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Environmental Impact of Construction Site Activities in Ghana.

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Abstract

This paper reports on a study to assess the negative impacts of construction site activities on the environment using structured questionnaire survey approach. Fifty-five major construction sites involving a total of 330 contractors, site workers, consultants, and nearby residents were studied using the convenience purposive sampling method. The results showed that blasting, site clearance, earthmoving, and demolishing are the main site activities having adverse environmental impacts in Ghana. "Public nuisance" effects arising from construction site activities are degraded air quality from dust and stack emissions, noise and vibration from the use of powered mechanical equipment, and construction waste materials. The breeding of mosquitoes and other pests is also of concern to construction practitioners. Site workers, people in schools and hospitals, and nearby residents may suffer from sleeplessness and stress effect caused by noise nuisance, and allergies caused by dust nuisance from construction sites activities. Measures that will ensure the use of the best practicable means to reduce "public nuisance" effects should be instituted to address the concerns of nearby residents and the general public. Monitoring regulations to ensure that contractors measure and report impact levels during construction are recommended.

Keywords*:* environmental impact, construction site, construction industry, Ghana

INTRODUCTION

The impact of construction activities on the environment has recently been recognized the world over, and the evaluation of the environmental impacts of construction activities is currently required by law in many countries (Tam et al., 2006; Teixeira, 2005; Cole, 2000; Ofori et al., 1999). Construction sites may cause damage to the environment, and also interfere in the daily lives of local residents. Inconveniences caused by construction activities include dust and noise generation, waste materials deposition in public spaces, soil and water contamination, damage to public drainage systems, destruction of plants, birds and terrestrial fauna etc (Esin and Cosgun, 2007; Tam et al., 2006; Teixeira, 2005; Cole, 2000; Ofori, et al., 1999).

Although the relationship between construction activities and the environment has been extensively studied, and has become of strategic importance in the developed countries, the situation is different in many developing countries including Ghana. Chrisna du Plessis (2002) observes that sustainable construction in developing countries tends to focus on the relationship between construction and human development, often marginalizing the environmental aspect. In his opinion biophysical considerations in the built environment has not been clearly articulated beyond the impact on environmental health, but hoped that with the severe environmental degradation experienced by most of the developing world, the construction industry cannot continue to ignore the environment. Schaefer (1994) argued that architects, developers, builders and owners often overlook the site as one of the significant elements of sustainable development and construction. So far, development proceeds in a heroic mode - that nature is to be conquered, mastered and subdued for economic gain.

The construction industry will continue to impact the physical environment as long as the industry demands natural resources, and this will assume huge environmental significance with the rapid growth in population and the attendant implications for natural resources (Ebohon and Rwelamila, 2001; Ofori et al., 1999). Housing and infrastructural development which are very resource-intensive, will so much negatively impact the physical environment. The call for sustainable construction is in the realization of the construction industry's capacity to make a significant contribution to environmental sustainability because of the enormous demands it exerts on global resources (Chrisna du Plessis, 2002).

The construction industry is therefore challenged to adopt sustainable approaches to its operations. This challenge has taken the form of compulsion through regulatory control (Petrovic- Lazarevic, 2006; Ofori et al., 2000). Considering laws made to preserve and protect the environment, construction clients and practitioners bear as much of a burden of regulatory compliance and penalties for non-compliance as those operating chemical industries (Francis et al, 1995).

The construction industry has been encouraged to re-use built assets, minimize waste, re-cycle materials, and minimize energy in the construction and use of buildings (Ofori et al., 1999). The industry should also use environmental management systems to reduce pollution, enhance bio-diversity, conserve water, respect people and their local environment, measure performance and set targets for the environment and sustainability (Ofori et al., 1999).

Good construction practice offers both environmental and economic benefits such as reduced health and safety impacts on staff and local community, reduced liability costs in connection with disposal, less remedial work and reduced construction delays (Cole, 2000).

Environmental impacts of the construction process cover resource use and waste generation, ecological loadings and human health issues (Cole, 2000). Construction uses natural resources and generates waste. Waste occurs within the life cycle of buildings (that is during the construction, modification, and demolishing phases). The amount of waste generated by construction, modification and demolition activities is substantial and has become a serious environmental problem in many countries (Esin and Cosgun, 2007; Uher, 1999; Levin, 1997; Guthrie and Mallet, 1995; Spence and Mulligan, 1995). Surveys conducted in countries such as Brazil, Australia and the United States found the amount of waste generated as high as 20–30% of the total waste entering landfills throughout the world (Ibn-Homaid, 2002; Pheng and Tan, 1998; Wong and Norman, 1997; Bossinick and Brouwers 1996; Akintoye, 1995). Accordingly, waste management at construction sites has assumed substantial international concern. Environmental issues concerning resource use include conscious attempt to salvage materials and components for future re-use and recycling, and the reduction of construction waste and construction energy use. Cole (2000) estimates that as much as 80% of waste generated during construction are re-usable or recyclable since it is relatively clean. Energy and other transportation impacts are also associated with the construction process. Worker transportation to and from the construction site and associated energy use and air emissions arise from the labour-intensive building construction practice. The transportation of materials from distribution centres to the building sites also has energy and environmental impacts. Energy is used to demolish buildings and transport and dispose of waste materials.

Construction and demolition processes cause several direct and indirect environmental impacts. The act of building disturbs pre-existing conditions. Construction of buildings is carried out to occupy the entire site, destroying the natural green system (Teixeira, 2005; Chrisna du Plessis, 2002; Levin, 1997). Construction activities may cause soil compaction, substantial increase in the soil level, opening of ditches and trenches, removal of the superficial soil layer, loss or damage to the roots, and damaging of the trunk and leaves (Teixeira, 2005; Uher, 1999). Trees are natural elements of urban landscape, and must be preserved on construction sites (Esin and Cosgun, 2007; Teixeira, 2005). The preservation of trees is associated with respect for the environment and for the well-being of populations, and damaging existing trees may give rise to complaints and public concern. Construction during the rainy season requires effective storm water control because run-off from construction sites can contain significant sources of pollution including sediment and fine concrete (Cole, 2000). Lubricants and fuels, solvents, pesticides etc. which enter storm drains may pollute water systems with silt and change their chemical balance or remove dissolved oxygen. Water used in construction generates pollutant fluids which may spoil the land and adjacent pavements (Teixeira, 2005; Uher, 1999; Levin, 1997). Washing water from construction sites contains considerable amounts of suspension solids which may block sewage systems and damage pipes and treatment plants. Paints, solvents, oils and washing water from construction sites are also dangerous products. Repair costs of damaged infrastructure are high, and disruption causes severe inconvenience (Esin and Cosgun, 2007; Teixeira, 2005; Teixeira and Couto, 2000).

Construction practice can have direct and indirect human health effects on construction workers, building occupants and residents near construction sites. Even with careful management, some toxic substances in paints, solvents wood preservatives, pesticides, adhesives and sealants, which are hazardous to workers, are released into the air, soil or water. Cole (2000) states that occupants of buildings undergoing remodeling or renovations should also be given adequate degree of protection, since dust and vapours from construction areas are easily transported into occupied zones by air currents, people moving between zones and by heating, ventilation and air-conditioning systems.

Construction site activities can create "public nuisance" effects, as building construction operations can be disturbing to people living near the site (Blodgett, 2004). Noise and odours can be annoying and disruptive (Blodgett, 2004; Cole, 2000). Excessive noise generated on a construction site may affect the right to silence, comfort and health of workers, nearby residents and the visiting population, and may have negative influence on normal activities of nearby schools, hospitals and other services (Teixeira, 2005; Blodgett, 2004; Choi, 1997). Excavation and earth movements, demolition and other construction activities may produce blowing clouds of dust, with pernicious effects on people suffering from respiratory diseases, and may also cause eye irritation and other health risks; dust can require increased cleaning (Teixeira, 2005; Blodgett, 2004; Cole, 2000; Uher, 1999; Levin, 1997; Choi, 1997). Many air quality permits require that sampling be done once every 7 days for one 24-hour period, indicating that the air quality at any site is sampled 14% of the time (Blodgett, 2004).

Site fences and other items produce aesthetic degradation, which may be viewed as environmental aggression (Esin and Cosgun, 2007; Teixeira, 2005; Blodgett, 2004). Traffic of vehicles and machinery from the site or related to the site may also introduce a significant increase in local traffic and resultant safety hazards (Teixeira, 2005; Blodgett, 2004). Parking spaces usually available are often reduced due to the increased demand of workers and suppliers. Teixeira (2005) states that construction activities can seriously cause damage of public spaces such as pavements, garden spots, concrete drains, and inspection covers.

Although the effects of construction site activities on the environment has recently gained increased importance the world over, the situation is different in Ghana. A survey was conducted to assess the negative impacts of construction site activities on the environment, and "public nuisances" arising from specific construction site activities in Ghana.

METHODOLOGY

An investigation in the form of questionnaire survey and interviews was conducted to identify the main impacts of construction site activities on the environment and the causes and effects of "public nuisances" arising from construction site activities. The convenience purposive sampling method was used (Mugenda and Mugenda, 1999; Patton, 1990) to select construction sites for the study. Five major donor-funded road projects and 50 building construction sites in the Kumasi and Accra metropolitan areas were selected. The projects sites were selected because the construction works actively going on at the time were considered suitable for the study. Most major construction projects suitable for the study could be found in the Kumasi and Accra metropolitan areas. The contractors involved in the selected sites were registered in Class K1, D1 or D2. The respondents drawn from the selected sites were in four categories – contractors, site workers, consultants, and nearby residents. The contactor and consultant-respondents targeted in the study were mainly senior management personnel who are relevant to decision making in their firms. The site worker-respondents were those considered technically competent to address issues raised, whilst nearby residents who lived within 500 meters radius or distance from the selected sites were targeted.

Both closed and open-ended questions were used in the survey. The questionnaire consisted of two sections. The first section inquired about the context of the respondent's business and professional background. The second section comprised issues about the impacts of construction site activities on the environment. For each of the 55 selected construction sites, one questionnaire was given to the construction manager, the foreman and the consultant in charge of the project, whilst five questionnaires were administered to randomly selected nearby residents in a face-to-face approach. This resulted in a total of 55 questionnaires per group for the construction managers, site workers and the consultants, and 275 for nearby residents. Of the questionnaires delivered, 35 were completed by contractors (response rate = 64%), 31 were completed by site workers (response rate = 56%), and 38 completed by the consultants (response rate = 69%). Two hundred and twenty-six (226) questionnaires were also completed by the nearby residents (response rate = 82%). The response rates obtained were considered enough to ensure validation of the data obtained.

Qualitative analyses were adopted for the environmental impacts of construction site activities. Respondents were asked to express their views on the impacts of construction site activities on the environment on a five-point Likert scale (from 1= "not severe" to 5="extremely severe"). The factors were ranked according to the mean scores μ calculated using the following formula:

$$\mu = \frac{\sum_{i=1}^{5} i.f_i}{\sum_{i=1}^{5} f_i} \quad \text{................ (1)}$$

Where f is the frequency of score i for the factor concerned.

Mean score above 3 implies that the factor under consideration is severe. The one sample t-test was used to determine whether the mean score of a factor is significantly different from the population mean, $\mu = 3$ (Ofori et al., 2002; Tse, 2001). The test statistics were obtained from the formula,

$$t = \frac{\sqrt{n}(X - \mu_x)}{S} \quad \text{.................. (2)}$$

Where X is the sample mean, μ_x is the population mean, S is the sample standard deviation, and n is the sample size.

RESULTS AND DISCUSSIONS

Profile of study areas and respondents

All the respondents were drawn from five major donor-funded road projects and 50 building construction sites in the Kumasi and Accra metropolitan areas. Accra is a highly populated capital city of Ghana, and Kumasi, the second largest city in the central portion of Ghana, is also highly populated. The selected construction sites were either in the busy city centre, a highly populated residential area, or in an academic institution. Nine percent (9%) of the selected contractors are registered in Class K1, 54% in D1 and 37% in D2, and were international and local contractors. Forty-six percent (46%) of the consultant-respondents were civil and structural engineering firms, and 54% were architectural design and quantity surveying firms. Among these consultants, 67% were regional consultants and 33% focused on international operations. The contactor and consultant-respondents to the questionnaire were mainly Construction Managers, Senior Quantity Surveyors, Project Managers and Resident Engineers. The site worker-respondents were mainly foremen and site supervisors at the selected construction sites whilst nearby residents were mainly public/civil servants, business/self-employed people, and the unemployed.

Initial analysis indicated that there were no significant differences in the responses from contractors, site workers and consultants. Their responses were therefore grouped together under "construction practitioners" in the analysis. The views of residents near construction sites were considered separately from that of the construction practitioners.

Site activities adversely affecting the environment

Respondents in the four categories were asked to suggest which site activities had adverse environmental effect. The results presented in Table 1 show that all the site activities evaluated had mean scores above the population mean of μ = 3.000, except *renovation* evaluated by residents near construction sites. When the mean scores of these activities were tested using the one sample t-test at 5% significance level, they were found to be statistically significant, except *renovation.*

Table 1 Site activities adversely affecting the environment

Site activities	Construction practitioners			Nearby residents		
	Mean score	Std. Dev.	Ranking	Mean score	Std. Dev.	Ranking
Blasting	4.533	0.640	1	4.512	0.597	3
Earthmoving	4.411	0.669	2	4.610	0.542	2
Site clearance	4.344	0.656	3	4.756	0.435	1
Demolishing	4.300	0.644	4	4.415	0.756	4
Excavation	4.189	0.685	5	4.317	0.706	5
Driving piles	4.133	0.706	6	3.781	1.107	10
Test drilling	4.011	0.742	7	4.098	0.889	8
Transportation	3.856	0.743	8	4.171	0.803	7
Landfill, compaction and leveling	3.744	0.773	9	4.268	0.775	6
Concrete batching, mixing and placement	3.578	0.834	10	3.951	0.947	9
Concrete vibration	3.422	0.899	11	3.489	1.028	11
Renovation	*3.111	1.043	12	2.781	1.013	12

** T-test indicates that the mean score above 3.000 is not significant at 5% level*

The ranking of all the activities (Table 1) shows that construction practitioners and nearby residents chose the same five site activities as those which had the most adverse environmental effects. Blasting, site clearance, earthmoving, demolishing, and excavation are the construction site activities that had the most adverse environmental effects. Whereas construction practitioners ranked blasting first and site clearance third, nearby residents ranked site clearance first and blasting third. Both respondent-groups ranked earthmoving, demolishing and excavation equally, as second, fourth and fifth respectively. The ranking of the other activities differed among the respondent groups. The results show that *renovation works* have no serious environmental effect.

The activities identified in this study are among those reported by the U.S. Environmental Protection Agency (n.d) as resulting in environmental degradation. The results therefore indicate that if these activities can be controlled or carried out within acceptable levels, the adverse environmental impacts of construction activities can greatly be reduced.

"Public nuisance" effects from construction site activities

Respondents were requested to indicate which "public nuisance" effects are caused by construction site activities. Eight effects emanating from construction site activities were considered of concern (Table 2). The mean scores of all the effects evaluated by the construction practitioners, except for *chemical pollution from spillage,* were above the population mean of 3.000 and were also found to be statistically significant when tested using the one sample t-test ($p=0.05$). All the effects evaluated by the nearby residents had mean scores above 3.000, and were also found to be statistically significant ($p=0.05$) except for *mosquitoes from stagnant water*. Thus apart from *chemical pollution from spillage* on construction sites and *mosquitoes from stagnant water*, all the public nuisance effects from construction sites that were evaluated by the respondents were considered significantly severe. Table 2 shows divergence of opinions between construction practitioners and nearby residents in the ranking of the "public nuisance" effects. Whereas nearby residents ranked *dust generation* and *noise generation* as the first and second most severe effects respectively from construction site activities, construction practitioners ranked *generation of waste materials* first, followed by *air pollution from toxic emissions* ahead of *dust* and *noise generation*. For construction practitioners, the *breeding of mosquitoes in stagnant water* was more severe than *vibration*, and these were ranked fifth and sixth respectively. Nearby residents, however, ranked *vibration* from construction sites as a more severe activity (ranked fourth) than the *breeding of mosquitoes in stagnant water* (ranked eighth on the list). Residents near construction sites are therefore more concerned, and paid much attention to environmental impacts that directly affect them. The results, generally, show that apart from *the generation of waste materials*, *the generation of dust*, *noise* and *vibration* were key concerns to residents. Construction practitioners, however, seem to be more concerned about issues relating to cost and general pollution than the direct impact of their activities on nearby residents. The *breeding of mosquitoes and other pests* was of concern to construction practitioners seemingly because it affects the health of their workers. Contractors are also expected to give consideration to the concerns of nearby residents and the general public, and take corrective measures to address the nuisance effects of their site activities.

The results agree well with findings from other studies which identifies similar "public nuisance" effects from construction site activities. Building construction operations are reported to disturb people living near the site (Blodgett, 2004). Noise and odours can be annoying and disruptive (Blodgett, 2004; Cole, 2000). Excessive noise generated on a construction site may affect the right to silence, comfort and health of workers, nearby residents and the visiting population, and may influence normal activity of nearby schools, hospitals and other services (Teixeira, 2005; Blodgett, 2004; Choi, 1997). Excavation and earth movements, demolition and other construction activities are reported to produce blowing clouds of dust, with pernicious effects on people suffering from respiratory diseases (Teixeira, 2005; Cole, 2000; Uher, 1999; Levin, 1997; Choi, 1997). Dust may also cause eye irritation and other health risks (Uher, 1999; Levin, 1997).

Table 2 Nuisance effects from construction site activities

Nuisance effect	Construction practitioners			Nearby residents		
	Mean score	Std. dev.	Ranking	Mean score	Std. dev.	Ranking
Generation of waste materials	4.678	0.470	1	4.342	0.656	3
Air pollution from toxic	4.622	0.488	2	4.000	0.742	5
emissions	4.489	0.503	3	4.683	0.471	1
Dust generation	4.400	0.557	4	4.512	0.553	2
Noise generation	4.156	0.669	5	*3.073	1.081	8
Mosquitoes from stagnant water	4.022	0.749	6	4.195	0.749	4
Vibration	3.511	0.864	7	3.781	0.909	6
Construction traffic	2.878	0.946	8	3.512	0.925	7
Chemical pollution from spillage						

** T-test indicates that the mean score above 3.000 is not significant at 5% level*

Noise from construction sites activities

Apart from *the handling of steel bars* on construction sites, all the site activities identified by the construction practitioners and nearby residents had mean scores above 3.000, and were also found to be statistically significant when tested using the one sample t-test ($p=0.05$). Both the construction practitioners and nearby residents ranked *powered mechanical equipment* as the site activity that generates the most noise (Table 3). Both groups of respondents chose the same four activities, *the use of powered mechanical equipment, use of excavators, use of dozers,* and *hammering works* (ranked 1 to 4) as the activities that generate the most noise on the site. Opinions of the groups, however, differed in the ranking of the other severe site activities causing noise generation. The use of powered mechanical equipment and other heavy-duty construction equipments have been recognized to cause excessive noise on construction sites (Gangolells et al, 2009; Teixeira, 2005; Blodgett, 2004; Blodgett, 2004; Cole, 2000; Choi, 1997).

Various practical directives have been given for controlling such harmful noise on site. Vehicles such as excavators, dozers and scrappers can be noisy when operating under load or during quiet background conditions.

Table 3 Sources of noise generation from construction site activities

Sources of noise	Construction practitioners			Nearby residents		
	Mean score	Stand. dev.	Ranking	Mean score	Stand. dev.	Ranking
Use of powered mechanical equipment	4.644	0.481	1	4.725	0.452	1
Use of excavators	4.433	0.520	2	4.500	0.506	3
Use of dozers	4.300	0.589	3	4.375	0.628	4
Use of scrappers	4.144	0.591	4	3.925	0.859	6
Hammering works	4.000	0.636	5	4.575	0.501	2
Rubble disposal	3.867	0.657	6	3.500	0.934	7
Erection or dismantling of formwork/ scaffolding	3.567	0.794	7	4.175	0.747	5
Steel bars handling	2.822	0.882	8	2.950	0.815	8

**T-test indicates that mean scores of all factors above 3.000 were significant at 5% level*

The study also showed that over 60% of the construction practitioners considered the level of noise generated by construction site activities as high, whereas 95% of nearby residents considered the level to range from high to excessive. On the time of most noise occurrence, 51% of construction practitioners were of the view that most noise occur in the afternoons, 41% in the morning, and the rest were undecided. In the case of nearby residents, however, 70% were of the view that most noise occur in the afternoons, and 25% in the morning. Since nearby residents are almost always affected by the activities on the site, they are more sensitive and pay much attention to noise generation on the site than construction practitioners, and this accounts for their high percentage in the assessment. Noisy activities in the afternoon should suit nearby residents better than in the evening since the afternoon is less sensitive as most residents leave home for work in the morning and return home in the evening. However, afternoon noise is of much concern to people in schools and hospitals in the vicinity.

Dust from construction site activities

Opinions of the four groups of respondents were sought on construction activities which generate dust on site. The results are presented in Tables 4a and 4b. The results show that apart from *restoration of site with the placement of topsoil and sowing down of grass*, all the site activities evaluated by the contractors, site workers and nearby residents had mean scores above 3.000 and were also found to be statistically significant when tested using the one sample t-test ($p=0.05$) except for *concrete batching* (for contractors), *crushing and screening of aggregates* (for site workers and residents near construction sites), and *transporting of fill on public roads* (for nearby residents). *Demolishing and material handling* was not statistically significant, but *restoration of site with the placement of topsoil and sowing down of grass* was statistically significant ($p = 0.05$). All the respondents ranked dust from *exposed areas of soil and gravel,* and *vehicle activity on dry unsealed roads* as the first two significantly severe sources of dust on construction sites (Tables 4a and 4b). Apart from site workers, all the other respondents ranked *dust from exposed areas of soil and gravel* first in the list of sources of significantly severe dust. The ranking of the other sources of dust differed with the different respondent groups. Contactors and consultants did not consider *concrete batching* to generate significant dust on site. Contractors and nearby residents did not consider *restoration of site with the placement of topsoil and sowing down of grass* to generate significant dust on site. The sources of dust on construction sites identified in the study agree with those reported in other studies. Degraded air quality from particulate matter arising from exposed ground areas have been recognized as a nuisance effect from construction site activities (Gangolells et al, 2009; Teixeira, 2005; Blodgett, 2004). Vehicle activities on construction sites generate excessive dust (Teixeira, 2005; Blodgett, 2004; Cole, 2000; Uher, 1999). Excavation and demolishing activities also cause dust generation on the site (Teixeira, 2005; Blodgett, 2004; Choi, 1997).

All the contractors and consultants, and 52% of site workers considered the level of dust generated by site activities as high, whilst 48% of site workers consider dust level to be low. Fifty-one percent of nearby residents considered dust levels to be excessive and the remaining 45% thought that dust levels were high. On the time of day that most dust was generated by construction activities, 87% of all the respondents were of the view that most dust occur in the morning and afternoon, whilst the remaining 12% (mostly nearby residents) were of the view that most dust occur in the night. The choice of excessive dust levels by the nearby residents is ample indication that they are always affected by the dust nuisance, and are therefore more sensitive, and pay much attention to dust generation on site than construction practitioners. Excessively dusty activities in the morning and afternoon when most residents are away should suit nearby residents better than in the evening when they return home.

Dusty mornings and afternoons, however, is of much concern to people in schools and hospitals in the vicinity. Nearby homes can be covered with fine layer of dust from construction site which creates public nuisance for people unfortunate enough to live near such operations (Blodgett, 2004). Excavation, demolishing, vehicle activities etc. have been found to generate dust which can result in health risks (Teixeira, 2005; Blodgett, 2004; Cole, 2000; Uher, 1999; Levin, 1997; Choi, 1997).

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Table 4a Sources of dust from construction site activities - contractors and site workers' opinion

Sources of dust	Contractors			Site workers		
	Mean score	Std. dev.	Ranking	Mean score	Std. dev.	Ranking
Dust from exposed areas of soil and gravel	4.629	0.598	1	4.323	0.702	2
Vehicle activity on dry unsealed roads	4.457	0.657	2	4.516	0.677	1
Excavation and placement of the fill	4.371	0.670	3	3.903	0.831	5
in stock piles or to embankment	4.229	0.731	4	4.032	0.836	4
Stripping and clearing site	4.057	0.765	5	3.742	0.855	6
Transporting of fill on public roads	3.857	0.879	6	4.161	0.779	3
Demolition and material handling	3.686	0.932	7	*3.290	1.039	8
Crushing and screening of aggregates	*3.186	1.040	8	3.452	0.995	7
Concrete batching	2.943	1.120	9	2.903	1.044	9
Restoration of site with the placement of topsoil and sowing down of grass						

** T-test indicates that the mean score above 3.000 is not significant at 5% level*

Table 4b Sources of dust from construction site activities – consultants and nearby residents' opinion

Sources of dust	Consultants			Nearby residents		
	Mean score	Std. dev.	Ranking	Mean score	Std. dev.	Ranking
Dust from exposed areas of soil and gravel	4.667	0.482	1	4.525	0.506	1
Vehicle activity on dry unsealed roads	4.458	0.588	2	4.400	0.496	2
Excavation and placement of the fill	4.208	0.779	4	3.825	0.874	4
in stock piles or to embankment	3.750	0.847	7	4.125	0.686	3
Stripping and clearing site	4.083	0.717	5	*3.010	0.928	8
Transporting of fill on public roads	*3.133	1.050	8	3.400	0.900	6
Demolition and material handling	4.417	0.504	3	*3.075	0.971	7
Crushing and screening of aggregates	2.417	0.974	9	3.600	0.871	5
Concrete batching	3.875	0.797	6	2.250	0.870	9
Restoration of site with the placement of topsoil and sowing down of grass						

** T-test indicates that the mean score above 3.000 is not significant at 5% level*

Other effects of construction activities

The study identified four causes of vibration namely, *the use of powered mechanical equipment*, *movement of heavy-duty equipment, blasting,* and *hammering works*. Black smoke or fume from construction equipment, and smoke from open burning of refuse on construction sites were also identified as two main causes of air pollution from toxic emissions from construction sites. Respondents were all of the opinion that *diversion around construction sites* and *road closure due to construction activities* are the two main causes of construction traffic arising from construction sites activities. With regards to the level of construction traffic, 55% of nearby residents regarded it high or excessive and the remaining was split between low and undecided. For the consultant, 60% considered the level of traffic as high and 40% of them considered it as low. Fifty percent of site workers considered the level as low and 40% as high. The contractors were split in opinion on low (33%), high (33%) and excessive (33%). Majority of respondents (over 65%) from the four categories were of the view that construction traffic is very frequent in the morning. The rest, mainly consultants, were also of the view that frequent construction traffic occur in the afternoon.

Health hazards arising from construction site activities

On health hazards due to construction site activities, respondents were unanimous in their views that *sleeplessness* and *stress effect* are the two main health hazards caused by noise, whilst *respiratory disorders*, *asthma*, and *allergies* are the three main health hazards caused by dust generation on construction sites (Figures 1 and 2).

Nearby residents were most concerned about health hazards arising from noise and dust than the other respondent groups (Figures 1 and 2). Ninety-six percent (96%) and 92% of nearby residents identified sleeplessness and stress effects respectively as major health hazards from noise, whilst 91%, 88% and 76% also identified respiratory disorders, asthma and allergies respectively as major health hazards from dust. Excessive noise generated on construction sites is reported to affect the health of workers, nearby residents and the visiting population (Teixeira, 2005; Blodgett, 2004; Choi, 1997). Excavation and earth movements, demolition and other construction activities have been found to produce blowing clouds of dust, with pernicious effects on people suffering from respiratory diseases; dust also causes eye irritation and other health risks (Teixeira, 2005; Blodgett, 2004; Cole, 2000; Uher, 1999; Levin, 1997; Choi, 1997).

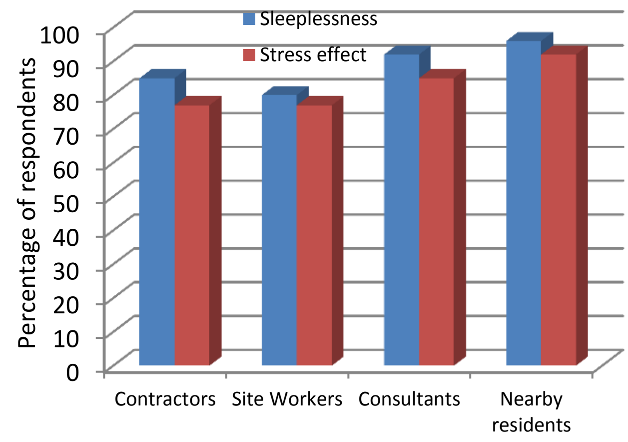

Fig. 1 Comparing health hazards from noise nuisance from construction activities

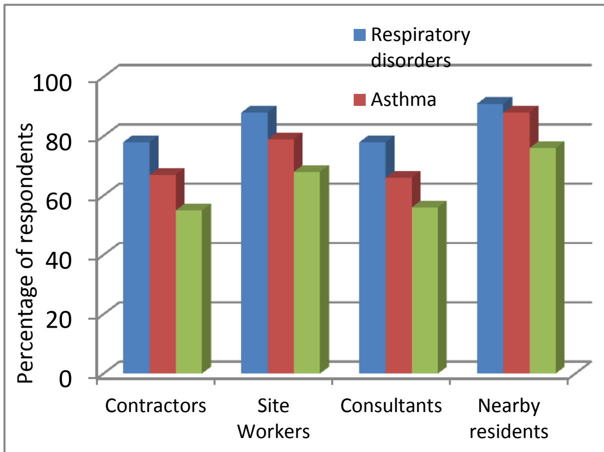

Fig. 2 Comparing health hazards from dust nuisance from construction activities

People likely to be affected by negative effects of construction site activities

On people likely to be adversely affected by the impacts of construction site activities, respondents indicated three groups most severely affected in the following order: nearby residents (75%), site workers (65%), and people in schools and hospitals in the neighborhood (35%). The results explain why residents are worried and concerned about effects of construction activities in their neighborhood, given the close proximity of some residents to construction sites. Public concerns over the environmental impact of construction activities must therefore be given serious attention. The results show that construction practitioners are not only concerned about the health of residents in the neighborhood but also that of their site workers. Building construction operations can be disturbing to people living near the site. Noise and odours can be annoying and disruptive to nearby residents, site workers, and people in schools and hospitals in the neighborhood (Blodgett, 2004; Cole, 2000). Excessive noise generated on construction sites affect the right to silence, comfort and health of workers, nearby residents and the visiting population, and influence normal activities of nearby schools, hospitals and other services (Teixeira, 2005; Blodgett, 2004; Choi, 1997).

Impacts on the ecosystem

Respondents' views on ecosystem impacts arising from construction site activities are given in Table 7. Mean scores of all the impacts on the ecosystem evaluated by the construction practitioners were above the population mean of 3.000 and therefore considered severe, except *aquatic biota* and *terrestrial and aquatic vegetation*. Mean scores of the impacts evaluated by nearby residents were above 3.000, except *in-stream habitat* and *aquatic biota.* The one sample t-test found mean scores of all the impacts on the ecosystem to be statistically significant ($p = 0.05$) except *birds and terrestrial fauna* which was evaluated by nearby residents. The results show that whereas construction practitioners ranked *loss of wildlife habitat, loss of native plant life, erosion,* and *sedimentation associated with use of heavy machinery* as the four most severe ecosystem concerns in that order, nearby residents ranked *erosion* first, followed by *contamination of surface and ground water, loss of wildlife habitat* and *loss of native plant life* in order of severity. Contrary to the opinion of construction practitioners, nearby residents did not express serious concern over the effect of construction activities on aquatic biota and in-stream habitat. This result suggests that whereas construction practitioners are more concerned about general issues relating to environmental pollution, residents near construction sites are more concerned, about environmental impacts that directly affect them such as erosion and contamination of surface and ground water. Respondents also identified, through interviews, the main cause of contamination of surface and ground water as the discharge of waste and flood water from construction sites into public storm drains.

Construction activities have been found to have adverse impacts on the ecosystem. Trees are natural elements of urban landscape, and must be preserved on construction sites (Esin and Cosgun, 2007; Teixeira, 2005). Construction activities must be carried out in a manner that ensures that the biodiversity value of the land is conserved, and where possible improved. The vegetation of the construction area must be re-established using native plants to provide excellent habitat for invertebrates. As preservation of trees is associated with respect for the environment and for the well-being of populations, damaging existing trees may give rise to complaints and public concern (Esin and Cosgun, 2007; Teixeira, 2005).

Table 7 Impacts of construction site activities on the ecosystem

Ecosystem impacts	Construction practitioners			Nearby residents		
	Mean score	Std. dev.	Ranking	Mean score	Std. dev.	Ranking
Loss of wildlife habitat	4.656	0.501	1	4.317	0.610	3
Loss of native plant life	4.533	0.565	2	4.122	0.714	4
Erosion	4.467	0.565	3	4.659	0.530	1
Sedimentation associated with use of heavy machinery	4.367	0.608	4	3.439	0.950	7
Birds and terrestrial fauna	4.289	0.658	5	*3.220	1.013	8
Contamination of soils	4.133	0.657	6	3.732	0.895	6
Contamination of surface and ground water	3.889	0.756	7	4.489	0.553	2
In-stream habitat	3.367	0.661	8	2.537	1.142	10
Aquatic biota	2.522	0.691	9	2.927	1.034	9
Terrestrial and aquatic vegetation	2.067	0.797	10	3.927	0.818	5

** T-test indicates that the mean score above 3.000 is not significant at 5% level*

CONCLUSIONS

The study has shown that primary environmental impacts of construction site activities in Ghana include *degraded air quality from air particulate matter and stack emissions, noise from the use of powered mechanical equipments, waste materials* and *vibration*. Residents near construction sites are more concerned, and pay more attention to issues such as *dust and noise generation, vibration, waste generation, contamination of surface and ground water* among others. Construction practitioners, however, are more concerned about issues relating to cost and general pollution than the direct impact of their activities on the environment and nearby residents. The breeding of mosquitoes and other pests were of concern to construction practitioners seemingly because they affect the health of their workers. Chemical pollution from spillage is of least severity to construction practitioners. Blasting, site clearance, earthmoving, and demolishing are the construction site activities that were found to have the most severe environmental effects in Ghana.

People living near construction sites, site workers, and people in schools and hospitals are most likely to be adversely affected by construction site activities, and this explains why residents are more worried and concerned about the effects of construction activities in their neighborhoods. They suffer from sleeplessness and stress effect due to noise nuisance, and respiratory disorders, asthma, and allergies due to dust nuisance from construction sites.

Construction organizations are called upon to carry out their activities such that the biodiversity value of the land is conserved, and where possible improved. Limits to hours of working must be enforced to reduce the adverse impact of site activities on local residents and businesses. There should also be specific restrictions on construction vehicles and machinery, and on piling works. Dusty materials have to be sprayed with water during dry weather and the loads of any vehicles carrying potentially dusty materials must be covered during transportation. The cutting and grinding of materials on site should also be controlled.

RECOMMENDATIONS

The following recommendations are made to mitigate the impacts of construction site activities on the environment.

1. Measures taken by contractors to mitigate noise nuisance should be documented in Noise Management Plans of the construction project.
2. Contractors should measure and report on noise during construction. There should be limits to hours of working, construction vehicles and machinery, and on piling works to reduce the impact of construction activities on local residents and businesses. Hydro-demolishing technology (high pressure water jet) may also be used instead of jackhammers to drastically reduce the noise impact (Transport for London, 2009). A Noise Generation Permit should be required in order to carry out noisy activities between 7 p.m. and 7 a.m.
3. Measures to control dust generation must be enforced on construction sites, and contractors should be required to record and report dust levels during construction (Transport for London, 2009). Air quality permits should require that sampling be done once every 7 days for one 24-hour period (Blodgett, 2004). Limits to hours of working must be specified to reduce the impact of dust on local residents and businesses. There should also be specific requirements on construction vehicles transporting materials to and from sites. For example, dusty materials must be sprayed with water during dry weather, and the loads of any vehicles carrying potentially dusty materials must be covered during transportation. The cutting or grinding of materials on site should also be controlled.

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