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Highlights

Detection of Fracture Zones

Environmental Terrorism and Poverty

A Territory-Oriented Approach

Heavy Metal Content of Agricultural

Discovering Thoughts, Inventing Future

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A Territory-Oriented Approach to Operationilize Sustainable Management

By Ana L. burgos & Alejandro Velázquez
Universidad Nacional Autónoma de México

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A Territory-Oriented Approach to Operationilize Sustainable Management

Ana L. Burgos [α] & Alejandro Velázquez [σ]

Abstract- Sustainable science ultimately seeks to minimize the negative impact of human activities on nature, however its role is regarded as limited, chiefly because it lacks a robust spatial framework to join ecological and social processes. Space, from a territorial perspective, is the result of historical interactions between socio-economic forces governing access to natural resources. This paper provides a territory-oriented approach to improve land use policy from a spatially explicit perspective. We develop a novel approach, namely 'Territorial Configuration' implying the dissection of the geographic continuum into territorial conglomerates. These are delimited by a range of meaningfully socio-historical liason encompassing a clear understanding of how space is controlled by space holders trigging proximal and underlying governing processes. We discuss how the territorial configuration facilitates overcoming pending issues in land use policy, such as ecological and geographical articulation, legitimate decision-making process, and increase of certainty on the subject of management among others.

Highlights: The geographic continuum dissected by territories gives meaningfully socio-historical basis.

The territorial configuration approach bridges holistically social and ecological approaches.

The territory-oriented approach helps moving forward to sound land use policy.

Keywords: environmental management, sustainable science, territory, geographic continuum, biodiversity conservation, watershed management.

I. Introduction

Environmental Management (EM) emerged in the 1990s in the light of current man-made pressures on the natural system. It focuses on documenting the relationship between natural resources and human activities and assessing derived proximal and underlying effects on the environment, eventually minimizing the negative impact of human activities. In the last decade, EM has evolved as part of the emerging fields known as Sustainability Science and Transdisciplinary Research. These fields focus on coupled human-environmental systems, science-society links and knowledge systems (Komiyama and Takeuchi 2006; Miller et al. 2014). It is therefore expected that EM be reframed in order to fulfill the needs of Sustainability Science and Trans-disciplinary Research (Lang et al. 2012). This reframing is critical to gaining insight from previous experiences and eventually in over coming failures. It is undeniable that EM has had a positive impact on a number of topics, namely, biodiversity and forest management and environmental services, among others. Even so, EM has revealed barriers and difficulties when applied to real problems, and its role in sustainable science has been regarded as limited (Conacher 2003; Barrow 2006; Fisher et al. 2012). Coordination and collaboration between stakeholders and institutions have been pinpointed as major weaknesses in terms of achieving effective EM (Margerum and Whitall 2004; Margerum2008; Gregory et al. 2012; Eshrag et al. 2015). The goal of recreating EM as an operational framework and eventually as a bridge to other complementary approaches such as resilience, vulnerability and adaptation (Brand and Jax 2007), confronts a number of challenges: first, a dissected rather than a unified perception of natural resources (soils, water, forests and biodiversity, among others) which occur interacting interdependently at all times in all places (Fish 2011); second, integrative analysis of past, present and future socio-economic underlying driving forces (Ostrom 2008); third, a robust geographic framework to holistically approach the former and latter challenges (Turner et al. 2003); and fourth, recognized mismatches among stakeholders or agencies across multi-level state and non-state governance, involving issues of legitimacy and equity (Margerum 2008; Moss and Newig 2010;Mikulcak et al. 2013). These last two challenges were clearly identified as cornerstones in most ecological studies, and they have remained insufficiently amended.

Space in ecological studies has been approached by dissecting the geographic continuum into vector or raster (pixels) formats (Geoghegan et al. 1998). Other approaches based upon biophysical categories, such as regions, watersheds or aquifers have been used as surrogates for geographic framework (Wu 2006). Neither pixels nor biophysical categories provide a comprehensive understanding of the underlying aspects such as social and governing forces (Liverman et al. 1998). We argue that geographic framework is far more than pure geometric spatial dissection or temporal and functional links and fluxes. Space, from a geographical framework viewpoint, is the result of historical interactions between socio-economic forces governing access to natural resources. Furthermore, space is affected by the presence of

Author α σ: Centro de Investigaciones en Geografía Ambiental, Universidad Nacional Autónoma de Mexico (UNAM).
e-mail: alex@ciga.unam.mx

intertwined feelings connecting people with places by establishing limits through political, economic and cultural processes (Santos 2001; Claval 2002). The aim of depicting the geographic continuum is ultimately to establish boundaries. Boundaries are flexible, fuzzy, porous and dynamic. These boundaries, rather than being limited uniquely by biophysical attributes, are depicted by short and long-term social processes from which territories were then derived. In turn, place-based social processes interaction results in a tied liaison between place and the holder who seeks to control access to all resources (Raffestin and Butler 2012).

Territory deals with space engagement, rules of control and power relationships and ultimately represents the arena for grounded decision-making processes. Territories, however, can also be the following: fuzzy, non-homogeneous, non-consistent and non-contiguous, with disconnected nodes across linking spaces. To our knowledge, EM formulation and practice has remained 'de-territorialized' and little research has been done to provide a territory-oriented approach to link spatially explicit functional relationships between natural resources and socio-economic driving forces.

The aim of this paper is to provide a territory-oriented approach to improve operationalization of Environmental Management from a spatially explicit functional perspective. Specifically, we revisit the roots of the concept of "Territory", hence developing a semantic map to introduce a novel approach, namely "Territorial Configuration". Furthermore, the territorial configuration approach is discussed as a complementary pathway to turn the concept of socio-ecological systems into effective management actions by providing sustainable science with a robust geographic framework.

II. Environmental Management Framework

Environmental Management (EM) is generally understood as the processes of decision making, planning, administration, implementation and evaluation of human activities--purely driven by social actors such as individuals, community or institutional aggregations--directed toward transforming nature into resources (Barrow 2006). Ideally, EM aims to maximize positive internalities (maximum profit) represented by social groups (stakeholders) and natural resources (object of management) and to minimize negative externalities (minimum environmental costs). The theoretical roots originally established by Patten (1978) refer to "Environmental" as fluxes affecting a system, explicitly related to causes and effects impacting upon the original system state. EM has now come to encompass natural capital conservation, watershed management, payment of ecosystem services and environmental policy programs, among many other issues of sustainable science (Barrow 2006). EM has evolved towards adaptive management and participatory approaches (Kapoor 2001), such that transdisciplinary platforms are strongly recommended (Brand and Karvonen 2007). EM (sensu Margerum 1999) comprises two significantly different connotations, namely, programs geared toward regulating access to resources (so-called "administration" in English, whereas "gestion" and "gestión" in French and Spanish, respectively) and man-made actions to transform nature (ecosystems) into resources (so-called "management" in English and French or "manejo" in Spanish). Because of the two above-mentioned management connotations, two types of flows are identified: top-down and bottom-up. The former is more related to policies, whereas the latter is oriented toward nature transformation.

Lately, social and ecological sciences have been complemented and intermingled with the aim of increasing effectiveness in EM (Young et al. 2006; Díaz et al. 2011). Ecological literature often reports inconsistent spatial concepts, such as bioregions, ecozones, ecodistricts, biophysical units, ecoregions and ecosystems to denote geographic framework (e.g. Margerum 1999; Barrow 2006). Other efforts refer to "Territory" as administrative units (Loiseau et al. 2012) or arbitrary regions such as the Iberian Peninsula (Quintana et al. 2010). Upon thorough review, it became evident that EM has largely neglected the concept of territory. Two well-documented environmental management topics may serve to illustrate the previous statement, namely biodiversity conservation and watershed management.

The establishment of protected areas? has recently emerged as the main environmental policy instrument targeted at preserving ecosystem integrity and biodiversity conservation, as a response to the unprecedented rate of species extinction (Pimm and Raven 2000). Conservation of hot spots and effective management of protected areas have become critical from the global viewpoint. The development of this environmental management policy was clearly illustrated by Naughton et al. (2005), who documented the exponential increase in the number of parks established and the area under protection (in the 1960s there were around 1,000 protected areas, and today there are over 100,000, covering about 20 millionKm^2). The effectiveness of protected areas worldwide, in spite of their clear spatial delimitation (Terborgh 2002), has been largely controversial (Bruner et al. 2001; Rodriguez et al. 2004; Vallino 2014). Design, operation, law enforcement and disengagement of local stakeholders are just a few of the main issues yet to become uniformly effective within protected areas (Cumming et al. 2015). "Making parks work", as literally stated by Terborgh (2002), became critical when studies showed that mega diverse regions harboring most global biodiversity hot spots were the ones most ineffective (Brechin et al. 2003;

Figueroa and Sanchez-Cordero 2008). In most cases, ineffectiveness has been related to the lack of enrolment of key stakeholders with legal and legitimate jurisdiction and scope for decision making with whom negotiation may take place with the aim of eventually engaging them as core allies (Kaimowitz and Sheil 2007; Velazquez et al. 2009) rather than as the major threat (Terborgh 2002; Redford et al. 2008).

The Watershed Management approach was initially a technical tool defined by hydrological processes with tangible spatial boundaries, and it has recently transformed into a policy framework where watersheds are no longer regarded as biophysical polygons, but rather as governance units (Molle 2009; Cohen and Davidson 2011). It is undeniable, nonetheless, that current progress in conceptual and technical capabilities in watershed management are significant. Uncertainty on the governance issue, however, has emerged as the core challenge. Currently, the most outstanding topics in watershed management are articulation of public policies via coordination across sectorial government agencies (Molle 2009), collaboration and partnerships with non-governments take holders (Margerum and Whitall 2004; Huitema et al. 2009; Benson et al. 2013) and decision-making support systems (Muste et al. 2013). These topics are regarded as stepping stones for promoting watershed governance networks (Castro 2007; Moss and Newig 2010) as well as social learning processes (Pahl-Wostl 2009). The former and the latter are essential underlying conditions for envisaging adaptive capacities and facing uncertainty in water resources and societies that depend on them.

The negligence of a territory-oriented approach in biodiversity conservation and watershed management is even more conspicuous within specific study cases, such as the one in Mexico.

a) Overview of biodiversity conservation and watershed management in Mexico.

Mexico, indisputably regarded as a mega diverse country (Sarukhan et al. 2015), adopted the biodiversity conservation initiative by establishing protected areas. In the 1940s, Mexico set up 39 covering an area of 0.62% of the national territory, whereas, today, it has established 177, covering 13.04% of the country's area (www.CONANP.gob.mx). The effectiveness of Mexican protected areas is controversial too. A limited number of protected areas have been somewhat effective in some regions such as the Baja California Peninsula (Rosete et al. 2014), whereas other regions, such as the states of Chiapas, Oaxaca, Guerrero and Michoacan, have been rather ineffective (Figueroa and Sanchez-Cordero 2008). A top-down authoritarian commissioner governs Mexican protected areas, each operated by a director. An advisory committee board (scholars, park administrators and policy makers) supports to a greater or lesser degree from area to area the commissioner-director´s decisions. Regional and local stakeholders are mostly overlooked when management policies are designed, and, eventually, these are dictated with the expectation that all concerned will govern themselves accordingly. It has been documented that most outstanding Mexican biodiversity hot spots are not socially empty spaces (Bray and Velázquez 2009; Sarukhan et al. 2015). Under these circumstances, novel territorial conservation strategies based upon genuine engagement of regional and local stake (right) holders with whom agreements and need-based negotiation strategies can be designed, have proved more promising. Protected areas should, therefore, not be primarily targeted at preserving the integrity of pristine functional ecosystem processes or biodiversity sinks, but rather regarded as strategies to reduce inequality and poverty, acting as vehicles of empowerment (Velazquez et al. 2009). As a result, natural resources are regarded by local communities as their natural heritage and therefore fiercely conserved and defended (Brechin et al. 2003; Bray and Velazquez 2009; Herner 2010).

Watershed Management in Mexico started in 1992 under the umbrella of the National Water Law known in Mexico as the "Ley de Aguas Nacionales" (Ortiz-Rendón 1993). Consequently, national territory (1,973,000 km^2) was split into 13 administrative hydrological regions. This environmental policy raised expectations as to sound management for contrasting regions -- either by managing hydrological excesses (recurrent floods) or deficits (recurrent droughts) or by providing watershed management as an opportunity for regional development. In turn, basin councils for decision-making were progressively installed, reaching 26 by 2015 (www.CONAGUA.gob.mx). In practice, the National Water Commission, known as the "Comisión Nacional del Agua" enforced a top-down vision in the composition of decision-making structures. Outcomes so far have shown that the capacity of basin councils for institutional coordination and the opportunity for stakeholder collaboration have not fulfilled needs and expectations (e.g. Moreno 2015). These failures remain in spite of manifested political will for tackling national watershed problems (e.g. CONAGUA 2011).

III. Territory Framework

a) Conceptual Overview

The concept of territory emerged from the domain of human-political geography (Delaney 2005); and, according to Elden (2010a), it has been used as a surrogate for land, plot, area and landscape, or as a noun to refer to a specific jurisdiction (municipality, state, nation, country). According to Santos (2001), "Territory" is the result of historical interactions between socio-economic forces governing access to natural resources by establishing limits through political,

economic and cultural processes. In consequence, a "Territory" is under continuous construction and derived by compartmenting the geographical continuum. Owing to the complex socio-economic processes involved in constructing territories, the concept is clearly multipurpose (Paasi 2003a). The concept of Territory is core within the domain of geographical sciences and indisputably comprises polysemic interpretations. In general terms, it refers to the process of engagement or appropriation of a given space by subjects (stakeholders). The concept of territory now refers to an orderly humanized place where nature and culture are melded together through the influence of social institutions in charge of creating and implementing rules targeted at pursuing stakeholders' actions (Raffestin and Butler 2012). Territory is, therefore, a state of power depicting habits, traditions and access to the most critical resource, "the space". To claim there is a Territory, recognizable tangible boundaries, functional or symbolically established borders, rules and levels of governance to enforce them must be present (Elden 2010b; Herner 2010). In this way, engagement or appropriation harbors tangible, functional and cultural territories and denotes a geographic continuum etched by the history of occupation and social meanings (Fig. 1).

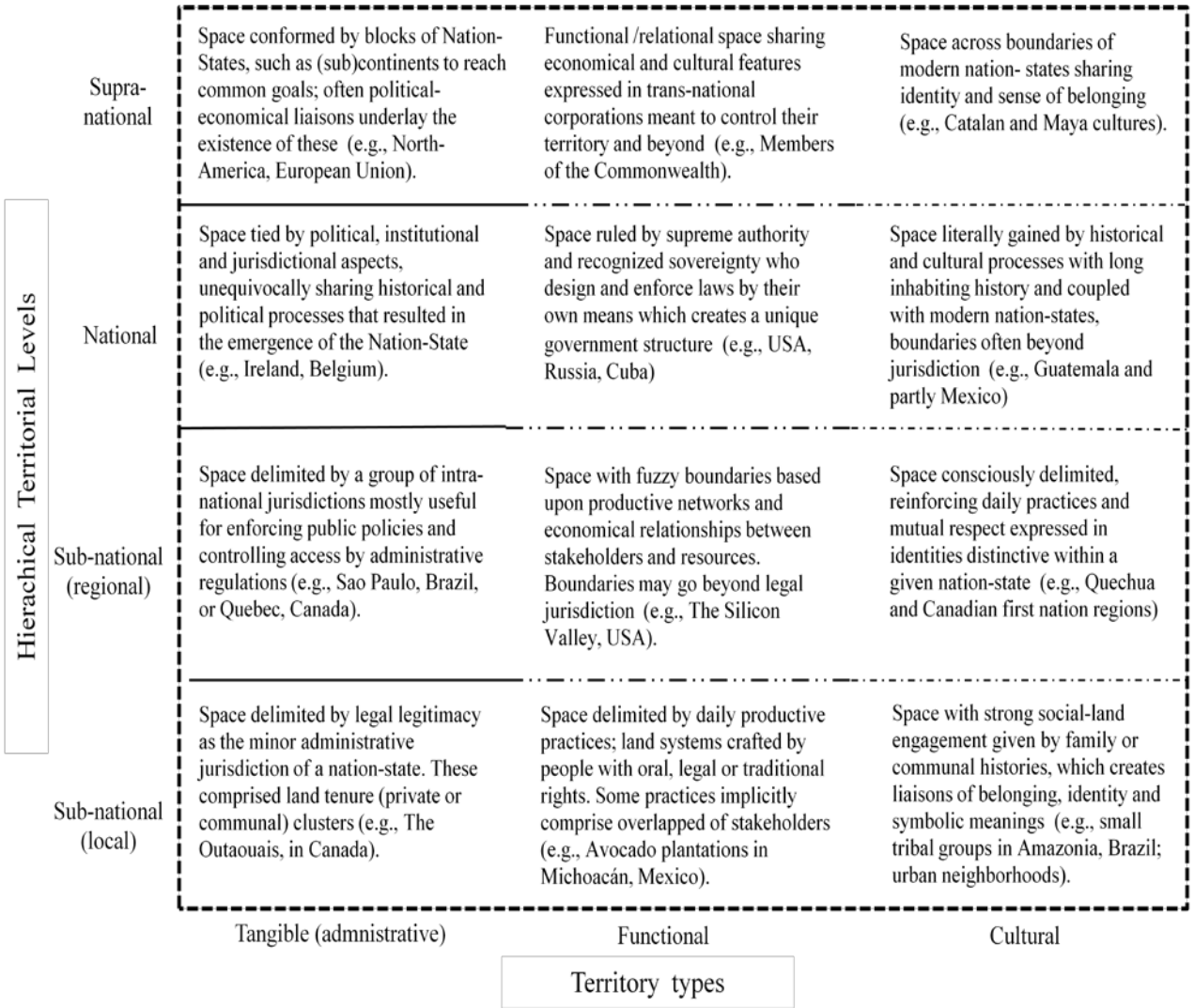

Figure 1: Semantic map describing types and hierarchical levels of territories. These all are spatial entities delineated by boundaries stating degrees of power and jurisdiction by space holders as defined in this contribution.

b) Territory Types

Tangible (administrative) territory types are spatial expressions delimited by the control of a subject, group or institution with clearly established authority (Fig. 1). The subject ruling tangible territories enforces economic control by controlling use of space and limiting access to natural resources. Tangible (administrative) territories are constructed by pondering, based upon a relative value, the geographic continuum into a recognized spatial arrangement, seeking at compromising externalities among stakeholders and allowing the possibility of being mapped (Newman 2003). These territories are clearly illustrated by spatial entities with specific jurisdiction such as municipalities,

an established national park or physical boundaries, such as a given watershed, where it is desired to implement a given policy. Tangible (administrative) territories are delimited by clear boundaries, often supported by laws. Sovereignty is therefore crucial and the construction of these territories and its permanence ranges from decades to centuries.

Functional territory types refer to spatial entities with changeable limits characterized by high internal cohesion resulting from practical socio-economic processes derived from natural resource-stakeholder relationships occurring within those given spatial entities (Amin 2004).There are two main types of functional territories: those resulting from long-term endogenous process such as traditional productive systems (e.g., The Chakra [Hammen 1992] and The Chinampa [Parsons 1976]) and those largely driven by exogenous issues, such as global markets, international agreements, and product prices, among others. To illustrate further, consider that a given spatial entity is devoted to soy production. This spatial entity may change drastically if the price of the product drops markedly as a result of global markets. In turn, the former functional territory will adapt to a new situation and, in consequence, the geographic continuum will be re-configured (Peyrony and Denert 2012). Sun-grown coffee, sugar cane, livestock production and mining are clearly other typical examples (Garces-Feliu et al. 2010). Functional territories are delimited by a mosaic of fuzzy boundaries and their permanence ranges from years to decades.

Cultural territory types arise when individual human beings, usually clustered in communities, establish certain engagements or an identity with their spatial entity through symbolic representations. This representation emerges from the inhabited history of the place resulting in cultural milestones (traditions), which indisputably create a unique connection between individuals clustered in communities and their environment. Traditions are built and internalized via socio-cognitive constructions, which govern daily life decisions (Herner 2010). Generally, endogenous issues drive cultural territories. Examples comprise geographic entities sharing food habits, a given language or a specific belief. The geographic continuum split by cultural territories is often intermingled, since symbolic representations may not be shared homogeneously by all members of a given community and, in consequence, they are not universally valid (Newman 1999). Within a given spatial entity, for instance, a community may comprise individuals of the same ethnic group speaking a unique language; said individuals may, nevertheless, not share the same religious beliefs. These symbolic representations, however, comprise the most critical aspects of belonging and identity and therefore the essence of most human beings. Cultural territories are delimited by a degree of fuzzy boundaries and their permanence ranges from centuries to millennia.

c) Hierarchical Territorial Levels

Hierarchical organization is an important issue in EM, and it has, for decades, been regarded as a cornerstone of sustainable and ecological sciences (Kareiva and Wennergren 1995) as well as of social sciences (Lamont and Molnár 2002). Within the domain of geography, hierarchical territorial levels are the following: local (community-municipality), regional (state-subnational), national and supranational (Fig. 1). Scientific focus on a specific hierarchical level has changed, such that, in the nineteen century, much attention was given to the local and regional; in the twenty century, attention moved towards the national; for the last 30 years, planetary environmental and socio-economic issues have rekindled interest in territorial expressions at the supranational level (Tuathail and Luke 1994). Hierarchical territorial levels are here described in order of jurisdiction, with national first, followed by regional, local and, last but not least, supranational.

The national territorial level is primarily depicted by political and institutional processes and represents the roots of most nation-states (Antonsich 2010). At a certain point, communities, in spite of their likely cultural differences, gain identity. The notion of a nation hence emerges as a cultural identity of groups, which have historically occupied certain defined spaces. The State governs by means of enforcing laws, which establish control and vigilance over clearly defined spatial limits. These limits designate territorial division where the State exercises sovereignty through legal jurisdictions (Berg and Kuusk 2010). National territories are delimited by indisputably tangible boundaries, and exogenous and endogenous forces rule, such that the exogenous play a key role in the recognition of sovereignty, whereas endogenous forces do so in the exercise of jurisdiction. At this level, urban-rural centers share the ruling role, although this depends on the level of development. It is still mostly centralized governments that take dictatorial decisions.

The regional territorial level (provinces or clusters thereof) is the result of a top-down administrative vision of a nation-state, clearly tangible in their boundaries and aimed at enforcing laws, policies, programs and projects (Baletti 2012). Territories at this level bring to mind the concept of territory as a demographic container (Taylor 1994) or political instrument where the State governs by attending to the local population's needs (Baletti 2012). In these territories, functional issues prevail (Allen and Cochrane 2007), whereas symbolic ones are hardly relevant. To illustrate this, Paasi (2003) differentiated between "identity of a region" and "regional identity". The former aims to enforce a political manipulation of the

population or market-oriented objectives. The latter is built from the consciousness and feelings of belonging of individuals as a result of a lengthy common history (Jonas 2012). Regional territories are defined by tangible boundaries. If a nation is highly developed, decisions prevail in urban areas; whereas decisions dominated by rural areas prevail if a nation is still developing.

The local territorial (municipal-communal or clusters thereof) level is constructed by a lengthy history of occupation (several generations), where daily life traditional practices have prevailed. At this level, every spatial entity is used, perceived, conceived and lived in by specific stake(right)holders in whom belonging, identity and action converge (Governa and Salone 2004). Definitions of roles are fuzzy, since, for some practices, a stakeholder forms part of one cluster (e.g., livestock producers), yet the same stakeholder may be part of another cluster occupied with another functional activity (e.g., logging). Therefore, at this level, tangible, functional and symbolic territories intermingle, donating life and spirit to the geographic continuum. Yet contested situations are the rule rather than the exception. Local territorial level is not synonymous with indigenous community. Other non-indigenous communities, such as pioneers, immigrants and even emigrants from their place of origin currently expatriate may also qualify as local territory type communities as long as the time of occupation is long enough explicitly to show their engagement and symbolic attachment to the geographic continuum established by traditional practices created by the natural resource-man-made relationship. Urban neighborhoods sharing similar socio-economic classes eventually turn into local territorial identities too. Indigenous communities, nonetheless, often fit as excellent candidates if their traditional practices have not been significantly diminished.

Spatial boundaries of the local territorial level range from tangible to fuzzy owing to the fact that one spatial unit may be devoted to multipurpose functions (Fig. 1). Local level is crucial for implementing actions and is, in consequence, regarded as a motor of development at the municipal level (Jalomo-Aguirre 2009). At this level, space is highly contested because it represents livelihoods and power. Decision-making is also contested, such that open alliances with regional level decision makers are crucial to enforce laws. Because of the contested prevailing framework, this level is rather vulnerable and often unstable in comparison with the regional, national and supranational levels. At this level, rural-urban centers share the ruling role, while the rural ones prevail in most developing countries.

The supranational territorial (global) level emerged through the configuration of clusters of nation-states (the European Union, North American Free Trade Agreement, MERCOSUR) to address common economic interests, taking into account historical and cultural backgrounds. These are predominantly tangible and gain territorial functionality no longer through the notion of sovereignty, but rather through systems of planning, policies and processes agreed upon by the governments of member nations. Supranational territories are mainly functionally driven and allow the rise of so-called cross-border or trans-border regions, as the case of Western Europe (Zonneveld and Stead 2007; Knipps child and Wiechmann 2012; Peyrony and Denert 2012). These territories have also become relevant spatial entities for attending to environmental problems in order to minimize negative effects as a result of their land-use practices affecting natural resources beyond their borders, sometimes jeopardizing planetary sustainability (Conca 1994). In the symbolic dimension, these supranational territories are palpable in contrasting ways. One of them is the ethno-territorial conflict where national identities are unrecognized through divisions created by the limits of modern states. Conversely, advances in the reconstitution of symbolic territories across state borders have been reached through the recovery of the cohesion based on historic identities as in the case of the Catalan territoriality expressed in Spain, Andorra and France (Prytherch 2010). A number of examples can be seen in the trans-boundary parks in Africa and shared river basins in Mexico and in the USA as well as in many other instances where this supranational territorial level becomes relevant. At this level, urban centers play the ruling role, since centralized governments make most decisions.

IV. Territorial Configuration Approach

We define territorial configuration (TC) as the array of tangible (administrative), functional and cultural territories that co-exist and overlap across different hierarchical levels. In consequence, the geographic continuum is dissected into territorial conglomerates delimited by a range of meaningful socio-historical boundaries. TC harbors a unique array of stake(right)holders with legal and legitimate rights over the space (hereafter referred to as spaceholders). Accordingly, it is unequivocally place-based dependent (Fig. 2).

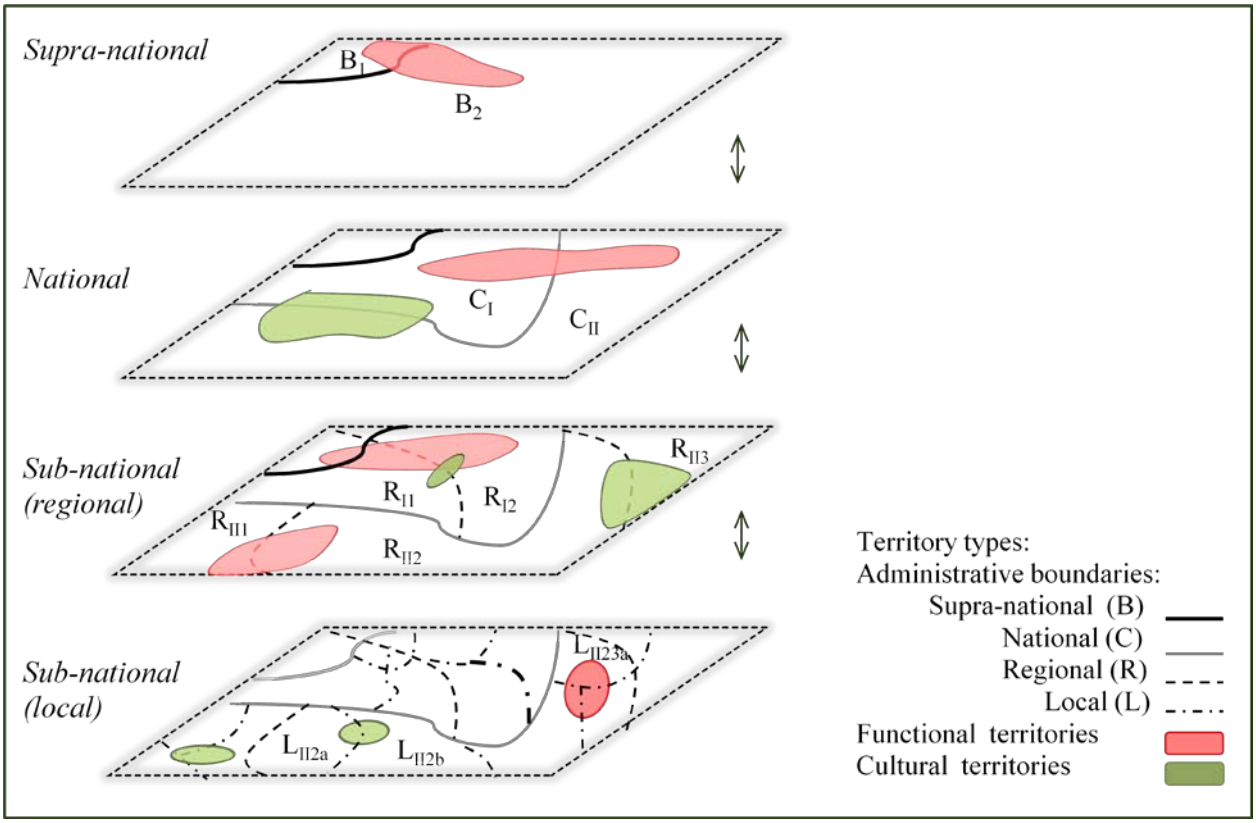

Figure 2: Types and hierarchical levels of territories dissect the geographic continuum forming territorial configuration (TC) conglomerates. The Territorial Configuration approach is meant to provide a common ground where both perspectives may match, namely, jurisdictions, laws and normativity as well as belonging, identities, historical charge, contested spaces and socio-economic functionality. B stands for blocks of countries clustered at supranational boundaries; C is for country boundaries; R is for regional boundaries and L for local boundaries.

From a functional perspective, TC embraces multiple fluxes (matter, energy and information) controlling unstable stages and changing processes throughout territorial conglomerates, thus resulting in non-linear dynamics, such that outcomes are tagged with a high degree of uncertainty. These input-outputs change into internalities or externalities when moving through territorial conglomerates along their path from their departing point toward the endpoint (Fig. 2). Taking into account that fundamental issues in decision-making on environmental management comprise consensus, collaboration and coordination, TC constitutes a benchmark for unified space, function and spaceholders. Three underlying attributes of TC sustain this statement. First, governing spaceholders are identified through their territorial engagement; second, spatially explicit relationships are established to recognize internalities and externalities; third, a negotiation process among spaceholders can be envisaged and strategic pathways leading toward the creation of territorial pacts and agreements may, therefore, be established.

Ambiguity and uncertainty often result from uncoupling actions of the spaceholders, who are distributed across all hierarchical territorial levels. Because of the spatially explicit character of the TC, ambiguity and uncertainty are diminished because of the need to understand that multiple resources are managed-administrated by multiple stakeholders distributed along a geographic continuum where limits overlap. In response, sound communication is enhanced, and, trust is established easing the implementation of environmental programs. Territorial configuration, in addition, serves to identify key social actors from all territory types as well as any hierarchical level. By understanding the arrangement and the pondered role of these key social actors, agreements, pacts, rules and eventually effective EM may be pursued.

We further state that understanding TC implies admitting that no single EM action will be equally effective in all spatial units. The Territorial Configuration approach here described, places the fact that any environmental management action to be implemented will face opposition. The Territorial Configuration approach takes it as implicit that bottom-up and top-down space holders might be brought together in order to design place-based environmental policies, programs and actions. Consequently, tradeoffs and win-win scenarios are feasible as a crucial first step to regulate

access to spaces based on reciprocity, shifting to a needs-based rather than rights-based negotiation strategy. To summarize, the Territorial Configuration approach provides meaningful grounds for the processes of decision-making on environmental management (Fig. 3).

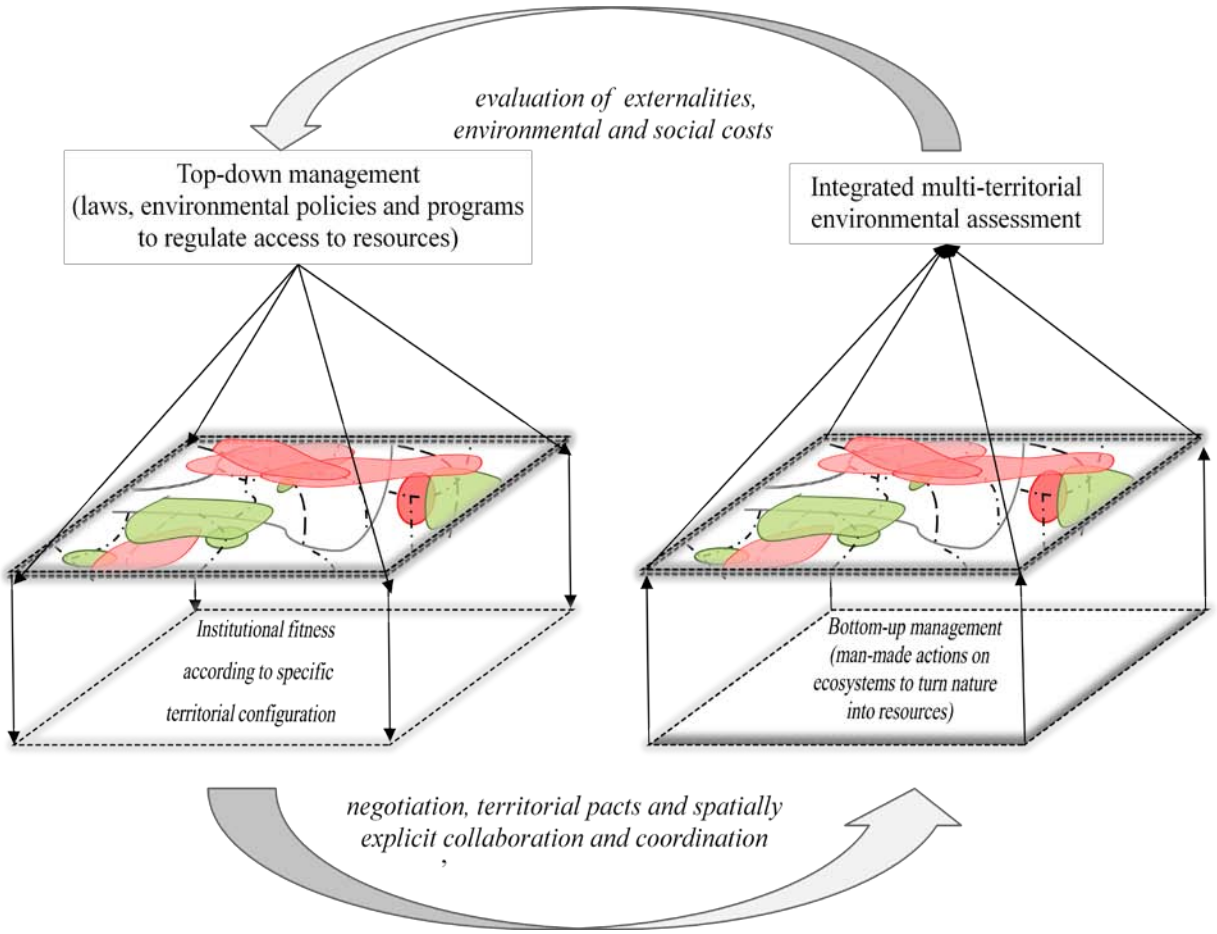

Figure 3: Schematic representation of the virtuous cycle comprised within the Territorial Configuration approach.

Here we portray the cyclical relationship between top-down and bottom-up approaches often unsuitable among institutional organizations, space holders and places. TC conglomerates are crucial for governing national and supranational levels designing policies to regulate access to natural resources (top-down vision). Complementary, bottom-up EM initiatives also adapt their management to their TC. The probability of merging environmental policies with management actions increases because both approaches share the same ground. In addition, because of the place-based institutional framework, pacts, compromises and agreements needed to trigger management actions at regional and local hierarchical territorial levels are feasible too. Environmental actions, even if these are articulated through top-down and bottom-up approaches, trigger positive and negative internalities and externalities. Governing national and supranational levels are able to assess the impact and eventually reorient EM toward sound environmental programs. This dialectical relationship needs to be adapted on an ongoing basis, since TC is invariably changing.

V. Discussion

Mexican environmental policy has largely neglected the concept of territory, and overemphasis has been placed on concepts such as ecosystems and, recently, socio-ecological systems (Sarukhán et al. 2015). Environmental management policies targeted at watersheds (Burgos and Bocco 2015) and biodiversity conservation (Bray et al. 2005) are primarily designed following a top-down approach, disregarding TC conglomerates. Despite of all these examples, successful medium- and long-term operation has yet to be ascertained. Disarticulated sector-oriented policies increase uncertainty and diminish trust, such that weaknesses and failures are mainly found in the implementation, monitoring and adaptation phases at regional and local levels (Figueroa and Sánchez Cordero 2008, Velazquez et al. 2009). Most regional and locally driven environmental management programs lead to unsustainable actions, since political will (meaning economic and technical support) is not likely to accommodate initiatives originating with local

governments, even where legitimate decisions underlay (e.g. peasant reserves). Disruption of the dialectical relationship between top-down and bottom-up processes increases the number and intensity of conflicts among and across territorial conglomerates. In sum, Mexican environmental management initiatives have lacked the dialectical relationship provided by the Territorial Configuration approach.

For a number of decades, the space concept in applied ecological sciences has remained a sticking point (Kareiva and Wennergren 1995) and has often been regarded as a socially empty unit. The revisited concept of territory portrayed here in a semantic map provides an overview of the multipurpose understanding of space. It is argued that territory is a continuous process of spatial construction, permitting socio-ecological systems to be better understood and eventually effectively managed by regarding the underlying Territorial Configuration. Various authors (e.g., Pahl-Wostl 2009; Moss and Newig 2010) hold that the Territorial Configuration approach may serve as a robust starting point from which to operationalize Environmental Management (Table 1). As previously explained, territorial configuration encompasses a clear notion of space, spaceholders and tangible and cultural proximal and multi-level governing processes (Mikulcak et al. 2013). Understanding this underlying complexity, negotiations, pacts, agreements and reciprocal collaboration are feasible. The Territorial Configuration approach implies reviewing the structure and composition of stakeholders involved in decision-making processes. Rather than sector-oriented stakeholders, this approach empowers genuine and legitimate spaceholders to be enlisted so that one common environment a lissue engages neighborhood, contagion and vicinity principles. This engagement leads to pathways toward facilitating governance as a critical component so far over looked in most literature related to Environmental Management (Newig and Fritsh 2008).To illustrate this further, ethnic, political (power), economic and religion-driven cultural features have triggered some of the worst human environmental transformations with global implications. These are the reasons why understanding territorial configuration of space is crucial in finding reconciliatory paths forspaceholders to follow in order to construct new territories from which innovative man-made actions may maximize environmental internalities and minimize externalities (Larson 2010). At this stage, governance and co-operation are likely to be included as a critical route to enforcing rules for a common purpose (Lockwood 2010).

Robust construction between the Territorial Configuration approach and Environmental Management force us to recall that, according to Aguilar (2009), public policy comprises four compulsory and sequential steps, namely, identification of the target, design, implementation and monitoring-adaptation. In addition, Margerum (2008) has pinpointed that frequent atomization and mismatches between sector-oriented policy formulations at high organizational levels remain the major challenge in Environmental Management. Along this line, the Territorial Configuration Approach provides the driving force and basis for environmental policy makers from different sectors to articulate programs and actions. Policy makers should be geared toward common targets according to specific territorial capabilities. Territorial capabilities imply identification of spaceholders who, ideally, should participate actively in all four steps of the public policy cycle. Design of shared programs and actions to be implemented with regard to specific spatial conditions reduce uncertainty and increase trust among spaceholders (Odom et al. 2015). In consequence, the ability to trigger negotiations and pacts in addition to medium- and long-term agreements based upon mutual benefits is developed (Fisher et al. 2012). On the whole, the Territorial Configuration approach may drive Environmental Management into a more effective, concrete and operational framework, making the management of negative externalities more efficient. Eventually, the Territorial Configuration approach should help to avoid policies likely to be antagonistic. These often increase uncertainty and discourage spaceholders (Table 1).

Table 1: Synthetic comparison among prevailing issues to overcome in sustainable management and improvements reached by following the Territorial Configuration approach.

Attributes of Sustainable Management	Prevailing issues to overcome	Improvements reached by following the Territorial Configuration approach
Conceptualization of geographic space	Scanty perception of the process controlling the space as a social construction.	Geographic continuum dissected into territorial conglomerates delimited by a range of meaningfully socio-historical liaison (e.g., place-belonging-engagement-control).
	Geographic framework is only conceived as pixels or biophysical units leading to the disarticulation of ecological and geographical levels of organization.	Ecological and geographical levels of organization are clearly articulated throughout intermingled territorial conglomerates.
	Vagueness in depicting place-based exter(inter)nalities.	Stakeholders producing place-based positive or negative exter(inter)nalities are revealed.
Composition of decision-making structures	Dictating role of administrative (tangible) territories at high organizational levels (supra-national or regional) illustrated by basin councils, advisor boards).	Non-tangible territories (functional and cultural) could be as well visualized, so that more comprehensive decision-making structures can be integrated.
	Place-based key stakeholder are excluded when forming decision-making structures (illustrated by contagion, up-down, nested territories), diminishing likely negotiations.	Negotiation potential increase because weighted role of place-based key stakeholders are anticipated and based upon specific environmental problems.
	Lack of legitimacy in decision making´s structures due to the composition of decision makers often enrolled arbitrary.	Increasing legitimacy because of the supported composition of place-based decision makers.
Capability for favoring institutional (governmental) coordination	Ill-coordinated, mismatched and ungrounded public environmental policies due to the fact that these are sector-oriented.	Fitting public environmental policies to specific territorial configuration.
Abilities for conducting collaboration	Increase of uncertainty and distrust among stakeholders because environmental public policies are detached from the reality of other.	Increase of certainty and trust among stakeholders when environmental public policies are devoted to common territories so that from the reality of other are not mismatched.
	Lack of awareness of socio-cultural background that limits collaboration between vertical and horizontal stakeholders.	Acknowledgment of territorial boundaries that favors collaboration for building territorial pacts, and vice versa.
	Facilitator fails as mediators in solving stakeholder´s conflicts.	Stakeholder´s conflicts may be solved through more effective strategies for building territorial pacts.
Efficiency for negative externalities management	A functional criterion for environmental externalities assessment uniquely weakens efficiency for implementation of mitigation and control actions.	Integrated territorial environmental assessment for improving management of externalities among stakeholder´s responsibilities.
Coherence and dynamics for adaptive learning processes	Disconnected top-down and bottom-up processes so that contested situations prevailed.	Territorial Configuration approach constitutes a common ground for triggering dialectical relationships between top-down and bottom-up decision making processes.

Top-down perspectives dominated by policy makers build the 'reality' around administrative territories at high institutional levels. In contrast, bottom-up perspectives in regional and local spaceholders build their 'reality' around daily life practices derived from tangible, functional and cultural territory types carved outby tacit-empirical knowledge. This mismatch is known as "levels of reality" within the transdisciplinary approach (Nicolescu 2010). The Territorial Configuration approach provided here is meant to serve as common ground where all perspectives can match, namely, jurisdictions, laws and normativity in addition to belonging, identities, historical charge, contested spaces and socio-economic functionality. Contrasting levels of reality ought to be brought together and this approach may serve to do so. This bridging effect refers to literally "the logic of the included middle" described within the transdisciplinary approach by Nicolescu (2010). The Territory Configuration approach may be considered as a surrogate of the included middle because it contains the logic of administrative boundaries in the form of other territorial boundaries linked to different perceptions. Although contrasting perspectives will remain, the building of a shared vision on environmental issues is likely as a consequence of re-connecting the dialectic relationship between top-down and bottom-up perspectives (Table 1 and Fig. 3). This has been identified as the core of the multi-level governance framework (Moss and Newig 2010), governance networks (Newig and Fritsh 2008;Netwig et al. 2010) and knowledge systems, leading to flexible adaptive capacity and triple-loop learning processes (Cash et al. 2003; Fazey et al. 2007; Pahl-Wostl 2009).

VI. Conclusion

We state that the Territorial Configuration approach provides a sound geographic framework for linking a holistic perception of natural resources as well as past and present socio-economic underlying forces. this approach furthers, serves to resolve the misfit across multi-level state and non-state governance actors. The review on Environmental Management and Territory concepts reveals that territorial configuration of space permits an understanding of the complexity behind Environmental Management occurring along the geographic continuum. Emphasis was given to considering reciprocal connections and dialectical relationships, which determine the continuous construction of emerging territories. In order to reduce the conceptual mismatch between ecological concepts and Environmental Management actions, we suggest a Territorial Configuration approach as a critical pathway.

The outreach of the territory-oriented approach to operationalize Environmental Management in moving forward sustainable science has yet to be ascertained (Miller et al. 2014). Other conceptual approaches so far de-territorialized, such as socio-economic systems, governance and resilience fostering sustainable transitions may also be enriched (Folke et al. 2011; Fabinyi et al. 2014; Norström et al. 2014). It is, therefore, concluded that neither ecosystem nor socio-ecological-system concepts have encompassed a robust platform around which key spaceholders can unite. It is certain, however, that these previous approaches lacked a sound geographic perspective and therefore practical implementation is becoming a burden that needed to be transformed into an opportunity.

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Detection of Fracture Zones for Groundwater Investigation from Interpretation of VLF-EM Anomalies of Kwara State Polytechnic Ilorin and its Environs

By Sunday, J.A., Usman, A., Ologe, O. & Lawal, T.O.
Kwara State Polytechnic

Abstract- The Very Low Frequency–Electromagnetic (VLF-EM) geophysical methods have been used to map selected settlements in Kwara State Polytechnic (Permanent Site) and its environs, Ilorin, North-central Nigeria with a view to determine the groundwater potential of the area. A total of thirteen (13) profiles were covered during VLF data collection with 20m sample interval along each profile with spread length of between 100m. The VLF data were collected using ABEM WADI instrument. The data were interpreted using KHFFILT software. The qualitative interpretation of the acquired VLF–EM data identified areas of hydro-geologic importance. The results further showed that the EM anomalies vary greatly. Some of the anomaly peaks are narrow and sharp while others are broad with varying width extent. The values of the filtered real range from -0.9 to 22.5 across the study area. The study area is adjudged, based on the VLF data interpretation which indicates the presence of interconnected fracture zones, to have potentially good prospects for groundwater development; while recommendation is made for further geophysical methods to be employed in order to detect suitable locations for productive and sustainable borehole.

Keywords: very low frequency –electromagnetic (VLF-EM), moro lga, abem wadi, em anomalies, fracture zones, groundwater.

GJHSS-B Classification: FOR Code: 050299

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Detection of Fracture Zones for Groundwater Investigation from Interpretation of VLF-EM Anomalies of Kwara State Polytechnic Ilorin and its Environs

Sunday, J.A.,[α] Usman, A.,[σ] Ologe, O.[ρ] & Lawal, T.O.[ω]

Abstract- The Very Low Frequency–Electromagnetic (VLF-EM) geophysical methods have been used to map selected settlements in Kwara State Polytechnic (Permanent Site) and its environs, Ilorin, North-central Nigeria with a view to determine the groundwater potential of the area. A total of thirteen (13) profiles were covered during VLF data collection with 20m sample interval along each profile with spread length of between 100m. The VLF data were collected using ABEM WADI instrument. The data were interpreted using KHFFILT software. The qualitative interpretation of the acquired VLF–EM data identified areas of hydro-geologic importance. The results further showed that the EM anomalies vary greatly. Some of the anomaly peaks are narrow and sharp while others are broad with varying width extent. The values of the filtered real range from -0.9 to 22.5 across the study area. The study area is adjudged, based on the VLF data interpretation which indicates the presence of interconnected fracture zones, to have potentially good prospects for groundwater development; while recommendation is made for further geophysical methods to be employed in order to detect suitable locations for productive and sustainable borehole.

Keywords: very low frequency –electromagnetic (VLF-EM), moro lga, abem wadi, em anomalies, fracture zones, groundwater.

I. Introduction

The VLF-EM technique was developed in the 1960s with the use of the transmitted signals of the already established powerful radio communication stations (in the 10-30 kHz band). The transmitters of these stations generate primary fields with horizontal magnetic components (H_y), and vertical electric component (E_z). Both components are perpendicular to the direction of propagation (X). At great distance, their wave front is considered uniform and plane. It is known that the induction caused by the primary magnetic field in a homogenous earth modifies the H_y component and creates a horizontal electric component E_x, and when a subsurface conductor is encountered, a secondary magnetic field will be generated (Mahemed*et al.*, 1998).In recent times, the VLF EM method has been applied successfully to map the resistivity contrast at boundaries of fractured zones having a high degree of connectivity (George *et al.*, 2013). Also VLF method yields a higher depth of penetration in hard rock areas because of their high resistivity (McNeill and Labson, 1991). VLF method is capable of delineating fractures in lateral direction effectively compared to resistivity sounding (Sharma and Baranwal, 2005), characterize aquifer structures in a complex environment (Ozegin*et al.*, 2012), underground water contamination by solid waste (Deborah and Ayobami, 2013) and examination of the fault pattern of industrial estate (Theophilus and Lukman, 2012).

The Very Low Frequency Electromagnetic (VLF – EM) method has found useful application in groundwater investigation in basement terrain, most especially as a reconnaissance tool (Amadi and Nurudeen, 1990; Olorunfemi et. al., 1995). It is an accepted fact that most of the ground VLF-EM anomalies are caused by the galvanic effect (McNeil, 1985) where the influence of frequency may be neglected (Guerin *et al.*, 1994). This method of geophysical prospecting was primarily developed for the delineation of sheet – like metallic conductors, which are often concentrated within fault and fracture zones which are known to be good groundwater aquifers, particularly when the fracture frequency is high (Olorunfemi et. al., 1995). The technique may be applied indirectly to the location of sites with appreciably thick overburden to the mapping of geological structures such as fault and fracture zones that are favourable to groundwater accumulation (McNeil, 1980; Palacky et. al., 1981; Adiat et. al., 2009).

The mapping of fracture zone which is a break in crystalline basement rock due to tectonic forces or intrusion of magmatic bodies is important for civil engineering and hydrogeological applications. In civil engineering, it helps to locate the safest depth to lay the foundation of buildings. The geological significance of fracture zones in hydrogeology is that it determines the

Author α σ: Department of Science Laboratory Technology (Physics Unit), Kwara State Polytechnic, Ilorin, Nigeria.
e-mail: sunjohna@gmail.com
Author ρ: Department of Geology, Federal University, Birnin-Kebbi, Nigeria.
Author ω: Department of Physics, University of Ilorin, Ilorin, Nigeria.

competency of the underlie rocks (George *et al.*, 2013). Areas that are extensively fractured and where the fractures are deep are considered as weak zones and considered suitable zones for groundwater development (Alagbe*et al.*, 2013);but areas that are slightly fractured and where fractures are not deep are considered as competent zones and are considered better sites for engineering purposes (Sunmonu and Alagbe, 2011). In hard rock areas, groundwater is found in the cracks and fractures of the local rock. Groundwater yield depends onthe size of fractures and their interconnectivity.

This study was driven by the desire to investigate water bearing fracture zones in the area under investigation using very low frequency (VLF) electromagnetic method. Most boreholes drilled in the past in the area are unproductive and due to this failure, it is therefore necessary to use an appropriate geophysical method to locate the fracture zones. This became important as the inhabitants of the study area depend solely on streams, lakes and groundwater for their domestic needs and otherwise.

II. The Study Area

Kwara State in its entirety is located in the North-Central part of Nigeria. It lies between the Longitude 3^0 and 6^0E and Latitude 8^0 and 10^0N respectively (Fig. 1). It covers an area of over 32,500 square kilometer and bounded by an international boundary with Benin Republic in the West, in the North by Niger, in the East by Kogi and to the south by Oyo, Ekiti and Osun.

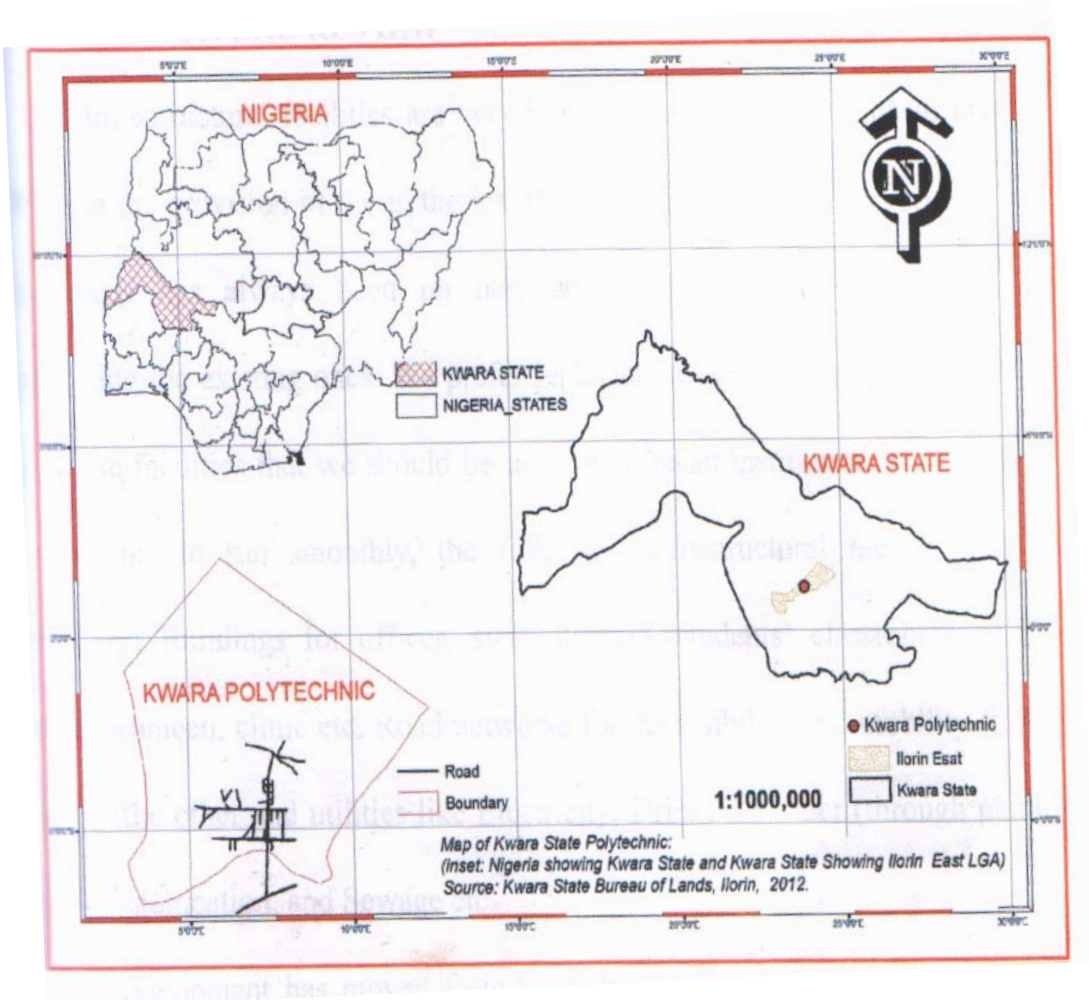

Figure 1: Merged geographical map of nigeria, kwara state and the study area, herein referred to as kwara polytechnic (source: kwara state bureau of lands, ilorin, 2012)

The area of study, falls in Ilorin, the capital city of Kwara State, with Kwara State Polytechnic (Fig. 2) as the central point, lies within the crystalline basement rocks of western part of central Nigeria. The area is a semi-arid region of Nigeria with vegetation mainly guinea savannah, with shrubs and undergrowth (Nwankwo, 2011). The area is drained by rivers and streams such as Oyun River and river Ile-Apa as a tributary of river Niger (Nwankwo*et. al*., 2004).

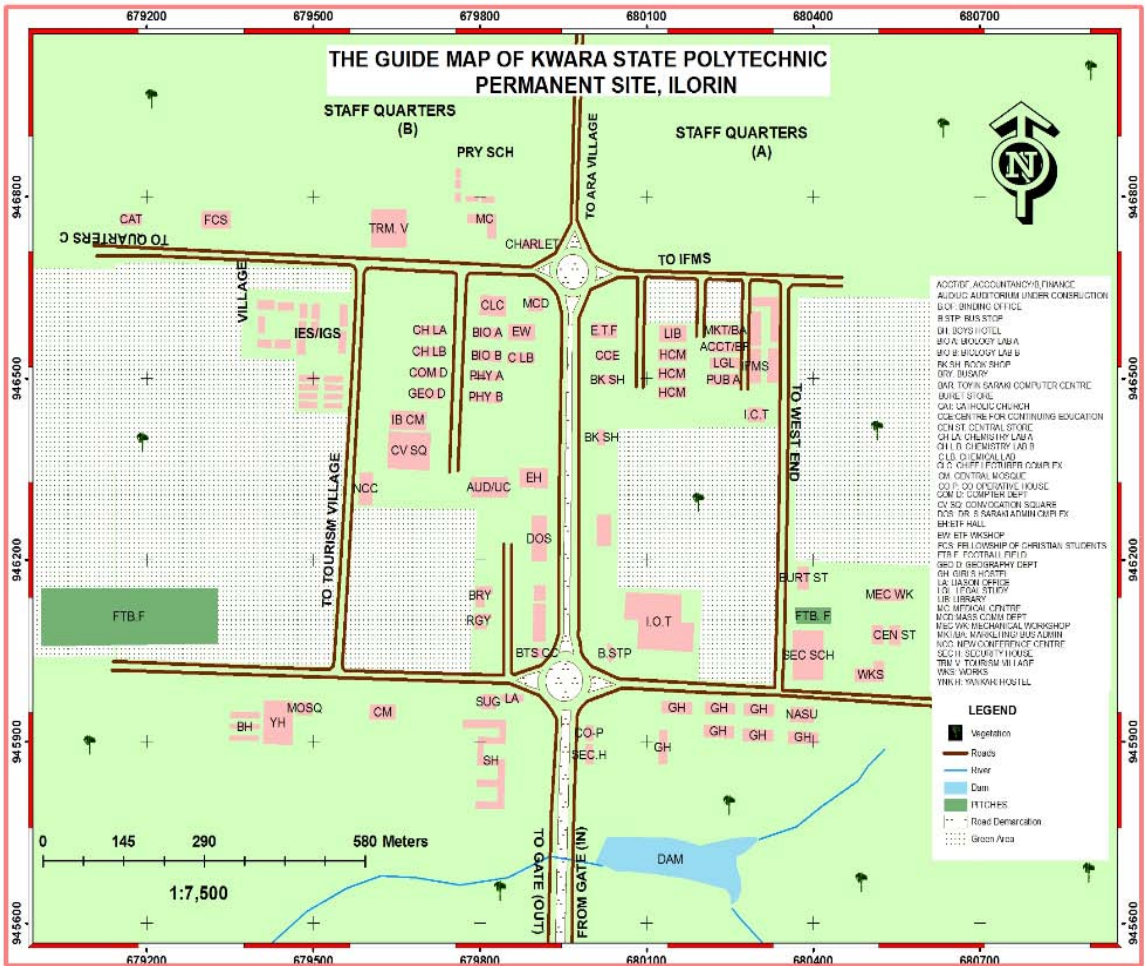

Figure 2: Guide map of the central point of the study area (kwara state polytechnic, permanent site)

The progressive population growth in Ilorin, the nearest major town to the study area, has led to severe shortage of portable drinking water for the area which poses a great challenge to both the citizens and the government. It is therefore obvious that the demand for reliable and consistent water supply is high. Certainly the use of water is beyond mere domestic as virtually all the industries, companies and governmental establishments are in dare need of water. Such high demand can only be achieved through viable boreholes. The drilling of viable boreholes can be obtained by carrying out adequate geophysical studies to empirically ascertain areas or sites where long term steady supply can be achieved.

Furthermore, rapid industrialization recently witnessed by the Ilorin metropolis has resulted in population increase and has led to the urbanization of satellite villages and settlements of which the ancient Eleko, Kwara Poly. (Permanent site), Ara and Akuo settlements, all of which fall in the study area. The people of these settlements depend solely on surface water from streams and hand dug wells for their domestic use. However, these sources of water are highly vulnerable to pollution thereby making the people to be susceptible to water borne diseases. Moreover, fast increase population growth of this region occasioned by the influx of people from nearly congested city of Ilorin, coupled with the location of government institutions such as Kwara State Polytechnic and University of Ilorin Teaching Hospital has also made these sources of water inadequate for its dwellers, and the need for good quality and readily available portable groundwater in this area forms the basis for this research.

III. Materials and Methods

The ABEM WADI VLF-EM Instrument used to measure the EM response is a portable instrument which measures the electrical properties of the subsurface, using EM induction as detailed in McNeil (1980a). In this work, thirteen EM profiles were made using a 20m coil spacing, with an expected maximum depth of investigation of about 15m for the horizontal dipole (HD) mode (McNeil, 1983). The EM data were collected at 20m interval along thirteen profiles (Fig. 3) with lengths ranging from 300 to 1700m. The VLF-EM

data were presented as profiles figures by plotting raw real (quadrature) measured on the field and the filtered real while their corresponding Karous-Hiljet (K-H) pseudo sections are shown in Figures respectively. The interpretation of both the profiles and pseudo sections was basically qualitative or semi quantitative.

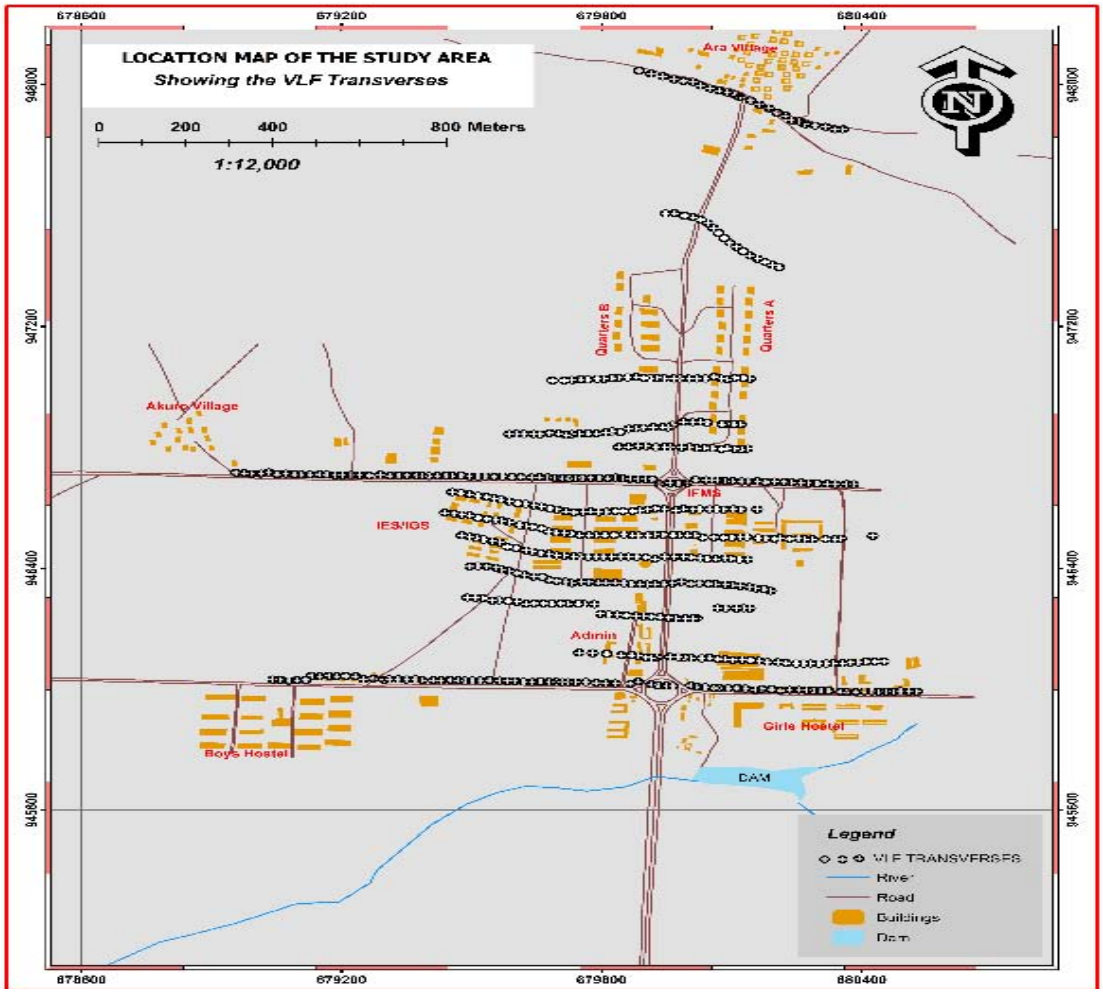

Figure 3: Location map of the study area showing vlf transverses

The VLF WADI instrument displays the filtered real anomaly on the screen, and this anomaly can be roughly interpreted on site. This feature of the instrument is used to select sounding locations for resistivity surveys. For further detailed information of the subsurface, the measured real anomalies were re-discretized at 1 m interval and filtered using the approach of Karous and Hjelt (1983). This process yields pseudo-section of relative current density variation with depth. A higher value of relative current density corresponds to conductive subsurface structures.

IV. Results and Discussions

It is observed that apparent current density cross-sections using real and imaginary anomalies show almost similar features. Therefore, for simplicity only the real component results are presented below (Fig. 4-Fig 16).

At location VLF01 with traverse oriented in the E-W direction, a plot of filtered data shows intermitent positive responses with the most prominet one between 20-30m (Fig 4a) resulting in probable fracture zone located around same region along the profile at a depth extending from 0-6moriented at NW-SE direction (Fig 4b).

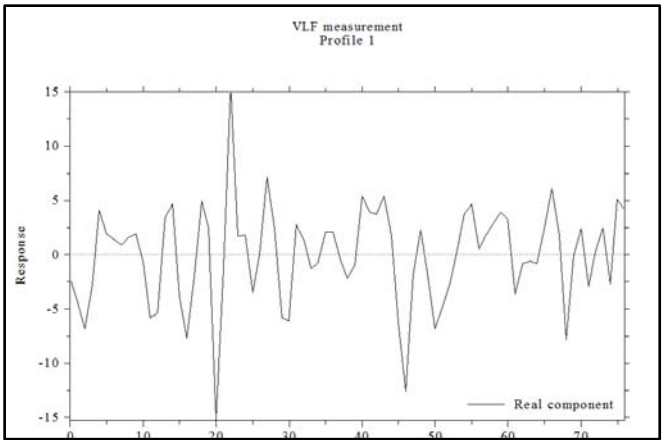

Figure 4a

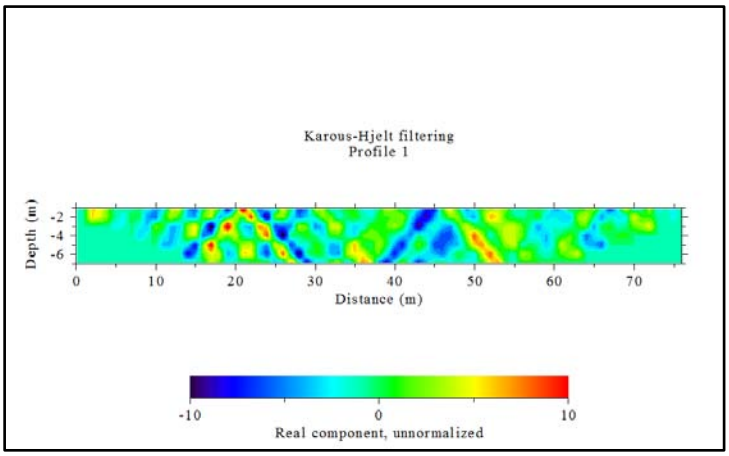

Figure 4b

Figure 4 (a): Filtered in-phase data against distance at location VLF 01 (b): Current density cross section plot in-phase data against distance at location VLF 01

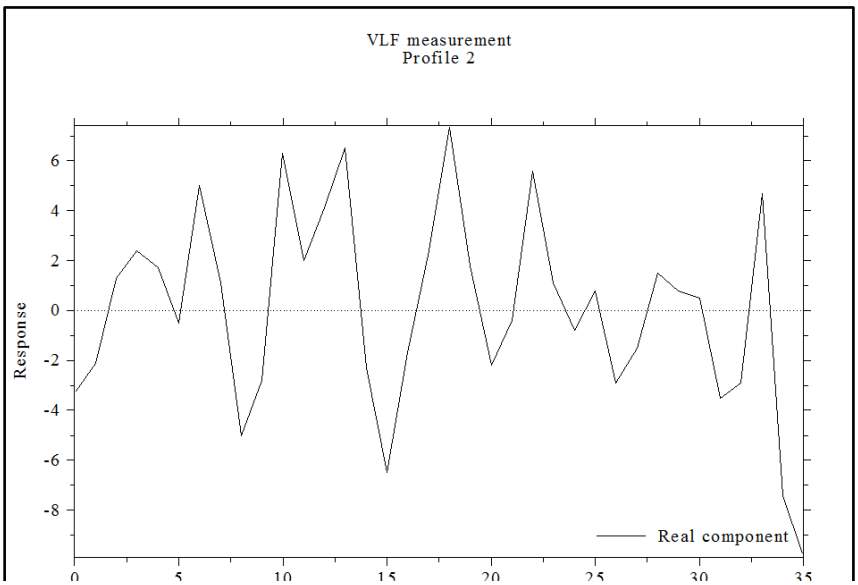

Figure 5a

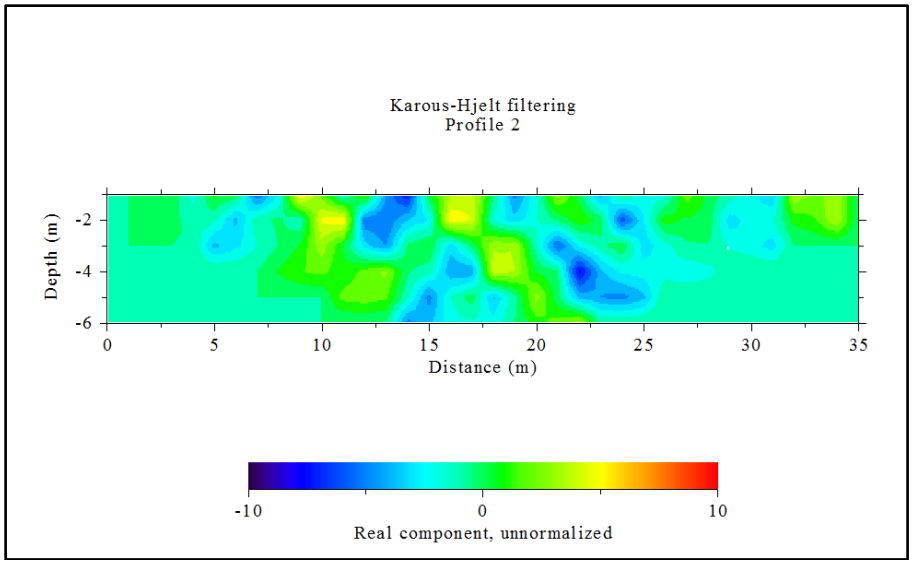

Figure 5b

Figure 5 (a): Filtered in-phase data against distance at location VLF 02 (b): Current density cross section plot in-phase data against distance at location VLF 02

At location VLF 02 with traverse oriented in E-W direction, there also intermittently well-fractured zone (Fig 5a) located at a horizontal distance of between 5-25m, along the profile at depth of between 0-6m. This zone is oriented at NW-SE (Fig 5b).

A very similar result was observed at locations VLF 03 and VLF 04 with both having same traverse orientation but 20m and 40m away respectively from Location VLF 02. They however lies along their corresponding profiles at depth between 20-60m. (Fig 6 and Fig 7).

At location VLF 05 with traverse oriented E-W direction, three (3) probable fracture zones were identified with one (the first) highly conductive. They were located between 5-7m, 15-17m and 25-27m respectively along the profile (Fig 8a). The depth of the fracture zones is between 10-40m with orientation sat NW-SE (Fig 8b).

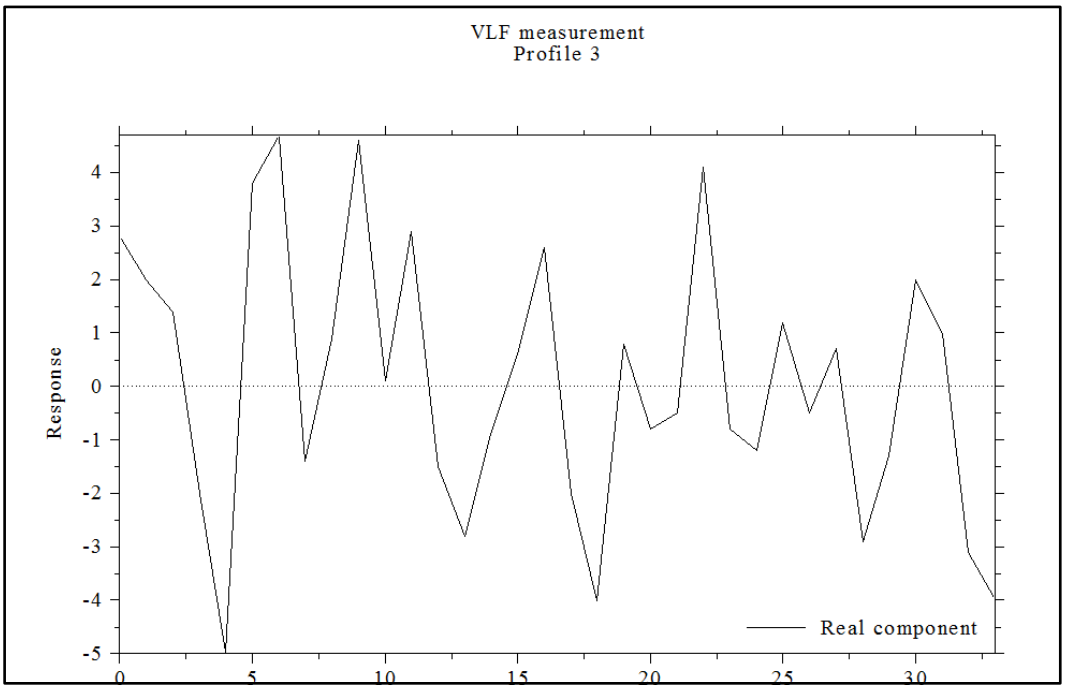

Figure 6a

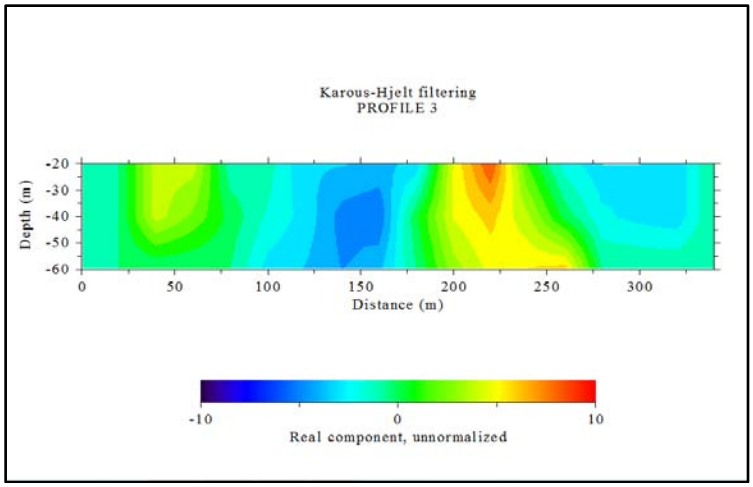

Figure 6b

Figure 6 (a): Filtered in-phase data against distance at location VLF 03 (b): Current density cross section plot in-phase data against distance at location VLF 03

At location VLF 06 with traverse oriented in the E-W direction, a well-fractured zone with positive Fraser filter was identified (Fig 9a). It is located at a horizontal distance between 11-13m, along the profile at depth of between 2-6m. Similar was the case at location VLF 07 with a prominent fracture zone located at a horizontal distance between 28-34m (Fig 10a), along the profile at depth between 2-6m.

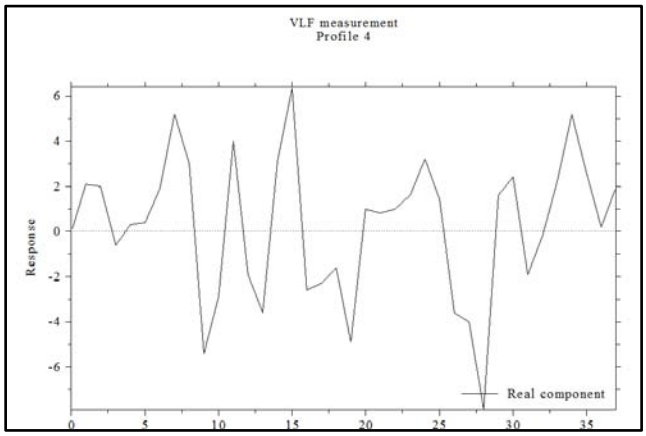

Figure 7a

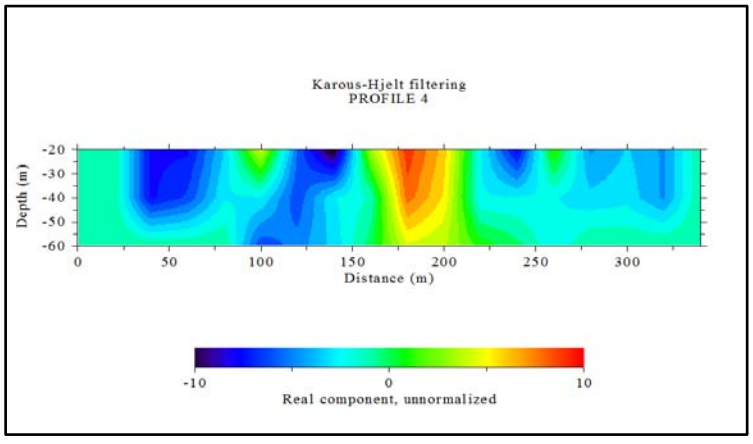

Figure 7b

Figure 7 (a): Filtered in-phase data against distance at location VLF 04 (b): Current density cross section plot in-phase data against distance at location VLF 04

At VLF 08 with traverse oriented in the N-S direction, two probable and another two not well-fractured zones were identified. They were located between 5-8m, 32-34m, 50-52m and 68-70m respectively along the profile (Fig 11a). The depth of each fracture zone was between 0-40m, 0-35m, 0-30m and 0-30m respectively all with orientation sat NE-SW (Fig 11b).

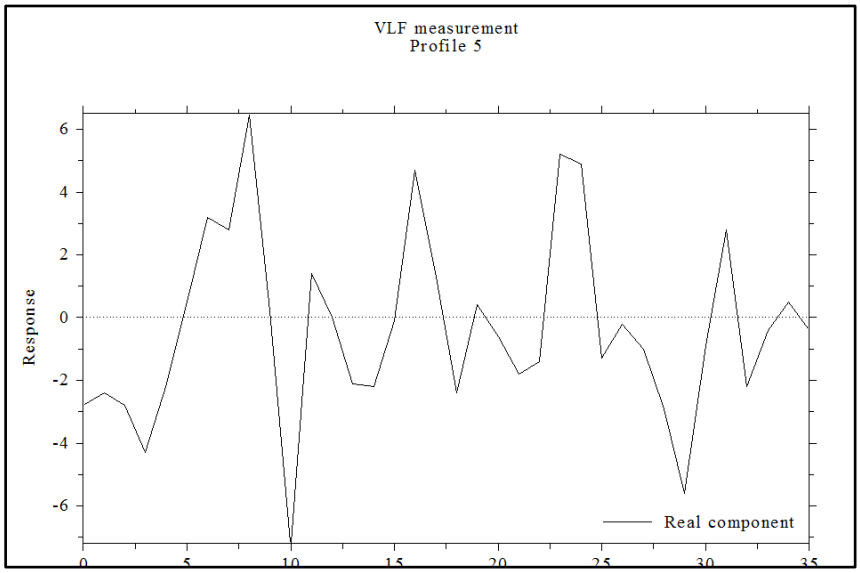

Figure 8a

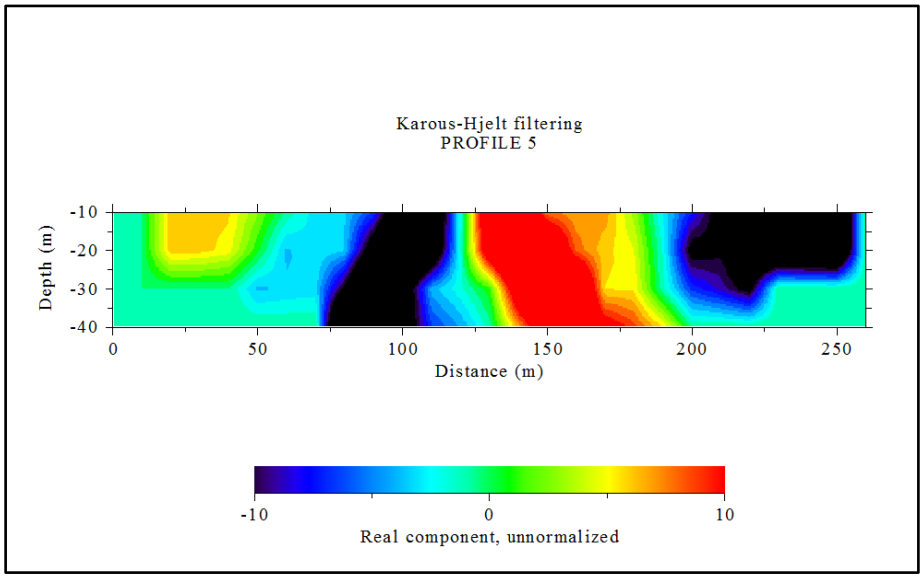

Figure 8b

Figure 8 (a): Filtered in-phase data against distance at location VLF 05 (b): Current density cross section plot in-phase data against distance at location VLF 05

At location VLF 09 with traverse oriented E-W direction, a not well-fractured zone with positive Fraser filter was identified (Fig 12a). This zone is located at a horizontal distance between 6-8m, along the profile at depth of between 20-40m (Fig 12b).

The result of VLF data collected at location VLF 10 with traverse oriented in E-W direction (Fig 13a) shows two positive fracture Fraser filter responses along the horizontal distance between 7-9m and 16-18m with depth extending from 30-40m for both. They were oriented at NW-SE and NE-SE respectively (Fig 13b).

The VLF responses at location VLF 11 with traverse oriented in the E-W direction shows positive responses along the traverse (Fig 14a) resulting in a not pronounced fracture zones located between 0-4m (Fig 14b).

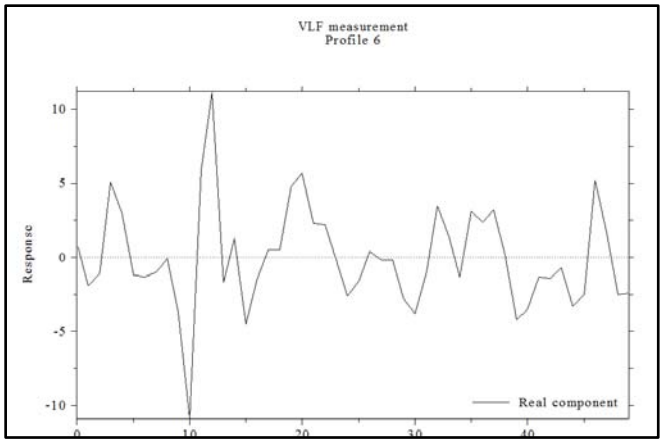

Figure 9a

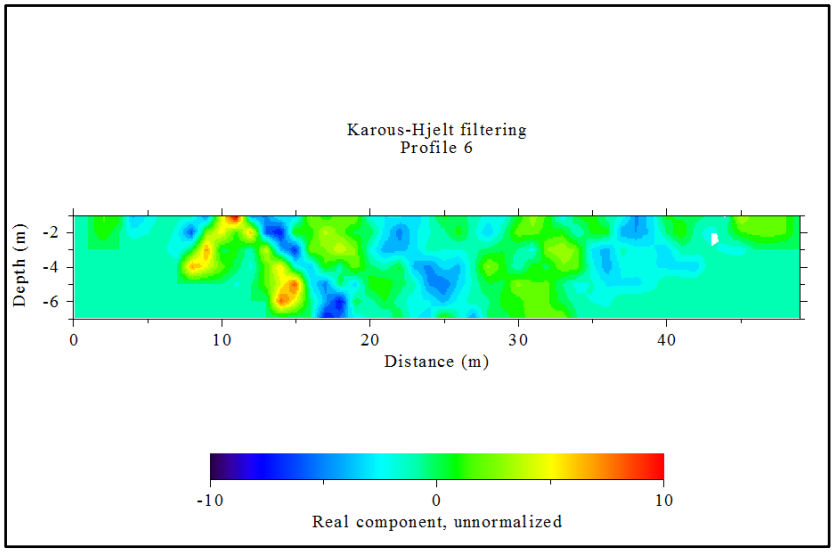

Figure 9b

Figure 9 (a): Filtered in-phase data against distance at location VLF 06 (b): Current density cross section plot in-phase data against distance at location VLF 06

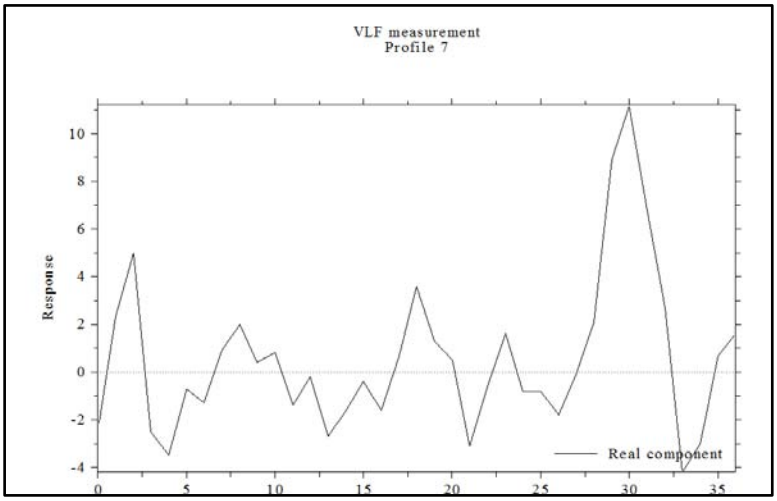

Figure 10a

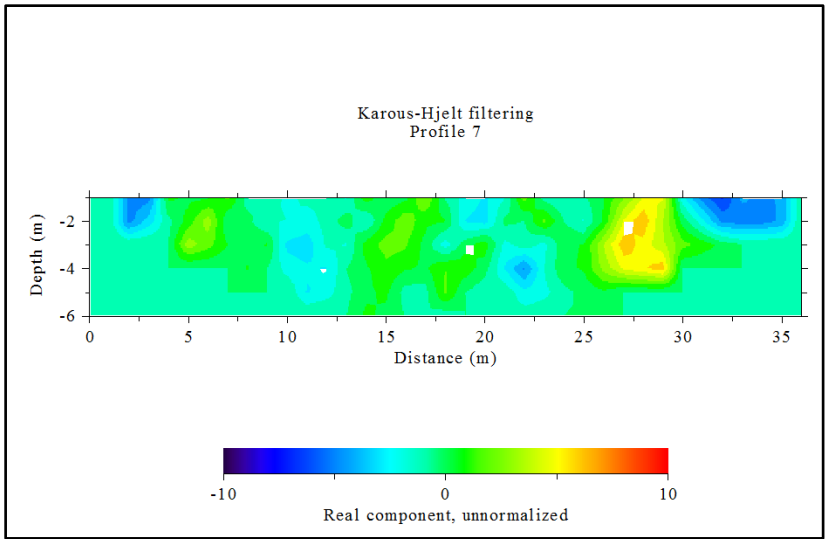

Figure 10b

Figure 10 (a): Filtered in-phase data against distance at location VLF 07 (b): Current density cross section plot in-phase data against distance at location VLF 07

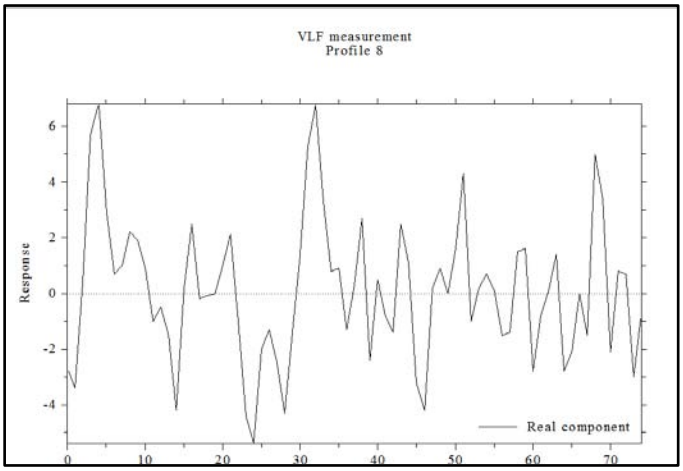

Figure 11a

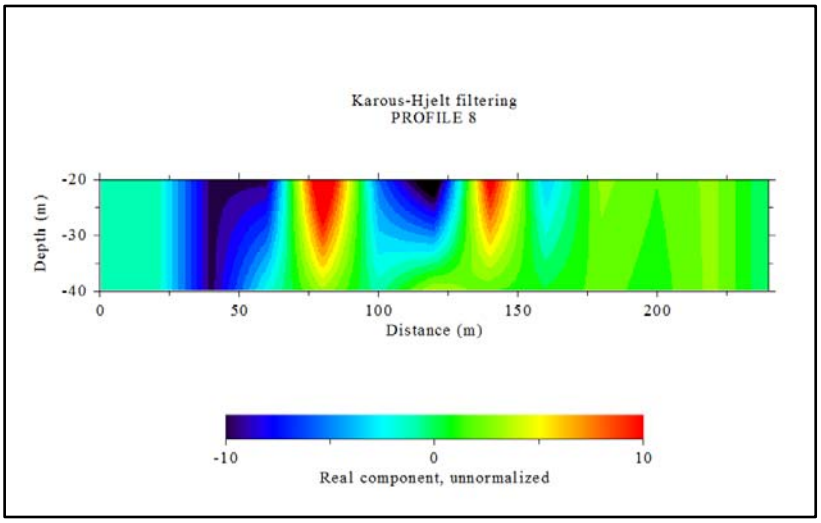

Figure 11b

Figure 11 (a): Filtered in-phase data against distance at location VLF 08 (b): Current density cross section plot in-phase data against distance at location VLF 08

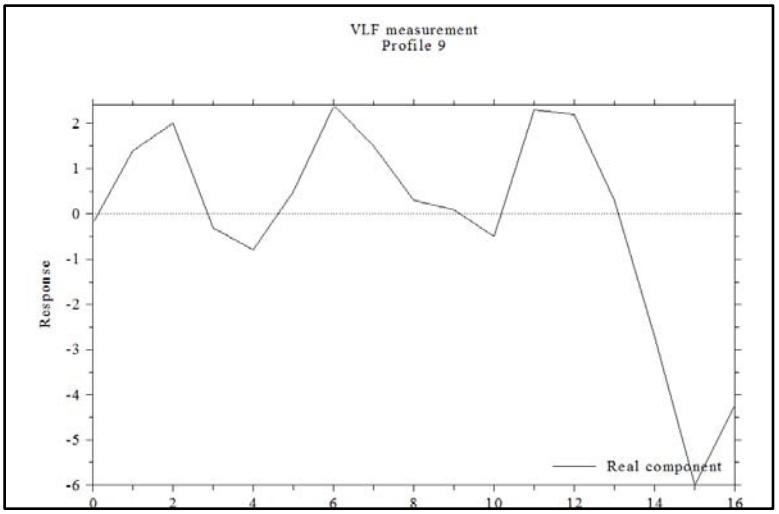

Figure 12a

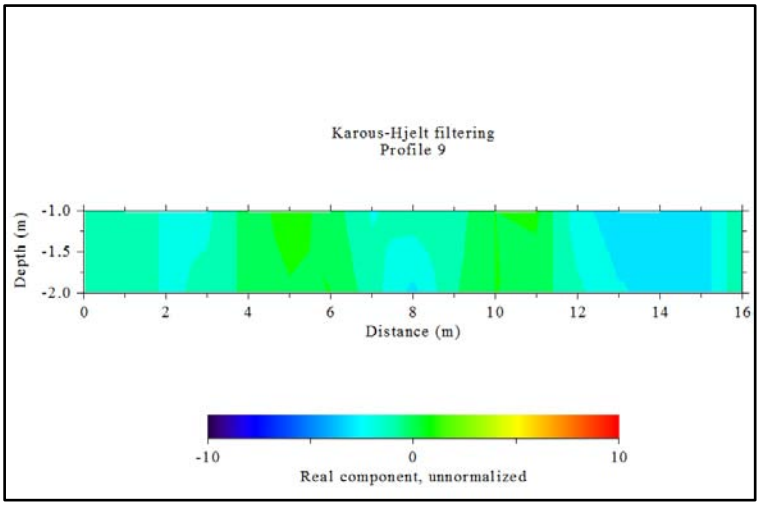

Figure 12b

Figure 12 (a): Filtered in-phase data against distance at location VLF 09 (b): Current density cross section plot in-phase data against distance at location VLF 09

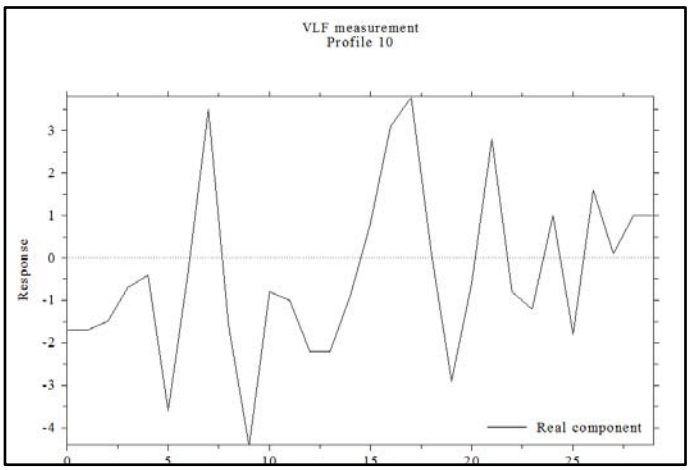

Figure 13a

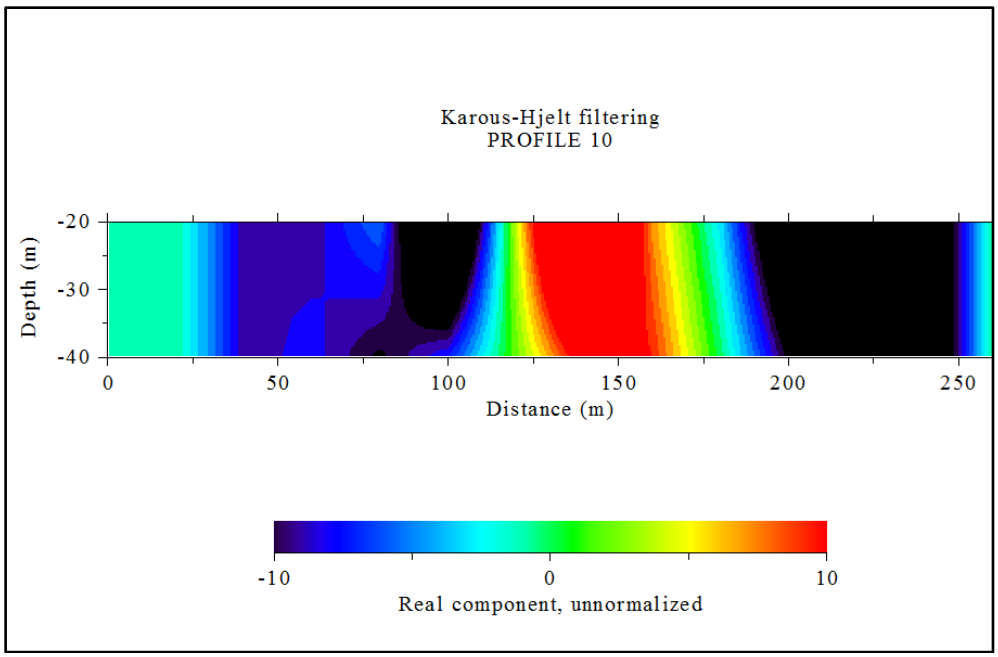

Figure 13b

Figure 13 (a): Filtered in-phase data against distance at location VLF 10 (b): Current density cross section plot in-phase data against distance at location VLF 10

VLF data at locations VLF 12 and VLF 13, both has a positive response identified each along the traverse (Figb15a and Fig 16a), these were between 17-19m and 19-22m respectively. These correspond to zones located at depth between 0-4m and 0-2m (Fig 15b and Fig 16b).

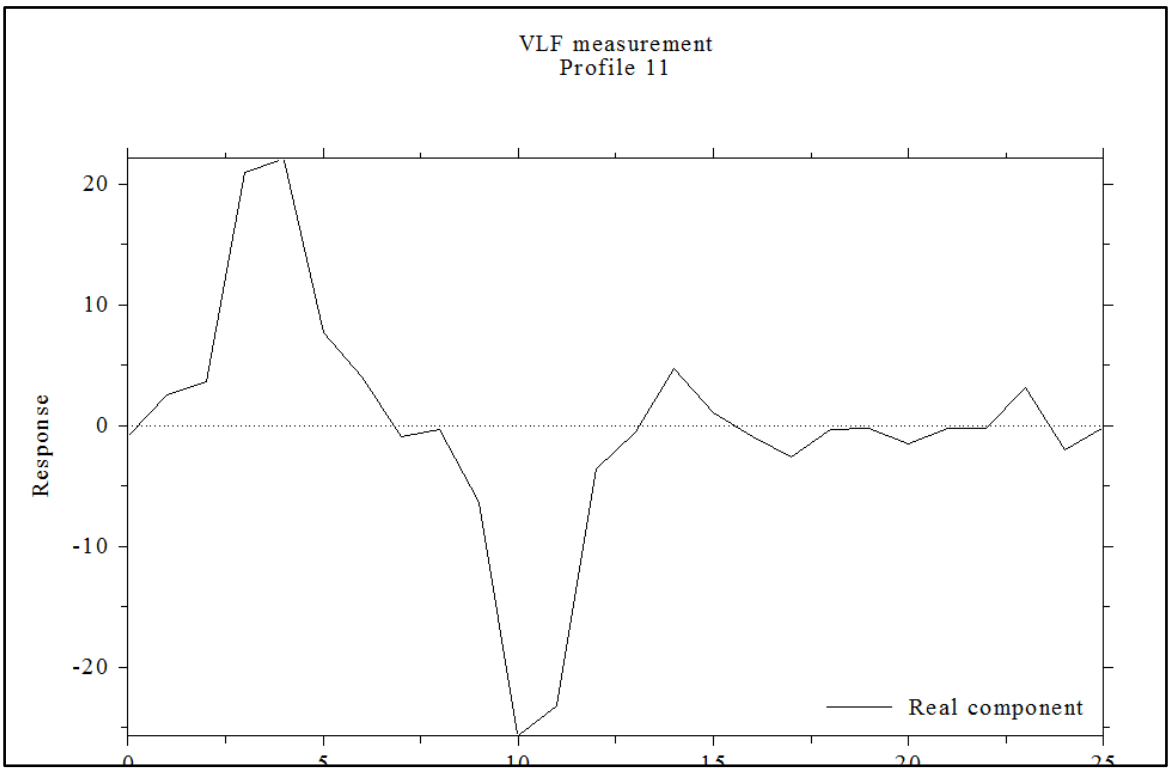

Figure 14a

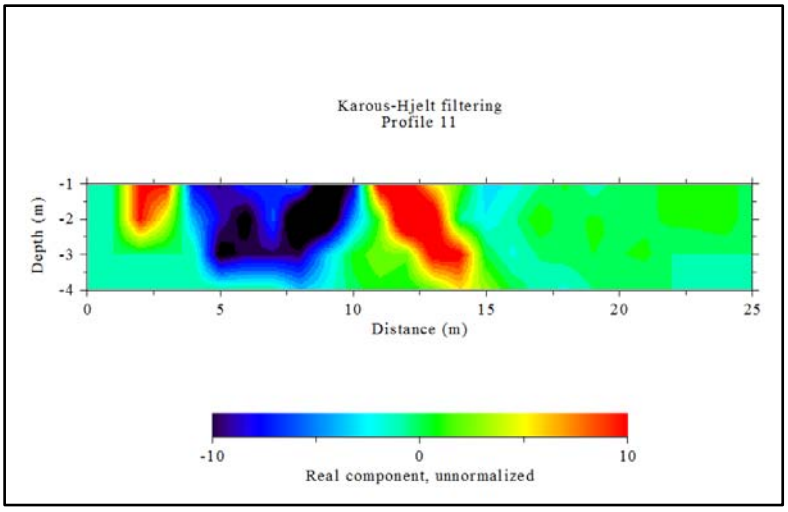

Figure 14b

Figure 14 (a): Filtered in-phase data against distance at location VLF 11 (b): Current density cross section plot in-phase data against distance at location VLF 11

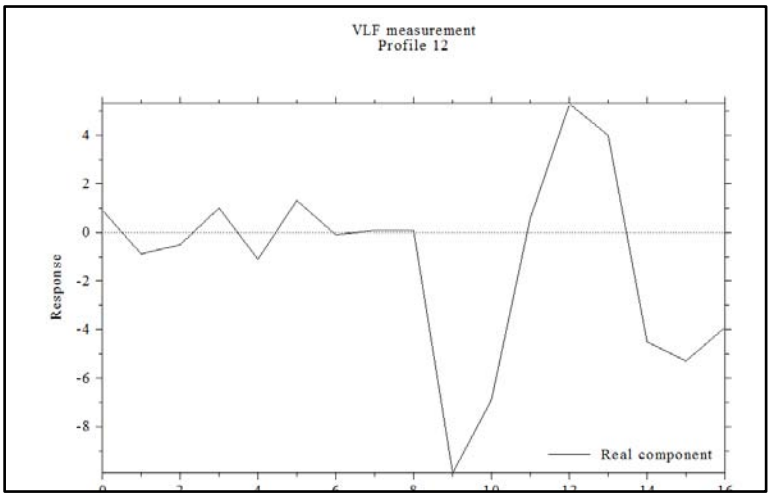

Figure 15a

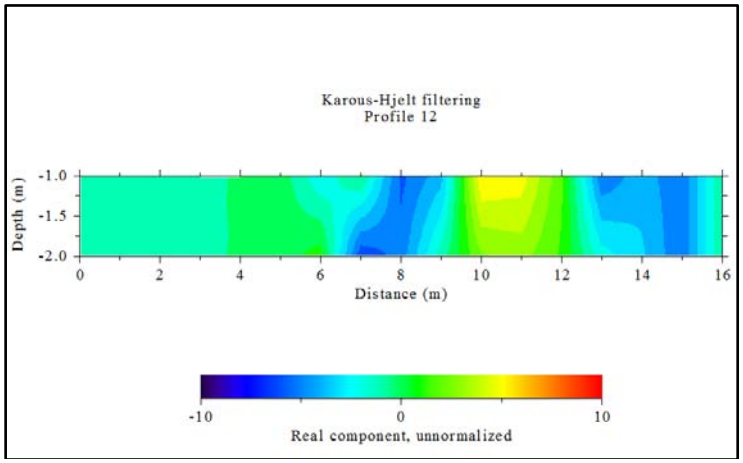

Figure 15b

Figure 15 (a): Filtered in-phase data against distance at location VLF 12 (b): Current density cross section plot in-phase data against distance at location VLF 12

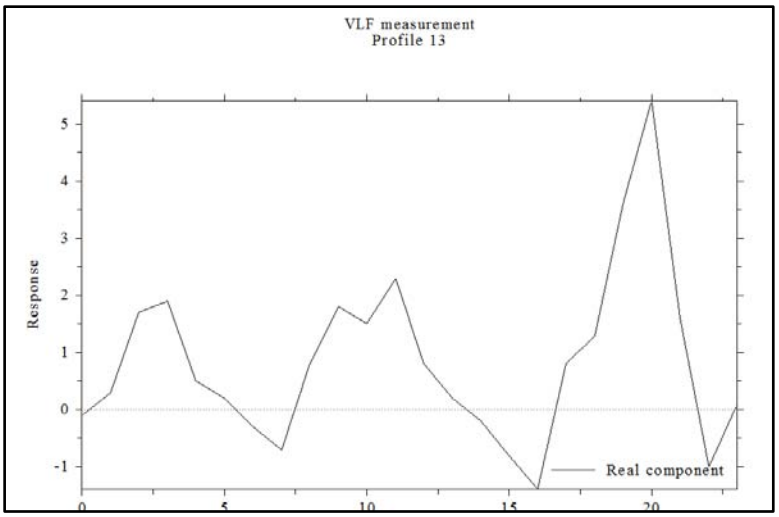

Figure 16a

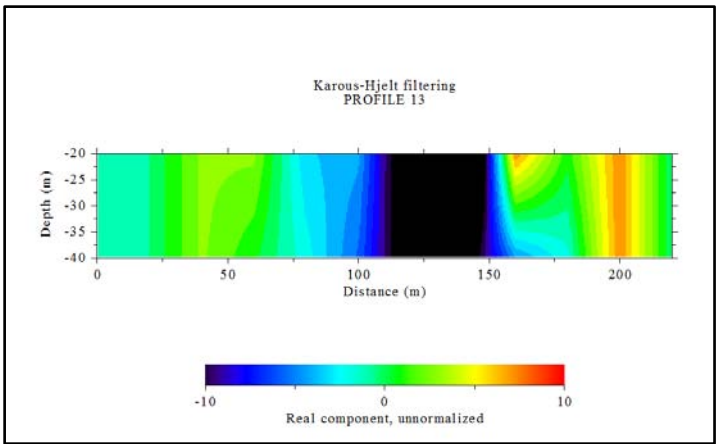

Figure 16b

Figure 16 (a): Filtered in-phase data against distance at location VLF 13 (b): Current density cross section plot in-phase data against distance at location VLF 13

The EM anomalies vary greatly. Some of the anomaly peaks are narrow, sharp while others are broad with varying width extent. The values of the filtered real range from -0.9 to 22.5 across the study area. The profiles for the EM sections contain significant maxima in the filtered real part. Zones with peak positive filtered real anomalies are considered priority areas for electrical sounding, since they often correspond to zones with high conductivity, characteristic of water-filled fractures or faults (Alvin et. al., 1997), or effect of appreciable depth to bedrock or lithological variations within the unconsolidated regolith (White et al., 1988). In other words, VLF-EM anomalies were delineated as fairly-conductive, conductive, highly-conductive, fairly-resistive and resistive responses at different locations across the study area. Positive anomaly is indicative of steeply-dipping linear features such as fractures. These features serve as channels for migrating fluids and minerals. These points are zones of interest in groundwater abstraction in basement complex terrain. These results therefore form the basis for Vertical Electrical Sounding (VES) investigation that may subesequently be carried out on any portion of the study area.

V. Conclusion

The study area has good prospects for groundwater development due to the presence of fracture zones which are interconnected in nature. Further investigations for groundwater in the study area is therefore recommended; these should however be aimed at searching for fracture zones where overburden is relatively thin and any borehole drilled in the study area should be made to pass through as many fracture zones as possible. Finally, it is recommended that for productive and sustainable boreholes to be drilled on any location in the study area, relevant electrical resistivity methods should be employed for the Vertical Electrical Sounding (VES) of all areas of interests (as

suggested by the results of the present study) along each of the thirteen profiles that were traversed.

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Heavy Metal Content of Agricultural Soils in a Tropical Sudan Savannah Area: Katsina State, North-Western Nigeria

By Yaradua AI, Alhassan AJ, Nasir A, Hamisu I, Usman A, Idi A, Muhammad I, Muhammad IU & Saulawa lA
Umaru Musa Yaradua University

Abstract- This work contributes to the monitoring of Agricultural soil pollution in Katsina State, North western Nigeria by assessing the degree of heavy metal pollution in Agricultural soil samples. The study was conducted in the year 2017 within some catchment areas located within the 3 senatorial zones that constitute to make up the state (Katsina senatorial zone: Birchi, Dutsinma and Katsina; Daura senatorial zone: Daura, Ingawa and Zango; Funtua senatorial zone: Dabai, Funtua, Kafur, Malunfashi and Matazu). Analysis for the concentration of these heavy metals; Cr, Cd, Fe, Ni, Mn, Pb and Zn was conducted by the use of AAS (by Atomic Absorption Spectrophotometry) method. Several indices were used to assess the metal contamination levels in the Agricultural soil samples, namely; Geo-accumulation Index (Igeo), Enrichment Factor (EF), Contamination Factor (CF), Degree of Contamination (Cd) and Pollution Load Index (PLI).

Keywords: *agricultural soils, heavy metals, katsina state, pollution load index, contamination factor.*

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Heavy Metal Content of Agricultural Soils in a Tropical Sudan Savannah Area: Katsina State, North-Western Nigeria

Yaradua AI,[α] Alhassan AJ,[σ] Nasir A,[ρ] Hamisu I,[ω] Usman A[¥], Idi A,[§] Muhammad I,[χ] Muhammad IU[ν] & Saulawa IA[θ]

Abstract- This work contributes to the monitoring of Agricultural soil pollution in Katsina State, North western Nigeria by assessing the degree of heavy metal pollution in Agricultural soil samples. The study was conducted in the year 2017 within some catchment areas located within the 3 senatorial zones that constitute to make up the state (Katsina senatorial zone: Birchi, Dutsinma and Katsina; Daura senatorial zone: Daura, Ingawa and Zango; Funtua senatorial zone: Dabai, Funtua, Kafur, Malunfashi and Matazu). Analysis for the concentration of these heavy metals; Cr, Cd, Fe, Ni, Mn, Pb and Zn was conducted by the use of AAS (by Atomic Absorption Spectrophotometry) method. . Several indices were used to assess the metal contamination levels in the Agricultural soil samples, namely; Geo-accumulation Index (Igeo), Enrichment Factor (EF), Contamination Factor (CF), Degree of Contamination (Cd) and Pollution Load Index (PLI). The result of this study has shown that generally among the heavy metals evaluated, the highest concentration was observed for Fe (range: 20.195-38.347 ppm), followed by Zn (range: 0.528-1.134 ppm), Pb (range: 0.256-0.627 ppm), Mn (range: 0.261-0.572 ppm) and Cr (range: 0.093-0.344 ppm). While Cd has the lowest concentration (range: 0.022-0.043 ppm). For all the site sampled the heavy metal Ni was below detection level (BDL). From the results of heavy metals I-geo values, according to Muller's classification, soil samples from Birchi, Daura, Dutsinma, Kafur and Zango were unpolluted (class 0) while soil samples from Dabai, Funtua, Ingawa, Katsina, Malunfashi and Matazu are moderately polluted (class 1). The result for the enrichment factor has shown that with the exception of the heavy metal Fe, which shows significant enrichment for all the sites sampled all the other heavy metals show deficiency to minimal enrichment. Also based on the contamination factors for all soil samples the heavy metal Fe has a CF values range of 1.2861-2.3240, indicating that the Agricultural soil samples are moderately contaminated with Fe. In contrast, the rest of the heavy metals exhibit low contamination in general. The value of PLI ranges from 0.2408 to 0.4935, indicating unpolluted to moderate pollution, with the sampling site for Katsina displaying the highest PLI value while the sampling site of Ingawa has the lowest PLI. The Eri values for all samples are all < 40, presenting low ecological risk. The results suggest that the Agricultural soils samples from Katsina state has low contamination by the heavy metals evaluated.

Keywords: agricultural soils, heavy metals, katsina state, pollution load index, contamination factor.

Author α ¥ χ: Department of Biochemistry, Faculty of Natural and Applied Sciences, Umaru Musa Yaradua University, P.M.B. 2218, Katsina, Nigeria. e-mail: aliyuyaradua5@gmail.com

Author σ §: Department of Geography, Faculty of Basic Medical Sciences, Bayero University Kano, P.M.B. 3011, Kano, Nigeria.

Author ω: Department of Biochemistry, Faculty of Basic Medical Sciences, Yusuf Maitama Sule University, P.M.B. 3220, Kano, Nigeria

Author θ: Department of Animal Production and Health, Federal University, P.M.B. 5007, Dutsinma, Katsina State, Nigeria.

I. Introduction

Soil is not only a medium for plant growth or pool to dispose of undesirable materials, but also a transmitter of many pollutants to surface water, groundwater, atmosphere and food. It is a key part of the Earth system as it control the hydrological, erosional, biological, and geochemical cycles (Chen et al., 1997). The soil system also offers goods, services, and resources to humankind (Berendse et al., 2015; Brevik et al., 2015; Decock et al., 2015; Smith et al., 2015). Soils have been used to detect the deposition, accumulation, and distribution of heavy metals in different locations (Alirzayevaet al., 2006; Onder et al., 2007), this is why it is necessary to research how soils are affected by societies. Pollution is one of these damaging human activities, and we need more information and assessment of soil pollution (Mahmoud and El-Kader, 2015; Riding et al., 2015; Roy and Mcdonald, 2015; Wang et al., 2015). Heavy metal pollution of agricultural soil can result not only in decreased crop output and quality and hurt human health through the food chain, but also further deterioration of air and water environmental quality (Turkdogan et al., 2002; Su and Wong, 2003; Xia et al., 2004). Excessive accumulation of heavy metals in agricultural soils can affect the quality and safety of food and further increase the risk of serious diseases (cancer, kidney, liver damage, etc.), as well as impact ecosystems, thus combining environmental chemistry with biological toxicology and ecology (Suresh et al., 2012).Literature indicates that studies have been conducted on pollution by heavy metals of some areas in Nigeria (Ahaneku and Sadiq, 2014; Opaluwa et al., 2012; Abdullateef et al., 2014; Orisakwe et al., 2012), but nothing of such has been monitored on the heavy metal levels emanating from Agricultural soils in Katsina state

Northwestern Nigeria and their possible effects on the quality of soil and human health. Therefore, it is important to investigate the level of heavy metals in Katsina agricultural soil to ascertain pollution levels.

II. Material and Methods

a) Study Area

The study was carried out during 2017 in Katsina State, Nigeria located between latitude 12015'N and longitude of 7030'E in the North West Zone of Nigeria, with an area of 24,192km2 (9,341 sq meters). The study was conducted within some catchment areas located within the 3 senatorial zones that constitute to make up the state (Katsina senatorial zone: Birchi, Dutsinma and Katsina; Daura senatorial zone: Daura, Ingawa and Zango; Funtua senatorial zone: Dabai, Funtua, Kafur, Malunfashi and Matazu). Katsina State has two distinct seasons: rainy and dry. The rainy season begins in April and ends in October, while the dry season starts in November and ends in March. This study was undertaken during the dry season. The average annual rainfall, temperature, and relative humidity of Katsina State are 1,312 mm, 27.3^{o}C and 50.2%, respectively. Like most alluvial soils, the soil in Katsina state is the flood plain type and is characterized by considerable variations. The soil has two main types, which are soils with little hazards and soils with good water holding capacity.

b) Soil Sampling

Fifty-five soil samples were collected from 0-20 cm depths (plough layer) of cultivated farmland with a hand auger from the designated sampling areas. Five samples were collected randomly from each location. The distance from one sampling point to another was approximately 50 m at each location. The collected five samples from each location were mixed and about 250-300 g of the soil was sampled and put into a polyethylene container in accordance with the method adopted by (Syed et al., 2012).The samples were properly labeled and were taken to the laboratory for analysis.

c) Chemical Analysis of Soil Samples

Soil samples were dried at room temperature and pebbles, stones, and large debris were removed from the soils before it was passed through a 2 mm polyethylene sieve. All glassware and plastic ware were soaked in 10% nitric acid for 24 hrs and rinsed thoroughly with deionized water. The soil samples were digested by mixed acid (HCl-HNO3) for Mn, Zn, Pb, Cd, Ni, Fe and Cr analyses. The concentrations of the heavy metals were measured by an atomic absorption spectrometer (AA210RAP BUCK Atomic Absorption Spectrometer flame emission spectrometer filter GLA-4B Graphite furnace, East Norwalk USA) according to standard methods (AOAC, 1995) and the results were given in part per million (ppm).

III. Results and Discussion

Soil samples from 11 locations within the 3 senatorial zones of Katsina State were analyzed in this study. As shown in Table 1, among the heavy metals evaluated, the highest concentration was observed for Fe (range: 20.195-38.347 ppm), followed by Zn (range: 0.528-1.134 ppm), Pb (range: 0.256-0.627 ppm), Mn (range: 0.261-0.572 ppm) and Cr (range: 0.093-0.344 ppm). While Cd has the lowest concentration (range: 0.022-0.043 ppm) and the concentration range for the heavy metal Ni was BDL in all the soil samples.

The Pb concentration range for the agricultural soil samples in this study is similar to that reported for soils from post office area, Bulunkutu and Bama station in Maiduguri metropolis, Borno state Nigeria (Abdullateef et al., 2014) and that reported for soil samples from Lafia metropolis, Nasarawa state, Nigeria with a Pb concentration range of 0.100- 0.530 ppm (Opaluwa et al., 2012). But the values are lower than those reported for the Pb concentration in soils in Bosso, Chanchaga, Gidan Kwano, Ogbomosho, Owerri and Ibeno Akwalbom in Nigeria (Ahaneku and Sadiq, 2014; Oladeji et al., 2016; Orisakwe et al., 2012; Udosen et al., 2012), and also in Pb levels in soils reported in studies conducted in Tarnaveni city of Romania, Birjand city of Iran, Western Rajastan, Faisalabad, Suxian county south China and Thrace region of Turkey (Mihaileanu et al., 2019; Sayadi et al., 2017; Anjula, 2014; Farid et al., 2015; Daping et al., 2015; Ekmekyapar et al., 2012). Furthermore the result for the Pb concentration in this study is higher than that reported in a study that evaluates heavy metal concentrations of some selected Dams sediment in Katsina state Nigeria (Yaradua et al., 2018).

The Cd concentration range for the soil samples in this study is similar to that reported by Farid et al., (2015) for Cd values for soil samples from Madina town of Faisalabad and that reported for Nanxun county Southeast China (Zhou et al., 2015), Thrace region of Turkey (Ekmekyapar et al., 2012) and the results for studies on heavy metals in soils conducted in the towns of Bosso, Chanchaga, Gidan Kwano, Lafia metropolis, Maiduguri metropolis and the city of Owerri all in Nigeria (Ahaneku and Sadiq, 2014; Opaluwa et al., 2012; Abdullateef et al., 2014; Orisakwe et al., 2012). But the values are lower than that reported in studies for the Cadmium concentration in soils conducted in Suxian county, western Rajastan, Birjand city in Asia (Daping et al., 2015; Anjula, 2014; Sayadi et al., 2017) and in studies conducted in Nigeria (Udosen et al., 2012; Oladeji et al., 2016) and that reported for Cd in sediments from Katsina state Nigeria (Yaradua et al., 2018).

Though an essential heavy metal, Fe has the tendency to become toxic to living organisms, even when exposure is low. In the present study, the mean Fe concentration in both the soil samples was higher than that reported for soil samples from Lafia metropolis Nasarawa state, Nigeria (Opaluwa et al., 2012) and that of a study conducted by Abdullateef et al., (2014) in Maiduguri metropolis Borno state, Nigeria. But the result is lower than the Fe concentration in soil from Ibeno Akwa Ibom state Nigeria (Udosen et al., 2012).

The heavy metal Zn concentration obtained in this study is higher than the report of a study conducted in Lafia, Nasarawa state Nigeria (Opaluwa et al., 2012). But the result is lower than that that reported for Zn in soil from western Rajastan (Anjula, 2014), Zn concentration in soil from Thrace region of Turkey (Ekmekyapar et al., 2012), the result of Oladeji et al., (2016), the result for Zn in soil from Ogbomosho, Nigeria and that reported for Zn in soils from Bosso, Chanchaga and Gidan-Kwano Niger state Nigeria (Ahaneku and Sadiq, 2014).

The present study recorded a concentration range of 0.093-0.344 ppm for the heavy metal Cr, values that are lower to that reported for Cr in soils from western Rajastan and Birjand city of Iran (Anjula et al., 2014), Thrace region of Turkey (Ekmekyapar et al., 2012), Tarnaveni in Romania (Mihaileanu et al., 2019) and the result of Cr in various soil samples from Maiduguri state, Nigeria (Abdullateef et al., 2014). But the values are similar to the results of Ahaneku and Sadiq (2014) of Cr in soils from Bosso, Chanchaga and Gidan Kwano in Nasarawa state, Nigeria.

The heavy metal Mn mean concentration obtained in this study is lower than the Mn concentrations in soil near a former chemical manufacturing facility in Tarnaveni, Romania (Mihaileanu et al., 2019).

Table 1: Heavy metals concentration in agricultural soils from katsina state (ppm)

Location			Heavy Metal				
	Mn	Zn	Pb	Cd	Ni	Fe	Cr
Birchi	0.300 ± 0.0005	0.641 ± 0.0004	0.448 ± 0.0002	0.033 ± 0.0003	BDL	21.212 ± 0.0009	0.344 ± 0.0003
Dabai	0.566 ± 0.0015	1.207 ± 0.0002	0.348 ± 0.0003	0.025 ± 0.0001	BDL	24.896 ± 0.0012	0.093 ± 0.0002
Daura	0.287 ± 0.0006	0.968 ± 0.0003	0.529 ± 0.0008	0.043 ± 0.0003	BDL	22.246 ± 0.0002	0.226 ± 0.006
Dutsinma	0.321 ± 0.0004	0.612 ± 0.0004	0.441 ± 0.0006	0.032 ± 0.0004	BDL	23.342 ± 0.0006	0.342 ± 0.0006
Funtua	0.572 ± 0.0004	1.132 ± 0.0006	0.541 ± 0.0015	0.025 ± 0.0006	BDL	28.264 ± 0.0012	0.268 ± 0.0003
Ingawa	0.261 ± 0.0007	1.099 ± 0.0003	0.627 ± 0.0002	0.034 ± 0.0002	BDL	20.195 ± 0.0023	0.143 ± 0.0010
Kafur	0.511 ± 0.0006	1.083 ± 0.0015	0.462 ± 0.0013	0.031 ± 0.0004	BDL	31.716 ± 0.0009	0.241 ± 0.0004
Katsina	0.486 ± 0.0004	0.775 ± 0.0002	0.256 ± 0.0002	0.024 ± 0.0002	BDL	38.347 ± 0.0009	BDL
Malunfashi	0.470 ± 0.0012	1.094 ± 0.0004	0.402 ± 0.0003	0.026 ± 0.0003	BDL	32.985 ± 0.0017	0.285 ± 0.0002
Matazu	0.277 ± 0.0004	1.134 ± 0.0002	0.285 ± 0.0003	0.022 ± 0.0001	BDL	37.442 ± 0.0009	0.099 ± 0.0007
Zango	0.272±0.0015	0.528±0.0006	0.564±0.0002	0.032±0.0004	BDL	24.568±0.0006	0.232±0.0002

Values are expressed as Mean ± Standard deviation

a) Indices

Several indices were used to assess the metal contamination levels in the Agricultural soil samples, namely; Geo-accumulation index (I-geo), Pollution Load Index (PLI), Enrichment Factors (EF), Contamination Factor (CF) and Degree of Contamination (Cd). World surface rock average data of heavy metals which was used as background values were taken from Martin and Meybeck (1979).

b) Geo-Accumulation Index

Geo-accumulation index (I-geo) was employed to evaluate the heavy metals pollution in the Agricultural soil samples. This method has been used by Müller since the late 1960s (Muller, 1969). I-geo was calculated using the following equation:

$$\text{I-geo} = \log_2 / (C_n / 1.5B_n)$$

Where C_n is the measured content of the examined metal in the sediment samples and B_n is the geochemical background content of the same metal. The constant 1.5 is introduced to minimize the effect of possible variations in the background values, which may be recognized to anthropogenic influences The index of geo-accumulation (Igeo) is characterized according to the Muller seven grades or classes profile of the geo-

accumulation index i.e. the value of soil quality is considered as unpolluted (Igeo is ≤0, class 0); from unpolluted to moderately polluted (Igeo is 0 - 1, class 1); moderately polluted (Igeo is 1 - 2, class 2); from moderately to strongly polluted (Igeo is 2 - 3, class 3); Strongly polluted (Igeo is 3 - 4, class 4); from strongly to extremely polluted (Igeo is 4 - 5, class 5) and Extremely polluted (Igeo is >6, class 6) (Muller, 1969).) Therefore, from the results of heavy metals I-geo values on table 2, according to Muller's classification, soil samples from Birchi, Daura, Dutsinma, Kafur and Zango were unpolluted (class 0) while soil samples from Dabai, Funtua, Ingawa, Katsina, Malunfashi and Matazu are from unpolluted to moderately polluted (class 1). The Igeo values seen in the present study similar to the values.

Table 2: Heavy Metals Geo-accumulation Values for Agricultural Soils from Katsina State

			I-geo			
Site	Mn	Zn	Pb	Cd	Fe	Cr
Birchi	-3.1549	-2.4685	-1.7282	-0.9586	-0.0680	-2.4949
Dabai	-2.9208	-2.2007	-1.8386	-0.0794	0.0026	-3.0969
Daura	-3.2219	-2.2924	-1.6556	-0.8438	-0.0463	-2.6778
Dutsinma	-3.1549	-2.4949	-1.7352	-0.9718	-0.0254	-2.4949
Funtua	-2.9208	-2.2292	-1.6478	-1.0793	0.0577	-2.6021
Ingawa	-3.2219	-2.2366	-1.5834	-0.9457	0.1077	-2.8861
Kafur	-2.9586	-2.2441	-1.7144	-0.9859	-0.0883	-2.6383
Katsina	-2.9586	-2.4202	-1.9706	-1.0969	0.1902	BDL
M/Fashi	-3.0000	-2.2441	-1.7747	-1.0620	0.1247	-2.5686
Matazu	-3.2219	-2.2219	-1.9245	-1.1350	0.1798	-3.0458

c) Enrichment Factor

Enrichment Factors (EF) were considered to estimate the abundance of metals in the Agricultural soil samples. EF was calculated by a comparison of each tested metal concentration with that of a reference metal (Muller, 1981). The normally used reference metals are Mn, Al and Fe (Liu et al., 2005). In this study Fe was used as a conservative tracer to differentiate natural from anthropogenic components, following the hypothesis that its content in the earth crust has not been troubled by anthropogenic activity and it has been chosen as the element of normalization because natural sources (98%) greatly dominate its contribution (Tippie, 1984). According to Rubio et al. (2000), the EF is defined as follows:

$$EF = (M/Fe)_{sample}/(M/Fe)_{Background}$$

Where EF is the enrichment factor, $(M/Fe)_{sample}$ is the ratio of metal and Fe concentration of the sample and $(M/Fe)_{background}$ is the ratio of metals and Fe concentration of a background. Five contamination categories are reported on the basis of the enrichment factor (Sutherland, 2000). EF <2 deficiency to minimal enrichment, EF = 2-5 moderate enrichment, EF = 5-20 significant enrichment, EF = 20-40 very high enrichment, EF>40 extremely high enrichment. As shown in Table 3, with the exception of the heavy metal Fe, which shows significant enrichment for all the sites sampled all the other heavy metals show deficiency to minimal enrichment.

Table 3: Enrichment factor values for soil samples from selected sites in katsina state

			Enrichment	Factor (EF)		
Site	Mn	Zn	Pb	Cd	Fe	Cr
Birchi	0.2007	0.4288	0.2828	0.0221	14.1949	0.2301
Dabai	0.3403	0.7257	0.2092	0.0150	14.6681	0.0559
Daura	0.1784	0.6017	0.3288	0.0267	13.8280	0.1405
Dutsinma	0.1989	0.3793	0.2733	0.0205	14.4649	0.2119
Funtua	0.2610	0.5166	0.2469	0.0114	12.8989	0.1223
Ingawa	0.0181	0.0761	0.0433	0.6024	13.9750	0.0099
Kafur	0.2410	0.5108	0.2179	0.0146	14.9586	0.1137
Katsina	0.1969	0.3140	0.1037	0.0097	15.535	BDL
M/Fashi	0.2168	0.5046	0.1854	0.0120	15.2138	0.1315
Matazu	0.1150	0.5054	0.1270	0.0098	16.6854	0.0441
Zango	0.1607	0.3119	0.33320.	0.0189	14.5124	0.1370

d) Contamination Factor

Contamination Factor (CF) was used to determine the contamination status of the Agricultural soils in the current study. CF was calculated according to the equation described below (Pekey et al., 2004):

$$C = M_c/B_c$$

Where M_c Measured concentration of the metal and B_c is the background concentration of the same metal. Four contamination categories are documented on the basis of the contamination factor (Hakanson, 2000). CF<1 low contamination; 1≤CF≥3 moderate contamination; 3≤CF<6 considerable contamination; CF>6 very high contamination, while the degree of contamination (Cd) was defined as the sum of all contamination factors. The following terms is adopted to illustrate the degree of contamination: Cd<6: low degree of contamination; 6≤Cd<12: moderate degree of contamination; 12≤Cd<24: considerable degree of contamination; Cd>24: very high degree of contamination indicating serious anthropogenic pollution. The result of the contamination factors for the evaluated heavy metals is shown on table 3. From the table, the relative distributions of the contamination factor among the samples are: Fe > Cd > Pb > Zn > Cr > Mn. Soils have been used as environmental indicators, and this ability to identify heavy metal contamination sources and monitor contaminants is also well documented. Thus, the accumulation of metals in the soils is strongly controlled by the nature of the substrate as well as the physicochemical conditions controlling dissolution and precipitation (Venkatramanan et al., 2012). For all soil samples the heavy metal Fe has a CF values range of 1.2861-2.3240, indicating that the Agricultural soil samples are moderately contaminated with Fe. In contrast, the rest of the heavy metals exhibit low contamination in general.

Table 4: Contamination Factor for Agricultural Soil Samples from Katsina State

		Contamination	Factor	(CF)		
Site	Mn	Zn	Pb	Cd	Fe	Cr
Birchi	0.0010	0.0051	0.0280	0.1690	1.2861	0.0049
Dabai	0.0018	0.0095	0.0218	0.1250	1.5089	0.0013
Daura	0.0009	0.0076	0.0331	0.2150	1.3482	0.0032
Dutsinma	0.0010	0.0048	0.0276	0.1600	1.4147	0.0048
Funtua	0.0019	0.0089	0.3380	0.1250	1.7130	0.0038
Ingawa	0.0008	0.0086	0.0392	0.1700	1.2239	0.0020
Kafur	0.0017	0.0085	0.0289	0.1550	1.9220	0.0034
Katsina	0.0016	0.0061	0.0160	0.1200	2.3240	BDL
M/Fashi	0.0015	0.0086	0.0251	0.1300	1.9990	0.0040
Matazu	0.0009	0.0089	0.0178	0.1100	2.2692	0.0014
Zango	0.0009	0.0042	0.0353	0.1600	1.4890	0.0033

e) Degree of Contamination and Pollution Load Index

The degree of contamination (Cd) was defined as the sum of all contamination factors. The following terms is adopted to illustrate the degree of contamination: Cd<6: low degree of contamination; 6≤Cd<12: moderate degree of contamination; 12≤Cd<24: considerable degree of contamination; Cd>24: very high degree of contamination indicating serious anthropogenic pollution. Pollution Load Index (PLI) was used to evaluate the extent of pollution by heavy metals in the environment. The range and class are same as Igeo. PLI for each sampling site has been calculated following the method planned by Tomlinson et al. (1980) as follows:

$$PLI = [[(CF_1 + CF_2 + CF_3 \ldots\ldots\ldots CF_n)]] \wedge (1/n)$$

Where n is the number of metals and CF is the contamination factor.

The value of PLI ranges from 0.2408 to 0.4935 (Table 5), indicating unpolluted to moderate pollution. However, the sampling site for Katsina displayed the highest PLI value while the sampling site of Ingawa has the lowest PLI.

Table 5: Degree of contamination and pollution load index of agricultural soils from katsina state

Site	Degree of Contamination	Pollution Load Index
Birchi	1.4941	0.2490
Dabai	1.6633	0.2772
Daura	1.6080	0.2680
Dutsinma	1.6129	0.2688
Funtua	2.1906	0.3651
Ingawa	1.4445	0.2408
Kafur	2.1195	0.3533
Katsina	2.4677	0.4935
M/Fashi	2.1682	0.3614
Matazu	2.4082	0.4014
Zango	1.6927	0.2821

f) Potential Ecological Risk Index

This research employed the Potential Ecological Risk Index (PERI) proposed by Hakanson (1980) to evaluate the potential ecological risk of heavy metals. This method comprehensively considers the synergy, toxic level, concentration of the heavy metals and ecological sensitivity of heavy metals (Nabholz, 1991; Singh et al., 2010; Douay et al., 2013). PERI is formed by three basic modules: degree of contamination (CD), toxic-response factor (TR) and potential ecological risk factor (ER).The ecological risk index (Eri) evaluates the toxicity of trace elements in sediments and has been extensively applied to soils (Liang et al., 2015). Soils contaminated by heavy metals can cause serious ecological risks and negatively impact human health due to various forms of interaction (agriculture, livestock, etc.) where highly toxic heavy metals can enter the food chain. To calculate the Eri for individual metals, the following Equation was used;

$$Eri = Tri \times Cfi$$

Where, Tri is the toxicity coefficient of each metal whose standard values are Cd = 30, Ni = 5, Pb = 5, Cr = 2, and Zn = 1, Mn = 1 (Hakanson, 1980; Xu, 2008) and Cfi is the contamination factor. To describe the ecological risk index the following terminology was used: $Er < 40$, low; $40 \leq Er < 80$, moderate; $80 \leq Er < 160$, considerable; $160 \leq Er < 320$, high; and $Er \geq 320$, very high. The risk factor was used as a diagnostic tool for water pollution control, but it was also successfully used for assessing the contamination of soils in the environment by heavy metals (Mugosa et al., 2016). The Eri values for all samples are all < 40 (Table 6), presenting low ecological risk.

Table 6: Ecological risk index of agricultural soils from katsina state

	Ecological	Risk Index (Eri)			
Site	Mn	Zn	Pb	Cd	Cr
Birchi	0.0010	0.0051	0.1400	5.0700	0.0098
Dabai	0.0018	0.0095	0.1090	3.7500	0.0026
Daura	0.0009	0.0076	0.1655	6.4500	0.0064
Dutsinma	0.0010	0.0048	0.1380	4.8000	0.0096
Funtua	0.0019	0.0089	0.1690	3.7500	0.0076
Ingawa	0.0008	0.0086	0.1960	5.1000	0.0040
Kafur	0.0017	0.0085	0.1445	4.6500	0.0068
Katsina	0.0016	0.0061	0.0800	3.6000	BDL
M/Fashi	0.0015	0.0086	0.1255	3.9000	0.0080
Matazu	0.0009	0.0089	0.0890	3.3000	0.0028
Zango	0.0009	0.0042	0.1765	4.8000	0.0066

IV. Conclusion

The main goal of this research is to assess the levels of some heavy metals in Agricultural soils of Katsina state, north western Nigeria, in order to determine the impact of anthropogenic heavy metal pollution arising from Agricultural activities. Several indices were used to assess the metal contamination levels in the Agricultural soil samples, namely Geo-accumulation index (I-geo), Pollution Load Index (PLI), Enrichment Factors (EF), Contamination Factor (CF) and Degree of Contamination (Cd). The result of this study reveals that generally among the heavy metals evaluated, the highest concentration was observed for Fe (range: 20.195-38.347 ppm), followed by Zn (range: 0.528-1.134 ppm), Pb (range: 0.256-0.627 ppm), Mn (range: 0.261-0.572 ppm) and Cr (range: 0.093-0.344 ppm). While Cd has the lowest concentration (range: 0.022-0.043 ppm) and the heavy metal Ni BDL in all the soil samples. From the results of heavy metals I-geo values, according to Muller's classification, soil samples from Birchi, Daura, Dutsinma, Kafur and Zango were unpolluted (class 0) while soil samples from Dabai, Funtua, Ingawa, Katsina, Malunfashi and Matazu are from unpolluted to moderately polluted (class 1). The result for the enrichment factor has shown that with the exception of the heavy metal Fe, which shows significant enrichment for all the sites sampled all the other heavy metals show deficiency to minimal enrichment. Based on the contamination factors for all soil samples the heavy metal Fe has a CF values range of 1.2861-2.3240, indicating that the Agricultural soil samples are moderately contaminated with Fe. In contrast, the rest of the heavy metals exhibit low contamination in general. The value of PLI ranges from 0.2408 to 0.4935, indicating unpolluted to moderate pollution. However, the sampling site for Katsina displayed the highest PLI value while the sampling site of Ingawa has the lowest PLI. The Eri values of heavy metals for all samples are all < 40, presenting low ecological risk.

Competing Interests

Authors have declared that no competing interests exist.

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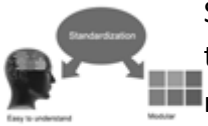

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Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

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Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for writing a good quality Social Science Research Paper

Techniques for writing a good quality homan social science research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of homan social science then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.
Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

19. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

20. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

21. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

22. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

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Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to 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 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 avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

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

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite 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 approaches 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. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a 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 limit the initial two items to no more than one line each.

Reason for writing the article—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 for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity 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 of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets 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 for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory 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 soundly written procedures segment allows a capable scientist to replicate 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 to give the least amount of information that would permit another capable scientist to replicate 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 section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show 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:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the 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—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and 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 as 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. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give 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 manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit 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 section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an 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 implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully 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 the prospect, and let it drop at that. Make a decision as to whether each premise is supported or 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 an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of 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 other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals

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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