Environmental Impact Assessment Of Water Using RIAM (Rapid Impact Assessment Matrix)

Aiswarya.M and Sruthi M

Abstract-*Environmental Impact Assessment (EIA) is one of the proven management tools for incorporating environmental concerns in development process and improved decision making. It is an assessment of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether to proceed with a project.This project evaluates an Environmental Impact Assessment (EIA) for Travancore Titanium Products Ltd Company (TTP), Kochuveli, Trivandrum at a distance of 1km & 5km by using Rapid Impact Assessment Matrix (RIAM) tool. EIA analysis has four sequential phases such as identification, analyzing, prediction and policy making. Identification involves characterizing the existing physical, social, economic, and ecological environment due to rapid urbanization and unsustainable development which are severely impact the condition of present and future environment by direct or indirect mode. The Rapid Impact Assessment Matrix (RIAM) is a new tool for the execution of environmental impact assessments. RIAM is quite flexible, transparent and leaves a permanent record, which can be independently checked, validated or updated. The RIAM is the ideal mechanism that guarantees the safeguard of a fast and clear evaluation of main impacts, because all the components and parameters can easily be integrated into one platform - RIAM. The importance of the method lies on a standard definition of the importance of the criterion in the evaluation of the impact and in the way semi-quantitative values, which are gathered for each one of those criteria, allow different conditions to obtain independent and precise classifications*.

Key Words: RIAM, effluent, EIA, toxic chemicals, criteria, alkalinity, titanium, conductivity**.**

1. Introduction

The beginning of the civilization, human beings always coexisted with water and looked for developing techniques in order to allow them to dominate the water resources. The great hydraulics workmanships, with effects on the distribution of the surface water flow date back to Antiquity. More than 3000 years ago in the Egypt, the Mesopotamian, the Persia, in India and in China, the hydraulics works were used to control the water resources with some remarkable knowledge about the hydrologic cycle. As the evolutionary processes took humanity into the industrial age, the construction of hydraulic structures become more and more important in domains such as river navigation, energy production, more efficient irrigation systems and more reliable water supply to bigger and bigger cities and industries[1]. Only recently the concepts of environmental protection, water scarcity, flood damages and water quality have taken the centre stage. To develop a preventive policy, it is required that most of the projects like the construction of a dam go through an environmental impact assessment.

- *Aiswarya.M, is currently pursuing Masters degree in Civil Engineering in UKFCET, India, PH-7025084086. E-mail: ash1993.m@gmail.com*
- *Sruthi.M, is currently working as an Assistant Professor in UKFCET, India, PH-9496468589. E-mail: muraleedharansruthi89@gmail.com*

Water quality is determined by assessing three classes of attributes: biological, chemical, and physical. There are standards of water quality set for each of these three classes of attributes. The national standards for drinking water are developed by the federal government's Environmental Protection Agency (EPA). All municipal (public) water supplies must be measured against these standards.

Some attributes are considered of primary importance to the quality of drinking water, while others are of secondary importance. Therefore, the EPA drinking water standards are categorized as primary drinking water standards and secondary drinking water standards. Primary drinking water standards regulate organic and inorganic chemicals, microbial pathogens, and radioactive elements that may affect the safety of drinking water. These standards set a limit--the Maximum Contaminant Level (MCL)--on the highest concentrations of certain chemicals allowed in the drinking water supplied by a public water system. Secondary drinking water standards regulate chloride, color, copper, corrosivity, foaming agents, iron, manganese, odor, pH, sulfates, total dissolved solids, and zinc, all of which may affect qualities of drinking water like taste, odor, color, and appearance. The concentration limit of these contaminants is referred to as the Secondary Maximum Contaminant Level (SMCL).

This project evaluates an Environmental Impact Assessment (EIA) for Travancore Titanium Products Ltd Company (TTP) and nearer area, Kochuveli, Trivandrum by using Rapid Impact Assessment Matrix (RIAM) tool. EIA analysis has four sequential phases such as identification, analyzing, prediction and policy making. Identification involves characterizing the existing physical, social, economic, and ecological environment due to rapid urbanization and unsustainable development which are severely impact the condition of present and future environment by direct or indirect mode.

Environmental Impact Assessment (EIA) is one of the proven management tools for incorporating environmental concerns in development process and improved decision making. It is an assessment of the possible positive or negative impact that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether to proceed with a project. The Environmental Impact Assessment (EIA) experience in India indicates that the lack of timely availability of reliable and authentic environmental data has been a major bottle neck in achieving the full benefits of EIA. The environment being a multi-disciplinary subject, a multitude of agencies is involved in collection of environmental data.

The Rapid Impact Assessment Matrix (RIAM) is a new tool for the execution of environmental impact assessments. RIAM is quite flexible, transparent and leaves a permanent record, which can be independently checked, validated or updated. The RIAM is the ideal mechanism that guarantees the safeguard of a fast and clear evaluation of main impacts, because all the components and parameters can easily be integrated into one platform - RIAM. The importance of the method lies on a standard definition of the importance of the criterion in the evaluation of the impact and in the way semi-quantitative values, which are gathered for each one of those criteria, allow different conditions to obtain independent and precise classifications[2][5].

2. Scope and objective

Establishing the scope of the EIA is a fundamental component of the EIA process. The purpose of EIA scoping is to define those environmental topics that should be assessed as part of the EIA, the methods to be used and the geographical scope of the environmental impact assessment. Although not a mandatory requirement, EIA scoping is an important facet of the environmental impact assessment process.

Fig1. Effluent pool

The term "water quality" includes the water column and the physical channel required to sustain aquatic life. The goal of the federal Clean Water Act, "*to protect and maintain the chemical, physical, and biological integrity of the nation's waters*," establishes the importance of assessing both water quality and the habitat required for maintaining fish and other aquatic organisms. Although water quality potentially encompasses a wide range of topics, it is necessary in a watershed assessment to focus on critical issues and partition the evaluation into components.The effluent contains toxic chemicals which may cause the surroundings and aquatic life in danger. Due to the ferrous compound present in the waste that is going to the sea, some portion of the sea water is reddish brown in colour. The colour change is due to the presence of toxic chemicals in the effluent.

Also the polluted gases thrown out from the factory causes problems in respiratory organs etc. and it affects plants and trees. Hence the polluted wastes & gases affect the surrounding lives and the environment. Hence there is a need to study showing the negative impact of the effluent to the near area.

ISSN 2229-5518

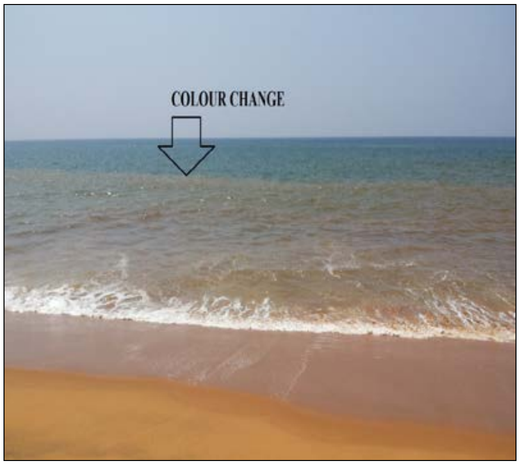


Fig2. Colour change in sea due to effluent discharge

This project evaluates an Environmental Impact Assessment (EIA) by using Rapid Impact Assessment Matrix (RIAM) tool. EIA analysis has four sequential phases such as identification, analyzing, prediction and policy making. Identification involves characterizing the existing physical, social, economic, and ecological environment due to rapid urbanization and unsustainable development which are severely impact the condition of present and future environment by direct or indirect mode.

Fig3. Effluent Channel from factory

The objectives of the study are:

- To identify, predict, and evaluate various impacts on environment in Travancore Titanium Products Ltd Company (TTP) and nearer area, Kochuveli, Trivandrum area
- To check the quality and characteristics of industrial effluent and water from 1km & 5km distance from the industry.
- Environmental Impact Assessment using RIAM software.
- To conduct surveys of surrounding areas.

2.1 study area

Our study area is Titanium Products Ltd Company (TTP) and nearer area, Kochuveli which is located in Trivandrum district. Travancore Titanium Products Ltd (TTP) is the leading manufacturer of anatase grade titanium dioxide in India. The company was incorporated in 1946 at Thiruvananthapuram, the capital of Kerala, India on the initiative of Sir C.P. Ramaswamy Iyer. The main product is pigment grade titanium dioxide, which is extracted from ilmenite, which is abundantly available as placer deposits on beaches near Kollam, 65 km north of Thiruvananthapuram. Ilmenite, a mixture of titanium dioxide and iron in the form of ferric/ferrous oxide, is treated with Sulphuric Acid to get Titanium dioxide and ferrous sulphate.

The company was promoted by His Highness ChithiraTirunal Balaramavarma Maharaja, the then ruler of the State of Travancore (now Kerala State in India) with the technical collaboration of British Titan Products, (now Tioxide Group). Though the company was registered in 1946, actual production was started only in 1952 with a small capacity of 5 t.p.a. Later subsequent expansions were made in 1962 and 1973 and now TTP can produce about 20000 tons of titanium dioxide per annum.

In 1960 Government of Kerala took over the management of the Company. Now the administrative control is vested with the Department of Industries, Government of Kerala.

The company also possesses a modern sulphuric acid plant which was commissioned in 1996, for utilizing the tail gas recycling DCDA (Double Catalysis Double Absorption) technology. An alkali scrubbing system is incorporated in the plant, and this in turn helps to keep sulphur dioxide emissions from the factory well within permissible limits.

3. Materials and Methodology

3.1 Water quality analysis (WQA)

Water quality is determined by assessing three classes of attributes: biological, chemical and physical. There are standards of water quality set for each of these three classes of attributes. The national standards for drinking water are developed by the federal government's Environmental Protection Agency (EPA). All municipal (public) water supplies must be measured against these standards. Some attributes are considered of primary importance to the quality of drinking water, while others are of secondary importance. Therefore, the EPA drinking water standards are categorized as primary drinking water standards and secondary drinking water standards.

Primary drinking water standards regulate organic and inorganic chemicals, microbial pathogens, and radioactive elements that may affect the safety of drinking water. These standards set a limit--the Maximum Contaminant Level (MCL)--on the highest concentrations of certain chemicals allowed in the drinking water supplied by a public water system.

Secondary drinking water standards regulate chloride, color, copper, corrosivity, foaming agents, iron, manganese, odor, pH, sulfates, total dissolved solids, and zinc, all of which may affect qualities of drinking water like taste, odor, color, and appearance. The concentration limit of these contaminants is referred to as the Secondary Maximum Contaminant Level (SMCL).

3.1.1 Biological assessment

Biological attributes of a waterway can be important indicators of water quality. Biological attributes refer to the number and types of organism that inhabit a waterway. The poorer the quality of water, the fewer the number and types of organisms that can live in it. When assessing water quality, it is also important to look at the quality of organisms that live in a waterway. Some species are more sensitive to chemical and physical changes in their habitat than other species. If species that tend to be sensitive to pollution are present in a waterway, then that waterway most likely has good water quality.

3.1.2 Chemical assessment

Chemical attributes of a waterway can be important indicators of water quality. Chemical attributes of water can affect aesthetic qualities such as how water looks, smells, and tastes. Chemical attributes of water can also affect its toxicity and whether or not it is safe to use. Since the chemical quality of water is important to the health of humans as well as the plants and animals that live in and around streams, it is necessary to assess the chemical attributes of water.

Assessment of water quality by its chemistry includes measures of many elements and molecules dissolved or suspended in the water. Chemical measures can be used to directly detect pollutants such as lead or mercury. Chemical measures can also be used to detect imbalances within the ecosystem. Such imbalances may indicate the presence of certain pollutants. For example, elevated acidity levels may indicate the presence of acid mine drainage.

Commonly measured chemical parameters include pH, alkalinity, hardness, chloride, calcium, magnesium and dissolved oxygen and biochemical oxygen demand. The presence of fecal coliform, bacteria is also determined using a chemical test. This microscopic organism is too small to detect during the biological assessment of macro invertebrate populations. In addition, some "chemical" measurements actually indicate the physical presence of pollutants in water. These include measurements such as conductivity and density.

3.1.3 Physical assessment

Physical attributes of a waterway can be important indicators of water quality. The most basic physical attribute of a stream is the path along which it flows. Most streams are classified as "meandering" or S-shaped. Meandering streams have many bends. The bends are characterized by deep pools of cold water along the outside banks where faster-moving water scours the bank. Meandering streams also have riffles along the straight stretches between pools. The riffles appear as humps in a longitudinal stream profile.

The S-shaped path of meandering streams prevents water from moving too quickly and flooding downstream ecosystems. The deep, cold pools of water provide ideal habitat for many species of fish — even when overall stream-flow is reduced. The riffles help to hold water upstream during times of low stream-flow. Also, turbulence in the riffles mixes oxygen into the water. Natural stream-channel patterns, with their bends, pools, and riffles, are essential to decreasing flooding as well as providing a suitable habitat for certain aquatic plants and animals. For these reasons, it is important to assess the physical attributes of a stream when examining its water quality.

Measurements of a stream's physical attributes are used to describe the structure of a sampling site. This allows for the comparison of the biota and chemistry of similarly-structured streams at different locations. Measurements of a stream's physical attributes can also serve as indicators of some forms of pollution. For example, changes in temperature may indicate the presence of certain effluents, while changes in stream width, depth, and velocity, turbidity, and rock size may indicate dredging in the area. Other commonly measured physical characteristics of a stream include: elevation and catchment area, stream order, forest canopy, and total solids.

3.2 Methodology

RIAM (Pastakia, 1998) Rapid Impact Assessment Matrix is a method used to evaluate all sorts of environmental impacts. It allows the completion of subjective classifications justified for each analyzed item, resulting not only in a clear way, the outcome of the assessment, but also a register for subsequent revaluations. Since Environmental Impact Assessments are the product of the work of a multidisciplinary team, the RIAM is the ideal mechanism that guarantees the safeguard of a fast and clear evaluation of main impacts, because all the components and parameters can easily be integrated into one platform - RIAM. The importance of the method lies on a standard definition of the importance of the criterion in the evaluation of the impact and in the way semi-quantitative values, which are gathered for each one of those criteria, allow different conditions to obtain independent and precise classifications.

The impacts of the activities of the project are evaluated according to the environmental components, and for each condition a classification is determined (using the pre-defined criterion), what provides an expected impact measure for environmental components.

The importance of the evaluation criterion is divided in two groups: criteria relative to the degree of the relevance of the condition, and that individually can alter the resulting classification (A); criteria relative to the development of the condition but individually is not capable of altering the obtained classification (B). The value designated for each group of criteria is determined by the use of a series of simple formulas. Those formulas allow the determination, in well-defined bases, of the classifications for individual conditions. Positive and negative impacts can be demonstrated using scales that pass of negative values the positive ones through zero for the group criteria (A), where the value zero presents a condition of "any alteration" or "any relevance." Using zero this way, in group A's criteria, it allows a single criterion to isolate conditions that don't present any alteration or which relevance is null for the analysis. However, the zero is a value avoided in the group B's criteria because, if the classification of all of criteria of that group was equal to zero, the final result of the ES would, naturally, be also zero. Eventually, that situation of nullity of the magnitude of the impact could happen in group A's criteria that presented some relevance degree. To avoid this situation, the scale of group B's criteria uses the unitary value (1) as classification for no alteration/ without relevance.

A measure of the importance of the relevance condition (A1) is evaluated according to the space borders or interest of the man that will be affected. The scale is defined in the following way:

0 - irrelevant:
1 - relevant just to the local condition;
2 - relevant to the areas immediately out of the local condition;
3 - relevant to the Regional / National interest;
4 - relevant to the National / International interest;

The magnitude (A2) is defined as a measure of the scale of benefit / damage of an impact or condition. The scale is defined in the following way:

3 - Extremely positive benefit;
2 - Moderately positive benefit;
1 - Lightly positive benefit;
0 - No alteration / actual state;
-1 - Lightly negative damage;
-2 - Moderately negative damage;
-3 - Extremely negative damage;

This permanent criterion (B1) defines if a condition is temporary or permanent, and if it should

only be seen as a measure of the temporary state of the condition. The scale is defined in the following way:
1 – No alteration / actual state
2 - Temporary;
3 - Permanent;

The reversibility criterion (B2) defines if a condition can be changed and if it can be seen as a measure of control on effect of the condition. The scale is defined in the following way:
1 - No alteration / actual state;
2 - Reversible;
3 - Irreversible;

This cumulative criterion (B3), where the effect of a condition will have a single direct impact or there will be a cumulative effect during the course of time, or, on the other hand, a synergetic effect with other conditions. Theoretically, the cumulative criterion is the mean used to judge the sustainability of a condition, and it should not be confused with a permanent situation or reversible condition. Its scale is defined in the following way:
1 - No alteration / not applicable;
2 - Non cumulative / of direct effect / singular;
3 - Cumulative / of indirect effect / synergetic;
The RIAM requests the definition of specific components of impact evaluation and each one of those environmental components falls upon one this four categories:

Physical / Chemical (PC):

Includes all physical and chemical aspects of the environment, including non-renewable natural resources (no-biological) and the degradation of the physical environment through pollution. It also includes geophysics, soil, water quality & water resources, climate, air quality, environmental noise, rainfall, loss of forest cover, solid waste.

Biological / Ecological (BE) :

Includes all biological aspects of the environment, including renewable natural resources, conservation of the biodiversity, interaction between species and pollution of the biosphere. It also includes flora, fauna, vegetation, habitat lose, house sanitation, sewage intrusion, proper sewage connection, foul smells.

Sociological / Cultural (SC):

Includes all human aspects of the environment, including social subjects that affect the individuals and the communities; with cultural aspects, it is included the inheritance conservation and human development. It also includes culture, education, science, mosquitoes, house flies, medical facilities, development due to technology.

Economical / Operational (EO):

To identify qualitatively the economic consequences of environmental change, temporary and permanent, as well as the complexities of administration of the projects inside the context of the activity project. It also includes job, access road, and tourism.

3.2.1 Assessment criteria

The important assessment criteria fall into two groups.

Group A: Criteria that are of importance to the condition, and which can individually change the score obtained. A measure of the importance of the relevance condition (A1) is evaluated according to the space borders or interest of the man that will be affected. The magnitude (A2) is defined as a measure of the scale of benefit / damage of an impact or condition.

Group B: Criteria that are of value to the situation, but should not be individually capable of changing the score obtained. This permanent criterion (B1) defines if a condition is temporary or permanent, and if it should only be seen as a measure of the temporary state of the condition. The reversibility criterion (B2) defines if a condition can be changed and if it can be seen as a measure of control on effect of the condition. This cumulative criterion (B3), where the effect of a condition will have a single direct impact or there will be a cumulative effect during the course of time, or, on the other hand, a synergetic effect with other conditions. Theoretically, the cumulative criterion is the mean used to judge the sustainability of a condition, and it should not be confused with a permanent situation or reversible condition. After necessary calculations, the RIAM classifies the degree of the damage or benefit according to Table.1. The value allotted to each of these groups of criteria is determined by the use of a series of simple formulae. These formulae allow the scores for the Individual components(Table.2.) [4][11].

The process can be expressed (Pastakia, 1998)

If $(a1) * (a2) = aT$ and $(b1) + (b2) + (b3) = bT$

Then (aT) * (bT) = ES (1)

Where,

- a1) and (a2) are the individual criteria scores for group(A)
- b1) to (b3) are the individual criteria scores for group (B)
- T is the result of multiplication of all (A) scores
- T is the result of summation of all (B) scores
- S is the Environmental Score for the condition

Environmental classification (ES)	Value of the class	Value of the class (numerical)	Description of the class
72 to 108	E	5	Extremely positive impact
36 to 71	D	4	Significantly positive impact
19 to 35	C	3	Moderately positive impact
10 to 18	B	2	Less positive impact
1 to 9	A	1	Reduced positive impact
0	N	0	No alteration
-1 to -9	-A	-1	Reduced negative impact
-10 to -18	-B	-2	Less negative impact
-19 to -35	-C	-3	Moderately negative impact
-36 to -71	-D	-4	Significantly negative impact
-72 to -108	-E	-5	Extremely negative impact

Table1: Environmental classifications according to RIA

Group	Category	Scale	Description
A	A1 Importance of condition	4	International importance
		3	National importance
		2	Outside of local condition
		1	Local condition
		0	Not Important
	A2 Magnitude of change-effect	+3	Major positive benefit
		+2	Significant improvement
		+1	Improvement in "status quo"
		0	No change / "status quo"
		-1	Negative change to "status quo"
		-2	Significant negative effect
		-3	Major negative effect
B	B1 Permanence	1	No change / not applicable
		2	Temporary
		3	Permanent
	B2 Reversibility	1	No change / not applicable
		2	Reversible
		3	Irreversible
	B3 Cumulative	1	No change / not applicable
		2	Non – cumulative /single
		3	Cumulative / synergistic

Table2:Assessment criteria(PASTAKIA & JENSEN,1998)

4. Result and discussion

As a part of the project the different data's are collected. The details of the houses are collected from people's lives in nearer area of Travancore Titanium Products Ltd Company.

Sl No:	Description	House 1	House 2	House 3	House 4
1	No: of Members	6	4	5	4
2	Source(Well/Municipal Supply/Bore well)	MS,BW	BW	W,MS	MS,BW
	AVAILABILITY OF WATER				
3	Well	×	×	✓	×
4	Municipal supply	✓	✓	✓	✓
5	Bore well	✓	✓	×	✓
	QUALITY(Very poor, Poor, Good))				
6	Well	Poor	Poor	Poor	Poor
7	Municipal supply	Good	Good	Good	Good
8	Bore well	Poor	Poor	Poor	Poor
9	Hard Water(HW) or Soft Water(SW)	SW	SW	SW	SW
10	Presence of Bleaching Powder(Yes or No)	No	No	No	No
11	Presence of salinity (Yes/No)	No	No	No	No
	HEALTH ISSUES				
12	Affected for (Children/Adult)	Yes	Yes	Yes	Yes
13	Rate of increase of mosquito breeding (low/high/very high)	Low	Low	High	Low
14	Skin Disease(Yes/No)	Yes	No	Yes	Yes
15	Lasting Period(Days/Weeks/Months)	Days	-	Days	Days
16	Other Diseases(Yes/No)	No	Yes	No	Yes
	IMPACT FACED DUE TO TITANIUM FACTORY				
17	Degradation of Environment(Yes/No)	No	No	Yes	Yes
18	Mixing of well water with factory effluent(Yes/No)	Yes	Yes	Yes	Yes
19	Favours mosquito breeding(Yes/No)	No	No	No	No
20	Impact on marine life(Yes/No)	Yes	Yes	Yes	Yes
21	Social Issues(Yes/No)	Yes	Yes	Yes	Yes
22	Quality Degradation of well water(Yes/No)	Yes	Yes	Yes	Yes
23	Depreciation of land value(Yes/No)	Yes	Yes	Yes	Yes
24	Is emigration occurring here(Yes/No)	No	No	No	No

Table3: Questionnaire Survey Form

ISSN 2229-5518

The test is conducted for determining the values of turbidity, pH, total hardness, chloride, turbidity, conductivity, alkalinity, calcium, magnesium, DO, BOD. The samples obtained from surrounding houses, sea water and the effluent channel undergone the above tests and result obtained are as follows.

Distance	1km north	1km south	1km east	1km West (sea water)	Effluent	5km north
pH	2.8	5.82	1.75	1	0.6	6.32
Turbidity(NTU)	8	2	3	208	47	6
Conductivity (µs/cm)	609	158	419	29.9	46.6	635
Total hardness(mg/l)	128	76	164	1200	1400	62
Calcium hardness(mg/l)	36	64	120	900	1200	46
Alkalinity(mg/l)	40	16	40	600	600	120
Chloride(mg/l)	590	387	367	4666	8240	367
Total solids(mg/l)	1000	1000	1000	7000	5000	1000
DO(mg/l)	0	0	0	0	0	4.45
BOD(mg/l)	2215.68	2025.72	2430.37	20426.96	37337	2.425
Calcium(mg/l)	14.42	33.66	48.09	851.92	801.6	42.48
Magnesium(mg/l)	22.35	2.916	10.69	72.9	48.6	3.88

Table4: WQA result

ISSN 2229-5518

RIAM ANALYSIS

EFFLUENT CHANNEL

Physical and chemical components (PC)

	Components	ES	RB	A1	A2	B1	B2	B3
PC1	Colour	-8	-A	1	-1	3	2	3
PC2	Temperature	-12	-B	2	-1	2	2	2
PC3	pH	-36	-D	2	-3	2	2	2
PC4	Turbidity	-14	-B	2	-1	2	2	3

Biological and ecological components (BE)

	Components	ES	RB	A1	A2	B1	B2	B3
BE1	Effect on flora and fona	0	N	1	0	1	1	1
BE2	Habitat loss	0	N	0	0	1	1	1
BE3	Effect on local population	-12	-B	2	-1	2	2	2

Sociological and cultural components (SC)

	Components	ES	RB	A1	A2	B1	B2	B3
SC1	Emigration of people	-18	-B	3	-1	2	2	2
SC2	Developmental activities	-6	-A	1	-1	2	2	2
SC3	Health issues	-6	-A	1	-1	2	2	2
SC4	Employment	0	N	0	0	1	1	1

Economical and operational components (EO)

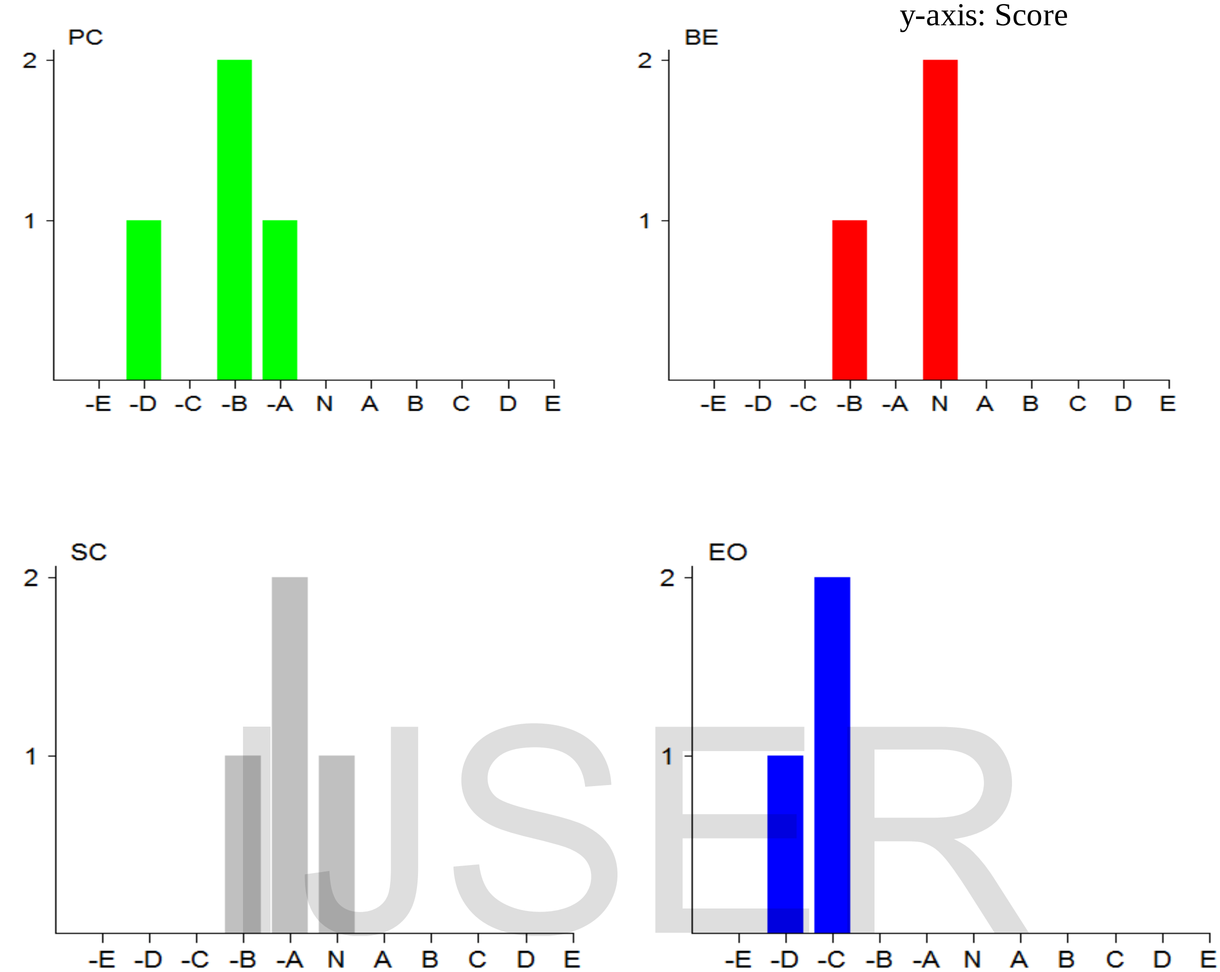
	Components	ES	RB	A1	A2	B1	B2	B3
EO1	Land value	-24	-C	2	-2	2	2	2
EO2	Marine economy	-24	-C	2	-2	2	2	2
EO3	Tourism	-36	-D	3	-2	2	2	2

Summary of scores

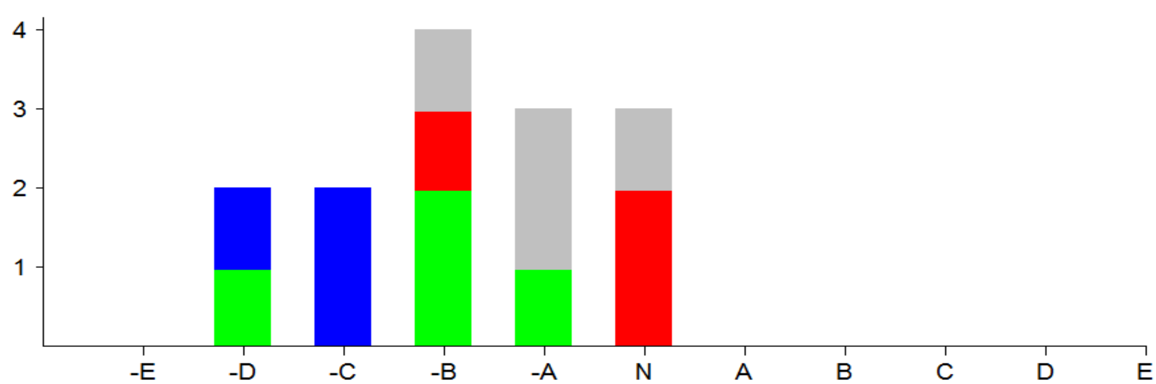
Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	1	0	2	1	0	0	0	0	0	0
BE	0	0	0	1	0	2	0	0	0	0	0
SC	0	0	0	1	2	1	0	0	0	0	0
EO	0	1	2	0	0	0	0	0	0	0	0
Total	0	2	2	4	3	3	0	0	0	0	0

ISSN 2229-5518

x-axis: Range band
y-axis: Score



EFFLUENT CHANNEL



ISSN 2229-5518

EFFECT OF MIXING WITH WATER

Physical and chemical components (PC)

Components		ES	RB	A1	A2	B1	B2	B3
PC1	Colour	-12	-B	2	-1	2	2	2
PC2	Temperature	-12	-B	2	-1	2	2	2
PC3	pH	-36	-D	2	-3	2	2	2
PC4	Turbidity	-6	-A	1	-1	2	2	2

Biological and ecological components (BE)

Components		ES	RB	A1	A2	B1	B2	B3
BE1	Effect on flora and fona	0	N	0	0	1	1	1
BE2	Habitat loss	0	N	0	0	1	1	1
BE3	Effect on local population	-6	-A	1	-1	2	2	2

Sociological and cultural components (SC)

Components		ES	RB	A1	A2	B1	B2	B3
SC1	Emigration of people	0	N	0	0	1	1	1
SC2	Developmental activities	0	N	0	0	1	1	1
SC3	Health issues	-6	-A	1	-1	2	2	2
SC4	Employment	0	N	0	0	1	1	1

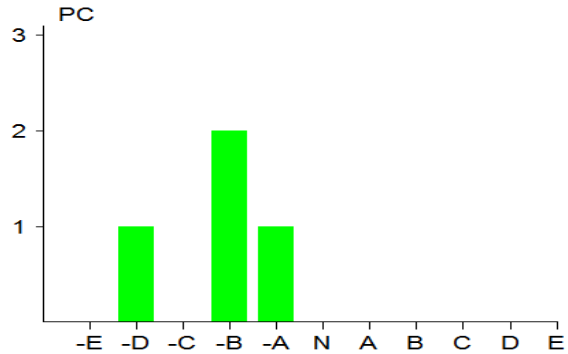
Economical and operational components (EO)

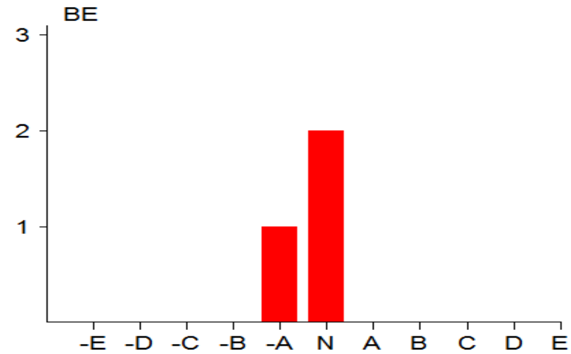
Components		ES	RB	A1	A2	B1	B2	B3
EO1	Land value	-6	-A	1	-1	2	2	2
EO2	Marine economy	-24	-C	2	-2	2	2	2
EO3	Tourism	0	N	0	0	1	1	1

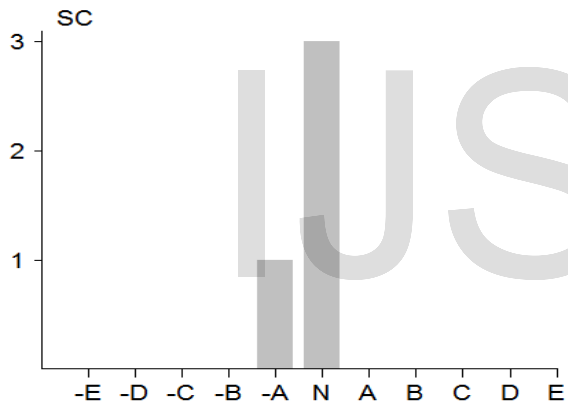
Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	1	0	2	1	0	0	0	0	0	0
BE	0	0	0	0	1	2	0	0	0	0	0
SC	0	0	0	0	1	3	0	0	0	0	0
EO	0	0	1	0	1	1	0	0	0	0	0
Total	0	1	1	2	4	6	0	0	0	0	0

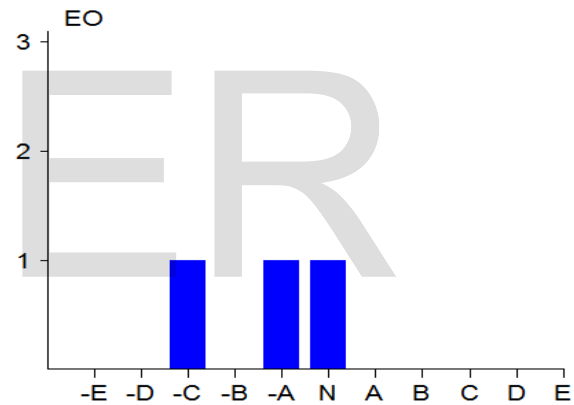
ISSN 2229-5518

x-axis: Range band
y-axis: Score

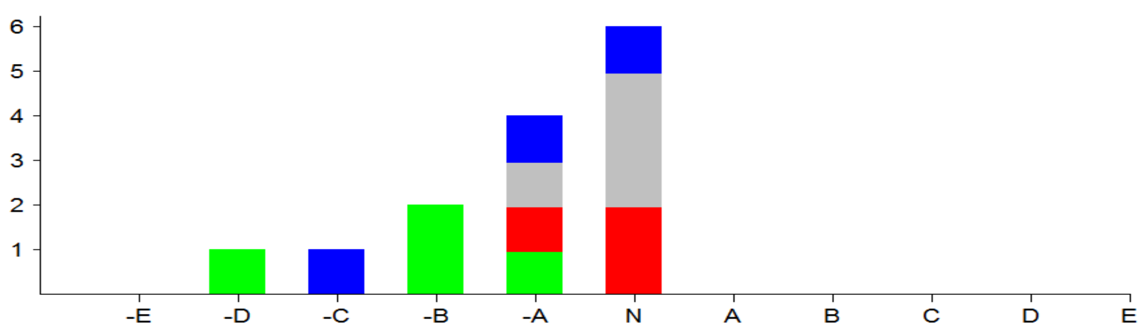








EFFECT OF MIXING WITH WATER



ISSN 2229-5518

EFFECT ON SEA WATER

Physical and chemical components (PC)

Components		ES	RB	A1	A2	B1	B2	B3
PC1	Colour	-24	-C	2	-2	2	2	2
PC2	Temperature	-12	-B	2	-1	2	2	2
PC3	pH	-24	-C	2	-2	2	2	2
PC4	Turbidity	-24	-C	2	-2	2	2	2

Biological and ecological components (BE)

Components		ES	RB	A1	A2	B1	B2	B3
BE1	Effect on flora and fona	-6	-A	1	-1	2	2	2
BE2	Habitat loss	0	N	0	0	1	1	1
BE3	Effect on local population	-12	-B	1	-2	2	2	2

Sociological and cultural components (SC)

Components		ES	RB	A1	A2	B1	B2	B3
SC1	Emigration of people	-24	-C	2	-2	2	2	2
SC2	Developmental activities	-6	-A	1	-1	2	2	2
SC3	Health issues	-6	-A	1	-1	2	2	2
SC4	Employment	0	N	0	0	1	1	1

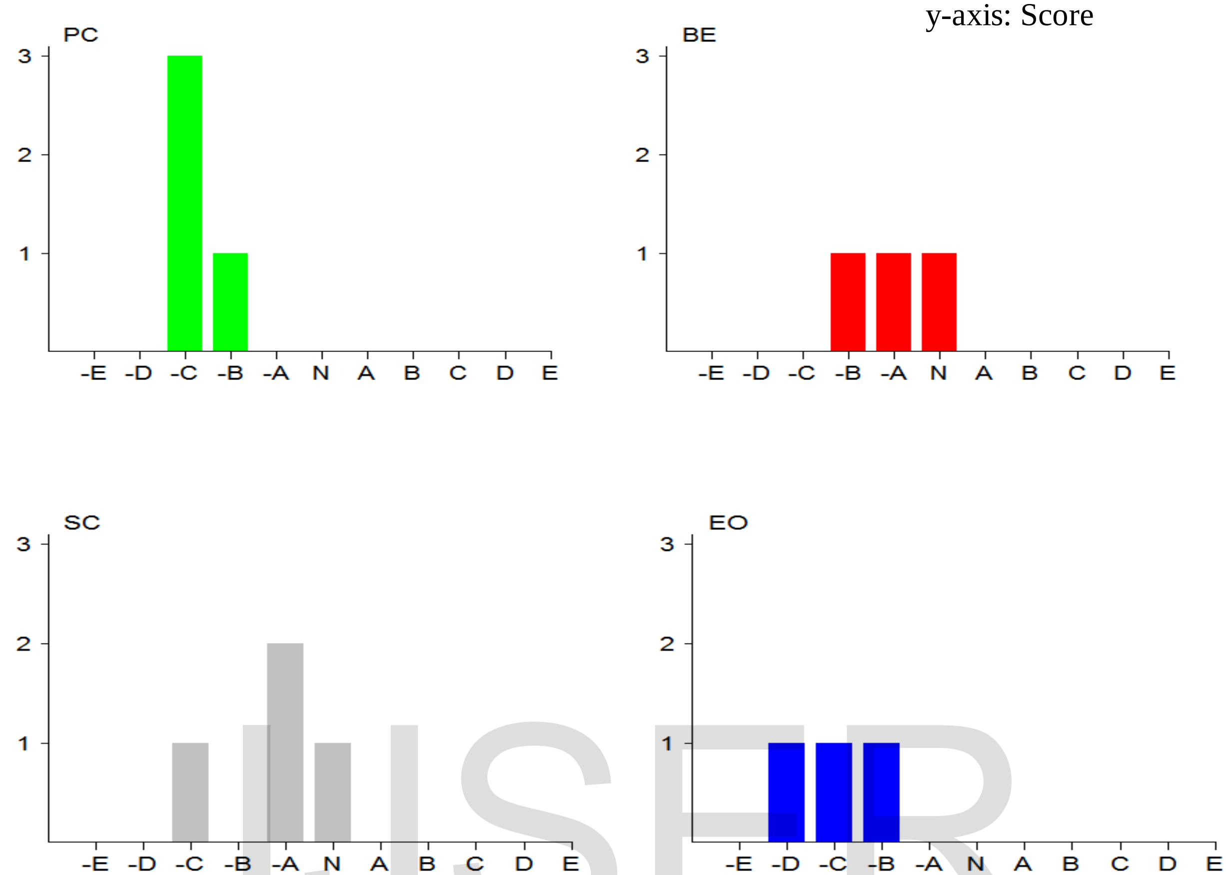
Economical and operational components (EO)

Components		ES	RB	A1	A2	B1	B2	B3
EO1	Land value	-12	-B	1	-2	2	2	2
EO2	Marine Economy	-24	-C	2	-2	2	2	2
EO3	Tourism	-36	-D	2	-3	2	2	2

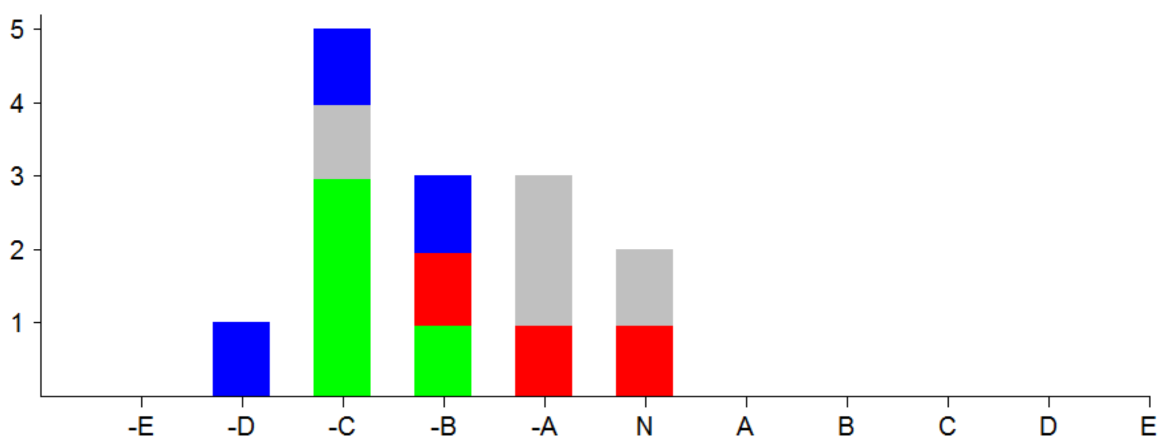
Summary of scores

Range	-108 -72	-71 -36	-35 -19	-18 -10	-9 -1	0 0	1 9	10 18	19 35	36 71	72 108
Class	-E	-D	-C	-B	-A	N	A	B	C	D	E
PC	0	0	3	1	0	0	0	0	0	0	0
BE	0	0	0	1	1	1	0	0	0	0	0
SC	0	0	1	0	2	1	0	0	0	0	0
EO	0	1	1	1	0	0	0	0	0	0	0
Total	0	1	5	3	3	2	0	0	0	0	0

x-axis: Range band
y-axis: Score



EFFECT ON SEA WATER



5. Result and Discussion

- From the Survey conducted in the nearby area, we came to know that the factory's polluted wastes & gases effect the surrounding life's and the environment.
- The effluent and the samples from 1km north , south, east & west are highly acidic and most of the components are above desirable limits.
- Sample from 5km distance from the industry is fit for drinking.
- From RIAM results it can be concluded that,
- The **physical and chemical components** such as pH has a significant negative impact on the environment and turbidity and colour has a moderate impact on the environment.
- The **biological and ecological components** such as flora and fauna and the habitat is not much affected whereas the industry has a slight negative impact on the local population.
- The **sociological and cultural components** such as emigration, health issues are negatively affected due to the existence of the industry.
- The **economical and operational** such as land value, marine economy and tourism are also negatively impacted due to the operations of the industry.

6. Reference

1) Anand, S., Bell, D.A., Hughes, J.G., (1996). EDM: A general framework for data mining based on evidence theory. Data & Knowledge Engineering 18, 189–223.

2) Appiah-Opoku, S., (2001). Environmental impact assessment in developing countries: The case of Ghana. Environmental Impact Assessment Review 21, 59–71.

3) Barker, A., Wood, C., (1999). An evaluation of EIA system performance in eight EU countries. Environmental Impact Assessment Review 19, 387–404.

4) **P**astakia, C. M. R. and Jensen, A. (1998): '*The Rapid Impact Assessment Matrix (RIAM) for Environmental Impact Assessment*', Environmental Impact Assessment Review,18(5), pp. 461-482.

5) Wathern, P., 1988. '*An introductory guide to EIA'*. In: P. Walthern (ed.), Environmental Impact Assessment – Theory and Practise. Unwin Hyman, UK. World Bank, 1988. Environmental Guidelines. Environmental Department.

6) Mohorjy, A.M., and Aburizaiza, O.S. 1997. Impact assessment of improper effluent control system: A Delphi approach. *Impact Assessment Review* 17,205–217.

7) Wathern, P., Young, S.N., Brown, I.W., and Roberts, D.A. 1986. Ecological evaluation techniques. *Landscape Planning* 4(12):403–420.

8) Jensen, A. (1998): Environmental Impact Assessment of Halong City Sanitation Project, Vietnam. In *Environmental Impact Assessment Using the Rapid Impact Assessment Matrix (RIAM)*, (Ed. K.Jensen), Olsen & Olsen, Fredensborg, Denmark.

9) Kankam-Yeboah, K., Asare, E.B., Gyau-Boakye, P., Nishigaki, M. (2005): *Rapid Impact AssessmentMatrix (RIAM) – An Analytical Tool in the Prioritization of water Resources ManagementProblems in Ghana*. In: Journal of the Faculty of Environmental Science and Technology,Okayama University, Vol. 10, No. 1, pp 75-81.

10) Padash, A. (2014): *Modeling of Environmental Impact Assessment Based on RIAM and TOPSIS for Desalination and Operating Units*. In: Environmental Energy and Economics International Research (2014) 1(1):77-90. ISNN: 2345-57.

11) Bisset, R., 1988. Developments in EIA methods. In: P. Walthern (ed.), Environmental Impact Assessment – Theory and Practise. Unwin Hyman,U