Nexus of Urban Expansion and Socio-Economic Transformation of Bahawalnagar, Pakistan: A Geospatial Perspective

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Abstract

Urban expansion is a serious threat, and many cities worldwide face unorganized expansion issues. This problem is widespread in developing countries, especially in Pakistan and Bahawalnagar, an essential and historical city of south Punjab. The urban area has increased and created so many problems in cities, including food security, loss of agricultural land, the stress on educational and health facilities, economy, housing accessibility and affordability, increase in land prices and also increase in the gap between rich and poor. This research analyses urban expansion through satellite data from 1990, 2000, 2010, and 2020. Supervised classification results show that the urban area increased from 1235 acres to 2717 acres from 1990 to 2020, and the agriculture area decreased with 4446 acres value to 3458 acres from 1990 to 2020. Prediction simulation also shows that the agriculture area will decrease and the built-up area will increase. The impacts are analyzed through questionnaire data. Most respondents agree and strongly agree that the social and economic problems have increased in the last few decades due to the expansion. This study clarifies the scenario and provides the baseline for the sustainable management of the city for present and future needs.

Keywords: Unorganized Expansion, Food Security, Satellite Data, Sustainable Management.

Introduction

Urban expansion is a significant phenomenon in the recent world (Butt et al., 2012; Carpio & Fath, 2011). The statistics show that in Africa and Asia, almost 3 billion people live in urban areas and will reach from 300,000 km2 in 2000 to 1,200,000 km2 in 2050 (Angel et al., 2011). The urban population of South Asia will increase and reach 250 million in 2030 (Anwar et al., 2017). This trend is widespread in developing countries, especially Pakistan (Arshad et al., 2020). This phenomenon affects many cities from social, economic, and environmental points of view (Abubakar & Dano, 2018). Social parameters and the economy are considered the backbone of any society. Land use and land cover change are human-caused changes on the earth's surface (Balk et al., 2018). Due to population growth, the urban areas have become l, directly affecting agricultural land. Agriculture land is one of the soft targets for investors and local property dealers as well (Dewan & Yamaguchi, 2009; Rimal et al., 2017). Land is the most essential resource for human activities (Yesmin et al., 2014). Due to these activities or to fulfil the population's requirements, the system of living other things has changed in the last few decades (Buhaug & Urdal, 2013).

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Urban growth is defined as an increase in the urban population of any town or city, which can be caused by natural expansion or rural-urban migration (Hall et al., 2017; Kojima, 1996). One important factor contributing to urban expansion and the extension of cities in all directions is population, which is expected to reach 9 billion in 2050 (Zhai et al., 2021; Schneider, 2012; Xiao et al., 2006). The population of rural areas considered that in urban areas, the facilities and opportunities are high compared to rural areas, so they migrate to grab these facilities and opportunities for a better future (Li et al., 2018; Miro et al.,1968). The effects of the socioeconomic transformation are scary for low-income families and persons; they cannot afford even the basic amenities for their families (Khan, 2000). Food prices are high in cities, and accessibility and affordability have become a question mark (Cohen, 2006; Houessou et al., 2020). The loss of agriculture creates many problems, including the increase in land prices and the transformation of the agriculture sector to another profession (Beckers et al., 2020; Hall et al., 2017).

Remote sensing is one of the significant tools used in urban studies to detect changes. Technically, assessing large geographical areas is traditionally challenging (Yamamoto, 2014). Landsat satellites are one of the crucial satellites that provide data from 1972 to the present, and researchers can quickly assess how these kinds of land use changes temporally (Schneider, 2012). This research uses data to detect urban expansion in 1990, 2000, 2010, and 2020. Based on these results, the prediction of 2030 and 2040 is generated. Due to the urban expansion, the impacts on socioeconomic conditions and the transformation of the scenario are analyzed with the help of direct questionnaires.

Statement of the Problem
Urban expansion is one of the significant trends in urban areas in the last decades: the abrupt expansion of cities (Aliyu & Amadu, 2017). People from rural areas rapidly migrate to urban areas for better infrastructure, facilities and opportunities (Abubakar & Dano, 2018). Different socioeconomic consequences exist in cities, including food security, loss of agricultural land, housing, economy and education. In Bahawalnagar, the phenomena of urban expansion and their impact are high. Remote sensing or satellite data is the prime and most valuable data for determining the temporal changes in geographical areas. The effects of urban expansion are limitless, and the major one is on the socio-economy. The assessment of the expansion and the consequences are very important for city planning. Through these advanced techniques, the result will be reliable and beneficial for the decision-makers regarding the sustainable management of the town.

Research Objectives
1. To find out the Spatio temporal changes and land conversion of Bahawalnagar city using satellite data
2. To investigate the significant socioeconomic impacts and consequences of urban expansion in Bahawalnagar city

Research Questions
1. How does the land use land cover change occur, and what kind of conversion has been observed in Bahawalnagar City?
2. What are the significant impacts, and how is the urban expansion behind the transformation of the socioeconomic scenario

Material and Methods
In most of the research, urban expansion is detected with the help of satellite data. The results of the satellite data analysis are more accurate and authentic than those of other methods. The selected years for temporal changes are 1990, 2000, 2010 and 2020. The different aspects of this research are related to assessing socioeconomic transformation concerning urban expansion. They are analyzed with the help of questionnaire data acquired directly from the field of different ages and professionals.

Satellite Data
Different types of satellite data are available to detect land use land cover changes, but the Landsat satellite is the most common data used in the research. Landsat satellites provide the data freely to researchers for analysis. Present land use land cover change detection is analyzed with the reference of 1990, 2000, 2010, and 2020 in the Sensors of TM 5 and OLI 8, with the row 039 and path 149, spatial resolution of 30M, cloud cover of 0 % and number of Bands of 7 and 9.

Table 1: Detail of Remotely Sensed Data and its Characteristics

SN	Year	Sensor	Row	Path	Spatial Resolution	Cloud Cover	No of Bands	Date of Acquisition
1	1990	TM 5	39	149	30-m	< 0 %	7	1/11/1990
2	2000	TM 5	39	149	30-m	< 0 %	7	1/23/2000
3	2010	TM 5	39	149	30-m	< 0 %	7	2/3/2010
4	2020	OLI 8	39	149	30-m	< 0 %	9	1/14/2020

Questionnaire Data
The second part of this research is related to the impact of urbanization on socio-economic transformation, which is analyzed with the help of questionnaire data. The parameters of the data collection are related to food security, education; traffic problems housing housing-related issues and are discussed and acquired from the city residents on different perspectives including period and area. A total of 200 Questionnaires were distributed and collected from different sources in person, via Google form and personal interviews from different age groups, and different professionals.

Data Processing and Analysis
Urban expansion is analyzed for the years of 1990, 2000, 2010 and 2020. Satellite data is remote sensing data collected by different satellites. The Landsat satellite data is used in this research. Initially, the data were collected from the website of USGS Earth Exploder and then it classified that data in Erdas imagine software into five classes including water, barren land, built-up, agriculture and fallow land. The future prediction is performed based on previous trends for the years 2030 and 2040 with simulation techniques with the help of ENVI and ARC GIS software. Socioeconomic conditions and transformation data are collected directly from the field and processed in SPSS software after tabulations. The data was collected from the field related to education, housing, economy, food security and other parameters and related to the expansion of the city.

Study Area

Bahawalnagar City is the administrative center of Bahawalnagar District, located approximately 29.9989° North latitude and 73.2536° East longitude. It's located on the eastern side of the river Sutlej. The nearby cities include Bahawalpur, Pakpattan and Vehari, etc. The land of Bahawalnagar city is famous for the production of fine quality agricultural products in Pakistan. The climate of the city is dry and in the winters, the minimum temperature is 2.53 degrees and in the summers the maximum temperature is 51.38 degrees recorded (Govt of Pak, 1998).

**Figure 1: Location Map of Bahawalnagar City, Southern Punjab, Pakistan**
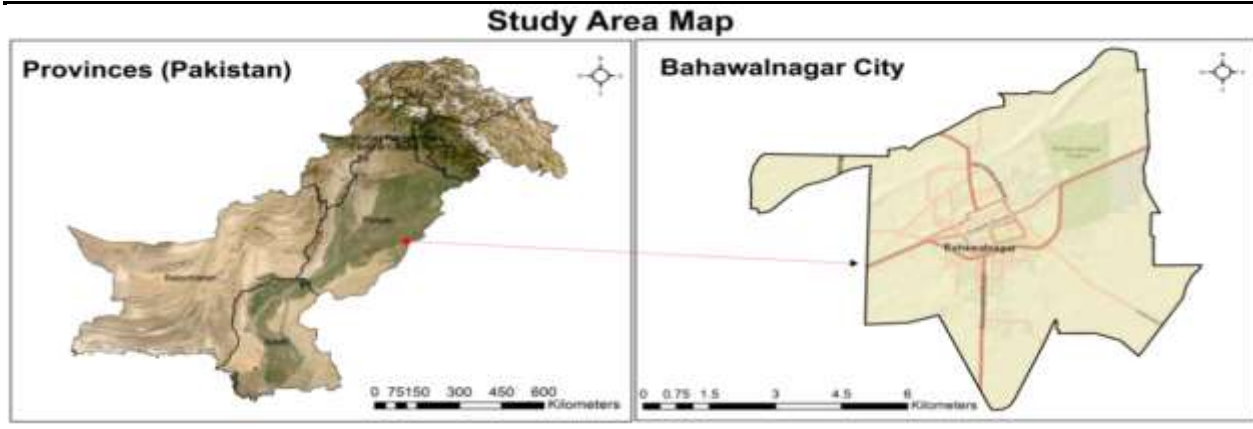
Results and Discussion

Population Growth

Population growth is a natural phenomenon. In the last few decades, the population of the cities is growing rapidly. Urban areas become the centers of populated areas due to this natural growth and rural-to-urban migration. The rate of population growth is very high in developing countries like Pakistan. The rate of growth is very high in Punjab province because of the favorable climate, topography and fertile agricultural lands. Bahawalnagar is one of the major agricultural areas which are highly supported to migrants and city dwellers. As a result, the population of the city has increased in the last 3 to 4 decades. Administratively the city area is divided into two categories including the Bahawalnagar Municipal Corporation and Bahawalnagar Revenue Estates. According to the statistics of the population census and the relevancy of this research three censuses are conducted in the years of 1998, 2017 and 2023.

Figure 2: Population growth in Bahawalnagar City from 1990 to 2023

The results of the figure 02 shows that the population of Bahawalnagar Municipal Corporation was 111313 in 1998, 160883 in 2017 and 163353 in 2023. The population of Bahawalnagar Revenue estates was 32537 in 1998, 52294 in 2017 and 60769 in 2023. The total population of Bahawalnagar City including Bahawalnagar Municipal Corporation and Bahawalnagar Revenue estates was 143850 in 1998, 213177 in 2017 and 224122 in 2023. Discussed population statistics are the official statistics of the Pakistan Bureau of Statistics. The other years including 1990, 2000, 2010 and 2020 are the relevant years regarding the satellite data. The statistics of the population of these years are estimated population based on census data. As we see the population of Bahawalnagar city is increased in these 3 decades. To accommodate this population the urban area is increased.

Urbanization

The phenomenon of urbanization is increasing in developing countries and Pakistan is one of the major in this list. Bahawalnagar city is facing the same scenario as other cities of Pakistan. Although the rate of urban expansion is low as compared to Karachi, Lahore and Multan, but the consequences are the same as these cities. Urbanization is detected with satellite data and the statistics of the results for the years of 1990, 2000, 2010, and 2020 are given below in table 02. The future prediction statistics of the study area for the years of 2030 and 2040 extracted from the previous trends are also incorporated for future planning.

Table 2: Statistics of LULC Transformation and Prediction of Urban Land Use in Bahawalnagar City, 1990-2040

	Area in Acres					
Land Covers	**1990**	**2000**	**2010**	**2020**	**2030**	**2040**
Water	494	1729	1235	1235	494	247
Barren	2223	1235	988	247	247	247
Agriculture	4446	4199	3952	3705	3458	3211
Built up	1235	2223	2470	2717	4940	6175
Fallow land	2964	2223	2964	3705	2470	1729
Total	11609	11609	11609	11609	11609	11609

The result of the statistics shows that the total area of Bahawalnagar city is 11609 Acres. In the year of 1990 the water was 494, barren was 2223, agriculture 4446, built up 1235 and fallow land 2964 acres. In the year of 2000 the water was 1729, barren was 1235, agriculture 4199, built up 2223 and fallow land 2223 Acres. In the year of 2010 the water was 1235, barren was 988, agriculture 3952, built up 2470 and fallow land 2964 acres. In the year of 2020 the water was 1235, barren was 247, agriculture 3705, built up 2717 and fallow land 3705 acres. The prediction data shows that in the year of 2030 the water will reach on 494, barren was 247, agriculture 3458, built up 4940 and fallow land 2470 acres. In the year of 2040, the water will reach on 247, barren was 247, agriculture 3211, built up 6175 and fallow land 1729 acres. Despite these statistics, we can visualize the scenario of LULC with the images in figure 3.

Figure 3: LULC Transformation and Prediction of Urban Land Use in Bahawalnagar City, 1990-2040
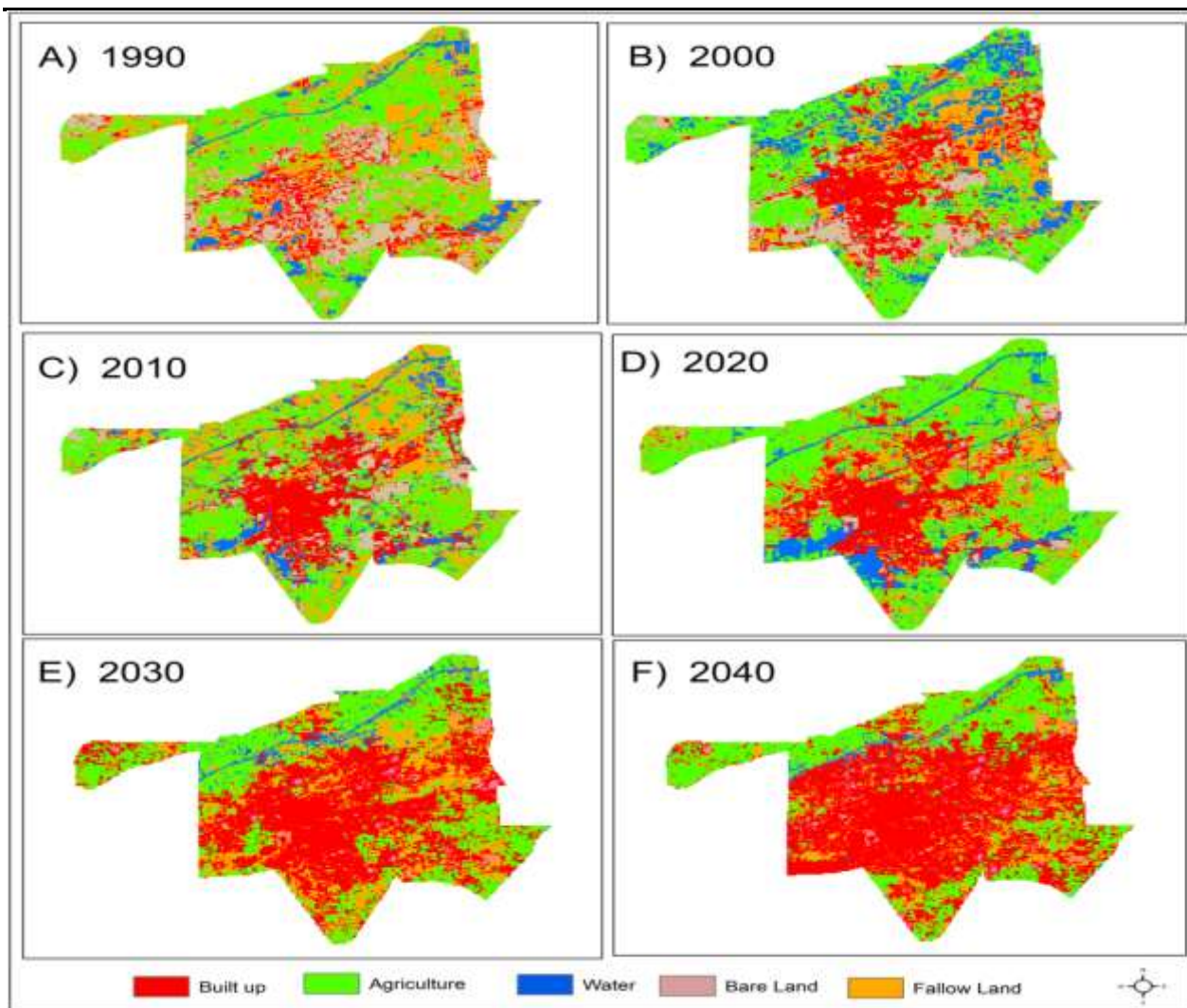
The maps of the supervised classification show that the classification is classified into 5 land covers including Built up, Agriculture, Water, Bare land and Fallow land. The year of the satellite

images is 1990. 2000, 2010 and 2020 as well as the prediction years 2030 and 2040 which show the temporal land use land cover changes in the study area.

Figure 4: Analysis of Urban Land Use and Future Prediction, 1990-2040
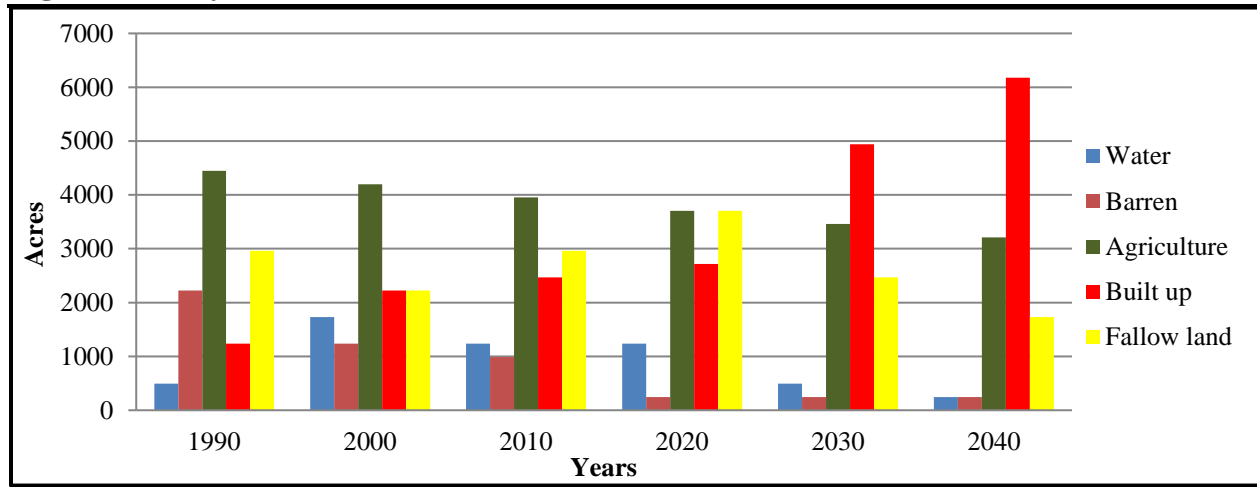
Change in Built Up and Agricultural Area

The two major land covers include a built-up area and the second one is an agricultural area. As we see in figure 5, the built area gradually increased in all years from 1990 to 2020. Increasing the built area depicts that with the passage of time urban expansion has occurred in Bahawalnagar City. As vice versa urban agriculture is decreased in this time period. Residential areas, colonies and commercial areas are constructed on fertile agricultural land and occupied by gray structures. The local people and city residents are experiencing food shortages and severe environmental and health problems. An increase in the built-up area and a decrease in agriculture is negatively affect the socio-economic activities as well.

Figure 5: Change in built up and agriculture area, 1990-2040
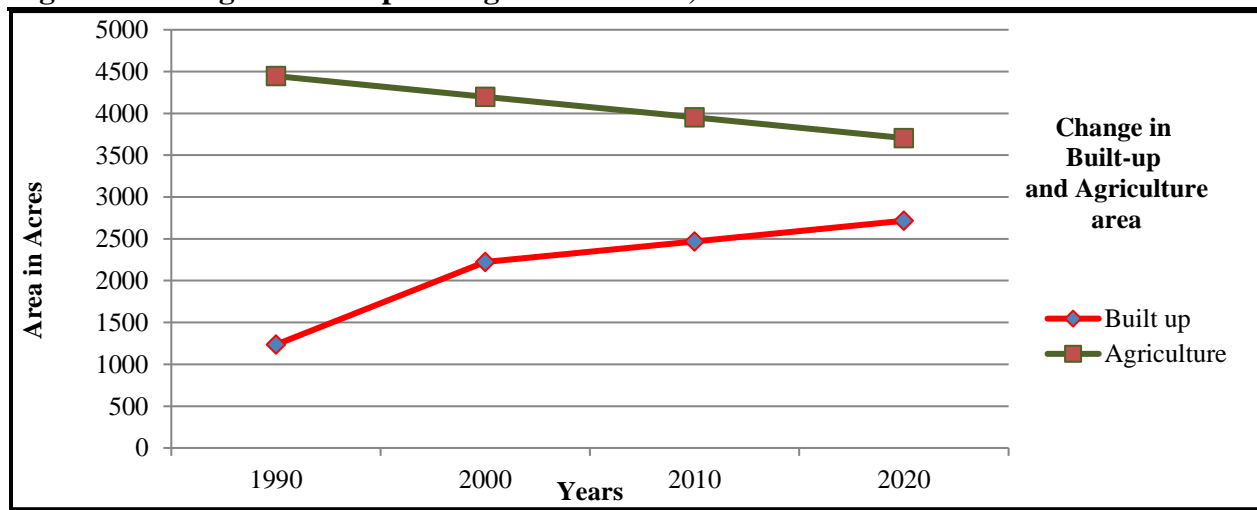
Socio-Economic Transformation

Agriculture and food security are some of the major affectees of urban expansion. Due to the expansion of the cities, the agricultural areas are directly converted into residential colonies and commercial properties. The response of section A depicts that due to the urban expansion, the food prices in the city has increased and 59 % of respondents agree and 31 % strongly agree. The second question is with related to the loss of agricultural land and decrease in food production due to urban expansion and 53 % of respondents are agree and 35 % are strongly agree with this statement. The third question is related to loss of agricultural land due to urban expansion and 57 % of respondents agreed and 21 % strongly agreed.

Housing and the economy are other major stakeholders in the socio-economic scenario. It has been affected by urban expansion in the last few decades all over the world and in Pakistan as well. Housing is going to worse day by day due to inflation and the high prices of properties. The economy is stressed due to high competition and fewer resources as well as. Section B is related to housing and the economy, the question emphasizes on that due to the urban expansion the land values in the city are increased and 43 % of respondents are agree and 33 % are strongly agree on this statement. The second question is related that due to urban expansion, the difference between rich and poor is increased and respondents are 48 % of respondents are agreed and 31 % are strongly agreed. The third question emphasizes on that due to the expansion the land prices in the city are increased and making it more difficult for low-income families to acquire shelter and respondents are 43 % agree and 36 % strongly agree.

Education is a very important part of the socio-economic scenario and the education sector is highly affected sector due to the expansion of the city. The first question is related to whether education is deprived the quality of education due to the expansion and 34 % agree and 45 % strongly agree. Another question is related to facilities and infrastructure compromise due to the expansion and 39 % agree and 40 % strongly agree. The last question is depicts that due to urban expansion, education for low-income families becomes difficult and 54 % agree and 34 % of respondents are strongly agree. The Medical and health facilities also disturbed the questions due to urban expansion, the pressure on existing infrastructure, qualities and standards are disturbed and the respondents of questions 39, 46, 41 % agree and 45, 33, 42 % strongly agree respectively.

Figure 6: Respondent's response regarding the socio economic transformation
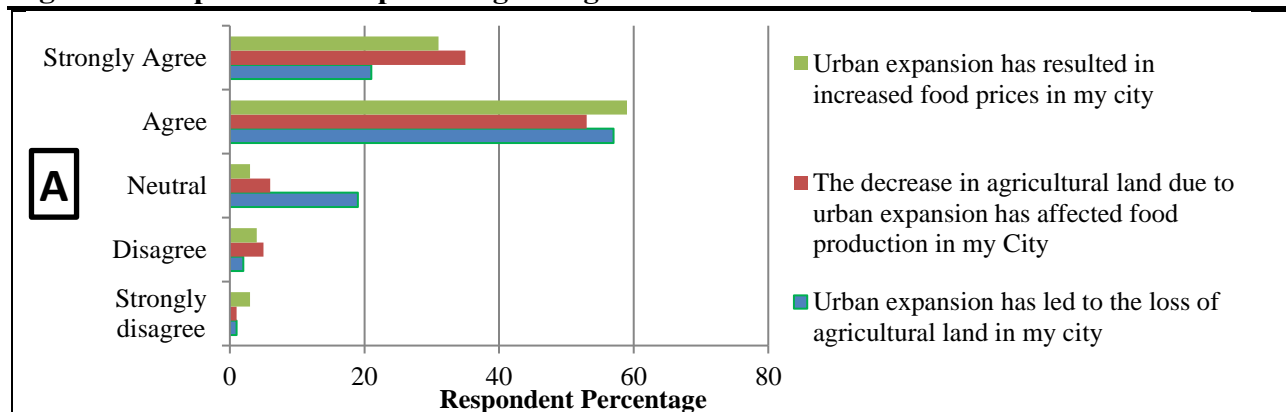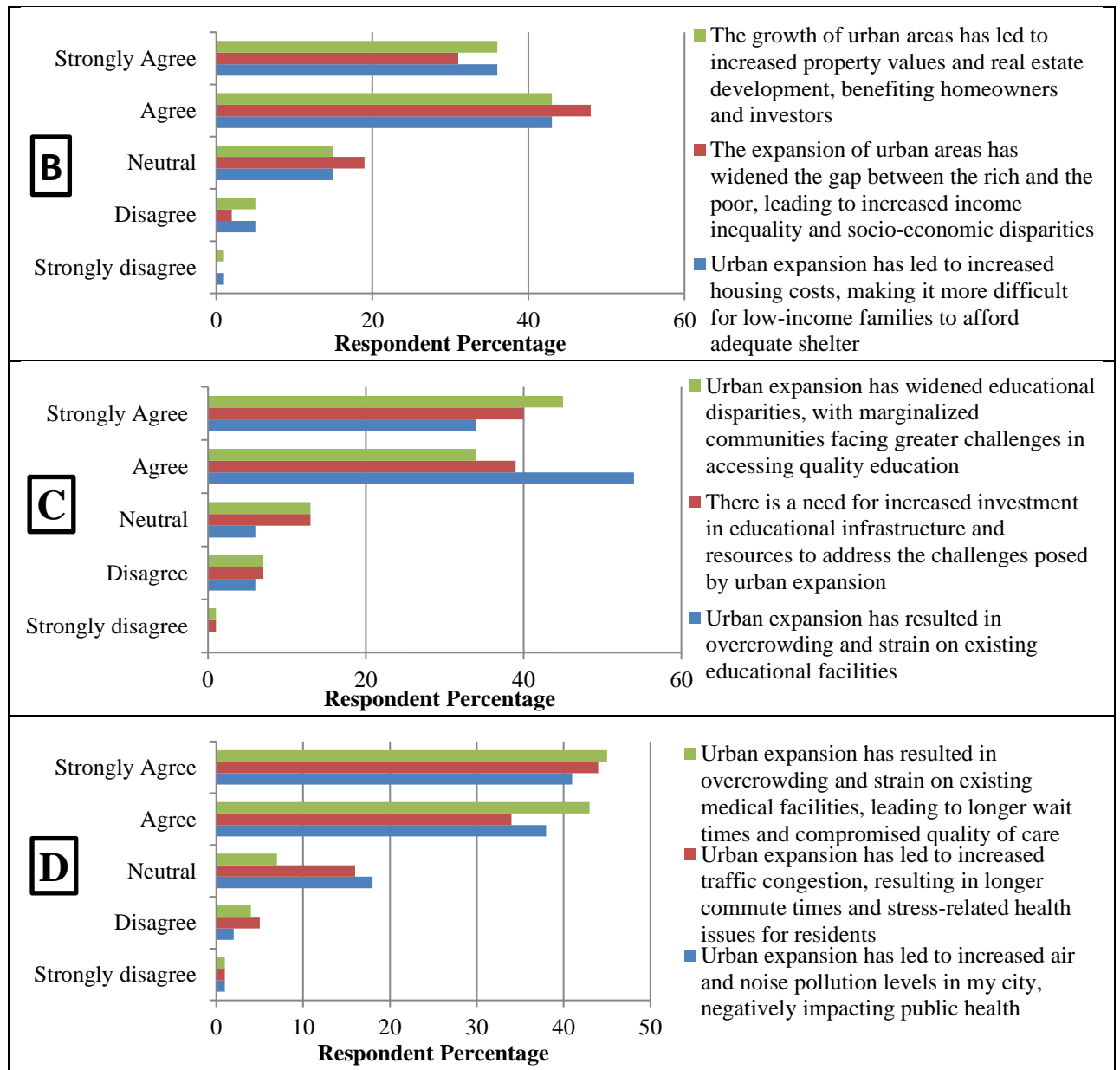
Management of the issues through public perception and public participation is one of the major techniques to solve the issues. Public involvement can fix the issues properly because they are facing these issues directly and know the ground realities. The question-related management like sustainable urban planning and management, the consequences regarding food security and loss of agricultural land which is very important can be solved and the percentages of respondents of 46 % agree and 33 % strongly agreed on that. Better government policies can solve socio-economic issues and 41 % agree and 42 % strongly agreed. The third question related to management is that policies related to education despite the conflict of financial status can elevate the education of the people and 39 % agree and 45 % strongly agreed on that. The fourth question is related with the increase in health infrastructure to facilitate the growing population is one the major solutions for the health sector and 42 % agree and 46 % strongly agreed on that.

Figure 7: Respondent's response regarding the management of socio economic transformation
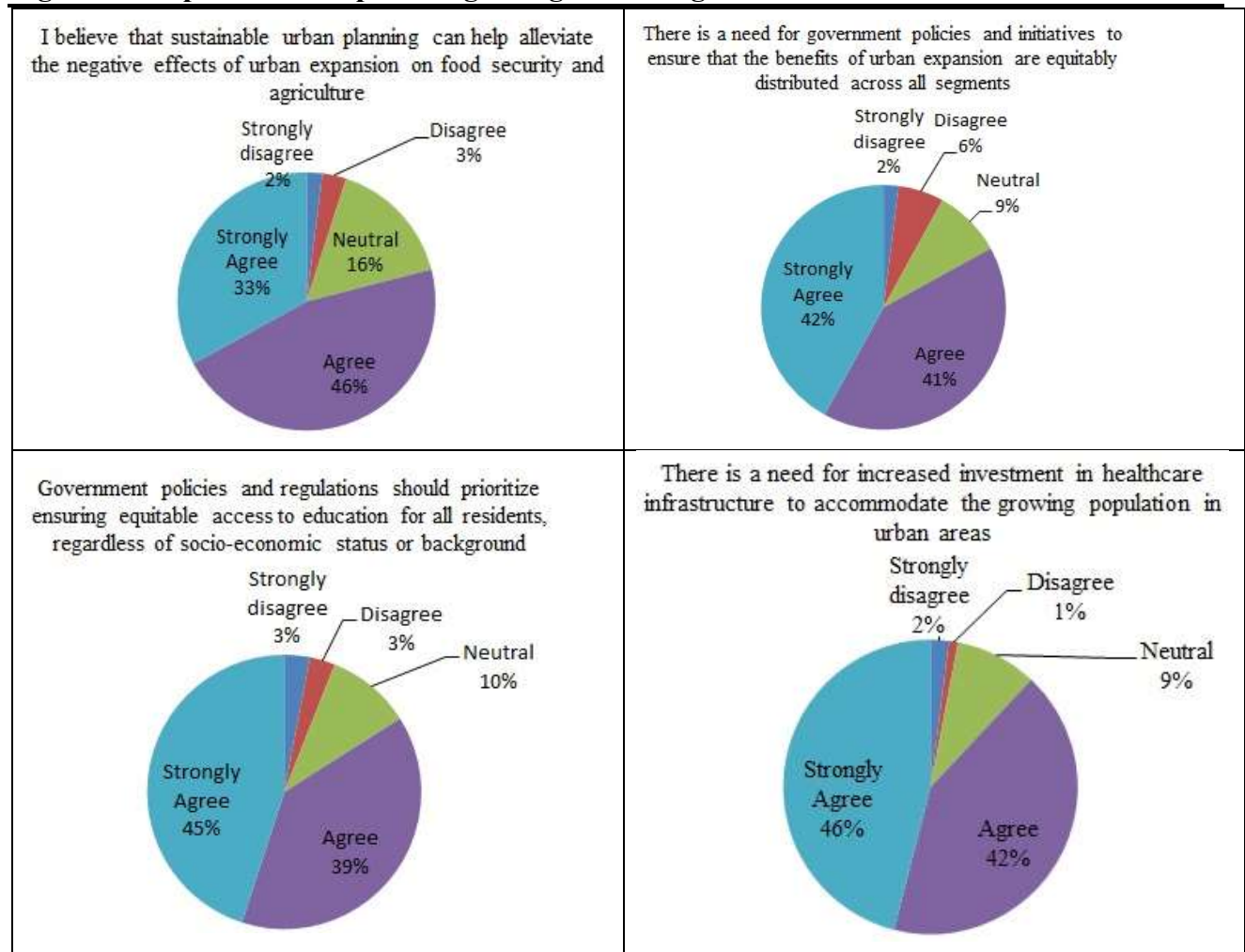
Discussion

Urban areas are considered the centers of economic development and a sign of prosperity all over the world. The people of urban areas are associated with secondary and upward economic activities like industries, services and high official jobs, which are considered valuable as compared to primary economic activities like agriculture, mining and lumberjack etc. As a result, the people of the rural areas migrate from rural to urban areas for acquire these opportunities and facilities. Population growth in cities is one of the other important factors of urban expansion especially in Pakistan. The pressure on urban areas is increased due to rural-to-urban migration and population growth. With the passage of time, the pressure on cities increased and created so many environmental issues, groundwater pollution, and overall air quality of the city, environmental oriented diseases, and green infrastructure of the city as well as the socio-economic transformation. The objective of the research is to find out the temporal changes in Bahawalnagar city and the impacts of the urban expansion on the socio-economic conditions of the residents of Bahawalnaga city. The results of the urban expansion acquired from temporal satellite data show that the total area of Bahawalnagar city is 11609 Acres and the built area was 1235 Acres in 1990, its increased and reached on 2223 acres in 2000, again its increased and reached on 2470 Acers in 2010 and

reached on 2717 after increasing in 2020. The future prediction of 2030 and 2040 results shows that in the future the built-up area will reach on 4940 acers and 6175 acers. The results of the Questionnaire data after the analysis in statistical package for social sciences shows that the socio-economic transformation has occurred because of urban expansion, the agriculture area decreased and the issues of food security are increased, poverty increased and housing became tough for low-income people, the pressure medical and educational infrastructure increased and the quality of education and health compromised in last few decades. Like other cities, in Bahawalnagar urban expansion increased in the last few decades and the scenario of socio-economic activities changed due to this expansion. Education, health, economy, housing, food security and agriculture-related activities are changed and transformed. The survey results show that due to urban expansion, the pressures on these activities are increased and life become tough for low-income families.

Conclusion

Population growth and rural to urban migration become the major causes of urban expansion in the cities of developing countries. Urban growth rate is very high in cities of Pakistan especially Karachi, Lahore, Faisalabad and Multan. Opportunities and facilities attract the people to migrate and settle down in urban areas to get these opportunities and facilities. In the result the cities are not accommodate this population and gape between the population and resources increased with the passage of time. This gape become disaster in cities now a days and the condition of the cities become worse day by day. In terms of population and size the medium city Bahawalnagar is one of them. Due to the population growth and rural to urban migration, the area of Bahawalnagar city is increased 1482 acers in just 30 years and prediction analysis shows that in coming 20 years, more 3458 acers will be a urban. At the same time the agriculture area decreasing due to increase of built up area. Agriculture area is a soft target for developers and property dealers. The issues of fresh agricultural products, their accessibility and affordability as well as the issues of food security will increase. Due this drastic expansion, the quality of education and health is disturbed because of the lack of infrastructure and facilities. The infrastructure is not serving properly to this population. The land prices are increasing and housing becomes a dream for a middle class. The social system is going to worse day by day due to the haphazardness. These issues are very serious and need to be address otherwise the gap between the poor and rich will increase in the future. Sustainable development is a very important to solve these issues. These issues can overcome with wise and sustainable decisions. Urban expansion should be controlled with proper planning and settle down this population in some certain protocols which should not be against the community and environment as well. The basic amenities should be the responsibility of the government at any cost. Education and health should be better with proper planning and statistics. Authorities should be vigilant and the prices land should be an under control for the betterment of middle class families. These are some suggestions, which can be beneficial for the policy makers and decision makers to make the city beneficial and affordable.

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