

**THE IMPACT OF OVERHEAD POWER LINES
ON AN INFORMAL SETTLEMENT: MOTSOLEDI VILLAGE,
DIEPKLOOF (SOWETO)**

By

MCDONALD GREGORY SITEI

A mini-thesis submitted in partial fulfilment
of the requirements for
the degree of

Master of Arts

in

Geography and Environmental Management

in the

FACULTY OF ARTS

at the

RAND AFRIKAANS UNIVERSITY

SUPERVISOR : DR P. J. WOLFAARDT

NOVEMBER 2003

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own unaided work. It is being submitted for a degree of Masters of Arts in Geography and Environmental Management at the Rand Afrikaans University. It has not been submitted before, in its entirety or in any part, for any degree or examination at any other university.



SIGNATURE

DATE

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	iv
SUMMARY	v
OPSOMMING	vi
LIST OF TABLES.....	vii
LIST OF FIGURES.....	vii
GLOSSARY	viii
CHAPTER 1: INFORMAL SETTLEMENTS: ORIGINS AND PROBLEMS.....	1
1.1 Introduction.	1
1.2 Backround to the study.	1
1.3 The study area	2
1.4 Statement of the problem.....	4
1.5 Research design.	5
1.6 Conclusion.	5
CHAPTER 2: LITERATURE REVIEW.....	7
2.1 Introduction.	7
2.2 Housing provision and the political context.	7
2.3 Urban migration and population growth.	9
2.4 Occupation of unsuitable land.....	12
2.4.1 Effects of EMFs on humans.	12
2.4.2 Electrocutation, shock and other effects of EMFs.....	14
2.5 Debates around the effects of EMFs on human health.....	15
2.6 Other scientific reviews on EMFs and human health.	16
2.7 Field intensity around overhead power lines.....	17
2.9 EMFs exposure measurements.	19
2.10 Conclusion.	20
CHAPTER 3: METHODOLOGIES.....	21
3.1 Introduction.	21
3.2 Data collection.....	21

3.2.1 Questionnaire surveys.	21
(a) Sampling process.	22
(b) Representativeness of the sample.	22
(c) Substituting.	22
3.2.2 GIS mapping.	23
3.3 Conclusion.	24
CHAPTER 4: ANALYSIS AND RESULTS.	25
4.1 Introduction.	25
4.2 Interviewing the Motsoaledi community.	25
4.2.1 Overhead power lines in Motsoaledi.	25
4.4.2 Health effects around overhead power lines.	27
4.3 Land-use analysis.	31
4.4 Conclusion.	35
CHAPTER 5: SYNTHESIS.	36
5.1 Introduction.	36
5.2 Evaluation of problem statement and objectives.	36
5.3 Evaluation of literature reviewed.	37
5.4 Evaluation of research methodology.	38
5.5 Evaluation of the results.	38
5.6 Environmental management.	39
5.7 Conclusion.	40
SELECTED BIBLIOGRAPHY.	42

ACKNOWLEDGEMENTS

I wish to thank and extend my sincere appreciation to all who assisted me. I would like to specially thank the following people for their invaluable contribution to the progress of this study from the beginning.

- Dr. Peets Wolfaardt, my study leader who was always available to give help where necessary.
- Ms. Heidi van Deventer, my former study leader, for her positive encouragement, positive criticism and supervising this study in the beginning.
- The Department of Geography at RAU for their support and friendly spirits.
- Africon Engineering International (Pty) Ltd and Sentech for their permission with regard to the preparation of maps and the production of this document.
- Mr. Ezra Mantini, the Zion Christian Church Bursary Fund, Mr. Joseph Seitei and Mrs Ellen Ntombela for all the assistance and the funding of this research project.

To my wife Peggy and family and my mother Nnuku, for their ever encouraging spirit and support. Finally, I would like to thank God for making everything possible.

SUMMARY

Emergence of informal settlements on vacant lands in urban areas results from intuition and political decisions, and sometimes cultural background. So any available vacant land is used for settlement development and dwelling sites. An informal settlement named after Elias Motsoaledi, a political activist of the African National Congress (ANC), was developed in the south-western part of the city of Johannesburg in 1993. Motsoaledi informal settlement was established on a vacant piece of land where there are overhead power lines. Motsoaledi community members that have their dwellings in close proximity and even underneath overhead power lines are exposed to an environment that is surrounded by electrical magnetic fields (EMFs).

There are no reported cases of biological and health consequences that have been caused by EMFs as yet. This study aims to focus on the health aspect of persons who have their dwelling in the vicinity of the overhead power lines in Motsoaledi. The high levels of EMFs around Motsoaledi is further exacerbated by the zinc structures that are conductive to electricity and may result in electrocution for dwellers that are in the direct vicinity of overhead power lines. Longer exposure to athermal conditions may result in bio-effects and lead to changes in human health. Furthermore, effects from EMFs are possible electrocution, often causing immediate death of persons and destruction of property.

Due to the lack of proper planning of informal settlements, such settlements become vulnerable to potential environmental hazards such as the destruction of structures. This study hopes to identify the plight of a particular informal settlement, namely, Motsoaledi as an isolated case to reflect dire conditions of most of the informal settlements around the country.

OPSOMMING

Die verskyning van informele nedersettings op oop stukke grond in die stedelike gebiede is die resultaat van intuisie en politieke besluite en soms speel kulturele agtergrond ook 'n rol, sodat enige beskikbare oop grond vir nedersetting ontwikkelings en woon areas gebruik word. 'n Informele nedersetting vernoem na Elias Motsoaledi, 'n politieke aktivis van die African National Congress (ANC), is in die suid-westelike gedeelte van die stad van Johannesburg ontwikkel. Motsoaledi informele nedersetting is ontwikkel op 'n oop stuk grond waar daar oorhoofse elektriese kraglyne loop. Motsoaledi gemeenskapslede wie se huise in die nabyheid en selfs onder die oorhoofse kraglyne geleë is, word bloot gestel aan 'n omgewing wat omring is deur elektriese magneetvelde (EMVs).

Daar is geen gerapporteerde gevalle van biologiese gesondheidstoestande as gevolg van blootstelling aan EMVs tot dusver nie. Hierdie studie se fokus is om die gesondheidsaspek van persone, wie se huise in die omgewing van oorhoofse elektriese kraglyne in die Motsoaledi area voorkom, op die voorgrond te plaas. Die hoë vlakke van EMVs in die omgewing van Motsoaledi word verder vererger deur die metaal strukture wat elektriese krag kan gelei en wat tot die elektrokusie van bewoners aanleiding kan gee wat in die direkte omgewing van die oorhoofse kraglyne woon. Langdurige blootstelling aan atermiese toestande mag veroorsaak dat bio-effekte plaasvind wat veranderinge in menslike gesondheid teweeg kan bring. Verdere invloede van EMVs is die moontlike elektriese skokke wat dikwels die oombliklike dood van die persone, en die vernietiging van eindom tot gevolg kan hê.

As gevolg van die gebrek aan behoorlike beplanning van informele nedersettings, word sulke nedersettings blootgestel aan potensiële omgewingsgevaare soos die vernietiging van strukture. Hierdie studie hoop om die verknorsings te identifiseer van 'n spesifiek informele nedersetting naamlik Motsoaledi, as 'n geïsoleerde geval om te toon in watter hagglike toestande die meeste van die informele nedersettings regdeur die land hul bevind.

LIST OF TABLES

Table 1: General public concerns.	15
Table 2: Scenarios and action taken in substituting selected respondents.....	23
Table 3: Scores for unsuitability indicator.	31
Table 4: Scores for settledness indicator.	31

LIST OF FIGURES

Figure 1: Motsoaledi (<i>digitised from 2627BD Grasmere 1: 50 000 map</i>).....	4
Figure 2: Dwellings constructed of zinc in Motsoaledi.	11
Figure 3: Dwellings constructed of wood in Motsoaledi.	11
Figure 4: A dwelling constructed of brick and zinc in Motsoaledi.....	12
Figure 5: Potential effect of EMF on humans.....	13
Figure 6: Human being in the electrical field [<i>surrogate (proxy) model</i>]......	18
Figure 7: Dwellings in close proximity and underneath overhead power lines in Motsoaledi.	26
Figure 8: Danger in the vicinity of overhead power lines.	26
Figure 9: Property loss due to close proximity to overhead power lines.	27
Figure 10: Peculiar illnesses in Motsoaledi.....	28
Figure 11: Type of illnesses that may result from over exposure to EMFs.	28
Figure 12: Causes of peculiar illnesses.	30
Figure 13: Area suitability.....	30
Figure 14: Study area buffered into zones of equal distance from the overhead power lines.....	33
Figure 15: Land suitable for dwelling.	34

GLOSSARY

AC	Alternate current
ANC	African National Congress
CASE	Community Agency for Social Enquiry
CBD	Central Business District
CIRRPC	Committee on Interagency Radiation Research Coordination
DC	Direct current
EBU	European Broadcasting Union
EMC	Electromagnetic Compatibility
EMFs	Electric and magnetic/ Electromagnetic Fields
EMR	Environmental Management Report
EMVs	Elektriese magnetiesevelde
EPA	Environmental Protection Agency
EPRI	Electric Power Research Protection Institute
ESRI	Environmental Science Research Institute
EU	European Union
GIS	Geographical Information Systems
Hz	Hertz
IEC	International Electrotechnical Commission
kV/m	kilo-volts per metre
WHO	World Health Organization

CHAPTER 1: INFORMAL SETTLEMENTS: ORIGINS AND PROBLEMS.

1.1 Introduction.

The definition of an informal settlement varies widely from country to country and depends on a variety of parameters. In general, it is considered as a residential area in an urban locality inhabited by the very poor who have no access to tenured land of their own, and hence 'squat' on vacant land, either private or public. Informal settlements, low-income settlements, semi-permanent settlements, spontaneous settlements, unauthorized settlements, "...shantytowns, squatter areas, favelas, barriadas, barong-barong and gecekondu*" are a world-wide phenomenon (Finlayson, 1978: 3). Informal settlements as a form of urban development, are generally characterised by their physical appearance of being poorly planned, lack of utilities and urban services, as well as the spirit of man's will to house himself to the best of his ability.

Some of these settlements emerge in areas not suitable for settlement; hence inhabitants are faced with many problems such as the destruction of structures for example, caused fires and electrocution from disturbed overhead power lines, electrical shock as well as athermal related health problems. The influence of direct or indirect electromagnetic fields (EMFs) on human beings can impact negatively on their health. People in the Motsoaledi informal settlement are exposed to radiation caused by overhead power lines that are in close proximity to the settlement.

1.2 Background to the study.

Motsoaledi informal settlement is situated on a piece of unused land that has overhead power lines running through it. This settlement, as in case of other informal settlements, was not planned. Most residents moved to this settlement from many parts around the country especially rural areas, due to various reasons including an economic recession in their former localities. Most people who reside in informal settlements came to the urban areas with the hope to find employment. Some come from rural areas where conditions are very poor. One of the interviewee in Motsoaledi said: "*Where we were staying before there were no schools, no streets, no water, no lights, no clinics, no jobs.*"

* favelas=Brazil, barriadas=Peru, barong-barong=Phillipines, gecekondu=Turkey

We were living just because we had to live, but you know that we were not living, we were dead” (employed man, about 35 years old).

According to Everatt, *et al.*, (1998), people who need their own place have unique problems and the only thing in their minds is to find their own place. Among other reasons, informal settlements emerged due to:

- *People needing somewhere to stay.*

Most young occupants have come to these settlements because they wanted to get away from their families and to gain independence. The issue of independence ranges from among several reasons, especially overcrowding conditions in their family units, and the need for privacy.

- *Dispute with landlords.*

The second most important set of reasons for moving to these settlements and common to all the settlements, involved difficulties with renting. Tenants usually rent space in the landlord's yard where they build their own shack. Some survey respondents said they had not been able to afford to pay rent any more. Others had had disputes with their landlords. Autonomy of having one's own dwelling, albeit a shack with minimal services, seemed to be a common goal and was perceived to be a better option than living under obligation to a landlord or family member for some of the interviewees (Safire, 1992 in Stevens & Rule, 2001).

Despite little resources, financial or otherwise, skills or access to these resources, the drastic option of illegally occupying vacant land to build a rudimentary shelter, is the only option available to these people. The appropriateness of land for settlement development further compounds the problem and thus, Motsoaledi was developed on a piece of land where overhead power lines are in close proximity to the settlement.

1.3 The study area

Motsoaledi is an informal settlement that emerged during 1993/1994 and is located within the portion of Power Park and Chris Hani Baragwanath Hospital in Diepkloof (Soweto). This settlement was named after an African National Congress (ANC) activist, Elias Motsoaledi, who died in 1995 (Development Atlas, 1997).

The settlement is situated adjacent to the Old Potchefstroom road that is an access route to the central business district (CBD) of Johannesburg and Pimville. Other routes are Nicholas (access route to Orlando East), and Dynamo (access route to Power Park and Eldorado Park). It extends 2 kilometres eastwards, and one and a half kilometre northwards. The Motsoaledi settlement is located in the south-western region of Johannesburg, next to the Orlando power station.

Digitised from the 1: 50 000 topographical map reference [2627BD Grasmere], the absolute location of this settlement is 27°55'03" East, 26°15'45" South. Motsoaledi has a population of 5220 of which 67.2 percent are female and 31.9 percent male. Youth from the age of six to eighteen are mostly school-goers. Most males are working in industries in Johannesburg and Pretoria. On average, 37 percent of females are working in the city (Development Atlas, 1997). The settlement has social facilities within a radius of 2 kilometres, including a hospital and a mobile clinic.

The western part of the settlement has overhead power lines alongside and the area was initially not used for settlement or development of any kind. Diepkloofspruit river runs north-westwards across the settlement to Orlando Dam (see Figure 1). From field observations, it is evident that some dwellings in the settlement were erected in an area with overhead power lines.

Owing to lack of proper planning the squatters may probably face problems such as health risks and possibly electrocution from overhead power lines (Brail, 1990). Motsoaledi, like most informal settlements, is found on an open area on which construction of formal houses is not practical (due to rough terrain and presence of overhead power lines) and is also on the periphery of the municipality boundary in an unused (peri-urban) space within the municipality boundary (Statistics South Africa, 2000b: 13).

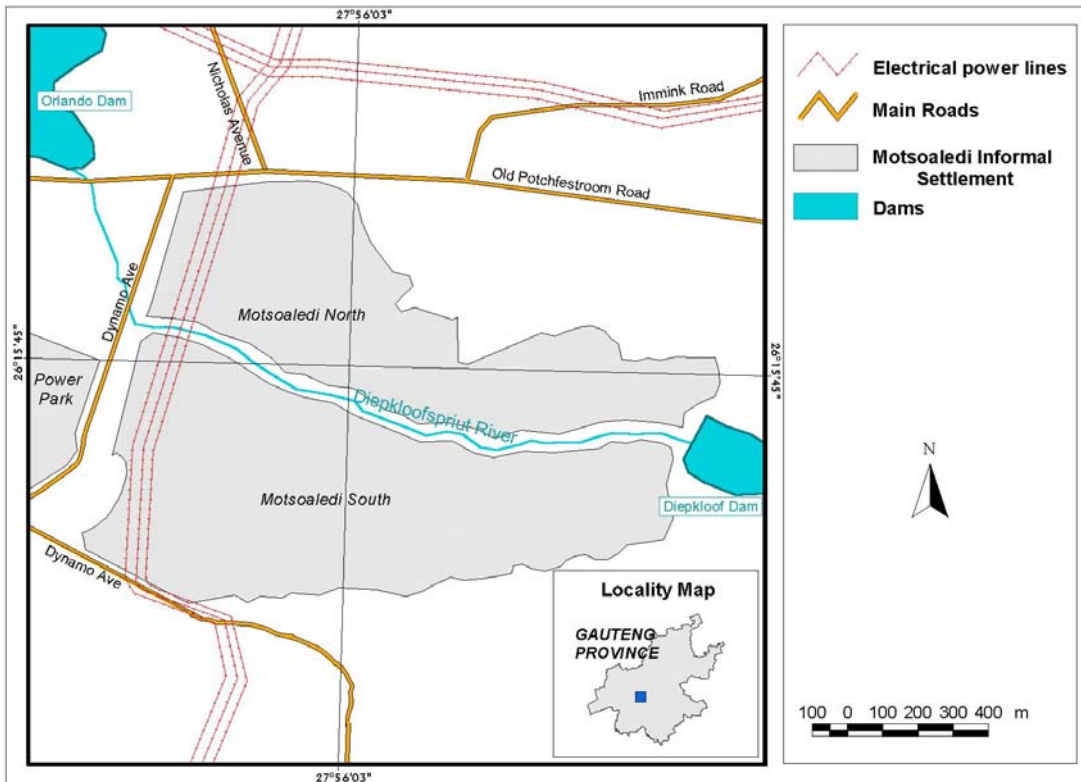


Figure 1: Motsoaledi (*digitised from 2627BD Grasmere 1: 50 000 map*)

1.4 Statement of the problem.

Dwellings on the western side of Motsoaledi are in the vicinity of and underneath overhead power lines that have the capacity of high voltage levels. These overhead power lines radiate high levels of electromagnetic fields (EMFs) to dwellings that are underneath and in close proximity. Due to the zinc structure type that is conductive, such type of dwellings often have 'bad influence on the health of human beings due to the direct influence of the EMFs that is highly possible' (Haubrich & Seitz, 1993: 19). The problem being investigated is whether the location of some shacks in Motsoaledi in the vicinity of the overhead power lines constitutes, any health and environmental risks to the inhabitants of the settlement.

The aim of this research is to assess the effects of EMFs on those dwellings that are in close proximity to overhead power lines in Motsoaledi and the impacts thereof on inhabitants. To achieve this aim, the following research procedures were set.

- A literature review on the effects of electromagnetic fields (EMFs) on human health.
- Conduct a survey on how the presence of overhead power lines that are on the western side of Motsoaledi, affect the inhabitants.
- Conduct a survey on the awareness of the effects of staying underneath and in close proximity to overhead power lines.
- Model a land-use map to outline suitable and unsuitable areas for dwelling in the Motsoaledi settlement using a Geographical Information System (GIS).

1.5 Research design.

The research investigates the effects of the EMFs emitted from the overhead power lines on human health around Motsoaledi settlement. The close proximity of some dwellings to overhead power lines is important in that there may be direct influence of electromagnetic fields (EMFs) on human health. Also the physical safety from electrocution of the settlement by overhead power lines is another aspect to consider in this study.

This study on the effects of EMFs around Motsoaledi settlement has been conducted for two years. Inhabitants were interviewed by selecting a systematic random sample of 500 households. The questionnaire surveys were conducted in August 2000 and repeated in August 2001 as a follow-up evaluation. Where persons were unavailable or not willing to participate, substitutions were selected. The questionnaire comprised of questions on the development of the settlement as well as people's understanding of the health issues relating to the presence of overhead power lines in and around the settlement. Differences in response to the questionnaire made provision for a cross-section of opinions. The issues raised during the interviews were a means of exploring idiosyncrasies that could be captured in the questionnaire surveys (Stevens & Rule, 2001). In addition, a Geographical Information System (GIS) was used for mapping and analysis of land-use with regard to land-suitability for settlement.

1.6 Conclusion.

The definition of informal settlements and reasons for their emergence were outlined. One such settlements is Motsoaledi. Its location, background, development as well as problem statement of the study were discussed. The objectives of the study and the

research design in relation to the effects of the EMFs that may be emitted from the overhead power lines around Motsoaledi settlement were also mentioned. The effects of EMFs may directly affect those residents that are underneath and in close proximity to the overhead power lines because of the assumed influence of electromagnetic fields (EMFs) on human health.

The literature review with regard to overhead power lines and emitted EMFs, and how they may affect dwellings that are underneath and in close proximity as well as persons around Motsoaledi informal settlement, will be discussed in the following chapter.



CHAPTER 2: LITERATURE REVIEW.

2.1 Introduction.

There has been a high and drastic migration of people to urban areas in the past, especially since 1986 (after scrapping the pass laws) and which is currently continuing in South Africa. Migration to urban areas is characterised by industrialisation, among other factors, which "applies to the whole process of change and its accompanying consequences, as society moves from an agricultural to an industrial economy; from a small, rural homogeneous society to a large, metropolitan, heterogeneous massing" (Carter, 1989: 29). Urban migration creates a tremendous impact on issues related to housing. As a result, immigrants face unfortunate circumstances of homelessness and they often opt for squatting or illegally occupying available land.

In this section, factors that relate to urban migration and the emergence of squatter settlements as well as the types of settlements found in South Africa will be discussed. The discussion will also focus on the Motsoaledi informal settlement, and the overhead power lines that are in the vicinity of the settlement as well as how the electromagnetic fields (EMFs) that are produced from overhead power lines, may affect residents that are living in close proximity and underneath the servitude.

2.2 Housing provision and the political context.

According to Carter (1989: 292) "Urbanisation cannot be considered apart from political systems. Issues relating to housing provision have such an overt political context that it is necessary to set these out." The far left view regards housing provision as the state's or the municipal authorities responsibility. However, most informal settlements emerged during the political instabilities in South Africa in different municipalities and they were not controlled by the existing authorities, thus most of them are regarded as illegal settlements (Mlaba, 1998: 8). Some are still continuing to emerge in many parts around the country.

The moderate left view by Carter (1989: 293) regards housing provision as a social service like health and education. The attitude to private provision of such services is

ambivalent and reaches a greater degree of tolerance in relation to housing where owner occupation is considered permissible. This is usually justified by the argument that owner-occupiers acquire property for use rather than for accumulation of wealth in the Marxist sense and, therefore, has more in common with tenants than the landowners and exploiters of property. Landowners, developers, and others involved in the supply of housing have a monopoly over productive capital in the settlement which is not in any way shared with those who buy their own homes.

Thus in terms of Marxist political economy, owner occupiers are not a distinctive class since although they have accumulate wealth, they do so through consumption rather than production, their property does not reproduce itself, and their profit (if such it is) does not represent the extraction of surplus value. The rents charged by the state should, because housing is a service, be nominal rather than economic (Carter, 1989: 293).

According to Carter (1989: 23) housing provision is regarded as a commodity like any other good and should be bought and sold on the open market through the bidding process and without any state intervention. The disposable income that the individual has and earns will determine his choice and desire of property. The far right is the exact opposite to the far left. This political view would enable everyone, in theory, to make a successful bid for property in a country where a standard of living is rising.

Most of the inhabitants in the informal settlements fall in the category of the poor and cannot afford housing, even of their choice. Only persons who fall in the category of the economic middle and upper class can afford to own property. The far right political view assures the individual freedom of choice to bid for property, 'but at a price of inequality' (Carter, 1989: 293).

The moderate right regards housing provision as an essential for all, like education and health care, but the amount which any individual wishes to consume is related to his own decisions. This view states that any decision is based on an individual owner-occupier to rent either public or private accommodation. Furthermore, rents cannot be subsidized and a full economic rent must be charged. Most persons in informal settlements moved out of formal dwellings for various reasons, one of them is the high rent charged by

landlords. They moved to informal areas where they can stay without renting or paying for services.

The perception of non-payment of services and freedom of site selection that informal settlement dwellers have, makes it a difficult task for the municipalities and local authorities to monitor and control issues related to land occupation. The moderate right political view democratises property ownership because every individual can charge any amount of rent to occupants of his property.

2.3 Urban migration and population growth.

South African urban cores of advanced economic development surrounded by extensive rural hinterlands where a subsistence system often prevails, exemplifies the spatial dualism inherited from the colonial era. Such an uneven development is particularly marked in South Africa, where a minority white élité held the political power before 1994. The South African black population were offered a limited 'separate development' under the Nationalist government's apartheid policy (Blunden, *et al.*, 1978). *

With the scrapping of the Influx Control Act in 1986, urban areas experienced increasing population growth, especially in the Gauteng province. The department of housing was faced with a big problem of a housing shortage. According to the Department of Housing (2001a), the following problems were experienced:

- **Severe housing shortage:** There is a severe housing shortage in South Africa. In 1997 the National Housing Department estimated that the number of families without adequate housing was 2,2 million. Due to population growth this figure increases by about 204 000 every year.
- **Lack of affordability:** Due to high levels of unemployment and relatively low average wage levels, a significant number of South Africans cannot provide for their own housing needs. These households are defined as those with no income, and those earning up to R3 500 per month. In 1996 it was estimated that of all the families living in South Africa, 80% fell into this category. It was further estimated that in fact more than 50% of families earned between R0 and R1 500 per month.

* The apartheid policy designed to create a racially economic space where blacks provide labour and the perpetuation of white political control that required that blacks to be disenfranchised (Blunden, *et al.*, 1978).

- Non-payment of housing loans and service payment boycotts: The 1980's were characterised by bond, rental and service payment boycotts initiated by the civic movement and communities, aimed at undermining the status quo. As a result of this many households were reluctant and some unable to re-commence paying their bonds, rents and services.
- Lack of end user finance: For a number of reasons including the non-payment of housing loans, service payment boycotts etc. many lenders are reluctant to lend to low income families. As a result, many low-income families are unable to access housing loans, even if they could afford to pay back these loans.
- Insufficient land: Slow and complex land identification, allocation and development processes resulted in insufficient land for housing development purposes.
- Inappropriate standards: Infrastructure, service and housing standards were inappropriate to the needs of the low-income market, resulting in difficulties in providing affordable housing products.
- Different requirements between Provinces: There are major differences between the housing needs experienced by different provinces. For example, in terms of the 1996 census, Gauteng and Western Cape generally have housing backlogs in urban areas, while in the Northern Province and Eastern Cape the housing backlogs are generally in rural areas. Given the different problems in the different provinces, different policy responses are necessary.

Despite some problems mentioned above, informal settlements continue to emerge in most urban areas. Most of the informal settlements are not sustainable and they are prone to disaster due to their area of location, like Motsoaledi and many others. The Housing Act, 1997 (No.7 of 1997) outlines that the establishment and maintenance of habitable, stable and sustainable public and private residential environments to ensure viable households and communities, in areas allowing convenient access to economic opportunities to health, education and social amenities, in which all citizens and permanent residents of the Republic will, on progressive basis have access to permanent residential structures with secure tenure, ensuring internal and external privacy and providing adequate protection against the elements. This Act is aimed at ensuring that settlements areas are sustainable and inhabitable. Motsoaledi, like many other informal settlements, is a squatter settlement. Squatter settlements or informal settlements often appear overnight as a result of high demand for accommodation.

These settlements are constructed by persons who illegally occupy a piece of land, and are liable for eviction and prosecution by the law (Statistics South Africa, 2000a: 35). The type of houses normally found in these settlements are often built from materials like zinc (see Figure 2), wood (see Figure 3), or constructed of a combination of brick and zinc (see Figure 4).

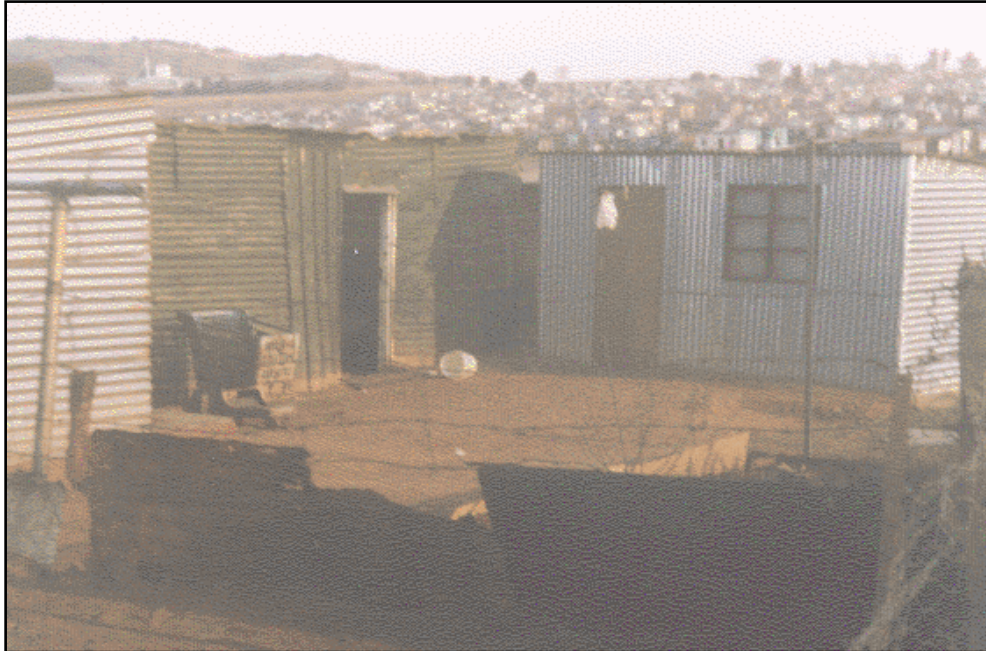


Figure 2: Dwellings constructed of zinc in Motsoaledi.

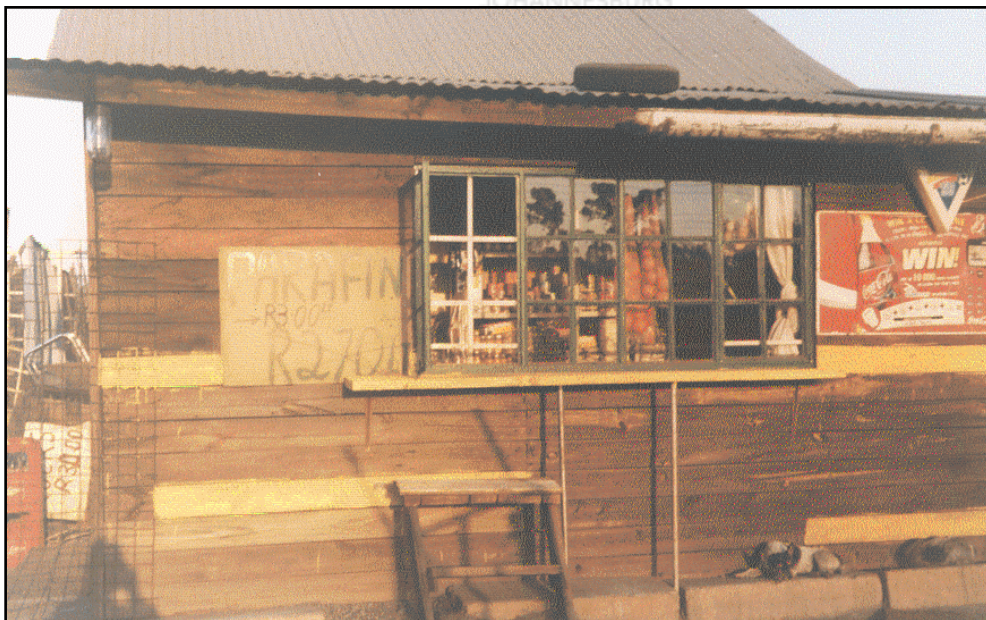


Figure 3: Dwellings constructed of wood in Motsoaledi.



Figure 4: A dwelling constructed of brick and zinc in Motsoaledi.

2.4 Occupation of unsuitable land

Most informal settlements were not part of the municipal development plan. The Surveyor General's office does not have records of most informal settlements. Thus they are considered temporary and illegal, especially since some informal settlements were located on land that is for various reasons unsuitable for occupation. As previously mentioned, part of Motsoaledi informal settlement has overhead power lines running through it on the western side of the settlement (see Figure 1). Overhead power lines radiate EMFs that may be potentially harmful to human health. Residents that have their dwellings underneath and in close proximity to overhead power lines may be highly affected by the EMFs from overhead power lines.

2.4.1 Effects of EMFs on humans.

EMF refers to electromagnetic fields, or electric and magnetic fields. These fields occur wherever there is electricity - near radio and microwave towers, high voltage overhead power lines, and low power electrical distribution lines, household appliances and electrical office equipment. An electric field exists when an appliance is "plugged-in." The magnetic field only exists when the appliance is "turned on" and operating (New York State Department of Health, 2001).

Electric and magnetic fields result from electrically charged particles. Charged particles in motion are referred to as electric current (measured in amperes). The force that makes the charges move is the electric potential or voltage. The voltage produces the electric field; the current produces the magnetic field. The concept of electric and magnetic fields describes how charged particles exert forces on objects some distance from the electricity (Savitz, Pearle, & Poole, 1989: 214).

In the region of overhead power lines, conductors carrying alternating electric current and all conducting materials, such as zinc structures in Motsoaledi, will experience induction currents. Therefore, not only will the shield wires carry induction currents but also the earth and all living organisms. Due to the presence of overhead power lines, the intensity of EMFs is higher on the ground underneath the structure, and decreases with distance away from the structure. The current capacity of overhead power lines around Motsoaledi is only 1150kV. The components of EMFs in this study are not coupled in the low-frequency range that is used by the public electricity supply (Haubrich & Seitz, 1993: 19).

When overhead power lines distribute electricity, "an electromagnetic pulse of energy propagates outward from the simulator in all directions and *exposes* the surrounding environment. The field may *interact* with individual environmental elements (e.g., humans, flora, fauna and electronic systems). These interactions will not always produce reported observed *effects* on the environmental element. *Interactions* and *effects* are not considered either beneficial or detrimental. The *effects* in turn may or may not produce *consequences* that are beneficial (e.g., bone healing) or detrimental (e.g., cancer) to humans. These *effects* or *consequences* may be either transitory or permanent" (Hadlock, et al., 1993: 15).

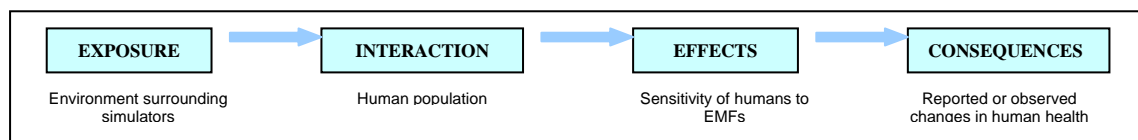


Figure 5: Potential effect of EMF on humans (Hadlock, et al., 1993: 15).

There is no definite proof of harmful effects, so this study will focus on potential effects of EMFs to human health. EMFs produce invisible electromagnetic particles that in turn produce energy that is related to electricity and electrical systems which can range from electrocution to less understood connections with stray voltage and human health", therefore overhead power lines across settlements could adversely affect humans and animals. EMFs are electrical pollution and electrical pollution is similar to chemical pollution. Certain chemicals can affect you when they are present in small concentrations, say in parts-per-million range. The same thing can happen with electricity. Say you're exposed to a millionth of an amp, but it's all the time. You won't feel the shock, but it accumulates. Cumulative electrical poisoning can contribute to negative health effects such as cancer and constant headache (Dahlberg, 2001: 2).

2.4.2 Electrocution, shock and other effects of EMFs.

By present scientific definition, the perceptions of effects from the EMFs are separated into at least three categories. First, is the well-known effect commonly referred to as electrocution. Electrocution occurs when a large, usually short duration electric current passes through a living organism, often causing immediate death. The second category is the perceived effects from exposure to 50 and 60 Hz electricity, primarily from the 50 and 60 Hz magnetic fields. Of particular significance is the proximity of people to overhead power lines. Third are the perceived effects associated with micro- and radio-wave EM energies from radar systems, microwave transmission, radio and television transmission, and cellular systems (Dahlberg, 2001: 4).

The most familiar EM energy effect is electric shock. Humans and animals experience various levels of electric shock. Some shocks are hardly noticeable, whereas others can cause great distress and are sometimes lethal. The possibility of a lethal shock is associated mainly with making contact with a high voltage wire in the home or business or on the distribution system. Research assessing the electrical injury effects from severe athermal and non-lethal shock has revealed both acute and long-term chronic effects. "While the acute effects are quite well known, the chronic effects are more difficult to assess and have only been studied more recently. The chronic effects are long-term and associated with complex interactions of the shock current with the electrical systems of the body" (London, 1991: 930). The other effect that is associated

with overhead power lines is fire. Fire can be experienced when an entity or body is in contact with a broken or disturbed active transmission line (Eskom, 2000: 1).

2.5 Debates around the effects of EMFs on human health.

The table below outlines general public concerns about the EMFs and human health. The summary of questions are extracted from the New York Health Department (New York State Department of Health, 2001).

Table 1: General public concerns.

QUESTION	ANSWER(S)
<ul style="list-style-type: none"> • What do we know about the relationship, if any, between electric and magnetic field exposure and health effects? 	<ul style="list-style-type: none"> • Global subsequent research studies that suggest that exposure to EMF may possibly relate to a number of health effects in human beings. • These studies do not provide firm evidence that EMF exposure causes health effects • Further research is needed for us to better understand any link between exposure to EMF and health problems
<ul style="list-style-type: none"> • Does exposure to electric and magnetic fields increase the risk of cancer? 	<ul style="list-style-type: none"> • No one knows for sure but there is some evidence that EMF exposure may be associated with an increased risk of cancer. • Studies of men exposed to high levels of EMF as part of their jobs have found an increased risk of these men developing cancer. • There is also some evidence from laboratory studies that indicates that EMF exposure may interfere with certain hormones that may play a role in the development of cancer. • There is little scientific data demonstrating an increased risk of cancer among humans exposed to EMFs, but this question requires further scientific study.
<ul style="list-style-type: none"> • What is a safety level? 	<ul style="list-style-type: none"> • There is no number to which one can point and say, 'that is a safe or dangerous level of EMF exposure.' • Scientifically, it is not known what levels of EMFs exposure are safer or less safe. • It is not known if continuous exposure to a given field intensity causes a biological effect, or if rapid changes in exposures cause effects. • According to Occupational Health and Safety Act, the safety level of residence to overhead power lines is 4,5m away from the servitude. • This safety level has been set to prevent dwellings from electrocution and physical destruction, however, it cannot ensure that the exposure to EMFs is not possible and further studies in the field of EMFs and human health still need to be conducted.

2.6 Other scientific reviews on EMFs and human health.

There have been both positive and negative studies on the subject. One study is a document *Biological and electric and magnetic fields: Biophysical mechanisms of intersection* by Valberg (1994). It cites that "is plausible to speculate that exposure to environmental EMFs, which can exert forces on fixed and moving charges, may have the potential to modulate the function of biological systems" (Valberg, 1994: 7). For example, the way cells use genetic information had long been reported as a 'real' effect of EMF, but now these results have been shown to be reproductive.

Another study is *Biological Effects of Power Frequency Electric and Magnetic Fields* by Office of Technology Assessment (1989), which concluded that while no clear-cut evidence for health effects was to be found, it might be wise to practice a 'prudent avoidance' strategy to minimize exposure in cases where the economic costs are low. A prudent avoidance strategy is difficult to apply in practice because scientists have been unable to identify what aspect, if any, of EMFs is to be avoided.

In 1990, the Environmental Protection Agency (EPA) also published a study, *Evaluation of the Potential Carcinogenicity of Electromagnetic Fields* that evoked debates around evidence for the carcinogenicity of EMFs. During the two years of study, EPA produced a draft review that concluded that data available at the time of the draft report were not sufficient to show that EMFs are carcinogenic. Science Advisory Board finally made recommendations that the EPA report be rewritten in a more balanced fashion (Science Advisory Board, 1992). The revised report has not yet appeared.

Another study requested by the US Department of Labor and conducted through the federal CIRRPC* found no evidence that EMFs generated by sources such as electrical power lines and household appliances pose health risks to human beings. In spite of the fact that a number of scientific review groups have failed to establish a hazardous EMF level or even a definitive EMF-disease links, the issue continues to capture the public interest. Human beings are more important than capital gains; therefore one cannot stand to see their communities being a specimen of destruction due to scientists' ignorance of EMFs in their vicinity.

* Committee on Interagency Radiation Research and Policy Coordination.

2.7 Field intensity around overhead power lines.

Overhead power lines operate on high voltages and transport high-power electricity. Electrical charged objects (charged negative or positive) produce electrical fields which exert force on other electrically charged objects. Oppositely charged objects attract, while like-charged objects repel. Likewise, magnetic fields express the forces between current-carrying objects. Two wires carrying currents in the same direction and two wires carrying current in the opposite direction repel. Permanent magnets contain electrical currents at atomic level and produce strong magnetic fields. Permanent magnets respond to magnetic fields, such as when a compass needle orients with the earth's magnetic field (Kaune, *et al.*,1987).

Humans are exposed to a wide variety of natural and anthropogenic electric and magnetic fields. The earth's atmosphere produces slowly varying electric fields (probably 0.1 to 10kV/m), and the earth's core produces a steady magnetic field, which ranges in strength. Steady electric current - direct current (DC) -and nonmoving magnets produce steady magnetic fields. With alternating electric current (AC), time-varying magnetic fields are produced and that can change both the size and direction. Overhead power lines, electrical appliances and other sources of electricity produce EMFs that vary in time and are measured in Hertz (Hz). Near appliances, the magnetic fields can be high but diminish sharply with distance (Electric Power Research Institute, 1992).

Athermal consequences (changes in permeability of cell walls, calcium efflux changes, tumor growth, and bone growth rate changes) may result from direct interaction of the biological organism with EMFs (Hadlock, *et al.*,1993: 17). Athermal effects occur under certain conditions (low to high-field magnitudes and / or very fast pulse repetition rates and possibly fast rise-time pulses). Any conductive element that is exposed to the efflux of EMFs is bound to incur athermal effects. In the process of generation of power, field components become highly intense. Any potential biological effects or health consequences of EMF exposure could only occur through some athermal mechanism.

The epidemiologic studies usually quantify the athermal exposure as the relative risk. This is the risk of an "exposed" person getting EMFs divided by the risk of an "unexposed" person getting EMFs. Since no one is unexposed to power-frequency fields, the comparison is actually "high exposure" versus "low exposure"(Olsen, *et al.*, 1993). Informal dwelling settlements that are underneath and those that are in close proximity to overhead power lines are highly exposed to EMFs. Zinc as a construction material is conductive of electric and magnetic fields and some occupants, especially those that are in the vicinity of power lines are highly exposed. EMFs able to induce the conductive substance of the human body and may result in observed changes in the human health. Haubrich & Seitz (1993: 23) models how EMFs are induced in human body (see Figure 6).

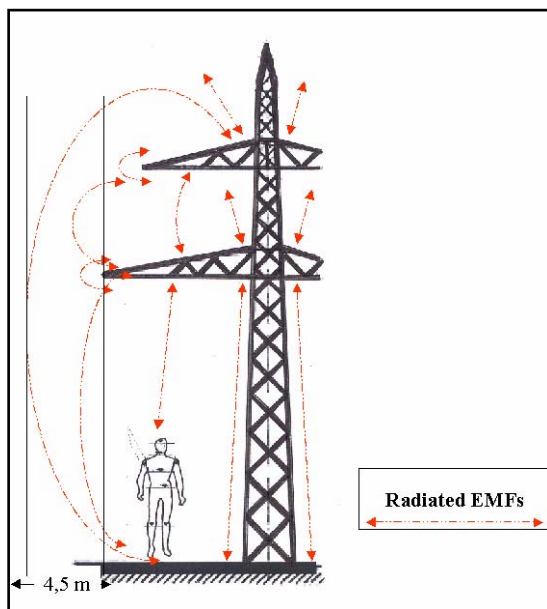


Figure 6: Human being in the electrical field [*surrogate (proxy) model*] (Haubrich & Seitz, 1993).

The model describes the sphere of influence on the ground area in the vicinity of the power line, which creates the electric fields. The electric fields are then degenerated into radiated alternating (magnetic) fields and form electromagnetic fields (EMFs) around the power line. In the elliptic/dummy model, the peak of an electrode exists about 15 times higher intensity than in the 4,5m distance away from the less intense field. Children have a smaller body size and when they are highly exposed to EMFs, detrimental effects to their body mass is higher than to adults and brain cancer or leukemia may result as a consequence.

Many studies have used the distance from the power line corridor to the residence as a measure of power-frequency fields (Tomenius, 1986; Savitz, 1988; Coleman, *et al.*, 1989; Myers, *et al.*, 1990; Youngson, *et al.*, 1991; Feychting & Ahlbom, 1993; Petridou, 1993; Feychting & Ahlbom, 1994; Li, *et al.*, 1997). When something we can measure (distance to the line) is used as an index of what we really want to measure (the magnetic field), it is called a surrogate (or proxy) measure. Two of the 9 studies (Feychting & Ahlbom, 1993 and Li, *et al.*, 1997) that have used distance from overhead power lines as a surrogate measure of exposure, have shown a relationship between proximity to power lines and the occurrence of cancer. The most notable is a study of children that may show an increase in leukemia incidence for residences within 5m of high-voltage overhead power lines, and adults that may show an increase in cancer or leukemia incidence of residence within 4,5m of high-voltage overhead power lines. The study of proximity to overhead power lines and cancer can find some association with any kind of cancer in children living within 5m of overhead power lines or substations.

2.9 EMFs exposure measurements.

A number of studies have measured power-frequency fields in residences (Savitz, *et al.*, 1988, Severson, *et al.*, 1988 and London, *et al.*, 1991). Both one-time peak, 24-hour and 48-hour average measurements have been made. Two of the studies, namely, Green, *et al.*, (1999) and Schüz (2001), using measured fields have shown a statistically significant relationship between exposure and leukemia. In Motsoaledi a household survey on health has been conducted and only 0.1 percent of illness cases are found to be associated with the close proximity to overhead power lines. These illnesses are known to be brain cancer (in children) and leukemia.

Ahlbom (2000) outlines the practical measurement that concludes the view that proximity to overhead power lines and over-exposure to EMFs may result in health problems. Ahlbom (2000: 696) calculated that if all the studies that included long-term measurements of magnetic fields were pooled, a statistically significant association could be found for children with 24-48 hr average exposure of 0,4 microT or greater. Another study by Greenland & Sheppard (2000) reported that if all the studies that included estimated or measured magnetic fields were pooled, a statistically significant association could be found for children with exposures of 0,3 microT or greater.

The EMFs may indirectly affect the occurrence of various cancers by increasing the cell division rate, and therefore the occurrence of natural or spontaneous cancers (those produced by radiation or chemicals), or by suppressing the immune system and therefore allowing more cancers to develop. The cell division may occur because the biological system is able to perceive the presence of the EMFs and probably not be able to identify it. The unidentified stimulus may produce a physiological stress that may increase the cell division rate. The electromagnetically induced stress may suppress the immune system and thus allow more cancers to develop. On the other hand, the EMFs might not produce cancers but rather influence or enhance the development of natural or spontaneous cancers. Consequently, the effects of EMFs are indirectly rather than direct (Hoefl, 1992: 77).

2.10 Conclusion.

The scrapping of the Influx Control Act in 1986 resulted in more urban migration, which created a huge housing shortage in most urban areas. More people came to urban areas due to the perceived glooming employment opportunities in the cities and some ended up without having places to stay. With the rate of population growth and housing demand in urban areas, other people occupied vacant lands and erected shacks that lead to the emergence of informal settlements. In this section, discussion was based on the location of Motsoaledi informal settlements as well as the overhead power lines that are in the vicinity of the settlement. In this chapter, different scientific literatures that are based on the sources of EMFs and their effects to human health were discussed.

The following chapter will discuss the methodologies that were used in the investigation of the effects of the power lines and EMFs on the western side of Motsoaledi and their perceived effects on the people's health living in close proximity and underneath the servitude.

CHAPTER 3: METHODOLOGIES.

3.1 Introduction.

Overhead power lines have been in the vicinity long before Motosledi settlement was erected. This "illegal" location of Motosledi and the type of dwellings found here, have prompted questions about the awareness of dangers and possibilities of athermal effects of EMFs from these power lines in the affected section of the informal settlement. The methodologies undertaken in this study were aimed at addressing community awareness about the effects of EMFs to human health, as well as safety of their settlement in relation to overhead power lines that are in close proximity to their settlement. Methodologies used in this study are data collection using questionnaires and land-use maps of the study area, data processing and Geographic Information Systems (GIS) for land-use analysis and mapping.

3.2 Data collection.

The following data sets have been gathered:

- (a) Topographical map of 1: 50 00 scale (2627BD Grasmere);
- (b) An ortho-photo map of 1: 10 000 scale (2627BD 4 Pimville);
- (c) Maps displaying the direction of overhead power lines around Motosledi on 1: 1 000 scale and related data from Johannesburg Electrical Department;
- (d) A health related questionnaire survey.

3.2.1 Questionnaire surveys.

A focus group was formed with inhabitants of the settlement for baseline survey purposes. Sample of 10% of homeowners or potential homeowners (about 500) were interviewed between August 28th 2000 and August 21st 2001. The majority of interviews were conducted in the last two weeks of May 2001. Data capturing of records was also undertaken in the process. This methodology section discusses how the survey was conducted, in particular the process of selecting and tracking respondents.

(a) Sampling process.

In the baseline surveys conducted in Motsoaledi, about 500 respondents were interviewed. Fieldworkers selected the households in a systematic way. Beginning at a randomly selected starting point, and visiting every eleventh stand, they asked to interview the 'household head' (defined as 'the person who makes the most important decisions in the household'). Field workers believed that even if the kind of self-identification employed in the baseline survey may not be entirely satisfactory, one was confident that they had interviewed individuals with at least some decision-making power over a variety of aspects in that particular household.

(b) Representativeness of the sample.

Findings and results of this report should not be interpreted as representative for all the informal settlements. The results are specifically for Motsoaledi informal settlement. However, it is hoped that the Motsoaledi informal settlement may be indicative of a broader picture of how dangerously some settlements are situated. The survey focuses on respondents who have identified themselves as household heads. Other groups within the settlements (such as youth, or the elderly) are not represented within the survey. Household heads were chosen because they make the most important decisions in relation to the issues that are important for decision making to the settlement for developmental and upgrading processes.

Given our sample of 10% respondents in Motsoaledi, it is possible to calculate the representativeness of our findings. The confidence interval for this sample size at the 80% level is approximately 10% (see figure 13, Chapter 4). In other words, we can be ascertain that 80% of the results from our sample represent a 10% of the results you would achieve from a full census of household heads. Furthermore, we found that 62% of the survey respondents strongly agreed that '*reconstruction of the settlement away from overhead power lines is a better option*'.

(c) Substituting.

There were inevitably cases where, for a variety of reasons, the respondent could not be interviewed. The following extract from Community Agency for Social Enquiry (2002:10), outlines different possible scenarios, the action that was taken, and the number of times

it occurred in this survey.

Table 2: Scenarios and action taken in substituting selected respondents.

SCENARIO	ACTION
<ul style="list-style-type: none"> • If the respondent has died in the original stand. • If the respondent was not available to be interviewed because they come home late from work, or was temporarily away. 	<ul style="list-style-type: none"> • A family member was interviewed in their place.
<ul style="list-style-type: none"> • If the fieldworker visited the stand on several occasions and each time there was nobody at home. • If the respondent refused to be interviewed. • If the respondent and all their family had moved away from the settlement. 	<ul style="list-style-type: none"> • A new respondent was selected from the baseline.

In certain cases, as indicated in the table, a new respondent needed to be selected from the baseline. The new respondent was chosen for the next stand number from the list of 500 chosen stands. For example, if a substitute was required for the respondent at stand number 258 in Motsoaledi, the next highest stand number on the list (277) was chosen. This method was chosen to preserve a relatively even geographical spread of respondents within the community (Community Agency for Social Enquiry, 2002)

3.2.2 GIS mapping

A Geographical Information System (GIS) is used as a tool to facilitate the process of identifying possible suitable areas for dwelling around Motsoaledi informal settlement. Data used for GIS were cadastral data which refers to all land-use parcels that is used to build or erect informal dwellings, and services data which refers to the overhead power line that is found within Motsoaledi informal settlement.

Data that will be used in this study are considered primary for spatial analysis (Campbell, 1989: 3). Cadastral and services data will be integrated, manipulated and processed to differentiate between land that is suitable and unsuitable for dwelling. Overhead power lines will be buffered at an interval of 4,5m zones and be classified from the highly unsuitable areas to highly suitable areas for dwelling. The resultant map will display suitable areas for dwelling around Motsoaledi.

3.3 Conclusion.

The methodologies used for this study are mainly aimed at determining people's understanding of the implications of living in the vicinity and in close proximity of overhead power lines. Community participation was of paramount importance in achieving objectives of this study. Methodologies that were employed in this study were interviews with the members of the community for data collection using questionnaires, land-use maps of the study area for data processing and GIS for mapping and land-use analysis. In the following section, analysis and results of the methods used will be discussed.



CHAPTER 4: ANALYSIS AND RESULTS.

4.1 Introduction.

The biological effects discussed in this study are based on athermal biological effects of electromagnetic fields (EMFs). The conclusions drawn from theoretical models discussed in this study show that over exposure to EMFs may have biological consequences. In the process of analysing of the effects of EMFs to human health, surveys were conducted around Motsoaledi, and homeowners or potential homeowners were asked several questions related to their knowledge about dangers of residing in close proximity and underneath overhead power lines. In this section, the discussion focuses on the results of these interviews using the questionnaire. Furthermore, analysis of the land-use in Motsoaledi is modelled through mapping.

4.2 Interviewing the Motsoaledi community.

A questionnaire was compiled and several interviews based on health and safety of the community of Motsoaledi were undertaken. In this settlement, the majority of the respondents are 'uneducated' therefore, their assumptions and answers to specific questions were genuine feelings about their health conditions and views about their settlement. Of particular importance about the interviews held in August 2000 and August 2001, was the willingness of respondents to participate in the exercise. Some respondents used unfamiliar language, which created communication barriers in the process. Graphical analysis of the research sample is outlined in this section.

4.2.1 Overhead power lines in Motsoaledi.

The majority of dwellings, about 70% in Motsoaledi settlement, are at a 'safe' distance from overhead power lines. A fairly small number of dwellings, about 23%, are in close proximity to overhead power lines. The smallest number, about 7% are directly located underneath overhead power lines. Residents who erected their shacks in close proximity of and underneath the overhead power lines, say among other reasons, that there was no available open land left for them to build their shacks (see Figure 7).

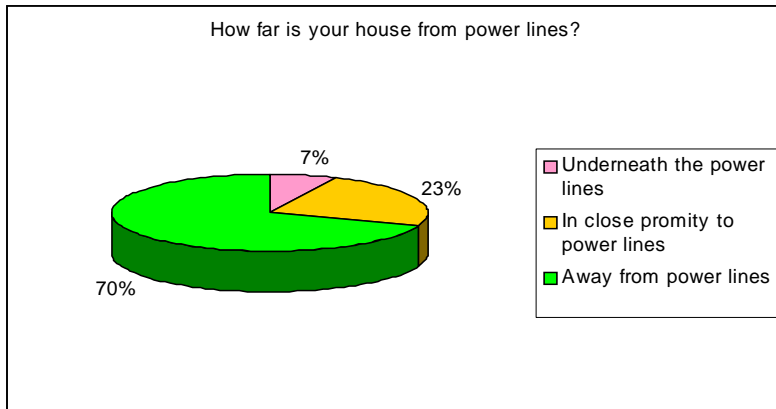


Figure 7: Dwellings in close proximity and underneath overhead power lines in Motsoaledi.

Living in the vicinity of power lines is unsafe and lack of knowledge among some members of the community poses the danger of being electrocuted. According to the survey sample most people do not know that there is a physical danger. They think that the overhead power lines are placed far higher than their dwellings and they will not be harmful to them and their property. Some members of the community admit that their lives are in danger, especially those dwellings that are in close proximity to and underneath the overhead power lines.

According to the survey sample, 10% of the respondents reflected that they 'know' that settling in the vicinity of overhead power lines is unsafe and only 28% do agree that it is dangerous, while 62% do not know and are not interested in knowing anything (see Figure 8).

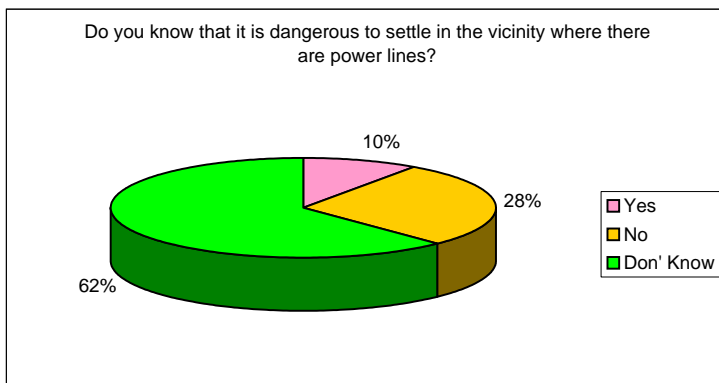


Figure 8: Danger in the vicinity of overhead power lines.

In a public meeting held by members of the community in the settlement, debates around loss of property due to fire have been attributed to negligence such as misuse of paraffin stoves and candle lights that result in the burning down of some of the shacks.

To a lesser extent, residents have attributed loss of some property, especially property that is in close proximity to overhead power lines, to electrical shocks caused by power lines and electrical related problems. While zinc is highly electrostatic and conductive of electricity and lightning, only a small number of persons and dwellings (less than percent) have experienced electricity shocks in their dwellings because of the nature of materials used to build shacks (see Figure 9).

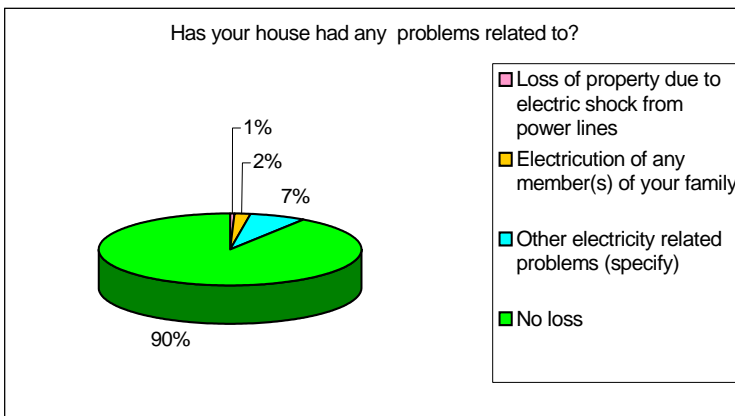


Figure 9: Property loss due to close proximity to overhead power lines.

4.4.2 Health effects around overhead power lines.

In the sample survey, health related questions were asked and for the purpose of this study it was to assess whether overhead power lines do affect their health or not, and to ascertain whether exposure to EMFs may cause constant headache, and brain cancer/leukemia. For the purpose of this study, perculiar diseases refer to constant headache, and brain cancer/leukemia (see Figure 10).

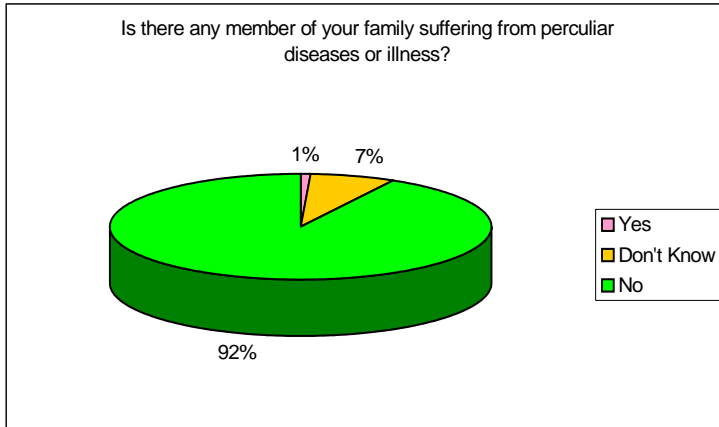


Figure 10: Peculiar illnesses in Motsoaledi.

A prompting question to the interviewees to assess whether peculiar diseases developed when they relocated to Motsoaledi or before was asked. Most of the respondents replied that they were not sure because illnesses like persistent/constant headaches seem normal to many people. On the other hand cancer/leukemia seemed to have developed after they have relocated to the settlement. Less than a percent (1%) of persons living in the vicinity of overhead power lines suffer from peculiar illnesses (cancer/leukemia) and they do not think that the cause is EMFs from the adjacent overhead power lines. From the surveyed households (95%) do not suffer from any unfamiliar or peculiar illnesses (see Figure 11).

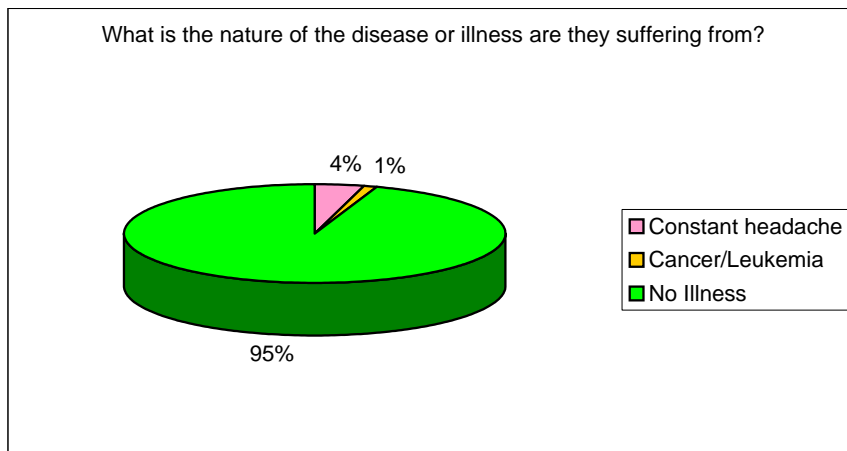


Figure 11: Type of illnesses that may result from over exposure to EMFs.

According to the sample, less than a percent suffer from cancer related disease. Among persons who suffer from peculiar diseases are children who were born within the

settlement during 1994 and 1997. It might be possible that during the time their mothers were pregnant, their body absorbed athermal emissions from overhead power lines.

Studies by Smith & Cleary (1993) of animal cells exposed to EMFs, in conjunction with theoretical calculations, showed that it takes more than 20 000kV/m with a pulse width greater than 200 nsec to cause cell membrane permeability changes due to dielectric breakdown (electroporation) of the cells within their biological host. High field intensities and exposure rate to EMFs may produce biological effects for some physiological indices. Biological effects on physiological indices from EMFs have been classified as 'probable human carcinogen' (EPA, 1992). Furthermore, biological effects around electrical power lines have been postulated relative for the reason that they may show a consistent pattern of development of effects yet that does not prove the causal link to EMFs exposure (Szmigielski, 1992: 91).

Epidemiologists argue that in order to investigate or evaluate the possible effects of EMFs to human health, there should be links between the observed effects and the associated data. The criteria used in the most studies includes among others, the strength of association between the factor and the observed effect. The observed effect refers to the changing behaviours in health of the persons affected by EMFs, however, such data is difficult to find in new residential areas like Motsoaledi informal settlement.

Bearing in mind that the possibilities of association between the development of health effects are still minimal, residents in Motsoaledi were asked about their perception with relation to peculiar illnesses. When persons were asked about the causes of peculiar illnesses within Motsoaledi, about 7% mentioned overhead power lines, while others, about 13% mentioned heredity and 77% did not know what the cause might be (see Figure 12).

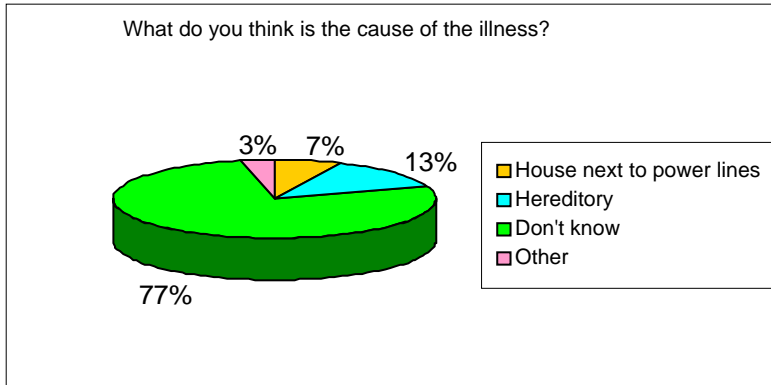


Figure 12: Causes of peculiar illnesses.

Safety of dwellers as well as their property remains the main objective of this study. Majority of dwellers in Motsoaledi (about 62%) do acknowledge that the area is not suitable for dwelling, they think that reconstruction of the settlement is the best option while 10% do not know whether the area is suitable or not. The remaining 28%, believes that the place is suitable for dwelling (see Figure 13).

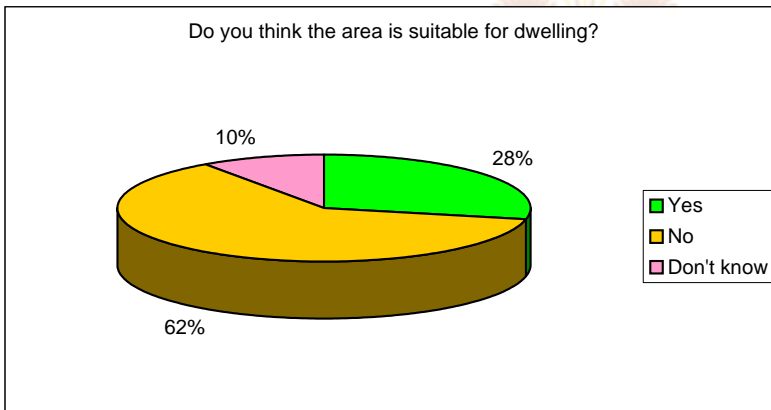


Figure 13: Area suitability.

A large percentage of persons believe that Motsoaledi is not suitable for dwelling. They based their reasons, among others, on the presence of overhead power lines that are above and in close proximity to the settlement. In using suitability indicator around Motsoaledi, the area was divided into two sections, namely south and north of Diepkloofspruit river. Observations during surveys indicated that there are dwellings underneath overhead power lines, others that are in close proximity and those that are away from overhead power lines. On average, the response that indicates scores of

shacks for unsuitability in the "South" of the settlement area is 1.1%, while for the "North" of the settlement area is 0.9% (see Table 2).

Table 3: Scores for unsuitability indicator.

SCORE	SOUTH	NORTH
	% of unsuitability	% of unsuitability
Highly unsuitable	0.7 %	0.4 %
Suitable	87 %	92.7 %
Highly suitable	12.3 %	6.9 %
Total	100 %	100 %
Average score (highly unsuitable)	1.1 %	0.9 %

Homeowners or potential homeowners that have their dwellings in unsuitable areas and in close proximity or underneath overhead power lines, were asked if the possibility of poor health of children emanated from the servitude in the settlement and how in their view, should health problems be addressed. From the responses gathered during the survey, one could sense some feeling of settledness. In their response about 72.3% were settled, while 19.2% were for the opinion that if they get a chance they will move to a much better place. The remaining 8.5% responded that they "don't know".

According to the survey, average scores for settledness indicator indicates that "South" has 38.1% settled homeowners or potential homeowners and "North" has 34.2% settled homeowners or potential homeowners (see Table 3).

Table 4: Scores for settledness indicator.

SCORE	SOUTH	NORTH
	% of settledness	% of settledness
Settled	69.5 %	64.4 %
Move to better place	25.7 %	27.7 %
Don't know	9.8 %	2.9 %
Total	100 %	100 %
Average score (settledness)	38.1 %	34.2%

4.3 Land-use analysis.

Data collected from different sets of maps, that is, 2627 BD Grasmere (1: 50 000), 2627 BD4 Pimville (1: 10 000) and 1: 1000 servitude maps from JHB Electrical Department were used for mapping Motsoalededi informal settlement. ArcInfo and ArcView GIS are used in this study for digitising land-use mapping in order to identify areas that are most suitable and those that are not suitable for dwelling. GIS is one of the computer-based information systems capable of integrating data from various sources to provide the information necessary for effective decision-making in urban planning" (Yeh, 1999: 877).

Most GIS tools support efficient data retrieval, query, and mapping. "When combined with data from other tabular databases or specially conducted surveys, geographical information can be used to make effective planning decisions (Yeh, 1998: 878)." For visualisation purposes, GIS was used to digitise detailed mapping of Motsoaledi informal settlement, because it does not appear on the 2627BD Grasmere topographical map. Land-use as well as overhead power lines data were overlaid for modelling.

In the analysis of GIS data, distance measurement for buffering overhead power lines in relation to land-use was undertaken (Asante and Maidment, 1998). A buffer is a zone constructed outward from an isolated object to a specific distance (Chrisman 1997). Before a buffer is attained, the entire study area around the overhead power lines has to be sliced, this means that the entire area is classified into concentric zones of equal distance from the overhead power lines.

Apart from the basic biological investigations, the problem to be considered in the context of this paper, is the setting of the standard limit between the residential area and overhead power lines. The International Electrotechnical Commission (IEC) decided not to deal with the setting of limits but rely on the organisations such as European Union (EU), World Health Organisation (WHO), Environmental Protection Agency (EPA), Committee on Interagency Radiation Research and Policy Coordination (CIRRPC), European Broadcasting Union (EBU) and many others. These organisations allow a fair comparison of the different results. One of the mandates received from European Union for standardisation was the TC111 (generic standards) that deals with setting measurement limits in the field of Electromagnetic Compatibility (EMC). Compatibility levels, source of emission and duration of exposure are considered setting standards (Goldberg, 1994).

As noted, the effects of EMFs on people or on living beings in general, is the subject of a considerable number of studies in scientific and medical institutes and relevant national or international organisations such as WHO, IEC, EU, EBU and many others, the main matters for concern are the possible effects on human health. There is no consensus within the scientific community on specific biological responses to EMF, but there is evidence to suggest that health hazards may exist (World Bank, 1991).

The emergence and development of an informal settlement such as Motsoaledi was not in accordance to the National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977) that proclaimed that 'no local authority shall permit the erection of a new establishment which poses an acceptable risk to -

- (a) housing an other centres of population; or
- (b) any other facility.

In Motsoaledi, it is questionable whether permission from the local authority to erect shacks was given or not, hence this study foresees risks to the health and safety of the occupants of the settlement. In the view of the historical background of the emergence of the informal settlements as outlined in Chapter 1 and 2, this study is not intended to advocate on the removal of the settlement or relocation of settlers but to engage the community of Motsoaledi in an awareness program about the possible effects of EMFs from the adjacent overhead power lines in the vicinity of their settlement. The possible safety distance for dwelling is calculated as 4,5m away from overhead power lines (Occupational Health and Safety Act and Resolutions, EMR 19, 1993). The measured safety distance of 4,5m may be considered as a possible safety net that may reduce the risk of health and safety of members of the public to an acceptable level (see Figure 14).

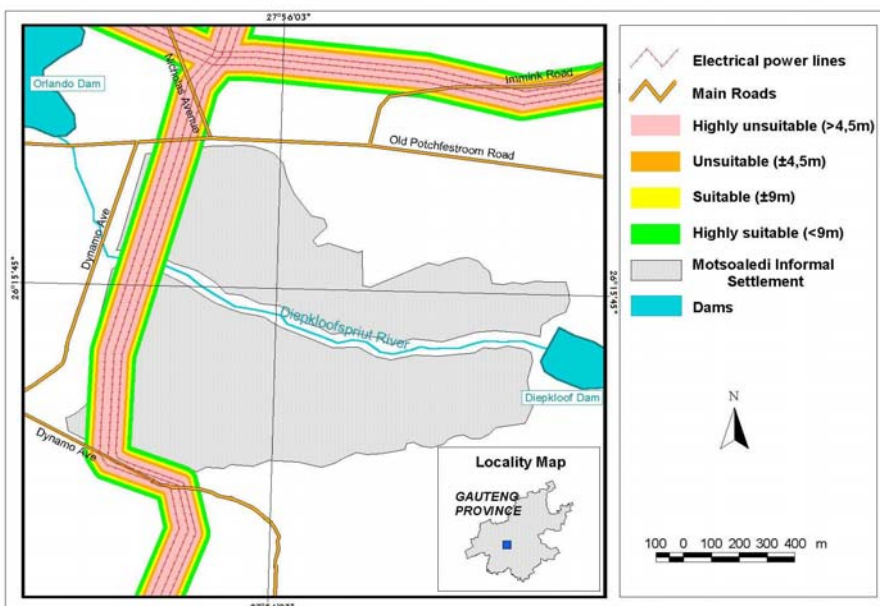


Figure 14: Study area buffered into zones of equal distance from the overhead power lines.

All polygons that were within the buffered zone were assigned the value of '0'. Any polygons that were outside the buffer zone were assigned the value of '1'. The attributes to polygons equalling '0' are unsuitable sites for dwelling, while all the values equalling '1' are suitable for dwelling. The identification of suitable land around Motsoaledi was undertaken by employing an overlaying technique of buffered overhead power lines to land-use polygons.

Through the use of the overlay technique to establish the areas suitable for dwelling in the settlement, areas that are highly at risk of EMFs and dwellings that may be easily electricuted are modelled. Furthermore, a query for suitable land was performed where areas that are suitable for dwelling are indicated as polygons and those that are not suitable are not indicated. Radiation is higher at a distance less than 4,5m and persons living in that vicinity are highly exposed to EMFs. Such persons are at a risk of being affected by diseases associated with EMFs. For persons who have their dwellings further than 4,5m, risks of being affected are less (see figure 15).

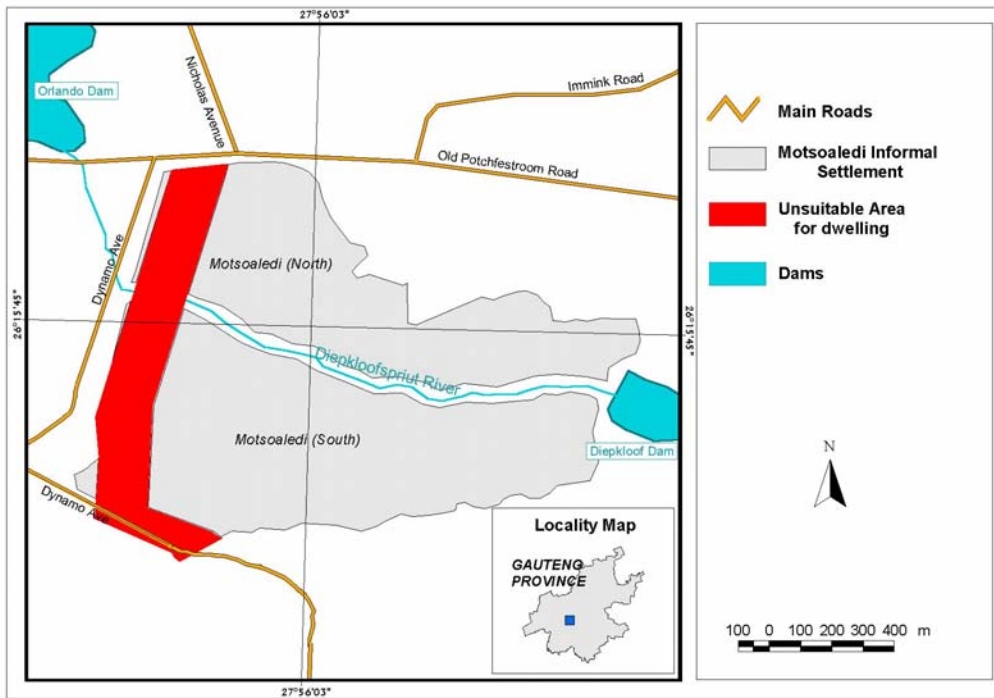


Figure 15: Land suitable for dwelling.

As compared to Figure 1, about 3% of the land on the western side of the settlement may be considered unsuitable for dwelling. The area indicated in red, underneath and in

close proximity to the overhead power lines, is not suitable for dwelling and pose health risks for persons in that vicinity.

4.4 Conclusion.

The intensity of EMFs around overhead power lines describes the sphere of influence between the soil and the entity within an electric field. In the elliptic/dummy model, optimal safety distance between entities and overhead power lines was discussed. In this study, the 4,5m distance away from overhead power lines was used as a safety net for dwellings underneath and in close proximity to overhead power lines. Though the nature and intensity level of EMFs underlying any association with adverse health effects is still not known, the epidemiologic correlations with proximity to power lines advocates prudent avoidance as much as possible. Statistically, long-term exposure to EMFs could lead to health problems. It was, in this regard that a survey was conducted in Motsoaledi to assess the people's knowledge and awareness about health risks that are associated with EMFs and overhead power lines.

The results from the survey pointed out that there is a lack of awareness and knowledge about risks and danger of overhead power lines and EMFs. Among other reasons, people have their dwellings underneath and in close proximity to these servitudes is that they wanted a place to stay within the settlement but there was no other vacant land. Graphically, results from the survey were outlined. Furthermore, GIS was employed as a tool to identify suitable land for dwelling around Motsoaledi. Overlaying of buffered overhead power lines, polygons with land-use data-set was employed and the results were modelled by means of a map.

CHAPTER 5: SYNTHESIS.

5.1 Introduction.

Informal settlements emerged due to the influx of people to urban areas to seek job opportunities and due to housing shortage, they also had to find places to stay. This led to the emergence of informal settlements on the outskirts of urban areas on land not proclaimed for residential development, which may make them illegal. Informal settlements are sometimes located on land unsuitable for settlement. Motsoaledi is such a settlement where some of the shacks were constructed underneath and in close proximity to overhead power lines. The aim of the study were to outline problems of the overhead power lines that are in the vicinity of an informal settlement and their effects or impact on human health.

5.2 Evaluation of problem statement and objectives.

The location of some shacks in Motsoaledi underneath and in close proximity to overhead powerlines may have bad influence on the health of human beings owing to the direct influence of the EMFs. Most persons may not be aware of the health risks that they are exposed to in Motsoaledi. The study has reflected the 'risk' conditions of this informal settlement and how indirect influence or athermal interaction of EMFs and humans may possibly have consequences to their health. Attention was directed to the dwellings that are in close proximity or underneath the overhead power lines.

The problem being investigated in the study is whether the location of part of Motsoaledi in the vicinity of power lines does constitute any environmental risks for the inhabitants or not. With the use of a risk awareness questionnaire, interviews with the community was undertaken to assess personal knowledge about the dangers or risks of dwellings underneath and in close proximity to overhead power lines.

In undertaking this study, the following were achieved:

- A literature review on the effects of EMFs on human health. This literature review outlined that EMFs may and may not be harmful to human health yet more scientific proof needs to be done.

- A health related survey about knowledge and perceptions of 'risks' and dangers of residing in close proximity or under overhead power lines.
- A graphic representation of the perception that there might be diseases that may develop due to over-exposure to EMFs or due to dwellings that are in the vicinity of overhead power lines. In light of the literature review, it might be possible that over-exposure to EMFs can lead to development of diseases such as cancer/leukemia.
- A land-use analysis, in which a buffer distance of 4,5m using GIS was applied to indicate unsuitable and suitable areas around the settlement.

5.3 Evaluation of literature reviewed.

Literature reviewed in this study correlate higher incidence of poor health, especially leukemia in children and adults to the proximity of overhead power lines. Some reviews also show that persons in living close proximity to or underneath power lines like in Motsoaledi are likely to develop various types of cancer.

Some studies, especially the Eskom Environmental manual found no correlation between overhead power lines and human health. Reasons for not finding any correlation in the studies are based on assumptions that only physical contact to electrical current or incidents related to shock or heating by electrical current can have adverse effects on human health. When the electric current traveling through an organism is sufficiently large to cause a sudden physical response, the organism is said to be shocked. Of course anyone can relate to the electric shock, and when it is sufficiently severe, it does cause adverse effects.

Effects from EMFs exposure would be attributed to secondary causes such as stress from the heating of internal of human physiology. Some studies have indicated that human interaction with EMFs has negative effects or changes to human health while others indicate that there are no effects or changes. The surrogate (proxy) measurement model used in the study as an index of measurement of electric and magnetic field, was used to indicate the severity of EMFs around the overhead power lines. Using the model, only intense exposures to EMFs would have the power to cause physical effects. The radiated EMFs around the overhead powerlines may cause effects that are transitory or permanent to human health.

5.4 Evaluation of research methodology.

A survey was conducted amongst dwellings that are underneath and in close proximity to overhead power lines around Motsoaledi. Particular attention was given to their perceptions about effects of overhead power lines and over exposure to EMFs. The following problems were experienced during the survey:

- Language problems were encountered from foreigners who did not speak ones of the eleven official languages.
- Fieldworker visited a stand on several occasions and each time there was nobody at home.
- Some of the respondents refused to be interviewed.
- Some respondents and their family members from the baseline had moved away from the settlement.

Analysis for the identification of suitable land around Motsoaledi was undertaken by employing an overlaying technique of buffered overhead power lines to land-use polygons. The strength of EMFs decreases with the distance from the power lines (World Bank, 1991), hence buffering of overhead power lines into equal distance to split the area into suitable and unsuitable areas for dwelling was undertaken.

5.5 Evaluation of the results.

Most of the persons that were interviewed have no educational background and the response was taken to be their genuine views and feelings. The results from the study shows that there is less than one percent of persons that have health problems (cancer or leukemia) caused by over-exposure to EMFs. Their dwelling places are found to be underneath or in close proximity to overhead power lines. GIS mapping and analysis of land through buffering of overhead power lines displayed highly unsuitable land as well as the suitable land-use for dwelling. Mapping results suggest that people in the vicinity of 'unsuitable area' (underneath and in close proximity of overhead power lines) in Motsoaledi may be faced with health 'risks' or danger of electrocution if the power lines can break or be disturbed.

Results of this study do not suggest that the residents from Motsoaledi must be evicted, as one of the earliest and most influential writers on squatter settlements (Turner, 1969)

argued that, 'It is clear that the peripheral squatter settlements do, in fact, perform the principal functions demanded by their inhabitants. So, in spite of many problems they may cause, they often act as forward moving vehicles of social change'. One of the issues about the existence of the informal settlements is that they reflect the outcry of many communities that there is a housing shortage in South Africa and in many parts of the world.

As some literature suggests that there is empirical evidence of the effects of EMFs from over-exposure of EMFs, and some evidence suggests that there is none, communities must be educated on the 'prudent avoidance' and awareness of possible harmful athermal effects of EMFs (O'Carroll, 2001). Community awareness as a precautionary principle has to be encouraged to the community of Motsoaledi and other settlements that may be similar to this one. The Motsoaledi community may learn that dwellings that are in the vicinity of 'unsuitable area' may relocate to a safer area around the settlement or opt to relocate elsewhere where they will be safe from the dangers that may result from the EMFs.

5.6 Environmental management.

As a prototype for other informal settlements, Motsoaledi was partly built on open land where there are overhead power lines that pose a health threat to the community. Most informal settlements are found to be illegally constructed in areas where settlement is not permitted due to terrain constraints, health factors or some other reasons best known by the local authority. Squatter settlements in urban areas are inevitable phenomena. As long as urban areas offer economies of scale and agglomeration economies, large cities will always continue to grow, attracting migrants from rural and smaller urban areas, leading to more squatting, especially where there is a housing shortage. There is no universal 'quick-fix' solution that can solve all the problems of squatting in all parts of the developing world.

Although other scientific literature do not entirely support the notion that EMFs may have negative effects on human health, precautionary principles should be considered as a safety step by the community of Motsoaledi. "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause-and-effect relationships are not fully established scientifically" (Dahlberg,

2001:13). Public concern should be expressed well before proof is reached, with good reason, and therefore:

- The people of Motsoaledi must try to increase the space and distance between the settlement and overhead power lines.
- People must try to avoid building the settlements too close to overhead power lines.
- Children must be discouraged from playing near overhead power lines at all times.

In this study, there are findings from the literature reviews that create some plausible connections between EMF exposures and their impact on human health. However, environmental concern of this study is aimed at the scientific urgency to resolve uncertainties over association between the exposure to EMFs and its impact on human health.

5.7 Conclusion

The study has spelt some rationale grounds for suspicion of associated health risks of cancer and biological effects. In light of the aims and objectives addressed by this study, public concern should be:

- (a) public information on safety and effects of overhead power lines around settlements;
- (b) that new developments be subjected to reasonable precautionary policy, especially exposure to radiation such as EMFs;
- (c) that communities be encouraged to adopt prudent avoidance from any possible harmful athermal exposure that may have negative effects on human health.
- (d) regulating steps such as that would prohibit people from occupying or settling in vacant lands that are proclaimed not for dwelling.

As the president of South Africa iterated in 2000 that '*Batho pele (people first)*', the community of Motsoaledi need to be educated about their local conditions. Education about 'risks' of residing in the vicinity of overhead power lines needs to be undertaken. Communities need to be taught that there might be some health 'risks' if persons are over-exposed to EMFs, also when one reside in the vicinity of overhead power lines,

their lives might be at risk.

In the light of the scientific studies around the risks and effects of EMFs 'People want assurance that no risk will be discovered in the future, and that life under overhead power lines will never result in disease. No scientist worth his or her salt will make such a promise and no guarantees can be given' (Henshaw, 2000: 6). Over time, apprehension about power lines may gradually abate. But the public may just transfer its anxiety to another part of the electromagnetic spectrum. Conflicting fears about the biological effects of power lines could generate more public health scare. Thus, the public debates may never fully end since the journey towards scientific revolution around EMFs still continues.



SELECTED BIBLIOGRAPHY

Adair, R. K. 1991: Biological Effects on the Cellular Level of Electric Pulse Fields. **Health Physics**, 1991. Vol. 61, No3: 395-399

Ahlbom, A. 2000: A pooled analysis of magnetic fields and childhood leukaemia. **British Journal of Cancer**, 2000. Vol 83: 692-698

Asante, K & D.Maidment 1998: The Building Blocks of GIS: **Geoinformation Africa**, 1998, September. Vol. 7: 22-24

Blunden, J., P. Hagget, C. Hamnett & P. Sarre, 1978: **Fundamentals of Human Geography: A Reader**. Harper & Row: London

Brail, R. K. 1990: Intergrating GIS into Urban and Regional planning: Alternate approaches for developing countries. **Regional Development Dialogue**, 1990, Vol 11. Issue 3: 63-79

Campbell, G. 1989: **Management Considerations in Applying GIS Technology within an Organization's Information System Strategy**. Canadian Conference on GIS Ottawa, Canada, March 1989

Carter, H. 1989: **The Study of Urban Geography**. 3rd Edition. Edward Arnold: London

Chrisman, N. 1997: **Exploring geographic information systems**. Wiley: New York

Committee on Interagency Radiation Research and Policy Coordination, 1992: **Health Effects of Low-Frequency Electric and Magnetic Fields: Report to CIRRPC 1992**. NTIS: Oakridge

Community Agency for Social Enquiry, 2002: **Upgrading Gauteng's Informal settlements Volumes 1-5: A study of Eatonside, Albertina (Etwatwa Ext. 30), Soshanguve South Ext. 4 and Johandeo**. www.case.org.za/html/informal.htm

Coleman, M. P., C. M. J. Bell, H. L. Taylor & M. P. Zakelj, 1989: Leukemia and Residence near Electricity Transmission Equipment: A case-control study. **British Journal of Cancer**, 1989, Vol 60: 793-798

Dahlberg, D. 2001: **Extra Low Frequency Power lines**. www.emfguru.com/ELF/dahlberg-testifies.html

Development Atlas, 1997: **Greater Johannesburg Metropolitan Council Development Atlas:Draft Document**. GJMC: Johannesburg

Department of Housing, 1997: **The Housing Act, 1997 (No.7 of 1997)**. www.acts.co.za/housing_html

Department of Housing, 2001a: **Housing the Nation: Environmental Implementation Plan**. www.housing.gov.za/pages/executivesummary.htm

Department of Housing, 2001b: **The User Friendly Guide: The Environmental Context**. www.housing.gov.za/pages/userfriendlyguide.htm

Electric Power Research Institute, 1992: **Survey of Residential Magnetic Field Sources: Interim Report**. EPRI Research Project 2946: 6-8

Electrical Machinery Regulations 20, 1993: **Occupational Health and Safety Act and Regulations**. EMR 20(d). 1993: 1416-1417

Environmental Systems Research Intitute. 1996: **ArcView GIS: The Geographic Information System for Everyone**. ESRI: Redlands

Environmental Protection Agency, 1990: **Evaluation of the Potential Carcinogenicity of Electromagnetic Fields: External Review Draft**. EPA: Washington

Eskom Annual Report, 2000. **Environmental Impact Assesment**. www.eskom.co.za

Everatt, D., R. Jennings, S. Davies & M. Isserow, 1988: Investigating Water and Sanitation in Informal settlements in Gauteng, **Community Agency for Social Enquiry**.
www.case.org.za

Feychting, M. & A. Ahlbom, 1993: Magnetic Fields and Cancer in Children Residing near Swedish High-voltage Power Lines. **Epidemiology 7**, 1993:467-481

Feychting, M. & A. Ahlbom, 1994: Magnetic Fields, Leukemia, and Central Nervous System Tumors in Swedish Adults Residing near High-voltage Power Lines, **Epidemiology 5**, 1994:501-509

Finlayson, K. A. 1978: **Squatting and the Role of Informal Housing in Incremental Growth and Self Improvement**. NBRI: Pretoria

Goldberg, G. 1994: International Standardization in the Field of Electromagnetic Compatibility. **EMC Wroclaw, July 1992**: 451-455

Green, L. M., A.B. Miller, D. A. Agnew, M.L. Greenberg, J. Li, P. J. Villeneuve & R. Tibshirani, 1999: Childhood Leukemia and Personal Monitoring of Residential Exposures to Electric and Magnetic Fields in Ontario, Canada. **Cancer Causes Control 10**, 1999: 233-243

Hadlock, D., P. Szerszen, J. Williams, E. Patrick, T Waltmeyer & I Kohlberg, 1993: Biological Effects of Large Unbounded Shielded and Unshielded Electromagnetic Pulse Simulators. **EMC Zurich, March 1993**: 15-18

Haubrich, H. J & T. H. Seitz, 1993: Electrical and Magnetic Fields Around Overhead Transmission Lines. **EMC Zurich, March 1993**: 19-23

Hazardous Substance Act, Act 15 Of 1973, **Regulation R1302**, dated June 1991. Government Print: Pretoria.

Henshaw, L. 2000: Illness and Power Lines Link yet to be Proved. **Extra Low Frequency Power lines**. www.emfguru.com/ELF/henshaw.html

Hoeff, L. O. 1992: Models for the Effects of Electromagnetic Fields on the Occurrence of Cancer. **EMC 92 Wroclaw, September 1992: 77-79**

Kaune, W. T., R.G. Stevens, N.J. Callahan, R.K. Severson & DB Thomas, 1987: Residential Magnetic and Electric fields. **Bioelectromagnetics, 1987. Vol. 8: 315-335**

Li, C.Y., G. Theriault & R. S. Lin, 1997: Residential Exposure to 60-Hertz Magnetic Fields and Adult Cancers in Taiwan. **Epidemiology 8, 1997: 25-30**

London, S. J., D. C. Thomas, J. D. Bowman, E. Sobel, T.C. Cheng & J. M. Peter, 1991: Exposure to Residential Electric and Magnetic Fields and Risk of Childhood Leukemia. **American Journal of Epidemiology 1991. Vol 134: 923-937**

Mlaba, O. 1998: **Cato Manor: Development Project.** www.cmda.org.za

Myers, A., A. D. Clayden, R. A. Cartwright & S. C. Cartwright *et al.*, 1990: Childhood cancer and overhead power lines: a case-control study. **British Journal of Cancer 62, 1990: 1008-1014**

National Building Regulations and Building Standards Act, 1977(Act No 103 of 1977).

National Housing Board, 1995: **Guidelines for the Provision of Engineering Services and Amenities in Residential Township Development.** CSIR: Pretoria

New York State Department of Health, 2001: **Power lines Project-Questions and Answers.** www.health.state.ny.us/nysdoh/consumer/envIRON/power.htm

O'Carroll, M. J. 2001: **Public health concern about electromagnetic fields from electricity supply.** www.revolt.co.uk/emfcon.html

Office of Technology Assessment, 1989: **Biological Effects of Power Frequency Electric and Magnetic Fields - Background Paper.** US Govt Printing Office : Washington

Poole, C. & D. Trichopoulos, 1991: Extremely Low-Frequency Electric and Magnetic fields and Cancer. **Cancer Causes Control** **2,1991**: 187-195

Petridou, E. *et al.*, 1993: Age of Exposure to Infections and Risk of Childhood Leukemia. **British Medical Journal** **307, 1993**: 774-776

Safire, H. 1992: Politics and Protests in Shack Settlements of Pretoria-Witwatersrand-Vereeniging Region, South Africa, 1980-1990. **Journal of Southern African Studies** **1992**. Vol 18: 670-697

Savitz, D. A., & A. Swedlow, 1988: Case-control Study of Childhood Cancer and Exposure to 60-Hz Magnetic Fields. **Am J Epidemiology**, **1988**. Vol 128:21-38

Savitz D. A, N.E, Pearle & C. Poole, 1989: Methodological Issues in the Epidemiology of Electromagnetic Fields and Cancer. **Epidemiology Review**, **1989**; 11: 59-78

Science Advisory Board, 1992: **A SAB Report: Potential Carcinogenicity of Electrical and Magnetic Fields**. USEPA: Washington

Schüz, J., U. Kaletsch, R. Meinert, P. Kaatsch & J. Michealis, 2001: Residential Magnetic Fields as a Risk Factor for Childhood Acute Leukaemia: Results from a German Population-Based Case-Control Study. **International Journal of Cancer** **91, 2001**: 728-735

Severson, R.K., R. G. Stevens, W. T. Kaune, D. B. Thomas, L. Heuser, S. Davis & L. E. Sever, 1988: Acute Nonlymphocytic Leukemia and Residential Exposure to Power-frequency Magnetic Fields. **American Journal Epidemiology** **1988**. Vol. 128:10-20

Slack, N. S., S. Chambers & R. Johnston., 1998: **Operations Management**. Pitman Publications: London

Smith, G. K. & S. F. Cleary. 1993: Effects of Pulsed Electrical Fields on Mouse Spleen Lymphocytes in Vitro. **Biochemica et Biophysica**, **1993**. Vol. 763 325-331

Srinivas, H. 2000: **Defining Squatter Settlements**. www.soc.titech.ac.jp/uem/squatters/s-and-s.html

Statistics South Africa. 2000a: **Stats in Brief**. Statistics South Africa: Pretoria

Statistics South Africa. 2000b: **Census 2001 Demarcation Manual version 1. 4**.
Statistics South Africa: Pretoria

Stevens, L. & S. Rule, 2001: **Moving to an Informal Settlement: The Gauteng Experience**. www.egs.uct.ac.za/sagj/Gauteng.htm

Szmigielski, S. 1992: Cancer and Electromagnetic Fields: **EMC 92 Wroclaw, September 1992**: 90-96

Tomenius, L. 1986: 50-Hz Electromagnetic Environment and the Incidence of Childhood Tumors in Stockholm County. **Bioelectromag 7, 1986**: 191-207

Turner, J. F. C. 1969: **Uncontrolled urban settlement: problems and policies**.
Englewood: London

Valberg, P. A. 1994: **Biology and electric and magnetic fields: Biophysical mechanisms of interactions**. EPRI Report TR-104800: California.

Van Riet, W., P Claasen, T. van Viegen & L. Du Plessis, 1997: **Environmental Potential Atlas for South Africa**. Van Schaik: Pretoria

World Bank, 1991: **Environmental Assessment Book, Volume I, II, III, Guidelines for Environmental Assessment of Energy and Industry Projects**, Updates 1-17, Washington.

Yeh, A. G. 1998: **Urban Planning and GIS. Geographical Information Systems Vol.2: Management and Application**. John Wiley: New York

Youngson, J. H. A. M., A. D. Clayden, A. Myers, & R. A. Cartwright, 1991: A Case/Control Study of Adult Haematological Malignancies in Relation to Overhead power lines. **British Journal of Cancer** 63, 1991: 977-985.



APPENDIX:

Health and safety survey in Motsoaledi Informal settlement.

Surveyor Name:

N.B. Respondent information-Respondent must be a homeowner or Potential homeowner.

This survey is being conducted on an anonymous basis and you do not have to give any details that enable another person to identify or locate you. Please use (X) to mark your answer.

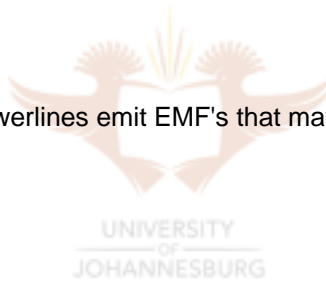
1. How far is your house from the power lines?

Underneath the power lines	Yes		No	
Close proximity to the power lines	Yes		No	
Away from the power lines	Yes		No	

2. Do you know that it is dangerous to settle in the vicinity where there are power lines?

Yes	
No	
Don' Know	

3. Do you know that powerlines emit EMF's that may cause health problems if one is exposed to?



Yes	
No	
Don' Know	

4. Is there any member of your family suffering from perculiar diseases or illness?

Yes	
No	
Don' Know	

5. What is the nature of the disease or illiness are they suffering from?

Constant headache	Yes		No	
Cancer	Yes		No	
Leukemia	Yes		No	
Other (specify)				

If "Other", please specify.....

6. What do you think is the cause of the disease or illness?

House next to power lines	Yes		No	
Hereditary	Yes		No	
Don't know	Yes		No	
Other				

If "Other", please specify.....

7. Has your house had any problems related to?

Loss of property due to electric shock from power lines	Yes		No	
Electricution of any member(s) of your family	Yes		No	
Other electricity related problems (specify)				

If "Other", please specify.....

8. If your house was electricuted, why are still around the area?

Do not have any other place to go	Yes		No	
Next to place of employment	Yes		No	
Cannot afford rent in municipal houses.	Yes		No	
Disputes with landlords at former location	Yes		No	
Need own place stay	Yes		No	

9. Do you think the area is suitable for dwelling?

Yes	
No	
Don't know	

10. Do you think that health in this area are caused by the availability of Overhead power lines around the areas

Yes	
No	
Not sure	

11. If you answered "Yes" to the above, what do you think can be done in addressing the problem?

Restructure the settlement	Yes		No	
Relocate to other places	Yes		No	
Other (Specify)				

If "Other", please specify.....

