Respiratory Infection

Annexure 3A

NUMBER OF PATIENTS REPORTED FOR EACH IDENTIFIED VILLAGE LOCATED WITHIN 11-15 KM OF UPCL

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Hejamadi/ Udupi	**Air borne Diseases**												
		Asthama	22	17	27	25	27	26	2	13	11	22	19	13
		ARI	217	88	94	474	121	123	1150	1306	1024	581	534	209
		Bronchitis	185	308	200	33	35	37	18	23	9	23	19	17
		Cancer	0	0	0	1	2	0	0	1	3	2	1	1
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	26	65	28	27	27	18	19	17	17	18	23	19
		Renal diseases	0	0	0	0	0	0	0	1	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
2	Muloor / Udupi	**Air borne Diseases**												
		Asthama	5	2	2	3	3	2	2	3	3	3	2	2
		ARI	2	3	3	3	4	2	3	3	2	2	3	2
		Bronchitis	0	0	0	1	0	0	1	0	0	1	0	1
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	3	0	2	0	0	2	0	0	0	0	0	0
		Diarrhea	3	0	0	2	0	0	0	0	0	0	0	0
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	2	0
3	Kaup-Padu / Udupi	**Air borne Diseases**												
		Asthama	6	3	3	4	5	2	2	3	3	2	2	2
		ARI	4	4	2	2	2	3	2	3	4	2	3	2
		Bronchitis	0	1	0	0	1	0	0	1	0	0	1	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Gastroenteritis	4	2	1	2	1	0	1	0	0	2	0	0
		Diarrhea	0	3	0	0	0	0	1	0	0	0	2	0
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	1	1	0	0	0	1	0	0	2	2
4	Shirva A / Udupi	**Air borne Diseases**												
		Asthama	1	2	0	1	0	2	0	0	1	3	2	1
		ARI	2	1	3	2	1	2	1	1	3	2	3	2
		Bronchitis	0	0	2	0	1	0	1	0	2	0	1	1
		Cancer	1	0	2	1	2	0	1	0	2	0	1	1
		Water borne Diseases												
		Gastroenteritis	0	2	0	2	1	1	0	2	2	1	2	2
		Diarrhea	0	2	1	2	2	1	3	2	2	1	4	3
		Renal diseases	0	0	0	0	0	0	0	0	0	2	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
5	Shirva B/ Udupi	**Air borne Diseases**												
		Asthama	2	2	0	3	1	3	0	3	1	0	2	2
		ARI	4	3	2	1	2	1	2	2	1	1	1	2
		Bronchitis	2	1	3	2	0	1	2	2	1	0	2	0
		Cancer	1	2	3	2	0	1	5	2	4	3	1	2
		Water borne Diseases												
		Gastroenteritis	2	3	4	3	2	2	1	1	0	2	1	1
		Diarrhea	12	4	16	20	14	13	12	11	12	13	11	11
		Renal diseases	0	0	1	0	1	0	1	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	1	0
6	Shirva C / Udupi	**Air borne Diseases**												
		Asthama	0	0	0	0	0	0	0	0	1	1	0	0
		ARI	0	0	0	1	0	1	1	1	2	0	1	1
		Bronchitis	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	2	0	0	1	1	2	2
		Water borne Diseases												
		Gastroenteritis	0	0	1	1	0	1	1	0	1	0	0	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years										
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Diarrhea	2	2	1	1	0	1	2	1	2	1	0	0
		Renal diseases	0	0	1	0	1	0	0	0	0	0	1	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
7	Kalathuru / Udupi	**Air borne Diseases**												
		Asthama	0	0	3	2	1	2	3	0	1	2	2	2
		ARI	1	1	2	1	1	2	2	1	2	2	1	1
		Bronchitis	2	1	3	1	2	2	1	3	2	2	1	1
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	2	3	1	2	1	1	2	3	1	2	2	1
		Diarrhea	12	14	3	1	1	2	3	2	1	2	1	1
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	1	1	0	1	0	1	0	0	0	0
8	Belman / Karkala	**Air borne Diseases**												
		Asthama	21	23	25	21	20	19	22	20	22	24	23	22
		ARI	242	251	257	263	271	264	269	272	248	253	245	259
		Bronchitis	20	21	18	23	20	25	19	22	23	25	21	23
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	72	76	71	68	73	69	75	72	69	68	64	61
		Renal diseases	13	10	12	10	15	11	13	12	12	11	14	12
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
9	Sooda / Karkala	**Air borne Diseases**												
		Asthama	4	3	2	5	3	7	6	5	4	2	4	8
		ARI	6	4	5	2	1	4	3	4	2	5	3	4
		Bronchitis	2	3	4	2	5	3	4	3	2	9	5	7
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	1	0	1	2	1	1	3	2	1	1	2	1
		Diarrhea	4	6	5	3	7	8	6	5	4	7	8	5

S. No.	Village /Taluk	Diseases	No. of patients reported for the years										
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
10	Inna / Karkala	**Air borne Diseases**												
		Asthama	2	2	1	2	1	2	5	0	0	0	0	5
		ARI	102	87	96	78	56	82	68	79	94	85	76	95
		Bronchitis	14	6	7	15	10	8	7	9	6	8	10	9
		Cancer	0	0	0	0	0	0	0	0	0	0	0	1
		Water borne Diseases												
		Gastroenteritis	0	0	0	0	0	0	0	0	0	0	0	0
		Diarrhea	9	10	8	12	14	13	17	15	18	21	20	23
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

ARI - Acute Respiratory Infection

Annexure 3B

NUMBER OF PATIENTS REPORTED FOR EACH IDENTIFIED VILLAGES LOCATED IN BETWEEN 16 TO 20 KMS

S. No.	Village /Taluk	Diseases	No. of patients reported for the years											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Padupelle/ Udupi	**Air borne Diseases**												
		Asthama	9	0	0	0	1	3	5	5	4	9	9	0
		ARI	16	7	2	0	0	3	4	6	10	16	16	7
		Bronchitis	3	0	0	0	0	2	1	1	2	3	3	0
		Cancer	3	0	0	0	0	1	2	2	1	3	3	0
		Water borne Diseases												
		Gastroenteritis	4	0	0	0	2	0	2	1	3	4	4	0
		Diarrhea	11	3	0	2	1	3	2	5	6	11	11	3
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
2	Mattar / Udupi	**Air borne Diseases**												
		Asthama	10	2	0	0	2	5	2	6	4	10	10	2
		ARI	16	8	2	3	3	0	0	8	8	16	16	8
		Bronchitis	4	0	0	0	0	2	2	1	3	4	4	0
		Cancer	4	0	0	0	0	2	2	2	2	4	4	0
		Water borne Diseases												
		Gastroenteritis	6	0	3	0	2	1	0	4	2	6	6	0
		Diarrhea	17	9	3	2	1	1	1	10	7	17	17	9
		Renal diseases	0	0	0	0	0	0	0	0	0	0	0	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
3	Moodabettu / Udupi	**Air borne Diseases**												
		Asthama	18	0	0	0	2	7	9	8	10	18	18	0
		ARI	129	26	22	11	10	29	31	76	53	129	129	26
		Bronchitis	4	0	0	0	0	0	4	1	3	4	4	0
		Cancer	13	0	0	0	1	4	8	8	5	13	13	0

S. No.	Village /Taluk	Diseases	No. of patients reported for the years										
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Water borne Diseases												
		Gastroenteritis	3	0	0	0	0	1	2	2	1	3	3	0
		Diarrhea	121	8	14	10	13	9	67	53	68	121	121	8
		Renal diseases	6	0	1	0	0	2	3	4	2	6	6	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
4	Kurkal / Udupi	**Air borne Diseases**												
		Asthama	20	0	0	0	0	8	12	9	11	20	20	0
		ARI	156	39	32	18	14	12	41	82	74	156	156	39
		Bronchitis	5	0	0	0	0	0	5	3	2	5	5	0
		Cancer	13	0	0	0	2	0	11	5	8	13	13	0
		Water borne Diseases												
		Gastroenteritis	5	0	0	0	0	0	5	2	3	5	5	0
		Diarrhea	139	12	20	13	15	11	68	66	73	139	139	12
		Renal diseases	4	0	0	0	0	0	4	3	1	4	4	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
5	Uliyargoli / Udupi	**Air borne Diseases**												
		Asthama	26	2	4	4	5	7	4	13	13	26	26	2
		ARI	24	2	4	2	5	5	6	12	12	24	24	2
		Bronchitis	17	0	3	4	3	2	5	8	9	17	17	0
		Cancer	11	0	3	2	3	1	2	5	6	11	11	0
		Water borne Diseases												
		Gastroenteritis	29	4	5	6	3	5	6	14	15	29	29	4
		Diarrhea	36	7	6	5	8	5	5	18	18	36	36	7
		Renal diseases	23	2	3	4	3	5	6	11	12	23	23	2
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
6	Pangala / Udupi	**Air borne Diseases**												
		Asthama	21	0	2	3	5	5	6	9	12	21	21	0
		ARI	16	1	3	3	3	2	4	8	8	16	16	1
		Bronchitis	13	0	1	2	2	5	3	6	7	13	13	0
		Cancer	3	0	0	0	0	2	1	2	1	3	3	0
		Water borne Diseases												

S. No.	Village /Taluk	Diseases	No. of patients reported for the years										
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
		Gastroenteritis	28	0	3	5	7	5	8	12	16	28	28	0
		Diarrhea	20	0	4	5	3	2	6	8	12	20	20	0
		Renal diseases	8	0	2	0	3	1	2	7	1	8	8	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
7	Innanje / Udupi	**Air borne Diseases**												
		Asthama	28	0	0	4	5	5	12	10	18	28	28	0
		ARI	34	0	4	8	8	4	10	14	20	34	34	0
		Bronchitis	16	0	0	6	4	2	4	8	8	16	16	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
		Water borne Diseases												
		Gastroenteritis	20	0	0	2	5	5	8	8	12	20	20	0
		Diarrhea	10	2	2	0	2	1	3	4	6	10	10	2
		Renal diseases	4	0	0	0	0	1	3	1	3	4	4	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0
8	Nandalike / Karkala	**Air borne Diseases**												
		Asthama	21	0	0	0	2	5	14	13	8	21	21	0
		ARI	236	72	43	19	18	46	38	73	163	236	236	72
		Bronchitis	79	7	9	15	10	20	18	32	47	79	79	7
		Cancer	12	0	0	0	2	2	8	6	6	12	12	0
		Water borne Diseases												
		Gastroenteritis	167	34	24	19	45	31	14	86	81	167	167	34
		Diarrhea	96	28	15	13	13	14	13	51	45	96	96	28
		Renal diseases	18	0	0	0	0	2	4	4	2	6	18	0
		Cancer	0	0	0	0	0	0	0	0	0	0	0	0

ARI - Acute Respiratory Infection

Annexure 4

No:JDA/U/T/NGT Information/2020-21

Office of Joint Director of Agriculture,
Rajathadri, Manipal
Udupi District, Dated : 11.01.2021

Regional Director,
Central Pollution Control Board,
Nisarga Bhawan, A Block,
1 & 2 floor, Thimmaiah Road,
7th D-Main, Shivanagar,
Bengaluru -560079.
Email:cpcbsuresh@gmail.com

Respected Sir,

Subject: Additional Information on Agriculture Crops with respect to Hon'ble NGT Southern Zone, Chennai order in the matter of O.A No. 578 of 2018 (Earlier O.A 26 of 2013) related to M/s Udupi Power Corporation Ltd (UPCL), Udupi Reg.

Reference: Yours office email letter dated : 23.11.2020

-:-

Clarification with respect to extent of agriculture land affected due to water pollution in villages surrounding UPCL (ANNEXURE -1) prepared based on **the information provided by the farmers** of the area which was provided in letter no: JDA/U/T/NGT Information/ 20120-21 dated on 19.09.2020.

Average rainfall during khariff i.e June to September month observed in these villages were 2654 mm, 3027mm, 2685mm, 2854mm and 2763mm in 2015, 2016, 2017, 2018 and 2019 respectively (Annexure 4). Leakage of saline water into agriculture fields has not led to variation in average yield of paddy and blackgram may be due to heavy rainfall during (growing period) vegetative stage resulted in dilution of salt effluents in and around the villages of UPCL. Therefore damage was found to be less or nil on the crop as observed from yield statistics given in annexure -2a. It is observed that there is no remarkable change in average yield of paddy over last 11 years starting from 2008-2009 to 2019-2020.

Area under rainfed paddy was highest during 2009-10 i.e. 3211.80ha in mentioned villages. There after area under rainfed paddy showed sharp declaning trend till 2014-15 (i.e 2807.22). In the year 2015-16 and 2016-17 area under paddy increased slightly i. e 2899.57 ha and 2920.44 ha respectively. Next it maintained earlier trend, area under paddy declined in subsequent years (Annexure -3a). It is observed that there is no remarkable changes in the productivity of paddy over the last 11 years as per the yield statistics information obtained from department of

economics and statistics. (Annexure -2a). Decline in the area of paddy and Rabi blackgram was not only a trend in this area but also this phenomenon noticed in the entire district.

Area under blackgram during Rabi season showed decreasing trend over a period of 11 years (Annexure -3b). Whereas Crop yield of blackgram is found to be in increasing order over a same period of 11 years. (Annexure -2b) Hence it is observed that there is no such drastic changes in the productivity of blackgram over a 11 years period of time.

Soil electrical conductivity is a measure of amount of salts in soil. It is an important indicator of soil health. Soil sample of entired district was analysed for EC and other soil parameters as per the Govt. India Guidelines. Soil samples tested for EC during 2015-16 and 2016-17 for the 1st cycle, subsequently during 2017-18 and 2018-19 for the 2nd cycle and the results are presented in the Annexure 5 and 6 respectively. EC Readings less than 1 dS/m, soil are considered as non saline and do not affect most crops and microbial processes. First cycle soil analysis report recorded EC of 0.00 - 0.77 dS/(As per results) in a villages surrounding UPCL and EC of soil in these villages were recorded during Second cycle was ranged between 0.06- 0.46 dS/m. Soil analysis result showed average EC of soil in Udupi, Kundapura and Karkala taluk were recorded with 0.16, 0.32 and 0.15 dS/m respectively. Udupi District average EC of soil is 0.22. Hence it can be concluded that Soil electrical conductivity is found to be normal in a villages around UPCL.

Above information is provided based on the available statistics and soil test results.

This is for your kind information.

Thanking You

Yours Faithfully

Joint Director of Agriculture,
Udupi district, udupi.

Annexure -1

INFORMATION ON AGRICULTURE LAND AFFECTED

Sl .N	Name of the vilage	Name of the farmer	Total acres of land	Distance of land from UPCL (km)	Irrigated	Unirrigated	Seasonal crops	The acres of land affected with water pollution (As per information provided by the farmers)	The acres of land affected with air pollution
1	Yelluru	Kamala moolya,badagubettu mane, kolachuru	1.0	1.0	_	Unirrigated	PADDY	1.0	_
2		Girija moolyadi, badagubettu mane	0.25	1.0	_	Unirrigated	PADDY	0.25	_
3		Dinesh moolya S/o sundar moolya	1.56	1.0	_	Unirrigated	PADDY	1.56	_
4		Vishwanath bhat, S/o govinda bhat ,Thaje	1.80	0.6	_	Unirrigated	PADDY	1.80	_
5		Subramanya bhat, thaje	1.16	0.6	_	Unirrigated	PADDY	1.16	_
6		Husen saheb, thaje	1.52	0.6	_	Unirrigated	PADDY	1.52	_
7		Janardhan rao s/o kashiyamma vasudeva nivasa,thaje	1.70	0.6	_	Unirrigated	PADDY	1.70	_
8		Vimala, shri gurukrupa nivasa, thaje	0.89	0.6	_	Unirrigated	PADDY	0.89	_
9		Vasudeva Rao, thaje	2.19	0.6	_	Unirrigated	PADDY	2.19	_
10		Ramesh salyan, kolachuru	4.91	1.0	_	Unirrigated	PADDY	4.91	_

11	Yelluru	Kalyani thaje	0.88	0.6	–	Unirrigated	PADDY	0.88	–
12		Aithappa Poojary kolachuru	1.70	1.0	–	Unirrigated	PADDY	1.70	–
13		Harischandra rao kolachuru	2.53	1.0	–	Unirrigated	PADDY	2.53	–
14		Vimala w/o Divakar bhat,kolachuru	2.23	1.0	–	Unirrigated	PADDY	2.23	–
15		Jaganath moolya s/o ellu moolya kolachuru	1.47	1.0	–	Unirrigated	PADDY	1.47	–
16		Vijaya shetty D/O susheela shetty kolachuru	1.50	1.0	–	Unirrigated	PADDY	1.50	–
17		Hari D shetty, kolachuru	3.80	1.0	–	Unirrigated	PADDY	3.80	–
18		Giriyappa shetty, Deccharu	0.75	1.5	–	Unirrigated	PADDY	0.75	–
19		K Ramesh rao Decharu	1.76	1.5	–	Unirrigated	PADDY	1.76	–
20		Varija shedthi, decharu	0.23	1.5	–	Unirrigated	PADDY	0.23	–
21		Jaganath v shetty decharu	1.84	1.5	–	Unirrigated	PADDY	1.84	–
22		Nagappa devadiga S/O thouda devadiga	1.03	1.0	–	Unirrigated	PADDY	1.03	–
23		Gulabi shedthi W/O sanjeeva shetty, kolachuru	2.00	1.0	–	Unirrigated	PADDY	2.00	–
24		Jalaja shedthi,Ulluru	1.84	0.5	–	Unirrigated	PADDY	1.84	–
25		Manorama acharya W/o ramachandra acharya,	0.42	0.5	–	Unirrigated	PADDY	0.42	–

26		Gopala krishna acharya, ullru	0.98	0.5	_	Unirrigated	PADDY	0.98	_
27		Dulcin Fernandis W/O lawrence fernandis, ulluru	3.00	0.5	_	Unirrigated	PADDY	3.00	_
28		Shrinivas acharya, ulluru	1.00	0.5	_	Unirrigated	PADDY	1.00	_
29		Meenu moolya w/o rukka moolya, ulluru	1.10	0.5	_	Unirrigated	PADDY	1.10	_
30		Y. Madhava acharya,ulluru	1.50	0.5	_	Unirrigated	PADDY	1.50	_
31		Sundar shettigar S/o honnu shettigarthi, Ulluru	1.00	0.5	_	Unirrigated	PADDY	1.00	_
32	**Yelluru**	Janaki Poojarthi, ulluru	1.34	0.5	_	Unirrigated	PADDY	1.34	_
33		Ramachandra acharya,ulluru, gurgundi	1.0	1.5	_	Unirrigated	PADDY	1.0	_
34		Kamala poojary,ulluru, gurgundi	1.00	1.0	_	Unirrigated	PADDY	1.00	_
35		Laxmiyamma,ulluru, gurgundi	1.00	1.0	_	Unirrigated	PADDY	1.00	_
36		Krishna shetty,ulluru, gurgundi	2.25	1.0	_	Unirrigated	PADDY	2.25	_
37		Gundu kannada s/o loku kannada,ulluru, gurgundi	0.39	1.0	_	Unirrigated	PADDY	0.39	_
38		Girija D/o Malingu poojay,ulluru, gurgundi	0.92	1.0	_	Unirrigated	PADDY	0.92	_
39		Ananth ram bhat,ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_

40	Yelluru	Mohan shetty ,ulluru,	.00	1.0	_	Unirrigated	PADDY	1.00	_
41		Vitala shetty, ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_
42		Chennu moolya, ulluru	0.50	1.0	_	Unirrigated	PADDY	0.50	_
43		kutti shetty, Ulluru	0.21	1.0	_	Unirrigated	PADDY	0.21	_
44		Narayan achari, ulluru	0.35	1.0	_	Unirrigated	PADDY	0.35	_
45		Raghupathi rao, ulluru	1.50	1.0	_	Unirrigated	PADDY	1.50	_
46		Sanjeeva shetty. Ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_
47		Sheetha shetty ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_
48		Sharada shetty, Ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_
49		Jaya shetty, Ulluru	1.00	1.0	_	Unirrigated	PADDY	1.00	_
50		Kariya shetty s/o mainda	2.00	1.0	_	Unirrigated	PADDY	2.00	_
51		Dayananda shettigar s/o Narayana shettigar	2.00	1.0	_	Unirrigated	PADDY	2.00	_
52		shantharam shetty S/o venkappa	1.00	1.0	_	Unirrigated	PADDY	1.00	_
53		Ammi shetty w/o subbayya shetty	1.00	1.0	_	Unirrigated	PADDY	1.00	_
54		Lalitha devadiga w/o sadananda	1.50	1.0	_	Unirrigated	PADDY	1.50	_
55		Vitala shetty s/o peku	1.00	1.0	_	Unirrigated	PADDY	1.00	_

56	**Yelluru**	Vitala devadiga S/o koraga devadiga	1.50	1.0	_	Unirrigated	PADDY	1.50	_
57	**Thenka**	Menka shetty S/O Nagappa shetty	2.50	3.5	_	Unirrigated	PADDY	2.50	_
58		Amba shedthi W/o Balakrishna shetty	2.00	3.5	_	Unirrigated	PADDY	2.00	_
59		Shridhar moily	0.80	3.5	_	Unirrigated	PADDY	0.80	_
60		Shymala poojarthi W/o Somappa poojary	1.50	3.5	_	Unirrigated	PADDY	1.50	_
61		Omayya poojary S/o Sheena poojary	1.00	3.5	_	Unirrigated	PADDY	1.00	_
62		Ashok raj S/o Shanthiraj aras	2.00	3.5	_	Unirrigated	PADDY	2.00	_
63		Shantha W/o Sheena poojary	1.00	3.5	_	Unirrigated	PADDY	1.00	_
64		Sumathi devadiga W/o Babu devadiga	0.75	3.5	_	Unirrigated	PADDY	0.75	_
65		Sudhakar devadiga S/o akkani moilthi	0.30	3.5	_	Unirrigated	PADDY	0.30	_
66		Varija bhat W/o govinda bhat	0.60	3.5	_	Unirrigated	PADDY	0.60	_
67		Akkanni moilthi W/o sheena devadiga	0.60	3.5	_	Unirrigated	PADDY	0.60	_
68		Rukkayya poojary S/o Thouda poojary	1.05	3.5	_	Unirrigated	PADDY	1.05	_
69		Sarasu belchadthi	1.00	3.5	_	Unirrigated	PADDY	1.00	_

70	Thenka	Ganesh kotyan S/o Krishnappa poojary	1.50	3.5	_	Unirrigated	PADDY	1.50	_
71	Santhuru	Balakrishna nayak s/o devaki nayak	0.49	2.5	_	Unirrigated	PADDY	_	0.49
72		Sadashiva nayak	3.10	2.5	_	Unirrigated	PADDY	_	3.10
73		Shantha Bai W/O Yellappa prabhu	1.51	2.5	_	Unirrigated	PADDY	_	1.51
74		Sundar prabhu	2.25	2.5	_	Unirrigated	PADDY	_	2.25
75		Devadas prabhu s/o pushpa prabhu	2.27	2.5	_	Unirrigated	PADDY	_	2.27
76		Shri subraya devaru	4.41	2.5	_	Unirrigated	PADDY	_	4.41
77		sundari shedthi	1.30	2.5	_	Unirrigated	PADDY	_	1.30
78		Prema ankur kheer	0.60	2.5	_	Unirrigated	PADDY	_	0.60
79		Bhagi shedthi ,Muttakka shedthi	1.94	2.5	_	Unirrigated	PADDY	_	1.94
80		Sundar shetty s/o pammi shedthi	4.16	2.5	_	Unirrigated	PADDY	_	4.16
81		Lalitha poojary D/o balu poojary	2.38	2.5	_	Unirrigated	PADDY	_	2.38
82		Sharada D/o panduranga naik	0.19	2.5	_	Unirrigated	PADDY	_	0.19
83		Shobha/ sumathi nayak D/o prabhavathi amma	1.47	2.5	_	Unirrigated	PADDY	_	1.47
84		Janardhana Prabhu S/O ganapayya prabhu	0.14	2.5	_	Unirrigated	PADDY	_	0.14

85	Santhuru	Vasudeva prabhu s/o Hiriyanna Prabhu	2.58	2.5	_	Unirrigated	PADDY	_	2.58
86		Y Sheena shetty Yelluru	0.75	2.5	_	Unirrigated	PADDY	_	0.75
87		Sundara poojary S/O Thunde hensu	0.84	2.5	_	Unirrigated	PADDY	_	0.84
88		Prabhakara nayak S/o sumathi nayak	0.28	2.5	_	Unirrigated	PADDY	_	0.28
89		Seetharam Poojary	1.00	2.5	_	Unirrigated	PADDY	_	1.00
90		Damodara suvarna	1.00	2.5	_	Unirrigated	PADDY	_	1.00
91		Shankara prabhu s/o narayana	2.00	2.5	_	Unirrigated	PADDY	_	2.00
92		Akkamma shedthi haigemaru	0.66	2.5	_	Unirrigated	PADDY	_	0.66
93		Leela shetty W/o appu shetty	0.88	2.5	_	Unirrigated	PADDY	_	0.88
94	Bada	Jagannath Shetty S/O chandayya Shetty	8.00	3.0	_	Unirrigated	PADDY	8.00	_
95		Lingappa Shetty S/o poovappa Shetty	2.00	3.0	_	Unirrigated	PADDY	2.00	_
96		Latha W/o govardan	3.00	3.0	_	Unirrigated	PADDY	3.00	_
97		Padma poojarthy	2.50	3.0	_	Unirrigated	PADDY	2.50	_
98		Sarsu pojarthy D/o seethe poojarthy	0.50	3.0	_	Unirrigated	PADDY	0.50	_
99		Thungu poojarthy	0.30	3.0	_	Unirrigated	PADDY	0.30	_
100		Shanthiraj aras s/o maram hedge	0.53	3.0	_	Unirrigated	PADDY	0.53	_

101		Narayana palan S/o kalyani poojarthi	0.18	3.0	_	Unirrigated	PADDY	0.18	_
102		Sumathi Shetty	0.80	3.0	_	Unirrigated	PADDY	0.80	_
103		Mariyambi yermal	0.70	3.0	_	Unirrigated	PADDY	0.70	_
104		Leela sanil D/o girija Poojarthy	0.90	3.0	_	Unirrigated	PADDY	0.90	_
105		Arun kumar S/o rajani poojarthy	1.50	3.0	_	Unirrigated	PADDY	1.50	_
106		Girija poojarhy	0.25	3.0	_	Unirrigated	PADDY	0.25	_
107		Shambavi W/o thukra amin	0.20	3.0	_	Unirrigated	PADDY	0.20	_
108		Rathna kotyan W/o Raghunath kotyan	1.00	3.0	_	Unirrigated	PADDY	1.00	_
109	**Bada**	Srimathi amma D/o shekh ahammed	0.30	3.0	_	Unirrigated	PADDY	0.30	_
110		Mutthu poojarthy W/o kadya poojary	0.32	3.0	_	Unirrigated	PADDY	0.32	_
111		Ranga poojary	3.50	3.0	_	Unirrigated	PADDY	3.50	_
112		Meenakka shedthi	3.00	3.0	_	Unirrigated	PADDY	3.00	_
113		Suresh poojary S/o channappa	1.50	3.0	_	Unirrigated	PADDY	1.50	_
114		Harish kotyan S/o Mahesh kantappa kotyan	0.50	3.0	_	Unirrigated	PADDY	0.50	_
115		Nagaveni amma W/o gundraya	0.30	3.0	_	Unirrigated	PADDY	0.30	_
116		Yamuna kotyan D/o dugganna poojary	0.15	3.0	_	Unirrigated	PADDY	0.15	_
117		Sundari D/o narsi poojarthy	0.50	3.0	_	Unirrigated	PADDY	0.50	_
118		Ashok kotyan S/o kamala kotyan	0.80	3.0	_	Unirrigated	PADDY	0.80	_

Annexure -2(a)

CROP YIELD PER ACRE (Q)

Sl. no	Grama Panchayath	Village	District	Taluk	Hobli	Name of the major agriculture crop	CROP YIELD PER ACRE (Q)											
							2008 -09	2009 -10	2010- 11	2011- 12	2012 -13	2013 -14	2014- 15	2015- 16	2016- 17	2017- 18	2018- 19	2019- 20
1	YELLURU	YELLURU	UDUPI	KAPU	KAPU	PADDY	15.00	13.29	12.80	15.89	14.27	18.14	16.66	12.32	17.96	20.35	19.98	20.06
2	THENKA	THENKA					15.00	13.29	12.80	15.89	14.27	18.14	20.81	14.03	16.14	20.62	13.69	13.75
3	MUDARANG ADI	SANTHURU					15.00	13.29	12.80	15.89	14.27	18.14	17.63	16.61	13.43	16.23	14.15	14.95
		PILARU																
4	BADA	BADA					15.00	13.29	12.80	15.89	14.27	18.14	17.59	12.77	15.22	19.92	10.83	15.37
5	BELAPU	BELAPU					15.00	13.29	12.80	15.89	14.27	18.14	14.65	12.67	12.42	16.78	16.55	14.39
6	PADUBIDRI	PADEBETTU					15.00	13.29	12.80	15.89	14.27	18.14	13.17	11.34	8.11	21.50	11.24	22.68
		NADSALU																
7	PALIMARU	PALIMARU					15.00	13.29	12.80	15.89	14.27	18.14	18.61	11.75	15.78	20.25	16.10	18.91
		NANDIKURU																
8	MAJURU	MAJURU					15.00	13.29	12.80	15.89	14.27	18.14	16.64	12.14	20.72	17.16	19.87	16.73
		PADURU																
		HERURU																
9	SHIRVA	SHIRVA					15.00	13.29	12.80	15.89	14.27	18.14	20.13	11.51	18.06	16.37	17.39	19.47
10	HEJAMADI	HEJAMADI					15.00	13.29	12.80	15.89	14.27	18.14	14.59	11.80	8.02	19.01	11.58	14.80
11	KAPU PURASABHE	PADU					15.00	13.29	12.80	15.89	14.27	18.14	18.34	16.22	19.75	14.90	19.94	16.71
		MOOLURU																
		MALLARU																
12	KUTHYARU	KUTHYARU					15.00	13.29	12.80	15.89	14.27	18.14	21.10	14.99	22.10	12.85	15.06	14.63

13	BELMANNU	SOODA	Udupi	Karkala	Karkala	Paddy	11.94	13.00	11.98	13.52	13.61	15.62	12.67	14.10	13.61	27.19	18.90	
		BELMANNU					11.94	13.00	11.98	13.52	13.61	15.62	12.70	13.65	17.93	16.78	9.25	17.14
14	INNA	INNA					11.94	13.00	11.98	13.52	13.61	15.62	13.21	15.02	9.83	15.21	18.46	18.16
15	NANDALIKE	NANDALIKE					11.94	13.00	11.98	13.52	13.61	15.62	19.32	12.75	13.52	18.54	18.03	16.29
16	MUNDKURU	MUNDKURU																

1. **The yield statistics for the years 2008-09 to 2013-14 given based on the hobli average crop cutting results, where as for the year 2014-15 to 2019-20 the yield statistics were provided based on the crop cutting result of GP level average yield.**
2. **Individual farmer wise yield statistics were not available in the department since Crop Cutting experiments were not conducted in thisfarmers fields enlisted in Annexure -1.**
3. **Based on the available crop cutting results (Hobli average yield- 2008-09 to 2013-14 & GP Level average yield -2014-15 to 2019-20) it is observed that there was no drastic yield loss over the years. Even cropping pattern also not changed during this period in this area.**

Joint Director of Agriculture,
Udupi District.

Annexure -2(b)

District Crop yield per Acre in (Q)

Sl. No.	District	Name of the major agriculture crop	CROP YIELD PER ACRE (Q)											
			2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Udupi	Blackgram	1.82	1.88	1.88	1.88	1.86	1.88	1.88	2.07	2.06	2.10	2.12	2.08

Taluk/Hobli Crop yield per Acre in (Q)

Sl. no	District	Taluk	Hobli	Name of the crop	CROP YIELD PER ACRE (Q)											
					2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	Udupi	Kapu	Kapu	Blackgram	1.95	2.21	2.48	2.20	1.50	2.24	2.56	1.59	2.05	1.28	2.71	1.47

Remarks : 1. The yield statistics for the years 2008-09 to 2019-20 were provided based on the hobli average crop cutting results.

Joint Director of Agriculture,
Udupi District.

Annexure -3(a)

AREA COVRAGE KHARIFF (HA)

S. n	Grama Panchayath	Village	District	Taluk	Hobli	Name of the major agriculture crop	AREA COVREAGEKHARIFF (HA)											
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	YELLURU	YELLURU	UDUPI	KAPU	KAPU	PADDY	-	257	252	257.55	230.65	234.92	166.35	240.05	241.90	230.91	151.08	163.69
2	THENKA	THENKA					-	119	123.50	124.32	110.23	111.95	113.90	115.55	155.95	108.96	123.71	63.25
3	MUDARANGADI	SANTHURU					-	131	133.39	134.34	120.21	122.45	124.90	125.80	126.70	123	114.60	130.35
		PILARU																
4	BADA	BADA					-	182	178	180.70	166.66	164.93	166.85	167.48	166.93	161.93	75.94	100.12
5	BELAPU	BELAPU					-	124	118	118	104.11	97.21	99.17	98.15	97.96	93.96	79.05	77.42
6	PADUBIDRI	PADEBETTU					-	120.1	118.1	117.79	103.1	103.64	103.18	106.86	104.33	98.96	45.83	35.16
		NADSALU																
7	PALIMARU	PALIMARU					-	142.5	137.5	138.76	125.01	129.96	133.41	133.87	131.67	132.95	114.03	120.82
		NANDIKURU																
8	MAJURU	MAJURU					-	95.56	93	94	84.40	85.97	88.09	87.06	86.82	82.30	66.50	53.40
		PADURU																
		HERURU																
9	SHIRVA	SHIRVA					-	560	555	561.49	543.27	518.8	520.08	518.04	520.19	509.79	513.58	417.49

10	HEJAMADI	HEJAMADI					-	196	192	195.87	181.79	178.93	180.85	182.42	178.23	175.93	62.98
11	KAPU PURASABHE	PADU					-	96	94.33	93.75	85.35	85.64	88.27	87.48	86.64	83.30	43.10	32.00
		MOOLURU																
		MALLARU																
12	KUTHYARU	KUTHYARU					-	191	188	185.60	175.73	168.92	170.34	175.13	177.92	164.93	121.22	195.49
13	BELMANNU	SOODA	Udupi	Karkala	Karkala	Paddy	-	204.57	202.14	201.87	200.84	199.32	188.53	202.78	184.24	196.15	144.76	128.38
		BELMANNU																
14	INNA	INNA					-	261.30	261.43	258.60	255.77	255.77	243.63	251.21	251.01	240.89	182.30	227.95
15	NANDALIKE	NANDALIKE					-	196.28	191.61	188.71	185.07	183.61	168.56	164.78	164.71	129.55	155.41	90.85
16	MUNDKURU	MUNDKURU					-	335.49	334.28	273.17	265.07	260.62	251.11	242.91	245.24	248.99	242.15	242.78
TOTAL							-	3211.80	3172.28	3124.52	2937.26	2902.64	2807.22	2899.57	2920.44	2782.50	2236.24	2138.63

Joint Director of Agriculture,
Udupi District.

Annexure -3(b)

AREA COVRAGE RABI (HA)

S.n	Grama Panchayath	Village	District	Taluk	Hobli	Name of the major agriculture crop	AREA COVREAGERABI (HA)											
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	YELLURU	YELLURU	UDUPI	KAPU	KAPU	BLACK GRAM	-	24.00	20.00	15.00	34.38	11.00	10.00	11.00	9.00	9.00	9.00	9.75
2	THENKA	THENKA					-	12.00	9.62	7.50	7.50	7.49	7.00	6.50	5.00	4.50	4.00	3.50
3	MUDARANGADI	SANTHURU					-	20.50	18.82	14.75	11.74	9.25	9.49	9.80	8.00	7.00	5.00	8.25
		PILARU																
4	BADA	BADA					-	3.00	2.00	1.50	1.50	1.500	1.50	2.00	1.00	2.00	6.50	2.00
5	BELAPU	BELAPU					-	18.00	15.00	11.75	9.75	9.75	9.49	10.00	8.00	7.00	7.00	7.00
6	PADUBIDRI	PADEBETTU					-	33.74	29.81	23.28	19.27	14.27	12.00	11.75	8.50	7.50	7.00	7.25
		NADSALU																
7	PALIMARU	PALIMARU					-	21.00	17.50	13.65	11.69	8.95	8.49	8.00	6.50	6.75	8.00	7.25
		NANDIKURU																
8	MAJURU	MAJURU					-	14.19	11.67	9.25	8.04	5.58	6.16	5.67	4.66	3.83	3.41	3.92
		PADURU																
		HERURU																
9	SHIRVA	SHIRVA					-	46.00	48.00	38.40	34.39	24.54	23.99	22.99	18.99	6.0	6.0	9.50

10	HEJAMADI	HEJAMADI					-	25.00	20.00	15.00	12.99	12.99	11.00	10.49	9.00	8.00	8.00	
11	KAPU PURASABHE	PADU					-	20.66	17.00	13.28	9.99	8.24	8.49	7.99	5.99	5.66	5.99	5.66
		MOOLURU																
		MALLARU																
12	KUTHYARU	KUTHYARU					-	19.00	20.00	18.00	13.99	9.00	9.00	10.49	8.49	7.49	6.00	9.50
13	BELMANNU	SOODA	Udupi	Karkala	Karkala	BLACK GRAM	-	3.26	2.87	2.81	2.26	5.07	2.02	1.86	1.82	1.11	1.11	1.06
		BELMANNU																
14	INNA	INNA					-	2.12	2.23	0.81	1.46	3.50	1.21	1.01	1.11	1.09	1.01	0.07
15	NANDALIKE	NANDALIKE					-	4.05	3.64	3.56	2.51	6.15	2.43	2.19	2.02	2.02	1.62	1.42
16	MUNDKURU	MUNDKURU					-	2.12	2.23	0.81	1.46	7.20	2.83	2.87	1.11	2.83	2.81	2.41
TOTAL							-	268.64	240.39	189.35	182.92	144.48	125.1	124.61	99.19	81.78	82.45	84.79

Joint Director of Agriculture,
Udupi District.

Annexure -4

2015 Rainfall Report

DISTRICT	TALUKNAME	HOBLINAME	June	July	Aug	Sep	Kharif Total	Oct	Nov	Dec	Rabi Total
UDUPI	KARKALA	Belman (GP)	828	1265	735	323	3150	322	204	9	535
UDUPI	KARKALA	Mundkuru (GP)	736	1075	649	220	2680	301	230	28	559
UDUPI	KARKALA	Inna (GP)	671	972	644	208	2495	306	178	12	496
UDUPI	UDUPI	KAPPU	614	1071	668	246	2599	308	138	32	477
UDUPI	UDUPI	(GP)	606	980	556	246	2388	322	137	32	491
UDUPI	UDUPI	Hejamadi (GP)	607	1088	563	250	2508	208	88	0	297
UDUPI	UDUPI	Kuthyaru (GP)	841	1167	686	275	2968	356	207	1	564
UDUPI	UDUPI	Majur (GP)	757	975	658	211	2601	342	166	4	513
UDUPI	UDUPI	Mudarangadi (GP)	687	1067	716	272	2742	380	167	4	551
UDUPI	UDUPI	Padubidri (GP)	462	822	499	184	1967	208	103	25	336
UDUPI	UDUPI	Phalimaru (GP)	665	1193	711	260	2829	317	195	27	539
UDUPI	UDUPI	Bada (GP)	721	898	736	348	2702	399	192	17	607
UDUPI	UDUPI	Belapu (GP)	736	1103	622	255	2715	306	201	6	513
UDUPI	UDUPI	Shirva (GP)	788	1050	682	262	2782	283	190	0	474
UDUPI	UDUPI	Thenka (GP)	641	1082	686	282	2691	318	162	47	527
Total							**2654**				

Annexure -4

2016 Rainfall Report

DISTRICT	TALUKNAME	HOBLINAME	June	July	August	September	Khariff Total	October	November	December	Rabi Total
UDUPI	KARKALA	Belman (GP)	1275	1066	614	237	3191	65	7	3	75
UDUPI	KARKALA	Mundkuru (GP)	1294	805	518	275	2891	42	2	3	47
UDUPI	KARKALA	Inna (GP)	1172	800	498	235	2706	41	8	4	53
UDUPI	UDUPI	KAPPU	1584	899	418	260	3160	96	14	3	112
UDUPI	UDUPI	Kappu (Ground) (GP)	1635	923	460	263	3281	99	15	5	118
UDUPI	UDUPI	Hejamadi (GP)	1414	890	391	185	2880	73	8	6	87
UDUPI	UDUPI	Kuthyaru (GP)	1222	917	430	209	2777	45	3	5	53
UDUPI	UDUPI	Majur (GP)	1635	909	460	274	3278	82	8	6	96
UDUPI	UDUPI	Mudarangadi (GP)	1498	959	502	250	3209	48	10	5	64
UDUPI	UDUPI	Padubidri (GP)	1297	806	420	189	2712	73	1	6	79
UDUPI	UDUPI	Phalimaru (GP)	1308	816	449	202	2775	52	24	5	80
UDUPI	UDUPI	Bada (GP)	1400	709	358	261	2727	67	8	4	80
UDUPI	UDUPI	Belapu (GP)	1812	1165	525	264	3766	121	8	6	135
UDUPI	UDUPI	Shirva (GP)	1468	944	456	215	3083	41	15	5	60
UDUPI	UDUPI	Thenka (GP)	1426	893	446	208	2974	60	0	0	60
Total							3027.267				

Annexure -4

2017 Rainfall Report

DISTRICT	TALUK NAME	HOBLI NAME	june	july	agust	Sept	Kharif Total	Oct	Nov	Dec	Rabi Total
Udupi	Karkala	Belman (GP)	997	906	817	275	2995	366	44	25	435
Udupi	Karkala	Mundkuru (GP)	1036	810	843	322	3010	374	43	31	448
Udupi	Karkala	Inna (GP)	1004	802	818	270	2894	323	29	18	370
Udupi	Kaup	KAPPU	865	706	712	201	2484	194	5	11	209
Udupi	Kaup	Kappu (Ground) (GP)	960	765	745	179	2649	211	6	11	227
Udupi	Kaup	Hejamadi (GP)	788	641	707	260	2395	223	51	10	284
Udupi	Kaup	Kuthyaru (GP)	888	875	755	196	2714	216	10	238	463
Udupi	Kaup	Majur (GP)	937	785	848	231	2801	219	1	7	227
Udupi	Kaup	Mudarangadi (GP)	1015	879	778	217	2889	305	18	16	339
Udupi	Kaup	Padubidri (GP)	849	582	691	215	2336	243	6	9	258
Udupi	Kaup	Phalimaru (GP)	978	673	797	242	2690	180	0	22	202
Udupi	Kaup	Bada (GP)	860	585	759	211	2415	173	18	6	197
Udupi	Kaup	Belapu (GP)	945	747	764	226	2682	183	15	10	208
Udupi	Kaup	Shirva (GP)	975	938	804	213	2930	273	18	23	313
Udupi	Kaup	Thenka (GP)	845	643	692	215	2395	243	6	9	258
Total							**2685**				

Annexure -4

2018 Rainfall Report

DISTRICT	TALUKNAME	HOBLINAME	June	July	August	September	Khariff Total	October	November	December	Rabi Total
UDUPI	KARKALA	Belman (GP)	1067	1061	1037	91	3256	299	11	4	315
UDUPI	KARKALA	Mundkuru (GP)	994	973	884	80	2932	330	2	2	334
UDUPI	KARKALA	Inna (GP)	901	733	842	92	2567	254	1	3	258
UDUPI	KARKALA	Nandalike (GP)	1099	1149	1116	84	3448	304	9	0	312
UDUPI	UDUPI	KAPPU	881	926	867	148	2821	172	9	16	197
UDUPI	UDUPI	Kappu (Ground) (GP)	883	924	870	148	2824	182	9	17	207
UDUPI	UDUPI	Hejamadi (GP)	1042	737	687	58	2524	162	6	1	169
UDUPI	UDUPI	Kuthyaru (GP)	1001	1234	893	78	3206	202	0	11	213
UDUPI	UDUPI	Majur (GP)	845	834	817	139	2635	193	5	25	223
UDUPI	UDUPI	Mudarangadi (GP)	1047	906	846	83	2882	194	1	11	205
UDUPI	UDUPI	Padubidri (GP)	932	727	627	100	2386	169	15	0	184
UDUPI	UDUPI	Phalimaru (GP)	1043	913	881	62	2900	244	3	6	253
UDUPI	UDUPI	Bada (GP)	951	806	683	104	2544	152	4	3	159
UDUPI	UDUPI	Belapu (GP)	963	1022	837	116	2938	209	3	11	223
UDUPI	UDUPI	Shirva (GP)	1418	813	1515	117	3863	345	3	13	360
UDUPI	UDUPI	Thenka (GP)	877	717	640	111	2345	168	1	0	169
Total							2854				

Annexure -4

	2019 Rainfall data									
TALUKNAME	HOBLINAME	June	July	August	September	Kharif Total	October	November	December	Rabi Total
KARKALA	Belman (GP)	525	765	1348	643	2755	416	58	44	517
KARKALA	Mundkuru (GP)	587	871	1254	673	2798	381	57	26	464
KARKALA	Inna (GP)	607	909	1249	630	2788	387	54	45	486
KARKALA	Nandalike (GP)	535	361	1357	574	2291	434	58	44	536
UDUPI	KAPPU	654	912	1102	430	2444	408	36	6	449
UDUPI	Kappu (Ground) (GP)	667	941	1109	467	2516	460	38	6	503
UDUPI	Hejamadi (GP)	631	852	1179	570	2601	416	41	20	478
UDUPI	Kuthyaru (GP)	736	1002	1281	648	2931	472	60	19	551
UDUPI	Majur (GP)	728	992	1171	495	2659	472	42	7	521
UDUPI	Mudarangadi (GP)	615	1009	1199	678	2886	429	56	26	510
UDUPI	Padubidri (GP)	580	861	1181	503	2545	379	31	17	428
UDUPI	Phalimaru (GP)	638	886	1203	602	2691	371	45	13	429
UDUPI	Bada (GP)	644	971	1183	470	2625	341	31	25	397
UDUPI	Belapu (GP)	735	1056	1336	642	3034	572	54	45	671
UDUPI	Shirva (GP)	1065	1596	1785	865	4245	624	132	46	801
UDUPI	Thenka (GP)	557	933	1007	456	2397	298	63	19	379
Total						2763				

Anneuxre 5

FIRST CYCLE SOIL HEALTH STATUS IN SURROUNDING VILLAGES OF UPCL PLANT (2015-16 and 2016-17)				
SI NO	**TALUK**	**Panchayat Name**	**Village**	**EC**
1	UDUPI	YELLURU	ELLURU	0.7777
2		THENKA	THENKA	0.08
3		MUDARANGADI	SANTHURU	0.0638
4			PILARU	0
5		BADA	BADA	0.1175
6		BELAPU	BELAPU	0.0606
7		PADUBIDRI	PADEBETTU	0.1127
			NADSALU	0.1084
8		PALIMARU	NANDIKURU	0.0971
			PALIMARU	0.087
9		MAJRU	MAJURU	0.1538
			PADURU	0.1042
			HERURU	0
10		KAPU PURASABHE	MALLARU	0.126
11			PADU	0.3331
12			MULURU	0.1193
13	KARKALA	SHIRVA	SHIRVA	0.0684
14		HEJAMADI	HEJAMADI	0.4847
15		KUTHYARU	KUTHYARU	0.0543
16		BELMANNU	SOODA	0.0939
			BELMANNU	0.1647
		INNA	INNA	0.11181
		NANDALIKE	NANDALIKE	0.0938
		MUNDKURU	MUNDKURU	0.1117

Anneuxre 6

SOIL HEALTH STATUS IN SURROUNDING VILLAGES OF UPCL PLANT (SECOND CYCLE 2017-18 and 2018-19)				
SI NO	**TALUK**	**Panchayat Name**	**Village**	**EC**
1	UDUPI	YELLURU	ELLURU	0.1025
2		THENKA	THENKA	0.1456
3		MUDARANGADI	SANTHURU	0.3984
			PILARU	0.0937
4		BADA	BADA	0.168
5		BELAPU	BELAPU	0.1226
6		PADUBIDRI	PADEBETTU	0.1124
			NADSALU	0.1348
7		PALIMARU	NANDIKURU	0.1511
			PALIMARU	0.1878
8		MAJRU	MAJURU	0.1121
			PADURU	0.1284
			HERURU	0.0578
9		KAPU PURASABHE	MALLARU	0.1
			PADU	0.1804
			MULURU	0.0661
10		SHIRVA	SHIRVA	0.1065
11		HEJAMADI	HEJAMADI	0.1158
12		KUTHYARU	KUTHYARU	0.085
13	KARKALA	BELMANNU	SOODA	0.1245
			BELMANNU	0.3113
14		INNA	INNA	0.2563
15		NANDALIKE	NANDALIKE	0.1837
16		MUNDKURU	MUNDKURU	0.4633

By Speed Post

Annexure 5

ಕರ್ನಾಟಕ ಸರಕಾರ
ತೋಟಗಾರಿಕೆ ಇಲಾಖೆ

ತೋಟಗಾರಿಕೆ ಉಪನಿರ್ದೇಶಕರು (ಜಿ.ಪಂ.)
ಉಡುಪಿರವರ ಕಛೇರಿ
ಶಿವಳ್ಳಿ ಮಾದರಿ ತೋಟಗಾರಿಕೆ ಕ್ಷೇತ್ರ,
ದೊಡ್ಡಣಗುಡ್ಡೆ,
ಉಡುಪಿ-576102
Email: ddhudupi@gmail.com

O/o Deputy Director of
Horticulture (ZP), Udupi,
Shivalli Model Horticulture
Farm, Doddanagudde,
Udupi-576102
Office Phone: 0820-2531950

No.:DDH:ZP:UDUPI:ADH(TA):49:2020-21/1504 Date: 15-01-2021

27 JAN 2021
1527

To

Regional Director,
Central Pollution Control Board,
Nisarga Bhawan, A Block,
1st & 2nd floors, Thimmaiah Road,
7th D-Main, Shivanagar,
Bengaluru -560079.

Respected Sir,

Subject: Information on Horticulture Crops with respect to Hon'ble NGT Southern Zone, Chennai order in the matter of O.A No. 578 of 2018 (Earlier O.A 26 of 2013) related to M/s Udupi Power Corporation Ltd (UPCL), Udupi Reg

Ref.: 1) Your office letter No: Tech 39:Legal (NGT):RDS:2019-20 203 Dated : 19.06.2020

2) Joint Director of Agriculture, Udupi District Letter No. ಜಕೃನಿ:ಉ:ತಾಂ:NGTಮಾಹಿತಿ:2020-21 Dated: 01-07-2020

3)This Office letter No. DDH:ZP:UDUPI:ADH(TA):49:2020-21 424-25 Dated: 24-07-2020

4) Yours office letter No: Tech 39:Legal (NGT):RDS:2019-20 486 Dated : 26-08-2020

5)This Office letter No. DDH:ZP:UDUPI:ADH(TA):49:2020-21 424-25 Dated: 11-09-2020

6) Expert Committee Visit on 07-09 December-2020

****

With reference to the above subject Hon'ble NGT Southern Zone, Chennai order in the matter of O.A No. 578 of 2018 (Earlier

25/1/2021

82

O.A 26 of 2013) related to M/s Udupi Power Corporation Ltd (UPCL), Udupi, as per ref. (1) in letter ref. (3) and (5) submitted information on major Horticulture crops of this region pertaining to surrounding villages in the prescribed formats.

Further from 07-12-2020 to 09-12-2020 Expert Committee visited fields and conducted meeting with District level Officers in this matter, based on the discussion the following information is furnished,

1) As per Horticulture Crops is concerned individual farmer wise, village wise yield statistics were not available in Department since Crop Cutting Experiments were not Conducted in the farmers field for major crops grown in locality
2) As per point no. 1 the yield data of Coconut, Arecanut, Cashew and Banana is given based on the average yield of taluka
3) No crop loss is reported between 2008-09 and 2019-20 in surrounding areas related to the case

Thanking You

Yours Faithfully,

Deputy Director of Horticulture
(Zilla Panchayath), Udupi

By Speed Post

ಕರ್ನಾಟಕ ಸರಕಾರ
ತೋಟಗಾರಿಕೆ ಇಲಾಖೆ

ತೋಟಗಾರಿಕೆ ಉಪನಿರ್ದೇಶಕರು (ಜಿ.ಪಂ.)
ಉಡುಪಿರವರ ಕಛೇರಿ
ಶಿವಳ್ಳಿ ಮಾದರಿ ತೋಟಗಾರಿಕೆ ಕ್ಷೇತ್ರ,
ದೊಡ್ಡಣಗುಡ್ಡೆ,
ಉಡುಪಿ-576102
Email: ddhudupi@gmail.com

O/o Deputy Director of
Horticulture (ZP), Udupi,
Shivalli Model Horticulture
Farm, Doddanagudde,
Udupi-576102
Office Phone: 0820-2531950

No.:DDH:ZP:UDUPI:ADH(TA):49:2020-21 -646 Date: 11-09-2020

To

Regional Director,
Central Pollution Control Board,
Nisarga Bhawan, A Block,
1st & 2nd floors, Thimmaiah Road,
7th D-Main, Shivanagar,
Bengaluru -560079.

केन्द्रीय प्रदुषण नियंत्रण बोर्ड
17 SEP 2020
बेंगलूर/पावती सं. 678

Respected Sir,

Subject: Information on Horticulture Crops with respect to Hon'ble NGT Southern Zone, Chennai order in the matter of O.A No. 578 of 2018 (Earlier O.A 26 of 2013) related to M/s Udupi Power Corporation Ltd (UPCL), Udupi Reg

Ref.: 1) Yours office letter No: Tech 39:Legal (NGT):RDS:2019-20 203 Dated : 19.06.2020

2) Joint Director of Agriculture, Udupi District Letter No. ಜಕೃನಿ:ಉ:ತಾಂ:NGTಮಾಹಿತಿ:2020-21 Dated: 01-07-2020

3)This Office letter No. DDH:ZP:UDUPI:ADH(TA):49:2020-21 424-25 Dated: 24-07-2020

4) Yours office letter No: Tech 39:Legal (NGT):RDS:2019-20 486 Dated : 26-08-2020

****

With reference to the above subject Hon'ble NGT Southern Zone, Chennai order in the matter of O.A No. 578 of 2018 (Earlier O.A 26 of 2013) related to M/s Udupi Power Corporation Ltd (UPCL), Udupi, as per ref. (1) in letter ref. (3) submitted information

84

on major Horticulture crops of this region pertaining to surrounding villages in the prescribed formats.

Further as per ref. (4) yield details of Inna, Nandalike, Muloor, Belaman, Mundkuru and Sooda of Karkala Taluk and Padebettu, Nadsalu, Mallaru, Padu, Muluru, Majuru, 92-Heruru, Paduru, Kalathuru, Kutyaru, Pilaru, Belapu, Hejamadi, Palimaru, Nandikuru, Bada and Shirva of Udupi taluka and revised yield details of Santhuru is attached to this letter for your needful. Kelthur, Karnire, Kollur, Balkunje and Kavathuru are not belongs to Udupi District

Thanking You

Yours Faithfully,

Deputy Director of Horticulture
(Zilla Panchayath), Udupi

Annexure

Crop yield per acre

sl.no.	Gram Panchayath	Village	District	Taluk	Hobli	Name of the major horticulture crop	Crop yield per acre											
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1		Inna, Nandalike, Muloor, Belman, Mundkuru, Sooda	Udupi	Karkala	Karkala / Ajekaru	Coconut (Nuts/acre)	3920	3920	3920	3920	3920	4000	3920	4000	4000	4000	4000	4000
2						Arecanut (quintal/acre)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	6.88	7.00	7.00
3						Cashew (quintal/acre)	8.40	8.00	8.00	8.00	8.00	8.00	8.40	8.40	8.20	8.40	8.00	8.20
4						Banana (quintal/acre)	96.00	94.00	96.00	63.00	94.00	96.00	96.00	98.00	98.00	98.00	98.00	98.00

Remarks: Individual farmer wise and Village wise yield statistics were not available in the department since Crop Cutting experiments were not conducted in this farmers fields and these crops enlisted in Annexure. Hence Average yield of the taluk was taken based on Horticulture Crop Statistics Data.

ಜಿಲ್ಲಾ ಪಂಚಾಯತ್, ಉಡುಪಿ

Deputy Director of Horticulture
ZILLA PANCHAYATH, UDUPI

98

Annexure

CROP YIELD PER ACRE (Q)

SL.NO	GRAM PANCHAYATH	VILLAGE	DISTRICT	TALUK	HOBLI	NAME OF THE MAJOR Horticulture Crop	CROP YIELD PER ACRE (Q)											
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	PADUBIDRI	PADEBETTU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
		NADSALU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
2	KAPU	MALARU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
		PADU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
		MULURU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00

....2

ಜಿಲ್ಲಾ ಪಂಚಾಯತ್ ತೋಟಗಾರಿಕೆ ನಿರ್ದೇಶಕರ
ಜಿಲ್ಲಾ ಪಂಚಾಯತ್, ಉಡುಪಿ

Bhumeshwara
Deputy Director of Horticulture
ZILLA PANCHAYATH, UDUPI

87

SL.NO	GRAM PANCHAYATH	VILLAGE	DISTRICT	TALUK	HOBLI	NAME OF THE MAJOR Horticulture Crop	CROP YIELD PER ACRE (Q)										
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
3	MAJUR	MAJUR	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
		92 HEROOR	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
		PADURU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
4	KUTYARU	KALATHURU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
		KUTYARU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
5	MUDARANGADI	PILARU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00

ಜಿಲ್ಲಾ ಪಂಚಾಯತ್ ತೋಟಗಾರಿಕೆ ಉಪನಿರ್ದೇಶಕರು
ಜಿಲ್ಲಾ ಪಂಚಾಯತ್, ಉಡುಪಿ

Bhuvaneshwari
Deputy Director of Horticulture
ZILLA PANCHAYATH, UDUPI

...3

88

SL.NO	GRAM PANCHAYATH	VILLAGE	DISTRICT	TALUK	HOBLI	NAME OF THE MAJOR Horticulture Crop	CROP YIELD PER ACRE (Q)											
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
6	BELAPU	BELAPU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
7	HEJAMADI	HEJAMADI	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
8	PALIMARU	PALIMARU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
		NANDIKURU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
9	BADA	BADA	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
10	SHIRVA	SHIRVA	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00

REMARKS:

1. Individual farmer wise and Village wise yield statistics were not available in the department since Crop Cutting experiments were not conducted in this farmers fields and these crops enlisted in Annexure. Hence Average yield of the taluk was taken based on Horticulture Crop Statistics Data.

Senior Assistant Director of Horticulture
Udupi Taluk

Deputy Director of Horticulture
Udupi District, Udupi.

Deputy Director of Horticulture
ZILLA PANCHAYATH, UDUPI

89

Annexure

CROP YIELD PER ACRE (Q) (Revised)

SL NO	GRAM PANCHAYATH	VILLAGE	DISTRICT	TALUK	HOBLI	NAME OF THE MAJOR Horticulture Crop	CROP YIELD PER ACRE (Q)										
							2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
1	MUDARANGADI	SANTHURU	UDUPI	KAPU	KAPU	Coconut	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16	14.16
						Arecanut	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88	6.88
						Cashew	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
						Banana	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00

REMARKS:

1. Individual farmer wise and Village wise yield statistics were not available in the department since Crop Cutting experiments were not conducted in this farmers fields and these crops enlisted in Annexure. Hence Average yield of the taluk was taken based on Horticulture Crop Statistics Data.

ಸಹಾಯಕ ತೋಟಗಾರಿಕೆ ಅಧಿಕಾರಿ
ರೈತ ಸಂಪರ್ಕ ಕೇಂದ್ರ
ಕಾಪು

Senior Assistant Director of Horticulture
Udupi Taluk

Deputy Director of Horticulture
Udupi District, Udupi.

90

Annexure 6

Office Of the Deputy Director,
Animal Husbandry & Veterinary Services, Udupi District, Udupi.

Ph. No.0820-2534024 E-mail: udpddahvs@gmail.com

No:DDU:O.A.NO.578 OF 2018 w.r.t:UPCL Udupi :20-21 | 1772 Date 23.12.2020

To,

The Deputy Commissioner,
Rajathadri, Udupi.

Sir,

Sub:- In the matter of O.A.No.578 of 2018 w.r.t. M/s Udupi Power Corporation Ltd (UPCL), Udupi.

Ref:- 1. Your e mail dated 11.12.2020
2. Report received from Veterinary Officer, Padubidri dated 18.12.2020

****

With reference to the above mail, information sought for cattle deaths reported due to environmental pollution in the villages / taluks of Udupi located in 10 km radius from M/s Udupi Power Corporation Ltd (UPCL), Udupi for a period from 2008 to till date.

Vide reference (2) above, Veterinary Officer, Veterinary Dispensary, Padubidri has reported that from villages of Nandikur, Santhoor, Pilar, Kuthyar and Yellur (10 km radius from M/s Udupi Power Corporation Ltd (UPCL), Udupi. No animal deaths reported from the year 2008 to 2020 (up to 18.12.2020).

Your's faithfully,

Sd/-
Deputy Director,
Animal Husbandry &
Veterinary Services, Udupi.

✓Copy to The Environmental Officer, Karnataka State Pollution Control Board, Shivalli Industrial Area, Manipal 576104 for information.

Pl. Scan it & Send it to CPCB - Mr. Thirumurthy 24/12

24/12/2020
2090

Deputy Director,
Animal Husbandry &
Veterinary Services, Udupi.

Annexure 1

Working Paper 485

Economic Estimation of Health and Productivity Impacts of Traffic Congestion: A Case of Bengaluru City

Vijayalakshmi S
Krishna Raj

ISBN 978-81-946531-1-0 June 2020

Institute for Social and Economic Change (ISEC) is engaged in interdisciplinary research in analytical and applied areas of the social sciences, encompassing diverse aspects of development. ISEC works with central, state and local governments as well as international agencies by undertaking systematic studies of resource potential, identifying factors influencing growth and examining measures for reducing poverty. The thrust areas of research include state and local economic policies, issues relating to sociological and demographic transition, environmental issues and fiscal, administrative and political decentralization and governance. It pursues fruitful contacts with other institutions and scholars devoted to social science research through collaborative research programmes, seminars, etc.

The Working Paper Series provides an opportunity for ISEC faculty, visiting fellows and PhD scholars to discuss their ideas and research work before publication and to get feedback from their peer group. Papers selected for publication in the series present empirical analyses and generally deal with wider issues of public policy at a sectoral, regional or national level. These working papers undergo review but typically do not present final research results, and constitute works in progress.

Working Paper Series Editor: **M Balasubramanian**

ECONOMIC ESTIMATION OF HEALTH AND PRODUCTIVITY IMPACTS OF TRAFFIC CONGESTION: A CASE OF BENGALURU CITY

Vijayalakshmi S[1] and Krishna Raj[2]

Abstract

Traffic congestion in urban areas is mainly due to the exponential growth of the vehicular population. It imposes a huge economic cost in the form of the opportunity cost of time and alsohealth cost. It is observed that urban residents, particularly commuters, are the main sufferers of traffic emissions. These costs are incurred in the form of morbidity and mortality. The epidemiological evidences show that there is a strong causal relationship between vehicular emissions and possible health impacts. The present study substantiates this interrelationship with empirical evidences. Using the ARDL approach, the study establishes empirically that an increase in vehicular mobility results in increased traffic-induced air pollution. Further, various research studies found that constant exposure to traffic pollution for more than an average of 38 minutes per day not only cause high incidence of respiratory-related illness among commuters, but also reduced their economic productivity. To quantify these impacts for Bengaluru city, India, the study has adopted the cost of illness approach by classifying the costs into direct and indirect costs. The results show that the direct and indirect cost of illness due to traffic congestion amounted to an average of 1.17 per cent and 11.2 per cent of theannual income of the respondents respectively.

Key words: Traffic Congestion; Health; Productivity; emissions; ARDL; RSPM; COI.

Travelling in personal vehicles has both benefits and costs. Travel that is free from traffic congestion has an economic gain in terms of the opportunity cost of saving time. On the other hand, traffic congestion imposes acost on health, affecting the economic productivity of commuters. Being a universal phenomenon, traffic congestion hasresulted in increased travel time and a constant exposure to air pollution. A World Health Organization (2016) report states that 80 per cent of urban residents of the world are exposed to air pollution above the WHO standard, half of which can be attributed to vehicular pollution. Research studies (HEI, 2010) proved this relationship with the aid of epidemiological and clinical evidences.

In a developing country like India, traffic congestion has become a serious problem as it imposes a high cost on health and productivity. HEI (2019) reports that among the top ten developing countries, India ranks second, next only to China, with the highest mortality attributable to air pollution. Studies on air pollution in India, especially by OECD (2014) cite air pollution as the major cause due to a lack of control over vehicular emissions, which resulted in a 12 per cent increase in the number of deaths and three per cent increase in years of life in 2012. The Central Pollution Control Board (CPCB, 2011) also observed that urban air pollution is escalating in recent years (1990 to 2010) mainly due to growing private vehicle ownership.

Though the issue of air pollution has been studied widely in the world, traffic congestion-led air pollution and pollutants' density at traffic junctions and its economic impacts like morbidity and mortality remain less studied. As motor vehicles emit a large quantity of carbon dioxide (CO_2), carbon

[1] PhD Scholar at Centre for Economic Studies and Policy, Institute for Social and Economic Change, Bengaluru - 560072. E-mail: vijaya@isec.ac.in.

[2] Professor of Economics at CESP, ISEC, Bengaluru - 560072.

monoxide (CO), nitrogen oxides (Nox), and particulate matter (PM) whose concentration and density increases at traffic junctions, causing adverse health effects on commuters who are exposed continuously for more than 38 minutes every day (See Table 9). In this background, the present study has selected Bengaluru to assess the economic impact of traffic congestion on commuters. The rationale behind the selection of the city is that being a dynamic city in the country, its vehicular population is growing at the rate of 10 per cent per annum which contributes around 40 per cent for Respirable Suspended Particulate Matter (RSPM) in the city (TERI, 2015[3]). Further, the city has been ranked among the cities with the worst traffic congestion (IBM, 2011).

This paper is organized into five sections: The *first section* identifies traffic-related air pollutants and their epidemiological evidences; the *second section* reviews literature on economic estimation of health costs; the *third section* deals with the methodology adopted for the study and the *fourth section* analyses the economic estimates of health impacts due to traffic-related air pollution; the *final section* concludes with policy suggestions.

Traffic-related Air Pollutants and Epidemiological[4] Evidence

Research studies have found scientific and statistical evidences for the causal relationship between vehicular emissions and health impact (HEI, 2010). But it is hypothesized in the present study that vehicular emissions, especially at traffic junctions, tend to have a high concentration of pollutants due to greater vehicular density, inflicting a negative health impact on commuters. To prove this hypothesis, the study relies on the epidemiological evidences from the literature as medical enquiry is not in the scope of the present research. In the following section, the study identifies the major pollutants from automobiles and their epidemiological evidences.

Traffic-related Air Pollutants

Vehicular emissions can be classified into primary pollutants and secondary pollutants. Primary pollutants are the ones which get generated at source and then dispersed. In the case of vehicular emissions, the primary pollutants are carbon dioxide, carbon monoxide, hydrocarbon, particulate matter (PM), nitrogen oxide and substances called mobile source air toxics like benzene, aldehyde, acetaldehyde and 1,3-butadiene. Secondary pollutants are formed due to chemical interactions with air. For example, oxidation of NO turns into NO_2 and ozone (O_3). Further, the nature of pollutants is linked to the type of vehicle (light or heavy-duty vehicles), age, operating and maintenance condition, type and quality of the fuel used.

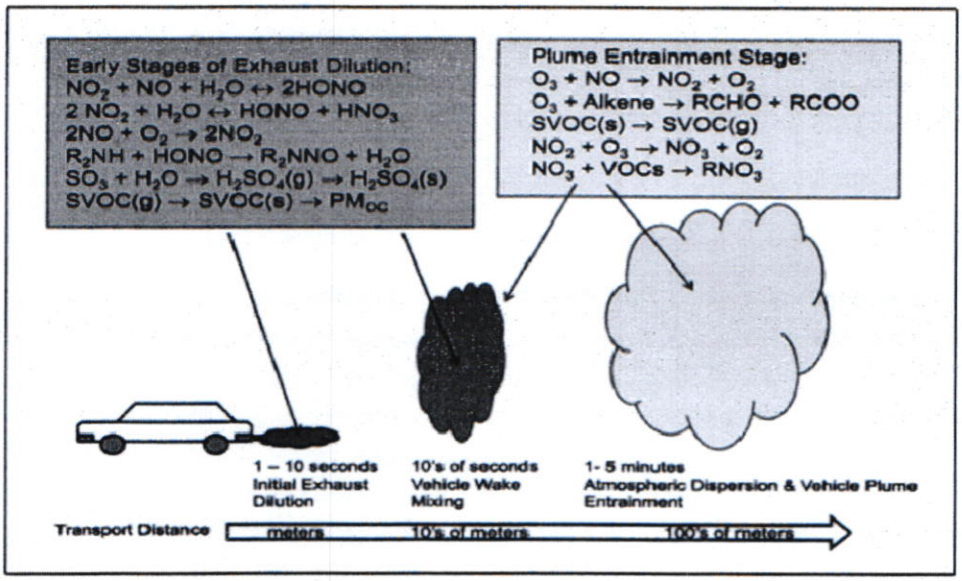
Queued up vehicles near traffic signals, with their engines on, tend to have high emissions and the commuters constantly get exposed to pollutants. For example, the average concentration of $PM_{2.5}$ due to vehicle exhaust is 2.5 times higher and CO is six times higher than in a normal environment (Chan CC *et al*, 1991; Adams *et al*, 2001; Kaur *et al*, 2005). Figure 1 provides a graphical representation of the emissions due to vehicles and how chemical transformation would take place. The early stage of

[3] As per the report, it is only in Bengaluru that automobiles are the major contributor of RSPM compared to other metropolitan cities of the country.

[4] Study of distribution and determinants of health related events (diseases) (WHO).

the exhaust contains CO_2, H_2O, CO, NO, NO_2, HC, semi volatile organic compounds, inorganic materials and PM from the exhaust of tailpipes at relatively high temperature and concentration. This exhaust of foreign material mixes with (entrains) background air in the environment and there is a chance of chemical diffusion and a limited reaction takes place. This phenomenon is very localized and likely to occur within 100meters of the source. This shows that commuters are particularly susceptible to the vehicular pollutants in traffic junctions.

Figure 1: Schematic Representation of Possible Chemical Transformation of Motor-Vehicle Emissions



Source: HEI, 2010

Health Effects of Traffic-related Air Pollution: Epidemiological Evidences

Although there exists vast evidence on the impacts of air pollution on human health, isolating the impact of traffic-related air pollutants on health is quite challenging. WHO has given several criteria for assessing human exposure to transportation led air pollution which includes a concentration of pollutants in $\mu g/m^3$ or any other equally valid metric; duration of exposure; the setting like workplace and transport mode and exposed population (WHO, 2005). Based on this definition, this study concludes that commuters are exposed to a high concentration of pollutants in traffic junctions and are highly susceptible to negative health impacts.

1. Impact on Health by Type of Traffic-related Air Pollutants

Vehicular emissions have different types of effects on human health, which vary from itchy eyes to chronic lung disease or heart failure (McCubbin and Delucchi, 1999). Notable studies have proved that

criteria pollutants[5] have adverse effects on human health (Pervin *et al*, 2008). In Table 1, major automobile-related pollutants and their impact on human health is described.

Table 1: Traffic-related Pollutants and Their Possible Health Impacts

Pollutant	Short term impact	Long term impact	Source
Fine Particulates: $PM_{2.5}$ and PM_{10}	Hospital admission for respiratory disease; Exacerbated lung and heart condition	Premature death; affects quality of life	McCubbin and Delucchi, 1999; COMEAP, 2009
Ozone (O_3)	Respiratory irritation, asthma	Cardiovascular disease through prolonged inflammatory effects on lungs; myocardial infarction and cardiac arrhythmias in older people	McCubbin and Delucchi, 1999; Portney and Mullahy, 1986; WHO, 2005
Nitrogen dioxide (NO_2)	Bronchocontriction, increased bronchial reactivity, airway inflammation	Decreased pulmonary function, inflammation of lung and immunological changes	HEI, 2010; COMEAP, 2011
Carbon Monoxide (CO)	Heart troubles Headaches	It binds with hemoglobin in the blood to form carboxyhemoglobin. This reduces the oxygen carrying capacity of the blood and limits the release of oxygen from circulating hemoglobin	McCubbin and Delucchi, 1999; Schwartz and Zeger, 1990

2. Morbidity Impacts and Their Causal Pollutant Relations

The above table establishes that diverse epidemiological evidences have strongly established the causal relationship between traffic emissions exposure and respiratory issues, cardio-health outcomes like heart related diseases and adverse cardiovascular events. Hoffmann *et al* (2006 as reported in HEI, 2010) conducted a cohort study on adults in various cities of Germany and found a causal relationship between coronary heart disease and long-term exposure to traffic-related air pollution. Similar studies are listed in Table 2.

[5] Criteria pollutants are non-toxic air pollutants (CO, NO_2, PM, SO_2, lead, ozone), excess concentration of these would be hazardous to health.

Table 2: Morbidity Impact Studies

Morbidity issue	Study/Author[6]	Pollutant/area	Impact/Finding
Cardiovascular morbidity	Peters *et al* (2004)	Traffic-related air pollution	Found association between traffic exposure and myocardial infarction
	Rosenlund *et al* (2006) Stockholm	NO_2	0.89% increase in cardiovascular morbidity per 30μg/m^3 increase in NO_2
Asthma & Breathing problems	Modig *et al* (2006)	Residents near main roads	1.1% of residents of Lulea, Sweden had incidence of asthma
	Burr *et al* (2004) North Wales, UK	5.7% improvement in respiratory symptoms among residents near major road due to traffic diversion	
	Livingstone *et al* (1996 HEI 2010) London	High incidence of asthma among residents of main road	
	Bayer & Oglesby (2006) Switzerland	0.9 to 1.3% of residents living in main road suffer from wheezing and breathing problem respectively	
	Oosterlee *et al* (1996) Netherlands	Incidence of asthma, wheezing, cough are common among residents near busy streets	
Issue of Asthma and respiratory issues among Children	Studies reviewed in HEI (2010)	Found high incidence of asthma among school children near busy roads	
Respiratory Allergy and Hospital Admission	WHO (2005)	NO_2 and PM_{10}	Each 50 μg/m^3 increase in NO_2 concentration would increase respiratory hospital admission by 2.5 per cent and 10 μg/m^3 increase in PM_{10} would lead to 0.8 per cent increase in respiratory hospital admission
	Cesaroni *et al* (2008)	$PM_{2.5}$ and NO_2	Allergy incidences, itchy rashes, eczema, otitis media, outdoor aeroallergens, hay fever, self reported rhinitis are most common issues
Lung issue and lung cancer	Brunekreef *et al* (1997)	Traffic emissions	The study found significant association between lung function and density of lorry traffic
	Hrisch *et al* (1999) Dreseden	NO_2, CO and Benzene	The study found association of lung function with high level of exposure to benzene
	Northridge *et al* (1999) New York	Diesel exhaust	Association to asthma
	Nyberg *et al* (2000) Stockholm	NO_2	Association of lung cancer and prolonged exposure to transport related air pollution
	Nafstad *et al* (2003) Norway	NO_2	There is risk ratio of 1.08 per 10 μg/m^3 increase in average concentration of nitrogen oxide with lung cancer among residents
	Beelen *et al* (2008)	NO_2	Cases of lung cancer associated with black smoke and NO_2 from traffic. It was found that an increase of 30 μg/m^3 of NO_2 would increase the risk of lung cancer by 0.86 per cent and 10 μg/m^3 increase in Black smoke would increase the case of lung cancer by 1.03 percent
Occupational exposure	Hansen *et al* (1998)	Increased risk of lung cancer among Danish drivers	
	Jakobsson *et al*, 1997	The risk of lung cancer was high among urban drivers than the rural areas in Sweden	
	De Paula Santos *et al* (2005)	Found incidences of BP and stress closely associated with CO, SO_2 and NO_2	
	Evans *et al* (1988)	Found respiratory symptoms and lung function as common incidences among male toll takers in tunnels of New York	

[6] This information is sourced from HEI (2010) and McCubbin and Delucchi (1999).

3. Epidemiological Evidences from Indian Studies

A few studies are available in India that analyzed the economic impact of urban air pollution, that too inthe case of traffic-related air pollution.

Table 3: Epidemiological Evidences from Indian Studies

Study/Author	Study area	Findings
Parikh and Parikh (1997)	Mumbai	Significant association is found between urban air pollution and morbidity
Cropper *et al* (1997)	Delhi	Impact of PM is analyzed and found that mortality is high among age group of 14-15 years
Giri *et al* (1997)	Kathmandu	Impact of PM emissions and found 95 deaths out of 10000 attributable.
Dewaram *et al* (1997)	Kolkata, Chennai, Delhi and Mumbai	The study found increasing episodes of illness and premature death due tohigh level of SPM released from automobiles
Paramesh (2004)	Bengaluru	Increase in cases of asthma from 20 per cent to 36.6 per cent (from 1999 to 2004)
Ravi (2014)	Bengaluru	Every 10μg/m^3 decrease in PM_{10} and $PM_{2.5}$, the average mortality would reduce from acute respiratory infection by eight percent, cardiopulmonary illness by six per cent and lung cancer by five percent
TERI (2015)	Indian cities	10μg/m^3 increase in PM_{10} concentration would lead to increase in mortality by 0.22 per cent in Bengaluru and 0.20 per cent in Mumbai

The epidemiological studies discussed in this section establish the fact that traffic-induced pollutants, mainly in urban areas, cause severe health issues. In the next section, an elaborate review of the literature on the valuation of such health impacts due to traffic-related air pollution is provided.

Review of Literature on Economic Estimation of Health Cost due to Traffic-related Air Pollution

Some research studies have quantified the ill-effects of air pollution at large and traffic air pollution in specific. In this section, a brief literature is provided on the estimates of costs due to air pollution and more elaborated evidences for traffic-related air pollution costs on human health. Such economic estimation of urban air pollution enables policy makers to design measures to improve the air quality by increasing the remedial benefits which will reduce the cost of pollution.

The economic valuation of air pollution is largely based on the role of individual preference in valuing the environmental damage (Shin *et al*, 1992). There are two broad categories of valuation techniques to estimate the costs of air pollution viz., the physical linkage approach and the behavioural linkage approach. The physical linkage method, also called as the damage function approach, estimates the effects of pollution with the application of market prices (Ligus, 2018). The behavioural linkage approach, on the other hand, is based on the behavioural changes due to environmental damage[7]. A number of studies have used these methods to derive the air pollution cost estimates.

For instance, a WHO study (1997) on the economic cost of air pollution used Cost of Illness and Human Capital Approach (COI & HCA). El Fadel and Masood (2000) and Friedrick and Bickel (2001)

[7] An elaborate explanation of these methods is provided in Section III.

estimated the loss due to air pollution using the same methodology (COI & HCA). On other hand, studies by Farber and Rambaldi (1993) and Loehman *et al* (1979) derived Willingness To Pay (WTP) for improved air quality as a method to value the loss from air pollution. Berger *et al* (1987) used both the COI and WTP approaches to estimate the urban air pollution in the USA.

Economic Estimation of Health Cost due to Traffic Pollutants

Disentangling the impact of traffic pollutants is a complicated task, and the same is true with quantification of individual pollutants' impact on human health. There are a few studies which have attempted such estimation for traffic pollutant emissions. The following section will provide a brief review of them[8].

Particulate matter is a primary and dangerous pollutant from automobiles that affects human health. Research studies have considered the impact of this pollutant and tried to quantify it using different approaches. For instance, Zimrou *et al* (1999) used the Cost of Illness Approach to measure the direct cost of health due to exposure to PM_{10} in France and the Human Capital Approach to measure the productivity loss. The direct cost (medical expenses) ranged from US$ 6.60 to $ 1.25 million and productivity loss was around US$ 5.10 – $ 8.72 million (1994 US dollars) and the total societal cost was estimated to be US$ 13.43 to $ 22.95 million.

Alberni and Krupnick (2002) used the COI and WTP approach for Taiwan. They estimated that the direct loss through medical expense amounted to around US$ 510,491 for 100μg/m^3 reductions in PM_{10} and US$ 117,575 to $244,477 for productivity loss (using the HCA Approach). Kan and Chen (2003) estimated that US$ 67-82 million would be lost as the direct cost of health expenses due to exposure to PM_{10}emissions in Shanghai city of China. The study adopted the Contingent Valuation Method (CVM) to estimate the productivity loss due to premature mortality which accounted around US$ 557.58 million.

DSS Management Consulting Inc. (2000) estimated the pollution cost of ozone and PM_{10} exposure in Canada. They adopted the COI and HCA methods and estimated a loss of US$ 674 million on medical cost, US$ 2,696 million due to productivity loss and intangible cost of US$ 3,370 million. A World Bank study (2002) also examined the impact of the same pollutant as DSS Management Consulting Inc, and estimated the cost for metropolitan Mexico City (ZMV) which amounted to US$ 760 million (1999 US $) of societal cost.

Voorhees *et al* (2000) examined the impact of NO_2 on health in Tokyo, Japan. By using both COI and HCA approaches, the study estimated a direct cost of US$ 6,860 million and productivity loss cost of US$ 6,330 million and non-health cost of US$833 million, totalling up to a societal cost of US$ 14,023 million. Rozan (2005), on the other hand, estimated the cost of air pollution in total[9] for Strasbou city of France. The study used COI and HCA approaches to estimate the direct cost of pollution and used the CVM approach to estimate the intangible cost of pain and suffering. The direct cost included doctor visit of US$ 24.91 per patient and medical cost of US$ 74.75 per patient. The

---

[8] In these studies, motor vehicles are the major source identified but not the only source. Hence, pollutant-wise cost estimates are given more prominence.

[9] The study did not separate the impact of pollutant

indirect cost included productivity loss of US$ 21,299 due to wage loss from air pollution. With the WTP approach, the intangible cost was estimated to be around US$ 46.83 per patient. Neidell (2004) estimated a cost of US$ 5.2 million spent for illness caused due to CO in California, USA using the COI approach.

Among a few Indian studies on estimation of pollution cost, anotable study was conducted by Srivastava and Kumar (2002) for Mumbai city using the COI and HCA methods for direct cost and WTP for premature mortality due to NO_2, CO, HC and PM. The study reported a direct cost of US$ 232.34 million and productivity loss of US$ 76.32 million which accounted for a societal cost of US$ 308.66 million (1997 US$). Another study by Saksena and Dayal (1997) applied the HCA and COI methods for direct cost and Value of a Statistical Life (VOSL) for mortality impact. The study aggregated the cost and reported the direct cost due to PM_{10} exposure as US$ 199.11 million and productivity loss of US$ 18,784 million (1995 US $). Ravi (2014) estimated the productivity loss due to urban air pollution in Bengaluru as around Rs. 4,253/year per person and out of pocket expenditure as around Rs. 990 per year using the COI and WTP approaches.

These evidences of estimates not only indicate the severity of the issue on the health of individuals but also point at the productivity loss caused to the economy. As the cities of developing countries are emerging as economic hubs of the world, the problem of traffic congestion has become severe and hence it is the need of the hour to quantify its impact so that better policy solutions could be obtained. In this effort, the present study stands as the first of its kind to examine the impact of traffic-related air pollution on the health of commuters in the city of Bengaluru, one of the most dynamic cities of the World. The study observed the impact in terms of mortality and morbidity which will help for prudent policy suggestions to tackle the city congestion issues.

Methodology of the Study

Valuation of health damage has been a critical aspect of the study and requires an inter-disciplinary approach. One important element of the valuation lies in establishing the dose-response function of the pollutant under study. With the epidemiological evidence established in Section I, it is established that primary pollutants (PM) from automobile emissions would have a serious impact on the health conditions of commuters. Particulate matter has been studied by various researchers who have proved epidemiologically that commuters in especially high emissions-concentrated areas (traffic junctions) are highly prone to serious health issues. An attempt is made in the study to estimate the impact of traffic congestion on the health of commuters.

Economic Estimation of Traffic Pollution and Morbidity

The morbidity effects of air pollution are commonly valued using the Cost Of Illness (COI) approach. There are basically three different costs involved in COI. Direct costs involve medical treatment; indirect costs include loss of productive days and intangible costs are the cost of suffering and pain. Since the third cost is highly subjective in nature, which is often difficult to capture, the current study considers the first two costs of illness: direct and indirect costs. Under direct cost, the medication expenses for traffic-related health issues are estimated. In the case of the indirect cost of illness, productivity loss

due to illness is estimated using the number of workdays lost and wage lost per day. The indirect cost also includes preventive expenditure such as expenses made by commuters to avoid the congested route. In our study, the toll paid by commuters and metro train users are taken as a proxy for preventive costs. Hence the estimation of morbidity cost includes:

Cost of illness = direct cost (cost of medicines) + indirect cost (productivity loss & preventive expenses)

Pollutants Considered for the Study

The primary element of vehicular emissions is RSPM which is found above set standard (60μg/m^3). Further the study does not consider sulphur dioxide (SO_2) as the pollutant is within the standard limits and also there is lack of strong evidence that SO_2 has an impact on health by being an independent pollutant. Though in the literature we may find some arguments that SO_2 might be linked with incidences of cough, wheezing, eye irritation, runny nose and discomfort in chest, epidemiological evidence shows that there is no strong causation proved (Studies reported in HEI, 2010).

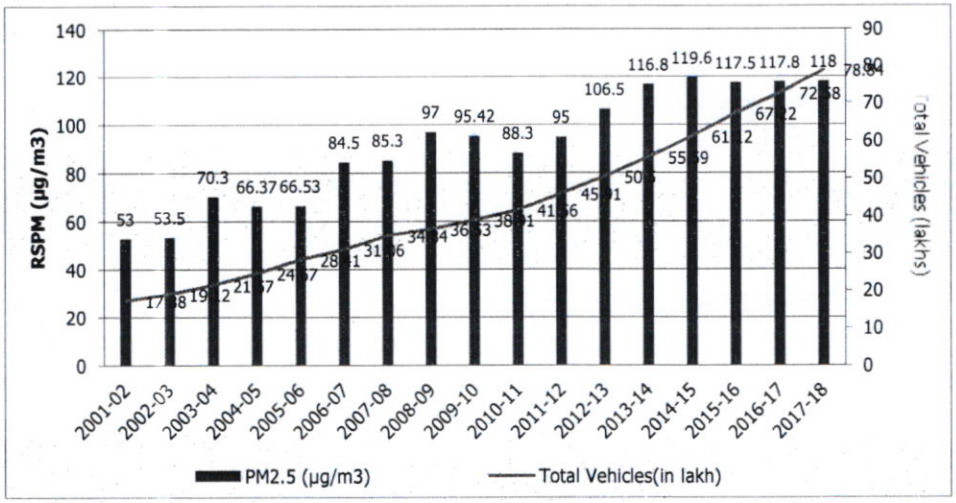
Major limitations of the study are: The study assumes that commuters are exposed to these pollutants regularly. Further, the study has not classified the pollutants based on vehicle type, age, operating and maintenance condition and quality of fuel used, though these are some relevant factors affecting the emissions level. Since consideration of these parameters requires micro-level data and more engineering specifications, the study is limited on these aspects. Though the study acknowledges that existence of different types of pollutants from vehicles (combustion and non-combustion), since emissions monitoring data do not have such classification, the present analysis refrains from such classification and considers primary pollutants for estimation (RSPM).

Health Profile of Study Area and Estimation of Traffic-related Health Cost

Traffic-induced Pollution in the City: Econometric Analysis

Based on the literature review, it was identified that primary pollutants from vehicular emissions are respiratory suspended particulate matter (RSPM). This pollutant has awide range of health impacts, irrespective of the socio-economic conditions of the study area (Dockery *et al*, 1993; Pope *et al*, 1995; Ostro, 1994). Even in the study area, the levels of RSPM concentration is showing a trend of increasing in parallel with the vehicular population.

Figure 2: RSPM Level and Number of Registered Vehicles in Bengaluru



Source: KSPCB and Transport Department of Karnataka Annual reports from 2001-2018

With an annual growth of vehicular population by 9.9 per cent from 2001-2018, the RSPM level is increasing at 3.8 per cent annually and from Figure 2, it is evident that both variables have an association. To know this causal relationship, the study adopted the time-series econometric approach in the next section.

Econometric Model

The study specifies the following equation to know the relationship between the RSPM and vehicular population and private vehicle kilometer travelled as[10]. The data on RSPMand vehicles has been taken from a monthly series of studies from January 2015 to December 2018. In the same manner, the vkt is calculated based on the IRC guidelines.

$$\ln(rspm_t) = \beta_0 + \beta_1 \ln(vhcl) + \beta_2 \ln(vkt) + u_t \quad \text{..... (1)}$$

where rspm, vhcl and vkt represent respiratory suspended particulate matter, vehicular population and private vehicle kilometer travelled[11], while ln is the natural logarithmic form of the series. β_0, β_1, β_2 and β_3 are the long-run elasticities of rspm with respect of vhcl and vkt respectively. A summary descriptive statistics of the variables used in the model is provided in Table 4.

[10] Though there are other factors like road dust etc which affect the RSPM level, the study assumed that they are the result of vehicular population (TERI, 2015).

[11] Private vehicle kilometer travelled (VKT) is derived from IRC (1990) guidelines for Bengaluru city using average trip length and total vehicles called theload factor. Load factor is the average distance travelled by a category of vehicle in a day. Load factor for private transport=15kms/day.

Table 4: Descriptive Statistics

	Vehicle	VKT	RSPM
Mean	42.69471	19496.76	91.26000
Median	38.91000	18773.00	95.00000
Maximum	78.84000	35475.00	119.6000
Minimum	17.38000	8421.000	53.00000
Std. Dev.	19.04045	8111.269	23.06230
Skewness	0.445202	0.459575	-0.267799
Kurtosis	2.072887	2.228247	1.816360

Data source: KSPCB, RTO, author's analysis

To test the long run relationship, the most popular methods followed are Engle and Granger (1987) test and Johansen-Juselius (1990) test. These methods impose the conditions that the variables in the model should be stationary at first difference i.e I (1). Hence, the said model needs to be tested for stationarity to continue for further analysis. For this purpose, the unit root test is conducted using Augmented Dickey Fuller (ADF) and Philip Perron (PP) tests whose results are given in Table 5.

Table 5: Unit Root Test Result

Variable	ADF (t-stat)	Result	PP (t-stat)	Result
lnrspm	-3.02*	I (0)	-3.06*	I (0)
lnvhcl	-19.74*	I (1)	-18.25*	I (1)
lnvkt	-6.18*	I (0)	-12.42*	I (0)

*Significant at 1% level; ** Significant at 5% level; *** Significant at 10%level

Clearly the variables are of mixed order (I(0) & I(1)) and hence our study is restricted to the use the popular methods of cointegration like Engle and Granger or Johansen-Juselius tests. To overcome the limitations of these tests, Pesaran, Shin and Smith (1996) have developed an alternative approach called Autoregressive Distributed Lag (ARDL) which was further developed by Pesaran *et al* (2001). This approach gained popularity over other approaches by providing the inclusion of variables at different order (Pesaran and Pesaran, 1997). The main advantage of ARDL is that it corrects both the residual correlation and endogenity problems among the variables, and hence provides robust and consistent results of long run coefficients (Pesaran and Shin, 1991).

On this basis, the present study has adopted the ARDL model and the long run equation is as follows:

$$\Delta \ln(rspm_t) = \beta_0 \sum_{i=1}^{q} \beta_{1i} \Delta \ln(rspm_{t-i}) + \sum_{i=1}^{q} \beta_{2i} \Delta \ln(vhcl_{t-i}) \sum_{i=1}^{q} \beta_{3i} \Delta \ln(vkt_{t-i}) + \beta_4 \ln(rspm_{t-1}) + \beta_5 \ln(vhcl_{t-1}) + \beta_6 \ln(vkt_{t-1}) + u_{ti} \quad ..(2)$$

Where Δ is the first difference operator, q is optimal lag length, β_1, β_2, β_3 represent the short-run dynamics of the model and β_4, β_5, β_6 are long run elasticities. ARDL model of co-integrating vector is reparametrized into Error Correction Mechanism (ECM). The error correction model for equation (2) will be:

98

$$\Delta lnrspm_t=a_{10}+a_{11}[lnrspm_{t-1}-b_{11}lnvhcl_{t-1}-b_{12}lnvkt_{t-1}]+\gamma_{11}\Delta lnrspm_{t-i}+\gamma_{12}\Delta lnvhcl_{t-i}+\gamma_{13}\Delta lnvkt_{t-i}+\varepsilon_{ti} \quad ..(3)$$

The coefficient a_{11} indicates the speed of adjustment to equilibrium and its corresponding value in the bracket is the error correction term. The γ coefficients indicate the short-term relation. For the cointegration, these coefficients must be significantly different from zero and estimates of them must not be too large (it must lie between 0, -2). The reparametrized result gives the short run dynamics and long run relationship of the variables (Nkoro & Uko, 2016). In order to find out the long run relationship, a Bounds test on equation (3) is conducted using Bound F statistics with two bounds, i.e., lower and upper bound.

H_0 (null Hypothesis) – there is no cointegration among variables.

The rule of thumb is if the calculated F-statistic is greater than the upper bound, then the null hypothesis is rejected and if it is less than the lower bound, the null hypothesis is accepted and if it falls between the lower and upper bounds, the test is inconclusive (then we check for the error correction term for finding the relationship). With respect to lag length, the Schwarz Bayesian Criterion is used to select the optimal lag length of variables, which gives the optimal lag length 1. Since the data is in anannual series, we expect the impact will be captured with a lag of one year.

1. Empirical Findings

The long run result of the model is given in Table 6. From the model, it can be seen that the variables under consideration have a positive impact on RSPM. A one per cent increase in total vehicular population will increase theRSPM level in the city by 2.22 per cent,whereas vehicle kilometre travel will increase the RSPM level by 3.62 percent.

Table 6: Short and Long-term Estimates of the Models

Long term estimates*

Regressor	Coefficient	t-stat
Constant	26.4	2.41*
$Ln(vhcl_t)$	2.22	1.89**
$Ln(vkt_t)$	3.62	2.43*

*Significant at 1% level; ** Significant at 5% level; *** Significant at 10% level

Short term estimates[1]

$\Delta ln(rspm_t)$ = - 0.61EC* + 0.56 $\Delta ln(rspm(-1))$* + 0.39 $\Delta ln(rspm(-2))$* + 142.14 $\Delta ln(vhcl)$*
(-6.03) (3.29) (2.31) (2.14)
+ 395.3 $\Delta ln(vhcl(-1))$* + 46.97 $\Delta ln(vhcl(-2))$* + 0.88 $\Delta ln(vkt)$*
(4.71) (2.57) (2.23)
+ 0.79 $\Delta ln(vkt(-1))$* + 0.26 $\Delta ln(vkt(-2))$* + 0.08 d2017* - 0.03d2009*
(3.47) (3.79) (1.38) (-3.8)

R^2 = 0.98; Adj. R^2 = 0.96; DW = 2;

* denotes significance of the coefficient at 1 per cent level.

[1] t-values are in parenthesis.

The short- run error correction (EC) term is negative and significant, which indicates that there is co-integration among the variables. The speed of adjustment i.e., 0.61 suggests that nearly 61 per cent of disequilibrium occurred in the short run is corrected in the longrun. ARDL model co-integration is verified with the F-statistics. The computed F-statistics of themodel is above upper critical bound I (1) value according to Pesaran and Pesaran (1996) & Pesaran *et al* (2001) which confirms that the variables have long run relationships.

Table 7: Bound F-statistics

F Statistics	Lower bound I (0)	Upper bound I (1)[12]
7.21 (2)	2.63	3.33

Further to test for the stability of the selected ARDL, the cumulative sum of recursive residuals (CUSUM) test has been conducted. Appendix 1 will provide the plots of CUSUM which shows that the plots remain within critical bounds at 5 per cent level of significance which indicates that the model is structurally stable. The results on Multicollinearity, Heteroskedasticity and normality tests are provided in Appendix 2.

Sample Details of the Study Area and Health Profile

The first step involved in themeasurement of the health impact due to traffic-related air pollution is to establish the dose-response function. This involves a detailed epidemiological analysis, which is out of the scope of the present study. Hence, the study relied on the evidences provided by other studies. One caution taken is that the results of these studies should be supported by clinical and toxicological evidences to have strong evidence for the relationship (Lvovsky, 1998) and the epidemiological study conducted should be either in the study area or inanother location similar to the study area (geographical and socio-economical). Based on these conditions, the present study borrows the epidemiological evidence for Bengaluru city from major studies like TERI (2015), Cropper *et al* (1997), Srivastava and Kumar (2002).

Since the study was concerned with urban commuters, the secondary data on their health status is not available. Hence the study relies on primary survey using structured questionnaire, by conducting both direct and indirect[13] interviews. The survey is conducted in the Central Business District (CBD) of Bengaluru which is mainly under the BBMP jurisdiction (Bruhat Bengaluru Mahanagara Palike). This area is classified into four zones based on the report of Bangalore Metropolitan Region (BMR) – 2031 published in 2018 namely CBD (Central Business District), adjacent CBD, inner periphery and periphery[14]. 12 major junctions with volume to capacity ratio (V/c) greater than 2 (V/C<0.5 is ideal as per IRC, 1990) are identified[15]. In these junctions, the traffic stream stays for more than three minutes

[12] The lower and upper bounds are taken from Table CI(iii) Case III: Unrestricted intercept and no trend given in Pesaran et al. (2001).

[13] Involved both over the telephone and emailing the questionnaire.

[14] The study has limited its scope to the BBMP jurisdiction of 198 wards.

[15] As per the report of DULT 2011

and they face heavy traffic congestion. Since the objective of the study is to estimate the traffic specific pollution impact on health, it was justified to select the daily commuters in these junctions. A stratified random sampling technique is adopted to cover different sections[16] of the commuter population in the city and the number of sample selected is provided in Appendix 3.

The study mainly considered the working section of the population as they are the regular commuters with fixed origin and destination. The health history of the respondents was obtained through specific questions on the travel-related health issues they were suffering from for at least the previous three or more months. Table 8 provides prevailing traffic-related health issues as reported by respondents.

Table 8: Health Issues Reported by the Respondents

Health Issues	Percentage of respondents reported[17]
Stress and Blood Pressure	39.8
Headache	38.4
Back pain[18]	31.6
Cough	28
Respiratory infection	26.9
Skin allergy	24.4
Irritation in throat	24.4
Asthma	16.9

Source: Primary Data

From 427 interviews with the respondents, it was found that 73.5 per cent of the commuters suffer from certain health issues due to long travels for work[19]. Among them, cases of stress, BP, headache and back pain are very high (30%). Acute diseases like respiratory infections and cough are also common among the commuters.

One major factor influencing the health status of respondents is age. Among various health issues suffered by individuals during their life spans, travel-related health issues are some of the prominent issues which will have confounding impacts. From the field observation, it is evident that traffic-related health issues are more common in the age group of 26-45 years than in the younger

---

[16] The sample is classified into three levels of employment.

First level of employees includes professionals like doctors, chief engineers, professors, general managers, purchase managers, team mangers, sales managers, project managers and chief executives;

Second (middle) level of employees includes assistant managers, assistant engineers, assistant administrative officers, second division clerks, supervisors, HR assistants, Business associates, floor managers, executive engineers, traffic police constables, operational assistants, senior process managers;

Third (entry) level ofemployees includes positions like salespersons, construction workers, carpenters, security guards, street vendors, cleaners, mechanics, petty shop owners, trainees, drivers and service boys. This level also includes informal sector employees.

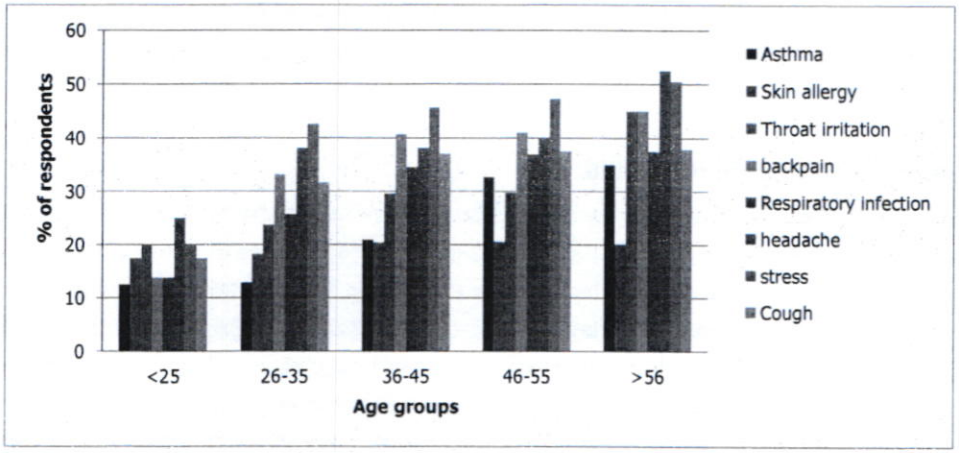
[17] Since these are multiple answers, the percentagewill not add up.

[18] Though it is not a health issues due to traffic-related air pollution, due to long travel time, often commuters reported the issue of back pain.

[19] The data is controlled for smoking habits among respondents.

agegroup (less than 25 years). The traffic-related health issues get aggravated with age. Figure 3 provides details about the age-wise health issues reported by the respondents in the study area.

Figure 3: Age-wise Travel-related Health Issues Reported (%)



Source: Primary Data

Figure 3 clearly indicates the severity of the travel-related health issues growing with age. Among the age group of less than 25 years, the prominent health issues suffered was headache (25%), throat irritation and stress (20%), skin allergy and cough (both 17.5%). Among the age group of 26-35 years, most of the respondents reported that stress (42.6%) is a major health issues due to traffic followed by headache (38.1%), back pain (33.2%) and cough (31.7%). Stress (45.7%), back pain (40.7%) and headache (38.1%) are the traffic-related health issues most commonly reported by the age group of 36-45 years. Among the age group of 46-55 years, more than 35 per cent of the respondents were suffering from most of the traffic-induced illnesses. Among them, headache (52.5%), stress (50.5%), back pain and throat irritation (45%) cough (38%) and asthma (35%) were very common.

Another factor related to traffic-related health issues is the duration of exposure and travel distance. It has been established already that traffic junctions have a high concentration of pollutants and long exposure could lead to high incidence of diseases. Owing to this hypothesis, Table 9 provides details about the exposure duration and distance travelled by respondents with disease type.

Table 9: Average Traffic Exposure and Distance Travelled with Disease Type Classification

Details	Asthma	Stress	Cough	Headache	Respiratory infection	Back pain
Average distance travelled (kms/day)	34.5	30.5	33	14	35	32.25
Average traffic exposure (min/day)	43.5	38.5	40.6	22.4	42.7	32.7

Source: Primary Data

The primary survey reveals that if a commuter travels more than 34kms a day and is exposed to 43.5 minutes/day of traffic emissions, he/she would be likely to suffer from the issue of asthma and 35kms of travel and 42.7 minutes of exposure would lead to respiratory infections. Even the epidemiological literature also supports this argument that cases of asthma and respiratory issues would be high if individuals are exposed to high levels of RSPM. Having established the epidemiological evidence for the study area, the next section will provide the economic valuation of health due to traffic air pollution.

Economic Valuation of Morbidity

Under the direct cost of illness, the present study estimated the cost of medication (as it is an important element of the COI) and under indirect cost, productivity loss and preventive expenditure are accounted for. Studies have provided evidence that exposure to increased level of RSPM (which is a primary pollutant of vehicular emissions) would lead to certain morbidity issues like respiratory infection, asthma and other ailments. Similar results are also found in the present study where the working commuters in the city have a high incidence of respiratory infection, cough and stress related issues.

From the primary survey, it is observed that respondents do not resort to immediate medical attention for all the health issues; rather they prefer certain non-medical solutions (taking rest or home remedies). But it is also observed that such cases are reported mainly among the younger age group, below 35 years. Hence, it can be argued that as emissions exposure increases with age, certain issues get compounded and aggravated, resulting in the sufferers seeking medical attention. For estimation purpose, the study has not considered those respondents who reported that they do not seek medical attention.

1. Direct Cost of Illness: Cost of Medicines

Among the total number of respondents who suffer from traffic-related health issues (73.5%), almost 67.19 per cent reported that they seek some medical aid. The rest (32.8%) although reporting that they suffer from incidences of headache, cough and back pain, said they avoid medical help as the issue subsides in a day or two. An important observation made from the data is that among 32.8 per cent of respondents who did not seek the medical aid, a majority (78%) belong to the age group below 30 years which indicates that with increased travel and by age, the issue may get aggravated over time. Table 10 provides details about the traffic-related health issues for which medical attention was sought.

Table 10: Medical Treatment Sought for Health Issues

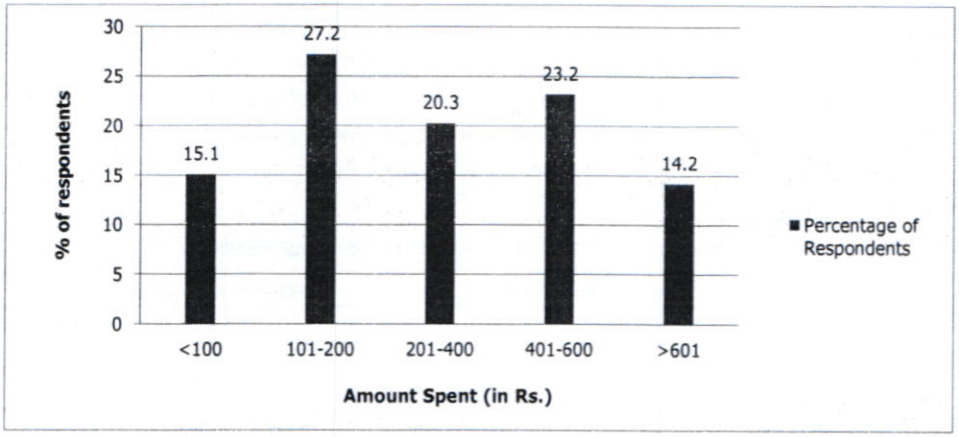
Health issues	Percentage of respondents seeking medical help
Respiratory infection	30.5
Asthma	27.4
Headache	20.7
Back pain	10.2
Skin allergy	5.4

Source: Primary Data

Among the various health issues, stress and blood pressure are the commonly reported and treated health issues (30.3%). Though these health issues can be linked with the age factor and tend to aggravate with the type of occupation and micro environment, long delays due to traffic congestion might compound these issues. Further, asthma and cough are the next major issues which often require medical attention (27.4 and 18% respectively).

With the details of the health status of respondents from the study area, the next section will estimate the direct cost of illness, that is cost of medication. For the estimation, the study considered only those respondents who have bought medicines in a month exclusively for travel-related health issues from out of pocket expenditure (without any health insurance claims). Among the total 67.19 per cent of medical assistance seekers, nearly 27 per cent of the respondents incurred cost ranging from Rs. 101-200, and around 23.2 per cent of them incurred cost ranging from Rs. 401-600.

Figure 4: Percentage of Respondents Incurring Cost towards Medicines



Source: Primary Data

Further, in Table 10, details of the cost of medicines for the type of disease were given. It is evident from the survey that respiratory related issues like asthma and respiratory infection incur a high cost of Rs. 690 and Rs. 354 per month respectively[20].

Table 11: Cost Incurred towards Medicines

Disease	Average cost of medicines (Rs. P.M)
Asthma	690
Respiratory infection	354
Back pain	325
Cough	286
Stress and BP	222
Headache	116

Source: Primary Data

[20] These costs do not include any major medical investigation costs.

On an average, a commuter in the city would spend around Rs. 412 per month as cost of medicine due to travel-related health issues. This would sum up to Rs. 4,944 per year spent as cost of illness, which is the direct or out of pocket expenditure.

2. Indirect Cost of Illness: Productivity Impacts

In the previous section, there was an estimation of out-of-pocket expenditure (cost of medicines), but there are certain implicit costs borne by the commuters if they suffer from the traffic-related health issues for a long time which makes them to take the workday off (sick leave). This measures the cost of foregone earnings due to traffic-related illness which inflicts productivity loss to the workplace (though certain workplaces provide sick leave provisions) and hence has economic cost implications.

In this background, the study estimated the productivity impacts by collecting the data of sick leave days[21] from the work due to traffic-related health issues. The utmost care was taken while gathering the information on sick leave days from the respondents, as there might be other reasons for the sick leave and they might be paid leave[22]. To avoid overestimation, the study collected the data on sick leave due to traffic-induced health problems only. Further, to avoid recall bias, data was collected for the previous three months and cross verified with the employers wherever possible. The details of the percentage of respondents taking sick leave are reported in Table 12.

Table 12: Percentage of Respondents on Sick Leave due to Traffic-related Health Issues

No of days of sick leave in last three months	Percentage of respondents
Below 2 days	83.0
3 days	10.8
4 days	3.0
5 days	1.9
More than 6 days	1.0

Source: Primary Data

From Table 12, it is evident that majority of the respondents reported that they have taken sick leave of less than 2 days in last three months due to traffic-related health issues (apart from casual leave). Since the sick leave will have productivity loss to the workplace (even though there is provision of medical leave) the study has estimated these days loss by attaching theper day income of the respondents in Table 13.

[21] It is apart from casual leave (CL)

[22] Though they are paid leave, there is economic loss to the employer due to worker being absent due to traffic induced health issues.

Table 13: Details on Productivity Loss due to Traffic-related HealthIssues

Health issues suffered	Percentage respondents	Average days of sick leave in a year
Asthma	39.6	12
Respiratory infection	19.8	12
Cough	19.8	08
Headache	2.9	04
Stress and BP	10.8	08
Skin allergy	4.9	08
Total	100	08 days on average

Source: Primary Data

Commuters reported that major issues for which they have taken sick leave are respiratory infection and asthma. The average days of sick leave taken by the respondents for traffic-related health issues are 12 days in a year which could lead to productivity loss of Rs. 15, 520/person per year. The number of days of sick leave taken also depends on the type of issues suffered due to traffic congestion. Evidently, cardiovascular issues would lead to more sick leave than other issues.

2.1. Preventive Measures

Preventive measures are measures to avoid traffic-related air pollution or travel on a congested route. It may be in the form of diversion of route or shifting to less congested mode. In this section, both measures are considered as preventive measures and an effort is made to estimate their cost. The rationale behind this estimate is: Commuters in Bengaluru reported that they prefer travelling in less congested roads even if they have to pay a toll amount for it and some commuters would prefer shifting their transport mode to metro trains from bus or private vehicles. In the first case, toll amount paid by commuters is taken as an additional cost due to traffic congestion and in the second case, difference in the ticket fare amount compared to bus fare[23] is taken as an additional cost of traffic congestion.

Table 14: Preventive Measure: Tolled Road Users

Disease Type	% of commuters using tolled road	Average toll amount per day[24] (in Rs.)
Asthma	31.57	175
Cough	57.8	135
Headache	55.8	130
Back pain	55.8	130
Respiratory issues	47.36	91.25
Stress	47.36	91.25

Source: Primary Data

[23] Assuming the bus fare is comparatively cheaper than other modes of transport in the city.

[24] Though toll amount differs depending on the types of vehicles, the major objective of the estimation is to know the use of toll road by the type of disease.

A very low number of respondents (6%) use the toll road for their daily commute and a majority of the toll road users are four-wheelers (60%) as driving in the toll road is more convenient and faster. Among the road users, those with issues like cough (57.8), headache and back pain (55.8%) and respiratory infection (47.36%) would prefer the toll road. On an average, the toll paid by a commuter is Rs. 125 per day which can be anaverage of Rs. 30, 000 per year/person.

Table 15: Preventive Measure: Metro Train Users

Disease Type	% of metro users[25]	Distance commuted	Amount paid for metro ticket (Rs./month)	Additional cost of traffic congestion (Rs/month)
Asthma	22	8.8	1110	110
Cough	22	8	1107	107
Headache	33	9	1110	110
Back pain	29	12	1125	125
Respiratory infection	40	12	1120	120
Stress/BP	55	132	1130	130

Source: Primary Data

Among the total public transport users in the sample, 18 per cent of commuters are the metro users. These commuters have shifted to metro trains due to inconveniences faced due to traffic congestion while travelling in bus or in their own vehicle. Among the total metro users in the sample, 58 per cent of the respondents have shifted from bus to metro and reported that travelling in the metro is more convenient and faster than bus travel. The rest (42%) of the respondents who shifted to metro are owners of private vehicles who reported that travelling in their own vehicle is stressful due to traffic congestion.

In Table 15, metro train users have been examined in terms of disease. To calculate the preventive cost, the difference between the bus travel cost (average of Rs. 1000/month) and metro travel cost is calculated (as a majority of commuters have shifted from bus to metro). On an average, metro train users will bear an additional cost of Rs. 150/month as a preventive expenditure. Hence, annually, it would cost around Rs. 1800 per person. Further on average, the commuters would have to bear an annual additional cost of Rs. 31,800 which can be considered as preventive expenditure of traffic congestion.

2.2. Mitigative Measures

Under mitigative measures, common measures adopted by the commuters are wearing masks, closed helmets, closing car windows, using ACs in car or opting for work from home. From the primary data, we have collected the possible mitigative measures adopted by the commuters in the city. It is observed that 63 per cent of the respondents[26] who suffer from health issues wear face masks and closed helmets to avoid pollution due to traffic congestion. Among the car users, 80 per cent of respondents

[25] % to total metro users

[26] Two-wheeler users.

close their car window and use AC to avoid the pollution while travelling. Just eight per cent of the respondents prefer work from home to avoid traffic congestion in the city. A major issue faced in measuring the mitigation cost is the monetary valuation of these measures. Hence, the study has not accounted for mitigative measures in the cost estimation.

Total Cost of Illness

The total cost of illness would sum up the direct and indirect cost of illness.

Cost of illness = Direct cost + Indirect cost

The study has estimated the cost of illness by adding up the average cost of medication (Rs. 4,944 per year) and average loss of productivity (Rs. 15,520 per year) and average preventive measure cost of Rs. 31, 800 per year. This can be summed up as Rs. 4,944 of direct cost and Rs. 47,320 of indirect cost and a total of Rs. 52,264 per person/year is lost due to traffic congestion. This is accounted as an average of 1.17 per cent and 11.2 per cent of the annual income of the respondents respectively.

Conclusions

Being one of the dynamic cities of the world, Bengaluru city is inevitably caught in a gridlock of traffic congestion. Usually, commuters in any city complain about the long waiting times in traffic junctions or slow movement of vehicles, but they often ignore the health impacts of long exposure to traffic emissions. This study is novel in its approach to estimate these costs and calls for urgent attention from the policy makers to address the issue of traffic-related air pollution in the city.

Respirable Suspended Particulate Matter (RSPM), being the primary pollutant from vehicular emissions, tends to have various health impacts ranging from irritation in the eyes and throat to major issues like respiratory infections and cardiovascular problems. Having established the concentration response function between the traffic pollutants and health impact, the study estimated the economic cost of morbidity using the Cost of Illness approach, which accounted for approximately 13 per cent of the personal income of commuters being lost due to traffic congestion.

These estimates call for immediate policy measures to improve the city's air quality level. The increased affordability of automobiles (backed by easy finance facility) has imposed a huge health cost. To curb this, there is a need to make public transport affordable and efficient and in the meantime impose certain restrictions on the automobile finance facility.

References

Adams, H S, L C Kenny, M J Nieuwenhuijsen, R N Colvile and R A Gussman (2001). Design And Validation of A High Flow Personal Sampler For $PM_{2.5}$. *Exposure Anal Environment Epidemiology,* 11: 5-11.

Alberni, A and A Krupnick (2002). Cost of Illness and Willingness to Pay Estimates of the Benefits of Improved Air Quality: Evidence from Taiwan. *Land Economics,* 76 (I): 37-53.

Berger M C, G C Blomquist, D Kenkel and G S Tolley (1987). Valuing Changes in Health Risk: A Comparative of Alternative Measure. *Southern Economic Journal,* 53: 967-84.

BMR (Bengaluru Metropolitan Region) (2013). Draft report on Bengaluru Metropolitan Region Revised plan 2031, BMRDA, Groupe SCE India pvt. Ltd.

Chan C C, H Ozkaynak, J D Spengler and L Sheldon (1991). Diver Exposure to Volatile Organic Compounds, CO, Ozone And NO_2 Under Different Driving Conditions. *Environment Science Technology,* 25: 964-72.

COMEAP (Committee on the Medical Effects of Air Pollutants) (2009). Long Term Exposure to Air Pollution: Effect on Mortality. A Report by the COMEAP. Didcot: Health Protection Agency. Retrieved 22 August 2019 from www.comeap.org.uk/images/storeis/documents/reports/mortality%20report$202009.pdf..

———— (2010). The Mortality Effects of Long-Term Exposure to Particulate Air Pollution in the United Kingdom. A Report by COMEAP. Didcot: Health Protection Agency. Retrieved 28 August 2019 from www.hpa.org.uk/webc/hpawebfiel/hpaweb_c/1317137012567.

CPCB (Central Pollution Control Board) (2011). Air Quality Standards in India. Central Pollution Control Board and Ministry of Environment and Forest, Government of India.

Cropper, M L, N B Simon, A Alberini, S Arora and P K Sharma (1997). The Health Benefits of Air Pollution Control In Delhi. *American Journal of Agricultural Economics,* 79 (5): 1625-29.

Dewaram, W, J D Spengler and J Schwartz (1997). Valuing Environmental Cost in India: The Economy Wide Impact of Environmental Degradation. *Environmental Research,* 59: 362-73.

Dockery, D W, C A Pope, X P Xu, J D Spengler, J H Ware, M E Fay, B G Freeris Jr and Speizer (1993). An Association between Air Pollution and Mortality in Six Cities. *New England Journal of Medicine,* 329: 362-73.

DSS Management Consulting Inc (2000). *The Illness Cost of Air Pollution in Ontario.* Report Commissioned By Ontario Medical Association (OMA).

DULT (2011). Directorate of Urban Land Transport, Bangalore Mobility Indicators 2010-11, final report. Urban Mass Transit Company Ltd.

El, Fadel and M Massod (2000). Particulate Matter In Urban Areas: Health Based Economic Assessment. *The Science of the Total Environment,* 257: 133-46.

Engle, R and C W J Granger (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica,* 55: 252-76.

Farber, S and A Rambaldi (1993). Willingness to Pay for Air Quality: The Case of Outdoor Exercise. *Contemporary Policy Analysis,* XI (October): 19-30.

Friedrich, R and P Bickel (eds) (2001). *Environmental External Cost of Transport.* New York: Springer-Verlag Berlin Heidelberg GmbH.

Giri, D, V K Murthy, P R Adhikary and S N Khanal (2007). Estimation of Number of Deaths Associated With Exposure To Excess Ambient PM10 Air Pollution. *International Journal of Environmental Science and Technology,* 4 (2): 183-88.

Health Effect Institute (HEI) (2019). *State of Global Air 2019: A Special Report on Global Exposure to Air Pollution and Its Disease Burden.* Boston: MA. Health Effect Institute.

HEI Panel on The Health Effects Of Traffic-Related Air Pollution (2010). Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure and Health Effects. *HEI Special Report 17.* Boston, MA: Health Effect Institute.

IBM (2011). *Frustration Rising: IBM 2011 Commuter Pain Survey.* IBM. Accessed from http://www.profacility.be/piclib/biblio/pdf_00000552UK.pdf

IRC (Indian Road Congress) (1990). *Guidelines for Capacity of Urban Roads in Plain Areas.* New Delhi: IRC.

Johansen, S and K Juselius (1990). Maximum Likelihood Estimation and Inference on Cointegration – With Application to the Demand for Money. *Oxford Bulletin of Economics and Statistics,* 52: 169-210.

Kan, H and B Chen (2003). Particulate Air Pollution in Urban Areas of Shanghai, China: Health-Based Economic Assessment. *Science of the Total Environment,* 322: 71-79.

Kaur S *et al* (2005). Personal Exposure of Street Canyon Intersection Users to $PM_{2.5}$, Ultrafine Particle Counts and Carbon Monoxide in Central London, UK. *Atmospheric Environment,* 39: 3629-41.

KSPCB (Karnataka State Pollution Control Board). Annual Reports – 2001-02 to 2017-18. Bangalore: KSPCB.

Ligus, M (2018). Measuring the Willingness to Pay for Improved Air Quality: A Contingent Valuation Survey. *Poland Journal of Environmental Studies,* 27 (2): 763-71.

Loehman (1979). Distributional Analysis of Regional Benefits and Cost of Air Quality Control. *Journal of Environmental Economics and Management,* 6: 222-43.

Lvovsky, K (1998). Economic Cost of Air Pollution With Special Reference to India. Paper prepared for the National Conference on Health and Environment, Delhi, India. July 7-9. Accessed from http://siteresources.worldbank.org/PAKISTANEXTN/Resources/UrbanAir/Economic+costs+of+air+pollution+KL.pdf.

McCubbin, R D and M A Delucci (1999). The Health Cost of Motor Vehicle Related Air Pollution. *Journal of Transport Economics and Policy,* 33 (3): 253-86.

Navade, K, A V Kumar, R S Patil and K S V Nambi (2002). Source Apportionment of Suspended Particulate Matter at two Traffic Junctions of Mumbai India. *Atmospheric Environment,* 35: 4245:51.

Neidell, M (2004). Air Pollution, Health and Socio-Economic Status: The Effect of Outdoor Air Quality on Childhood Asthma. *Journal of Health Economics,* 23: 1209-36.

Nkoro, E and K A Uko (2016). Autoregressive Distributed Lag (ARDL) Cointegration Technique: Application and Interpretation. *Journal of Statistical and Econometric Methods,* 5 (4): 63-91.

Organization for Economic Cooperation and Development (OECD) (2014). *The Cost of Air Pollution: Health Impacts of Road Transport.* OECD Publishing. http://dx.doi.org/10.1787/9789264210448-en

Ostro, B (1994). Estimating the Health Effects of Air Pollutants – A Method With an Application to Jakarta. *World Bank Policy Research Working Paper: 1301.* World Bank Publication Division. Geneva.

Paramesh, H (2004). Air Pollution Trends and Prevalence of Asthma in Bangalore City. *Journal of Pediatrics*, 53: 74-78.

Parikh and Parikh (1997). *Accounting and Valuation of Environment (Vol I & II).* Economic and Social Commission for Asia and The Pacific.

Pervin, T, G Gerdtham and C H Lyttkens (2008). Societal Cost of Air Pollution-Related Health Hazards: A Review of Methods and Results. *Cost Effectiveness and Resource Allocation, Biomed Central*, 6 (19). Accessed from www.resoure-allocation.com/content/6/1/19.

Pesaran and Y Shin (1991). An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis. In Strom, S, A Holly and P Diamond (eds), *Centennial Volume of Rangar Frisch.* Cambridge: Cambridge University Press.

Pesaran, H M and B Pesaran (1997). *Microfit 4.0: Interactive Econometric Analysis.* Oxford University Press.

Pesaran, Smith R J and Y Shin (1996) Bounds Testing Approaches To The Analysis of Level Relationships. *Journal of Applied Econometrics*, 16: 289-326.

Pope, III C A, M J Thun, M M Namboodiri, D W Dockery, J S Evans, F B Speizer and C W Heath (1995). Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of US Adults. *American Journal of Respiratory and Critical Care Medicine,* 151: 669-74.

Portney, P R and J Mullahy (1986). Urban Air Quality and Acute Respiratory Illness. *Journal of Urban Economics*, 20: 21-38.

Ravi, D R (2014). Environmental Burden of Disease Due to Urban Air Pollution with Special Reference to Bangalore City. Unpublished thesis work submitted to Mysore University. Accessed from ISEC library.

Rozan, A (2005). How to Measure Health Costs Induced by Air Pollution. *Swiss Journal of Economics and Statistics,* 137: 103-16.

Saksena, A and V Dayal (1997). Total Exposure as a Basis for the Economic Valuation of Air Pollution in India. Paper Presented at the 20th Annual International Conference on Energy and Economic Growth, New Delhi, India.

Schwartz, J and S Zeger (1990). Passive Smoking, Air Pollution and Acute Respiratory Symptoms in a Diary Study of Student Nurses. *American Review of Respiratory Disease,* 141: 62-67.

Shin, E, R Gregory, M Hufschmidt, Y S Lee, J E Nickum and C Umestu (1992). *World Bank Economic Valuation of Urban Environmental Problems Report.* Washington DC.

Srivastava, A and R Kumar (2002). Economic Valuation of Health Impact of Air Pollution in Mumbai. *Environmental Monitoring and Assessment.* 75: 135-43.

The Energy and Resource Institute (TERI) (2015). Air Pollution and Health. Discussion Paper by the Energy and Resource Institute, New Delhi.

Voorhees, A S, S Araki, R Sakai and H Sato (2000). An Ex-Post Cost-Benefit Analysis of the Nitrogen Dioxide Air Pollution Control Program in Tokyo. *Journal of Air Waste Management Association,* 50: 391-410.

World Bank (1997). Valuating the Economic Impacts of Urban Environmental Problems: Asian Cities, Shin, *et al. Working Paper Series 13.* Urban Management and Poverty Reduction. Washington, DC.

———— (2002). *Urban Transport in The Europe and Central Asia Region: World Bank Experience and Strategy.* World Bank Infrastructures and Energy Services Department, Europe and Central Asia Region. Washington, DC. World Bank (Report No. 25188 ECA; http://wbln0018.worldbank.org/eca/transport.nsf/3355693bf49ed34985256c4d004873dd/751dd38b86409bbe85256cb5005a57/ad/$file/ecauts-dec$2002.pdf. Accessed 25 May 2019.

World Health Organization (WHO) (1995). Assessment of Sources of Air, Water and Land Pollution. A Guide to Rapid Source Inventory Techniques and their Use in Formulating Environmental Control Strategies. Part I. Rapid Inventory Techniques in Environmental Pollution. By AP Economopoulos. Geneva (WHO/PEP/GETNET/93.1-A).

———— (2005). *Health Effects of Transport-Related Air Pollution*, Michal Krzyanowski, Birgir Kuna-Dibbert and Jurgen Schneider (eds). Copenhagen, Denmark: WHO Regional Office for Europe.

———— (2014). *Burden of Disease from the Joint Effects of Household and Ambient Air Pollution for 2012.* Geneva: World Health Organization.

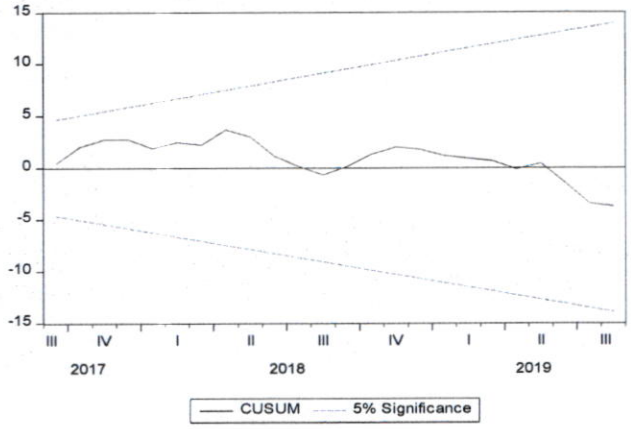
———— (2016). Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease. Geneva, Switzerland: WHO.

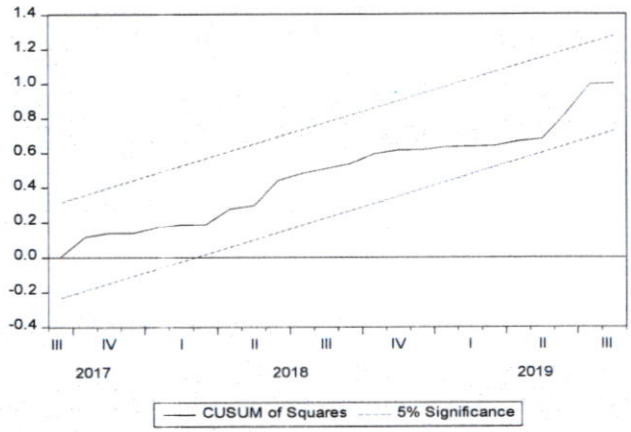
Xu, Xiping, D W Dockery and Y Chen (1994). Air Pollution and Daily Mortality in Residential Areas of Beijing, China. *Archives of Environmental Health*, 49: 216-22.

Zimrou, D, A Deloraine, F Baldducci, C Boudet and J Dechenaux (1999). Health Effect Cost of Particulate Air Pollution. *Journal of Occupational Environmental Medicine*, 41: 847-56.

Appendix 1: CUSUM Test and CUSUM of Squares Test of ARDL Model

The straight line represents critical bounds at 5 per cent significance level





Appendix 2: Diagnostic Test Result of ARDL Model

LM test	BP test	Jarque-bera
0.65	0.66	0.62
(0.26)	(0.4)	(0.23)

Parenthesis is the probability values

Appendix 3: Zones and Junctions in Bengaluru City

Zone No.	***Zone Name***	***Junctions identified***	***Sample collected***
1	CBD	Corporation Circle, Hudson Circle, KR circle	107
2	Adjacent CBD	Trinity Circle, Richmond Circle, Navarang Junction, Oklipuram Signal	106
3	Inner Periphery	Magadi Road, Mehkri Circle, Sony World Junction, Silk Board	108
4	Periphery	BEL Circle, Hebbal Flyover, KR Puram Junction (Tin Factory), Marathhalli Bridge Signal	106
Total			***427***

Source: Author

Recent Working Papers

423 **Role of Worker's Compensation Benefit in Estimating Value of Statistical Life**
Agamoni Majumder and S Madheswaran

424 **Making Every Drop Count – Micro-Level Water Demand Accounting Challenges and Way Forward**
Chaya Ravishankar, Sunil Nautiyal and S Manasi

425 **Conceptualizing Peri-Urban-Rural Landscape Change for Sustainable Management**
Mrinalini Goswami

426 **Social Entrepreneurship: A Business Model for Sustainable Development**
Neeti Singh and Anand Inbanathan

427 **Revenue-Based Business Model to Growth-Based Business Model: A Critical Review of Indian Pharmaceutical Industry**
P Omkar Nadh

428 **Role of Social Entrepreneurship in the Quality of Life of Its Beneficiaries**
Neeti Singh and Anand Inbanathan

429 **Land Alienation in Tripura: A Socio-Historical Analysis**
Rajiv Tewari

430 **The Indian Mining Industry: Present Status, Challenges and the Way Forward**
Meenakshi Parida and S Madheswaran

431 **Impact of Irrigating with Arsenic Contaminated Water on Farmers' Incomes in West Bengal**
Madhavi Marwah Malhotra

432 **Macroeconomic Determinants of Software Services Exports and Impact on External Stabilisation for India: An Empirical Analysis**
Aneesha Chitgupi

433 **Fiscal Dependency of States in India**
Darshini J S and K Gayithri

434 **Determinants of Farm-Level Adoption of System of Rice and Wheat ntensification in Gaya, Bihar**
Shikha Pandey and Parmod Kumar

435 **Monsoon Diseases in Lower Kuttanad (Kerala): An Environmental Perspective**
Bejo Jacob Raju and S Manasi

436 **Risk Sources and Management Strategies of Farmers: Evidence from Mahanadi River Basin of Odisha in India**
Jayanti Mala Nayak and A V Manjunatha

437 **Determinants of Intra Urban Mobility: A Study of Bengaluru**
Shivakumar Nayka and Kala Seetharam Sridhar

438 **Structure and Strategy of Supermarkets of Fruits and Vegetables Retailing in Karnataka: Gains for Whom?**
Kedar Vishnu and Parmod Kumar

439 **Income and Vehicular Growth in India: A Time Series Econometric Analysis**
Vijayalakshmi S and Krishna Raj

440 **A Critical Review of Apprenticeship Policy of India**
K Gayithri, Malini L Tantri and D Rajasekhar

441 **Sustainability Concerns on Sugarcane Production in Maharashtra, India: A Decomposition and Instability Analysis**
Abnave Vikas B

442 **Economic, Occupational and Livelihood Changes of Scheduled Tribes of North East India**
Reimeingam Marchang

443 **Need for a Study of State Policies towards the Development of Religious Minorities in Karnataka**
Azhar Khan C A

444 **An Analysis of Bilateral Trade Between Canada and India**
Malini L Tantri and Preet S Aulakh

445 **Should they Avoid the Middlemen? An Analysis of Fish Processing Firms in India**
Meenakshmi Rajeev and Pranav Nagendran

446 **Growth and Consolidation of Kerala Non-Gazetted Officers' Union: From Its Formative Years to Union Militancy Phase**
Jithin G

447 **The Relationship Between Economic Growth and Carbon Emissions in India**
Kaumudi Misra

448 **Tax Revenue in India: Trends and Issues**
Pratap Singh

449 **Technical Efficienc of Unorganised Food Processing Industry in India: A Stochastic Frontier Analysis**
Padmavathi N

450 **Demonetisation 2016 and Its Impact on Indian Economy and Taxation**
Pratap Singh

451 **Impact of Perform-Achieve-Trade Policy on the Energy Intensity of Cement and Iron and Steel Industries in India**
Kaumudi Misra

452 **Impact of Non-Cognitive Skills on Cognitive Learning Outcomes: A Study of Elementary Education in India**
Indrajit Bairagya and Rohit Mukerji

453 **Assessment of Vulnerability to Floods in Coastal Odisha: A District-Level Analysis**
Niranjan Pradhan and S Madheswaran

454 **Who Benefits from Higher Education Expenditure? Evidence from Recent Household Survery of India**
Ramanjini and Karnam Gayithri

455 **How the Modern Food Retail Chains Emerging as Alternative Channels of Agricultural Marketing? Evidence from Karnataka**
Kedar Vishnu, Parmod Kumar and A V Manjunatha

456 **Educational Development, and Household and Public Expenditures on Education in Manipur**
Reimeingam Marchang

457 **Social Audit of MGNREGA - A Panacea or a Placebo? Issues and Ways Forward in Karnataka**
Sanjiv Kumar and S Madheswaran

458 **State, Religion and Society: Changing Roles of Faith-Based Organisations in Kerala**
Abdul Raoof

459 **Single Child Families in Tripura: Evidence from National Family Health Surveys**
N Pautunthang and T S Syamala

460 **MGNREGA Ombudsman a Forlorn Scarecrow: Issues and Ways Forward in Karnataka**
Sanjiv Kumar and S Madheswaran

461 **Dynamics of Procurement of Modern Food Retail Chains: Evidences from Karnataka**
Kedar Vishnu and Parmod Kumar

462 **Determinants of Micro-Level Decisions of Sugarcane Farmers**
Lavanya B T and A V Manjunatha

463 **Assessing Quality of Higher Education: An Empirical Study of Commerce Graduates, Kerala State**
Indrajit Bairagya and Bino Joy

464 **Farmers' Perception on Risk and Management Strategies in Mahanadi River Basin in Odisha: An Economic Analysis**
Jayanti Mala Nayak and A V Manjunatha

465 **An Analysis of Revenue Diversification Across Select Indian States**
J S Darshini and K Gayithri

466 **Urban Governance in the Context of Urban 'Primacy': A Comparison of Karnataka and Andhra Pradesh**
Anil Kumar Vaddiraju

467 **Urban Financing and Accountability Structures - Case Study of Bruhat Bengaluru Mahanagara Palike**
Shankari Murali and S Manasi

468 **Status of Unorganised Food Processing Industry in Inida - A Study on Key Performance Indicators**
Padmavathi N

469 **Sustainability of India's Current Account Deficit: Role of Remittance Inflows and Software Services Exports**
Aneesha Chitgupi

470 **BCIM Economic Corridor and North East India**
Reimeingam Marchang

471 **The Nation and Its Historical Mediations: Towards Typologies of Regions/States**
Anil Kumar Vaddiraju

472 **Structure and Functions of Social-Ecological Systems: A Case Study from Indian Sundarbans**
Sneha Biswas

473 **Multiple Vulnerabilities in Utilising Maternal and Child Health Services Across Regions of Uttar Pradesh, India**
Prem Shankar Mishra and T S Syamala

474 **Fertility at the Crossroads of Ethnicity and Gender: Understanding Oraon Tribe in Jharkhand, India**
Ujjwala Gupta

475 **Complexities of Collaboration, Negotiation and Contestation: Agragamee and the State**
Ambuja Kumar Tripathy

476 **International Best Practices of pprenticeship System and Policy Options for India**
K Gayithri, Malini L Tantri and D Rajasekhar

477 **Public Healthcare Infrastructure in Tribal India: A Critical Review**
Mohamed Saalim P K

478 **Whether Caste Impedes Access to Formal Agricultural Credit in India? Evidence from NSSO Unit Level Data**
Karthick V and S Madheswaran

479 **Whether Caste Impedes Access to Formal Agricultural Credit in India? Evidence from NSSO Unit Level Data**
Karthick V and S Madheswaran

480 **Decentralization and People's Participation in Educational Governance: A Review of Internatonal Experiences**
Mahima Upadhyay and D Rajasekhar

481 **Initiatives in Solid Waste Management: A Case Study of the City of Bengaluru**
Natasha Kalra and S Manasi

482 **Agrarian Change in Bihar: A Study of Two Villages**
Prashant Kumar Choudhary

483 **Information Asymmetry, Exclusion and Inclusion Errors and Elite Capture of MGNREGA: Critical Examination of IEC Strategies in Karnataka and Ways Forward**
Sanjiv Kumar, S Madheswaran and B P Vani

484 **Political Regimes and Religious Minorities in Karnataka: 2008-2018**
Azhar Khan Chikmagalur Akbar

Price: ₹ 30.00

ISBN 978-81-946531-1-0

INSTITUTE FOR SOCIAL AND ECONOMIC CHANGE
(ISEC is an ICSSR Research Institute, Government of India
and the Grant-in-Aid Institute, Government of Karnataka)
Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: balasubramanian@isec.ac.in; Web: www.isec.ac.in