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Impacts of food processing industry on some environmental health and safety factors

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ABSTRACT
In developing countries, it is common to site (or locate) industries without environmental impact assessment. In this study the impacts of two food processing industries on land use and land capability, noise and vibration, environmentally sensitive areas and visual quality as environmental elements were investigated. The research method adopted was the investigative survey research approach (ISRA) which included the collection of baseline and screening data. Noise level was determined using the decibel scale. The impacts of the industries on land use and land capability, noise and vibration, environmentally sensitive areas and visual quality included: displacement of agricultural production, quarrying activity and fishermen; loss of forestry and pasture lands; cracks on buildings near or adjacent to the industries due to vibrations from heavy machines; noise pollution from processing machines leading to hearing loss/impairment; reduced shell-fish yield; increased commercial and social activities; and distortion of visual content and coherence. 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 the environment and recommendations towards alleviating negative impacts were made.

Keywords: Baseline data, ecosystem,Environmental auditing, Environmental impact assessment, Food processing industry, ISRA.

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 food, 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 can be subdivided into 13 categories, namely: 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 O.O, 1998, unpublished data). Food processing projects involve the processing and packaging of meat products, fish and shell fish, dairy products, fruit and vegetables, grains and beverages production. It includes refinement, preservation, 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 are a part of our environment and are often major generators of wastes. Since the existing environment within 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 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 enterprises. Industrial waste is a major source of environmental pollution that affects the geology, soil and ecology of an area. The food industries should be aware of the contents of the wastes they generate with the view to making them environment friendly.

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 O, 2005, unpublished data). It is one of the technical activities which characterizes the Nigerian environmental impact assessment procedure developed by the Federal environmental protection agency (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 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 (EEC, 1993; Dalzell, 2000).

MATERIALS AND METHODS

Description of the study areas

Two food-related industries were selected for the purpose of this study. Industry A is located in Jos (lat. 9° 52′ N and long. 8° 54′ E, approx. 1250 m above sea level), capital of Plateau State in the middle belt of Nigeria. The average monthly temperature ranges between 21°C and 25°C. The monthly rainfall ranges from 200 mm to 325 mm between May and September; and 2.5 mm to 85 mm for the months of January through April and October through December (Chukwu O, 2005, unpublished data).

Industry B was located in the city of Ikeja 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 temperature ranges between 22.3°C and 32.2°C. The annual average rainfall is 1507 mm (Chukwu O, 2005, unpublished data).

Design of the study

The study design was based on the investigative survey research approach (ISRA) (Anazodo, 1975; Chukwu, 2008). Site visits were made to the selected food processing factories. The tasks accomplished during such visits included inspection of processing operations; taking relevant measurements; collection of solid and liquid wastes for laboratory analysis; interviewing relevant 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 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 publiccations.

Description of the questionnaire

The questionnaire for this study was in two parts. Part 1 contains the screening /preliminary assessments of the natural (physical) environment. It seeks information on potential environmental impacts. It also entails the isolation of the elements and subelements of the environment upon which the activities of the food processing industries may have severe or significant impact. The key environmental elements screened in this study are land use and land capability, noise and vibration, environmentally sensitive areas and visual quality. The sub-elements of land use and land capability audited are the use to which land is put and the capability of the land to support agriculture. The subelements of noise and vibration audited are potential risk to hearing, history of hearing loss, classification of internal noise generated by plant, noise-sensitive land-users within 1.6 km of plant site, noise levels sent to nearby properties, internal vibration levels, permanent and temporary machines that cause vibration and exposure of employees to vibration. The sub-elements of environmentally sensitive areas audited are location of plant, land fills (solid/toxic waste disposal sites) and effects of plant on wetlands. The sub-elements of visual quality audited are visual content and visual coherence.

Part 2 of the questionnaire sought information about the baseline environment. The baseline environment was the environment prior to the establishment of the food processing industry. The purpose was to elicit information from the industries and residents of the industrial area on the environment without the factory, 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. land use and land capability) and subelement (e.g. ability of the land to support agriculture) 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 Industry A and Industry B are presented in Tables 1 and 2 (for land use and land capability), Tables 3 and 4 (for noise and vibration), Tables 5 and 6 (for environmentally sensitive areas) and Tables 7 and 8 (for visual quality), respectively. The results of the baseline studies and the screening assessments on land use and capability, noise and vibration, environmentally sensitive areas, and visual quality (Tables 1 – 8) were used to adjudge whether an impact has

occurred or not due to the establishment of the two industries.

The land use and land capability, noise and vibration, environmentally sensitive areas and visual quality for the two industrial environments are discussed simultaneously to enhance comparative analyses of the environmental parameters studied.

Table 1. Assessment of land use and land capability at industry A.

Sub-element	Baseline data	Screening data	Impact
Land use	Food production/grazing; Quarrying/development	Development	Displacement of agricultural production /quarrying
Land capability	Development/cropland/ range land/pasture land	Development/crop land/range land	Loss of pasture land

Table 2. Assessment of land use and land capability at industry B.

Sub-element	Baseline data	Screening data	Impact
Land use	Development/food production	Development	Displaced agricultural production
Land capability	Forestry/ silviculture	Development	Loss of forestry land

Table 3. Assessment of noise and vibration at industry A.

Sub-element	Baseline data	Screening data	Impact
(a) Potential risk of hearing loss due to internal noise	Very quiet (20dB)	Moderately loud(60dB)	Causes discomfort among residents
(b) History of hearing loss	NA	Moderately loud(60dB)	Minimal discomfort
(c) Classification of internal noise generated by plant	NA	Moderately loud(60dB)	Discomfort
(d) Noise-sensitive land-users within 1 mile (8/5km) of plant site	NA	Recreational areas and Commercial outlets	Source of discomfort
(e) Noise levels sent to nearby properties	NA	Moderately loud	Source of discomfort
(f) Internal vibration levels	NA	Moderately loud	Source of discomfort
(g) Permanent & temporary machines that cause vibration	NA	Milling machines/diesel engines/transport trucks/plant generators/ packaging machines	Source of noise
(h) Exposure of employees to vibration	NA	Short duration (115dB)	Hearing impairment/loss

NA = Not Applicable; dB = decibel (unit of sound level).

Table 4. Assessment of noise and vibration at industry B.

Sub-element	Baseline data	Screening data	Impact
(a) Potential risk of hearing loss due to internal noise	Nil	Nil; workers use ear muffs on floor	-
(b) History of hearing loss	NA	-	-
(c) Classification of internal noise due to plant	NA	Moderately loud(60dB)	Minimal level of discomfort
(d) Noise-sensitive land-users within 1 mile (8/5km) of plant site	Recreational areas/churches/ mosques	Recreational areas/churches /commercial outlets	Source of discomfort
(e) Noise levels sent to nearby properties	NA	Moderately loud	Source of discomfort
(f) Internal vibration levels	NA	Moderately loud	Source of discomfort
(g) Permanent and temporary machines that cause vibration	NA	Boilers/ovens/Allen-Generators/transport trucks	Source of noise
(h) Exposure of employees to vibration	NA	Short duration (115dB)	Ear pain

NA = Not Applicable; dB = decibel (unit of sound level).

Table 5. Assessment of environmentally sensitive areas at industry A.

Sub-element	Baseline data	Screening data	Impact
Location of plant	Prime agric. land/fertile wetland that protected plant &animal species	Prime agric. land; loss of wetlands, plants and animal species	Displaced farmers/families; displaced fishermen/families
Landfills, solid/toxic waste disposal sites	Active/existing	Planned land filling sites	Displacement of farmers
Effects of plant on wetlands	NA	Waste discharge	Reduced shell- fish yield

NA = Not Applicable.

Table 6. Assessment of environmentally sensitive areas at industry B.

Sub-element	Baseline data	Screening data	Impact
Location of plant	Prime agric. land/fertile wetland that protected plants & animal species	Prime agric. land; loss of wetlands, plants and animal species	Displaced farmers and families; displaced fishermen and families
Landfills, solid/toxic waste disposal sites	Does not exist	Active/existing land filling/dump sites	Displacement of farmers
Effects of plant on wetlands	NA	Waste discharge	Reduced shell-fish yield

NA = Not Applicable.

Table 7. Assessment of visual quality at industry A.

Sub-element	Baseline data	Screening data	Impact
Visual content	Cool and serene	Cool and serene	-
Visual coherence	Harmonious with no development	Harmonious/rapid dev./job creation	Increased commercial/ social activities

Table 8: Assessment of visual quality at industry B.

Sub-element	Baseline data	Screening data	Impact
Visual content	Serene	Distorted seriously	Disfigured the environment
Visual coherence	Harmonious with no development	Impaired due to development	Increased commercial/social activities

Land Use and Land Capability

The site of Nasco plant was used for food production, quarrying and grazing (Table 1). The location of Nasco Foods there displaced the activities of agricultural production and quarrying. The removal of vegetal cover due to site preparation and construction led to loss of pasture land. Rangeland and pastureland were hurriedly developed into recreation and commercial outlets. This had a negative effect on sedentary farmers.

The land use and land capability before the location of Cadbury plant were for food production and forestry/ silviculture (Table 2). The location of Cadbury at the present place led to loss of forestry land and also displaced food production activities. As a result, proposed land use was altered and this necessitated the out-migration of farmers to seek alternative sites. The change in land use reported above and the associated many human activities affect the pattern, amount, and intensity of surface-water runoff, erosion, and sedimentation. For instance, the effects of land-use change on the drainage basin and its streams may be quite dramatic. This is because streams in naturally forested or wooded areas may be nearly stable; that is, there is no excessive erosion or deposition. Converting agricultural or forested land to an industrial site, especially during the construction phase, generally increases the runoff and sediment yield or erosion of the land. As a result, streams become muddy and may not be able to transport all of the sediment delivered to their channels. Therefore, the channels will partially fill with sediment, which may be accompanied by a moderate increase in runoff. The response of streams in the area is complex and may include both channel erosion and aggradations, resulting in wide shallow channels. The combination of increased runoff and shallow channels increases the flood hazard. Following the construction phase, much of the land is covered with buildings and

sediment yield drops to a low level. However, the large impervious areas increase runoff which increases the magnitude and frequency of flooding. The streams may respond to the lower sediment yield and higher runoff by eroding (deepening) their channels. Channelization has adverse environmental effects including, inhibition of the production of fish and wetland wildlife and degradation of the aesthetic qualities of streams (Ajisegiri, et al., 2002; Anikwe & Nwobodo, 2002).

Noise and Vibration

Noise pollution represents the exposure of people or animals to levels of sound that are annoying, stressful, or damaging to the ears. Noise generated by Nasco is of the order of 60 – 115dB (Table 3). Before the establishment of the plant, the area was classified as being very quiet and of the order of 20dB on the decibel scale. Recreation centres, commercial outlets, milling and other processing machines, diesel engines, transport trucks, plant generators as well as packaging machines have singly and severally caused discomfort among residents. The permissible noise level to guarantee minimal comfort to humans is 80 dB (Kupchella & Hyland, 1993). Exposure of employees to vibration has led to ear and hearing impairment/loss. However, damage to structure due to permanent and temporary machines that cause vibration has not been reported (Table 3).

In the case of Cadbury, the industrial area hitherto described as being quiet (40dB on the decibel scale) is now classified as being moderately loud (60dB) due to internal noise generated (Table 4). Noise sensitive land users such as churches, mosques and recreation centres within 1.6km of plant site now complain of discomforting noise. The permanent and temporary machines that cause vibration include boilers, transport trucks, Allen generators and ovens (Table 4). The employees are exposed to vibration risk of the order of 115dB sound level. This causes ear pain but there has been no case of hearing loss due to internal noise because workers normally use ear muffs on floor.

The most significant health problem caused by noise pollution is hearing loss. This is because any noise appreciably louder than talking can damage the delicate hair cells in the cochlea, the structure in the inner ear that converts sound waves into auditory nerve signals. Even though hearing loss has not been reported by the industrial workers, it has to be pointed out that the initial damage to the cochlea may be temporary, and with repeated exposure, the damage becomes permanent. It has been reported that sound levels of only 85 decibels will cause some hearing loss after prolonged exposure (Hauschild & Wenzel, 1998). In addition to deafness, many people with damaged ears are afflicted with tinnitus, or ringing in the ears. Even at levels below those that cause hearing loss, noise pollution produces problems. Noise makes conversation difficult, interferes with some kinds of work, and disturbs sleep. As a source of stress, it can promote high blood pressure and other cardiovascular problems, as well as nervous disorders. Noise also puts stress on domestic animals and wildlife. Noise from industrial processes frightens animals. There is concern that increasing noise levels in the oceans may confuse the natural sonar that whales use to navigate, communicate, and locate food. Since noise pollution is not a necessary price to pay for living in an industrial society, much can be done to reduce the severity of the problem (Chukwu O, 2005, unpublished data).

Environmentally Sensitive Areas

The location of Nasco plant is on prime agricultural land and fertile wetland (Table 5). This led to the displacement of farmers and their families. The loss of wetlands (which protected plants and animal species) to Nasco led to displacement of fishermen and their families. Plants and animal species were also lost due to the removal of vegetal cover. Land filling and waste discharge also caused reduced shellfish yield. The attendant loss of their means of livelihood caused serious agitation by the farmers, fishermen and their families. This led to strained relationship between them and Nasco Foods.

Cadbury plant is located on prime agricultural land and fertile wetland. Prime agricultural lands and fertile wetlands which hitherto protected plants and animal lives were lost and shellfish cropping was reduced (Table 6). There was a loss of 30% – 45% of shellfish yields. This affected between 60 and 75 local shell fishermen who provided the

principal or only source of income for 260 – 320 people. (Most fishermen had assistance from one or more members of their family). Up to 22 of the fishermen have skills which were needed in Cadbury but 40 – 55 men had to switch to other types of fishing. This imposed considerable stress on existing in-shore fishing and resulted in over fishing and bankruptcies. The consequence was display-cement of farmers, fishermen and their families with it attendant social dislocation and loss of income (Ajisegiri et al., 2002).

Visual Quality

Visual quality here implies the visual amenity or aesthetics of the industrial location. One important effect of a new industrial plant is its visual impact. This is particularly marked in areas with outst-anding scenic quality and where the development impinges directly on people and their residential and recreational areas. At the Nasco location (Table 7), devel-opmental activities adversely affected the content of the scene formerly perceived by the residents of the surrounding area. The Nasco plant also distorted and impaired the visual coherence of the surrounding area. Before the location of Nasco plant, the area was described as serene and harmonious. The area became disfigured due to enhanced commercial and social activities, high rise buildings and emission/dispersion of dusts and exhaust gases into the atmosphere.

In the case of Cadbury (Table 8), the visual content and coherence which were respe-ctively serene and harmonious respectively became seriously distorted and impaired due to developmental activities. The environment became disfigured due to enhanced comm-ercial and social activities, noise from trucks conveying raw materials and finished products, emission and dispersion of gaseous air pollutants and dusts. The effects of dusts and other gaseous deposits on vegetation include discolouration, reduction in rate of transpiration, and decreased photosynthetic areas. It also has adverse effects on pasture, rangeland and grazing animals. This forced pastoral farmers to look for grazing sites elsewhere. More so, the hurly-burly which characterizes city life became the life style of the industrial area (Chukwu et al., 2007).

CONCLUSION AND RECOMMEND-ATIONS

The two industries considered in this study do have both positive and negative impacts on the environment. The positive impacts are more in the nature of social services to their host communities. Of greater significance to this study are the negative impacts of the selected industries on land use and land capability, noise and vibration, environmentally sensitive areas and visual quality. Pollution of environmental elements resulting from unrestrained activities of the food processing industries has impacted negatively on land use and land capability for man, aquatic life, flora and fauna.

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 of the identified negative environmental impacts, it is recommended that utilization of the best available technology; payment of optimal liability compensation to local com-munities and institutionalization of adequate abatement measures be adopted. The manufacturing processes should be designed to maximize recycling potential and min-imize the generation of wastes. For example, new low and non-waste technologies which can reduce environmental impacts should be adopted.

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