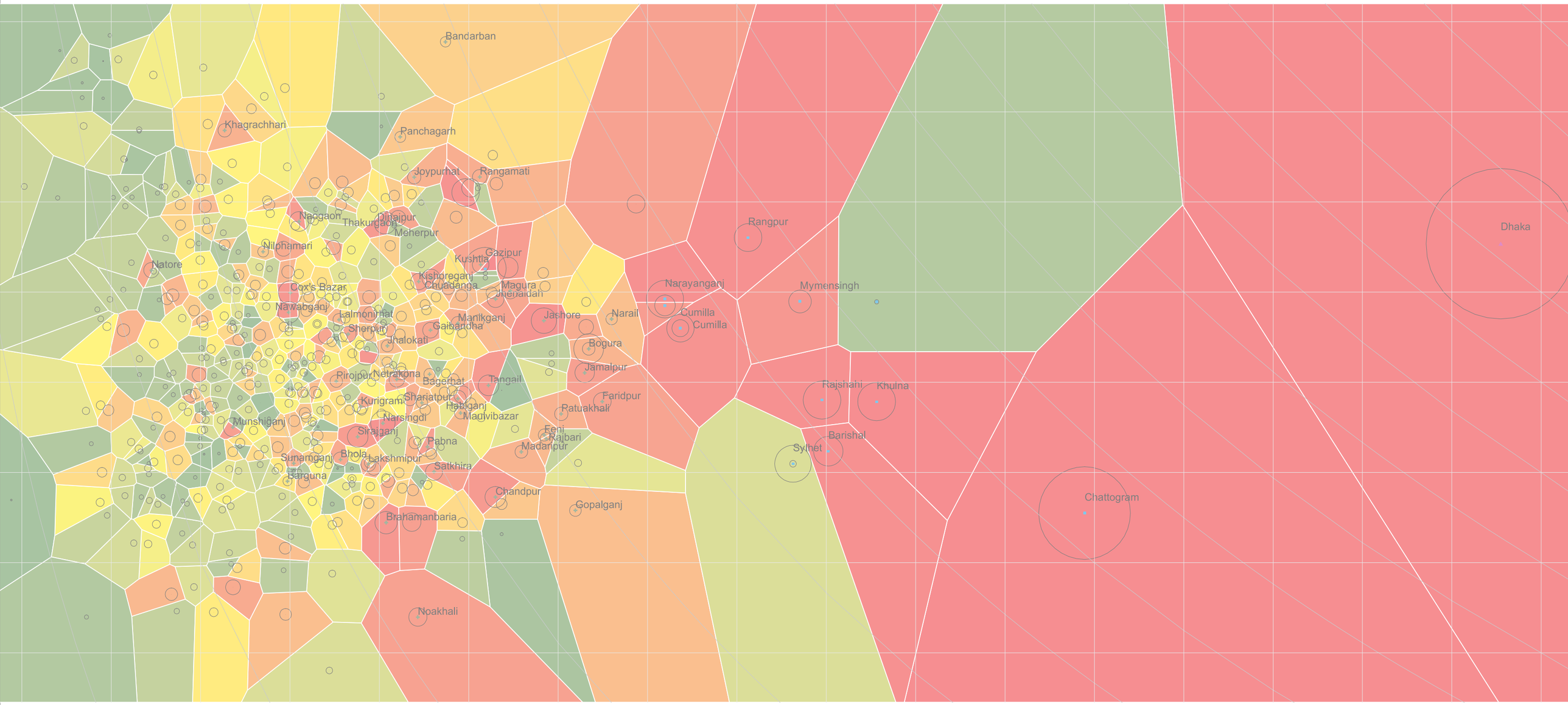
URBAN READINESS GUIDELINE IN BANGLADESH



Urban Development Directorate (UDD)
Ministry of Housing and Public Works
Government of the People's Republic of Bangladesh

URBAN READINESS GUIDLINE IN BANGLADESH

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জাতির পিতা
বঙ্গবন্ধু শেখ মুজিবুর রহমান এঁর প্রতি বিনম্র শ্রদ্ধা

Humble Respect to the Father of the Nation
Bangabandhu Sheikh Mujibur Rahman

জাতির পিতার জন্মশতবার্ষিকী ও বাংলাদেশের সুবর্ণজয়ন্তী
উপলক্ষে নগর উন্নয়ন অধিদপ্তরের এই গবেষণা সংকলনটি উৎসর্গিত

“

সবার জন্য আবাসন
কেউ থাকবে না গৃহহীন

”

মাননীয় প্রধানমন্ত্রী শেখ হাসিনা

Honourable Prime Minister Sheikh Hasina

Sharif Ahmed M.P
Honourable State Minister
Ministry of Housing & Public Works
Government of the People's Republic of Bangladesh

MESSAGE

I convey my heartiest thank to Urban Development Directorate (UDD) under the Ministry of Housing and Public Works (MoHPW) for publishing Urban Readiness Guideline for growth centers in Bangladesh. UDD is playing a significant role to device means for planned urbanization and extending civic services with facilities in rural areas through proper planning and conducting social-economic research as well. Urban Readiness is a monolithic example where theoretical knowledge is translated into practice. I believe that the data illustrations presented in this research conducted by UDD would contribute to build "Bangladesh on the march towards prosperity." I welcome such innovative approach to UDD and also expect the gradual enrichment of the Urban Development Directorate (UDD).

Sharif Ahmed M.P

Md. Shahid Ullah Khandaker
Secretary
Ministry of Housing & Public Works
Government of the People's Republic of Bangladesh

MESSAGE

I am delighted to know that Urban Development Directorate (UDD) is conducting research activities regularly as part of its allocation of function regularly. Urban Readiness is an excellent base work of urban planning guideline focusing on existing urban system and function. I expect that the output of this study will contribute to develop a planned Bangladesh.

Md. Shahid Ullah Khandaker

Dr. Khurshid Zabin Hossain Taufique
Director
Urban Development Directorate, Ministry of Housing & Public Works
Government of the People's Republic of Bangladesh

MESSAGE

Government of Bangladesh has framed "Vision 2021" and "Vision 2041" to uplift the status of Bangladesh as middle income country by the year 2021 and as developed country by the year 2041 through achieving "Sustainable Development Goal 11: Sustainable Cities and Communities" of agenda 2030 of the United Nations following the principle "No one will be left behind." This commitment has been rightly reflected in the vision of present government "My Village-My Town." Urban Development Directorate (UDD) under Ministry of Housing and Public Works (MoHPW) is working hard to achieve the benchmarks of Sustainable Development Goal. Urban Readiness Guideline is the first endeavor for integration of the ecological factor with infrastructural and services available in the growth center of Bangladesh. It is expected that determining the development perspectives of the existing growth centers system, this monograph would act as the base planning guideline for the urban planners and related professionals. It is important to make note that this research is based on available secondary data from different sources. It is an in-house study to understand the existing urban system of Bangladesh. I convey my heartiest thank to all concerned personnel and officials of UDD for successful completion of the research work. I hope UDD will continue this trend and develop new ideas to build a planned Bangladesh.

Dr. Khurshid Zabin Hossain Taufique

Executive Summary

Urban Readiness guideline is an attempt to explore and understand the existing urban system of 484 (BBS, 2011) growth centers in Bangladesh. The goal of this study is to accommodate available secondary data in a single platform to make tangible scenario for understanding those urban systems. This document address issues which are directly or indirectly related to urban/rural, and regional planning.

First chapter of this study describes the background, limitation and short description of the steps which are pre-requisite for such study.

Second chapter analyzes ecological sensitivity of growth centers, and at the same time urban ecologycal suitability of those corresponding centers, considering 18 different ecological variables.

Third chapter describes the infrastructure-services suitability of said growth centers considering 11 different urban infrastructure-services variables.

Fourth chapter of this study deals with the term **Urban Readiness** as a composite result of ecological condition and infrastructure-service accessibility of each growth center. Based on different nature of these two sates of variables (ecology & infrastructure), this study applied a matrix format for appropriate representation of two different data sets. Results of this study reveals that those growth centers are grouped together into 8 (eight) distinct group based on the values which is named as **Spatial Urban Groups (SUG)**. It is observed that different SUGs require different urban policy guidelines to reach higher level of urban readiness.

In the **Fifth** chapter of this research, an attempt has been made to test the urban readiness result of growth centers with respect to (1) on-going **COVID-19 pandemic** situation for **first 100 days** only and (2) **flood scenario** of Bangladesh occurred during **August 2020** for finding out any kind of statistical correlation for each growth center in Bangladesh. The results of pandemic situation shows that 44 out of 64 **(68.75%)** cases urban readiness can explain the existing quality of growth centers. At the same time the results from the flood scenario shows the 84.98% identical character with Urban Readiness.

Chapter **Six** deals with clustering of growth center based on ecological variable for clear understanding of its real word implication which may be one of the important tools for upcoming risk sensitive land-use planning of Bangladesh.

Annexure of this study is composed of different maps, database, satellite images, data transformation steps and list of data sources used in this study.

Urban Readiness Guideline is the first endeavor for integration of the ecological factors with infrastructural services available in the growth centers of Bangladesh. It is expected that, this monograph would act as the basic planning guideline for the urban planners and related professionals.

The team collected secondary data from different sources with different data formats which is a major challenge. Absence of normalization process for urban and ecological suitability score is another drawback of this study. This kind of study is a continuous process and Urban Development Directorate (UDD) will hopefully update this study in future. The team will be happy to accommodate any kind of criticism, comments, suggestion on this guideline.

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Preface

According to the United Nations Department of Economics and Social Affairs (UN-DESA), 55% of the world population lives in urban areas. Urbanization trends in the countries of Asia and Africa are comparatively higher than those of the rest of the world. Urban planners and practitioners are generating new ideas to synthesize this rapid trend of urbanization. They are developing new tools to explore the potentiality of urban centers. In the year 2015, Urban Development Directorate (UDD), under Ministry of Housing and Public Works (MHPW) proposed a project to prepare "National Comprehensive Development Planning Interfaced Land Use Plan for the Whole Country." Perpose of the project is planned and coordinated development of the country and urban areas in particular by integrating existing infrastructure-services, ecology, geology, hydrogeology, disaster risk, adverse impact of climate change, and other related factors.

In the year 2016, meeting of the Project Evaluation Committee (PEC) was held at the Physical Infrastructure Division of Planning Commission. According to the decision of PEC, the proposed project is still now under active consideration by the General Economic Division of Planning Commission. The project will be guided under the broader framework of the 'Delta Plan 2100'.

Meanwhile, UDD has taken an initiative for in-house research based exercise to develop a manual under the title of Urban Readiness. It will be a baseline study for the said national comprehensive plan. In this research, secondary data, which have been generated by various government agencies for their own purposes with different objectives, are used as base data-set. Hence, synchronization of data in a single planning platform was a major challenge of this research.

Shaheed Minar monument
Dhaka University Campus, Dhaka

Picture collected from Internet

National Martyrs' Memorial
Savar, Dhaka, Bangladesh

National Assembly Building of Bangladesh

Dhaka

Chapter 01
Introduction

- Neo-classical Economic Interpretation of Urban Suitability
- Matrix Formation
- Interpretation and Justification
- Aim and Objectives
- Existing Urban Center in Bangladesh and Geo-Spatial Dilemma
- Limitation of the Study
- Methodology of the Study

Introduction

Bangladesh has successfully achieved the target of Millennium Development Goal (MDG, 2015). Now the country, it is looking forward to achieveing Sustainable Development Goal (SDGs). Different organizations are working in different sectors to achieve the Goal no.11 of SDG: Sustainable Cities and communities along with its new urban strategy. Urban Development Directorate (UDD) has the mandate to prepare the master plan outside the jurisdiction of the Six development authorities (RAJUK, CDA, KDA, RDA, CoxDA, GDA) . As a planning organization, UDD realizes that a comparative study of urban characteristics in national context is necessary. This study is an attempt to evaluate urban property of all growth centers in Bangladesh on a single platform.

Neo-classical economic interpretation of urban suitability

Urban Readiness guideline synthesizes urban growth centers of the country from productivity point of view. Neo-classical economists identified 4 (four) factors of production including land, labor, capital and entrepreneurship. Producers rearrange the factors of production and convert the raw materials into products. These products circulate in the goods market. Size of the market and level of products in the market of a growth center depends on a lot of factors. This study assumes productivity is one of them. Productivity itself is a complex phenomenon. Quality and quantity of production factor is a significant ingredient of productivity. Getting actual measurement of these factors in growth centers was not possible for the study team. Considering the data availability this study identified 11 urban infrastructure-services variable that indicates the availability and quality of production factors. This study also identified 18 ecological variables that influence the accessibility and efficiency of production factor in the urban system of growth centers in Bangladesh. The country is located at the downstream of 3 major rivers system. Geologically, most of its land is sediment soil and very sensitive to ecology, especially water related ecology. Settlement pattern of the growth centers in different parts of the country reflects the influence of its ecological property which is not ignorable. It is the supreme determinant behind the formation of early settlements and present functionality of their infrastructure and services. This study assesses, the ecological sensitivity of growth center based on historical statistics and geological property declared by the authority concerned.

So, assessment of these variable is indicative assessment of productivity of growth center. A growth center with higher productivity is more urban suitable from the productivity point of view.

First part of this study synthesizes urban suitability considering ecological sensitivity. This study assumes that urban suitability is inversely proportionate function of ecological sensitivity. Second part of this study analyzes urban suitability of all 484 growth centers in Bangladesh considering infrastructure and services suitability.

Matrix Formation

Third part of this study introduces a new terminology “Urban Readiness.” This study defines urban readiness as a blending form of urban supremacy of growth centers considering ecology and infrastructure-service suitability. Infrastructure-service suitability and ecological suitability score of each growth center have been plotted in a matrix format where x-axis and y-axis are representing correspondingly. Several isoquant lines is generated from the above matrix. An isoquant is a contour line drawn through the set of points at which the same quantity of output is produced while changing the quantities in two axis. 20 isoquant lines have been generated at 5-unit interval for this research purpose. Points on each isoquant line represent same values which are called

as urban readiness of a certain growth center in this matrix. Different growth centers have different level of urban supremacy despite their administrative levels. This study does not determine any cause and effect relationship between ecological and infrastructure-service factors. It evaluates the events under each factor and tries to exercise another view point where urban planners and policy makers can visualize the growth centers and their urban property together. This chapter tries to explain how "Urban Readiness Index" can numerically indicate the needs of development effort for each growth center to gain equity in development initiatives.

Based on the position (x,y) in the graph, growth centers are grouped into 8 (eight) distinct groups which is termed as Spatial Urban Groups (SUG). This study suggests that different SUGs require different urban policy guidelines to achieve higher level of urban readiness.

Interpretation and Justification

In this research, an attempt has been made to evaluate urban readiness with respect to ongoing situation of COVID-19 pandemic. It starts from the 40th day of first identification, consecutive 50th, 60th, 70th, 80th, 90th and ending on the 100th day respectively. It reveals that there is a significant correlation between readiness and intensity of pandemic spreading. Hence, urban readiness can explain the pandemic situation. This study carried another attempt to evaluate the ecological parameter with the flood situation of 2020. The result was satisfactory as well.

Aim and Objectives

Aim of this study is to understand the comparative urban status of urban units and the complexity of urban policy requirments in Bangladesh.

There are 3 (three) objectives for this study-

1) to assess comparative urban status of urban units considering infrastructure and service distribution
2) to assess the comparative ecological compatibility of urban units
3) to integrate urban infrastructure-service and ecological compatibility of urban units

This study is an outcome of a long-term effort from different contributors. Factors or variables are selected based on the availability of data. Treatment method of events among each variable is based on the understanding of their interaction from urban perspective. Some conventional terms were used differently for this study such as growth center and the highest administrative level.

Existing Urban Center in Bangladesh and Geo-Spatial Dilemma

Bangladesh is divided into 8 (eight) divisions with 64 districts. Each district is divided into several upazilas. Each upazila has different level of urban center and the number of urban center in a upazila is different. According to Bangladesh Bureau of Statistic (BBS), there were 506 urban centers in 484 upazilas in 2011. It also redefined urban center into three different levels. They are-

City Corporation (10): administered by the Ministry of Local Government under City Corporation Act, 2009.

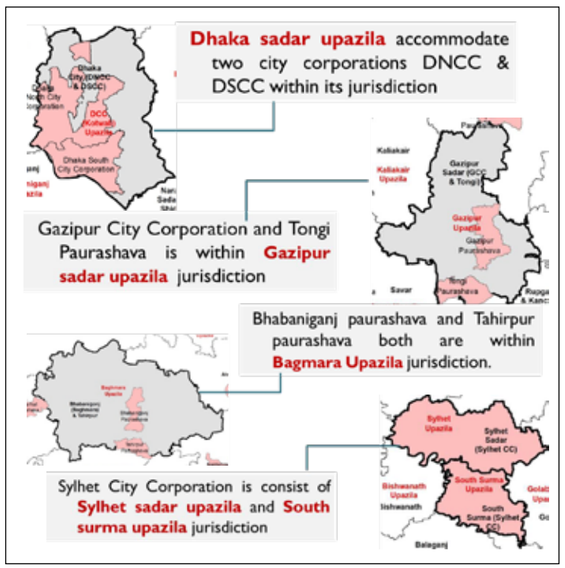
Paurashava/Municipality Area (316): administered by local government under Paurashava Ordinance, 1977.

Other Urban Area (OUA): 178 upazila headquarters which are not paurashavas; 17 unions adjacent to Dhaka City Corporation under Dhaka Metropolitan area and Cantonmet area.

Introduction

There are Geographical overlapping among the jurisdiction of these urban centers. Upazila with district headquarters serves as district level administrative center and named as district sadar upazila. Gazipur, Narayanganj and 8 (eight) divisional districts have district sadar upazilas with both city corporation and paurashava. Such as, Gazipur City Corporation and Tongi Paurashava are within Gazipur district sadar upazila jurisdiction. But Sylhet City Corporation consists of Sylhet district sadar upazila and South surma upazila. Dhaka is the only mega city and capital of the country. But there isn't any separate administration unite for the megacity or capital. The capital is located within "Dhaka City (Tejgaon)" district sadar upazila with 2 (two) city corporations, Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC). Other 53 district sadar upazila or upazila has single paurashava (municipality) and few of them have multiple paurashavas. Such as Bagmara upazila has Bhabaniganj and Tahirpur paurashavas within its jurisdiction. There are 246 paurashavas among 238 upazilas and 57 paurashavas among 53 district upazilas. This study simplified all these urban centers as growth center.

Figure 01: Geo-Spatial dilemma of urban center in Bangladesh



Bangladesh has 5 (five) hierarchical jurisdiction units (BBS 2018). Division (8), District (64), Upazila (492), Union (4,571), Mauza (56,348) and Village (87,310). In this study, Upazila is considered as a measuring unit for analysis. So geographically, a growth center is jurisdiction of an upazila and a growth center may consist of multiple urban centers. According to Population Census of BBS, 2011, there are 484 upazilas in Bangladesh. Therefore 506 urban centers have been redefined as 484 growth centers for this research to overcome the geo-spatial dilemma.

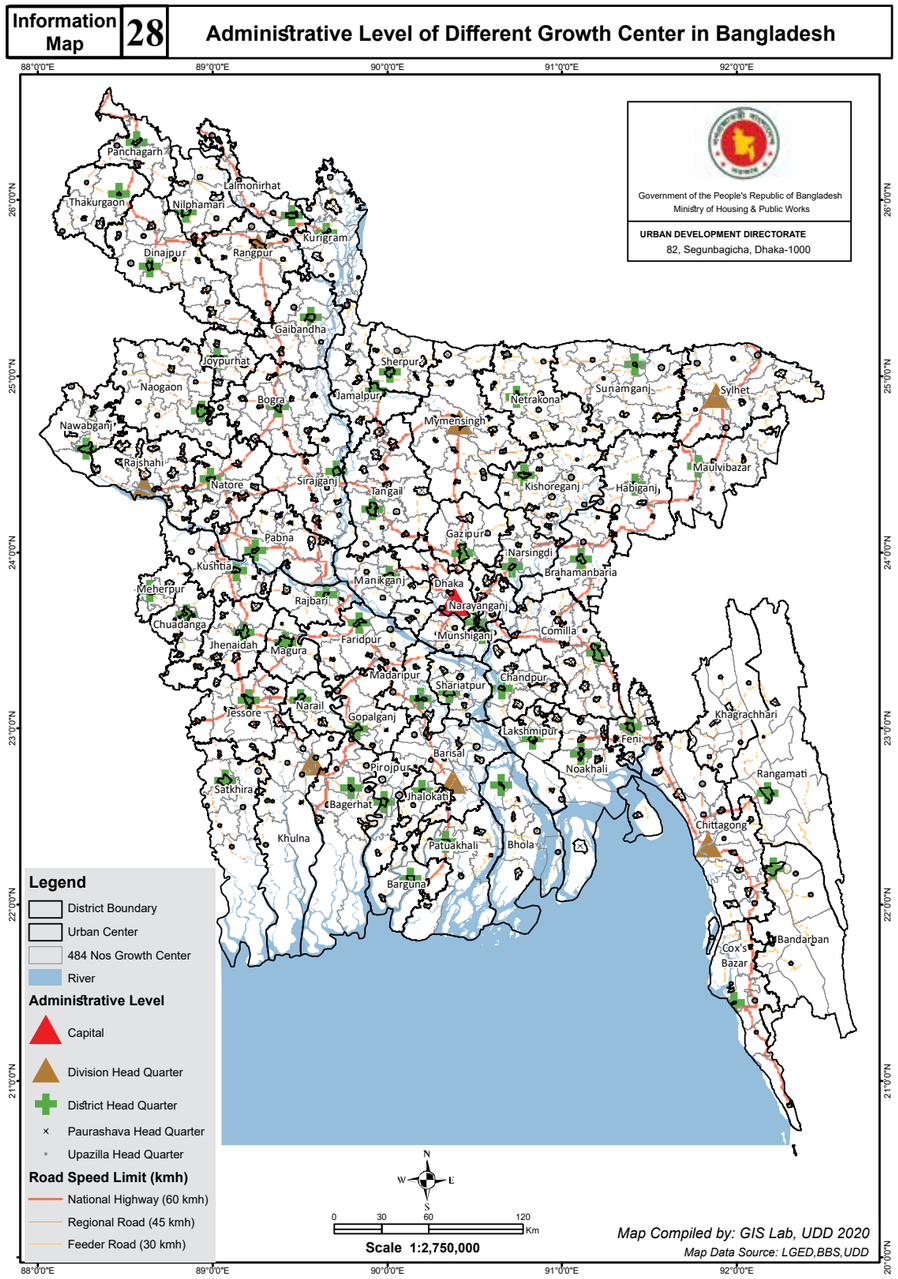
This study considered 5 (five) administrative levels for a growth center. They are Capital, City Corporation, District Headquarters, Paurashava Headquarters and Upazila Headquarters. Highest level of administration in the country is central government at the capital and upazila parishad is the lowest level of the urban administration. The table below clarifies the number of growth centers with different administration levels.

Table 01: Growth center and administrative level

Admin level	Growth center Nos.	City Corporation Nos.	District HQ Nos.	Paurashava HQ Nos.
Capital	1	2	1	N/A
City Corporation	14	10	10	13
District HQ	53	N/A	53	57
Paurshava HQ	238	N/A	N/A	246
Upazila HQ	178	N/A	N/A	N/A
Total	**484**	**12**	**64**	**316**

This study considers the highest level of administration within a growth center as its administrative level.

Figure 02: Administrative center in Bangladesh



There are 12 (twelve) city corporations in the country. 2 (two) city corporations, (DNCC and DSCC) are within a single Growth center Dhaka City (Tejgaon) growth center as Capital. Khulna City Corporation (KCC), Cumilla City Corporation (CCC), Narayanganj City Corporation (NCC) and Sylhet City Corporation (SCC) are divided among multiple growth centers. The table shows the distribution of 15 growth centers among 12 city corporations.

Table 02: Distribution of 15 growth center among 12 city corporations

SI	Growth center	City corporation
01	Dhaka City (Tejgaon)	Dhaka North City Corporation (DNCC)
		Dhaka South City Corporation (DSCC)
02	Chattogram City (Kotoali)	Chattogram City Corporation (CCC)
03	Khan Jahan Ali	Khulna City Corporation (KCC)
04	Khulna Sadar	
05	Boalia	Rajshahi City Corporation (RCC)
06	Rangpur Sadar	Rangpur City Corporation
07	Barishal Sadar (Kotwali)	Barishal City Corporation
08	Cumilla Sadar (Kotwali)	Cumilla City Corporation
09	Cumilla Sadar Dakshin (Kotwali)	
10	Bandar	Narayanganj City Corporation (NCC)
11	Narayanganj Sadar	
12	Sylhet (Kotwali)	Sylhet City Corporation
13	South Surma	
14	Gazipur Sadar	Gazipur City Corporation (GCC)
15	Mymenshing Sadar	Mymenshing City Corporation

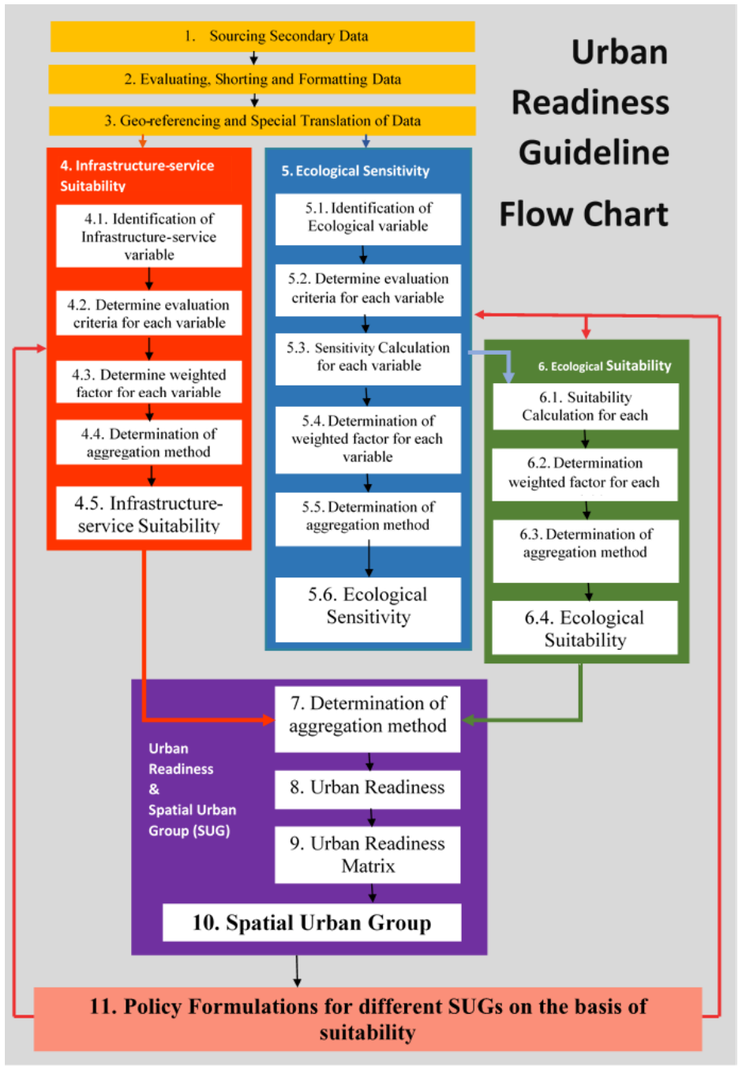
Limitation of the study

This study is a unique experience for UDD and it's team is associated with this study. The team acknowledges that, this study has a lot of limitations. Firstly, all information used in this study are collected from freely available online or offline sources and complied on desk. None of them were verified on ground. The team has very little knowledge whether the data are expired or too old to use as different organizations use different methods for creating spatial data. So there are risks of geo-referencing error as well as misinterpretation of color code. Another important limitation is methodical appropriateness. This study followed least complex and generalized methods for quick calculation. But different issues may need different treatment methods. Such as, all ecological variables are supposed to be evaluated from vulnerability perspective or based on property damage, loss of lives or livelihood disruption. But, this study could not afford the necessary data or expertise and calculated sensitivity considering area coverage. Another limitation is the weightage for the variables are decided in closed group. This study considered the ecological and infrastructure-service variables as linearly related, which is a matter of further study. Urban economics and energy are two vital issues, which need to be addressed. Culture and heritage are also excluded from this study. As an intangible value, their contribution cannot be ignored. The study team will highly appreciate suggestions, recommendations or comments from any interested person or organization. Source of data is included with each map. The study team will be happy to incorporate recommendations, suggestions and will acknowledge them accordingly.

Methodology of the study

This study follows agile method to develop the urban readiness guideline for Bangladesh. Data availability and integrity is uncertain for any study at national level. Spatial transformation is another challenge for this study. Method of data treatment, conversion technique, evaluation criteria were modified on several stages of the study. The urban readiness guideline is a workflow of 11 major steps. Steps are described in following pages

Figure 03: Total work flow of the study



Short description and outcome of each step

Step 1: Sourcing secondary data

Key Point: Data collection,
Primary assessment of potentiality

Data for urban study are available in various forms. Some of them fit in perfectly and some of them may not. There are lots of data that do not meet study requirement but indicate status of crucial variables. A tread-off between data availability and data authenticity is the main challenge in this step. In-house discussion, arrangement and collection of these data are the first step in this study.

Step 2: Evaluating, sorting and formatting data

Key Point: Fixing spatial unit: Growth center;
Convert non-spatial data into spatial form: chart/text/ image to shape/ attribute;
Process spatial data for attribute of spatial unit: point feature to count;
linear feature to distance;
polygon feature to area;

Resolution of data rationalization is another challenge for spatial analysis in national context. Data must represent a particular variable for all spatial units within the national boundary. After rapid evaluation, all collected data were sorted in this study to re-define growth center and assigned into there spatial units. Growth centers mostly represent upazila level urban area i.e., city corporation or paurashava. Missing data were interpolated; rescheduled and non-spatial data were integrated with spatial database.

Step 3: Geo-referencing and spatial translation of data

Key Point: Projection transformation;
Incorporate spatial data as attribute of spatial unit:
point data to number of point;
linear data to distance along the network or intersect;
polygon data to intersecting area;

Next challenge is correctly Geo-referencing of spatial data and transfer them into a common format. Different data were prepared at different scale for different purposes. So, spatial modification of thus data sate are necessary. All growth centers are assigned with a numerical value for all variables. All data sate are now in same platform and same format in this step having the fact that scale of data is not generalized yet.

Step 4: Infrastructure & service suitability

Key Point: Theoretical background between urban suitability and spatial allocation of infrastructure-services
Understanding the nature of data from production economics point view.

This is a set of 5 (five) consecutive sub-steps. Assessment of comparative urban suitability of growth center from spatial distribution of infrastructure and service is the objective of this step. General assumption is infrastructures and services indicates the supply of production factor (land, labour, capital and entrepreneurship) or potential productivity from neo-classical economic point of view. A growth center (spatial unit of this module) is more suitable than other growth centers if it has higher productivity potential.

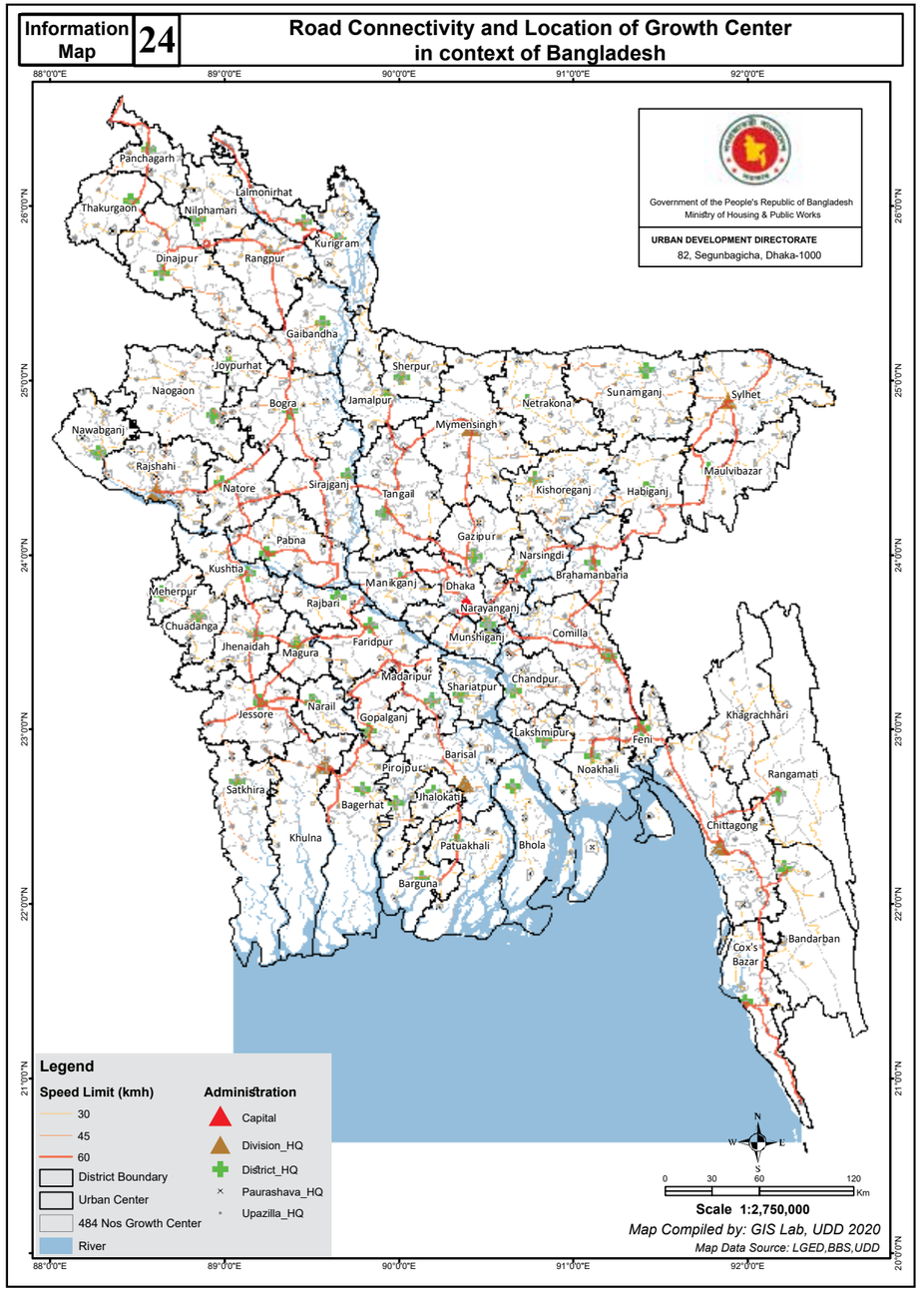
Introduction

Step 4.1: Identification of infrastructure-service variable

Key Point: Identifying infrastructure-services variables from data;
Exclude non-supporting data;
Develop variable catalog;

Infrastructure-services data are collected and grouped as urban suitability indicating variables. 9 (nine) different variable data are incorporated as indication of capital allocation for this module. Land factor was excluded because primary assessment shows that jurisdiction area of growth center has little variability among each other. Exact size of labour force and entrepreneurship data were not readily available at same spatial scale. So, urban population and apex administrative level were accepted as indicating variable respectively.

Figure 04: Information map of an Infrastructure-service variable



Step 4.2: Determine evaluation criteria for each variable

Key Point: Data specific score assignment for each variable

Obtain normalized score from variable score.

Selected variables are analyzed and a catalog was developed to understand their evaluation technique. The catalog shows dissimilarity among variables by nature, data type and geometry type. Even for some variables of growth center are point features and some variables have sub-category of different levels. Total 4 (four) different types of data derived from different geometry were integrated. Score of each variable was normalized between 0 to 1 (min-max normalization).

Table 03: Infrastructure-service variable catalog

SI	Indicative Factor	Representing Variable	Sub-class	Nature	Data type	Geometry type	Growth center geometry	Weighted Value
01	Capital	Education, Health and Religious	10	Service / feature	integer/ count	Vector/ Point	Polygon	12.9
02	Capital	Agriculture and Emergency	11	Service / feature	integer/ count	Vector/ Point	Polygon	4.5
03	Capital	Rural Economy Related	5	Infrastructure / feature	integer/ count	Vector/ Point	Polygon	8.1
04	Capital	Water based communication	6	Service / feature	integer/ count	Vector/ Point	Polygon	6.5
05	Capital	Rail communication	2	Service / feature	integer/ count	Vector/ Point	Polygon	5
06	Capital	Road connectivity	3	Infrastructure / feature	integer/ score	Vector/ Poly line	Polygon	8
07	Capital	Airport proximity	*N/A*	Infrastructure / location advantage	double/ distance	Raster/ Cell	Point	5
08	Capital	Seaport proximity	*N/A*	Infrastructure / location advantage	double/ distance	Raster/ Cell	Point	5
09	Capital	Capital proximity	*N/A*	Infrastructure / location advantage	double/ distance	Raster/ Cell	Point	5
10	Entrepreneur	Administration level	5	Service / Function	integer/ score	Attribute/ Ordinal	Attribute	15
11	Labour	Urban population	*N/A*	Service / feature	integer/ value	Attribute/ Ratio	Attribute	25

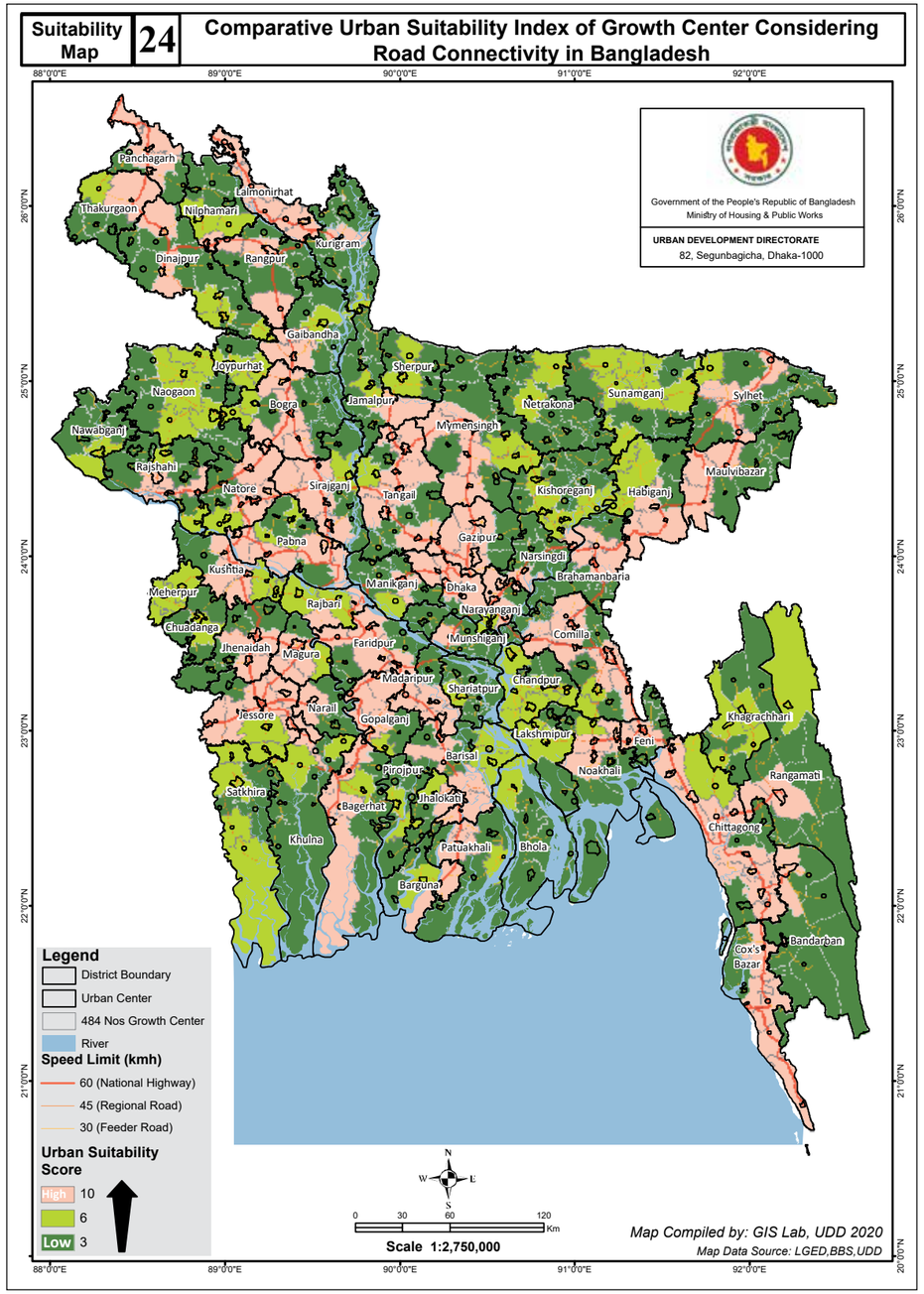
Step 4.3: Agree on weighted factor for each variable

Key Point: Survey for expert opinion

Determine weighted factor

Most disruptive part in this step is assigning weight for different variables along with corresponding sub category. Opinion from urban planning experts selected through a snowball sampling, contributed to determine the weighted factor for each variable and sub category.

Figure 05: Suitability map of an infrastructure-service variable



Step 4.4: Determine additive aggregation method

Key Point: Agreed to apply additive aggregation method.

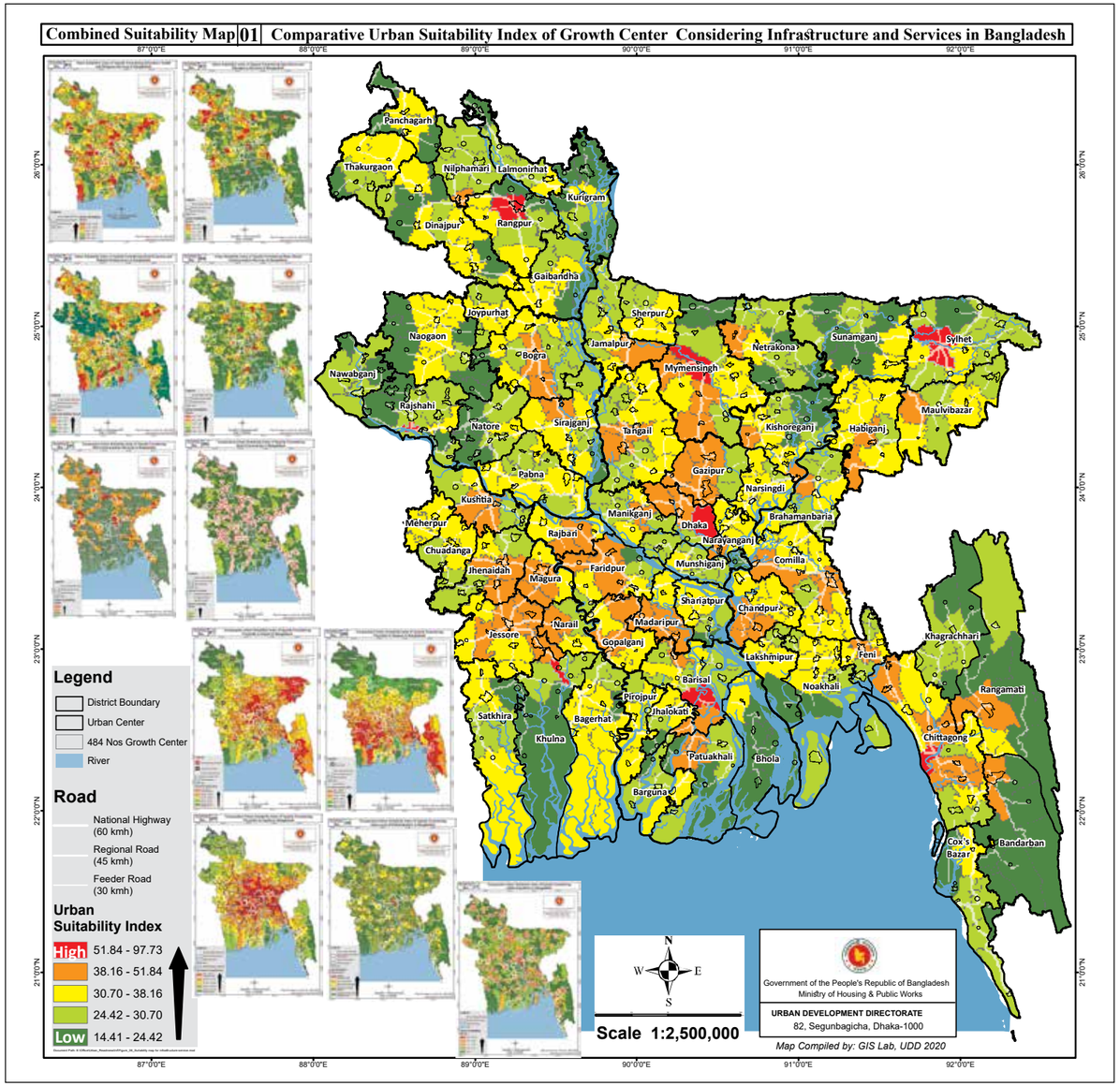
Factors of production are inter related. Absent of any of these factor results to zero production. So, aggregation method is supposed to be multiplicative. But indicative variables used in this module which are independent from each other. So this module used additive method for aggregation of individual suitability of eleven (11) different infrastructure-service variables.

Step 4.5: Infrastructure & service suitability

Key Point: Urban suitability considering infrastructure-service

It is the final sub-step where comparative urban suitability considering infrastructure-service is computed. All growth centers obtain a suitability score between 0 and 1. It is than converted in to 0 to 100 scale for easy visualization.

Figure 06: Suitability map for infrastructure-service



Step 5: Ecological sensitivity

Key Point: Conceptualization of ecological sensitivity
Understanding the limitation of data

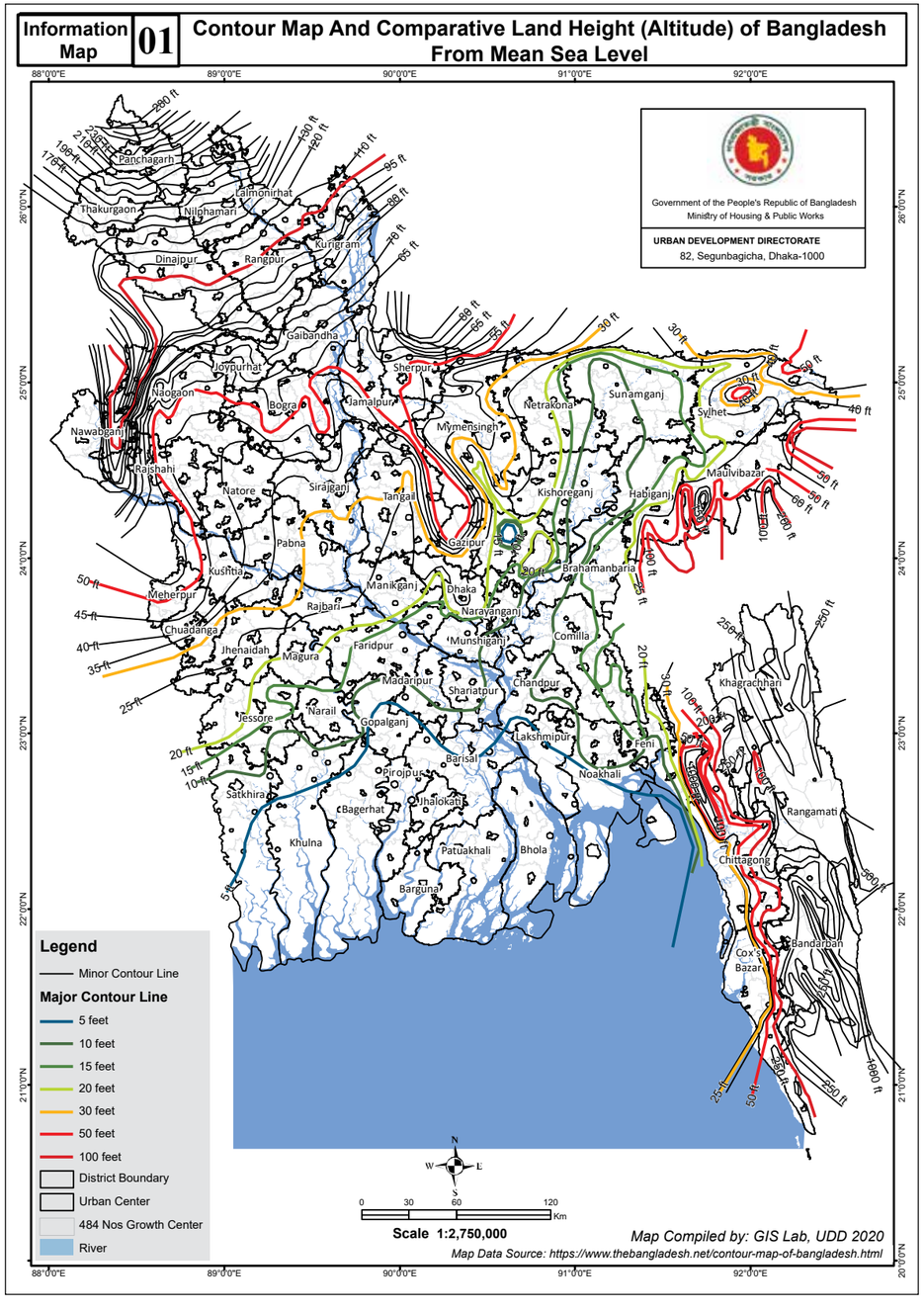
As like as infrastructure & service suitability, it is a set of 6 (six) consecutive sub-steps. Objective of this step is to assess comparative ecological sensitivity of growth center from geographical context. Prominent ecological phenomenon and concentration of their effect on urban functioning in geographic plain are the bases of sensitivity calculation. It is also true that sensitivity must be discussed from vulnerability point of view. But considering data unavailability, this module defines ecological sensitivity as comparative rigorousness of ecological phenomenon on urban area.

Step 5.1: Identification of Ecological variable

Key Point: Identifying ecological sensitivity variables from data
Exclude non-supporting data

Collected information is grouped as ecological sensitivity indicating variables. Climatic data like air temperature or humidity is excluded as no meaningful definition of suitable or not suitable range possible to agreed upon. 18 variables corresponded geographical, geological, hydro-geological and soil character, maritime and riverine hazards were incorporated.

Figure 07: Information map of an ecological variable



Step 5.2: Determine evaluation criteria for each variable

Key Point: Develop variable catalog
Determined data specific scoring method

Selected ecological variables are analyzed and a catalog was developed to understand their evaluation technique. The catalog shows dissimilarity among variables by source data type, data category and sensitivity indicative data.

Table 04: Ecological variable catalog

Sl	Representing Variable	Source Data Geometry/ data type	Sensitivity level indicator	Data category	Growth center geometry	Converted Sensitivity indicator	Weighted Value
01	Altitude	Contour line	Area below contour line	Geographical character	Polygon	Area percentage for intensity class	2
02	Cyclone	Vector line/ Line count	Count value	Maritime hazard	Polygon	Area percentage for intensity class	6
03	Tidal Flood	Vector polygon/ Attribute	level of intensity	Riverine hazard	Polygon	Area percentage for intensity class	2.43
04	River Flood	Vector polygon/ Attribute	level of intensity	Riverine hazard	Polygon	Area percentage for intensity class	2.295
05	Flash Flood	Vector polygon/ Attribute	level of intensity	Riverine hazard	Polygon	Area percentage for intensity class	2.025
06	Flood Depth	Vector polygon/ Attribute	level of intensity	Riverine hazard	Polygon	Area percentage for intensity class	8.25
07	River Erosion	Vector polygon/ Attribute	level of intensity	Riverine hazard	Polygon	Area percentage for intensity class	4.5
08	Seismic	Vector polygon/ Attribute	level of intensity	Geological character	Polygon	Area percentage for intensity class	3
09	Soil Salinity	Vector polygon/ Attribute	level of intensity	Soil character	Polygon	Area percentage for intensity class	12
10	Draught	Vector polygon/ Attribute	level of intensity	Climatic hazard	Polygon	Area percentage for intensity class	1.5
11	Ground Water Depletion	Vector point/ Attribute	interpolated mean value	Hydro-geological character	Polygon	Area percentage for intensity class	9
12	Ground Water Depletion Acceleration	Vector point/ Attribute	interpolated mean value	Hydro-geological character	Polygon	Area percentage for intensity class	6
13	Arsenic	Vector point/ Attribute	interpolated mean value	Geological character	Polygon	Area percentage for intensity class	3
14	Slope	Raster cell/ Cell value	Calculated mean value	Geographical character	Polygon	Area percentage for intensity class	8
15	River & Sea	Vector line/ Attribute	level of intensity	Geographical feature	Polygon	Area percentage for intensity class	8.1
16	Waterbody	Vector polygon/ Attribute	Area Percentage	Geographical feature	Polygon	Area percentage for intensity class	5.4
17	Forest	Vector polygon/ Attribute	Area Percentage	Geographical feature	Polygon	Area percentage for intensity class	3
18	Haowr Area	Vector polygon/ Attribute	Area Percentage	Geographical feature	Polygon	Area percentage for intensity class	13.5

Step 5.3: Sensitivity Calculation for each variable

Key Point: Data specific score assignment for each variable
Obtain normalized score from variable score

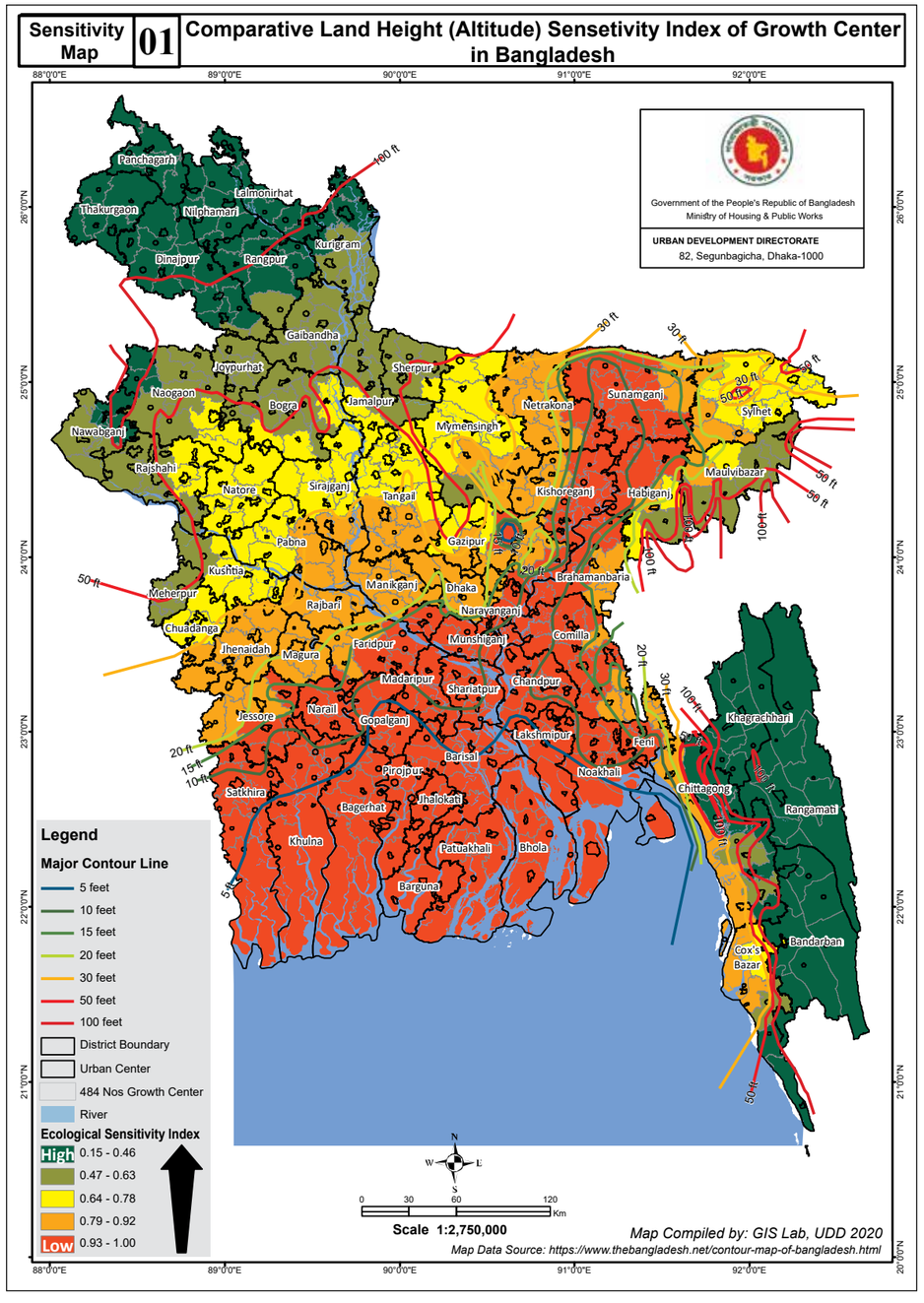
Some variables have different intensity level with area percentage but some variables are number of events or interpolated value. Different methods were applied to extract sensitivity value for these variables. Finally, intensity data of all 18 variables were converted as area percentage. Sensitivity or suitability of a growth center is sum of area percentage multiplied by intensity level.

Step 5.4: Determination of weighted factor for each variable

Key Point: Determine weighted factor

This module initially assigns equal weight for all variables. The team conducted a rapid assessment of the outcome on 15 growth center throw field observation. The team observed the settlement pattern, their organization and then realized that influence of different ecological phenomenon is different. Based on the observation, the team agreed to apply weighted factor for ecological variables.

Figure 08: Sensitivity map of an ecological variable



Step 5.5: Determination of additive aggregation method

Key Point: Agreed to apply additive aggregation method.

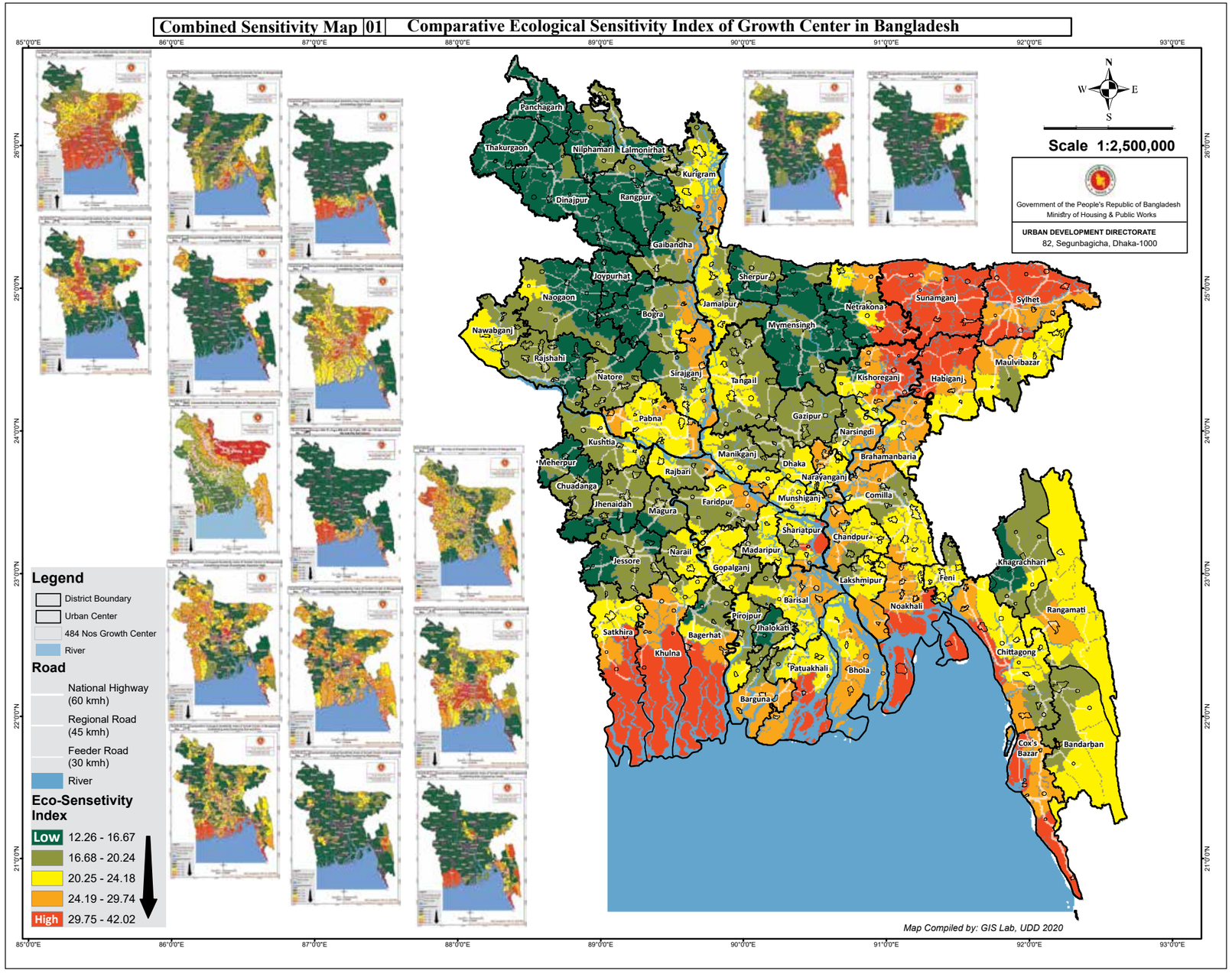
This module used additive method to aggregate ecological sensitivity considering the variables are independent from each other.

Step 5.6: Ecological Sensitivity

Key Point: Ecological sensitivity of growth center

It is the final sub-step where comparative ecological sensitivity is visible. All growth centers obtain a sensitivity score between 0 and 1. It is converted into 0 to 100 scale for easy visualization.

Figure 09: Sensitivity map of aggregated ecological variable



Step 6: Ecological Suitability

Key Point: Ecological sensitivity driven suitability for urban functioning

This module assumes that ecological suitability for urban is opposite to ecological sensitivity. An area in a growth center with the highest intensity level of sensitivity must be lowest intensity level of suitable for urban functioning. But it is true that mathematical relationship between sensitivity and suitability will be disproportionate. Further study is necessary to satisfy this argument.

Step 6.1: Suitability Calculation for each variable

Key Point: Suitability score assignment for each variable based on sensitivity;
Obtain normalized suitability score

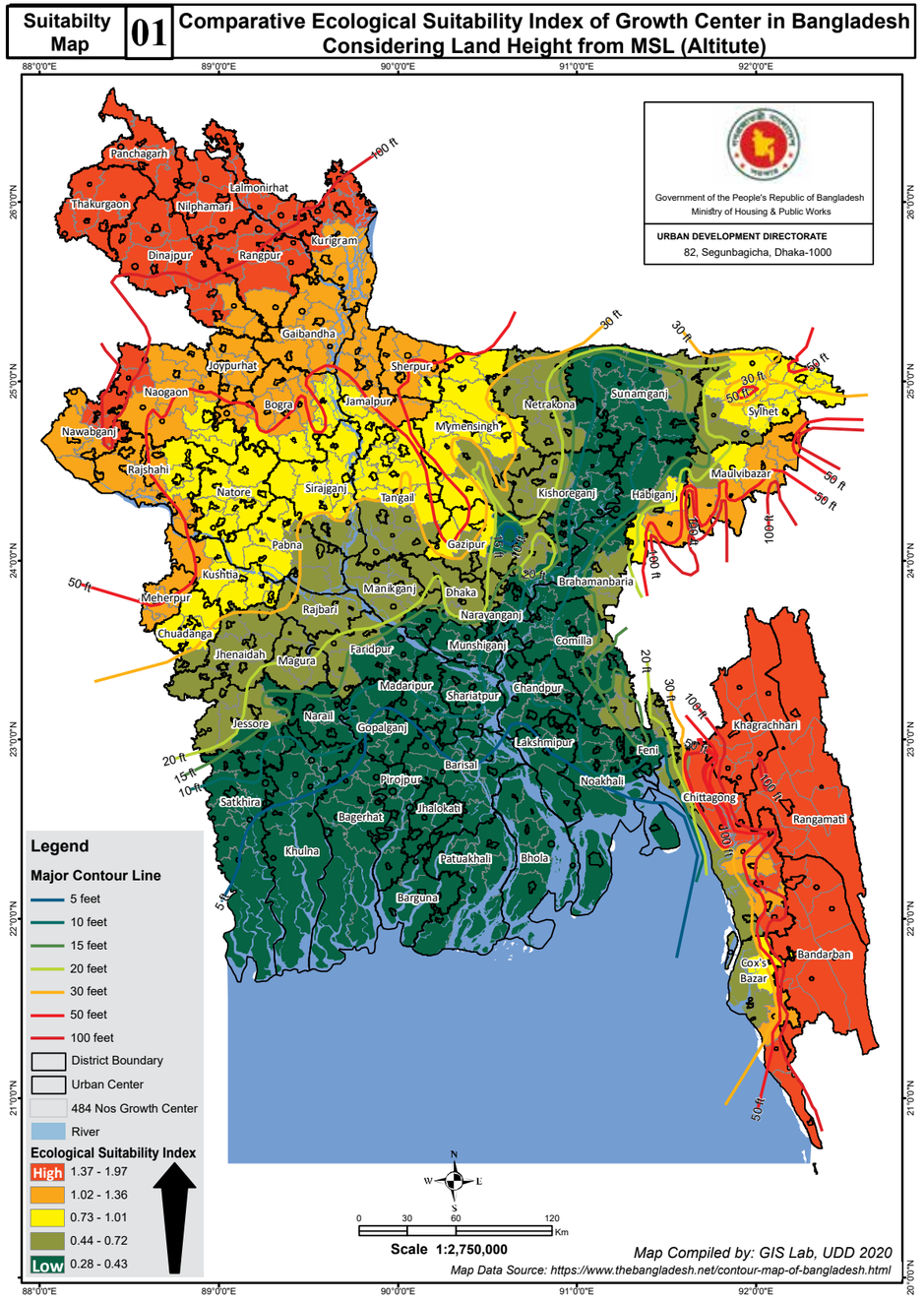
Ecological suitability is concurrently calculated with the help of ecological sensitivity calculation. Intensity level with the highest ecological sensitive score obtained lowest urban suitability score for any variable. So suitability and sensitivity are indicated by same level with opposite intensity for a variable.

Step 6.2: Determination of weighted factor for each

Key Point: Determine of weighted factor

Based on the observation from rapid assessment on ground, the team agreed to apply weighted factor for each ecological variables. Area percentage of growth center under different intensity level is same for sensitivity and suitability calculation. But the assigned score is different. Intensity level assigned with high score for sensitivity is assigned with low score for suitability.

Figure 10: Suitability map of an ecological variable



Step 6.3: Determination of additive aggregation method

Key Point: Agreed to apply additive aggregation method.

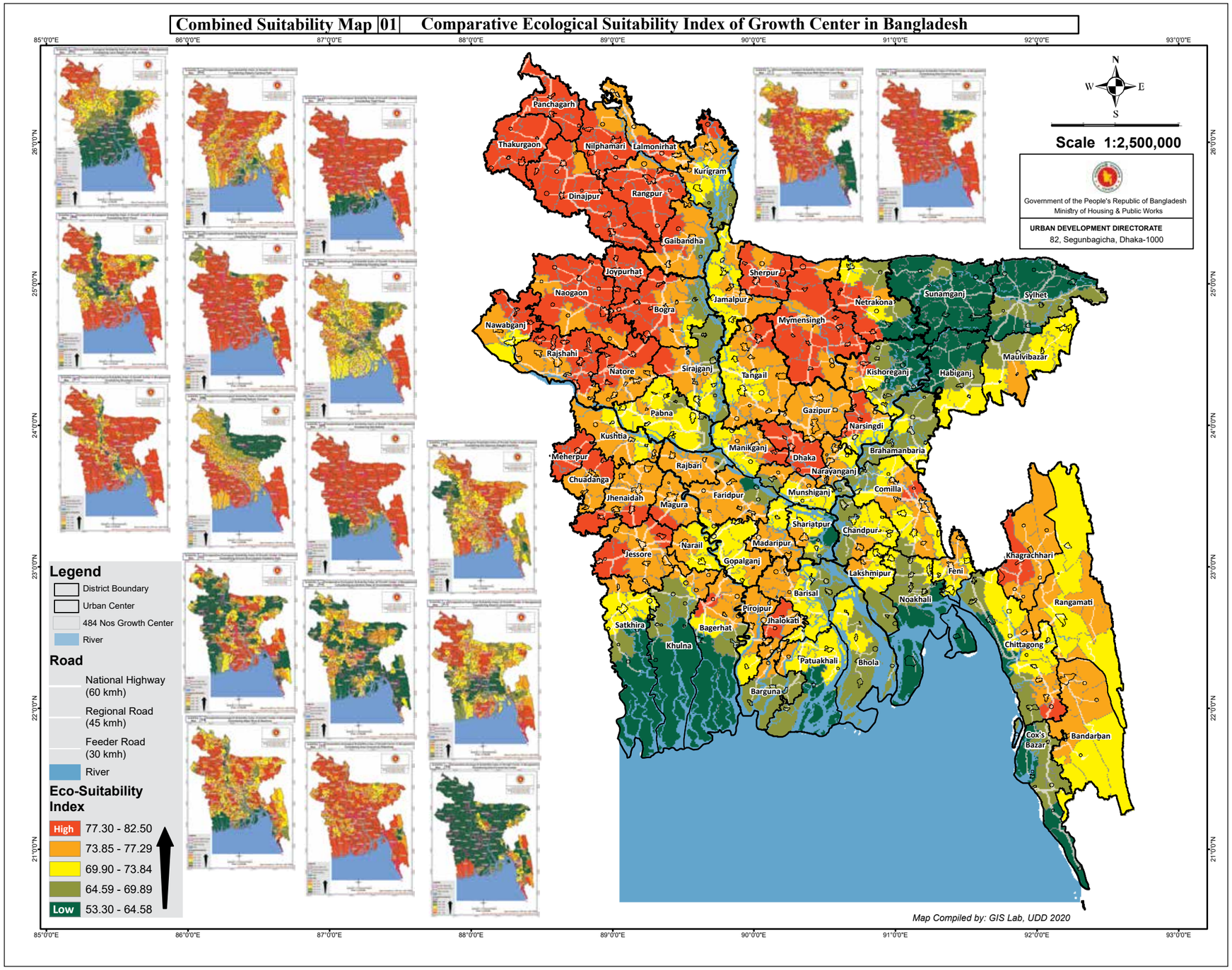
This module used additive method to aggregate ecological suitability considering the variables are independent from each other.

Step 6.4: Ecological Suitability

Key Point: Urban suitability of growth center considering ecology

It is the final sub-step where comparative ecological suitability is visible. All growth centers obtain a suitability score between 0 and 1. It is converted in to 0 to 100 scale for easy visualization.

Figure 11: Suitability map for ecological variable



Step 7: Determination of aggregation method for infrastructure-service and ecological suitability

Key Point: Multiplicative aggregation method to obtain combined suitability.

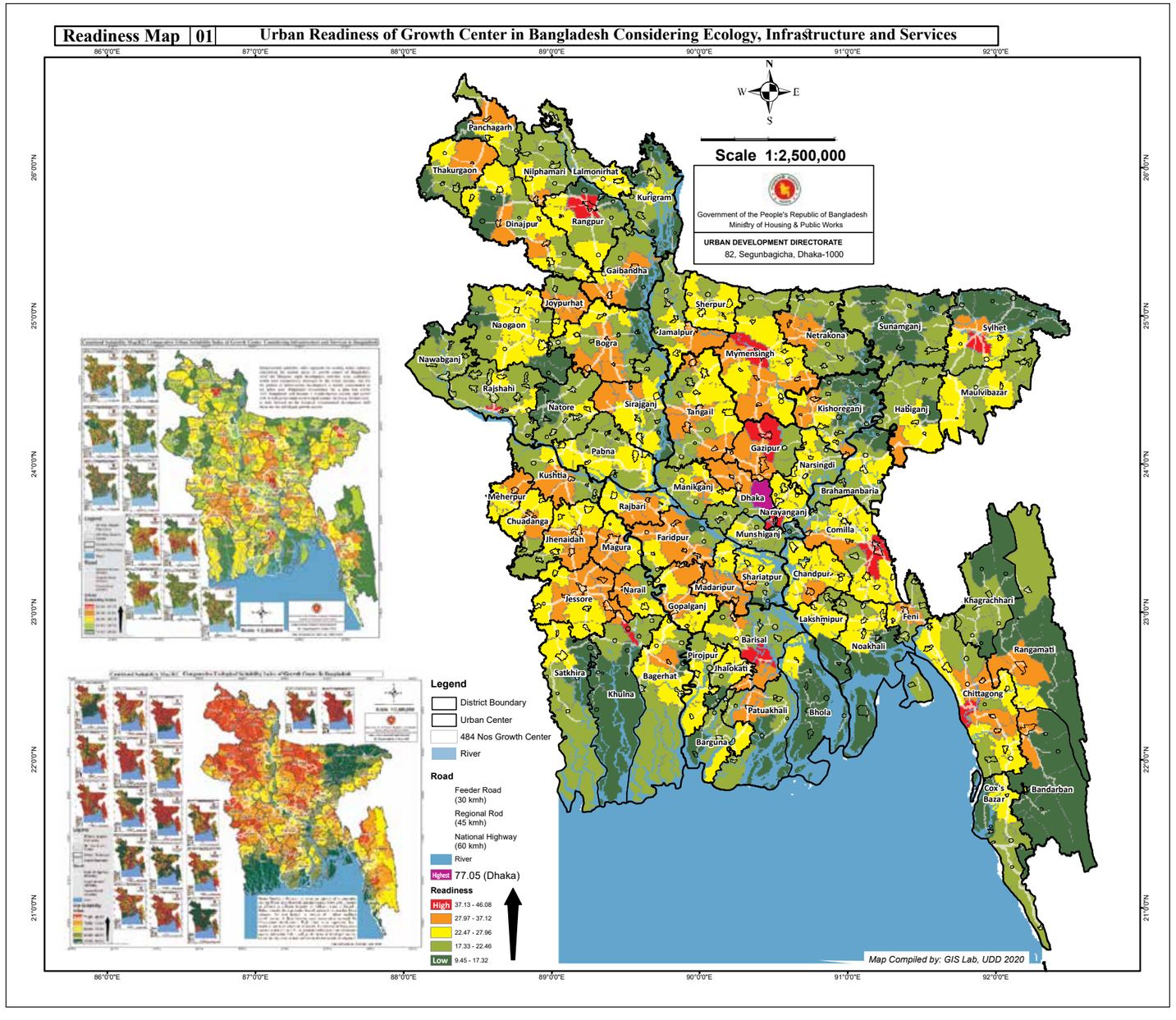
It is easy to plot each growth center in a two-dimensional plain where both suitability scores representing there co-ordinate. Underling area below its 2D position is combination of both suitabilities. The area is actually multiplicative aggregation of infrastructure-service suitability and ecological suitability. Each growth center obtains a numeric score for combined urban suitability from infrastructure-service and ecological dimension.

Step 8: Urban Readiness

Key Point: Urban Readiness concept
Urban Readiness score

In this step growth centers are assigned with a new property. It is a super imposition of ecological incompatibility over existing urban infrastructure-service in a growth center. This module attempt to draw policy guideline based on this property. It is a score range from 0 to 1 which is converted into 0 to 100 scale. It reveals that growth center with close suitability score have widely different readiness score. A growth center has to achieve high score in both dimensions to achieve higher readiness score. Implication of this property or urban readiness score is more comprehensive in graphical analysis.

Figure 12: Urban Readiness map



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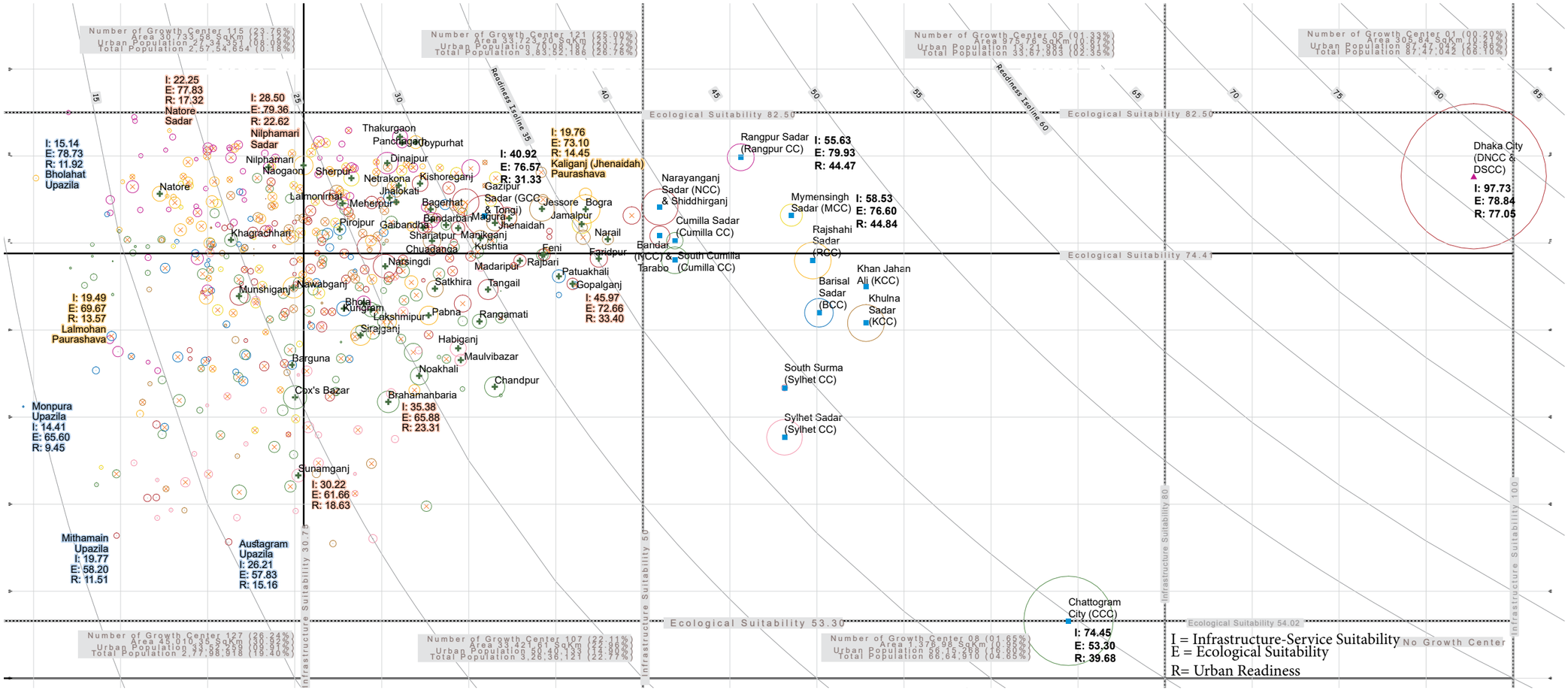
Step 9: Urban Readiness Matrix

Key Point: Urban readiness matrix
Urban readiness iso-quant curve/line

According to relative position in infrastructure-service and ecological dimension, a 2D plot is developed in this step for graphical presentation of growth centers. Assuming Urban readiness score is being calculated and plotted from iso-quant curve/line. Each point on the iso-quant curve/line represents comperative equal value above the line in the graph. So, growth center on same readiness iso-quant curve/line has considered same property (readiness score) with different combination of suitability score. Aim of urban planning policy in this study is to bring growth center in higher level readiness iso-quant curve/line.

Figure 13: Urban readiness matrix

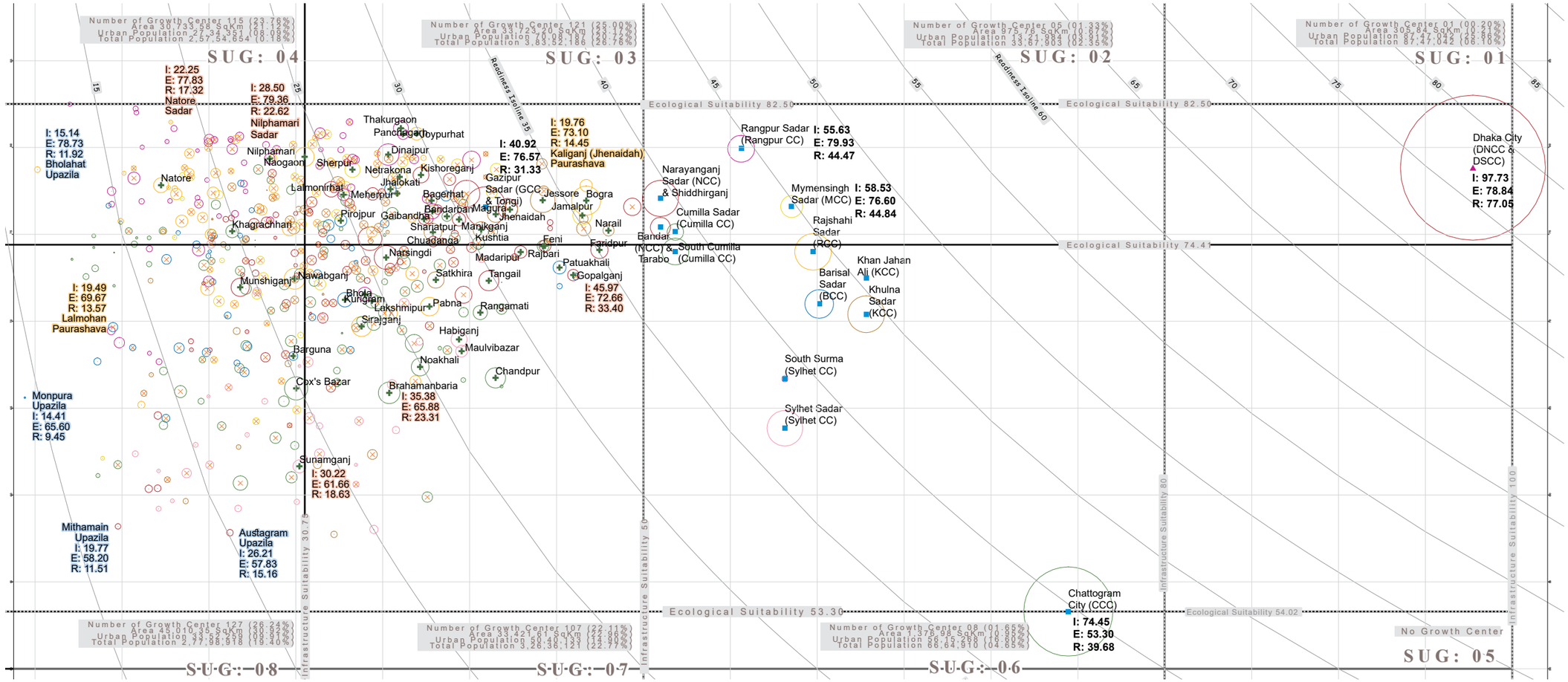


Step 10: Spatial Urban Group

Key Point: Concept and formation of Spatial Urban Group (SUG)

Drawing a circle proportionate to population size along the plotted growth center will provide a demographic property in this matrix. Shifting of the growth center along the ecological dimension is not possible. Policy intervention can move growth centers relative position along with infrastructure-service dimension only. According to the assumption of productivity potentiality (step 4), growth center in higher position has higher advantage for uplifting. On the other hand, ecological suitability determines smoothness in this movement. So, this module classifies the growth center into small group, based on their relative position into eight (8) quadrant. Each quadrant is termed as Spatial Urban Group (SUG) and marked with number based on there subjective similarities.

Figure 14: Spatial Urban Group (SUG)



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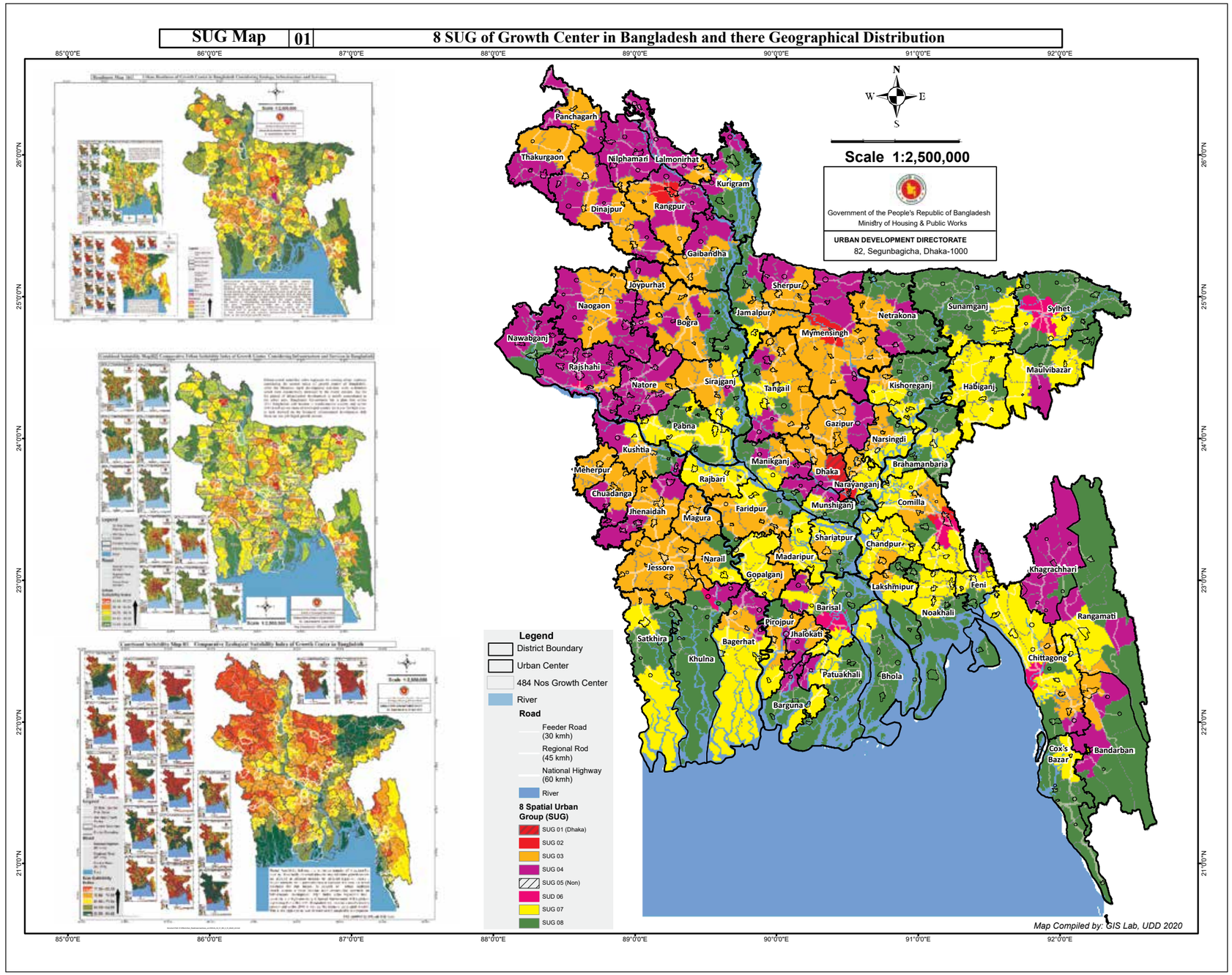
Step 10: Policy Formulation for different SUGs on the basis of suitability

Key Point: Guideline for planning policy

A key element of need based planning policy is to define the priority effectively. Different SUGs show different policy requirements not only from planning perspective but also from political, ecological and economic perspective.

Figure 15: Geographic Distribution of Spatial Urban Group

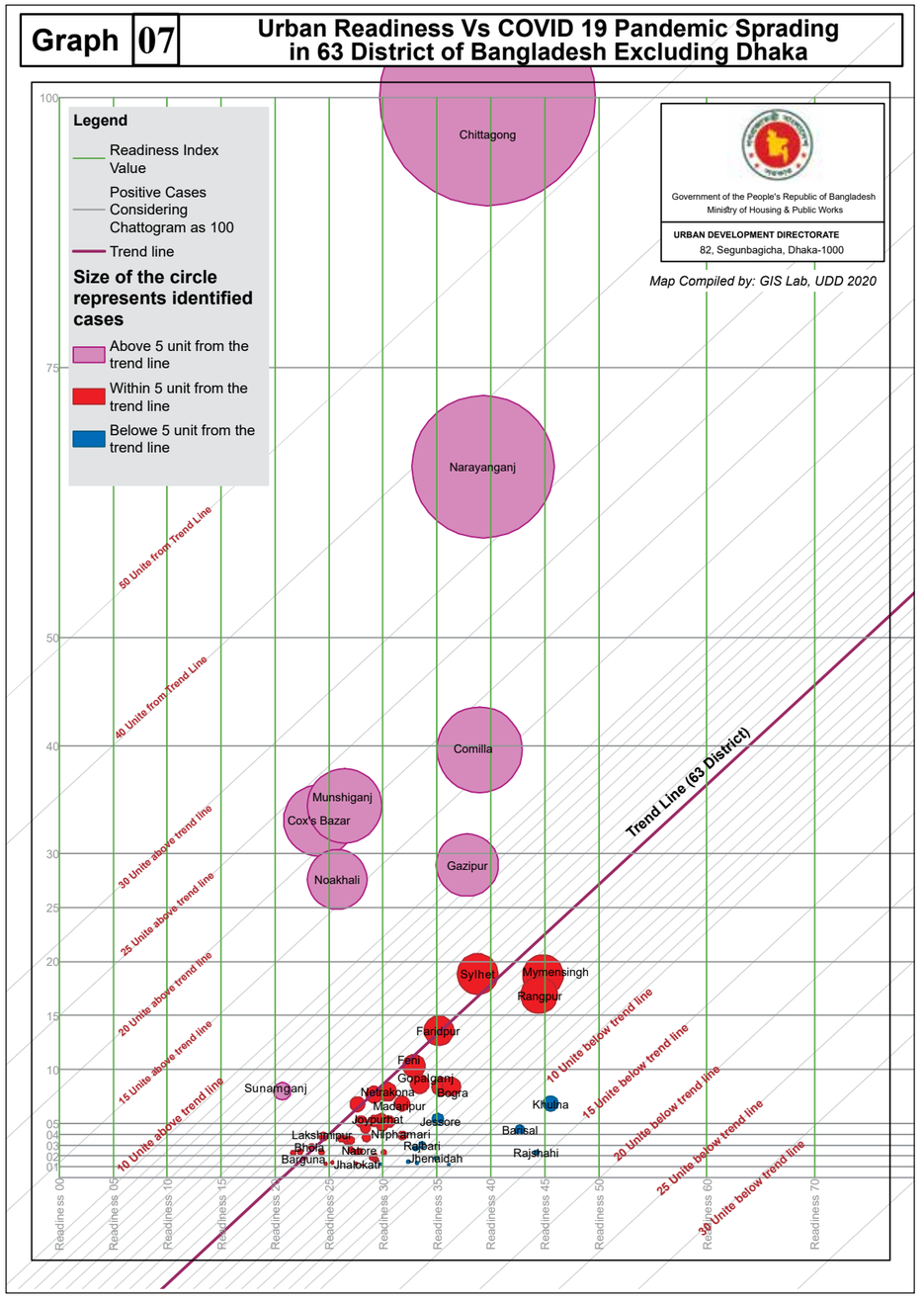


Case Study 01: Spatial Urban Group (SUG) & identified COVID-19 positive cases in Bangladesh

First COVID-19 positive case identified in Bangladesh on 8th March in 2020. Directorate General of Health Services (DGHS) has been publishing daily statistics of identification and causality report up to district level since then. In this case study, Urban readiness data sets are overlaid on the pandemic data set to assess the real world implication of urban readiness. Data inputted against 64 districts among 484 growth centers. All analyses were confined at district level considering data availability. District wise Pandemic data is available from 40th day of first identification. The case study conducted over 64 districts headquarters level growth center. Pandemic data up to the 100th day published by DGHS were collected and processed. The outcome is 3 (three) sates of district level growth center. Each sate shows positive co-relationship between the trend line of spreading intensity and readiness score. In 40 out of 64 district level growth centers (62.50%), urban readiness can explain direct urban property or functionality of growth center with the form of pandemic scenario.

But pandemic scenario of rest 9 and 15 growth center is not directly correlated with urban readiness trend line, which indicates that there are possibilities of there variable such as economy is working as a important factor for this deviation from the trend line.

Figure 16: Urban Readiness and Pandemic (First 100 Days)



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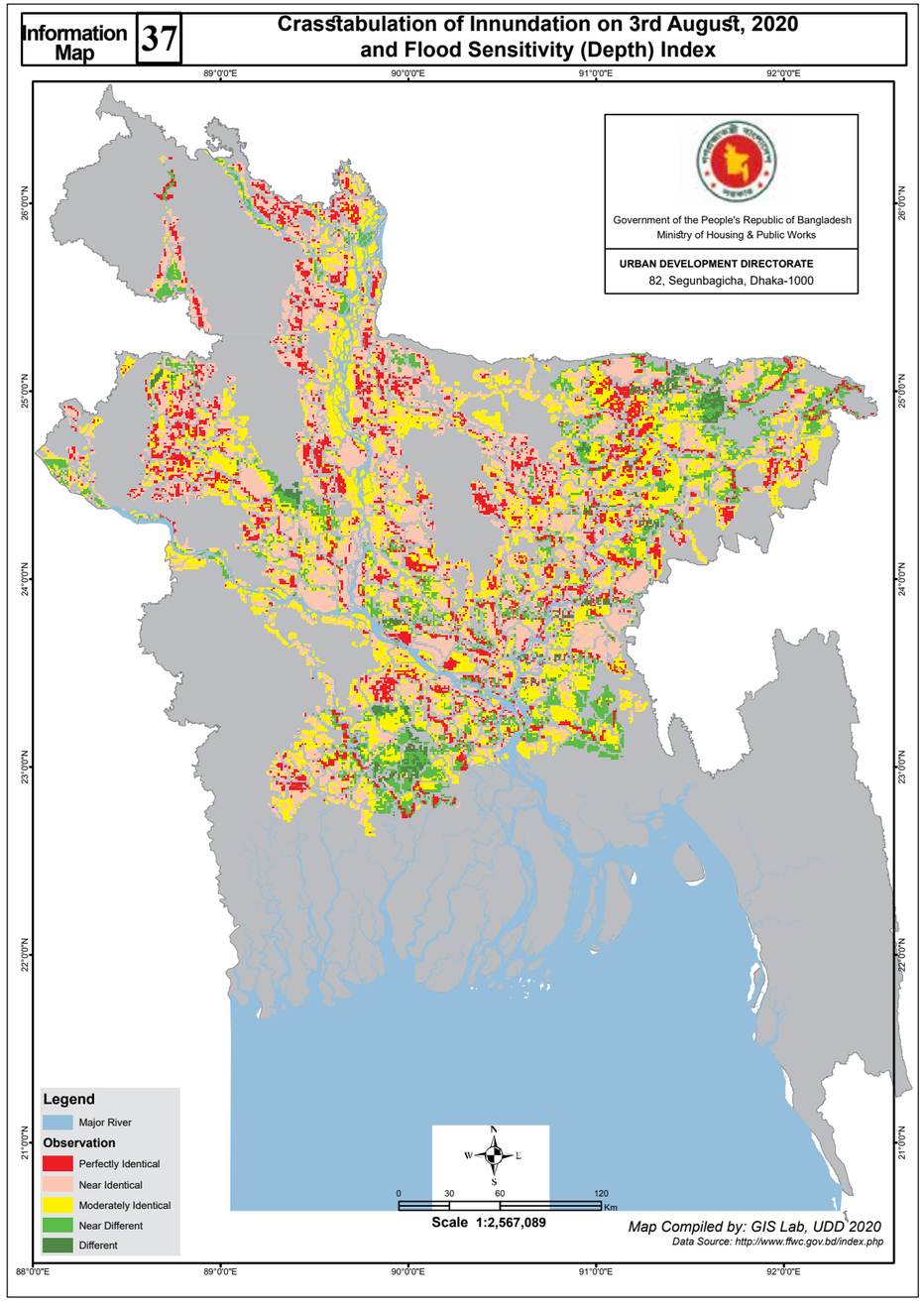
Case Study 02: Ecological sensitivity of flood in August 2020, Bangladesh

This case study is an attempt to evaluate Flood situation of 2020 in Bangladesh on related ecological sensitivity variable. Flood Forecasting & Warning Centre (FFWC) of Bangladesh generated inundated area map of Bangladesh on 3rd August, 2020. It is considered as the base of this case study. There are four flood related sensitivity variables. Among them a statistical evaluation is performed on only flood sensitivity index considering flooding depth and the actual flood situation on the base map. Figure 15 represent the output map of cross-tabulated observation in geographical space. The result shows that there is 84.98% area with identical character specified in the flood sensitivity index of urban readiness study. Therefore urban readiness can usually explain 85% of ecological events happens in Bangladesh.

Figure 17: Flooding depth observation and data comparison



A Rural Road
Pathorghata Upazila, Barguna

Ratargul Swamp Forest
Gowain River, Fatehpur Union, Gowainghat upazila, Sylhet