A Methodology for the Regeneration of Indian Steel Cities: Case Study Durgapur, West Bengal

Synopsis submitted by

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SYNOPSIS

Durgapur, developed as a government-funded steel city between 1951 and 1961 to make India self-sufficient in steel production, was supported by an integrated township for workers. Over time, tertiary sectors emerged, earning it the title "Ruhr of India." However, following the 1995 WTO reforms, industries faced global competition, leading to workforce reductions, declining profits, and closures of units unable to modernize. Consequently, the civil infrastructure of these steel cities became surplus and deteriorated due to poor maintenance over the past decades (Figure 1).

Aim: In this context the **aim** of the present research is 'regeneration' of the government-backed Indian steel cities and the-then 'Ruhr of India', Durgapur, in the West Bardhhaman district of West Bengal, India, has been chosen as a Case Study.

Dilapidation in Durgapur Steel Township

Abandoned school

Rarely used market

Abandoned housing

Abandoned health care centre

Abandoned Industrial Training Institute

Abandoned housing

Figure 1: Examples of degradation in Durgapur

Though the production and profit has improved over time, employment has always followed a downward trend that only steepened after 1991.

The steel township, managed by the steel plant authority, lies outside the jurisdiction of governing body, leading to the neglect and decay of SAIL-owned facilities. This study focuses on reviving the deteriorating township.

Objective: To meet this aim, literature studies have been conducted to identify different strategies and techniques practiced globally to revitalize, especially, the industrial cities. The **objective** of the present research that culminated from this review is that, to improve the economic mainstay and ebbing employment in Durgapur,

(a) it is necessary to formulate a generic methodology for ranking the prospective complementary industries according to their financial competence in the present competitive environment,
(b) affix their proportions,
(c) suggest their most conducive locations, and
(d) plan their support infrastructures utilizing the excess facilities efficiently, thus curbing investment and generating revenue out of the existing facilities.

It could thus benefit Durgapur and the other Indian steel cities as a whole. To the best of the author's knowledge, no published literature have been found which has explicitly dealt with the regeneration of Indian steel cities, or suggested any numerical tool to trace appropriate supplementary industries for any industrial town or suggest appropriate locations.

Review has further shown that among the Indian steel industries, Tata steel at Jamshedpur has fared best.

Proposed methodology: The competitive positions of the probable industries are figured out through a coupled analysis using the 'Porter's five forces framework (Porter, 1979), an analytical tool, and the 'Analytical Hierarchy Process (Saaty, 1987), a numerical tool for multi-criteria decision making, to figure best-suited industries in the present environment. The horizon year for the present study is confined to 2031, since a quick makeover can save the deteriorating facilities, while the outcome could be reassessed using Census report expected in 2031. To locate the proposed industries and allied city infrastructure in suitable places, the growth direction of the city is determined using QGIS 2.18.2 with MOLUSCE plugin (Hakim Y, Baja, Rampisela, & Arif, 2019) for the horizon year after suitable validation of the adopted process. The city's growth equations have been formed using multivariate polynomial regression through TAYLOFIT RSA freeware (Vaccari D. A., 2018), which has been used to figure out the required support for industrial transition. Finally, development proposal is made

by generating employment through industry transition, and providing supporting infrastructure. These are dealt with in Chapter 1 of the thesis.

Chapter 2 examines the study area's evolution from inception to the present, analyzing land cover change, the condition of SAIL and MAMC quarters, and industrial classification into eight clusters.

Chapter 3 identifies suitable supplementary industries for Durgapur by evaluating their business competence within local market conditions. Among various analytical tools—SWOT, PESTLE, BCG Matrix, VRIO, and others—Porter's Five Forces Framework is adopted to assess external market competitiveness for new entrants. The five forces and their sub-forces are rated and weighted using the Analytical Hierarchy Process (AHP), based on expert evaluations. The final aggregated scores determine each industry's comparative competitive value (Table 2).

Table 2: Comparative business competence for each industry sector

Industry sector	**Business Competence**
Steel	1.821
Allied to Steel Industries (ASI)	2.332
Non-metal	2.344
IT	3.244
SSE	2.164
MSE	1.835
Educational	2.143
Healthcare	1.933

Studies show that 'IT' sector is the most able industry, followed by 'Non-metal' and other sectors. The level of competence refers to the amount of competition a business faces in its industry. This includes both the challenges and opportunities that arise from competition, as well as potential customer bases in different locations.

Chapter 4 focuses on identifying additional facilities in areas of dynamic land use change within the industrial city. Using QGIS with the MOLUSCE plugin, LULC maps for 2000, 2010, and 2020 were analyzed from Resourcesat imagery, classifying land into water bodies, built-up areas, vegetation, and vacant land. Changes between decades were compared, and validated data from ArcGIS and QGIS were used to simulate the 2031 LULC map, helping project the city's future growth patterns.

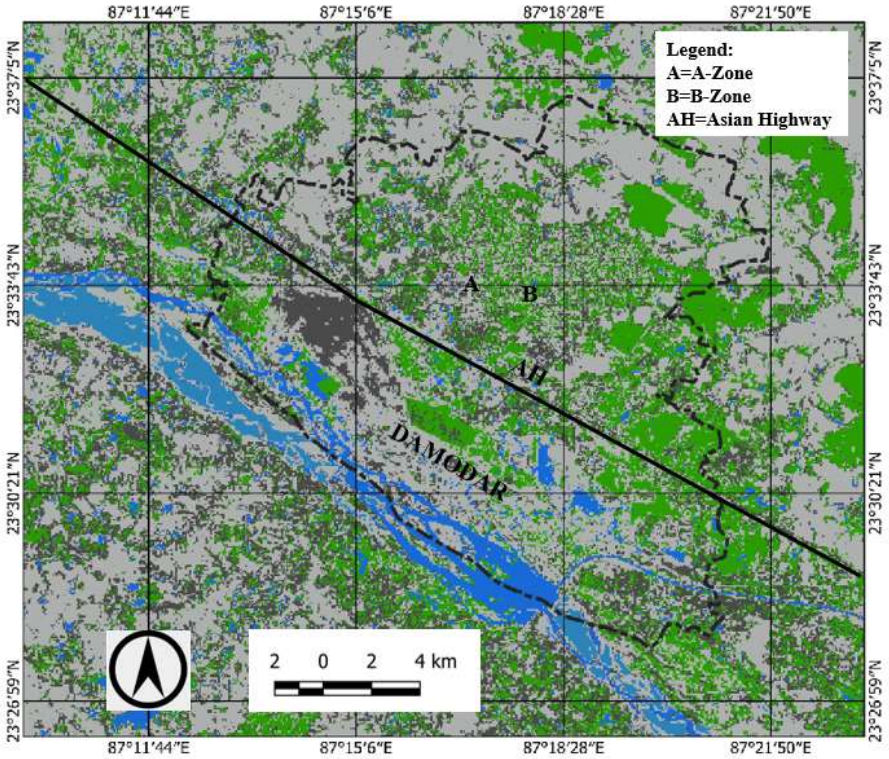


Figure 2: LULC of Durgapur in 2000 (Study area is marked in chain dot line)

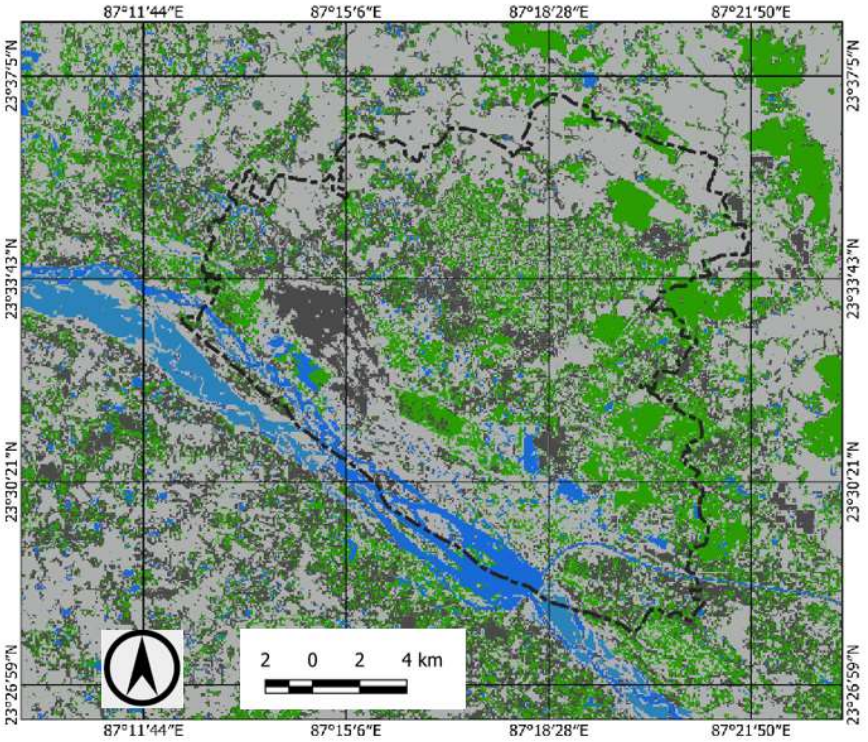


Figure 3: LULC of Durgapur in 2010 (Study area is marked in chain dot line)

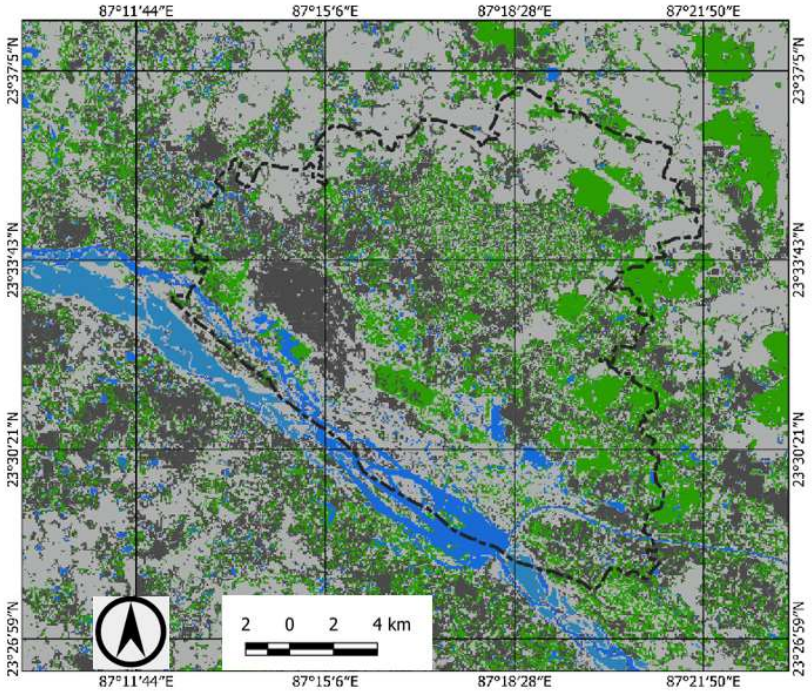


Figure 4: LULC of Durgapur in 2020 (Study area is marked in chain dot line)

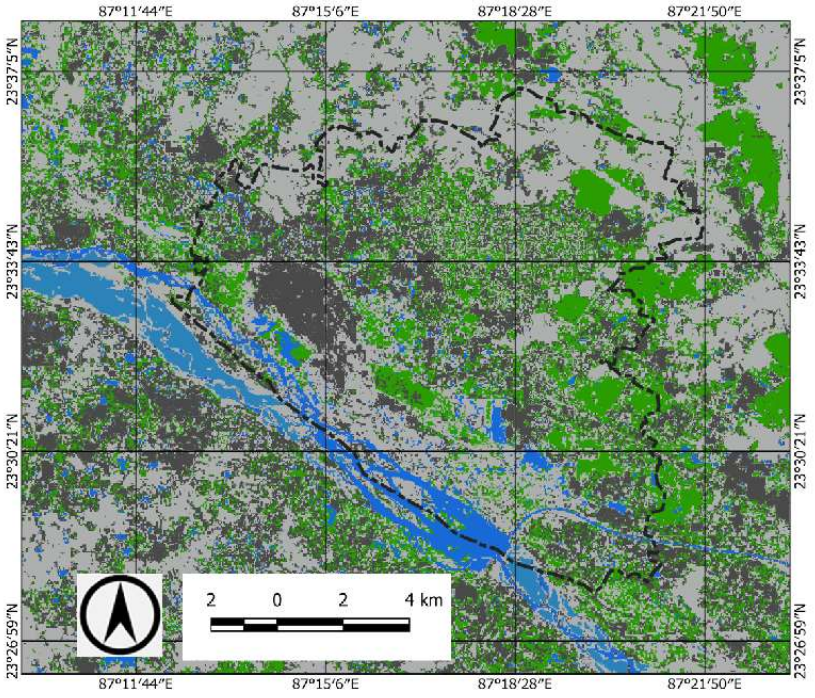


Figure 5: Predicted LULC of Durgapur in 2031

The land simulation shows that though the extent of water body has remained more-or-less intact, a major transformation is noted with vacant land transforming to built-up space. It is also observed that the city is growing along the Asian Highway-1 running east-west, primarily in the north-west and south-east regions of the study area. The newly developed Bidhhannagar is one such example.

Chapter 5 identifies key variables for predicting city growth through literature review and contextual refinement for Durgapur. The selected variables include population, density, distance from CBD, infrastructure, ground coverage, greenery, employment, and market potential, with total population as the dependent variable representing city growth. A regression model is proposed to predict future population trends.

To obtain the relation among the variables, the value for each variable is listed year wise. The set of data is small since the population has been collected from the census data. Thus, an attempt has been made in the following to predict population (Pop), in light of existing Ground Coverage ($Gr\ Cov$), Market Potential ($Mkt\ Pot$), Employment (Emp), Green Space (Gr), and Infrastructure (Inf).

Through TAYLORFIT RSA (Response Surface Analysis), an open source academically accepted software, multivariate polynomial regression is run and various models are tried. Among them, some best suited models are as below.

$$Population = Pop, Ground\ coverage = Gr\ Cov, \qquad Market\ potential = mkt\ Pot,$$
$$Employment = Emp, Green = Gr, Infrastructure = Inf$$

Model 1

$$Pop = -0.7975 + 0.0675(Gr\ Cov)^2(\mathrm{M}kt\ Pot)^{-1} + 0.5212(Gr\ Cov)^2(Emp)^{-1} - 0.0134(Gr\ Cov)^2 \quad (5.1)$$

Model 2

$$Pop = 0.7809(Inf)^2(Gr)^{-1} + 2.1235(Gr\ Cov)(Emp)^{-1} - 18.726(\mathrm{I}nf)^{-1}(Mkt\ Pot)^{-1} \quad (5.2)$$

Table 9: Combined percentage of error of models

Year	Eqn-1: % error	Eqn-2: % error	Eqn-3: % error	Eqn-4: % error	Eqn-5: % error	Eqn-6: % error	Remarks
1961	-15.53	-37.76	-42.46	-1869.4	-19.989	-3.71429	Eq. (1)
1971	-5.84	-4.46	-6.32	42.27	-13.852	0.902913	is most

1981	-5.69	4.64	2.92	106.22	-55.106	-68.7588	accurate followed by Eq. (2)
1991	-0.72	-2.38	3.14	68.01	-50.771	-69.6188	
2001	5.33	-8.56	-5.13	15.88	-49.22	-70.7383	
2011	-0.89	8.68	2.79	-48.63	-36.174	-74.5115	
Root mean square of errors	18.36	40.27	43.53	1874.82	40.69	57.93	

Root mean square values of errors over the decadal predicted population from Equation (1), (2), (3), (4), (5), and (6) are 18.36, 40.27, 43.53, 1874, 40 and 57 respectively which suggests that Equation (1) is most efficient followed by other models. The error in the second-best equation is 40.27, more than double that of the first model.

In the development proposals suggested in chapter 6, a series of industry is proposed considering their competitive competence, the growth pattern of Durgapur, and planner's discretion. The proposal considers Jamshedpur as a benchmark, which is proved to be performing better among the existing Indian steel cities. ASI, IT sector and Non-metal sector have been emphasized. The increment of population due to the revised industry proposal is calculated to proceed for infrastructure demand. Projected population for 2031 is considered as 850000 and 338865 as total employment.

Table 10: Industry wise proposed employment distribution in the study area

	Year 2020		**Year 2031**		**Difference between 2031 and 2020**	
Industry	**Total jobs**		**Proposed job distribution**		**Percent change**	**Additional employment due to the first proposal**
	Absolute	**Percent**	**In percent***	**Absolute**		
	$\boldsymbol{A}$	$\boldsymbol{B}$	$\boldsymbol{C}$	$\boldsymbol{D = T \times C}$	$\boldsymbol{E = C - B}$	$\boldsymbol{F = D - A}$
1. Steel	12931	4.7	7 (8)**	23721	2.3	10790
2. ASI	24879	9.1	12 (13)**	40664	2.9	15785
3. Non-metal	6480	2.4	5 (10)**	16943	2.6	10463
4. SSE	91350	33.4	25 (21)**	84716	-8.4	-6634
5. Healthcare	13200	4.6	4 (6.14)**	13555	-0.6	355
6. Educational	12500	4.8	4.6 (8.5)**	15588	-0.2	3088
7. IT	5350	2.0	4.5 (2.8)**	15249	2.5	9899

8. Shopping mall	4154	1.5	2 (3.78)**	6777	0.5	2623
9. MSE	71260	26.1	24 (17)**	81328	-2.1	10068
Balance	31266	11.4	12 (10)**	40664	0.6	9398
Total	**273365**	**100**	**100**	**338865**		**65550**

* Author's proposal.
** The terms within parentheses are the percentages noted in Jamshedpur in 2021 (ref. Table 1.2)

Along with this development proposal, an urban intervention scheme is also proposed, specifically for the degraded zones and buildings. It is proposed that the vacant or dilapidated quarters and building will be put to a use based on the context. The renewed use is expected to generate employment and revenue. An example is shown below.

Location of the sample: B-Zone, Durgapur

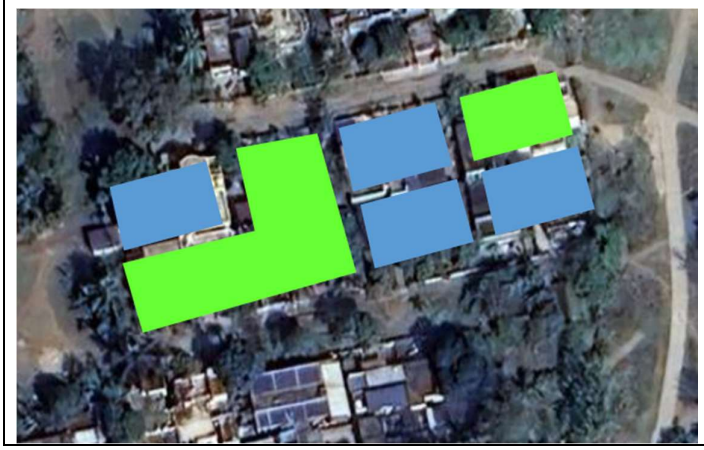
Co-ordinate: 23.567326 N, 87.326563 E

Scale- Not to scale

Existing condition

Option-1

Legend	
	Occupied quarter
	Dilapidated vacant quarter
	Reused quarter



Option-2

Figure 6: Development option in industrial civic facility of Durgapur

To effectively implement, the development schemes, it is proposed that the development scheme will be implemented as per the PMBOK guidelines.

In the concluding chapter, Chapter 7, strategies and recommendations are being drawn after commenting on the salient observations in the earlier chapters and a mention of contribution of this research. Finally, scope for future research in similar lines has been proposed. The strategies and recommendations are listed below for ease of understanding:

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