

URBAN DEVELOPMENT AND SUSTAINABILITY MILIEU: A CASE STUDY OF FAISALABAD CITY, PAKISTAN

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ABSTRACT: This research aimed to analyze the spatiotemporal changes in urban development pattern and to discuss the spatial urban pattern in the context of sustainability. For this purpose, geospatial techniques were used to analyze the spatial urban development pattern of study area. The existing development pattern in Faisalabad city is linear sprawl at outer edges of the city along major roads and infill development pattern in the center of the city that has been observed very closely in this research and results also revealed this pattern is likely to sustainable. However, the major finding reflects that Faisalabad city is experiencing phenomenal physical development pattern rather than pre-planned development pattern. So, there is an urgent need of urban lens to facilitate such delineations. The broader purpose of this research work was to conceptualize the urban sustainability for better development and planning of Faisalabad city.

Key Words: SDGs, Remote sensing, spatial pattern, urban sustainability, Faisalabad City.

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INTRODUCTION

Virtually, half of the world's population subsists in urban areas today (Un-habitat, 2010). Although, cities have always been focal luff for cultural as well as socio-economic development, and technological innovations. In Pakistan, urban development rate was 4.4 percent conferring to the 1972 & 1981 census report. In developing regions, 95 percent urban expansion will take place in next ten years and for the very first time ever before on the fabric of the earth, there will be the considerable shrinkage in rustic settlements (Ahern,

2011). Urban settlement patterns are closely related to urban sustainability that delineates the emblem of the green built up environment, ecological as well as socio-economic praxis and policy making that confesses the function of urban centers in an inclusive fashion. Urban ecology describes the resilience that endorses sustainability while sustainability is endorsed by social equity, economic feasibility and environmental integrity (Frantzeskaki, Kabisch, & McPhearson, 2016). It is worth noting that extent and nature of sustainability varies significantly from one geographical location to another.

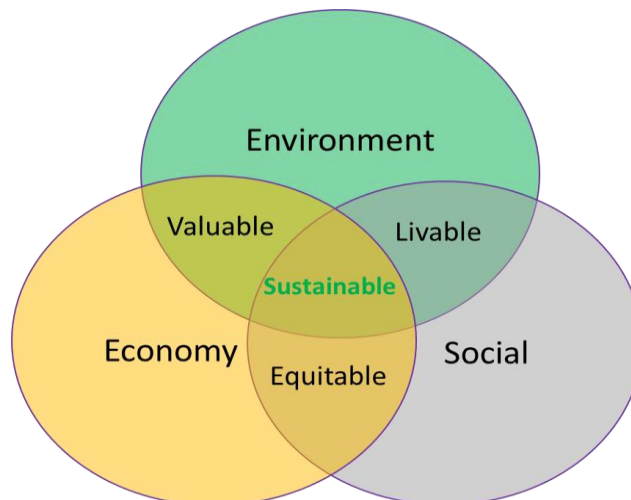


Figure 1: Dimensions of Sustainability

Sustainable development can be defined as the process of constant change where execution of natural resources, the direction of development, institutional change and dimension of investment all are intermingled and boost the potential to fulfill present and future needs (Madu, Kuei, & Lee, 2017; Zhou, Pickett, & Cadenasso, 2017). Sustainable development differs from sustainability as it is an extensive and challenging goal to reach the high level of being sustain in environmental, economic, and social dimension. While all the means, approaches through which sustainability would be obtained termed as sustainable development (Mebratu, 1998). The concept of sustainability came into eminence in 1980s when (WCED) World Commission on Environment and Development and (IUCN) International Union for Conservation of Nature put forward the objective of sustainability (Eizenberg & Jabareen, 2017; Fuchs, 2017). However, Sustainability was defined for very first time in Brundtland's World Commission Report on Environment and Development which is also known as Brundtland's Commission report (Bell & Morse, 2008; Mowforth & Munt, 2015). Dr. Gro Harlem Brundtland also known as (Mother of Sustainability) had given the classical definition of sustainable development as the 'Humanity has the aptitude to make development sustainable to ensure that it encounters the needs of the present without compromising the ability of future generations to meet their own need' (Brundtland et al., 1987). There are two crucial concepts, the concept of basic needs and the idea of limits, sustainable development imply some limitations on natural resources to absorb the effects of anthropogenic activities and to meet the needs of future as well as present (Boron, Murray, & Thomson, 2017). (Bugge & Watters, 2002; Jamieson, 1998; Sengupta et al., 2017). It is also stated that sustainable development is 'living on the earth's income, not its capital'. (Garvey, 2008). Many life sustaining issues are subjected to uneven development, population growth, resources distribution and poverty and place the unprecedented pressure on natural resources, not least in the developing regions. Many forms of development erode the natural resources and put strain on earth's own capital. This environmental strain would be reduced by designing the cities instead of cars, saving \$3 trillion worldwide in urban infrastructure investment over the next fifteen years. Therefore, it's a time to transit from linear approaches to loop models in terms of production, consumption, design and disposable waste management that would be more consistent and efficiently productive. Moreover, Sustainable communities are built mutually supportive, dynamic balance between and among environmental quality, economic opportunity as well as social well-being and executed in a responsible, responsive manner within inclusive context of sustainable development (Ingram, 2015). It is not an end goal, it is observed as a continuous

process and dynamic in nature (Moss & Marvin, 2016). The SDGs sustainability development goal eleven identifies the fundamental role of urban development to approach the high profile of sustainability as well as calls for being cities safe, sustainable, inclusive, and resilient. In this way, sustainability of urban development patterns is very crucial to achieving the global sustainability (Hoorweg & Freire, 2013). Rapid urban growth has put some greatest challenges that offers the tremendous opportunities of sustainable urban development and most of the SDGs targets are thematically in geographic nature (D'Alessandro & Zulu, 2016; Girma, 2017; Willis, 2016). Moreover, in undertaking of world developmental challenges, professionals will observe the poor data quality, lack of data (Diaz-Sarachaga, Jato-Espino, & Castro-Fresno, 2017; Serajuddin, Uematsu, Wieser, Yoshida, & Dabalen, 2015; Servaes, 2017). In sustainability context, problem defining is the gap among the desired and prevailing states (Toppolo, Cucurachi, Salomone, Saija, & Shi, 2016). Cities speculate the technological, socio-economic and environmental development in their transformation; as far as these all are soundly driven by the sprouting spatial urban structure itself. It is well documented that modeling foundations based in GIS and it is Geographical information system are very reliable source to evaluate the Spatio-temporal changes.

Study Area: Faisalabad is the third largest city of Pakistan and prevalently known to the world as "Manchester of Pakistan". Geospatially positioned in very fecund land and well connected to the other cities of the Punjab province through well-defined life lines. Faisalabad city was established as a (Mandi) a market town in 1805 being under influence of colonization. The study area lies between 30°42' to 31°47' E latitudes and 72°40' to 73°40' N longitudes on the south of capital city Islamabad (Ahmed, Mustafa, & Khan, 2015; Anjum, 1990; Bhalli, Ghaffar, & Shirazi, 2012; Shafqaat, Ghaffar, Butt, Sajjad, & Aslam, 2013). In 1904, when Faisalabad city was established under British rule, its aerial extent was only 5.8 sq. km. Currently, Faisalabad city constitutes area of 213sq.km while its metropolis extent is 1295 sq.km (Mahmood, 2014).

Data Collection and Manipulation: As the study intended to analyze the sustainability in spatial urban pattern and Spatio-temporal dynamics in Faisalabad city area the data was collected through field survey and satellite Imagery from United States Geological Survey (USGS). Remote sensing data was acquired for the year 1995, 2000, 2005, 2010, and 2015 respectively. The administrative boundary of Faisalabad city falls over 149 row and 38 path of Landsat Images. To collect the data for sustainability indicators different books, research articles, reports, journals were also reviewed. Housing condition and provision of spatial urban services,

household size, and housing condition was also observed. One of the major challenges for this research was unavailability of data for sustainability measures.

Methodology: In present research, supervised classification has been done to classify satellite imagery of study area into different classes (Built-up area, Crop land, water bodies and Open Spaces) respectively. Supervised classification is a pixel based classification (Browning & Duniway, 2011). Representative sample pixels were selected for each class of the land cover in training stage and then these sample pixels were assembled into a single class representation one land use class. The first step in image classification was training stage. In training stage, to develop the statistical characterization signature editor analysis was utilized for each class. Thereafter, signatures were used in next stage for supervised classification. The first step in satellite images processing was layer stacking. For this process, the images should have in similar extent (number of rows and number of columns) to resample the bands which have different spatial resolution to the target resolution. Image layer stacking was done to combine all the bands and to produce the multispectral image while using spectral tool in ERDAS Imagine 2014. Image enhancement was also done in order to make the image more visible and interpretable by adding the

panchromatic band and wavelet resolution merge analysis from pan sharpening toolbox. The gap fill error, missing values, information was found in the image 2005, 2010 and 2015 due SLC (Scan Line Corrector) of sensor off-product. To remove this error from the images neighboring pixels focal analysis was applied from spatial toolbox. In order to avoid the geometric distortion caused by the aircraft or satellite sensor deviation or altitude geometric correction was undertaken which is prerequisite process performed prior to image processing. After geometric correction the next step was to mosaic the images of selected years. Layer or image mosaicking is also known as the image tiling, often AOI (area of interest) covers more than one image frame. These individual layers or frames need to be mosaicked into a single image. Mosaicing algorithms are mostly used to obtain the mosaiced scene. After that, image sub-setting was carried out as subset is the large section of the image. It is done to focus on the scene. In supervised classification signatures are assigned to give a name of specific class to specified area. They are created from AOI object and can be collected from objects in shape file data or feature space images. Software ERDAS Imagine was used to process the satellite imagery for the collected years while spatial outlook was given in ARC GIS.

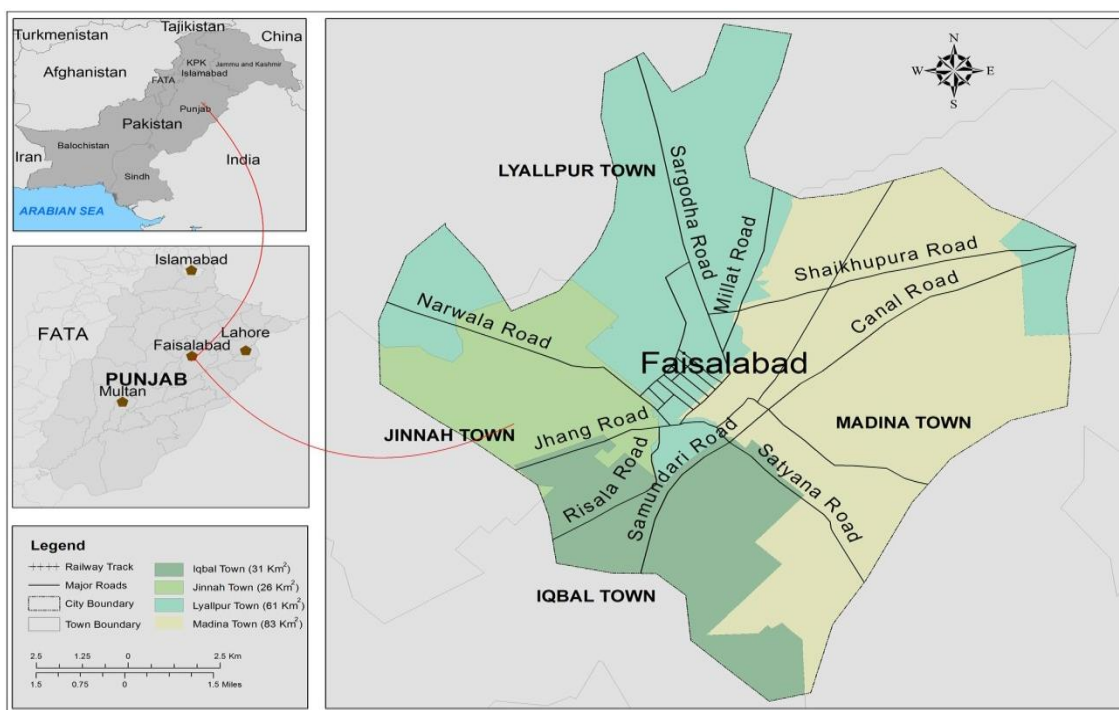


Figure 2: Study Area Faisalabad

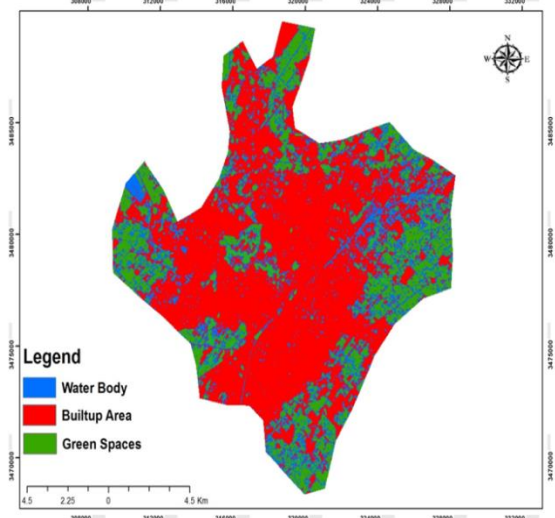
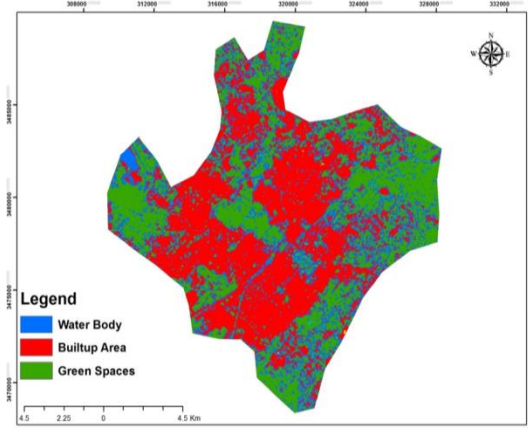
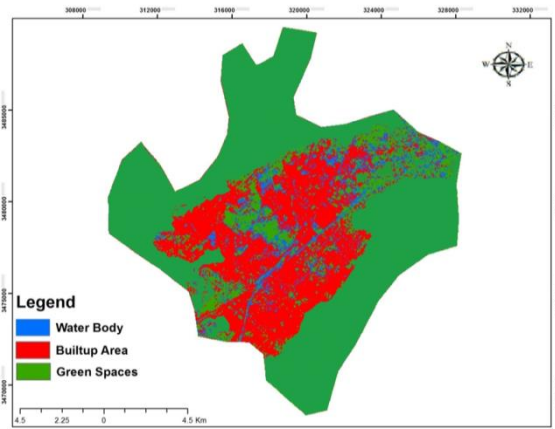
Results and Discussion: Results revealed that in Faisalabad city area urban development followed by the linear pattern. In 1995, development pattern was focused along Narwala road, Jhang road and highly concentrated

along the canal while there are small patches along the Jaranwala and Sargodha road. The maximum area covers with vegetation including crop land which has been decreased gradually in the year 2000 and continued this

trend in studied time period. Image 1995 also shows that urban growth rate was slow and development pattern of the city was infill-linear form due to the establishment of grain market and availability of canal water and fertile land. Image 2005 reveals more concentrated pattern for built up area while clustered pattern on the edges of the city. Proportion of built up area and vegetation is almost in same proportion. The extent of built up area increased as compared to the year 2000 and become more in nuclear structure due to socioeconomic activities. In past, there was high proportion of vegetation cover and crop land which replaced by the urban development infrastructure establishment of residential colonies etc. Built up area has the highest shares in the study area land. Spatiotemporal pattern of urban development for the year 2010 shows the high buildup area and gradual decrease in vegetation cover from 1995 to present. In previous maps satellite data shows the concentration in built up only in city center while scattered structure of development pattern at outer edges of the city. Here, in 2010 built up area continued to increase due to the development of colonies more connectivity to other cities, establishment

of dry port, industrial office, and improvement in city government etc. Built up area is slightly less than the half of the total area of Faisalabad city. Built up area covers the 47%, agricultural 32 %, and water body only 1% shares in land cover. A noticeable increase in built up area has been observed in the year 2015.

The table 1 shows the temporal dynamism in urban development pattern in study area for different years. Results revealed that the proportion of built up area has been increased continuously while gradual decline in green spaces, vegetation cover and agricultural area as we have merged it into green spaces to extract the more clear results and to concentrate on the development pattern. The transforming pattern is the outcome of the socio-economic factors and their utilization by human beings in space and time. In developing countries, cities exhibits mixed development pattern over the geographic space. Faisalabad city is experiencing two peculiar development patterns; Infill or compaction pattern in old built up areas and Connected Linear sprawls in outer edges, normally termed as linear pattern along the main city entrance corridor.



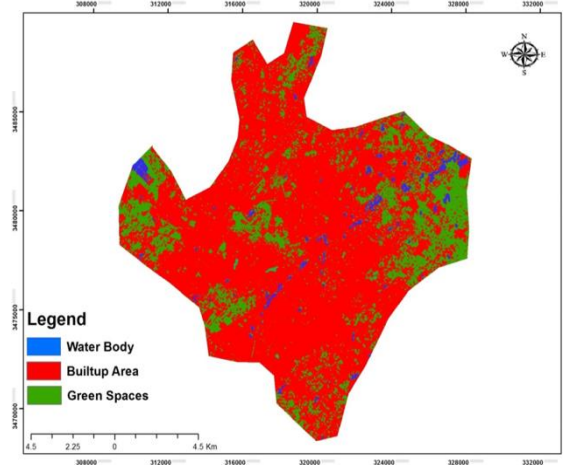


Figure 3: Spatial Urban Pattern over different Time Periods in Faisalabad City

Table 1. Urban Development Pattern in Faisalabad City Area (sq.km).

Sr. No.	Change in Urban Development Pattern	Year 1995	Year 2000	Year 2005	Year 2010	Year 2015
1	Built-up Area	59.25	71.72	78	100.4	120.07
2	Blue Spaces	1.89	1.29	1.76	1.22	1.37
3	Green Spaces	100.84	97.89	90.33	81.75	67.09

Table 2: Annual Growth Rate of Urban Development in Faisalabad City Area

Year	Areal (AGR) Annual Growth Rate km ²	Urban growth rate in % percentage
1995-2000	4.74	4.45
2000-2005	1.75	3.47
2005-2010	6.46	6.08
2010-2015	3.95	9.25

The table 2 shows the annual growth rate in built up area in square kilometer and percentage for the five years 1995-2000 then 2000-2005 similarly 2005-2010 and

2010-2015 respectively. Highest proportion in built up area has been observed as between 2005-2010 which was 6.46 km².

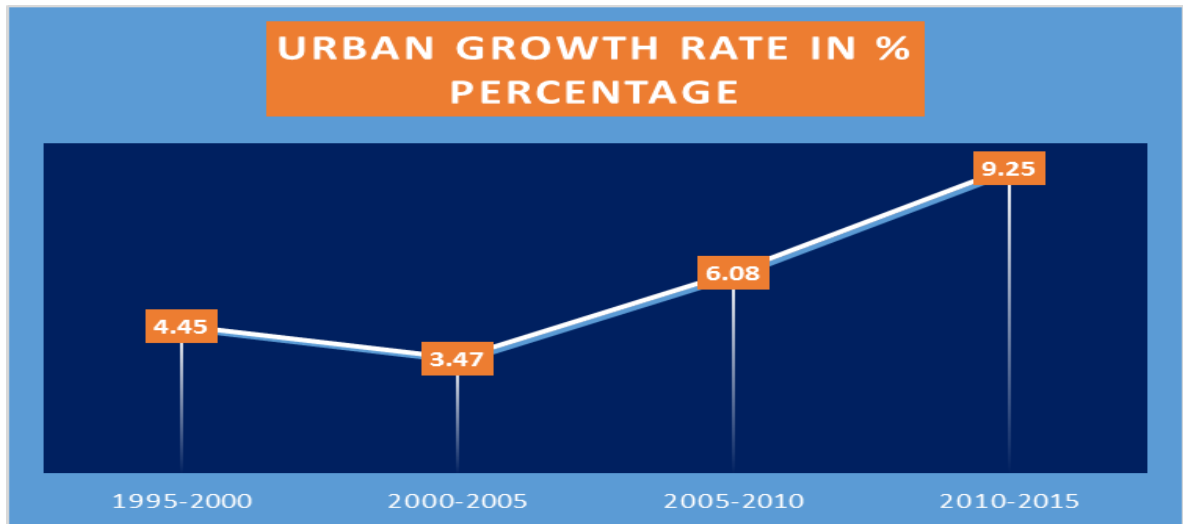


Fig 4: AGR Annual urban Growth Rate of Study Area

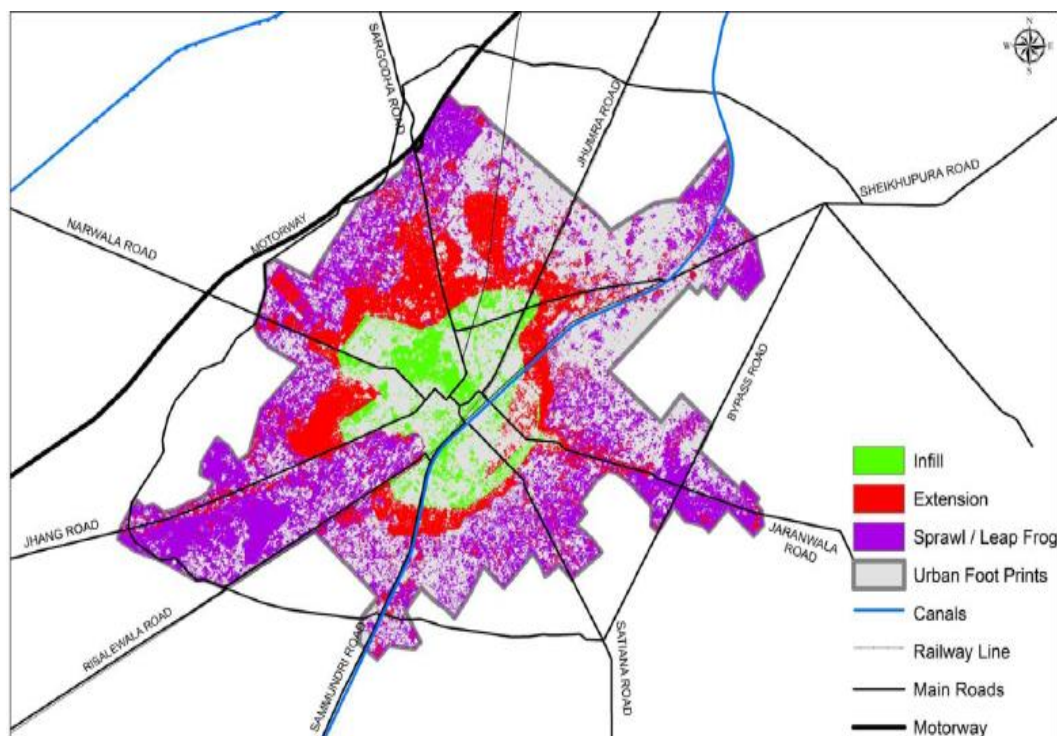


Fig 5: Spatial Urban development Pattern of Faisalabad

By analyzing Faisalabad development pattern (1995-2015), study reveals that infill development is present in urban core city area. Moreover, linear, sprawl and leapfrog development pattern can be clearly envisaged in fig. 5 along major roads connecting to bypass from all sides. The present spatial pattern reveals into underlying main categories; residential and supported urban services, commercial, institutional services, and Industrial in older city parts and in urban fringe. However, all development patterns well connected with an overlay of rail and road network. The existing road network originates from the core city and forms a hub pattern that runs along towards the intercity corridors, whereas the rail network intersects the city into two parts in west and east directions. The current city core consisting on the eight Bazars and clock tower, including different historical buildings these eight bazaars reflects the historic character of CBD (Central Business District) of study area as well as special grain and cotton yarn market which caters the demands for industrial raw material and ensuring the provision of the regional products. The spatial morphology of the city intersected by the Rakh branch canal and railway line into two parts, northern side of the city area consist Tata bazaar, Jinnah colony, and eight adjacent bazaar. And the city center comprises on the public and administrative offices such as civil lines Commissionaire office, DCO office, and old office of provincial government (irrigation department). Highly dense residential area is characterized by the Dhobi Ghaat, Dougluspura, Islam Nagar, and Sant Nagar

while some old communities dated back to 1970s are Muslim Town, Ghulam Muhammadabad, Model town and other small communities in the northern part of the city. While in southern side, there are low density built up area such as People Colony1, Muhammadabad, Sarfraz Colony, Madina Town, People Colony2 and other settlements along the Samundri road and canal road etc. However, low density residential built up area exist along the major roads and canal which transacts suburban development. The industrial offices, buildings, warehouses and agricultural buildings are located in different parts in the city. However, study area is a hub of goods transportation and services at regional level and having significant economic linkage to the international markets as well.

Conclusions: The present research was carried out to detect the spatiotemporal development changes and to discuss the sustainability of spatial urban pattern in study area. For this purpose, twenty years raster data was analyzed and multiple research reports, articles, books land use maps and, topo-sheets consulted. To detect the spatiotemporal development pattern dynamism Landsat data for the five different years (1995, 2000, 2005, 2010, and 2015) was acquired. And image processing was done in ERDAS Imagine software and spatial outlook was given in ARC GIS. Supervised Image classification was performed for each image separately. The spatiotemporal development results revealed that green and open space are transforming into the built up area and high

residential area. CBD (Central Business District) of the city area is highly compact and there is no more space available to accommodate further infill development pattern, either this area has to go under regeneration or new opportunity zones desired to accommodate medium and high rise buildings for future activities. Compactness in urban development is decreasing in the south-eastern part along Satiana road, while in the north along Sargodha road and south Samundri road respectively. Haphazard industrial development is creating environmental challenges and threats which need to be dealt wisely on urgent basis. To enjoy the international trading hub area there is a need to extend present airport infrastructure facility. Linear commercialized roads are intensifying the congestion in urban built-up, so study area needs further planned commercial districts instead of linear commercialization. The main development indicators/ driver are the same as in past, socioeconomic activities of human beings.

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