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A Decade Assessments

Maiduguri Urban Expansion

Highlights

Implications for Teaching

Opportunities and Challenges

Discovering Thoughts, Inventing Future

VOLUME 14 ISSUE 2 VERSION 1.0

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A Decade Assessments of Maiduguri Urban Expansion (2002 - 2012): Geospatial Approach

By Ikusemoran Mayomi & Jimme Abba Mohammed
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Abstract- For almost a decade now, Maiduguri urban has been faced with security challenges which were believed to have negatively affected the growth and expansion of the city, hence the need for proper assessment of the rate and pattern of the urban expansion within the last one decade. Google images of 2002 and 2012 of Maiduguri urban were downloaded from the Google Earth Pro, the images were then referenced, classified and reclass into four main classes of undeveloped areas, developed areas, water body and bare surfaces. The area module of the Idrisi Andes was then used to calculate the area of the classes of the re-classed images. The calculated areas were then used to derive the trends, magnitudes and the annual changes of the urban during the study period, while the image calculator module of the Idrisi Andes was used to delineate the actual places where built-up existed between 2002 and 2012. The study revealed that a total land area of 15.1km2 was occupied with built-up within the decade. It was also revealed that most of the expansion in the urban took place at the periphery of the urban notably, the University and its environs, Baga road, Bulumkutu/ Ngomari area, the land area between Biu and Damboa road as well as some areas in old Maiduguri. It was recommended that constant urban monitoring should be undertaken by the government so as to have an in-depth idea of the rate and pattern of urban growth for proper planning and sustainable development.

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A Decade Assessments of Maiduguri Urban Expansion (2002 - 2012): Geospatial Approach

Ikusemoran Mayomi [α] & Jimme Abba Mohammed [σ]

Abstract- For almost a decade now, Maiduguri urban has been faced with security challenges which were believed to have negatively affected the growth and expansion of the city, hence the need for proper assessment of the rate and pattern of the urban expansion within the last one decade. Google images of 2002 and 2012 of Maiduguri urban were downloaded from the Google Earth Pro, the images were then referenced, classified and reclass into four main classes of undeveloped areas, developed areas, water body and bare surfaces. The area module of the Idrisi Andes was then used to calculate the area of the classes of the re-classed images. The calculated areas were then used to derive the trends, magnitudes and the annual changes of the urban during the study period, while the image calculator module of the Idrisi Andes was used to delineate the actual places where built-up existed between 2002 and 2012. The study revealed that a total land area of 15.1km^2 was occupied with built-up within the decade. It was also revealed that most of the expansion in the urban took place at the periphery of the urban notably, the University and its environs, Baga road, Bulumkutu/ Ngomari area, the land area between Biu and Damboa road as well as some areas in old Maiduguri. It was recommended that constant urban monitoring should be undertaken by the government so as to have an in-depth idea of the rate and pattern of urban growth for proper planning and sustainable development.

I. Introduction

Maiduguri was made the capital of the defunct North Eastern state in 1967 and since then, the city has been state capital till date. In 1976 when Nigeria was divided into nineteen states and which Borno state was one of the newly created states, Maiduguri became the capital of Borno state. In 1991 Yobe state was carved out of Borno state and Maiduguri still maintains the capital of the state - the position the city holds till date.

According to Walad (1969) in Kawka (2002), the area of the town which is nowadays called Maiduguri was covered with *dusu* trees *(Dichrostachys sp)* and inhabited by large numbers of wild animals. Therefore, hunters came (here) to chase near the shores of the river, they latter set up their settlements and stayed for short periods. During this period, the people of Birni Gazargumo came southwards to the Mandara and Kasar mountains for warfare in order to capture slaves. It was during this period that the people of the Maidugu (title of a descendant of a ruler) arrived during their raids and settled around the areas. The hunters who had earlier settled near the river invited the people of the Maidugu to settle with them. The Maidugu took his people and settled with the hunters near the river. They called that place Maiduguri: meaning the town of the Maidugu. Maiduguri latter became an important town because in the words of Walad (1969) in Kawka (2002) that "whatever major road one takes, when you come to that place from the east, you will stay, from the south, you will stay there and from the north, it will be that place where you will stop. It became a busy trading center". Hence is likened to the present day nodal town. Maiduguri was founded in 1672 with Yerwa as the traditional name.

Maiduguri urban is the capital of Maiduguri metropolitan Council (MMC) and Jere Local Government Areas. Despite the fact that the city is located in semi arid region; the city is protected from intense rays of the sun with trees starting from the colonial authority when tree planting was a priority. Today, all major roads in the city are lined with trees; mostly neem tree which has adaptability capability with dry lands, coupled with its fast growth rate as noted by Ayuba (2009) that on the major streets of towns in Borno state there are exotic species of *Azadirachta indica, Gmelina arborea* and *Eucalyptus spp* which are to protect the environment from drought and desertification, and to supply fuelwood and other minor forest products

Since urban expansion cannot be discussed in isolation without demographic development, the rapid expansion of Maiduguri was said to have began in 1960s when the city rapidly expanded in landmass and population. The population of Maiduguri was 10,000 in 1910 This figure according to the National Population Census rose to 139, 965 in the 1963 and 654, 400 in 1991 (Kwaka 2002). The 2006 Population Census put the total population of the Maiduguri urban (MMC and Jere LGA) at 749,123. The increase in population and expansion of urban land mass, also lead to the creation and restructure of the wards. The 1952 census in Kwaka (2002), distinguished between the administrative units of Yerwa town and Yerwa town surroundings. Yerwa town comprised the following wards: Bulabuni, Fezzan, Gamboru, Hausari, Lamisula, Limanti, Mafoni, Shehuri North, Shehuri South and Zongo. Yerwa Town

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Surroundings comprised Alau, Bale (Galtimari), Bolori, dala (Lawanti), Dusman, Gongulong, Liberty (Village), Maiduguri, Mai Musari (Mairi) and Ngudda (Addamari).

Uneven growth of the population in the different wards, administrative convenience and easy tax collection and control were the three reasons given for the creation and restructuring of the existing wards (Kwaka 2002). Prior to 1920, the present Maiduguri comprised of only one ward – the Udje District with Udje Maiduguri and Udje Mabani as the two big settlements. In 1957, the Yerwa town and Yerwa town surroundings were split into the urban Yerwa District and the peri-urban and the rural known as Maiduguri Districts. In 1991 Bolori District was created while the Gwange District was carved out from Yerwa Distrct in 1994. Jere Local Government Area (LGA) was created from Maiduguri urban with Old Maiduguri, Mashamari, Ngomari Gana, Mairi, and Bale Galtimari belonging to the Jere LG. Today, Maduguri urban comprised four LGAs: Maiduguri metropolitan Council (MMC), Jere LGA, Konduga LGA and a smaller part of Mafa LGA.

The present day Maiduguri is blessed with infrastructural, developmental, commercial, health and industrial activities. Road network, international air port, and rail are some of the means of transportation. There are pipe borne water, boreholes and wells as sources of water. Many public and private primary and secondary schools, College of Education, State Polytechnic College of Agriculture, College of Legal Studies, School of Nursing and the University of Maiduguri are some of the tertiary institutions in the urban. Nigeria Television Authority (NTA), and Borno Radio Television (BRTV) are also available for information dissemination and entertainments. There are chains o hotels among the important ones are Chad Hotel, International Hotel, Dujima, Chezcon, Mairi Place and Lake View Hotels. Major industries include; Neital shoe Factory, Haske Sweet and confectionaries, Borno Aluminium and Co. Maiduguri Flour Mills, Borno Polythene and Plastic Industry, Nail and Office Pins factories etc. Modern banks such as GTB, Diamond, First Bank, Union Bank, UBA, Mainstream Bank, Keystone Access, Fidelity and other banks are also available in the urban.

a) Statement of the Problem

Borno State in general and Maiduguri in particular were known in history as a very peaceful state and city respectively, hence, the state slogan as "the home of peace". However, the recent crisis in the urban which started in almost a decade ago and which has gradually cropped into the other parts of the state and now extended to other parts of Nigeria has served as threats to the peace of the urban in particular. We read, see and hear in newspapers; television and radio that the crisis has made many people especially the non-indigenes to flee to other parts of the country. This of course is believed to have major impacts on the growth and expansion of the urban especially in residential development sector. This paper therefore sought to assess the status of the urban expansion of Maiduguri so as to ascertain whether the city is expanding, static or contracting during the last one decade when the city has been under serious security challenges and also to measure the trends, magnitude and the annual rate of the expansion, or otherwise of the urban.

b) Aim and Objectives

The aim of this paper is to assess the level of urban expansion of Maiduguri urban between 2002 and 2012, so as to ascertain the level of expansion of the city within the period of the crisis. The specific objectives include:

- to assess, the built up areas in Maiduguri urban between the last one decade that is, 2002 and 2012 using GIS techniques based on Google maps of Maiduguri urban.
- to calculate the trends, magnitudes, percentages and annual rate of changes of the actual built up areas within the period (2002 to 2012).

II. The Study Area

Maiduguri is located between latitudes 11 42N and 12 00 N and longitudes 12.54 and 13 14 E (Haruna 2010). She further claimed that Maiduguri covered an area of 543km^2. The city is bounded in the north by Jere LGA, in the west, south and south-west by Konduga LGA, in the north-west by Mafa LGA. Maiduguri has mean annual maximum temperature of 34.8 with mean temperature ranging between 30 and 40 C. The months of March and April are usually the hottest months, while November and January are the cold and dry periods of harmattan. The city receives rainfall from June to September. However in rainy years, the city records rainfall earlier than June and latter than September. Being a nodal city, trading is the major occupation of the inhabitants with few agrarian practices. The city is situated in a plain area. One of the problems confronting the geography of Maiduguri urban is the non-availability of a standard boundary of the urban. Therefore, in this study, the urban is defined to be the areas between latitudes 11° 27′ 30″ N and 11° 33′ 30″ N and longitudes 13° 2′ 30″ E and 13° 9′ 10″ E (Fig. 1)

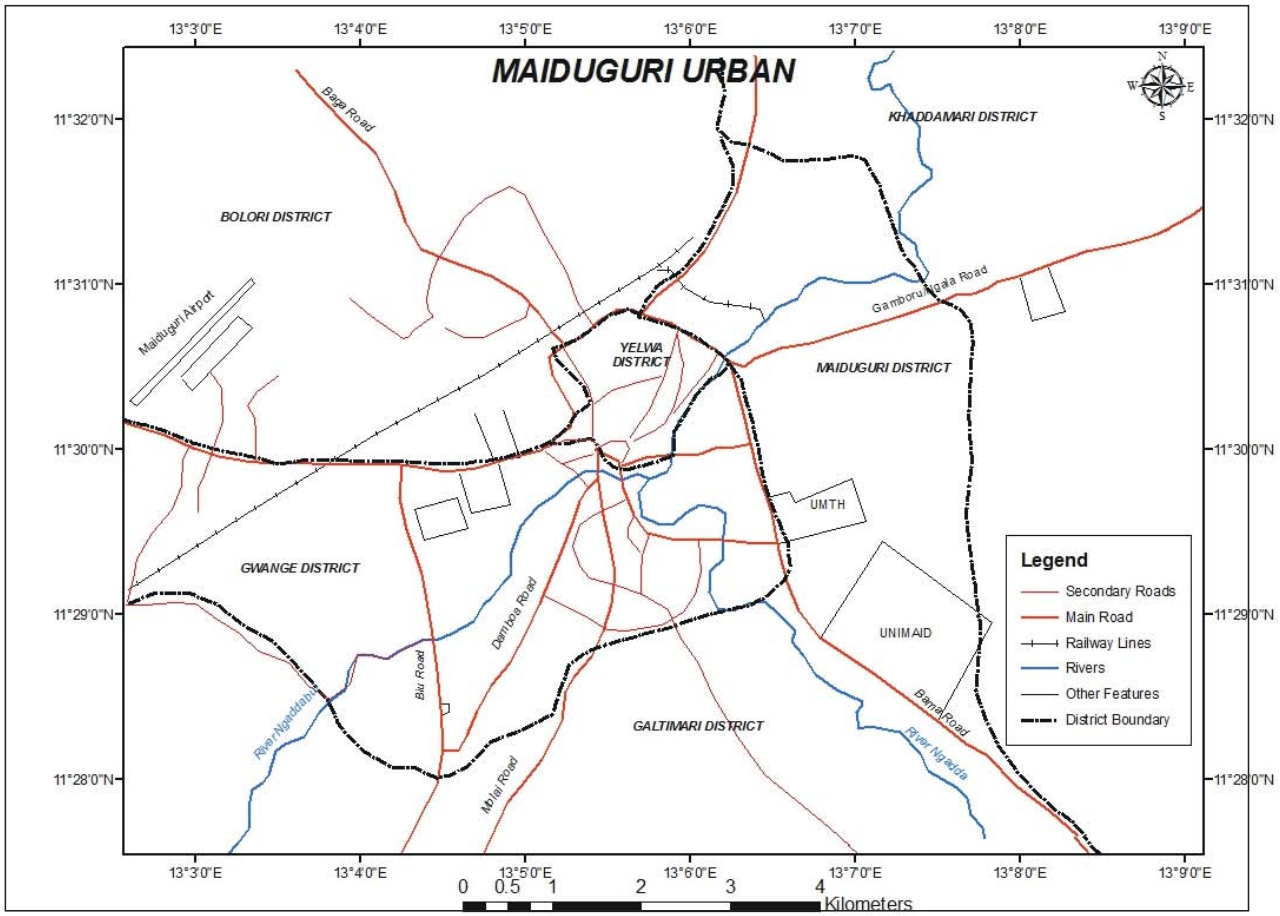

Figure 1 : The Study Area

III. Materials and Methods

The 2002 and 2012 Google maps, both of which were captured in January, were acquired from Google Earth Pro. The map of Maiduguri urban which comprises the roads, wards, rivers, and important features and places in the urban was also acquired from Ministry of Land and Survey, Maiduguri. Ilwis 3.3 Academic and Idrisi Andes were the two main GIS software that were used in this study. While all the images and maps were referenced and resampled in Ilwis, map overlay, area calculations and analysis were done through the respective modules of the Idrisi Andes. It was the figures that were derived from the area calculations that were used to develop the items in table 1. The two Google images which were referenced in Ilwis were exported to Idrisi Andes where the images were reclassed into four main landuse and landcover types, that is, waterbody, built up areas, undeveloped areas and bare surfaces (Figs. 2a and 2b). Each of these classes was assigned a specific value to differentiate them from the other landuse types.

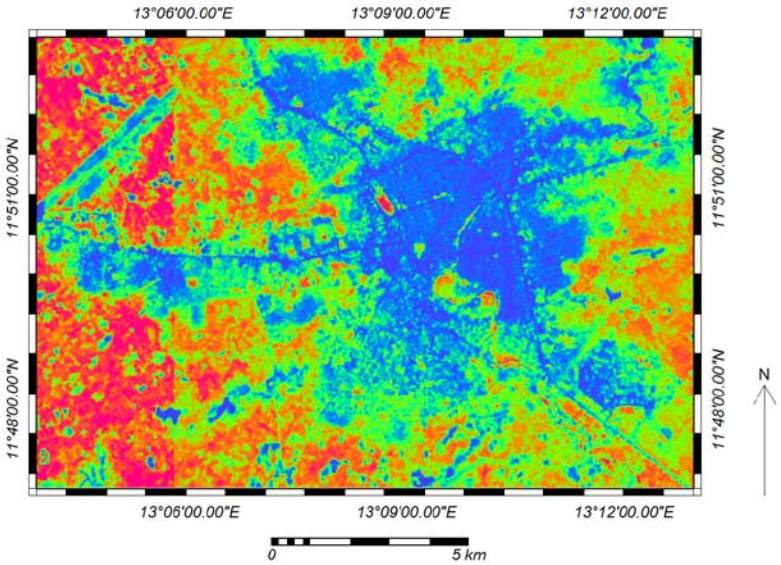

Figure 2 a : 2002 Google Image of Maiduguri

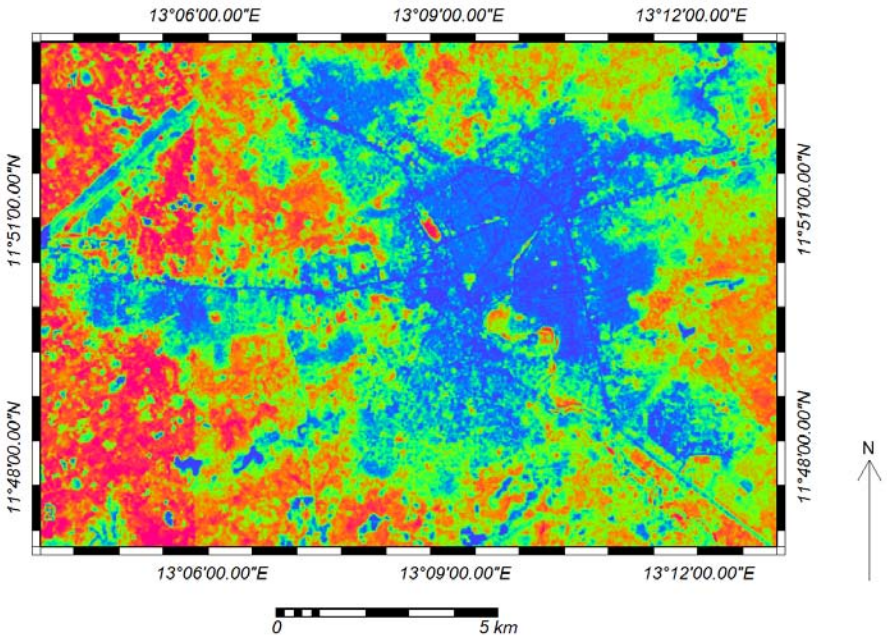

Figure 2 b : 2012 Google Image of Maiduguri **Urban**

The area module of the Idrisi Andes was then used to calculate the area cover of each of the landuse type. The maps of Maiduguri urban was finally overlain on the final output of the reclassed images so as to enable the readers to use the wards, roads or important features as reference in describing the areas where development has taken place or not as presented in Figs 3 and 4

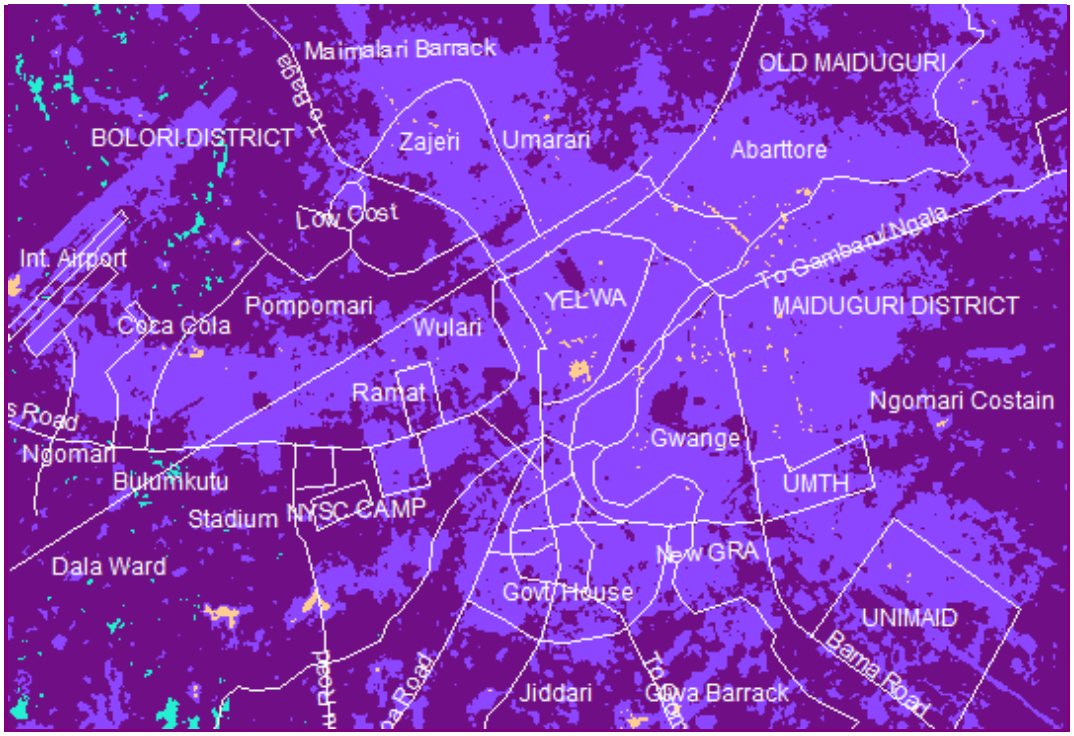

Figure 3 : Classified Google Image of 2002

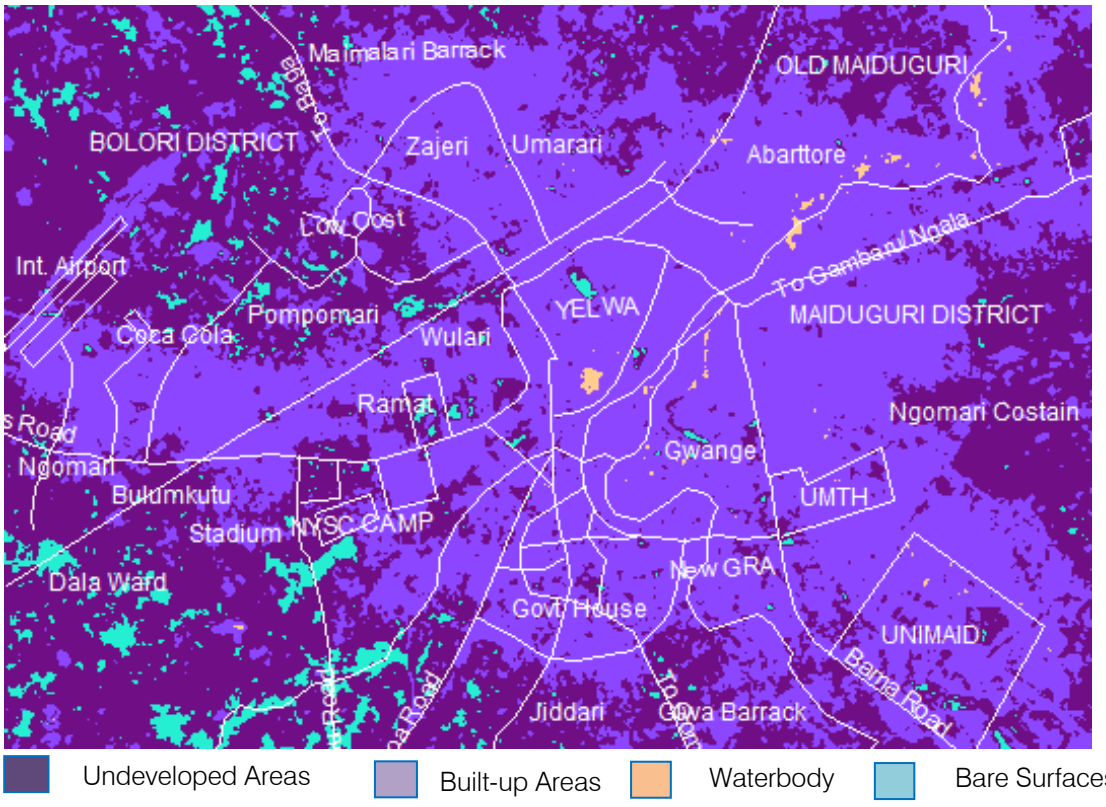

Figure 4 : Classified Google Image of 2012

IV. Results and Discussions

a) Trends, Magnitudes, Percentage Annual Change and Annual Rate of Change of Maiduguri Urban.

Table 1 : The trends, magnitudes, and annual rate of changes of Maiduguri urban

Landuse & Landcover	2002 Area (Km2)	%	2012 Area (Km2)	%	Magnitude of Change (km^2)	Percentage Change	Annual Rate of Change
Waterbody	0.75	0.40	0.40	0.21	-0.35	-99.25	-9.93
Built-up Areas	87.52	46.77	102.62	54.84	15.1	2.62	0.26
Undeveloped Areas	97.99	52.36	78.19	47.78	-19.8	-21.81	-2.18
Bare Surface	0.87	0.46	5.87	3.14	5	-94.13	9.41
Total	187.13	100	187.13	100			

In Table 1, Built up areas and undeveloped areas constitute the major parts of the landuse of the urban. Built-up areas are the areas that are delineated by the image as places where buildings of houses have taken place. It must be noted that houses that are even yet to be roofed are classified as built-up areas. The term undeveloped areas denote areas that are suitable for development but are yet to be developed. That is, such areas are currently occupied by other landuse and landcover types such as agriculture, shrubs and open spaces. There was an increase in the built up areas from 87.52km^2 in 2002 to 102.62km^2 in 2012. This means that a total land area of 15.1km^2 was occupied by built up areas between 2002 and 2012, with, a percentage change of 2.62%. The study also revealed that built up areas is increasing at the rate of 0.26% annually, though if compared with the other landuse types, the annual rate of change of the built up areas may be considered low as bare surfaces for instance, is changing annually at the rates of 9.41%. Undeveloped areas that occupied a land area of 97.99km^2 in 2002 have decreased to 78.19km^2 in 2012. The reason for the decrease may be attributed to the fact that most of the developed areas took place from the hitherto undeveloped areas. For instance, part of the land area that have changed from undeveloped area to other landuse types which is 19.8km^2 (97.99 in 2002-78.19 in 2012) between 2002 and 2012 (Table.1) might have been taken over by built up areas which has 15.1km^2 increase in landmass in 2012. The remaining 4.7km^2 (19.8-15.1km2) of the undeveloped areas might have been consumed by bare surface which increased from 0.87km^2 in 2002 to 5.87km^2 in 2012. Waterbody in the urban was also found to have reduced slightly from 0.75 to 0.40km^2 within the ten years period of study. Development was observed to have taken place along river courses such as River Nggada that runs through the city as Daura et al (1997) had reported that in Maiduguri, the flood plain at sides of the banks of river Ngadda have been converted to residential, public and commercial sites for block industry, markets, motor parks and shopping malls. It is these activities that is still in place and which is reducing the water body in the urban. Therefore, because of this developmental activities coupled with the pressure on land as a result of high population have made some of the areas that were formally waterbody areas to have changed to other landuse types. In summary, the increase in built up areas and the decrease in the yet-to-be developed areas as revealed from the image signifies urban expansion.

b) The Location and Pattern of Maiduguri Urban Expansion

Fig 5 shows the actual locations or areas where development had taken place within the decade which was derived through the use of the image calculator menu of Idrisi Andes. This Fig 5, revealed that much of the expansion in Maiduguri urban were recorded especially at the hitherto periphery areas which include University of Maiduguri (UNIMAID) and the surroundings, Bulumkutu/Ngomari area, areas along Gamboru Ngala and Baga roads, Giwa barrack areas, some patches of land area between Biu and Damboa road and other suburbs. The development within the University of Maiduguri is attributed to so many completed and on-going Education Trust Fund (ETF) projects such as lecture theaters, laboratories, faculty buildings and some other notable buildings. The noticeable developments around the university up north to Ngomari costain were mainly to cater for the ever increasing demand of accommodation mostly for the university students. The Ngomari/Bulumkutu area has much government impact especially at Ngomari where 777 and 1000 housing units were constructed around the Ngomari Old Airport axis within the period of study. Equally along Gamboru- Dikwa Road, 505 housing units were constructed, in addition to new primary and secondary schools as well as new residential buildings that emerge in the areas.

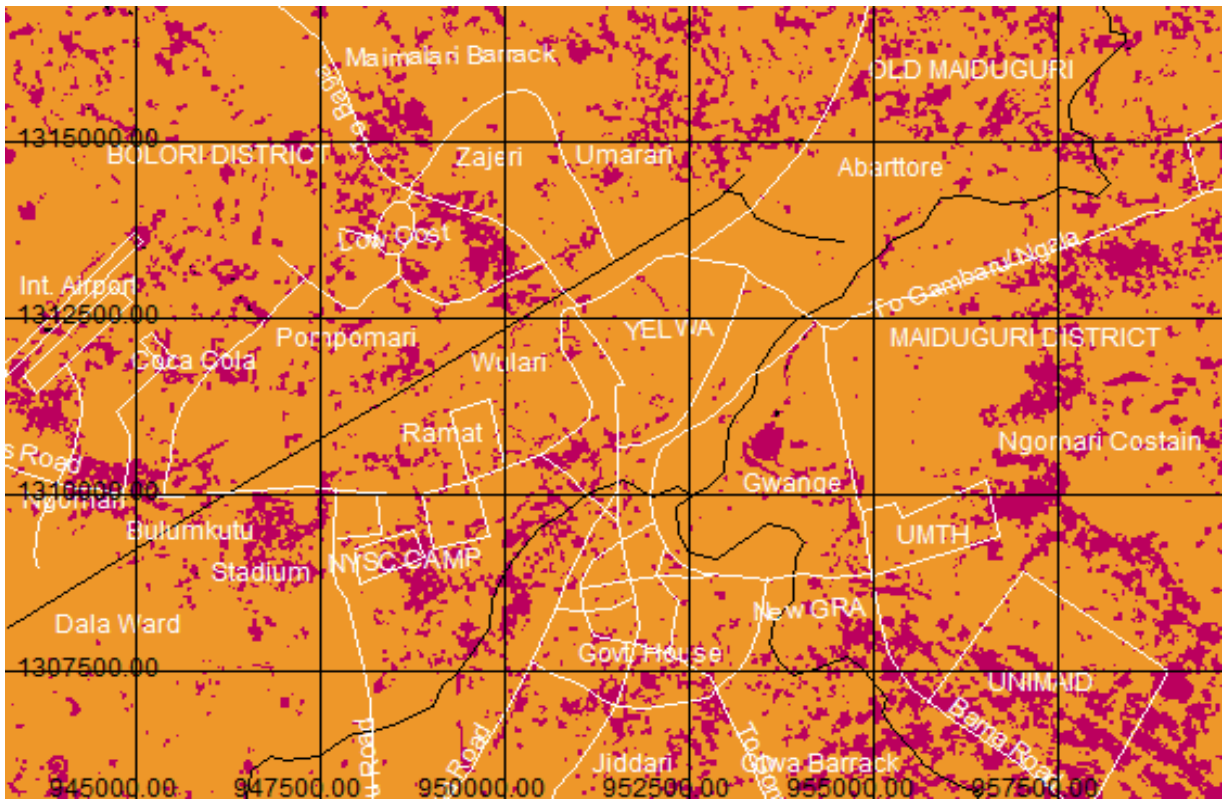

Figure 5 : Built up areas between 2002 and 2012

Generally, Maiduguri has been discovered to be rapidly expanding as Borno State Urban Planning and Development Board (2013) reported that the primacy of Maiduguri developed because it was first the capital of Borno Province (1902-1967) and latter capital of North-Eastern State (1967-1976) and that it has during these years been the focus of government, employment and trade as well as the gate way to Chad Republic, the northern province of Cameroon and the Diffa province of Niger Republic. They concluded that the agglomeration economies developed over the years have enabled Maiduguri to draw more people from far and near at the expense of other urban towns in the state. The most important structure of expansion that was noticed in the map (Fig.5) is that Maiduguri urban is rapidly expanding towards the periphery areas of the city. This had earlier been noticed by Kawka (2002) that the growth of Maiduguri and the encroachment into its hinterland is a two process, the town expands into the periphery because new quarters are added at its boundary, and also the creation of new villages near the city and the growth of the peripheral settlements promote the expansion of the city. However, the current pattern of the urban expansion could be attributed to two major factors: the first is that the nucleus of the city (Yerwa, Gwange etc) have already been chocked up with buildings and hardly is any open space within these areas, as Lock (1976) in Jimme and Bashir (2009) had reported that some areas (in Maiduguri urban) that are marked green zones and are either unsuitable for farming have all been occupied by people and it is associated with a lot of environmental degradations, hence, people are forced to look towards the periphery for the construction of their houses. Secondly, the security challenges in the city for almost one decade has also make many inhabitants to build their houses in the suburbs of the city where the "heat" of the crisis is considered to be minimal. The high standard of living especially the civil servants between 1999 and 2003 when the salary of the civil servants were increased also contributed a lot to the urban expansion as many people could then afford enough capital to erect their houses.

V. Conclusion and Recommendations

The paper demonstrated the applicability of Google images for urban monitoring and assessment, that is, Google images can as well be used like satellite images for urban monitoring and assessment. It was revealed in this study that the crisis and the security challenges has little or no effects on the urban growth of Maiduguri urban as a total land area of 15.1km^2 has been discovered to be built-up within the last one decade with annual growth rate of 0.26%. The location and patterns of the urban expansion was also discovered to be shifting towards the periphery of the urban, a development that is environmentally acceptable

because it reduces the pressure on the land in the core areas and brings development to the periphery. Waterbody in the urban was also found to be reducing probably because of the ever increasing population and climate change, no wonder, the landuse type that had the highest annual rate of change is bare surfaces. The government and other stake holders should put up programs that will stabilize our environment now – programs that will conserve our water bodies and reduce the encroachment of bare surfaces. The government through the federal and state ministries of urban planning, land surveys, environment and other relevant ones should undertake constant urban monitoring for proper planning so as to avert future calamities that may arise from improper urban planning.

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Overall Structure of the Universe

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Matter and Empty Universe- The Universe is created in common algorithm. The law and phenomenon natural have very simple explanation. The micro and macro universes have one genuine origin. In other words the world has one (absolutely) phenomenon of emergence display and affection beyond forties a time impression.

We don't know what electron and core atom is. We don't know neither what kind elementary particle composed the electron, proton and neutron. Only we suppose that it is very small particle. What structure of this elementary particles.

Just there elementary particles emitted energy when syntheses or disintegration atoms. It is energy of super smaller elementary particle. Also we don't know about the minimal and maximal unlimited of our universe.

The very small particles compose elementary particle. The elementary particles compose atom, the atoms compose molecule, the molecules compose sun system, the stars compose galactic, and the galactic compose the universe. So on the contrary we are consider that point is infinitely then the stars compose the atom.

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Overall Structure of the Universe

D. I. Sanitsar

We do not know what is the minimal and maximal both side unlimited of our universe system. I suppose in the unlimited of Universe the matter transfers to emptiness. On the contrary from emptiness regenerate new matter.

I. Matter and Empty Universe

The Universe is created in common algorithm. The law and phenomenon natural have very simple explanation. The micro and macro universes have one genuine origin. In other words the world has one (absolutely) phenomenon of emergence display and affection beyond forties a time impression.

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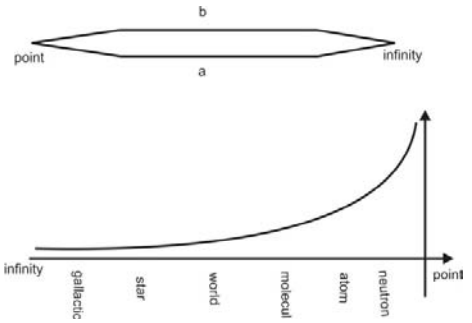
So far we have accepted unanimously that the world is consisted of electrons and protons, but we still don't know what is behind of electrons and atoms (beyond L1), neither we nor Universe our vision can imagine, galaxies etc. So we understand the matter exist is space, energy and time.



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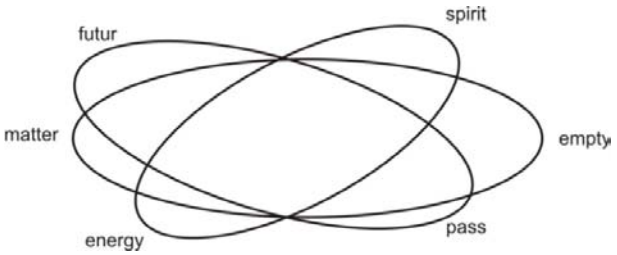
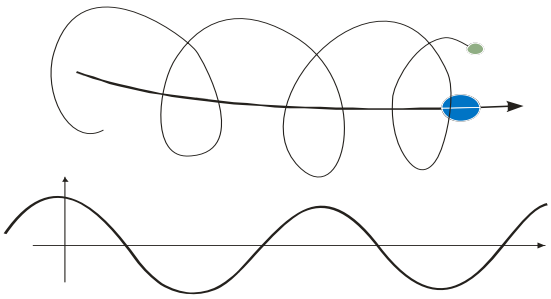
So existing the matter exist space, if exist space then curing the time. We are thinking the time is passing unreturned. This is mistake, time returned. But by other way. Such as the water flow streaming down and water steaming evaporate to transferring in cloud, the rain bring get back and the water curing again. As for me the time has its nature of circulation. So I understand there must be in separable inter connection between the matter is it is existing in time. The time is we understand it must have its past. So there must be a future. Only in the material Universe the time curing from passes to future. In the emptiness the future transferred to pass.

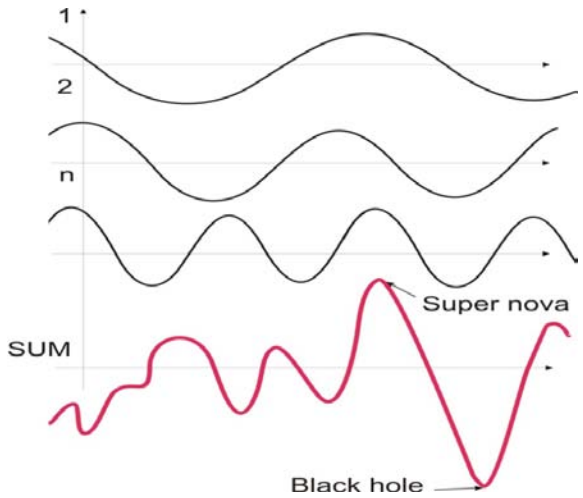


Sense the mechanism Big bang is reflection of the moment future to past transformation. As we understand, these days, due to Big Bang the Universe is spreading to all direction and dimensions (beyond L2). The terming Big Bang is understand today as Natural cosmic disaster and we humanity is still on the way directed by this mechanism. In my view the mechanism of the Universe in our vision was not provoct by one and only such an extreme blow. The sense of existence of our Universe innumerable and continues such explosions. Therefore you can understanding that PASS=FUTURE.

All the universe is consist over the rotary motion. Therefore some event from time to time return at regular reiterated. Such bodies the electrons or the world are said to have a motion of vibration or oscillation.



Every rotary mechanism has its physical impact: waves. Other words the waves born from matter circulation. From general physic the waves have inter affection positive and negative.

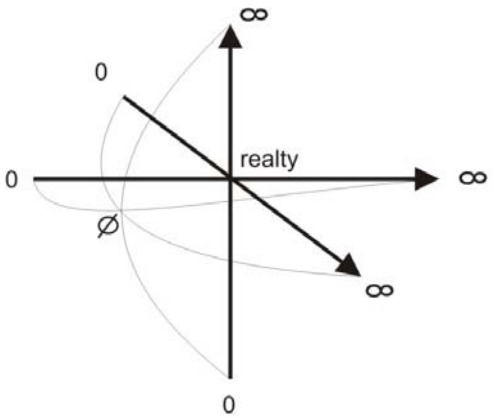


If we shall add different waves over each other the result shall produce diffraction. This kind of interference leading shape the diffraction. Rule of diffraction mechanism is under law subtraction and summation waves. We are called this diffraction named black hole and antipode supernova.

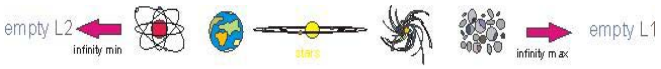
The universe is existing too many years eternally, everlasting. You see only short time interval of the existence. Every material substance has its mass, speed, inertia, and circulation and rotary motion mechanism. Black hole is not emptiness; this is only one of result diffraction of interference stars motion energy. Therefore black hole changing here disposition in long time.

And my question as when and where its shall end. I suppose the Universe unlimited; therefore the energy atoms stars, galaxies have shall reduce and disappear at the end of their tripe. In my vision this energy shall transferred to spiritual energy. In other words the sense of spiritual energy the existence it's into empty realty. The spiritual energy has memory, but has no notion of the speed. Therefore information instantaneously transmitted from one part of universe to another part of world and transferred to matter.

Thus, we have arrived to the point when where no time, no mass is and neither no space, in other words there shall be they absolute Neil.



The smallest particle forming an atom or the smallest particle, which we cannot define, can be reduced without limit till it is dissolved into emptiness. A galaxy, which is a concentration of stars, as well as the re-grouping or concentration of galaxies also turn into emptiness with the reduction of energy.



L1=L2

The emptiness of unlimited macro-universe L1 and the emptiness of unlimited micro-universe L2 are dissolved into each other, and constitute the only eternally connected thing. In other words, L1=L2 (L1 is equivalent to L2).

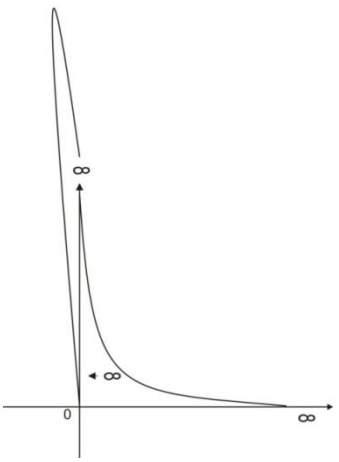
Therefore

$$\frac{1}{0} = \infty \qquad \frac{1}{\infty} = 0$$

$$\text{If Lim } \infty = \text{Lim } 0 = \varnothing$$

$$\text{Then } 1 = \infty * 0 = \varnothing * \varnothing = \varnothing^{2}$$

If multiply emptiness by empty we get one unit i.e. matter.

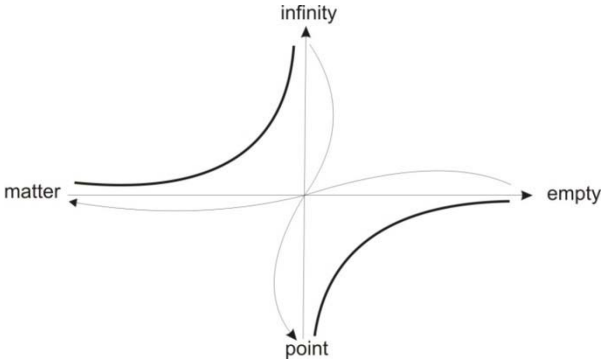


At the unlimited of universe, the energy is exhausted and transferred to spirit. By the principle of Einstein which shows the equivalence of mass and energy, the mass will disappear and motion will stop. The matter transfers to emptiness. This is Emptiness of the emptiness.

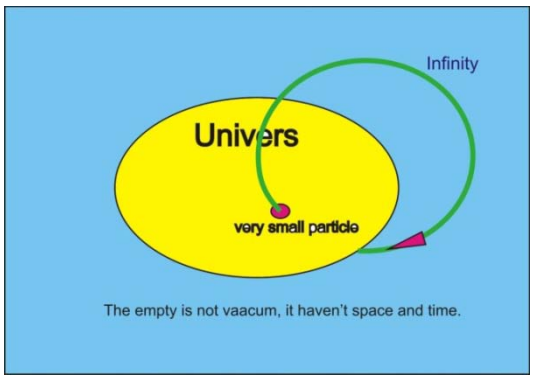
Please don't confuse between emptiness and vacuum. So I mine vacuum is absolutely different of Neil. The vacuums have space and time, in emptiness hasn't space, energy, time and matter. If we stop all the motions of universe, the universe transferred also to empty. The space transform a nothing, the time transform nonsense. Some time our earth rotation motion has stopped but not definitely. Example of this

occurrence is event of recent braking core of our earth. This time all mantle pressed from west to east by here inertia and create mountains flexure in east side each continents. May be this was Noah's Ark time, rise great tsunami and cover all dry land destroy life. Clarity trace of this great tsunami leaves in Gobi Mongolia.

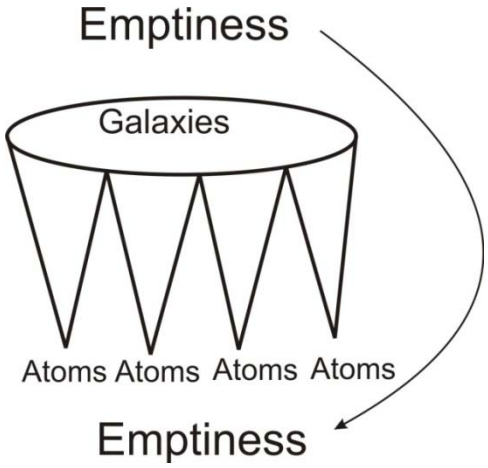
Actually the phenomenon of absolute Neil or Emptiness as both beyond (Beyond L1=Beyond L2) is the very sense of the existence of the Universe. Our spirit connected with empty universe by specially mechanism of God. When infinitely transferred point, in empty spring up rotary moment under the spirit action this moment get energy.



The very sense of Natural is rotation any kind of energy in material suspense. Due to this mechanism or law of order as soon as material energy shall develop (or transfer) from spiritual energy they strength (scope and scale) it shall gain power and motion, leading to the standard existence of material.



Energy given mass and from empty appears matter. This matters compose super micro elementary particle, the super micro elementary particles composed neutron. Then constructed the space, and appear positively and negatively charged particles. Then compose atom. Transform unlimited the matter to emptiness and from emptiness regenerates new super smallest matter. As soon as the matter comes in to existence shall be under Law of Nature rules. There are unimagined versions of matter following destine. This destine shall depend under the law of time. Sense of law is general for whole of Nature. Every kind of matter shall have its lifespan. But where is end of existence (life and time). So sense something exists (birth present, past and future). Let's talk about sense of Future. The sense future is the moment.



Every time renascent billion and billion new very small particles and disappearing billion and billion galaxies. The Universe we are able to catch with our eyes and the technique we were able to design is a break capability a human being could ever produce.

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Multiple Livelihoods and Wastewater Irrigation Farming in Peri Urban Areas in Zambia: Opportunities and Challenges

By Evaristo Mwaba Kapungwe
University of Zambia, Zambia

Abstract- The urban poor use heavy metal contaminated wastewater in production of crops to sustain their livelihood in Zambia. Despite the inherent dangers of food crop contaminations and potential health risks associated with consumption of heavy metal contaminated food crops, a lot of people engaged in wastewater irrigation farming as a source of livelihood in peri urban areas in Zambia. The study focused on the urban poor engaged in cultivation of crops using heavy metal contaminated industrial wastewater and domestic sewage in order to sustain their livelihoods in peri urban areas of Mufulira and Kafue towns in Zambia. To study investigated the livelihoods of people engaged in crop production using heavy metal contaminated wastewater. Two study field sites were selected in the peri-urban areas of Mufulira in the Copperbelt Province and Kafue in Lusaka Province in Zambia. The snowball principle was used to select informal crop cultivators at two study sites. A total of 31 crop cultivators were sampled at New Farm study site in Mufulira from 26th April, 2007 to 14th November, 2007 whilst a total of 29 crop cultivators were sampled at Chilumba Gardens study site in Kafue from 17th September, 2013 to 12th December, 2013. The interview schedules were administered to selected crop cultivators.

Keywords: multiple livelihood activities, wastewater irrigation farming, poverty, land tenure, peri urban areas, zambia.

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Keywords: multiple livelihood activities, wastewater irrigation farming, poverty, land tenure, peri urban areas, zambia.

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I. Background

Studies in wastewater irrigation farming conducted in developing countries indicated that a lot of people were engaged in production and selling of crops from waste water irrigation farming in peri-urban areas in towns (Faruqui, 2002). The main drivers of the wastewater use in crop farming included lack of alternative cheaper or safer water sources; the increased urban water demand; high demand for food in urban areas; poverty and rural-urban migration (Raschid-Sally and Jayakody, 2008). According to Buechler et al., (2002) wastewater use for livelihood activities in urban and peri-urban areas is a reality that planners and policy makers must face.

The majority of people in sub-Saharan African countries are poor and live below the poverty datum line (Potts, 2002). There has been drastic fall in real income for the urban people and subsequent decline in the standard of living in the last 20 years starting from the 1960's (Potts, 2002). There was the gap between the incomes and survival needs of urban household. In the absence of socio-welfare, the urban dwellers had to find ways of adapting to the urban 'wages puzzle' (Potts, 2002) which include increase in the urban agriculture which included informal wastewater use in crop farming (Drechsel et al., 2011).

The rate of poverty is relatively high in urban areas in Zambia (GRZ, 1998; GRZ, 2004). In order to sustain their standard of living, poor people in urban areas engage in informal activities such as peri-urban agriculture (Hampwaye et al., 2007 Hampwaye, 2013) including wastewater irrigation farming (Kapungwe, 2011). The urban poor use heavy metal contaminated wastewater in production of crops to sustain their livelihood in Zambia (Simukanga et al., 2002; Marshall et al., 2004; Kapungwe, 2011). Despite the inherent dangers of food crop contaminations and potential health risks associated with consumption of heavy metal contaminated food crops, a lot of people were engaged

in wastewater irrigation farming as source of livelihood at the two study sites (Kapungwe, 2011; Kapungwe, 2013a). The benefits of using wastewater in crop irrigation in Zambia included increased in crop yield, income generation and improved food security at the household (Mtonga, 2001 Holden and Kapungwe, 2007). The study focused on the urban poor engaged in cultivation of crops using heavy metal contaminated industrial wastewater and domestic sewage in order to sustain their livelihoods in peri urban areas of Mufulira and Kafue towns in Zambia. To study investigated the livelihoods of people engaged in crop production using heavy metal contaminated wastewater. It was hypothesised that there was no significant relationship between the cropping systems and livelihoods of crop cultivators.

II. Theoretical Framework

In this study the livelihood model developed by Carney (1998 a, b) were used to analyse the livelihoods of the urban poor engaged into crop production using the heavy metal contaminated wastewater in peri-urban areas of Mufulira and Kafue towns in Zambia. According to Carney (1998 a, b), the livelihood comprises the capabilities, assets and activities done to earn a living. The livelihood activities can be either on farm or off- farm activities. Capacities refer to the ability of the community to take part in decision making, the acquired indigenous technical knowledge that makes the community to have the resilient to respond to environmental stress and socio-economic changes. The five livelihood assets (Carney, 2002; Carney, 1998a; b) are:

i. Natural resources include the natural resources such as water, land and air.
ii. Human resources include skills, knowledge and health status of the people.
iii. Financial resources include income, saving and credit.
iv. Physical resources include the tools and equipment.
v. Social resources include the socio-organisation such as institutions, legislations and policy

People continue to build on assets endowments so that they can enjoy sustainable livelihoods (Little and Edward, 2003). For the urban poor property rights to land, water together with labour, form the most common endowments used to produce for home consumption as well as for cash that allow the family or individual to pay for other needs such as education, health and shelter (FAO, 2002). It is argued that property rights to land and water are the most powerful resources available to people to increase and extend their collection of assets beyond land and labour to full portfolio necessary for sustainable livelihoods (FAO, 2002).

It is argued that improving livelihoods can help people to become less vulnerable to poverty (Bradbear, 2004). This is achieved by helping the people to gain access to a range of assets and supporting their capacity to build these assets into successful livelihood activities (Bradbear, 2004). Furthermore, people who have limited cash or financial savings often have the capacity to ameliorate against the socio-economic stress and minimise disposal of household assets significantly by being members of organisations that provide assistance when they experience financial problems (Bradbear, 2004; Saasa and Carlson, 2002). Therefore, assessment of trends in the assets, capabilities and activities over time can indicate if livelihoods are deteriorating or improving (Little and Edwards, 2003) among the urban poor.

III. Study Areas

a) Location of study areas

Two study field sites were selected in the peri-urban areas of Mufulira in the Copperbelt Province and Kafue in Lusaka Province in Zambia (Figure 1). Mufulira is located between latitudes 12o 30' South and 12o 40' South and between longitudes 28o 10' East and 28o 20' East. Kafue is located between latitudes 15o 45' South and 15o 50' South and extends from longitude 28o 05' East to 28o 15' East. The New Farm study site in Mufulira is located along the Kansuswa River adjacent to Kantanshi Stabilization Ponds in the triangle shaped area between the Kansuswa River and tailing dams (Figure 2). The Chilumba Gardens study site in Kafue is located along Kasenje and Shikoswe Rivers in the Kafue Estate Industrial area between Zambia and Soloboni Compounds behind Nitrogen Chemicals of Zambia (Figure 3).

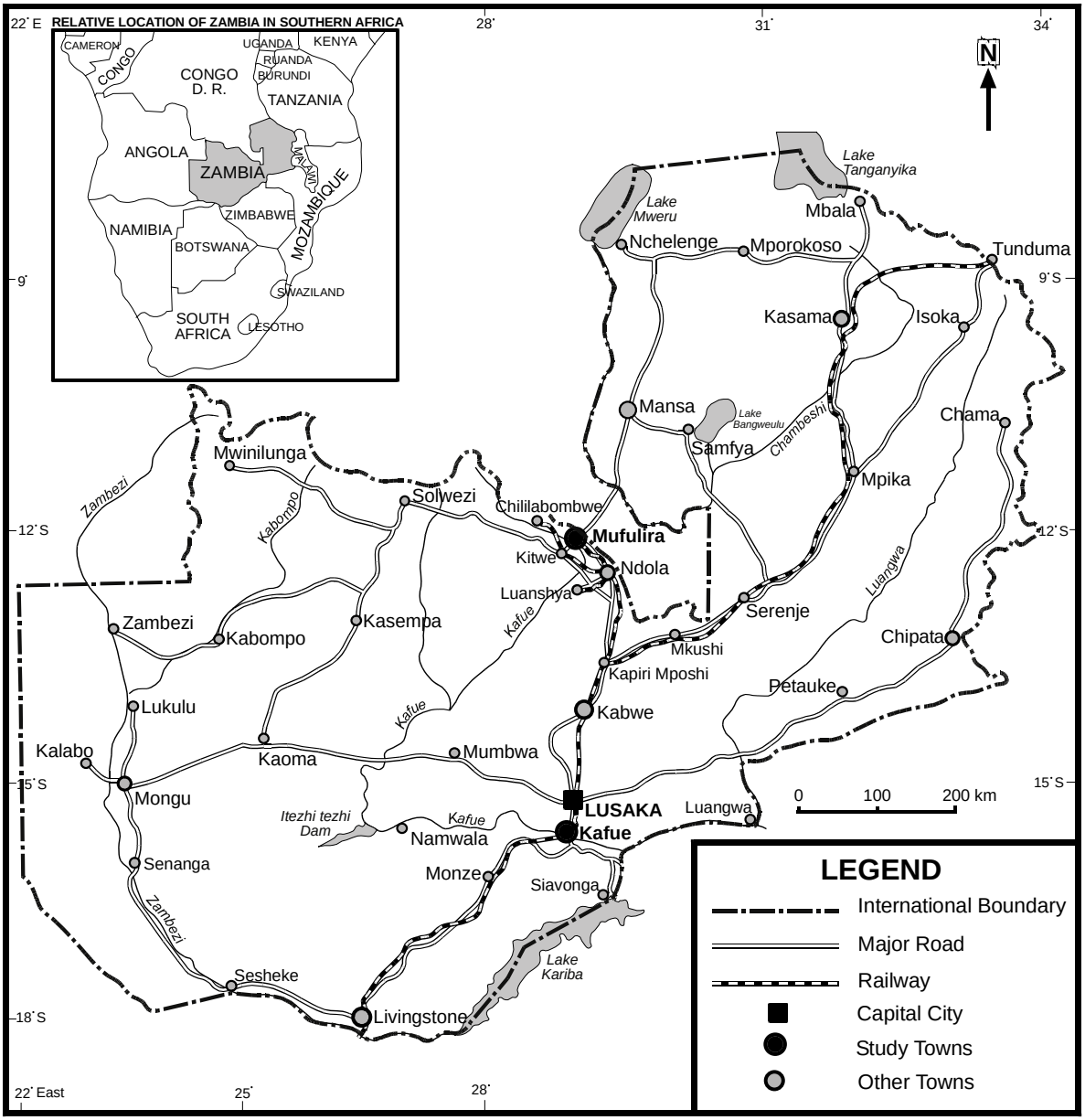


Figure 1 : Location of Mufulira and Kafue study towns in Zambia (Kapungwe, 2011; 2013a; 2013b)

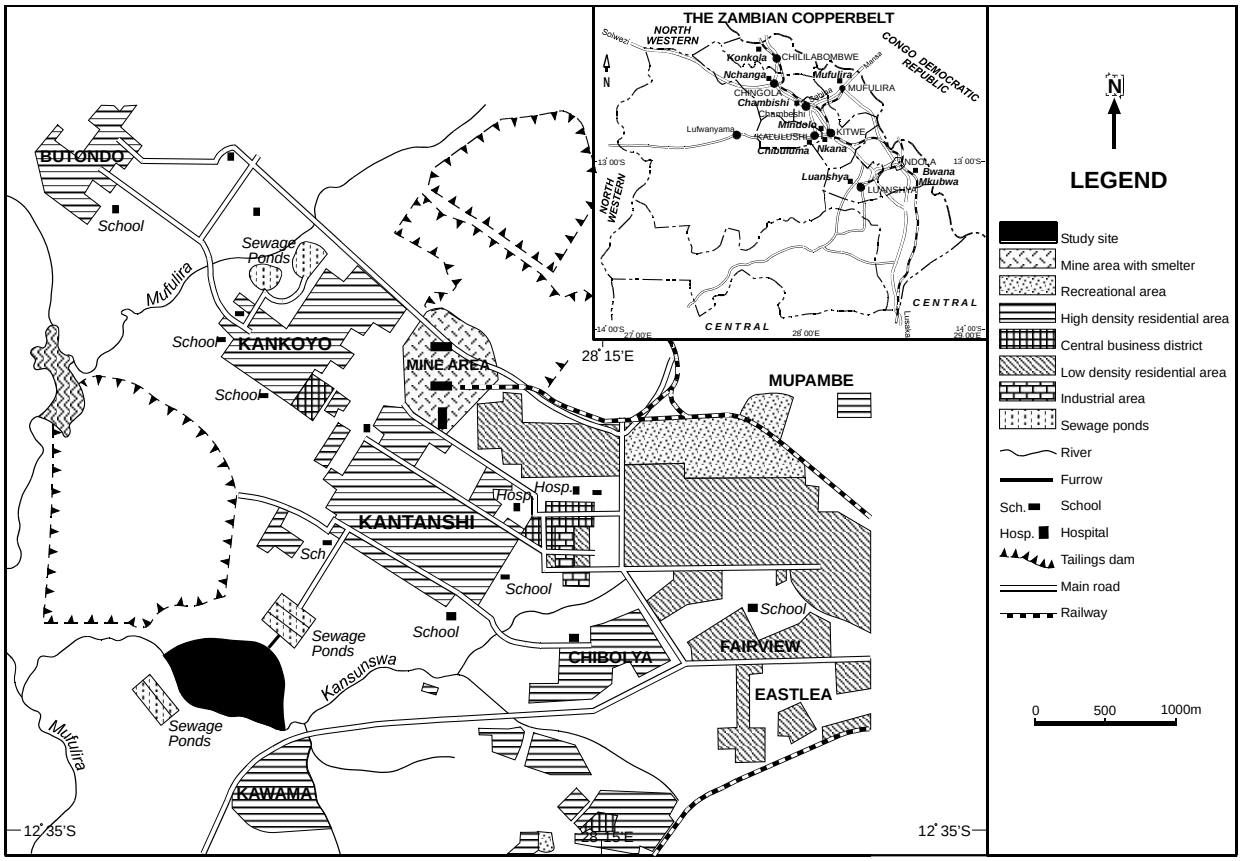


Figure 2 : Location of New Farm study site in Mufulira(Kapungwe, 2011; 2013a; 2013b)

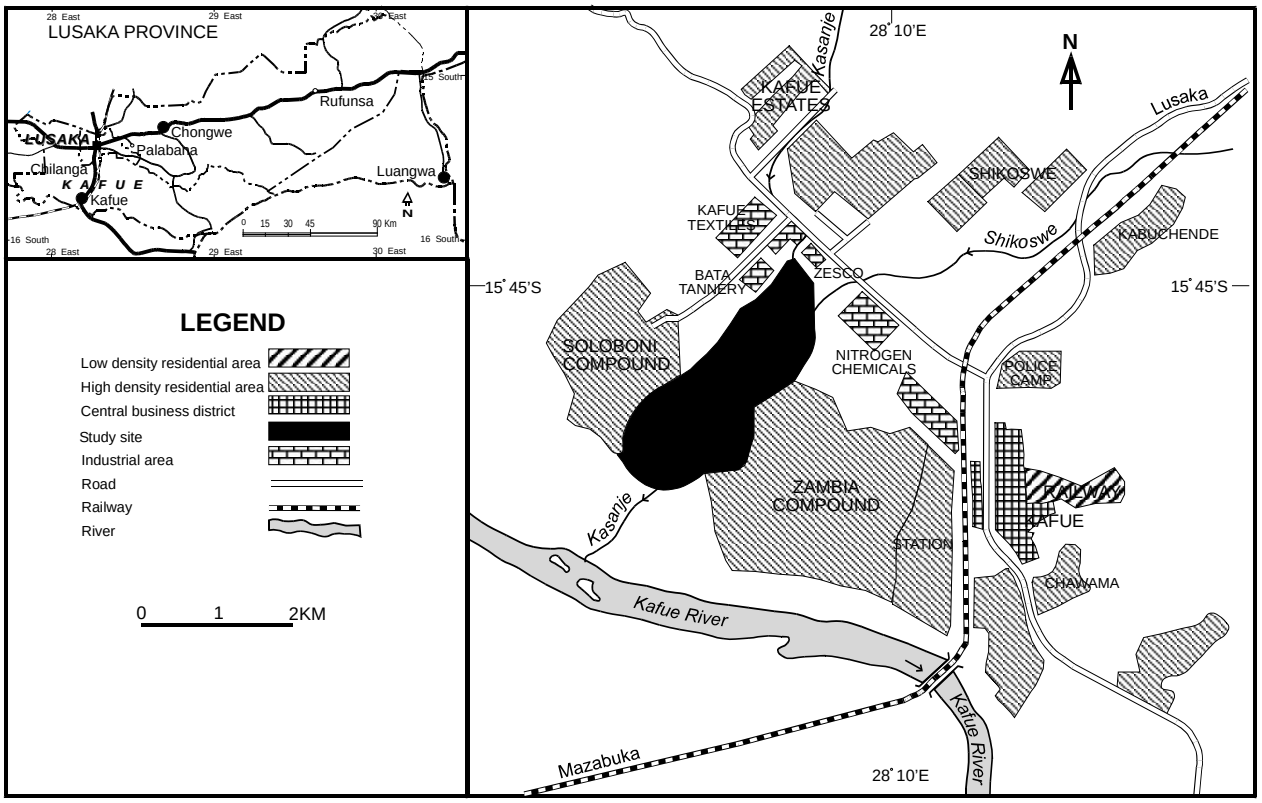


Figure 3 : Location of Chilumba Gardens study site in Kafue (Kapungwe,2011; 2013a; 2013b)

IV. Socio- Economic Characteristics of the two Study Sites

The crop cultivators at the study sites engaged in crop production as an informal activity because they were not officially recognised by the relevant authorities (Kapungwe et al., 2007). The crop cultivators were both full time and part time. The dominant crop grown was sugarcane interspersed with vegetables and maize while there were seven distinct cropping systems at the study sites (Kapungwe, 2011). There was heavy metal contamination of wastewater, soil and crops at the study sites (Kapungwe, 2013a). Previous preliminary findings indicated that the informal crop cultivators engaged in multiple livelihood activities to sustain their living at the two study sites (Holden and Kapungwe, 2007; Kapungwe, 2011). The Kansuswa Peasant Farmers Association at New Farm in Mufulira and the Chilumba Peasant Farmers Association at Chilumba Gardens in Kafue allocated times of watering by different crop cultivators and controlled the selling of crops (Holden and Kapungwe, 2007; Kapungwe et al., 2007). The summary of socio-economic characteristics of the study sites as shown in Table 1.

Table 1 : Socio-economic characteristics of the two study sites

Characteristics		New Farm in Mufulira	Chilumba Gardens in Kafue
Livelihood activities		Crop production Livestock rearing Formal employment Grocery stall such as Tutemba	Crop production Livestock rearing Fishing Selling firewood Transportation Brick making Street vending Grocery stall such as Tutemba
Types of crops	Field crops	Sugarcane**, maize	Sugarcane**, maize
	Indigenous vegetables	Common beans, Cowpeas, Pumpkins** Sweet potatoes, Aprior rape, Aubergines, Groundnuts, Common okra**, [b]Mponda (Bottled gourd)	Common beans, Cowpeas, Pumpkins**, Sweet potatoes**, Aprior rape, Aubergines, Common okra, Bottle gourd [a]Lubanga (Spiderplant) Sorghum,
	Exotic vegetables	Tomatoes**, Rape, Carrots, Chinese cabbage, Swiss chard** Onions, Cabbage, , Green pepper, Irish potatoes	Tomatoes, Rape, Chinese cabbage**, Swiss chard, Onions, Cabbage, [b]Fwakafwaka (Mustard spinach [c]Komatsuna)
Types of cropping systems		Sugarcane mono cropping Maize mono cropping Vegetable growing Sugarcane-vegetable cropping Maize-vegetable cropping Sugarcane –maize-vegetable cropping Sugarcane-maize cropping	Sugarcane mono cropping Maize mono cropping Vegetable growing Sugarcane-vegetable cropping Maize-vegetable cropping Sugarcane –maize-vegetable cropping Sugarcane-maize cropping
Type of wastewater		Domestic wastewater	Industrial effluents
Registered organisation		Kansuswa Peasant Farmers Association	The Chilumba Peasant Farmers Association
Number of informal farmers		150-200 members	900-1200 members
Type of informal farmers		Part time/full time	Part time/full time

[a]Bemba vernacular language, [b]Chinyanja vernacular language, [c]Japanese
*** heavy metal contamination recorded*
Source: Holden and Kapungwe, 2007; Kapungwe et al., 2007; Kapungwe, 2011, 2013a, 2013b

V. Methodology

a) Sampling techniques

The snowball principle was used to select informal crop cultivators at two study sites. The snowball principle which is a non-probability sampling technique was usually used by researchers to identify potential subjects in studies where subjects are difficult to locate. The potential respondents were approached and only those people who showed willingness to take part in the research were selected as respondents. The people who were willing to take part in research were interviewed until a reasonable number of respondents were interviewed. The initial respondents had to willingly and freely take part in the interview. Then researcher had to seek guidance from the initial respondent on who could be suitable and willing to be interviewed freely without suspicion until a reasonable number of respondents were reached. A total of 31 crop cultivators were sampled at New Farm in Mufulira from 26th April, 2007 to 14th November, 2007. whilst a total of 29 crop cultivators were sampled at Chilumba Gardens in Kafue from 17th September, 2013 to 12th December, 2013. The interview schedules were administered to selected crop cultivators. The questions in the interview schedule included questions on livelihood and farming activities

b) Data analysis

The frequencies and percentages were used to analyse the responses from questions in the interview schedule. The Chi-square statistical test was used to ascertain the association between livelihoods and socio-economic characteristics of informal crop cultivators.

VI. Results and Discussions

a) Demographic characteristics of crop cultivators

The results indicated that both males and females engaged in crop production which indicated a fair proportional representation of male and female engaged in wastewater irrigation farming (Table 2). The results from this study confirmed the findings in the study by Hampwaye et al., (2007) on seasonal farming in City of Lusaka, Zambia where both females and males engaged in crop production. The results indicated that the majority of crop cultivators at the two study sites had attained either primary or secondary education (Table 3).

Table 2 : Sex of respondents

Sex of respondents	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Female	16	51.6	18	62.1
Male	15	48.4	11	37.9
Total	31	100.0	29	100.0

Source: Field data, 2007, 2013

Table 3 : Education level

Education level	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Secondary	16	51.2	8	27.6
Primary	11	35.5	15	51.7
None	3	9.7	3	10.3
Others: tertiary	1	3.2	3	10.3
Total	31	100.0	29	100.0

Source: Field data, 2007, 2013

The results indicated that the majority of respondents have large families which they supported (Table 4). The results indicated that the average the household size was seven persons with the minimum of three persons and maximum of eighteen persons at New Farm while the average the household size six persons with the minimum of two persons and maximum of thirteen persons at Chilumba Gardens which implied that the crop cultivators had a lot of people dependants. The results from this study were similar to findings in the study by Hampwaye et al., 2007 in rain fed farming areas of Lusaka where an average household size ranged from seven persons up to maximum of fifteen persons.

Table 4 : Size of household

Number of people in the household	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
1-2 people	0	0	1	3.7
3-8 people	20	64.5	19	70.4
9-15 people	10	32.3	7	25.9
above16 people	1	3.2	0	0
Total	31	100.0	27	100.0

Source: Field data, 2007, 2013

The results indicated that the majority of respondents resided in high density residential areas and unplanned settlements at the two study sites (Table 5). The urban residential areas were potential sources of labour for crop production and provided readily available markets for crops. The results indicated that the average number of years of residence in a particular residential area by respondents was twenty two years with the minimum of five years to maximum of thirty eight years at New Farm in Mufulira while at Chilumba Gardens in Kafue the average number of years of residing in the residential area by the respondents was twenty four years with the minimum of one year to maximum of forty seven years

Table 5 : Names of residential areas

Name of residential areas	No.	Percentage (%)
New Farm in Mufulira		
[1]Kansuswa	1	9.1
[1]Kantanshi	2	18.2
[2]Kawama west	8	72.1
Total	11	100.0
Chilumba Gardens in Kafue		
[2]Mutendere	9	31.0
[2]Soloboni	20	69.0
Total	29	100.0

[1]high density residential areas
[2]unplanned settlements
Source: Field data, 2007, 2013

b) Multiple livelihood activities

The results indicated that the crop cultivators and members of their household were engaged in diverse of livelihood activities to earn a living at the two study sites (Table 6 and Table 7). The livelihood activities included on-farm activities such as crop production and the off-farm activities included formal employment, livestock rearing and business especially selling merchandise in grocery stalls (Tuntemba). The majority of the crop cultivators (54%) and their members of the households (21.4%) engaged in crop production as source of livelihood on full time basis at New Farm whiles a total of 65.5% of the crop cultivators and 44.4% of members of the households engaged in crop production as source of livelihood on full time basis at Chilumba Gardens. Some of the informal crop cultivators engaged in formal employment took part in crop production on part-time basis at New Farm (3.2%) and Chilumba Gardens (3.4%) which indicated that the informal crop cultivation provides an alternative means of supplementing income from wage labour for most of the urban poor who were engaged in formal employment which was similar to findings in the study by Saasa (1982) in seasonal farming in Kaunda Square residential area in Lusaka, Zambia and the study by Mac Gaffey (1983) in Kivu, North Eastern of Democratic Republic of Congo (DRC).

Table 6 : Livelihood activities by crop cultivators

Livelihood activities	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Crop production	17	54.8	19	65.5
Crop production and livestock rearing	4	12.9	1	3.4
Crop production and grocery stall *(Tuntemba)*	4	12.9	3	10.3
Crop production and selling at Market	2	6.5	3	10.3
Crop production and others: bicycle repair, selling local beverage (*munkoyo)*	2	6.5	0	0
Crop production, livestock rearing and grocery stall (*Tuntemba*)	0	0	1	3.4
Crop production, livestock rearing and formal employment	1	3.2	1	3.4
Crop production and formal employment	1	3.2	1	3.4
Total	31	100.0	29	100.0

Source: Field data, 2007, 2013

Table 7 : Livelihood activities by members of households

Livelihood activities	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
None	15	53.6	7	24.1
Crop production	6	21.4	13	44.8
Selling at market	3	10.7	0	0
Grocery stall *(Tuntemba)*	1	3.6	0	0
Employment	1	3.6	0	0
Crop production and livestock rearing	0	0	3	10.3
Crop production and selling at market	0	0	4	13.4
Grocery stall and selling at market	0	0	1	3.4
Crop production and formal employment	0	0	1	3.4
Street vending and other activities	1	3.6	0	0
Other activities:	1	3.6	0	0
Total	28	100.0	29	100.0

Source: Field data, 2007, 2013

It can be argued that the crop cultivators practising wastewater irrigation engaged in multiple livelihood activities for self sustenance which confirmed the findings from studies on seasonal farming in Zambia (Jaeger and Huckabay, 1986; Simukanga et al., 2002; Lusaka City Council, 2005 cited in Hampwaye, 2007, Hampwaye 2013), wastewater irrigation farming in Zambia (Kapungwe, 2011) and other developing countries (Mubvami and Toriro, 2008; Obuobie et al., 2003, 2006; Buechler et al., 2002). It can be argued that the crop cultivators practising wastewater irrigation and seasonal farming were engaged in multiple livelihood activities for self sustenance because it was likely that the people engaged in the two types of farming had similar socio-economic backgrounds.

It was hypothesised that there was no significant relationship between the cropping systems and livelihoods of crop cultivators. The Chi-square test indicated that:

a) there was no significant association between livelihood activities and cropping systems at Chilumba Gardens ($\chi 2 = 33.163$ df=30, P>0.05)
b) there was a significant association between selling at market and cropping systems at New Farm ($\chi 2 = 38.08$, df=22, P<0.05). All of respondents involved in selling at market were engaged in sugarcane mono cropping system. It can therefore be argued that the probable reasons which account for the fact that the crop cultivators involved in selling at markets were engaged in sugarcane mono cropping system included:

- low labour and inputs requirements;
- high returns on sugarcane; and
- less time spent attending to sugarcane production activities.

From the foregoing explanation, it can be argued that there was a significant relationship between cropping systems and livelihood activities. The results indicated that the crop cultivators practised the cropping systems such as sugarcane mono cropping which apparently contribute to sustenance of households through accumulation of capital to invest into other economic activities apart from crop production. The results from this study were similar to the findings from the study on wastewater irrigation in Hubli-Dharwad, India (Bradford et al., 2003).

c) Reasons for engaging in crop production

The results indicated that the wastewater irrigated farming has been going for a long period of time. The results indicated that the average number of years of crop production by the respondents was 18 years with the minimum of 2 year to maximum of 41 years at New Farm in Mufulira while at Chilumba Gardens in Kafue the average number of years of crop production by the respondents was 13 years with the minimum of 1 year to maximum of 30 years. The results from this study were similar to findings in the study by Hampwaye et al., (2007) in Lusaka where the average length of time for cultivation was nine years with maximum of forty years.

The respondents indicated several reasons for starting crop growing which included lack of basic needs and income generation (Table 8).

Table 8 : Reasons for starting crop growing using wastewater

Reasons for crop growing	New Farm in Mufulira			Chilumba Gardens in Kafue		
	n	No.	Percentage (%)	n	No.	Percentage (%)
Lack of formal employment	31	4	12.9	29	2	7.7
Income generation	31	7	22.6	29	16	61.6
Poverty reduction	31	1	3.2	29	3	11.5
Earn a living	0	0	0	29	5	19.5
Drop out of school	31	3	6.5			
Hunger problem	31	3	9.7			
Introduced to farming by friends	31	3	9.7			
Introduced to farming by relatives	31	1	3.2			
Orphaned	31	1	3.2			
Lack of basic needs	20	12	60.0			
Hobby and interest	11	2	18.2			

Source: Field data, 2007, 2013

The reasons for starting crop growing using wastewater were similar to findings in the studies in seasonal farming in Zambia (Hampwaye et al., 2007;Mulenga, 1991; 2001). According to the study by Hampwaye et al., (2007) in Lusaka, Zambia where the majority of crop cultivators indicated income generation. Earlier studies by Mulenga, (1991, 2001) in Lusaka and Chipata, Zambia identified several reasons which included poverty, high population growth, strategic position of peri-urban areas in relation to urban markets and deteriorating economy associated with economic structural adjustment.

d) Multiple of labours for crop farming

The results from this study revealed three sources of labour comprising hired labour, members of household and crop cultivators(Table 9) while the methods of payment for hired labour included money and kind such giving workers crops (Table 10) which implied that there was lack of separation of labour and means of crop production. Those in formal employment tended to their field plots during the weekend and when off duty while other household members or workers tended to field plots during the weekdays. The results indicated that the hired people were a source of labour for crop production in wastewater irrigation farming which was similar to the findings of the study by Raschid-Sally and Jayakody (2008) on wastewater irrigation farming in other developing countries.

Table 9 : Source of labour for crop farming.

Source of labour for crop farming	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Household members only	3	10.7	17	58.6
Hired people only	10	35.7	1	3.4
Household members and hired labour	14	50.0	11	37.9
Other sources	1	3.6	0	0
Total	28	100.0	29	100.0

Source: Field data, 2007, 2013

Table 10 : Methods of payment for hired labour.

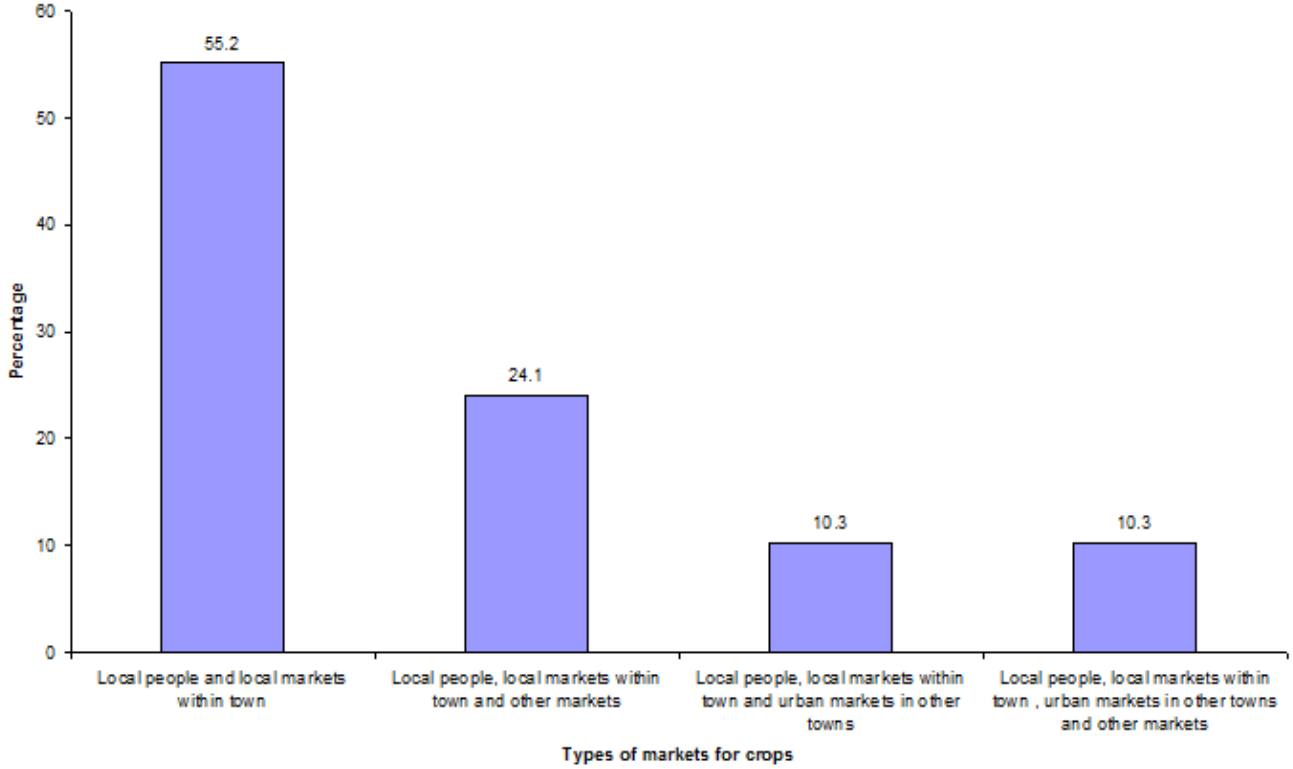
Methods of payment for hired labour	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Money only	23	88.46	10	37.0
Kind only	2	7.69	1	3.7
Money and kind	1	3.84	4	14.8
Others:	0	0	12	44.4
Total	26	100.0	27	100.0

Source: Field data, 2007, 2013

The results indicated that the informal crop cultivators and members of household provides a widely available alternative source of labour in order to avoid proletarianization through hired labour which implied that the crop commodities were produced at low cost under the non-capitalist relations of production and there was lack of separation of labour and means of crop production which was similar to findings in the study by Mac Gaffey (1983) in Kivu, North Eastern of Democratic Republic of Congo (DRC) and the study by Raschid-Sally and Jayakody (2008) on wastewater irrigation farming in other developing countries.

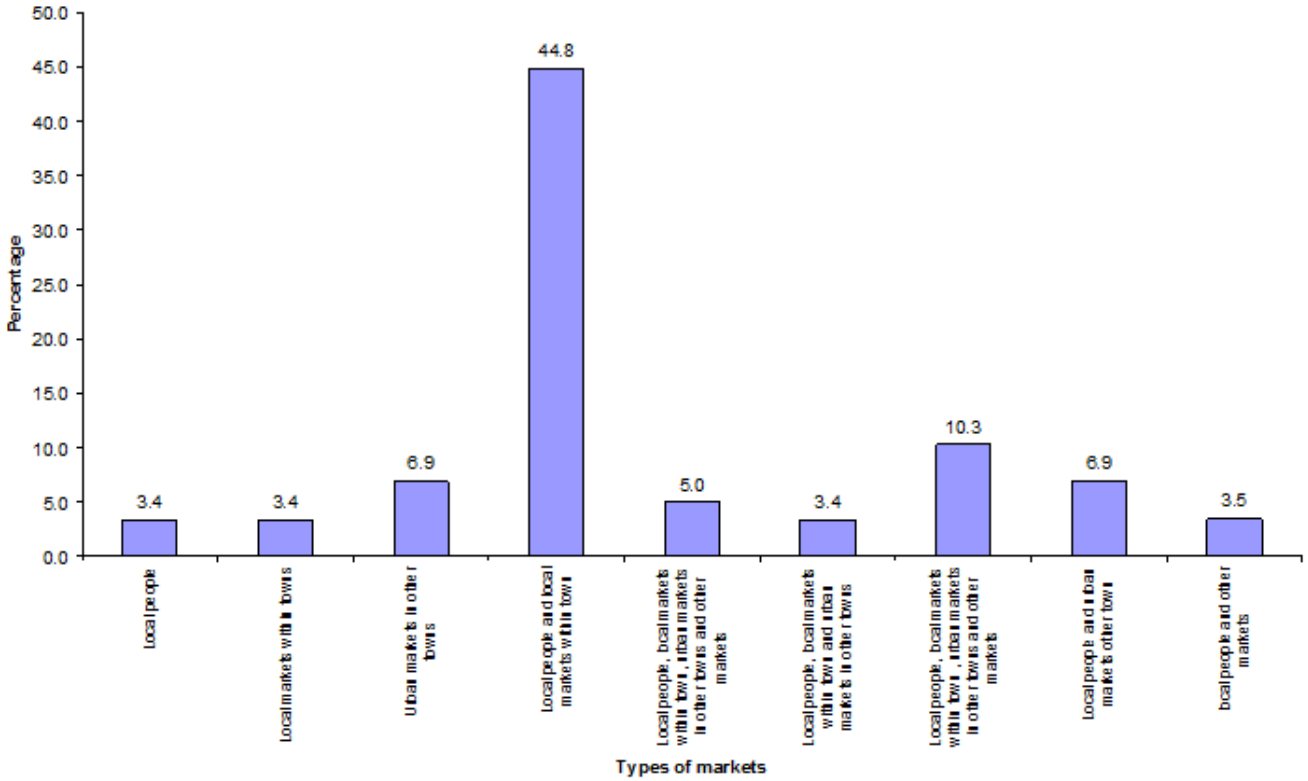
e) Multiple markets for selling of crops

The crops were sold to multiple markets which included the local people in residential areas; local markets within town, urban markets in other towns and any other market (Figure 4 and Figure 5). The crops were consumed at the community or township level through the sales of crops in the local markets and other markets. The results indicated that the heavy metal contaminated crops were consumed by other members of the public and people in distant places such as Lusaka from Chilumba Gardens in Kafue and Kitwe from New Farm in Mufulira. The residential areas provide the readily available markets for crop produced in wastewater irrigation farming areas which was similar to the findings from study by Raschid-Sally and Jayakody (2008) on wastewater irrigation farming in other developing countries. The crops were sold at the local markets and any other markets which imply that the crops were sold at high prices in the capitalist markets hence the mode of distribution was through the formally organised economy by sales at the market which was similar to findings in the study by Mac Gaffey (1983) in Kivu, North Eastern of Democratic Republic of Congo (DRC).



Sample number (n=31)

Figure 4 : Types of markets at New Farm in Mufulira



Sample number (n=29)

Figure 5 : Types of markets at Chilumba Gardens in Kafue

f) Benefits of crop production

The respondents indicated that they used food crops for both domestic consumption (Table 11 Table 12 and Figure 6) and income generation through sale of crops (Table 13 and Table 14). Crops are consumed at household level which indicated that the heavy metal contaminated crops were consumed by the crop cultivators and members of their households. It can be argued that there is the likelihood of potential health risks associated with consumption of heavy metal contaminated food crops grown in wastewater irrigation farming systems in peri urban areas in Zambia. There were variations in terms of the proportion of total income of the households which came from the sale of crops (Table 15). The contribution of urban crop production to household income varied considerably which ranged from 100%, 75%, 16.7%, and 10% of household income respectively. These figures of income contribution to household are similar to findings from studies in urban agriculture in Zambia which indicated the proportion of 75%, 50% and 25% in Lusaka City Council (2005 cited in Hampwaye et al., 2007) while the proportion ranged from 48% to 53% as contribution to annual household income in Ndola, Kitwe and Kabwe (Hampwaye, 2013). The results from this study were similar to findings from the studies by Hampwaye et al., 2007 and Hampwaye, 2013 in seasonal farming and the study by Mtonga, 2001 in wastewater irrigation in Zambia where crop cultivators indicated that they used crops for both domestic consumption and income generation.

Table 11 : Proportion of total vegetables consumed by the household

Proportion of vegetables consumed	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Three quarters (75%)	2	8.0	2	6.9
Half (50%)	2	8.0	3	10.3
Quarter (25%)	0	0	1	3.4
Less than quarter (<25%)	9	36.0	23	79.3
Others	10	40.0	0	0
I do not know	2	8.0	0	0
Total	25	100.0	29	100.0

Source: Field data, 2007, 2013

Table 12 : Proportion of total sugarcane consumed by the household

Proportion of sugarcane consumed	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Half (50%)	1	4.8	0	0
Quarter (25%)	0	0	1	5.0
Less than quarter (<25%)	5	23.8	19	95.0
Others	11	52.4	0	0
I do not know	4	19.0	0	0
Total	21	100.0	20	100.0

Source: Field data, 2007, 2013

Figure 6 : Sugarcane consumed by the children in Mufulira

Table 13 : Proportion of total vegetables sold by the crop cultivators

Proportion of vegetables sold	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Three quarters (75%)	7	28.0	23	82.1
Half (50%)	1	4.0	3	10.7
Quarter (25%)	0	0	1	3.6
Less than quarter (25%)	1	4.0	1	3.6
Others	13	52.0	0	0
I do not know	3	12.0	0	0
Total	25	100.0	28	100.0

Source: Field data, 2007, 2013

Table 14 : Proportion of total sugarcane sold by the crop cultivators

Proportion of sugarcane sold	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
Three quarters (75%)	4	14.8	23	100.0
Others	20	74.1	0	0
I do not know	3	11.1	0	0
Total	27	100.0	23	100.0

Source: Field data, 2007, 2013

Table 15 : Crop earnings as a proportion of total household income.

Proportion of total income of the households	New Farm in Mufulira		Chilumba Gardens in Kafue	
	No.	Percentage (%)	No.	Percentage (%)
All income (100%)	5	16.7	0	0
Three quarters (75%)	3	10.0	23	82.1
Half (50%)	1	3.3	2	7.1
Quarter (25%)	0	0	1	3.6
Less than quarters (<25%)	1	3.3	0	0
Others (10%)	5	16.7	2	7.1
I do not know	15	50.0	0	0
Total	30	100.0	28	100.0

Source: Field Data, 2007, 2013

g) Living conditions of crop cultivators

The results on the total income per year from livelihood activities are shown in Table 16. Results from this study indicated that the total income per year by crop cultivator was estimated at US$ 1,021=67 while the average total income per year was US$ 1,000=00 from the livelihood activities done by the members of their household at New Farm in Mufulira (the exchange rate was one US Dollar equivalent to four Zambian Kwacha in 2007). The total income per year by crop cultivators at Chilumba Gardens in Kafue was estimated at US$ 977=85 while the average total income per year was US$ 904=00 from the livelihood activities done by the members of their household (the exchange rate was one US Dollar equivalent to five Zambian Kwacha in 2013). Some of the income was generated from crop production activities. The total average income per year from sale of crops was US$ 815=91 (one United States Dollar to four Zambian Kwacha in 2007) with the minimum figure of US$50=00 and the maximum figure of US$ 2,000=00 at New Farm while the total average income per year from sale of crops was US$ 906=40=00 (One United States Dollar to five Zambian Kwacha in 2013) with the minimum of US$100=00 and maximum of US$ 2800=00 at Chilumba Gardens in Kafue.

Table 16 : Total income per year from livelihood activities

Amount in US$	New Farm in Mufulira		Chilumba Gardens in Kafue	
	[1]Crop cultivators	[1]Household members	[2]Crop cultivators	[2]Household members
Maximum	2000=00	1500=00	3000=00	2600=00
Mean	1021=75	1000=00	977=85	904=00
Minimum	250=00	375=00	70=00	120=00

[1]exchange rate of one US Dollar equivalent to four Zambian Kwacha in 2007)
[2]exchange rate of one US Dollar equivalent to five Zambian Kwacha in 2013)
*** Missing values*
Source: Field data, 2007, 2013

The total income per month as compared to non-taxable income threshold, basic needs and food basket showed that their living conditions were below the poverty datum line (Table 17) specified by the Zambian Government Central Statistical Office (*Zambia Daily Mail*, 2008a) which indicated that the majority of the crop cultivators were poor. The results from this study confirmed the perception that the majority of crop cultivators engaged in wastewater irrigation farming were seemingly poor in developing countries (Marshall *et al.,* 2004; Raschid-Sally and Jayakody, 2008). The results from this indicated that wastewater urban agriculture provides livelihoods to the lowest income groups in the society in Zambia which was similar to findings from wastewater irrigated farming in Hyderabad City, Andhra Pradesh, India (Buechler *et al.,* 2002). The foregoing explanation supports the view of urban agriculture as a coping strategy to challenging urban living conditions which is similar to findings from the studies by Jaeger and Hackabay, (1986), Mulenga, (1991) and Hampwaye *et al.,* (2007) on seasonal farming in Lusaka Zambia, Page (2002) on seasonal farming in Cameroon and other study by Buechler *et al.,* (2002) on livelihood and wastewater irrigation agriculture in Hyderabad city, Andhra Pradesh, India.

Table 17 : Total income as compared to non-taxable income threshold, food basket, basic needs and urban living standards in Zambia

Elements	Characteristics	[1]New Farm in Mufulira	[2]Chilumba Gardens in Kafue
		[3]Amount(US Dollar)	[4]Amount (US Dollar)
Total income of crop cultivators from all livelihood activities	Total income per year	1,021=87	977=86
	Maximum total per year	2,000=00	3000=00
	Minimum total per year	250=00	70=00
	Total income per month	85=16	100=00
Total income of crop cultivators from sale of crops	Total income per year from sale of crops	815=91	906=40
	Minimum total income per year from sale of crops	50=00	100=00
	Maximum total income per year from sale of crops	2,000=00	2800=00
[5]Non taxable income	[5]Non taxable income threshold per month	125 (2007)	600=00(2013)
	[5]Non taxable income threshold per month	150 (2008)	600=00(2014)
[5]Basic needs and Food basket	[5]Food basket per six in family per month	177=29(September, 2007)	[a]165=63 (August, 2012)
	[5]Basic needs and food basket per six in family per month	295=57(September, 2008)	[b]691.31(August, 2012)
	[5]Basic needs and food basket per six in family per month	375(December, 2007)	**
[6]Urban living standards in Zambia	[6]Index of real minimum wage	56 (1960), 128 (1970), 83 (1985)	

Source: [1]Field data, 2007, [2]Field data, 2013, [3]One United States dollar to four Zambian Kwacha in 2007; [4]One United States Dollar to Five Zambian Kwacha in 2013, [5] Zambia Daily Mail, 2008a, [3]Potts, 2004, [a]Food basket per five in family per month,(Jesuit Centre for Theological Reflection, 2012)

*[b]Basic needs and food basket per five in family per month (Jesuit Centre for Theological Reflection, 2012), ** Missing values*

h) Informal access to land

The land cultivated by crop cultivators was characterised by a complex multiple land tenure system. There was official ownership of the land by the private companies, local councils and commercial farmers who have the official title deeds issued by the Ministry of Lands. The cultivated land legally belongs to Mufulira Farms and Mufulira Municipal Council at New Farm in Mufulira while at Chilumba Gardens in Kafue the cultivated land officially belongs to the Nitrogen Chemicals of Zambia and Kafue District Council. On other the hand there was the unofficial ownership of land by the individual crop cultivators which is attained by the exchange of user rights through money, gift and inheritance (Table 18). It was apparently that the crop cultivators informally accessed the land cultivated at the two study sites.

Table 18 : Acquisition of field plots

Methods of acquisition of field plots	New Farm in Mufulira		Chilumba Gardens in Kafue	
	Number of field plots	Percentage (%)	Number of field plots	Percentage (%)
Gift only	5	6.17	12	6.45
Bought only	19	23.46	87	46.77
Inheritance only	11	13.58	45	24.19
Bought and inheritance	17	20.99	40	21.50
Gift and bought	5	6.17	2	1.07
Bought and others	7	8.64	0	0
Gift and others	5	6.17	0	0
Inheritance and others	4	4.94	0	0
Bought, inheritance and others	6	7.41	0	0
Others: renting of field plots	2	2.47	0	0
Total	81	100.0	186	100.0

Source: Field data, 2007, 2013

There were conflicts of interests between the formal owners of land and the crop cultivators who informally accessed land through inheritance, buying the land from others and being given as a gift. The kinship relationship among the crop cultivators is evident in the way the people transfer the user rights of cultivable land through inheritance, gifts from relatives and buying from other crop cultivators. The crop cultivators have developed the sub culture based on the customary traditional values of land tenure even though they did not officially own the land which they cultivate.

It can be argued that informal access to land by crop cultivators at the two study sites was an impediment to long term investment into farm infrastructures such as construction of permanent irrigation furrows and discouraged crop cultivators from practicing conservation farming. The findings confirmed results from the studies on seasonal farming in Zambia (Jaeger and Hackabay, 1986; Steckley and Muleba, 2003 Hampwaye et al., 2007) and wastewater irrigated farming in developing countries (Obuobie et al., 2003; 2006) including Zambia (Kapungwe, 2011).

VII. Conclusion

In conclusion the poor informal crop cultivators engaged in multiple livelihood activities to sustain household needs and accumulate capital. The mode of production of crops was low cost under informal non capitalist relations of production systems while the mode of distribution was through the formally organised economy by sales at the market. The opportunities of crop production included income generation and improved food security at household of crop cultivators. The major challenges were consumption of heavy metal contaminated food crops, poverty and informal access to the land cultivated. The results from this study were similar to findings from other studies in developing countries. The research findings would further the development of programmes that would improve livelihoods of urban poor. It is recommended relevant authorities can promote alternative income generation livelihood activities which can sustain the living standard of the crop cultivators engaged in heavy metal contaminated wastewater irrigation farming in Zambia.

VIII. Acknowledgement

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Residues of Mining: A Retrospective View

By Dr. Ramananda Goswami
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Abstract- This paper focuses on the various issues related to the coal mining in India. Coal mining contributes largely towards economic development of the nation although it has a great impact upon the human health. It also has its impact on socio-cultural aspect of the workers and people residing in and around coal mining areas. Thus a holistic approach for taking up to mining activities, keeping in mind concerns for adjoining habitats and ecosystem, is the need of the hour. This requires identification of various sites where minerals exist and various factors ranging from appropriate angle of slope of overburden dumps, safe disposal drains, and safe techniques to various silt control structures etc.

Keywords: pollution, environment, greenhouse, technology, eco-system.

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Residues of Mining: A Retrospective View

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Keywords: pollution, environment, greenhouse, technology, eco-system.

I. Introduction

It is globally accepted that coal mining adversely affects local and global environment. Dangerous levels of air and water pollution have been recorded in coal mining areas. Mining adversely affects local environment in that it destroys vegetation, causes extensive soil erosion and alters microbial communities. Although coal mining does affect global environment through release of coal- bed methane, which is about 30 times as powerful as greenhouse gas as carbon dioxide[1]. Coal mining thus adversely impacts on air quality standards. Underground mining causes depletion of groundwater at some places, as well as subsidence etc. resulting in degradation of soil and land. Subsidence of the soil beyond permissible limits requires filling of the subsidence area. The displacement and resettlement of affected people including change in culture, heritage and related features, criminal and other illicit activities on account of sudden economic development of the area can be said to be the adverse social and cultural impact[2].

Some of the beneficial impacts of mining projects are changes in employment pattern and income opportunity, infrastructural change and community development. Development in communic-ation, transport, educational system, commerce, recreation and medical facilities etc. are some positive impacts. It is thus clear that coal mining leads to environmental damage, while economic development and self-reliance call for the increased mining activities of the available mineral resources. Though there is no alternative to the site of mining operations, options as to the location and technology of processing can really minimize the damage to the environment.

II. Sources of Data & Methodology

The methodology of the research includes collection of research materials by field study and observation methods. The present study is based on both Primary and Secondary data.

a) Primary Data

1. Field study: Field study through observation method and interrogation with Management and laborers of the several collieries.
2. Documentary facts: Collection of day-by-day recorded information from Coal Mining Authority and unpublished information materials gathered from the office of coal mines.
3. Observation of the present condition of the several collieries during field study and also observation of coal mines (underground and opencast).

b) Secondary Data

The study mainly based on secondary data, collected from various sources like Economic and Statistical Department of E.C.L headquarters for all the Colliery related data like the manpower of concerned colliery, depth of the underground mines, location of opencast mines, record of accidents, etc.

c) Study Area

One of the important coalfield in India as well as of West Bengal, namely Raniganj coalfield has been selected for research purpose. The Raniganj coal field is bounded by latitudes 23° 35° N to 23° 55° N and longitudes 86° 45° E to 87° 20° E is the most important coalfield of West Bengal (Burdwan District) lies in the Damodar valley region is surrounded by Durgapur – Asansol Industrial belt. For empirical study, another study area of Jharkhand namely, Jharia coalfield has been selected for research purpose. The Jharia coalfield is located in the Dhanbad district of Jharkhand state at a distance of 260 km from Kolkata towards Delhi. It is bounded by latitudes 23° 38° N to 23° 52° N and longitudes 86° 08° E to 86° 29° E.

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[1] See report of Prabha, J & Singh, G. 2005. "*A Reviev on Emission factor Equations for Haul Roads: The Indian Perspective*": The Indian mining and engineering Journal.

[2] See Goswami, S "*Coal Mining, Environment and Contemporary Indian Society*" published in Global Journal of Human Social Science, U.S.A (B) (Volume 13 Issue 6 Version 1.0 Year 2013)

III. Assessments of Environmental Impacts of Coal Mining in India

a) Impacts of Opencast Mines on Environment (Operational Stage)

Before going to the post mining stage, the environmental impacts of the operational stage can briefly be discussed.

i. *Air*

The air in the opencast mine including its surrounding zone is affected due to various mining operations. If effective dust suppression measures are not taken the air quality deterioration in the operational stage of an opencast mine may become appreciable. However, for environment, health and operational efficacy the dust suppression is taken care by the mine management.

ii. *Water*

The natural water system in the project area as well as its surrounding zone is affected due to various reasons like mine water discharge, erosion from dump etc.

iii. *Land*

The impact on land in the operational phase is direct and visible. The mined-out area, the overburden or reject dumps, the infrastructural built-up area all affect the land during the operational stage. Unless proper reclamation is possible by backfilling, the land impacts during the operational stage remain visible and glaring. Most of the land management can be done only in the post-mining stage. However, at present thrust is for concurrent or early backfilling and physical reclamation of the mined areas or OB dumps during the operational phase itself.

iv. *Flora and Fauna*

The flora and fauna in the forest areas face the direct impact of the mining operation. The diversion of forest land for the mines and OB dumps clearly affect the floral system in the area. The fauna in the area normally migrate because most of the coal mines in the forest area are surrounded by contiguous forests.

b) Impacts of Open Cast Mines on Environmental (Post-Mining Stage)

The following are the impacts on the environmental descriptors in the post-mining stage as can be envisaged at present.

i. *Air*

After closure of the mining operation the activities causing air pollution are minimized. The activities of reclamation and rehabilitation of the areas may generate just a meager quantity of dust. This is not likely to have any impact on the ambient air quality.

ii. *Water*

The impact on water quality after the closure of the mining operation will also get reduced appreciably. The pumping of the mine water is likely to the mine water is likely to stop due to reduced activities. The quality of mine water, even if pumping is continued for some reason will be always within the acceptable limits. The pollution due to arete dumps will also slowly reduce with improved vegetative cover on these arete dumps. The problem of acidity or alkalinity will also appreciable reduces with no exposure of fresh rock surfaces in the mined area. It is therefore stated that rehabilitation of the dumps is a must for controlling the water pollution.

iii. *Land*

Land is a major problem even in the post-mining stage. The following land uses will result upon completion of the mineral extraction.

a. Mined-out area (voids)
b. Internal dump areas
c. External dump areas
d. Infrastructural areas
e. Residential areas.

Out of the above, the residential areas may be suitable developed so that aesthetically and also environmentally they remain acceptable. However, other four post-mining land uses need proper rehabilitation so that they match with the ambient scenario and are acceptable to the society as a whole.

iv. *Flora and Fauna*

The impact on flora and fauna after completion of the mining operation would remain insignificant. However, a possible impact can always be envisaged with proper planning of the land use and proper harvesting of the water and soil resources within or near the project area. The proper rehabilitation of the mining areas and rational utilization of water and soil resources will help to enrich the growth of flora and thereby advent of the migration fauna. This could be useful post-mining scenario.

IV. Site Development and Land Use Plan

A site development and land use plan should be prepared to encompass pre-operational, operational and post-operational phases of a mine. It should clearly indicate the planned post-operational land use of the area, with details of the measures required to achieve the intended purpose. The general survey for the purpose must take into account not only the broad features of the actual or proposed mining operations, nut also the surrounding terrain conditions. The important components of this survey include:

(i) Present land use pattern of the area;
(ii) Main features of the human settlements in the area;

(iii) Characteristics of the local eco-system;
(iv) Climate of the area;

Relevant terrain information that will help in arête dumping, tailings disposal, etc., with least effects on the local land-water system, including-

(a) geo-morphological analysis (topography and drainage pattern),
(b) Geological analysis (structural features-faults, joints, fractures, etc.),
(c) Hydro-geological analysis (disposition of permeable formations, surface-ground water links, hydraulic parameters, etc.),
(d) Analysis of the natural soil and water to assess pollutant absorption capacity, and
(e) Availability and distribution of top-soil;

(v) Communication and transport facilities;
(vi) Details concerning the mining plans-

(a) Minerals to be worked,
(b) Method of working,
(c) Details of fixed plants,
(d) Nature and quantity of arêtes and disposal facilities required for them,
(e) Possibilities of subsidence and landslides,
(f) Transport facilities needed, and
(g) Services to be installed.

An action plan for minimizing the adverse environmental impact from the proposed mining activity may be prepared including rehabilitation of the mining area. The important aspects to be considered are:

a) Pre-Operational Phase

(i) Vegetation barriers should be raised along the contours in the hilly areas for the prevention of soil erosion and for arresting the mine area.
(ii) Steps should be taken to construct check dams, either of rubble or brush wood, across small gullies and streams on the ore body to contain soil area. The check dams shall be stabilized by vegetation.
(iii) The banks of streams in the mining are should be intensively vegetated to prevent the discharge of sediments into the streams.

b) Operational Phase

(i) For opencast mines, screens or banks of soil and overburden shall be constructed in the peripheral area.
(ii) Vegetation barriers shall also be constructed along the periphery of a mining area on either side of the mine/service roads and between other locations. The advantages include top-soil preservation, lessening of adverse visual impact, noise-baffling, dust suppression, etc.
(iii) Clearance of vegetation should be restricted to the minimum necessary for mining operations, and planned in advance.

c) Post-Operational Phase

Once the mining operations are over, the land should be rehabilitated for productive uses like agriculture, forestry, pasturage, recreation, wild life habitats and sanctuaries.

V. Nose Pollution in Coal Mines in India

The noise is now being recognized as a major health hazard; resulting in annoyance. Partial hearing loss and even permanent damage to the inner ear after prolonged exposure is general phenomena. The problems of underground are of special importance because of the acoustics of the confined space. The ambient noise level of the underground mining area is affected by the operation of the cutting machines, tub/conveyor movement and blasting of the coal. The movement of coaling machines and transport units-conveyor, tubs and transfer points caused audible noise which becomes disturbing underground because of the poor absorption by the walls[3].

VI. Noise Pollution Due to Mining Activities

The most note generating equipment underground are the haulage, ventilators-main, auxiliary and forcing fans, conveyor transfer points, cutting and drilling machines. The ambient noise level due to different operations in underground mines varies within 80-1040 dB (A).In a mine of Raniganj and Jharia the noise level near fan house, conveyor system shearer and road headers are reported to be within 92-93 dB (A). The values increased in many Indian mines because of poor maintenance of the machines and exceeded the permissible limit of 90 dB (A) for 8 hours per day exposure[4]. The result of a noise survey for a coal mine conducted by DGMS is summarized in the following table which indicates noise over 90 dB by the drills, breaking and crushing units and transport system underground.

Table 1 : Noise Level in Underground Coal Mines

Location of survey	Average Noise level dB (A)
Near shearer	96
Transfer point	99
Tail end belt conveyor	89
Power pack pump	91
Drive head of AFC	96

Sources: CMPDI, Survey Report, 2010

[3]Refer the report of Kumar, R, G, Singh and A, Pal .2004. "Assessment of coal and minerals related industrial activities in Korba Industrial belt of Chhattisgarh": Centre of Mining Environment, Indian School of Mines, Dhanbad

[4]See Goswami, S " *Environment Management in Mining Areas*" published in Global Journal of Human Social Science, (B) U.S.A (Volume 13 Issue 7 Version 1.0 Year 2013)

The mechanized mines have lower noise problem in comparison to the old conventional mines operational mines operating with haulage and coal cutting machines. The results show that (Table 2) covering wholly manual, partly mechanized with coal cutting machines and partly mechanized with SDL loading showed reduction in the noise level underground.

Table 2 : Noise Survey in Selected Coal Mines

Type of mine	Machine points	Noise Level	Duration of Operation
Wholly manual	Drill Tugger haulage	87dB(A) 105Db(A)	1-2 hrs 4 hrs
Mechanized with CCM cutting	CCM Drill Auxiliary fan	94Db(A) 94Db(A) 93dB(A)	1 hrs 1-2 hrs 8hrs
Mechanized loading	Drill LHD Chain conveyor	88Db(A) 98Db(A) 84Db(A)	2 hrs 4-5hrs 4-5hrs

Sources: CMPDI, Survey Report, 2010

VII. Noise Pollution Due to Blasting

The blasting in underground cause's high frequency sub audible noise measured in terms of air over pressure. The magnitude of air pressure is found to be 164 dB (1) at 30m distance reduced to 144 dB (l) at a distance of 70m. Test results of some of the sites are summarized in the following table.

Table 3 : Air Pressure Due to Blasting in Underground

Mine	Explosive type	Max, charge/delay Total charge Max, (kg)		Air over pressure at Distance-m Value Db(l)	
Ray Bacha	P1 P5 P3	kg kg 12.5kg	10.6 kg 2.4 kg 12.5 kg	50m 70m 15m	153.8 144.5 150.1
Girmit	P5	6.4 kg	2.5 kg	30m	164.8

Sources: CMPDI, Survey Report, 2010

The total noise menace due to blasting underground is the result of the audible and sub audible noise. The sub audible noise responsible for vibration causes vibration of the surface features and in case of thin overburden cracks in surface structures. This societal reaction of Jharia Town Development Forum over blasting forced the pick mining in some of the situations. The reaction of blasting is reported in the following forms.

- Damage of old structures due to vibrations.
- Public nuisance vis-à-vis disturbance of sleep.
- Disturbance of sewerage and water supply line.

The amplitude of vibration due to blast wave is observed to be reduced with increase in the height of the building and hence drop in the level of nuisance in the upper floors. The investigation in some of the mines revealed that in case of machine cut the blasting in the lower section generated more vibration than that of the upper portion. The restriction of total charge is essential to minimize the vibration due to blasting underground. The P5 explosive generates low vibration in comparison to P3 grade of explosives[5].

The noise control measures in general are categorized in three groups: personal protective measures, engineering control measures and administrative measures. The engineering control measures are the most effective as they are based on sophisticated techniques like Retrofit approach for installation of noise control treatment on mining equipment. Designing of inherently quite mining equipment is also included in this technique which aims to control and reduce the noise emission successfully. The preferred cost effective system for the underground mining has been the personal protective system – ear muffs for the operator of the noise producing units.

VIII. Toxic Arete Treatment

Nearly 25-35% of rain water drained back to ocean through reveres and streams; the major source of potable water for local population. Except particulate impurities (coal dust/soil/clay) and bacteriological or biological impurities; the river water are normally fit for consumption. Normal filtering and disinfectants made the water acceptable and had been used in India and elsewhere. Ground water on the other hand is not fit for consumption unless treated for hardness. The quality of mine water of Jharia and Raniganj Coalfield obtained from the underground mines are summarized in the following table.

[5]See Sinha, A.K and G.K. Pradhan.1986. "Bulk handling explosive system-its application in Indian surface mines": Indian Mining Journal, 25-27.

Table 4 : Mines Water Quality

Area	Kunustoria	Effluent water(MOEF schedule-vi standard)
Project	Parasea UGP	
Qtrending	June 2009	
Samplining station	W1	
Date of sample	Mine discharge from pit no. 2	
Colour	9th May 2009	
Orour	unobjectionable	unobjectionable
TSS	unobjectionable	unobjectionable
PH	44.00	100.00
Temperature °c	8.40	5.50-9.00
Oil & grease	Normal	Shall not exceed 5°c
Total residual chlorine	<1.00	10.00
Ammonical Nitrogen	Nil	1.00
Total kjeldahi nitrogen	0.03	50.00
Free ammonia	0.76	100.00
B.O.D.	BDL	5.00
C.O.D.	-	30.00
Arsenic	40.00	250.00
Lead	<0.01	0.20
H .Chromium	<0.05	0.10
Total Chromium	0.08	0.10
Copper	0.08	2.00
Zinc	0.05	3.00
Selenium	0.02	5.00
Nickel	<0.01	0.05
Fluoride	-	3.00
Dissolved phosphate	0.46	2.00
Sulphide	-	5.00
Phenolics	0.04	2.00
Maganease	<0.001	1.00
Iron	0.22	2.00
Nitrate nitrogen	0.18	3.00

Sources: CMPDI, Survey Report, 2009

Note : *All parameters are in mg/l unless specified otherwise NA stands for not analyzed.*

The water pollution problem in the mining areas is broadly classified into the following major heads depending upon the nature of coal and dump, effluents and rock formation:

- Acid mine drainage in case of high sulfur coal
- Eutrophication and Deoxygenating due troth of algae because of sulfur.
- Heavy metal pollution

High level of dissolved solids such as bicarbonates, chlorides and sulfates of sodium calcium, magnesium, iron and manganese are introduced to water while passing through aquifuge and aquiclude made permeable due to sagging and industrial usage without treatment. This makes the water hard, unfit for drinking, other impurities in a few selected mines of Jharia and Raniganj coalfield. Low level nitrates and phosphates served as nutrients to algae; rapid growth of which caused deoxygenating of water, and lowering of dissolved oxygen. This are likely to occur when the underground water are accumulated in water pools. Use of such water for irrigation might improve production and yield of crop.

IX. Heavy Metal Pollution

Heavy metals like lead, zinc, arsenic and cadmium are detected in traces in the mine water, mainly because of leaching of aquifuge, aquiclude and igneous intrusions and effluent of oil and grease from the machines underground. The toxic substances generally in the confined state within the rock mass are exposed to dynamic setting of soil water system when they start polluting mine water. The list of the toxic elements and their impact is summarized as follows:

Table 5 : Toxic Trace Elements and their Impact

Element	Impact/Effect
As	Toxic, possibly carcinogenic
Cd	Hypertension, kidney damage & toxic to biotic
Be	Acute toxicity, possibly carcinogenic
B	Toxic to plants
Cu	Toxic to plants and algae
Fl	Cause mottled teeth
pH	Toxic (Anemia, Kidney disease, nervous disorder)
Mn	Toxic to plants

Sources: CMPDI, Survey Report, 2010

Some of these elements served as nutrient to plants and aquatic life at lower concentration. There concentration in coal mine water are normally within permitted limit and required no special treatment. The survey result of two mines of Raniganj coalfield is summarized in the following table.

Table 6 : Micro Elements in Bonjemihary & Ghanshyaam Mines

Micro elements Cmol (P+) kg	Benjemihary	Ghanshyaan
Ca	0.78	51.0
Fe	0.51	0.89
Al	0.49	0.68
Mn	0.09	0.08
Zn	11	0.14
Mo	0.02	0.02
Cu	0.02	0.005
Bu	0.02	0.02

Sources: CMPDI, Survey Report, 2010
**Results in ppm.*

The presence of a large number of trace elements in coal is attributed to species of carbonaceous swamps or contemporaneous sedimentation with holmic acids solubilizing and binding these elements. Trace elements may have come through inflowing these element might have come through inflowing ground water during calcification. The magma tic and fluid might have resulted epigenetic mineralization and enrichment of trace metals. The elements like As, Cd, Hg, Pb and Zn are the inorganic fraction of coal while Cr, Cu and Sb are present in mineral in organic form. The concentration of trace elements in Raniganj and Jharia coalfield is summarized below.

In the process of mining these elements are released or mixed to the inflowing water and ultimately to water channel.

Table 7 : Concentrations of Trace Elements in Coal

Element	Concentration ($\mu g / g^{-1}$) of trace elements in regions			
	Kunustoria	Parasia	Katras	Victoria
Antimony	1.35	-	3.5	3.33
Arsenic	14.9	4.8	6.8	16.8
Cadmium	2.89	0.2	-	0.2
Chromium	14.1	12.7	17.5	31.9
Fluorine	59.3	54.0	-	-
Lead	39.8	0.8	-	21.7
Mercury	0.21	0.07	0.42	0.22
Barium	113.8	146.0	-	21.7
Nickel	22.4	5.5	-	-

Sources: CMPDI, Survey Report, 2010

Quality of water, however, is the main casualty of the scenario when hardness of the water increases up to 700 mg/l inclusive of 300-500 mg/l permanent hardness which necessitates special treatment. The other impurities like heavy metals and oxygen balance of the underground water in most of the Indian coalfields are well within the accepted limit.

The ground movement impact on hydrosphere are manifested in the form of increased storage and charging character, lowering and disturbance of the water table, loss of streams or water pools. Some of them have improved the water availability to the flora and fauna and biomass in general and improved the environment and ecology while a few caused temporary damage to the environment and ecology with the development of the fracture planes and opening of the cracks. The positive impact of the ground movement over the hydraulic regime are however, diluted due to repeated mining of the seams one after the other. With each seam working, the cycle of negative impact are repeated, water table loaded and level of pollution increased time and again. It takes time – a couple of years again before the regime are restored to normalcy.

X. Concluding Remarks

Mining below the surface destabilizes the ground, while the process of mining particularly blasting causes vibration of the surface structures and noise generation. The transfer of the raw coal, its beneficiation and handling generates coal dust, whiles open burning of coal for steam or other usage release gaseous discharge to the surface atmosphere. The movements of coal from the pit head to the loading, or consumption points in open trucks or open wagons also add coal

dust to the environment all along the routes. The air absorbing moisture from the underground workings often reduces the suspended particulate matter but the fames of explosives, methane, So2, and Oxides of carbon are added to the general body of air. The concentration of these hostile gases often creates negative impact over the surface and the population nearby. With the latest realization about the impact of these green house gasses over the ozone layer has drawn the attention of the global community and efforts are on to drain methane and put it use as a fuel. The bio - diversity and the local people are also disturbed by the mining activities though they are mostly underground.

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Critical Exploration in the University Classroom: Implications for Teaching and Teachers

By Dr. Sabine Hoidn
University of St. Gallen, Switzerland and Harvard University, USA

Abstract- The paper introduces an educational approach developed by Eleanor R. Duckworth named Critical Exploration in the Classroom (section 1) and outlines the basic educational components central to this approach (section 2). After that selected finding so fan in-depth case study conducted in Professor Duckworth's higher education classroom at Harvard Graduate School of Education in the United States will be presented. The empirical case study investigated how the learning environment in the classroom was designed to support deep exploratory learning exploring both, curriculum design and pedagogy (section 3). As a result, pedagogical implications on how educators can use their know-ledge to help students learn will be outlined (section 4).

Keywords: *Critical Exploration, higher education, understanding, deep learning, teaching.*

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Keywords: Critical Exploration, higher education, understanding, deep learning, teaching.

I know I cannot teach anyone anything,
I can only provide an environment in
which he can learn. (C. Rogers)

I. What is Critical Exploration in the Classroom?

Critical Explorationis an approach that challenges the traditional role of the teacher as one who imparts knowledge. Instead, it supports a move towards students' greater intellectual involvement by fostering student-centered learning processes in the classroom. As a progressive approach to learning and teaching, Critical Exploration puts learners and their understanding of the world center-stage. According to Piaget "to understand is to discover, or reconstruct by rediscovery;" therefore, certain conditions must be complied with "if in the future individuals are to be formed who are capable of production and creativity and not simply repetition" (1972, p. 20). Duckworth (1987/2006, p. 1) considers the development of intelligence to be a creative affair and "the having of wonderful ideas" to be the essence of intellectual development. In order for these ideas to arise it is necessary that teachers are willing to listen to students' ideas and that they provide educational settings suggesting different ideas for different students so that each student can work on a challenging intellectual problem (ibid., p. 7). "Wonderful ideas" can only flourish in an educational environment where students can generate their own knowledge and where students and teachers are co-learners working alongside each other in the educational process.

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BärbelInhelder first introduced the term "Critical Exploration" for Piaget's clinical interviewing method as she applied it to pedagogical contexts that included observing children as well as interviewing and interacting with children who were experimenting and investigating a problem set by the researcher. When applied in an educational context, Critical Exploration as a scientific method can have two levels of meaning, according to Duckworth (1987/2006, p. 159): (1) exploration of the subject matter by the student (instead of only words) and (2) exploration of the students' thoughts, i.e. striving to understand the meaning an experience holds for the student, by the teacher. As a pedagogical approach Critical Exploration supports a move toward students' greater intellectual involvement by considering the learner to be an active explorer building her own understanding while the teacher acts as a facilitator to assist the learners' inquiries. The teachers' responsibility is to develop explorable curricula and to create a classroom environment where learners' thoughts generate the intellectual life of the classroom while the teacher provides some direction through environmental resource selection (assignments, materials), activities and genuine questions to further students' engagement. Duckworth (1987/2006, 2009) stresses the following two major aspects that are original about Critical Exploration as a pedagogical approach:

a) *The way teachers use their own subject matter knowledge, as curriculum planers and as teachers*

They plan how to engage students' minds in exploring the subject matter, put students in direct contact with the subject matter and keep them attending closely to the material. For example, the teacher thinks about what materials he will use, how he proposes to begin the session, different ways in which the session might develop, and what he might do in each case. He brings materials to the classroom that provide a source of feedback and against which the students can test their ideas.

b) *The way educators focus on the students' thoughts rather than their own*

The teacher invites students to express their thoughts/ideas to come to understand how students are seeing things. Teachers are getting students to talk about their thoughts on various matters, they show interest in what students are saying and they are careful

not to influence what students say as they are saying it. This way, teachers can use their insights to inform their teaching in terms of how next to call on their knowledge of the subject matter – what resources to provide, what next questions to ask to engage the students' minds continually with the subject matter and to broaden and deepen their understanding.

II. Basic Components of Critical Exploration in the Classroom to Support Deep Conceptual Understanding

Critical Exploration in the Classroom constitutes a triangular, dynamic relation between three pedagogical elements: the represented challenge, the teacher, and the students. These three elements create a dynamic that offers the teacher a window into the ways in which different students go about making sense of the represented challenge. The didactic triangle represents the basic structure of the teaching and learning process and helps to analyze its main components and their relations (Figure 1).Moreover, this structure can help to think more about what teachers can do with their knowledge if they do not simply tell it to the students. Although the components will be tackled separately below they are interrelated and need to be closely aligned to allow for deep learning to take place.

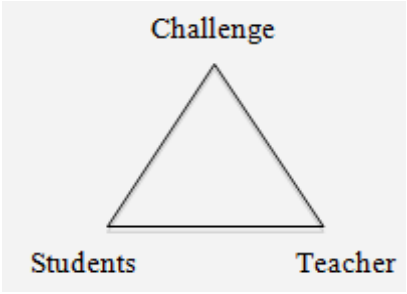


Figure 1 : Three educational components of Critical Exploration in the Classroom

a) Represented Challenge

In order to learn, students should be given opportunities to be *in contact with phenomena* related to the area to be studied. A specific intellectual challenge is represented in concrete form (object), for example, a poem, a painting, a case in economics, materials embodying a problem in physics or mathematics. Thus, the students have something complex and authentic to look at and think about, instead of oversimplified, artificial materials or just spoken words. This way, they can connect with the phenomena and make sense out of it for themselves instead of being presented with the meaning somebody else is making. Duckworth argues:

"[I]f you want to help kids and teachers learn about the material world, like batteries and bulbs, or pendulums, or earthworms, or butterflies, you give them batteries and bulbs, pendulums, earthworms, and butterflies. And you let them look at them, notice them, figure out their questions, and come to be familiar with these things. You don't give them *words* about these things, you give them *these things*. Now that's similar to the poem, too. You don't give them somebody else's words about a poem, you give them the poem." (Duckworth in Meek, 1991, p. 32)

These concrete representations or objects can fulfill several educational functions:

- The subject matter itself instead of words allow students to act on material things so that they can *discover the specifics of an object* for themselves. This way, they can make a connection to the world and assimilate new experiences in ways that make sense to them.
- Students have reliable *materials* at their hands that are *the proving ground* against which they can develop and assess their own ideas or upon which students and teachers can *collaboratively assess each other's ideas and claims to develop shared understandings*. This way, the subject matter is the *source of authority* – without the need for the teacher as intermediary.
- *Getting to know each other's ideas and seeing each other's confusions* can help students and teachers to understand as they might have similar confusions and ideas. However, sometimes students "see how each other's ideas pass right over their heads, and they can't connect with them. Then six weeks later they hear exactly the same idea; and they notice, well, now they can connect with it." (Duckworth in Meek, 1991, p. 31)
- Students are given opportunities to *work on topics and projects that interest them and often construct their own objects.* While working on something on their own, students come up with their own ideas as they make sense out of the phenomena. They also pass through confusions and feelings as they cannot make sense out of the phenomena yet. Finally, when they get their minds around their own puzzling questions and ideas and see that their ideas can work out and can be of interest to other people, they can expand their connection to the world and also develop feelings of self-confidence.
- *Interesting materials and activities can engage students' minds* by providing occasions where surprise, puzzlement, excitement, patience, caution, confusion, honest attempts and wrong outcomes are important elements of intellectual development (Duckworth, 1987/2006).

b) The Role of the Student in the Learning Process

In Piaget's view, intellectual development is a process of equilibration where an individual interacts with the world based on two complementary processes: Assimilation means "the integration of external elements into evolving or completed structures." The process of

assimilation allows an individual to take external elements into previously constructed structures and thus, provides for continuity and sense-making in a person's cognitive development. Accommodation is "any modification of an assimilatory scheme or structure by the elements it assimilates" (Piaget, 1976, pp. 170 and 172). The process of accommodation is responsible for the transformation of already existing structures and thus, for further cognitive development. Through the intrinsic process of equilibration, which Piaget considers to be the motive for cognitive growth, a learner actively constructs structures throughout his life while acting upon the world – either alone or in social collaboration. Hence, for students to connect to the world, they must construct their own "wonderful ideas," move their ideas forward via exploration, discuss them with each other and (collaboratively) assess them against materials which provide reliable grounds. In this process students share with the teacher the responsibility of making sure they understand each other. This way, they do not just recount other people's ideas and learn for the test but develop greater confidence in their own ideas instead (Duckworth, 1987/2006). Therefore, it is a valuable and important cognitive and emotional experience for students to come to their own understanding, not through being told answers, but through the power of their own minds – often in interaction with others. A student-centered learning process leads students to

- have or develop a great sense of *confidence* in their own minds;
- *bring their prior expectations and knowledge about a subject matter to the learning experience* and then make a connection from the subject matter to what they already understand to reach an understanding of the subject matter;
- *explore challenging questions and to figure things out* based on their own interests;
- *wrestle with their own ideas* about a subject matter with confusions and conflicts being seen as valuable aspects of learning;
- *try to make sense* by testing ideas and posing questions, by thinking out loud and explaining what they think and why in a convincing fashion, and in the light of the phenomena they are trying to understand;
- *have the courage to submit an idea of their own* to someone else's scrutiny. Students form their own ideas, share what they think, see how their ideas relate to the ideas of others and are open to the questioning of their peers (Duckworth, 1987/2006, p. 67).

A student-centered learning process requires students to consider and discuss each other's thinking in relation to their own thoughts and to their ongoing observations and explorations of the material proving ground. Thus, they develop their understanding of the subject matter and their ability to think further and gain confidence in their own minds.

c) The Role of the Teacher in the Learning Process

The student's learning is the focus of teaching; therefore, the teacher's role is to *help students learn*. The teacher facilitates learn ersso that they can have wonderful ideas on their own and realize the power of their own minds. Understanding requires searching thought about the nature of the subject matter on the part of the students and avoiding technical words to open a variety of connections to the subject matter. A teacher cannot assume that students have understood something because he has led them through it very carefully (Duckworth, 1999). Telling is not effective, especially when it comes to promoting higher order thinking processes, as Duckworth (in Meek, 1991, p. 30) points out: "telling people what they ought to understand has very little impact on what they actually understand. You have to put them in a situation where they develop that understanding – it's not going to happen from your telling them." Duckworth (1987/2006) highlights two main aspects regarding the role of the teacher as critical explorer:

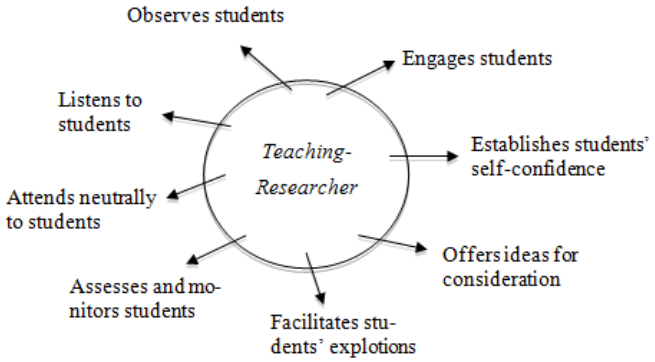
a) The teacher *puts students in contact with the phenomenon*– the real thing – related to the area to be studied and gives them the space to explore what is interesting to them. He engages the students and puts authentic materials in the students' hands so they will continue to think and wonder about the subject matter. A good teacher knows how to get students interested in a subject matter/problem and keeps them interested in it (Duckworth in Meek, 1991).This brings the teaching and learning to life and sets up the subject matter as the source of authority. Students are attending to each other's thoughts and generate their own puzzles and questions while the teacher provides students with yet further elements of subject matter to help them to take charge of their own explorations of the subject matter and deepen their knowledge.

b) The teacher *has the students explain the sense they are making* and provides them with the time to create their own meaning while he is observing and listening. The teacher listens genuinely without trying to guide students' explorations asking, "What do you notice? What do you think? or How do you think about it?", for example. He keeps trying to find out and understand what sense the students are making and helps them to develop their ideas further offering new aspects for consideration while at the same time assessing and monitoring their progress. He attends to them with the neutrality of a researcher, that is, he reacts to the substance of their answers without judging them. The teacher invites students to talk and establishes their feeling

of self-confidence instead of explaining things to the students and imposing his knowledge.

In short, in the course of the educational process, *engaging learners in phenomena* and *working to understand the sense they are making* are the main aspects of teaching. This take on the educational process has further implications for the design of learning environments. The following Figure two summaries important core tasks of a teacher(teaching-researcher) as outlined above:

Figure 2 : Core tasks of a teacher as critical explorer



III. Designing Student-Centered Learning Environments that Support Exploratory Learning Processes

Exploratory learning has its roots in the works of John Dewey, Jean Piaget, Friedrich Fröbel and Maria Montessori. The learner is considered to be an active explorer and discoverer building his own understanding while the teacher acts as a "guide on the side" to assist the learners' inquiry and help him engaging the learning environment. An exploratory learning environment "supports learners in constructing their understanding about a specific subject through learner-driven reflective inquiry" (Rick & Lamberty, 2005, p. 180). Exploratory learning activities are more open in nature allowing students to explore the educational material available. Work relevant for exploratory learning environments has been done in educational theory (e.g. Bruner, 1966), educational technology (e.g. Papert, 1993; Resnick, Bruckman & Martin, 1996), and educational psychology (Duckworth, 1987/2006).

The following section draws on the results of a case study that was conducted over the course of one semester (13 classes) in professor Duckworth's signature university course at Harvard Graduate School of Education during Fall term 2009: "T-440: Teaching and Learning: 'The Having of Wonderful Ideas'". The university course was designed to develop teacher students' ability to engage different people's minds in thinking about subject matter and to learn how to make sense of how their learners are thinking about that material. Situations where teachers keep learners connected to the subject matter and listen while learners do the sense-making and explaining were continually enacted and explored in the classroom and through equivalent field work. The aim of the empirical case study was to gain first-hand knowledge of how an expert instructor in the field of higher education designs an exploratory learning environment that engages teacher students in deep learning. The case study triangulated the following research methods: participant observation/videotaping, a handful interviews with students and one interview with the instructor, and document analysis (syllabus, classroom materials, course evaluation) (see Hoidn, 2010 for a detailed account of the case study). The following section presents the main curricular and pedagogical implications for the creation of exploratory learning environments that the enactment of Critical Exploration in the Classroom entails based on the findings of the case study research: (1) A challenging and explorable curriculum, and (2) a student-centred pedagogy.

a) Challenging and Explorable Curriculum

In order to make sense out of the world individuals need to make intellectual connections between their prior knowledge (internal structures) and the subject matter. Therefore, curricula need to provide occasions so that students can construct knowledge based on their own repertoire of actions and thoughts as there are endless numbers of adequate pathways for students to encounter and apprehend the material and make sense of the subject matter. Curricula must build on this diversity by engaging students intellectually and inviting them to explore the subject matter. A learning environment that provides a rich source of selected cultural, social and material resources can invite students to raise questions that concern them and contributes to a democratic classroom. Lectures are rare in such classrooms and the instructor does not talk too much in class but instead is mostly silent and listens very carefully to what the students are saying while trying to avoid any (judging) comments on students' ideas. The instructor is the one who orchestratesexploratory activities, carries out demonstrations (modeling) and is mainly in charge of moderating large class discussions (including, for example, students' reflections on activities). Students explore and do the talking and explaining using artifacts as testing-grounds for their ideas and thus, as a source of authority. Translated into pedagogical practice this means that the instructor

- has to know her subject matter (what she teaches), diverse ways into a subject matter, and has to find out what her students know about it trying to engage with students at their level of understanding;
- provides a fluent and flexible course structure/syllabus that can adapt to changes and incorporate a variety of students' ideas, questions,

viewpoints and pathways (students as co-designers);
- designs diverse class activities (exploratory activities, discussions, demonstrations) and related open-ended assignments aligned with assessment tasks;
- presentsstudents with interesting/stimulating problems and materialsthat engage and challengethem, and spark their interest;
- organizes teaching and learning as an interactive process encouraging (joint) student-driven explorations, discussions and reflections requiring high student involvement as well as shared responsibilities;
- supports class activities with different artifacts/objectsin order to carry certain activities out, to make it easier for students to think about a problem and visualize their thoughts, and to use the material as the source of authority to test their ideas;
- is open to self-evaluation listening to students' feedback (e.g., course evaluations) and looking at what students are learning as a result of the classroom interaction to continuously improve her teaching.

b) Student-Centered Pedagogy

The teacher retains a focal role presenting engaging problems and attending to how students figure them out. She is continually tracking the students' investigations (observing, listening) to gain information about what to do next and she often provides queries and materials to take the students' thoughts further and keep them connected to the subject matter. By talking to students and engaging them with phenomena, instructors can prompt students to start thinking and to express their thoughts, and subsequently instructors can use their understanding to attend to the learner's sense making. The following characteristics and related roles of the instructor emerged from the analyzed data presenting implications for the creation of exploratory learning environments:

- *Establishing a positive classroom climate and a productive learning culture*

The overall atmosphere in the classroom both during class meetings and sections was described as "quite relaxing," "quite friendly," "lively," "fun," "fantastic," "positive" and "inclusive" by the interviewees, because "you could talk about everything that was on your mind." Students (and the instructor) sat in a big circle, called each other by their first names andstudents were activeconstructing knowledge ("doing"), participating in exploratory activities and discussions (involvement/interaction), and reflecting on the subject matter as well as on their learning processes. Students had the freedom to make choices with what and how to engage and they shared responsibilities with the instructor to make sure that everyone understood each other within a comfortable, responsiveand productive environment.

- *Constructing knowledge through student-driven explorations and discussions*

It was the students who actively constructed meaning – individually and collectively inside and outside of the classroom. Thus, students shared responsibility and were held accountable for their own as well as for others' learning leading to increased autonomy on part of the students. The instructor provided space for student thinking and validated that thinking by making it auditable and visible to the entire group (e.g., students wrote on chalkboards, presented their solutions). Working on their questions and having some choice around what and how to explore helped students to come up with their own ideas, make more connections, deepen their understanding and get more engaged with the subject matter they were learning about (e.g., mathematical problem, poem).Class activities were designed to allow for individual or joint explorations and discussions orchestrated and facilitated by the instructor.

It was the students' work to figure out how to do the problem while negotiating different viewpoints and perspectives that could illuminate each other. Students also used a variety of resources to keep track of their thinking as a group. Confusions and conflictsheld students' minds to the problem, nourished their thinking andwere seen as a positive indication that real learning was taking place: While learning, students felt at times both "excited," "surprised," "engaged," "inspired," and "a little bit frustrated," "awful," "confused" or "bored."Because of their active involvement in and responsibility for knowledge construction in class, students experienced the power of their thinking understanding what other students said and building on each other's ideas and thus, positioning themselves as capable and independent. Her constructivist pedagogical viewpoint and respect for others' ways of understanding led the instructor to shift the power from teacher to students and to share responsibility for the direction the learning in the classroom had taken.

- *Shaping and maintaining positive social relationships in a safe environment*

The instructor created a space where people felt safe and accepted and where they were encouraged to feel free to explore and talk. She modeled inclusive an appreciative instructional behaviors and flexibly structured the course to account for students' interests, ideas and questions. This way, students could feel that their ideas were worthwhile having and were motivated to following through. The class was a "very positive experience" for the students and a place where positive as well as negative emotions, like surprise, excitement, confusion and frustration, involved in the process of joint

knowledge construction, were accepted. Students experienced the community as "incredibly supportive," were invested in each other's learning, and concerned about how others or the group as a collective was thinking about things. Students felt free to say something that they were not sure of and felt their ideas valued by the instructor and thus, could further develop their self-confidence as learners and thinkers.

IV. Discussion and Conclusions: What to do With the Teacher's Knowledge?

Critical Exploration in the Classroom is an approach to teaching and learning that puts the students at the heart of the learning process. It is a fairly progressive approach involving two important roles that the instructor plays: Engaging the learner with the phenomena (the real thing) or activity, and trying to understand students' explanations to help them learn. In order to learn and to make sense out of the world, the learners need to make intellectual connections between their prior knowledge (internal structures) and the subject matter by acting in the world (National Research Council, 2000, 2005; Piaget, 1985). Teaching is then thought of as helping students to learn, i.e. to understand, so that they are empowered to realize their full potential (Duckworth, 1987/2006). Instead of teaching students what to think, the instructor teaches students how to think and the teacher becomes a facilitator of the relationship between the learner and the world. This combination of a researchers' and teachers' stance provides a window into the development of human minds for the teacher and at the same time helps the student to advance his understanding of the subject matter.

Based on the theoretical concept of Critical Exploration (section 2) and the empirical findings in the context of an empirical case study in the higher education classroom (section 3) the following features stand out in exploratory learning environments that bring Critical Exploration to life in the classroom:

- *Practicing teaching by listening rather than by explaining:* Instructors lecturing and trying to present the subject matter in a certain way by telling or explaining it to students can never be sure that the meaning they want to convey seems equally clear to individual learners. Thus, learners need to have the opportunity to reach out to the world, discover intellectually challenging problems, express their thoughts, raise questions, and construct knowledge based on their own repertoire of actions and thoughts. Students are asked to explain what they think and why and in trying to make their thoughts clear for others they achieve greater clarity for themselves.
- *Engaging students intellectually and actively:* Instead of over-simplifying curricula and expecting students to thoughtlessly memorize a given absolute knowledge, learning situations should engage students intellectually and invite them into figuring out ways of creating meaning and solving problems. Instructors need to think about how to develop challenging problems to engage students' minds with the subject matter and put the learners into the forefront – letting them do the thinking, talking, explaining and discussing. Such pedagogy provides students with occasions to express their thoughts and understandings and to make their own connections.
- *Creating a culture valuing lifelong learning with understanding:* Deeper learning can be promoted or hindered depending upon whether social norms value the search for understanding, whether confusions are honored or whether students are encouraged and given the time to try out their ideas, for example. Therefore, it is crucial to create occasions where everyone has the opportunity to develop his or her potential to the fullest. A safe learning environment that provides a rich source of cultural, social and material resources invites the students to explore and raise questions that concern them and thus, learn deeply.

In order to know whether students understand a given phenomenon or are on their way to understand and figure a problem out, teachers need to give them space to think on their own, choose their own path, and explain the sense they are making without forcing them to follow them jointly on their road. Instead of telling students what they know, teachers have to search for new strategies helping the students to build (jointly) on their knowledge and understanding taking their own thoughts further (Duckworth, 1987/2006).

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High Speed Railway Station: Mobility and Spatial Dynamics in Germany and Spain

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Abstract- This paper contains certain considerations on the High-Speed Railway (HSR) Station's area and its surroundings, as well as the reasons and effects thereof. The complexity and wide range of possible scenarios require a more specific context pertaining to medium-sized cities and a specific location of the station in those cities, i.e., the city centre.

From the analysis based on the fieldwork carried out in certain stations in Germany, as well as from the study of their accessibility level, German cases are compared to other examples in Europe, especially to examples in a country in which HSR was implemented at the same time: Spain.

It can be concluded that there are material differences on the ways to approach the revitalisation of stations and the urban surroundings thereof in order to take advantage of the building's renovation project and the reorganisation of the railway environment as an important engine of urban renovation.

Keywords: high speed rail impacts, station area development, transit oriented design, urban design, urban regeneration, station area regeneration, high-speed rail (HSR) station.

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I. Introduction

Decades of experience in the implementation of high-speed rail have resulted in expertise thanks to which a position within the framework of the cities served can be adopted. On the contrary, critics underline the (selective) boosting of the transport system, the effects of polarisation, the comparative abandonment of regional railways or the over sizing of the HSR station area and the surrounding developments thereof. The effects are thus highly heterogeneous and sometimes they do not only depend on development and planning activities, but also on traditional models in the context of planning and mobility of each country's reality. While the potential to gain ridership is certainly not the only factor in a project's success (the ability to secure funding, maintain local support, and overcome design and engineering challenges is equally critical), ridership demand is important enough to be used as a preliminary screen of a proposed project's utility. Projected ridership is one way to measure whether rail services can realize their potential benefits, including gains in energy efficiency, economic productivity, reducing greenhouse gas emissions, and others.

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This is precisely the strategic point of the subject of this paper, through an approach to four cases in Europe: Fulda and Ulm in Germany and Toledo and Lerida in Spain.

II. The High-speed Railway Station: A link between the Network and the City

Despite the fact that new transport systems are developed with a unimodal logic, in sight of the attempt to prioritise its competition compared to other transport modes, High-Speed Rail's degree of territorial consumption is as high as that of other controlled access infrastructures, which strengthens the centrality of those locations served -separated by big distances as per the infrastructure's own definition- but does not imply any advantages whatsoever. Under this circumstance, known as "tunnel effect", [1, 2, 3], many scholars, [4, 5, 6], have historically found the threat of a source of territorial unbalance that polarises space and establishes hierarchies within the cities system, and has become a matter of concern even during the first year of this mode's implementation in Europe, as shown in the European Spatial Development Perspective (ESDP), which identifies the risks and warns on the importance of planning and coordination with other networks:

"Spatial development policy should work towards having high-quality transport infrastructure supplemented by secondary networks to bring about their positive effects in the regions", [7].

This way, through the existence and coordination of secondary, the network's polarising effects are not only mitigated but their capacity makes the convergence of greater volumes of traffic to the largest networks possible, which brings about benefits through their profitability and in time leads to a cost-benefit compensation resulting in the service's improvement by means of benefits, destinations and schedules. De Rus et al [8].

Due to the foregoing and despite the fact that a traditional perspective would implicitly assign a crucial role to technological innovation applied to the revolutionary mean of transport as a driver of development, with the danger of accepting this technological determinism as well as perceiving spatial and territorial developments as a simple reaction against the technological conditions and the potentials

thereof Luhmann [9], the planning process is essential to turn associated risks thereto into opportunities. In this context, the high-speed railway station and its surroundings have different functions within the city they serve and turn into its most relevant spot since it is a link between the networks(s): spaces with a high accessibility potential, new exhibition pieces where functions, activities and facilities are amalgamated, their regeneration being the flagship of urban planning in many cities served by HSR.

Rail stations will differ depending on their location — downtown, airport transfer, suburban, and small town. While every station area is unique and should reflect local context, culture and climate, some common principles apply to the creation of forms and public spaces regardless of location. This document offers such principles along with different strategies for the creation of places that invite people to stay and enjoy, and that enhance the economy and sustainability of the region.

III. The Station: Location and Development

Major passenger transport stations work best in existing regional centers. By virtue of their employment and residential densities, recognizable built environment, walkability, and connections to local transportation systems, existing regional centers provide a justifi able foundation for high-speed rail passenger stations. When centers are linked to one another, they create robust regional and mega-regional networks. Car-free access at one or both ends of a trip maximizes the convenience of train travel. Once in the regional center, close proximity to destinations can make a big difference in initial ridership and in the continued growth of ridership over time. People will walk from public transport to jobs and major venues when the walk is interesting and not too long.

Also, coherent development, in which the whole is greater than a sum of the parts, requires strong organizing patterns. Establishing a clear hierarchy of public spaces connected by spatial and visual linkages can give new vibrancy, usefulness, and cohesion to station areas. Designing public spaces for use by crowds, small groups, and individuals, can be thought of as designing stage sets for urban theater. Finally, it is necessary to consider the existing development patterns in the region and city in terms of sustainability and memorability. Let the urban design in the station area (the shape and form-making activity) spur a reconception of the regional design — based on a rural-to-urban progression of development form and density; clarity of form and hierarchy; preservation of resources; and sustainable compact development patterns.

IV. Methodology

Firstly, medium-sized cities with the station located in the centre thereof have been chosen within a wide range of possibilities when choosing the case study, since the integration of high-speed rail is more weighable in this kind of cities, Burckhart [10] -where implementation of high-speed rail has a dramatic impact on accessibility [11, 12]- than in bigger ones that already have access to a previously implemented intermodality, leading to shared effects. In addition, countries where high-speed rail has been implemented for more than twenty years have been chosen; these cities are located in countries where there is not only a historical urban planning tradition administratively implemented in the field of physical planning but also with a historical spatial tradition acting as a link between economic and social planning.

This way, the case studies chosen are Ulm and Fulda in Germany and Lerida and Toledo in Spain; despite the fact that HSR was commissioned at a similar time -1991 in Germany, 1992 in Spain- enabling a comparative framework, the differences found in terms of public transport policies and mobility tradition would show significant differences in the results. A prior consideration of them would be appropriate.

a) COND Features inherent to each country regarding mobility and railway

The conventional railway network, developed since 1825, has a very uneven presence in European countries, fig. 1. In Germany, it has 43,800 km in length; in France, 31,939 km; far from Spain, whose conventional railway network has only 14,743 km and a gauge of rails that is incompatible with the rest of Europe. If we compare these figures with those regarding to High-Speed Rail nowadays, the different application policies of the new mode can be found, fig 1.

In addition, as pointed out by Burckhart [10], there are significant differences in the demand for railway services in Europe in a scenario prior to the current economic crisis. Germany, with 1,309 km/year and Spain, with only 576 km/year. Regarding high-speed rail, Germans travel an average of 400 km in high-speed train every year, whereas Spanish only travel 50 km/year, which shows the poor popularity of Spanish high-speed rail network despite recent investments and differences in terms of railway mobility in the different networks. On the other hand, Germany is densely populated and has a tradition in terms of public transport use, which implies .

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In order to check against the different transformations that have taken place in each case upon the implementation of HSR, this paper focuses on two aspects:

- The planning processes of the station and its surroundings, regarding the level of accessibility by applying the "town planning" function. The "town planning" function [14, 15] was created to calculate the different static and dynamic indexes used to study networks through the graph theory by applying the Floyd Algorithm.
- The renovation or replacement of the building hosting high-speed rail.

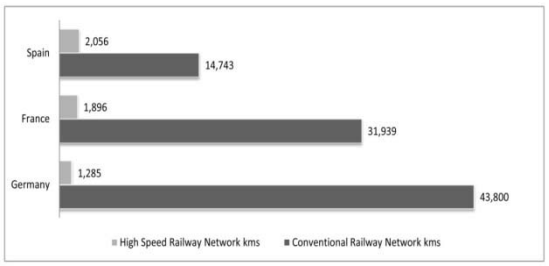

Figure 1 : Length of the conventional and high-speed railway networks in service and planned. Source: Prepared by the author based on data from UIC 2010.

b) Mobility and railway

This in turn enables the transport network to increase access for passengers at the scale of the city. Better access to a number of focus areas attracts development and can help to stem sprawl. Accessibility is a concepts used in several scientific fields such as transport planning, urban planning or geography and plays a key role when establishing economic and social policies. The implementation of High-Speed Rail (HSR) definitely renders the connection between a large number of cities possible, and its competitiveness is based on the transport marketplace, service quality and access time to the main centres of activity; for this reason, in order for it being efficient, excellent connections with the access point of secondary transport networks that spread the node's positive impact are a key aspect. This performance is vital in Europe, where urban agglomerations are located hundreds of kilometres far from each other, which has obvious consequences for the development potential of the regions served the distribution of economic activity in Europe.

Based on the modelling of the real object, i.e. the public transport network, the analysis of the way the networks are linked and the organisation into hierarchies of their links has traditionally been carried out by applying the graph theory through the connectivity's topological features. This way, each spot can represent a city, a station or a computer belonging to a network (or any set of linked objects). The lines that link them can represent roads, railways or cables (or any physical element linking certain objects). Those spots are called vertexes and those lines are called edges. A graph can thus be defined with elements that are related to each other and applied to situations where data modelling so allows, ranging from road, and transport and telecommunication networks to the Internet or industrial processes.

In this paper we also focus on the study of connected graphs, if there is a trajectory between any pair of node (vertexes), i.e. a road that links them, and on the study of labelled graphs, if the segment (and/or nodes) are assigned any kind of data.

In the case of labelled graphs, a value is generally assigned to an edge and the trajectory's value is thus defined as the addition of the values of the segments that are part of it.

By applying the Floyd algorithm to this case, i.e., the urban bus transport network in one of the studied cities, Ulm (Germany), matrixes of minimum distances of 177 rows and 177 columns are obtained 31329 data. In order to operate them, a commercial program of symbolic calculation has been used, the "town planning" function having been created- see Planning of the implementation of high-speed rail. A comparative study on the planning policies from the analysis of the territorial implications thereof , by Carmen Mota, doctoral thesis presented at the UCLM-to calculate the aforesaid static and dynamic indexes. In this function, the Floyd algorithm to the matrixes defined between two bus stops directly connected.

V. The German Case

In the German case, infrastructure investments in the node has traditionally had a particular interest, conceiving it as a link between city in mobility (tramway, metro, cycle paths and bus station -in the surroundings- normally converge) and functions, attaching great importance to the urban development that feeds back its performance Wulfhorst et al [16]. Most German cities have a street at the railway station -Bahnhofsstraße- that is the most important link between the city centre and the railway station and becomes a counterpoint of the original mall Schivelbusch [17]; as pointed out by Bodenschatz [18], this way it contributes to stimulating administrative activities and services. In the early 90s, a phenomenon commonly called Renaissance der Bahnhöfe, Köhler [19] appears, precisely together with

the implementation of high-speed rail. This phenomenon claims that the station must be the core of urban life again, a show display of the city for visitors and a driving force for new passengers that contributes to a sustainable urban development. In the 90s, the railway company crystallised these objectives through advertising examples that underlined that "Staying in the railway station must not be seen just as something necessary but as an opportunity to feel something" and in half of the 6,500 stations in Germany, the station's rebirth was seen as a revitalisation of stations and their urban surroundings simultaneously with a search for the sector's liberalisation, aiming at taking advantage of the building renovation project and the rearrangement of the railway environment as an important driver of urban remodelling. Deutsche Bahn, by means of "Die Marke Bahnhof" and "Bahnhof der Zukunft" [20] performed renovation and modernisation works through the service extension to new offers related to the trip, such as the "travel centre", which studied the trip "from door to door" and extended transfers by train to destinations were are not linked and established new retail sale services, such as post offices, premises aimed at catering and food services, boutiques and even chemist's. All this policy was also accompanied by a travelling exhibition called "The stations' rebirth. The city in the 21st century".

a) Ulm

The motto used for the NU21 project should be underlined, "Leben in der Stadt. Neu Definiert" (Living in the city. A new definition) by breaking the traditional railway barrier by relocating the tracks at a lower level and partially burying it.

The Ulm case falls within the "Stuttgart 21" project, fig. 2. Ulm's central station, with an average of 40,000 users everyday and built in 1954, was already a maximum centrality spot -the most accessible spot out of 188 of the local network according to the aforesaid function- within the city and region before high-speed rail was implemented, fig. 3.

Figure 2 : Magistrale für Europe.

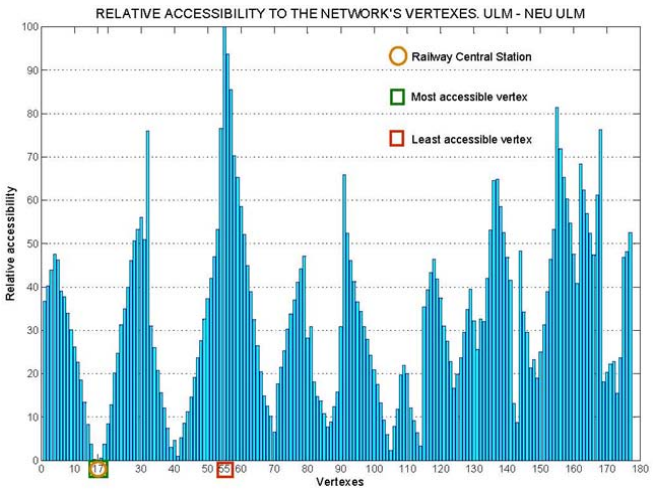

Figure 3 : Graphical representation of the relative accessibility of the vertexes of Ulm´s bus transport network

In order to establish a perfect link for all the transport modes, the bases for a public tendering process were set to present a project for the station and its urban surroundings. The project included the station's general layout, with 2,000 m² for railway functions, 5,000 m² for retail sale and 2,000 m² of service areas. The general public was given the opportunity to participate in the tendering process through different local actions. The actions started to be developed on 1st October 2004 and are ongoing at present; the estimated total cost amounts to 160 million euros and have a priority objective: a new positive definition of life in the city.

This modification became part of the *Städtebau Rahmenplan* (Local Master Remodelling Plan), fig. 4, approved on 2012: north from the street that covers the tracks are located those blocks dedicated to trade in order to invigorate the area, as well as residential blocks with commercial premises.

Figure 4 : Städtebau Ramhmenplan, 2012. Ulm-Neu Ulm's Master Remodelling Plan. Source: Neu Ulm City Council.

b) FULDA

Its connection to the German high-speed network in 1992 contributed to its positioning as an important transport node within the German railway network that serves 20,000 passengers everyday approximately. It is a class 2 Deutsche Bahn node that

amalgamates an Intercity-Express stop, interurban and regional services. The original station was inaugurated as part of the Frankfurt-Bebra line in 1866; it was destroyed during World War II and rebuilt thereafter. The strategies developed in the city centre with the implementation of high-speed rail are especially interesting due to the policy of coordination with other transport networks (urban, regional and national) and to the role played by the station in its surroundings. The station, which serves a population exceeding Fulda's population, is used as a spot that links and coordinates the different transport modes. This way, the station becomes the fourth out of 249 most accessible vertex of the entire local network, according to the aforesaid "town planning" function.

About the urban planning, in the mid-80s, the implementation of HSR was finally approved and the city started to get ready for the planning of the station and its surroundings. The first action performed was the transformation to reduce traffic volume by promoting the use of taxi and urban bus. This way, the adjacent bus station was built between 1989 and 1991. The total renovation of the station area was carried out, the surroundings were pedestrianised and the first floor was raised, opening accesses for car traffic, fig. 5. The entire traffic system of the city was modified and in 1992 all the historic quarter was closed to vehicles. Despite the city has a high heterogeneity of uses, administrative uses inherent to its hierarchy, residential, industrial use, etc., the number of houses in the station surroundings increased and commercial uses were promoted.

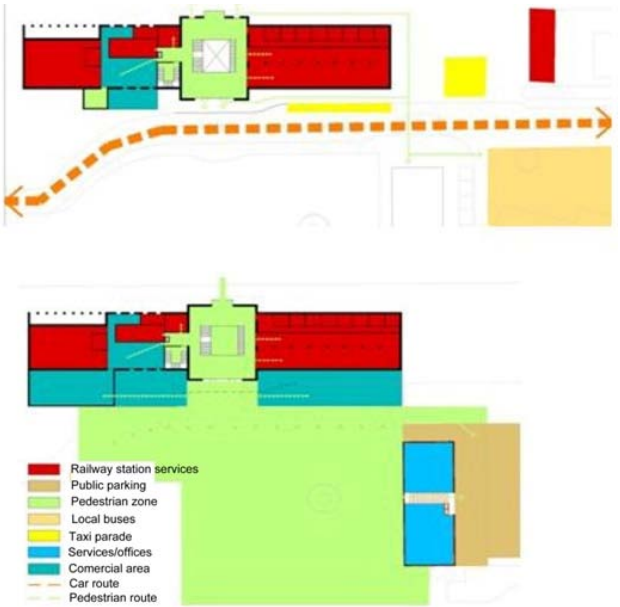

Figure 5 : Station working schemes. First floor. Source: Prepared by the author

VI. The Spanish Case

The Spanish case has big differences compared to the German model regarding not only the implementation of railway transport but the mobility culture, and many high-speed railway stations, especially those of small-sized cities, are located in the city outskirts. Nevertheless, these cases chosen do opt for the renovation of the existing station to implement the mode.

a) Toledo

The high-speed line with stop in Toledo, in service since 2005, is conceived as an independent line of the Madrid-Seville line, inaugurated in 1992.

When the high-speed line was implemented, the General Urban Planning Plan of 1986 was in force. Another document, the Local Planning Plan of 2007 is currently in force, although it is has been suspended by the High Court of Justice, fig. 6. While the General Plan of 1986 was in force, amendment no. 19 was introduced in order to arrange the land plots in the station surroundings before the implementation of high-speed rail but it was not executed. In the suspended plan, the analysis of the area crystallises in the action unit (UA27) that intends to complete the residential fabric around the station, guaranteeing its connectivity. It does not achieve this objective at present, since the station is the 73rd most accessible spot within the local transport network.

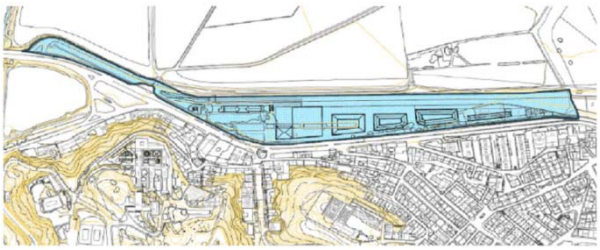

Figure 6 : Modification proposal for the station surroundings. Source: Local Planning Plan of Toledo, 2007

The station's renovated 19th century building, which is small and only had ticket desks, a cafeteria and a waiting area, has the same features today: it is an industrial area, mainly with workshops and garages, surrounded by land plots that are not used at present but recently classified as developable.

Figure 7 : HSR Station Surrondings. March 2013.

b) Lerida

The final implementation Project of high-speed rail in Lerida was approved in 1997, guaranteeing the

connection between Figueres (Spain) and Perpignan (France) through a tunnel executed across the Pyrenees that is in service at present.

In the mid-90s, while the study for the optimal implementation of the railway service was being performed, the planning document was a General Plan in force since 1979. The plan being outdated and due to the substantial modifications in the context conditions, the Plan Office was created in 1994. This way and upon rendering the municipal services, in 2003 the Regional Department of Spatial Policies of Catalonia approved the new General Plan, fig. 5, which incorporated the implementation of the new transport mode as one of the major strategies within the context of the urban project and intended to improve the urban environment defined in general plan PE3, aiming at crystallising the demands for improvements in the station area through a specific plan to that end; it was finally approved in December 2008. The strategic objectives sought are giving continuity to the city's neighbourhoods, improving the transport intermodality conditions and rearranging building construction according to the new urban conditions.

The station's building, built in 1929, was remodelled by creating a series of side covers attached thereto that cover the platforms and create a second side access. As in most stations of its kind in Spain, the services offered are cafeteria, bookstore, car rent and ticket desks.

Figure 8 : Urban Development Plan. Lerida City Council, 2003. Source: Lerida City Council

VII. Conclusion

The preparation of roads and walkways plans (Verkehrplanen) is clearly a factor that affects the planning of the station surroundings in the German case, and the competencies thereof cover the modification of sections of streets or squares, the broadening of sidewalks, etc. Regarding the complexity of the station's building, despite the fact that in Spain there is an increasing number of examples with more diversified functions, the huge German tradition makes the station's building act as a powerful driver of urban revitalisation and as a link between the network and the city.

Upon applying the methodology to the study of high-speed railway stations within the urban framework by means of urban bus transport networks, very different results are obtained depending on the city studied. Upon comparing and assessing these results over time, they turn to be a very valuable tool when planning mobility policies that assure both the profitability and the social performance of the inversions made.

The inaccuracy or lack of plans or policies for the integration of the different sectoral areas or lack of coordination between the various territorial levels poses serious difficulties to putting into practice and the consistent implementation of a phenomenon like high speed rail, resulting in severe effects on the different scopes of its integration: the local, the district, the regional and the national scope.

When, on the other hand, planning involves a localized investment programming, the absence of mechanisms linking the necessary sectoral requirements with the execution controls, the solvency of the project is hindered, threatening its economic viability, social and territorial, in the medium and in the long term. Due to the differences compared to Spanish legislation, understanding the scope of the actions carried out by this tool is specially interesting, as well as understanding the need for making mobility become a common tool in the legal framework of spatial planning. In the Spanish cases, to a greater extent in Toledo than in Lerida, the scope of intermodality by connecting the high-speed railway station is poorer, which combined with a lower population density, has a negative impact when taking advantage of the infrastructure, its amortisation and thus of the opportunities to refinance improvements for it.

The existence and permanence of these problems may be indicative of the necessary reformulation of aspects of mandatory compliance with respect to obtaining an effective urban and regional planning, incorporating in a factual manner aspects such as sustainability, territorial planning and mobility management into the integration of a phenomenon, in which the maturity of its integration articulate precisely.

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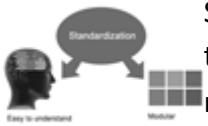

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Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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