Developing Conceptual Land Grade Model for Bench Mark Lease Price Determination using Fuzzy Analytical Hierarchy Process and GIS Approach: A Case of Woldiya City, Ethiopia

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Abstract
Land grading plays a crucial role to develop appropriate benchmark lease prices. An efficient land grading system brings transparent and clear land marketing system. However, the existing land grading system of urban centers of Ethiopia has not been very successful in allowing the urban centers to benefit from the advantages of having an efficient land grading system. The major reasons for those limitations emanates from three main factors. The first reason is due to the fact that some major factors that have paramount importance for developing urban land grading had been left out. The second limitation is related to a methodological approach how land grade is prepared. In Ethiopia land grading is developed in the context of traditional urban land uses models. Yet, the notion of mono centric city concept (Burger's 1925 model) is dominant. However, currently this model does not reasonably represent real land value patterns in urban Ethiopia. Thirdly, in Ethiopia, the conventional method used to prepare land grade map is manual and labor intensive due to this limitations most municipals are not in position to prepare predictable and flexible land grade map.Taking this gap into account, the objective of this research was to develop a predictable and flexible conceptual land grading model for improved land management system in urban areas. In this study three -stage methodologies were used. The first stage was focused in identifying influential factors that are used as input to develop conceptual land grading model. The second was about determining preference weight of criteria using FAHP method. The third method was aggregating the factor maps in arc GIS10.2 (map algebra) so as to create prototype land grading map. The developed conceptual model was found to be effective and has improved information gain compared to previous works. The study concluded that GIS approach is not only facilitate the organization and management of digital data layers but it also enable municipals to take full advantage of location information contained in databases that can support spatial decision making in land grading. The study also confirmed that FAHP model allows decision makers to give interval judgments, which can capture a human‘s appraisal of ambiguity when complex multi-attribute decision making approaches like land grade are involved.
Keywords: Fuzzy; GIS; land grade; valuation; benchmark price.

1. INTRODUCTION

Land is an important and valuable natural resource that can be considered as wealth and as an input in production **(William, 2015).** Unlike in developed countries, the function of land as a production resource is still very crucial in developing countries **(Tunji, 2008).** In Ethiopia access to land is extremely important and is a major socio-economic asset (ACCSA (2009). Hence the way in which land is governed and administered has a significant impact on a country's development **(Samira, 2014).** However, in many developing countries, effective and efficient land use planning and management control is not well established **(Abubakari and Romanus, 2011).** Land management in urban Ethiopia is in transition and faces many interrelated challenges simultaneously. The overarching challenge is the process of attempting to replace the old system of urban land valuation by more market oriented of long term leases **(Olga, 2005).** According to **MUDHC (2014),** Ethiopia is not only least urbanized but also most urban centers in the country are predominantly unplanned. One manifestation of this issue is absence of legal framework and clear methodology for preparation, implementation and revision of urban land grading map.

Based on the works of **Daniel (1992)** urban land grading is essentially the process to determine the relative value of urban land for taxation and investment purposes. Grading urban land correctly and determining the land price are important and basic work to carry out the valuation exploitation and develop the real estate market. Furthermore, designing land grade must be built on objective evaluation and scientific evaluation and calculation of land quality **(Liu, 2002).** Therefore, Land grade has a crucial role to play in that it grades urban land into different level of valuation scales making it possible for efficient urban land valuation and pricing.

However, the existing land grading system of urban centers of Ethiopia has not been very successful in allowing the urban centers to benefit from the advantages of having an efficient land grading system. The major reasons for those limitations emanates from three main factors. The first reason is due to the fact that some major factors that have paramount importance for developing urban land grading had been left out. The second limitation is related to a methodological approach how land grade is prepared. In Ethiopia land grading is developed in the context of traditional urban land uses models. Yet, the notion of mono centric city concept (Burger's 1925 model) is dominant. However, currently this model does not reasonably represent real land value patterns in urban Ethiopia. Thirdly, in Ethiopia, the conventional method used to prepare land grade map is manual and labor intensive. This manual method is not only labor intensive, but also may distort the real values of certain land parcels because of its inability to reduce the elusiveness and vagueness in the evaluation process. In line with this traditional approach, the land use assessment and valuation system are static, subjective and an aesthetic exercise than a dynamic process tied to real market development and land valuation. Furthermore, adopting GIS as new approach in preparing and implementing urban plan has not developed substantially (**MUDHC, 2014)**

Taking this gap into account, the objective of this research was to develop a predictable and flexible conceptual land grading model for improved land management system in urban areas. In this study three -stage methodologies were used. The first stage was focused in identifying influential factors that are used as input to develop conceptual land grading model. The second was about determining preference weight of criteria using FAHP method. The third method was aggregating the factor maps in arc GIS10.2 (map algebra) so as to create prototype land grading map. The developed conceptual model was found to be effective and has improved information gain compared to previous works. The study concluded that GIS approach is not only facilitate the organization and management of digital data layers but it also enable municipals to take full advantage of location information contained in databases that can support spatial decision making in land grading. The study also confirmed that FAHP model allows decision makers to give interval judgments, which can capture a human's appraisal of ambiguity when complex multi-attribute decision making approaches like land grade are involved.

2. Research Methodology and Methods

2.1 Description of the Study Area

Woldiya which is found in Amhara National Regional State (ANRS) is one of the fastest growing urban centers in northern Ethiopia. It is found in northern Wollo, about 520 kms north of Addis Ababa. It is placed approximate between latitude 11° 47' 34" − 11° 50' 29" N and longitude 39° 33' 58" ─ 39° 37' 06" E (Fig. 1). The total area of city is 220 hectare. In recent decades, it has been the center of attention and population because of economic and industrial development which have increased requests for different industrial, residential, transport, business and educational uses. Woldiya city was growing at the rate of 3.5% between the years 1970-1984. After 10 years that is in 1994, it was reported that the population size of Woldiya was counted to be 24,533. Comparably, the third Ethiopian census of 2007 has revealed that there were about 46,126 people residing in the city during the count **(CSA, 2007).** Based on the projection made during the master plan preparation, the population size in year 2013/2014 was about 64,802. This implies that the population is increasing at the rate of 4.86%. Physiographical, the nature of the land of the city of Woldiya is rolling, hilly, and mountainous. The average altitude in the city is estimated to be 2000m above sea level.

2.2 Research Methodology

This paper proposed a combined three-stage methodology. The first stage focuses in identifying influential factors that are used as input to develop land grading model. The second stage focuses on integrating fuzzy logic with the Analytic Hierarchy Process (AHP) to model Fuzzy Analytic Hierarchy Process (FAHP). The FAHP method was used to determine the preference weightings of criteria. In determining or measuring the value given to each criteria and in establishing the level of desirability of each attribute, different measurements and ranges have been used; where most applicable to existing national norms and standards. However, in the absence of known standards, expert judgment had been used. Review of available literature and documents, collection and analysis of both primary and secondary data was carried out. Interviews and discussions with relevant officials, private companies who are working in urban plan, universities staffs, and practitioners in person and in the form of focus group were also held. Data processing and analysis of all factor maps was done in the Arc GIS software. Distances maps have been generated by using the spatial analyst straight line distance function in ArcGIS which creates such maps by calculating the straight line (Euclidean) distance from the identified criteria. The "RECLASS" function was then used to determine the grade zones. Each grade was scaled between 1 and 5. The higher the score is, the more valuable in grading.

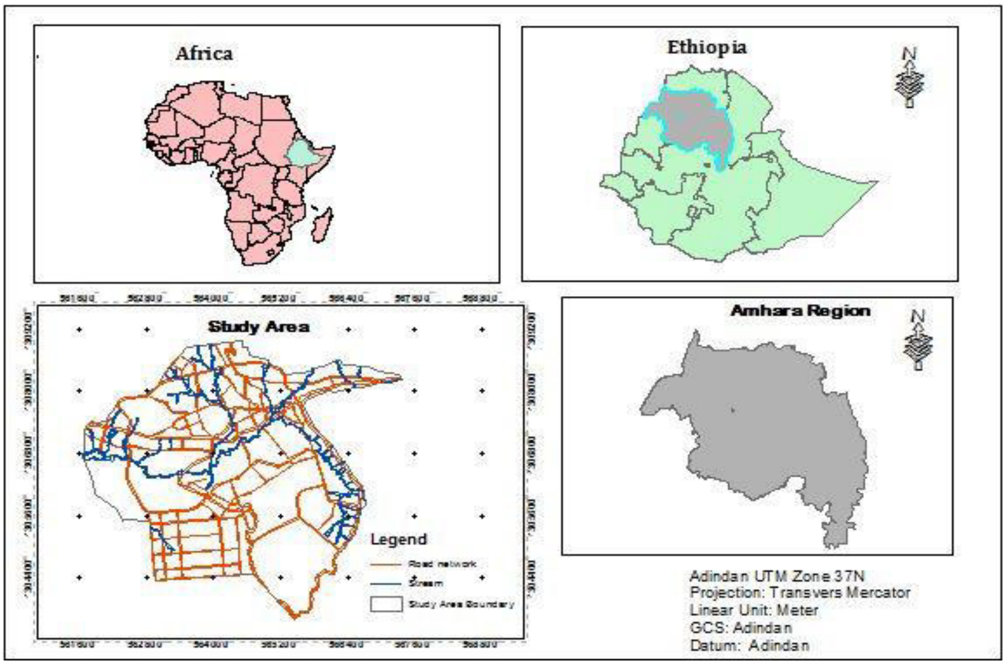


Figure.1: Study area

2.2 Research Methods

2.2.1 Data Acquisition and Collection Methods

The data used in this study were collected both from primary and secondary sources. Primary data were captured from satellite imagery and field observations. Furthermore, opinions of selected experts from all over groups has been sought to ascertain the influence of different factors on the development of land grade. The secondary data were collected from the National Urban Planning of Ethiopia, the Regional Urban Planning of Amhara Regioanal state and Woldyia city administration master plan report. The data used in this research were categorized into two parts called spatial data and non-spatial data (Table.1). The spatial factors that have influence on land grade are mainly obtained from the digital maps obtained from the master plan of the city. From different CADs maps which includes road plan, land use plan, green and recreational areas, public facilities and amenities has been converted to spatial data layers and stored in the Geographic Information System data database. To represent the different vector formats the shape file format was used in Geographic Information System (GIS). All the CAD files and satellite image were rectified and Georeferenced to UTM coordinate system based upon well distributed ground control points. In this study 15 uniformly distributed ground points were collected by using GPS and then all digital maps and satellite image were Georeferenced and rectified to UTM zone 37N coordinate system. Finally, a first-order polynomial model was applied and all data were resembled using the nearest neighbor method. The Geometric correction was resulted in RMSE 0.030 - 0.60.

Table .1 Data sources of the study

Type Of Data	Data Description	Data Format
Spatial	Topo map scale 1:50000 1139 B_1	Digital
	2m contour interval	Digital
	Satellite Imagery(QuickBird)	Digital
	City Land use plan (2009)	In CAD
	City Land use plan (1995)	In CAD
	City road plan(2009)	In CAD
	City boundary	In CAD
	Land grade map (1995)	Hard copy
Non spatial	Norms and standards	Literature
	Land grading factors	Literature
	Lease proclamation	Document
	Population statistic	Document
	Master plan report	Document

2.2.2 Method of Determining Grading Scales

In order to prepared land grading at city-wide, bringing a certain level of homogeneity in classification of the land grading becomes essential. In Ethiopia, different experience has shown that the urban centers are classified into five valuation scales (grade one, grade two , grade three, grade four and grade five).This implies that each land rents decreased progressively from higher (grade one) to lower (grade five). Taking as bench mark of the national standard of land grading and other countries experience this study also used the five type of grading scales to develop the land grading of the study area.

2.2.3 Criteria Preparation Method

Different researchers like Saba *et al.,* (2011), suggested that the selected criteria should be relevant to the analysis and also the selection process has to be tailored to the needs of the problem at hand and be based on the characteristics of the system that is analyzed. In this study, twenty four criteria/attributes were used to develop the conceptual land grade model. They fall into five main categories, which include infrastructure, land use, topography, environmental visual quality and population density (Table5). In determining the value given to each criteria/attribute and in establishing the level of desirability of each attribute, different measurements and ranges have been used where most applicable to existing national norms and standards. The national standards for urban planning like local development manual and implementation manual of urban planning were mainly adapted to establish the ranges. Data processing and analysis of all factor maps was done in the Arc GIS 10.2 software. Distance maps have been generated by using the spatial analyst straight line distance function, which creates such maps by calculating the straight line (Euclidean) distance from the identified criteria. 3D analysis was used to create TIN model from digital topographic map (2m contour interval) to generate elevation, slope and aspect. The "RECLASS" function was then used to determine grade zones (Table.5)

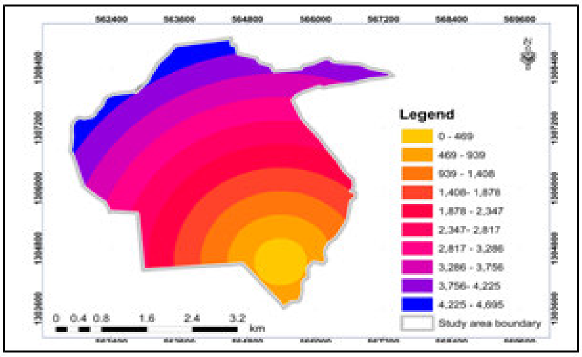
2.2.4 Method of Creating Factor Maps

According to Afzali et al. (2011, as cited in Mahini and Gholamalifard, 2006) factor is a criterion which causes the suitability of an alternative increase or decrease for a specific application. Based on the affirmed concept, the following section presents some of the criteria maps

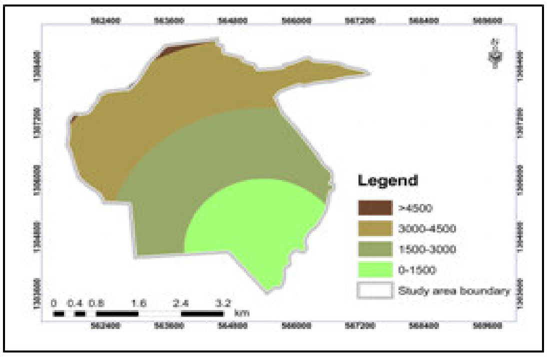
The distances to roads, education facilities, health facilities, transport facilities, recreation and civic centers, market area and commercial activities are some of the important criteria used in determining the urban land grading of the study area. Their maps have been created by using the Spatial Analyst Straight Line Distance function in ArcGIS which creates such maps by calculating the straight line (Euclidean) distance from center of site (roads, education facilities, health facilities, transport facilities, recreation and civic center's). The result is a raster dataset in which every cell represents the distance to the main facility center in meters. Some of the distance maps used in the land grade is given below but do not limit the following.

2.2.5 Methods of Integrating Fuzzy Logic and Analytical Hierarchy Process

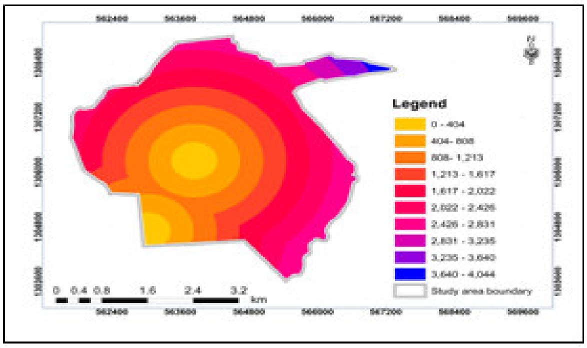
Fuzzy Analytic Hierarchy Process (FAHP), which is an extension of AHP was used to determine the weight of each criterion. The conventional AHP technique of expressing decision maker's judgments in the form of single numbers (crisp) does not fully reflect a style of human thinking (Rodney and Tesfalem, 2011). Fereydoon *et al.*(2010) and Abedi *et al.(*2013) indicated that integrating fuzzy logic into the AHP process can overcomes the defect in AHP, and accordingly this approach is used to integrate fuzzy logic and AHP to model FAHP. In modeling fuzzy analytical hierarchy Process (FAHP), the method of Triangular Fuzzy Numbers (TFNs) was considered. When using TFNs, the decision maker's judgment is represented as an interval defined by three real numbers or parameters, expressed as (l, m, u), where l is the lowest possible value, m is the middle possible value and u is the upper possible value (Ibrahim *et al.,* 2010). By using the concept of TFNs the fuzzy judgment matrix was constructed to obtain pair wise comparisons for criteria at each level of the hierarchy. To determine scale of relative importance of each criteria/attribute, experts interview were conducted about the relative weights of each criterion/attribute. Criteria/attribute scores were determined by fuzzing crisp pair-wise comparison matrix introduced by Saaty (1980) and triangular fuzzy number of linguistic variables was developed to compare two criteria by six basic linguistic variables (Table 3). Based on triangular fuzzy number of linguistic variables, pair wise comparison of the fuzzy judgment matrix was established (Table 4). To normalize differences existing in expert opinion simple average of fuzzy numbers for all linguistic variables have been calculated and corresponding weights were assigned (Table.5)



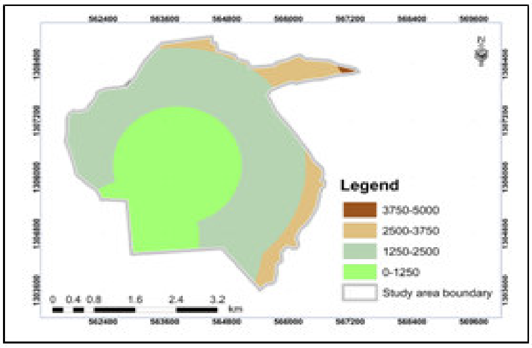
Distance to university



Reclassified University



Distance to high school



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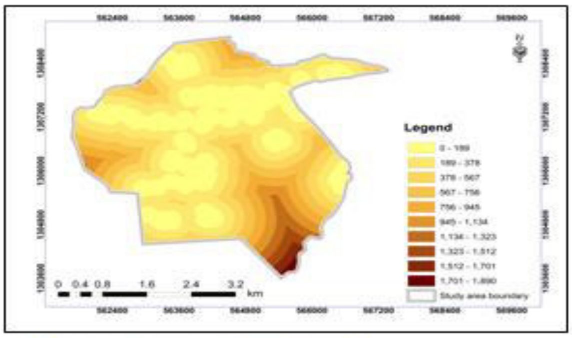
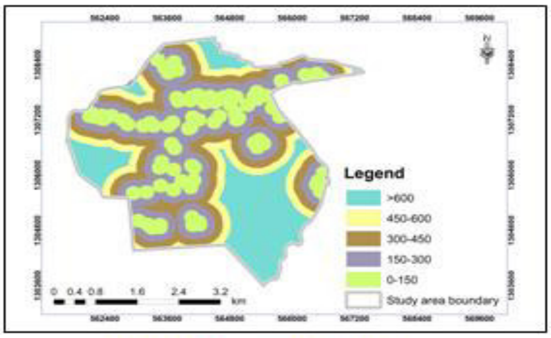


Distance to commercial colliders



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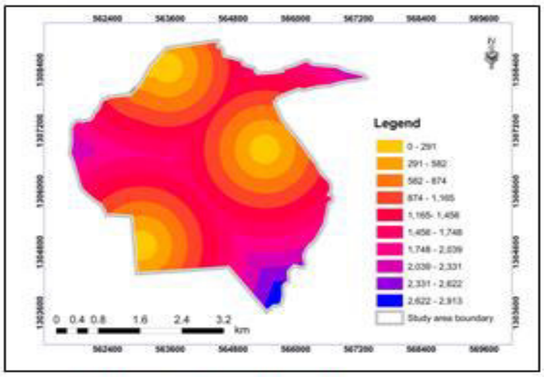
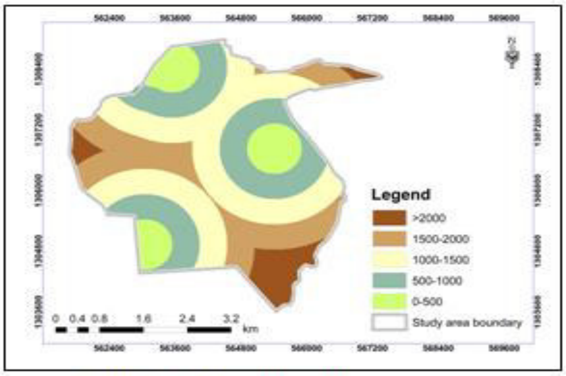


Distance to market centre



Reclassified market centre

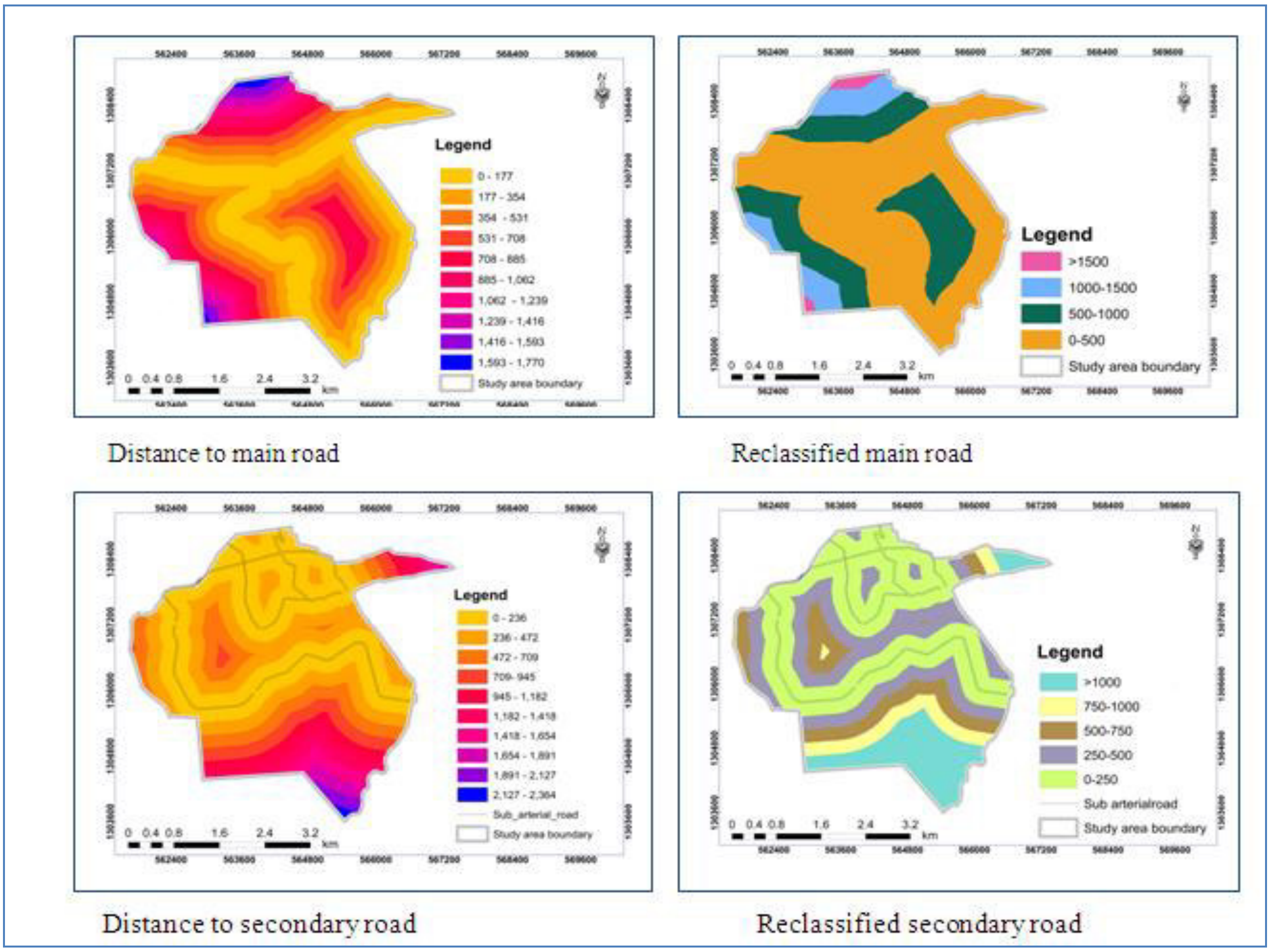


Fig.2 Sample Factor Maps

Table.3 Triangular fuzzy number of linguistic variables

Linguistic variables	Crisp numbers	Triangular fuzzy numbers (l,m,u)	Reciprocal triangular fuzzy numbers
Extremely strong	9	(9,9,9)	(1/9,1/9,1/9)
Very strong	8	(6,7,8)	(1/8,1/7,1/6)
Strong	6	(4,5,6)	(1/6,1/5,1/4)
Moderately strong	5	(2,3,4)	(1/4,1/3,1/2)
Equally strong	1	(1,1,1)	(1,1,1)
Intermediate	3,4,5	(3,4,5)	(1/5,1/4,1/3

Table. 4. The fuzzy judgment matrix of experts' on the criteria

	C1 Infrastructure	C2 Land use	C3 Topography	C4 Environmental	C5 Population density
C1	(1,1,1)	(2,3,4)	(4,5,6)	(6, 7,8)	(9,9,9)
C2	(0.25,0.33,0.5)	(1,1,1)	(2,3,4)	(3,4,5)	(6,7,8)
C3	(0.167,0.2,0.25)	(0.25,0.33,0.5)	(1,1,1)	(1,2,3)	(4, 5,6)
C4	(0.125,0.143,0.167)	(0.2,0.25,0.33)	(0.33,0.5,1)	(1,1,1)	(1,2,3)
C5	(1/9,1/9,1/9)	(0.125,0.143,0.16)	(0.167,0.2,0.)	(0.33,0.5)	(1,1,1)

Table.5 Normalized weights for each criteria

Criteria	Sub criteria	Ranges	Rank	Valuation	Weight
Social infrastructure					
Health facility	Distance to hospital	0-1500	5	Most Valuable	0.0382
		1500-3000	4	Very Valuable	
		3000-4500	3	Valuable	
		4500-6000	2	Less Valuable	
		>6000	1	Least Valuable	
	Distance to health center	0-500	5	Most Valuable	0.0307
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
Education facility	Distance to University	0-1500	5	Most Valuable	0.0357
		1500-3000	4	Very Valuable	
		3000-4500	3	Valuable	
		4500-6000	2	Less Valuable	
		>4000	1	Least Valuable	
	Distance to high school	0-1250	5	Most Valuable	0.0305
		1250-2500	4	Very Valuable	
		2500-3750	3	Valuable	
		3750-5000	2	Less Valuable	
		>5000	1	Least Valuable	
	Distance to primary school	0-1000	5	Most Valuable	0.02551
		1000-2000	4	Very Valuable	
		2000-3000	3	Valuable	
		3000-4000	2	Less Valuable	
		>4000	1	Least Valuable	
Entertainment	Distance to recreation center	0- 500	5	Most Valuable	0.0204
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
	Distance to sport center	< 500	5	Most Valuable	0.0179
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
Accessibility to security	Distance to police station	< 500	5	Most Valuable	0.0150
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
	Distance to local administration	0- 500	5	Most Valuable	0.0129
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
Access to public service	Distance to sector office	0- 1000	5	Most Valuable	0.0153
		1000-2000	4	Very Valuable	
		2000-3000	3	Valuable	
		3000-4000	2	Less Valuable	
		>4000	1	Least Valuable	
	Distance to postal service	0- 500	5	Most Valuable	0.0127
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	

Criteria	Sub criteria	Ranges	Rank	valuation	Weight
physical Infrastructure					
Road network	Distance to main roads	0- 500	5	Most Valuable	0.064
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
	Distance to secondary roads	0-250	5	Most Valuable	0.0384
		250-500	4	Very Valuable	
		500-750	3	Valuable	
		750-1000	2	Less Valuable	
		>1000	1	Least Valuable	
	Distance to collectors	0-100	5	Most Valuable	0.02551
		100-200	4	Very Valuable	
		200- 300	3	Valuable	
		300-4000	2	Less Valuable	
		>4000	1	Least Valuable	
Transportation	Distance to bus station	0-1000	5	Most Valuable	0.0382
		100-2000	4	Very Valuable	
		200-3000	3	Valuable	
		3000-4000	2	Less Valuable	
		>4000	1	Least Valuable	
	Distance to CBD	< 500	5	Most Valuable	0.0890
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
Market facility	Distance to market center	< 500	5	Most Valuable	0.0639
		500-1000	4	Very Valuable	
		1000-1500	3	Valuable	
		1500-2000	2	Less Valuable	
		>2000	1	Least Valuable	
	Distance to commercial colliders	0-150	5	Most Valuable	0.0890
		150-300	4	Very Valuable	
		300-450	3	Valuable	
		450-600	2	Less Valuable	
		>600	1	Least Valuable	
Land use		Commerce	5	Most Valuable	0.25571
		Mixed	4	Very Valuable	
		manufacturing	3	Valuable	
		Residential	2	Less Valuable	
		Others	1	Least Valuable	
Population and housing density		>20000	5	Most Valuable	0.039066
		15000-20000	4	Very Valuable	
		10000-15000	3	Valuable	
		5000-10000	2	Less Valuable	
		< 5000	1	Least Valuable	
Distance from visual and environmental quality	Flood Line distance or stream line	< 500	5	Most Valuable	0.068938
		< 400	4	Very Valuable	
		300 – 400	3	Valuable	
		200 – 300	2	Less Valuable	
		100 – 200	1	Least Valuable	
Topography	Slope	0-5	5	Most Valuable	0.0945
		5-10	4	Very Valuable	
		10-15	3	Valuable	
		15-20	2	Less Valuable	
		>20	1	Least Valuable	
	Aspect	North	5	Most Valuable	0.0315
		East	4	Very Valuable	
		South	3	Valuable	
		West	2	Less Valuable	
		Flat	1	Least Valuable	

To determine whether consistency is maintained in assigning the weights of each factor fuzzy, consistency ratio (FCR) was calculated. The algorithm used in this research is adapted from Chang (1996). The FCR is designed in such a way that if FCR < 0.10, the ratio indicates a reasonable level of consistency. However, if FCR is greater than 0.10 the value of the ratio indicates inconsistent judgments. This was conceptualized by the following equations

$$CI = \frac{\lambda_{max} - n}{n - 1} \text{ and } FCR = \frac{C_I}{R_I} \ldots\ldots\ldots\ldots\ldots.. Equation\ 1$$

$$where, \lambda \text{ is average value of consistency vector and } n \text{ is number of criteria}$$

To determine average value of consistency vector the Weighted Sum Vector (WSV) of each criterion /attribute was calculated (Table 6)

Table 6 Aaverage value of consistency vector

	0.510181	0.183665	0.102036	0.076527076	0.05612
	0.76713	0.25571	0.092056	0.06648459	0.038356
	0.63053	0.378318	0.126106	0.076924618	0.026482
	0.482566	0.275752	0.137876	0.068938045	0.042052
	0.35159	0.273459	0.195328	0.07813111	0.039066
Total WSV	2.741996	1.366904	0.653401	0.36700544	0.202076
WSV/Column	5.374561	5.345524	5.18137	5.323699567	5.17275

$$Average\ Consistency = \frac{5.374561 + 5.345524 + 5.18137 + 5.17275}{5} = 5.279581$$

$$CI = \frac{\lambda_{max} - n}{n - 1} = 5.279581 - \frac{5}{5 - 1} = 0.0698$$

$$Calculating\ Fuzzy\ Consistency\ ratio\ (FCR), FCR = \frac{C_I}{R_I} = \frac{0.0692}{1.12} = 0.06$$

FCR is less than 0.10. And indicates a reasonable level of consistency

2.3 Implementation on GIS

Multiple factors assessment method on a raster-based GIS was implemented to develop the land grading map. Once the criteria/attribute maps had been developed and the associated weights are assigned to each input layer, aggregation stage was undertaken by using map algebra in Arc GIS software to combine the various criteria/attribute. Moreover, the criteria/attribute of the analysis may not be equally important; hence, each criterion were reclassified into units of valuable and then multiplied them by a weight to assign relative importance to each and finally added them together for the final weight to obtain a land grade map. This can be conceptualized by the following equations.

$$F = \{f_1, f_2, \ldots\ldots.. f_n\} \_\_\_\_\_\_\_\_\_ Equation\ 2$$

$$Where, f_i, i = 1,2,3 \ldots\ldots. n \text{ represents each indivisual criteria}$$

$$W = \{W_1, W_2, W_i \ldots\ldots.. W_n\} \_\_\_\_\_\_\_\_\_ Equation\ 3$$

$$Where, W_i, i = 1,2,3 \ldots\ldots. n \text{ represents weight of each indivisual criteria}$$

$$L_g = \sum_{i-1}^{n} W_i * f_1 \quad where, L_g = land\ grade \ \_\_\_\_\_\_\_\_\_ Equation\ 4$$

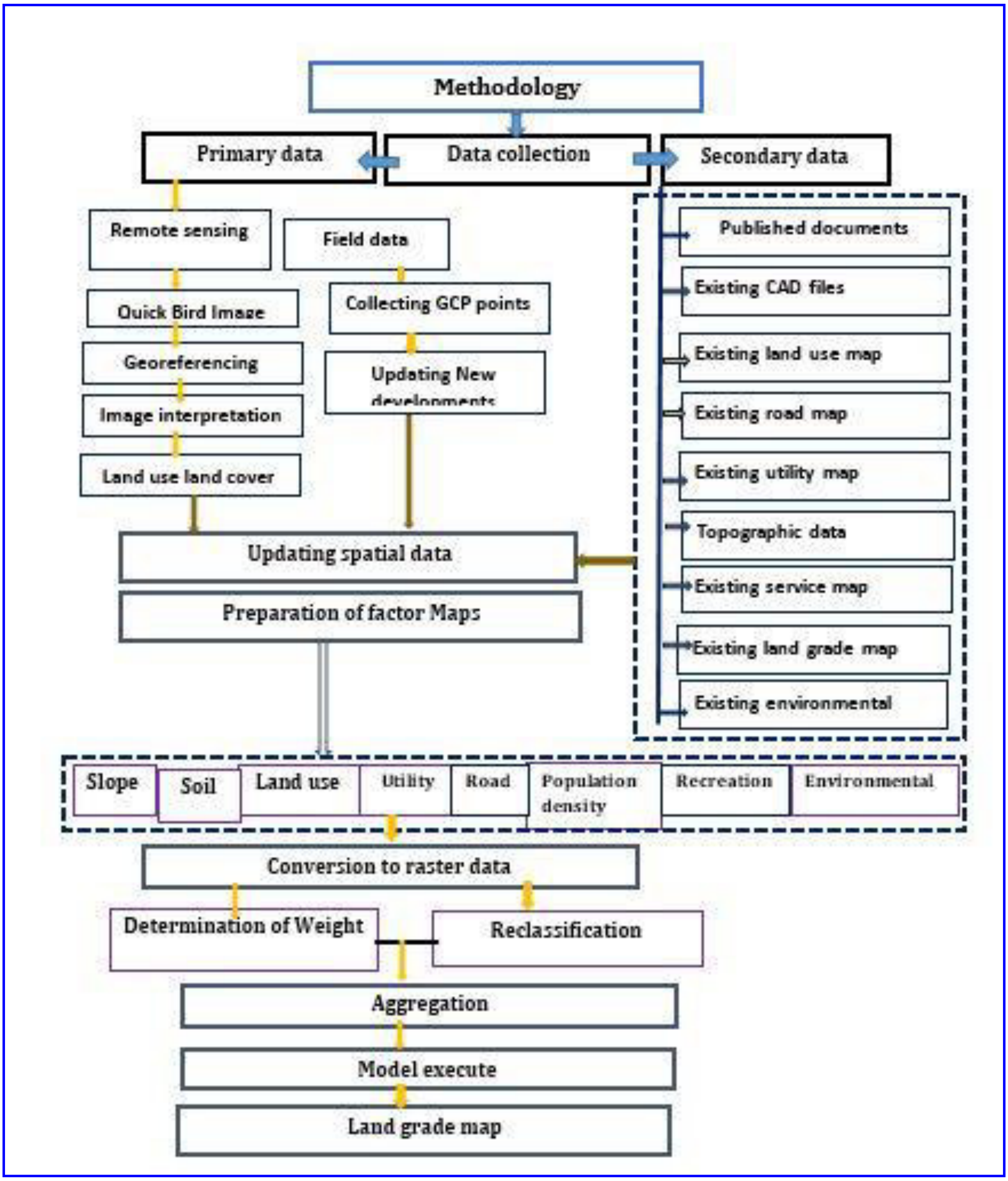


Fig. 3 Conceptual land grading Model

3. Result and Discussion

3.1 Influential Factors for Designing Urban Land Grading

The results of this research reveal that the development of urban land grading is influenced by multi criteria factors. These include land use, environmental quality, infrastructure and topography. Literatures also confirm that the multiple factors assessment method has been widely used in urban land grading as a primary method (Daniel, 1992 and Liu, 2002). Based on the study under taken, the influential factors for designing urban land grading can be coined to four pillars. The first and most important factor in grading a piece of land is its location which is related to accessibility parameter. The finding of this research indicated that the intensive capital investment in the CBD that explain the concentration of the most valuable land in the CBD is gained due to its location advantage which is accessible to transport and infrastructure provision.

The second important factor is related to the surroundings i.e things that border on a piece of land can have a major effect on its value in both positive and negative ways. A building lot on improved neighborhood will probably have a high land grade. Conversely, a plot of land near to land fill or pollutant industrial area will be less desirable for residency. The third factor goes to the state of existing structures. Physical infrastructure development in the form of different structures has a direct impact on urban land grading and therefore on the bench mark price of land. The fourth factor is related to condition of the land which will have also an effect on its value. For example planned area will be worth more than unplanned area. The geological, environmental condition and psychological perception of the condition of the land has also impact on the land grade and hence on the bench mark price.

Another important finding of this study is that the influential factors for designing urban land grading their roots originated from family of infrastructure and land use provision. In this study, five major factors were identified which fall into five main categories that includes infrastructure, land use, topographic factors and physical conditions, visual and environmental quality and population density.

The study confirmed that among the identified factors infrastructure takes the major's share that has 51% weighting influence and land use is in second position with weight influence 25.6 %. Topography, environmental and visual quality and population density has weight influence of 12.6%, 6.9% and 3.9 % respectively.

- **Influence of Urban Spatial Structure on Land Grading**

Collectively, the analysis result and literature review makes sure that the urban land structure of Woldiya is composite where by the commercial activities appear clustered near the city center followed by manufacturing and residential uses. The analysis result also revealed that expansion of road simulates the growth of the transportation network by generating centers and sub centers adjacent to roads (Adago, Gonderber and Pizza). This type of growth promotes land value because of increased accessibility along the transportation network. The literature and analysis result strongly confirmed that the manner in which a city grows has significant influence on land use patterns. So, is on land grading.

- **Influence of Urban Land Use on Land Grading**

The field work vividly noticed that larger commercial land use types are associated with significantly higher property values which suggest that commercial areas belong to the most valuable in designing urban land grading. In the city, the mixed use of urban land use has also becomes a prerequisite for the commercial development of city.

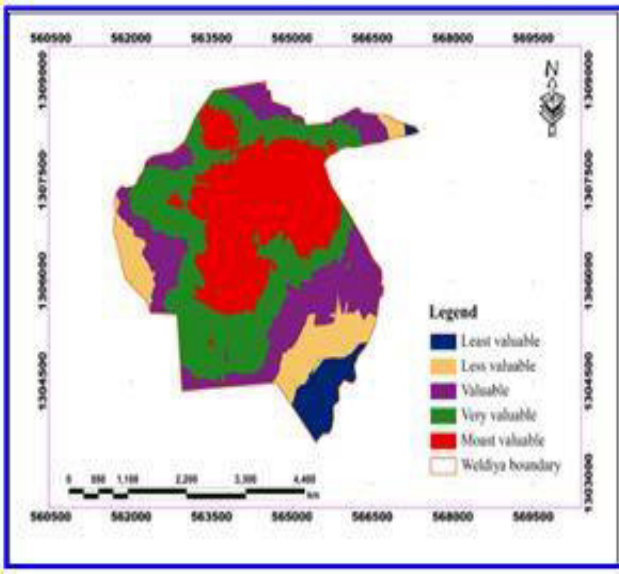
- **Influence of Slope/ Topography on Land Grading**

The result of this study has revealed that topographic factor (slope) has impact on the land grading. Table 7.1 and figure 3 demonstrates the influence of slope in land grading.

Table. 7 Influence of slope on land grading

Land grade with slope factor			Land grade without slope factor		
Grade	Area (ha)	Area (%)	Grade	Area (ha)	Area (%)
Least Valuable	206.2	12	Least Valuable	88.3	5
Less Valuable	382	22	Less Valuable	176	10
Valuable	371.2	22	Valuable	386.8	22
Very Valuable	417.5	24	Very Valuable	545.9	32
Most Valuable	345.5	20	Most Valuable	527.5	31
	1722.4	100		1722.4	

As it is indicated on the Table 7, when slope is added as one factor, the most valuable area is decreased by 11% in the other hand; the least valuable area is increased by 7%. Furthermore, as it indicated in Figure 4.1 and Figure 4.2 the spatial distribution of the land grading valuation scales has dramatically changed due to the influence of the slope



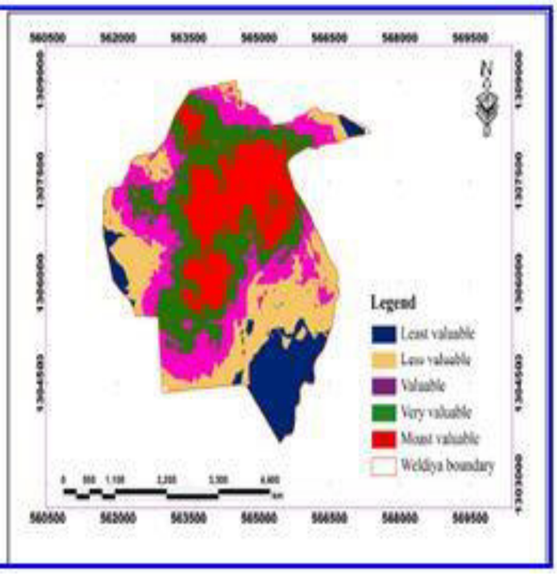


Figure 4.1. Land grade without slope factor

Figure 4.2 Land grade with slope factor

3.2 Modeling Fuzzy Analytical Hierarchy Process (FAHP)

The conventional AHP technique of expressing decision maker's judgments in the form of single numbers (crisp) does not fully reflect a style of human thinking (Rodney and Tesfalem, 2011). According to (Fereydoon et al., 2010 and Abedi et al., 2013) integrating fuzzy logic into the AHP process can overcome the defect in AHP. Hence, Fuzzy Analytic Hierarchy Process (FAHP) which is an extension of AHP was used in this research to determine the weight of each criterion/attribute. The weights to be acceptable, several researchers have discussed that the preference ratio should be less than 10 % (Ibrahim, *etal*,, 2011 and Peter, 2011). In this model the preference ratio value obtained was about 0.060. This indicates a reasonable level of consistency in the pair wise comparisons and t the weights are accepted.

3.3. Proposed Framework to Develop Conceptual Land Grading (Integration of GIS and FAHP)

The Proposed conceptual model comprises four steps. The first step deals with the identification of factors. The second step deals with integrating fuzzy logic and AHP to calculate weights of factors by using FAHP. Step three deals with aggregation phase. The fourth step deals with the evaluation phase. Compared with the traditional land grade model, this conceptual frame work can produce a prototype land grade that could be used as more universal template to prepare land grade. The system was successfully able to generate the land grade model of the study area (Fig 5) As it is indicated in (Fig. 5), the main reasons for which most valuable areas (red color) are placed in the inner city is because of its proximity to existing CBD in which the probability of finding existing infrastructure and organized service system is high, its proximity to recreational sites, shopping centers and commercial areas that represent first necessity for any economic activity, its proximity to main roads and its good connection to the market and access to transportation nodes are the most important factors.

The location advantage and intensive capital investment in the CBD may explain the concentration of the most valuable land around the center of the city. The general pattern of urban land value tends to decrease from the urban center to the periphery with some exception. Instead of showing a monotonous concentric pattern like Burgess Model the conceptual land grade approach follows the composite of the sector and concentric land use models (Fig. 6). The result also demonstrated that physical infrastructure development has a direct impact on urban land grading. In the other hand, the steep slopes, wetlands and water areas also limit the gradual transition of the urban land values of the land grading.

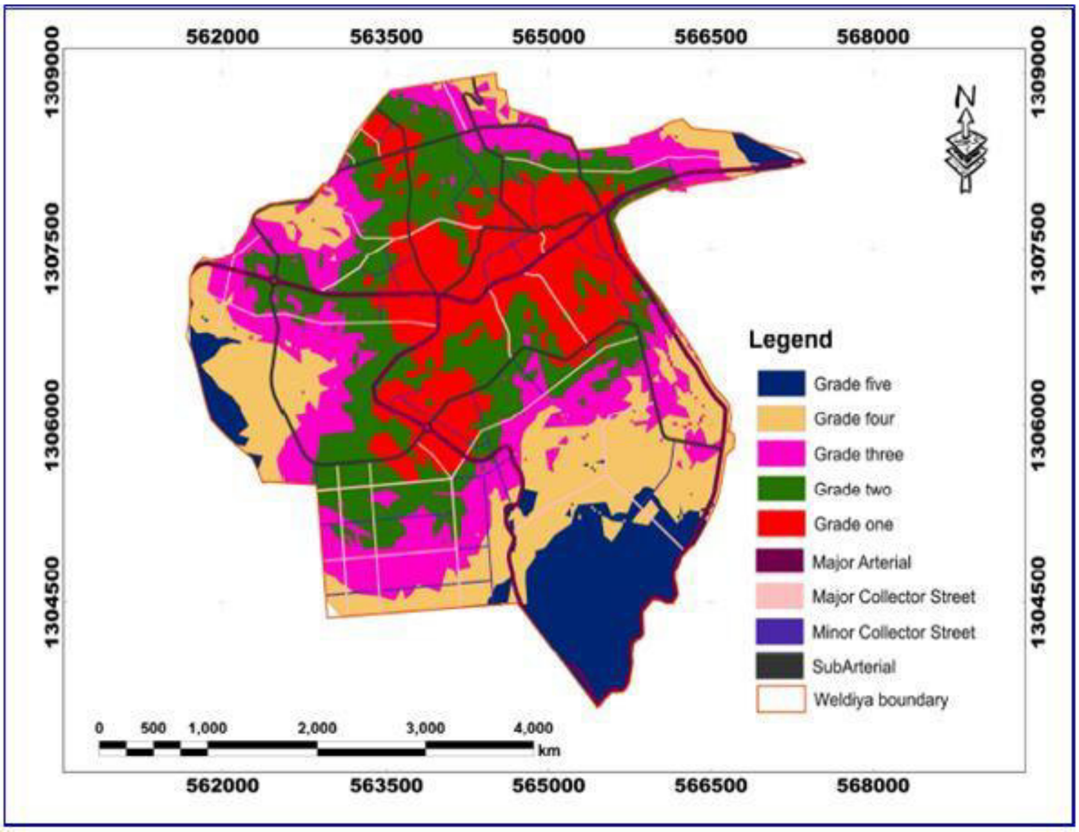


Fig. 5 Developed Conceptual Land Grade Model

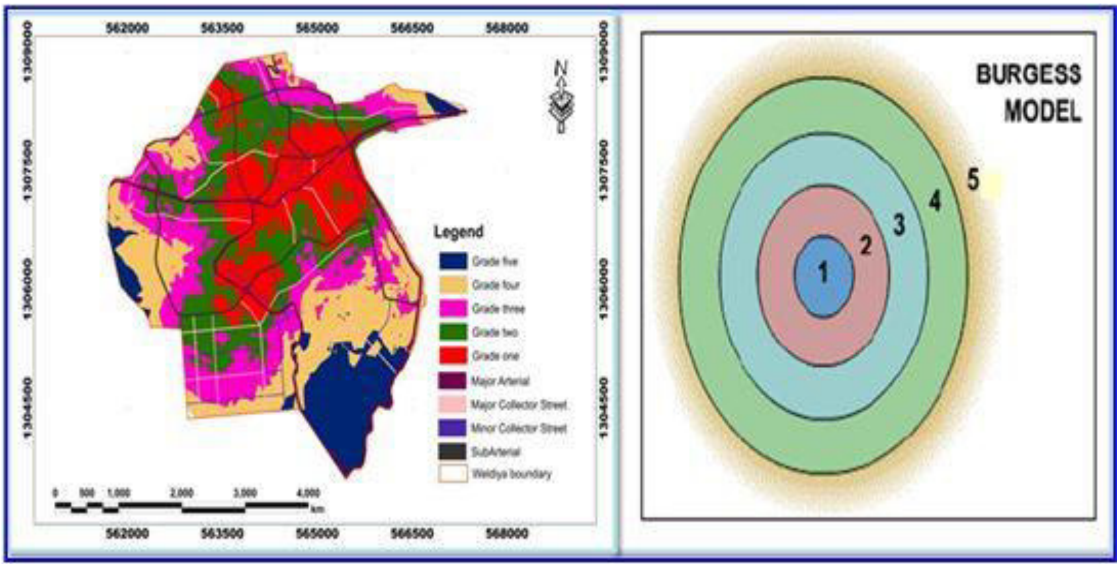


Fig. 6. Comparison between new land grade map and traditional land use models.

From the comparison between the existing land grading and the finding of this research (Fig 7 and Fig 8). The existing land grade is mainly influenced by road. During the preparation, unique opportunities and constraints were not considered. A study conducted by ACCSA (2009) also confirmed that in Ethiopia, road is the main determinant factor in land grade preparation. Furthermore, the existing urban land grade map was not constantly updated based on its growth boundary. However, the model employed in this study used multi criteria system which has its own data structure to update the land grade when new developments flourish. It also provides a digital data base for long-term monitoring of the land grade and with small modifications. The method can be also used for other cities as well. The researchers believe that this is one of the significance of the model.

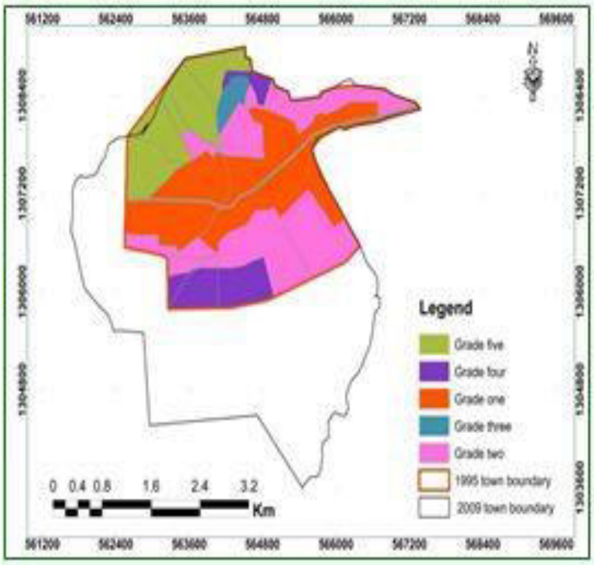


Fig. 7. Existing land grade

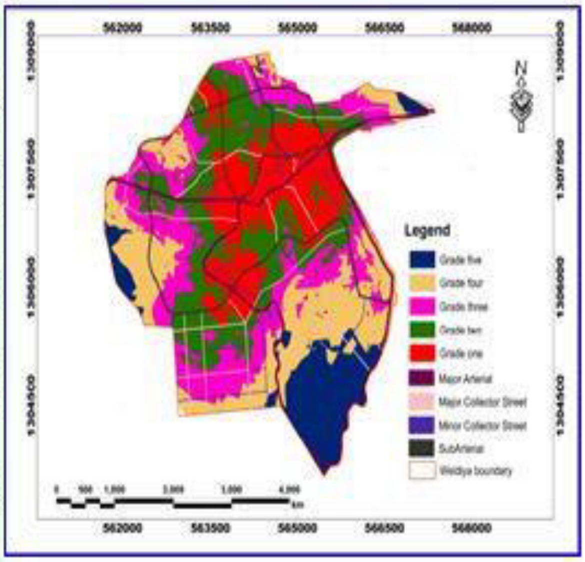


Fig. 8. The new land grade

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The finding of this study assured that the influential factors for designing urban land grading in Woldiya city can be coined to four pillars. The first and most important factor in grading a piece of land is its location which is related to accessibility parameter. The second important factor is related to the surroundings i.e things that border on a piece of land can have a major effect on its value in both positive and negative ways. The third factor goes to the state of existing infrastructure development. The fourth factor is related to condition of the land which will have also an effect on its value. Another important finding of this study is that the influential factors for designing urban land grading their roots originated from family of infrastructure and land use provision.

GIS Conceptual Modeling (GISCM) is a new approach based on fuzzy logic integration with GIS. It is an appropriate methodology to support location choice and land grading assessment. In any of these methods, factor identification, weighting and integrating GIS and fuzzy logic approaches are important prerequisites that serve as platform to develop land grading. In all, land can be classified for the anticipated grades based on the trend of uses and physical and socio economic and environmental factors. This paper indicates the fuzzy modeling approach can avoid the loss of information that often arises when the strict Boolean logic is used on the basis of the crisp sets (Yes/No).

To sum, the fuzzy land grading method can produced a better and more reasonable result than using pure Boolean operators. As a result the researchers found that the proposed model is practical and effective in developing land grade with respect to multiple criteria. In line with this, the research has resulted in the following contributions:

1) The key factors that characterize land grade are identified and used to model land grade.
2) It provides a digital data base for long-term monitoring of the land grade
3) FAHP is best alternative to determine the criteria weights from judgments of decision making domain of experts.

To sum up, the study methodology can be used as template to develop urban land grade information system. Furthermore, users may modify the conceptual land grade model in two ways (a) adding data layers not included in the original model that add value to the analysis and (b) changing weights in the model to better reflect land use planning priorities and perspectives in a particular jurisdiction. In future research, the researcher recommends using different fuzzy mathematical programming method to improve the conceptual model. Also, the researcher recommends applying this model on a WebGIS to receive the basic bench mark price of the land information

4.2 Recommendations

Achieving efficient land use, encouraging investors and investment and realizing the cost of urban land and make an efficient use of it are some of the major national and regional goals in Ethiopia. Furthermore, planning and managing cities in the new era of globalization is becoming demanding task calling for new skills and approaches. Among these issues having efficient land grading takes the major's share. To take advantage of the efficient land grading the following recommendations should be paid due attention.

Facilitate Training to Local Staffs
Training of the local government staffs, particularly those sections which have direct relation to land management should be the first priority. The plan preparation, implementation and monitory of any urban plan need technical staff to follow its impact on the urban development. This is a difficult task unless there is sufficient qualified manpower that can assess and updated information.

Allow Participation
One of the major problems to be addressed for the successful implementation of the urban policy in the country as a whole is the lack of awareness and understanding of the contribution from stake holder participation. Likewise, the preparation of land grade requires adequate participation by the relevant stakeholders during the preparation and implementation of different regulations that enables to implement the land grade. The bench mark price of land grades shall be made accessible to the public via different public media.

Develop Proper Cadastral and Land Register System
Develop clear and transparent instructional operations, procedures and legal formalities in the registration and titling of land holding. Without a proper updated cadastral maps and land registry system it is difficult to have a clear picture of the land grading and land valuation system.

Allow Flexible Urban Planning Approach
Plans must have flexibility to provide for ever-growing and ever expanding city boundaries and infrastructure development.

Providing Accurate and Up-to-Date Geospatial Information System
The local urban planning authorities and agencies should adopt new technologies like computerized data base and GIS application. Because these have capability to provide necessary spatial data for preparation of base maps, for planning proposals and act as monitoring tool during implementation phases.

Update the Land Grade as Per the Proposed Time Frame
The land grade has to be constantly updated and it should be updated on the basis of defined time frame. Given the rapid infrastructure development and construction work that is being carried out in the town, the growing need for redevelopment, radical changes in the town's space organization the land grade has to be updated as per the lease proclamation i.e every two year.

Providing Regulatory Framework
There should be an institution or even a department under the land administration authority which is responsible for this particular task. This institution should be responsible for monitoring new developments, updating the land grade, facilitating stakeholder participation in the review process and making the updated land grade public information

REFERENCES

Abedi. M., Torabi, S.A. and Norouzi, G.H. (2013). Application of fuzzy AHP method to integrate geophysical data in a prospect scale, Bollettino di Geofisica Teorica ed Applicata. Volume, 54: 145-164.

Abubakari, A and Romanus, Dogkubong, D (2011). 'Urbanization and the challenges of development controls in Ghana: A case study of WA Township'. Journal of Sustainable Development in Africa. Volume 13, No.7, pp.210-233.

ACCSA (2009) Addis Ababa Chamber of Commerce and Sectoral Associations. Land Lease Policy in Addis Ababa. SIDA, Addis Ababa, Ethiopia, 99pp.

Chang, D.Y. (1996). Applications of the extent analysis method on fuzzy AHP. *Eur. J. Oper. Res.* Pp.649-655.

Daniel, Z. S. (1992). A fuzzy GIS modeling approach for urban land evaluation. *Comp., Environ and Urban Systems*. Volume **16**, pp. 101-115.

Fereydoon, S., Ali, K., Behnam, R. and Sadegh, A. (2010). Application of MCDM method in fuzzy modeling of land suitability evaluation. In: *Proceedings of19th World Congress of Soil Science*, pp. 25-28. Brisbane, Australia.

Ibrahim, E. H., Mohamed, S. E. and Atwan, A. A. (2011). Combining fuzzy analytic hierarchy process and GIS to select the best location for a waste water lift station. *IJET*. Volume 11, pp .44-50.

Liu, Yaolin. (2002). 'Design of the urban land grading information system'. *Geo-spatial Information*. Volume 5, No.3, pp.26-32.

MUDHC (2014) Ministry of Urban Development, Housing and Construction Government of the Federal Democratic Republic of Ethiopia, Urban Plan Preparation and Implementation Strategy. 14pp.

MUDHC (2014). Ministry of Urban Development, Housing and Construction Government of the Federal Democratic Republic of Ethiopia, Local development plan manual, Addis Ababa, Ethiopia, 94 pp.

Peter, H. R., Max, H. B., Ahmed, A. H, and Maha, A. (2011). Overlay weighted model and fuzzy logic to determine the best locations for artificial recharge of groundwater in a Semi-Arid Area in Egypt. *Nile Basin Water Science & Engineering Journal.* Volume 4. Pp. 24-35.

Rodney, G. T. and Tesfalem, S. H. (2011). 'Integrating Geographical Information Systems fuzzy logic and analytical hierarchy process in modeling optimum sites for locating water reservoirs'. Open Access. Volume 3. Pp 254-290.

Saaty, T. L. (1980). A scaling method for priorities in hierarchical structures

Samira Lindner (2014). Overview of corruption in land administration in Ethiopia, Transparency International, June 2014

Tunji Titilola (2008). 'Environmental degradation and its implications for agricultural and rural development: The issue of land erosion's'. Journal of Sustainable Development in Africa. Volume 10, No.2, pp.241-263.

William Larson (2005). New Estimates of Value of Land of the United States, US Department of Commerce, Bureau of Economic, April 3, 2015