Arth Ganga Project: District Khagaria

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EXECUTIVE SUMMARY

Khagaria, a religious diverse city in the state of Bihar, surrounded by seven rivers namely Ganges, Kamla Balan, Koshi, Budhi Gandak, Kareh, Kali Koshi and Bagmati.

The total geographical area of the district is 1493.20 km^2. The primary sector contributes, on average, 36.21% to the district GDP with average annual growth of 8.30% from 2007-08 to 2013-14. However, its share decreased from 40.39% in 2007-08 to 32.45% in 2013-14 because other sectors grew faster than the primary sector. The share of the secondary sector increased from 12.88% in 2007-08 to 19.57% in 2013-14 with an average annual growth rate of 20.16%. The tertiary sector occupies, on average, 46.97% share in the district economy with an average annual growth rate of 12.38%. Its share increased from 46.73% in 2007-08 to 47.98% in 2013-14. Overall, the district economy grew by 11.90% per annum during the study period.

The cropping intensity of the district is 143.60%. Major crop types are wheat, rice, maize, pulses like a variety of black gram, green gram, etc. along with pea, mustard, etc. The livestock consists of cattle (indigenous and crossbred), buffalos (indigenous and crossbred), pigs (indigenous and crossbred), goats; poultry, and fisheries. The total number of cattle increased in the district from 230 thousand in 2003 to 298 thousand in 2019, a net increase of 29.31%. The number of goats also increased whereas that of pigs decreased. The total livestock population increased in the district from 509.23 thousand in 2003 to 670.84 thousand in 2019, a net increase of 31.73%. In 2019-20, the percentage of net and gross irrigated area was 74.32% and 67.95%, respectively.

The share of cultivable wasteland and barren and uncultivable land remained constant at 0.40% and 9.11% respectively, during 2011-12 to 2019-20. The fallow land significantly increased from 6.03% in 2011-12 to 7.90% in 2019-20, a matter of concern for the district economy. The net sown area decreased over the years, from 61.42% in 2011-12 to 59.48% in 2019-20. The area for non-agricultural use remained constant over the period. The use of nitrogen is more than the recommended ratio, while the Phosphorous and potassium usage is less than the recommended ratio. In 2019-20, the nitrogen share decreased to 68.63%, while the phosphorus and potassium share increased to 18.89% and 12.46%, respectively. Although the overall use of chemical fertilizers has decreased in the district from 133.2 kg/ ha GSA in 2013-14 to 127 kg/ ha GSA in 2019-20.

The forest covers 18.45 km^2 area which is 1.24% to the total area which makes district severly forest deficient area. Out of total forest cover, the maximum area is covered by Open Forest (15.27 km^2) followed by Moderately dense forest (3.18km^2). The area under trees and gardens also remained constant, i.e., 2.08% between 2011-12 to 2019-20.

Khagaria is known for its spiritual as well as ecological significance and hosts fair and festivals. The district is well connected through roads and the railway network is developed better. The district is famous for Katyayani Mandir, Ghats, Jama Masjid Ratan, Jama Masjid Bela Ganj, Khanquah Faridia Jogiya Sharif, Khanquah Gulzaria Faridia, Lakes, etc.

In the district, around 86.90% of the households are dependent upon Kerosene for their lightning needs and 12.40% of the households are dependent upon electricity for their lightning needs. Solar energy is used by 0.30% of the households. 63.40% of the households use crop residue, 24.30% of the

households use fire-wood, 6.70% of the households use cow dung cake, and 4.70% of the households use LPG/PNG.
The total number of wetlands existing in the district is 288 consisting of both Man-made and Natural. Most of them are riverine and waterlogged. The district's biodiversity data includes various crop production, livestock population, bird species, and forest cover with 335 bird species and 21 threatened/rare species of bird in the district. Biogas potential from animal waste is calculated approximately as 86 lakh m^3/year and ninety six lakh m^3/year from agricultural waste. No hydropower plant has been identified in the distict. The total solar power potential in the district is 0.0294. The total biomass rice husk potential of the district is 3089 MT/Year.

To promote sustainable development creating awareness, educating people about renewable energies, sanitation, maintaining decorum of the properties by not destroying or keeping them clean, Adopting Public-Private partnerships, upgrading staff and facilities, etc. Drip and Sprinkler irrigation, introducing Vermicomposting, use of high-yielding seeds, micro-irrigation, constructing and maintaining harvesting structures, adopting greenhouse farming with organic farming, and encouraging farmers for adapting different crop cultivation and various irrigation methods, adopt resources conservation technologies, Various measures such as eco-tourism should be taken to improve tourism and enhance the use of renewable energy especially by creating awareness. Along with focusing on agriculture practices Bee culture, dairy, poultry, fisheries, etc. needs encouragement as they have high economic potential. Monitoring and training programs and awareness and introducing Pradhan Mantri Matsya Sampada Yojana, KVKs instruction, subsidized crop insurance system, branding effort under the National Organic Foods Market, etc.

1. DISTRICT OVERVIEW

1.1 INTRODUCTION

Khagaria district is an administrative district in the state of Bihar in India. The district headquarters are located at Khagaria. Earlier it was a part of Munger District as a sub-division that was created in 1943–44. It was upgrad Khagaria district occupies an area of 1,486 square kilometres (574 sq mi),[3] comparatively equivalent to Greenland's Nares Land.[4] The district is surrounded by seven rivers namely Ganges, Kamla Balan, Koshi, Budhi Gandak, Kareh, Kali Koshi and Bagmati. These rivers cause floods every year which causes great loss of life and property including livestock. River Ganga forms the southern boundary of the district. Khagaria experiences an extreme climate with very hot summers and extremely cold winters. Rainy season continues up to October with heavy rainfall causing the rivers to overflow and causing floods in most regions.ed to the status of a district on 10 May 1981. Khagaria district is a part of Munger Division.

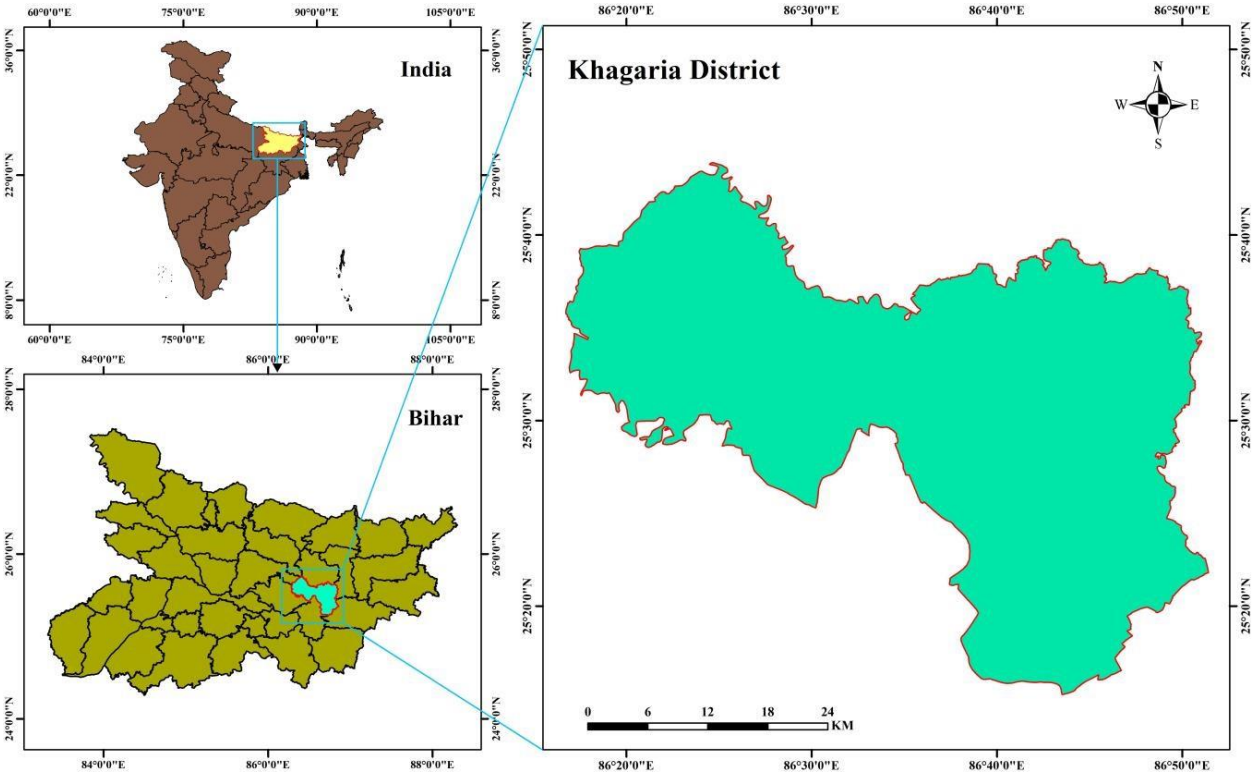


Figure 1 Map of the district

1.2 DEMOGRAPHIC PROFILE OF KHAGARIA

On 10th May 1981, Khagaria district was established, before that it was a sub-division of Munger district. The district lies at a latitude between 25º 15' to 25º 44' North and between a longitude 86º 17' to 86º 52' East. The district headquarters is the Khagaria town. The aggregate area of the district is 1486 sq.km. and consists of 2 sub-divisions, 7 blocks and 129 villages. The subdivisions are Khagaria and Gogari. The 7 blocks in the district are Khagaria, Alouli, Choutham, Mans, Gogari, Parwatta, Beldour. The district is surrounded by Saharsa in the north, Samastipur and Begusarai in the west, Madhepura and Bhagalpur in the east, and Munger in the south. The major rivers flowing in this district are the Ganga, the Gandak, the Bagmati, the Kamala and the Koshi. Due to the presence of these rivers in the district, they are responsible for the floods in the district, which leads to loss of livestock, lives of the people and the agricultural productivity.

According to the Census 2011, the aggregate population of the district is 1666886, out of this 53.02% of the population is male, implying that 883786 people are males, and 46.97% of the population is female, implying that 783100 people are female. Out of the total population, 94.77% of the population resides in the rural area, meaning 1579727 people lives in the rural area, while 5.22% of the population resides in the urban area, meaning 87159 people lives in the urban area. The sex ratio in the district is 886 females per thousand males. According to the Census of India 2011, the literacy rate is 57.92%, the literacy rate among males is 65.25% and among the females is 49.56%.

The economy of the district is dependent upon agriculture, horticulture and dairy. Textiles, jewellery, food grains, hardware are the other important traded items. Moreover, milch cattle are plentiful in the

district so sale of milk and its products like ghee also have a profitable business. The important agricultural products are wheat, paddy, maize, oil seeds, and vegetables.

The maize production in the district is high, but paddy production has been impacted by the recurrent floods. The banana production has also increased over the years as a cash crop. Choutham, Gogari and Parvatta blocks are the main production regions for banana. the government has also announced various irrigation methods to improve the crop production, but due to poor maintenance of the tube wells and lift irrigation schemes, most of them are non-functional. The farmers have to depend upon private boring fitted pump sets for irrigational needs.

1.3 ECONOMIC PROFILE OF KHAGARIA

The District Economy

The primary sector contributes, on average, 36.21% to the district GDP. It achieved a remarkable average annual growth of 8.30% from 2007-08 to 2013-14. However, its share decreased from 40.39% in 2007-08 to 32.45% in 2013-14 because other sectors grew faster than the primary sector. The share of the secondary sector increased from 12.88% in 2007-08 to 19.57% in 2013-14. The sector grew with an impressive average annual growth rate of 20.16%. The tertiary sector occupies, on average, 46.97% share in the district economy. Moreover, the sector grew with an average annual growth rate of 12.38%. Its share increased from 46.73% in 2007-08 to 47.98% in 2013-14. Overall, the district economy grew by 11.90% per annum during the study period. All the sectors have performed well during the time of the study. Steps should be taken to increase the primary sector's productivity to maintain its growth.

Table 1: Trends in Gross District Domestic product in Khagaria at Constant Prices (base 2004-05),
Millions in Rs

Year	Sector-wise GDDP				Annual Growth Rates			
	Primary Sector	Secondary Sector	Tertiary Sector	Total GDDP	Primary Sector	Secondary Sector	Tertiary Sector	Total GDDP
2007 -08	5783	1844	6691	14318	-	-	-	-
	(40.39)	(12.88)	(46.73)	(100)				
2008-09	6332	2136	7584	16052	9.49	15.84	13.35	12.11
	(39.45)	(13.31)	(47.25)	(100)				
2009 -10	5857	2888	8513	17257	-7.50	35.21	12.25	7.51
	(33.94)	(16.74)	(49.33)	(100)				
2010-11	7204	3608	9353	20165	23.00	24.93	9.87	16.85
	(35.73)	(17.89)	(46.38)	(100)				
2011 -12	8236	4192	10166	22595	14.33	16.19	8.69	12.05
	(36.45)	(18.55)	(44.99)	(100)				
2012 -13	9132	4880	12000	26011	10.88	16.41	18.04	15.12
	(35.11)	(18.76)	(46.13)	(100)				
2013-14	9097	5486	13450	28033	-0.38	12.42	12.08	7.77
	(32.45)	(19.57)	(47.98)	(100)				

Average Growth Rate	8.30	20.16	12.38	11.90

Source: http://data.icrisat.org/district-level-data/
Note: Figures in Parenthesis are percentage share of total GDDP

2. Quantitative Data Analysis

2.1 Agriculture and Allied Activities

The total declared area of the district is 1493.20 sq. km². The share of cultivable wasteland remained constant at 0.40% during 2011-12 to 2019-20. The share of barren and uncultivable land has remained constant (9.11%) over the years, which should further be reduced. The fallow land significantly increased from 6.03% in 2011-12 to 7.90% in 2019-20, a matter of concern for the district economy. Moreover, the net sown area (NSA) decreased over the years, from 61.42% in 2011-12 to 59.48% in 2019-20. The area for non-agricultural use remained constant over the period (Table 2). The area under trees and gardens also remained constant, i.e., 2.08% between 2011-12 to 2019-20. Overall, the land use pattern shows that the area under fallow land significantly increased while the NSA slightly declined over the years.

Table2: Trends in land use pattern in Khagaria (as % of the total reported area)

Year	Total Reported Area (in 1000 ha)	Cultivable Wasteland	Total Fallow	Barren And Uncultivable Land	Land Other Than Agriculture	Pasture Land	Area Under Trees And Gardens	Net Sown Area
1	2	3	4	5	6	7	8	9
2011-12	149.3	0.40	6.03	9.11	20.90	0.13	2.08	61.42
2012-13	149.3	0.40	5.76	9.11	20.90	0.13	2.08	61.62
2013-14	149.3	0.40	5.56	9.11	20.90	0.13	2.08	61.82
2014-15	149.3	0.40	4.29	9.11	20.90	0.13	2.08	63.09
2015-16	149.3	0.40	9.71	9.11	20.90	0.13	2.08	57.74
2016-17	149.3	0.40	4.02	9.11	20.90	0.13	2.08	63.36
2017-18	149.3	0.40	8.10	9.11	20.90	0.13	2.08	59.34
2018-19	149.3	0.40	8.10	9.11	20.90	0.13	2.08	59.28
2019-20	149.3	0.40	7.90	9.11	20.90	0.13	2.08	59.48

Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/

2.1.2 Trends in Operational Land Holdings

In Khagaria district, the total number of operational farms decreased from 219 thousand in 2010-11 to 215 thousand in 2015-16, a net decrease of 1.83%. While in the state, their numbers increased from 16191 thousand in 2010-11 to 16412 thousand in 2015-16, a net increase of 1.36%. Most land positions in the district are marginal and small. In the district, the share of marginal and small farms increased

from 94.92% in 2010-11 to 96.01% in 2015-16. Similarly, the corresponding share of these categories in the state went up from 96.92% to 96.96% during the same period. Table 3 indicates a slight decline in the percentage share of the semi-medium land holding and an increase in the share of the marginal, small, medium, and large land holdings.

Table3: Distribution of Operational Holdings by Size-categories of farms (in %) in Khagaria

	Agri Census	Marginal Holdings (0-1 Ha)	Small Holdings (1-2 Ha)	Semi-Medium Holdings (2-4 Ha)	Medium Holdings (4-10 Ha)	Large Holdings (10 & above Ha)	Total Holdings ('000 No.)
Khagaria	2010-11	87.13	7.79	4.22	0.85	0.01	219
	2015-16	88.14	7.87	2.95	0.99	0.05	215
							[-1.83]
Bihar	2010-11	91.06	5.86	2.56	0.5	0.02	16191
	2015-16	91.21	5.75	2.52	0.5	0.02	16412
							[1.36]

Source: Compiled from https://agcensus.nic.in/. Figures in [] are percentage increase/ decrease in 2015-16 over 2010-11.

2.1.3 Trends in Area, Production, and Yield of Principal Crops

2.1.3.1 The Trend in Cropping Patterns

Rice, Wheat, and Maize dominate the agriculture of the district. Table 4 shows the area devoted to various crops over the last seven years. In 2019-20, maize made up the highest share of GCA (46.85%), followed by Wheat (21.97%) and rice (14.49%). These three crops constitute around 83.31% of the GCA. The area shared by the total cereals has decreased from 85.14% in 2013-14 to 83.94% in 2019-20. The main pulses produced are urad, moong, and peas. The total pulses acreage slightly declined from 5.93% in 2013-14 to 5.28% in 2019-20. The food grains acreage decreased from 91.07% in 2013-14 to 89.21% in 2019-20. Mustard is the only major oilseeds crop produced, and the total oilseed acreage significantly increased from 2.78% in 2013-14 to 4.09% in 2018-19. Overall, the cropping pattern is dominated by food grain crops. The average cropping intensity is 143.60.

Table 4: Trends in cropping pattern (as % GSA) and cropping intensity

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Rice	16.37	17.63	16.50	15.14	14.98	15.00	14.49
Wheat	22.82	22.52	23.20	21.56	22.58	22.38	21.97
Maize	45.20	44.59	43.57	43.68	47.15	47.22	46.85
Other cereals	0.75	0.67	0.63	0.63	0.63	0.63	0.63
Total Cereals	85.14	85.41	83.90	81.01	85.34	85.24	83.94
Black gram (urad)	1.95	1.93	2.05	1.80	1.82	1.83	1.73
Green gram (Moong)	1.35	1.26	1.42	1.32	1.43	1.43	1.42
Peas	1.05	1.04	1.10	0.99	0.95	1.03	1.02
Other Pulses	1.58	1.56	1.74	1.32	1.19	1.11	1.10

Total Pulses	5.93	5.78	6.31	5.43	5.39	5.40	5.28
Total Foodgrains	91.07	91.19	90.21	86.44	90.73	90.63	89.21
Mustard	2.03	2.00	2.37	2.13	2.30	2.38	2.36
Other Oilseeds	0.75	0.74	0.71	0.80	0.55	0.56	1.73
Total oilseeds	2.78	2.74	3.08	2.94	2.85	2.94	4.09
Net Sown Area	69.29	69.78	68.03	70.02	70.21	70.24	69.92
Gross Sown Area (in 1000 Ha)	133.20	135.00	126.70	135.10	126.20	126.00	127.00
Cropping Intensity	144.31	143.31	146.98	142.81	142.44	142.37	143.02
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.3.2 Trends in per hectare yield of principal crops

Table 5 shows that the per hectare yield of most crops varies across years. Maize, Wheat, and rice are the major crops in the district, and their yields were 48.12 qtls, 31.18 qtls, and 15.65 qtls, respectively, in 2019-20. Per hectare yield of total cereals significantly increased from 27.07 qtls in 2013-14 to 37.79 qtls in 2019-20, majorly due to a significant increase in the yield of maize. On the other hand, the per hectare yield of total pulses decreased from 11.14 qtls in 2013-14 to 8.96 qtls in 2019-20. The yield of total oilseeds decreased from 18.11 qtls in 2013-14 to 10.77 qtls in 2019-20. However, the yield of total food grains significantly increased from 26.03% in 2013-14 to 36.08% in 2019-20. In summary, all crop yields show yearly fluctuations. The yield variabilities make farmers' income riskier and more unstable, requiring a solid insurance protection system.

Table 5: Trends in yield of Principal Crops in Khagaria District (in qtl per ha)

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Rice	10.60	16.60	18.56	16.25	22.22	14.39	15.65
Wheat	32.27	11.18	28.03	28.30	34.11	34.01	31.18
Maize	30.73	35.68	30.22	39.62	49.53	42.92	48.12
Total Cereals	27.07	25.07	27.15	32.00	40.36	35.32	37.79
Black gram (urad)	9.23	9.23	8.46	8.84	8.70	8.70	8.64
Green gram (Moong)	11.11	5.88	8.33	8.22	7.22	8.89	7.78
Peas	10.71	10.00	11.43	11.00	12.50	10.77	10.77
Total Pulses	11.14	8.85	9.38	9.55	9.26	9.56	8.96
Total Foodgrains	26.03	24.05	25.91	30.59	38.52	33.78	36.08
Mustard	19.63	13.70	9.00	13.41	10.69	15.67	12.33
Total oilseeds	18.11	13.78	10.26	13.15	11.67	15.41	10.77
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.3.3 Trends in Production of Principal Crops

Table 6 shows the trends in the production of the main crops over the years. Maize and Wheat dominate the production. In 2019-20, Maize (286.3 thousand tonnes) and Wheat (87 thousand tonnes) formed a significant part of the total cereal production (402.8 thousand tonnes). Moreover, the production of total cereals went up from 307 thousand tons in 2013-14 to 402.8 thousand tons in 2019-20. Coming

to pulses, Urad, Moong, and Peas occupied the highest production, with their production being 1.9 thousand tons, 1.4 thousand tons, and 1.4 thousand tons, respectively, in 2019-20. Although these pulses show variation in the production across years, they still represent 78.33% of the total pulse production. Mustard production in 2019-20 was 3.7 thousand tons, which comprised 66.07% of the total oilseed production. Looking at the annual production data of various crops, we find that production of cereals increased during the period while the production of pulses and oilseeds declined, partly due to changes in weather conditions and partly due to market conditions. Proper insurance arrangements are required to get assured farm income, take more risks and diversify crop production.

Table 6: Trends in Production of Principal Crops in Khagaria District (in 1000 Tons)

Crop/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Rice	23.1	39.5	38.8	33.2	42	27.2	28.8
Wheat	98.1	34	82.4	82.4	97.2	95.9	87
Maize	185	214.8	166.8	233.8	294.7	255.4	286.3
Other cereals	0.8	0.8	0.6	0.7	0.8	0.8	0.7
Total Cereals	307	289.1	288.6	350.3	434.7	379.3	402.8
Black gram (urad)	2.4	2.4	2.2	2.2	2	2	1.9
Green gram (Moong)	2	1	1.5	1.5	1.3	1.6	1.4
Peas	1.5	1.4	1.6	1.5	1.5	1.4	1.4
Other Pulses	2.9	2.1	2.2	1.9	1.5	1.5	1.3
Total Pulses	8.8	6.9	7.5	7.0	6.3	6.5	6
Total Foodgrains	315.8	296	296.1	357.3	441	385.8	408.8
Mustard	5.3	3.7	2.7	3.9	3.1	4.7	3.7
Other Oilseeds	1.4	1.4	1.3	1.4	1.1	1	1.9
Total oilseeds	6.7	5.1	4	5.2	4.2	5.7	5.6

Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/

2.1.3.4 Variability assessment in the area, production, and yield

To understand the variability across the years (Table 7), we calculated the mean, standard deviation (SD), and coefficient of variation (COV) of the area, production, and yield of the main crops. Among different crops, the lowest variability in the area is observed in moong (2.09%), followed by maize (2.94%) and Wheat (3.45%), and the highest in rice (9.42%). The variability in the area under total pulses (7.78%) is much higher than in the area under total cereals (3.23%). Since Wheat and Maize dominate the production, the variability in the area under total food grains is also relatively low (3.33%).

Table 7: Variability in Area, Production, and Yield of Principal Crops (2013-14 to 2019-20)

	Area (1000 Ha)			Production (1000 Ha)			Yield (Qtl/Ha)		
Crop	**Average**	**SD**	**COV**	**Average**	**SD**	**COV**	**Average**	**SD**	**COV**
Rice	20.45	1.93	9.42	33.23	7.14	21.48	16.32	3.58	21.93
Wheat	29.13	1.01	3.45	82.43	22.40	27.18	28.44	7.99	28.10
Maize	59.02	1.74	2.94	233.83	48.59	20.78	39.55	7.79	19.70

Total Cereals	109.45	3.54	3.23	350.25	57.95	16.54	32.11	5.92	18.43
Black gram (urad)	2.43	0.17	6.98	2.15	0.20	9.20	8.83	0.30	3.37
Green gram (Moong)	1.78	0.04	2.09	1.47	0.30	20.71	8.21	1.61	19.57
Peas	1.33	0.07	5.59	1.47	0.07	5.08	11.03	0.78	7.04
Total Pulses	7.33	0.57	7.78	7.00	0.93	13.35	9.53	0.76	8.00
Total Foodgrains	116.78	3.88	3.33	357.25	57.29	16.04	30.71	5.61	18.26
Mustard	2.88	0.13	4.66	3.87	0.89	23.02	13.49	3.46	25.65
Total oilseeds	3.97	0.56	14.09	5.22	0.92	17.69	13.31	2.77	20.84
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/									

The variability of production depends on the variability of the cultivated area and the variability of the yield. Since variabilities in crop yields are higher than that in crop areas, the variability in the production of different crops is higher than that in their cropped areas. The highest variability in production is observed in Wheat (27.18%), followed by Mustard (23.02%), Rice (21.48%), and Maize (20.78%). The variability in the production of total oilseeds is 17.69%. Variability is lowest in peas (5.08%), black gram (9.20%), and total pulses (13.35%). Improvement in crop insurance conditions and better market accessibility can lower the variability in crop production.

In the case of yield, the highest variability is estimated in Wheat (28.10%), followed by mustard (25.65%), and rice (21.93%). Yield variability in total pulses (8.0%) is lower than in total cereals (18.43%). Several factors, such as climate change, market prices, rainfall patterns, etc., influence the variability in agricultural production.

2.1.4 Consumption of Chemical Fertilizers

Table 8 shows the trends in the use of chemical fertilizers in agriculture. The recommended nitrogen to phosphorus and potassium ratio is 4:2:1, which is not maintained in the district. For example, in 2013-14, nitrogen represented 73.08% of the total fertilizers used, while the proportions of phosphorus and potassium were 15.96% and 10.95%, respectively. In 2019-20, however, the nitrogen share decreased to 68.63%, while the phosphorus and potassium share increased to 18.89% and 12.46%, respectively. The use of nitrogen is more than the recommended ratio, while the Phosphorous and potassium usage is less than the recommended ratio. The table also shows that fertilizer consumption varies across years, which can be due to several factors, such as rainfall and cultivation patterns, etc. Although the overall use of chemical fertilizers has decreased in the district from 133.2 kg/ ha GSA in 2013-14 to 127 kg/ ha GSA in 2019-20, still the government can incentivize the farmers to use organic and bio fertilizers.

Table 8: Trends in Use of Chemical Fertilizers in Agriculture (Kgs/per ha GSA)

Fertilizer/Year	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Nitrogen	240.61	232.90	334.92	253.30	322.29	334.40	414.40
Phosphorous	52.55	62.89	84.29	80.45	102.77	105.79	114.09
Potassium	36.06	45.47	51.44	61.46	68.00	59.60	75.24

Total	329.21	341.26	470.66	395.21	493.06	499.79	603.74
GSA (1000 Ha)	133.2	135	126.7	135.1	126.2	126	127
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/							

2.1.5 Irrigation Structure and Status

2.1.5.1 Source-wise area under irrigation

Groundwater (GW) is the primary source of irrigation in the district. The share of wells and tube wells in NIA (average, 99.93%) remained almost constant over the years. The district is heavily dependent on groundwater for irrigation purposes. Its overexploitation can have serious environmental issues. The district's percentages of the net and gross irrigated areas show low variations across the years.

Table 9: Source-wise Area under Irrigation in Khagaria (in % of NIA)

Source/Year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Wells and Tube Wells	99.96	99.94	99.96	99.94	99.95	99.89	99.89	100.00	99.85
Other Sources	0.04	0.06	0.04	0.06	0.05	0.11	0.11	0.00	0.15
NIA (1000 Ha)	67.53	67.39	68.12	68.15	64.45	72.77	66.22	66.20	66.00
GIA (1000 Ha)	82.30	86.60	84.93	86.88	83.79	95.50	86.61	86.50	86.30
% of NIA	73.64	73.25	73.80	72.35	74.77	76.92	74.74	74.80	74.32
% of GIA	66.42	66.87	63.76	64.36	66.13	70.69	68.63	68.65	67.95
Source: Compiled from http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/									

2.1.6 Status of Organic Farming

To promote sustainable agricultural practices and improve the farmers' livelihood, the Government of India launched PKVY and Namami Gange schemes. Under these schemes, farmers are incentivized to form groups to do organic farming and sell their products with PGS certification. Under the programme, the beneficiary farmers get Rs.12000, Rs. 10000 and Rs.9000 per hectare, respectively, in the first, second and third year of the conversion period.

The transition period for the full conversion from conventional to organic is considered three years. During this period, crop yield, on average, is expected to decline by 10—15 percent. But after three years, it may reach its original level. Financial assistance received by the beneficiary farmers seems to be adequate to compensate for the yield losses and motivate them to do organic farming. There is a need to set up an integrated processing unit for organic products. Monitoring of the project should be periodically done through MIS, Geo-tagging, and monthly physical and financial reports.

There may be a possibility that in the absence of the regulatory framework, the beneficiary farmers may revert to conventional farming. In this context, two things need to be thought of—a well-designed regulatory and monitoring framework and the introduction of payments for ecosystem services for the organic farmers after the transition period so that they may carry on the activity sustainably. Organic and zero-budget farming will provide ecological services in terms of soil health, human and animal health, saving of water, protecting biodiversity, etc. A long-term system of payments for ecological services may be evolved to retain the existing farmers and motivate others to

move towards this sustainable farming system. There is no assured market for these products, and farmers do not get premium prices. They sell their products at the same prices their conventional counterparts do. Certification and quality check and monitoring mechanisms are yet to be set up.

Table 10 shows the details of establishing organic clusters under the Paramparagat Krishi Vikas Yojana and Namami Gange schemes in the district. The district has 55 groups in two development blocks. The highest number of groups are in Parbatta (32), followed by Khagaria (23). Significantly high variation can be seen in the number of farmers per group in the district. It is reported that the maximum limit of land under a cluster per farmer is 2.00 hectares. Hence, the majority of the beneficiary farmers are small and marginal. Groups need to be added under the Paramparagat Krishi Vikas Yojana (PKVY), and more groups should be further encouraged in other development blocks.

Table 10: Status of Organic Farming PGS Groups under PKVY and Namami Gange Schemes in Khagaria (as on June 6, 2022)

S. No.	Block	Scheme	No. of groups	No. of farmers in groups			
				Total	Average	Median	SD
1	**Khagaria**	Namami Gange	23	129	5.6	5	4.03
	Parbatta	PKVY	5	176	35.2	34	3.03
2		Namami Gange	27	249	9.22	5	10.69
	District Total	PKVY	5	176	35.2	34	3.03
		Namami Gange	50	378	7.56	5	8.44
3		Total	55	554	10.07	5	11.38

Source: Compiled from https://pgsindia-ncof.gov.in/

A gradual shift of farmers from conventional to organic farming systems can positively impact water quality and soil health along with farming sustainability. However, organic farming is a knowledge-intensive system, so farmers need proper training to know the practical details of this system. Since economies of scale in both production and marketing matter in organic farming, some institutional framework may be needed in the forms of SHGs/ farm cooperatives/PFOs/contract farming, etc. Organic farming could be an economically viable option in the district if the government builds strong marketing networks linking farmers, processors, and distributors with the easy certification process and minimizes farmers' risk by protecting their farm income through payments of ecosystem services. A long-term system of incentives and regulation needs to evolve to retain the existing farmers and motivate others to move towards a sustainable farming system in the district.

The major problem for the growth of organic farming observed are:

1. The major problem of the farmers was poor marketing of the organic products and the inability to fetch a premium.
2. Scaling up the organic production is another problem. The problem of marketing is even more severe in the case of perishable vegetable crops. Contract farming companies and Farmer Producers' companies can be encouraged.
3. Although organic farming clusters are formed, the farmers allocated a part of their lands to organic farming and practiced conventional farming in the rest of the area, which may fail the purpose of the cluster approach in organic farming.

4. The knowledge and awareness level regarding practices under organic farming was inadequate among farmers.

2.1.7 Trends in Livestock Sector

The total number of cattle increased in the district from 230 thousand in 2003 to 298 thousand in 2019, a net increase of 29.31%. However, the number of adult male cattle significantly decreased from 15 thousand to 5 thousand in the same period. The increase in total cattle has been due to an increase in adult female cattle (from 78 thousand to 147 thousand) and young cattle (from 137 thousand to 145 thousand) during the same period. Cattle represent 71.55% of the total large ruminants. Moreover, cattle's share in large ruminants increased from 73.57% in 2003 to 75.99% in 2019. Similarly, total buffaloes increased from 83 thousand in 2003 to 94 thousand in 2019, a net increase of 13.75%, which is mainly due to an increase in female buffaloes. Buffaloes comprised 28.45% of the total large ruminants in 2019. Total sheep increased from 0.02 thousand in 2003 to 0.19 thousand in 2019. Total goats increased from 192 thousand in 2003 to 276 thousand in 2019, a net increase of 43.72%. Total pigs have decreased from 4.44 thousand in 2003 to 3.14 thousand in 2019. The total livestock population increased in the district from 509.23 thousand in 2003 to 670.84 thousand in 2019, a net increase of 31.73%.

The number of female cattle and buffaloes substantially increased over the period, indicating the growth of livestock products, including milk. The substantial decline in the number of male cattle also shows the rising farm mechanization and declining relevance of animal power, mainly because of the high maintenance cost of livestock.

Table 11:Trends in Livestock population (in 1000 numbers) in Khagaria

Category	2003	2007	2012	2019
CATTLE TOTAL	230.2	234.08	239.34	297.68
CATTLE ADULT MALE	15.14	9.82	4.69	5.2
CATTLE ADULT FEMALE	78.32	118.56	144.39	147.59
CATTLE YOUNG TOTAL	136.73	105.69	90.26	144.88
CATTLE SHARE IN LARGE RUMINANT (Percent)	73.57	63.53	73.11	75.99
BUFFALO TOTAL	82.69	134.38	88.02	94.06
BUFFALO ADULT MALE	1.14	2.06	1.9	1.29
BUFFALO ADULT FEMALE	45.46	72.74	55.21	46.68
BUFFALO YOUNG TOTAL	36.09	59.59	30.92	46.09
BUFFALO SHARE IN LARGE RUMINANT (Percent)	26.43	36.47	26.89	24.01
SHEEP TOTAL	0.02	0.06	0	0.19
SHEEP SHARE IN SMALL RUMINANT (Percent)	0.01	0.03	0	0.07
GOATS TOTAL	191.88	198.17	228.27	275.78
GOATS SHARE IN SMALL RUMINANT (Percent)	99.99	99.97	100	99.93
PIGS TOTAL	4.44	5.54	4.42	3.14
LIVESTOCK TOTAL	509.23	578.52	563.57	670.84

Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/

2.1.8 Trends in Fishery Production

Table 12 shows the trends in Fish Production in Khagaria district compared to the total fish production in Bihar. Fish Production was 7.05 thousand tons in 2011-12 in Khagaria, which increased to 23.89 thousand tons in 2017-18. The share of Khagaria district in the total fish production in the state went up significantly from 2.04% in 2011-12 to 4.06% in 2017-18.

Table12: Trends in fish production (1000 tons) in Khagaria				
District/Year	**2011-12**	**2013-14**	**2015-16**	**2017-18**
Khagaria	7.05	7.22	18.9	23.89
Bihar	344.47	432.29	506.88	587.85
Source: http://dse.bihar.gov.in/ and http://data.icrisat.org/district-level-data/				

2.2 FORESTRY

Baseline Data

According to the Forest Survey 2021, the total Forest Cover in the State is 7380.79 sq km which is 7.84 % of the State's geographical area. The state has 333.42 sq. km. under very dense forests, 3285.83 sq. km. under moderately dense forests and 3761.54 sq. km. under open forests. In recent years, massive plantation programs have been taken up in the State to increase the forest & tree cover.

According to the 2021 Forest survey, forests cover of the district is 1.24% out of the total geographical area which is 1486 sq. km. With respect to 2019 forest assessment there has been no change in the forest area of the district.

The district has a total of 18.45 sq. km. under the forests out of which 3.18 sq. km. is under moderately dense forests and 15.27 sq. km under the open forests. The district does not has any land area under very dense forests and scrubs as depicted in Fig. 1.

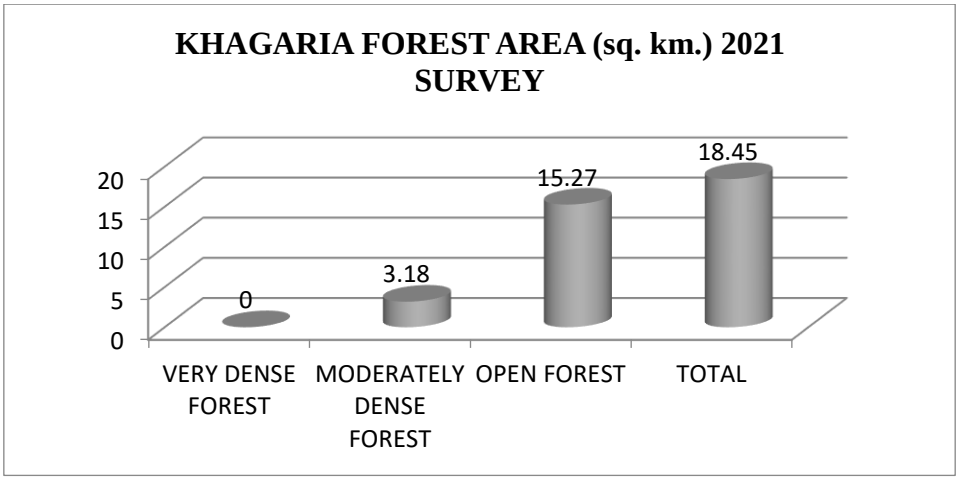


Fig. 1

The district has 2200 ha of cultivable wasteland, 6000 ha of current fallow and 22800 ha of other fallow land.

2.2.1. Biodiversity

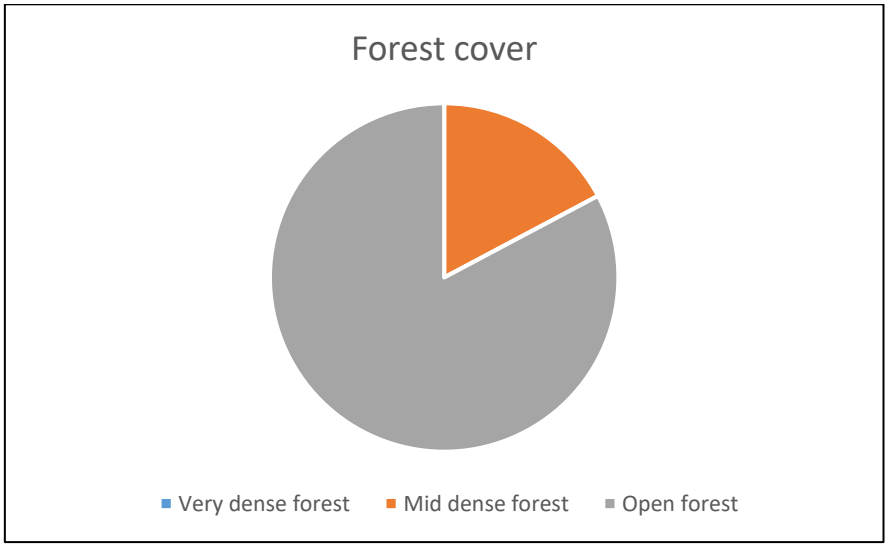
The district's biodiversity data includes crop production, livestock population, bird species, and forest cover. The district has a forest area of 61.98 square km, in which 17% area is mid-dense forest, and 83% area is open forest.

Table 1 Bird species recorded in the district.

Number of species	335
Number of rare/accidental species	21

Forest cover (in sq. km.)

Geographical area	Very dense forest	Mid dense forest	Open forest	Total	% of Geographical area `	Change with respect to 2017 assessment	Scrub
1486	0	3.18	15.27	18.45	1.24	-2.55	0



2.3 TOURISM

BIHAR: YEAR WISE TOURIST ARRIVALS (2001 TO 2020)

Tourism is one of the latest growing industries in the state of Bihar. The tourism influx is very irregular in terms of Domestic as well as of Foreign in the Bihar. In one year region witnessed a very huge tourist influx and in very next year number of tourists decreased suddenly owing to prediction of heavy flood, Crime and poor infrastructure facilities. Tourism has been worst hit in **2020 covid Pandamic** ravaged Bihar, caused a steep fall of **-83.03%** in tourist traffic.

Table: 2 Bihar: Year Wise Tourists Arrivals (2001 to 2020)

Year	Domestic	Growth	Foreign	Growth	Total	Overall Growth
2001	6061168	0.00%	85673	0.00%	6146841	0.00%
2002	6860207	13.18%	112873	31.75%	6973080	13.44%
2003	6044710	-11.89%	60820	-46.12%	6105530	-12.44%
2004	8097456	33.96%	38118	-37.33%	8135574	33.25%
2005	8687220	7.28%	63321	66.12%	8750541	7.56%
2006	7774732	-10.50%	84942	34.15%	7859674	-10.18%
2007	10352887	33.16%	177362	108.80%	10530249	33.98%
2008	11889611	14.84%	345572	94.84%	12235183	16.19%
2009	15784679	32.76%	423042	22.42%	16207721	32.47%
2010	18491804	17.15%	635722	50.27%	19127526	18.01%
2011	18397490	-0.51%	972487	52.97%	19369977	1.27%
2012	21447099	16.58%	1096933	12.80%	22544032	16.39%
2013	21588306	0.66%	765835	-30.18%	22354141	-0.84%
2014	22544377	4.43%	829508	8.31%	23373885	4.56%
2015	28029118	24.33%	923737	11.36%	28952855	23.87%
2016	28516127	1.74%	1010531	9.40%	29526658	1.98%
2017	32414063	13.67%	1082705	7.14%	33496768	13.45%
2018	33621613	3.73%	1087971	0.49%	34709584	3.62%
2019	33990038	1.10%	1093141	0.48%	35083179	1.08%

2020	5644524	-83.39%	308080	-71.82%	5952604	-83.03%

Source: Data Compiled from dse.bihar.gov.in

In Bihar there was an increase of **33.96% of Domestic Tourists in 2004**. This growth sharply declined in **2006** and accounts **-10.50%.** However, it again increases up to **33.16%** in **2007**. Talking about Foreign tourist arrival in Bihar, **Foreign Tourists** increase up to **31.75%** in **2002** and **108.80%** in **2007.** However, we witnessed a very huge decreased in the number of foreign tourist suddenly owing to prediction of natural catastrophe, poor infrastructure and experieces of tourists. Like in the year **2013 and 2020** Foreign Tourist decline **-30.18% and -71.82** respectively.

Figure: 1 Bihar: Year Wise Tourists Arrivals (2001 to 2020)

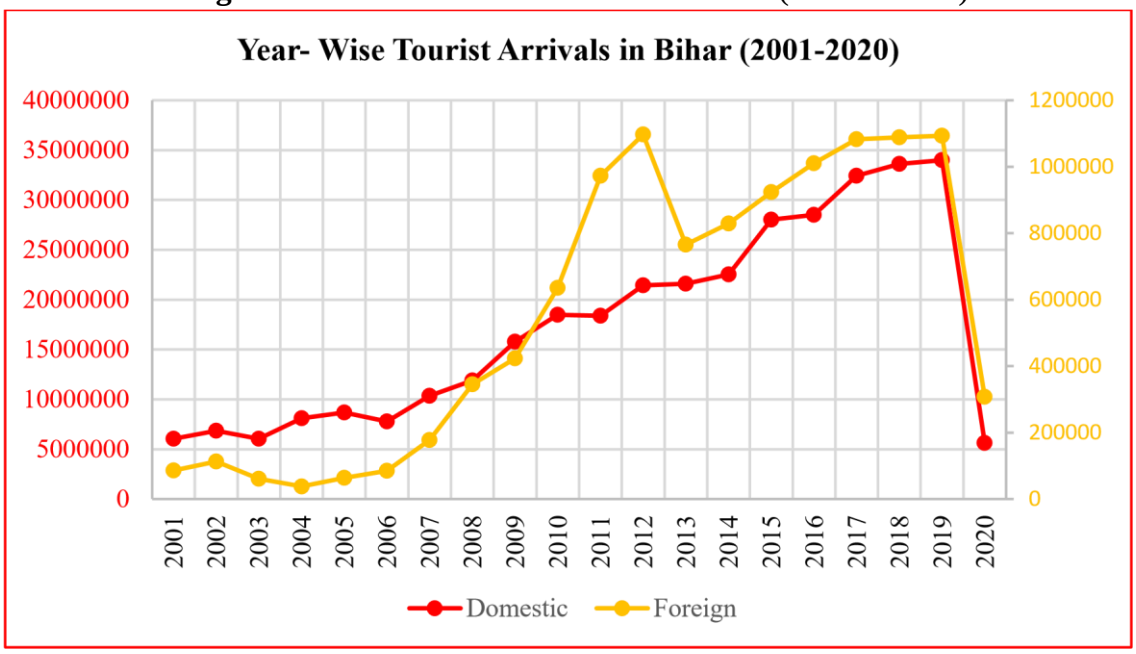


Figure: 2 Bihar: Year Wise Domestic Tourists Arrivals (2001 to 2020)

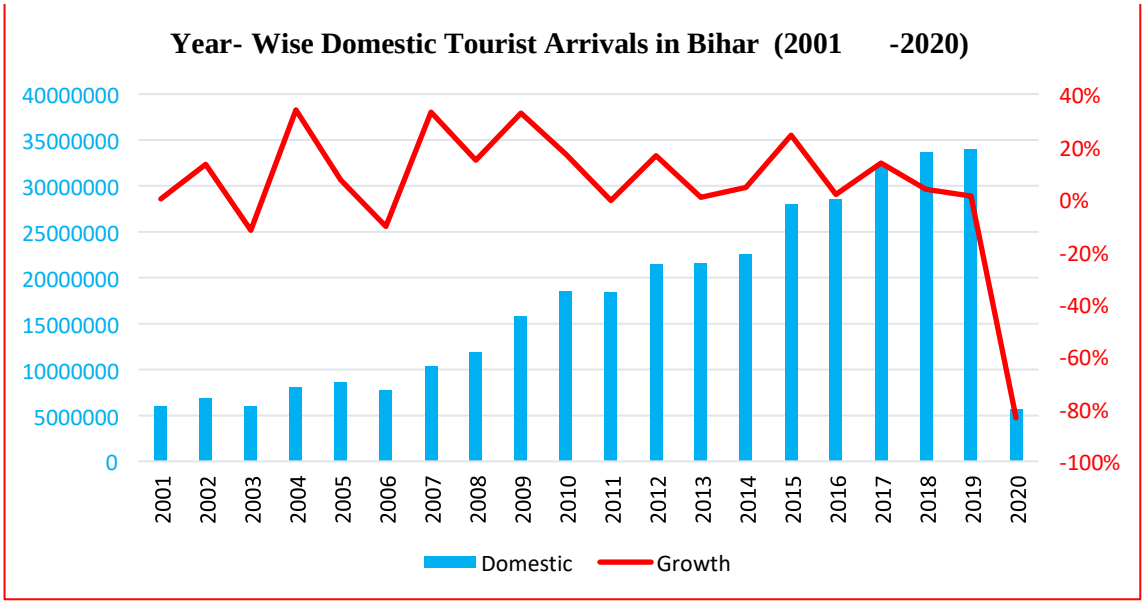


Figure: 3 Bihar: Year Wise Foreign Tourists Arrivals in Bihar (2001 to 2020)

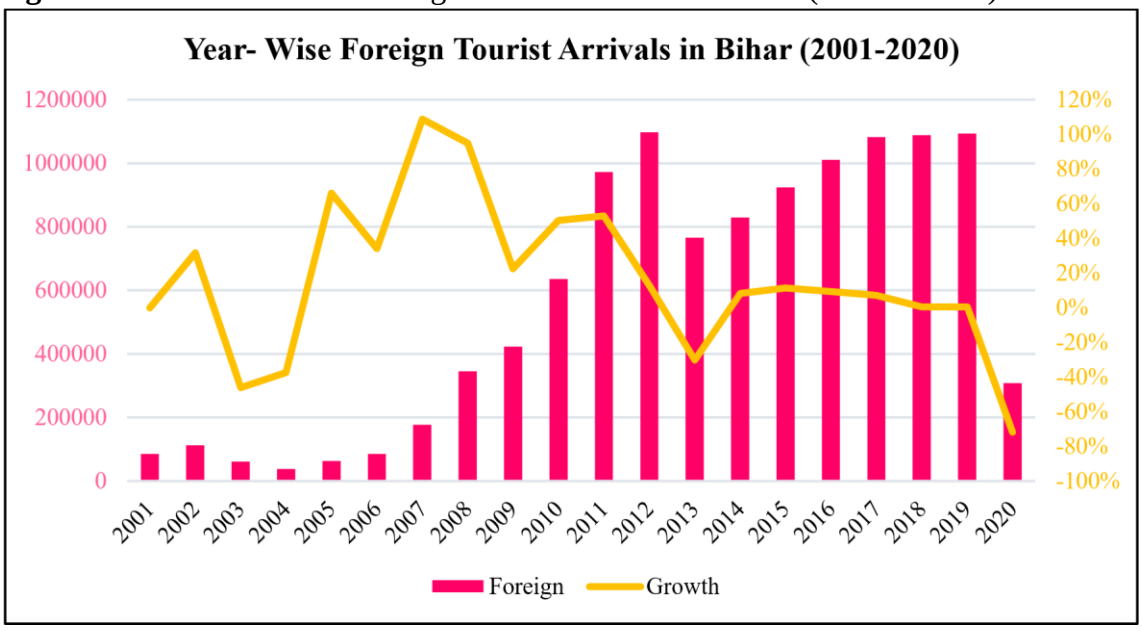


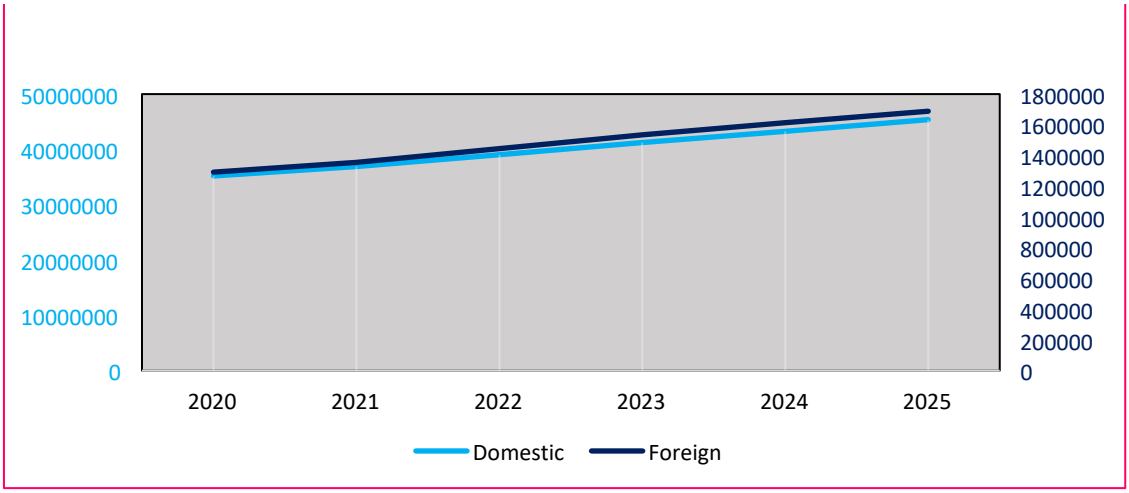
Table: 3 Bihar: Year Wise Tourists Arrivals (2020 to 2025) Forecast

Year	Domestic	Foreign	Total
2020	35185067	1291658	36476724
2021	36910980	1355501	38266481
2022	39061662	1444141	40505803
2023	41247899	1533826	42781725
2024	43268513	1614654	44883168

2025	45375097	1688413	47063510

Source: Data Compiled from Tourism Department of Bihar

Figure: 4 Bihar: Year Wise Tourists Arrivals (2020 to 2025) Forecast



Tourist Arrivals in Bihar (FORECAST)

BIHAR: SECTORAL CONTRIBUTION TO GSDP (1999-2000 TO 2006-2007)

Bihar is one of the fastest growing economies in India. It is largely service based, with a significant share of agricultural and industrial sectors. The sectoral contribution to the state GDP, the contribution of tertiary sector accounts **(53.88%)** in **1999-2000** increases to **(56.65%)** in **2003-2004**. The contribution of Primary sector is accounts between **(33.69%)** in **1999-2000** to **(36.80%)** in **2002-2003** and again decrease to **(30.77%)** in **2006-2007**. Meanwhile, contribution of Secondary sector is **(12.43%)** in **1999-2000** to **(16.31%)** in **2006-2007**. Moreover, the contribution of Trade, repair, hotel, and restaurant to tertiary Sector accounts **(27.89%)** in **1999-2000** while crossed **(40.62%)** in **2006-07**. Therefore, Bihar has great potential to contribute to the economy, Tourism and Hospitality sector in the state can further be promoted to harness its growth through providing world class infrastructure facilities, establishing tourism centres across the state, adopting disaster management policy, Law and Order.

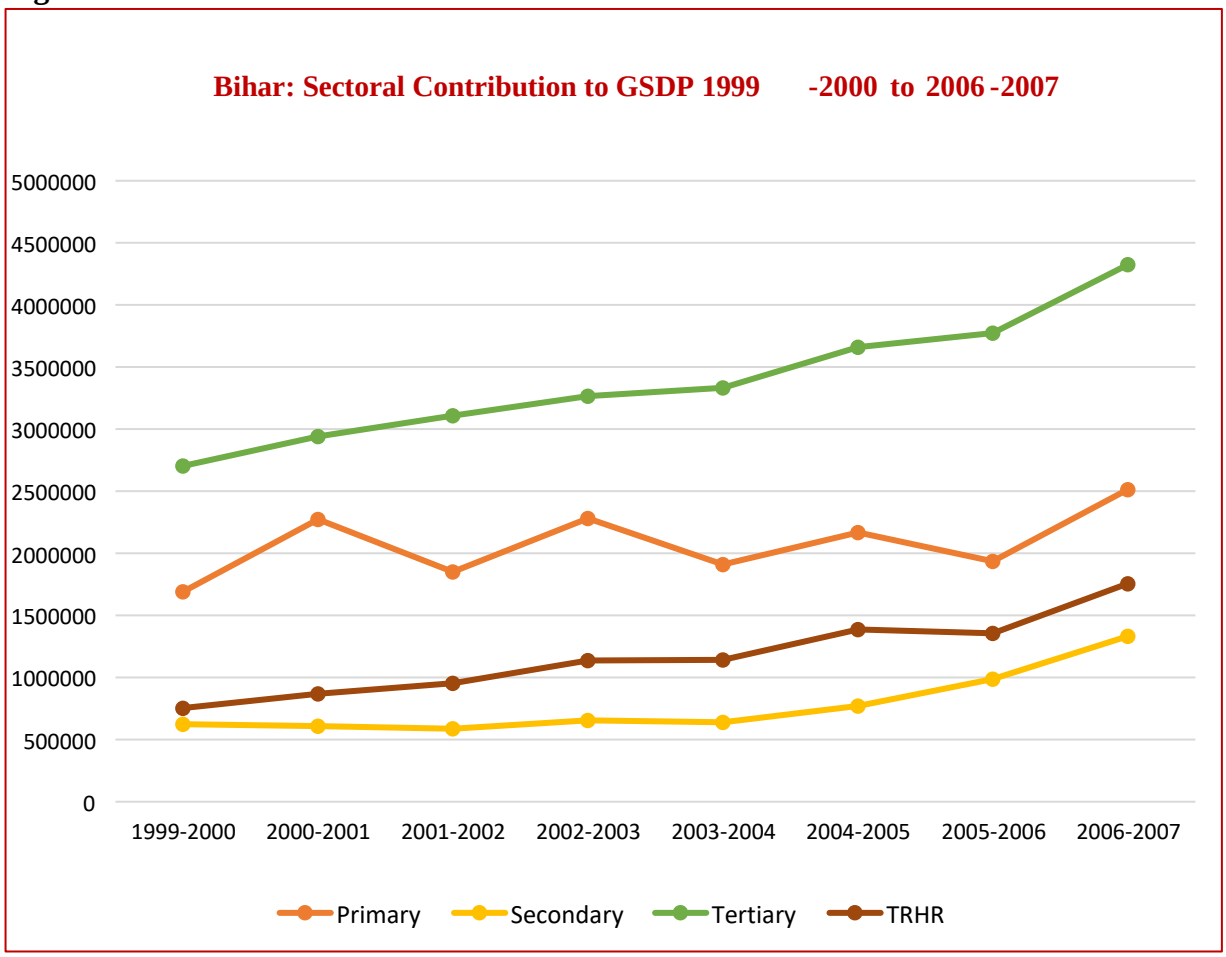
Table: 4 Sectoral Contribution to GSDP Bihar 1999-2000 to 2006-2007

Year	**Primary**	**Secondary**	**Tertiary**	**TRHR as % of Tertiary**
1999-2000	1690440 (33.69%)	623589 (12.43%)	2703347 (53.88%)	754097 (27.89%)

2000-2001	2272675 (39.03%)	609252 (10.46%)	2940338 (50.50%)	870083 (29.59%)
2001-2002	1850242 (33.36%)	587654 (10.59%)	3108764 (56.05%)	952986 (30.65%)
2002-2003	2282622 (36.80%)	654300 (10.55%)	3265587 (52.65%)	1135730 (34.78%)
2003-2004	1911225 (32.49%)	639591 (10.87%)	3332491 (56.64%)	1142426 (34.28%)
2004-2005	2167878 (32.85%)	770771 (11.68%)	3660900 (55.47%)	1388261 (37.92%)
2005-2006	1937233 (28.92%)	986505 (14.73%)	3774182 (56.35%)	1356901 (35.95%)
2006-2007	2514504 (30.77%)	1332672 (16.31%)	4324459 (52.92%)	1756746 (40.62%)

Source: Data Compiled from dse.bihar.gov.in

Figure: 5 Sectoral Contribution to GSDP Bihar 1999-2000 to 2006-2007



KHAGARIA: SECTORAL CONTRIBUTION TO GSDP (1999-2000 TO 2006-2007)

Like Bihar as a state, the District of Khagaria has potential for Religious and Ecotourism etc. Comparing the sectoral contribution to the state GDP, the contribution of tertiary sector in **Khagaria** is **(44.35%)**, whereas for the state it is **(53.88%)** in **19992000** while it exceeds to **(47.34%)** and **(56.05%)** in **2001-2002** respectively. Moreover, the contribution of Trade, repair, hotel, and restaurant **(3.18%)** outperforms in comparison to the state counterpart **(27.89%)** in **1999-2000**, however this gap further strengthen during **2006-2007** were Khagaria accounts **(9.93%)** that of state (**40.62%)**.

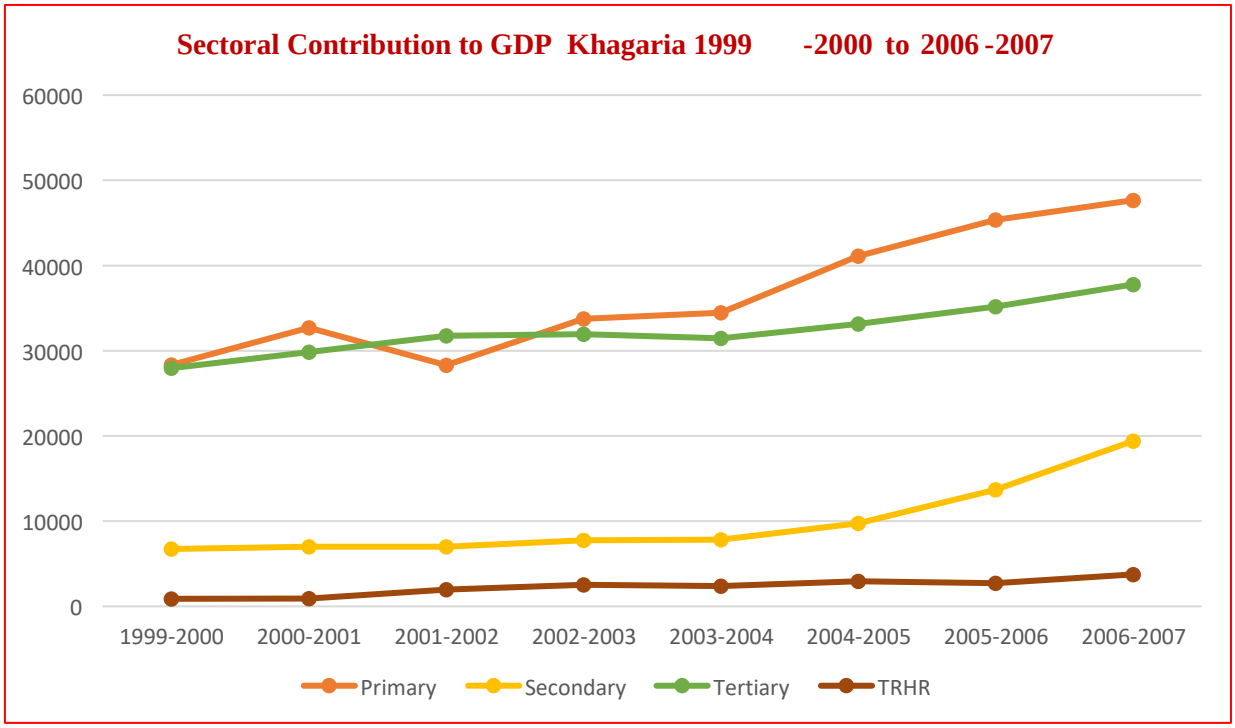
Thus, the contribution of Khagaria's Tertiary sector shows increasing manner and similarly with trade, repair, hotel, and restaurant.

Table: 5 Sectoral Contribution to GDDP Khagaria 1999-2000 to 2006-2007

Year	Primary	Secondary	Tertiary	TRHR as % of Tertiary
1999-2000	28339 (44.96%)	6735 (10.69%)	27957 (44.35%)	888 (3.18%)
2000-2001	32682 (47.01%)	7005 (10.08%)	29827 (42.91%)	928 (3.11%)
2001-2002	28304 (42.21%)	7005 (10.45%)	31740 (47.34%)	1971 (6.21%)
2002-2003	33752 (45.93%)	7770 (10.57%)	31960 (43.49%)	2517 (7.88%)
2003-2004	34456 (46.71%)	7838 (10.63%)	31475 (42.67%)	2378 (7.56%)
2004-2005	41108 (48.95%)	9730 (11.59%)	33149 (39.47%)	2963 (8.94%)
2005-2006	45356 (48.15%)	13677 (14.52%)	35165 (37.33%)	2731 (7.77%)
2006-2007	47664 (45.46%)	19398 (18.50%)	37776 (36.03%)	3752 (9.93%)

Source: Data Compiled from dse.bihar.gov.in

Figure: 6 Sectoral Contribution to GDDP Khagaria:1999-2000 to 2006-2007



Khagaria has great potential to contribute to the economy. Hence, tourism and hospitality sector in the district can be promoted to harness its growth and benefits to the district economy. However, promoting tourism sector by considering its economic contribution may lead to bad policy decisions without noting the natural disaster as well as tourism infrastructure and crime and implementation policy. Moreover, development of projects and strong research is mandatory to know the detailed information on disaster, Crime, tourism infrastructure, tourist foot fall etc.

Bihar: GSDP Growth Rate at Constant Price (1999-2000 to 2006-2007)

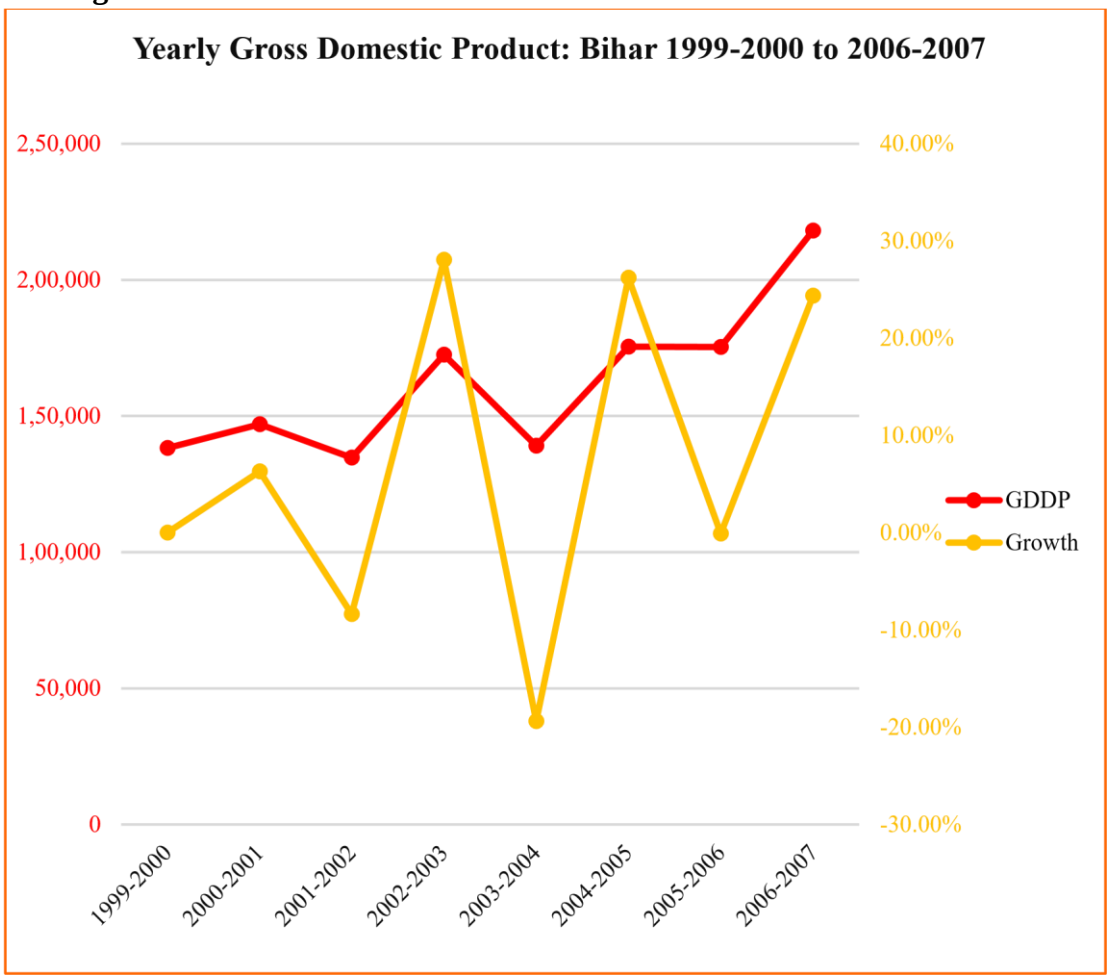
The impact of the Disaster, High Crime rate, Poor Infrastructure, Under-investments, Poor Economic Policy, and Poor Political Vision etc. has been reflected in terms of reducing the annual growth rate of the state from (**16.04%)** in **2000-2001 to (-4.73%)** in **2001-2002**. While the state annual growth was again rise to **(11.82%)** in **2002-2003** affected during **2003-2004 (-5.15%)** which is the lowest growth rate during a 5-year period; the effect of the disaster and economic policy has negatively affected the district annual GDP growth rate for subsequent

years. However, we can see a huge growth during **2006-2007** when GDDP accounts 8171635 i.e. **22.00%** of growth. This states that disaster and economic policy largely has a micro regional impact, hence disaster and development related policies must be made be made considering micro regional contexts and be site specific.

Table: 6 GSDP Growth Rate at Constant Price: Bihar 1999-2000 to 2006-2007

Year	GDDP	Growth
1999-2000	5017376	0
2000-2001	5822265	16.04%
2001-2002	5546660	-4.73%
2002-2003	6202509	11.82%
2003-2004	5883306	-5.15%
2004-2005	6599549	12.17%
2005-2006	6697921	1.49%
2006-2007	8171635	22.00%

Figure: 7 GSDP Growth Rate at Constant Price: Bihar 1999-2000 to 2006-2007



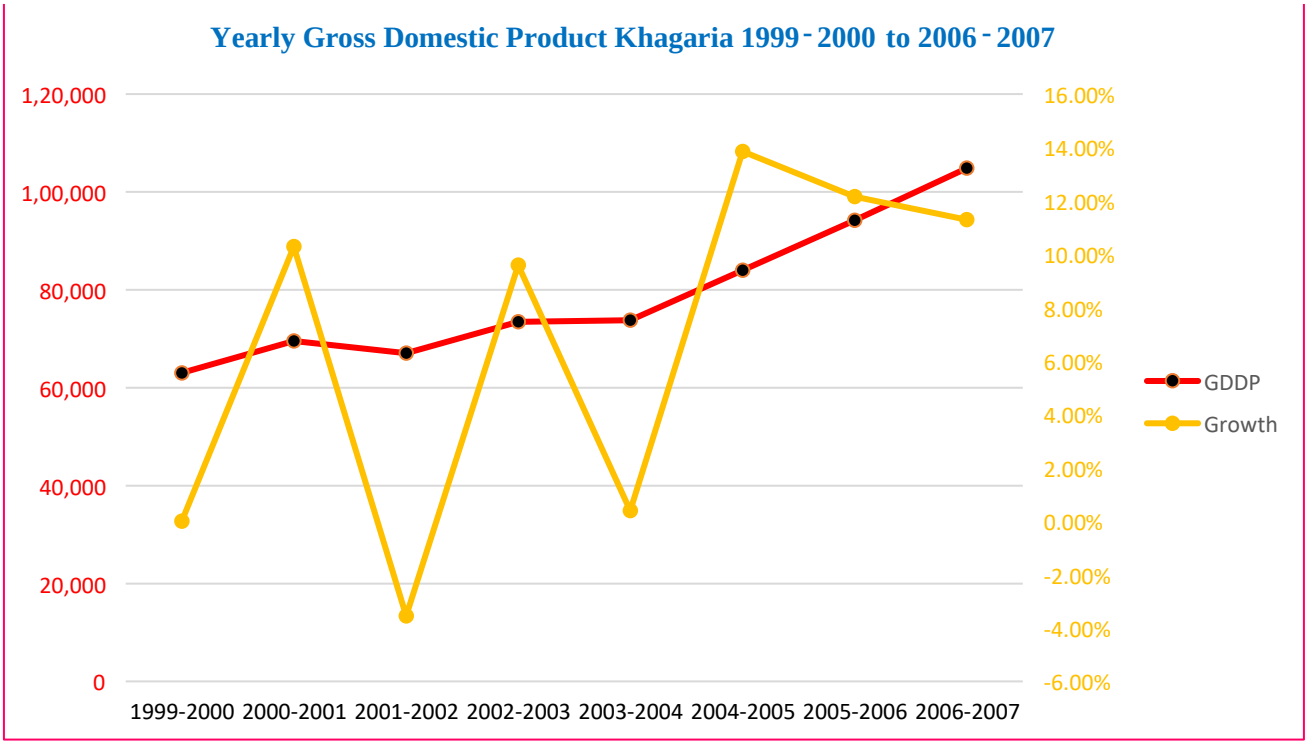
Khagaria: GDDP Growth Rate at Constant Price (1999-2000 to 2006-2007)

The impact of the Disaster, High Crime rate, Poor Infrastructure, Under-investments, Poor Economic Policy and Poor Political Vision etc. has been reflected in terms of reducing the annual growth rate of the district from (**10.29%)** in **2000-2001 to (-3.55%)** in **2001-2002**. The district annual growth was again rise up to **(13.85%)** in **2004-2005**. This states that impact of the Disaster, High Crime rate, Poor Infrastructure, Underinvestments, Poor Economic Policy and Poor Political Vision etc. largely has severe regional impacts in reducing the annual growth rate of the district, hence disaster and development related policies must be made taking into account micro regional contexts and site specific.

Table: 7 GDDP Growth Rate at Constant Price: Khagaria 1999-2000 to 2006-2007

Year	GDDP	Growth
1999-2000	63031	0
2000-2001	69514	10.29%
2001-2002	67048	-3.55%
2002-2003	73482	9.60%
2003-2004	73769	0.39%
2004-2005	83987	13.85%
2005-2006	94199	12.16%
2006-2007	104838	11.29%

Figure: 8 GDDP Growth Rate at Constant Price: Khagaria 1999-2000 to 2006-2007



KHAGARIA: CONTRIBUTION OF TRHR TO THE GDDP AT CONSTANT PRICE (1999 TO 2025)

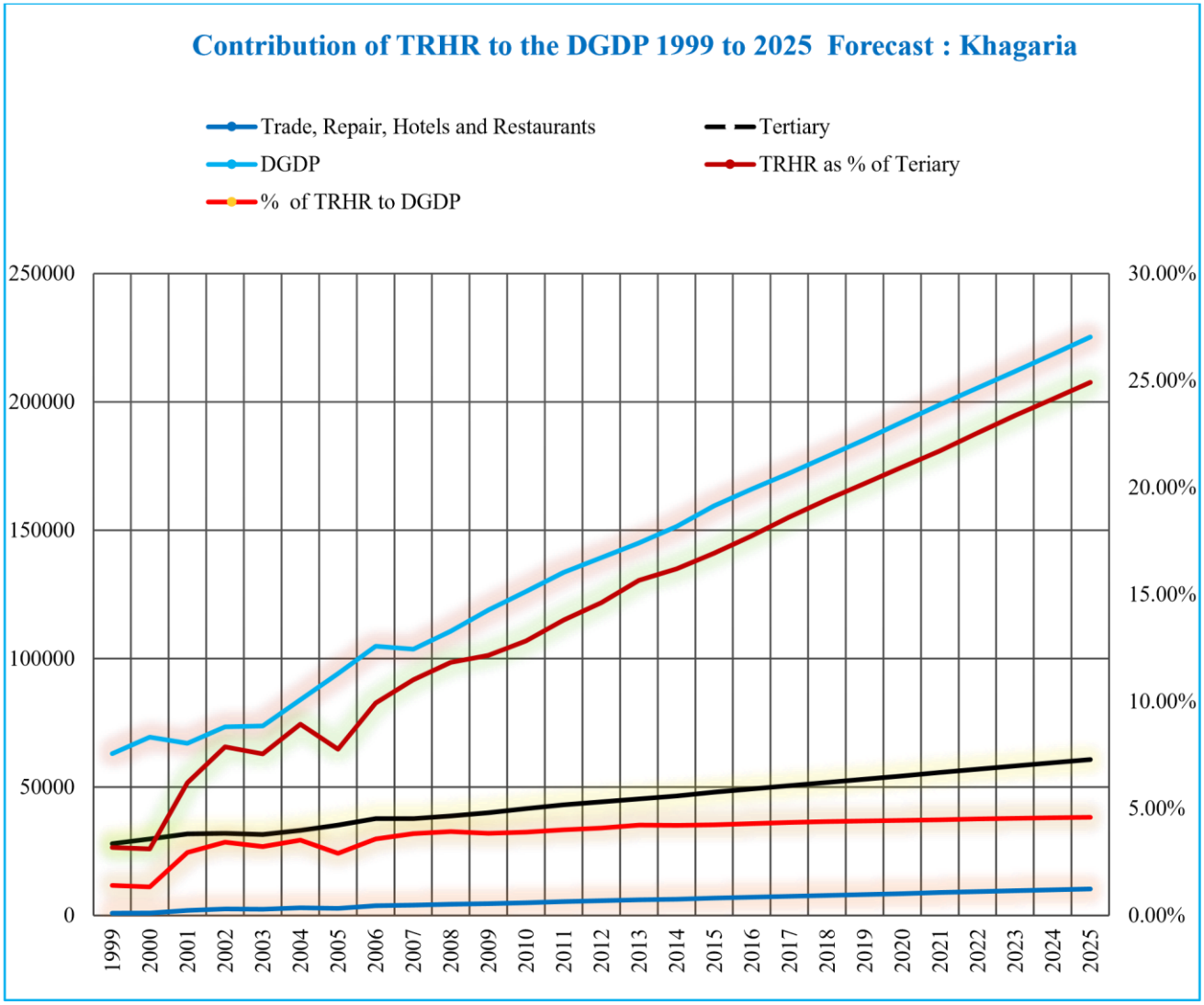
Table: 8 Contribution of TRHR to the GDDP at Constant Price Khagaria (1999 to 2025)

Year	Trade, Repair, Hotels and Restaurants	Tertiary	TRHR as % of Tertiary	DGDP	% of TRHR to DGDP
1999	888	27957	3.18%	63031	1.41%
2000	928	29827	3.11%	69514	1.33%
2001	1971	31740	6.21%	67048	2.94%
2002	2517	31960	7.88%	73482	3.43%
2003	2378	31475	7.56%	73769	3.22%
2004	2963	33149	8.94%	83987	3.53%
2005	2731	35165	7.77%	94199	2.90%
2006	3752	37776	9.93%	104838	3.58%
2007 Forecast	3975	37694	11.02%	103761	3.83%
2008	4337	38770	11.82%	110667	3.92%
2009	4564	40009	12.16%	118976	3.84%
2010	4912	41592	12.83%	126151	3.89%

2011	5351	43160	13.80%	133648	4.00%
2012	5703	44306	14.62%	139352	4.09%
2013	6121	45372	15.66%	145142	4.22%
2014	6372	46495	16.20%	151542	4.20%
2015	6750	48018	16.93%	159484	4.23%
2016	7116	49340	17.75%	166007	4.29%
2017	7497	50600	18.63%	172289	4.35%
2018	7852	51800	19.43%	178750	4.39%
2019	8194	53031	20.18%	185291	4.42%
2020	8549	54345	20.96%	192145	4.45%
2021	8902	55666	21.72%	198930	4.47%
2022	9277	56953	22.56%	205519	4.51%
2023	9630	58182	23.36%	211925	4.54%
2024	9984	59449	24.14%	218588	4.57%
2025	10338	60732	24.91%	225292	4.59%

Source: Data Compiled from dse.bihar.gov.in

Figure: 9 Contribution of TRHR to the GDDP at Constant Price Khagaria (1999 to 2025)



2.4 WETLANDS

The district has vast wetlands; the majority of them are riverine and waterlogged. Table 1 shows the number of wetlands and their area representation in the district.

Table 1: Wetland Data of Khagaria district

	Total Number of												
	Wetlands:			**Area (ha)**									**Aquatic Vegetation**
Natural Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	
Lake/ponds	23	24	1	0	0	11	5	6	1	0	0	0	22

Ox-bow lakes/cut off meanders	49	55	6	0	8	15	12	9	4	1	0	0	38
High altitude Wetlands	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverine Wetlands	39	42	3	0	12	10	12	4	1	0	0	0	34
Waterlogged	29	31	2	0	8	10	3	1	5	2	0	0	25
River/Stream	0	44	44	0	0	0	0	0	0	0	0	0	0
Man-made Wetlands	**NRCD**	**NWIA**	**Diff.**	**<2.25**	**<5**	**<10**	**<20**	**<50**	**<200**	**<500**	**<1000**	**>1000**	**AV**
Reservoirs/Barrages	0	0	0	0	0	0	0	0	0	0	0	0	0
Tanks/ponds	17	17	0	0	14	2	1	0	0	0	0	0	14
Waterlogged	0	0	0	0	0	0	0	0	0	0	0	0	0
Salt pans	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (288)	157	213	56	75	42	48	33	20	11	3	0	0	133

Source: National River Conservation Directorate (NRCD), National Wetland Inventory and Assessment (NWIA) Atlas

Some of the wetlands that exist in the district with their area (in Ha) are as follows:

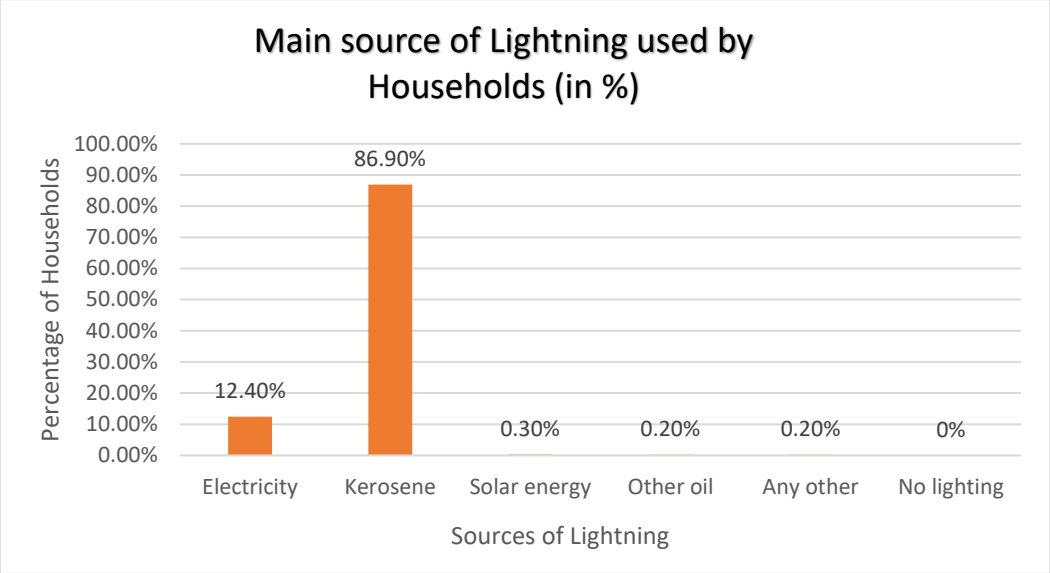
Natural wetlands (lake/ponds)		Natural wetlands (Ox-bow lakes/cut off meanders)	
Wetland	Area (Ha)	Wetland	Area (Ha)
Sunhauli Moin	46.83	Dainee Man	110.86

2.5. ENERGY

2.5.1. Solar

BREDA or Bihar Renewable Energy Development Agency is responsible for the promotion of renewable energy requirements in the state, with an emphasis on providing rural electrification.

The graph has been made according to the data collected during the Census of India 2011, of main sources of lightning used by the households in the district of Khagaria. Around 86.90% of the households are dependent upon Kerosene for their lightning needs and 12.40% of the households are dependent upon electricity for their lightning needs. Solar energy is used by 0.30% of the households, other oil is used by 0.20% of the households for lightning sources, other sources of lightning are used by 0.20% of the households.



2.5.2. Biomass

BREDA or Bihar Renewable Energy Development Agency has been set up to promote renewable energy resources in Bihar and is a nodal agency for electrification program in the villages.

The net sown area of the district is 87100 hectares, area sown more than once in a year is 46000 hectares, and gross cropped area is 133100 hectares. The cropping intensity is 152.7%. The aggregate forest area is 4000 hectares.

The district's main occupation is agriculture. The major crops grown in the district are rice, wheat, maize, chickpea, and green gram. The horticulture crops grown in the district are mango, guava, litchi, banana, and lemon.

Crop	**Productivity** (kg/ha)
Rice	3420
Wheat	2104
Maize	4007
Chickpea	992
Green Gram	683
Mango	9431
Guava	8769
Litchi	7176
Banana	44944

Lemon	5043

Table 1

The data from Census of India 2011 has been used to construct the pie chart for the type of fuel used by the households for cooking in Khagaria district. 63.40% of the households use crop residue, 24.30% of the households use fire-wood, 6.70% of the households use cow dung cake, and 4.70% of the households use LPG/PNG.

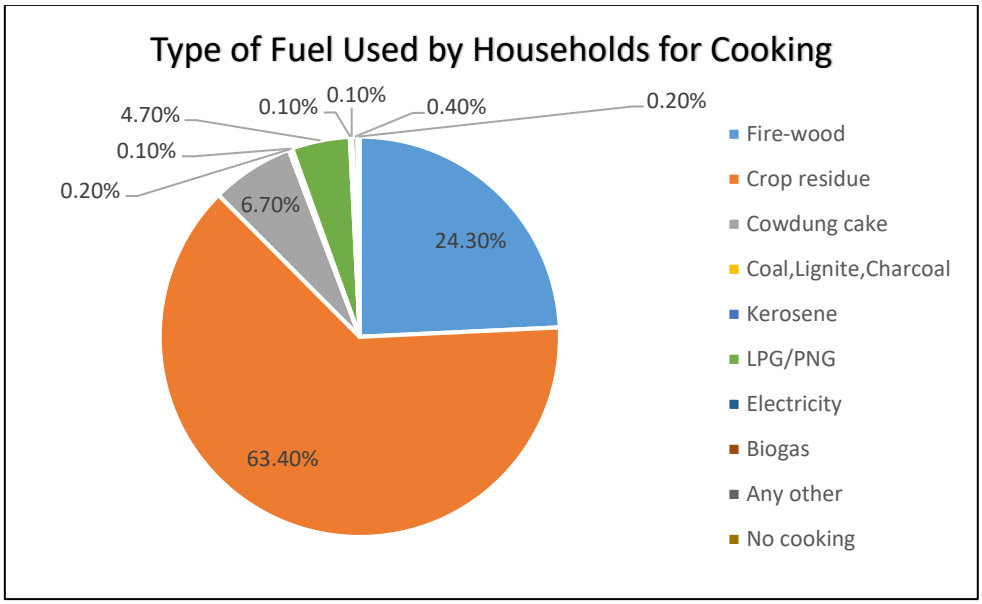


Fig. 1

2.5.3. Biogas

Either the biogas data is not available for the district, or no plants exist in the district. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as eighty six lakh m3/year and ninety six lakh m3/year from agricultural waste. This amount of biogas generation can efficiently complete the energy demand of the district. Biogas data is not available for the district. Based on the livestock population and agricultural waste biogas potential calculated. Biogas potential from animal waste and agricultural waste was calculated approximately as one crore m^3/year and eighteen crores m^3/year. This amount of biogas generation can efficiently complete the energy demand of the district.

2.5.4. Hydro Power

The Ganga, Gandak, Bagmati, Kamala, and Koshi rivers run through the area. These rivers can be a source to produce electricity through turbines. However, no hydropower plant exists in the district; nor any project sites have been identified for small hydropower projects.

3 QUALITATIVE DATA ANALYSIS

3.1 FORESTRY

Khagaria district spreads over vast tracts of flat alluvial plain and swampy lands. The northern part of the district is an extensive plain formed by the rich alluvial soil. The southern portion of Khagaria district consists of vast rice tracts and forests. The major part of the alluvial plain is inundated during the rains by the over flow of the rivers. However, the inundation has slightly decreased after construction of embankments but still a large part in the north eastern part of the district

The district is categorized under Agro-climatic zone II i.e. the Northern east zone. The district has sandy loam to clay loam type of soil with pH between 6.5-7.8.

3.1.1. Biodiversity

From 2010 to 2021, Khagaria lost 0.139 ha of tree cover, equivalent to a 0.14% decrease in tree cover since 2010, and 47.2t of CO_2e emissions. Between 10th of June 2019 and 6th of June 2022 Khagaria experienced a total of 19 VIIRS Alerts fire alerts. No dense forest cover exist in the district.

3.2. ENERGY:

3.2.1. Solar

The total solar power potential in the district is 0.0294, which has been calculated on the basis of solar radiation (kWh/m2/day), availability of total wasteland and total sunny days (D, K, Mishra, & Bhattacharyya, 2016).

According to the input survey of 2016-17, the total net sown area is 64445 hectares, out of this 46550 is irrigated net sown area and 17895 is unirrigated net sown area. According to the CEEW report of 2020, the solar pumps would be beneficial for the district's agricultural output but due to high proportion of marginal and small farmers, it is imperative that government should give sufficient subsidies for the installation of individual solar pumps.

In 2015, Clairo Energy, Delhi decided to set up grid connected solar power projects having a capacity of 10 MW in Khagaria district (Jha, 2016). The socio-economic profile of the district is weak and so mini-grid type of intervention would be unsuitable, here government support is required (D, K, Mishra, & Bhattacharyya, 2016).

3.2.2. Biomass

The total biomass rice husk potential of the district is 3089 MT/Year (The World Bank, 2014). The biomass energy in the district has not yet been exploited fully.

According to the Census 2011 data, more than half of the household's percentage rely on crop residue for cooking, it means that they use traditional biomass for cooking which is environmentally harmful and increases ambience pollution. In this situation, it would be better if there is any mechanism to transport the biomass raw materials to the biomass plants. Moreover, subsidies should be provided to use LPG/PNG for cooking, under the Pradhan Mantri Ujjwala Yojana (PMUY). Awareness about modern biomass technology is not available to the households of the district.

3.2.3 Biogas:

The district has a lot of potential to generate bioenergy through biogas plant based on animal or agricultural waste. However, there is no data showing installation of biogas plant in the district. There is no treatment facility for WW and Faecal Sludge (FS). WW from 15 wards conveyed via major storm water drains ends up in low lying areas. FS collected is discharged in solid waste dump yard in outskirts of the city. This sludge can be treated through STP cum biogas plant.

3.2.4. Hydropower:

Floods were a yearly occurrence since five main rivers – The Ganga, The Gandak, The Bagmati, The Kamala, and The Koshi – ran through the Khagaria region. During the wet season, communication was particularly difficult due to the recurrence of floods and water logging. The vast area of land between the railway line and three streams, namely the Bagmati, the Kamla, and the Ghaghri (the mainstream of Koshi) and various streams, such as the Maria river and the Maitha river, used to be covered in marshes before the construction of the South embankment of Baghmati and the Gogari-Narayanpur embankment. Still, hydropower potential is yet to be discovered. No hydroelectric power plant exists in the district, nor the site has been identified.

3.3 TOURISM

Khagaria, included in the old district of Munger, formed part of the Madhya-desa or "Midland" of the first Aryan settlers. Khagaria has been identified with Modagiri, a place mentioned in the Mahabharata, which was the capital of a kingdom in eastern India near Vanga and Tamralipta. (*Khagaria District History*, n.d.)

Further, Khagaria is known for its religious diversity and the warmth of the people. Here tourist will find a number of temples and many mosques, all coexisting in peace.

With various villages dotting the region, it's an opportunity to peek into the lives of the quintessential Indian hailing from a small town. Khagaria's history is comparatively not as colorful as many other Indian cities, in that, there aren't any forts or palaces to visit. However, what Khagaria is indeed known for is its various festivals and the enthusiasm with which they

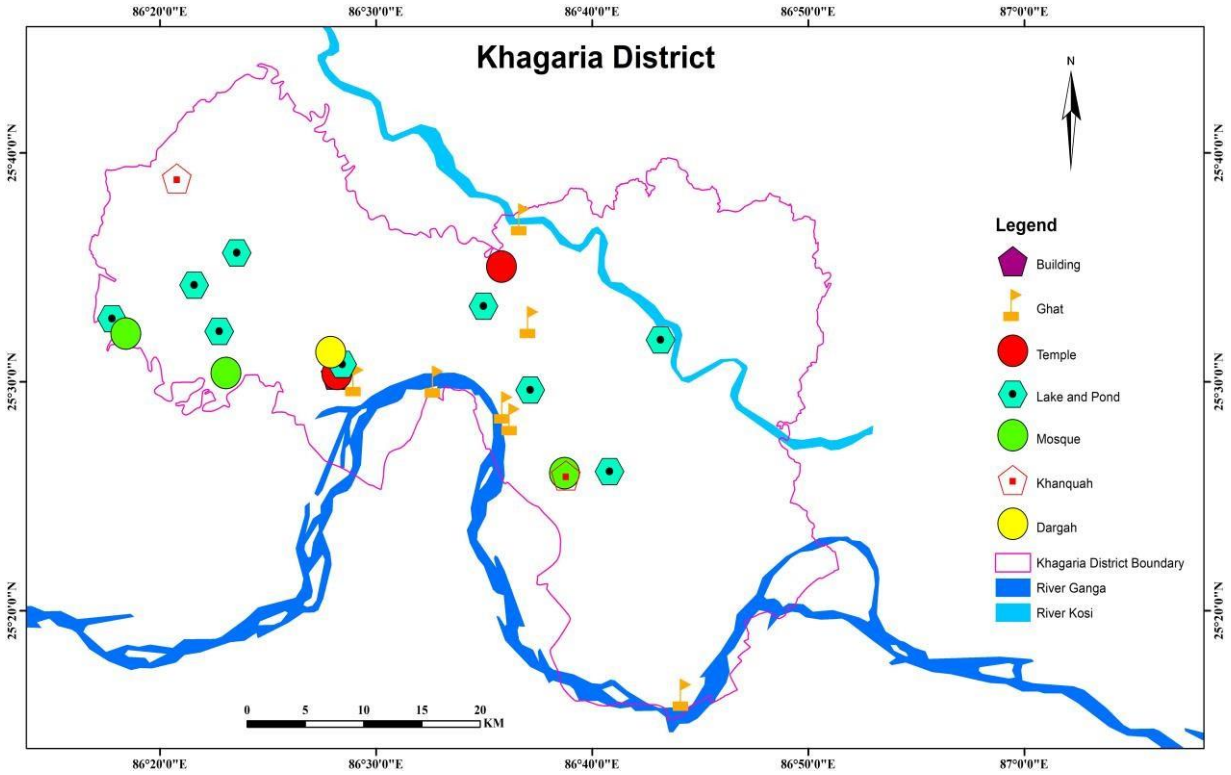
are celebrated. Till date, Khagaria is still rich in natural beauty, and this works to the locals' advantage, as the region is wholly dependent on its agricultural produce. We will find lush green hills overlooking babbling brooks and gushing rivers, creating a picturesque backdrop. (*Khagaria Tourism*, n.d.)

Most melas or fairs in Khagaria are held during the festive season, around Dussehra and Diwali. During this time, the city truly lights up and is teeming with people who come from far and wide to join in on the merriment. (*Khagaria Tourism*, n.d.). Some of the most popular and crowded festivals here include the one held in Katyani Asthan, the Gopastami Mela, Janmashtami, Holi and Shivratri, among others.

The Bihar State Tourism Development Corporation Ltd. is the agency that is responsible for all tourism activities in the state. Though there is not much evidence from the state tourism department that shows the tourist in-flow to Khagaria, there is a promising tourism in Khagaria. The tourism potential is yet to be tapped by the Government. Khagaria district has potential for Religious and Eco tourism. There are number of religious and Eco tourism sites present in the district. These sites include temple, Masjid, dargah, Khanquah and Lakes. Incentive based policy should be formulated to protect these religious structures from further decay. The district has wide scope for tourism, the historical significance of Khagaria has contributed a lot to the growth and development of Khagaria tourism. Therefore, Khagaria district can be promoted as a popular destination for tourist from all over the world.

Some significant temples and religious spots within the district are Katyayani Mandir, Jama Masjid Ratan, Jama Masjid Bela Ganj, Khanquah Faridia Jogiya Sharif, Khanquah Gulzaria Faridia, Aguwani Ghat, Lohiyar Ghat, Dhamara Ghat, Mansi Ghat, Gouchhari Pond, Rajendra Sarovar, Badlaghat Pokhar lake, Dumri Chaur, Shumbha Wetland Lake and Gorhia Wetland Lake etc.

Map:2 Tourism Sites of Khagaria District



Source: Prepared by Author

3. RELIGIOUS & SPIRITUAL TOURISM

Khagaria has is a deeply religious setting in the state of Bihar. Katyayani Mandir, arguably the most famous temple here, Jama Masjid Ratan, Jama Masjid Bela Ganj, Khanquah Faridia Jogiya Sharif, Khanquah Gulzaria Faridia etc. are other sacred spots in the district.

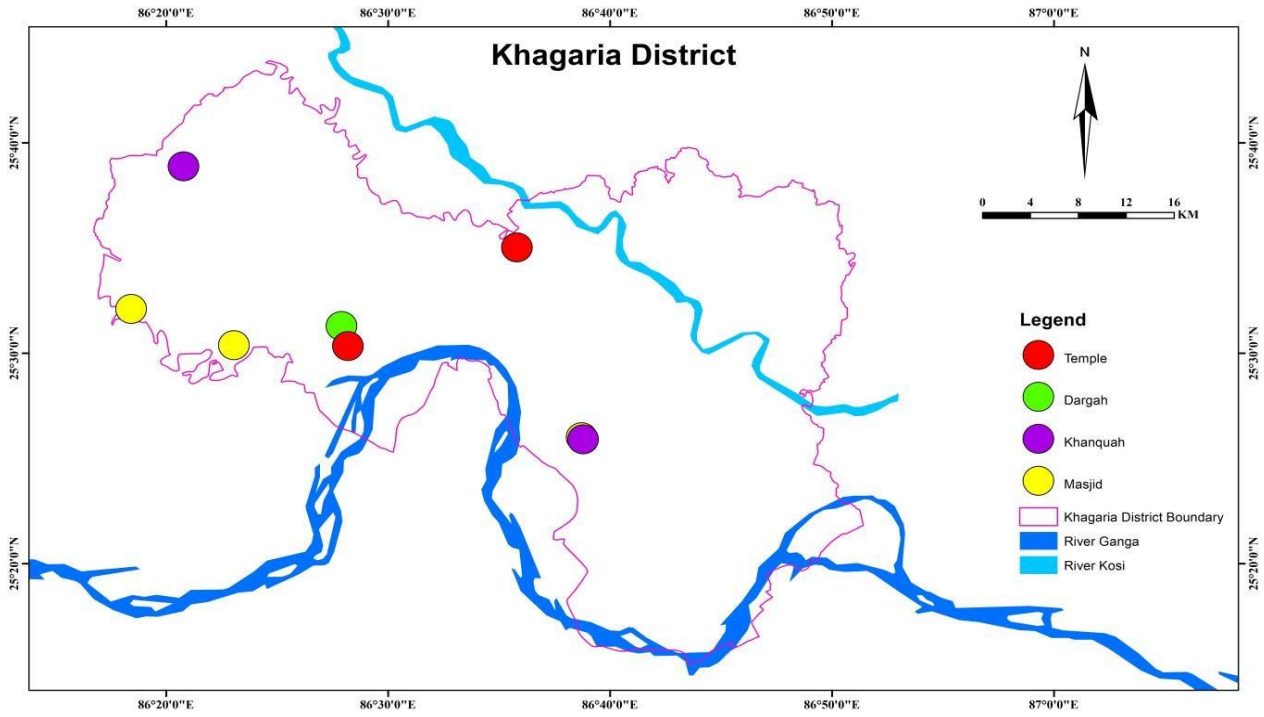
★ **Katyayani Mandir:** Katyayani Asthan is situated at distance of approximately 12 kms. From the district headquaters, on the bank of river Koshi, between the stations Badlaghat and Dhamaraghat. (*Khagaria District*, n.d.-b). Every Monday and Friday, large number of devotees come to this place for offering puja. As per the local folk traditions, Ma Katyayani is worshiped in two forms in this area. Some devotees worship Ma Katyayani as Sidh Peeth, while a large number of devotees worshiped as Lok Devi- Devi of Milk Cattles. That is why devotees offer raw milk to the deity. It is said that Rishi Katyayan was performing Tapasya on the bank of river Kaushiki (now Koshi) when Ma Durga- the deity of Shakti took 'avtar' in child form and was accepted by

Rishi as his daughter. Hence, she is called Katyayani. Another story says that around 300 years ago, this place used to be dense forest. One day a devotee Shripat Maharaj saw Ma Katyayani

in dream and as per her directions constructed an earthen Temple at that place and started worshiping her. (*Katyayani Mandir*, n.d.)

- ★ **Panchmukhi Hanuman Mandir:** Panchmukhi Hanuman Mandir is one of the well maintained and beautiful temple in Khagaria. Being in hearth of Khagaria, it attracts lot of attention. This Panchmukhi Hanuman Temple is wonderful and is located near Rajendra chowk khagaria.
- ★ **Jama Masjid Ratan:** This Mosque is made in 18 century. The mosque is located in Ratan Village of Gogri Subdivision of Khagaria district in Bihar.
- ★ **Jama Masjid Bela Ganj:** This mosque is located in Bela Ganj, Bela Simri Khagaria
- ★ **Ismailpur Masjid:** This mosque has three dome structure, located in Labhgaon village of Khagaria district.
- ★ **Khanquah Faridia Jogiya Sharif:** Khanquah Faridia Jogiya is located in Jogia Village of Khagaria.
- ★ **Khanquah Gulzaria Faridia:** Khanquah Gulzaria is located near Masjid ratan village of Gogri subdivision of khagaria district.
- ★ **Dargah Hazrat Syed Abdul Azim:** Hazrat Syed Abdul Azim was a prominent Muslim scholar of 19th century. In Bachhouta Sharif his center of meditation and spiritual guidance. In construction of the khanqah. A masjid, 20 rooms and a big compound was built.

Map:3 Religious Tourism Sites of Khagaria District



Source: Prepared by Author

4. ADVENTURE, NATURE & ECO TOURISM

Physiographic and the natural surroundings along the river Ganga in Khagaria are part of the natural heritage of Khagaria. The Khagaria is surrounded by river Ganges on the southern side and by river Kosi on the northern side. These rivers impart prosperity to the people and play an important role in making this district significant and unique. Khagaria district has seven rivers and 54 streams and streams flow in the district. Due to these, there are five thousand 645 hectares of marked wetlands (water logging areas) that are very important from the point of view of biodiversity in this flood-affected district. This land is considered very important from the point of view of biodiversity due to the abundance of many types of animals, birds and plants. Along with this, this land is also suitable for the cultivation of makhana and water fruit.

★ **Pasraha Area:** This area extends from Pasraha in Khagaria district to Navgachiya in Bhagalpur district. The Pasraha area of the district remains a sanctuary for migratory birds. The chirping of indigenous and foreign birds in the wetlands of Kosi is attracting a lot of people. The Pasraha area of the district remains a sanctuary for migratory birds. The chirping of indigenous and foreign birds in the wetlands of Kosi is attracting a lot of people. Thousands of migratory birds come from Siberia: Due to the favorable climate, every year thousands of migratory birds start coming to the banks of the Kosi river of Pasaraha as soon as the winter starts after the rainy season. A large number of birds make their camp on the banks of the Kosi river. These birds arrive: In Kosi Cachar, dozens of species of birds like Oriole, White Chicked Atolan, Kaman Tit come here in exotic birds. In the same indigenous birds, birds like Lalsar, Silli, Bagedi, Adhanga, Indian Rabin, Bulbul, Kaman Myna, Kamal Nayan, Abalakh Myna, Dipaunch, Chaha etc.

★ **Gouchhari Pond**

★ **Rajendra Sarovar**

★ **Dumri Chaur**

★ **Badlaghat Pokhar lake**

★ **Rani Sakarpura Wetland Lake**

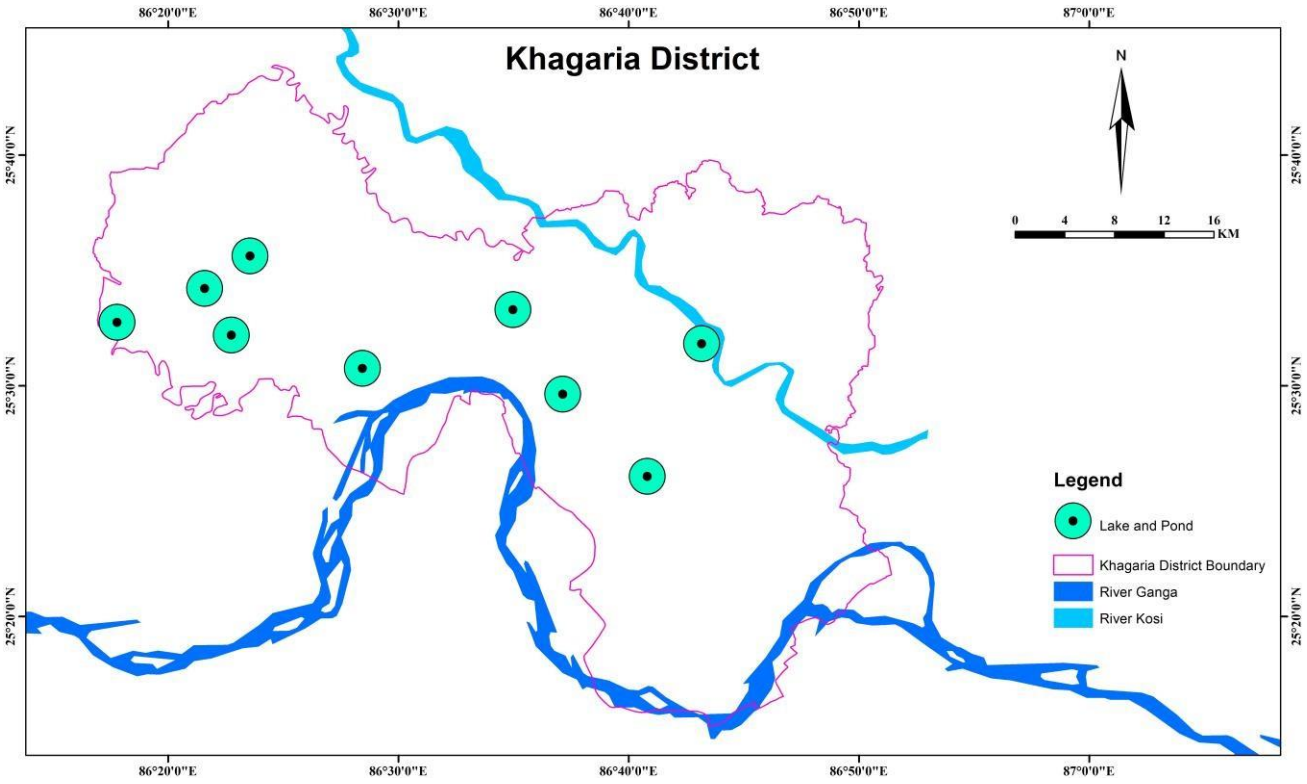
★ **Jahangira Wetland Lake**

★ **Dighni Wetland Lake**

★ **Shumbha Wetland Lake**

★ **Gorhia Wetland Lake**

Map: 4 Adventure, Nature and Eco Tourism Sites of Khagaria District



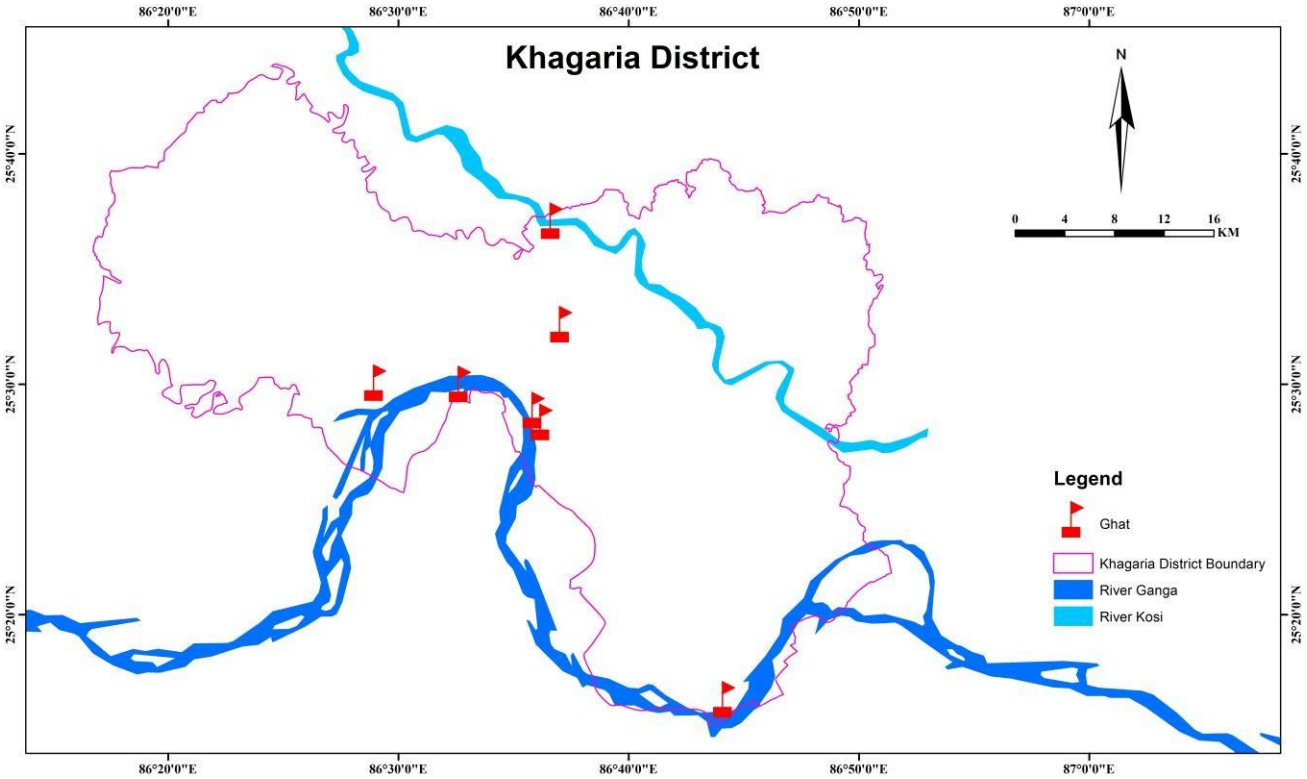
Source: Prepared by Author

5. GHAT TOURISM

Every city has some specialty that is engraved in the heart of it. A visit to Khagaria cannot be complete without a visit to the ghats running along river Ganges. As a dip in Ganga is considered holy in the Hindu religion, most of the ghats are dedicated to religious rituals. One of the more visually spectacular ghats is the Aguwani Ghat, Banni Ghat, Mansi Ghat and Koiri Ghat etc. Ghats in Lakhisarai are riverfront steps leading to the banks of the river Ganges and Sone. Most of the ghats are bathing, Puja ceremony ghats and cremation site. Earlier Morning boat ride on the Ganges across the ghats is a popular visitor's attraction.

- ★ Aguwani Ghat
- ★ Mansi Ghat
- ★ Sidhi Ghat
- ★ Banni Ganga Ghat
- ★ Koiri Ganga Ghat
- ★ Lohiyar Ghat
- ★ Dhamara Ghat
- ★

Map: 5 Ghat Tourism Sites of Khagaria District



Source: Prepared by Author

6. CULTURE & ARTS TOURISM

The district of khagaria is unfortunate in the sense that very little has been recorded regarding the social and cultural history of this area. Whatever account of the old district of Munger has been unearthed, covers mainly the southern Munger and to some extent Northwest Munger i.e. the present Begusarai district.

Culturally, this district has tradition of Melas, usually held on the occassion of Hindu religious festivals, particularly in Dussehara and Kalipuja. Old tradition of mela continues in Katyani Asthan, a place in Choutham Block. Another old traditional mela is Gopastami Mela, held just after chhath in the month of Kartik, near Goshala, Khagaria. This Mela still continues to be held at the same place and same time. (*Khagaria District*, n.d.-b)

It has been mentioned in the Gazetter of 1960, that an Agricultural and Industrial Exhibition was organised with help of the non-official gentlemen of Khagaria, sometime in the month of November 1952, to spread awareness about modern methods of agricultural and small industries. The 10 days long exhibition was formally inaugurated by the then Chief Minister of Bihar, and several government departments like Public Health, Agriculture, Veterinary, Silk Institute of Bhagalpur, Jail Department of Bhagalpur and Munger, Fishery, Cottage Industries, agriculture section of Sabour etc. participated in the exhibition. It was repeated in 1953, on a bigger scale, for about a fortnight. The exhibition was formally opened by the Finance Minister, Shri Anugrah Narain Singh and was visited by the Chief Minister Dr. S.K. Sinha and Irrigation Minister, Shri Ram Charitra Singh. These exhibitions served very useful

purpose in not only disseminating knowledge but also in providing light entertainments to the general masses visiting the exhibition. (*Khagaria District*, n.d.-b)

No important social or cultural event of the recent past was found recorded. However, everybody remembers the devastating floods of the year 1987, when even Khagaria town was heavily flooded, including collectorate and other government offices. Though floods have become an annual occurrence since times imemorial, but the floods of 1987 left a devastating trail, after a long time, especially after the major embankments were constructed. (*Khagaria District*, n.d.-b)

7. ARCHAEOLOGICAL AND HISTORICAL TOURISM

It is believed that the entire area, currently encompassed in the district of Khagaria, was

"Dahnal," flooded by the Ganga, the Gandak, the Kamla, the Bagmati, and the Koshi, and that any important site was washed away due to its physical location. As a result, it lacks any historically significant sites.

According to local legend, during the reign of Emperor Akbar, Raja Todarmal was tasked with conducting a survey of the whole region, but when he failed to do so, he advised that this area be omitted, thus establishing the "Farak Kiya" policy, which is why the area is known as "Pharkiya Pargana."

Khagaria, included in the old district of Munger, formed part of the Madhya-desa or "Midland" of the first Aryan settlers. Khagaria has been identified with Modagiri, a place mentioned in the Mahabharata, which was the capital of a kingdom in eastern India near Vanga and Tamralipta. The first historical account of the old district of Munger appears in the records of Hiuen-Tsiang who visited the region towards the close of the first half of the seventh century A.D. Khagaria does not possess any famous site of historical importance. The entire district of Khagaria, was affected by floods, hence any site of historical importance must have been washed away. In the 9th century A.D., Khagaria passed into the hands of Pala kings. The history during this period has become known mainly through the inscriptions. According to the history, commonly known in this part, it is said that during the time of Emperor Akbar, revenue minister Raja Todarmal had been entrusted with the duty of making a survey of the entire area, but he failed to do it due to difficult terrain, rivers and dense forests. So, he named it Farakiya (Farak in Hindi means separate). He advised that this area should be excluded, in other words, he adopted the policy of "Farak Kiya" and that is why the area is known as

"Pharkiya Pargana ". Munger came into prominence in the year 1762, when Kasim Ali Khan shifted his capital from Murshidabad. The East India Company capture Munger in the year 1763. With the extension of the British dominions, Munger ceased to be an important frontier post. (Khagaria District History, n.d.).

It is said that several important national leaders of freedom movement had visited and stayed in Khagaria, especially in Gogri and Parvatta. Important centres of freedom movement were

Shyamlal National High school, founded in 1910, at Khagaria; Gogri and Nayagaon village in Parvatta.

★ **Shyamlal National High School:** This high school was established in 1910 AD. Shri Shyamlal had donated substantial land for the establishment of the school. Students and teachers at this school have very little in the freedom movement was played an important role. At the time of the independence movement, this place was a prominent place to meet the revolutionaries. (*Places of Interest*, n.d.) **Gogri Village:** Freedom Movement related site.

★ **Nayagaon Village:** Freedom Movement related site.

3.4. WELANDS:

The wetlands create a unique ecosystem that supports many species simultaneously like aquatic, terrestrial, and human beings. Local stakeholders directly or indirectly depend on the wetland for their income and small-scale business. The district has a close connection with Hindu devotees, and the district is also known for Mithila paintings and the Maithili language. The data collected and analyzed shows the region's production and possible product that can be derived from the raw product. The list of sources and the possible products are mentioned below:

- Maize, rice and wheat production is high in the region
- Oilseed like rai has high production in the region
- Fruits like banana and mango have high productivity in the district

4 ACTION PLAN DEVELOPMENT

4.1 FORESTRY

The district should practice agroforestry. It is recommended that for agro-silviculture in non-flood affected areas Poplar, Shisham, Gamhar, Melia, Chah, Eucalyptus, Kadam, Semal, Ulmus, Sagwan, Toon, Bamboo, Casurina etc. and in the flood affected areas: Eucaluptus, Kadam, Semal, Chah, Arjun, Salix, Jamun, Bamboo, Casurina etc. can be grown. If farmers want to take up agro-horticulture then Mango, Litchi, Jamun, Kathal, Barhar, Guava, Bel, Ber etc. is recommended.Medicinal plants like Kalmegh, Aswagandha, Sarpgandh, Satawar, Lemon grass, Safedmusli etc. can be grown along with tree component.

Water logging is one of the major problems in the district. Farmers face water logging problem especially during rainy season in the alluvial plains. Under such unfavourable condition, cultivation is not possible for most of the crops. Therefore, they need suitable crop especially during rainy season. It is a success story of village *Pandori* of Anand District in Gujarat which has emerged as a brahmi

cultivating village under low lying fields. On an average, a farmer can get approximately Rs. 2,49,000/ha/year net returns from the cultivation of brahmi as a sole crop under low lying field.
One thing which is very important is making people aware about the need of forests and trees. Educating them about the policies and how planting trees can be beneficial in both the ways, i.e. environmentally as well as economically. The district has large chunks of cultivable waste lands and fallow lands, which can be planted under the National Afforestation Mission (NAP). NAP is being implemented for afforestation of degraded forest lands.

PROJECTION AND MONITORING MATRIX

Firstly, the awareness needs to be raised among the people of Khagaria district.

Secondly, training and skill building with respect to solar products needs to be raised.

Thirdly, solar pumps need to be promoted in the state to improve the irrigation system, through component B of the PM-KUSUM scheme.

Through these methods, the solar energy could pave the way for the development of the district.

4.1.1 Biodiversity –

- Different course related to agriculture engineering, horticulture, animal science was conducted to help farmers to earn more and enhance productivity through scientific management.

4.2 TOURISM

Khagaria has good potential for the development of tourism, though the district has high tourism potential for religious and Eco tourism, owning to lack of infrastructure facilities such as, tourist information Centre, transport, communication facilities, accommodation and other tourism supported facilities, most part of it remains unexplored by the tourist. In the high flood prone and minimum opportunities for other industries, tourism could be the best way for economic growth and employment generation in the district. There is a need to minimize the hurdles and threats by developing good governance. Many destinations in the district are still unexplored and reason behind is infrastructure problem. Lack of adequate infrastructure deprives them from fulfilling their desire of leisure and rest. This has adversely affected the perception of the district as a tourist destination. It is expected that if the infrastructure is improved and the introduction of more activities at the site and to the excursion point can increase the duration of stay and lure more tourists. For many places of interest accessibility and accomodation is a huge problem whereas for others condition of roads needs to be vastly improved.

- **Religious Tourism:** Khagaria has is a deeply religious setting in the state of Bihar. Katyayani Mandir, arguably the most famous temple here, Jama Masjid Ratan, Jama Masjid Bela Ganj, Khanquah Faridia Jogiya Sharif, Khanquah Gulzaria Faridia etc. are other sacred spots in the district.

- **Waterfront Tourism:** The river 'Ganges' offers potential for development of waterbased sports & activities along its stretch. Riverfront development has to be undertaken in the Lakhisarai district to promote tourism.
- **Adventure, Nature and Eco Tourism:** Khagaria's rich natural scenery, Wetlands, Ponds, Diara and Rivers make it an important destination for nature tourism which has huge potential fo ecotourism and providing opportunities for tourists to indulge in the activities. The Pasraha area of the district remains a sanctuary for migratory birds. Khagaria district has seven rivers and 54 streams and streams flow in the district. Due to these, there are five thousand 645 hectares of marked wetlands (water logging areas) that are very important from the point of view of biodiversity in this flood-affected district.
- **Ghat Tourism:** district has huge potential for water-based tourism spot. The Khagaria Ganga and Kosi ghats has great potential of been a source of inspiration for artists, filmmakers, photographers, writers and musicians for centuries. One of the more visually spectacular ghats is the Aguwani Ghat, Banni Ghat, Mansi Ghat and Koiri Ghat etc.
- **Archaeological Tourism:** Khagaria does not possess any famous site of historical importance. The entire district of Khagaria, was affected by floods, hence any site of historical importance must have been washed away. In the 9th century A.D., Khagaria passed into the hands of Pala kings. The history during this period has become known mainly through the inscriptions. It is said that several important national leaders of freedom movement had visited and stayed in Khagaria, especially in Gogri and Parvatta. Important centres of freedom movement were Shyamlal National High school, founded in 1910, at Khagaria; Gogri and Nayagaon village in Parvatta.
- **Fair and Festival:** Khagaria district has tradition of Melas, usually held on the occassion of Hindu religious festivals, particularly in Dussehara and Kalipuja. Old tradition of mela continues in Katyani Asthan, a place in Choutham Block. Another old traditional mela is Gopastami Mela, held just after chhath in the month of Kartik, near Goshala, Khagaria. This Mela still continues to be held at the same place and same time.

- **SWOT ANALYSIS: KHAGARIA DISTRICT**

STRENGHT

★ Khagaria's natural features (Rivers, Wetlands and Lakes dominate the landscape) and unique ecosystems are valuable scenic and recreational resources and can contribute to environmental services.

★ There are various religious spots around the district.

★ Cohesive Community and residents who are passionate and involved.

★ Financial institutions / willingness to invest in the district.

WEAKNESSS

★ Lack of tourist information centre, thus an inadequate infrastructure facility for the tourists.

★ The district is prone to different kinds of disasters, which include floods and earthquakes etc.

★ Lack of proper communication and the inaccessibility of the place by road has hampered the development of Khagaria district.

★ Poor maintenance of religious heritage and lack of awareness among local population about their heritage value.

★ Lack of desire of skilled work force to stay in the district, lack of accountability of service delivery, Lack of Leaders and Entrepreneurs in the community and Lack of developable land in and around the district.

★ No maintenance of natural heritage leading to loss of valuable recreational space that can act as tourist destinations.

★ District are facing problem of Poor drainage system and sewerage system, Solid waste collection transportation and disposal, Pollution, connectivity, open space and parks.

★ Lack of recreation, sports facilities, moreover large area of the district has poor building quality and unhygienic living conditions.

OPPORTUNITY

★ Ongoing, committed, and proposed development projects.

★ Potential for growth in Religious, Eco tourism and Ghat Tourism.

★ A wide scope for river front development along river Ganga and Kosi.

★ Encourage Public – Private partnership for provision of infrastructure services.

★ Potential for growth in Religious and Eco tourism.

THREAT

- ★ Tourism industry is underdeveloped. At present Tourism has very little contribution towards economic generation of the district.
- ★ Lack of tourism infrastructure and tourist information centers.
- ★ The district is prone to different kinds of disasters, which include floods and earthquakes etc. Incorporating disaster mitigation measures within the infrastructure planning process.
- ★ Across the district the rise of crime including, robbery, snatching, drugs, and murder etc.
- ★ Political stability, Naxalism and Corruption, the district is surrounded by Naxal affected areas.
- ★ Lack of governmental response towards tourism infrastructure such as tourism centre, tourism promotion and tourism accommodation.
- ★ Poor Infrastructure facilities for tourists in Khagaria.
- ★ Too much dependence on single economic sector.
- ★ Lack of desire of skilled work force to stay in the district.
- ★ Inadequate infrastructure for sorting, grading, packing, etc., in addition to the high cost of raw material (at processor's level).

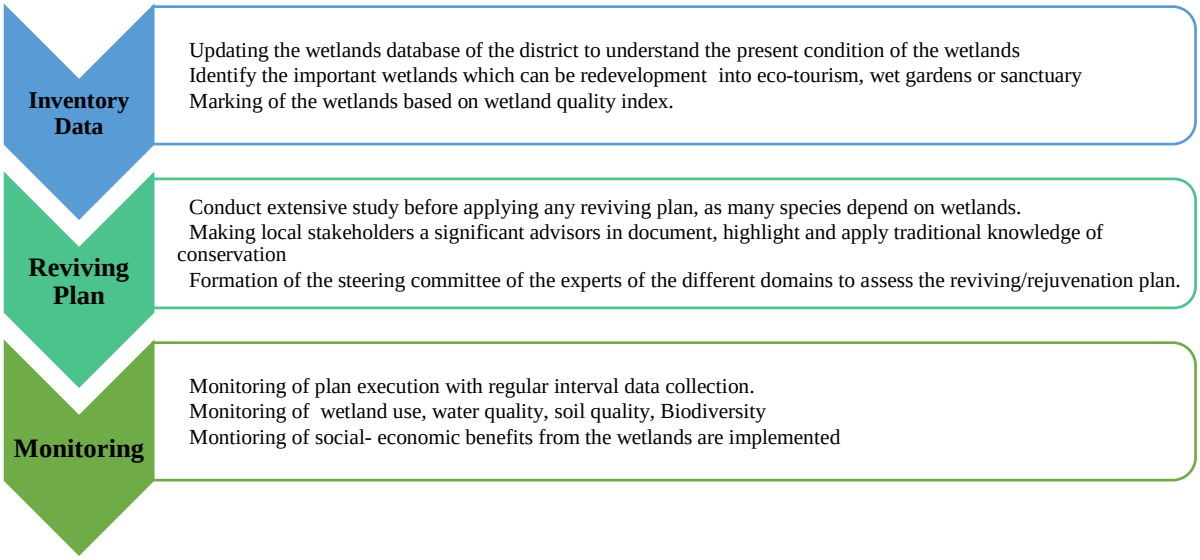
• PROJECT DEVELOPMENT

- ★ Project on development of tourist information centres at all important places of Khagaria district.
- ★ Lack of proper communication and the inaccessibility of the place by road has hampered the development of Katyani maandir, Khanquah Jogiya and Masjid Bela Ganj.
- ★ In order to maximize the use of the Ganga and Kosi River flowing through the district, Ganga riverfront development would be a great potential for Boating, Public Promenades, Religious Facilities, Cruise etc, making it the vibrant heart of the urban fabric.
- ★ Landscaping and flood protection along Ganga River front through Meditaion park and Millenium Park.
- ★ Development of Parks and playgrounds, development of Recreational Facilities of higher order Strengthen the existing Tourism spots and infrastructure, Create the new tourism attraction points and recreational centers.
- ★ Till now, no religious and Eco tourism circuit are found in the Khagaria district. Therefore, new projects to diversify the tourist inflow, emphasis on promotion of tourism activities like, fair & festivals, waterfront development, Ghat tourism etc.

★ Development of combined projects involving Tourism department/ Ministry, Disaster management department and Environment, forest, and climate change section/Ministry. Stakeholder consultation & Participatory management and involvement of Municipality, and local communities from Ganga villages and tour operators to build ecotourism options and choosing adventure and religious tourism sites.

4.3 WETLANDS

Some of the known wetlands in the district need to be taken care and action on different fronts must be taken. The action plan below gives a glimpse of the action and development required to protect, conserve, and rejuvenate the wetlands existing and extinct.



4.4. ENERGY

4.4.1. Solar

The district can utilize the solar energy by focusing its energy needs on the non-conventional sources of energy like solar panels, because the un-electrification rate is 70.57% in the district (D, K, Mishra, & Bhattacharyya, 2016). The irrigation facilities are also not developed in the district, which needs support from the state government to implement component B of the PM-KUSUM scheme in the district. The awareness also needs to be raised in the district for usage of solar energy. The skills and

knowledge of the people needs to be raised because due to lack of skills there has been poor maintenance of the existing irrigation facilities.

4.4.2. Biomass

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It is apparent that the people of Khagaria district become aware about the modern biomass technology. They should also be made aware about the harmful effects of traditional biomass energy for cooking. Moreover, government subsidies should provide LPG access to the poor, so that they reduce their consumption of traditional biomass for cooking, and subsidies for establishment of biomass plants. There is also a need for the development of biomass plants in the district, and improvement in the transport infrastructure, so that the excess crop residue or forest residue could be transported to the biomass plant site and that could be used to generate energy for the rural areas.

PROJECTION AND MONITORING

Firstly, it is crucial to create biomass awareness in Khagaria district.

Secondly, harmful effects of traditional biomass need to be told to the rural population, so that they reduce this type of fuel and use better fuel for cooking.

Thirdly, government should provide subsidies to the poor families through Pradhan Mantri Ujjwala Yojana and for setting up of biomass plants in the district.

Lastly, infrastructure needs to be developed in the district for better transportation of biomass raw materials.

4.4.3. Biogas:

The government should conduct a program to encourage or educate people to install at the household level; all the incentives or subsidy schemes should be told to local people and make them aware of the benefit of installing the biogas plant.

4.4.4. Hydropower:

The state plans to establish huge hydropower projects and pumped storage systems with the help of bilateral and international finance agencies, joint partnerships with government entities like the National Hydro Power Corporation (NHPC), and even private sector participation.

5 RECOMMENDATIONS

5.1 AGRICULTURE AND ALLIED SECTORS

1. The district's main fruits are banana and mango. Other fruits such as papaya, guava, litchi, ber, and others must be encouraged.
2. The district has ample scope for fish culture in the low land areas; Farmers should be encouraged to practice integrated fish farming and export to neighbouring and other states.
3. Flooding is a major concern in the district's north-eastern alluvial plain. Flood prevention measures should be implemented.
4. Micro-irrigation should be promoted, especially for fruits and vegetable crops, to increase water use efficiency.
5. Cultivation of cucurbits, pulses, vegetables, oilseed crops, and summer maize should be encouraged.
6. Organic cultivation of vegetables and fruits should be promoted.
7. Beekeeping and mushroom cultivation should be promoted in the district to generate income for the rural youth
8. The district has ample scope for Goatary and poultry farming, which can be promoted.
9. The district has scope for medicinal and aromatic plant cultivation, which needs to be promoted.
10. Mushroom cultivation should be promoted in the district.
11. Farmers should practice intercropping of the elephant foot yam in the mango and litchi orchards to generate higher income.
12. Farm mechanization should be promoted.
13. There is scope for the small-scale processing units of jam, jelly, squash, tomato, and mango.
14. Farmers should follow the weather-based agro advisory.
15. Production of low-cost vermicompost should be encouraged to boost soil health.

5.2 FORESTRY

- Khagaria District is sever forest deficient area with only 1.24% of forest area.
- The district has some popular tourist places. These places can be focused for afforestation drives.
- The trees in the afforestation drive should be fruit yielding or medicinal and aromatic plants. In this way the locals can earn and increase their livelihood options.

- District has 0% very dense category of forest. These forests are important for carbon sequestration and ecological balance in the local area. Local government should focus on dense groves of native trees to balance the flora and fauna. Agro-forestry and afforestation on barren and unused government lands, and land adoption to the local people to increase income and to provide the incentives to the guards and government can be the better option.
- People should be made aware of the importance of forests. The large chunks of fallow land should be planted with trees under the National Forest Mission. Agro-forestry is highly recommended for the district. Administration should act in accordance with the State's Agroforestry Policy, 2018. The district also has some of the low lying areas which can be used for cultivation of Brahmi.

5.2.1 Biodiversity

- The district is badly affected by flood therefore climate smart agriculture approach should be implemented across the district to make it more resilient to draught and floods. This approach also improves forestry and grassland management

- It is recommended to conduct afforestation program as data shows very low forest area.

- Income generation of rural youth through bee keeping, mushroom cultivation, goatary, poultry and processing of fruits and vegetables.

5.3 WETLAND

The wetlands need to be intact, but at the same time, they need to be planned wisely to support the district economically, socially and environmentally, which will lead to indirectly relieving of stress from the Ganga River to a large extent. It will also lower the local people's dependence on the Ganga River for their small-scale industry or basic daily needs. The following recommendation and interventions are required to get valuable products and solve the issues/ challenges faced by the local people of that region.

- It is recommended to introduce improved cultivars and production technologies for rai and rice.
- It is recommended to develop flower gardens and wet gardens around the wetlands. These wetlands can be turned into an eco-tourism site.
- Small-scale industries like boat making and net making should be promoted under the schemes by the Ministry of Micro, Small & Medium Enterprises.
- It is recommended to create awareness about the Fisheries and Aquaculture Infrastructure Development Fund (FIDF) scheme and Pradhan Mantri Matsya Sampada Yojana (PMMSY).

5.4 ENERGY

5.4.1. Solar

- ❖ PM-KUSUM needs to be implemented in the district to improve the irrigation in the district.
- ❖ Grid-connected solar PV systems need to be promoted by the government.

- ❖ Financial assistance from the government and financial institutions needs to be improved.
- ❖ Training of rural youth could help in future maintenance of the solar products.

5.4.2. Biomass

- ❖ Awareness regarding modern biomass energy is needed through government support and NGO's support.
- ❖ Availability of financial resources should be improved.
- ❖ Infrastructure needs to be improved.
- ❖ The district cultivates rice, wheat, maize and has a good forest cover, so biomass and cogeneration plants should be encouraged in the district.

5.4.3. Biogas

- A centralized biogas plant for the district should be constructed for the treatment of organic fraction of municipal solid waste.
- A biogas can be constructed using cattle dung as feedstock in different gaushala such as Sri Khagaria Gaushala.
- It is recommended to construct more family-size biogas plants by implementing the GOBAR-Dhan scheme, which focuses on cleaning villages, increasing rural households' income, and generating biogas and organic fertilizer from cattle waste.
- A centralized biogas plant for the district should be constructed for the treatment of organic fraction of municipal solid waste.
- A biogas can be constructed using cattle dung as feedstock in different gaushala such as Sri Khagaria Gaushala.
- It is recommended to construct more family-size biogas plants by implementing the GOBAR-Dhan scheme, which focuses on cleaning villages, increasing rural households' income, and generating biogas and organic fertilizer from cattle waste.

5.4.4. Hydropower

- It is recommended to build multipurpose canal in the district for electricity and irrigation purpose

5.5. TOURISM

- **SUGGESTIONS AND INTERVENTIONS**

✞ Establish Tourist Information Centre in the District Headquarters. Tourist information centres will be equipped with the modern information and communication technology devices.

✞ Developing Tourism circuits through the Integration of Religious, Eco tourism and Ghat by development of capacity building, engagements with local stakeholders.

✞ Provide adequate Park and Open Spaces/ Recreational Facilities, Eco Park, Water Park, Water Sport and Riverfront development etc. around the tourism sites and along Ganga ghats to attract all type of tourism.

✞ Development of tourist facilities and overall improvement of infrastructure facilities for tourists in places of tourist attractions.

✞ To strengthen the tourism and attract large number of tourists, Tourism Product Diversification/Improvement is needed like, Promotion and packaging of tourist resources, Upgradation of identified tourist spots, Quality accommodations, Tourist Information Centre, Road and public transportation and Road furniture and signages etc.

✞ Maintenance of law and order, deploying tourist police force, disposing grievances, enacting suitable rules, regulation and laws for tourism development and Standardizing quality of tourism product and services.

✞ Empowering and Sensitizing Ganga Ghats (Cleaning of garbage and waste management at each Ghats sites) to make tourism compatible, environment friendly and sustainable. For example: Development of boating and cruise facility in existing Ghats.

✞ Stakeholder consultation & Participatory management and involvement of Municipality, Disaster management authority and local communities from Ganga villages and tour operators to build ecotourism options and choosing adventure and religious tourism sites.

CHALLENGES AND THREATS

- ★ Crime and social amenities (including, robbery, snatching, drugs, and murder etc.) being one of the biggest challenges in the district tourist development, have been neglected.
- ★ Lack of tourism infrastructure and tourist information centers.
- ★ The district is prone to different kinds of disasters, which include floods and earthquakes etc. Incorporating disaster mitigation measures within the infrastructure planning process.
- ★ Lack of proper communication and the inaccessibility of the place by road has hampered the development of Khagaria district.
- ★ The water bodies and open spaces are used as the dumping areas in the district.
- ★ There are chances of epidemic due to lack of sewage and solid waste disposal system for the core city area particularly in slums. These increase losses during disasters. Thus, a disaster mitigation plan should be prepared for the city and whole district.
- ★ Tourism industry is underdeveloped. At present Tourism has very little contribution towards economic generation of the district.
- ★ The problems being faced by pilgrims while taking dip during the ongoing festivals like: Chath Puja is a matter for serious concern.
- ★ Inadequate and inappropriately located facilities for garbage collection, inadequate fire services due to congested lanes, storm water, and sewerage connections has led to overall deterioration of the urban fabric.
- ★ Strategies for Social Infrastructure, Environment & Tourism Encroachments, inadequate municipal services and insensitive building control mechanisms are leading to the chaos in the urban landscape in the Khagaria.
- ★ Too much dependence on single economic sector and Competing cities for external investments in the vicinity.

6 Discussion during the Report Presentation

- The Kanwar Taal located in Begusarai is Asia's Largest freshwater oxbow lake (Ramsar Wetland).
- The IIML Report for Arth Ganga should be a regular Agenda item for next 6-8 DGC meetings.
- Hon'ble PM during the post-Budget webinar on Tourism had spoken about market potential of destination weddings. It was suggested that suitable Ashrams in Ganga Basin may be identified for such purpose to promote blissful experience, cost reduction, livelihood opportunities and better upkeep.
- Allocate separate space for Namami Gange Awareness and Jalaj Marketing kiosk in Melas/Congregatios/Fairs for providing better marketing opportunities to the Jalaj products.
- As Dilli Haat Centre – Namami Gange Awareness and Marketing Centre – is being launched soon, it was requested that every district to identify niche products with a creative story and link it with Jalaj in their area.
- To identify Arth Ganga Tourist Trails and organize Ganga Guide training
- Promotion of Natural Farming in Ganga Basin and training workshops should be organized on a regular basis. NMCG is supporting this initiative in coordination with MoA& FW and NCOF.
- Make plans for reuse of treated waste water for agriculture, industrial etc. purpose and also the sludge.
- Training of volunteers for Ganga awareness & Aarti workshops to promote regular aartis on Ghats.

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6 APPENDICES

Table 1 Biogas potential from animal waste.

Livestock	**Residue type**	**Total population as of 2012**	**Manure yield * (kg/day)**	**Total manure generation annually (kg)**	**Average collection (75%)**	**Dry manure after removing Moisture content**	**Manure required for biogas* (kg/m^3)**	**Biogas potential (m^3/yr)**	**m3/day**	**Dry matter per day**
Cattle	Manure	239339	10	87,35,87,350	655190512.5	131038102.5	25	5241524.1	14360.34	359009
Buffalo	Manure	88022	15	48,19,20,450	361440337.5	72288067.5	25	2891522.7	7921.98	19850
Sheep	Manure	0	1	0	0	0	25	0	0	0
Goat	Manure	228270	1	8,33,18,550	62488912.5	12497782.5	25	499911.3	1369.62	34241
Pig	Manure	4417	2.5	40,30,513	3022884.375	604576.875	25	24183.075	66.255	1656.4
Poultry	manure	70,519	0.1	25,73,944	1930457.625	386091.525	25	15443.661	42.3114	1057.8
Total		**6,30,567**						**8672584.836**		

Table 2 Biogas potential from agricultural waste.

Crop	**residue type**	**Total crop production (tons) (2006-2007))**	**Residue production ratio**	**Residue amount (tons)**	**Average collection (70%)**	**Moisture content**	**Residue amount after removing moisture (tons)**	**Biogas potential [m3/(tons of dry matter)]**	**Overall biogas potential (m3)**
Rice	husk	19132	0.28	5356.96	3749.872	30	2624.9104	800	2099928.32
wheat	straw	47655	1.5	71482.5	50037.75	80	10007.55	750	7505662.5
Total		**66787**							**9605590.82**

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