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Distribution Trend of Chemical Industry and the Resultant Landscape Changes in Kochi

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Introduction:

Human interaction over space is the focal theme of every geographic study. Economic Geography is one such discipline that deals with the distribution of economic activities, the spatial manifestations of these activities and its effects. Industrial location theories are the building blocks of Economic Geography.Although the traditional location theories are outmoded and challenged by the modern economic equations and globalization, the geographic realization of how and why certain spatial pattern or localization of activities occur still seems relevant. It has been found that certain sectors of manufacturing concentrates or get localized in certain areas. It can be due factors of production, as established by location theories or because of agglomeration forces (Krugman, P, 1991).

Urban spatial structure is by and large determined by the location of its economic activities. Cities grow and evolve around these activity centers. It also controls the direction and trajectory of urban growth and development. Moreover, manufacturing industries tend to locate at points away from residential centers making use of land availability. Gradually, the land in between industrial centers and residential centers fill up and urban sprawl occurs. Thus it influences urban planning. Therefore, the studies regarding industrial location help in land use management and practices, urban planning, environmental monitoring and sustainable development.

Kochi is a west coast port city and the largest city of Kerala. Chemical industry is one among top ten manufacturing industries of Kochi. According to the report of District Industries Centre (2018) Kochi holds 861 chemical manufacturing houses providing employment to 13284 persons as on 31/03/2017.This paper attempts a distributional analysis of chemical industries of Kochi. The paper finally assess multi-temporal satellite images to trace changes in built up areas and concrete landscape of select areas through Index Based Built up Index (IBI) in Arc GIS platform.

Objectives:

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- To find out the distribution pattern of chemical industry in Kochi
- To assess the built up land changes in select areas of Kochi.

Study Area:

Kochi is the largest city in Kerala and commonly called as 'the financial capital of Kerala'. Theselected area is located between 9° 47' 16" N to 10° 12' 39" N latitudes and 76° 12' 18" E to 76° 30' 36" E longitudes across an area of 658 sq.km. The area falls under the midland and the coastal plains. The altitude generally increases towards Northeast. The maximum elevation for the entire region is 76m above mean sea level at Karimugal. RiverPeriyar drains this area.Kochi has a large backwater network near the coast and it has helped in transportationand supporting the livelihood of a fair portion of the population since ancient times. Kochi has a hot humid tropical climate with an annual average minimum temperature of 30.5 ℃. The average annual rainfall ranges from 250 cm to 360 cm (District Census Handbook, Part A, 2011).

The total population of the selected area is 1719891. Kochi is a market center and has accessibility with many other market centers. Kochi is a transportation hub for the whole district of Ernakulam and the nearby areas of adjoining districts. This well connected transport network expedited the rural urban transformation of the region.

Materials and Methods:

A sample of 70 chemical manufacturing units were randomly chosen from the data obtained from District Industries Centre (DIC), Ernakulam and from Kerala State Industrial Development Corporation (KSIDC), Thiruvananthapuram and distribution maps were prepared in Arc GIS. Clustered areas were identified through Kernel Density Estimation tool.As such the municipalities of Kalamassery and Eloor and Kadungalloor panchayats having high clustering were selected for built up area change analysis of past 25 years (1994 to 2019). Index Based Built-up Index (IBI) in Arc GIS is the technique employed for built up change detection. The database was multi temporal satellite images obtained from USGS Earth explorer (earthexplorer.usgs.gov). They are:

i. Landsat 5 TM data captured on 04 February 1994.
ii. Landsat 8 OLI/TIRS data captured on 08 January 2019.

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IBI make use of three thematic indices namely, Soil Adjusted Vegetation Index (SAVI), Modified Normalised Difference Water Index (MNDWI) and Normalised Difference Built up Index (NDBI) to represent soil, water and built up land, the three major urban components. The indices make arithmetic calculation using four spectral bands: Green, Red, Near Infrared (NIR) and Mid Infrared (MIR) bands. Thus IBI is arithmetically calculated through the following steps:

NDBI = (MIR – NIR) / (MIR + NIR)

MNDWI = (Green – MIR) / (Green +MIR)

SAVI = {(NIR – Red) (1+*l*)} / (NIR + Red + *l*); *l* is the correction factor, the value ranges from 0 to 1 where very high plant densities will be given 0 and very low plant densities will be given 1 (Ridd, 1995). For this study *l* is given value of 0.5.

Hence, IBI = $\frac{\{NDBI - (SAVI + MNDWI) / 2\}}{\{NDBI + (SAVI + MNDWI) / 2\}}$; (H Xu, 2008)

The value of IBI ranges from -1 to 1, where the enhanced features are represented by positive values. This IBI raster images for both 1994 and 2019 were then reclassified using spatial analyst tool into binary images comprising built up and non-built up classes. This was done by assigning the value 1 for every built up features and 0 for non-built up features. The reclassified images were later converted from raster to vector using conversion tool. Then area was calculated for built up and non-built up land to detect change from 1994 to 2019. This was represented as table and urban growth map.

Results and Discussions:

The economy of Kochi is driven by its tertiary sector like any other parts of Kerala. But manufacturing industries has played a significant role in determining the land use practices and urban growth trends of the city. It is evident from map 02 that chemical industry of Kochi has an uneven distribution pattern. The units are highly clustered at certain locations like Eloor and Kalamassery. Clustering reduces cost of production, increases quality and competitiveness, promotes technological innovation and spreading of the technical know-how among units, thereby leading to modernisation. As a result of this, Government of India introduced cluster based development model in 1990s. Consequently, Kerala Government adopted cluster based approach through the State Industrial Policy of 2003.

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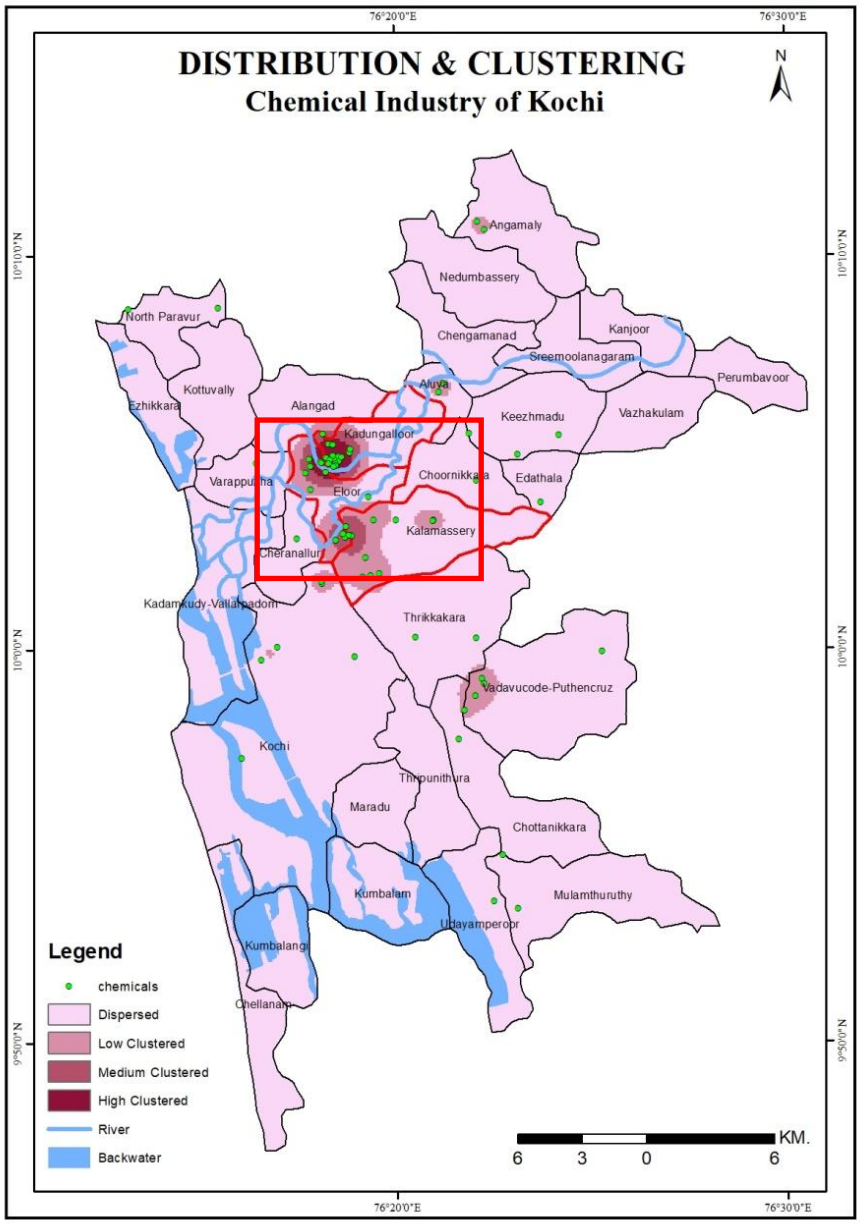
Map 02: Distribution of Chemical Industry & Cluster Zones



The query that what are the land conditions after the mushrooming of industries at these clusters is always relevant. Establishment of numerous industries upon a small tract of land obviously has resulted in changing the landscape of that area by increasing impervious concrete surfaces at the cost of water and vegetation. These impermeable concrete structures are called as built up areas, the monitoring and measuring of which is a significant indicator in analysing urban growth and for sustainable land resource practices.

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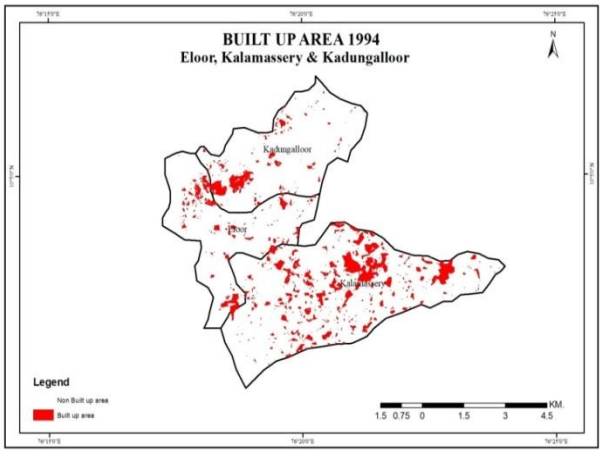
Built up Land Change Analysis:

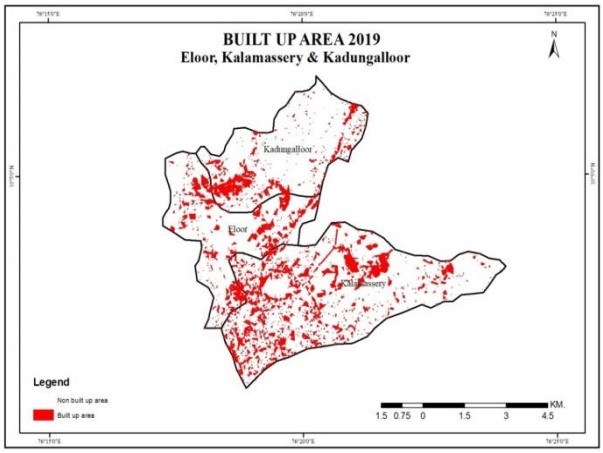
For detecting changes in built up land, binary images of built up and non-built up features were created using IBI. The positive values of IBI represents built – up features. For the change assessment a 25 year time period was taken by using Landsat 5 TM data of 1994 and Landsat 8 OLI/TIRS data of 2019. Analysis was conducted only for three administrative units where the agglomeration zones fall in (inside the red box in Map 02). These are Eloor Municipality, Kalamassery Municipality and KadungalloorPanchayat.

Industrial growth in an area definitely results in conversion of land from agricultural and other uses to built-up and industrial uses. Establishment of industry in an area also results in spreading of commercial establishments, more roads and other concrete structures thereby bringing urban imprints in that area. Generally, built up area expands at the cost of vegetation and water bodies. This will have serious repercussions in the environment and sustainability of that area. Therefore timely monitoring and assessment of urban growth is necessary to plan for the sustainable growth of theses agglomeration zones.

From, the maps (03, 04 & 05) it is evident that within a period of 25 years a large tract of land has been converted into built up areas. All these are green field developments that might have occurred clearing forest or agricultural lands. Kalamassery has registered a rapid urbanisation over these two and half decades. It has been found out that (table 01) built up land in this area increased from 5.4 sq km in 1994 to 10 sq. km in 2019 registering an increase 85.2%.

Map 03: Built up area, 1994Map 04: Built up area, 2019





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Map 05: Urban Growth Model (1994 -2019)

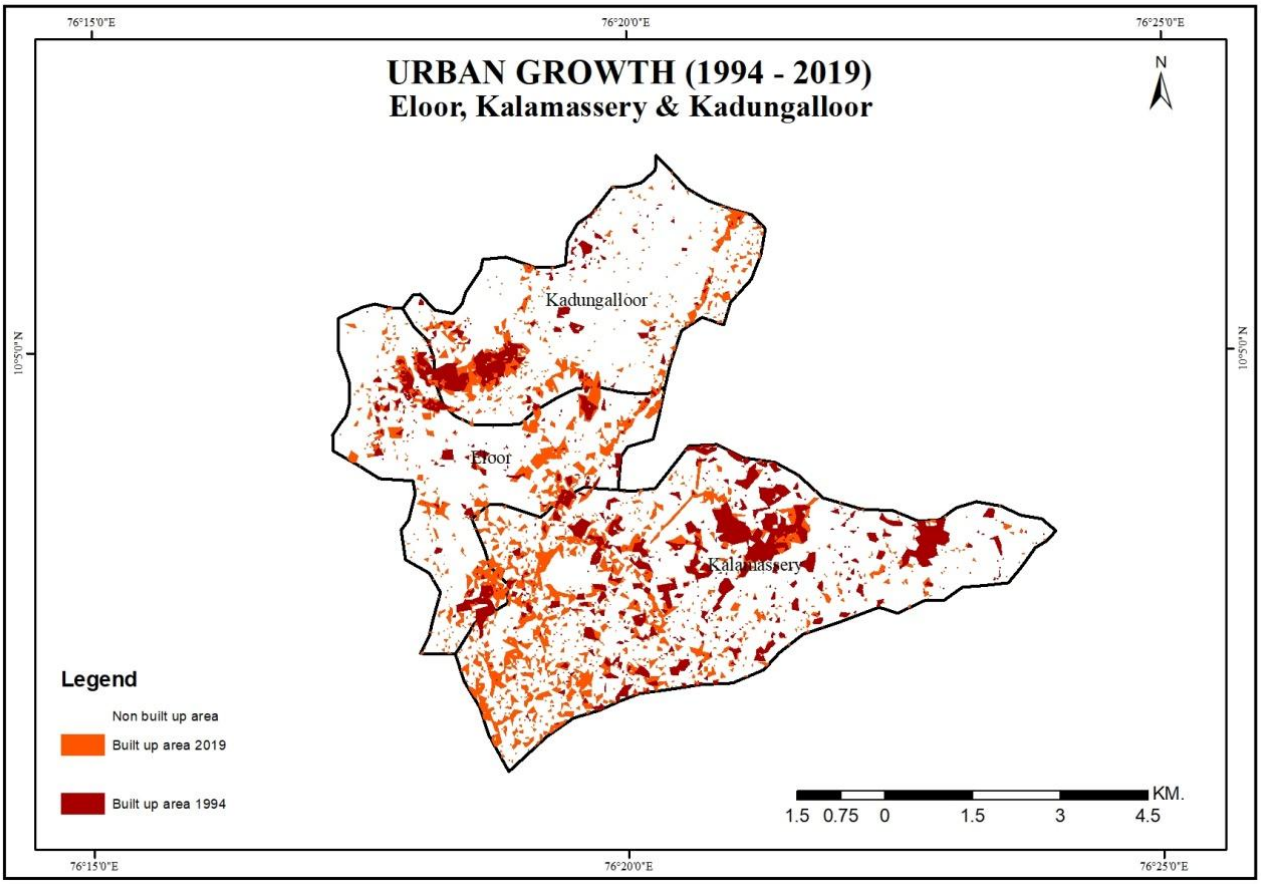

Table 01: Temporal changes in built up area

Category	Area in 1994 (sq.km)	Area in 2019 (sq.km)	Percentage change
Built up area	5.4	10	+85.2
Non built up area	49.6	45	-9.3
Total	55	55	—

It is obvious that the areas that had been previously used for other land uses were largely altered into concrete structure to meet the requirements of ever increasing population and urbanisation. Kalamassery is urbanising at a faster pace where vegetative cover is rapidly decreasing. Initially the urban growth confined to certain pockets have now been scattered throughout the region

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resulting in tough differentiation of rural pockets from the urban expansion. Thus it has been proved that spatial localisation of industries has resulted in rampant urban expansion of Kochi. But the negative environmental consequences shall be taken into account and it should be subjected to further studies.

Conclusion:

It may now be concluded that the chemical industry of Kochi exhibits dense spatial concentrations at Eloor and Kalamassery owing to factors like land, drainage, transportation and institutional policies. It has been found at that this spatial agglomeration has resulted in urban growth and rapid rise of built up areas at these areas. This spatial localisation has acted as urban growth poles attracting urban developments from city heart to these peripheral areas. Even though it supports urbanisation, the negative effects of this industry driven urban growth shall not be foreseen and should take strict measures to ensure sustainable development of the area.

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