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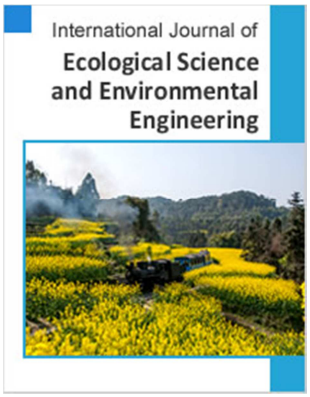

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Assessment of Environment Pollution Potential Index for Re-Categorization of Industries in Context of Developing Nations

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Abstract

Industries are one of the key factors in the economy for any country. At the same time increasing in industry increasing pollution in the air, water, and soil. Pollutant emission in the air, water, and soil is not only an environmental challenge but it also affectspublic health as well. Categorization of industries is based on pollution potential index, which is calculated by pollutant emission in the air, water, and soil. There are three categories in this categorization: Green, Orange, and Red. There is a percentage span in each categorization, so highly polluted and moderate polluted might fall in the same category. There is a need to develop such algorithm, which can differentiate highly polluted and moderate polluted industry. The suggested method given in this paper is categorizing industries in gradient color manner instead of percentage span. In suggested method categorization of highly polluted and moderate polluting industry, based on industry's pollution potential index, will be different. So in order to harmonize the 'Criteria of Categorization', here an attempt has been made to Re-categorize the existing categorization based on the Integrated Environmental Pollution Potential Index (EPI) of different industries. The aim of the study is to prioritize industries in the order of planning needs for interventions. EPI, therefore, forms the basis for a comprehensive remedial action plan for the identified severely polluted/critically polluted industries.

1. Introduction

Industries are playing important role in the economic growth of any country [1]. The growth of industries increases employment and investment also. But if we look another side of this growth then we will find out how much it affects the environment. Pollutants emitted from the industries are unbalancing characteristics of air, water, and soil. Emission of pollutants depends on size, manpower, and consumption of resources and production industry [2]. So categorization of industries depends on their emission of pollutants. Categorization of industries is done by calculating industry's pollution potential index [3]. This pollution potential

index must be integrated, means it is collective PPI of air pollutant emission and/or water pollutant discharges and/or soil pollution emission [4].

Present categorization method is based on the score calculated by the emission of pollutants in the air, water, and Hazardous waste store. Moreover, based on this score industry will be categorized in Red, Orange, Green, and White, from highly polluted to less polluted respectively.

Pollution control boards usecolor categorization (Red, Orange, Green, and White) to carryout inspection for management and vigilance purposes. This color categorization doesn't an emphasis on controlling the pollution but the emphasis on prioritizes the industries based on their Pollution Index [5], [6].

2. Genesis of Categorization of Industries

State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) use the criteria of Red, Orange, Green, and White categories for consent management and vigilance purposes for carrying out inspections to verify compliance to the stipulated standards [7]. However, the above does not an emphasis on a sector-specific plan for control of pollution for dealing them in accordance with priority based on pollution index, [8].

The industries will be categorized on basis of their composite score (0-100) of pollution index which is summation of Air, Wastewater and Toxic Solid Waste pollution score and maximum score for each of these is described below:

a) Maximum score for Air Pollution is 40, which is calculated on basis of following parameters:
b) Parameters: Nitrogen Oxides, Sulphur Oxides, Particulate Matters, Carbon Mono-Oxide, HMs, Ammonia, Benzene and other toxic parameters [9].
c) Maximum score for Water Pollution is 40, which is calculated on basis of following parameters:
d) Parameters: Biochemical Oxygen Demand, Total Suspended Solids, pH, Phenol and other toxic pollutants [10].
e) Maximum score for Toxic Solid Wastes (TSW) is 20 and score is assigned on basis of TSW produced by the industries which may be incinerable, recyclable or landfillable.

After computation of composite score of pollution index for individual industry, categorization of industries is done as described below:

a. An industry is categorized as Red if Pollution Index is 60 and above.
b. An industry is categorized as Orange if Pollution Index is from 41 to 59.
c. An industry is categorized as Green if Pollution Index is from 21 to 40.
d. An industry is categorized as White if Pollution Index is less than 20.

Scoring Methodology:

The details on the scoring methodologyin respect of the aforesaid 3 components are presented following

Methodology for calculating Water Pollution Index:

Overall Water Pollution Index is, W = W1+W2

Where, for W1 scoring is done on basis of the presence of water pollutants in wastewater generated from industries and maximum Score for W1 is 30, and for W2 score is assigned for industries having massive discharges, and maximum score for W2 is 10.

For W1, maximumscore is assigned from the below listed seven categories which is mentioned as W11 to W17:

If any industry possesses any of the following listed wastewater characteristics, its belongingness is considered in W11 category and maximum score assigned for same category is 30.

a. Waste-waters which arenot easily biodegradable, having BOD>5000mg/l; or
b. Waste-waters which aretoxic in nature; or
c. Waste-waters which areboth toxic in nature as well as not easily biodegradable.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W12 category and maximum score assigned for same category is 25.

Waste-waters which are non-toxic having BOD range 1000-5000 mg/l and may have biodegradable pollutants present in wastewater.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W13 category and maximum score assigned for same category is 20.

Waste-waters which are non-toxic having BOD < 1000 mg/l and also have easily biodegradable pollutants present in wastewater.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W14 category and maximum score assigned for same category is 15.

Waste-waters obtained from chemical processes and are polluted because of high TDS (total dissolved solids) which are inorganic in nature.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W15 category and maximum score assigned for same category is 12.

Waste-waters obtained from unit operations or processing of units and are polluted because of high TDS (total dissolved solids) which are inorganic in nature and have a natural origin like brine solution rejects, fresh-water RO rejects, etc.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W16 category and maximum score assigned for same category is 12.

Waste-waters which are non-toxic in nature and have < 10KLD of wastewater generation; and

Waste-waters which are easily biodegradable, having BOD>200mg/l, which can be easily treated in a single stage ASP (activated sludge process) based Effluent Treatment Plant.

Note: This category is only applicable to those units having wastewater generation less than 10 KLD.

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W17 category and maximum score assigned for same category is 10.

Waste-waters obtained from cooling-re-circulation processes in towers.

For W2 score is assigned on basis of discharges which is mentioned below:

If any industry possesses following listed wastewater characteristics, its belongingness is considered in W2 category and maximum score assigned for same category is 10.

Wastewater generation of 100KLD or > 100KLD from the industry.

Air Pollution Index

Overall Air Pollution Index A = A1 + A2

Where, for A1 scoring is done on basis of the presence of air pollutants in emissions from industries and maximum score for A1 is 30, and for A2 scoring is done on basis of technologies used for controlling air pollution and amount of fuel consumption.

For A1, maximum score is assigned from the below listed categories which is mentioned as A11 to A17:

If any industry possesses following listed air emissions, its belongingness is considered in A11 category and maximum score assigned for same category is 30.

Emission having criteria air pollutants which limits up-to 2 mg/Nm^3

If any industry possesses following listed air emissions, its belongingness is considered in A12 category and maximum score assigned for same category is 25.

Emission having criteria air pollutants which limit from 3 to10 mg/Nm^3

If any industry possesses following listed air emissions, its belongingness is considered in A13 category and maximum score assigned for same category is 20.

Emission having criteria air pollutants which limit from 11 to 50 mg/Nm^3

If any industry possesses following listed air emissions, its belongingness is considered in A14 category and maximum score assigned for same category is 15.

Emission having criteria air pollutants which limit from 51 to 250 mg/Nm^3

If any industry possesses following listed air emissions, its belongingness is considered in A15 category and maximum score assigned for same category is 10.

Emission having criteria air pollutants which limit from 251mg/Nm^3& above

If any industry possesses following listed air emissions, its belongingness is considered in A16 category and maximum score assigned for same category is 10.

Particulate Matters emitted but not because of combustion or burning of any kind of fossil fuel.

Particulate Matters emitted during processing/handling of materials

Emitted Particulate Matters can be easilycontrolled with simple conventional methods

If any industry possesses following listed air emissions, its belongingness is considered in A17 category and maximum score assigned for same category is 10.

Odours generated because of applied adhesives/ cement/enamels/binding gums;

Odours which can be easilycontrolled with simple conventional methods.

For A2, maximum score is assigned on basis of technologies used for controlling air pollution and amount of fuel consumption, from below listed two categories, which is mentioned as A21 and A22.

If any industry possesses following listed fuel consumption, its belongingness is considered in A21 category and maximum score assigned for same category is 10.

Industries where fuel or coal consumption is > 24MT/day

If any industry possesses following listed fuel consumption, its belongingness is considered in A22 category and maximum score assigned for same category is 05.

Industries where fuel or coal consumption ranges from 12MT/day to 24MT/day

Scoring of Toxic Solid Waste is done on basis of Toxic Solid Wastes generated in areas asper Schedule 1 / Schedule 2 of Hazardous Wastes (M, H & TBM) Rules, 2008.

The maximum score is assigned from the listed four categories which is mentioned as TSW1 to TSW4.

Based on the following listed solid waste disposal method of any industry, its belongingness is considered in TSW1 category and maximum score assigned for same category is 20.

Solid Waste which is disposed at the landfilling site and requires treatment and special attention before disposal.

Based on the following listed solid waste disposal method of any industry, its belongingness is considered in TSW2 category and maximum score assigned for same category is 15.

Solid Waste which is disposed of by incineration method.

Based on the following listed solid waste disposal method of any industry, its belongingness is considered in TSW3 category and maximum score assigned for same category is 10.

Solid Waste which is disposed at the landfilling site, which does not requires treatment and special attention before disposal.

Based on the following listed solid waste disposal method of any industry, its belongingness is considered in TSW4 category and maximum score assigned for same category is 10.

Solid Waste which is easily recyclable by latest technologies.

After obtaining the score of Wastewater, Air and Toxic Solid Wastes, total score is calculated as follows:

Total Score = Wastewater Pollution Index + Air Pollution Index + Toxic Solid Waste Index

Scoring of a particular industry is to be done on basis of Wastewater Pollution Index, Air Pollution Index, and Toxic Solid Waste Index. Therefore, for calculating pollution index of particular industry the scores are to be normalized to the any of five cases described below:

If any industry having either Wastewater pollution or Air pollution, the normalization of score is to be done as follows;

Normalized Score = {100 x Wastewater Pollution Index (or Air Pollution index)} / 40

If any industry having Wastewater pollution and Air pollution but absence of Toxic Solid Waste, the normalization of score is to be done as follows;

Normalized Score = {100 x Wastewater Pollution Index+ Air Pollution index} / 80

If any industry having Air pollution and Toxic Solid Waste but absence of Wastewater pollution, the normalization of score is to be done as follows;

Normalized Score = {100 x Wastewater Pollution Index+ Air Pollution index} / 60

If any industry having Wastewater pollution and Toxic Solid Waste but absence of Air pollution, the normalization of score is to be done as follows;

Normalized Score = {100 x Wastewater Pollution Index+ Air Pollution index} / 60

If any industry having Wastewater pollution, Air pollution and Toxic Solid Waste, no need of normalized score; therefore, total score will be;

Score = Wastewater Pollution Index+ Air Pollution index + Toxic Solid Waste

(Final Document on Revised Classification of Industrial Sector Under Red, Orange, Green and White Categories, 2016, CPCB)

3. Lacuna in Present Approach & Suggested Methodology

Based on the scoring methodology, prescribed by SPCB/PCC, the final categorization of the industries by the SPCB/PCC is shown in table 1.

Table 1. *Final categorization of the industries by the SPCB/PCC.*

Category of Industrial Sector	No. of industries falling in specific category
Red	59
Orange	93
Green	53
White	36
Total	241

The decision regarding the categorization of any industry which doesn't come under any of these four color categories is taken by respective state boards or PCCs.

After studying the concept of present categorization of industrial sector by a working group of SPCB/PCC; it has observed that the same concept can be understood more easily if same thing is represented by color slit, in which four colors named Red, Orange, Green and White is being used to represent the Red, Orange, Green and White industries.

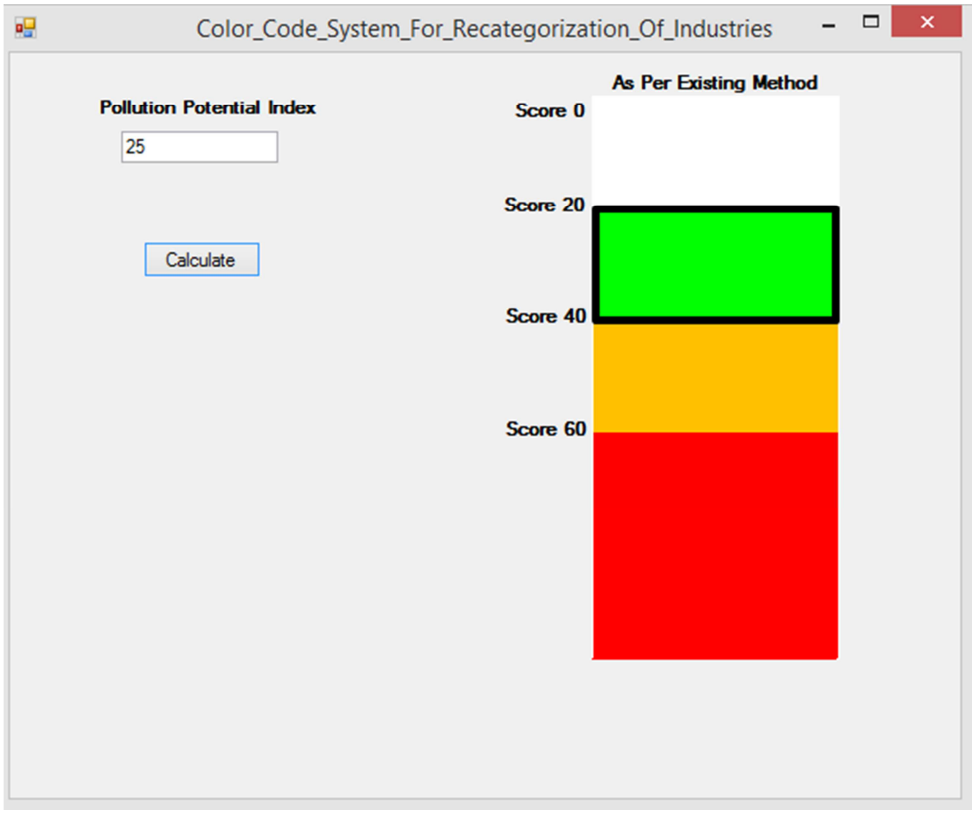

Figure 1. *Colour code system for visualization of categorization of Industries.*

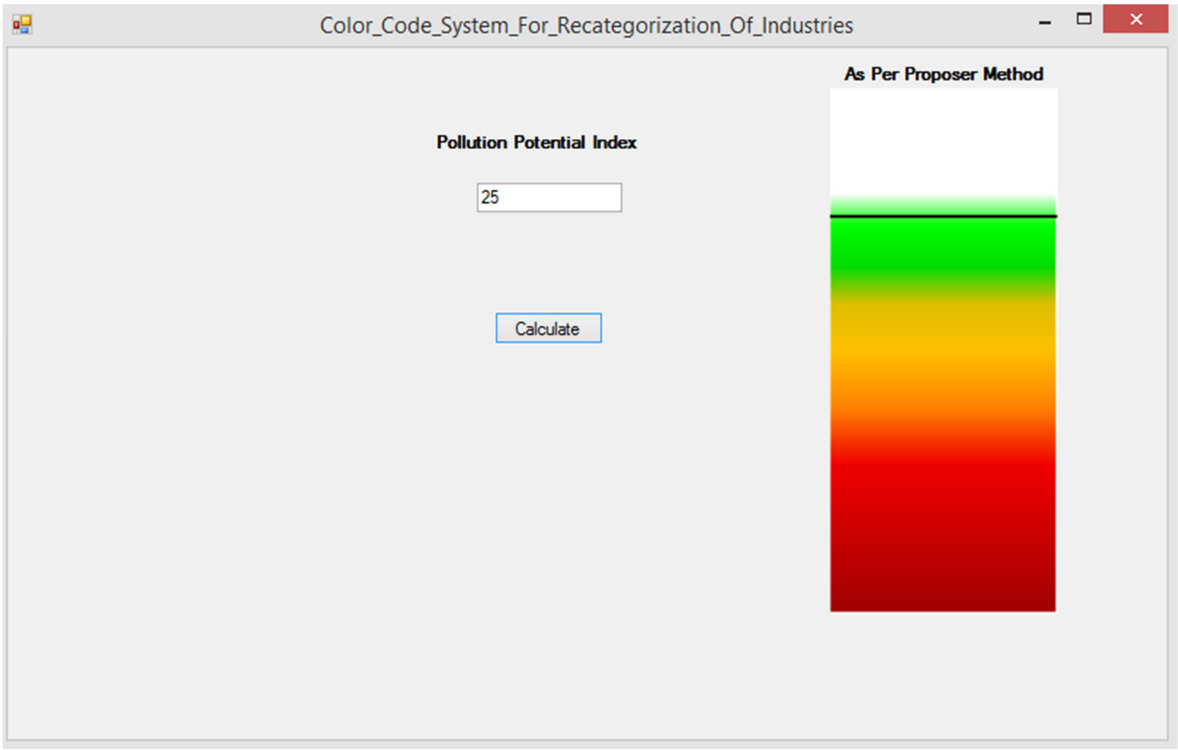

Figure 2. *Colour code system for visualization of categories of industries with continuous spectrum.*

Figure 3. *Comparison of existing and proposed method of colour code system.*

Now this color code concept is being formulated for easy understanding and transparency of the present concept, which is shown in figure 1. The same concept is further enhanced to find the industry with more pollution load in the same category. This, leads to an impression that though the industry having lower pollution score is polluting the environment with the same impact as industry having higher pollution score in the range of same color code. It asks for some improvement in existing concept of color categorization industries and also calls to develop new color code system of industries which gives continuous spectrum from red to white color categorization of industries. Same can be visualized in Figure 2 which shows the development of new color code system for classification of industries with continuous color spectrum. Figure 3 shows a comparative analysis of developed color code system based on existing

concept of categorization of industries to the proposed color code system based on the proposed concept of categorization of industries.

4. Conclusion

From the analysis of the present study, following conclusion has been drawn.

Developing color code system based on related integrated pollution potential of industry proves to be more appropriate in identifying more polluting industry within the same group of categorization of the industry.

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