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Impact of Food Processing Industry on Geology, Soil and Ecology: The Nigerian Experience

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Abstract: In developing countries, it is common to cite industries without carrying out environmental impact assessment. This is the case of the 2 industries audited in this study. It becomes necessary, therefore, to audit food processing industries in Nigeria to determine their impact on geology, soil and ecology. This will enhance a cleaner and healthier environment. In this study, the impact of food processing industries on geology, soil and ecology of their environments were reported. The method adopted is the Investigative Survey Research Approach (ISRA), which involves the collection of baseline and screening data. The effects of pollution on geology, soil and ecology include depletion of natural reserves, endangered terrestrial habitats leading to migration of arboreal animals to safer places and loss of them in the host communities, increased compaction due to increased vehicular and human traffic and reduction in yield of lands within the vicinity of the industries. The reduced soil fertility could be attributed to leachate from chemical wastes from NAS. The need for environmental impact auditing and the importance of impact auditing as a project management tool were highlighted. It was concluded, that the food processing industries do have positive and negative impacts on their environments and recommendations towards alleviating negative impacts on the environment were made.

Key words: Baseline data, ecology, ecosystem, environmental impact assessment, food processing industry, geology, impact auditing, screening data, soil

INTRODUCTION

The last two decades marked the emergence, rapid proliferation, growth and development of food processing industries (both foreign and indigenous) in Nigeria. This is due to increasing demand for processed foods particularly in urban areas. The raw materials for the processed food industries are mainly agricultural, from where finished products such as beverages, edible oils, sugars and other sweeteners, drinks (both alcoholic and non-alcoholic), fish and meat products emerge. Food processing as an industry was introduced into Nigeria by the United African Company (UAC) in 1923. Today, food industries in the country are so many that they could be sub-divided into 13 categories. These are flour and grain, soft drinks and carbonated water, breweries, starch and miscellaneous food products, meat, poultry and fish, tea, coffee and other beverages, fruit juices, animal feed, sugar, distilleries and blending of spirits, cocoa, chocolates and sugar confectioneries, agricultural and food chemicals and industrial packaging (Ojo, 1998). Food processing projects involve the processing and packaging of meat products, fish and shell fish, dairy products, fruits and vegetables, grains and beverages production. It includes refinement, preservation and improvement of product; storage, handling, packaging and canning. The processing may involve receiving and storing raw or partially processed plant, animal or other food materials, processing the raw materials into finished products and packaging and storing the finished products.

The processing industries exist in our environment and are the main generators of wastes. Since, the existing environment withinm, which they operate is the only one we have and shared by both the consumers and operators of other sectors of the economy, there is the need therefore, to ensure the preservation of the environment in as natural and as ecologically balanced a state as possible for the use of all. This must and should be made to be the motivating factor during the design, construction and operation of all industrial set up. Industrial waste is a major source of environmental pollution that affects the geology, soil and ecology of an area. The food industries must be aware of the contents of the wastes they generate with the view to making them environment friendly.

As a result, environmental auditing is a management tool that systematically, periodically and objectively

reviews performance of existing projects, organizations, management and equipment with the aim of safe-guarding the environment (FEPA, 1995; Chukwu, 2005). It is one of the technical activities, which characterize the Nigerian environmental impact assessment procedure developed by the Federal Environmental Protection Agency in FEPA (1995). It involves a periodic assessment of the positive and negative impacts of a project. As a post-commissioning activity, environmental auditing is the organization and analysis of environmental monitoring data in order to establish the record of change associated with a project. It also, enables the comparison of actual and predicted impacts in order to determine the effectiveness of the impact assessment and management practices and procedures. When used in this way, it is called impact monitoring (Partidario, 1996). Impact monitoring is the activity undertaken to identify variation in environmental parameters, which can be attributed with confidence to the presence of a project. Its role is to identify project-induced change and it can assist in the management of environmental effects by observing the extent of change and the degree of mitigation, which is necessary (FEPA, 1995; Sadler, 1996).

The need for environmental auditing: It is never possible in advance to predict all the environmental impacts of a development project with complete certainty or accuracy. Moreover, no situation is static or incapable of improvement. What is needed, therefore, is a regular environmental audit or review of projects after their implementation. This involves the systematic examination of the consequences for the environment of the projects and the continuing identification of means of reducing adverse impacts. This is increasingly becoming a part of sound environmental management in many countries and a part of normal management practice in many commercial enterprises (Olesen *et al*., 1996). The aim (EEC, 1993) is to safeguard the environment by identifying the defects of an establishment (either a single plant or enterprise or an entire organization) whether of design, technology, operations, management or maintenance that are contributing to environmental pollution and degradation, facilitating management control of environmental practices, assessing compliance with industrial policies (including the meeting of regulatory requirements and relevant standards), increasing awareness of the establishment's environmental performance and identifying the scope for improvement and prioritizing preventive and remedial actions.

MATERIALS AND METHODS

Description of the study areas: The 2 industries NAS Nigeria Limited and CAD Nigeria Plc are located in Jos and Ikeja, Nigeria, respectively. Jos is a city in the middle belt of Nigeria and capital of Plateau State. It is on Lat. 9° 52' N and Long. 8° 54' E. Jos is about 1250 m above sea level on the Delimi River. The average monthly temperatures range between 21 and 25°C. The monthly rainfall ranges from 200-325 mm between May and September and 2.5-85 mm for the months of January through April and October through December (Chukwu, 2005).

Ikeja is a town in the South-West of Nigeria and capital of Lagos State. Ikeja is on Lat. 6° 30' S and Long. 3° 30' W. It is located in Lagos Mainland. Ikeja is about 305 m above sea level. The average monthly temperatures range between 22.3 and 32.2°C. The annual average rainfall is 1507 mm (Chukwu, 2005).

Design of the study: The study design was based on Investigative Survey Research Approach (ISRA) (Chukwu, 1994). The ISRA for obtaining data entails the schedule of a series of visits to the food processing industries of interest. The tasks accomplished during such visits include inspection and witnessing processing operations, taking relevant measurements, collection of solid and liquid wastes for laboratory analysis, interviewing relevant and competent staff of the industries and residents of the industrial areas and administering questionnaires to them and completion of structured questionnaires from available records kept by the industries. Two types of data were sought for in each of the industrial projects visited. These are qualitative and quantitative in nature and were based on observations, measurements, computations, existing records, information from structured questionnaires, expert opinions and authoritative publications.

Description of the questionnaire: The questionnaire for this study was in 2 parts. Part 1 contains the screening/ preliminary assessments of the natural (physical) environment. It seeks information on potential environmental impacts. It entails the isolation of the elements and sub-elements of the environment, upon which the activities of the food processing industries may have severe or significant impact (s). The key environmental elements screened in this study are geology, soil and ecology. The sub-elements of geology audited are tectonic/seismic/volcanic activity, geological features of human interest at/adjacent to plant site, mineral resources of potential value, current economic significance of the minerals and extractive activity. The sub-elements of soil audited are erosion (including wind and water), soil type and settlement/heave. The sub-elements of ecology audited are species checklists (including unusual, endangered and rare species), unusual plants of scientific value and effect of industry on productivity of land on sight and surrounding area.

Part 2 of the questionnaire sought information about the baseline environment. The baseline environment was the environment without the food processing industry. The purpose was to elicit information from the industries and residents of the industrial area on the environment without the plant, so that all significant direct and induced environmental impacts attributable to the food processing industries would be known. The questionnaire was analyzed in a composite table containing the baseline and screening data from the food processing industries.

Assessment of impacts: At the selected industries, baseline data on the natural environment were collected. These are data that describe the conditions and circumstances of the industrial environment prior to the setting up of the industry. Also, screening tests or assessments on the existing industrial environment were carried out through measurements, computations, interviews and use of structured questionnaires. Screening tests or evaluations give information or data on the conditions and circumstances of the existing industrial environment. It is a form of situation report on the environment. Therefore, assessment of impact involves the evaluation of potential environmental impact through the application of screening tests to isolate the element (e.g., geology) and sub-element (e.g., extractive activity) of the environment, upon which there may be a severe or important impact. The natural environmental elements considered for both baseline data and screening assessment have been listed above.

RESULTS AND DISCUSSION

The baseline data and screening assessment data for NAS Nigeria Ltd and CAD Nigeria Plc are presented in Table 1 and 2 (for geology), Table 3 and 4 (for soil) and Table 5 and 6 (for ecology), respectively. The results of the baseline studies and the screening assessments on geology, soil and ecology (Table 1-6) were used to adjudge whether an impact has occurred or not due to the establishment of the 2 industries-NAS and CAD.

The geology, soil and ecology for the 2 industrial environments are discussed simultaneously to enhance comparative analyses of the environmental parameters studied.

Geology: The mineral resources of potential value identified in the industrial area of NAS plant are tin, columbite and tantalite. The mining of these minerals by a subsidiary of NAS group of companies has depleted the natural reserves. The mining and extractive activities such as quarrying of rocks have increased the economic status of the residents. The presence of geologic features, e.g., rocks encouraged the setting up of modern recreational facilities and commercial outlets in form of parks and workshops. The geological features around the location of Cadbury plant have not been altered in any observable form. It was only the features of human interest such as parks and gardens that have been improved upon commercially (Table 2). The setting up of the parks and gardens involved land excavation, including the removal of vegetation. As a result, terrestrial habitats were endangered leading to migration of arboreal animals to safer places and loss of them in the host communities. This was in agreement with the findings of Ajisegiri *et al.* (2002).

Mining, which is a process of obtaining useful minerals from the earth's crust includes excavations in underground mines and surface excavations in open pit, or open cut (strip) mines. It involves the physical removal of rocks. The mining operation results in the shifting of loads on the strata and in extreme cases such shifting may

Table 1: Assessment of geology of NAS environment

	Sub-element	Baseline data	Screening data	Impact
(a)	Tectonic/seismic/volcanic activity	Nil	Nil	-
(b)	Geological features of human interest at/adjacent to plant site	Commercial outlets and rocks	Commercial outlets, parks and workshops	Modern recreational facilities and commercial outlets
(c)	Mineral resources of potential value	ND	Tin, columbite and tantalite	Encouraged mining activity
(d)	Current economic significance of the minerals	NA	Very useful	Improved mining activity
(e)	Extractive activity	NA	Quarrying	Increased mining activity

ND = Not Determined, NA = Not Applicable. They have these meanings in all tables

Table 2: Assessment of geology of CAD environment

Sub-element		Baseline data	Screening data	Impact
(a)	Tectonic/seismic/volcanic activity	Nil	Nil	-
(b)	Geological features of human interest at/adjacent to plant site	Park, gardens, schools and petrol station	Park, gardens, schools and petrol station	Improved commercial outlets
(c)	Mineral resources of potential value	Nil	Nil	-
(d)	Current economic significance of the minerals	N.A.	N.A.	-
(e)	History of subsidence	Not reported	Not reported	-

Table 3: Assessment of soil of NAS environment

Sub-element	Baseline data	Screening data	Impact
Erosion			
(a) Wind	Dust rain	Dust rain	-
(b) Water	Slight	Slight	-
(c) Soil type	Sandy with rocks	Sandy with rocks	-
(d) Settlement/heave	Nil	Nil	-

Table 4: Assessment of soils of CAD environment

Sub-element	Baseline data	Screening data	Impact
Erosion			
(a) Wind	Nil	Nil	-
(b) Water	Slight	Slight	-
(c) Soil type	Clayey-loam	Clayey-loam	-
(d) Alteration to existing conditions of soils	Nil	Water regime /table	Decreased water regime /table

Table 5: Assessment of ecology of NAS environment

Sub-element	Baseline data	Screening data	Impact
Species checklists			
(a) Unusual species	Present	Absent	Extinct
(b) Endangered species	Present	Absent	Extinct
(c) Rare species	-	-	-
Unusual plants of scientific value	Nil	Nil	-
Effect of industry on productivity of land on site and surrounding area	NA	Reduced soil fertility	Reduced yield

Table 6: Assessment of ecology of CAD environment

Sub-element	Baseline data	Screening data	Impact
Species checklists			
(a) Unusual species	Present	Absent	Extinct
(b) Endangered species	Present	Absent	Extinct
(c) Rare species	Nil	Nil	-
Unusual plants of scientific value	Nil	Nil	-
Effect of industry on productivity of land on site and surrounding area	NA	Decreased soil fertility	Reduced yield

Apply pressures on a critical section of rock that exceeds the strength of the rock and result in sudden collapse. This phenomenon, which is known as a rock burst, as reported by Chukwu (2005) occurs particularly in deep mines and was observed in the vicinity of NAS Nigeria Limited.

Dust and emissions from vehicles carrying materials, particularly quarried rock and aggregates generate dust nuisance in communities along their routes. Dust produced during mining and quarrying operations was generally injurious to health and causes the lung disease known as black lung, or pneumoconiosis. It also affects, communities and farm fields in the immediate vicinity of sites. It was significant within 500 m of site where it seriously affects orchards and houses. The effects of dust on climate and air quality have been reported elsewhere by Chukwu *et al.* (2007).

Soils: There has been no significant impact on the soil properties of the industrial area after the establishment of NAS plant (Table 3) just as there was no reported case of severe impact on soil properties, in the case of CAD, except for decreased water table (Table 4). However, we do know that the activities of both industries do have deleterious effects on soil. In soil, acid rain (a consequence of the industries) dissolves and washes away nutrients needed by plants. It can also, dissolve toxic substances, such as aluminum and mercury, which are naturally present in some soils, freeing these toxins to pollute water or to poison plants that absorb them. By removing useful nutrients from the soil, acid rain slows the growth of plants, especially trees. In the final analysis, soil fertility decreases. This is in confirmation of the study by Anikwe and Nwobodo (2002). In Sweden, as many as 10,000 lakes have been polluted by mercury released from soils damaged by acid rain and residents have been warned to avoid eating fish caught in these lakes (Kupchella and Hyland, 1993; Chukwu, 2005). This is because a number of toxic substances that humans encounter regularly may pose serious health risks. For instance, pesticide residues on vegetable crops, mercury in fish and many industrially-produced chemicals may cause cancer, birth defects, genetic mutations, or death (Chukwu, 2005). Many chemicals have been found to mimic estrogen, the hormone that controls the development of the female reproductive system in a large number of animal species. Results have indicated that these chemicals, in trace amounts, may disrupt development and lead to a host of serious problems in both males and females, including infertility, increased mortality of offspring and behavioural changes such as increased aggression.

Another, effect the industries have on soil as reported by Chukwu (2005) is increased compaction due to increased vehicular traffic. More humans and vehicles now ply the industrial areas, leading to soil compaction. Compaction rearranges soil particles, increasing the density of the soil and reducing porosity. Crusts form on compacted soils, preventing water movement into the soil and increasing runoff and erosion.

Ecology: The establishment of NAS Foods at the present site led to the extinction of unusual and endangered species such as monkeys (Table 5). There has also, been a reduction in yield of land on NAS site and surrounding area. The reduced soil fertility could be attributed to leachate from chemical wastes from NAS. The effects of toxic chemicals on soils have been discussed above. According to Ajisegiri *et al.* (2002), the activities of NAS Foods have led to a reduction of 10-25% in yield for livestock grazed on the neighbouring lands. Consequently, farmers and their dependants (76 people in number) could no longer sustain their livelihood and were forced to seek alternative lands. The establishment of CAD at the present location led to a reduction in yield of land on CAD site and surrounding area (Table 6). The

reduced soil fertility could be attributed to leachate from chemical wastes from abandoned and active land filling/waste disposal sites.

Other ecological effects of the 2 industries are reduced yields of crops, animals, fisheries and minerals. The ecological consequences of industrial wastes pollution on crops, animals, minerals, aquatic and terrestrial ecosystems have been discussed by the author elsewhere (Chukwu, 2007). It is to be pointed out at this stage that habitat destruction and species extinction now go on at an unprecedented rate. Estimates that range from 4,000 to as many as 50,000 species per year become extinct. At the CAD site, the destruction of snail habitat led to a significant reduction in snail harvests gathered by rural women and consequent major reduction of the women's income (Ajisegiri *et al*., 2002).

CONCLUSION

The two industries do have both positive and negative impacts on the environment. The positive impacts are more of social services to their host communities. But of greater significance to this study, are the negative impacts of the selected industries on geology, soil and ecology. Soil and water pollution resulting from unrestrained discharge of solid and liquid wastes has impacted negatively on quality of soil and water for man, aquatic life, flora and fauna.

RECOMMENDATIONS

In order to protect the environment from the adverse effects of food processing industries, a number of mitigation measures and management options that should be implemented are hereby recommended. For all the identified negative environmental impacts, it is recommended that utilization of the best available technology; payment of optimal liability compensation to local communities and institutionalization of adequate abatement measures be adopted. The manufacturing processes should be designed to maximize recycling potential and minimize the generation of wastes. For example, new low and non-waste technologies, which can reduce environmental impacts are to be adopted.

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