

An Analysis on Studies of Population Developments of Ardabil City

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ABSTRACT: Studying a society's Population changes is important for any planning. Since all eco-social planning are designed due to the society's requirements and demands and so all of eco-social aspects of these planning are in relation to population statistics and population structure characteristics. The paper has been written about studying population changes in Ardabil city; herein, these changes and their reasons of existence are exactly assessed and analyzed so that a suitable field for appropriate planning in future could be provided. On this base, methodology of this paper is descriptive-analytical and quantitative. The main obtained results indicated that the population growth rate of this city except of 80s was approximately even. Ardabil city is about to experience a population growth transition and its population go toward adultery. Population density in this city hasn't been dispersed evenly and therefore several city regions have the highest density. In this case study, fertility and birth rates are high on one hand and on the other hand, mortality rate is low. Sex ratio, in this city, has lower trend and also proportion of male to female figures is to decline. Literate estate is not suitable among women. And the last point that employers' ratio has and will have declined, which is why the percentage of unemployed people have a high trend.

Keywords: Population Change; Planning; Statistics; Population Structure; Ardabil city

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INTRODUCTION

In recent years, an unprecedented population growth of the world was reported. Total world population is now reached to more than 6.5 milliards, which are increasingly focused in high-density conurbations. In 1950, only 30% of the world's population was living in urbane regions, but today this number is increased to 50% and it is estimated that until 2030 more than 60% of world population is considered as urbanized. These estimations show that more than predicted growth of world population will be centralized in low income countries (Figure 1) (Tatem and Hay, 2004).

Population developments in recent years had deep effect on economic, social and environmental structures of societies. Population increase, in one's turn, strengthens the needs, which by passing of time and evolution of human's life, also the quantity and quality of needs change, and these changes increase pressure on resources and facilities. On one hand, population and its growth have become one of challenges and national issues or even international issues and this feature shows more obvious appearance in developing countries than developed countries, thus the process of urbanization and urban-orientation among these countries is considered as an unusual issue, so that, today, it has affected all issues of developing countries (Shokui, 1998). On the other hand, in order to present outcome solution to this crisis, governments pay high costs to study and investigation of different aspects of population changes and its prediction for future. Because in order to perform all kinds of economic, social and cultural planning's, one of the most important and the most determinant elements, is population factor.

In another word, existing and predicted studying and investigation of each region is the basis of authorities' and planners' action of that region for kinds of planning. Hence, in order to provide future needs of the population, planners perform projections based on previous observations. Generally, population predictions are considered basis of every planning activity such as: preparation and codification of transportation plans and land use, determination of future path of economic development and regulation of strategy in order to develop houses, schools, shopping centers and etc. Therefore, studying the state of these developments and change processes especially urbane population can be a background to remove urbane society needs and estimation of required equipment (Fried, 1992).

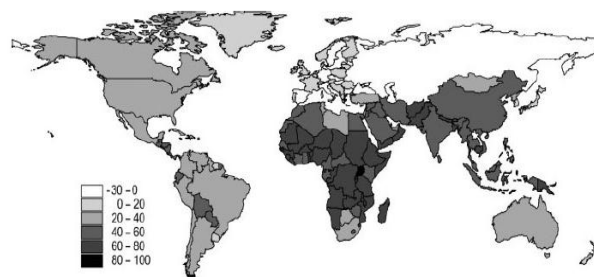


Figure 1: The percentage of predicted increase of population in world's urbane regions (2000-2030)(source: Tatem and Hay, 2004)

In this direction, the present research is mapped with aim of representing clear picture of the appearance of population developments of Ardabil in order to desired planning. In this article, it is attempted to focus on research method by using common methods of

population analysis and their prediction in this city so we can represent status quo of Ardabil city population and its characteristics by investigating population development process of the city from 1976 to 2011 and then we can predict and evaluate future process of city population (until 2021) by utilizing well-known and common used models of demographics.

MATERIAL AND METHODS

The present research method is of quantitative analytic and descriptive methods. In this research, first the results of all general census related to the city are extracted and categorized and then if necessary they are represented as tables, diagrams and various figures, and finally they are analyzed by using formulas and population models. In order to draw kinds of maps, ArcGis software and to provide and draw diagrams and tables related, Excel software and in order to analyze features and processes, population analysis and in order to population predictions until 2021 two models, linear population model and geometric population model, are used.

Based on this population studies were performed which are in three steps, as follow: (A) studying and recognizing the processes and past trends of the population, (B) recognition of population in status quo from sex and age combination point of view, (C) prediction of population raise in the future (Pour-Mohammadi, 1989).

Studying area

Ardabil city is the capital of Ardabil province in north-east Azarbaijan and 38° north latitude and 48° and 2 minutes east longitude. This city is placed in west south of Caspian sea and between two mountains of "Sabalan and Baghro" and its height from sea is 1263 meters (Figure 2) (municipal website of Ardabil: www.eardabil.ir). Based on some historical reports, appellation of Ardabil is derived from two Avesta words "Arta" and "Ville" meaning "sacred city". Also, historians attribute the structure of the city to SasanianPhyruz. In all historical periods, Ardabil has continued to its evolution and growth like other important cities of Iran. But maybe the most important level in changes in development and growth of the city is related to contemporary times, so that today the total area of the city in its range is more than 6500 hectares. The population of this city in 2011 was about 485153 persons and the density of the city was 74 persons in a hectare and among Iran's cities it has the 17 urban ranking in urbanization population point of view. Now, this city has more than 35 districts and 3 urban areas (statistical calendar of Ardabil province, 130 and 1287, Statistical Center of Iran).

Generally topography or land non-smoothness in Ardabil city has two main types of plain lands and mountainous farmlands and by keeping distance toward around, the height particularly in west south regions of this city increases (a scope that Sabalan Mountains are placed). Generally the city and around of it are located on plain's sediments and young alluvial terraces and alluvial fans (design and plan consultant engineers, 1989). Amongst the most important river areas of this

city we can mention Balighlochai that has divided the city into two parts.

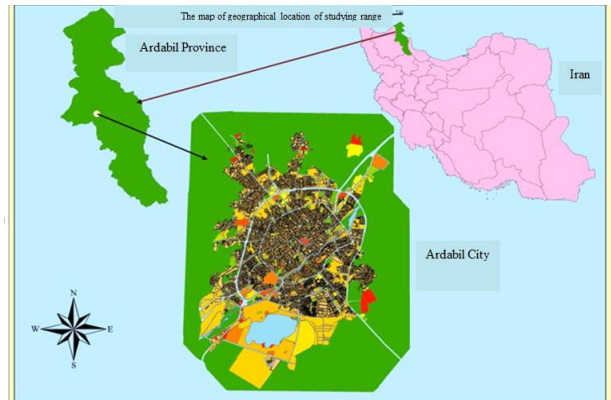


Figure 2. Geographical location of Ardabil City

The process of Ardabil's population in various statistical decades

In most of population studies and social planning that somehow relates to the population, the number of population is particularly important. Since that the recognition of numeral changes of population is performed better in longitude and as the time is longer, the differences of numeral changes of population becomes more important and valuable (Zanjani, 1999). If we overlook the fluctuations of Ardabil population from Safavie extinction to early 1300 of solar year, population growth rate of this city is significant after solar year of 1300 (1921 A.D). So that this city experience a growth equal to 2.4 percent from 1956 to 1966 that in the next decade the rate reaches to 5.7 and in 1989 it reaches to its peak means 6.23. But in years between 1986 to 2006, because of population decrease policies this process is decrease to 5 percent and finally in 2011 the mentioned rate reaches to 2.5 with a little increase (Table 1 and Figure 3).

During 50s and 70s the percentage of urbanized population of Ardabil was static. But after 1991s, because of increasing population share of other cities of the province, the percentage of urbanization of Ardabil city is decreased and descends to 38% in 2011 (Table 2).

Table 1. The population of Ardabil city in various statistical years and their growth rate

Year	1956	1966	1976	1986	1996	2006	2011
Population	65742	83596	147865	281973	340386	418262	485153
Growth rate	-	2.4	5.7	6.2	1.9	1.9	2.5

(Source: Statistical Center of Iran)

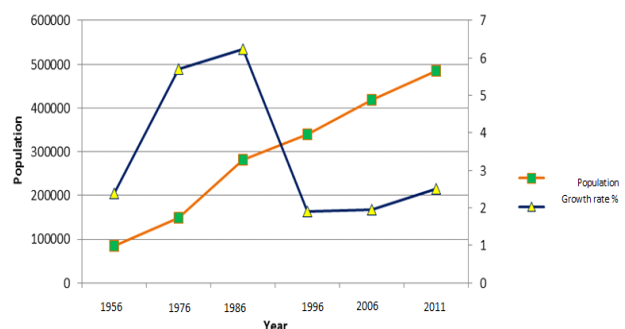


Figure 3.

Table 2: The percentage of urbanized population of Ardabil to total population of urbanized province

Year	1956	1966	1976	1986	1996	2006	2011
The population of total province	95208	127875	218119	440030	577231	715597	1248488
The population of Ardabil city	65742	83596	147865	281973	340386	418262	485153
The percentage of urbanized population of Ardabil to the total population	69%	65%	67%	64%	58%	51%	%38

Source: 1- Statistical Center of Iran, 2- statistical calendars of Ardabil Province, 2011-2011

Table 3: Comparison of sex ratios of Ardabil city with the entire country 1345-1390 (resource: Statistical Center of Iran)

Year	1956	1966	1976	1986	1996	2006	2011
Ardabil	103.3	109.7	111.1	108.3	105.3	106.2	103.3
Entire country	102	107.3	106.1	105	103.3	103.5	102

Main age groups	1956	1966	1976	1986	1996	2006	2011
0-14	41.6	47.9	47.4	46.3	46.3	28.9	23
15-64	52.8	47.9	49.3	51.2	51.2	69	72
+65	3.6	4.2	3.2	2.5	2.5	2	5

Gender and age combination of Ardabil city population

- Sex combination of the population

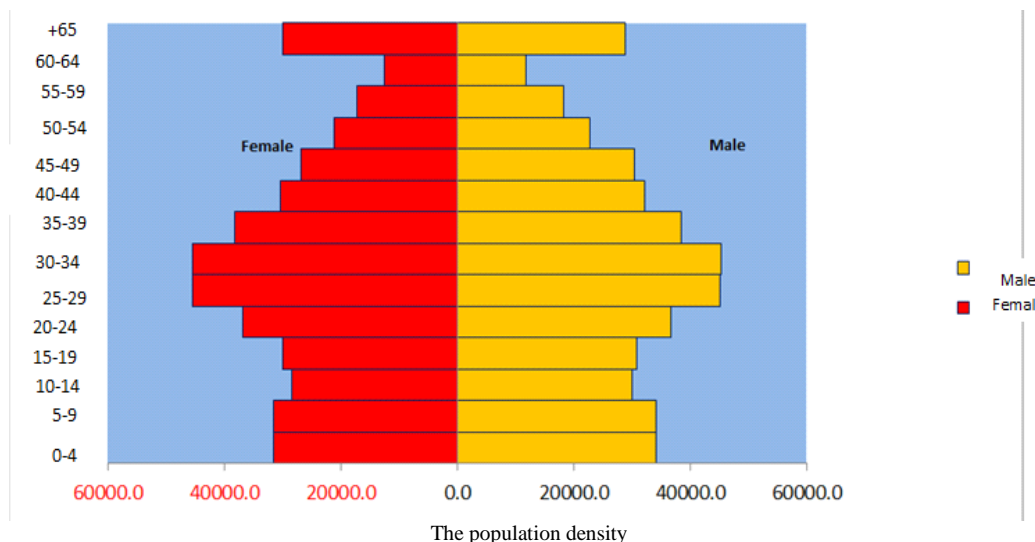
As we know, population structure is composed of two sexes; male and female and the literature of demographics says the male to female ratio as sex ratio. Like growth rate of Ardabil population, also sex rate of this city was fluctuating in various decades. So that sex ratio of the city in 1966 was equal to 109.7 that during ups and downs this number in 2011 has reached to 103.3. According to table 3, first sex ratio of studying scope to the total regions of statistic is more than its natural number meaning 105 male per 100 female, due to some reasons, second these numbers show that this rate in Ardabil continuously during various statistics was more than its number in entire country. As a result of these elements the natural parallel between these two sexes is destructed by male interest and caused the increase sex ratio.

- Age combination of the population

As Table 4 illustrates, Ardabil city is experiencing population transient and age structure is relatively young but it is transferring. Comparison of population distribution in main age groups in 1986 and 2011 clearly

reveals that in various statistical years under 15 year old share of the population is decreased and is added to other main age groups. Therefore, this population is toward senescence that this does not have a factor except governmental policy effect in family planning and the decrease of family population in recent decades. As a result, this issue attracts urban planners to the needs of these ages.

One of the most important demographic features of a population is its age-sex structure which effect on needs of a society and also on its work force. Therefore it is associated with important political meanings (Warf, 2006). Usually, the age-sex structure of a region is expressed and summarized through age pyramid. Therefore in order to summarize age-sex structure of Ardabil, this pyramid is used. By viewing age pyramid of Ardabil city (Figure 4) it is suddenly occurs to the mind that because of government population policies and promotion of person's awareness level and the decrease of bearings in previous decades, principle of this pyramid has become smaller than previous decades and in turn the width of the middle of the pyramid is increased. It means that the population of this city is toward middle age.

**Figure 4:** Age pyramid of Ardabil city population in 2011

- The population density in Ardabil city

One of other indexes of demographics is the study of population density in the city. Population density consists of population ratio to the region area (Razavian, 2002) and or:

$$Dr = \frac{P}{S}$$

According to the performed calculations, population density of Ardabil City had ascending process in recent decades, so that population density in 1996 and 1385 was increased 52 and 65 persons per hectare, respectively (Statistical calendar of Ardabil province, 2006 and 1999).

- Population density in population regions in triple areas of Ardabil city

Now, Ardabil city is divided into 3 urbane regions and 7 big districts with its sub-districts and 227 population area and more than 5 thousands population blocks from physical divisions point of view (figure 5).

Generally, population density of the city is in high level and also every year population density is increased. In order to illustrate population in triple areas, by consideration of population statistic in each urban block, population density of the city during 1996 and 2006 in each of urban regions is illustrated as figure 6.

As it is obvious in population density maps of Ardabil city in 1996 and 2006, the most population density in each decade of those regions is region 2 of Ardabil. Especially population density increases by progression to city center and the least population density relates to districts in region 1 of Ardabil. Another point about population density in Ardabil city is that in recent decades constructed towns in south of the city have accepted high population density, despite remoteness from city center. Because these towns (Sabalan, Karshenasan towns, etc.) are located in region 2, so the scale of population density balance in city regions is heavier region 2.

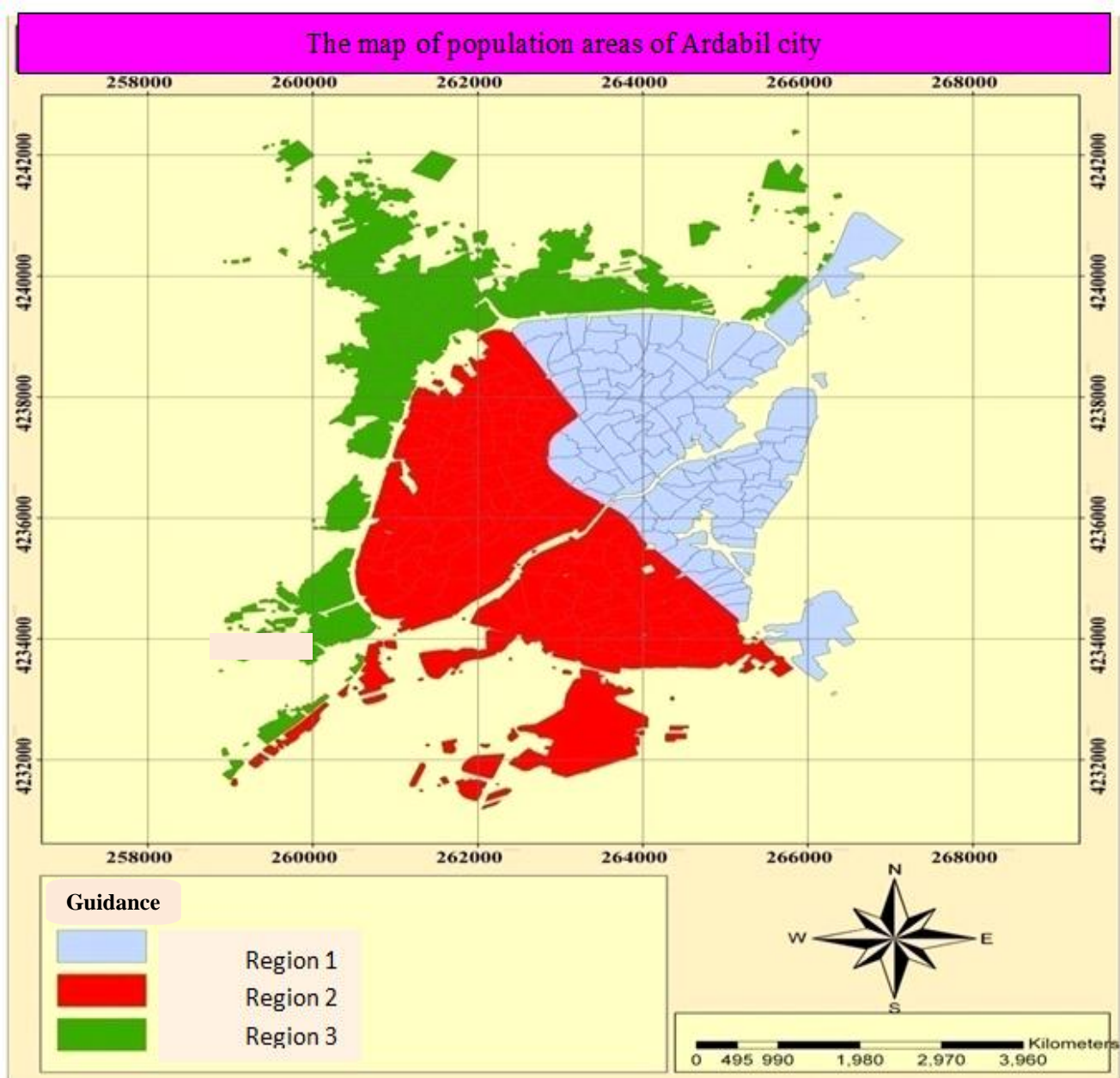


Figure 5: The map of triple Areas, Blocks and population regions of Ardabil city

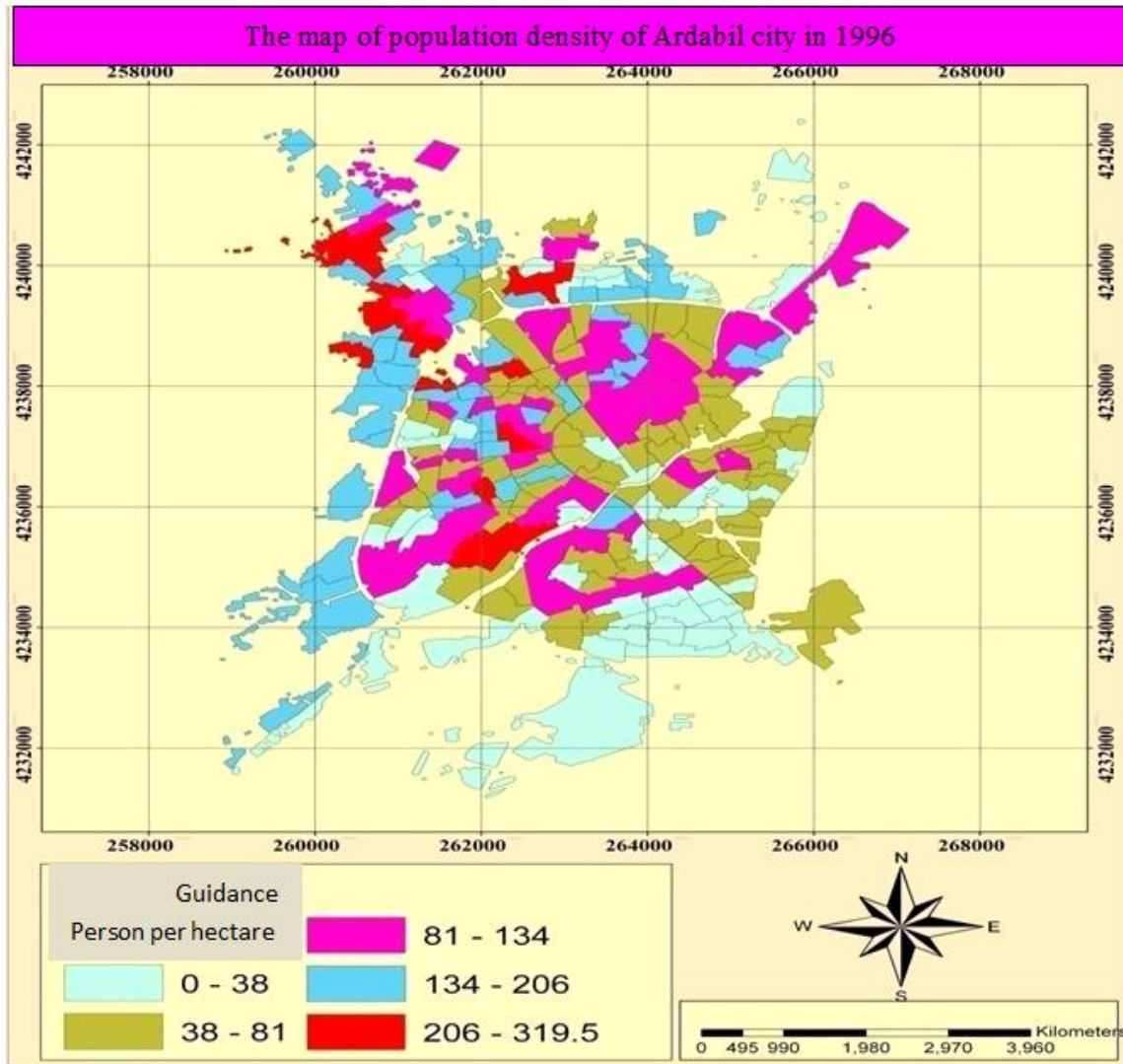


Figure 6: The map of population density of Ardabil city in 1996

Literacy level of the population

As figure 7 reveals, of total population of Ardabil in 1390, totally 47% of males and 43% of females are literate and 3.05% of males and 6.95% of females are illiterate. Totally we can say that more than 90% of the population is literate and male education condition is better than females in this city. Maybe this condition can be attributed to traditional beliefs of families in the city based on non-education of girls or their education until an especial age. However, surly by passing the time and changing of people attitudes to girls' education this ratio will be changed.

Population employment condition

Economic elements compose the main background of emerging and development of population unites. In theoretical surveys, the importance of economic elements and the necessity of performing urban studies and its link to other categories of urban development have been accepted, undoubtedly. The aim of performing economic studies is to recognize structure and the present abilities and potentials of urbane economy, investigation of the effect of this structure on physical formation of the city in the past and future, providence of economic-social situation and finally determination of the way of effect of economic

transformations on the physical formation and development of the city (Rafiee, 1988).

Therefore based on the last country census, Ardabil population in 2011 was about 485153 persons that from this number, 29.94% composes active population and 88.90% are employed and 11.9% are unemployed (The final results of comparative census of population and housing of Ardabil province, 2011). It is predicted that from 513452 persons of Ardabil city population in 2016, about 205380 persons equal to 39.9% compose the active population that of this number, about 80% meaning 164304 persons are employed and the remained 2% meaning 41076 persons are unemployed.

Based on existing statistics, totally 166981 employed persons are working in Ardabil city that of this number 29.46% are in agricultural segment, 25.22% in mining and industry and 44.32% in services (Figure 8) (Statistical Calendar of Ardabil province. 2001).

Of total 166981 employed persons in Ardabil city, 100188 persons equal to 60% are employed in Ardabil that of this numbers more than 60% are employed in city service segment and 15% employed belongs to mining and industry segment and 25% are agricultural employed persons (Figure 9).

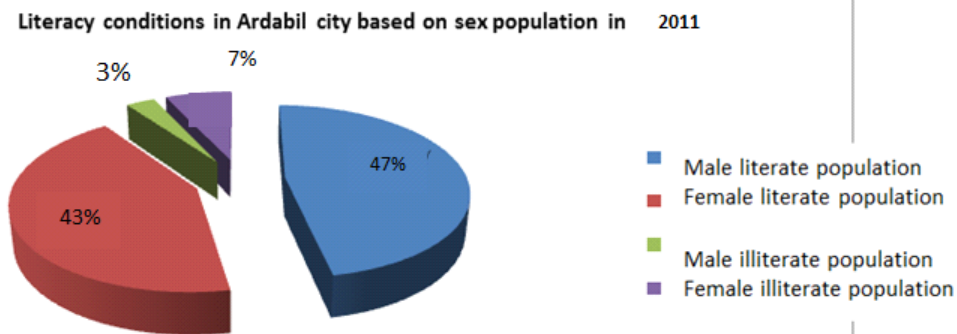


Figure 7. Education condition among Ardabil population

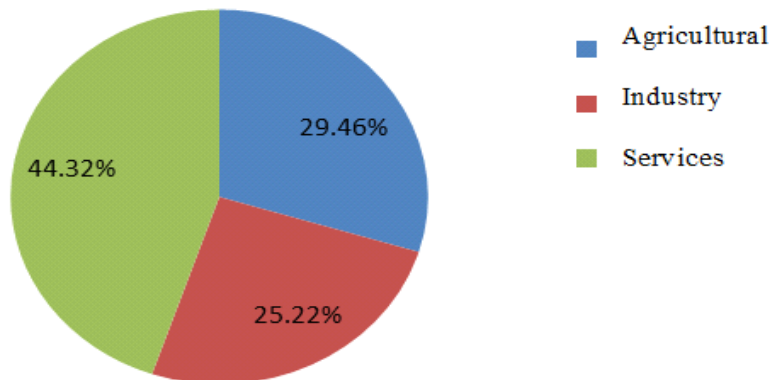


Figure 8. Distribution of employed population of Ardabil province in three segments of economic activities

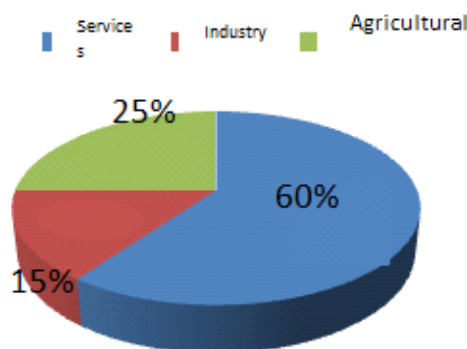


Figure 9. Employed population distribution of Ardabil city in three segments of economic activities

Critical Quadruple events or effective elements on population growth of Ardabil city

- The process of fertility development in Ardabil city

Ardabil province is in high fertility level due to its own especial social and cultural conditions. Planning data have estimated the measurement of population growth of general rate of country's births in 1973-1976 equal to 418 thousands. This number is estimated 42 thousands after modification and weighting in Ardabil. Stopping family planning after Islamic revolution was associated with fertility increase. This regulation was true in Ardabil too. The estimations reveal that in 1986 the birth rate in Ardabil city was 34 thousand that is natural in fertility. We should notice that probably fertility in Ardabil in early years of 80s was more than 1981. From 1981 to 1986 decrease of fertility process was low in entire country and this city. From raw data in 1986 the fertility rate of urban females of Ardabil

province was 4.24 and they had total fertility of 3.03. Based on census data in 1991, females' fertility of this province was 4.12 and the fertility was calculated 3.02 and for the year 2006 the fertility of females of Ardabil city was calculated 3.01 and for the year 2011 this number reaches to 3.15 (design and plan consultant engineers, 1989).

- The process of death level and life expectancy in Ardabil city

Based on statistics of 1996, the death of zero year old females in Ardabil in 1996 was about 39.2 per thousands, the death of 0-4 year old females was 25 per thousand and life expectancy of females in birth was equal 67.9. Corresponding numbers for 2006 was 42.8 per thousand, 13 per thousand and 72.5 years, respectively. Statistics reveal that the death of zero year old males in in 1996 was about 44.9 per thousands, the death of 0-4 year old males was 27 per thousand and life expectancy of males was equal 65.4. Table of lifetime in

1385 shows the numbers corresponding to above numbers as follow: death of zero year olds 30.9 per thousand, death under 5 year olds is 18.5 per thousand and life expectancy is about 68.5 years, these numbers for 1390 are 272.2 per thousand, 14.3 per thousands and life expectancy is about 70 years, respectively.

By comparing death rate of Ardabil city with other cities of the country we can conclude that Ardabil is in desired level from health developments but this point should be noted that it still is far away from global standards.

- Developments of emigration in Ardabil city

Migration is an important population element which is effective of population weight of regions and influence employment areas, marriage and age situations of the regions. Based on country census of emigrants who migrated in provinces of the country from 2006 to 1996 is estimated equal to 404744 that the most numbers of emigrations are related to Tehran, East Azarbaijan and the least numbers are related to Yazd and South Khorasan, and the provinces that had the most emigrants were: Tehran, Yazd and Qom. An interesting point is that the provinces that send the most emigrants are: Kermanshah (first ranking) and Ardabil (second ranking). We can say that one of the reasons that Ardabil sends emigrants is because of lack of industry installations and hence employment rate is low among youth especially educated people in this province. Therefore one of durable development basis has undesired condition that must be paid attention by economic planners in the province and country.

Based on census of 1996 totally 42007 persons were entered to Ardabil city from other points of the country and other points of the province, in this time totally 59 persons who was born in foreign countries entered the city (design and plan consultant engineers, 1989).

- Recorded marriages in Ardabil city

One of other studied population indexes in critical quadruple situations are recorded marriages. Based on existing numbers in table 5 the share of Ardabil province of recorded marriages of 1986 to 2009 are 7909, 10123, 16120 and 18615 recorded marriages, respectively that of these recorded marriages in the province, the share of Ardabil city is 4315, 6783, 9060 and 1035 marriage, respectively. As we can see the rate of recorded marriages in Ardabil city in various decades finds an ascending process that allocated to itself a half of recorded marriages in comparison to the entire province.

Table 5. The comparison of recorded marriages in Ardabil city with the province and the entire country 1986-2009

Year	1986	1996	2006	2009
Entire country	340342	479263	778291	890208
Ardabil province	7609	10123	16120	18615
Ardabil city	4315	6782	9060	1035

Source: The Registry Office Ardebil, Informatics Center

Prediction of population of Ardabil city

Planning for future needs is somehow requiring performing predictions based on past observations. Generally, population predictions are basis of many planning activities such as land planning and transportation planning, determination in order to future economic development and providing strategies in order to building shopping centers, schools and housing. Predictions and population estimations often are central part of comprehensive plans and future perspectives of the locations.

In scientific literature of demographics there are various models in order to people prediction that the most important models are linear population model, logistic model, prabolistic population model. With this introduction and according to existing population statistics from Ardabil city, we will use two linear and geometric models to predict and compare Ardabil city population for all future decade (until 2021).

First Scenario: Prediction of Ardabil city population by using linear model

Linear model of population is used widely due to its being understandable and calculation ease. The general form of this equation is as follow:

$$Pop_n = a + T_n \cdot \beta$$

Where

Pop_n = estimated population in the known year n

a = coordinate ax of linear regression model

β = the coefficient of linear regression model

T_n = index number for year n

The main hypothesis of this model is based on being direct linear, meaning population growth follows a linear pattern, which means that the population will grow with similar people in each consecutive year which is expressed with gradient (same resource). In order to predict the population of Ardabil City with abovementioned formula, first we obtain gradient coefficient and the coordinate ax related number. Hence we organize table of calculation of linear process of predicting Ardabil city population for years of 1996 to 2011 (Table 6).

In order to control the accuracy of performed calculations, as we can see in the following table, total deviations of averages should be zero. Now we put the obtained values of the above table in the following formula of gradient and coordinate ax of our model:

$$\hat{\beta} = \frac{\sum(Pop - \overline{Pop}) \cdot (T - \overline{T})}{\sum(T - \overline{T})^2} = \frac{\sum P \cdot t}{\sum t^2}$$

$$\hat{\beta} = \frac{1067750}{110} = 9707$$

Gradient Coefficient

$$\hat{a} = \overline{Pop} - \hat{\beta} \cdot \overline{T}$$

Coordinate ax of regression line

$$\hat{a} = 422427 - (9707 \times 6) = 364185$$

Table 6. Calculations related to linear process of Ardabil city population

t^2	Vector multiplied p.t	The deviation of index numbers t	Deviation of main values of population P	Observed population (PoP)	Index numbers (T)	Corresponding years
25	215515	5-	43103-	379324	1	2010
16	141264	4-	35316-	387111	2	2002
9	82584	3-	27528-	394899	3	2003
4	39428	-2	19741-	402686	4	2004
1	11953	-1	11953-	410474	5	2005
0	0	0	-4165	418262	6	2006
1	3622	1	3622	426049	7	2007
4	22888	2	11444	433871	8	2008
9	57594	3	19198	441625	9	2009
16	179272	4	44818	467245	10	2010
25	313630	5	62726	485153	11	2011
$\Sigma=110$	$\Sigma=1067750$	$\Sigma=0$	$\Sigma=0$	$\Sigma=4646699$	$\Sigma=66$ $\bar{T}=6$	-

As a result by entering the results of obtained parameters in the general formula of linear model of Ardabil population growth, our estimated model becomes as follow:

$$Pop_n = \hat{a} + \hat{\beta} \cdot T$$

$$Pop_n = 364185 + 9707 \cdot T$$

Therefore, by using approximate index values and linear model of estimated population of Ardabil city, the population of Ardabil city for future years is calculated as follow:

$$Pop_{2012} = 364185 + 9707 \times (12) = 480669$$

$$Pop_{2013} = 364185 + 9707 \times (13) = 490376$$

$$Pop_{2014} = 364185 + 9707 \times (14) = 500083$$

$$Pop_{2015} = 364185 + 9707 \times (15) = 509790$$

$$Pop_{2016} = 364185 + 9707 \times (16) = 519497$$

$$Pop_{2017} = 364185 + 9707 \times (17) = 529238$$

$$Pop_{2018} = 364185 + 9707 \times (18) = 538911$$

$$Pop_{2019} = 364185 + 9707 \times (19) = 548618$$

$$Pop_{2020} = 364185 + 9707 \times (20) = 558325$$

$$Pop_{2021} = 364185 + 9707 \times (21) = 568032$$

The diagram of linear model of the population is illustrated through matching a direct line with observed population data, as it is shown in Figure 10, by using linear process of observed population, population predictions of Ardabil city are coincident on this line.

Figure 10: Linear model of predicting of Ardabil population for 13400

Second Scenario, predicting Ardabil city population by using geometric model of population

Geometric model of population needs an extra level to be able to use "least square" criterion to estimate two parameters. This is realized through using logarithm:

$$Pop_n = a \cdot \beta^{Tn}$$

$$\log(Pop_n) = \log(a \cdot \beta^{Tn})$$

$$\log(Pop_n) = \log(a) + \log(\beta) \cdot Tn$$

In order to predict Ardabil city population, like the previous model, organize the calculation table related to geometric curve for Ardabil city population so our two un-known parameters become known (Table 7). The only difference of calculation table of geometric model

with its linear model is that here we have to obtain logarithm values of the observed population too:

Table 7. Calculation related to geometric model of predicting Ardabil city population

Deviation of values' average $\log(p)$	t Index values	Required multiplied $\log(Pop) \log(p) \times t$	t^2	
0.04-	5-	25	0.2	5.57
0.03-	4-	16	0.12	5.58
0.02-	3-	9	0.06	5.59
0.02-	0	4	0	5.60
0.008-	1-	1	0.008	5.61
0.01	0	0	0	5.62
0.01	1	1	0.01	5.62
0.02	2	4	0.04	5.63
0.033	9	9	0.06	5.64
0.05	4	16	0.2	5.66
0.07	5	25	0.35	5.68
$\Sigma=0$		$1.04=\Sigma$	$61.8=\Sigma$	$110=$ $\bar{p} = 5.61$

Now according to the related table coefficients of the geometric model are calculated as follow:

$$\log(\hat{\beta}) = \frac{\Sigma \log(P) \cdot t}{\Sigma t^2} = \frac{1.04}{110} = 0.0094$$

$$\log(\hat{a}) = \log(\bar{Pop}) - \log(\hat{\beta}) \cdot \bar{T}$$

$$= 5.61 - 0.0094 \cdot 6 = 5.56$$

Now by using estimated regression coefficients, we are able to extend the geometric model of Ardabil city population based on observed data as follow:

$$\log(Pop_n) = 5.56 + 0.0094 \cdot T_n$$

We can see that estimated population model for Ardabil city is still logarithmic. However we can use this model in order to predicting population of Ardabil city in future years. Before focusing on population predictions, we should turn estimated population values through antilogarithm, or reverse logarithm performance, to its previous mode. As we can see in the following items the results do not have any meaning for planning goals. However, we use logarithmic base of 10 and then perform the population prediction by obtaining reverse logarithm or antilogarithm. Therefore, Ardabil city population in the form of this model for future years is predicted as follow:

$$\begin{aligned} \log(Pop_{2012}) &= 5.56 + 0.0094 \times 12 = 5.67 \Rightarrow 10^{5.67} = 467735 \\ \log(Pop_{2013}) &= 5.56 + 0.0094 \times 13 = 5.68 \Rightarrow 10^{5.68} = 478630 \\ \log(Pop_{2014}) &= 5.56 + 0.0094 \times 14 = 5.69 \Rightarrow 10^{5.69} = 489778 \\ \log(Pop_{2015}) &= 5.56 + 0.0094 \times 15 = 5.70 \Rightarrow 10^{5.70} = 501188 \\ \log(Pop_{2016}) &= 5.56 + 0.0094 \times 16 = 5.71 \Rightarrow 10^{5.71} = 512861 \\ \log(Pop_{2017}) &= 5.56 + 0.0094 \times 17 = 5.71 \Rightarrow 10^{5.71} = 512861 \\ \log(Pop_{2018}) &= 5.56 + 0.0094 \times 18 = 5.72 \Rightarrow 10^{5.72} = 524807 \\ \log(Pop_{2019}) &= 5.56 + 0.0094 \times 19 = 5.73 \Rightarrow 10^{5.73} = 537032 \\ \log(Pop_{2020}) &= 5.56 + 0.0094 \times 20 = 5.74 \Rightarrow 10^{5.74} = 549541 \\ \log(Pop_{2021}) &= 5.56 + 0.0094 \times 21 = 5.75 \Rightarrow 10^{5.75} = 562341 \end{aligned}$$

Population prediction Geometric models assume decrease and increase of population in a fix growth.

About Ardabil city, according to simplified formula of

$$r = \frac{Pop_{n+1} - Pop_n}{Pop_n}$$

growth rate () this rate is equal to 2.4%.

In order to compare these two scenarios and choosing one of these models, linear curve of these two models is drawn as following diagram (Figure 11). As we can see in linear mode, population growth of the city is direct linear and following a certain pattern which means population growth in various periods is fixed regardless the entire population, while population growth in geometric model does not follow a certain pattern. Hence population increase depends on population size. Therefore geometric model is more appropriate for predicting population of Ardabil city.

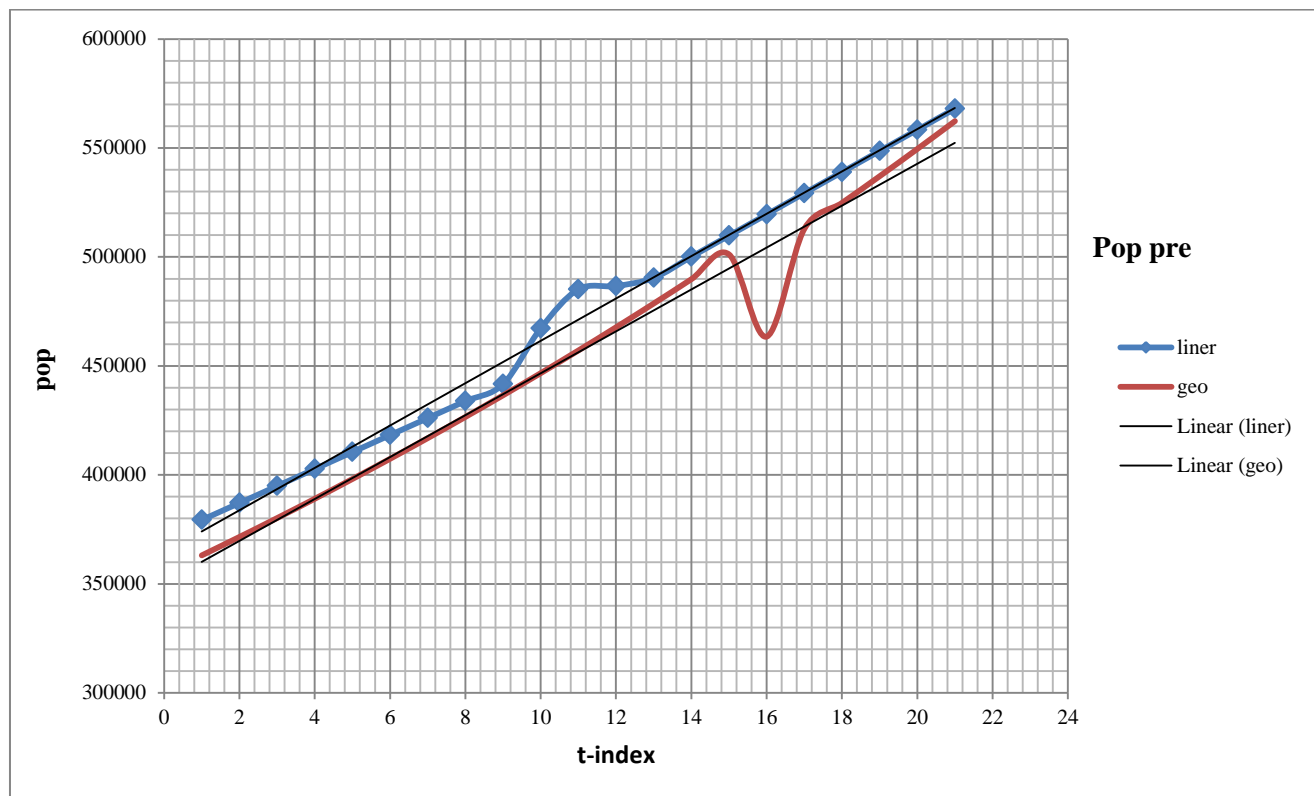


Figure 11: The comparison of the curve of linear model and geometric model of predicting Ardabil city population

CONCLUSION

Generally, studying and recognizing the process of developments of a population and getting familiar with changes and features of that population, help planners and authorities toward providing and evaluation of kinds of economic-social plans. Because these kinds of information are important sources to fairly distribute sources and facilities in a society.

The results of investigations reveal that the process of population growth of Ardabil city had an ascending process like the growth of country's population in 1360s, but in the next periods this increase in growth rate is turned to its natural mode, which this reveals the increase in people awareness and applying population policies from government. Also existing statistics show that more than 50% of total urbanized populations of the province are located in this city and

gradually by the increase of emigrations from around villages and small towns this number will be increased. Also Ardabil city is experiencing population transient and age structure is relatively young but it is transferring. The present process shows the intention to decrease in population under 15 years old and on the other hand shows the intention to middle age, which means the population of the city is toward middle age or even senescence, that because of society needs to active human forces in every field, the needs to new and happy human forces, and because of these the renewal of the society will be needed.

The results of this investigation reveal that because of dense spatial distribution in the city, the scale is heavier in existing districts in region 2. The ratio of literacy in Ardabil shows a desired process. However, the ratio of literacy in males is more than females. Employment process in the city is relatively desired, but

the ratio of employed in industry versus employed people in service segment shows descending process. Ardabil province and city has high fertility levels than the entire country, because of its own especial cultural and social conditions, but on the other hand because of high quality of general health, death levels are lower. Also the results of this research show that unfortunately Ardabil province generally and Ardabil city specifically because of the weakness in industry infrastructures and also ascending process of the population, is considered as the most emigrant sending cities of Iran.

Recommendations

- Providing and running regional plans in harmony with up hand plans, by considering space balance in service and facilities distributions in order to prevent kinds of emigrations, modifying the relationships between Ardabil city and other cities of the province, the reinforcement of economic bases and infrastructures of this city especially in industry segment, protecting regional small and medium towns
- Studying and recognizing the potentials of the region with considering Ardabil city in order to doing mechanisms to invest in various fields of economy, in addition, cultural and social suitable policy of organs and related organizations about increasing the level of female literacy and also decrease of fertility and birth controls.

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