Report on

Carrying Capacity Study in non-attainment city of Rourkela, Odisha

Under

National Clean Air Program of

Ministry of Environment Forest & Climate Change (MoEF & CC), Government of India

Submitted to

State Pollution Control Board, Odisha

Prepared by

Prof. Kakoli K. Paul and Prof. R.N. Behera

National Institute of Technology Rourkela 769008

(IoR)

November 2022

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LIST OF ABBREVIATIONS

ABBREVIATIONS	NAME
BOD	Biochemical Oxygen Demand
CC	Carrying Capacity
CPCB	Central Pollution Control Board
MLD	Million Litre per Day
MoU	Memorandum of Understanding
NCAP	National Clean Air Program
NIT	National Institute of Technology
IoR	Institute of Repute
RMC	Rourkela Municipal Corporation
RSP	Rourkela Steel Plant
SAIL	Steel Authority of India Limited
SPCB	State Pollution Control Board

1.0 INTRODUCTION

The carrying capacity of an environment is the maximum population size of a biological species that can be sustained by that specific environment, given the food, habitat, water, and other resources available. It refers to environment's maximal load and depends on the amount of natural resources available to residing population and how much of the resource is needed. In other words, carrying capacity refers to the number of individuals who can be supported in a given area within the limits of natural resources without degrading the social, cultural and economic environment for the present and future generation.

1.1 ORIGIN OF THE PROJECT

India is committed to create a clean environment with pollution free air and water. The Air (Prevention and Control of Pollution) Act, 1981, was enacted under Article 253 of the Constitution to implement the decisions taken at the United Nations Conference on Human Environment held at Stockholm in June 1972, in which India participated. India has been going through a phase of accelerated industrial activities for the past three decades. The associated growth in terms of industrialization and urbanization has led to pollution, especially air pollution, at an alarming level. In recent years, medium and small towns and cities have also witnessed an increase in pollution, thus getting fast reflected in the non-attainment cities of India. The impact of air pollution is not limited to health but extends to agriculture and the general well-being of humans, floral and faunal population. Furthermore, since air pollution is not a localized phenomenon, the effect is felt in cities and towns far away from the source, thus creating the need for regional-level initiatives through inter-state and inter-city coordination in addition to multi-sectoral synchronization.

National Institute of Technology Rourkela has been identified as Institute of Repute (IoR) for non-attainment cities of Rourkela, Talcher and Balasore under National Clean Air Program (NCAP). Memorandum of Understanding (MoU) was signed among NIT Rourkela, Regional offi ce of SPCB, Odisha, Rourkela and Rourkela Municipal Corporation (RMC) to work in concert towards reduction of air pollution. Under this program, NIT Rourkela has been assigned to carry out the current study "Carrying Capacity Study in non-attainment city of Rourkela, Odisha".

1.2 SCOPE OF THE WORK

Rourkela city is identified as one of the non-attainment cities of the country based on the air quality monitoring by CPCB. The present study has to be prepared with a view to identify optimum support for anthropogenic survival and allowing sustainable activities within carrying capacity of Rourkela city. The major scopes of the study are:

- Assessment of existing natural resources in terms of land, water, air, solid waste, wastewater.
- Identification and quantification of possible carrying capacity of the available natural resources.

This study incorporates an approach to assess the future expansion and urbanization of Rourkela city. The study area is entire city of Rourkela encompassing the Rourkela Municipal Corporation (RMC), National Institute of Technology Rourkela (NIT), Rourkela Steel Plant (RSP) and Railway.

1.3 STUDY AREA

Rourkela is a city located at 84.54°E longitude and 22.12°N latitude in Sundergarh district of Odisha, at an elevation of about 219 meters above mean sea level. The study area of Rourkela is 375 square kilometres approximately. The city is surrounded by a range of hills and encircled by Koel and Sankha rivers which meet at Vedvyas, Rourkela and flow as a single river called Brahmani. It has steel plant of the Steel Authority of India Limited (SAIL), named Rourkela Steel Plant. It also has one of the National Institutes of Technology (NIT Rourkela) of the country. According to the census report of 2011, the population of Rourkela Industrial Township is 210,412, Rourkela town is 273,217 (http://www.rmc.nic.in/aboutrkl.html) and the urban metropolitan area is 554,646 (https://worldpopulationreview.com/world-cities/raurkela-population). Fig 1 shows the map of Sundergarh district and Fig 2 shows the map of Rourkela.

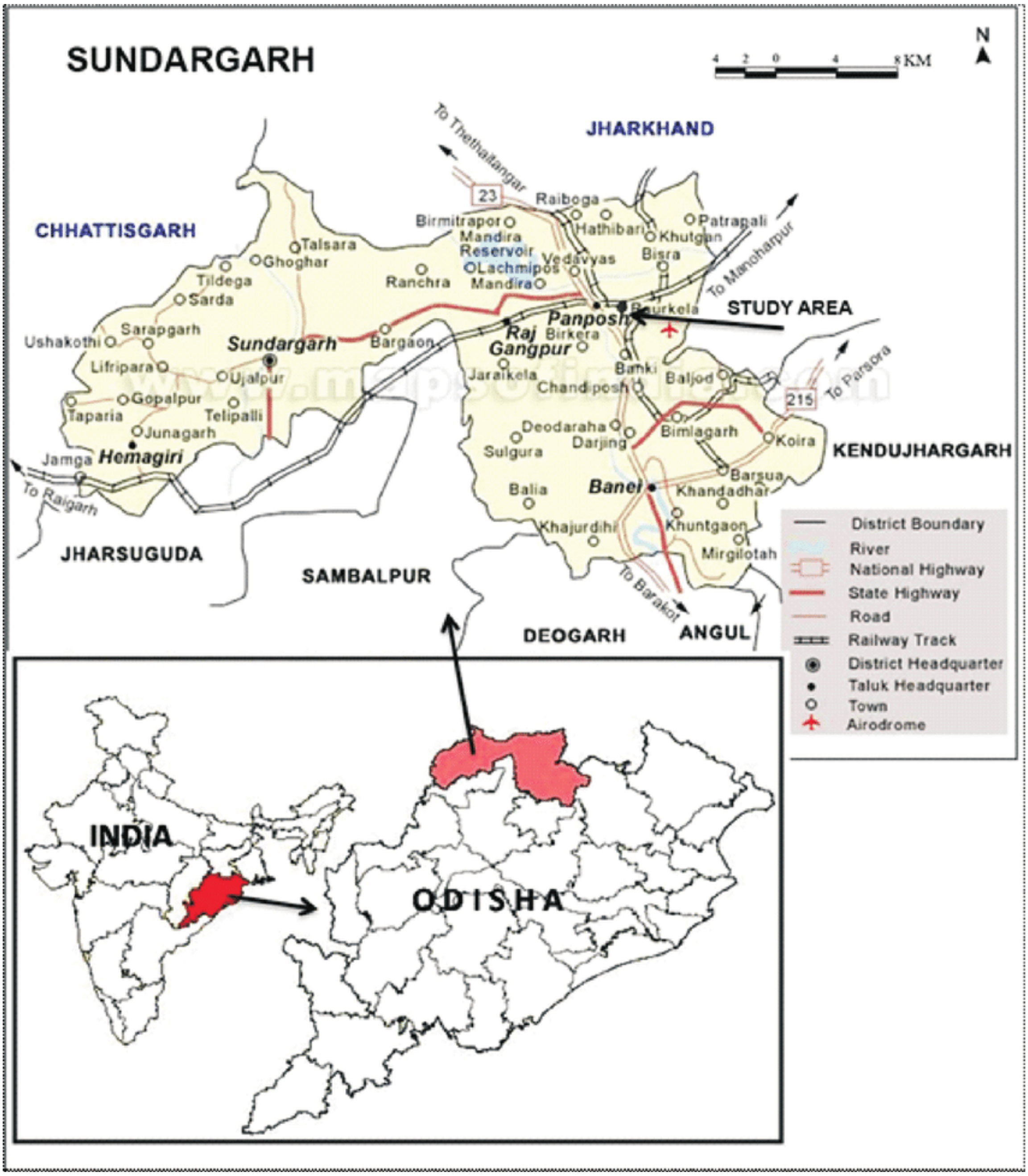

Fig.1 District map of Sundargarh

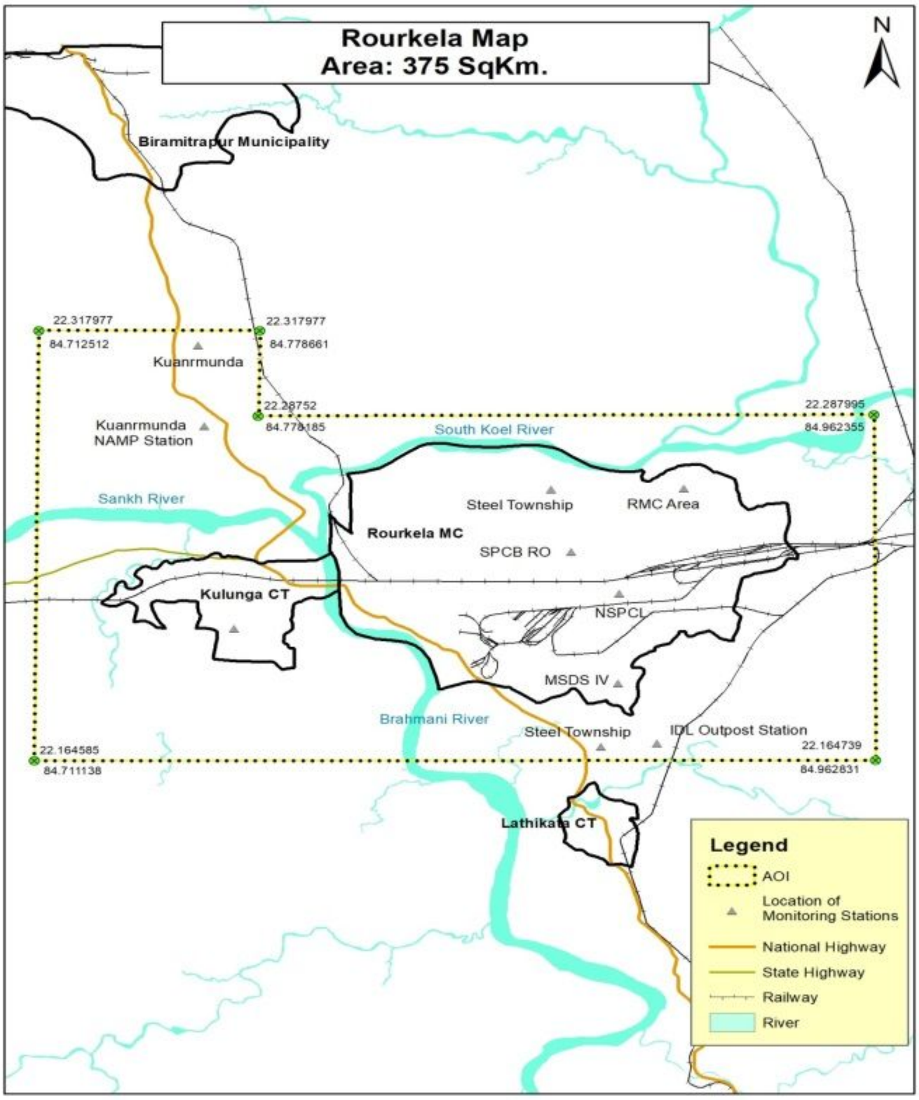

Fig.2 Map of Rourkela non-attainment city (the dotted line represents the boundary of the non-attainment city)

2.0 METHODOLOGY

Central Pollution Control Board Delhi has developed the methodology for assessment of environment carrying capacity. The present study has been done as per the prescribed methodology of CPCB.

2.1CARRYING CAPACITY CALCULATIONS

2.1.1Urban Land Carrying Capacity

The urban land carrying capacity is expressed by eq(1)

$$A \quad A \quad A_{ND} \quad A_{\;F} \quad \frac{FA}{} \tag{1}$$

where,

A_R = area of residential requirement

A_U = total urban area

A_{ND} = non-developable area

A_{IF} = area of infrastructure development

FAR = Floor area ratio

S = floor area requirement per head

2.1.2 Water Resource Carrying Capacity

Amount of available water resource (AWR) is given by eq(2)

$$AWR \quad A \quad WR \quad A \quad WR \quad AWR \tag{2}$$

Surface Water Withdrawal (SWW) is expressed as eq(3)

$$WW \quad W \quad W - \quad W \tag{3}$$

Where, AGWR = Available ground water resource

ASWR = Available surface water resource

OAWR = Other available resource, mainly reuse and collection of rainwater

TWS = Total water supply

GWS = Ground water supply

OSWS = Other sources of water

2.1.3 Water Environmental Carrying Capacity

Surface Water Carrying Capacity (W_R) is given by eq(4)

$$W \quad - \quad _0 \quad \frac{}{} \tag{4}$$

Considering BOD as the dominant water pollutant,

C_S is water quality target concentration at the downstream cross-section of the river in mg/l.

C_0 is actual water quality concentration at the upstream cross-section of the river in mg/l.

K is pollutant degradation coefficientin d^{-1}

u is average flow velocity of river in m/s

L is length of river in m

Q is designated flow of river in m^3/s.

Flow velocity of river is measured in Brahmani river both at upstream and downstream of disposal point as shown in Fig 3.

Fig. 3 Field measurement for flow velocity of river

The average values of flow velocity of river is tabulated and summarized in Annexure IV.

2.1.4 Atmospheric Assimilation Capacity

Atmospheric assimilation capacity is calculated by eq(5)

$$_{cc} \quad - \quad _{0} \quad u \quad W \qquad (5)$$

where,

Q_{CC} represents atmospheric assimilation carrying capacity

C represents concentration of pollutant, µg/m^3

C_0 is background concentration of pollutant, µg/m^3

u is average wind velocity, m/s

W width of city, m

H is mixing height of pollutant, m

2.1.5 Solid waste Carrying Capacity

Solid waste environment carrying capacity is calculated by eq(6)

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton) (6)

where,

SWECC is Solid Waste Environment Carrying Capacity

SWM_{EF} is Solid Waste Managed Environment friendly

RC is Remaining capacity. Capacity left/available for managing more SW

SWG is Solid Waste Generation in tons

2.1.6 Carrying Capacity for Sewage Management

Extent to which wastewater management facilities are available to individual properties across the city, whether through centralized underground sewerage, decentralized systems or onsite systems such as septic tanks. This should be computed for number of properties recorded in municipal records and not households, and should include all residential, commercial, industrial and institutional properties = A × 100 / B (7)

Say,

Total number of properties with connection to wastewater management systems (A)

Total number of properties in a city (B)

a) The actual proportion of wastewater generated in the city is collected by the available sewerage network = C×100/D (8)

Say,

Total wastewater collected per day = C

Total wastewater generated in the city per day = D

b) The proportion of wastewater received at the treatment plant that is recycled or reused for various purposes. Treated wastewater can be used for horticultural purposes in parks and gardens, irrigation of farmlands on city periphery, and/or supplied to power plants and industries = Ex100/F (9)

Say,

Quantum of wastewater recycled or reused per day = E

Total wastewater received at treatment plant per day = F

3.0 ASSESSMENT

3.1 CARRYING CAPACITY CALCULATIONS

3.1.1`Urban Land Carrying Capacity

The A_R is area of residential requirement. It is calculated using eq(1) and expressed as below

$$A \quad A \quad A_{ND} \quad A_{F} \quad \frac{FA}{}$$

Non developable area (A_{ND}) consists of forests, agriculture, waste lands and nallahs. Area for infrastructure development (A_{IF}) consists of area required for commercial, industrial, public, governmental and transportation activities and organized open spaces. The A_{ND} & A_{IF} are calculated using Sentinel-2 10m LULC data. Data processing and area calculation have been done by ArcGIS software.

A_U = total urban area = 375 km^2

A_{ND} = non-developable area = 274.3 km^2

A_{IF} = area of infrastructure development = 96.6 km^2

FAR = Floor area ratio = 1.5. This value is suggested based on general trend observation so far in Indian condition (CPCB Guidelines).

S = floor area requirement per head

Using eq(1), the area of residential requirement can be calculated as mentioned below:

$A \quad A \quad A_{ND} \quad A_{\ F} \quad \frac{FA}{}$

= 6.15/S population (by incorporating the obtained data)

Floor area ratio is basically the ratio between the total covered area of all floors of a building to the plot area. Though a floor area ratio affects volume, shape, and spacing of buildings on the land, it does not determine a particular shape or spacing. Almost invariably floor area is a gross measure and includes uninhabitable spaces like stair wells and closets. A floor area of a building or buildings is the sum of the gross horizontal areas of the several floors of all buildings on the lot, measured from the exterior faces of exterior walls, or from the centre line of walls separating two buildings.

The Floor Area Requirement per head is considered as 5 m^2 (http://www.ihatepsm.com/blog/assessment-overcrowding-household) .

Considering, S = 5 m^2

The FAR calculation formula, eq(10) is as below:

$$AR \quad \frac{il \quad a \quad a}{l \quad a \quad a} \tag{10}$$

$A \quad A \quad A_{ND} \quad A_{\ F} \quad \frac{FA}{}$ 6.15/S = 6.15/(5x10^{-6}) = 1.224 x10^{+6} population

The available area can accommodate 12,24,000 population.

According to the website (https://worldpopulationreview.com/world-cities/raurkela-population), population of Rourkela in last decades are tabulated in Table 1.

Table 1: Population of Rourkela

SN	Year	Population	Increase	Incremental increase
1	1981	324,906	---	---
2	1991	401,476	76,570	---
3	2001	486,987	85,511	8,941
4	2011	554,646	67,659	-17,852

= 76,580 = -4,455.5

By incremental increase method of population forecasting, population for the year 2041 is P_{2041}

$_0 \quad _0 \quad ^{-} \quad 1 \; - = 7{,}58{,}463$

Considering for next 20 years of expansion, estimated population will be 7,58,463.

Thus, A_R of 12,24,000 can safely accommodate population of 7,58,463.

3.1.2 Water Resource Carrying Capacity

According to the guidelines of Central Pollution Control Board,

Amount of available water resource (AWR) is given by eq(4)

$$AWR \quad A \quad WR \quad A \quad WR \quad AWR$$

Surface Water Withdrawal (SWW) is expressed as eq(5)

$$WW \quad W \quad W - \quad W$$

For Rourkela, AGWR = Available ground water resource is not available

Available surface water resource (ASWR) is noted from Central Water Commission, Water Year Book, Vol II, June 2019 – May 2020.

For Water Year : 2019-2020

Site : JARAIKELA; Code : EBJ00D5

State : Orissa; District: Sundergarh

Basin : Brahmani-Baitarani; Independent River : Brahmani; Tributary : Koel

= 1440 cumecs (minimum)

$ASWR_1$ = 1440 cumecs

Site : PANPOSH Code : EB000H6; State : Orissa District Sundergarh

Basin : Brahmani-Baitarani Independent River : Brahmani

= 13.2 cumecs (minimum)

$ASWR_2$ = 13.2 cumecs

Total ASWR = $ASWR_1$ + $ASWR_2$ = 1440 + 13.2 = 1453.2 cumecs

Neglecting available ground water resource (AGWR) and other available water resources (OAWR) in eq(4),

AWR = ASWR = 1453.2 cumecs

TWS = Total water supply

GWS = Ground water supply

OSWS = Other sources of water supply

Neglecting ground water supply (GWS) and other sources of water supply (OSWS) in eq(5),

SWW = TWS = 1453.2 cumecs

Considering surface water withdrawal (SWW) = WA (11)

Assume, per capita water demand of 135 litres daily,

Water demand = $WD \quad 1.8 \quad 135$

Where, P is forecasted population for next 20 years, i.e., for 2041

$$WD \quad 1.8 \quad 135 \quad 758463$$

$WD \quad 184.31 \quad LD \quad 2.13\, cu \quad ($

Thus, $WR \quad \frac{A}{D} \quad \frac{.\ 3}{.\ 3} \quad 682.3 \quad 3$

So, Water Resource Carrying Capacity is safe.

3.1.3 Water Environmental Carrying Capacity

Surface Water Carrying Capacity (W_R) using eq(4)

$W \quad - \quad _0 \quad \overline{\quad}$

Considering BOD as the dominant water pollutant,

C_S is water quality target concentration at the downstream cross-section of the river in mg/l.

C_0 is actual water quality concentration at the upstream cross-section of the river in mg/l.

The average BOD_5 at upstream cross-section of the river is summarized in Annexure I. According to Central Pollution Control Board, India for Designated Best Use Water Quality Criteria in class C for drinking water source after conventional treatment and disinfection, Biochemical Oxygen Demand 5 days (BOD_5) 20 °C is 3 mg/l or less. Hence, water quality target concentration at the downstream cross-section of the river, i.e., C_S can be assume/consider as 3.0 mg/l in eq(4).

$$W \quad 3.0 - 5.83 \quad \frac{0. \quad 00}{0.3} \quad 1453.2$$

W 3g/s (approx.)

The u is average flow velocity of Brahmani river, as calculated in Annexure IV and shown in Fig 2.

Lakes & Ground water are not representative for Rourkela city.

Thus, following the criteria of Central Pollution Control Board, India for Designated Best Use Water Quality Criteria in class C, it is safe for Rourkela.

3.1.4 Atmospheric Assimilation Capacity

By using the eq(5), atmospheric assimilation capacity is expressed as below.

$cc \quad - \quad _0 \quad u \quad W$

According to https://www.worldweatheronline.com/rourkela-weather-averages/orissa/in.aspx,

Average wind speed (u) of Rourkela is 10.5 km/h = 2.92 m/s

During winter & monsoon, mostly wind direction is Northern. During spring & summer, wind direction is South-Western.

Width (W) can be considered as 17 km (approx.) from shape file of Rourkela. Height (H) is mixing height, as 488.90 m. The average mixing height is obtained from ARAI data. Using eq(5), for $PM_{2.5}$,

Average ($C-C_0$) as 15.42 $\mu g/m^3$ as summarized in Annexure II.

$_{CC}$ 15.42 2.92 17000 488.9 374227918.32 $/s$ 374.23 $/s$

In a day, volume of air flows confined mixing layer = Area of Rourkela x Mixing height/Day

$$= \frac{3 \quad 0 \quad .9}{3 \quad 00} \; m^3/s$$

Area of Rourkela is 375 km^2

Mixing height is 488.9 m

$$\frac{3 \quad .3}{.9 \;\; 3 \quad 0 \quad 3 \;\; 00} \quad / \quad 3$$

$$= 176.36 \quad / \quad 3$$

The atmospheric assimilation capacity for $PM_{2.5}$ is quite higher than that measured values for Rourkela as summarized in Annexure II. Hence, it is safe.

Using eq (5), for PM_{10},

Average ($C-C_0$) as 35.26 µg/m^3 as summarized in Annexure III,

$_{CC}$ 36.07 2.92 17000 488.9 875382685.72 $/s$ 875.38 $/s$.

$$\frac{3 \quad .}{.9 \;\; 3 \quad 0 \quad 3 \;\; 00} = 412.53 \quad / \quad 3$$

The atmospheric assimilation capacity for PM_{10} is quite higher than that measured values for Rourkela as summarized in Annexure III. Hence, it is safe.

3.1.5 Solidwaste Carrying Capacity

Using the eq(6), solidwaste carrying capacity is calculated as shown below

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton)

Using eq(6), for National Institute of Technology Rourkela (Annexure V)

SWECC = (SWM_{EF} (ton/d) +RC (ton/d))/SWG (ton/d)

= (2+1)/3 = 1

Since, SWECC =1, it is on break point. It may overshoot very soon.

Using eq(6), for Rourkela Steel Plant

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton)

= (24,64,478 Ton/Yr + 0)/ 25,96,293 Ton/Yr

= 0.949

Since, SWECC <1, it is overshoot

Using eq(6), for Rourkela Steel Township

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton)

= (0 + NA)/ 40 ton/Day

= 0

Since, SWECC <1, it is overshoot

Using eq(6), for Railway Rourkela

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton)

= (750 +0)/(850 + 14.16×311.73 kg/m^3)

= 0.142

According to Palanivel and Sulaiman 2014, municipal solid waste has a density of 311.73 Kg/m^3.

Since, SWECC <1, it is overshoot

Using eq(6), for RMC

SWECC = (SWM_{EF} (ton) +RC (ton))/SWG (ton)

= (102 TPD + 10 TPD)/102 TPD

= 1.09

Since, SWECC >1, carrying capacity exist

3.1.6 Carrying Capacity for Sewage Management

The various calculations steps involve in determining the carrying capacity for sewage management are shown in eq(7), eq(8) and eq(9).

3.1.6.1 For National Institute of Technology Rourkela (Annexure VI)

- Total number of properties with connection to wastewater management systems (A)

Total number of properties in a city (B)

Ax100/B = 700×100/700 = 100%

- Total wastewater collected per day = C

Total wastewater generated in the city per day = D

Cx100/D =0×100/2.5 MLD = 0 %

- Quantum of wastewater recycled or reused per day = E

Total wastewater received at treatment plant per day = F

Ex100/F = 0 ×100/0 = 0%

3.1.6.2 For Rourkela Railway (Annexure VI)

- Total number of properties with connection to wastewater management systems (A) = 415

Total number of properties in a city (B) = 816

Ax100/B = 415 ×100/816

= 50.86 %

- Total wastewater collected per day = C = 240000

Total wastewater generated in the city per day = D = 640900

Cx100/D =240000 Litres x 100/640900 Litres

= 37.45 %

- Quantum of wastewater recycled or reused per day = E = 176000

Total wastewater received at treatment plant per day = F = 240000

E×100/F = 176000 ×100/240000

= 73.33 %

3.1.6.3 For Rourkela Municipal Corporation (Annexure VI)

- Total number of properties with connection to wastewater management systems (A) = 927

Total number of properties in a city (B) = 22000

Ax100/B = 927×100/22000 = 4.21%

- Total wastewater collected per day = C = 3.58 MLD

Total wastewater generated in the city per day = D = 3.85 MLD

Cx100/D = 92.99 %

- Quantum of wastewater recycled or reused per day = E = 0.1 MLD

Total wastewater received at treatment plant per day = F = 3.85 MLD

Ex100/F = 2.59 %

3.1.6.4 For Rourkela Steel Plant (Annexure VI)

- Total number of properties with connection to wastewater management systems (A) = 24000

Total number of properties in a city (B) = 24000

Ax100/B = 24000 ×100/24000

= 100 %

- Total wastewater collected per day = C = 277,560 M^3/Day

Total wastewater generated in the city per day = D = 277,560 M^3/Day

Cx100/D = 277,560 M^3/Day ×100/ 277,560 M^3/Day

= 100 %

- Quantum of wastewater recycled or reused per day = E = 182928 M^3/Day

Total wastewater received at treatment plant per day = F = 277,560 M^3/Day

Ex100/F = 182928 M^3/Dayx00/ 277,560 M^3/Day

= 65.91 %

3.1.6.5 For Rourkela Steel Township (Annexure VI)

- Total number of properties with connection to wastewater management systems (A) = 24000

Total number of properties in a city (B) = 24000

Ax100/B = 24000×100/24000

= 100 %

- Total wastewater collected per day = C = 20 MLD

Total wastewater generated in the city per day = D = 20 MLD

Cx100/D = 20 MLD×100/20MLD

= 100%

- Quantum of wastewater recycled or reused per day = E = Nil

Total wastewater received at treatment plant per day = F = 20 MLD

E×100/F = 0x100/20MLD

= 0 %

4.0 CONCLUSION & RECOMMENDATONS

CONCLUSIONS

The objective of the study is to assess the maximum load carrying capacity of environment in terms of land, air, water, solid waste and waste water. Following are the conclusions from the present study:

- Sustainable and optimal expansion of Rourkela city in terms of carrying capacity has been observed.
- It can be concluded in general that the study area, Rourkela city has sufficient land space to accommodate present and future population habitat for at least upto 2041.
- Water resource is sufficient enough for Rourkela city. It may be due to good discharge of Brahmani river.
- Water environment carrying capacity is also safe, may be due to practice of treated effluent discharge into river.
- The atmospheric assimilation capacity for PM_{10} and $PM_{2.5}$ are enough in terms of these air quality parametres than that measured values of Rourkela.
- Overall solid waste disposal system is overshoot or on breakpoint.
- Study also found that sewage treatment facilities need more attention.

RECOMMENDATIONS

- The study initiated to assess the balance between human and nature in terms of available land area, water quality, air quality, solid waste and wastewater. Following are the recommendations-
- Focus on optimal expansion of Rourkela city maintaining solid waste management and sewage treatment.

- Planning and implementation on collection and reuse of rainwater.
- Public awareness on practice of treated effluent discharge into river.
- Emphasize on controlling vehicular emission and road dust to reduce PM_{10} and $PM_{2.5}$.
- Need much attention in development of solid waste management.
- Sewage treatment facilities are lacking. Design and layout of sewage treatment plants are needed.
- Reuse and recycle awareness must be spread among citizen of Rourkela.

ACKNOWLEDGEMENT

We express sincere thanks and gratitude to Member Secretary, State Pollution Control Board, Odisha; Director, National Institute of Technology Rourkela; Regional Officer, Rourkela and other officers of State Pollution Control Board, Odisha.

We are thankful to National Institute of Technology Rourkela, Rourkela Steel Plant, Railway and Rourkela Municipal Corporation in sharing various data and informations required time to time in present study.

Special thanks to Dr Nihar Ranjan Sahoo, Mrs Subhadarshini Das, Mrs Babita Singh, Dr B B Dash and Mr Bijay Bhoi of State Pollution Control Board, Odisha for their sincere expeditious cooperation.

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1) Central Water Commission, Water Year Book, Vol II, June 2019 – May 2020.
2) http://www.rmc.nic.in/aboutrkl.html
3) https://worldpopulationreview.com/world-cities/raurkela-population

ANNEXURES

ANNEXURE I

Table A1: BOD_5 concentration in upstream point of Brahmani river (Source: Rourkela Steel Plant)

SN.	**Stack connected to**	**June., 2020**	**Aug. 2020**	**Oct., 2020**	**Dec. 2020**	**Jan., 2021**	**Feb. 2021**	**Mar, 2021**
1	pH	7.1	7.6	7.8	7.6	7.5	7.8	7.6
2	Conductivity	160	156	130	132	138	142	136
3	TDS	70	72	60	61	63	65	63
4	TSS	105	202	10	6	5	7	5
5	Free NH3	0.04	0.01	0.002	0.01	0.01	0.01	0.01
6	F & S NH3	0.34	0.26	0.18	0.15	0.14	0.16	0.18
7	CN	NT	NT	NT	NT	NT	NT	NT
8	Phenol	NT	NT	NT	NT	NT	NT	NT
9	O&G	NT	NT	NT	NT	NT	NT	NT
10	Iron	6.5	18	0.42	0.28	0.24	0.28	0.26
11	COD	-	48	16	10	8	10	8
12	BOD	-	15	6	4	3	4	3

Average BOD = 5.83 mg/l

ANNEXURE II

Table A2: $PM_{2.5}$ Conentration ($\mu g/m^3$) of Rourkela (Source: RSP)

AAQMS Location	April.,	May.,	June.,	July.,	Aug.	Sep.,	Oct.,	Nov.,	Dec.,	Jan.,	Feb.	March,
	2020	2020	2020	2020	2020	2020	2020	2020	2020	2021	2021	2021
I G club (North)	4.21	5.04	16.89	39.38	17.46	25.79	26.05	35.3	19.93	48.42	35.06	35.37
Sec -22 (South)	10.55	11.37	12.86	22.09	10.92	8.89	8.48	13.58	16.88	9.62	11.97	11.99
Pipe Plants (West)	12.48	12.38	14.08	12.51	13.98	18.12	17	17.79	21.2	22.91	32.28	23.6
SSSY (East)	14.58	11.58	15.78	26.19	13.78	7.46	7.38	14.52	9.92	10.3	15.12	11.5
N-S			4.03	17.29	6.54	16.9	17.57	21.72	3.05	38.8	23.09	23.38
S-N	6.34	6.33										
Avg ($C-C_0$)	**15.42**											

ANNEXURE III

Table A3: PM_{10} Conentration ($\mu g/m^3$) of Rourkela (Source:RSP)

AAQMS Location	**April 2020**	**May 2020**	**June 2020**	**July 2020**	**Aug 2020**	**Sep 2020**	**Oct 2020**	**Nov 2020**	**Dec 2020**	**Jan 2021**	**Feb 2021**	**March 2021**	**Avg**
I G club (North)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**36.07**
Sec -22 (South)	45.24	27.77	16.33	39.8	29.84	26.54	24.27	21.48	43.84	34.86	62.32	60.49	
Pipe Plants (West)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
SSSY (East)	36.74	14.89	29.66	17.62	26.4	26.5	42.08	41.31	39.53	33.21	57.7	47.84	

ANNEXURE IV

Table A4:Measured flow velocity of Brahmani river

Upstream flow velocity (u/s)				**Downstream flow velocity (d/s)**		
Distance (m)	**Time (s)**	**Velocity (u)**		**Distance (m)**	**Time (s)**	**Velocity (u)**
3	6.4	0.46875		3	6.48	0.462963
3	8.14	0.368550369		3	5.31	0.564972
3	5.79	0.518134715		3	6.31	0.475436
Average u/s flow velocity (m/s)		0.45		3	6.09	0.492611
				Average (m/s) = v1		0.50
				3	25.54	0.117463
				3	21.86	0.137237
				3	27.13	0.110579
				3	17.34	0.17301
				Average (m/s) = v2		0.13
Average d/s flow velocity(m/s) = (v1+v2)/2			0.32			
Average flow velocity (m/s)= (u/s +d/s)/2 = 0.38						

ANNEXURE V

Table A5: Solidwaste data of Rourkela

SN	Location	Solid Waste Managed Environment friendly	Remaining capacity. Capacity left/available for managing more SW	Solid Waste Generation	Source of data
1	National Institute of Technology Rourkela	2 ton/d	1 ton/d	3 ton/d	NIT Rourkela
2	Rourkela Steel Plant	24,64,478 ton/y	nil	25,96,293 ton/y	RSP
3	Rourkela Steel Township	Nil	NA	40 ton/d	RSP
4	Railway Rourkela	750 kg (only wet waste)	nil	5264	Railway Rourkela
5	Rourkela Municipal Corporation	102	10	102	RMC (RO, OSPCB)

ANNEXURE VI

Table A6: Sewage data of Rourkela

SN		NIT Rourkela	Rourkela Steel Plant	Rourkela Steel Township	Rourkela Municipal Corporation	Railway Rourkela
1	Total number of properties with connection to wastewater management systems	700	24000	24000	927	415
2	Total number of properties in a city	700	24000	24000	22000*	816
3	Total wastewater collected per day	0	277,560 m^3/Day	20MLD	3.58MLD	240000 litres/day
4	Total wastewater generated in the city per day	2.4 MLD	277,560 m^3/Day	20MLD	3.85 MLD	640900 litres/day
5	Quantum of wastewater recycled or reused per day	0	182928 m^3/Day	Nil	0.1 MLD	176000 litres/day
6	Total wastewater received at treatment plant per day	0	277,560 m^3/Day	20 MLD	3.85 MLD	240000 litres/day
7	Source of data:	NIT Rourkela	RSP	RSP	RO, OSPCB	Railway Rourkela

* Total number of properties in connection to RMC STP