# Chapter 5
Case Study

- Case Study 01: COVID-19 Pandemic (First 100 Days)
- Case Study 02: Flood of August, 2021

Case Study-1

Urban Readiness & Identified COVID-19 Positive Cases (First 100 Days) in Bangladesh

In this case study, an attempt has been made to represent ongoing situation of COVID-19 pandemic in Bangladesh on readiness surface. The objective is to evaluate whether urban readiness can explain the pandemic situation. The country identified its first positive case on 8th March, 2020. Directorate General of Health Services (DGHS) of Bangladesh has been publishing pandemic statistics of 64 districts in the country since then. Total number of infected person is plotted as concentric circle around 64 district level growth centers for 50th,

60th, 70th, 80th, 90th and 100th day respectively. The distribution appears to be random on readiness surface of infrastructure-service suitability and ecological suitability. The key observation in the graph is primacy of district Dhaka over other districts. Horizontal position (X-axis) of growth center (districts) towards right end indicates suitable infrastructure and vertically up-word position (Y-axis) represents less sensitivity to ecological hazard for growth centers. Circle size of each center represents the number of identified cases. Color of the circle represents the corresponding date from the first identification and symbol at the center represents the administrative level of the urban center.

Matrix: 05 — Spatial Urban Group (SUG) & Identified COVID 19 Positive Cases in Bangladesh
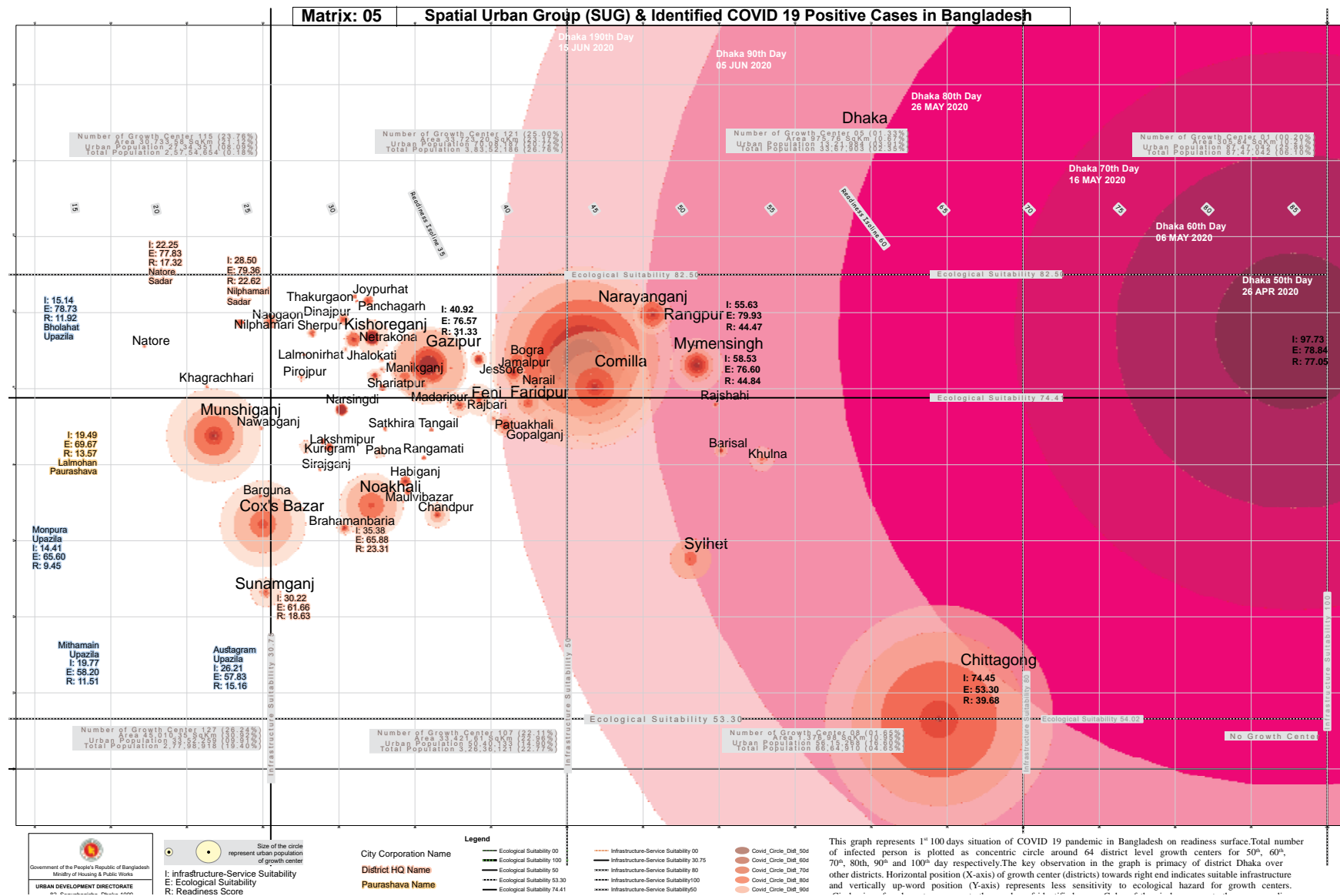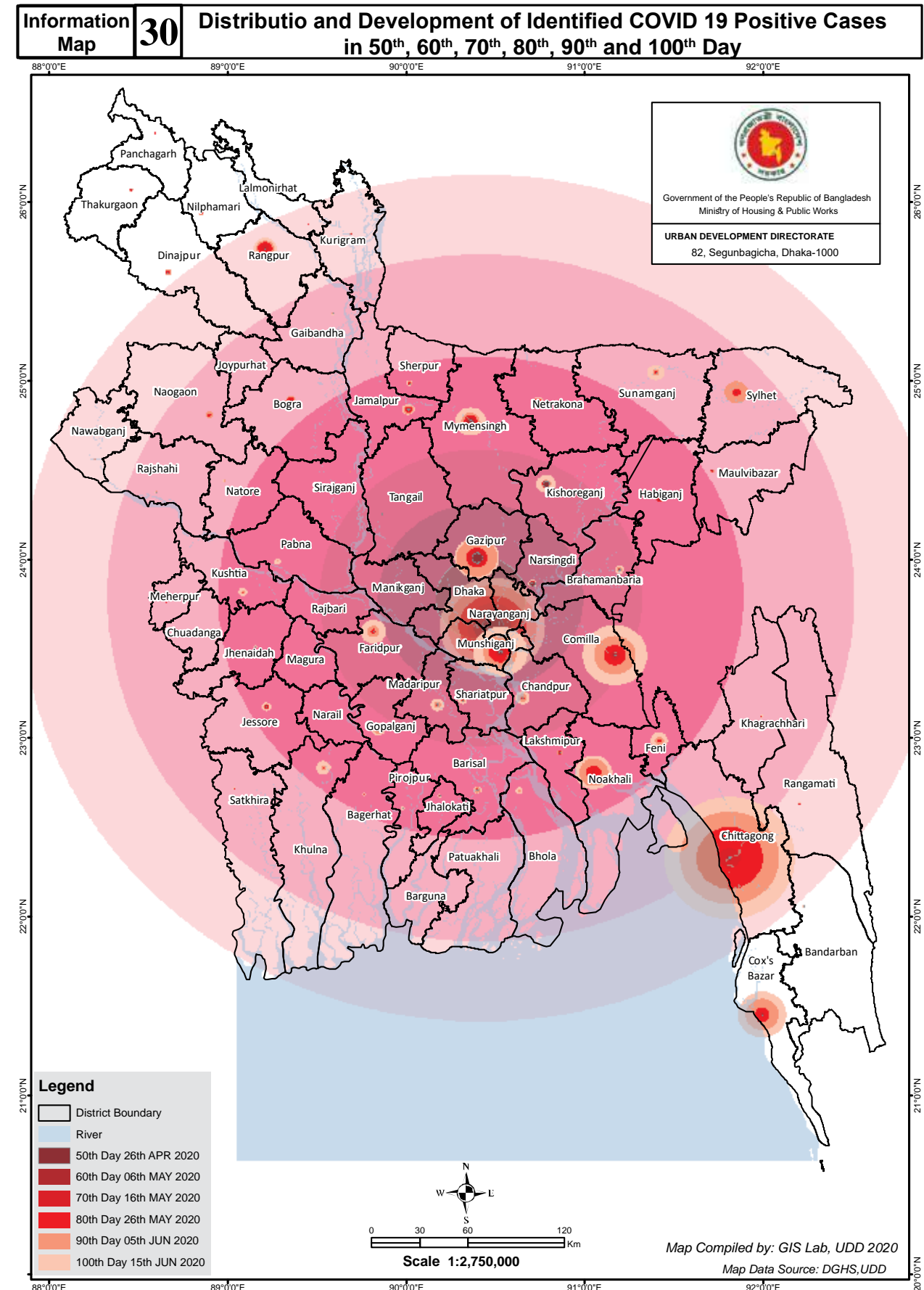
Geographical Distribution of Identified COVID-19 Positive Cases on 100th Day

This map represents the number of positive cases on geographic surface. It is clearly visible that Dhaka and districts surrounding the capital are more exposed to the pandemic. Another observation is district with higher administrative level has higher cases of COVID identification. Primacy of Dhaka District is also evident from this map. The table represents 10 districts with highest positive cases in Bangladesh on 100th day.

Table 10: Top 10 district with highest identified COVID 19 positive case on 100th day

Rank	District	Total cases		New cases		Avg. increase / day (slope	Positive cases / 10,000 popn	Density (population/ Sq. Km)	Readiness score
		Nos	%*	Nos	%*				
1	Dhaka	26,369	49.91	438	28.11	452.63	22.07	28,600	75.97
2	Chattogram	3,680	6.97	88	5.65	70.17	4.52	19,344	46.72
3	Naraynganj	3,011	5.70	41	2.6	46.26	10.21	12,994	38.04
4	Cumilla	1,854	3.51	169	10.85	27.84	3.44	3,453	37.85
5	Munshiganj	1,558	2.95	60	3.85	24.19	10.77	2,317	18.09
6	Cox's Bazar	1,411	2.67	71	4.56	23.24	6.16	2,049	22.51
7	Gazipur	1,278	2.42	8	0.51	20.34	3.75	3,974	31.23
8	Noakhali	1,057	2.00	30	1.93	19.39	3.40	1,571	21.17
9	Mymensingh	878	1.66	23	1.48	13.17	1.78	1,557	43.60
10	Faridpur	734	1.39	39	2.50	9.56	4.21	1,233	32.72

Source: Directorate General of Health Services (DGHS)

Bangladesh, BBS 2011

* calculated as percent of 64 districts

| Information Map | 30 | Distributio and Development of Identified COVID 19 Positive Cases in 50th, 60th, 70th, 80th, 90th and 100th Day |

Government of the People's Republic of Bangladesh
Ministry of Housing & Public Works

URBAN DEVELOPMENT DIRECTORATE
82, Segunbagicha, Dhaka-1000

Legend

- District Boundary
- River
- 50th Day 26th APR 2020
- 60th Day 06th MAY 2020
- 70th Day 16th MAY 2020
- 80th Day 26th MAY 2020
- 90th Day 05th JUN 2020
- 100th Day 15th JUN 2020

Scale 1:2,750,000

Map Compiled by: GIS Lab, UDD 2020
Map Data Source: DGHS,UDD

COVID-19 Positive Case (on 100th day) and Urban Readiness

District Dhaka has both the highest number of identified cases and rate of increase. About 49.66% of total cases of the country are identified in Dhaka alone. It has 6.96 times higher identified cases than Chattogram, the 2nd worst affected district. Primacy of Dhaka outnumbers the significance of pandemic condition in other districts in terms of identification as well as increase of identification. So, Dhaka has been omitted from calculation in this analysis; and Chattogram, the 2nd worst affected district, has been considered as base district for better convenience in representation. Chattogram district has 3,768 identified cases with average daily increasing rate of 70.27 person/day at 100th day from the first identification.

Number of positive cases in Chattogram is considered as 100 and recomputed other districts accordingly. The graph shows the positive cases and urban readiness value of 63 districts. The number of positive cases and total urban population are plotted in the same scale against corresponding urban readiness value in following two graphs. Both of the graphs show a positive relationship with corresponding urban readiness value. The calculated correlation coefficient between the number of positive cases and urban readiness is 0.71. So, it can be said that on 100th day of pandemic 71% of 63 districts shows positive relationship with corresponding urban readiness value.

Graph 01: COVID-19 positive case and urban readiness considering Chattogram as base

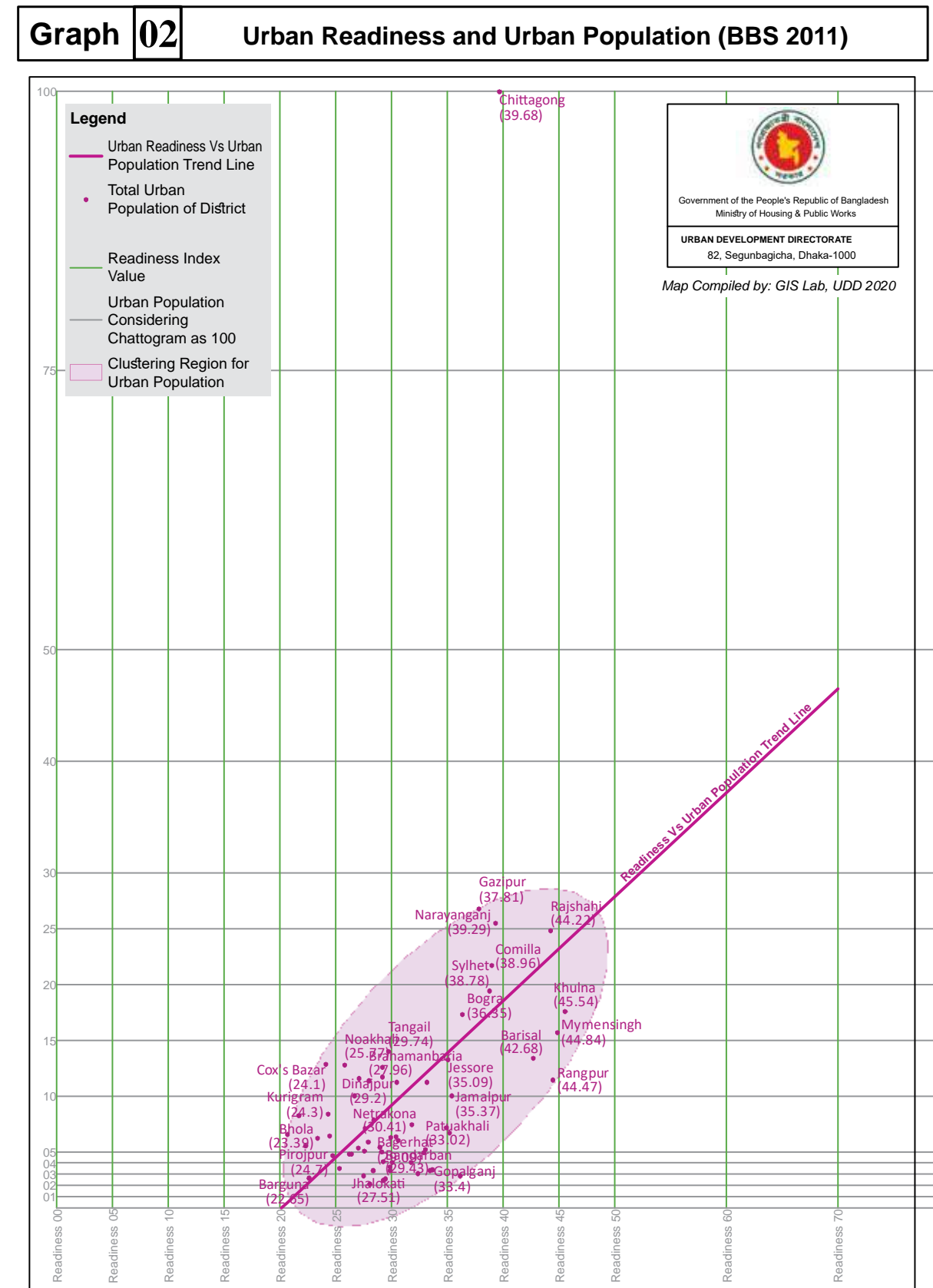Graph of COVID 19 Positive Cases (Scaled) on 100th Day and Urban Readiness
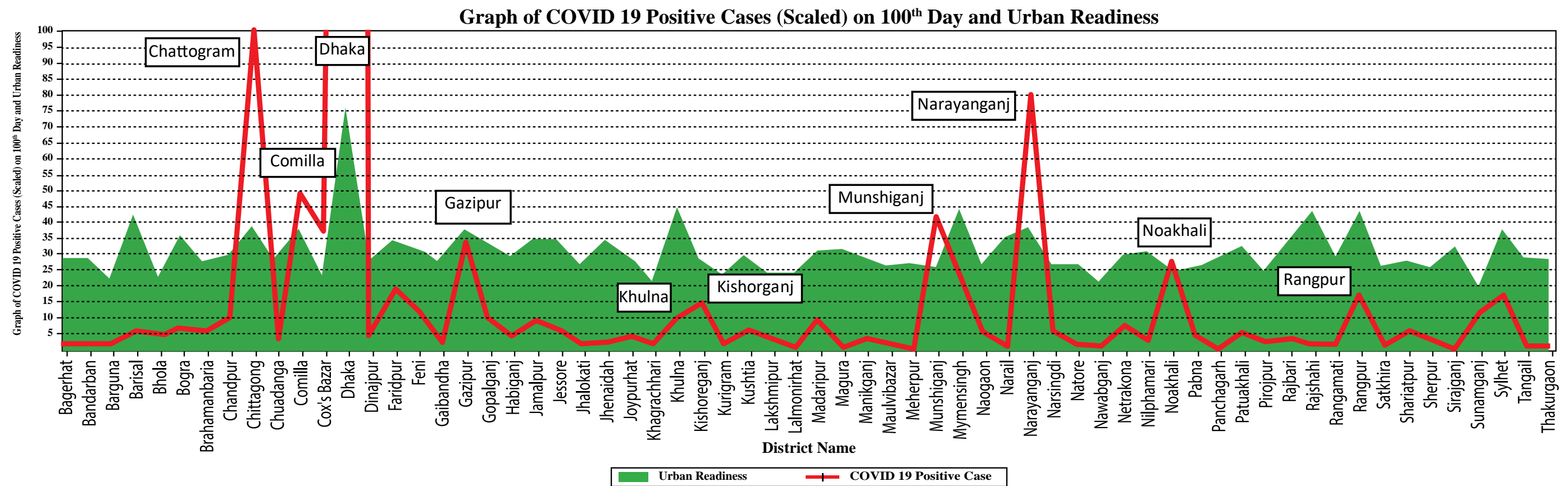
Total urban population and urban readiness

Excluding Dhaka, total urban population of 63 districts (2011) is plotted in this graph, in the same scale against corresponding urban readiness score. Relative position of districts in urban population vs urban readiness represents an elliptical form of clustering. Only significant difference is found in case of Chattogram. Orintation of mathematical trend line and the ellipse shows an excellent co-relationship among them.

Table 11: Urban population and urban readiness of 10 districts with the highest positive cases

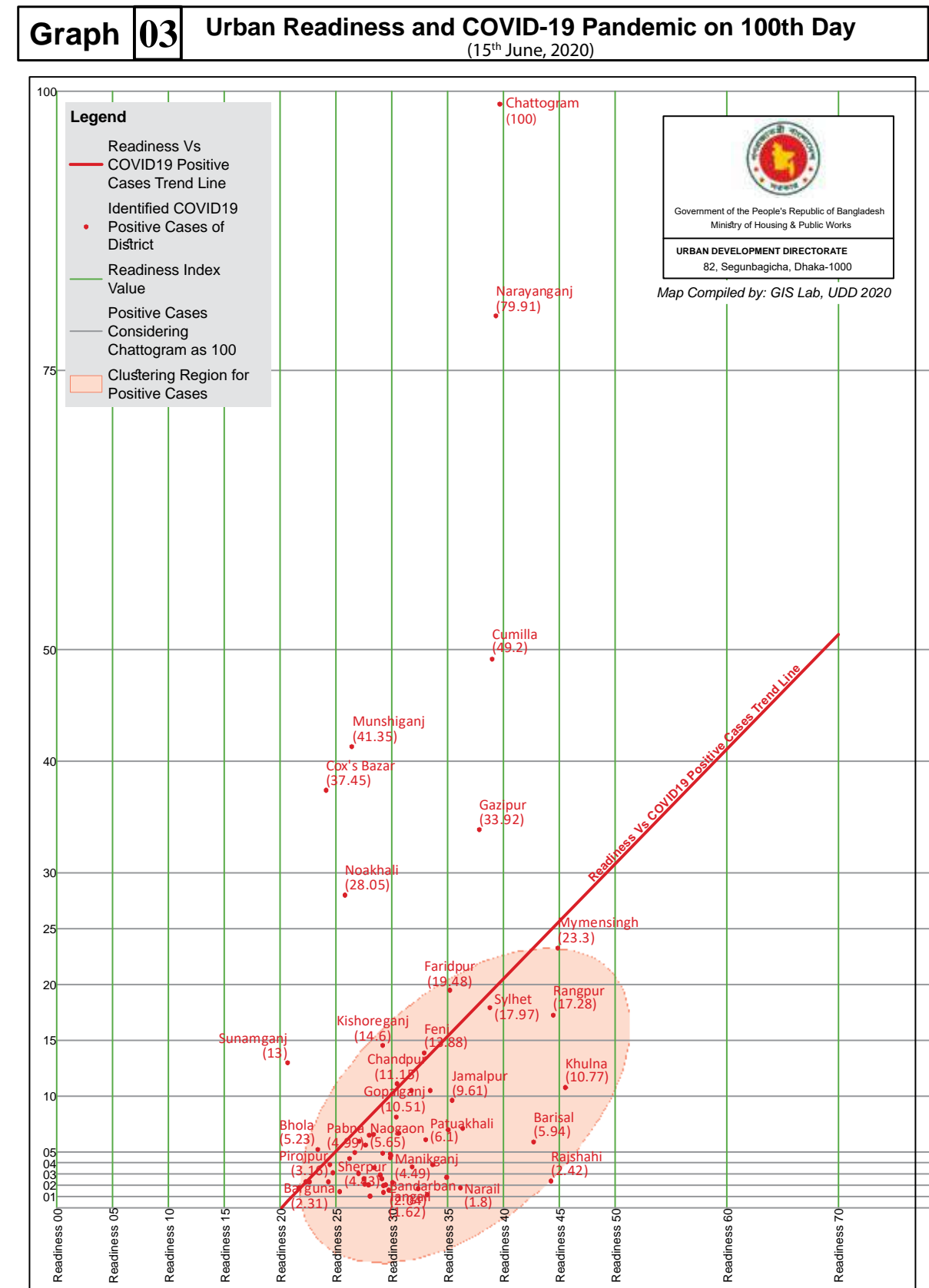| SI	District	Total Population	Urban Population	Area SqKm	Infr.-Servis Suitability	Ecological Sensitivity	Ecological Suitability	Readiness
1	Dhaka	87,47,042	91,58,046	14,69.33	97.73	26.39	78.84	77.05
2	Chattogram	33,10,027	38,70,217	4,798.41	74.45	42.02	77.55	39.68
3	Narayanganj	13,23,600	9,88,956	758.85	50.10	25.14	77.07	39.29
4	Comilla	5,32,419	8,40,326	3,095.43	51.84	28.26	77.32	38.96
5	Munshiganj	3,83,263	1,86,106	947.04	36.01	26.09	74.81	26.44
6	Cox's Bazar	4,74,465	4,99,011	2,336.60	34.49	32.67	69.86	24.10
7	Gazipur	18,20,374	10,37,574	1,765.13	49.36	20.13	76.59	37.81
8	Noakhali	5,49,308	4,96,700	3,311.80	37.16	34.04	72.85	25.77
9	Mymensingh	6,01,766	6,08,262	4,342.10	58.53	19.26	80.75	44.84
10	Faridpur	4,69,410	2,61,565	2,037.45	47.47	29.74	75.69	35.18

Graph 02 — Urban Readiness and Urban Population (BBS 2011)

Total COVID-19 positive cases and urban readiness

Excluding Dhaka, total number of COVID-19 positive cases of 63 districts is plotted in this graph, in the same scale against corresponding urban readiness value. Relative position of districts in positive cases vs urban readiness shows an elliptical form of clustering. The graph shows 7 (seven) districts namely Chattogram, Narayanganj, Cumilla, Munshiganj, Cox's Bazar, Gazipur and Noakhali placed outside the cluster. Dissimilar orientation of mathematical trend line and the ellipse shows the rest 56 districts (excluding Dhaka and above mentioned 7 (seven) districts) have a positive co-relationship.

Table 12: COVID-19 pandemic statistics of 10 districts with highest positive cases

SI	District	Toal Cases	(%)	New Cases	(%)	Slope Increase/day	Positive/10000	Density	Urban Readiness
1	Dhaka	26,239	49.67	438	28.11	452.63	30.00	5,953.08	77.05
2	Chattogram	3,768	7.13	88	5.65	70.27	11.38	689.82	39.68
3	Narayanganj	3,011	5.70	41	2.63	46.26	22.75	1,744.22	39.29
4	Comilla	1,854	3.51	169	10.85	27.84	34.82	172.00	38.96
5	Munshiganj	1,558	2.95	60	3.85	24.19	40.65	404.70	26.44
6	Cox's Bazar	1,411	2.67	71	4.56	23.24	29.74	203.06	24.10
7	Gazipur	1,278	2.42	8	0.51	20.34	7.02	1,031.30	37.81
8	Noakhali	1,057	2.00	30	1.93	19.39	19.24	165.86	25.77
9	Mymensingh	878	1.66	23	1.48	13.17	14.59	138.59	44.84
10	Faridpur	734	1.39	39	2.50	9.56	15.64	230.39	35.18

Graph 03 Urban Readiness and COVID-19 Pandemic on 100th Day (15th June, 2020)
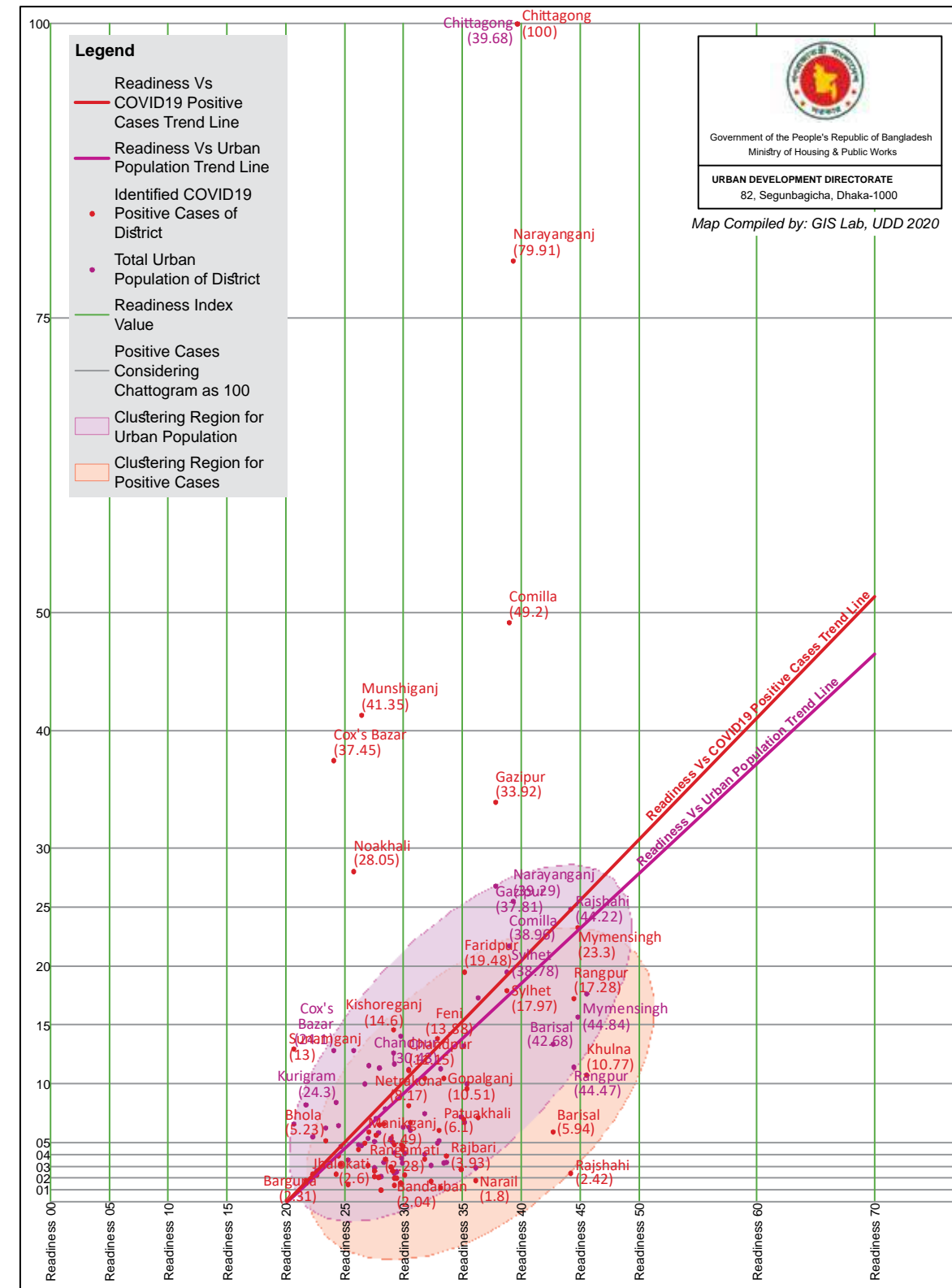
Overlaying of total COVID-19 positive cases and urban population in respect to urban readiness

Excluding Dhaka, total urban population and total number of COVID-19 positive cases of 63 districts are plotted together in this graph, in the same scale against corresponding urban readiness value. Relative position of districts in the graph shows nearly similar characteristics. Association of these population cluster and pandemic cluster show that the two factors have similar relationship with urban readiness.

Table 13: COVID-19 pandemic and urban population statistics of 10 districts with the highest positive cases

SI	District	Urban Population	Area SqKm	Toal Cases	(%)	Slope Increase/ day	Positive/ 10000	Urban Readiness
1	Dhaka	9158046	1469.33	26239	49.67	452.63	30.00	77.05
2	Chattogram	3870217	4798.41	3768	7.13	70.27	11.38	39.68
3	Narayanganj	988956	758.85	3011	5.70	46.26	22.75	39.29
4	Cumilla	840326	3095.43	1854	3.51	27.84	34.82	38.96
5	Munshiganj	186106	947.04	1558	2.95	24.19	40.65	26.44
6	Cox's Bazar	499011	2336.60	1411	2.67	23.24	29.74	24.10
7	Gazipur	1037574	1765.13	1278	2.42	20.34	7.02	37.81
8	Noakhali	496700	3311.80	1057	2.00	19.39	19.24	25.77
9	Mymensingh	608262	4342.10	878	1.66	13.17	14.59	44.84
10	Faridpur	261565	2037.45	734	1.39	9.56	15.64	35.18

Graph 04 — Overlaying of COVID 19 Positive Case and Urban Population with Respect to Urban Readiness

## Flactuation between COVID-19 positive cases and urban population

Excluding Dhaka, total urban population and total number of COVID-19 positive case of 63 districts are plotted together in this graph, in the same scale against corresponding urban readiness score. Relative position of districts in graph shows fluctuation of pandemic intensity is different from corresponding population. The graph shows there are 41 districts with negative fluctuation. Rest of the 21 districts have positive fluctuation. Flactuation of Chattogram is zero (0) because it is the base of calculation. Average negative fluctuation in 41 districts is 3.88 where average positive fluctuation in 21 districts is 11.03.

Table 14: Flactuation statistics between COVID-19 positive cases and urban readiness of 62 districts

Flactuation	Number of Growth center	Minimum Flactuation	Maximum Flactuation	Average Flactuation	Name of District
Negative	41	0.11	22.43	3.88	Bagerhat, Bandarban, Barguna, Barisal, Bhola, Bogra, Brahamanbaria, Chandpur, Chuadanga, Dinajpur, Gaibandha, Habiganj, Jamalpur, Jessore, Jhalokati, Jhenaidah, Khagrachhari, Khulna, Kurigram, Lakshmipur, Lalmonirhat, Magura, Maulvibazar, Meherpur, Naogaon, Narail, Narsingdi, Natore, Nawabganj,Nilphamari, Pabna, Panchagarh, Pirojpur, Rajshahi, Rangamati, Satkhira, Sherpur, Sirajganj, Sylhet, Tangail, Thakurgaon
Positive	21	0.52	54.36	11.03	Cumilla, Cox's Bazar, Dhaka, Faridpur, Feni, Gazipur, Gopalganj, Joypurhat, Kishoreganj, Kushtia, Madaripur, Manikganj, Munshiganj, Mymensingh, Narayanganj, Netrakona, Noakhali, Patuakhali, Rajbari, Rangpur, Shariatpur, Sunamganj

Flactuation of Chittagong is ziro (0) becase it is the base of calculation

Graph 05 Flactuation Between COVID 19 Positive Case and Urban Population with Respect to Urban Readiness
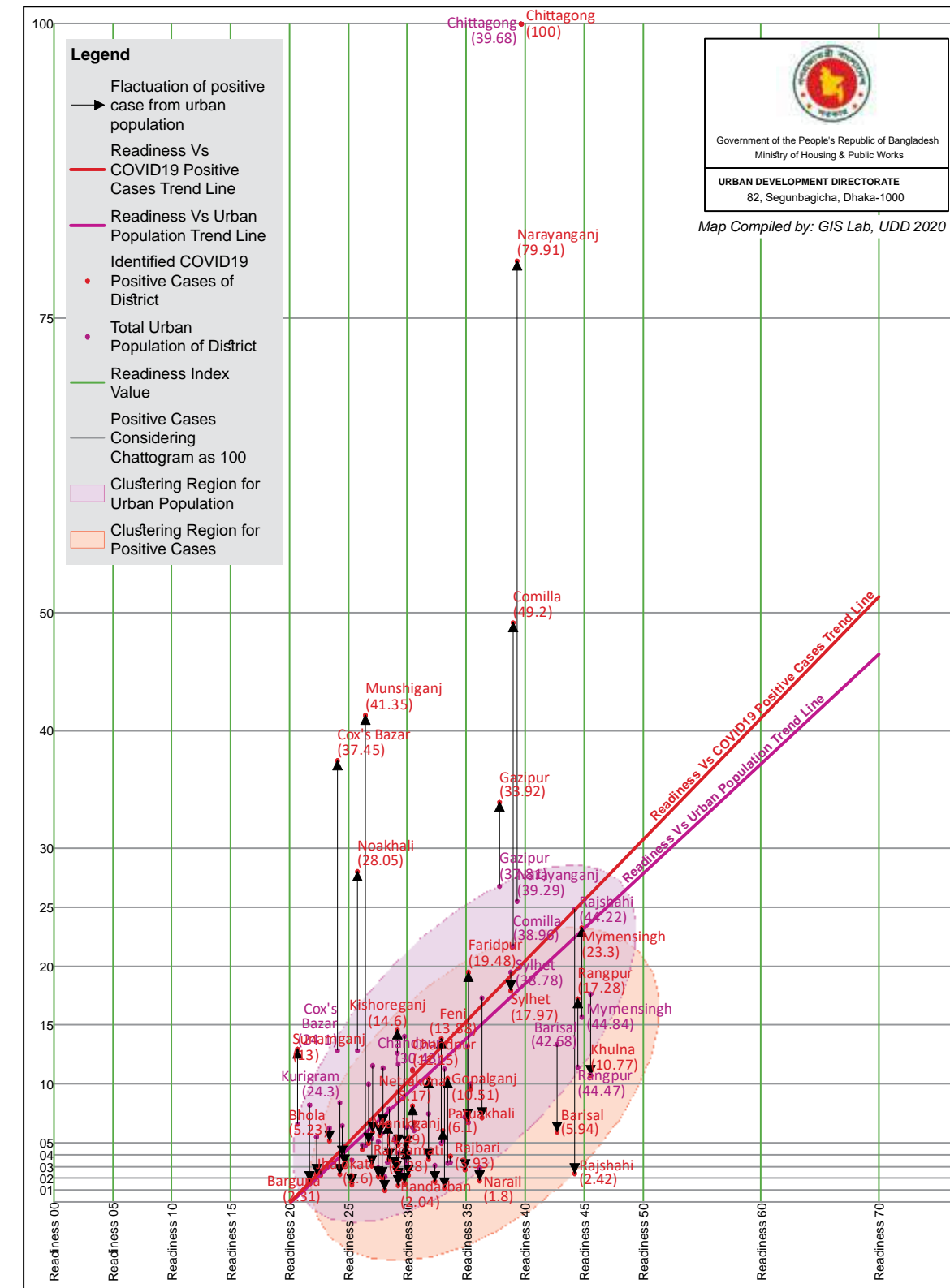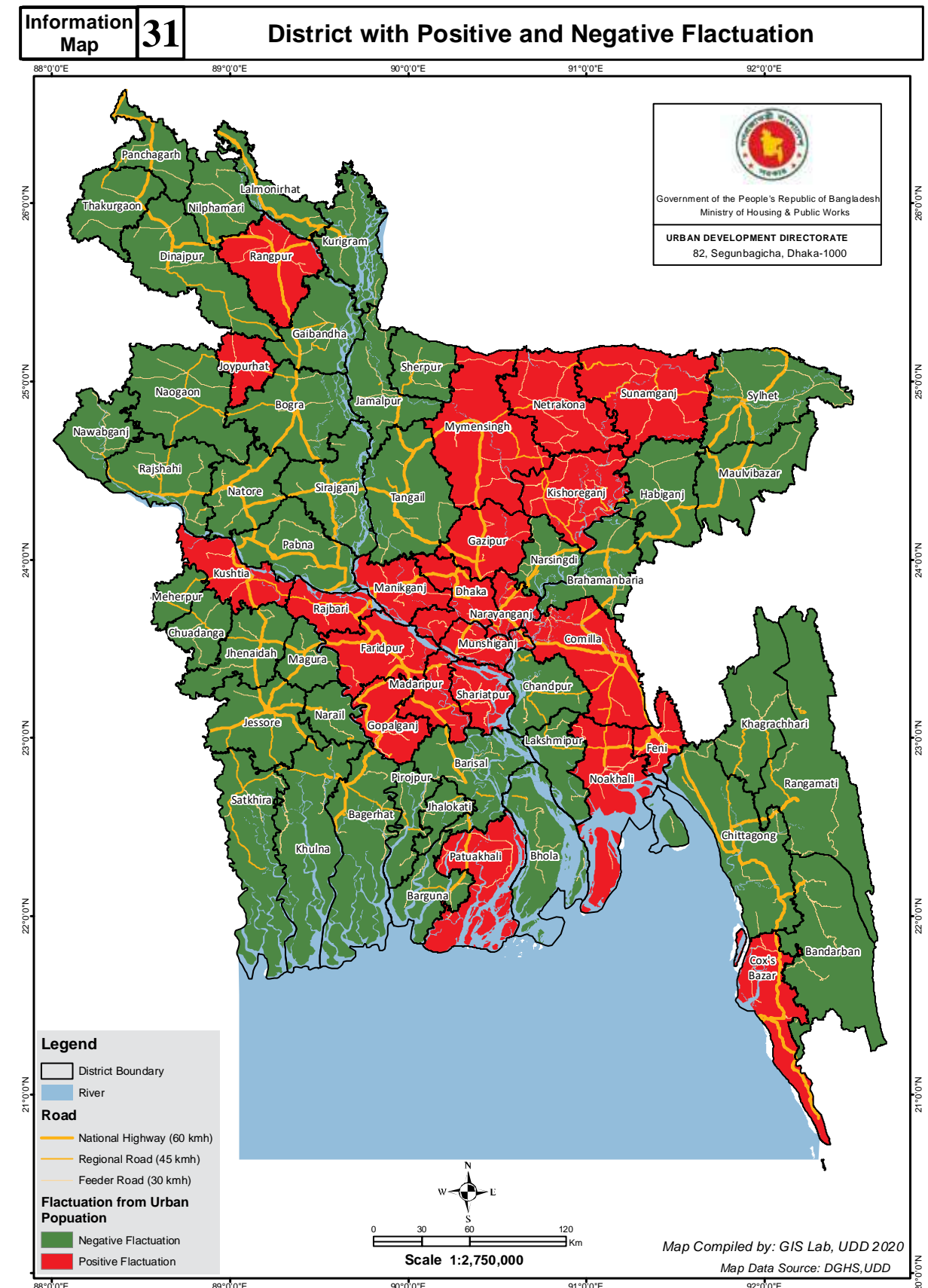
The map below represents the districts with positive and negative fluctuation of COVID-19 positive cases. The spatial pattern of COVID-19 positive cases suggests that there are some other factors that are necessery to incorporate in calculating urban readiness to discribe the pandemic situation better.

Table 14 (a): Districts with positive and negative fluctuation

Flactuation	Name of District
Negative	Bagerhat, Bandarban, Barguna, Barisal, Bhola, Bogra, Brahamanbaria, Chandpur, Chuadanga, Dinajpur, Gaibandha, Habiganj, Jamalpur, Jessore, Jhalokati, Jhenaidah, Khagrachhari, Khulna, Kurigram, Lakshmipur, Lalmonirhat, Magura, Maulvibazar, Meherpur, Naogaon, Narail, Narsingdi, Natore, Nawabganj,Nilphamari, Pabna, Panchagarh, Pirojpur, Rajshahi, Rangamati, Satkhira, Sherpur, Sirajganj, Sylhet, Tangail, Thakurgaon
Positive	Cumilla, Cox's Bazar, Dhaka, Faridpur, Feni, Gazipur, Gopalganj, Joypurhat, Kishoreganj, Kushtia, Madaripur, Manikganj, Munshiganj, Mymensingh, Narayanganj, Netrakona, Noakhali, Patuakhali, Rajbari, Rangpur, Shariatpur, Sunamganj

Flactuation of Chittagong is ziro (0) becase it is the base of calculation
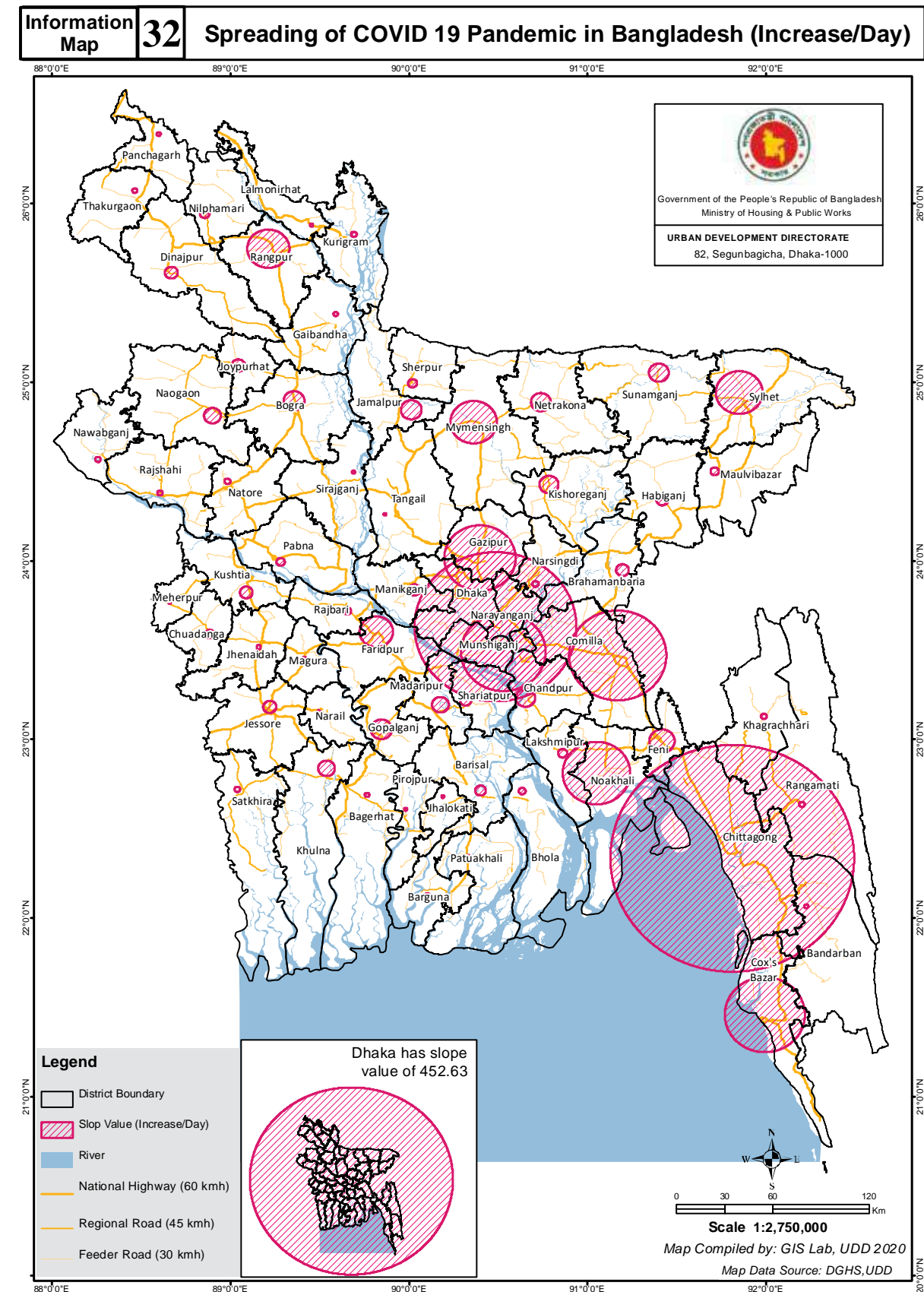

Information Map 31 — District with Positive and Negative Flactuation

Government of the People's Republic of Bangladesh
Ministry of Housing & Public Works
URBAN DEVELOPMENT DIRECTORATE
82, Segunbagicha, Dhaka-1000

Legend
District Boundary
River
Road
National Highway (60 kmh)
Regional Road (45 kmh)
Feeder Road (30 kmh)
Flactuation from Urban Popuation
Negative Flactuation
Positive Flactuation

Scale 1:2,750,000

Map Compiled by: GIS Lab, UDD 2020
Map Data Source: DGHS,UDD

Spreading of COVID-19 pandemic in Bangladesh (increase/day)

To overcome the outlier effects between total number of positive cases and urban readiness, this map represents spreading intensity of the pandemic on geographic surface. It is calculated by the slope of trend line generated from number of positive cases on 100th day. It is assumed that the slope of the trend line is an indication of average positive identification by a day. It represents the spreading intensity of pandemic in certain district. Increasing rate of Dhaka is extremely high in respect of rest 63 districts. So, the case of Dhaka is not presented in this map but it was included in the calculation. Chattogram has the second highest slope value of 70.27 and Dhaka has the highest slope value of 452.62.

Table 15: 64 districts with slope value

Dristict	Slope	Dristict	Slope	Dristict	Slope
Barisal	3.10	Feni	7.26	Nawabganj	1.60
Jessore	3.78	Gaibandha	1.28	Netrakona	5.62
Jhenaidah	1.27	Gopalganj	6.09	Nilphamari	2.73
Khulna	4.81	Habiganj	3.36	Pabna	2.40
Magura	1.02	Jamalpur	5.91	Panchagarh	1.13
Narail	0.82	Jhalokati	0.90	Pirojpur	0.89
Patuakhali	1.95	Joypurhat	3.78	Rangamati	1.63
Rajbari	2.10	Khagrachhari	1.67	Rangpur	11.87
Rajshahi	1.61	Kishoreganj	5.40	Satkhira	1.63
Sirajganj	0.95	Kurigram	1.64	Shariatpur	3.23
Tangail	0.87	Kushtia	3.63	Sherpur	2.57
Bagerhat	1.36	Lakshmipur	2.66	Sylhet	13.24
Bandarban	1.16	Lalmonirhat	0.97	Thakurgaon	1.43
Barguna	1.25	Madaripur	4.82	Chittagong	70.27
Bhola	2.00	Manikganj	3.41	Comilla	27.84
Bogra	5.91	Maulvibazar	2.42	Cox's Bazar	23.24
Brahamanbaria	3.65	Meherpur	0.76	Dhaka	452.6
Chandpur	5.52	Mymensingh	13.17	Gazipur	20.34
Chuadanga	2.60	Naogaon	4.77	Munshiganj	24.19
Dinajpur	3.67	Narsingdi	1.80	Narayanganj	46.26
Faridpur	9.56	Natore	1.70	Noakhali	19.39
				Sunamganj	5.62

Information Map 32 — Spreading of COVID 19 Pandemic in Bangladesh (Increase/Day)

Government of the People's Republic of Bangladesh
Ministry of Housing & Public Works
URBAN DEVELOPMENT DIRECTORATE
82, Segunbagicha, Dhaka-1000

Dhaka has slope value of 452.63

Legend
- District Boundary
- Slop Value (Increase/Day)
- River
- National Highway (60 kmh)
- Regional Road (45 kmh)
- Feeder Road (30 kmh)

Scale 1:2,750,000

Map Compiled by: GIS Lab, UDD 2020
Map Data Source: DGHS,UDD

Urban readiness vs pandemic considering spreading intensity

This graph below represents the spreading intensity of pandemic in Bangladesh on 100th day on graphical surface. This graph considers the intensity of Chattogram as 100 and recomputed other districts accordingly. This graph shows that 9 (nine) districts (Dhaka, 7 (seven) outlying districts and Sunamganj) have significant upward position from trend line. 15 districts have downward position from trend line. Rest of the 40 districts comply with trend line.

Graph 06 — Urban Readiness Vs COVID 19 Pandemic Sprading in 64 Districts of Bangladesh
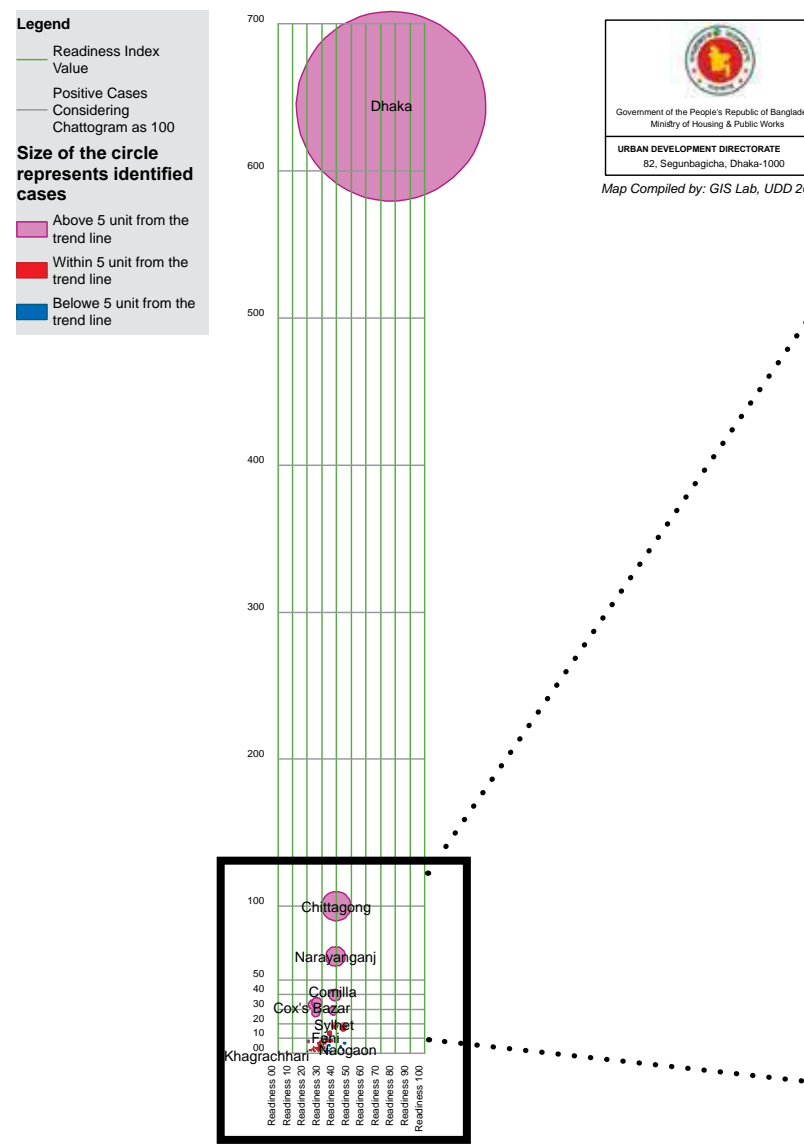
Graph 07 — Urban Readiness Vs COVID 19 Pandemic Sprading in 63 District of Bangladesh Excluding Dhaka
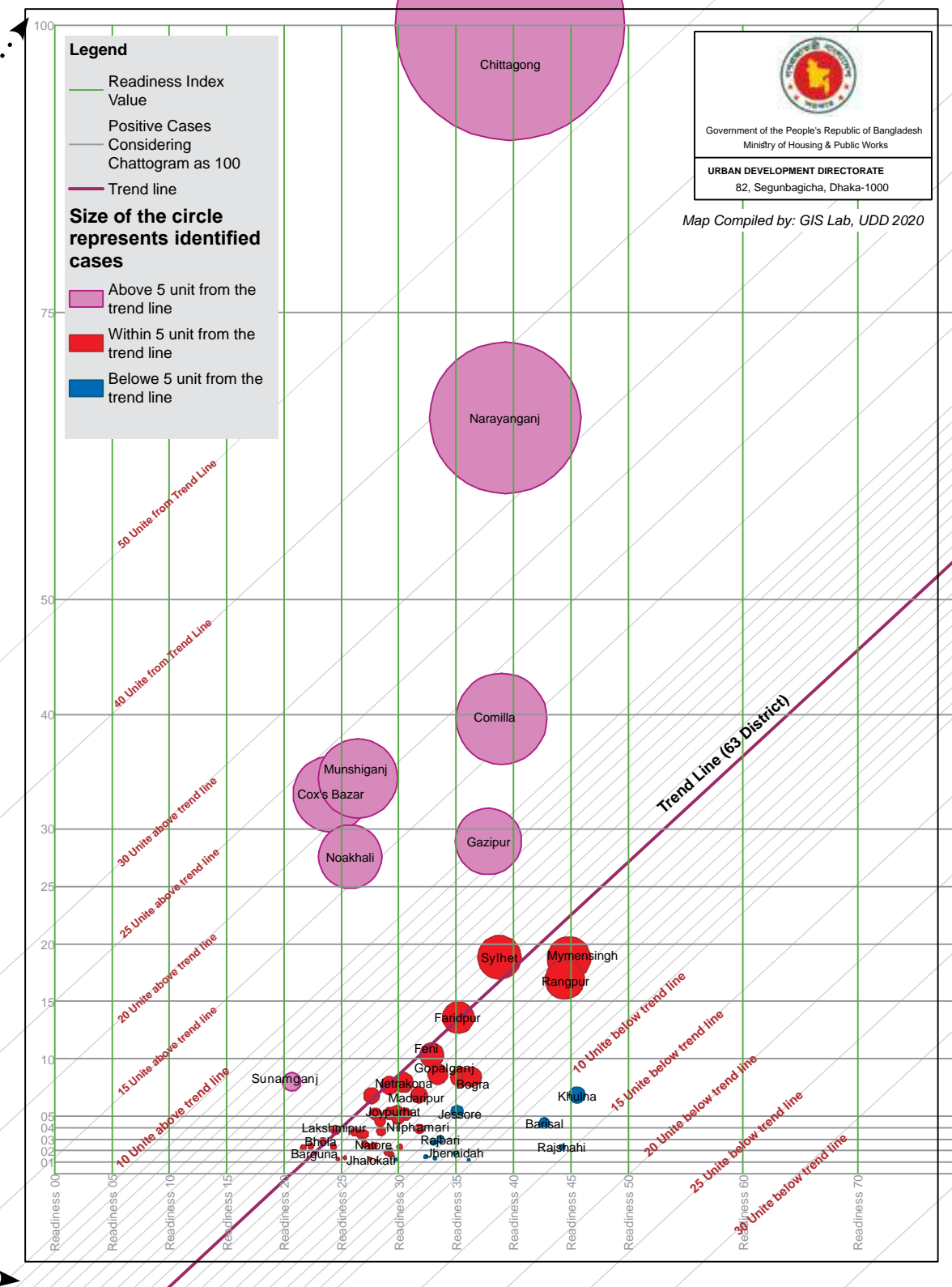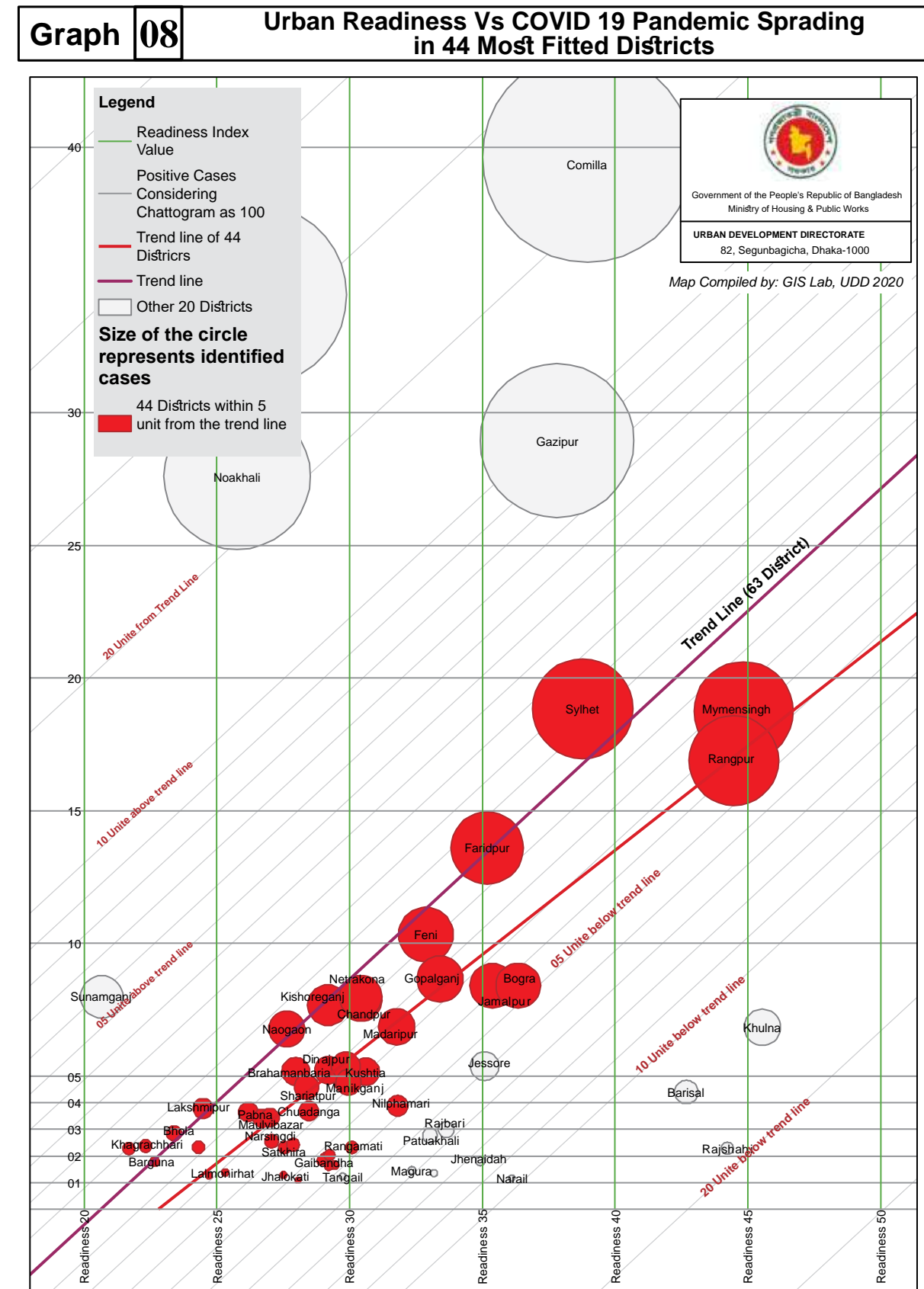
Case Study 1 : COVID-19 Pandemic

The graph below represents the cluster of 44 districts separately for better understanding. The calculated correlation coefficient between average positive cases by day and urban readiness is 0.731 within these districts. So, it can be stated that urban readiness can explain the pandemic situation very well within these districts.

### Table16 (a): Group of 44 District with Best Fitted Composition

Best Fitted Group	Name of the District
Districts within 5 unite from the trend line	Bagerhat, Bandarban, Barguna, Bhola, Bogra, Brahamanbaria, Chandpur, Chuadanga, Dinajpur, Faridpur, Feni, Gaibandha, Gopalganj, Habiganj, Jamalpur, Jhalokati, Joypurhat, Khagrachhari, Kishoreganj, Kurigram, Kushtia, Lakshmipur, Lalmonirhat, Madaripur, Manikganj, Maulvibazar, Meherpur, Mymensingh, Naogaon, Narsingdi, Natore, Nawabganj, Netrakona, Nilphamari, Pabna, Panchagarh, Pirojpur, Rangamati, Rangpur, Satkhira, Shariatpur, Sherpur, Sylhet, Thakurgaon

Graph 08 — Urban Readiness Vs COVID 19 Pandemic Sprading in 44 Most Fitted Districts

This graph below shows the cluster of 9 (nine) districts. The calculated correlation coefficient between average positive cases by day and urban readiness is 0.80 within these districts. It shows that urban readiness can explain the pandemic situation very well.

Table 16 (b) : Group of 09 District with Over Fitted Composition

Over Fitted Group	Name of the District
Districts above 5 unite from the trend line	Chittagong, Comilla, Cox's Bazar, Dhaka, Gazipur, Munshiganj, Narayanganj, Noakhali, Sunamganj.

Graph 09 — Urban Readiness Vs COVID 19 Pandemic Sprading in 09 Over Fitted Districts
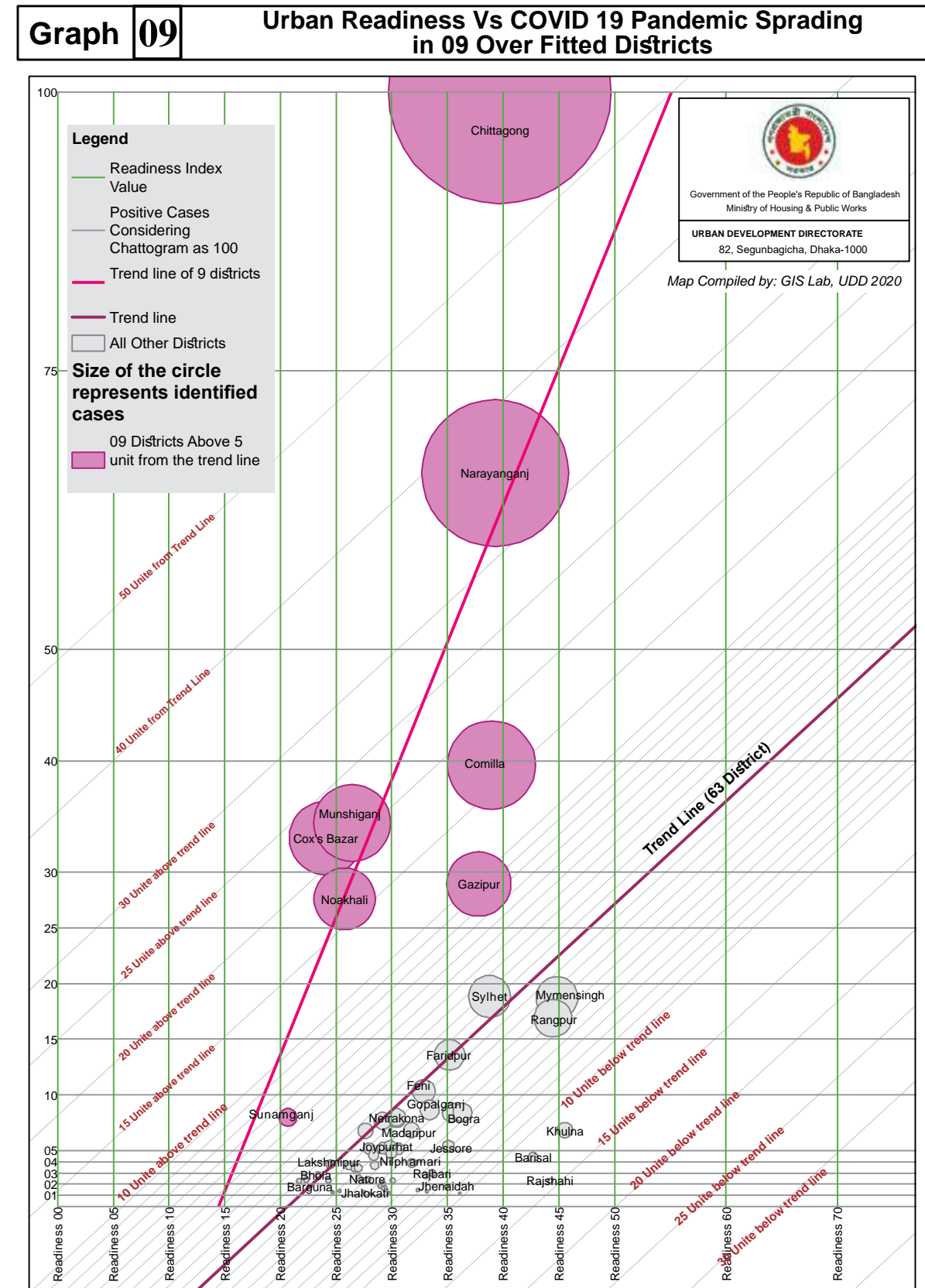
Case Study 1 : COVID-19 Pandemic

This graph below shows the cluster of 11 downward districts. The calculated correlation coefficient between average positive cases by day and urban readiness is 0.356. It shows that urban readiness cannot explain the pandemic situation within these districts as much as other two groups.

Table 16 (c): Group of 11 District with Less Fitted Composition

Less Fitted Group	Name of the District
Districts below 5 unite from the trend line	Barisal, Jessore, Jhenaidah, Khulna, Magura, Narail, Patuakhali, Rajbari, Rajshahi, Sirajganj, Tangail

Graph 10 — Urban Readiness Vs COVID 19 Pandemic Sprading in 11 less Fitted Districts
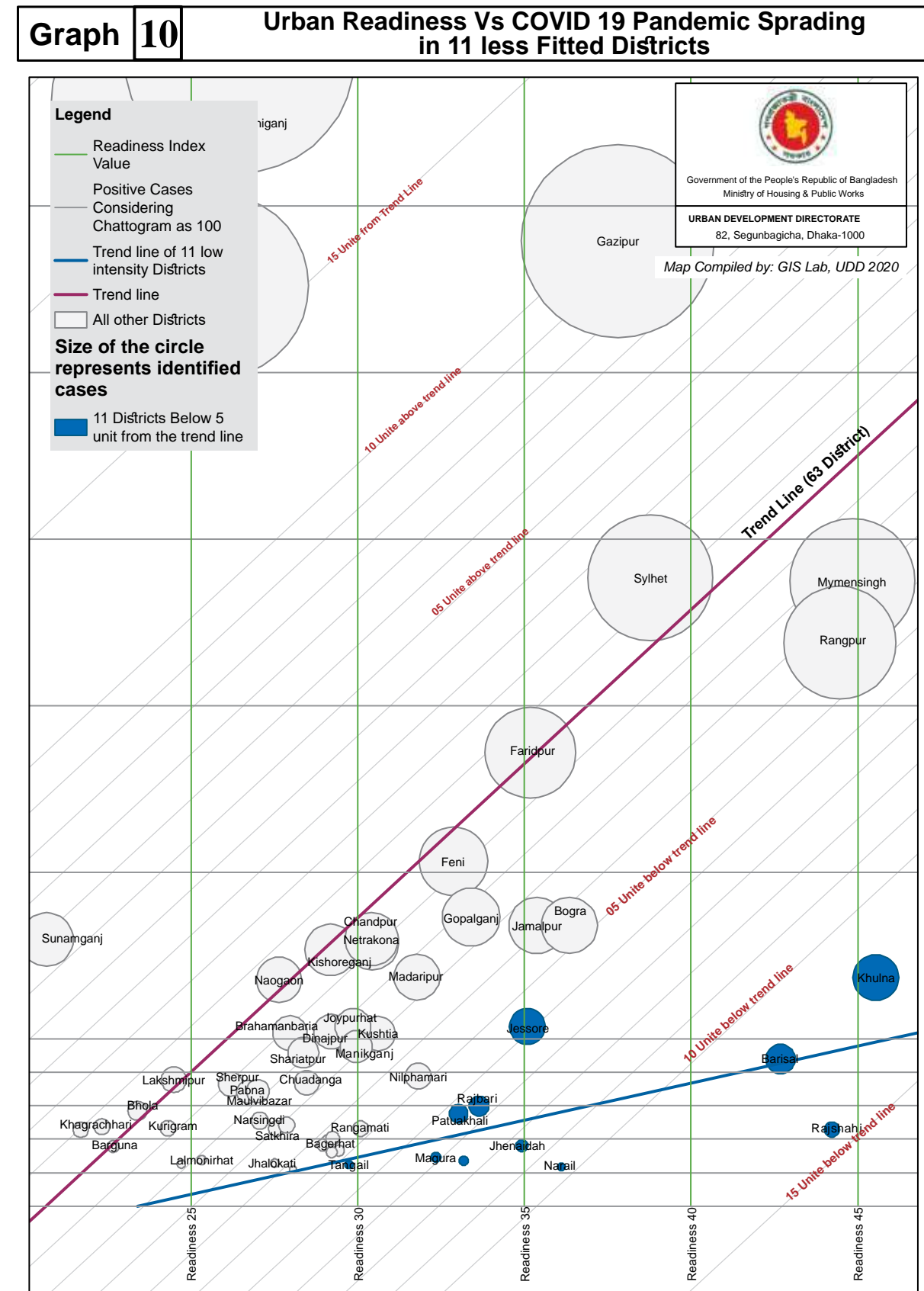
Geographic distribution of those 3 (three) groups is presented in the map below. This case study shows that 44 out of 64 cases (68.75%), urban readiness can explain urbanity of the growth centers. Urban readiness module includes 2 (two) bundles of variables representing ecological and infrastructure-service. Economy and culture are another two major factors that play vital role to describe the urban function of growth center. These two factors are not computed in this analysis.

Table 17: Geographic distribution of 3 groups

Fitted Group	Name of the District
Districts within 5 unite from the trend line	Bagerhat, Bandarban, Barguna, Bhola, Bogra, Brahamanbaria, Chandpur, Chuadanga, Dinajpur, Faridpur, Feni, Gaibandha, Gopalganj, Habiganj, Jamalpur, Jhalokati, Joypurhat, Khagrachhari, Kishoreganj, Kurigram, Kushtia, Lakshmipur, Lalmonirhat, Madaripur, Manikganj, Maulvibazar, Meherpur, Mymensingh, Naogaon, Narsingdi, Natore, Nawabganj, Netrakona, Nilphamari, Pabna, Panchagarh, Pirojpur, Rangamati, Rangpur, Satkhira, Shariatpur, Sherpur, Sylhet, Thakurgaon
Districts above 5 unite from the trend line	Chattogram, Cumilla, Cox's Bazar, Dhaka, Gazipur, Munshiganj, Narayanganj, Noakhali, Sunamganj.
Districts below 5 unite from the trend line	Barisal, Jessore, Jhenaidah, Khulna, Magura, Narail, Patuakhali, Rajbari, Rajshahi, Sirajganj, Tangail

Information Map 33 — Spatial Distribution of Districts in Three Group

Government of the People's Republic of Bangladesh
Ministry of Housing & Public Works
URBAN DEVELOPMENT DIRECTORATE
82, Segunbagicha, Dhaka-1000

Legend
- District Boundary
- River
- National Highway (60 kmh)
- Regional Road (45 kmh)
- Feeder Road (30 kmh)

Pandemic sprading intensity
- Lower then anticipated intensity
- Close to anticipated intensity
- Higher then anticipated intensity

Scale 1:2,750,000
Map Compiled by: GIS Lab, UDD 2020
Map Data Source: DGHS,UDD