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Effects of Sand Harvesting on Environment and Educational Outcomes in Public Primary Schools in Kathiani Sub-County, Machakos County, Kenya

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Abstract:
The purpose of this study was to examine the effects of sand harvesting on environment and educational outcomes in public primary schools in Kathiani Sub-County, Machakos County, Kenya. This study was premised on treadmill theory of production proposed by Schnaiberg (1980). The study adopted a survey design. Combinations of purposive and stratified random sampling was utilized in selecting 10 headteachers,10 class teachers, 80 pupils, 2 local administration officer and 2 education officer yielding a sample size of 104 to participate in the study . Data collection instruments were questionnaires and interview guides. The findings of the study were that sand harvesting had a profound negative impact on the environment ranging from destruction of water sources to soil erosion, and destruction of the infrastructure. Public primary schools in Kathiani District were also recording declining education standards in terms of low enrolment retention rates resulting in low academic outcomes in schools in the study locale. It was recommended that the devolved County Government of Machakos County and other stakeholder should regulate sand harvesting activities in order to minimise negative impact on the environment, educational outcomes and overall internal efficiency of schools in areas where the activities are conducted.[197 words] .
Key Words: Effects , Sand Harvesting , Environment , Educational Outcomes, Public Primary Schools , Kathiani Sub-County, Machakos County, Kenya.

Introduction

Background to the study

Literature is prolific which indicates that economic development and human development efforts are increasingly constrained by environmental concerns, including degradation of forests and fisheries, lack of fresh water resources, and poor human health as a result of air and water pollution, largely resulting from human activities (Banister 1998; Chu & Yu 2002). Intensified crop and livestock production combined with misdirected incentives have contributed to increased production of chemical and organic wastes, natural resource and biodiversity loss, and soil erosion. Lack of an adequate supply of clean water, the explosive growth in population, and the artificial methods of cultivation are the most severe environmental problem in many developing countries. Many of the analyses in the economic and medical fields have focused on the negative effects of pollution on learner absenteeism, fatigue, brain development and cognitive functioning of children.

Literature also suggests that there are two main channels through which pollution can affect the children academic outcomes (Mohai et.al. 2011). The first one shows how pollution is associated with absenteeism, fatigue and attention problems. Higher pollution exacerbates respiratory problems and it generates negative effects on academic performance because of the fatigue related to the illness and repeated absenteeism. Environmental pollutants can at the same time lead to long-lasting health problems on children. A second channel condemns the negative impacts of pollutants on brain development and behavioural problems. Higher exposure to pollution is accompanied by a higher probability of being sick and therefore higher chances that children fail to attend school Mohai et al. (2011). This could be a major cause of absenteeism, gradual school dropout and low academic performance in Kathiani Division of Kathiani Sub-County. It is against this backdrop that this study was conceived in an attempt to examine the impact of sand harvesting on environmental degradation and educational outcomes in public primary schools in Kathiani Division, Kathiani District, and Machakos County, Kenya.

Review of related literature

According to many writers, the number of people who have been displaced by environmental degradation is immense. Jacobson (1988) notes that, “environmental refugees have become the single largest class of displaced persons in the world.”Homer-Dixon (1991) further notes that environmental degradation is likely to produce “waves of environmental refugees that spill across borders with destabilizing effects” on domestic order and

international relations. All humans need a healthy environment for their livelihood. Most people from the less developed countries depend on agriculture for their survival. If their environment is degraded, they are likely to be challenged in terms of resources to support educational activities, rivers shall dry up, their farms shall be eroded and crop yields shall go down. This may lead to mass school drop out in the affected areas due to environmental degradation effects on their livelihoods.

Collins (1990), states that the effects of sand and gravel harvesting is; extraction of bed material in excess of replenishment by transport from upstream which causes the bed to lower (degrade) upstream and downstream of the site of removal. Bed degradation can undermine bridge supports, pipe lines or other structures, it may change the morphology of the river bed, which constitutes one aspect of the aquatic habitat, degradation can deplete the entire depth of gravelly bed material, exposing other substrates that may underlie the gravel, which could in turn, affect the quality of aquatic habitat. If a floodplain aquifer drains to the stream, groundwater levels can be lowered as a result of bed degradation. Lowering of the water table can destroy riparian vegetation.

Bruce (2009), observes that river system is replaced with an unstable, difficult to restore and relatively unproductive ecosystem, often with vastly different characteristics from the natural river. The loss of this ecosystem affects the overall environment in many and far reaching ways. Food sources are obviously impacted. The basic result of in-stream mining is the removal of the natural river system. They naturally rely directly, or in part, on food sources in the river to survive. Depriving these fauna of their food sources not only drives them to other areas to attempt to feed, but places a greater amount of stress on other fauna that may be more dependent on those other places for their food. The riverbanks are a special ecosystem that develops, with the extra water and extra sunshine found on the river's edge, in ways that cannot be replicated elsewhere. When the bank's collapse from increased sideways erosion of the river channel, these ecosystems are lost. When the riverbed is deepened, less sediment accumulates on riverbanks in floods so the natural rebuilding of the banks is decreased. The riverbanks are not only a unique habitat, but they supply wildlife with a road to the river to reach food and water. Many species find it difficult to cross open areas because of the risk of predation. Those that do cross are in danger of greater predation because of this increased risk. In-stream mining also impacts diversity. When the in-stream mining removes or alters the river and riverbank habitat, the number of individual species that once lived in those habitats declines (Bruce, 2009).

In Malaysia, the main source of sand is from in-stream mining. In-stream sand mining is a common practice because the mining locations are usually near the "markets" or along the transportation route, hence reducing transportation costs. In-stream sand mining can damage private and public properties as well as aquatic habitats. Excessive removal of sand may significantly distort the natural equilibrium of a stream channel. By removing sediment from the active channel bed, in-stream mines interrupt the continuity of sediment transport through the river system, disrupting the sediment mass balance in the river downstream and inducing channel adjustments (usually incision) extending considerable distances (commonly one km or more) beyond the extraction site itself. The magnitude of the impact basically depends on the magnitudes of the extraction relative to bed load sediment supply and transport through the reach (Kondolf et al, 2001).

In Nigeria, most rural people engage in agricultural activities as means of livelihood. They cultivate and harvest crops and by so doing, removes some of the nutrients from the soil without replenishment. They make land to suffer nutrient depletion and become unusable for further farming. At least 12 million rural dwellers engaged also in other livelihood activities that rely heavily on natural resources for parts of their livelihood which include animal rearing, mining of sand, gravel, rock mining and tree felling. Through these activities, over-cultivation, overgrazing, deforestation and over excavation occurred over time (IFAD, 2002).

Mining of sand and gravel on agricultural land is one of the alternative livelihood activities of the rural people in Nigeria which is now becoming an environmental issue. There is increase in demand for sand for construction and other purpose as communities grow because construction at present requires less wood and more concrete, which sprout a demand for low-cost sand. Mining of sand on farms and fallow agricultural land is becoming common and this is having noticeable impacts on the soil structure, vegetation and local wildlife in the rural areas.

Sand mining is widespread, highly unregulated, uncontrolled and is being carried out at an alarming rate. The gravity of the situation beyond the affected communities and the region at large is enormous and poses a threat not only to the environment but also to food security. Chiefs and land owners gave out land for monetary gains and caring less about the effects of the mining activities on the people and the environment. (Imoru, 2010) Although sand mining contributes to the construction of buildings and development, its negative effects include the permanent loss of sand in areas, as well as major habitat destruction.

Sand dust production was another land-related livelihood activity, which the respondents ranked to be 'severe'. The dust from this activity does not only affect the agricultural activity of the rural people, it pollutes air as well as affects their health. Guach (2001) reported that dust from mining sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry. The air pollution is not only a

nuisance (in terms of deposition on surfaces) and possible effects on health, in particular for those with respiratory problems, but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival.

According to Mutisya (2006), in Kenya, rapidly growing populations in urban areas have contributed to an unprecedented demand for sand to meet the ever-rising needs of the building and construction industry. To meet this demand, sand harvesters have invaded seasonal rivers in Kenya's arid and semi-arid areas, particularly those neighbouring the big cities, in search of this 'precious' commodity. The result has been unsustainable harvesting of sand beyond replenishment levels. The paper demonstrates that sand harvesting has had some severe environmental and socioeconomic effects. The most notable environmental effects include drying of aquifers, riverbank and bed erosion, water and air pollution, reduced water table and loss of valuable trees and animal species. Socio-economically, sand harvesting is a source of livelihood through the provision of incomes and employment opportunities. It is also associated with some negative social problems such as deaths resulting from conflicts between sand harvesters and the local community; prostitution and abuse of drugs and alcohol, which threaten the security of the local residents. Participatory sand harvesting is recommended for sustainable sand harvesting (Mutisya, 2006).

Makanya (2008) carried out a study to assess the impact of sand harvesting on the environment in West Pokot District of Rift Valley Province. The study adopted a research design with a target population of 200 residents of West Pokot District and 3 Provincial Administration. The data were collected using a questionnaire and an analysis of which was carried out in SPSS package. The study revealed that sand harvesting has adverse effects on the environment in terms of its destruction to the environment and the topography of the region. This study did not however examine the impact of the environmental degradation on education which the current study dealt with.

Environmental degradation and the associated resource depletion have been shown to sometimes create or exacerbate conflict between groups competing for these increasingly scarce resources (Homer Dixon, 2000; Schwartz, et al. 2001; Kahl, 1999). Ambient air pollution is a common cause of adverse health conditions, contributing to the occurrence and severity of respiratory diseases and infections. Children, being one of the most sensitive subgroups of the population, can be highly vulnerable, and high air pollution can end up affecting children's daily school performance. Several studies have identified the effects of ambient air pollution on hospital admissions, mortality rates, absenteeism and cognitive deficits in children. This is underlined by Lee (2006, p. 17) who reinforces that 'there are social conditions that facilitate the process of learning embodied in classical environmentalism: a scientific community that generates credible warnings of environmental harm'. Therefore, numerous mechanisms can explain the association between ambient air pollution and school performance. For instance, absenteeism has been associated with negative effects on school attainment (Carroll, 2010). There is also a vast literature on the general importance of health for school achievement that views physical health as a necessary pre-condition for children's daily school work. From early health problems to common illnesses, health decencies' can limit children's cognitive ability. Conversely; favourable environmental conditions can play an important role in children's learning processes.

Statement of the problem

Environmental degradation is a result of the dynamic interactions between socio-economic, institutional and technological activities. The environmental degradation is a direct result of human activities such as sand harvesting. These effects have devastating effects not only on the environment, but also on students learning and overall academic performance. Kariuki (2002) documents that Sand harvesting leaves behind a trail of environmental destruction, eliminates several organisms and destroy fish spawning and nursery areas, all of which ultimately change aquatic community composition and affects education supporting resources. This poses a challenge to school participation of boys and girls. It is against this background that this study derived the impetus to examine this developing problem of sand harvesting given its apparent impact on environment and educational outcomes in public primary schools in Kathiani Sub-County, Machakos County, Kenya.

Objectives of the study

The study had two main objectives, namely:

1. To find out how sand harvesting is affecting the environment which indirectly supports learning of boys and girls in public primary schools in Kathiani Division.
2. To identify ways through which sand harvesting activities can be carried out in order to minimize their negative impact on education development.

Theoretical framework

This study is premised in treadmill of production theory proposed by Schnaiberg (1980). The theory frames economic development as inherently in conflict with environmental sustainability In the ongoing struggle against competition for increasing profits, capitalists must increase worker productivity and increase

environmental extraction; profits increase, but environmental quality and worker stability decrease ((Gould, Pellow, & Schnaiberg, 2004).Despite the detrimental outcomes for workers and for the environment, there exists a false consciousness that this is progress that is necessary for societal advancement, thereby leading to diminished environmental concern.

Research methodology

Research Design and locale

A descriptive survey design was adopted in this study. Descriptive research designs has advantages of combining qualitative and quantitative methods and using smaller groups of people to make inferences about larger groups that would be prohibitively expensive to study (Holton & Burnett, 1997, p. 71). The study was conducted in Kathiani Division, Kathiani District in Machakos County. Kathiani Division cover an area of 78 square kilometres with a population of 126,644 (1999 census). The local climate is semi arid while the terrain is hilly. The division has an altitude from 1000 to 1600 metres above sea level. Akamba people are the dominant tribe.

Target Population and Sample Determination

The study targeted two education zones, Kathiani and Mitaboni in Kathiani Division which has 43 primary schools with a total population of 800 class 7 and 8 pupils, 43 principals, 20 class teachers, 2 local administration officers and 2 Area Education Officers. A representative sample is one that has at least 10% of the target population (Kothari, 2005). Stratified random sampling technique was applied to selected 80 pupils which is 10% of the total pupil target population of 800, twenty (20) class teachers which is 50% and 10 principals. All the 2 local administration officers and 2 Area Education Officers were involved in the study. The researcher consequently worked with a sample population of 104 respondents.

Research Instruments, Data Collection and Analysis

The research instruments for the study were questionnaires and interview guides. The questionnaires consisted of, open and closed ended questions. Questionnaires were used because they enable one to collect as much information as possible in a short time. Besides, use of questionnaires enables respondents to feel free to note down their responses without inhibition since they are not being observed.

After receiving permission to collect data from the National Commission for Science, Technology and Innovation (NACOSTI) and other laid down protocol, data collection was done by use of questionnaires and face to face interviews. Face to face interviews were done using interview guide for the key respondent's especially Education Officers, head teachers and public administrators who did not have ample time to fill in the questionnaire. The researcher administered the questionnaire to the targeted respondents and also conducted face to face interview in person, this gave the interviewer an opportunity to use probing questions where need arose in order to obtain more complete data. Data were analysed mainly through use of descriptive statistics and presented in frequency distribution tables, percentages, bar and pie charts and measures of central tendency especially the mean, mode and median.

Findings and Discussion

Effects of sand harvesting on the school environment

The researcher asked pupils, class teachers and head teachers to state the negative effects sand harvesting has on the environment. The results are as presented on Table 1.

Table 1: Negative Effects of sand harvesting on the school environment according to pupils (N=80)

Response	Frequency	Percentage
Has caused water shortage	57	71.2
Has caused sudden drying up of rivers	44	55.0
Has caused soil erosion	41	51.2
Led to the destruction of roads	39	48.7
Led to desertification	34	42.5
Makes river beds ugly due to expose rocks	23	28.7
Lorries have made cracks on the classroom walls	12	15.0
Causes a lot of dust on trees	1	1.2

The findings displayed in Table 1 indicates that that leading negative effect of sand harvesting was water shortages as cited by nearly three quarters of the pupils, constituting 71.2 % of the total number of pupils. The second and third highly ranked effects were sudden disruption of water as rivers dry up suddenly and soil erosion. These effects were cited by 55.0% and 51.2%, respectively. The fourth and fifth highly ranked effects of sand harvesting on environment were destruction of roads and desertification, cited by 48.7% and 442,5 %,

respectively. The other effects were exposure of river beds, cracks on school buildings and accumulation of dust, cited by 28.7%, 15.05 and 1,2%, respectively.

The results are an indication that sand harvesting has a profound negative impact of the environment ranging from destruction of water sources to soil erosion, and destruction of the infrastructure. These findings concur with Imoru (2010) who observed that although sand mining contributes to the construction of buildings and development; its negative effects include the permanent loss of sand in areas, as well as major habitat destruction.

The class teachers were also requested to indicate the negative effects of sand harvesting on school environment and results exhibited in a pareto bar chart in Figure1.

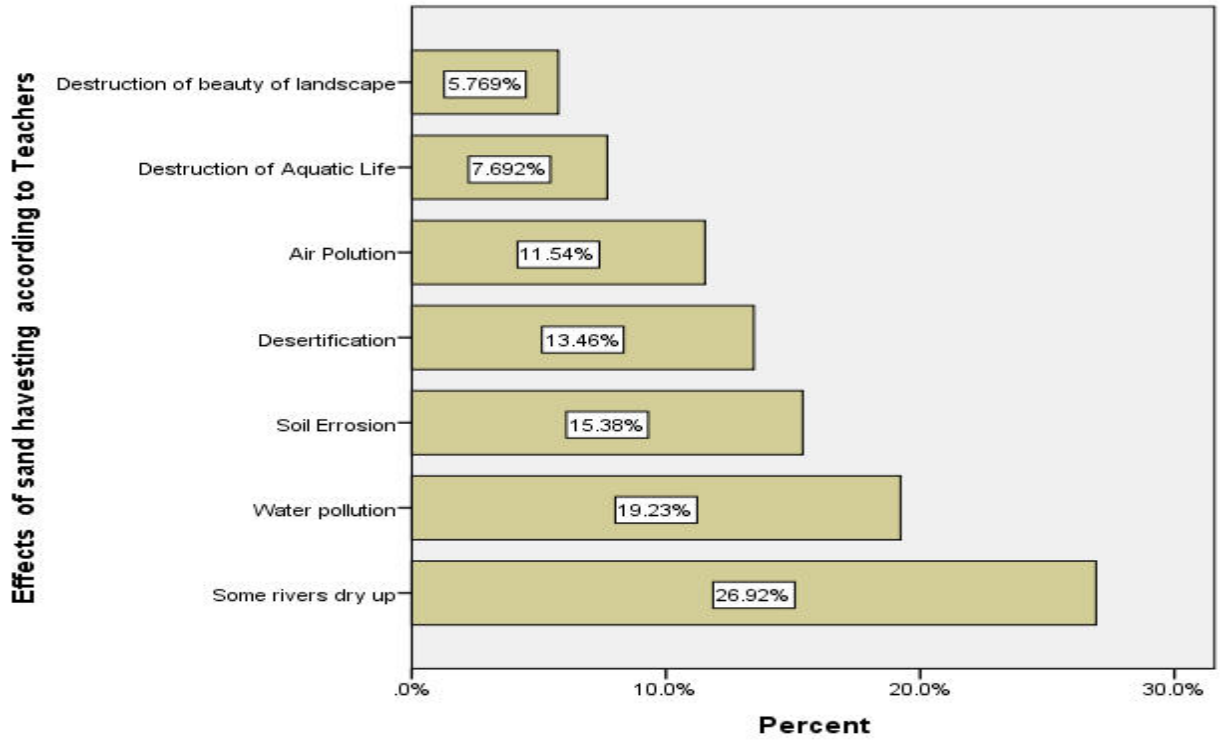

Figure 1: Effects of Sand Harvesting According to Teachers

The findings in Figure 1 indicates that the most highly ranked effect of sand harvesting on school environment according to teachers was some rivers drying up as cited by slightly over one quarter of all teachers. The second and third highly ranked causes were water pollution and soil erosion, cited by 19.23%, and 15.36 % ,of all teachers, respectively. The other effects of sand harvesting on environment were desertification, air pollution, destruction of aquatic life as well beauty of landscape, as cited by 13.46%, 11.54%, 7.692% and 5.769%, respectively. These findings are an indication that sand harvesting has numerous negative effects on the environment which have an impact of on pupils thus affecting their performance in school.

According to International Labour Organization (ILO) (1998) indicates that worldwide, children are being exposed to hazards in their work environments, such as coming into contact with toxic pesticides, lifting heavy loads, operating machinery without appropriate training, being exposed to strong sunlight, dealing with lack of water and sanitation facilities, etc. Guarcello et al. (2004) studied the cases of Bangladesh, Cambodia, and Brazil, where the causal link between hours of work and ill health indicates that the number of working hours exerts a significant effect on the probability of negative health outcomes.

The interviewed with head teachers revealed that the effects of sand harvesting on environment included:

> lack of water , loss of times in search of water and the noise from lorries interfering with learning, flooding which makes roads impassable, lack of concentration , pupils are affected by waterborne diseases causing coughing among pupils.

This is a further indication that sand harvesting has an adverse effect on the environment especially as it leads to scarcity of water and leads to the destruction of roads making schools inaccessible.

Impact of sand harvesting on environmental destruction and education

The study sought from pupils and head teachers whether the destruction of the environment caused by sand harvesting has an impact on education. The results are shown in a pie-chart in Figure 2. The results on Figure 2 show that 69 pupils (86.3%) said that the destruction of the environment caused by sand harvesting has an effect on education while 11 pupils (13.7%) said it has no effect. The Area Education Officer was of the view that environmental degradation as a result of sand harvesting has a direct negative impact on education.

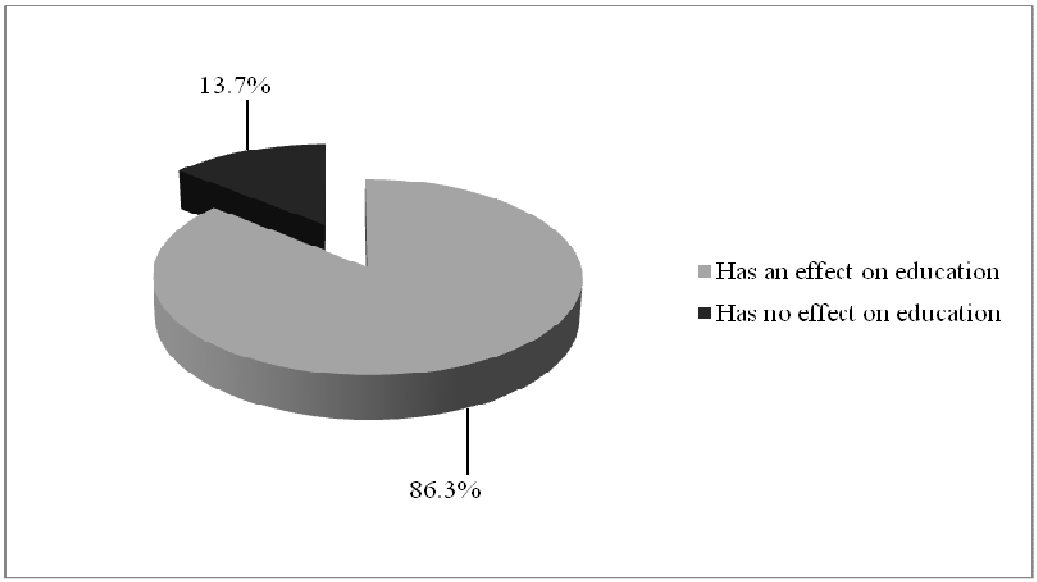

Figure 2: Impact of environmental destruction to education according to pupils

The findings also show that all head teachers said that the environmental destruction caused by sand harvesting has an effect on education. This further shows that sand harvesting leads to environmental destruction which in the end effects education. The findings are an indication that environmental destruction due to sand harvesting has an influence of education in public primary school in Kathiani Division.

Environmental impact of sand harvesting affects education

The researcher asked head teachers to state ways through which environmental destruction caused by sand harvesting affects education in public primary schools in Kathiani Division. The results are as shown on Table 2.

Table 2: Environmental impact of sand harvesting affects education according to Head teachers

Response	Frequency	Percentage
Led to insufficient water for the school	7	70.0
Pupils are introduced to drugs	5	50.0
Led to the destruction of roads	4	40.0

The findings show that majority of head teachers (70.0%) indicated that environmental destruction caused by sand harvesting affects education as it leads to insufficient water for the school followed by 50.0% who said pupils are introduced to drugs while 40.0% said it has led to the destruction of roads leading to school causing lateness.

Aside forcing them out of their farms, quarrying has other negative impacts such as noise pollution, air pollution, damage to biodiversity and habitat destruction, amongst others, which obviously made the rural people to rank it as 'severe' among those activities affecting their agricultural land. The finding of this study agrees with Okafor (2006) who opines that quarrying activities cause significant impact on the environment like many other man-made activities. It also corroborates with Anand (2006) and Mabounje (2008) who opines that the biggest negative impacts of quarrying on the environment is the damage to biodiversity and quarry carries the potential of destroying habitats and plant species. Air pollution generally and especially dust from quarry sites are known to be responsible for vegetation injury and crop yield loss and thus become a threat to the survival of plants (Iqbal & Shafig, 2001).

Sand dust production was another land-related livelihood activity, which the respondents ranked to be 'severe'. The dust from this activity does not only affect the agricultural activity of the rural people, it pollutes air as well as affects their health. Guach (2001) reported that dust from mining sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry. The air pollution is not only a nuisance (in terms of deposition on surfaces) and possible effects on health, in particular for those with respiratory problems, but dust can also have physical effects on the surrounding plants, such as blocking and damaging their internal structures and abrasion of leaves and cuticles, as well as chemical effects which may affect long-term survival.

Positive Effects of Sand Harvesting

The researcher asked class teachers and pupils to give positive effects of sand harvesting on education. The findings are as presented on Table 2. According to the results on Table 2, majority of class teachers (80.0%) said that sand harvesting has a positive impact on education as it serves as a source of income to parents. This is followed by 60.0% who said it is a source of livelihood for pupils who are orphans and a source of employment, half of the teachers said pupils get money to register for exams and to buy food, 40.0% said pupils get money to buy school equipment while 30.0% said sand has been used to build classes and that money earned has been used to by school uniform.

Table 2 : Positive effect of sand harvesting on education according to class teachers

Response	Frequency	Percentage
Source of income to parents	8	80.0
Source living to pupils who are orphans	6	60.0
Source of employment	6	60.0
Pupils get money to register for exams.	5	50.0
Money got used to buy food for pupils	5	50.0
Pupils get money to buy school equipment	4	40.0
Sand has been used to build classes	3	30.0
Money used to by school uniform for their children	3	30.0

This is an indication that sand harvesting has a number of positive effects on education in terms of enabling parents and pupils to acquire basic needs, pay educational levies and also purchase various educational materials.

Negative effect on sand harvesting on education

The researcher asked class teachers and pupils to give the negative effects of sand harvesting on education. Their responses are as presented on Table 3.

Table 3: Negative effects of sand harvesting on education according to Class Teachers

Response	Frequency	Percentage
Dropping in academic performance	10	100.0
Dropping out of school	8	80.0
Increase in school absenteeism	8	80.0
Lack of class concentration due to noise made by lorries.	8	80.0
Pupils are prone to illness	7	70.0
Failure to do homework	6	60.0
Parents forcing their children to join it.	6	60.0
Introduction of drug abuse	6	60.0
Pupils sleeping in class.	6	60.0
Exposure to money leading to lack of concentration in class.	5	50.0
Makes students worn out	4	40.0
Failure to attend remedial lessons	3	30.0

N = 10

The findings show that all class teachers (100.0%) said that sand harvesting affects education negatively as it leads to pupils dropping in academic performance followed by 80.0% who said it leads to pupils dropping out of school and lack of class concentration due to noise made by lorries. The findings also show that 70.0% of class teachers feel that it makes pupils to be prone to illness followed by 60.0% who said it leads to failure of pupils to do homework, parents forcing their children to join it, introduction of drug abuse and pupils sleeping in class.

The local administration officer observed that sand harvesting has led to many pupils dropping out of school having been lured by the money earned from the exercise. This is an indication that sand harvesting has negative influence of education as it takes most of pupils study time as well as numerous disruption caused by sand harvesting.

About 40.8 percent of respondents indicated that erosion occurrence was one of the changes observed due to sand mining activity of rural people. This agrees with Charlier and De Meyer (2000) who reported that erosion has increased in many locations as a consequence of human activity which encouraged increased frequency of flooding and deterioration of ecosystems. Aside the reduction in the size of land available for agricultural purposes (as indicated by 67.1 percent of the respondents), the sales value of such lands at the mining sites declined drastically. This makes it difficult either to use such land for farming activities, or dispose it in order to acquire fertile land or finance education. The cumulative effect of the sand mining activities does not only affect the agricultural activities on the land, but also has severe impacts on the construction of roads, bridges and school buildings. Large tracts of revenue land is rapidly getting cleaned up, besides innumerable trees are facing the axe and the land which was used for sand mining is becoming futile now which was once used for cultivation, (Hedge, 2011).

Conclusion and Recommendations

The study investigated the impact of sand harvesting on educational development in public primary schools in Kathiani Division. The study revealed that sand harvesting has a profound impact on the environment which has adverse effect on learning due to scarcity of water, damage to the infrastructure and noise from lorries passing nearby schools ferrying sand. It was finally revealed that sand harvesting have positive effects on education as income acquired from it is being used to fund education and also provide basic needs for students. The study therefore concludes that sand harvesting has negative impact on performance but is also an essential economic activity which calls for ways of streamlining it to minimise it negative influence on education.

In the light of the findings and conclusions of the study, it was recommended that the Government of the Republic of Kenya through the concerted efforts of the Ministry of Environment and Natural resources and the County Government of Machakos County should closely monitor sand harvesting to ensure that the activities are regulated to minimise the negative impact of the exercise on the school environment.

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