# Analysis of Geospatial Data of Morogoro Region: Lessons for Educationists and Researchers.

**Conference Paper** · May 2019



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# Analysis of Geospatial Data of Morogoro Urban: Lessons for Educationists and Researchers

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## Abstract

There has been a growing need of scientists to utilize geospatial data in a variety of fields of study due to the advancement of ICT as a tool for both gathering and analyzing geospatial data. As Geographic Information System (GIS) gains momentum, the use of geospatial data becomes prominent in education especially in subjects that deal with place and space processes such as geography. Unfortunately in developing countries propagation of GIS in education is of low pace partly because of less utilization of ICT and ICT based technologies in teaching and learning. In order to address the problem of underutilization of geospatial data in education teachers' knowledge, skills and motivation for using GIS data needs to be reinforced. This paper shows why the use of geospatial data in geography is necessary. It shows how teachers and students in schools can be both supported and motivated to use geospatial data with reference to analysis of information based on satellite images of Morogoro urban district. The paper shows the way these geospatial data can be used to address various questions raised for each topic in geography at advanced level secondary school. The discussion part shades light on the path that needs to be followed by policy makers to mobilize efforts of educationists and other experts in geography, mathematics, statistics and ICT based disciplines. The efforts should focus on gathering and analyzing more of GIS data and also simplify their accessibility by classroom teachers so that they can improve their classroom practice and outdoor learning avenues. The foreseen challenges and the role of individual stakeholders to advance the uses of GIS data in education are also highlighted.

**Keywords:** Geographic Information System (GIS); Geospatial data; Teaching and learning; Geography; Morogoro

## 1. Introduction

GIS represents an effective tool for teaching the understanding of space and place. GIS finds application in various fields from natural science and geology to sociology and anthropology, from political sciences, economics and urban studies to archaeology and history. The use of this tool enables the introduction of research methods in geography teaching, leading, for example, to the acquisition of the ability to create a conceptual model of reality that can be studied as well as to select the most useful data for this purpose, to interpret it independently, and to represent it effectively (*Azzari, Zamperlin, Landi, 2013)*
Many authors argue that GIS should be included in the geography curriculum (e.g. Bednarz& Van der Schee, 2006; Pallandino & Goodchild, 1993; Patterson, Reeve, & Page, 2003; Sumari, Shao, Kira, 2017). It is used more and more in fundamental geography as well as in applied geography. Researchers argued that GIS and other geospatial technologies are saving lives, helping planning more livable communities, fostering economic development, improving human health, and mitigating conflict (Scholten et al., 2009; Sumari et al., 2017). In order to give students an impression of what is geography in practice, students should learn about the way professional geographers and others in business, government, and science use GIS.

Geospatial analysis pose lessons to educationists who may need to demand more specific information for curricular materials at various levels of education which are more accurate, can help our society to address prevailing challenges and also establish the required physical and social infrastructure for development. This is by considering that educationists are the trusted educators who are believed by learners not only to be the custodians of useful knowledge, skills and attitudes relevant to the contemporary society but also the founder of curricular materials such as educational policies, syllabuses, textbooks, training guides and manuals. If geospatial information cannot be accessed to our educationists it is likely that teachers may be teaching outdated information in various fields.

One of the frequently cited challenges is teachers' limited knowledge about, skills in, and motivation for teaching geography with GIS. As teachers can be seen as the "gate keepers of educational innovations" (Wallace, 2004), the successful introduction and diffusion of GIS in secondary geography education largely depends on whether geography teachers possess the required competences. However, teachers often have the feeling they are not able to design and conduct good GIS-supported geographic inquiry projects with their classes (Lam et al., 2009). So whether teachers will be able to use GIS when teaching is determined by motivation or knowledge and skills on how to use it. The extent to which teachers can be motivated to use GIS data may partly depend on the role such data can be used to improve their classroom practice and also on the availability of such data.

The purpose of this paper is to use geospatial data of Morogoro urban to pin point the main areas particularly in geography curricular materials that seem to be misleading including the way applications of such data could address what is overlooked in the geography syllabus at advanced level secondary school. General questions are posed by the authors to exemplify why GIS should be used by teachers to influence their motivation in using it. These general questions are followed by more specific questions that show teachers why GIS should be applied when teaching particular geography.

## 2. Methodology

### 2.1 Study Area

The study was conducted in Morogoro urban district in Morogoro Region. The region lies between latitude $5^{o}$ 58'' and $10^{o}$ 0'' to the South of the Equator and longitude $35^{o}$ 25'' and $35^{o}$ 30'' to the East. Seven other Regions border it where Arusha and Tanga regions to the North, the Coast Regions to the East, Dodoma and Iringa to the West, and Ruvuma and Lindi to the South. Morogoro Region occupies 72,939 square kilometers' which is approximately 8.2% of the total area of Tanzania mainland. It is the third largest region in the country after Arusha and Tabora Regions.

### 2.2 Data Used and Method

The study used satellite images from Landsat sensor for land use classification and was validated using ground build up data. Authors selected Landsat satellite images for 1990, 1995, 2002, 2007, 2012 and 2017 acquired by Landsat- 5-TM (Thematic Mapper), Landsat 7- ETM+ (Thematic Mapper Plus) and Landsat-8-OLI respectively, which have multi-temporal and different spatial resolution. Landsat images, and NDVI variations from Google Earth Platform were selected because their spectral bands are designed for agricultural analysis (Chander, Markham, &Helder, 2009; Wang, 2017; Zhu, 2014). Furthermore, the surface reflectance was directly downloaded from Google Earth Engine (GEE) Landsat collections, path 167 and row 65, and processed to Standard Terrain Correction. The sampled points for all classification legendry were trained for 12,538 from 1990 to 2017, the Landsat images were re-projected to Universal Transverse Mercator (UTM)-WGS84.

Field survey data were collected on built-up area between January and June, 2018 to provide the valid and accurate information by definitions. Here the authors collected field sample data using mobile devices with built in GPS. All surveyed fields sample were randomly selected within the study region where by the reference sample was validated. Random sampling was adopted as all points were homogeneous and had equal chance to be sampled. Overall, a total of 1,312points of field samples were collected in the area of 72,939km$^2$(Figure 1 below).

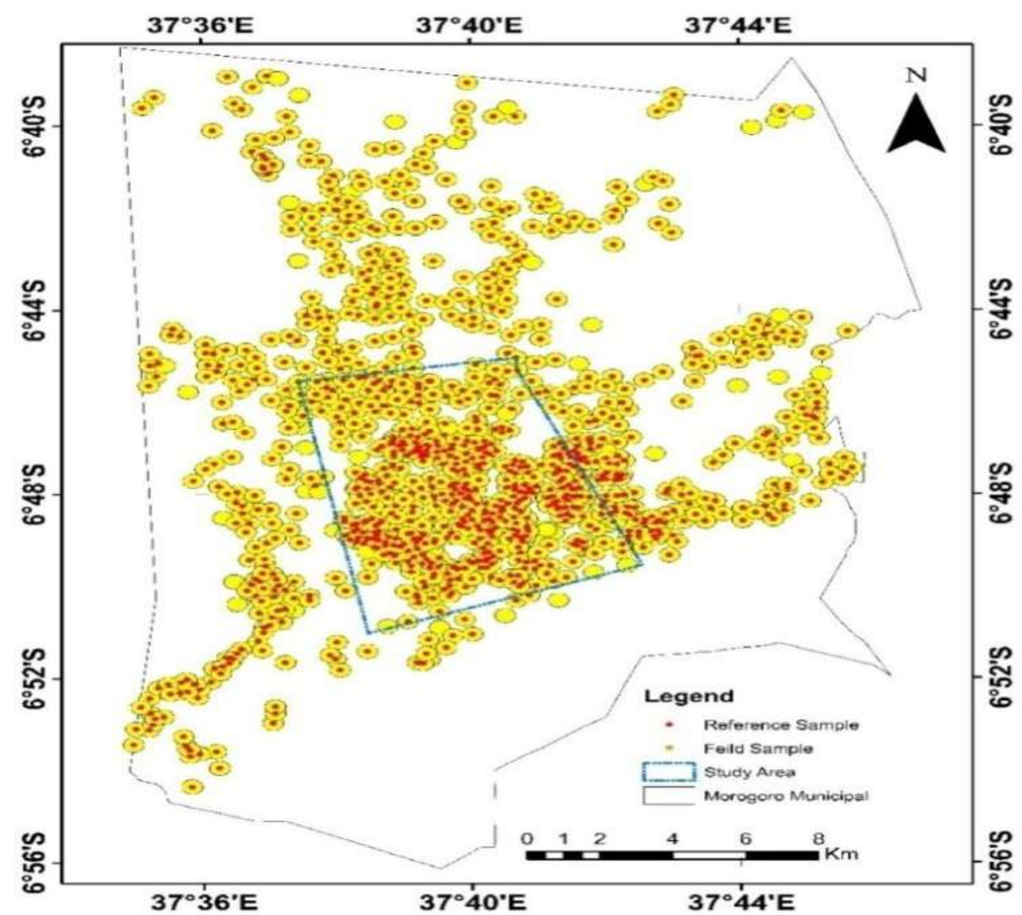
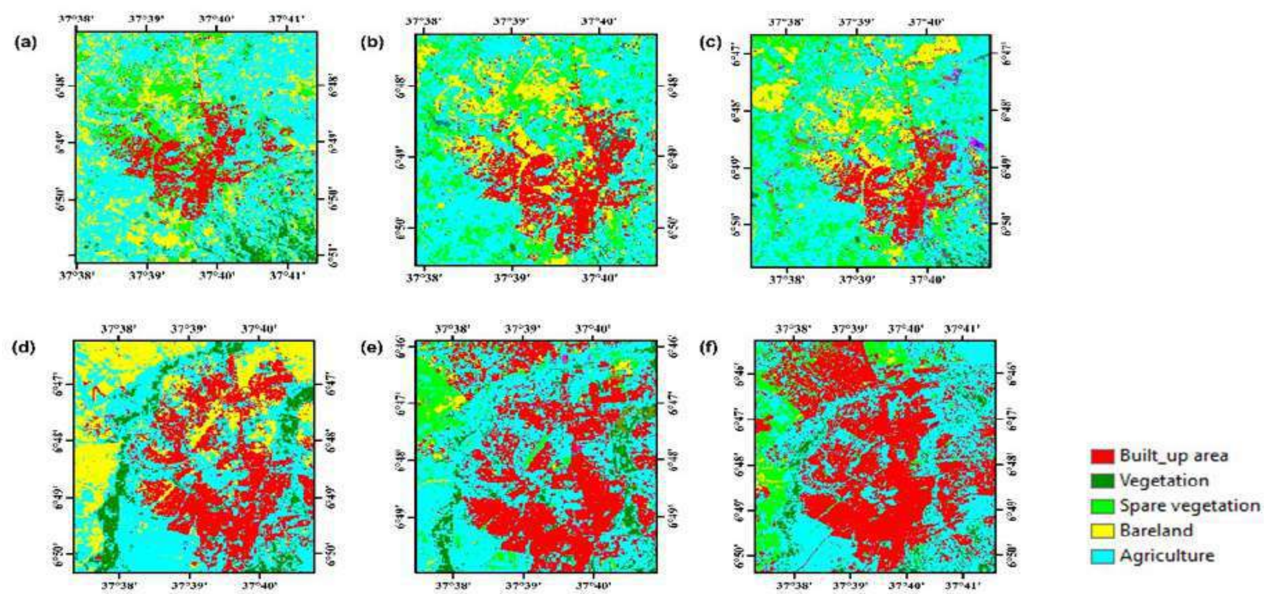



**Fig. 1: Spatial survey of sample sites developed in ArcGIS from GPS data Processing**

Satellite imagery can be accessed using different platforms such as Google Earth Engine platform (GEE). GEE is a cloud-computing platform that provides a mechanism to frequently monitor, and then visualize the Earth's surface in time series at spatial and temporal resolution. The utility of GEE to extract various land surface changes has been applied for studying land cover mapping (Kilawe et al., 2018; Sexton et al., 2013), In addition, GEE provides application programming interface (API) to access, process and visualize such data in an easy and suitable manner. Here an approach was presented to identify spatial changes of land use over a long period (28 years) using GEE and Landsat satellite observations. Then, all images were processed using ENVI version 5.3 and ArcGIS.

Different classification methods such as; Supervised Vector Machine known as SVM has been in use to classify satellite data for mapping agriculture, land cover mapping, impervious and pervious land (Huang el. at., 2018). Supervised algorithm on GEE for classification was applied. From the training data, authors identified unclassified area, built up area, vegetation cover, bare land, agricultural land and spare vegetation as six classes classified in Morogoro Region.

The following table, graph and images summarize these observations and interpretations.
The authors used these summarized data to provide clarification on how teaching




**Source:** Source: Field Data Survey, 2018

**Figure 3:** Satellite images of selected years showing trends of the changing land cover (a) 1990, (b) 1995, (c) 2002, (d) 2007, (e) 2012, and (f) 2017

of spatial sciences like geography using the available curricular materials may be misleading especially when focusing at a particular place and time**.**

**Table 1: Total area in Km$^2$ and percentage of land cover from 1990 to 2017 in** Morogoro

| Legends | 1990 | | 1995 | | 2002 | | 2007 | | 2012 | | 2017 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Km$^2$ | (%) | Km$^2$ | (%) | Km$^2$ | (%) | Km$^2$ | (%) | Km$^2$ | (%) | Km$^2$ | (%) |
| Built-up area | 8.58 | 3.43 | 11.06 | 4.41 | 17.82 | 7.10 | 26.73 | 10.67 | 38.85 | 15.49 | 48.24 | 19.24 |
| Vegetation | 43.42 | 17.34 | 43.54 | 17.35 | 41.89 | 16.7 | 39.89 | 15.92 | 36.85 | 14.69 | 44.97 | 17.94 |
| Agriculture | 144.47 | 57.70 | 140.69 | 56.06 | 138.08 | 55.04 | 133.98 | 53.46 | 128.85 | 51.37 | 120.38 | 48.01 |
| Spare vegetation | 46.66 | 18.64 | 44.43 | 17.71 | 42.28 | 16.85 | 39.77 | 15.87 | 36.92 | 14.72 | 34.31 | 13.68 |
| Bare Land | 7.26 | 2.90 | 11.23 | 4.48 | 10.80 | 4.30 | 10.22 | 4.08 | 9.35 | 3.73 | 2.81 | 1.12 |

**Source:** *Field Data Survey, 2018*

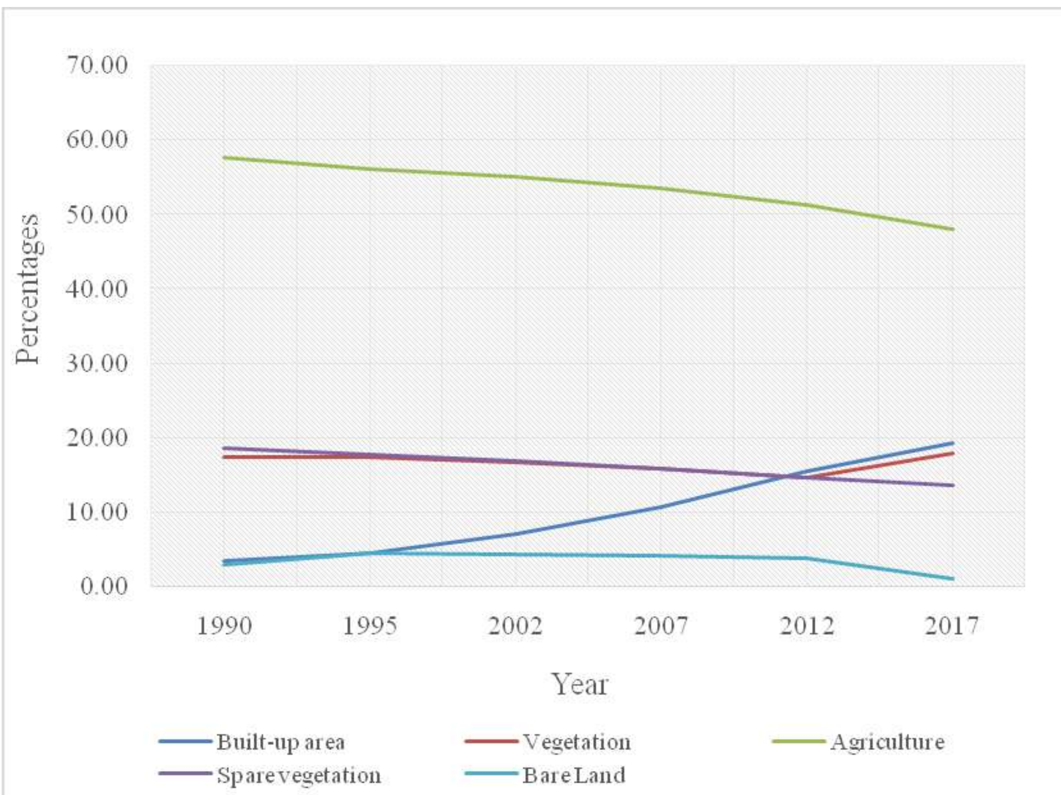



**Figure 2**: Trend of the changing land cover from 1990 to 2017 in Morogoro
**Source:** *Field Data Survey, 2018*

### *2.4 Misleading information in geography curricular materials*

In geography school, textbooks specify that Tanzania's climate range from tropical to temperate in the highlands. Average annual precipitation over the entire nation is 1,042-mm. Average temperatures range between 17°C and 27°C, depending on location. Natural hazards include both flooding and drought. Within the country, altitude plays a large role in determining rainfall pattern, with higher elevations receiving more precipitation. Only about half the country receives more than 762 mm annually (Mwandosya et al., 1998). This type of information is found in the school geography textbooks though it was researched several years back. Other data in the same books are like: Our economy is supported mainly by agriculture and the staple food is maize. Data in Table 1 which are clarified in Figure 2 show continuous decreases in natural vegetation and land available for agriculture and increasing urban population. Now questions that educationists need to ask themselves: Are climate variables constant with increasing urbanization and decreasing vegetation such that both temperature and rainfall are within the indicated limits? To what extent changing climate going to cause more natural hazards such as pastes, soil erosion, and landslides etc. other than the named two; i.e. floods and drought? With increasing, urbanization is maize a staple food in all places. However, more important question is that do educationists who prepare curricular materials such as syllabuses and textbooks specifically teachers capable of accessing up to date information across time and place? Also, are there researchers who are interested in generating database through geospatial analysis by establishing a relationship between geospatial data and the compounding physical and social economic issues?

Other information found in school geography books is like: Tanzania's economy is heavily dependent on agriculture, which accounts for nearly one-half of GDP, employs 80% of the workforce, and provides 85% of exports where topography and climatic conditions, however, limit cultivated crops to only 4% of the land area. In addition, Tanzania has about 338,000 km$^2$ under forest cover, which represents about 44% of the total land area. These forests are the important source of fuel wood and other products for large numbers of Tanzanians. The same information is also documented out of research (World Bank, 2002).Questions to ask are: Are these percentages constant under intensive urbanization and decreased land for agriculture, for instance considering the data in Table 2; are the forests in Tanzania occupying the same total area now as they were documented? It is important to note that the rate of urbanization differs from one region to another; some regions will be more affected than others. This implies that for geography books in primary schools which address the geography of specific regions in the country are likely to have data which are less realistic because of the variation in the rate of urbanization region wise where most of the researches address urbanization country wise.

Geography books and research indicate that Tanzania had over 44 million hectares of arable land with only 33 percent of this amount in cultivation. Almost 70 percent of the poor population lives in rural areas (World Bank, 2017) and almost all of them are involved in the farming sector (Jump, 2016). The land is a vital asset in ensuring food security, and among the nine main food crops in Tanzania are maize, sorghum, millet, rice, wheat, beans, cassava, potatoes, and bananas. The question is considering the observed rate of urbanization to what extent are these data still valid and to what extent they will likely deviate from reality as time passes. If teachers are to write school books today where such data are required they will likely use the same outdated figures not only because there is little use of geospatial data in education but also due to observed practice where teachers underutilize ICT and ICT based technologies in the classroom.

Students learn problems resulting from both natural and human activities so generally that they do not get motivation for either learn in detail enough beyond the level required to answer their examinations or they do not feel that there are problems that are directly facing them because they lack contextualized geospatial information as such they rarely feel that they are part and parcel of the solution to the problem. More importantly, when they become policymakers in future they are likely not to appreciate the use of geospatial information for both rural and urban planning. The following section raises questions on what is overlooked in the geography syllabus that may be improved by using geospatial information.

## 2.5 What is overlooked in the syllabus and means for improvement using geospatial data

In the Tanzanian geography syllabus at an advanced level a topic on the application of statistics, students are supposed to study nature of data and types of data variables where the suggested teaching and learning resources are texts on statistical data and documented data in charts and tables (URT, 2010). The questions are: can students access documents like research work on the rate of urbanization, increase in population or the loss of vegetation’s that exactly address their contexts at the level of the region, district or ward so that students can make sense out of them? Also, students are supposed to relate data to social and economic activities (p. 2), one should ask; can students relate rate of the urbanization with the exploitation of forest resources and industrialization or trading activities? This means geospatial data if could be made available to book writers, curriculum developers, and classroom teachers will enable students who are studying geography to sense the urbanization of their localities as they study statistics in geography. For instance, as students are required by the syllabus to present data in various ways it would be possible to present geospatial information like those in Table 1 and Figure 2 and learn the trend of the various variable by using statistical measures as they are required by the syllabus (p. 3). Upon calculating statistical measures such as mean, mode, median, variance, and standard deviation; students will not only learn statistics for its own sake but also learn the significance of using such measures in real life. This implies that it will be very easy for the teacher to be able to guide students realize the importance to consider the welfare of researchers during the organization of research (p. 5-6). The same data will likely motivate students in selecting appropriate research problem affecting the community, developing research tools, conduct field research, analyzing and presenting data and providing recommendations based on the research output as directed by the geography syllabus (p. 6).

Students are also required to learn the composition, importance, and impact of the atmosphere (p. 7). However, the question is: can the students internalize that there is decreasing the stability of the composition of the atmosphere due to rapidly depleting vegetation cover? Exposing the students to the satellite images like those in *Figure 3* will enhance students' ability to associate trends of the decreasing vegetation, increasing built-up area and availability of natural resources like water with the deteriorating quality of the atmosphere and the increasing temperature including its impact on various life forms within the students' local environment. The syllabus requires students to collect information on the disaster caused by the earthquake and propose precautions to minimize the impact of the disasters caused by the earthquake where the activity suggested is for students to make a visit to the geological departments and National earthquake centers (p. 11-12). Here students may learn the trends of the intensity of the earthquake and the general effects. However, the question is: will students be able to predict the possible future effects so that they can be able to propose precautions, which are more contextualized? If students will be able to observe images as in *Figure 3*, and to compare with the trends of increasing built-up areas in *Table 1*, then; they would likely be more specific in identifying the area that are more prone to the effects of earthquake and they can be able to proposal more contextualized precautions that are not only based on general data, but on specific locations that also consider social economic activities that take place in such places in relation to the structure and shape of the buildings and other physical infrastructures.

For the topic of dynamic earth and its consequences students have to study denudation and deposition processes where students have to identify agents of erosion, reasons for deposition of the weathered materials, carry out study visits to places with weathered and deposited materials and describe the importance of deposited materials in the community and also propose for the means of carrying out soil conservation. But the questions are: are the reasons for weathering at one place necessarily the same in all places? Can teachers identify appropriate sites with weathered and deposition features for students' visits and learning on how to conserve their local environment? Satellite images can indicate places where loss of vegetation is more intensive than others. For instance, in Morogoro increased human settlements in town under decreasing employment opportunities have created informal peasantry activities along mount Uluguru hills such that when it rains eroded materials from the hills accumulate downstream creating several deposition features and new streams, which widen to form rivers that flood the whole settlement areas down the hills.

Students are supposed to study types of photographs and describe position, type, size, and shape of objects on the photograph and uses of photographs in social and economic activities (p. 22-23). The question is: Do photographs that are referred to here including satellite images? If No; are satellite images not more informative than normal photographs? If yes; will teachers be able to include such images in their lessons or do they know how to interpret them? Assuming that teachers are knowledgeable on how to interpret satellite images; how can they access them? For example, satellite images like those in Figure 3 look simple and faint but can give many details regarding change in vegetation, built up areas and topography. For this case, how students in different places use the information obtained from these photographs cannot be the same because it will depend on the information displayed by the images in relation to the dominant social economic activities of the represented places.

Study on water masses requires students to establish a link between hydrological cycle and underground water, identify potential threats to underground water in terms of use and pollution and how to manage underground water (p. 25). The question is: Can students establish a link between hydrological cycles and availability, or quality of underground water by referring their local areas? Increasing rate of built up area that signifies loss of vegetation in Table 1 gives a local picture of how human activities in Morogoro contributes to the availability of underground water but also its decreased quality as waste water gets access to the water table through percolation. Data on the increasing rate of built up area will enable students identify the importance of surface water flow, run off and percolation process with vivid examples of their immediate environment. Such contextualized examples of threat on water resources will influence students' awareness on not only the way water use drives life on earth but also can result into conflicts. In addition, students can see the sense of carrying out thorough environmental impact assessment before establishing any development projects within water sources. They will also see the necessity of developing policies for water use and management specific for particular local environments. The exposure will motivate students in establishing the magnitude of water pollution in their environment, proposing means for controlling water pollution, visiting areas where water harvesting is being carried out, discussing broadly on the challenges involved in water harvesting and hence suggest means by which water can be used wisely for social and economic development as required by the syllabus (p. 31).

Teachers are directed to organize a discussion with students to identify indicators of soil degradation and organize field trip to several study sites to observe the process of soil fertility loss (p. 34). But the question is: can teachers identify with examples indicators of fertility loss of their immediate environment rather than basing on the general indicators? On the other hand, how can teachers identify the most appropriate sites to be visited for them to be able to learn indicators of fertility loss in their most nearest environment? Using satellite images combined with Google map it will be possible to locate places with intensive human activities like crop cultivation, grazing, mining and settlements construction; all of which influence soil erosion and hence affecting soil fertility. This will enable teachers and students be able to locate specific places of interest so that it will be possible to categorize the causes and factors for soil degradation according to location and levels of impact on soils and hence see the necessity of establishing the school soil management policy and use it in implementing soil conservation policies as required by the syllabus (p. 35).

When studying climate change teachers are directed to guide students to discuss about climate changes since 1850s by using pictures and data on climate change (p. 37). But the question is where will teachers get data on weather and climate of the previous years? Is it possible to get data on weather and climate of their immediate environment? For students in Dar-es-salaam may be possible as they can make a visit to the Tanzania Meteorological Agency (TMA) but how about students in other places of the country especially in the remote villages? Analysis of satellite images that can give comprehensive data for a specific location like those in Table 1will help students to locate the trend of the decreasing density of vegetation, increasing built-up area and increasing population all of which have both direct and indirect relationship with climate change. Through this it will be possible for students to identify their contribution as individuals and community around them in climate change so that when they have to debate on their role in sustaining climate and reduce its impact they can really feel to be part and parcel of the solution for the problem of climate change (p. 38).

Analysis of population structure is one of the objectives for secondary school students in the topic of population and development where students need to establish the relationship between population structure on social and economic development, effects of population change in the country's development, assess the contribution of population policy on population management and the relationship between population growth and development (pp. 40-42). Questions are: Are the reasons and rate of population growth the same throughout the country? Should population policies apply country wide or there may also be locally formulated policies by considering population growth rates of specific areas within the country? Is it significant for people to study effects of population growth on the specific environment rather than considering general effects? Population growth rates in a country like Tanzania is not homogeneous throughout the country because of several reasons as may be related with cultural values, social economic activities and resources availability. This implies that people within any locality need to understand the main factors that determine the population size of that place. Teachers and students in schools can better understand factors that determine the population size and growth rate of a particular place if they can have trends of population growth rates so that they can match such trends with data like those of Table 1 particularly loss of vegetation, increasing urbanization and social economic activities within the specified locality. The data will give students a broader picture so that they can see the necessity of proposing techniques that can be used to address the impact of population dynamics in the society as required in the syllabus (p. 41).

A topic on regional focal studies (pp. 44-54) requires students to assess the use of rangelands/marginal lands for agricultural production where among the resources required is the soil map of Tanzania and examine the problems and contribution of animal keeping to economic development and environment. The questions are considering the soil map of Tanzania, which was drawn several years ago will it be relevant in addressing the current soil fertility status where there is considerable evidence of continuous loss of vegetation and urbanization as intensified by the effects of climate change? This concern is based on the research observations that, changes in average temperatures and in precipitation, patterns will also influence soil organic matter. This, in turn, will affect important soil properties such as aggregate formation and stability, water holding capacity, cation exchange capacity, and soil nutrient content all of which contribute to soil fertility(Brevik, 2013; Stepniewski; Stepniewski; Rożej, 2011). These observations imply that the soil fertility status of the country is continuously changing based on both spatial and temporal analysis. Thus, the syllabus requirement that a teachers should organize study visit with students to a nearby livestock keeping places and observe the success and problems (p. 44), may not necessarily address the contemporary problems of livestock keeping. For instance; some traditionally pastoralist communities have shifted from animal keeping as a sole activity to practicing both animal keeping and crop cultivation as scarcity of the grazing land intensifies. Satellite images that can locate specific human activities that happen in a particular area of interest combined with Google maps would provide the right information to geography teachers so that they can plan for the appropriate sites to be visited in order for students to be motivated to analyze the impact of livestock keeping on the environment and be able to suggest for the appropriate measures of environmental management as one of the objectives in this topic (p. 45).

Likewise, there is a section in this topic where students are required to identify areas within the country that are affected mostly by deforestation and the associated effects where one of the teaching resources is a map of Tanzania. The question is: When is that map of Tanzania drawn? Will it be able to display the most vulnerable forests currently? It should be considered that one of the factors for increasing rate of deforestation is the culture and nature of social economic activities of the communities surrounding the Forrest area. This implies that reasons for the increasing problem of deforestation and its solution are not necessarily the same throughout the country. This implies that meaningful investigation of the factors for deforestation by students in Tanzania should begin with teachers being able to identify the most vulnerable nearby forest area using satellite images like those in *Figure 3* whereupon its visit with students they can be motivated to think for the appropriate measures relevant to the culture and social economic activities of the particular place.

## 3. Discussion

The wide applications of GIS as described in the introduction section is basically because it deals with space and place processes. These processes evolve with time and therefore understanding them clearly needs a geographic inquiry. One will engage in the inquiry of the place and space processes when he has knowledge, skills and motivation to do so. Van Rens (2005) stresses the importance of knowledge, skills, and motivation for learning to inquire as for a precondition for engaging in inquiry. For instance, it is possible for someone to start thinking on how to control problems like rural-urban migration, high population growth rates, unplanned settlements and environmental degradation if he is able to identify the magnitude of such problems and he thinks they are likely to affect him/her directly or indirectly. We teach students geography and other subjects in schools where these problems are addressed hoping that they will actively participate in solving them when they join the community. This is the reason why the last curricular review in Tanzania in 2005 had incorporated concepts of meteorology, environmental education and climate change in the geography syllabus with one of its main objectives targeting environmental management that: '*students should acquire skills for environmental conservation and management'* (MOEVT, 2005, p. vi), expecting that students will be able to apply their knowledge and skills in conserving their environment. The curricular review is echoed in the Tanzania education and training policy (2014) that stresses on fostering independent thinking, creativity, and hands-on skills.

But still, we face a lot of environmental problems emanating from human activities such poor farming practices, unplanned settlements and wastes mismanagement leading into soil erosion rock fall, mass wasting, floods, drought, global warming and endless conflicts between pastoralists and peasants. This is one of the indicators that schools need to play its role of equipping the learners with enough knowledge, skills, and motivation to solve these problems upon joining the community. Addressing these problems through education is an attempt to deal with the misalignment between the intended and the attained curriculum so that classroom practice can lead into attaining the stated objectives in the syllabus. Different authors stress that it is important to combine knowledge and skills in geography education for effective inquiry (Bednarz, 2000; Morgan, 2006; Van Westrhenen, 1987; Van der Schee, 2007). They further elaborate that geography should not be seen as a ready-made product that can be handed over from the teacher to the students, but as an activity in which students can be engaged in authentic investigations. The use of GIS has greatly brought about this authenticity where the problems, tasks, and settings of geography education can be made realistic and relevant to students. This implies that students should not only learn about conditions under which various social economic activities in various countries are carried out and relate with the way similar activities are done in their country in general but also be able to reflect on the comparable conditions of their immediate environments; i.e. geography in practice for the society. For example of Bednarz (2003), presented examples of GIS-supported geographic inquiry projects in which students engage in inquiry for society, in society, and about society. Interaction of students with their local environment has now been simplified by the use of the technology involved in GIS. Through the use of satellite images, Google maps, GPS device and programs like ArcGIS students can locate any place of interest on the earth to map the intensity of environmental problems, human activities or desired topography including also an evolutionary trend of these phenomena across time as clearly specified in the previous section.

A big challenge is what should be done for this technology to penetrate the school curricula. Experts in the use of GIS need to show education policymakers that GIS as a tool for learning is gaining popularity in almost every field of study because of its diverse applications in addressing social, political, environmental and technological problems. Upon getting access in the curriculum, it will be one stage in a chain of processes because even in the developed World where it has been recommended in schools a big number of teachers are still facing challenges in applying it fully. The problem is likely to be more serious in developing countries like Tanzania as a successful application of GIS in schools involves the use of ICT in a variety of activities both within and outside the classroom. Unfortunately, studies show both limited application of ICT in the classrooms and outdoor learning opportunities in schools despite a lot of campaigns on the significance of the same (Chin & Hortin, 1993; Kira, 2016; Kira & Mahumbwe, 2015; Sumari, Shao, & Kira, 2017). The practice is partly caused by the dominant teacher-centered teaching habit of teachers, which is mainly lecture method. Although the syllabus is competence based where teachers are supposed to ensure that students master the stated objectives by doing a variety of activities, still the practice of teachers has not changed. The implication is that the efforts of incorporating GIS issues in the school curriculum alone may not bear the expected results. There are supposed to be other means of ensuring that teachers are not only supported but also motivated to implement it. All education stakeholders particularly; education policy makers, curriculum developers at all levels, book writers, classroom teachers and school examiners need to work hand in hand with GIS experts so that they can scrutinize on the important concepts of GIS that need to be fitted to various levels of the school curricula including the identification of the relevant in-service and pre-service programs for teachers on the same.

Like the case of any other innovation one should expect a slow propagation of GIS in education institutions because of three main reasons:(i) Scarcity of financial resources for not only amending the school curriculum and train both pre-service and in-service teachers accordingly but also purchasing the necessary ICT facilities required for learning using GIS for both teachers and students;(ii)Changing the mindset of both teachers and other education stakeholders to shift from believing in traditional teaching and learning methods into contemporary teaching and learning perspectives; and(iii) Lack of reliable power supply in both schools and teacher training institutions. These challenges are pertinent but should not prevent education stakeholders from spearheading the idea because the solution to these challenges cannot come at once, it involves a number of stages of solution that start to unfold as people engage in implementing the idea. For, instance writing this paper on why geography teachers should use GIS data when teaching geography at advanced level secondary school should open other avenues where other scholars can start thinking on how GIS data can be incorporated with the other subjects at different levels of education and hence write textbooks, teachers' guides or manuals with a dual purpose of supporting teachers on the relevant teaching and learning resources under the prevailing conditions of unreliable power supply and also motivating them to do the same. When such materials will be available in large quantities in the market, most of their consumers will be education stakeholders who are required to take the front line in advancing the idea of utilizing geospatial data. Nevertheless, it should be noted that researchers in the fields such as statistics, mathematics, and economics have a key role to play in generating GIS data of the local contexts by hypothesizing and carrying out predictions for various variables used in geography at different levels of education, meteorology, agriculture, and many other subjects. This means, aggressiveness of researchers in the named fields in using GIS data to model situations and predict variables will contribute significantly in updating a lot of outdated information in school textbooks and teacher training manuals provided that educationists will have enough knowledge, skills, and motivation to use such information. These suggestions do not imply that we have to wait for things to happen spontaneously, rather policymakers have to take the active role of implementing the idea in research institutions, schools, and teacher-training colleges whenever there is possibility of soliciting financial resources from whatever sources.

## 4. Conclusion

The central theme of this paper is based on the observation that the use of geospatial data in education can substantially contribute in improving not only the quality of the curricular materials such as textbooks, the syllabuses, and teaching aids but also diversification of the classroom practice and outdoor learning opportunities. For the case of geography subject at advanced level secondary school, the use of geospatial data on the rate of urbanization and the loss of agriculture land in Morogoro region that was obtained using GIS tools can be used to update information on agriculture, forest, mining, statistics, soil fertility, livestock keeping, transportation, tourism, environmental degradation and population. This means, for geography teachers to be able to teach geography effectively in schools based on the contemporary data they need to have the knowledge, skills and motivation for using GIS tools. But support to these teachers so that they can use GIS tools depends largely on the established database of various geospatial variables. Therefore extent to which teachers in schools can utilize geospatial data in education depends both on the role that can be taken by education policymakers and researchers in fields like environmental education, geography, geo-informatics, ICT, statistics, mathematics, and others knowledgeable in generating data using GIS tools.

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