



Adam Smith
International



POLICY BRIEF

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GDP OF KHYBER PUKHTUNKHWA'S DISTRICTS

MEASURING ECONOMIC ACTIVITY USING NIGHTLIGHTS

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ABOUT SEED

Sustainable Energy and Economic Development (SEED) is a £37.5 million programme funded and managed by the UK's Foreign Commonwealth and Development Office (FCDO). The first component - Improved Economic and Urban Planning in Khyber Pakhtunkhwa (KP) – with a budget of £15 million, is delivered by Adam Smith International (ASI). The SEED programme, in close collaboration with the Government of Khyber Pakhtunkhwa (GoKP), aims to improve economic and urban planning in Khyber Pakhtunkhwa (KP) to help the province plan and finance investments needs for growth, jobs and prosperity.

This nightlights study has been undertaken in collaboration with and using support from, the Regional Accounts Wing at the KP Bureau of Statistics.

I Introduction

This policy brief, and the research study on which it is based, has been commissioned by FCDO's SEED program to support the Government of Khyber Pakhtunkhwa (KP) in understanding the spatial distribution of economic activity within the province. It uses nightlights (NTL) data to provide insights into:



District-level Gross Domestic Product (GDP), GDP growth and income per capita



For KP's major cities, patterns of growth and the distribution of economic activity within the city



Province-level estimates of GDP

These insights can be utilized by the Government of KP to plan effective, well-targeted public investments that support growth and address regional disparities. They can be used, for example, to plan road infrastructure to improve the connectivity of existing economic clusters. In addition, the data reveals low and stagnating levels of urbanization in KP overall, indicating that the growth potential of cities is not being utilized fully. This can be useful in planning secondary cities and in addressing pockets of stagnation to ensure that development is inclusive and that all areas of KP are able to become a part of KP's growth story.

In addition, insights on the existing cities can feed into better urban planning, for example to address issues of urban sprawl and plan for the provision of urban services and infrastructure to accommodate the pace and direction of growth. This in turn will ease the bottlenecks that prevent cities from becoming efficient and environmentally sustainable contributors to the provincial economy.

This is the first study in Pakistan to use this novel approach to estimate district- and city-level economic activity. It will remain a practical complement to official data as it allows for live feedback on the state of the economy at levels of disaggregation as fine as 1 km², in addition to being readily available, easy to use and inexpensive.

| Methodology

This study uses harmonized nightlight data to estimate non-farm economic activity. At the first stage, cross-country data is used to estimate the elasticity between GDP and nightlights growth, to help establish the strength of nightlights data in estimating GDP. The second step involves a similar exercise at the national level for South Asian countries and the subnational (province/state) level for urban areas in Pakistan and India. We find that while the relationship still holds at the subnational level, it is weaker than that in the cross-country regression, indicating lower strength in estimating GDP in the South Asian economies. At the third stage, the estimated coefficients from the sub-national model are used to estimate the non-agricultural component of GDP for the KP province of Pakistan. At the fourth stage, to arrive at the GDP of the districts and cities of KP, official provincial GDP is distributed using nightlights to determine the share of non-agricultural GDP in each district and city, and the share of rural population to distribute the share of agricultural GDP. Finally, the distribution of nightlights at the district level along with the daytime satellite imagery is used to identify urban growth trends.



Key Insights:



District-wise distribution

District-level estimates of economic activity are arrived at by distributing official provincial GDP numbers in proportion with nightlights for non-agricultural activity, and in proportion with the rural population for agricultural activity. Figure 1 overlays district boundaries on the map of nightlights in KP. The existing urban agglomeration in the Peshawar division and emerging agglomeration in the Hazara division are highlighted. The district GDP figures and district ranking based on the overall size of the local economy are presented in Table 1. The district-wise ranking is also shown using a heat map in Figure 2.

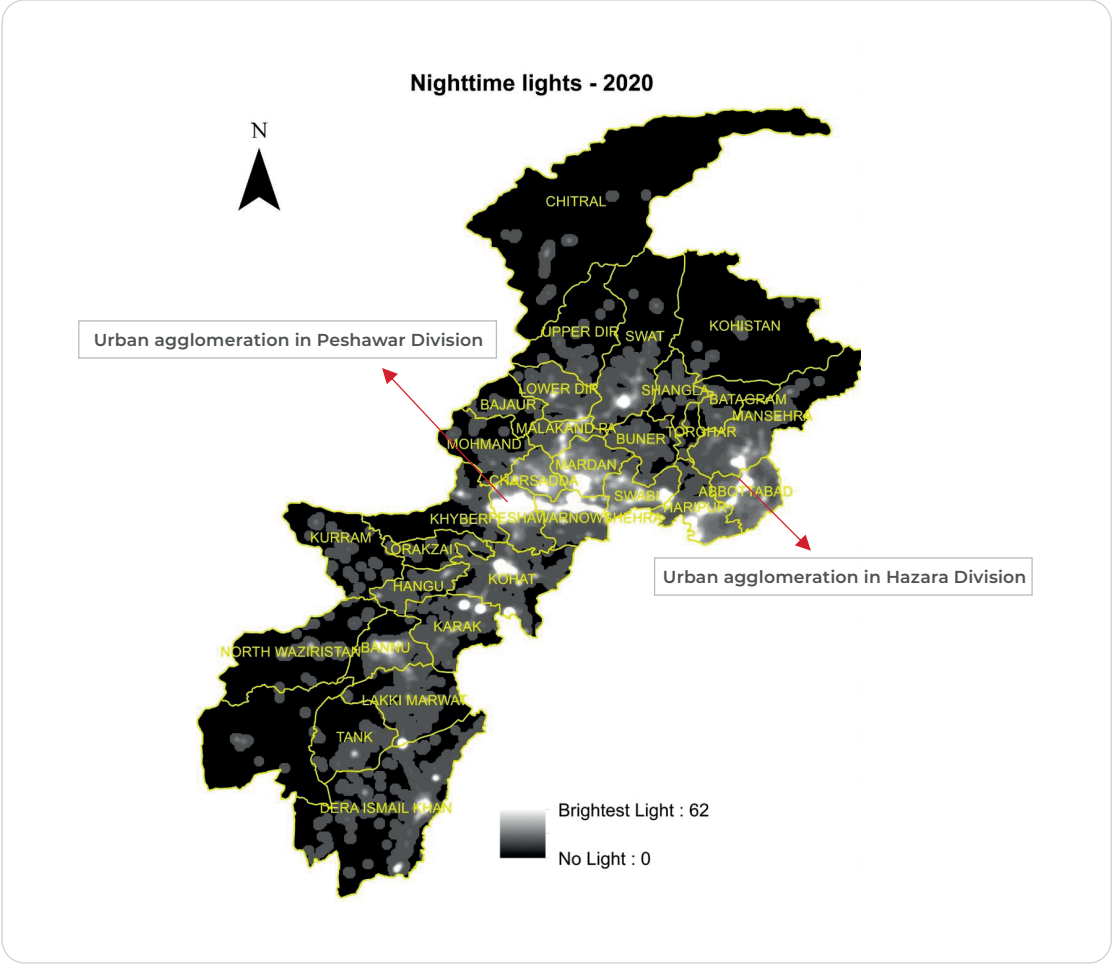


Figure 1: Nightlights in KP Province

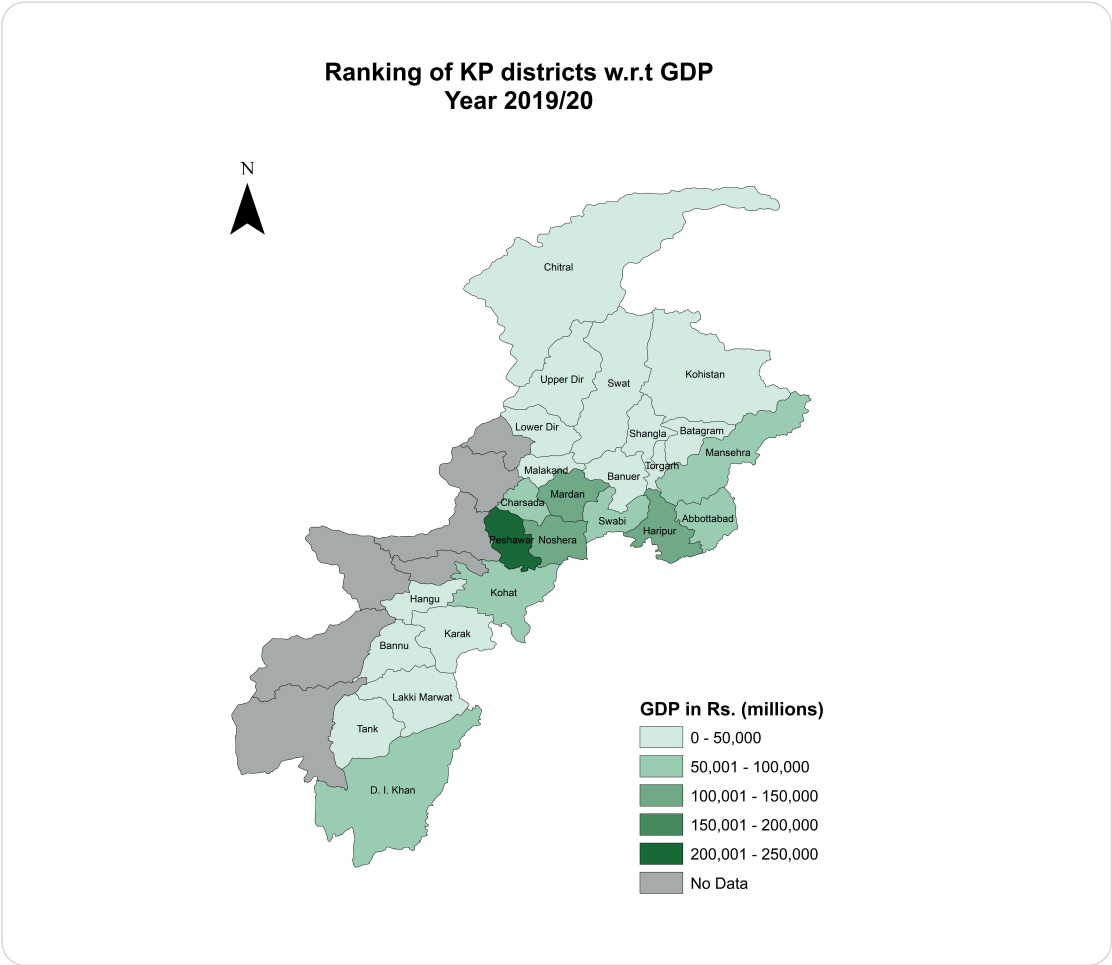


Figure 2: Heatmap of Districts' GDP Levels

Table 1: Economic Ranking of KP Districts

District	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GDP (Rs. in millions)		GDP per capita	GDP share (%).		Rank	Change	
	2005-06	2019-20	2019-20	2005-06	2019-20	2005-06	2019-20	
Peshawar	106,853	228,583	53,543	16	19	1	1	Same
Nowshera	55,821	142,301	93,708	8	12	4	2	Up
Mardan	69,816	113,350	47,765	10	9	2	3	Down
Haripur	35,655	104,021	103,707	5	9	7	4	Up
Abbottabad	23,240	81,088	60,835	3	7	11	5	Up
Swabi	53,070	74,478	45,843	8	6	5	6	Down
D. I. Khan	33,709	72,156	44,345	5	6	8	7	Up
Charsada	57,788	56,273	34,817	9	5	3	8	Down
Kohat	29,184	52,264	52,586	4	4	9	9	Same
Mansehra	23,115	51,039	32,791	3	4	12	10	Up
Bannu	36,221	45,886	39,289	5	4	6	11	Down
Swat	28,001	40,085	17,355	4	3	10	12	Down
Malakand	12,973	33,430	46,411	2	3	15	13	Up
Lakki Marwat	16,627	28,166	32,146	2	2	14	14	Same
Lower Dir	16,976	23,418	16,308	3	2	13	15	Down
Karak	12,491	14,650	20,741	2	1	16	16	Same
Tank	7,328	8,617	21,988	1	1	21	17	Up
Hangu	7,418	8,301	16,000	1	1	20	18	Up
Buner	10,547	8,107	9,034	2	1	17	19	Down
Upper Dir	8,457	6,665	7,042	1	1	19	20	Down
Shangla	3,927	6,403	8,448	1	1	24	21	Up
Batagram	4,758	4,932	10,348	1	0	23	22	Up
Chitral	6,551	4,632	10,355	1	0	22	23	Down
Kohistan	8,947	1,544	3,032	1	0	18	24	Down
Tor Ghar	1,221	811	4,733	0	0	25	25	Same

Several interesting insights can be gleaned from the data:

- Table 1 indicates that whereas the overall economy of Peshawar district is the largest in the KP province, Haripur district has the highest per-capita income followed by Nowshera and Abbottabad. In terms of per-capita GDP, the lowest figure is for Kohistan district preceded by Tor Ghar district. These results are consistent with the per-capita estimates from district-level Multidimensional Poverty Index (MPI) estimates made by UNDP Pakistan.
- The share of Peshawar in the provincial economy has grown from 16% to 19% from 2005-06 to 2019-20.
- The extent of regional disparity within KP is considerable whether measured through the overall size of the local economy or through per capita figures.
- Focusing on the lagging districts, Kohistan and Tor Ghar districts continue to be the lowest end of the spectrum in terms of overall economic activity. In terms of contribution towards the provincial economy, the combined share of eight lagging districts—Hangu, Buner, Upper Dir, Shangla, Battagram, Chitral, Kohistan, and Tor Ghar—is lower than the individual

share of more economically prosperous districts such as Peshawar, Nowshera, Mardan, and Haripur.

- Per capita GDP estimates at the district level reveal a similar story where there is a staggering difference among districts. The per capita GDP of Kohistan district is thirty times lower than that of Haripur district. The situation of the poorest four districts identified as Shangla, Upper Dir, Tor Ghar, and Kohistan has also been validated using multiple indicators such as literacy rates, Enrollment Gender Parity Index, and the UNDP developed district-level multidimensional poverty indices for the year 2014-15.
- All the newly merged districts except Khyber, Mohmand and North Waziristan have a nearly null share in the manufacturing/services sector as assessed by the NTL. As such we can safely assume that most economic activity in the region relates to the farming sector.
- Using the NTL share and the rural population share, the share of economic activity in the NMDs is around 1 % of national GDP.
- The district-level NTL map (Figure 1) along with the GDP map (Figure 2) indicates that economic growth and prosperity are strongly correlated with urban development. The districts with high GDPs—Peshawar, Nowshera, and Mardan—are the ones with the brightest NTL as well. Thus, it is evident that the agriculture sector's potential to bring major changes in the local economy is limited. This finding is in line with the urban economic theory that states that high density of population and economic activity in cities unleash agglomeration economies and benefits of scale.
- Following the high economic value block of Peshawar, Mardan, and Nowshera, the map shows that Haripur and Abbottabad districts form another emerging agglomeration. Economic spillover benefits can be observed in the case of Swabi, Mansehra, and Kohat districts as they are geographically contiguous to one or more high GDP districts. Thus, a pattern of growing and lagging districts is visible and hence could be useful for future public sector investment decisions. The NTL data also indicates that around 85% of non-farm economic activity is currently located in seven districts of KP: Peshawar, Nowshera, Haripur, Mardan, Abbottabad, D. I. Khan, and Kohat.
- The process of urbanization in the KP province has largely remained stagnant. As such, KP's share in the national economy has also remained around 9–10% in the period under study.



Cities

Since urban areas generate mostly industrial and service sector economic activity, nightlights are the best fit for generating city-level insights. Figures 3 and 4 illustrate economic activity in the Peshawar district and the city specifically. To examine intracity patterns of urbanization in our analysis, the city is divided into five distinct zones. The High and Medium-high zones refer to the city core and areas surrounding the core. The Medium region is the relatively less urbanized part of the district. The Medium-low region is the low-density boundary between the urban and rural regions and is indicative of urban sprawl and future direction of development. Finally, the Low region is the rural area of the district. In Figure 4, the core area boundary for the years 2014 and 2020 is overlaid on a Google map to add a specific place perspective and indicate the pattern of growth more explicitly. Figures 5 and 6 repeat this exercise for Abbottabad.

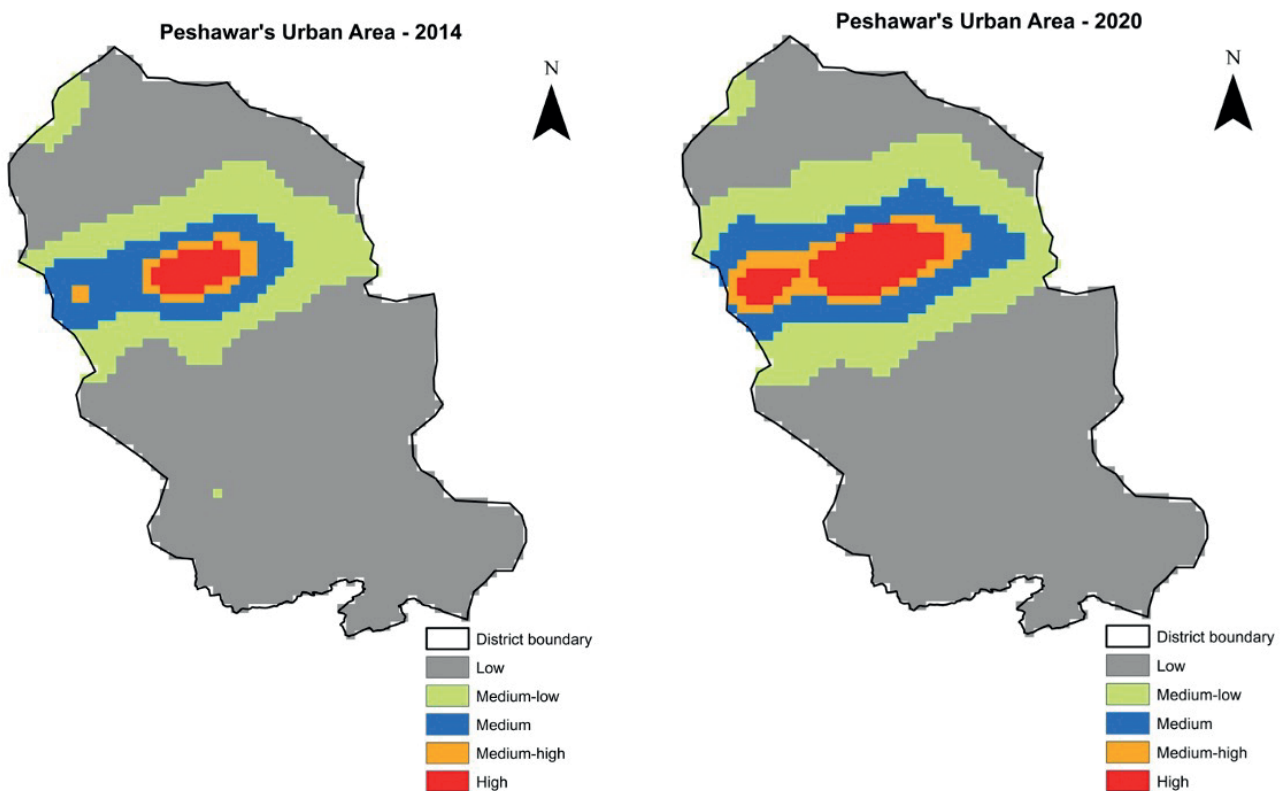


Figure 3: Urban Growth in Peshawar (2014-2020)

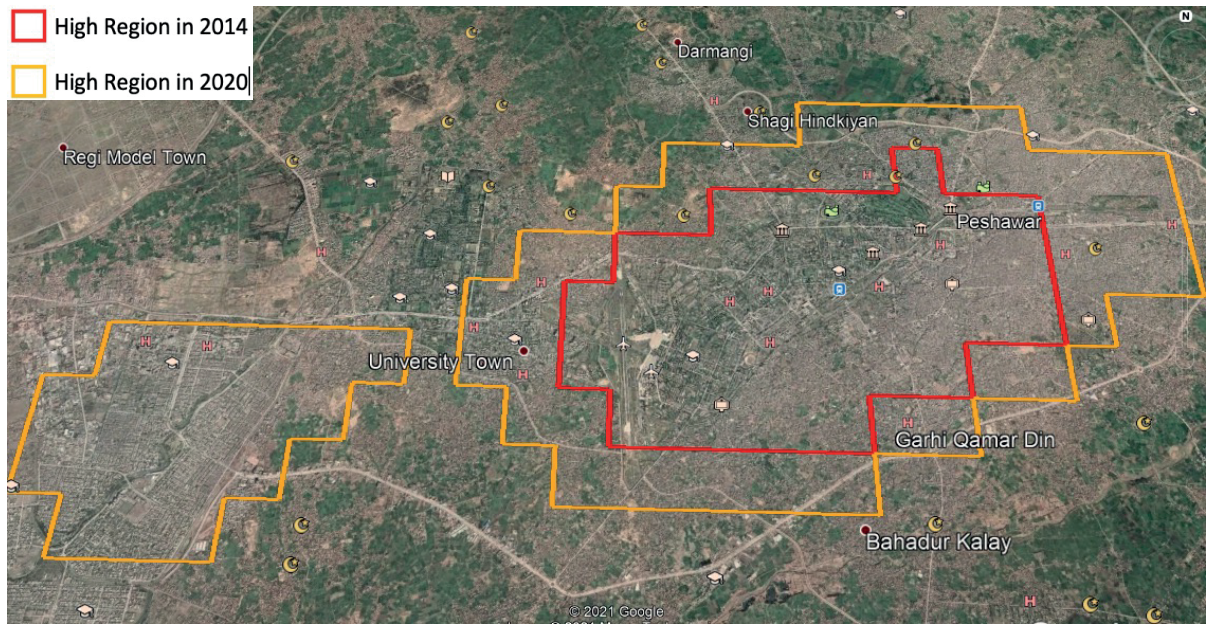


Figure 4: City Core Growth in Peshawar (2014-2020)

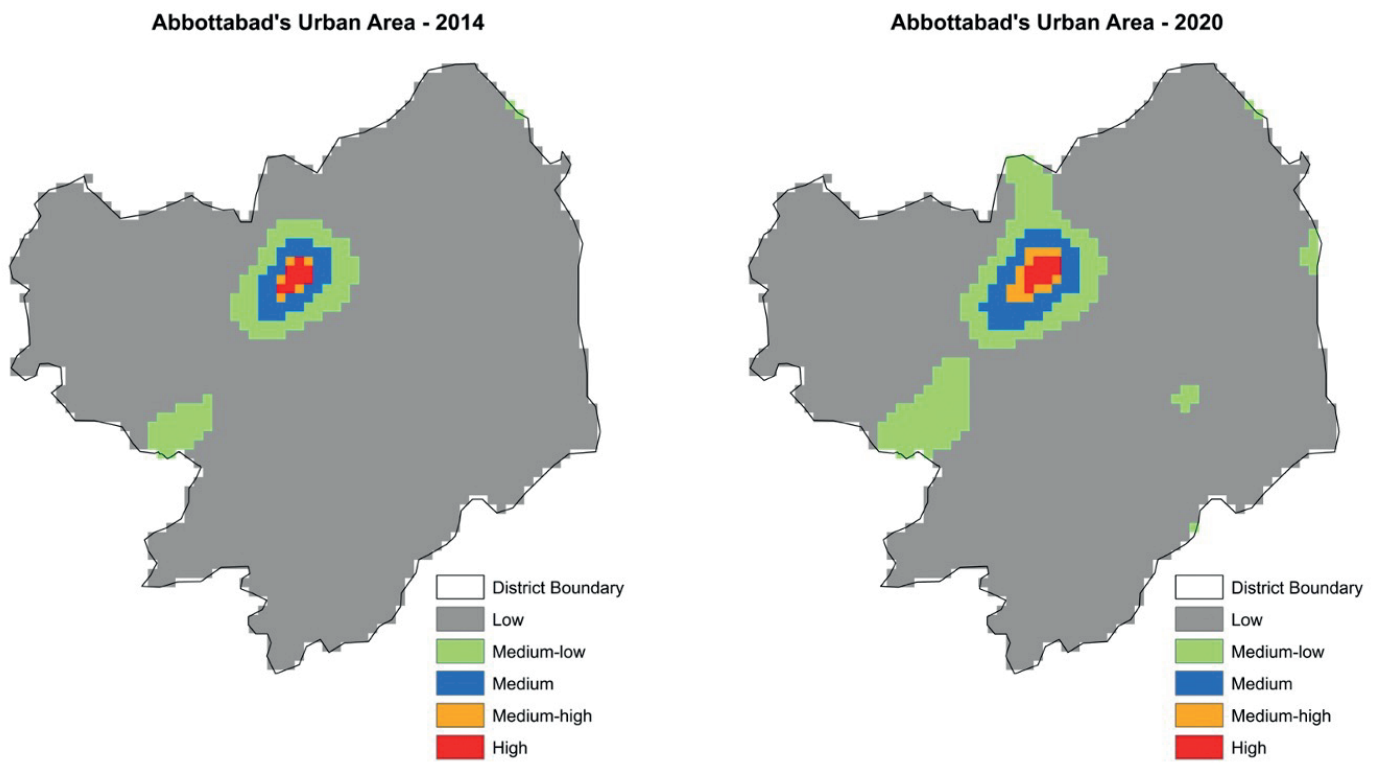


Figure 5: Urban Growth in Abbottabad (2014-2020)

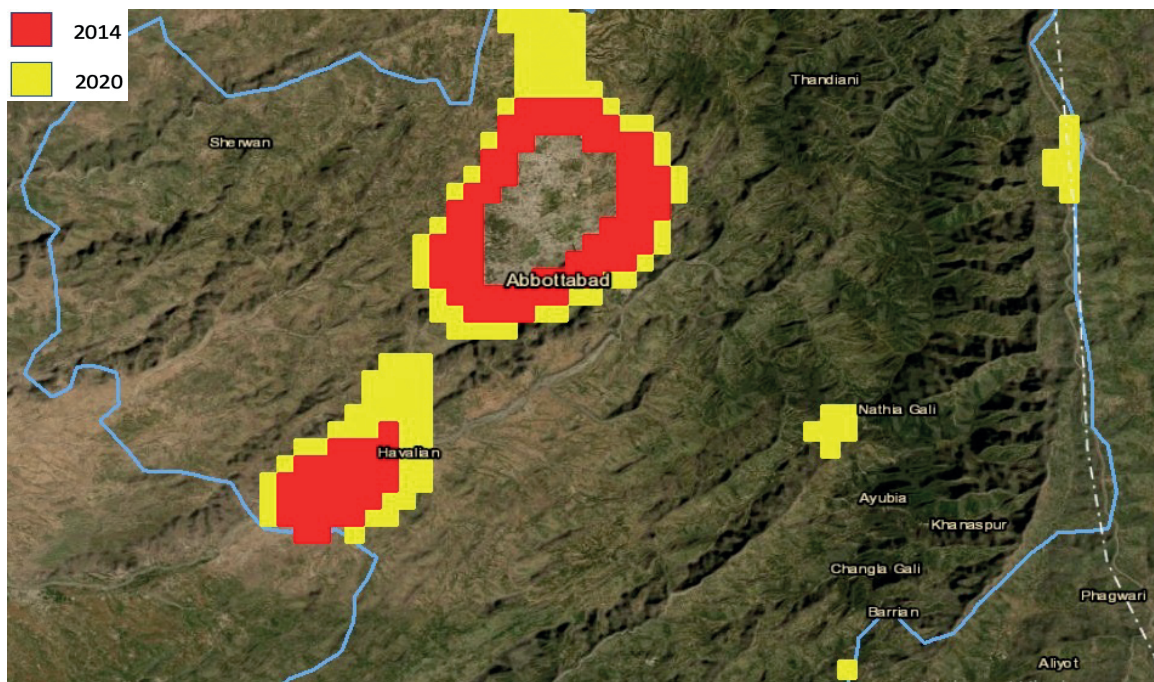


Figure 6: Periphery Growth in Abbottabad (2014-2020)

It uses nightlights data to provide insights into:

- Urbanization in the province, when analyzed using either the census data or the nightlights data, indicates a stagnating trend. According to the census, only one city in the province has a population of more than 1 million and hence all other cities are relatively small. Comparing across provinces, Sindh has two such cities (including Karachi, the largest city of the country) and Punjab has five such cities (including Lahore, the second-largest city of the country).
- In the case of Peshawar, the high-density city core and low-density city periphery have significantly increased over time (as shown in Figure 3). The extent of high intensity lights has not only increased around the 2014 area but also encompass new area on east (Figure 4).
- Despite having an increase in the high-density core region, Peshawar still experiences urban sprawl as well.
- In the case of Abbottabad, there is little change in the city core (Figure 5). However, most of the recent growth has taken place on the city periphery which is again indicative of increasing urban sprawl. Figure 6 highlights the change in the low-density development on the city periphery where the area shown in red pertains to 2014 and the one in yellow is its outgrowth in 2020.

- Figure 6 also shows that both the tehsils of Abbottabad district – Abbottabad and Havelian, as well as locations in the Galiyat region, are experiencing new low density urban development which is often regarded as a sub-optimal use of land leading to multiple inefficiencies in resource allocation and service delivery.
- In Mardan, Nowshera and Abbotabad, there is dimming of nightlights at the core of the city and more growth on the periphery which signals horizontal urban growth and potential issues related to efficient provision of municipal services and public transportation. Urban growth on the periphery of cities is sometimes not truly captured by population census. Hence, this form of urban growth could lead to “messy” and “hidden” urbanization as also highlighted by the 2015 World Bank report on the South Asian cities.



Estimated GDP for KP Province

To ensure the reliability of results, this study uses two methodologies to estimate province-level GDP for the KP province. In the first approach, we use coefficients from the regression on subnational GDP in India and Pakistan to estimate province-level GDP (manufacturing and services industries only) for the KP province. Due to data limitations, this is done for the period 2004-05 to 2013-14. Plotting estimated and actual values for the non-agricultural component, Figure 7 shows that both estimates are very close, and which is an indication of the robustness of our methodology, and that of the official data produced by KP Bureau of Statistics. The difference between the actual and estimated GDP can indicate the presence of an informal economy, although such differences can also reflect differences in methodology. Between 2009-2014, this difference has varied in the range of 5-11%.

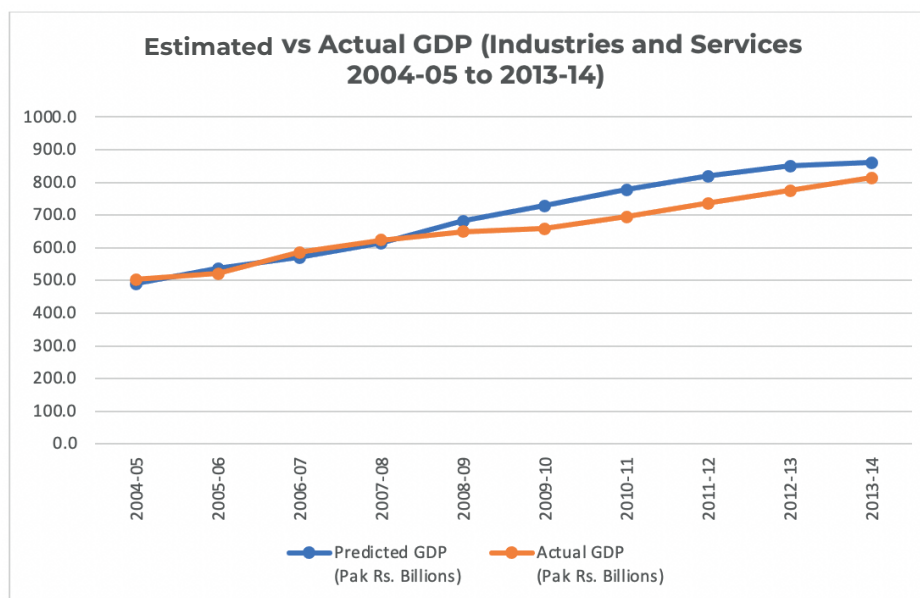


Figure 7: Actual and Estimated real GDP at constant prices for Industries and Services Sector-KP Province

Source: Author's Estimation

In the second method, we distribute official national GDP into provincial shares using their shares in nightlights and rural population numbers. To make up for the missing data in the earlier approach and to avoid weaknesses of nightlights data, this exercise is carried out for the years 2013-14 to 2019-20. The results are summarized in Tables 2 and 3.

Table 2: Provincial Share in National GDP (in percentage)

Fiscal Year	Using the distribution of national data in proportion to NTL and rural population shares				Official BOS data
	Baluchistan	Sindh	Punjab	KP	KP official
2013-2014	5.31	27.69	56.58	10.42	9.70
2014-2015	5.27	31.19	54.41	9.13	9.67
2015-2016	5.17	29.75	56.37	8.71	9.87
2016-2017	5.23	27.22	58.47	9.09	9.80
2017-2018	5.10	25.98	59.36	9.57	10.05
2018-2019	5.32	24.84	59.92	9.93	9.88
2019-2020	5.33	23.70	60.58	10.39	9.66

Table 3: Provincial GDP (NTL and Official in billion PKR)

Fiscal Year	Using the distribution of national data in proportion to NTL and rural population shares				KP Official GDP	Difference (NTL – official) (%)
	Baluchistan	Sindh	Punjab	KP		
2013-2014	542.89	2,828.90	5,780.96	1,064.31	991.54	7.3
2014-2015	560.62	3,316.10	5,784.33	970.60	1,028.10	-5.5
2015-2016	574.62	3,306.78	6,266.65	968.75	1,097.50	-11.7
2016-2017	611.27	3,183.47	6,839.49	1,062.70	1,146.20	-7.2
2017-2018	629.07	3,206.73	7,327.12	1,181.35	1,240.04	-4.7
2018-2019	669.99	3,129.43	7,550.00	1,251.24	1,245.44	0.4
2019-2020	667.86	2,971.89	7,598.40	1,303.69	1,211.20	7.6

Focusing on recent years, it is observed that the difference between official and estimated GDP figures was very small in 2018-19 but has again increased in 2019-20. These differences between official and estimated GDP figures arise because of (a) differences in methodologies and (b) annual variations in the scale of informal economic activity. The presence of these differences highlights the need to focus more on capturing the informal economic activity in the official estimates.



Using the Data

This study provides several insights that can be utilized for better planning and more effective targeting of public investments.

Firstly, it gives a clear understanding of the economic growth and development of districts in the KP province. This information is a prerequisite for planning infrastructure (for example to connect vibrant economic clusters and industrial parks) and is vital for designing policies to address regional disparities.

Secondly, our intra-city analysis gives a clear picture of the growth of cities, in particular the pace and direction of new development. This information can feed into urban planning, for example addressing issues of urban sprawl, planning for new infrastructure, and provision of urban services and local amenities (roads, transportation, utilities, crime control, waste disposal, mitigation of environmental degradation) to accommodate growing cities, realize their growth potential and help make them sustainable and efficient. It can also be used to develop a system of cities with plans for secondary cities, that so far appear to be less visible in the case of KP. The report also documents a low and stagnating level of urbanization in KP overall, which means that the agglomeration and growth potential of cities is currently highly underutilized and is an area where policymakers in KP can devote more attention.

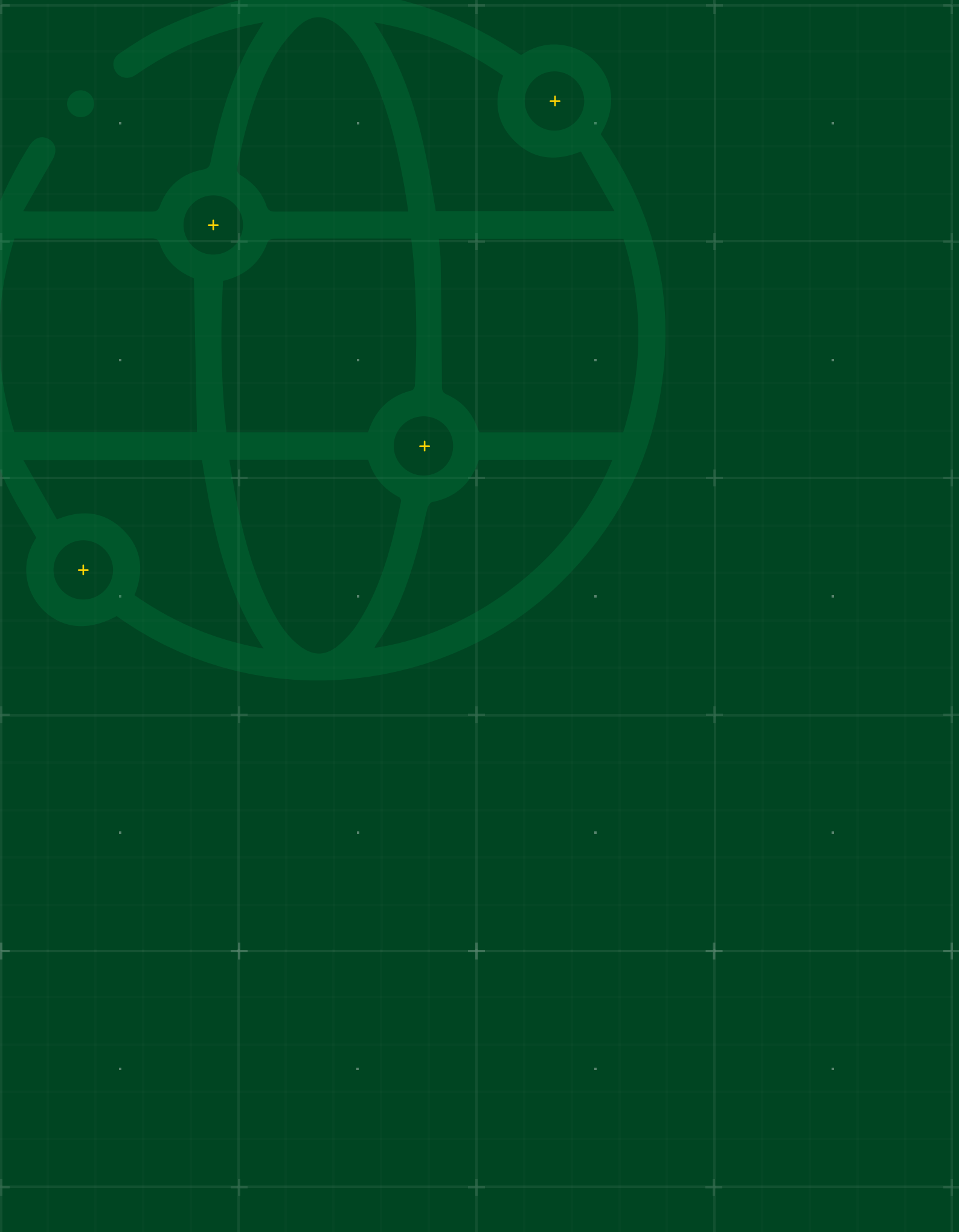
In addition to these immediate insights, once the capacity to understand and leverage nightlights data is developed in KP, it opens the doors to a reliable, live, and inexpensive source of information on future topics where official data is usually silent.

The spatial information embedded in the nightlights data gives it the unique advantage of providing granularity to the level of 1 km². Estimation of sub-national GDP to the level of a district or a tehsil/town yields an economic indicator that can be extensively used for policy planning and evaluation. Nightlights have been used to (a) obtain reliable estimates of poverty; (b) study the impact of cash transfers; (c) create wealth index; (d) create development indices; (e) validate district per capita income values obtained from Labor Force Surveys; (f) calculate regional inequality measures (g) understand urban crime patterns, etc. Most of these studies have been carried out by combining gridded nightlights data, gridded population data, and socioeconomic variables from other available datasets.

Recently, nightlight data has been used to study the economic impact of various events, for example, restrictive government measures such as the imposition of lockdowns following the COVID-19 outbreak. The argument is that non-pharmacological measures to contain disease transmission while mitigating their economic impact require an assessment of the economic situation in near real-time and at high spatial granularity. A comparison of changes in light intensity before and after lockdowns indicates the impact on

local economic activity and hence provides useful information for policymakers. This approach could be useful not just to measure COVID impacts but also to assess the impact of natural disasters or other policy measures, in a sense allowing the policymaker a way to continually monitor the pulse of economic activity in the province.

The utilization of satellite imagery, in particular nightlights, is a relatively new concept and is still evolving as researchers find novel ways to use it to understand development. It is an opportune time for KP to develop the expertise to analyze and utilize this rich source of information to help achieve its development targets.



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