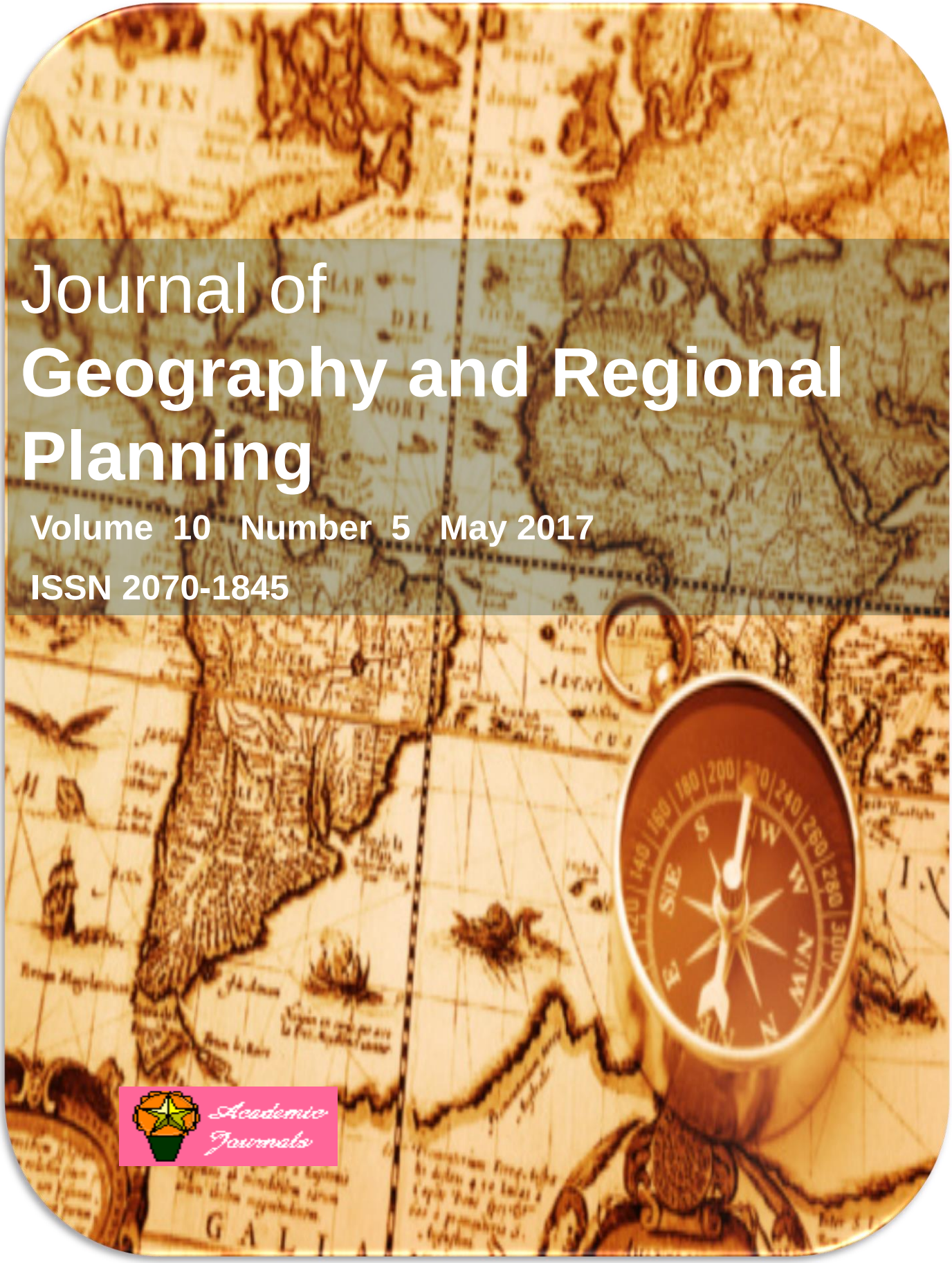

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Full Length Research Paper

A GIS based land suitability analysis for sustainable agricultural planning in Gelda catchment, Northwest Highlands of Ethiopia

Ebrahim Esa[1*] and Mohamed Assen[2]

[1]College of Social Sciences, Department of Geography and Environmental studies, University of Gondar, P.O. Box: 196, Ethiopia.
[2]Department of Geography and Environmental studies, Addis Ababa University, P.O. Box: 150116, Ethiopia.

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The present study was carried out to examine the suitability status of plots of land for selected land utilization types (*teff -Eragrostis tef*, maize - *Zea mays* and finger millet - *Eleusine coracana*). The land mapping units of the study area, prepared from land resource survey, were used for the purposes of land evaluation. The methodology used for land suitability evaluation was GIS-based multi-criteria evaluation following FAO (1976) guidelines involving matching diagnostic land qualities against crop requirements and assigning suitability rates for each land qualities. The weighted overlay analysis combining diagnostic soil, climate and topographic factors showed that the largest coverage (76.04, 69.52 and 67.79%) of the study area is classified as moderately suitable for *teff*, maize, and finger millet cultivation, respectively. The vector overlay analysis results revealed that about 20.25 and 63.92% of the catchment are moderately suitable and marginally suitable for cultivation of all selected land utilization types. This showed that competitions for the same parcel of land by different uses were possible. Thus, farmers could have freedom to choose a range alternative land utilization types with the same suitability level and allocate land utilization type that best meet his/her interest. Therefore, land suitability analysis for agricultural crops using multi-criteria evaluation in a GIS environment is a strong tool for measuring and valuating land in terms of the varying importance to decision makers for sustainable rainfed agriculture.

Key words: GIS, land utilization type, multi-criteria evaluation, weighted overlay analysis, vector overlay analysis, suitable land allocation, sustainable rainfed agriculture.

INTRODUCTION

Land is one of the most important natural resources, and maintaining its health is essential for meeting an ever increasing demand for food, fiber, fodder and fuel (Mohammad and Mohd, 2014). It is a significant resource mainly for countries where their economy is based on rural activities, such as agriculture (AGRA, 2013).

*Corresponding author. E-mail: ebroissa@yahoo.com, ebrahimesas036@gmail.com, Ebrahim.Esa@uog.edu.et.

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Therefore, maintaining the productivity of land is a determinant factor to obtain sustainable services and goods from land. The demands for goods and services increase overtime in association with a rapid growth of human population, which can be obtained either by intensification or expansion of land use e.g. for crop, fuel and fodder production. Land use intensification requires high available technology, which for many developing Sub-Saharan countries is less attainable (UN Department of Economic and Social Affairs/UNDESA, 2012; Ruben and Piters, 2005). However, further expansions of cultivation land are very limited or will be at the expenses of other life support systems, such as forest resources. In most of the African countries, population pressure has resulted in an expansion of cultivated land into other land use/ cover (LULC) classes and a reduction in the average available farm per capita (Sherbinin et al., 2007). Moreover, other LULC categories e.g. urban land uses and settlement have expanded into best prime agricultural land and this further reduces available land for agricultural expansion (Solomon et al., 2014).

In the highlands of Ethiopia, an uncontrolled agricultural land expansion onto fragile and less productive land e.g. steeper slopes coupled with low agricultural land productivity and population pressure have led to land degradation (Dula, 2010). In addition, long history of settlement and traditional agriculture in the highlands of Ethiopia are also responsible for deteriorating land quality and quantity (Ebrahim, et al., 2014). Despite the limitations caused by unsustainable land uses, the highlands of Ethiopia are classified as high potential cereal (HPC) zone (FAO, 1986). Cereals, such as *teff* (*Eragrostis tef*), maize (*Zea mays* L.), finger millet (*Eleusine coracana*), barley (*Hordeum vulgare* L.), sorghum (*Hordeum vulgare*), oats (*Avena sativa)*, and wheat (*Triticum* spp.) make up 85% of the total production of field crops and account for over 90% of input household consumption in Ethiopia (CSA, 2000). The sustainable production of these crops and acquiring of other services from the Ethiopian highlands are achievable only through implementing appropriate land use plan (Benin et al., 2003).

Agricultural land use planning involves making knowledgeable decisions about land use and the environment (Mohammad and Mohd, 2014). Allocation of land for particular use requires evaluations of the land quality with respect to its potential and constraints. The evaluation based on potential and constraints of land is critical for sustainable land use planning (Sarkar et al., 2014). Many researchers have attempted to provide a framework for optimal agricultural land use because much agricultural land used currently, in different parts of the world, are below its optimal capability and some has led to processes of degradation (Ebrahim, 2014). In Ethiopia, agricultural land use is often conducted without a correct pre-assessment of its potential and leading challenges, which has caused widespread degradation and significant decline in soil productivity (Asmamaw et al., 2015).

The available land resources, which include soil, topographic, water and associated climatic features, can deeply influence the cropping pattern and crop productivity in specified areas because each crop requires definite soil, climatic and site conditions for its optimal growth (Mohammad and Mohd, 2014). Crop production capacity of farmlands is influenced by land quality variations influenced by the inherent physical and chemical characteristics of soils that may or may not be economically controlled (Pound and Ejigu, 2005). These required farmers, in modern agriculture, to have some level of understanding on the physical capability and nutrients status of the soils to make informed choices of specific uses of land (Dickson et al., 2002). This has given rise to the need for land evaluation studies prior to actual land uses to decide rational decisions (FAO, 1976). These studies provide information on the choice of crops to be grown on best suited soil units for maximizing the crop production percapita, labor and inputs (Mohammad and Mohd, 2014). Managing the physical requirements of crops allows farmers to improve nutrient status of soils before the imbalances become so severe that it becomes a clearly observable factor for plant growth (Nafiu et al., 2012). Therefore, the success and failure of cropping is largely determined by the availability of both water and plant nutrients, which is in turn controlled by the physicochemical properties and micro environment of the soils. Agricultural land use practices in study area was not largely based on the matching of crop climatic, topographic and soil requirements to land qualities for optimum production. However, the land use decisions by local farmers are usually driven largely by long-term traditional farming experience on farmers' preference to adopt a particular cropping pattern and other social factors. This has generally led to low productivity and degradation of the available land resources. Accordingly, a thorough analysis of land in terms of their potentials and constraints is needed to make rational decisions on mechanisms of enhancing the potential and curbing the challenges of small-scale rainfed agriculture.

Computer based decision support models have been developed towards land evaluation following the advancement of information and communication technology (Sarkar et al., 2014). The advent of GIS and remote sensing technologies opened the door to the wider application of quantitative and qualitative land evaluation methods (Ashraf, 2010). It has the ability to perform numerous tasks utilizing both spatial and attribute data, and helps in the manipulations of assessment factors into land suitability maps (Neupane

et al., 2014). In the context of land suitability analysis, GIS support for spatial decisions making process, i.e., to determine what locations are most or least suitable for specific purpose and hence the spatial variations in suitability status of land for specific purpose can be adequately discerned.

The agricultural practices, in the study area, are largely characterized by small-scale, fragmented, traditional tillage, low fertility level with little irrigation activities along the main Gelda River. Irrigation was limited largely by the rugged topographic and lithologic conditions of the main river channel, except along the lower courses of the catchment. Thus, rainfed agriculture is the main source of income and form of survival for more than 90% of the households. Cereals and pulses are the major crops grown in the catchment. Traditional farming practices are common where crops are usually cultivated and chemical fertilizers are applied irrespective of the existing constraints and potentials of land. Thus, land suitability evaluation is essential to guide farmers to invest on land use options that would bring the greatest social and economic benefit, and minimum environmental costs. This will help to improve crop production and allocate the land to the most suitable use. Therefore, this study applied multi-criteria evaluation (MCE) integrated with GIS to delineate the suitable areas for three major locally grown subsistence food crops (*teff -Eragrostis tef*), maize - *Zea mays* L., finger millet-*Eleusine coracana*). The study was limited to evaluations of the physical requirements of crops for selected physical land quality characteristics.

MATERIALS AND METHODS

Study area description

The Gelda catchment is located between $11^0$38'14" and $11^0$46'15"N latitude, and $37^0$25'54" and $37^0$41'29"E longitude. It has about 26,264 hectares, covering about 2.2% of the Lake Tana watershed. It is drained by a stream named as Gelda (from where the name of watershed is given) flowing into Lake Tana from west direction (Figure 1). The landform of the catchment reflects its geological history where uplifting force created an initial elevated landmass and the subsequent outpouring of basaltic lava provided a thick protective cap and added on to the elevation (Eleni et al., 2013). According to the report of Geological Survey of Ethiopia (GSE, 1996), the catchment generally comprises materials ranges from alkaline to transitional basalts that often form shield volcanoes, with minor trachyte and phenolite flows called *"Tarmaber Gussa Formation"* in southeast and eastern parts of the catchment formed during the Oligocene to Miocene epochs of the Tertiary period. The western and northwestern parts of the catchment consist of alluvial and lacustrine deposits of the Quaternary period. The altitude ranges from 1780 to 2481meters above sea level.

The slope gradient is dominated by gentle slope (0-7.6%) covering about 48.5% (12,682 ha) and moderately steep (7.7-16%) with 37.13% ha (9,714) of the catchment. The steep (16.2-30.2%) and very steep (>30.3%) slope gradients cover about 11.22% (2,936 ha) and 3% (787 ha) respectively, commonly found in the southeast and southern corners of the catchment. Gleysols (54.9%) and Nitisols (30.5%) form the major soil types of the Gelda catchment. Gleyosols are poorly drained with seasonal water accumulation (FAO, 1997; FAO, 2001). The other soils are commonly found on the sloping lands.

There are about four weather stations within and nearby the catchment, however only Bahirdar station has longterm records and full weather variables. Consequently, temprature and rainfall records of Bahirdar station were considered in determining climate of the study catchment. Climate is generally sub-tropical with average rainfall amount of 1453 mm with relatively high inter-annual variability and a maximum effective rainy season of 120 days or more (Figure 2). The rainfall records for the period between 1961 and 2014 records showed that the pattern is predominantly uni-modal with long rainy season category (June to October), which accounted for about 90% of the total rainfall in the catchment. It is the main season that enables rainfed cultivation of crops (Figure 2). The dry season occurs between November and May where some alternative small-scale irrigation along Gelda River is possible. However, the topographic nature of the river is a physiographic-related limiting factor affecting agricultural production during the dry season in the catchment. In addition, the highest mean monthly temperature (30^0C) is recorded during April while the minimum (8^0C) is during December with monthly range of 5^0C (figure 2).

The local agroecology, which combines growing periods with temperature and moisture regimes associated with distinct soil, climate and land uses, generally is in the moist *weynadega* (largest coverage) and moist *dega* category. It is largely characterized by average length of growing period ranging from 120-240 days (Hurni, 1998). It is agroclimatic as well as ecologically most suitable conditions for rainfed farming, such as *teff* (*Eragrotis teff*), *nuog* (*Guizotia abyssinica)*, and maize (*Zea mais*). According to Dera Woreda ARD office (2013), vegetation species largely dominated by *Juniperus procera* (*Habesha tid*) are commonly found around churches and grave yards including *Hagenia abyssinica* (*kosso*); *Albizia* (*sassa*), *Podocarpus falcatus* (*zigba*); *Cordia africana* (*wanza*); and *Ficus vasta* (*warka*). However, field observation in the study area indicated that non-indigenous tree species like cypress (*yeferenj tid*), *Acacia sieberiana* (*Yeferenj girar*) and *Eucalyptus spp*. (*Bahir zaf*) are expanding.

Field observation in the study catchment revealed that subsistence rainfed agriculture, and to a lesser extent supplementary irrigation, livestock husbandry and bee keeping are the main stay of households. According to Hurni (1998), the most dominant Ethiopian agricultural belt is called *Weyna dega* (altitude from 1,500 to 2300m a.s.l and mean annual rainfall of ≤ 900 mm), which covers about 30% of the country. It is agroclimatically highly suitable for rainfed cropping allowing at least one cropping season per year, particularly teff and maize. The altitudinal difference (1778 and 2480m a.s.l), and mean annual rainfall (1453 mm) of the study area largely signify moist *Weyna dega* condition. Highlands reclamation study (HRS) also indicated that areas where the study catchment located are classified as high potential cereal zone (FAO, 1986). According to Dera Wereda Office of Agriculture and Rural Development (2014/15) production year report, 65,308 ha of arable land were covered with wide range of cereal and horticultural crops (Table 1). *Teff* (*Eragrostis tef*), maize (*Zea mays*), finger millet (*Eleusine coracana*) and potato (*Solanum tuberosum*) account for 22.8, 19, 18.4 and 8.5% of arable land of the wereda respectively. These are the major staple sources of food to the local people of the study area.

Methodology

Data sources and identification of land mapping units

Land mapping units (LMUs) are defined and mapped by natural

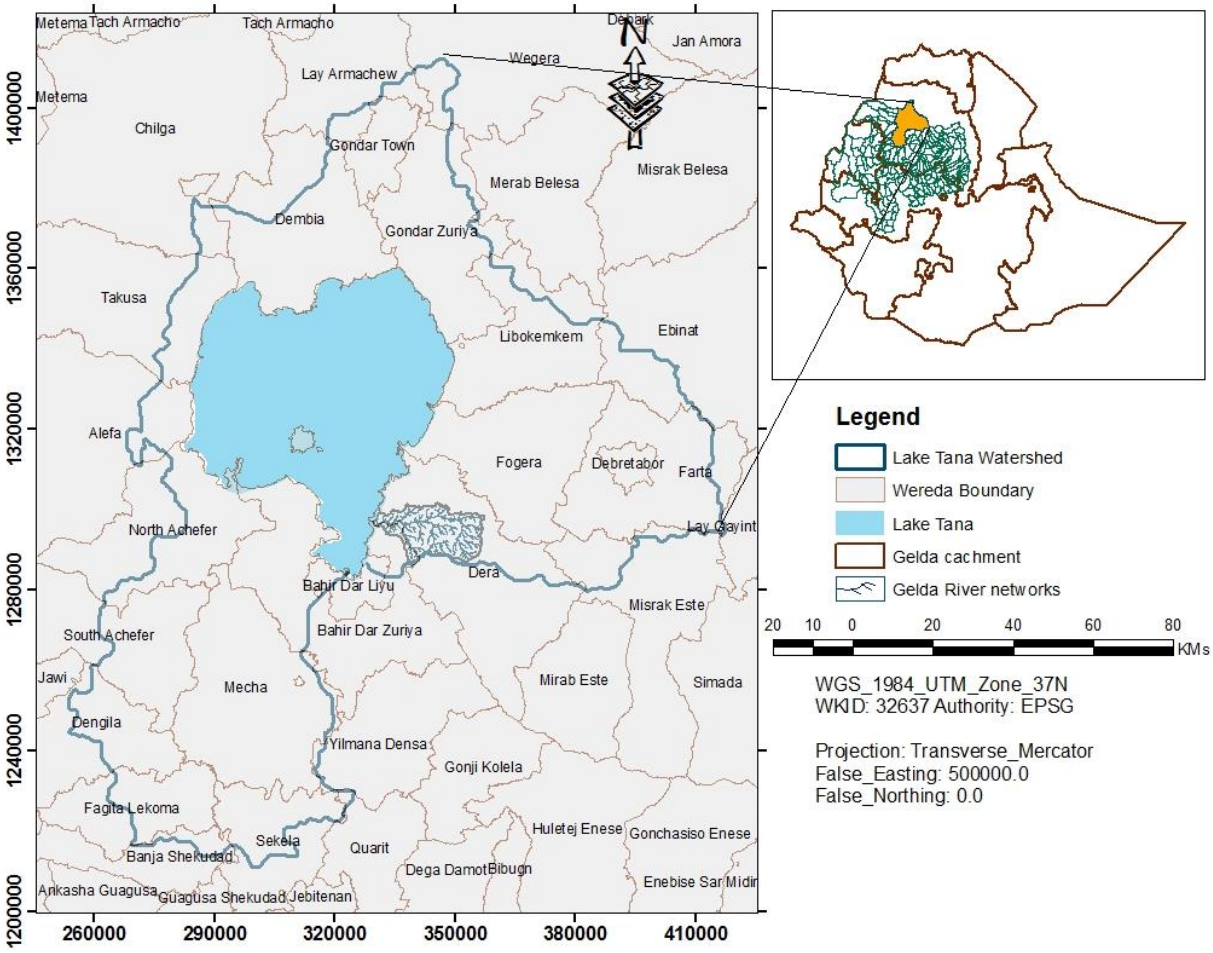

Figure 1. Location map of Gelda catchment, northwestern highlands of Ethiopia.

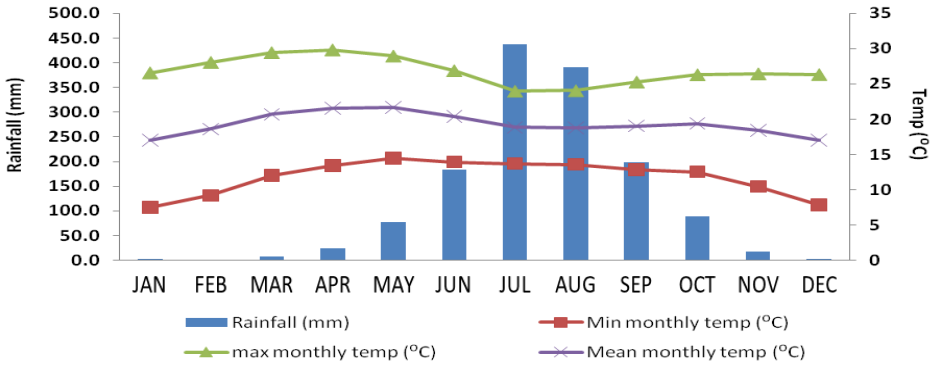

Figure 2. Mean monthly rainfall and mean monthly temperature rainfall records of Gelda catchment (1961–2014) based on the records of nearby Bahirdar station (NMA, 2014).

resource surveys, e.g. soil survey, LULC analysis and hydrology where the degree of homogeneity or of internal variation varies with the scale and intensity of the study (FAO, 1976). Soil survey is often the basis of dividing landscapes into basic spatial entities called mapping units. In this study, land resource survey was conducted between January and February 2014 to determine

Table 1. Major cultivated crops in Dera wereda, Northwestern Ethiopia.

Crop	Type of agriculture	Area (ha)	%
Teff (*Eragrostis tef*)	Rainfed	14,900	22.8
Maize (*Zea mays* L.)	Rainfed/supplementary irrigation	12,470	19.1
Finger millet (*Eleusine coracana*)	Rainfed	12,050	18.4
Potato (*Solanum tuberosum*)	Rainfed/supplementary irrigation	5583	8.5
Wheat (*Triticum aestivum*)	Rainfed	5460	8.4
Barley (*Hordeum vulgare*)	Rainfed	4400	6.7
Rice (*Oryza sativa)*	Rainfed	3648	5.6
Ethiopian Niger seed (*Guizotia abyssinica)*	Rainfed	2990	4.5
Linseed (*Linum usitattissimum*)	Rainfed	2200	3.4

Source. Dera wereda Agriculture and Rural Development Office Annual Report, 2013.

Table 2. LMUs identified in Gelda catchment, northwestern highlands of Ethiopia.

LMUs	Code	Area		Mean values for attributes associated to each LMU						
		Ha	%	Texture	Drainage	pH	EB	CEC	SOM	PAV	TN
Dystric gleysols	GlDy	13,986.5	53.3	CL	P	5.54	26.24	31.07	2.79	9.49	0.16
Dystric nitisols	NiDy	7962.2	30.3	C	VP	5.44	27.15	32.08	2.48	4.92	0.14
Eutric nitisos	NiEu	2776.4	10.6	SCL	P	5.52	33.33	38.04	3.55	1.04	0.21
Orthic luvisols	LuOr	1028.4	3.9	SL	SE	5.39	26.00	29.04	1.91	0.67	0.38
Eutric regosols	ReEu	510.5	1.9	CL	P	5.43	22.79	26.02	2.57	4.20	0.15

*Note: E= excessively drained; W= well drained; M= moderately drained; SE= somewhat excessively drained; P= poorly drained; VP= very poorly drained; C= Clay; CL= Clay loam; SCL= Silt-clay-loam; SiL= Silty-loam; L= Loam; SL= Sandy-loam.

LMUs. The spatial boundaries of land utilization types (LUTs) were determined from SRTM (30m×30m) image and Ethiopian soil database (1:1,000,000) using ArcGIS. During survey work, the diagnostic land quality characteristics were largely obtained from 21 surface sample points at a depth of 0-20 cm over the entire study catchment. As a result, a total of five LMUs were identified in Gelda catchment (Table 2 and Figure 3).These were the foundation for generating the thematic map layers in multi criteria decision-making (MCDM) process for selected LUTs.

Selection and description of land utilization types (LUTs)

The suitability of the LMUs was evaluated for the selected and locally grown major food crops of the study area, hereafter referred to as LUTs, and each LUT was described in order to determine its land use requirements (LURs). However, the LUTs in this research were prioritized and selected based on their spatial coverage in Dera wereda where the catchment is almost entirely found as well as field observation in the study area.

Teff (*Eragrostis teff*)

Teff is grown under diverse agro-climatic conditions in the altitude ranging from 1800 to 2100 meters above sea level (Fissehaye et al., 2009; Behailu, 2014). The report by National Academy of Sciences (NAS) in 1996 indicated that the average annual rainfall of *teff* growing areas is 1000 mm, but the range is from 300 – 2500 mm. Seyfu (1997) also reported that it grows at altitudes ranging from sea level to 2800 m above sea level. In fact, *teff* is able to withstand wet conditions, and even grows on partly waterlogged plots and acidic soils (pH < 5) perhaps better than any cereal crops other than rice (NAS, 1996). However, it cannot withstand largely waterlogged conditions unless it is sufficiently drained due to the shallow root system (Ebrahim et al., 2014). According to experiences gained so far from national yield trials, conducted at different locations across the country, *teff* performs excellently at an altitude of 1800 – 2100 m above sea level, annual rainfall of 750 – 850 mm, growing season rainfall of 450 – 550 mm and a temperature range of 10°C – 27°C (Seyfu, 1997). *Teff* has evolved on vertisols that frequently get waterlogged in the Ethiopian highlands with appropriate drainage (NAS, 1996). Although about a third of the land devoted to cereals in the country is under teff cultivation, production has been far below the potential, i.e., less than 0.50 t/ha due to poor soil fertility and soil moisture management (Fissehaye et al., 2009; Seyfu, 1997).

In most parts of Ethiopia, *teff* is grown during the main rainy season (*meher*); though there are places where it is grown during *belg* season (Seyfu, 1993). It usually needs high tillage frequency compared to other cereal grains in Ethiopia and moderate soil compaction by animal trampling (Behailu, 2014). In traditional farming, the *teff* seeds are broadcasted on a well ploughed land and lightly covered with soil for germination to occur in shorter period of time. However, despite the very small seed size of grains, row planting is an emerging practice as a means to boost

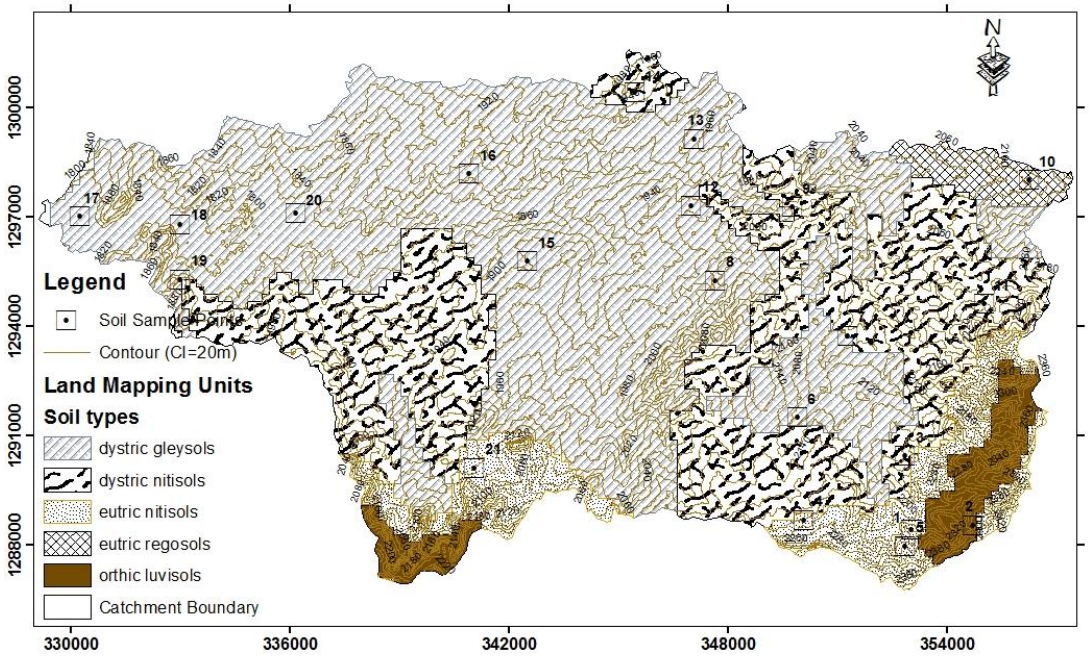

Figure 3. LMUs identified in Gelda catchment, northwestern highlands of Ethiopia.

production in rainfed agriculture. Research by Behailu (2014) in Minjar-shenkora wereda reported that row planting resulted in better *teff* yield than broadcasting. Repeated weeding is often required during the growing period (Assefa et al*.,* 2011). Harvesting is generally done in with ordinary sickles and straw is separated from the grain after it has been threshed into the ground with cattle. The straw is usually important for fodder during the dry season and construction material for houses made of mud. *Teff* is commonly used as a daily staple food *"injera"* (local sour pancake used as a staple food in Ethiopia) for more than 60% of the total population of the country (Behailu, 2014). It is also important in terms of the rate of consumption and amount of production (Berhe et al*.,* 2011). However, lack of high yielding cultivars, lodging, weed, water logging, moisture stress and low fertility conditions and poor harvest practices largely contributed to low productivity (Behailu, 2014).

Maize (*Zea mays* L.)

Maize shows tolerance to a wide range of environmental conditions and grows at optimal temperature between 18 – 32^{0}C, annual precipitation between 1000 – 1500 mm, and 500 – 1200 mm in the growing cycle (Sys et al*.*, 1993). During germination, the optimum temperature appears be around l8^{0}C; at temperatures below l3^{0}C germination is slow (Uriyo, 1982). However, its response to temperature varies with the growing stage of the crop. In humid-hot lowlands and tepid mid-altitude agroecologies of Ethiopia, maize has a long history of cultivation and served as a subsistence crop (Tesfa et al*.,* 2011). As a result, it is largely grown in *woyna dega* agroclimatoloy, which are highly suitable for rainfed farming in Ethiopia (Hurni, 1998). Well drained, well aerated, deep loam and silt loam soils with adequate organic matter are most suited for maize cropping (Sys et al*.*, 1993).

Maize requires tillage of farmlands 2 to 3 times before planting for suitable germination (EIAR, 2007). It is usually broadcasted in traditional farming; however row planting is also being practiced to improve production. Generally, maize is cultivated in subsistence and partially subsistence rainfed agriculture during the main rainy seasons in different parts of Ethiopia, but it can also be cultivated by irrigation during the dry seasons mainly for market (EIAR, 2007). Production of grain crops for private peasant holding report in 2014/15 production year in Ethiopia indicated that the percentage share of cereals was 80.3 and 87% of grain crop area and production, respectively (CSA, 2015). Harvesting is generally done in two stages such as the earheads are harvested with ordinary sickles and straw is cut to the ground; and earheads are heaped for 3-4 days to dry and then threshed with hand or cattle. Finally, the straw can be used for fodder and domestic source of energy.

Finger millet (*Eleusine coracana*)

It is locally called *dagussa* in Ethiopia, which can be grown throughout the year if temperature is more than 15 °C, i.e., a heat loving plant (Naidu et al*.*, 2006). The crop also tolerates cooler climate than other millets, but it grows best where the average maximum temperature exceeds 27°C and the average minimum does not fall below 18°C (NAS, 1996). The minimum mean annual rainfall requirement for successful cultivation is 460 mm, but the crop can be grown in higher rainfall area also (Naidu et al*.,* 2006). Finger millet is often cultivated in semi-arid and arid agro-ecology, where the area is frequently affected by drought (Masresha et al., 2011). As a result, the crop possesses good drought tolerance but is highly sensitive to frost. However, it requires a moderate rainfall (500 – 1000 mm) that is well distributed during the growing season with an absence of prolonged droughts (NAS, 1996). It can also be grown on all types of soils ranging from poor to fertile soils, but performs well on well-drained loams or clay loam soils (Naidu et al*.*,

2006). The crop is frequently produced on reddish-brown lateritic soils with good drainage and has outstanding ability to utilize rock phosphate than other cereals do (NAS, 1996).

In traditional farming of Ethiopia, the crop is generally planted in broadcasting after proper seedbed preparations. However, research by Tenywa et al. (1999) in Uganda confirmed row planting resulted in significantly better finger millet growth and yield than broadcasting. Harvesting is usually done in two stages such as the crop is cut with ordinary sickles and the grain is separated from the straw after threshing with cattle. After separation of grain from the straw, the straw is collected to be used for fodder and construction material for houses made of mud.

In Ethiopia, finger millet is the 6th important crop after *teff*, wheat, maize, sorghum and barley in terms of production and accounted about 5% of area devoted for cereal crops (Molla, 2012; EIAR, 2007). The crop is mainly grown in the northern, northwestern and western parts of the country, especially during the main rainy season (Asfaw et al., 2011). It is grown by subsistence farmers and serves as a food security crop because of its high nutritional value and excellent storage qualities (Masresha et al., 2011). This makes the farmer to store it for longer periods of time and sale whenever there is an attractive market price without significant damage by storage pests (EIAR, 2007; Tenywa et al., 1999). Finger millet is locally processed into various forms of food items such as *injera* and bread. However, it is mainly used for the preparation of traditional alcoholic beverages, locally called *Tella and Areki* in the country (Asfaw et al., 2011).

Methods of land/crop suitability analysis

Land suitability assessment is inherently a multi-criteria approach where multiple factors are analyzed by GIS for spatial MCDM process. The criteria are measurable based on which decisions about land quality and its suitability for a specified use can be made (Sarkar et al., 2014). This is a standard and accepted by many researchers to evaluate the suitability of the land for intended land use (Dula, 2010; Lupia, 2012; Wubet et al., 2013). Criteria identification can be done using the participatory approach by a group of experts from various disciplines, but it should adequately represent the decision making environment and must contribute towards the final goal (Lupia, 2011).

The methodology used for land suitability evaluation was the MCE based on FAO (1976) guidelines involving matching of diagnostic land quality against crop requirements and assigning suitability rates for each land quality factors. Each thematic layer in MCE represents a criterion for the land evaluation process (Lupia, 2012). Later on, the criteria were matched with the dominant crop requirements for selected crops (FAO, 1984; Sys et al., 1993; Teshome and Verhe, 1995; Mohammed, 2003; Naidu et al., 2006; Asmamaw et al., 2015). Once the criteria for suitability analysis have been arranged, combinations of the crop requirements and land quality values were made and factor rating for each LUT were decided. The values of the parameter or factor ratings calculated for each land quality parameters provide different suitability classes for each LUT. This can be determined by reclassification of spatial entities in terms of their representative attribute values of suitability for a given LUT (Burrough and McDonnell, 1998). Finally, the factor layers for each land quality parameters were standardized or rated before combination using "*reclass*" of ArcGIS. As a result, all the factors used for this study were reclassified into four land suitability class ratings, such as S1, S2, S3 and N1 (FAO, 1976, 1983, and 2007). These criteria maps are the input data to the GIS-based decision making procedure for the next higher level of suitability analysis.

The MCE process, in this study, involved information about the relative importance's of each criterion to decision makers in an overall suitability analysis. The derivation of weights is a central step in defining the decision maker's preferences as an indicative of its importance relative to other criteria under consideration (Lupia, 2012). As a result, the land suitability maps for the selected LUTs were produced using weighted overlay analysis (WOA) by "*Spatial Analyst Tool >>Overlay>>weighted overlay*" of ArcGIS; based on the relative significances of each factor layers on crop growth rate and yield. Finally, a suitable land allocation map was derived based on the results of land suitability map of each LUT using vector overlay analysis (VOA) by "*Analysis Tools>>Overlay>>Union*" of ArcGIS for sustainable rainfed crop production. Therefore, the methodological flow chart portrayed in Figure 4 indicated the overall procedures of land suitability evaluation in a step-wise process.

The AHP (Analytical Hierarchical Process) was developed by Saaty (1977) as a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. It has been extensively studied and integrated with GIS software packages like ArcGIS "*AHPforArcGIS10.x*" weight derivation module. It is a means to calculate the needed weighting factors by help of a preference matrix where all identified relevant criteria are compared against each other with reproducible preference factors (Mohammed, 2014). The weights, in this study, were defined through the AHP module in ArcGIS 10.1 where the weights must add to 1.0 or 100%. All the criteria, which are considered relevant for a decision, were compared against each other in a pair-wise comparison matrix. It is a measure to express the relative preference among the factors using numerical values (Sarkar et al., 2014). The values expressed a judgment of the relative importance (or preference) of one factor against another ranging from 1 to 9 where a value of 1 expresses "*equal importance*" and a value of 9 is given for those factors having an "*extreme importance*" over another factor (Saaty and Vargas, 1991).

The weighting process in this study combined the experts' suggestion, literatures and researcher's estimation to produce the resultant suitability maps of the study area. After discussion and careful analysis of the set of evaluation criteria with experts and inspection of literature, all the pair-wise comparisons for the set of criteria were made for three LUTs. Thus, all possible combinations of two factors were compared and the AHP calculated a set of weights and a "*consistency ratio*" in a step-wise process. This ratio indicated any inconsistencies that may have been arisen during the pair-wise comparison process. Tables 3 and 4 revealed the weights of the soil and climate land quality factors for *teff*, maize and finger millet production in the AHP weight derivation. Table 5 also showed factor weights of diagnostic soil, climate and topographic land quality for sustainable rainfed *teff*, maize and finger millet production.

Determination of land use requirements (LURs)

The FAO (1976, 1983, and 2007) publications for land evaluation have given a framework of land suitability analysis for crops in terms of suitability classes from highly suitable (S1) to not suitable (N) based on the crop specific land use requirements. Land use requirements are conditions of land necessary or desirable for a successful and sustained practice of a defined land use type (FAO, 1983). These are usually expressed in terms of the need for favorable climatic, topographic, soil attributes and management requirements for optimum production of crops (Wubet et al., 2013). Evaluation of crop requirements is a useful tool in assessing crop adaptability and suitability in a given area (Dula, 2010). Requirements are expressed by defining optimal, marginal and unsuitable conditions for each land attributes that influence directly

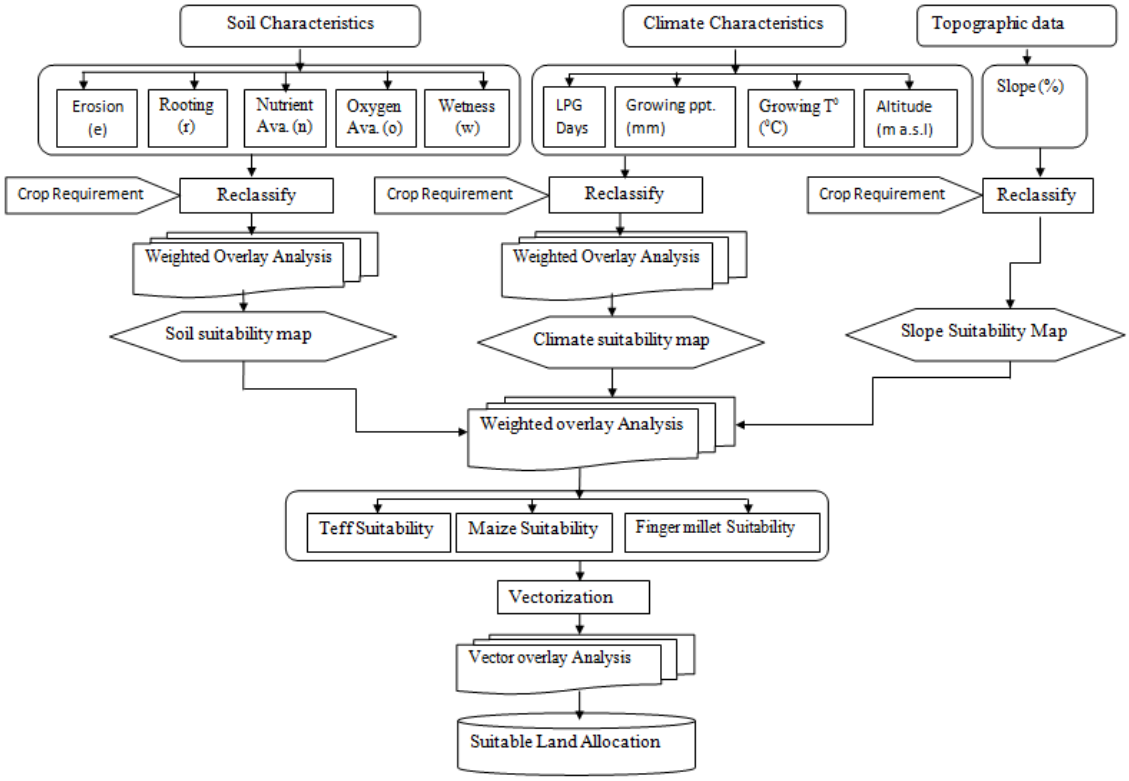

Figure 4. Methodological framework in MCDM process for land suitability evaluation.

Table 3. Criteria weights for LUTs regarding diagnostic soil factors calculated by AHP weight derivation module.

Soil quality factors for each LUTs	Weight (*Teff*)		Weight (Maize)		Weight (Finger millet)	
	%		%		%	
Texture (class)	0.086	8.6	0.088	8.9	0.077	7.7
Drainage (class)	0.073	7.3	0.055	5.5	0.055	5.5
Flood Risk (class)	0.057	5.7	0.055	5.5	0.055	5.5
Ph (H2O)	0.104	10.4	0.097	9.7	0.102	10.2
EB (cmol(+)/kg soil)	0.172	17.2	0.163	16.5	0.166	16.6
CEC (cmol(+)/kg soil)	0.218	21.8	0.189	18.9	0.209	20.9
SOM (%)	0.103	10.3	0.129	12.9	0.099	9.9
PAV (ppm)	0.129	12.9	0.129	12.9	0.124	12.4
TN (%)	0.057	5.7	0.095	9.4	0.113	11.3
Total	1.00	100	1.00	100	1.00	100
Consistency Ratio (CR)	-0.001*		0.109*		0.034*	

Note: * indicates that the CR <1.00 is considered to be consistent enough for all LUTs (table 3 – 5).

or indirectly plant growth, performance and biomass production (Sys et al., 1991). In the present study, soil, climate and landscape requirements of selected LUTs were considered as the major limiting factor or criteria for suitability analysis (Tables 6 – 8). Climate land quality factors considered in this study were moisture availability (precipitation of growing cycle and length of growing period) and temperature regime (mean temperature of the growing cycle and altitude). The topographic requirement was referred in form of slope steepness (%). The soil requirements referred are rooting conditions, oxygen availability, wetness and nutrient

Table 4. Criteria weights for LUTs regarding diagnostic climate factors calculated by AHP weight derivation module.

Land quality factors for each LUTs	Weight (Teff)		Weight (Maize)		Weight (finger millet)	
	%		%		%	
Precipitation of growing cycle (mm)	0.31	31	0.267	26.7	0.213	21.3
Length of growing period (days)	0.562	56.2	0.564	56.4	0.408	40.8
Temperature of growing cycle (classes)	0.069	6.9	0.108	10.8	0.325	32.5
Altitude (m a.s.l)	0.058	5.8	0.062	6.2	0.054	5.4
Total	1	100	1	100	1	100
Consistency Ratio	0.03*		0.02*		0.25*	

Note: Spatial variations in diagnostic climate factors for all LUTs are mainly due to altitude over the entire study catchment.

Table 5. Criteria weights for LUTs regarding Land quality factors calculated by AHP weight derivation module.

Land quality factors for each LUTs	Weight (Teff)		Weight (maize)		Weight (finger millet)	
	%		%		%	
Slope (percent rise)	0.209	20.9	0.204	20.4	0.265	18.5
Soil factors (classes)	0.461	46.1	0.465	46.5	0.624	52.4
Climate factors (classes)	0.329	32.9	0.331	33.1	0.293	29.3
Total	1.00	100	1.00	100	1.00	100
Consistency Ratio	0.03*		0.04*		0.3*	

Table 6. Land use requirements of *teff* (90-140 days) based on land characteristics data for small-scale rainfed agriculture (FAO, 1984; Lupia, 2012; Seyfu, 1997, Teshome and Verhe, 1995; Asmaamw et al*.,* 2015; Mohammed, 2003).

Land use requirements		Class, degree of limitation and rating scale			
Land quality	Diagnostic factors and unit	100-85%	85-60%	60-40%	<40%
		S1	S2	S3	N1
Moisture availability (m)	Precipitation of growing cycle (mm)	450-550	300-450 550-800	800-1200	<200, >1200
	Length of growing Period (days)	110-150	95-110	75-90; 150-180	<75 >180
Temperature regime (T)	Mean temperature of the growing cycle (^{0}C)	15-21	14-15, 21-22	11-14, 22-25	<11, >25
	Altitude (alt) in (m a.s.l)	1600-2200	1000-1600, 2200-2400	2400-2800	<1000,>2800
Erosion hazard (e)	Slope (%)	<13	13-25	25-50	>50
Rooting conditions (r)	Texture (class)	Si, SiC, C	SiCL	SiL, CL, L	S,SCL,SL
Oxygen availability(o)	Soil drainage (class)	M	P, W	VP	SE, E
Wetness (w)	Flood risk (F)	Fo	F1	F2	F3+
Nutrient Availability (n)	CEC(cmol(+)/kg soil)	>30	30-28	28-16	<16
	EB (cmol(+)/kg soil)	>27	27-15	15-10	<10
	pH ($H_2$01: 2.5)	5.5-7.5	5.2-5.5, 7.5-7.8	5.2-4.5, 7.8-8.5	<4.5, >8.5
	SOM (%)	>3.0	2.5-3.0	2.0-2.5	<2.0
	PAV (ppm)	>10	10-5	5-3	<3
	TN (%)	>0.20	0.20-0.15	0.15 -0.10	<0.10

Table 7. Land use requirements of Maize (120-150 days) based on land characteristics data for small-scale rainfed agriculture (FAO, 1984; Sys, et al., 1993; Mohammed, 2003).

Land Use Requirements		Class, degree of limitation and rating scale			
Land Quality	**Diagnostic factors and unit**	**100-85%**	**85-60%**	**60-40%**	**<40%**
		S1	**S2**	**S3**	**N1**
Moisture Availability (m)	Precipitation of growing cycle (mm)	500-750	400-500 750-1200	300-400 1200-1600	<300 >1600
	Length of growing period (days)	140-220	120-140; 220-270	90-120; 270-300	<90; >300
Temperature regime (T)	Mean temperature of the growing cycle (^{0}C)	24-19.5 24-32	19.5-16 32-35	16-14 35-40	<14 >40
	Altitude (alt) in (m a.s.l)	1500-2200	1000-1500, 2200-2400	2400-3000	<1000, >3000
Erosion hazard (e)	Slope (%)	0-8	8-16	16-30	>30
Rooting conditions (r)	Texture (class)	SiC,SiCL, Si, SiL, CL, SC,CL,L,C	SL,LS	S, SCL	S
Oxygen availability(o)	Soil drainage (class)	W	M, P	VP	E, SE
Wetness (w)	Flood risk (F)	Fo	-	F1	F2+
Nutrient Availability (n)	CEC(cmol(+)/kg soil)	>31	31-27	27-16	<16
	EB (cmol(+)/kg soil)	>25	25-15	15-5	<5
	pH ($H_2$01: 2.5)	7.0-6.0	6.0-5.5 7.0-7.8	5.5-5.2 8.2-8.5	<5.2 >8.5
	SOM (%)	>3	3.0-2.5	2.5-1.0	<1.0
	PAV (ppm)	>10	10-5	5-3	<3
	TN (%)	>0.20	0.20-0.15	0.15-0.10	<0.10

Table 8. Land use requirements of finger millet (120-150 days) based on land characteristics data for small-scale rainfed agriculture (FAO, 1984; Sys et al., 1993; Naidu et al., 2006).

Land use requirements		Class, degree of limitation and rating scale			
Land quality	**Diagnostic factors and units**	**100-85%**	**85-60%**	**60-40%**	**<40%**
		S1	**S2**	**S3**	**N1**
Moisture availability (m)	Precipitation of growing cycle (mm)	>900	600– 900	450– 600	<450
	Length of growing period (days)	>150	90 – 150	75– 90	<60
Temperature regime (T)	Mean temperature of the growing cycle (^{0}C)	28-34	25 – 27, 35 – 38	39 – 40, 19 – 24	>40, <19
	Altitude (alt) in (m a.s.l)	1500 – 2200	1200 –1500 2200 –2400	1000– 1200	<1000, >2400
Erosion hazard (e)	Slope (%)	<3	3-5	5-10	>10
Rooting conditions (r)	Texture (class)	L,SiL,SLSiC ,L,SCL	SiC, C, SC, CL	LS, S, C>60%	-
Oxygen availability(o)	Soil drainage (class)	W, M	P, SE	VP, E	-
Wetness (w)	Flood risk (F)	Fo	F1	F2	F3+
Nutrient Availability (n)	CEC(cmol(+)/kg soil)	>30	30 – 20	20 – 10	<10
	EB (cmol(+)/kg soil)	>25	25 – 15	15 – 3	<3
	pH ($H_2$01: 2.5)	5.5- 7.5	4.5 - 5.5; 7.6 - 8.5	4.0 - 4.4 ; 8.6 - 9.5	<4.4 <9.5
	SOM (%)	>2.8	2.8 - 2.0	2.0 - 0.8	<0.8
	PAV (ppm)	>14	14-5	5-2	<2
	TN (%)	>0.27	0.27-0.22	0.22-0.15	<0.15

Note: *PAV (ppm) and TN (%) are estimated from nutrient removals in kg/ha values (Tiwari, 2001).

Table 9. Area coverage of land suitability classes for selected LUTs in Gelda catchment, northwest highlands of Ethiopia.

Suitability classes	Teff		Maize		Finger millet	
	hectares	%	hectares	%	hectares	%
S2	19970.23	76.04	18258.47	69.52	17804.19	67.79
S3	6293.77	23.96	8005.53	30.48	8458.16	32.21
Total	26264	100	26264	100	26262.35	100

availability. Therefore, land quality factors such as soil, climate and topographic were considered as LUR in determining suitability status of the selected LUTs; such as *teff* (*Eragrostis tef*), maize (*Zea mays* L.) and finger millet (*Eleusine coracana*).

RESULTS AND DISCUSSION

Land suitability analysis results for selected LUTs

Table 9 and Figure 5 showed the results of WOA using MCE for diagnostic soil quality factors (rooting condition, oxygen availability, wetness, and nutrient availability); topographic factors (slope gradients) and climatic factors (moisture availability and temperature regime) for all selected LUTs. The analysis demonstrated that about 76.04, 69.52 and 67.79% of the study area are classified as moderately suitable (S2) for cultivation of *teff*, maize, and finger millet crops respectively. In addition, about 23.96, 30.48 and 32.21% of the study area were found to be marginally suitable (S3) for cultivation of *teff*, maize, and finger millet crops, respectively. However, none of the area in the study catchment was classified as highly suitable (S1) and unsuitable (N) classes. These indicated that the study area encountered limitations ranges from land having limitations which in aggregate are moderately severe to land having limitations which in aggregate are severe for the selected LUTs at sustained manner. The limitations were largely attributed to lower organic matter content; poor drainage condition in low-lying areas which are dominated by dystric gleysols; erosion in areas of south, southeast and eastern parts of the catchment dominated by steep slopes; and relatively acidic conditions of soils.

Suitable land allocation map analysis results for all LUTs

Figure 6 and Table 10 showed the suitable land allocation map, in the study catchment, along with their best suitability classes when multiple choices and competition were made for all selected LUTs on a particular parcel of land. The VOA results revealed that about 20.25 (5274.22 ha) and 63.92% (16644.38 ha) of the catchment are classified as moderately suitable (S2) and marginally suitable (S3) for cultivation of all selected LUTs, respectively. This showed that a particular plot of land was suitable for different LUTs at the same level of suitability classes. At this point, competitions for the same parcel of land by different LUTs were possible. Thus, farmers could have freedom to choose a range of land uses with the same suitability level and allocate one that best meet his/her interest. Conversely, about 4.38% (1140.87 ha) of land was moderately suitable (S2) for cultivation of both *teff* and maize, but marginally suitable (S3) for finger millet crops. Similarly, about 6.71% (1748.61ha) of land was marginally suitable (S3) for cultivation of maize and finger millet, but moderately suitable (S3) for *teff*. Thus, farmers could prefer cultivation of LUTs with higher level of suitability than others. These are indicatives of competition from among a range of LUTs at different suitability levels for the same parcel of land (Wubet et al*.,* 2013). The remaining suitable land allocation classes hold only small patches of lands over the entire study catchment. However, in the present study, none of the area fell into highly suitable class for all selected LUTs.

Conclusion

The results of land suitability and the suitable land allocation map analysis for *Teff* (*Eragrostis tef*), maize (*Zea mays*) and finger millet (*Eleusine coracana*) identified shortcomings for subsistence rainfed agriculture in the study area. These analyses provide mechanisms to overcome the identified limitations and optimize land use through the application of sustainable land management practices in the study catchment. Management practices involving measures that increase SOM levels and enhance soil fertility will have a significant effect on crop productivity. As a result, increased soil organic matter levels by organic fertilization could contribute improvement in soil structural stability, nutrient storing and exchanging capacity, water infiltration rates and reduced risk of soil erosion. Soil conservation measures could also be implemented in areas where soil erosion is by-far exceeding soil formation rates. This will considerably contribute runoff reduction by reducing

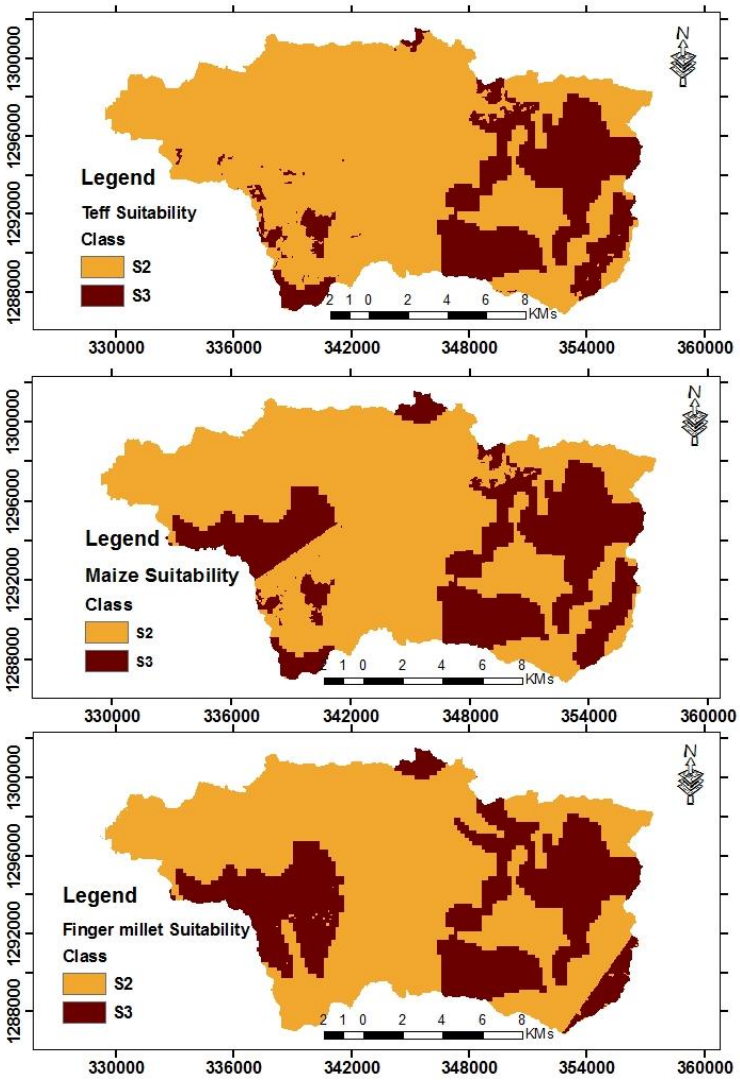

Figure 5. Land suitability maps for selected LUTs in Gelda catchment, northwest highlands of Ethiopia.

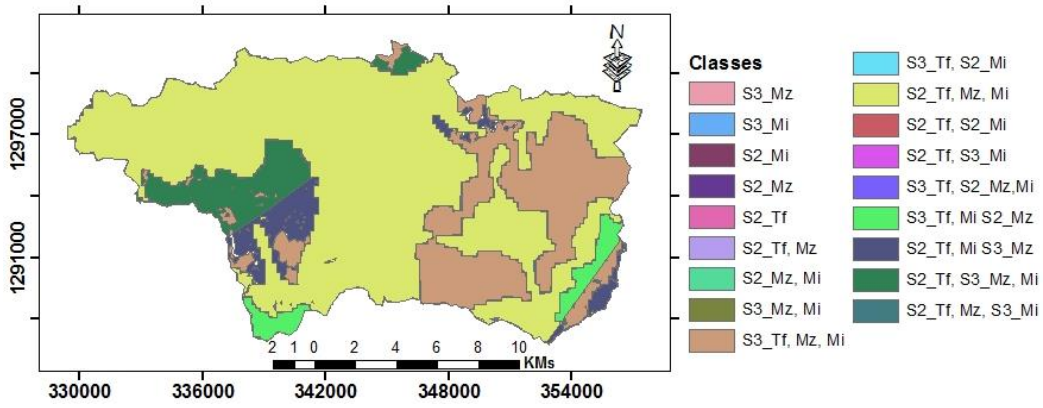

Figure 6. Suitable land allocation map with their respective degree of suitability in Gelda catchment, northwest highlands of Ethiopia. Note**:** Tf = *teff*, Mz = maize and Mi = finger millet.

Table 10. Suitable land allocation for the selected LUTs along with their area coverage.

Suitability land allocation code	Area coverage	
	Ha	%
S2_Tf	14.24	0.05
S2_Mz	20.65	0.08
S3_Mz	13.32	0.05
S2_Mi	21.6	0.08
S3_Mi	5.94	0.02
S3_Mz, Mi	8.82	0.03
S2_Tf, Mz	8.74	0.03
S2_Mz, Mi	21.82	0.08
S2_Tf, Mz	21.21	0.08
S3_Mz, Mi	7.11	0.03
S2_Tf,S3_Mi	10.34	0.04
S3_Tf, Mz, Mi	5274.22	20.25
S2_Tf_Mz, S3_Mi	1140.87	4.38
S3_Tf, Mi, S2_Mz	160.28	0.62
S2_Tf, S3_Mz, Mi	1748.61	6.71
S3_Tf, Mz, S2_Mi	737.67	2.83
S2_Tf, Mi, S3_Mz	134.13	0.52
S2_Tf, Mz, Mi	16644.38	63.92
S3_Tf, S3_Mz, Mi	40.95	0.16

slope length and steepness of farm plots. Proper soil and water conservation techniques (structural and non structural measures) are quite important to protect the top soil from being eroded in the highlands and retain water in soil for longer period of time, i.e., residence time increased in the catchment. These consecutively increase soil loss and runoff in the high slope areas; water retention and flooding in the lower slope areas; and sustain base flow of the main stream in the catchment, i.e., Gelda River. In areas where drainage problem and water logging is inherent, soil drainage practices such as construction of frequent diversion channels, waterways, etc can result in cost–effective mechanism of ensuring optimum production.

The results also showed that some plots of land were suitable for all LUTs at the same level of suitability classes where competitions for the same parcel of land are possible. Farmers could also prefer LUTs with higher level of suitability than others for plots of land that showed different suitability level for different LUTs. However, the parameters used for land suitability analysis in this study were entirely physical (soil, climate and topography) and much improvement can be made if an in-depth analysis on some socio-economic variables are considered. Therefore, land suitability analysis for agricultural crops using MCE in a GIS environment is a strong tool towards measuring and valuation of land in terms of the varying importance to decision makers for sustainable rainfed agriculture.

Conflict of Interests

The authors have not declared any conflicts of interest.

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Success of high-rise residential condominium housing development program in meeting its objectives and its liveablity in Addis Ababa: A case of Bole sub city

Samuel Sahle Weldemariam

Department of Geography and Environmental Studies, College of Social Sciences and Humanities, Debre Markos University, Debre Markos, Ethiopia.

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This study aims to study to examine the success of the condominium housing development program. The result of the study revealed that the housing development office is constructing and distributing condominium-housing units with slower pace. Settlement in high-rise residential condominium housing saves land from encroachment and improper utilization. The open space reserved at sites of condominium is not proportional to the number of residents, and it is not used properly. Residents of condominium are satisfied with their spatial accessibility to some selected social and infrastructural service centers. At some sites, the roads leading to or passing along sites of condominium is not paved or asphalted. Of residents, those who moved to their condominium unit before the proper functioning of the installation suffered from the problem of water and electric power for four to eight months. The strength of social interaction among residents of condominium is weaker. When residents move to their condominium unit, they quit their membership of Ekub and Iddir associations, to which they were member and the livelihood activities that they were practicing at their former residence. Sound disturbance and theft crime are common social problems at sites of such settlement.

Key words: Condominium, residents, housing.

INTRODUCTION

Homelessness is a common problem at urban centers of developing and developed countries, and is made worse due to rural-urban migration (Ingwani et al., 2010). As more people migrate to cities, the pressure to find suitable accommodation such as housing has great impact on the society as a whole (Hulchanski, 2002).

Shortage of affordable housing is one of the serious challenge that affect economic competitiveness, and quality of life. On the other hand, most municipal governments and housing providers are unable to meet housing need. Like other poor countries, the urban housing problem in Addis Ababa is mainly due to continuous population increase, low level of economic performance, in efficient land service delivery and in

E-mail: Samuel_sahle@yahoo.com.

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adequate urban management and regulatory framework.

The government of Ethiopia planned condominium housing [1] development program in the country since 2003. Accordingly, the first pilot test condominium housing units were constructed in Addis Ababa at Bole sub city between the year 2003 and 2005. In the subsequent years, regional and federal government of Ethiopia borrowed money from the commercial bank of Ethiopia, and constructed the subsidized condominium houses at the capital city and some selected towns.

The intervention of government is important for land and finance supply, capacity building, bulk purchase of industrial products of construction materials, organizing medium and small enterprises, standardizing housing, and introducing new construction technology that minimize cost and time (Tamiru, 2007). The government designed this form of housing development program to address multiple social, economic, and environmental problems of the urban society.

The first and foremost objective of the program is to address housing problem of low and middle-income group of the society by constructing subsidized affordable condominium houses (Tamiru, 2007). The second objective is to economize urban land through densification by utilizing open space, renewing decayed areas and vertical increment of units by constructing G+2 to G+4 condominium houses (Yenoinshet, 2007).

However, authors such as kunze (2005) described such settlement as “trading privacy for location”. The third objective is to ease the provision of amenities and services placing them at common area where it will be accessible for all (Yared, 2008), and reduce cost of provision (MWUD, 2007). This is because settlement with in high-rise building results in high density and small land area coverage. In turn, high density results in high concentration of infrastructures (Narayanan, 2006). The fourth objective is to reduce urban unemployment and poverty levels, enhance and build capacity of the domestic construction industry, reduce slum through upgrading, reduce urban sprawl, and encourage household saving for home ownership and ensure tenure security (United Nation, 1999; MWUD, 2007).

Condominium house residents not only have next-door neighbors but also have upstairs and down stair neighbors. Such types of house owners have the individually and communally owned properties (CMHC, 2009).

Common properties include: the roof, stair cases, exterior walls and windows, building foundations, infra-structure such as piping, electrical cables, recreational areas, gardens, lobbies, hall ways, walk ways, space for: animal slaughtering ,coffee grinding, spice drying areas, coffee ceremony, children’s play ground , green field and car parking(United nation human settlement, 2007). Since residents have these much communal possessions, they have a lot of chance to meet each other while they use these properties jointly.

As result, this frequent contact of residents probably leads them either to conflict or to peaceful relationship. No study previously conducted examine if the program addressed the four objectives mentioned earlier, and the strength of social interaction among residents.

Therefore, the purpose of this study is to examine the success of the condominium housing development program with regard to the progress of constructing and distributing condominium-housing units as per the demand, effective land management and infrastructure and social services provision efficiency as well as social problems related to resettlement to condominium housing and living in. Specifically the study aims to:

1. To examine the progress of housing development office in constructing and distributing condominium houses
2. To assess the implication of condominium housing system on effectiveness of land management and utilization of open space available at sites of condominium
3. To evaluate the satisfaction of residents by their spatial accessibility to different infrastructure and social services
4. To examine the social problems related to resettlement to condominium housing and living in.

MATERIALS AND METHODS

For this study, both primary and secondary data sources were used. Primary data were collected using one focus group discussion session, questionnaire, unstructured interview and observation. The focus group discussion was conducted among three females and four males. For the discussion, one person has been taken from each seven sampled sites (that is, Gerji1, Gerji2, Gerji3, Gerji5, Japan Embassy, International stadium, and Adwa Park). The participants of the focus group discussion are heads, house unit owners, and the one who lived longer at the site.

The questionnaires were used to gather information about the demographic characteristic of the household, satisfaction of households by the available open space, their access to social and infrastructural services, the social interaction, relationship of residents, and security related issues such as theft crime and sound disturbance. Questions were closed and open-ended. Interview was conducted with office head of housing development, owner’s association committee member, and the guards of each condominium site. The researcher employed observation to gather data concerning the utilization of the available open space, the road qualities, waste management mechanism, and the sanitation issues at sites of condominium.

Secondary data were collected from housing development office, land development and administration office of Bole sub city and housing transfer of Bole sub city. The general profile about the number of condominium houses constructed and distributed to owners within the whole city during the three phase of construction and six round of distribution is taken from housing development

[1] Condominium is common interest based types of house. It consists of two parts: the individual unit and common properties (CMHC, 2009). The individually owned property is only the air space within the walls of their units. In this case, owners do not own any portion of the floors, ceiling, and walls enclosing their unit. Their physical ownership is limited to the air rights within those floors, ceilings, and walls.

Tables 1. Number of sample households from each sampled site.

S/N	Site name	Total	Sample
1	Gerji1	696	19
2	Gerji2	320	10
3	Gerji3	1188	36
4	Gerji5	862	25
5	Japan embassy	304	10
6	International stadium	344	10
7	Adwa park	344	10
Total		**4058**	**120**

Source: Housing transfer office of Bole sub city.

office of the city. Cadastre ('*Carta*')[2] information concerning non-floored form of individual's residential house is taken from land development and administration office of Bole sub city.

Regarding sampling technique, multistage sampling is used. Since Addis Ababa is a city, where condominium houses are constructed as a pilot test in the country, it has longer experience than other regional cities and towns of the country. Due to this, Addis Ababa is selected as a research site. In particular from the ten sub cities of Addis Ababa, the researcher selected Bole sub city as a case study area because the first pilot test for this form of houses is conducted at this sub city particularly at Gerji. At the time of the survey, within Bole sub city, there are 12 sites of condominium.

However, residents did not occupy two sites at the time of the survey. Meaning during the survey for this study there were no people living at these two sites. These sites were Bole summit and Bole Ayat2. Hence, using simple random sampling technique out of ten sites seven of them sampled. The sampled sites are Gerji1, Gerji2, Gerji3, Gerji5, Japan Embassy, International stadium, and Adwa Park. These seven sites have 4058 households. From the total 4058 number of households, 3% that is 120 sample households were taken. Number of households varies from site to site. Hence, the number of sampled households from each site was proportional to the total number of households living at each site.

Accordingly; 19, 10, 36, 25, 10, 10 and 10 households were sampled using simple random sampling technique from Gerji1, Gerji2, Gerji3, Gerji5, Japan embassy, International stadium and Adwa Park respectively (Table 1). To analyze the collected data, the researcher used statistical techniques such as arithmetic mean, location quotient[3], Gini coefficient[4], one sample T-test, and percentage**.** The data were organized and described using tables and figures.

Arithmetic mean and density formula[5] was used to compare density at condominium sites and non-floored form of individual's house. Location quotient and Gini coefficient jointly was used to assess the proportionality between numbers of residents, and the size of open space available at sites of condominium. Location quotient shows the site's share of number of peoples (number of household) in comparison with general distribution. If the location quotient is less than one, number of residents of that site is below the general distribution in reference to the available open space. If location quotient equal to one, number of residents at the site is according to the general distribution. If the location quotient is, greater than one the number of people settled at the site is above the general distribution in reference to the available open space.

To do so, total number of residents of each site and size of open space at each site were important. Total number of residents was obtained by multiplying the number of households by average household size, which was estimated for Addis Ababa (that is, 4.1) by CSA in 2007. Open space size of each condominium site was obtained by subtracting the total area occupied by buildings from the total area of the site. Gini coefficient tells us the degree of in equality.

One sample T-test was used to measure the satisfaction of residents with the available open space, their spatial accessibility to different social and infrastructural services and the strength of social interaction. In the overall process of analysis, qualitative methods was also used to analyze data collected through observation, interview, and focus group discussion; and from secondary sources and open-ended questions.

RESULT

Progress of housing development office in constructing and distributing condominium houses

It is difficult to get the exact demand for condominium at city level. Therefore, the number of people registered for Condominium in 2004 in the city is considered as demand in this study. This information is not an updated one because the increased demand after 2004 is not known. The writer tried to get updated information from offices of housing development but the office did not record the demand after 2004. The office is on the process of responding to the demand of registered people since then. Hence, this study stressed to assess how much percentage of the demand of people registered in 2004 is solved over the last seven years (2004 to 2011). At city level, 453.287 people registered. Therefore, the total demand for condominium house in Addis Ababa is 453.287 units, and the supply varies over rounds of distribution (Table 2).

The number of people who registered for studio, one bedroom, two bedroom and three-bed room are 102287(23%), 201969 (44%), 118241 (26%) and 30790 (7%) respectively. Within the seven years, the housing development office constructed 80.287 housing units with three phases of construction,and distributed with six rounds of distributions. The total supply of studio, one bed room, two bed room and three bed room equal to 16801 (21%), 30367 (38%), 25304 (31%) and 8355 (10%) respectively.

According to the project plan of housing development office, it was to construct 50.000 units annually and fulfill

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[2] homeownership identification map

[3] Location quotient = $\frac{x/\sum x}{y/\sum y}$ …… (2)

Where x = number of people, y =open space size at each site in m^2, $\sum x$ = Total number of all sites people, $\sum y$= Total open space area of all sites.

[4] $GC=\frac{1}{100}*\frac{1}{100}*((x_1{}_*y_2+x_2*y_3{}_+x_3{}_*y_4{}_+x_4*y_5+x_5*y_6+x_6*y_7+x_7*y_8+x_8{}_*y_9+x_9*y_{10}+x_{10}*y_{11})-(y_1*x_2+y_2*x_3{}_+y_3{}_+x_4+y_4*x_5+y_5*x_6+y_6*x_7+y_7*x_8{}_+y_8*x_9+y_9*x_{10}{}_+y_{10}*x_{11}))*100$……(3)

Where; GC=Gini-coefficient

$x_1, x_2, x_3 \ldots\ldots\ldots\ldots\ldots x_{10}$ *Total number of each site*

$y_1, y_2, y_3 \ldots\ldots\ldots\ldots\ldots y_{10}$ *Total open space of each site*

[5] $\boldsymbol{Densit} = \frac{Total\ number\ of\ people\ of\ the\ site}{Total\ area\ of\ the\ site\ used}$……4

Table 2. Demand and Supply of condominium houses in typology.

Typology of houses	Number of registered people (demand)	Supplied over the last seven years
Studio	102.287	16801
One bed room	201969	30367
Two bed room	118241	25304
Three bed room	30790	8355
Total	453.287	80827

Source: Housing development office (2011).

453.287 demands within nine years (that is, 453, 287/50,000) but only 80.287 units were constructed and distributed within seven years. According to the plan, 80.287 units were supposed to be constructed within one or one and half year. Nevertheless, during the last seven years only 17.7% of the demand is met. If the construction and distribution continue with this pace another additional 32 years probably will be required to meet the rest 372.460 demand.

The high deficit rate is resulted from high demand and low supply of the houses. For example, one-bed room units have 171.602 deficits. This means that 171.602 of the demand for one bedroom did not get response during the last six round of distribution or three phase of construction (Figure 1).

Although the demand-supply deficit is high in the case of all typologies, the housing development office is constructing and distributing housing units based on the number of applicants for each typology. This means the supply for each typology is proportional to the respective demand. For example, as there is more demand for one bedroom than other typologies, more number of one bedrooms housing units were constructed and distributed through lottery.

The trend of construction and distribution of condominium housing units declined throughout the six round of distribution although it increased during the fourth round (Figure 2). As the researcher heard from the sub plan officer of housing development, the main obstacle of the office to construct houses according to the plan with an increasing rate are lack of finance and improper implementation of the plan.

Condominium housing development office made significant attempt to solve housing shortage problem but some rooms are still not occupied at some sites. At city level, there are 502 unoccupied units. Within Bole sub-city alone, there are 147 vacant units. At Gerji2, Gerji3, Gerji5, Japan embassy, international stadium, Adwa Park, and Bole ring road there are 26, 65,15,31,3,6, and 1 vacant unit respectively.

According to housing development office head, these units remain vacant mainly due to two reasons. The first one is that housing development office did not contract with owners because owners did not hear that they became winners of the lottery. Secondly, units made vacant by government to resettle people who will be displaced due to urban redevelopment. As a result, units remain vacant for along without returning the cost government incurred for construction.

Consequently, the financial capacity of the government may weaken, and the program becomes unsustainable. As information is obtained from focus group discussants and sample respondents, condominium housing is also not addressing the need of the targeted groups (that is, the middle and low-income group). Most people who get the chance to own a housing unit by the drawn lottery and who cannot pay the down payment are selling it to the richer people. Consequently, in addition to missing the chance of being homeowner, the poor also miss the chance to participate in this program for the second time or other housing development program in the future in the city. On the other hand, rich people own more number of houses while the poor remain homeless. This implies that the poor are without house, which is the important asset at urban areas.

Land management and open space utilization at the sites of condominium houses

Researches on high-rise or multi-storied houses indicated different advantages of it. For example, it is noted that settlement in such form of housing is efficient in land management, reducing traffic congestion, postponing urban sprawl, improving viability and access to community services and infrastructure provision (Sakowicz, 2004; Yuen et al., 2006; Alex, 2007) as well as efficient use of motor vehicles and therefore reduction in fossil fuel combustion (Marcotullio, 2001).

It also paves and opportunity to transform a form of settlement from isolated location to physically, socially, and economically interconnected form (Adeel, 2006; Alex, 2007), and reduces cost of infrastructure development. Moreover, it enables to get extra space for playing ground, greenery and constructions of other facilities (Yenoinshet, 2007); Alex, 2007).

In contrast to this, research work of other scholars noted that high-rise buildings have defects such as shadowing on other buildings, require high construction costs, small gross floor area ratio and wind effect on high

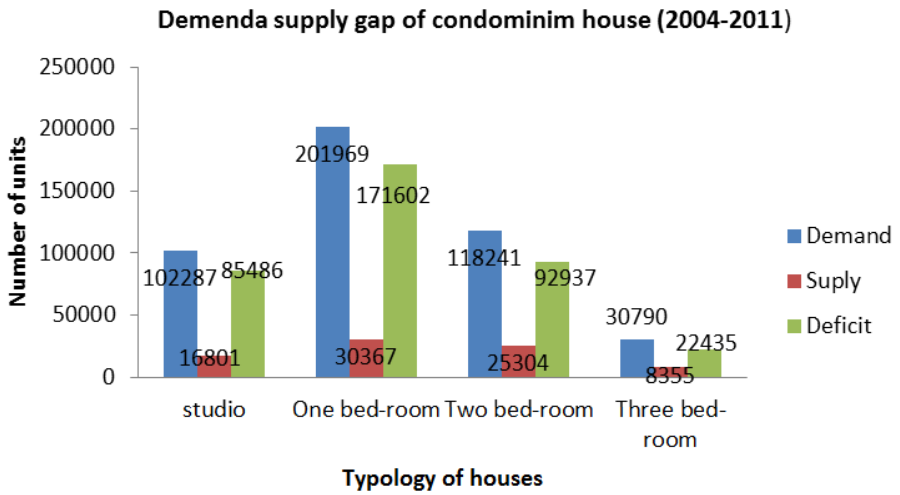

Figure 1. Demand -supply gap of condominium house in Addis Ababa.

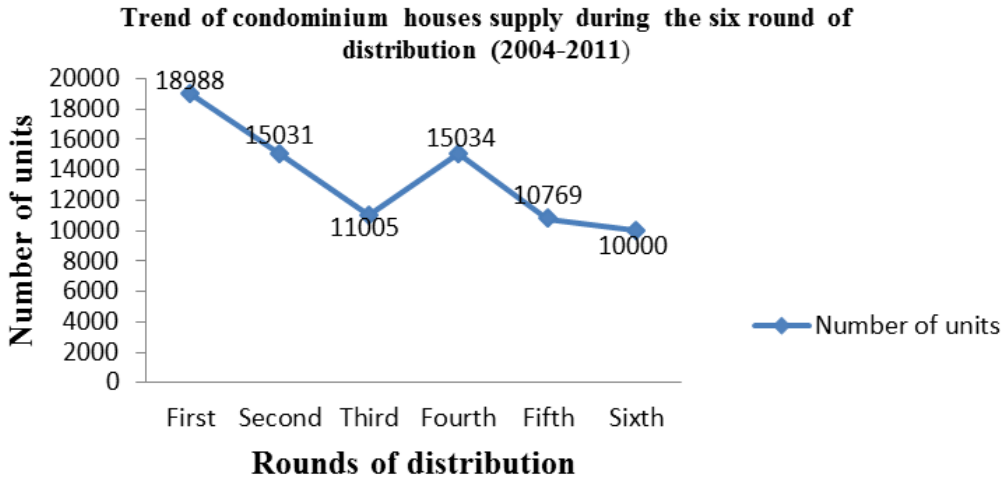

Figure 2. Trend of condominium house supply during the six round of distribution.

floor residents (Kunze, 2005; Narayanan, 2006), poor social interaction among neighbors (Narayanan, 2006) and shortage of open spaces (Alex, 2007).

Some other studies indicated that the satisfaction of condominium house residents relates with their feeling of crowdedness that directly associate with personal perception. For example, Annie et al. (1996) explained that the actual physical density is not a matter, but rather people's perception or feeling of it. The feeling of crowdedness at high-rise residential apartment houses is due to physical causes (restricted space ,tall buildings, lack of parks and greenery etc), social cause (interpersonal relationship), and individual factors (age, sex or socio-cultural back ground).

Land within the city of Addis Ababa is highly priced thus a growing number of high-rise apartment are being built in the city by both privates and government to bring effective land management for business and residence purposes (Yared, 2008). Open space at such residential home, which is necessary for children playing, and their socialization (Dublin city council, 2007), parking of the vehicles, aesthetical value, animal slaughtering, coffee grinding, and spice drying, coffee ceremony, children's playing and green field (Ingwani et al., 2010) also requires emphasis. Studies indicated that most selected sites of condominium houses in Addis Ababa are very small in size and fragmented creating difficulties in management, and this resulted in lack of space for car parking, children playing, and some other functions (Yenoinshet, 2007).

One of the purposes of condominium housing development program is to effectively manage and use

Table 3. Density (person/square meter) at 12 sites of condominium.

S/N	Site name	Total number of residential units at each site	Area of each site (m2)	Estimated Total number of people at each site (number of household * average house hold size (4.1))	(Density)Number of person per area of site (m^2)
1	Gerji 1	696	45.864	2853.6	0.062219
2	Gerji 2	320	21.950	1312	0.059772
3	Gerji3	1188	50.237	4583.8	0.091244
4	Gerji5	862	44.450.00	3534.2	0.07951
5	Japan embassy	304	94.68.33	1246.4	0.131639
6	Bole Mikael	244	6467	1000.4	0.154693
7	International stadium	344	12.533	1410.4	0.112535
8	Adwa park	344	9825.6	1410.4	0.143543
9	Bole ring road	111	4828	4555.1	0.094263
10	Bole Ayat1	2644	354530	10840.4	0.03057682
11	Bole Ayat2	1081	115392	4432.1	0.03840908
12	Bole summit	2915	2511300	11951.5	0.00475909
Total		11053	3186845	49130.3	1.003163

Source: Housing development design office and own calculation.

the expensive urban land, and to delay haphazard sprawl of cities and towns by settling in high-rise residential houses such as condominium. Although vertical form of residence considered having impact on urban sprawl, still no study was not conducted regarding its impact in saving land from encroachment and improper utilization as compared to non-zoning (single- use-zoning) form of houses for the purpose of residence.

Therefore, this study is designed to examine the nexus between effective use of urban land through high-rise residential condominium houses settlement and satisfaction of residents with the open space available at sites. Area of the twelve condominium sites of Bole sub city and area of 47 individual's single- use-zoned compound taken as a sample for density comparison.

The area of each condominium sites were taken from housing development office, but the total number of residents at each site calculated by multiplying the number of households by average household size. The average household size used was estimated by CSA for Addis Ababa (that is, 4.1) in 2007. The average density of the twelve condominium sites is equal to 0.083596920 ($\frac{1}{0.083596920}$) (Table 3). That is adding the density of all sites and dividing for the number of sites (12). This means that the land area share of one person at each condominium site is averagely 0.083596920m^2.

The average density for 47 sampled households' individual compound is equal to 0.017579914($\frac{1}{0.017579914}$). This means that the land area share of a person at each individual's house is averagely 0.017579914 m^2 (Table 4). As the aforementioned results showed, the average density of the two cases is different. The average density at condominium sites is 0.083596920 while it is 0.017579914 at an individual households' case. This shows that more land is reserved at condominium sites, which would be used for activities such as sport fields, car parking, playing ground, placement of septic tanks and soon.

However, if we compare the area occupied by the building of condominium and the land occupied by an individual houses, then more lands were occupied at the individual's houses. This is because condominium house are constructed in story form-one unit over another. This implies that more open is space is reserved at condominium sites. However, the problems related to open space are not much related with the small size of the available open space, but rather improper utilization of it. As the researcher observed, only small part of the open space is

Table 4. Calculated density for each sampled household's Area of compound.

S/N	Carta number	Area (m2)	House hold size	Density
1	bole3/15/4/13	108	4.1	0.037963
2	bole01/346/9670/00	129	4.1	0.031783
3	bole01/346/9666/00	129	4.1	0.031783
4	19031/92	670	4.1	0.006119
5	26673/93	250	4.1	0.0164
6	33745/91	1000	4.1	0.0041
7	4724/94	175	4.1	0.023429
8	42680/94	345	4.1	0.011884
9	4069/93	160	4.1	0.025625
10	18579/94	328	4.1	0.0125
11	42678/90	333	4.1	0.012312
12	7595/94	175	4.1	0.023429
13	726/90	500	4.1	0.0082
14	7676/94	175	4.1	0.023429
15	33632/94	207	4.1	0.019807
16	42636/93	192	4.1	0.021354
17	42684/93	407	4.1	0.010074
18	249/92	500	4.1	0.0082
19	8190/94	175	4.1	0.023429
20	41164/92	686	4.1	0.005977
21	247/92	500	4.1	0.0082
22	8188/94	175	4.1	0.023429
23	37321/93	420	4.1	0.009762
24	bole01/51/05-220/5668/01	397	4.1	0.010327
25	8257/95	175	4.1	0.023429
26	bole01/346/9675/00	129	4.1	0.031783
27	42645/95	192	4.1	0.021354
28	bole01/346/9663/00	129	4.1	0.031783
29	237/92	520	4.1	0.007885
30	000809/91	210	4.1	0.019524
31	9642/93	441	4.1	0.009297
32	0315/94	417	4.1	0.009832
33	8204/94	175	4.1	0.023429
34	0288/91	250	4.1	0.0164
35	28569/93	250	4.1	0.0164
36	0951/90	218	4.1	0.018807
37	1455/92	150	4.1	0.027333
38	0720/94	500	4.1	0.0082
39	bole01/67/51-3008	270	4.1	0.015185
40	719/89	500	4.1	0.0082
41	42685/94	402	4.1	0.010199
42	2569/93	175	4.1	0.023429
43	42688/95	345	4.1	0.011884
44	550/92	150	4.1	0.027333
45	35782/92	500	4.1	0.0082
46	440/92	175	4.1	0.023429
47	4580/94	175	4.1	0.023429
Total		14584	192.7	0.826256

Source: Land development and administration office of Bole sub city and own calculation (2011).

Table 5. Number of residents and open space size proportion

Site name	Total number of people (x)	Open space (m^2)	x/∑x	y/∑y	x/∑x/y/∑y
Ayat1	10840.4	305734	0.31476	0.584033	0.538946
Ayat2	4432.1	81567.5	0.12869	0.155815	0.825916
Gerji2	1312	13078	0.0381	0.024982	1.524881
Gerji1	3075	30338	0.08929	0.057954	1.540642
Gerji5	3714.6	32805	0.10786	0.062666	1.721137
International stadium	1549.8	11855	0.045	0.022646	1.98709
Gerji3	5133.2	33602	0.14905	0.064189	2.322023
Bole ring road	504.3	2610	0.01464	0.004986	2.936919
Japan embassy	1295.6	5032.3	0.03762	0.009613	3.913343
Adwa park	1533.4	4280.6	0.04452	0.008177	5.444955
Bole Mikael	1049.6	2585.5	0.03048	0.004939	6.170535

Source: Design Sub office of housing development office and own calculation.

properly utilized. The more part of it was covered by solid waste, occupied by satellite dish and grass and vegetation within which waste is deposited.

Open space at the sites of condominium is space not occupied by buildings. This space function for car parking, drying clothes, greenery, children playing, septic tank placement, entry and exit to and from units, recreation, crop drying, laying down tent (a portable shelter made of cloth)(dinkuan), which is used during occasion of sad and festivity.

Previous studies indicate that the available open space for such functions at condominium sites is insufficient. This study examined the proportionality between the number of residents (households) and the size of reserved open space at each site using location quotient and Gin coefficient jointly to understand if the problem relates with proportionality of space size and number of residents.

The location quotient result at BoleAyat1 and BoleAyat12 condominium sites is 0.53895 and 0.826 respectively, which are less than one (expected). When compared to the general distribution at these sites for larger area there are small numbers of residents (households). This means that at these sites there is condition of under population as compared to the general distribution. The rest, Gerji 2, Gerji1, Gerji5, International stadium, Gerji3, Bole ring road, Japan embassy, Adwa Park and Bole Mikael sites have location quotient greater than one, which is above the general distribution.

This means that as compared to the general distribution at these sites for larger number of residents (households) there is smaller size of open space. On the other hand, at these sites there is condition of over population as compared to the general distribution. Bole Mikael site has a location quotient of six (the greatest of all). Hence, Bole Mikael condominium site has smallest open space and followed by Adwa Park, Japan embassy, Bole ring road, Gerji3, International stadium, Gerji5, Gerji1, Gerji2, Bole Ayat-2, and Bole Ayat1 (Table 5). Gini coefficient result notifies that the overall degree of inequality in the distribution of households or residents in terms of the site open space area size is 25.095%.

Once we discussed the area size of sites and residents' number proportionality, it is important to substantiate resident's satisfaction with the available open space at sites of condominium that that is used for different functions. The satisfaction of respondents with the available open spaces was measured using likert scale (satisfied, unsatisfied and neither nor), and the result analyzed using on sample T-test. Their satisfaction coded as 1 for satisfied, 2 for neither nor and 3 for unsatisfied. Then 2 used as a test value and the hypothesis that stated "satisfaction of respondents for all uses- taken in to account is not different from 2" tested at 0.05 significance level. Consequently, the result is presented in Table 6.

The result revealed that the satisfaction of respondents with the space available for car parking, children playing and laying down tent are significantly different from neutrality ($p<0.05$). The mean difference for car parking is positive. This implies that respondents were satisfied with the available open space for car parking. This is mainly due to the fact that only few households have car so the problem is sensed only by those few. Although the general response showed that residents were satisfied with the available open space for car parking, at some sites for example, at Gerji2, Bole Mikael and Adwa park due to lack of space cars of some households which are parked outside the site compound on the road passing along the site.

The mean difference for the case of children playing and laying down tent is negative. This implies that respondents are dissatisfied with the available open space at sites of condominium. As respondents indicated, it is difficult to dry cloth near the car parking because the dust blows to it and make it dirty. Hence, households prefer to dry it on the corridors in front of their unit.

However, this does not mean that there is no space for

Table 6. Satisfaction of residents by the available open space at sites of condominium.

Types of uses	Test value = 2					
	t	df	Sig. (2-tailed)	Mean difference	95% CI difference	
					Lower	Upper
Drying cloth	-1.568	119	0.120	-0.142	-0.32	0.04
Car parking	3.863	119	0.000*	0.317	0.15	0.48
Drying food grain	-1.699	119	0.092	-0.150	-0.32	0.02
Children playing	-5.845	119	0.000*	-0.458	-0.61	-0.30
Laying down tent (Dinkuan)[6]	-2.287	119	0.024*	-0.200	-0.37	-0.03

Source: Own field survey and computed (2011); *Significant at 0.05 significance level.

[6] A portable shelter made of cloth

these uses at sites but the problem associates with improper utilization of it. When the available space occupied by few households for example for car parking or laying down tent or drying cloth some could not get space to use it for another purpose. As interview made with owners association committees, the rule of owners association did not allow residents to dry cloth on the corridor. However, considering the crowdedness of space to dry cloth the committees could not enforce the rule. That is why respondents did not indicated lack of space to dry cloth as a problem.

The low satisfaction of residents by the available open space for aforementioned activities is not due to the small size. It rather relates with improper utilization of it. For example, satellite dish of most households placed on the ground. Thus if all households have dish and placed on the ground it is not difficult to estimate how much of land will be occupied. Moreover, residents throw solid and liquid waste through their window top down with rapped plastic or container to the available open space. As a result, it makes even the available open space unpleasant for children playing, drying cloth and spice, recreation and some other functions. In general, it loses its aesthetic value and remains abandoned land. Subsequently households compete to use the small open space, which is relatively with good sanitation.

Infrastructural and social services provision at condominium sites

Spatial accessibility of residents to some selected infrastructural and social services

Since vertical settlement can comprise large number of residents on small plot of land and consequently eases infrastructure provision, government of different countries valued dense settlement. Vertical settlement avoids scatter settlement that require large resources for the provision of infrastructural services. High density creates opportunities for viability and access to community services, provides economy of infrastructure, supports public transport, and reduces car travel and parking demand (kunze, 2005).

The government of Ethiopia constructed high-rise condominium houses to achieve its purpose of easing infrastructure service provision for the densely settled people. With regard to this, no study was conducted previously, that examines the success of government with this aspect. The important indicators which are useful to measure residents spatial accessibility to infrastructure and social services include market, bank, schools (kindergarten, elementary school and secondary school),health center, main road, solid waste disposal site, tele center, religious worshiping places(church and mosque), hotel and restaurant and post office. As well as transport accessibility, water and electric light supply and sanitation issues are considered as indicators in this study.

In this study, spatial accessibility of residents to infrastructure and social services such as market, bank, kindergarten, elementary school, secondary school, health center, main road, solid waste disposal site, tele center, church, mosque, hotel, restaurant, and post office compared to the previous residence place is measured based on their judgment. Their response rated as far, neither far nor near and near. The far, neither far nor near and near responses were labeled as 1, 2 and 3 respectively. Then the result analyzed using one sample t-test. For the analysis the test value is two (neither far nor near) because the null hypothesis is that residents are neither far nor near to the stated service centers and the result is as shown in (Table 7).

The null hypothesis states, “residents are neither near nor far from the stated service centers” is rejected. This is because the probability values of all services indicate the presence of significant difference between the hypothesized or the test value, and the mean response of respondents. This implies that all residents rated that they are spatially accessible to the aforementioned service centers.

As information is obtained through the researcher’s

Table 7. Spatial accessibility of condominium house residents to infrastructural and social services compared to their previous residence place.

Test value = 2						
Service centers	**t**	**df**	**Sig. (2-tailed)**	**Mean difference**	**95% Confidence interval of the difference**	
					Lower	**Upper**
Market	7.535	119	0.000	0.542	0.40	0.68
Bank	17.615	119	0.000	0.825	0.73	0.92
Kindergarten	24.631	119	0.000	0.883	0.81	0.95
Elementary school	29.570	119	0.000	1.083	1.01	1.16
secondary school	16.274	119	0.000	0.792	0.70	0.89
Health center	9.485	119	0.000	0.617	0.49	0.75
main road	43.943	119	0.000	0.958	0.92	1.00
solid wasted	11.259	119	0.000	0.700	0.58	0.82
Tele center	20.413	119	0.000	0.825	0.74	0.91
Church	16.454	119	0.000	0.783	0.69	0.88
Mosque	11.063	119	0.000	0.650	0.53	0.77
Hotel and restaurant	12.857	119	0.000	0.717	0.61	0.83
Post office	7.885	119	0.000	0.558	0.42	0.70

Source: Own field survey (2011).

Table 8. The time residents moved to condominium and the functionality of water and electric power installations.

The housing facility type	**Alternatives**	**Response**	
		Frequency	**Percentage (%)**
Water	After the household come to condominium	33	27.5
	Before the household come to condominium	87	72.5
Electric power	After the household come to condominium	54	45
	Before the household come to condominium	66	55

Source: Own field survey (2011).

observation, the main roads that lead to or passing along sites of condominium is near to all sites. The maximum distance of the main road from sites is 100 meter. However, at some sites, the roads were not paved or asphalted. For example, the roads leading to or passing along gerji1,gerji2,gerji3,gerji5, international stadium and Japan embassy still not asphalted or even paved. At these sites, people travel through a cloud of dust rose as the trucks drove off. However, the road that lead to or passing along Adwa Park, Bole ring road, Bole mikael and Bole Ayat1 condominium sites is asphalted.

Water and electric power supply to condominium house residents

After lottery drawn for the ownership of condominium housing units, not all chanceful people move to their new unit at the same time. Some move immediately and some others move after some time. Residents who moved early to their condominium unit are more likely faced with electric light and water supply problems. The lately moved people came to the facilitated and furnished conditions. First comers lived without water and electric light until the installation functions properly (Table 8).

In total, 27.5% of respondents noted that the installed water became functional for their unit after they moved to the site. The rest, 72.5% of respondents responded that it was installed and was functional before they move to the unit of their site. In terms of light, 45% of respondents responded that the installed light is functional for their unit after they moved to their unit. The remaining, 55% respondents responded that installed light is functional for their unit before they move.

Some households' water or electric light installation can be adjusted easily while others may have serious problem and requires serious working and takes longer time. Therefore, the length of time the household stay

Table 9. Length of time pre comers stayed without water until the installation is functional.

Length of time residents stayed without water or electric power	Water			Electric power		
	Frequency	Percentage (%)	Cumulative percentage (%)	Frequency	Percentage (%)	Cumulative percentage (%)
2 days	0	0	0	1	1.9	1.9
4 days	0	0	0	3	5.6	7.4
5 days	0	0	0	3	5.6	13.0
6 days	1	3	3	0	0	13.0
1 week	1	0	3	3	5.6	18.5
2 week	2	6.1	12.2	1	1.9	20.4
1 month	8	24.2	36.4	22	40.7	61.1
2 months	8	24.2	60.6	14	25.9	87.0
3 months	0	24.2	0	3	5.6	92.6
4 months	8	24.2	84.8	4	7.4	100
5 months	2	6.1	90.9	0	0	100
8 months	3	9.1	100.0	0	0	100
Total	33	100	100	54	100	100

Source: Own field survey (2011).

without water and/or light is as shown in table Table 9.

The length of time residents stayed without water varies even among pre comers. They suffered from the problem of water for minimum of six days and maximum of eight months. Most of them (87.8%) of them suffered from the problem for more than one month. More than half of the respondents waited for more than two month to get pipe water that comes to their unit. As respondents explained, during that time residents were fetching water from private and public tap incurring one Ethiopian birr per a twenty-five liter container.

With regard to electric power residents who moved to the site before the light meter is adjusted for each unit or installations are not functional, suffered from the problem of eclectic power for a minimum of two days and maximum of four months. Of who moved to the site before proper functioning of the light wires and the light meter adjustment, more than 80% of them stayed without electric power supply for one to four month.

As understood from focus group discussion an interview conducted with the committees of owners association, the common reason for the delay of the installed water and light functionality at sites directly relates with improper adjustment of sewers of water and wires of electric light. Water sewers and light wires are adjusted at the time of construction. During this time, residents are not at the place so the adjusted sewers and wires will not be checked whether they are functional or not. Later on when residents come in and check the functionality of installation, they fail to function properly.

Water pipe and electric light wires are hided in the wall of the building. If problem is encountered somewhere in the wall it is difficult to readjust it. For example, at international stadium condominium site, the case of a certain household's unit the sewer was not adjusted properly. Consequently, it leaks water to the next lower unit. Readjusting it requires digging the wall of the building or the ceramic floor of the toilet and/or bathroom. This in turn requires large capital resource and deteriorates the quality of the building.

In addition, at some sites and blocks water did not reach the second floors and above units. This is due to the fact that the force of gravity restrains upward flow of water. Particularly at Japan embassy, Gerji3 and Adwa Park condominium site the problem is common. Tebarek (2007) also noted that the water pumped up ward against gravity could not reach to house of upper floor

residents due to loss of power. Consequently, residents of upper floors faced problems of sanitation because of lack of water to flush toilets and others.

As it is understood from the interview conducted with committee members of owners' association and the guards, the electric meter of all households of a given block placed together within a box like shelf immediately in front the ground units. However, households complained with such placement. This is because the source of electric power of each unit is from the respective electric meter of the household, which is placed in the box at the common place. Unfortunately, the light meter of one household may in mistake be connected with the wire of other household's. In addition, when someone wants to put off/on his/her light meter in mistake may put off/on others.

Sanitation

Neighborhood forms of settlement like condominium housing create conducive condition to manage liquid and solid waste. The liquid waste collected from unit of each household flows to the communal septic tank. However, as the writer understood from observation, focus group discussion and interview conducted with committee members of each site, improper solid waste management by residents is the source of the sanitation problem.

Residents drop solid wastes such as modus, utilized condom, peel of onion, peel of potatoes, peel of tomatoes and plastic bags within the toilet of their unit. These solid substances block the flow of liquid through sewer. This in turn either makes the sewerage returns back to the units of households or makes the sewer to fracture somewhere and pollute the environment. The other problem associated with this is improper adjustment of sewer. Adjusted sewer does not take in to account the inclination (level) of land that indicates flow direction of liquid. For example, at Gerji5 at the time of the survey the liquid waste was coming out from the sewer somewhere on the way to the septic tank and polluting the environment due to improper adjustment of the sewer.

Regarding the solid waste disposal mechanism, each household accumulates solid waste within a sack near their unit. Then group of workers who are organized in small and micro enterprise take it to the disposal site once a week. However, some residents carelessly throw solid wastes at undesignated area. As understood from respondents and committees of owners association, some people throw wastes to the open space through window mostly during nighttime when they could be hardly seen by others. For example, one of the committee members at Gerji3 said the following.

"There are residents who have commitment to take care of the sanitation of the site. In contrast, others never care. The careless group throws waste which is wrapped with plastics to the open space. They do not do it during the day time when others can see them but they do it during nighttime, and when there are no other residents or committee member/s around."

These aforementioned problems are not the only cause of sanitation, slaughtering of animals at undesignated area also pollutes the sites. The owner association committees and focus group discussants explained that some households slaughter animal near stair or in front of units or on the open space. As a result, the blood and waste of the slaughtered animal worsen the sanitation of the corridor and the nearest units. As understood from committee members this problem is especially more serious during holidays when many households slaughter animal at the same time, and the designated slaughtering space is crowded.

According to the rule and regulation of owners' association, even a person who slaughtered animal at the designated area for slaughtering should clean the place after completion. However, the committee members mentioned that most people do not obey the rule.

Social issues at condominium housing sites

Living in cohousing is different from regular neighborhood from perspective of social context and the organization of the physical environment. As people attend such kind of living they are face with different forms of informal and formal interaction. As several studies showed proximity of dwellings, the position towards other houses, buffer zones between private and common space and shared pathways affect interactions of the community. Social interaction relates to social well being. Social well being is dependent on the network of personal relationships and social exchanges that takes place.

Therefore, neighboring is a behavioral variable involving social interaction and the exchange of support between neighbors. The physical features of the neighborhood such as the proximity of homes, placement of doors of homes that is closer to one another and location of recreational facilities determine interaction (Farrel et al., 2004). The major sources of social welfare in Ethiopia are traditional associations such as Iddir[7],Ekub[8] and religious. These associations have religious, political, family, or other bases for their formation. Its main objective is to assist families financially during the time of illness, death, and property losses due to fire or theft. This institution became prevalent with the formation of the urban society.

As noted by Ingwani et al. (2010), condominium house influence the social network of traditional society which is established by traditional associations. When beneficiary join to condominium houses they obligated to cut off the relation they have with their former Neighbors and form another ties with their new Neighbors.

[7] Financial and other forms of aid for neighbors, people with the same occupation or friends
during challenges

[8] Traditional saving institution in Ethiopia

Table 10. Agreement of respondents for ten social interaction indicators questions.

Test value = 2						
Code of questions[9] (see the footnote)	t	df	Sig. (2-tailed)	Mean difference	95% Confidence interval of the difference	
					Lower	Upper
Q1	-.581	119	0.562	-0.050	-0.22	0.12
Q2	-8.290	119	0.000*	-0.600	-0.74	-0.46
Q3	-4.426	119	0.000*	-0.358	-0.52	-0.20
Q4	-5.158	119	0.000*	-0.417	-0.58	-0.26
Q5	-10.073	119	0.000*	-0.658	-0.79	-0.53
Q6	-.384	119	0.702	-0.033	-0.21	0.14
Q7	-1.747	119	0.083	-0.150	-0.32	0.02
Q8	-19.891	119	0.000*	-0.858	-0.94	-0.77
Q9	-4.619	119	0.000*	-0.375	-0.54	-0.21
Q10	-22.931	119	0.000*	-0.892	-0.97	-0.81

*Significant at 0.05 significance level (Source: Own field survey (2011)).

[9] Q1: Do your household member/members lend each other tools like dishes, knife, tea cub and the like with other household members?
Q2: Do your household member/members help each other in looking after home and child/children while they are away from home.
Q3: Do your household member/members go together with other household member/members to church, mosque, market, and institutions such as Ekub and Iddir?
Q4: Do your household member/members share information with your neighbors about home repairing?
Q5: Do your household member/members discuss with neighbors about neighborhood issues and problems with neighbor?
Q6: Do your household member/members invite each other to each other's home for coffee or food?
Q7: Do your household member/members assist each other with neighbor household to tasks such as room repair or moving furniture?
Q8: Do your neighbor assist your household member/members during emergency?
Q: Do you go to your neighbors for advice when you/your household member/members face problem?
Q10: Do you and your neighbors cooperate to solve a serious problem occur at your neighborhood?

In general, such form of settlement relates with different social issues such as interaction, social cost due to resettlement to condominium, sound disturbance, and theft crime.

Social interaction

Social housing may either create ground for social cohesion or unwanted interaction (Ely, 2007). As studies indicated, dense settlement may create an opportunity to form stronger social interaction than the scattered one. This is because of spatially proximity of households' units.

Some other studies noted that dense settlement such as high–rise condominium is not an opportunity to form strong social interaction. Beside to this some residents explain that social interaction at such settlement is weaker while others say the opposite. To examine these controversies the researcher in this study forwarded ten questions, which are indicators of social interaction for the residents.

First, the agreement of respondents for the questions is rated in likert scale. That is, one as agree, two as neither agree nor disagrees, and three as disagree. Then the hypothesis that stated "respondents neither agrees nor disagrees with the stated questions" is analyzed using one sample t-test, and the result is as shown in (Table 10).

As the result is depicted in Table 10, the agreement of respondents for question number 2, 3, 4, 5, 8, 9, and 10 are significantly different from neutrality (neither agrees nor disagrees). They agreed with these questions. In brief, residents of condominium house help each other in looking after home and children; go together to church, mosque, market, and institutions such as Ekub and Iddir; share information about home repairing and neighborhood issues; assist each other during emergency; take advice and cooperate to solve serious problems that occur at their neighborhood. On the other hand, respondents neither agree nor disagree for the question number1, 6 and 7. In short respondents are not sure that residents of condominium lend each other tools such as dishes, knife and tea cub, invite each other for coffee or food and assist each other with neighbor household to tasks such as room repair or moving furniture.

As the writer understood from focus group discussion, single men and women have weak social interaction than couples. Some residents not greet each other even with the neighbors living immediately next to their unit. This hindered the interaction of residents and the culture of assisting each other when a certain individual or household encounter problem. For example, a woman

Table 11. Strength of social interaction and prevalence of sources of conflict compared to the previous residence place.

Strength of social interaction				Prevalence of sources of conflict		
Strength scale	Frequency	Percentage (%)	Cumulative percentage (%)	Residence place	Responses	
					Frequency	Percentage (%)
Very weak	12	10.0	10.0	At the current	41	34.2
weak	57	47.5	57.5	At the former place	79	65.8
Neither nor	12	10.0	67.5	Total	120	100
strong	33	27.5	95.0	-	-	-
Very strong	6	5.0	100.0	-	-	-
Total	120	100	-	-	-	-

Source: Own field survey (2011).

interviewed at Gerji3 condominium site said the following about the man who was living with his dog only.

"A young man working in the bank was living next to my unit. He was living only with his small dog. He and I did
not greet each other. He was going out from his unit in the morning and return back in the evening. One upon a time I heard when the dog shouting inside his unit. I thought that he put it inside and shut the door. On the third day, I suspected that he is not well and knock the door but no one respond. The door was locked from inside. I called phone to police to take measure. The Police force came and broke the door. Unfortunately the man was dead but the only thing the police found near the dead was the small dog and pack of medicine."

Residents were asked about the strength of their social interaction with their neighbors and the prevalence of sources of conflict at condominium housing as compared to their previous residence place. Accordingly, the result revealed that more than half (that is, 57.5%) of the respondents noted that the strength of social interaction is weak and very weak at condominium sites. About 47.5% of them indicated that the strength of social interaction is weak while the rest 10% of them notify the strength is very weak (Table 11).

With regard to sources of conflict almost, more than half of respondents (65.8%) agreed that sources of conflict prevail more at the former residence place of residents. The rest (34.2%) noted that sources of conflict prevail more at condominium. Those who agreed with that source of conflict prevail more at their former residence place, attributed to different factors. At the former place renters and owners, live together in one compound. Most owners are aggressive and shout to renters when they use toilet, electric light, and water communally. Others who agreed that sources of conflict prevail more at condominium site reasoned out that there is no similar understanding and motivation among residents of condominium with regard to caring for sanitation of the sites, proper utilization of communal properties, controlling sound disturbance, and theft crime. This means that while others do for enhancement others do against enhancement either knowingly or unknowingly. This in turn may lead residents to conflict and weaken the strength of social interaction. In addition, most residents living in rental house externalize themselves about sources of problems that happened at their sites and are not volunteer to be part of the solution.

As it is inferred from the aforementioned results, residents of condominium house assist and interact with each other more for mutual interest, benefit, safety and when a member of a certain household face serious problem such as death.

Social costs induced by resettlement to condominium house

Residents of condominium house have different background. Some of them are owners, some others are living in rental house, and others resettled to condominium house due to urban renewal/ redevelopment. Residents who resettled to condominium houses due to urban renewal are mostly forced to move without their interest. The people, who are displaced by urban redevelopment/renewal and joined to irrespective condominium, occupied their current unit of their

Table 12. Residents membership status to social associations before and after they move to condominium.

Residents membership status to social associations	Alternatives	Frequency	Percentage (%)
The number of residents dropped out from Social associations when they move to condominium house	Dropped	36	30
	Not dropped	84	70
	Total	120	100
Types of association they drop out from	Ekub	4	11.11
	Iddir	24	66.67
	Ekub and Iddir	8	22.22
	Total	36	100
The current membership status of residents to social associations	Became member	18	50
	Not became member	18	50
	Total	36	100

Source: Own field survey (2011).

preference of the site and the unit.

Unfortunately, they leave the sub- city, where they were living previously. Consequently, these displaced people dropout from associations such as Ekub and Iddir in which they were member at their previous residence. However, it is not only the people, who resettled to condominium in the name of urban redevelopment; suffer from the problem of dropping out from such associations.

It also includes all others those moved by their own preference.

Respondents were asked about whether they dropped out from any social associations when they move to condominium, the types of association they dropped out from if any and their current membership status to any social associations, the result is presented in Table 12.

Of the total respondents, 70% of them did not drop out from any social associations they were member at their former place when they move to condominium. This is because either they resettled from the nearest place and continued their former membership or they were not member to such associations at their former residence place. The rest 30% of them notified that they dropped out from the associations they were member at their former place of residence when they move to condominium. They did so because the resettlement sites are far away from the former residence place.

Of those who quitted their membership of social associations, 66.67% of them exited from Iddir only. The other 22.22% of them dropped out from both Iddir and Ekub. The rest exited from Ekub only. Hence, it is possible to conclude that most people dropped out from membership of Iddir. As a result, they lost the benefit of Iddir that families are assisted financially during the time of illness, death, and property losses due to fire or theft. From this group half of them (50%) are member to such associations at their current residence place while the other half still did not be member due to their own reason.

In addition, to abandoning their membership to such associations, they are also faced with difficulty to continue the livelihood activities that they were practicing at their former residence place. For example, people who were selling bread, injera and other consumable goods at the former place were unable to continue at the newer place. Because at condominium housing sites, modern style of living were not matched with such type of livelihood activities. Furthermore, customers could not come in from outside of the site because guards do not allow them to get in. People at condominium are not interested in traditional drinks and cooked food such 'Injera'[10] with 'wat[11] '. The demand is only for Injera. A woman interviewed at Gerji2 said that:

"I came to this Gerji2 condominium site from shuromeda when my house is demolished in the name of urban renewal. At my previous residence place, I used to selling consumable goods like bread, Injera, potatoes, tomatoes, onions, and the like in my home or near my home. However, here I faced challenges to undertake similar activities. Furthermore, my daughter is not interested to stay weekends at this site because she could not experience playing with children of her age of the site. So I took her to my previous neighbors' home in the afternoon on Friday to play during weekends and took her back to my home in the afternoon on Sunday to go to school the next day"

Social problems related to sound disturbance and theft crime at condominium sites

Long (2007) stated that at multistoried houses while

[10] The traditional pancake in Ethiopia

[11] Wat is traditionally eaten with injera

Table 13. Sound disturbance and theft crime at condominium sites.

Statement	Alternatives	Response	
		Frequency	Percentage (%)
You disturbed by sounds produced by neighbors	Yes	94	78.3
	No	26	21.7
	Total	**120**	**100**
There is theft at your condominium site	Yes	102	85
	No	18	15
	Total	**120**	**100**

Source: Own field survey (2011).

people move upstairs footfall on hard surface and on carpeted floor wake the sleeping people in the morning. As well as when toilets flush upstairs, it sounds like waterfall running through their wall. The closing of door and window also create disturbing sound to the upper and the lower up stair units.

In this study, respondents were asked about the presence of sound disturbances and sources of sounds as wells the theft problems at their respective condominium sites. Accordingly, the result is presented in Table 13.

Out of 120 sampled households, 78.3% of them reported that sounds produced when the immediate upper stair unit residents move furniture, flush toilet, close and open door, grind coffee, open music from television and other player devices and sound of cars while entering and exiting to and from compound disturbs them. Most sources of music and dancing disturbances at some sites are bar and restaurants found close to the site or at the site. At most, sites ground units are commercial units. Thus, people take permit for shopping and convert it to bar and restaurant. During nighttime people dance, drink and shout. These sounds disturb people sleeping in their unit.

In terms of theft, 85% of the respondents reported that theft is experienced at their sites of condominium. Such form of settlement is convenient for the prevalence of theft problem. This is because as the writer understood from the focus group discussions and interviews with committee members of each site, even for the guards, it is difficult to identify residents of the site and newcomers. Using the gap thieves come from outside of the sites, and steal drying cloth and amenities placed outside the units on the corridor or inside of the units. Each site has its own guards but the problem is hardly possible to identify residents of the site and outsiders. For example, one of the guards of Japan Embassy condominium site said that;

"*As you see there are 304 households. If each of these households has three family members there shall be are at least 912 people. Look, it is difficult to identify the 912 people facially. Leave a side the people living within the site; relatives, friends, or families of these household come from outside. It is difficult to prevent them not to come in the only thing that I can do is I ask them to which unit they are going. This situation paves an opportunity for the thieves to come from outside and take something****"***

Conclusion

The housing development office is constructing and distributing condominium -housing units with slower pace. Consequently, the demand-supply deficit is still higher. According to the plan of the office it was to meet the demand of 453 287, total registered people within nine years by constructing and distributing 50.000 units per year. However, the office constructed and distributed only 80.287 units within seven years. In other word, only 17.7 % of the demand is met over the last seven years. If the office continued with this pace, it will take about 32 years to respond for the rest demand.

Settlement in high-rise residential condominium housing saves land from encroachment and improper utilization. The land is saved in terms of the land occupied by the buildings when compared with the land occupied by the non-floored individuals' house. However, when the total area size of condominium site is compared with the total area size of non-floored individuals house compound in terms of density, larger area of land that could be used for activities such as sport fields, recreation, greenery, and car parking reserved at condominium sites.

However, the open space reserved at sites of condominium is not proportional to the number of residents. As it is understood from the location quotient result at BoleAyat1 and BoleAyat2 condominium sites there is condition of under population as compared to the general distribution.

In contrast, at Gerji 2, Gerji1, Gerji5, International stadium, Gerji3, Bole ring road, Japan embassy, Adwa Park and Bole Mikael there is condition of over population as compared to the general distribution. These results imply that the size of open space reserved at sites of

condominium not took into account the number of people who would settle on.

Residents were dissatisfied with the space available for children playing and laying down tent (dinkuan). However, much complain about open space is not related with the size of it, but with improper utilization of it. At most sites, the satellite dish of most household is placed on the open space. In addition, the open space is also covered with solid waste and is unattractive to use it for other purpose. Some types of land use also contradict each other for example car parking and drying cloth at the same place or at nearby.

Residents of condominium satisfied with their spatial accessibility to social and infrastructural service centers such as market, bank, schools(kindergarten, elementary school and secondary school),health center, main road, solid waste disposal site, Tele center, religious worshiping places(church and mosque), hotel, restaurant and post office. However, most roads leading to or passing along sites of condominium is not paved or asphalted. As a result, people travel through a cloud of dust rose as the trucks drove off.

Water and electric power supply are the serious problems at sites of condominium. Of residents, those who moved to their condominium unit before the installation of water pipe, sewerage sewer and the electric power wires are functioning properly, suffered from the problem of water and electric power for a minimum of six days and maximum of eight months and minimum of two days and maximum of four months respectively. It is known that water and electric power are the two important services at such settlement. Absence of water not only causes lack of water for drinking and washing but also contributes for the problem of sanitation, when it lack to flush the toilet. Since there is no traditional kitchen at condominium sites, most source of energy for cooking is electric power. Therefore, electric power and water installations functioning should be checked before residents moving. These problems directly relate with improper adjustment of water pipe, sewerage sewer, and electric power wires at the time of construction. The mechanism of solid waste management is also weak. Most residents throw solid waste which is rapped with plastic bag at undesignated open space.

With regard to the strength of social interaction among residents, more than half (that is, 57.5%) of the respondents noted that the strength of social interaction is weak and very weak at condominium sites. Of this, about 47.5% of them indicated that the strength of social interaction is weak while the rest 10% of them notify the strength is very weak.

Residents of condominium house assist and interact with each other more for mutual interest, benefit, safety and when a member of a certain household face serious problem such as death. There is no certainty that residents invite to each other's home for food and coffee and assist each to tasks such as room repair or moving furniture, which is the business of an individual household only.

When residents move to their condominium unit, they quit their membership to associations such as Ekub and Iddir to which they were member at their former residence place. Moreover, they encountered difficulty to continue the livelihood activities they were practicing at their former residence.

About 78.3% of respondents noted that they are disturbed by sounds produced when the immediate upper stair unit residents move furniture, flush toilet, close and open door, grind coffee, open music from television and other player devices and sound of cars while entering and exiting to and from compound disturbs them. Moreover, 85% of the respondents noted that theft is common at their condominium site.

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CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Full Length Research Paper

The evaluation of land tenancy contracts using the analytical hierarchy process in Khyber Pakhtunkhwa Pakistan

Majid Khan[1]*, Puangkaew Lurhathaiopath[2] and Shusuke Matsushita[2]

[1]Graduate School of Life and Environmental Sciences, University of Tsukuba, Ibaraki Japan.
[2]Faculty of Life and Environmental Sciences, University of Tsukuba, Ibaraki Japan.

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New approaches and tools are needed to enable land tenancy arrangements in the developing countries to specify the landlord-tenant relationship in general and particularly in the targeted study area Khyber Pakhtunkhwa Pakistan. So this research work applied a multi-criteria decision making approach (MCDM) to investigate the important factors which greatly impact on initial signing process of land tenancy contracts between landlords and tenants by using Analytical Hierarchy Process (AHP) as a tool. This qualitative decision making technique has not been used extensively in the country especially in the landlord tenant relations. For the purpose field survey was conducted in August 2015 and interviewed 10 respondents (landlords and tenants) in a hypothetical situation from the baseline survey through a well-developed questionnaire by using Tones method in AHP. However, AHP is a methodology that facilitates respondents to trade off nonmarket factors of land tenancy contracts. Thus, the information was collected for the important factors (criterion) which has great effect in the initial contract agreement in the landlord-tenant relationship in our research area within each tenancy contract (alternative), then the important factors were incorporated in the AHP framework and subjected to the landlord-tenant judgments for each tenancy contract. The finalized factors were character, financial position, men power, experience, reference, land condition and house availability. The results of the AHP application to data collected from six different villages found that landlords' preferences are strongest for character, men power in share cropping, distance, financial position in fixed contract, experience and men power in owner cultivation and the tenant's partialities are strongest for house availability, financial position in share contract, land condition, reference in lease contract and in owner cultivation nothing found important. In overall, it was found that the dominant choice in the tenancy contract for landlords are share contract 45.7%, followed by rent contract 30.9% and less important owner cultivation 22.3% and in case of tenants it was found that the most preferable land tenancy contract is sharecropping 51.7% and fixed contract 41.7%, less effective 6.25% owner cultivation in the selected study villages. This study recommends that the agriculture and extension services departments of Khyber Pakhtunkhwa province to apply AHP as tool in the wide range of multi sector in agriculture decisions, such as to determine best allocation for farm production, adaptation of latest technological tools and choices among different food and cash crop.

Key words: Analytical hierarchy process, Pakistan.

INTRODUCTION

The land tenancy arrangements have received considerable attention in the literature over the last several decades. However, there is literally a huge amount of famous researches published works on land tenancy contracts, specifically in Asia. The most leading theme in these writing is a land and labor contracts in agrarian economies ("Theories and Facts") (Otsuka et al., 1992) and ("A Theory of Contractual Structure in Agriculture") (Eswaran et al., 1985). Also, Herring (1983) landed to the tiller; the political economy of agrarian reforms in South Asia. Most of these studies are discussed; the landlords-tenant's relationship and their contractual parameters but the common conclusion were discussed in short term land tenancy contracts. In our research work in the study area, the discussion was based on long-term land tenancy and their multiple contracts in the landlord-tenant relationship from the base line survey (2014). The utilization of land natural resources in Pakistan as a whole, and particularly in Khyber Pakhtunkhwa, getting higher attention due to the recent technological changes in agriculture production. The dominant contractual form can vary with the crop, the prevailing technology, the extent of market development and other characteristics of the economic and social environment (Eswaran et al., 1985). Thus, in the selected research area, land resources are utilized by traditional ways of contracts in the landlord-tenant relationship, which were (share, fixed and owner). However, the land tenancy contract and a labor employment contract are alternative ways of resource endowments in an agrarian economy (Otsuka et al., 1992). The important assumption of this research work, was to evaluate an hypothetical situation of each decision maker (landlord and tenant) in these tenancy contracts by applying a multi criteria decision making (MCDM) tool, the Analytical Hierarchy Process (AHP). However, the evaluation of (AHP) as an instrument or tool applied in property sectors from local and global context (Safian et al., 2011; Srinivasan, 1994; Bender et al., 1997, 2000; Chan, 2002). For the initial agreement between the landlord and tenant, there were essential factors (Criteria) which have great impact on these land tenancy contract (Alternative) towards the signing process. Thus, AHP serves the purpose of comparison and finds the important impacting factors of different farming practices (Bhatta and Doppler 2010). However, the selection of a good landlord for a tenant and a reliable tenant for a landlord play key role in these contracts for successful land management. ONI (2010) pointed out in the role of estate surveyors, that a prospective tenant must possess physical appearance, social status, income, while in some cases such attributes are imposed by the owner. The implications of theoretical models which are reliable with several stylized facts about land tenancy in developing countries agriculture and landlord-tenant preferences for these contract choice. However, the tenancy contracts tend to be rationed according to the initial endowments of wealth among prospective tenants (Shetty, 1988), thus most empirical research works discussed the important factors for non-marketed inputs tenant's superior endowments such as managerial ability, credit, family labor and bullocks or production technology (Reid, 1976; Zusman, 1979; Bliss et al., 1982; Pant, 1983) for which markets are highly imperfect. On the other hand, the ignorance on the part of landlords about tenant's abilities and assets is quite inappropriate for most rural communities because there is little mobility and information about it is easily available (Eswaran et al., 1985). Moreover, in the landlord-tenant relationship, the personal character of both parties play effective role in the contracts choice in general and specifically in our study area, so from the landlord side, to helps his tenant in bad production years by reducing rent (fixed) and timely division of output in share contract, also solved his family and political issues. However, in response the tenant pays loyal services for his and his family in farm production as well as in political and social activities. According to Otsuka et al. (1992), the small communities in agrarian economies, social interactions among people are intense, therefore both parties may be discouraged from behaving opportunistically giving the high expected cost of losing reputation by discovery of dishonest behavior. Also, the enduring contractual relationship between the landlord and tenant in a relative closed village society, are circumstances in which reputation has a significant effect in enforcing the terms of the contract. However, Bell et al. (1989), pointed out, empirical research, which attempts to identify the factors of contract choice with due consideration of household characteristics is still lacking. In the literature, researchers argue, in order for the contract to be perfectly enforceable, its term and conditions must be verifiable not only to the contracting parties but also to a third party (Holmstrom, 1983; Clive Bull, 1987). Moreover, in the one period contract, the tenant will maximize his utility without regard to the depletion of soil fertility and other damage to the land which will adversely affect its future productivity, thus the tendency is likely to be stronger under the fixed-rent

*Corresponding author. E-mail: majidkhan_psf1@yahoo.com.

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Table 1. Saaty's scale of pair-wise comparisons.

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
2	Weak or slight	-
3	Moderate importance	Experience and judgement slightly favor
4	Moderate plus	-
5	Strong importance	Experience and judgement strongly favor
6	Strong plus	-
7	Demonstrated importance	Activity is favored very strong over another
8	Very, very strong	-
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8		Intermediate values when compromise is needed
Reciprocals of above nonzero	If factor i has one of the above non-zero number assigned to it when compared with factor j, then j has the reciprocal value when compared with i	

Source: Thomas L. Saaty (2008), with author modification.

contract than the share and fixed wage contracts because the former implies greater returns from the neglect of the land (Otsuka at el., 1992). Alexander (2012), AHP was developed to optimize decision making when one is faced with a mix of qualitative, quantitative and sometimes conflicting factors that are taken into consideration. Saaty (2008), pointed out, the AHP is a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scale. Bayazit (2005), the approach of the AHP involves the structuring of any complex problem into different hierarchy levels with a view to accomplishing the stated objective of a problem. Chauhan et al. (2008), described that the AHP allows better, easier and more efficient identification of selecting criteria, their weighting and analysis.

Eagan and Wienberg (1999), the method permits comparison of alternatives with respect to multiple attributes, particularly useful for complex problems. Sato (2005), pointed out, the AHP has the subjective judgment of each decision-maker as input and the weight of each alternative as output. Saaty (1990) explained perhaps the most creative task in making a decision is to choose the factors that are important for that decision. Johnson (1980) said that AHP in solving problem involves four steps. Step 1, Setting up the decision hierarchy by breaking down the decision problem into a hierarchy of interrelated decision elements. Step 2, Collecting input data by pairwise comparisons of decision elements. Step 3, Using the "eigenvalue" method to estimate the relative weights of decision elements. Step 4, Aggregating the relative weights of decision elements to arrive at a set of ratings for the decision alternatives (Zahedi, 1986). The objective of this study was to find out the importance of each type of contract in the landlord-tenant relationship in the study area. Also, to check out the important factor, from landlord and tenant point of view in these land tenancy contracts by using AHP (Table 1).

Figure 3 represents comparison of the attributes and their importance in the land tenancy contracts. For example, the pairwise comparison of factor character versus men power indicates the selected survey respondent's judgment that both factors are equally important for making the first-hand contract in the landlord tenant relationship. On the other hand, the comparison matrix also specifies the reciprocal axiom of the respondent judgment (Figures 1 and 2; Tables 2 and 3).

METHODOLOGY

Study area

The study area was Khyber Pakhtunkhwa Pakistan, which was selected during the baseline survey in year 2014.

Sampling

In the first step, 10 respondents were selected from the base line survey, conducted in 2014, second 6 landlords and 4 tenants were meaningfully selected and not randomly on the bases of their deep local knowledge, educational and farming skills from the different

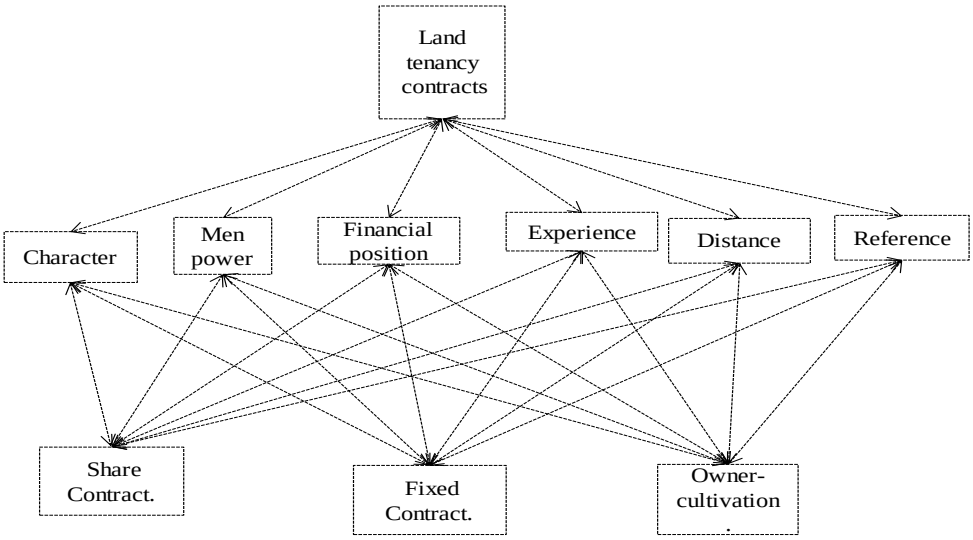

Figure 1. A hierarchical representation of the landlord in the land tenancy contract. Source: Author Field Survey (2015).

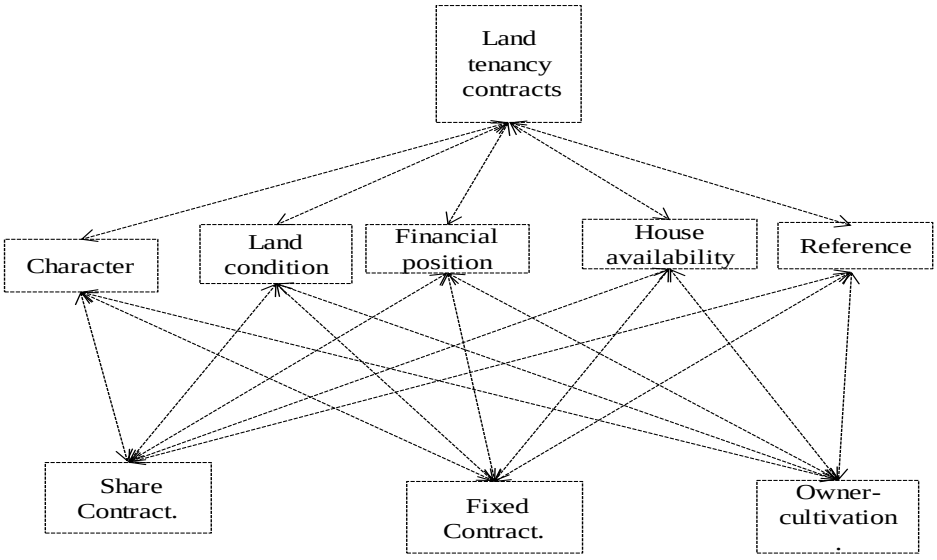

Figure 2. A hierarchical representation of the tenant in the land tenancy contract. **Source:** Author field survey (2015)

district and villages in the research area. So in the third step, the factors were finalized which are important for signing the initial land tenancy contracts process in the study area, from the view point of landlord and tenant. Finally, the pairwise comparison was made of all the important factors and then made its comparison with in each alternative by constructing AHP model, which was developed by Saaty (1980) (Table 4).

Questionnaire and Implementation

A comprehensive excel sheet questionnaire was developed to collect the data and information related to the important factors which greatly affect the initial contract process in land tenancy contracts and for making a set of pair-wise comparison in AHP. Also, a (Saaty), pair-wise comparison scale from 1-9 in (AHP) is applied, to get the data for input matrix and checking out the priority decision weights of landlord and tenant towards each selected factor with in each alternative (Fixed, Share and Owner). Therefore, each (respondent) is interviewed personally at his home/or/field during the field visits to the study area in (2015).

The interview schedule was pre-tested in the field accordingly from 13th of August 2015 which was finished in 11th of September 2015. From which the information was collected about different

Table 2. Impacting factors for landlords in the AHP with their definition.

No.	Factors	Definition
1	Character	The tenant is honest, hardworking (pay proper and due attention towards Agriculture production), socially acceptable in a close village society and utilize his inner potentiality in a sound miner to develop a long-term tenancy and personal relationship with landlord and his family. Such attitudes of tenants in the land tenancy contracts reduce the “monitoring and bargaining cost”
2	Financial position	Wealth of the tenant such as pay rent in time (fixed). Expenditure on production and their own bullocks or tractor in 50:50 share contract
3	Men power	Adult labor male (2-3) of tenant family are more concern for a landlord because most of the farm work is still done by human labor like plantation, fertilization, spraying, especially in 50:50 share tenancy
4	Experience	The tenant working experience in field of agriculture (5-10 years), aware from latest technology changes. Such as experience tenants are certain much preference in operational decision, efficient used of land in (share) and taking care of the land quality in (fixed). The phenomena of “transaction monitoring cost”
5	Reference	A person in the same village will play the role of middle-man (facilitator) in the initial signing process in these informal tenancy contracts. The most acceptable person for landlord. Such as to know the landlord and tenant families very well. Such facilitator provides structure to the tenancy contracts, also resolve the initial disputes among the contract parties and help out in all types of present “transaction cost”
6	Distance	The landlords cultivated area close to his home, distance away or very far. Incase very far, in such circumstances prefer to make fixed rent contract. Which is also the “phenomena of transaction cost”

Table 3. Impacting Factors for Tenants in the AHP with their defin**ition**.

No.	Factors	Definition
1	Character	The landlord which has a kind behavior, respect the tenant and his family such as not only support the tenant in farm production but also socially and morally. Equally and timely distribute the crop yield in share tenancy (50:50). Giving such feeling to tenants in land tenure will improve contracts efficiency and reduction in “monitoring and bargaining cost”
2	Financial position	The landlord to helps his tenant in the marketed inputs such as (fertilizer, hybrid seeds, etc) specially in the peak of crop season (growing or harvesting) in (share) and treat the tenant in a good way in bad agriculture production year in (fixed)
3	Land condition	Before making the contract, the tenant wants to know the quality of land, either land is irrigated such as (canal or tube-well) irrigation and the fertility of the soil as well in both contracts. Especially in fixed contract the rent per acre depends upon on the quality of landlord available land
4	House availability	The tenant preferences the availability of house in the landlord farm specially in share contract, if not available he demands for house before signing the contract. In case of fixed contract, the opportunity is not available for tenant or pay the rent for it
5	Reference	Actually the condition from a landlord side for his new tenant such as a tenant recently came to the study area.

Source: Author Field Survey (2015)

factors which were important from both sides. Then, analyzed all the decision using Tone’s Method in AHP.

RESULTS AND DISCUSSION

The AHP result of landlords:

$$\begin{bmatrix} \text{Character} \\ \text{Men power} \\ \text{Experiences} \\ \text{Financial position} \\ \text{Reference} \\ \text{Distance} \end{bmatrix} = \begin{bmatrix} \text{Share contract} & \text{Fixed contract} & \text{Owner cultivation} \\ 0.5820 & 0.3667 & 0.0513 \\ 0.5169 & 0.0775 & 0.4036 \\ 0.4898 & 0.0948 & 0.4134 \\ 0.3106 & 0.5408 & 0.1150 \\ 0.4500 & 0.4936 & 0.0524 \\ 0.1782 & 0.7514 & 0.0704 \end{bmatrix}$$

$$\begin{bmatrix}\text{Character}\\ \text{Men power}\\ \text{Experience}\\ \text{Financial position}\\ \text{Reference}\end{bmatrix} = \begin{bmatrix}\text{Character} & \text{Men power} & \text{Experience} & \text{Financial position} & \text{Reference}\\ 1 & 1 & 3 & \frac{1}{3} & 1\\ 1 & 1 & 5 & 1 & 3\\ \frac{1}{5} & \frac{1}{5} & 1 & \frac{1}{5} & \frac{1}{2}\\ 3 & 1 & 5 & 1 & 1\\ 1 & \frac{1}{3} & 2 & 1 & 1\end{bmatrix}$$

Figure 3. A hypothetical comparison of factors within tenancy contracts. **Source:** Author field survey, 2015

Table 4. Sample selection and demographics with basic statistics

Sample selection, demographics with basic statistics													
	No of HHS			No of Landlord HH (Mean)					No of Tenant HH (Mean)				
Classification				**Age**	**Education**	**Farm size**	**Actual contract**		**Age**	**Education**	**Farm size**	**Actual contract**	
Villages	**(No of LHH)**	**(No of THH)**	**Total**	(years)	(years)	(Acre)	Share	Fixed	(years)	(years)	(Acre)	Share	Fixed
Karnal Sher Killi	2	_	2	48.5	14	17.5	S	_	_	_	_	_	_
Fazle abad	1	2	3	55	16	3	S	_	51.5	7.5	6	S	_
Kaludair	_	1	1	_	_	_	_	_	47	0	5	S	_
kadame	_	1	1	_	_	_	_	_	49	10	7	S	F
Shewa Killi	1	_	1	50	12	35	S	F	_	_	_	_	_
Asfandari	2	_	2	50	12	35	S	F	_	_	_	_	_
Total	6	4	10	50.88	13.5	22.63	S	F	49.17	5.83	6	S	F

Source: Author Field Surveys (2014-15)

The resulting matrix indicates the landlord's pairwise comparisons judgment for each of the alternatives with respect to each criterion. However, their demand was easily captured for nonmarket contractual parameter, when they were making a contract with landless labors in a competitive labor market to utilize their land endowment in study area. Therefore, the weights of the alternative in the resulting set clarify the landlord's judgment preferences for each factors. For example, in case of share contract, the dominant factors weights were character 58.2%, men power 51.6% and experience 48.9%, respectively. However, the observation was based on the field visits to the research area that the landlords have the full bargaining power in the informal land tenancy contract arrangements to impose clearly contract demands on their

counterparts. Therefore, the character of the tenants was more concern in the share contract, especially in 50:50 output ratio, the importance of human labor force was still the main source of agriculture production in the region as whole and particularly in the research province due to the unavailability of latest agriculture technological tools. In the share contract, the landlords were demanding for male labor force of the tenant's family, depends upon their cultivated area to perform timely farm related task such as (plantation, irrigation and spraying, etc.) for crop production, when they were signing the contract. However, the demand for experience and skillful tenants were increasing due to the recently development in the hybrid varieties of seeds, intercropping and change in the agriculture market for the high quality products, such as different vegetable and cash crops. Therefore, the landlords were to achieve the first best efficiency from their share partner in share contract. On the other hand, the observed weights of financial position, reference and distance was 31.06, 45 and 17.82% as reported in the share contract. However, in fixed contracts, the responding resulting weights were in contrast of share contract in the study villages. The reported important weights of criterion were distance 75.1%, financial position 54.08% and reference 49.3%, respectively. In general, it was observed from the behavior of the landlords in these study villages that they were mostly concerned with timely payment issues of the tenants and the cultivated area which were far from their home town or absentee landlords they prefer to make a fixed rent contract. Therefore, from the observed weights, it is clear that they were not much concerned with the other characteristics of the tenant's households. In both contracts, the matrix set indicates that reference such as a third party play comparatively equal role because without knowing the tenants background the landlords were not making the contracts with them and if any conflict raised in the beginning he was play the role as a facilitator. The other reported weights were character 36.6%, 7.75% men power and experience 9.48% as reported from these villages in case of fixed contract. In case of owner cultivation, the landlords were managing all the farm task by himself with the help of their own family labor and were hiring the tenants as a causal labor on fixed wage. The data set important weights for owner cultivation of the landlord's judgments were experience 41.3%, men power 40.3% and 11.5% financial position as reported.

Finally, the portions of the landlords' judgments to be allocated to each land tenancy contract were found by determining the product of the factors priorities and the alternative weights as shown subsequently. In the pairwise comparison judgments of the landlords within the attributes, the important weights were men power 24.8%, reference 24.22%, experience 17.9% and financial position 17.6%, respectively. The composite score indicates the final judgments of the landlords for their natural resource utilization through land tenancy contracts.

Therefore, 45.7% were willing to make share contract, 30.1% to made fixed contract and 22.3% to work as owner cultivator.

$$\begin{bmatrix}\text{Share contract}\\ \text{Fixed contract}\\ \text{Owner cultivation}\end{bmatrix} = 0.1631 \times \overset{\text{Character}}{\begin{bmatrix}0.5820\\ 0.3667\\ 0.0513\end{bmatrix}} + 0.2482 \times \overset{\text{Men power}}{\begin{bmatrix}0.5169\\ 0.0751\\ 0.4036\end{bmatrix}} + 0.1790 \times \overset{\text{Experience}}{\begin{bmatrix}0.4898\\ 0.0948\\ 0.4134\end{bmatrix}}$$

$$+ 0.1768 \times \overset{\text{Financial position}}{\begin{bmatrix}0.3106\\ 0.5408\\ 0.1150\end{bmatrix}} + 0.0645 \times \overset{\text{Distance}}{\begin{bmatrix}0.1782\\ 0.7514\\ 0.0704\end{bmatrix}} + 0.2422 \times \overset{\text{Reference}}{\begin{bmatrix}0.4500\\ 0.4936\\ 0.0524\end{bmatrix}} = \overset{\text{Overall}}{\begin{bmatrix}0.4571\\ 0.3099\\ 0.2234\end{bmatrix}}.$$

However, in general, in the studies villages, most of the landlords were working in long term informal land tenancy contracts and their dominant contract was shared, followed by fixed contract and some were owner cultivator (base line survey 2014). So, the AHP results in hypothetical situation proved the landlord's preferences for each criterion within the alternative for their new tenants before signing the contracts with them and showed their importance weights for each decision in the pairwise comparison.

The AHP results of tenants are as follows:

$$\begin{bmatrix}\text{Character}\\ \text{Land condition}\\ \text{House availability}\\ \text{Financial position}\\ \text{References}\end{bmatrix} = \begin{bmatrix}\text{Share contract} & \text{Fixed contract} & \text{Owner cultivation}\\ 0.6420 & 0.2849 & 0.0672\\ 0.3667 & 0.5820 & 0.0513\\ 0.6887 & 0.2292 & 0.0763\\ 0.6729 & 0.2362 & 0.0783\\ 0.4737 & 0.4737 & 0.0526\end{bmatrix}$$

The resulting matrix of the tenant's respondents showed the importance weights within the alternative. Therefore, in case of share contract, the dominant criterion weights were house availability 68.8%, financial position 67.2%

and character 64.2% reported from the study villages, when tenants were entering to the share tenancy arrangements with landlords. However, from the discussion of long term tenancy contract duration (author 2014), it was observed that most of sharecroppers lived in the country as whole and specifically in the research area, houses developed by their landlords. Actually, one of the priority demand of the tenants during the initial contract signing process, when they were entering in share tenancy relationship such as 50:50 ratio, with their landlords, because, their economical position was not very strong, compared with those tenants which were working in fixed rent tenancy. In contrast, those tenants involved in fixed rent tenancy were living in their own houses or pay the rent to the landlord. In case of financial position of the landlords for the tenants in share contract in the research area were important in many ways, like some time a sharecropper need advanced money for their family oriented issues such as death, marriages, etc., circumstances, so first they want to borrow money from their own landlords and some time they need credit for agriculture marketed inputs, such as fertilizer, weedicide and pesticide to buy. Also, among the landlords' families, the wealth differences existed directly depending on their land size in the study villages. On the other hand, the less important factors judgments weights in share contract were 47.3% reference and 36.6% land condition as reported. In case of fixed contract in the resulting set for the tenants when they were making the initial contract settlement with their landlords, the important priority weights were, land condition 58.2% and reference 47.37%, respectively. However, due to the contract norms and condition in the study area, the landlords were not bounded to provide any assistance to his lease and the tenants were only thinking about the landlords cultivated land condition such as soil fertility, irrigated or unirrigated, etc., collect all this information before signing the contract and pay rents in accordance such as advance or after the harvest of cash crop. The reference role was more important in both cases, actually a condition from the landlord's side in general in the study villages. Also, the opinion is based on the field visits, that it, not the tenant's preferences in the initial land tenancy arrangements but the demand of their opponents. In addition, the factor reference provides a structure to these informal land tenancy contracts and resolved the initial dispute between the contraction parties. Therefore, the other priority weights in fixed contract were 28.4% character, 23.6% financial position of the landlords and house availability 22.9% as reported from the studies villages. It was based on neglecting the discussion related to owner cultivation because the tenants were not concerned with the landlords but if tenants want, they only work with a landlord as casual labor or permanent labor. However, the AHP resulting matrix set identified judgments weights of each criterion within each alternative of the tenant's respondents, the weights showed their choices for each tenancy contracts before starting the contracts with their landlords. Finally, the proportions of the tenant's decisions to be apportioned to each land tenancy contract are instituted by determining the product of the attributes and the alternative weights as follows:

$$\begin{bmatrix} \text{Share contract} \\ \text{Fixed contract} \\ \text{Owner cultivation} \end{bmatrix} = 0.1183 \times \overset{\text{Character}}{\begin{bmatrix} 0.6420 \\ 0.2849 \\ 0.0672 \end{bmatrix}} + 0.3961 \times \overset{\text{Land condition}}{\begin{bmatrix} 0.3667 \\ 0.5820 \\ 0.0513 \end{bmatrix}} + 0.2229 \times \overset{\text{House availability}}{\begin{bmatrix} 0.6887 \\ 0.2292 \\ 0.0763 \end{bmatrix}}$$

$$+ 0.0804 \times \overset{\text{Financial position}}{\begin{bmatrix} 0.6729 \\ 0.2362 \\ 0.0783 \end{bmatrix}} + 0.1113 \times \overset{\text{Reference}}{\begin{bmatrix} 0.4737 \\ 0.4737 \\ 0.0526 \end{bmatrix}} = \overset{\text{Overall}}{\begin{bmatrix} 0.5178 \\ 0.4170 \\ 0.0625 \end{bmatrix}}.$$

In the pairwise comparison decisions of the tenants within the factors, the important weights were land condition 39.6%, reference 11.1%, house availability 22.2% and character 11.8%, respectively. However, the combined score indicates the final judgments of the tenants for their human resource deployment through land tenancy contracts. However, 51.7% prefer to make share contract, 41.7% to make fixed contract and 6.2% to work as causal labor in the selected studies villages.

Conclusion

Most of the land tenancy literature discussed the landlord tenant relationship and their decision making behavior in farm production area. This study uses AHP to identify the important attributes in land tenancy contracts that the landlords and tenants are demanding before signing the contract. The AHP application presented provides informatics results of each relative factors in tenancy contracts and clarity of the finding of each respondent judgments in different villages of the targeted area. Thus, the dominant factors for landlords that influence the land tenancy choices show that character, men power, experience in share contract and distance, financial position of the tenant's household in fixed contract were most influential factors for signing the agreement. On the

opposite side, the significant factors for tenants' choices in land tenancy shows that house availability, financial position, character in share contract and land condition, reference in fixed contract of the landlord's household are main important factors. In addition, all the important factors and their weights found by AHP tool for new contract were to ensure a secure tenure between the contracting parties. Also, the factor character, reference, experience and distance have played key role in the reduction of transaction cost phenomena for the contracting parties in the land tenancy contracts in study area. The quantification of the impacting factors of the land tenancy contracts is an important piece of information that will contribute to the landlord's tenant's decision making in agriculture production and development in general and particularly in the region.

CONFLICT OF INTERESTS

The authors have not declared any conflicts of interest.

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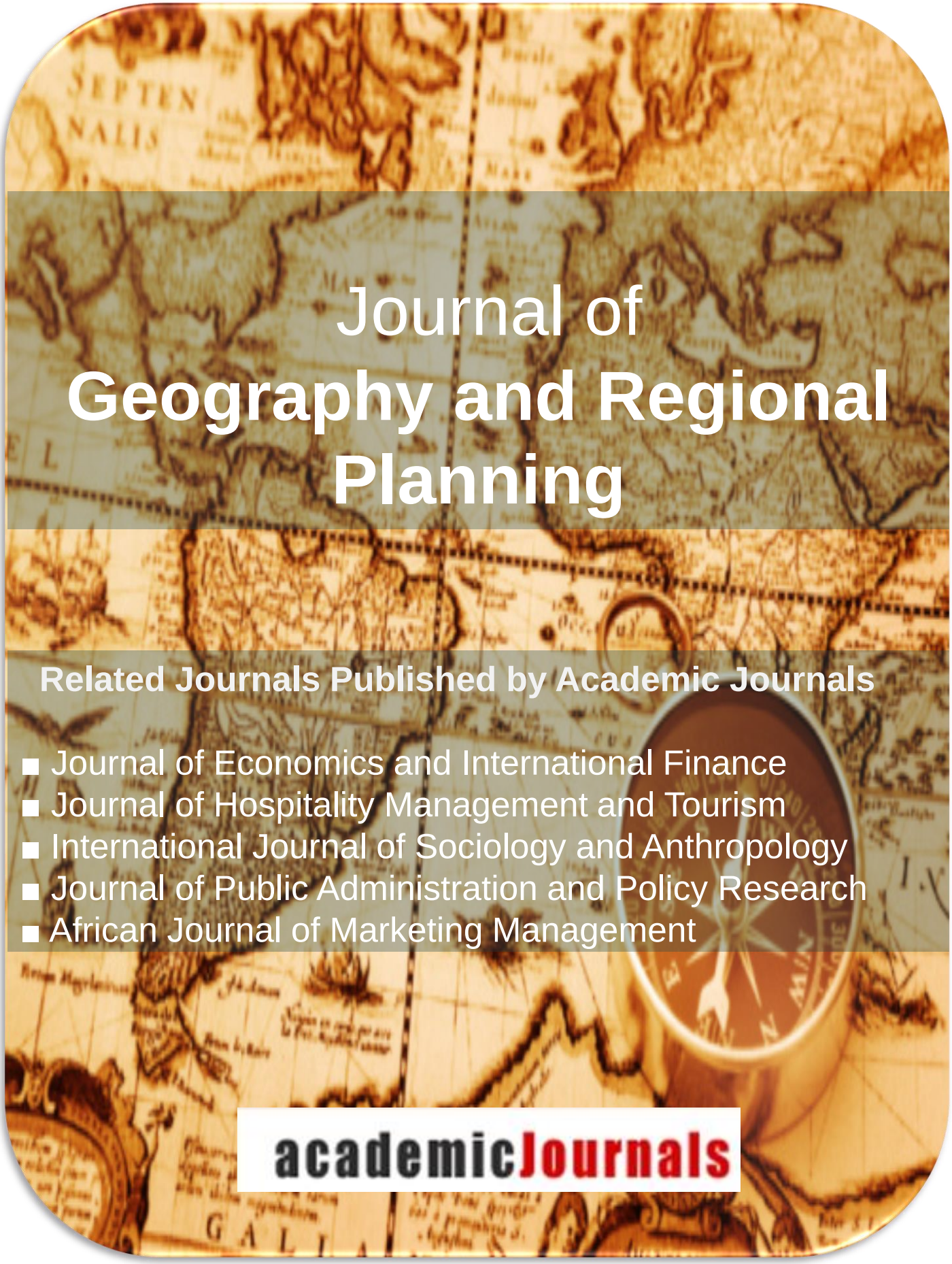

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