Planning for KMML Industrial Area and its affected Regions

Ajmi Shajahan S
Department of Architecture
TKM College of Engineering, Kollam, India

Abstract — KMML is the world's first fully integrated Titanium Dioxide facility having operations from heavy beach sand mining to Titanium Dioxide (TiO2) Pigment and Titanium Sponge Manufacturing. It is the only manufacturer of chloride-route rutile grade TiO2 pigment in India. Environmental pollution is a global problem which attracts the attention of human beings for its severe long-term consequences. Environment sources are being harmed by the effluents from KMML, a public sector integrated working in Chavara, Kollam, and creating a risk to public health. The degradation of ground water supplies was caused by the titanium dioxide manufacturing facility. In water samples, highly dangerous trace metals were found. The flora and fauna in and around the manufacturing region had been severely harmed by pollution. Concentrated hydrochloric acid and other environmental pollutants were discovered to have harmed crops and the quality of the underground water had dropped to high acidity. The environmental impact assessment of the area is conducted through primary surveys and secondary data collections. This paper discusses the impact of KMML industrial area and formulates strategies to maintain ecological balance in affected areas. It ensures integration of environmental control measures into the process of industrial area planning and process.

Keywords: Panmana, Acid Fields of Panmana, Strategic Industrial Area Planning, Industrial Pollution

I. INTRODUCTION

Mining and processing of heavy and rare earth minerals can produce a tremendously negative impact on the land and environment in the area, the magnitude and intensity of which depends on the kind of chemicals and processes used, the efforts taken in the management of waste as well as on environmental fragility of the location. Among the notable mining industries, KMML in Chavara is one of the noteworthy industries situated in Kerala. KMML spreads across two local grama panchayat Chavara and Panmana. The pollutants released from this industry and accidental leakages of free Chlorine, degrading the environment, and posing a public health hazard. EIA is one of the most valuable, interdisciplinary objective decision making tools considering various alternate routes for development, process technologies and project site options. It is an anticipatory mechanism which establishes quantitative and qualitative values for parameters indicating the quality of environment and natural systems before and after the proposed activity.[1]. The study area's impact is assessed using the EIA tool, and problems caused by the industrial area are examined before mitigation methods are formulated. The aim of "planning of industrial areas" is to exhibit innovative planning and design for new or upgraded industrial areas. Resource efficiency integrated environmental monitoring, and management systems for eco-friendly planning techniques can all be used to achieve this.

Panmana village of the Chavara block panchayat in Kerala's Kollam district has been claimed by deadly chemicals which have spread in all its wards- Ponmana, Mekkad and Chittoor. The toxic effluents from the government-owned Kerala Minerals and Metals Limited (KMML) plant in Chavara have had a free run ever since the factory was set up in 1984, when it began dumping deadly waste into a patch of ground within its premises.[2] The iron-oxide sludge mixed with acid and heavy metals has been leaking from the old effluent ponds, where it had been accumulating for decades, causing cancer and skin diseases. The canals which once had crystal-clear water are now overflowing with foaming waste. Domestic wells and ponds have been run over by pale effluents. The vegetation has been nearly wiped out. Panmana, once a green patch by the sea, is a picture of an industrial apocalypse. The LSGI with highest number of cancer cases reported are the coastal local bodies of Chavara, Panmana in the Kollam district. Out of 18 Tones/day of Sulphur Dioxide (SO2) emission, major share is concentrated in Panmana Grama Panchayat (12.98 T/day). Out of 3.6 Tones/day of Carbon Monoxide (CO) emission, highest emission is in Panmana Grama Panchayat (0.836 T/day). The areas adjacent to Agro Allied Development Zone where urban activities are dominating over rural activities is delineated as Special Development Zone, Panmana comes under special development zone category 4.[3] Based on the detailed study of each planning component of the study area to prepare an action plan for the study area.

It is not possible to wield the axe on a public-sector factory running in profit which contributes significantly to the state revenue besides providing employment. The study is conducted to understand the issues of the industrial area and major concerns of the local community and formulate strategies based on it.

Fig. 1: Water bodies of Panmana polluted due to iron oxide sludge of KMML industry.

II. AIM, OBJECTIVES AND SCOPE OF STUDY

A. Aim

To develop planning strategies for Kerala Minerals and Metals Limited (KMML) industrial area and its affected region.

B. Objectives

1) To study the concepts of industrial area planning and industrial policies
2) To study the impacts and determine the affected areas of the built environment in the KMML industrial region.
3) To evaluate and analyze the developed framework and determined parameters in the delineated region.
4) To analyze the issues and study various best practices for Industrial area planning
5) To develop planning strategies for Kerala Minerals and Metals Limited industrial area and its affected region

C. Scope

The strategies formulated suggest measures to minimize adverse impacts. It also put forward reclamation plans for acid fields; replenishment plans for nature conservation and landscaping with a future vision for retrieval and conservation of all land components. The scope of study includes detailed characterization of the Environmental status in respect of environmental components viz. air, noise, water, traffic, ecological and socio-economic components covering affected area with the industry boundary as its central nodal point. Managing and continually improving processes, activities in view:

1) To control the impact on land, air and water and thus prevent pollution
2) To reduce health and safety risks
3) To optimize the use of resources
4) Strictly complying with the statutory and regulatory requirements

III. METHODOLOGY

The first stage of methodology includes background research and literature review on how to build an industrial region without having its effects negatively affect the nearby built environment. The research into the tools that can be used to evaluate the impacts of an industrial area and the strategies of planned industrial region like Ashdod Industrial Area is studied. A framework for evaluating the study area is developed based on a pilot study conducted on the study area. The second stage includes evaluating the study area's framework, the effects of industrial pollution there, and the delineation of the study areas based on the intensity of the pollution. The study area's many planning components are studied and analyzed through primary and secondary data collection. The investigation of study area concerns and the selection of the best practices take place in the third stage. The development concept, mission, and vision are created in the final stage, and proposals for the KMML industrial area and its impacted regions.

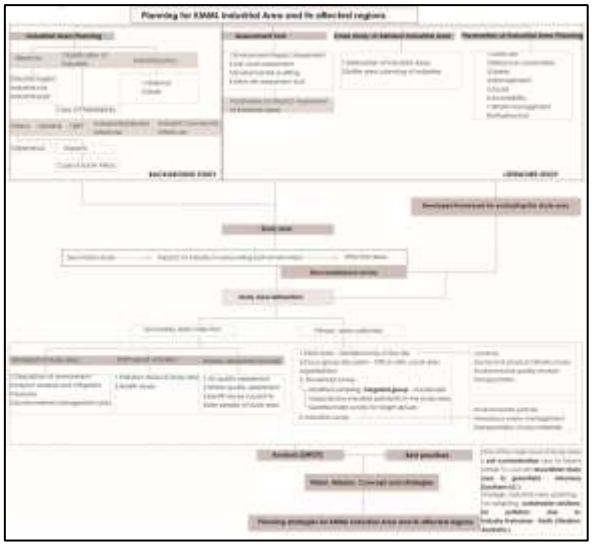

Fig. 2: Methodology of the study

IV. LITERATURE REVIEW

The major parameters for industrial area planning to be focused is studied. The two case studies such as Ashdod strategic industrial area planning and a case of Philadelphia, where industrial area is zoned from residential area to reduce its impact. The various tools are studied that is used foe the assessment of an industrial area. Based on this a framework is developed and used as a tool for the analysis of the study area.

V. STUDY AREA

The study area includes 16 wards of Chavara and Panmana panchayath surrounding KMML industrial area. It lies in Karunagapally Taluk under Chavara Block. It is 21.2 km from Kollam. The north of study area is Karunagapally municipality, south is Neendakara panchayat and east is Thevalakara and Thodiyoor panchayat.

	Chavara Grama panchayat	Panmana Grama panchayat
Block	Chavara	Chavara
Area	402.279 hectares	579.58 hectares
No. of wards	8	8
Population (SEC)- Above 18	12157	15330
Male population	5842	6460
Female population	6315	6870
Children population (1-18)	2416	2074
Total population	14573	15404
Population density	3622	15409

Table 1: Profile of Study Area

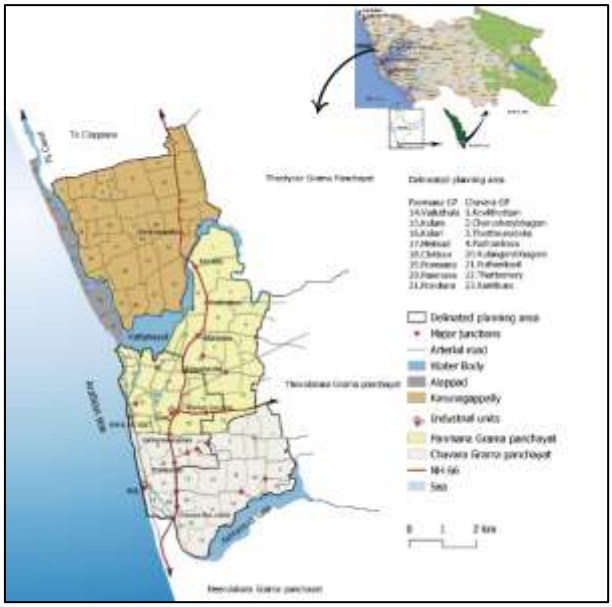

Fig. 3. Study area delineation

A. Reasons for Study Area Delineation

The 16 wards of Chavara and Panmana are affected due to the

1) Health issues among the people especially in the spreading up of allergic disorder, kidney and lung diseases which are attributable to rampant mosquito problem, poor air and water quality. The allergic and skin ailments are on the increase among the people.
2) The traditional job of the study area is diminished due to industrialisation.
3) The environmental degradation of study area such as acid fields, coastal erosion.
4) The chemical Hazard Prone Area in Karunagapally Taluk is 179.275 ha (KMML industrial area)
5) High Severity index has been arrived by taking the product of the values of backlog in source, treatment, storage, distribution, and quality of water in the study area.

VI. ANALYSIS OF THE STUDY AREA

The planning strategies for the affected population due to KMML industry is the targeted sample data. The stratified sampling is used because the target is to identify the issues of heavy industry KMML, how it affects the community surrounding region. The affected households are 4096 .12 % of the affected household 500 sample study is conducted in the 16 wards nearer to industrial area.

A. Socio -economic profile and Demography analysis

The annual population change (2001 to 2011): - Panmana is -0.050% and Chavara is 0.28%. In Panmana negative growth due to pollution of industry.

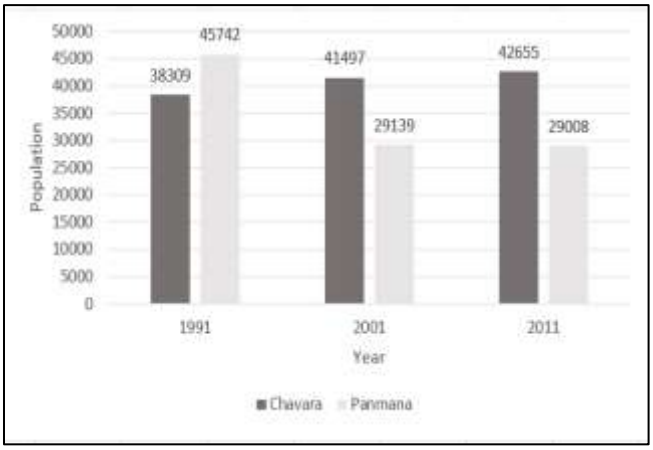

Fig. 4: Growth pattern of population of study area

The population density is high in wards Thattashery (22) and Kolam (15) and low density in wards Panmana (20), Puthenkovil (21) and Kulangarabhagom (20) due to industrial pollution. Puthenkovil and Kulangarabhagom are fishing villages. The 1- 18 age range the children population is high in Porukara ward in Panmana Panchayat. Urban sex-ratio of the Kollam district (1096) and the lowest in Panmana (CT) (1058). The rural child sex ratio (0-6 age) is lowest in Chavara (946). The decline due to the exposure to chemicals. The children's population (0-6 age) is increasing trend in Chavara and Panmana panchayat so need more health infrastructures to meet disability due to pollution of industries. The coastal wards have a smaller number of households most of the houses evicted due to mining activities. The most affected wards are Chittoor, Mekkad and Ponmana of Panmana panchayat. KMML total employee strength of 1770, 1067 are local people who were affected by the project. This represents 60% of the total employee strength. LAPA (Labour pension act) construction and labour cooperative society ltd provide local workers to KMML for temporary works. This indicates the local people depend on industry for occupation. The fisherfolks in Kovilthottam, Thattashery, Cherusherybhagom is 336, Kalari, Mekkad, Ponmana is 312 and Karithura, Puthenkovil, Kulangarabhagom is 279. The sand mining workers of India Rare Earth limited (dredging and mineral separation unit) is 427. It is important that these households be relocated away from the industrial area. It is essential to know the occupation and means of livelihood as this helps while formulating the policies and programmes of rehabilitation and resettlement.

90 percent of the respondents reported that the nature of ownership is inherited followed by purchased (10%). This shows that almost all of them have availed the land as inherited. Their families have been living here for years. Traditionally, they are living there and engaged in their own occupation (70%). And they are socially and culturally accustomed to this area. The sentimental attachment of the people of this soil necessarily compels them to stay there. So, care and caution may be taken while evacuating them from this area.

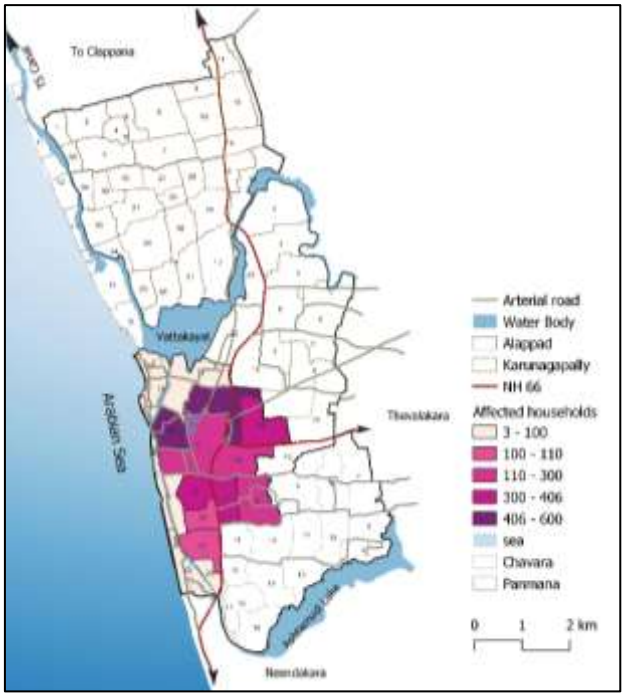

Fig. 5: Affected households of study area

B. Land use analysis

In the defined study area in 2023, the residential area's concentration is higher around the industrial area by 51%. Along the national highway is where most of the commercial (1%) and industrial (3%) area is located. KMML industrial area is 224 ha. Due to the presence of acids in the soil brought on by the heavy metal effluents released from the industry KMML, the agricultural land is concentrated in the mid and high regions of the panchayat and is higher (13%) near water bodies like Vattakayal in the delineated study area than it is in coastal wards and wards close to KMML. When compared to open space (2%) of land use of 2009 prepared by IDDP of Kollam, the vacant land increased to 4% due to vacating of residents due to health hazards. Acid fields (1%) and mining (2%) in the study region replaced and lowered agricultural concentration. Coconut is one of the major crops of delineated study area, but its major portion is destroyed due to acid fields. The reduced coastal belt due to mining can push the marginalized section of society in the region and more vulnerable to floods.

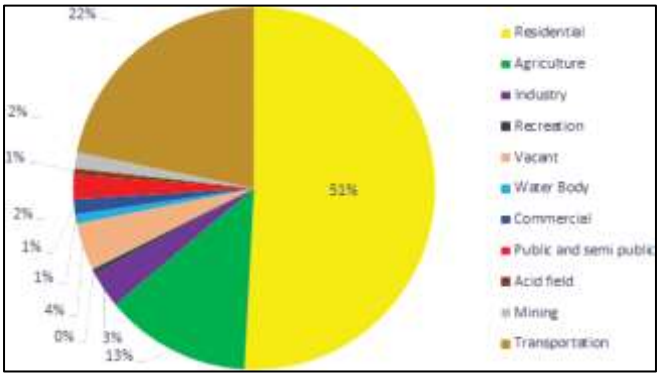

Fig. 6: Land use breakup of study area 2023

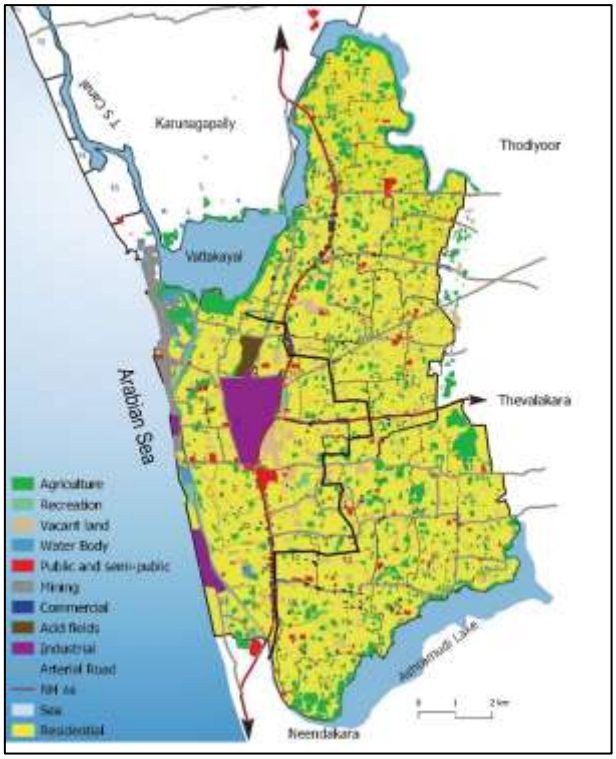

Fig. 7: Land use of study area 2023

The economic share of study region is high due to major commercial and industrial concentration. This leads to uneven development distribution. The mineral extraction industries in the region poses a public health hazard causing vacated residential concentration around the zone. The agricultural area is mainly concentrated in the mid and high regions of the panchayats. Towards the coastal belt the agriculture concentration is low. The reasons for this are the salinity of the water, mining and due to polluted water issues due to the heavy industries like KMML and IRE, which makes the ground water unsuitable for the agricultural purposes and coastal area more vulnerable to floods. The major occupational structure has also changed during time from agriculture to other work type. The industrial belt is along the national highway.

C. Economic aspects analysis

KMML is a public sector unit undertaking by Government of Kerala its net worth is Rs 880 Crores, greater contribution to State economic growth. The mineral deposit of the Kollam coast containing Monazite is one of the richest in the world and reported to have the highest content of Thorium which helps to increase economy, but mining of these minerals makes environmental degradation. Increase in industrial activities leads to pollution and diseases The soil quality in the wards surrounding industrial area was deteriorated by the acid effluents from KMML and the mined sand after mineral separation known as White sand that has been dumped in coastal areas is bad for all crops. Coconuts are the main crop grown in the study area, and the traditional industry was coir manufacturing. Once the coconut fields became acidic, their productivity, area, and agriculture have all declined. The study area's wards 19, 21, and 23 have large concentrations of agricultural near to water bodies, while the remaining wards have lower concentrations of agriculture altogether.

Intercropping, vegetables, ginger, and other crops grown in the study area in grow bags provided by LSGs made of cocopeat and red soil.

Fig. 8: Acid fields of study area

Fig. 9: White sand dumped in study area.

D. Transportation sector

The Kovilthottam-ward 1 coastal areas, which are close to mining sites, lack essential public transportation services. Heavy vehicle traffic worsens poor road conditions, creates dust, and makes it difficult for school children to safely arrive at school. The truck movement is stopped due to 2.30 pm to 4 pm through the road due to school time (Lourde Matha school) through the rural roads due to the protest of public. The fugitive dust emission is caused during the transportation of raw sand from Mining and beach washing to MS plant and Transport of mineral heavies from the MS plant to pigment plant. The existing roads connecting MSP and TiO2 plant should be, resurfaced and maintained in good condition for heavy load vehicle movement. Trees should be planted on sides. To eliminate traffic related issues, the transportation of mineral to KMML from the mining area through barges or country boats through National waterway III. Public transportation facilities must be made easily accessible by controlling heavy truck movement in morning hours and peak hours like school time.

E. Social Infrastructure Analysis

The cancer patients increased from 69 to 96 in Chavara and 96 to 172 in Panmana. There is an increasing trend in cancer patients due to the radiation of chemicals from industry and black sand in coastal areas. The cancer patients is high in wards Karithura (23), Kulangarabhagom (20) and Vaduthala (14). The 20 and 23 wards are coastal areas where the white sand is dumped after mineral separation, the radiation from this soil is the reason for cancer. The ward Vaduthala is located on the frontage of KMML industry mainly face the issue of air pollution. Kollam number of cancer cases is (1102 in year 2014) its 0.23 % is in Chavara and Panmana in district. The ARI patients increased from 2457 to 2720 in Chavara and 2781 to 3180 in Panmana. There is an increasing trend in ARI patients due to the air pollution. The industry releases sulphur and chlorine gases in the morning 7 am these gases create bad odour and a cause of respiratory diseases. The acidic content in the soil due to effluents from industry create skin diseases and it is high in ward Chittoor (ward 18) of study area. But the CHC Chavara not have a department for treatment of skin diseases, so the patients list related to it is unrecorded. The lack of health care facilities in the government hospital where the most public approach is also one of the major issues of the study area. The air pollution and release of chlorine like gases is the cause of acute respiratory infection in public. Proper curative and preventive action on the matter Otherwise the social unrest among the people will become a serious problem.

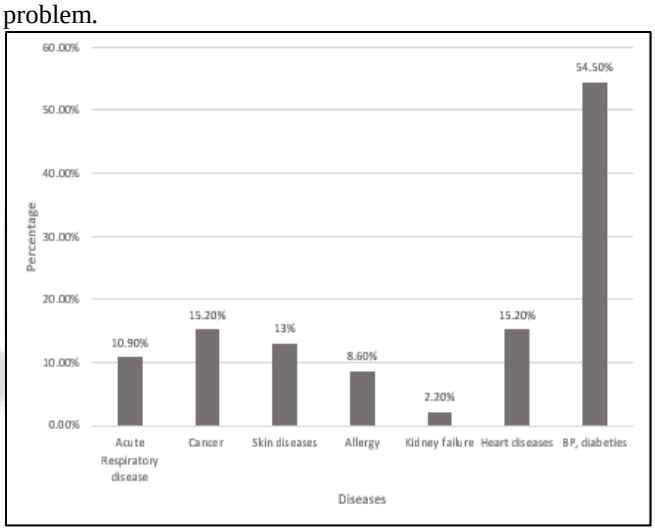

Fig. 10: Health pattern of study area

Fig. 11: Open well near KMML

The educational institutions GHSS Chavara, Baby John Memorial College, Valiyam central school is within 300m from the industrial area. As per the URDPFI guidelines, when specifically planning for an Industrial area; service villages, hamlets, and rural settlements to be provided with a buffer of 100-300 meters for the expansion of the settlements, for health & safeguard point of view. Fire stations are located

so that the fire tenders can reach disaster site within 3-5 minutes.

F. Physical Infrastructure Analysis

KMML industrial pipeline is most used in the study area (83%) and bore well (14%) and only 2 % of people use open well in the study area. The most of the open well of the study area is polluted due to iron oxide sludge of the industry. The 90% of well water have low quality in the study area. The PVC pipes have started falling resulting in number of holes in the base with the result the liquid portion of Iron Oxide sludge and ETP slurry started draining into the ground polluting the soil and the ground water. During rainy season more pollutants are dissolved and carried down to the ground and groundwater to far away areas due to lack of drainage facility. As Kollam has an average rainfall of 2.6 metre per year, the rainwater falling over the old ponds of nearly 5-hectare area results in generation of 130 million litres of polluted water per year spreading downward and outward contaminating the ground water. 94% of people in study area is satisfied with KMML water supply.6 % have issues related chlorinated water supply (odour, taste). All the well water near KMML exhibited high COD, TDS, total hardness, iron etc. which are sourced to industrial wastes being discharged into the surrounding areas. The values of TDS, BOD, COD, and iron exceeded the permissible limit. Hence, the well water near KMML is unsuitable for domestic purpose, as confirmed by water quality index. The consumption of the well water around the industrial area may cause health hazards to the residents. It is necessary to control the contaminant transportation and ground water pollution in and around KMML area.

G. Environment Analysis

Primary and secondary data on meteorology, air, noise, water, soil, land use, ecology was collected and analysed. Pollution is a serious threat to the inhabitants of the mining area. The mining machineries, transport vehicles and other mechanised equipment create air and noise pollution. The mining activity has also dried up most of the wells in the area and whatever amount of water is available in the remaining wells, they are contaminated due to toxic seepages. The fertility of the soil is also diminishing due to mining. In short, land utilisation for agricultural purpose is insignificant. The people in the area have different occupational skill but majority of them are well versed in fishing only. All these aspects adversely affect the people in the locality, especially their health and tranquil family life. It is a fact that the company is very slow in reducing the pollution at all levels. More and more precautions are to be taken to reduce pollution in the best manner and within the shortest possible time. On priority, the company has to take steps to intensify the water cleaning process and other issues which have a direct bearing on the health and wellbeing of people in the area. Coastal protection measures against sea erosion and Tsunami are a major part of the environmental management plan to be implemented in the area. Human settlement and rehabilitation -They are not favouring the land acquisition for the mining project. A small portion of the people in the locality are willing to let the land acquisition happen but on certain conditions especially in the land value and proper R&R. The coastal protection measures undertaken include Seawall construction and Groynes, by the state government and KMML in its mining areas. These measures are also being taken up by KMML over the stretches of mining areas every year for controlling erosion.

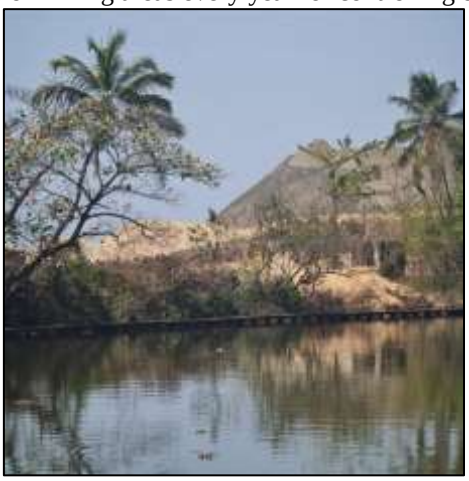

Fig. 12: Sand dunes of study area

Fig.13: Kwinana industrial area

VII. SWOT ANALYSIS

Fig. 14: Swot analysis of study area

VIII. CASE STUDIES AS BEST PRACTICES

The one of the major issues of the KMML industrial area is the acid fields (16.53 ha) that leads to environmental degradation and health hazard to the public. So, these brownfields to Greenfields through Phytoremediation. Privately owned scrap yard Arkansas-United States is taken as a case study for revival of acid fields.[4]

The Kwinana Strategic Industrial Area (SIA) is one of Western Australia's most important strategic industrial areas and is part of the State's premier heavy industrial zone, the Western Trade Coast. covering an area approximately 8km north-south and 2km east-west, on the eastern side of

Cockburn Sound some 30km south of the Perth CBD. Approximately 270ha.The increased environmental focus of Kwinana industry has resulted in a few improvements through reductions in air emissions, cleaner production, waste minimisation and water conservation and wastewater reuse. Through a commitment to open and honest communication, building enduring relationships with its neighbours that are based on mutual respect and long-term commitment, the KIC supports a range of forums including: Communities & Industries Forum, Kwinana Environmental Health Forum, Kwinana Industries Education Partnership, Kwinana Industries Noise Reference Group and Cockburn Sound Management Council. Employs more than 4,800 people directly, 64% of whom live locally. Contributes a high degree of social benefit to employees and its community with a high level of employee services and at least half of community partnerships invested locally.[5]

IX. PLANNING STRATEGIES

The strategies are formulated based on the analysis of issues of study area.

1) Socio economic profile – Consider the occupation and means of livelihood while formulating the policies and programmes of rehabilitation and resettlement. Controlling the pollution-induced negative population increase in Panmana Panchayat is necessary. The sentimental attachment of the people of this soil necessarily compels them to stay there. So, care and caution may be taken while evacuating them from this area.
2) Land use – The buffer zone (green belt) development in 300m surrounding area and provide resettlement and rehabilitation package for the affected households according to their demands.
3) Economic aspects -Phytoremediation and phytoextraction can revive the acid fields of study area. Phytoremediation is the in-situ (onsite) use of plants to reduce contamination of soil, sediments, surface water or groundwater. By harnessing the natural capabilities of plants, we can remove, degrade, or stabilize contaminants. It can be a low-cost, but time intensive alternative to traditional remediation on sites where toxins are at shallow depth. It can also be an effective approach to reducing the leaching of contaminants through soil or groundwater and can be used in combination with other remediation techniques.
4) Transportation sector - The existing roads connecting MSP and TiO2 plant should be, resurfaced and maintained in good condition for heavy load vehicle movement. Trees should be planted on sides. To eliminate traffic related issues, the transportation of mineral to KMML from the mining area through barges or country boats through National waterway III. Public transportation facilities must be made easily accessible by controlling heavy truck movement in morning hours and peak hours like school time.
5) Social infrastructure -Better health care facilities in the community health centre for meeting the needs of the public. Medical camps in 3 months regular intervals, cancer care centres and more infrastructure facilities. Mock drills for schools to meet emergency accidents.
6) Physical infrastructure - Water is now being supplied by the company but it is inadequate due to duration and other uses. Need a greater number of overhead tanks to meet the needs of people. Containment of the breached sludge pond is an urgent necessity as the entire groundwater may become permanently damaged and unfit for use. Immediate maintenance of dilapidated pipelines to prevent leakage of effluents into soil. Rainwater harvesting methods and new water supply schemes should be implanted in every household. Periodic inspection and maintenance of water distribution system like pump houses, pipelines etc
7) Environment – The company must take steps to intensify the water cleaning process and other issues which have a direct bearing on the health and wellbeing of people in the area. The coastal protection measures undertaken include Seawall construction and Groynes, by the state government and KMML in its mining areas. These measures are also being taken up by KMML over the stretches of mining areas every year for controlling erosion.

- Water reclamation plant for wastewater treatment
- Managed Aquifer recharge to reduce groundwater pollution.
- Air quality buffer zones and use of natural gas for industrial processing
- Waste management – The by products such as iron oxide sludge can be made profitable by selling.
- Heavy transport linkages such as ports to reduce air pollution.
- Positive and socially responsible action to help the community through sponsorship, data collection and comparability to better appreciate and present industries' performance, conducting research aimed at a better understanding of the interaction of industry activities and the local community. Maximising transparency consistent with good governance and commercial confidentiality.

X. CONCLUSION

The Kerala Minerals and Metals Limited' (KMML) is a Government of Kerala undertaking Public Sector Unit operating as a flagship unit and constantly generating profits & paying dividends to the exchequer. Its pollution is degrading the environment. The strategic industrial area planning can increase the economic growth and reduce public health hazards due to the industry. The Corporate social responsibility and industry sustainability covenants to go beyond regulation to utilise policies to encourage social, environmental, and economic integrated benefits.

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