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Industrial Development and Urban Growth as an Outcome of CPEC: A Spatial Analysis

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Industrial Development and Urban Growth as an outcome of CPEC: A Spatial Analysis

By

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Abstract

The paper look into the effect of China-Pakistan Economic Corridor (CPEC) on the local urban and socio-economic set up in Pakistan with special reference to spatial planning of urban areas and Special Economic Zones (SEZs). For the analysis CA-Markov model and Fuzzy membership technique has been adopted on area selected on CPEC route and one special economic zone named Rashkai-SEZ situated in Khyber Pakhtunkhwa. The analysis shows that population density at Eastern route of CPEC is greater than central and western route. Especially at western route, rare population settlement and less density is shown on maps. For the micro level analysis, we use Kot-Momin as study area. The analysis shows a visible growth pattern of settlement in surrounding parts of CPEC route of this area will be observed. The growth rate shows an enhancement of 2% in 2015 to 16% in 2030. The growth pattern observed during the said period shows that area grew from 20 km^2 to 144 km^2 by 2030, while demographic analysis of Raskai-SEZ observed a growth pattern during the 2015-2030 that shows study area grew from 27 km^2 to 104 km^2 by 2030.

Key Words: Spatial planning, CA-Markov model, CPEC, Special Economic Zones

1. Introduction

Globalization and fast growing economic and spatial expansion generates a concept of economic corridors. This idea was originally generated in 1960's in spatial theories prominently by George R. Collins, Doxiadis and J. Whebell. They used this ideas in their respective discipline but the base of their idea was linear cities and corridor development. Later in same decade, a shift from traditional to modern concepts of industrialization, technology and economy was seen due to increase in mobility and connectivity. With the interface of globalization, all countries become

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more concerned to its regional development which includes urban infrastructure growth, SMEs development, industrialization and development of regional or urban corridors. The term "Economic Corridors" is not only a representation of road infrastructure but it includes connectivity of market and people, spatial connectivity is also a part of it. Due to economic corridors, industrial development took place which also increase peri-urban process in surrounding areas (Douglas et al, 2014). These economic corridors can be regional or international. They can connect cities within an economy or borders of different countries to get benefit from international trade. In 1990's in Netherland, this concept of planned corridors was taking into account for policy implementation but due to lack of back ground planning and knowledge, it was not successful. India also implementing four industrial and economic urban corridors model among its big cities (IGC working paper, 2015). As far as regional corridors is concerned, one cannot ignore its positive effect on urban planning and economic development of the country. But in global economy, the importance of international economic corridor among neighbor countries can't be neglected. It not only accelerate socio-economic development in the region but also improves chances of growth of all economies included through international trade.

China Pakistan Economic Corridor (CPEC) was mainly initiated with same objective of regional connectivity and socio economic development in both countries. This planning includes interaction of socio-economic and administrative forces between two countries. Like any economic corridor, CPEC is based on centripetal and centrifugal economic forces while infrastructure which connect them will forms the spine of corridor. This structure mainly will rise core-oriented growth around the nodes as well as development along the spine of corridor. Generally it is considered that trade along with the spine becomes a driving force of new urban development and development of any corridor is dependent upon the size and development of its end nodes as well as distance between them (Friedman, 1966). CPEC designed to facilitate China and Pakistan in accessing markets, growth in trade and investment. The design of the project not only target transport of goods and services but also focus on the industrial development through nine industrial zones in different location of Pakistan. The project supposed not only to facilitate inclusive growth by creating economic opportunities along with spine of corridor but also create linkage between cities and industrial clusters. Initially corridor develop purely as transport corridor but after detailed planning, regional development becomes its main goal. CPEC supposed to start

its planning at stage 2 of Nagles (2014) stages and then supposed to achieve further four stages of this theory. Nagles (2014) stages are given in figure 1:

A number of researches is available on the issue of urban corridors and its outcomes. But no literature is found which cover the issue of economic corridors which attach boundaries of economies and affect volume of trade of included economies. The planning of regional corridors already involve master planning of associated urban centers growth, cost and benefit analysis of the project, but corridors involves interest of more than one economy needs a collaborative planning as well as individual planning to get benefits from project. This individual planning includes prioritization of industrial development, supply of agricultural raw material, development

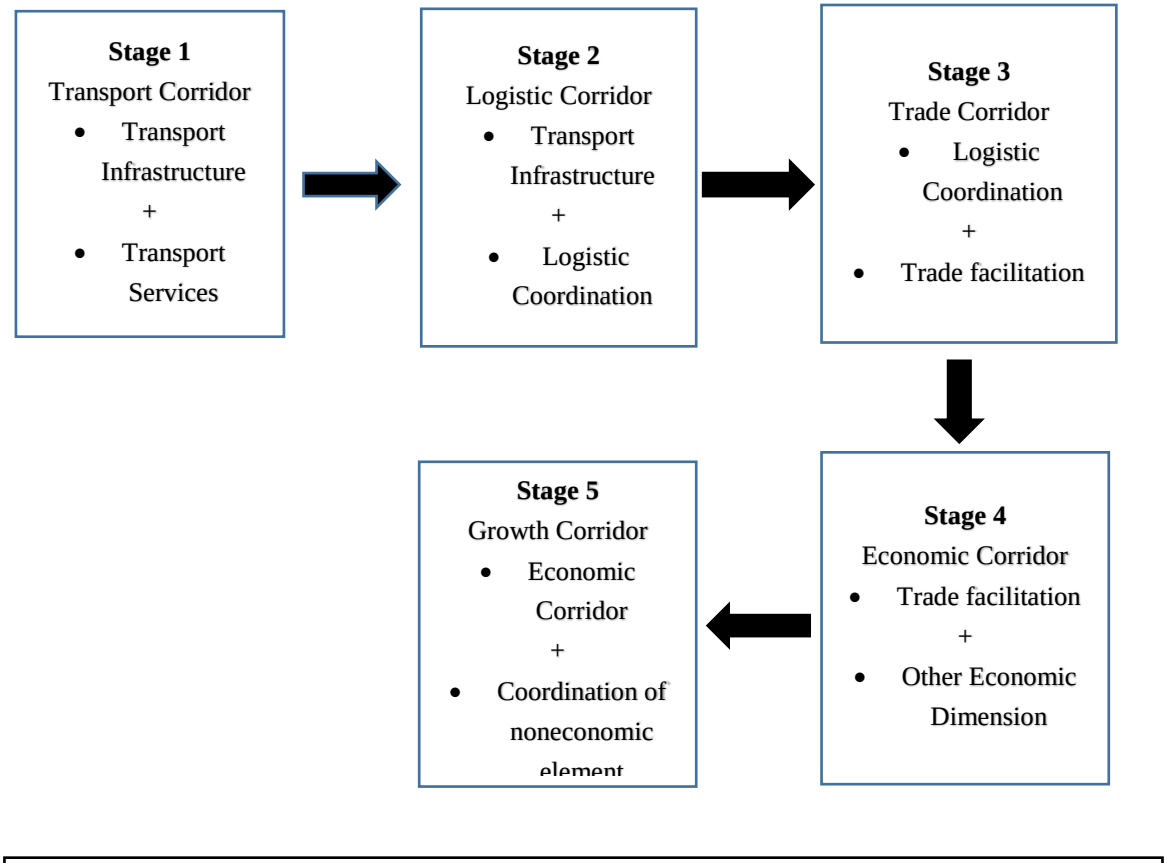


Figure 1: potential path of the Development of Corridors, Nagles (2014)

of middle class urban areas and its civic infrastructure.

This paper intends to find the impact of CPEC on regional development by taking urban and industrial growth into account. This urban growth needs a sound planning to meet infrastructure and other needs as well as industrial setup requires detailed analysis about provision of raw

material, major industry already established in respective area etc. By keeping these needs in consideration, this paper focus into spatial analysis of urban and industrial need in Pakistan in future.

The paper look into the effect of CPEC on the local urban and socio-economic set up in Pakistan with special reference to spatial planning of economic and social activities. The need of research is obvious as the master planning does not include to identify potential effect of CPEC on micro level economy of Pakistan. This paper targets the zones of industrial estate and its associated outcomes i.e. urban peripheries areas and its infrastructure need through Geographical Information System (GIS) mapping. As Douglas et al. (2014) also highlight the development of middle class areas as an outcome of industrial growth, by taking this point into account, the paper is more into the conceptual definition of economic corridors along with the programmatic model first to the projection of major agricultural raw material produced in surroundings of these industrial zone, main industry and second to structure social and economic response to the development of linear settlement of population, transportation infrastructure and associated potential economic activities and development of territory. In short the paper will focus on the need of investment on infrastructure, regulatory framework and provision of civic infrastructure on high density economic nodes with a dynamic business environment.

By defining these prioritized areas of research, this research intends to find answer of certain questions through projections. Few questions are as follows:

- Is CPEC expedite urbanization process and what are future challenges of this urbanization
- What would be the industrial outcome of CPEC in Pakistan
- What is the interplay between CPEC and land dynamic, economic process and policies?
- What would be the structure of socio-economic response to the development of population settlement?

2. Literature Review

The global transformation in production technology has expanded distribution network which also expand quantity of freight being shipped as well as complication of supply and distribution channel. The geography of freight needs strategic considerations where issues or routes, their nodes and points are considered for implementation of supply chain at global level. These

activities of freight distribution can plan for regional need as well as for international trade. The planning of corridors development not only expedite the growth of transport and rail linkages but also shift distribution channels to peripheral location. Rodrigue (2003) developed a relationship between the geography of transport terminal, regional freight distribution and urban corridors. He evaluate regional scale of freight transport of Boston-Washington (Bostwash) corridor. He concludes that transport corridors and urban regions are the dominant sphere of production and consumption and represent the geographical scale of freight distribution. Frank et al, (1997) make a significant contribution in the literature of analyzing economic impact of transport corridors. They developed two analysis scale one regional and second individual entrepreneurs. By developing a theoretical connection of transport corridor with general and specific economic condition, they used regional labor market model, a reference region approach and entrepreneurial survey to evaluate the impact. The first two models shows ambiguous impact of transport corridors on regional economy while survey from entrepreneurs shows a positive impact of employment generation, investment, perceived accessibility and travel time.

Planning and development are the key parts of a successful implementation of corridor project which includes benefits of all stakeholders involved in the project. Normally these projects targets employment opportunities, trade balances and industrial development but if the outcomes are not as per desired then that country faced huge tangible and intangible cost. Dzumbira et al, (2017) highlighted same issue in Maputo development corridor as this project ignore common citizen in its main planning resulted the outcome from project was not adequate. They used nodes to measure distance away from its spine and by using ArcGIS and multivariate regression they conclude that due to its top down approach, this project fail to generate adequate employment opportunities and faced real socio-economic challenges.

Industrialization generate economic activities and population agglomeration in surroundings. It was noted that urbanization process was fast in such areas where industrial growth took place during last four decades. On same line Douglas et al. (2014) focused on the issue of peri urbanization process in East Asia. They were of the view that industrialization creates rapid economic growth and social transformations. It also become a cause of second generation peri urban process. These peri-uban areas experienced improved transportation networks, growing middle class as well as social and environmental changes. On the other hand global transaction space and new technology transforms these production zones and affect its peripheries areas.

Nogales (2014) selected six cases of economic corridors from developing countries to evaluate their impact on agribusiness outcomes. He selected these corridors based upon their agricultural components and diversity of approaches. These corridors creates comparative advantage by using competitive analytical techniques in agribusiness, characteristics of agribusiness and policies and initiatives to build institutional capacity to develop opportunities for selected agribusiness actors and agri-food chains.

Corridor project is also considered as a key indicator of urban settlements growth. The prediction of such change and growth can be seen in different ways. The geographical information system is extensively used in the prediction of settlements growth and within this CA-Markov is considered one of useful tool to identify future pattern of growth (Mondal et al, 2016, Aburas et al, 2016, Aburas et al, 2017, Han and Jia, 2017). Jamal et al (2013) used markov chain method to predict Beijing's footprints from 2001 to 2020. The findings reveals that due to steady consumption patterns and government policies, it kept stable over the study time period. The analysis also reveals that due to expanding population size, this footprint is decreasing gradually. Hossein and Helbich (2013) examine land use changes of Mumbai on the basis of remote sensing data from 1973 to 2010. They used CA-Markov model to predict growth and expansion of city for 2020 and 2030. Results show that highest urban growth took place between 1973 and 1990 with a growth rate of 142% during these two time periods. This growth rate decreased by 38% till 2010, urban sprawl covers open and crop land in surrounding areas of the city. At the same time results also predict an increase in built up areas by 26% by 2020 and 12% by 2030 and refer a complex urban growth in future which link two nonaffiliated main settlement ribbons (north and east) which create pressure on urban management and planning.

Barath et al (2017) are targeting issues of urban growth in mega cities of India. They were of the view that globalization causes a rapid increase in urbanization process, ecological issues and a decline in environmental resources. They used CA-Markov model to analyze the influence of different agents of urban growth through soft computing skills. They found that different industrial, socio-economic and infrastructural factors contribute significantly in urban growth than biophysical factors. They analysis also help to suggest agent driven growth in the peripheries of cities with a transformation of urban corridors and industrial zones. It also suggested some local agents which help in identifying specific region of future intense urban growth. This analysis will help in identifying appropriate management strategies toward making Indian cities sustainable

during this century. On same ground Arfa et al, (2017) also tries to quantify and analyze drivers of urban growth in Indian cities. For study they took Lacknow as study area. They used CA-Markov model to predict urban growth for the years 1993, 2003 and 2013 by taking into account different biophysical and proximity factors. Factors maps were generated to predict growth for the year 2023. The projections show that city's expected growth is 441.2 sq.km in 2023 from 53.6 sq. km in 1993.

As far as CPEC is concerned, very few research is available on the issue. Most of the research include theoretical side of aspect. The empirical side is weak due to non-availability of data and a limited access to forecast features. Chang Hi-Lim (2017) discussed impact of CPEC on both nations in five different dimensions i.e. ethnoscape, technoscape, finanscape, mediascape and ideoscape. According to him CPEC project Pakistan is going to bring changes in culture, socio-economic and political structures, and financial positions etc. Another contribution was made by Ayub (2017) by analyzing the impact of CPEC on inflow of FDI in Pakistan. By comparing monetary and fiscal sector of Pakistan and China, he concluded that to get benefit from this project, it is important to make fiscal and monetary policies in line with the objectives in both countries. This would help to get socio-economic benefits from this project.

3. Methodology

3.1.The Markov Chain Model:

The Markov chain model is the stochastic modeling to predict chances of change in one state to another. It takes different previous spatio-temporal changes into account during this process. Markov chain model based on two time series data predicts future requirement of land use. The model output is based on probability of transition. The matrix used in this method is considered as a set of conditional probabilities to go at a particular new state (AKIN et al, 2014). This model is not appropriate for measuring spatial pattern of landscape changes (Li et al, 2015). This model can be used as a basis to predict how a particular LULC change over time. In this study Markov chain model used on the base of the following Eq.

$$S_{t+1} = p_{ij} * S_t$$

And

$$= \begin{bmatrix} p_{11} & \cdots & p_{1m} \\ p_{21} & \cdots & p_{2m} \\ \vdots & \cdots & \vdots \\ p_{m1} & \cdots & p_{mm} \end{bmatrix}$$

where $S(t+1)$ and $S(t)$ are the LULC status at time t + 1and t, respectively. $0 \leqslant pij < 1$ and $\sum_{j+1}^{m} p_{ij} = 1$, ($i$, j = 1, 2, ..., m) is the transition probability matrix. This study mainly targets projection of urban growth at CPEC route therefore Markov chain method is employed to evaluate transition matrix during 2000-2010, 2010-2015 and 2000-2015 LULC dynamics and probability of changes. A value of 0.15 is assigned to proportional error[4]. At first stage, demand changes is calculated through this method to obtain projected land use for 2030.

3.2.The Cellular Automata (CA) Method:

The model of cellular automata was originally developed by Wiener and Rosenblueth (1940), afterward a working on this model was started by different school of thoughts. In 1978, a true automata model was developed by J. M. Greenberg and S. P. Hastings. This model is considered as a competent approach to study change and control complex spatially distributed processes. It also provides a clear picture of land cover dynamics (Mondel et al, 2013). The CA model has a strong ability of simulating the spatio-temporal dynamics of complex system (Yang et al, 2014). It comprised with following components:

(i) A space in which a cell can exists.
(ii) The state of the cell out of infinite states
(iii) Cells adjacent to a particular cell
(iv) Transition rules
(v) Temporal space.

CA can be expressed as

$$\{S_{t+1}\} = f(\{S_t\} * \{I_t^h\} * \{V\})$$

[4] Literature support 15% marginal error as predication is not 100% confirm because study data is collected from different sources.

where,{St + 1} is the state of the cell in the CA at time (t + 1), {St} is the state of the cell in the CA at time (t),{It h} refers to the neighborhood, {V} is the suitability of a cell for growth f () denotes the transition rules, t is the time steps in temporal space and h is the neighborhood size (Maithani, 2010). As compare to Markov Chain model, CA model does not allow researcher to use information of the previous state of land cover but it uses state of neighboring cells for transition rules (Adhikari and Southworth, 2012). This model also has problem in defining transition rules and model structure therefore it has no potential to predict the LULC dynamics (Rocha et al, 2007). This problem can be overcomed with the integration of Markov Chain model with CA model.

3.3.The CA-Markov Model:

In the prediction of future LULC, the CA-Markov model has been recommended by large number of studies as it integrate advantage of cellular automata and Markov chain by taking elements of spatial contiguity as well as knowledge of spatial distribution of transition (Eastman, 2003, Li et al, 2015). This model is considered as a good approach in generating a better spatiotemporal pattern of future LULC. This study by using CA-Markov model try to predict likelihood of LULC dynamics of areas in CPEC projects in both spatial and temporal domain. The study also use this model to simulate ling term dynamics of LULC (2015-2030) based on existing land cover patterns.

To run the model appropriately, the CA-Markov.

$$S_{(t,t+1)} = f(S_t, N)$$

require initially three types of data sets such as the base land cover image (e.g., LULC of 2010, 2015), Markov transition areas file generated by the Markov chain model, and the transition suitability images collection. Two different methods are used to prepare transition suitability image to predict future LULC. Multi-criteria evaluation (MCE) method is use to prepare transition suitability image that is use to predict future LULC if economic zone not constructed. Probability image of all types of land use classes are generated using Markov method these images are use as transition suitability image to predict future LULC if economic zone constructed. Likewise, a standard contiguity filter of 5 × 5 was used to define the neighborhoods of each cell. The CA_Markov factors can be selected based on existing literature.

3.4.The Multi-criteria Evaluation:

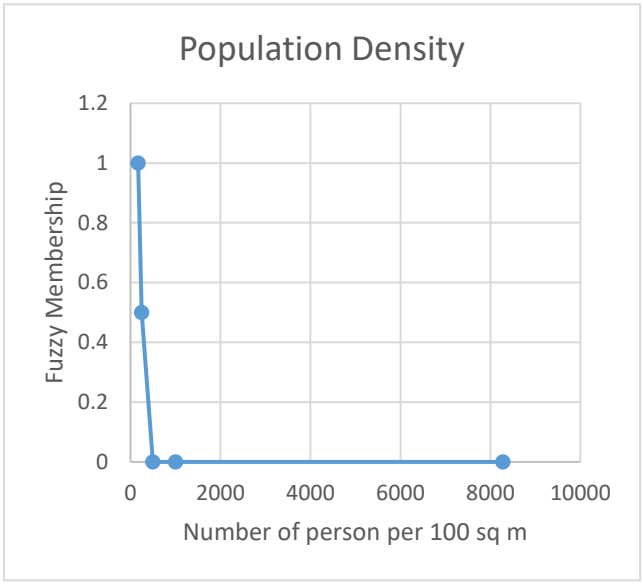
Multi-criteria evaluation method is use to combine different parameters on the basis of their weights. Eastman (2012) reported that one of the basic factors that can trigger the dynamics of LULC events is proximity (e.g. Proximity to road, river, etc...). The physical closeness to an existing LULC class is likely to be a driver of change to this class in the future (Halmy et al., 2015). Proximity to major road is thus one of the best indicators of LULC dynamics. (Halmy et al., 2015) reported that the LULC change drivers often include an increase in population, distance to roads and other factors. Therefore, this study considered the major physical and socio-economic parameters such as population density, settlement size, proximity to existing settlements, probability of land use classes, proximity to road and river is use as constrain to prepare the transition suitability map. The fuzzy membership value of population density, settlement size, proximity to existing settlements, and proximity to road is calculated using fuzzification method. The probability of land use classes is calculated by using Markov method. Analytical Hierarchy Process is used to calculate the weight of each parameter. Weight of each parameter is multiplied with fuzzy membership value.

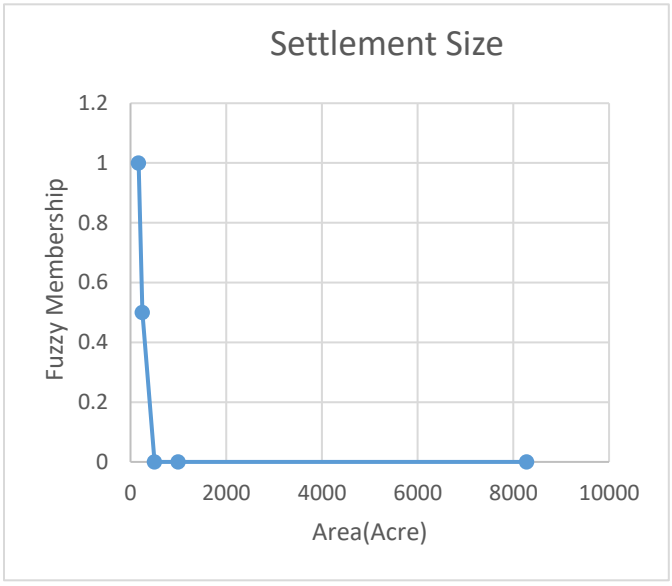
Parameter	Weight
Proximity Distance from Road	0.0866
Proximity Distance from existing Settlements	0.1242
Settlements Size	0.3591
Population Density	0.2689
Probability of Vegetation Class	0.0403
Probability of Builup Class	0.0403
Probability of Tree Cover Class	0.0403
Probability of Bare Land Class	0.0403

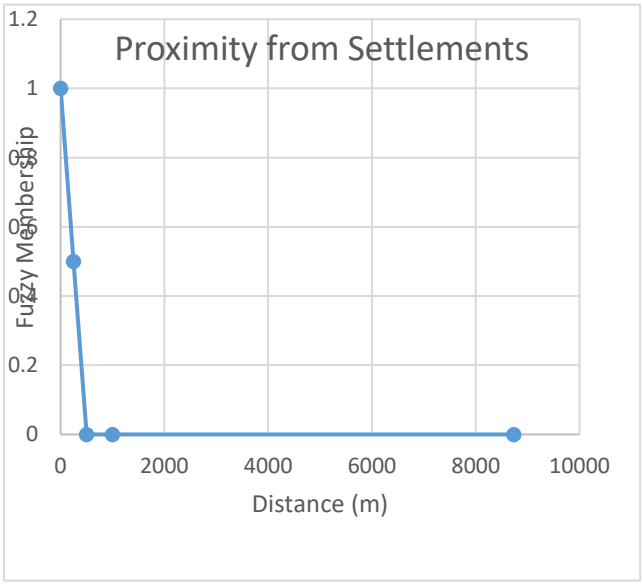
3.5.Fuzzification:

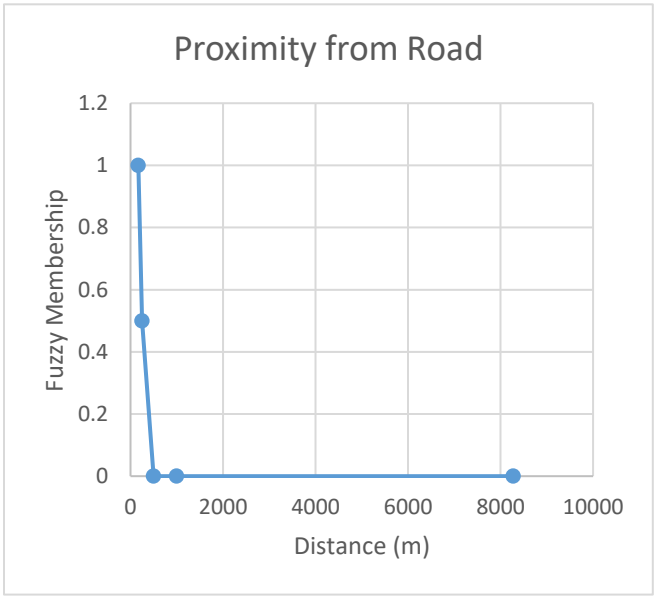
Fuzzy classification or fuzzification is a processes in which fuzzy graphs are used to assign a membership value of a parameter against its real value. The fuzzy membership value of parameters are calculated by using linear graph functions. The continuous suitability scale (0–1) through fuzzy approach is assigned.

Figure 2:









4. Analysis

4.1.Mapping Potential Growth Along with CPEC Route:

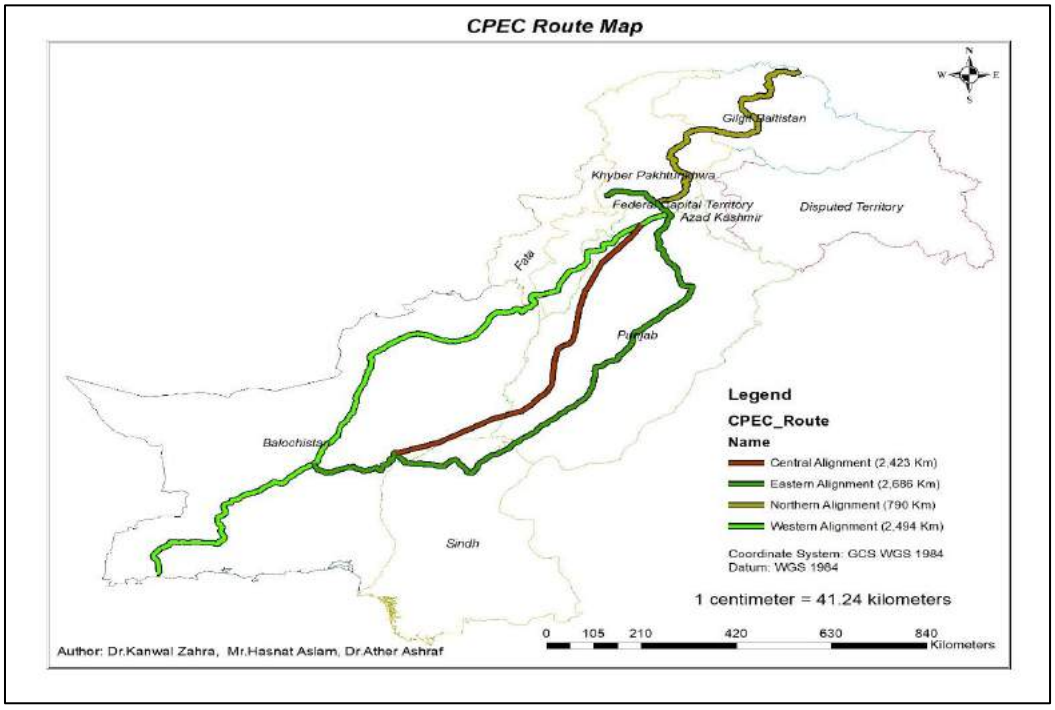
There are number of factors which affect growth patterns of an area. Political and economic factors are dominated by policies and major interventions in economy but demographic and social patterns can be influenced not only by policy but also by certain dynamics. The role of economic corridors

in developing socioeconomic and demographic patterns is understood. Especially urban settlement and sprawl is an outcome of economic and transport corridors, in developing countries roads are considered as main indicators of urban growth. In case of CPEC, this project is also considered as a main indicators of urban settlement growth, employment and economic development in Pakistan. The strategic planning includes all provinces and independent states of Pakistan to spread benefit of project equally throughout the country.

4.1.1. Study Area[5]:

Study area includes area along with CPEC route in Punjab. The reason of taking Punjab into consideration is the accessibility of data within Punjab province while data for other provinces were not available. Being most populated province of the state, Punjab has a major contribution in CPEC project after Baluchistan as shown in map below.

Map 1:



Initially three main routes were proposed under this project, Central, Eastern and Western. Among them eastern route is larger one and covered mainly Punjab and Baluchistan province. In Punjab

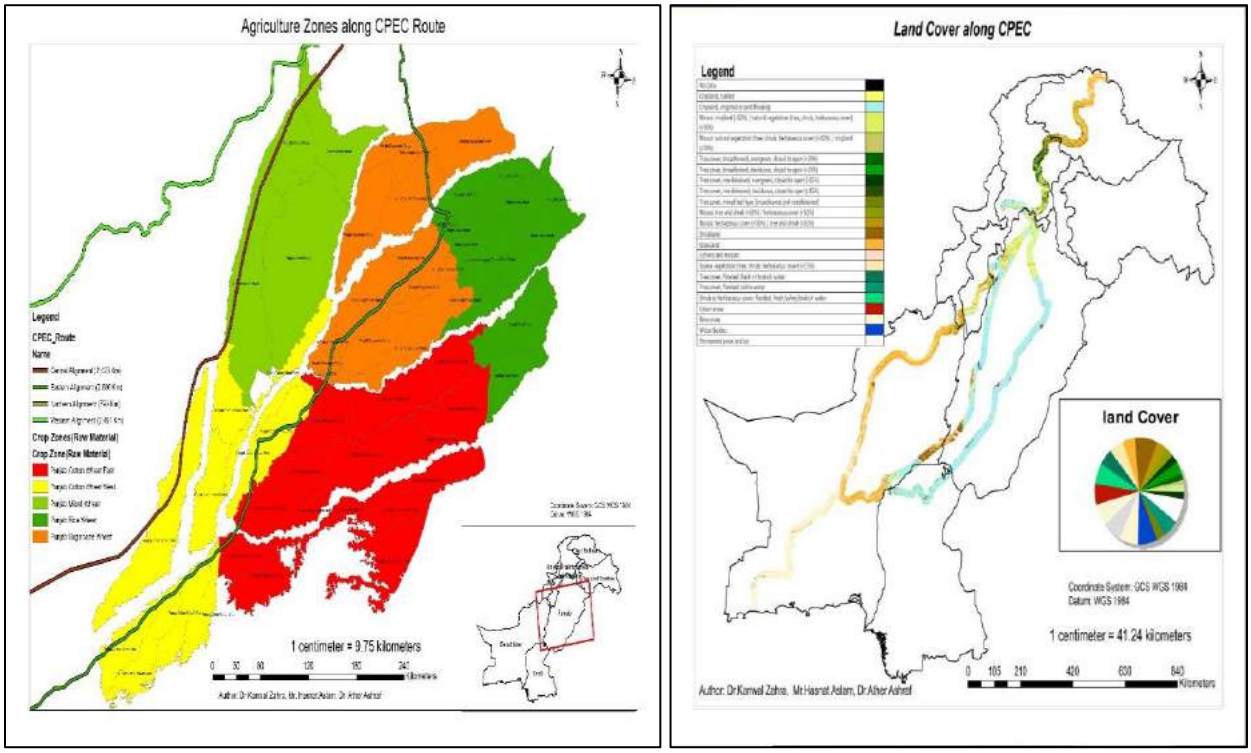
[5] Available route has limited shape files which does not include eastern extended route for study purpose. The research team request different authorities for updated shape files but not succeeded, in result we use available file to complete the study.

M2 (Lahore to Islamabad), M3 (Lahore to Multan) and M5 (Lahore to Karachi) are the parts of eastern route. These three parts of eastern route include high productive agricultural and industrial areas which mainly cover heavy industry and textile industry in central Punjab.

4.1.2. Land Use and Agricultural Zones Along with CPEC Route:

The map A of panel given below shows a major contribution of wheat, sugarcane and cotton as a major crop in surrounding areas of eastern route. This eastern route mainly covers two Special Economic Zones (SEZ) situated in Islamabad and Faisalabad. The Allama Iqbal SEZ in Faisalabad can mainly produce heavy industrial products as it is surrounded by industrial cities which can provide them raw material for heavy industrial products as well as textile related products, food and beverages and pharmaceutical industry.

Map 2: Land cover and Agriculture Zone along Proposed Route



Map B of panel given above represents 41.24 km in one centimeter area of map. This map mainly shows land use along with three proposed routes of CPEC project. The eastern route mainly covers irrigated cropland which is also threatened with flood in rainy season, surrounded by urban settlements in some pockets. This has comparatively high population density (264) and high

agricultural productivity with cultivated area 10,322 (000 ha) and industrial productivity with 30,928 thousand tones production (MPRU, 2015). The central route has less cropland as compared to eastern route and have human settlement, grass field, Mosaic cropland and tree cover area along with its alignment. The western route has very limited cropland as compare to other routes and it's mostly area covers grass field. The population density along with this route is only 98 with 2,933 (000 ha) cultivated land and 7,430 thousand tons industrial production (MPRU, 2015). These comparative statistics shows a high cost of doing business is high in term of land acquisition in eastern and central route but in term of raw material availability from agricultural and industrial sector, it is low. These routes mainly welcome industry which is farm oriented while on western route industry which required less raw material from local sources can be established.

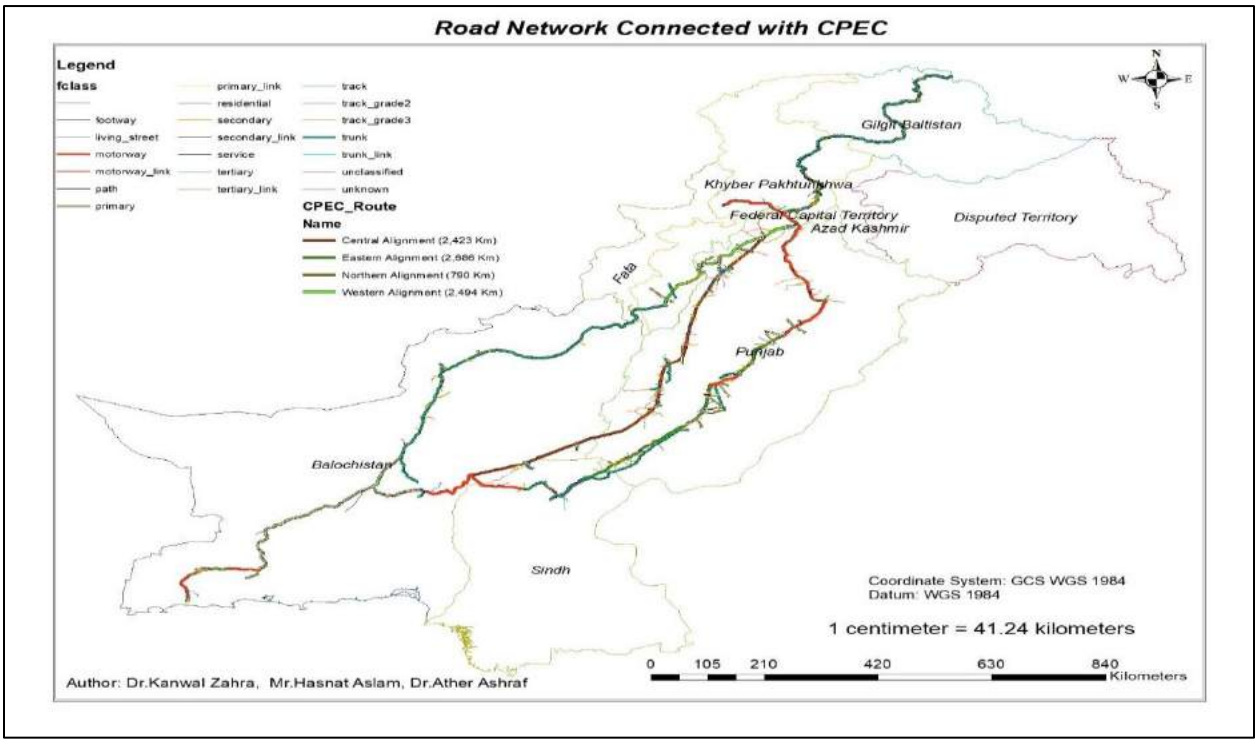
4.1.3. Road Network along CPEC Route:

The pattern of road network shows connectivity of route with population settlement. As CPEC is considerd as main source of generating indirect economic activities alongside of roads and nearby settlements therefore the analysis of existing road networks is important for future planning.

- The eastern route is mainly connected with surrounded areas with primary, trunk and tertiary road network, among them it has more connectivity through primary road network. The existing Connectivity with surrounding is high, it can cost less for further urban planning. It also indicate high chances of increase in direct and indirect economic activity.
- The western route is itself a trunk road and linked with settlements through secondary road and some primary road network. Future road connectivity can plan in collaboration with roads and network department as well as new urban settlement can plan for future growth
- The Central route has secondary, primary and trunk road for its network. It has comparatively more connectivity with its surroundings than western route.

The overall analysis shows that road connectivity is high in Punjab and less in other provinces which can also be adopted for future planning

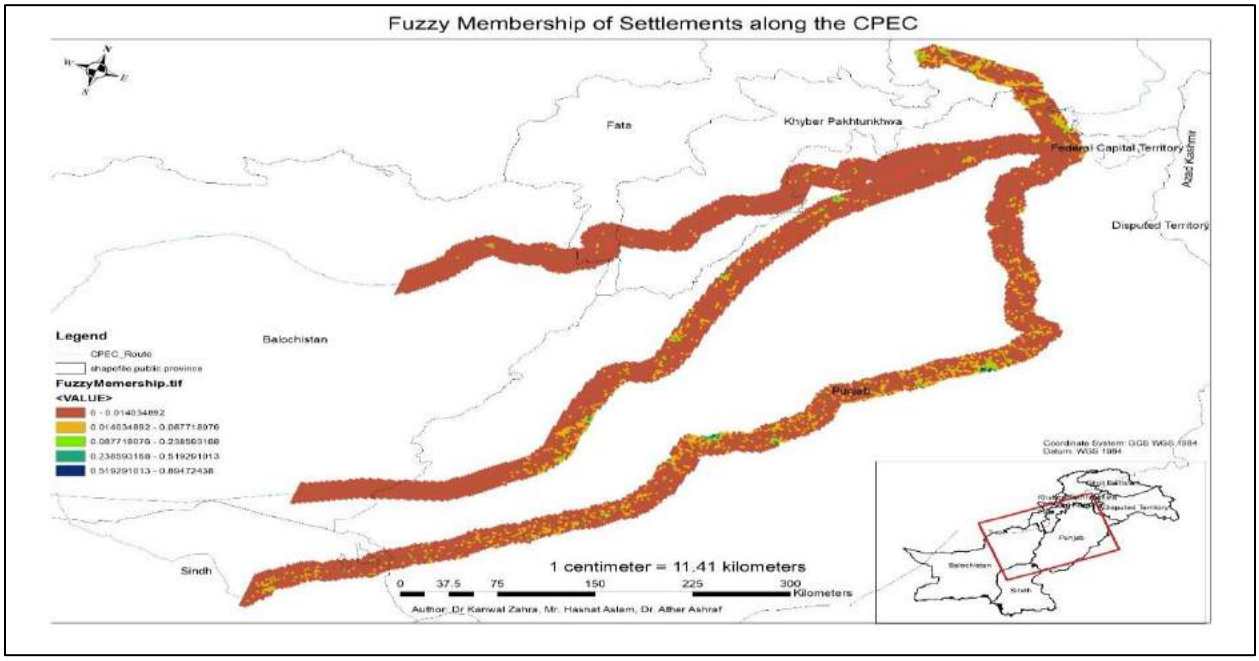
Map 3:



4.1.4. Fuzzy Membership of Settlement:

The fuzzy membership value shows future chances of urban growth. The potential urban growth can be predicted the method. The transition potential map which is given below can be seen as a map representing a range of 0 to 1. This range is the probability for a pixel of having conditions to experience land use changes. The future transformation of settlements along with CPEC route can be classified into no possibility (value equal to zero) to high possibility (value near or equal to one). A potential growth in urban settlement again is high in central and eastern zone and very less in western zone. Especially on eastern zone the probability of future urban growth is high.

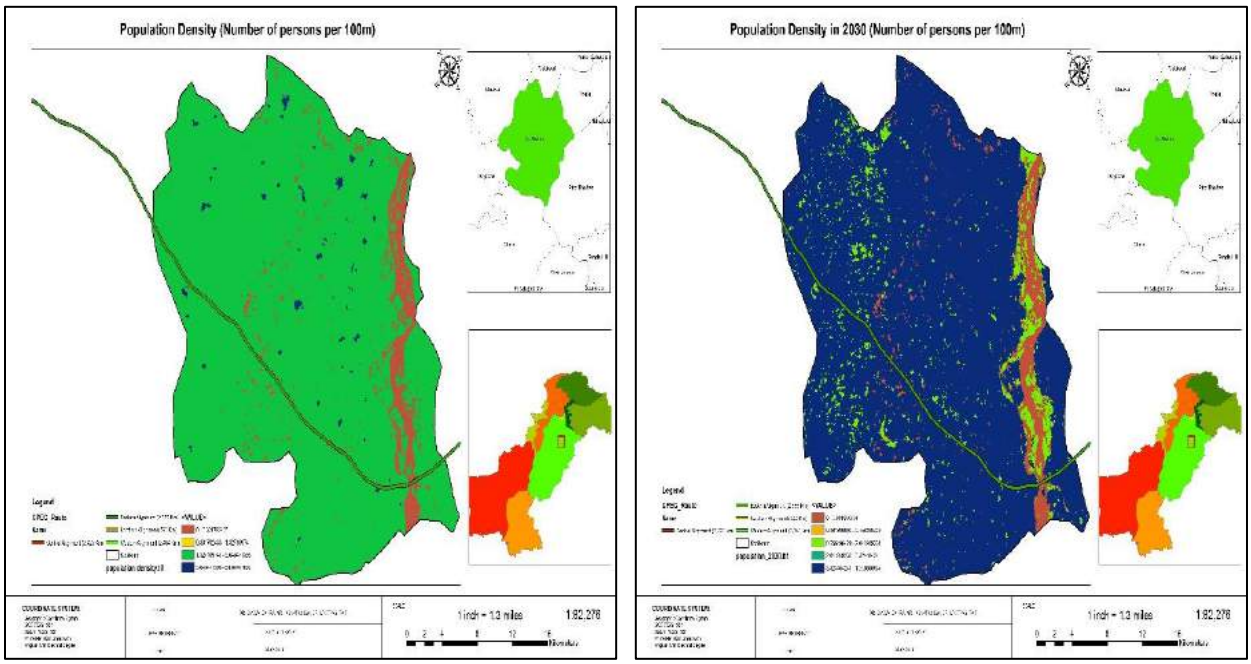
Map 4:



4.2.A Micro Level Analysis of CPEC Route:

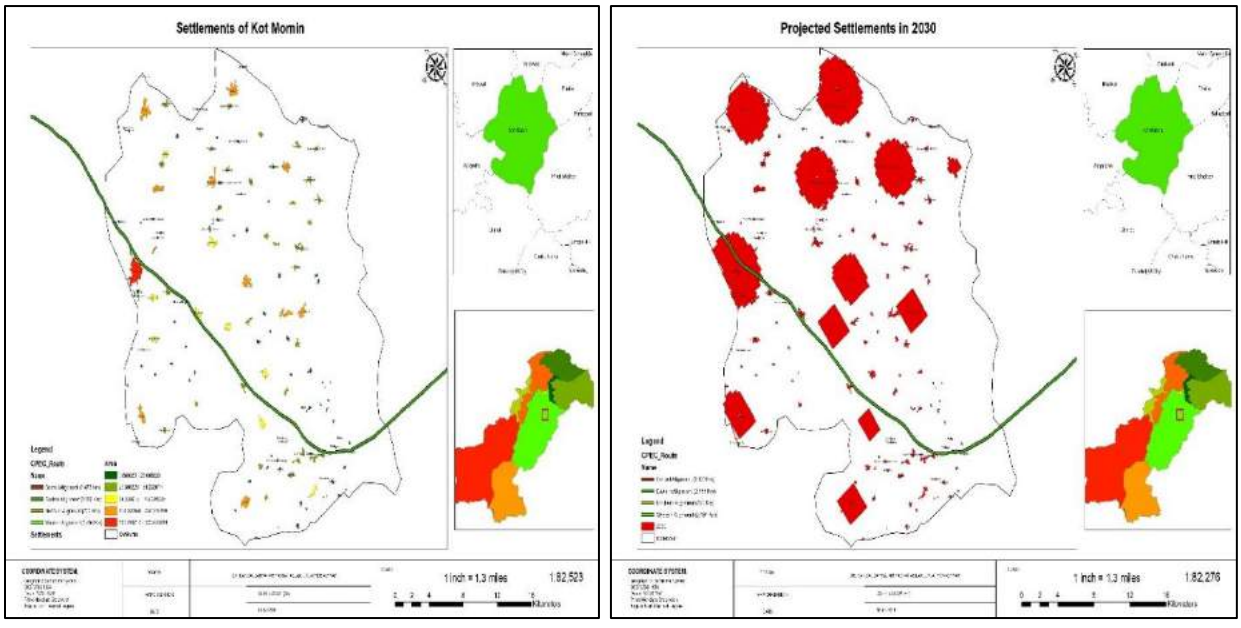
The analysis given above mainly for entire CPEC route which can be divided into multiple pockets to show existing position of infrastructure. This analysis is not only helpful for urban planning but also for industrial and agricultural potential. For this purpose, we take Kot Momin situated in district Sargodha along with eastern route of CPEC project.

Map 5: Comparative Analysis of Population Density



Population density maps shows a shift in population density during fifteen years of interval. During this time period projected population density will be increased remarkably. This can also be proved from the growth of projected urban settlements during said interval.

Map 6: Comparative Growth in Population Settlement



Majority of settlements are small with low density while in 2030, a visible growth pattern of settlement in surrounding parts of CPEC route of this area will be observed. The growth rate shows an enhancement of 2% in 2015 to 16% in 2030. The growth pattern observed during the said period shows that area grew from 20 km^2 to 144 km^2 by 2030, which comprised with land cover of 5010 acres in 2015 to 35343 acres in 2030.

In annexure, maps of road networks mainly shows an influence of primary road networks as this area is mainly included in rural areas of Sargodha district. The other maps show education and health institutions in area taken for study. As a rural area, it has few basic health unit, a network of primary school education, few high and higher secondary school. The industrial network is not very strong as the concentration of this area is agricultural with sugarcane and wheat as main production.

This micro level analysis can be used for all venues of CPEC route and special economic zones because it can help policy makers to design specific policy for future needs of the area. The study area is not productive in industrial point of view but similar analysis can be performed for the areas where industry for primary and secondary goods is already established and guide us for potential industry and economic activity of that specific area, on same line the education and health institution can also guide for future need once they compared with settlement growth and projected population density.

4.3.Mapping Effects of Special Economic Zone under CPEC Project:

For the purpose of future mapping of proposed special economic zones, we need to identify exact location through GPS coordinates. Unfortunately there is no data available for the economic zones proposed under CPEC projects. For the purpose of mapping, only Rashkai special economic zone is identified on Google map through different sources. This special economic zone has a 1000 acre of area with an international standard industrial planning. Although limited data is available which make mapping and projection of this economic zone bit difficult.

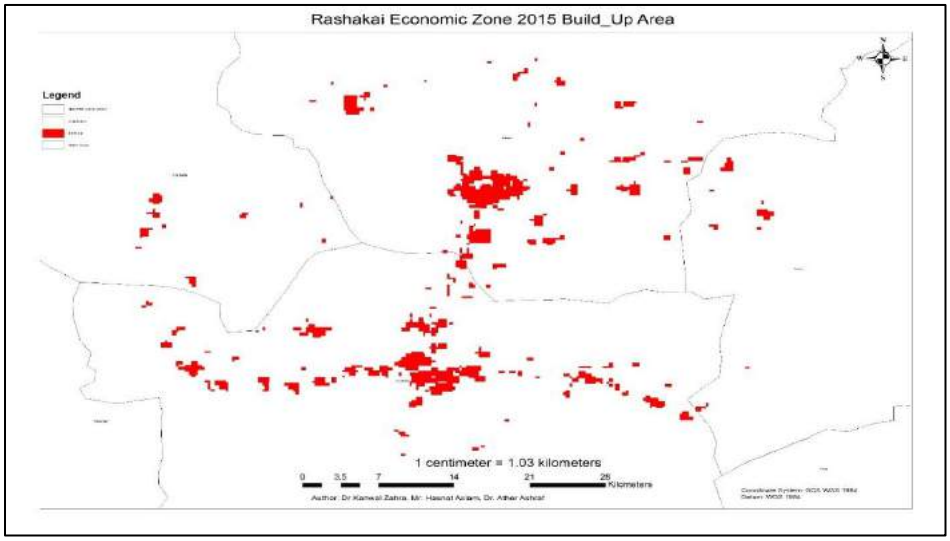
Under CPEC, Rashkai name changed to Rashkai technical city. It is a medium size town in KPK with 118,000 population. This special economic zone is situated 115 km from Afghan border.

There are five major rural settlement around this economic zones along with small scattered population pockets.

4.3.1. Temporal Urban Sprawl Mapping:

The map below shows a scattered picture of population in surrounding villages of Rashkai. These villages has approximately 523300 with a composition of 52% of female and 48% of male population. The implementation of this project will add growth in natural pattern of population increase. Rashkai Special Economic Zone (SEZ) has a potential to increase socioeconomic and demographic growth patterns as it will increase population growth through migration as well as development of new road network and other infrastructure.

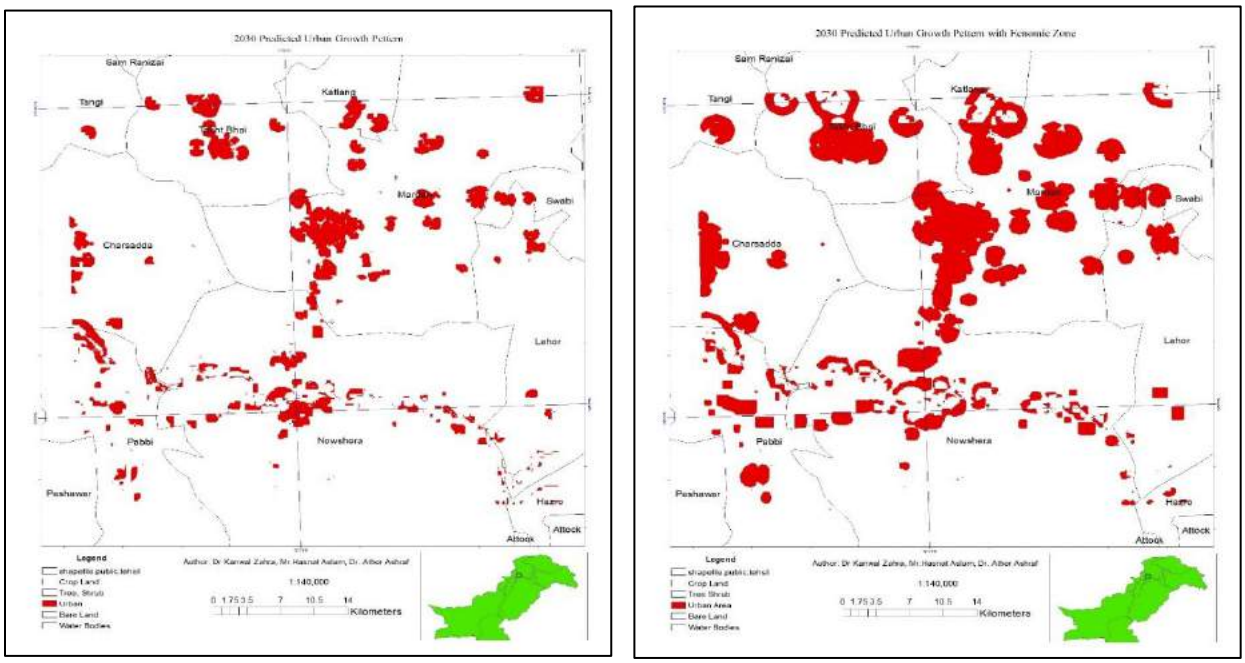
Map 7



Keeping an interval of fifteen years which depict built up and non-built-up area for the years of 2015 and 2030. The data set used for this purpose was land scan. The potential mapping covers urban sprawl, road and communication network, school and hospital network and other socio economic pattern. But data limitation restrict mapping only to population sprawl.

The growth pattern observed during the said period shows that area grew from 27 km^2 to 104 km^2 by 2030. The growth rate shows an enhancement of 4% in 2015 to 17% in 2030. The land cover area will grow by 5010 acres in 2015 to 35343 acres in 2030. The pattern of growth is scattered which shows a need of urban planning for better urban development.

Map 8: Predicted population Growth (2030) with and without Economic Zone



An analysis of population growth pattern from 2015 to 2030 shows an extension of population with SEZ in following manner:

a) Toward Mardan district in form of prominent major population settlements
b) Toward Nowshera district in form of prominent but small population settlements.
c) Toward Pabbi district in form of prominent but small population settlements

However a new pattern of development is observed along with Katlang and from Nowshera to Hazro. These new predicted settlements will establish in form of small pockets along with border side of district.

5. Conclusion

The study tries to forecast land use dynamics of CPEC project in Pakistan. For this purpose CA-Markov model and Fuzzy membership technique has been adopted on area selected on CPEC route and one special economic zone named Rashkai situated in Khyber Pakhtunkhwa. The analysis shows that population density at eastern route is greater than central and western route. Especially at western route, rare population settlement and less density is shown on maps. This shows an expected high cost of business at central and eastern route but in form of established primary industry and agricultural raw material and availability of skilled manpower these two route i.e.

eastern and central can be considered better than the third one because western rout has a range of grass field, mosaic crop, tree range in its adjacent areas. The micro level analysis use kot momin as study area. The analysis shows a visible growth pattern of settlement in surrounding parts of CPEC route of this area will be observed. The growth rate shows an enhancement of 2% in 2015 to 16% in 2030. The growth pattern observed during the said period shows that area grew from 20 km^2 to 144 km^2 by 2030, which comprised with land cover of 5010 acres in 2015 to 35343 acres in 2030. While demographic analysis of Raskai SEZ observed a growth pattern during the 2015-2030 that shows study area grew from 27 km^2 to 104 km^2 by 2030. The growth rate shows an enhancement of 4% in 2015 to 17% in 2030. The land cover area will grow by 5010 acres in 2015 to 35343 acres in 2030. The pattern of growth is scattered which shows a need of urban planning for better urban development.

The analysis become limited to population and some other dynamics as data about other dynamics is not available or acquired. This analysis can be extended to a comparison of socio-economic and demographic projections of different pockets situated at CPEC route to identify potential area for future investment both in goods and services industry as well as master planning for future cities. The analysis of SEZ located in or near by industrial cities can also be adopted for future research. It will not only help to design potential industry and its growth but also help to estimate future need of formal and technical education.

5.1.Limitation in CPEC Route and SEZ Dynamics Mapping:

- The mapping for entire CPEC route required data from all provinces of Pakistan, however only Punjab has furnished spatial data sets for describing socio-economic and demographic aspect of the surrounding areas of CPEC route.
- Time and resource constraints restrict analysis into basic land dynamics of CPEC route, however if we utilize good resources we can even plan for more dimensions in mapping which would help policy makers in designing urban infrastructure, industrial and agricultural needs for the future after and during CPEC project implementation.

5.1.1. For Micro Level Mapping (KOT Momin, Sargodha District) and Rashkai SEZ

- In case of Kot Momin, the accuracy of land cover data is also absent for the study area[6]

[6] The satellite base land cover data is used for the study which is based on Google earth, no ground survey is done for the verification purpose due to financial and time constraints.

- The study area has very less information being a part of backward area of Sargodha. A good insight can achieve by acquiring good data sources of all areas adjacent to this project. This will not only help to design industrial type but also urban infrastructure needs.
- The Location data of major SEZs is not available which restrict analysis to only one SEZ named Rashkai Special Economic Zone. The availability of information about other SEZ can make mapping more clear and fruitful as some of SEZ is surrounded by main industry and major crop of Pakistan. This will not only help to identify new potential industry but also new potential urban settlement and sprawl in future years.
- The SEZ mapping not only required population dynamics but also required information of existing industry, agricultural crop, irrigation, school and hospital data for better future planning. Unfortunately these information are not available for the study area of SEZ.

Recommendation:

The study focused on the impact of CPEC project on the urban footprint in Pakistan. For this purpose the area situated along with CPEC route and industrial zone was selected. Following recommendations are being made based on analysis by keeping all limitations in to account:

- The project intends to increase urbanization in the adjacent area of the route and special economic zones by new developments and extensions in existing urban centers. The policy should design to upgrade civic infrastructure in existing areas to reduce pressure on these areas as well as develop new settlements along with special economic zones so that country face less urban sprawl and related issues.
- The existing secondary and primary road infrastructure does not reflect satisfactory condition to approach main route. To create direct and indirect economic opportunities, it is recommended to develop new road infrastructure especially with western alignment to develop area and industry along with the route.

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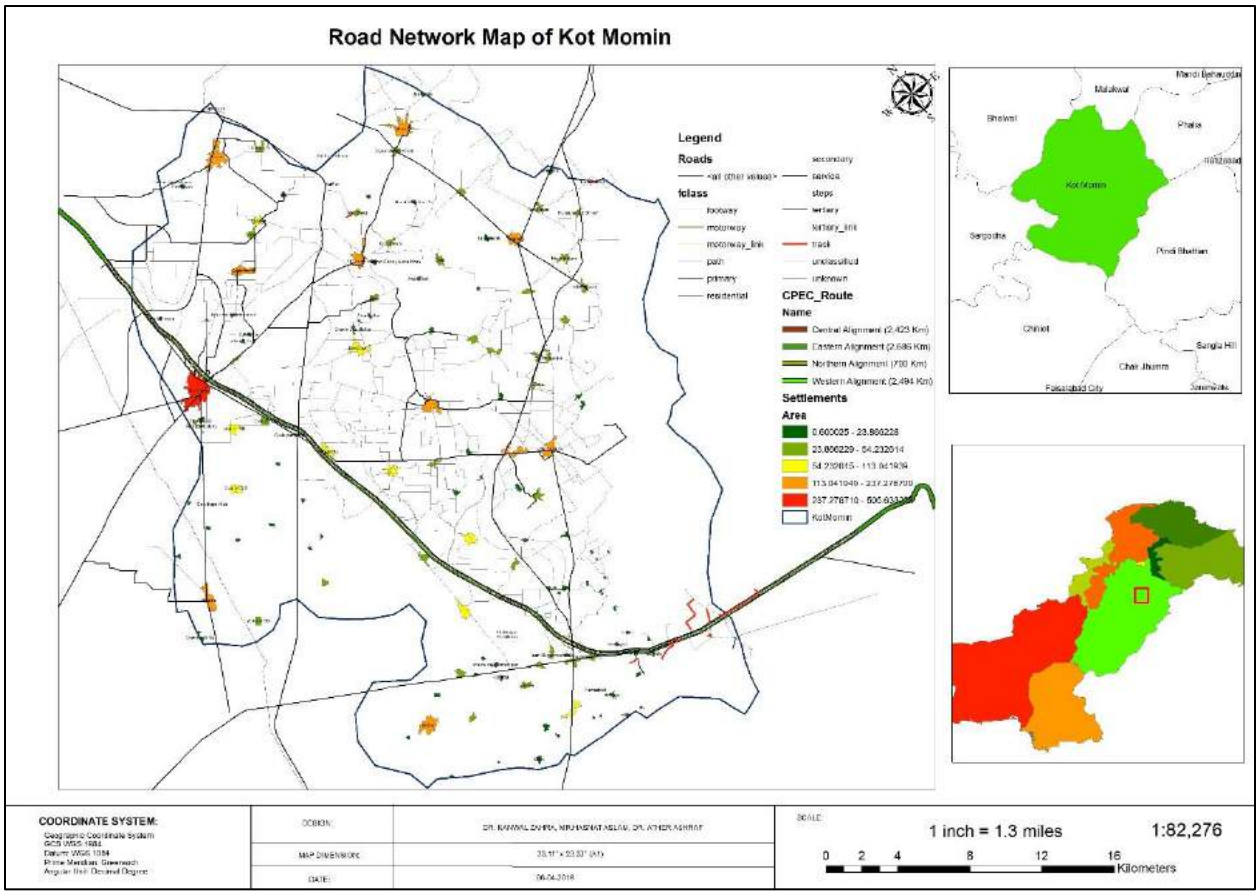
Annexure 1:


Road Network Map of Kot Momin
Legend
Roads
fclass
motorway
motorway_link
path
primary
residential
secondary
service
steps
tertiary
tertiary_link
track
unclassified
unknown
CPEC_Route
Name
Central Alignment (2,423 Km)
Eastern Alignment (2,685 Km)
Northern Alignment (700 Km)
Western Alignment (2,494 Km)
Settlements
Area
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23.860229 - 54.232514
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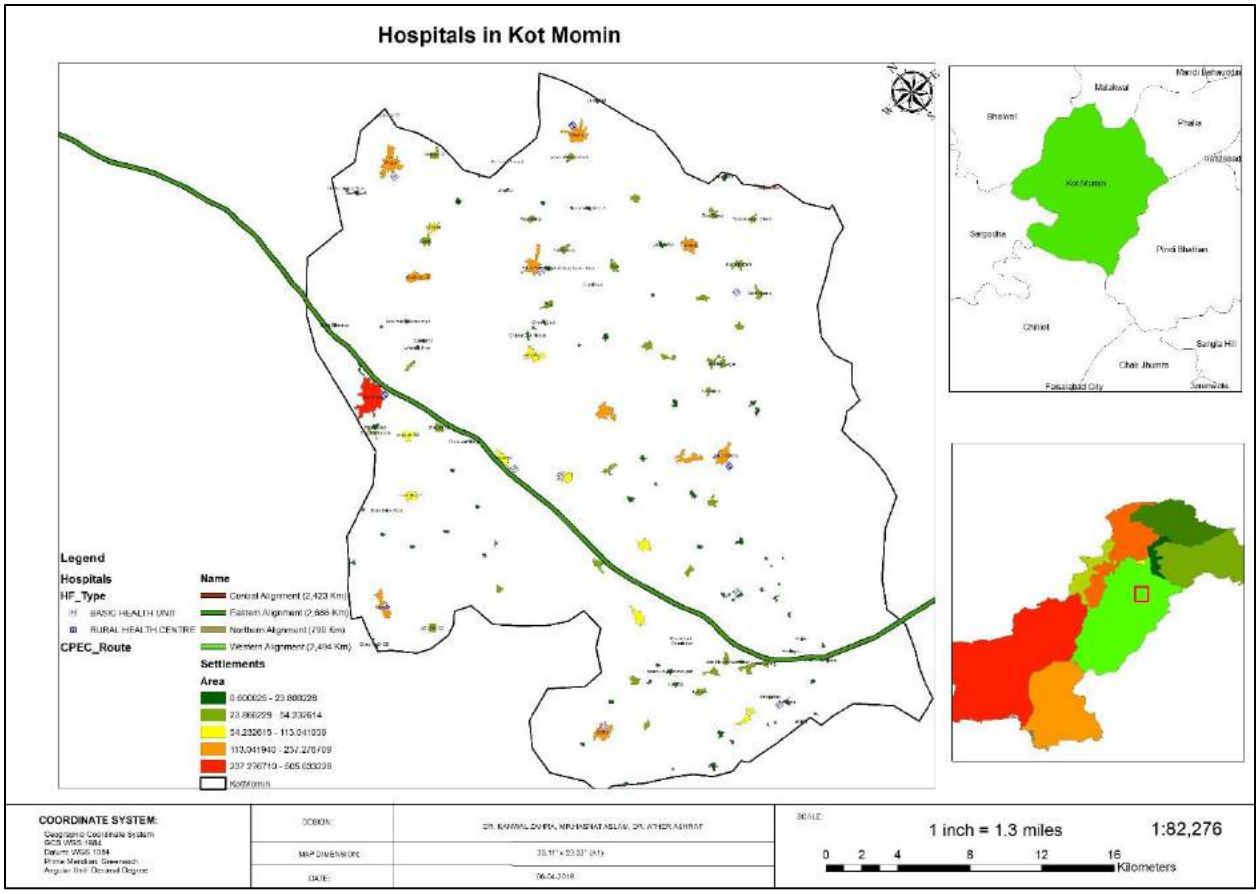
113.841940 - 237.276709
237.276710 - 606.633200
KotMomin
Malakwal
Bhalwal
Phalia
Kot Momin
Sargodha
Pindi Bhattian
Chiniot
Sangla Hill
Chak Jhumra
Faisalabad City
COORDINATE SYSTEM:
Geographic Coordinate System
GCS WGS 1984
Datum WGS 1984
Prime Meridian: Greenwich
Angular Unit: Degrees
AUTHOR:
MAP DIMENSIONS:
DATE:
SCALE:
1 inch = 1.3 miles
1:82,276
0 2 4 8 12 16
Kilometers


Hospitals in Kot Momin
Legend
Hospitals
HF_Type
BASIC HEALTH UNIT
RURAL HEALTH CENTRE
CPEC_Route
Name
Central Alignment (2,423 Km)
Eastern Alignment (2,688 Km)
Northern Alignment (700 Km)
Western Alignment (2,494 Km)
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KotMomin
Mandi Bahauddin
Malakwal
Bhalwal
Phalia
Kot Momin
Sargodha
Pindi Bhattian
Chiniot
Sangla Hill
Chak Jhumra
Faisalabad City
COORDINATE SYSTEM:
Geographic Coordinate System
GCS WGS 1984
Datum: WGS 1984
Prime Meridian: Greenwich
Angular Unit: Decimal Degree
DESIGN:
DR. KANWAL ZAHRA, MUHAMMAD ASLAM, DR. ATHER ASHRAF
MAP DIMENSIONS:
33.11" x 23.37" (A1)
DATE:
06.04.2018
SCALE
1 inch = 1.3 miles
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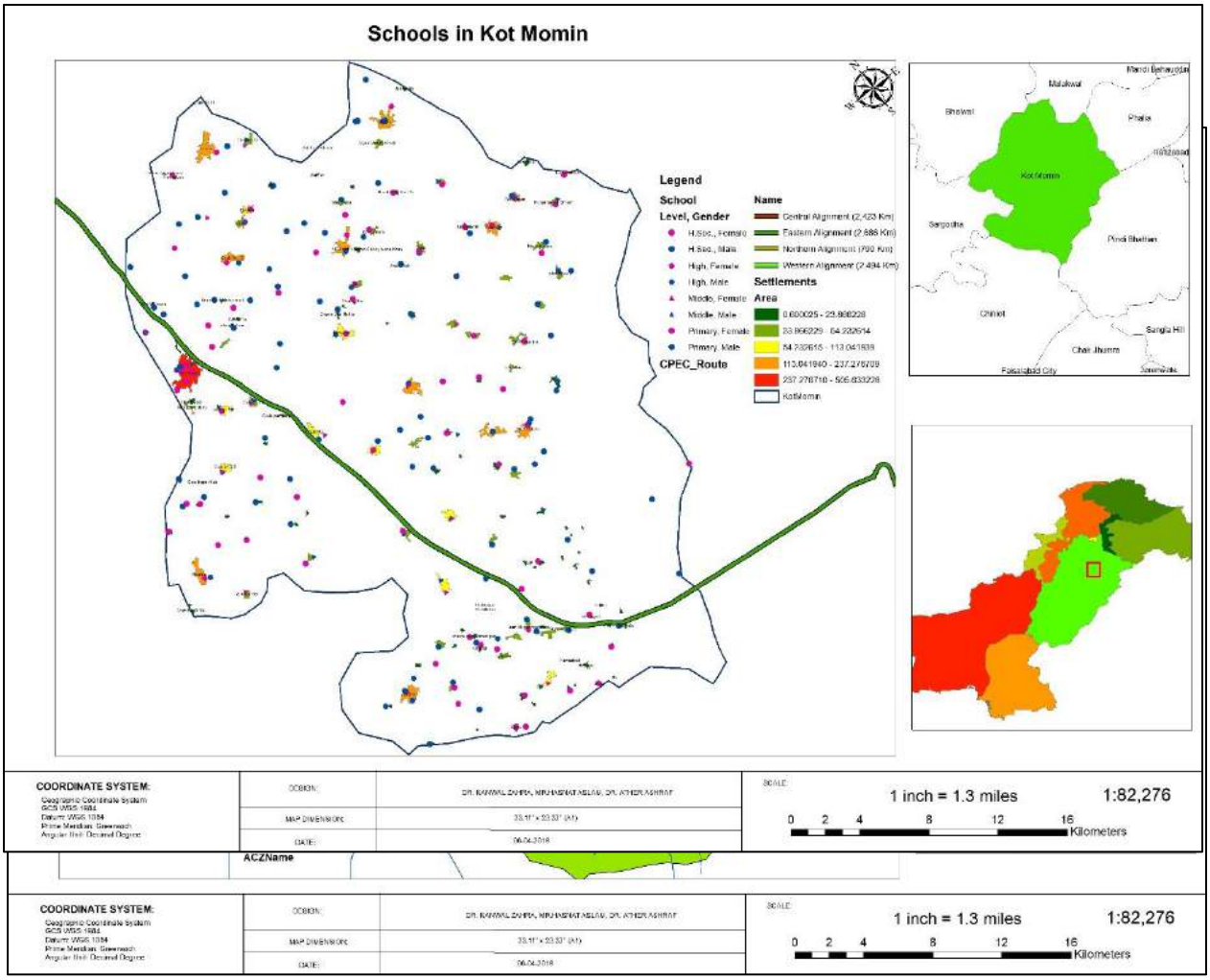
0 2 4 8 12 16
Kilometers



COORDINATE SYSTEM:
Geographic Coordinate System
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Datum: WGS 1984
Prime Meridian: Greenwich
Angular Unit: Degree
DESIGN:
DR. KANWAL ZAHRA, MUHAMMAD ASLAM, DR. ATHER ASHRAF
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06.04.2018
SCALE:
1 inch = 1.3 miles
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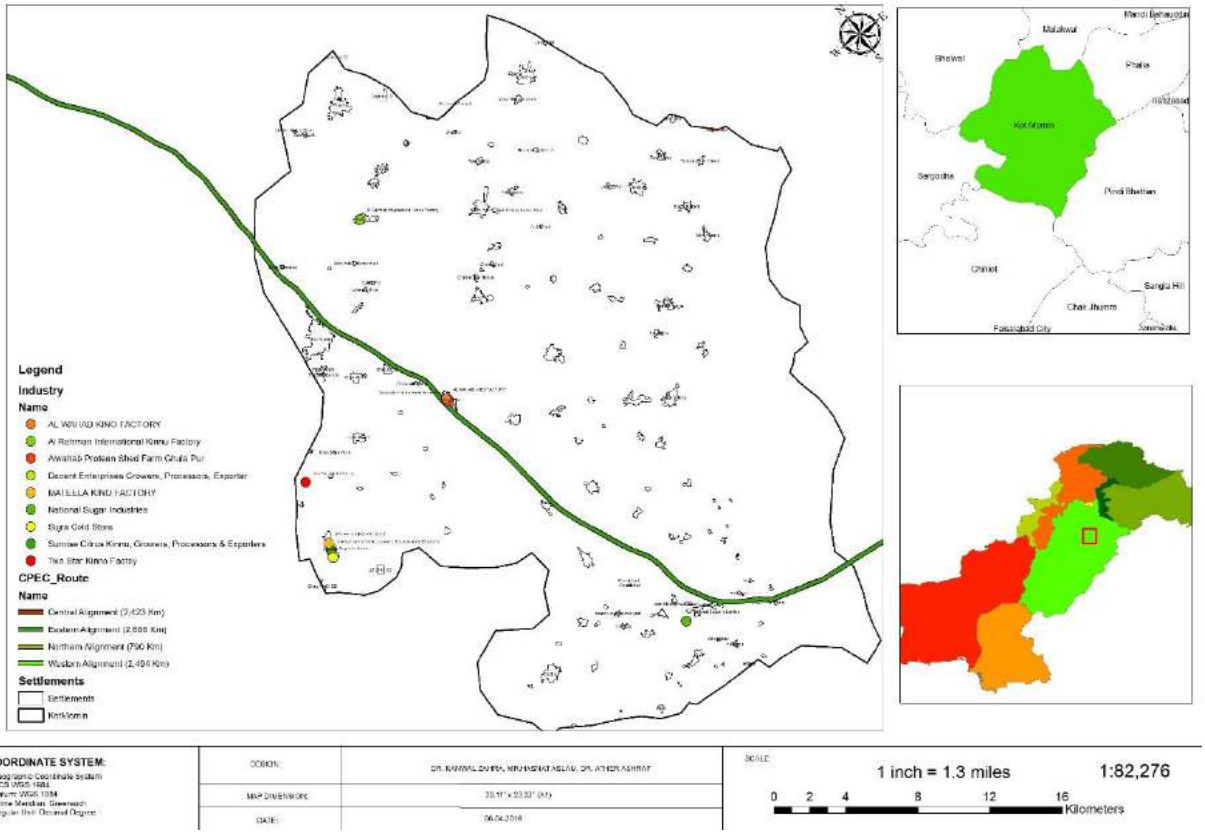
Kilometers

Industries in Kot Momin



Annex 2:

Table 1: Special Economic Zones under CPEC

S.No	Name of Zone	Location
1	ICT Model Industrial Zone	Islamabad-Federal Government
2	Industrial Park- Port Qasim	Karachi- Federal Government
3	Mohmand Marble City	Federal Administrative Tribal Area (FATA)
4	Allama Iqbal SEZs	Faisalabad-Punjab
5	Rashakai, Economic Zone (REZ)	M-1-Khyber Pakhtunkhwa (KPK)
6	China Special Economic Zone	Dhabeji-Thatta-Sindh
7	Boston Industrial Zone	Boston- Baluchistan
8	Moqpondass Special Economic Zone	Gilgit Baltistan (GB)
9	Bhimber Industrial Zone	Azad-Jammu and Kashmir (AJK)

Sources: Ministry of Planning, Development and Reforms