

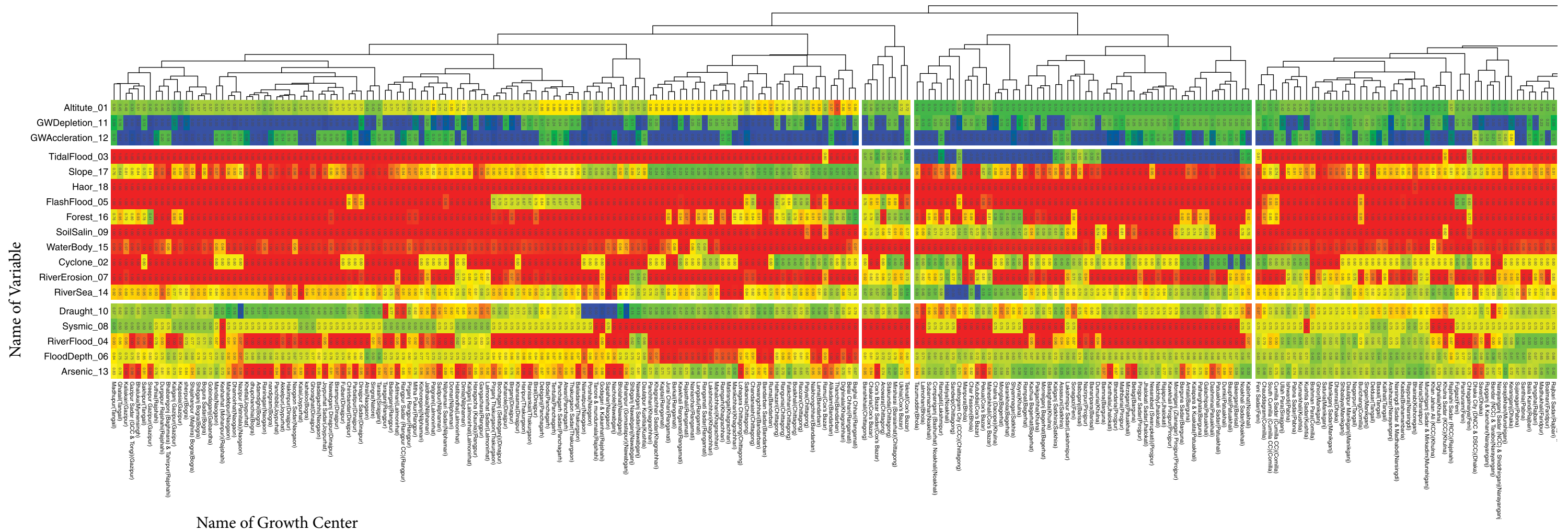
Chapter 6

Ecological Clustering

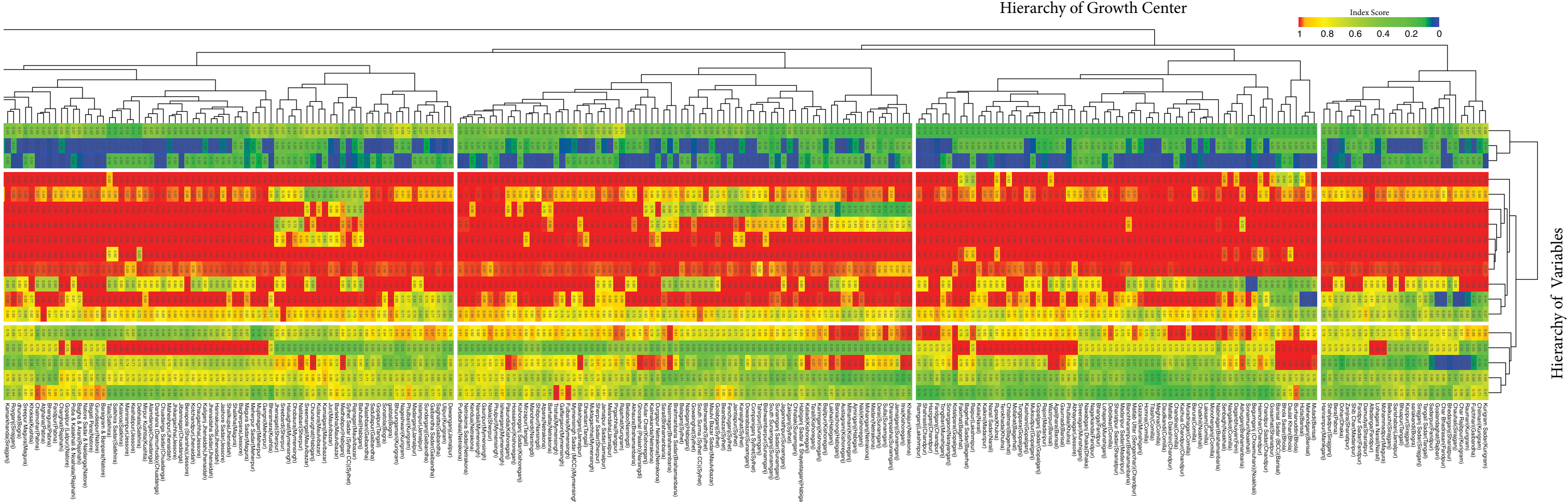
- Ecological Clustering of Growth Center
- Heatmap Generated from Growth Center Suitability Index
- Ecological Clustering Map of Growth Center

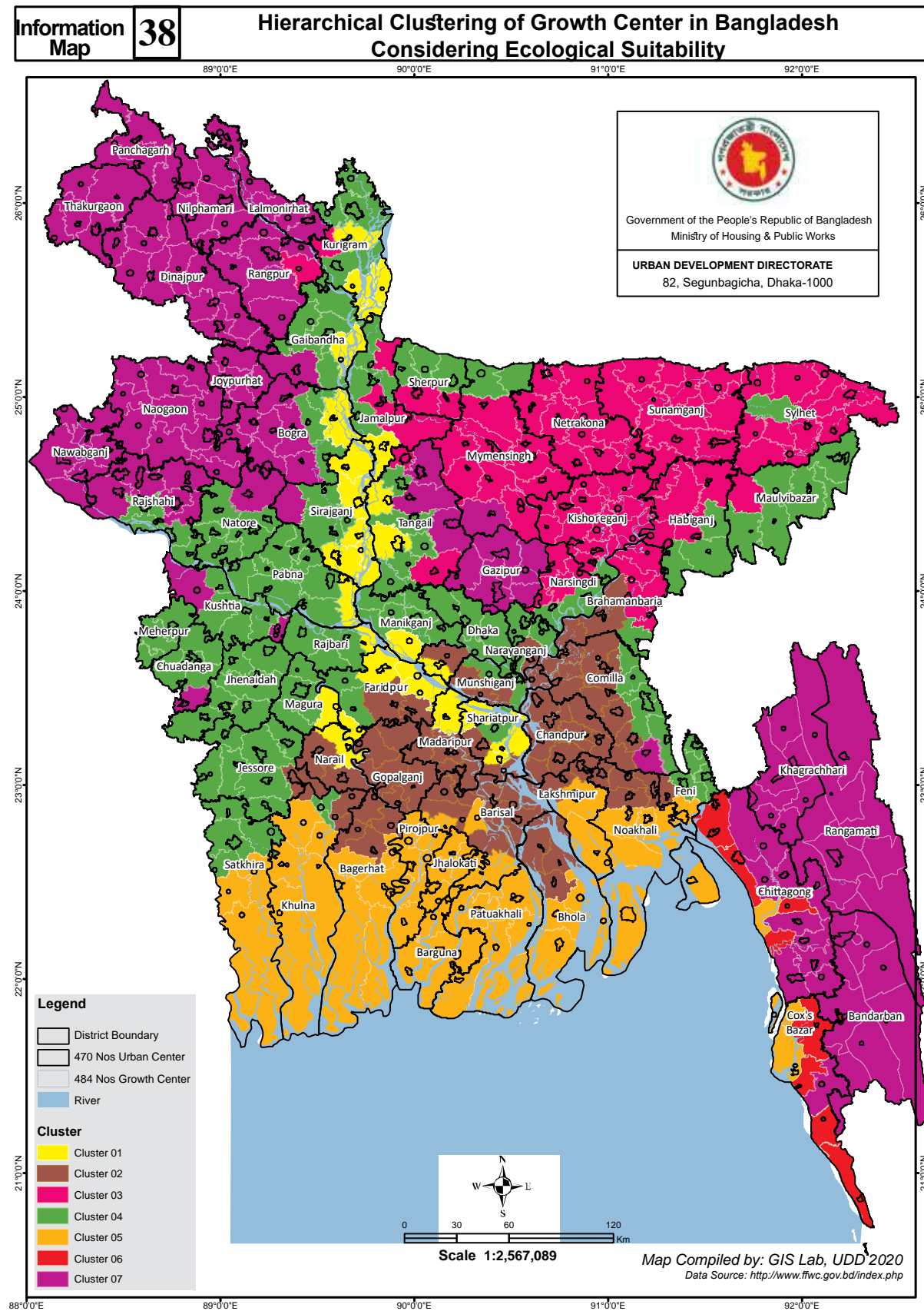
Ecological Clustering of growth center

So far this study accommodated, visualized and analyzed 29 different data. Two case studies show their reliability on two major events that affected the nation recently. Now, the question is how these data can be utilized for a national land use planning or how they can provide meaningful inputs in policy formation at national level. Among a lot of possibilities clustering of growth center is most viable option. Hierarchical clustering and k-means clustering are most dominant and widely used methods for machine learning and artificial intelligence application from database. Urban planning now a day is highly dependent on these cutting age technology, especially in mega cities. This study applies hierarchical clustering method based on 18 ecological data and divide 484 growth centers in to 7 most homogeneous cluster. It is the first attempt to do such exercise on all growth centers of Bangladesh in the field of planning. Despite its limitations output of this clustering is quite similar to the land formation of the country. There are about 75 dummy variables under these 18 ecological variables. So, clustering based on those dummy variables will provide better output. These exercise conducted on 18 ecological variables considering the limitations. As like as SUG this cluster are group of growth centers with most identical ecological character.



Graph 11 : Heatmap Generated from Growth Center Suitability Index in Bangladesh Considering 18 Ecological Variables





Clustering Map of growth center

This map is spatial representation of clustering output. Interpretation of this map is growth centers in a cluster has minimum dissimilarities considering all 18 variables. So it can be said that ecological policy requirement will be same for all growth centers in each cluster. Sus as cluster 5 represents costal area, cluster 7 represents highland area, cluster 1 represents river side area, cluster 2 represents lower depression area, cluster 3 represents haor adjustment area, cluster 6 represents costal highland and rest are included in cluster 4. This technique is highly utilized in zoning of megacities like Dhaka where variables are widely heterogeneous. The team associated with this study will expand this technique over infrastructure-service variables as well as economic variables in future. The team will be happy to share their experiences with other institutes including researchers and students. The team also appreciates criticism, comments and suggestion from any interested person or organization.

Table 24: Seven Cluster of Growth Center

Cluster	Name of Growth Center
Cluster 01	Alfadanga, Belkuchi, Bera, Bhedarganj, Bhuapur, Char Bhadrasan, Char Rajibpur, Chauhali, Chilmari, Damudya, Dohar, Faridpur Sadar, Fulchhari, Goalandaghat, Hari-rampur, Kazipur, Kurigram Sadar, Lohagara Narail, Mohammadpur, Raumari, Sadar-pur, sariakandi, Sarishabari, Shahjadpur, Shib Char, Sirajganj Sadar, Tangail Sadar, Zanjira
Cluster 02	Abhaynagar, Agailjhara, Ashuganj, Bagerhat Sadar, Banchharampur, Barisal Sadar (BCC), Barura, Begumganj (Chowmuhani), Bhanga, Bhola Sadar, Burhanuddin, Chandina, Chandpur Sadar, Chatkhil, Chitalmari, Daganbhuiyan, Daudkandi, Daulat Khan, Debidwar, Fakirhat, Faridganj, Gaurnadi, Gazaria, Gopalganj Sadar, Gosairhat, Haim-char, Haziganj, Hizla, Homna, Kachua Chandpur, Kalia, Kalkini, Kashiani, Kotalipa-ara, Laksam, Lohajang, Madaripur Sadar, Matlab Dakshin, Matlab Uttar (Sengarchar), Meghna, Mehendiganj, Mollahat, Monoharganj, Muksudpur, Muladi, Muradnagar, Nabinagar, Nagarkanda, Narail Sadar, Nawabganj Dhaka, Phultala, Raipur, Rajoir, Ramganj, Rupsa, Senbagh, Shahrasti, Shariatpur Sadar, Sonaimuri, Sonargaon, Sreen-agar, Terokhada, Titash, Tongibari, Tungipara, Wazirpur

Cluster 03	<p>Ajmiriganj, Akhaura, Atpara, Austagram, Bajitpur, Bakshiganj, Balaganj, Baniachong, Barhatta, Beanibazar, Belabo, Bishwambarpur, Bishwanath, Brahmanbaria Sadar, Chhatak, Companiganj Sylhet, Derai, Dhanbari, Dharampasha, Dowarabazar, Durgapur Netrakona, Fenchuganj, Fulbaria, Gaffargaon, Gauripur, Ghorashal (Palash), Golabganj, Gowainghat, Habiganj Sadar & Shayestaganj, Hossainpur, Ishwarganj, Itna, Jagannathpur, Jaintiapur, Jamalganj, Jamalpur Sadar, Kalmakanda, Kanaighat, Karimganj, Katiadi, Kendua, Khaliajuri, Kishoreganj Sadar, Kuliar Char, Lakhai, Madan, Manohardi, Maulvi Bazar Sadar, Melandaha, Mirzapur, Mithamain, Mohanganj, Muktagachha, Mymensingh Sadar (MCC), Nabiganj, Nakla, Nandail, Nasirnagar, Netrokona Sadar, Nikli, Pakundia, Phulpur, Pirgachha, Purbadhala, Rajarhat, Sarail, Sherpur Sadar, Shibpur, South Sunamganj, South Surma (Sylhet CC), Sulla, Sunamganj Sadar, Tahirpur, Tarail, Trishal, Zakiganj</p>
Cluster 04	<p>Alamdanga, Araihasar, Atgharia, Bagati Para, Bagha & Arani, Bagherpara, Bahubal, Balia Kandi, Bandar (NCC) & Tarabo, Baraigram & Banpara, Barlekha, Basail, Benapole (Sharsha), Bhairab, Bhangura, Bheramara, Bhurungamari, Boalmari, Brahman Para, Burichang, Charchat, Chatmohar, Chauddagam, Chaugachha, Chhagalnaiya, Chuadanga Sadar, Chunarughat, Cumilla Sadar (Cumilla CC), Darshana (Damurahuda), Daulatpur Manikganj, Debhata, Delduar, Dewanganj, Dhaka City (DNCC & DSCC), Dhamrai, Dhobaura, dhunat, Dighalia, Faridpur, Feni Sadar, Fulgazi, gabtali, Gaibandha Sadar, Gangni, Ghior, Gopalpur, Gopalpur (Lalpur), Gurudaspur, Haluaghat, Harinakunda, Ishwardi, Islampur, Jashore Sadar, Jhenaidaha Sadar, Jhenaigati, Jhikargachha, Juri, Kalaroa, Kaliganj Jhenaidah, Kalihati, Kamalganj, Kamarkhanda, Kasba, Keraniganj, Keshabpur, Khan Jahan Ali (KCC), Khulna Sadar (KCC), Kotchandpur, Kulaura, Kumarkhali, Kushtia Sadar, Madarganj, Madhabpur, Madhukhali, Magura Sadar, Maheshpur, Manikganj Sadar, Manirampur, Meherpur Sadar, Mirpur Kushtia, Mujibnagar, Munshiganj Sadar & Mirkadim, Nagarpur, Nageshwari, Nalitabari, Narayanganj Sadar (NCC) & Shiddhirganj, Naria, Narsingdi Sadar & Madhabdi, Natore Sadar & Naldanga, Pabna Sadar, Palashbari, Pangsha, Parshuram, Phulbari, Poba & Katakhal & Noahata, Rajbari Sadar, Rajnagar, Rajshahi Sadar (RCC), Raypura, Royganj, Rupganj & Kanchan, Sadullapur, Saghatta, Santhia, Satkhira Sadar, Sauria, Savar, Serajdikhan, Shailkupa, Shalikhah, Shibalaya, Singair, Sonatola, South Cumilla (Cumilla CC), Sreebardi, Sreemangal, Sreepur Magura, Sujanagar, Sundarganj, Sylhet Sadar (Sylhet CC), Tala, Ulipur, Ullah Para</p>

Cluster 05	<p>Amtali, Assasuni, Babuganj, Bakerganj, Bamna, Banaripara, Barguna Sadar, Batiaghata, Bauphal, Betagi, Bhandaria, Chalna (Dacope), Char Fasson, Chattogram City (CCC), Companiganj (Bashurhat) Noakhali, Dashmina, Dumki, Dumuria, Galachipa, Hatiya, Jhalokati Sadar, Kabirhat, Kachua Bagerhat, Kalapara & Kuakata, Kaliganj Satkhira, Kanthalia, Kawkhali Pirojpur, Koyra, Kutubdia, Lakshmipur Sadar, Lalmohan, Maheshkhali, Manpura, Mathbaria, Mirzaganj, Mongla, Morrelganj (Zianagar) Pirojpur, Morrelganj Bagerhat, Nalchity, Nazirpur, Nesarabad (Swarupkati), Noakhali Sadar, Paikgachha, Patharghata, Patuakhali Sadar, Pekua, Pirojpur Sadar, Rajapur, Ramgati, Rampal, Sandwip, Sarankhola, Shyamnagar, Sonagazi, Subarnachar, Tazumuddin</p>
Cluster 06	<p>Anowara, Boalkhali, Chakaria, Cox's Bazar Sadar, Mirsharai (Baraiarhat), Sitakunda, Teknaf, Ukhia</p>
Cluster 07	<p>Adamdighi, Aditmari, Akkelpur, Alikadam, Atrai, Atwari, Badalgachhi, Badarganj, Baghai Chhari, Baliadangi, Bandarban Sadar, Banskhali, Barkal, Belai Chhari, Bhabaniganj (Baghmara) & Tahirpur, Bhaluka, Bholahat, Biral, Birampur, Birganj, Bochaganj (Setabganj), Boda, Bogura Sadar, Chandanaish, Chirirbandar, Daulatpur Kushtia, Debiganj, Dhamoirhat, dhupchanchia, Dighinala, Dimla, Dinajpur Sadar, Domar, Durgapur Rajshahi, Fatikchhari, Fulbari, Gangachara, Gazipur Sadar (GCC & Tongi), Ghatail, Ghoraghat, Gobindaganj, Godagari & Kakanhat, Hakimpur, Haragacha (Kaulnia), Haripur, Hathazari, Hatibandha, Jaldhaka, Jibannagar, Joypurhat Sadar, Jurai Chhari, kahaloo, Kaharole, Kalai, Kaliakair, Kaliganj Gazipur, Kaliganj Lalmonirhat, Kapasia, Kaptai, Kawkhali Rangamati, Kesharhat (Mohanpur), Khagrachhari Sadar, Khansama, Khetlal, Khoksa, Kishoreganj, Lakshmichhari, Lalmonirhat Sadar, Lama, Langadu, Lohagara Chittagong, Madhupur, Mahadebpur, Mahalchhari, Manda, Manikchhari, Matiranga, Mitha Pukur, Nachole, Naikhongchhari, nandigram, Nangalkot, Naniarchar, Naogaon Sadar, Nawabganj Dinajpur, Nawabganj Sadar, Nazipur (Patnitala), Niamatpur, Nilphamari Sadar, Panchagarh Sadar, Panchbibi, Panchhari, Parbatipur, Patgram, Patiya, Pirganj Rangpur, Pirganj Thakurgaon, Porsha, Puthia, Rahanpur (Gomastapur), Rajasthali, Ramgarh, Ramu, Rangamati Sadar, Rangpur Sadar (Rangpur CC), Rangunia, Raninagar, Ranisankail, Raozan, Rowangchhari, Ruma, Saidpur, Sakhipur, Sapahar, Satkania, Shajahanpur (Majhira) Bogra, sherpur, Shibganj Bogra, Shibganj Nawabganj, Singra, Sreepur Gazipur, Tanore & mundumala, Taraganj, Tarash, Tentulia, Thakurgaon Sadar, Thanchi</p>



Kaptai Lake
Bandarban District

Picture collected from internet



Boga Lake
Bandarban District

Picture collected from internet

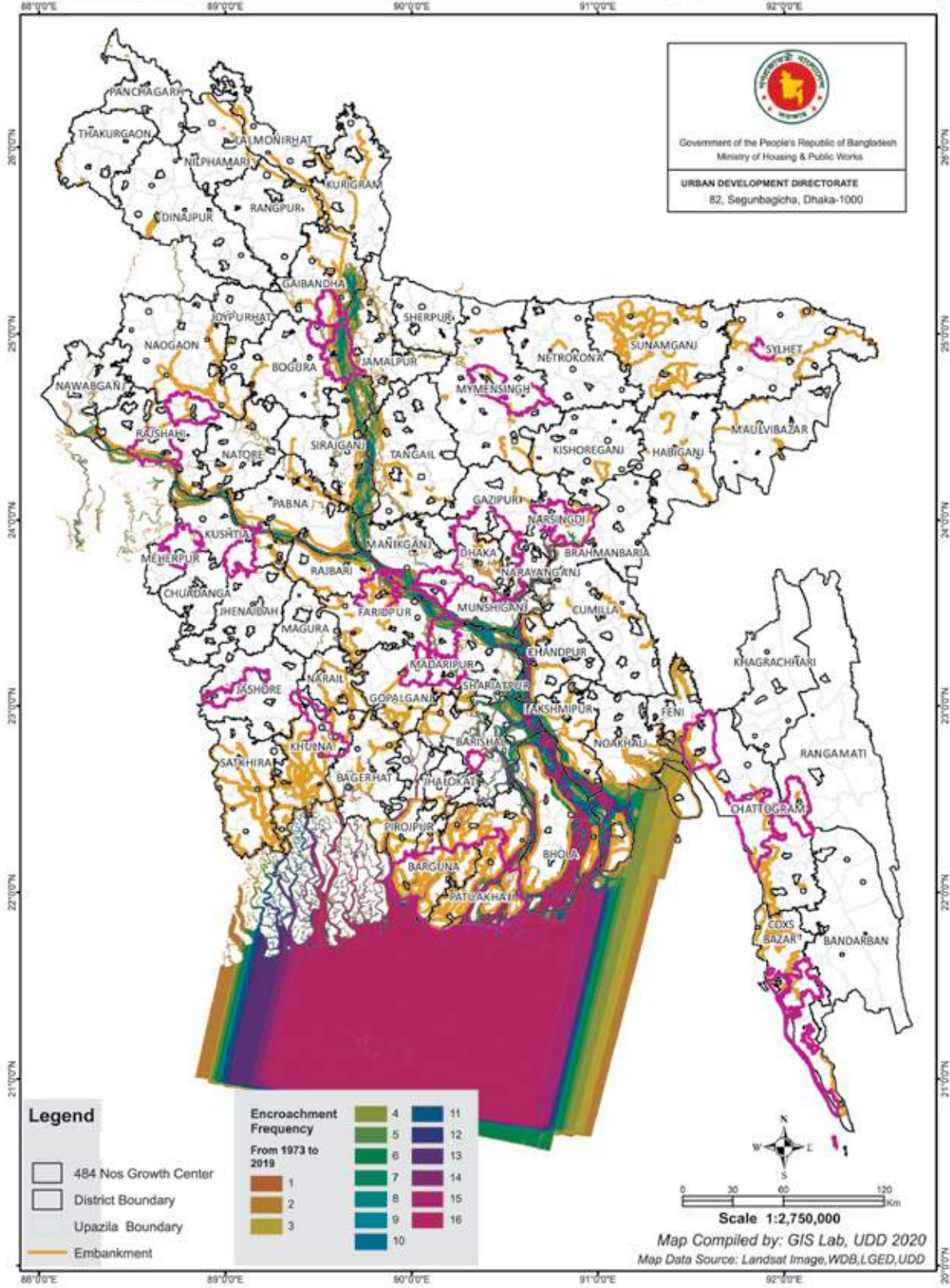


River of Bangladesh
Baghra Upazila, Munshiganj District

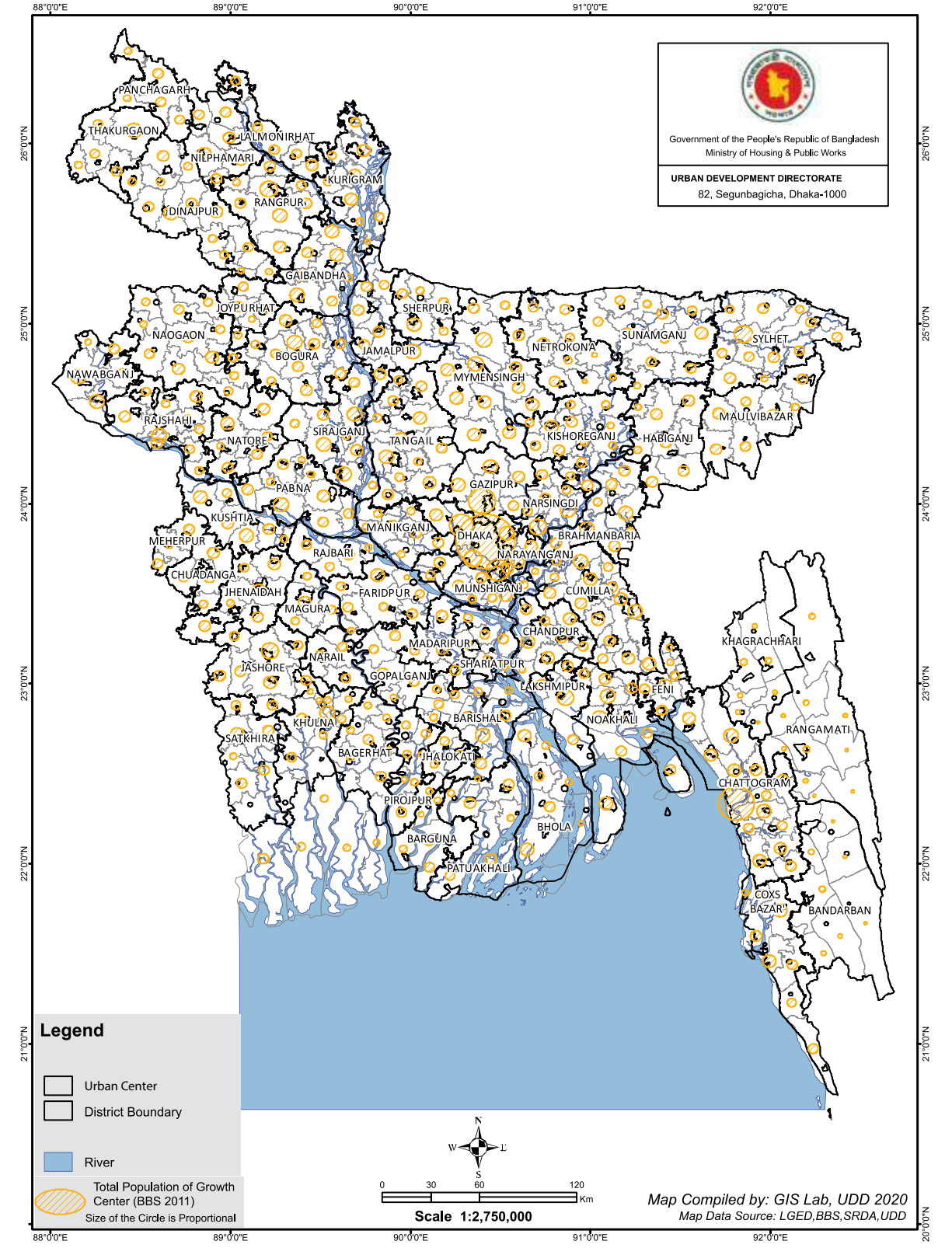
Picture collected from internet

Annexure

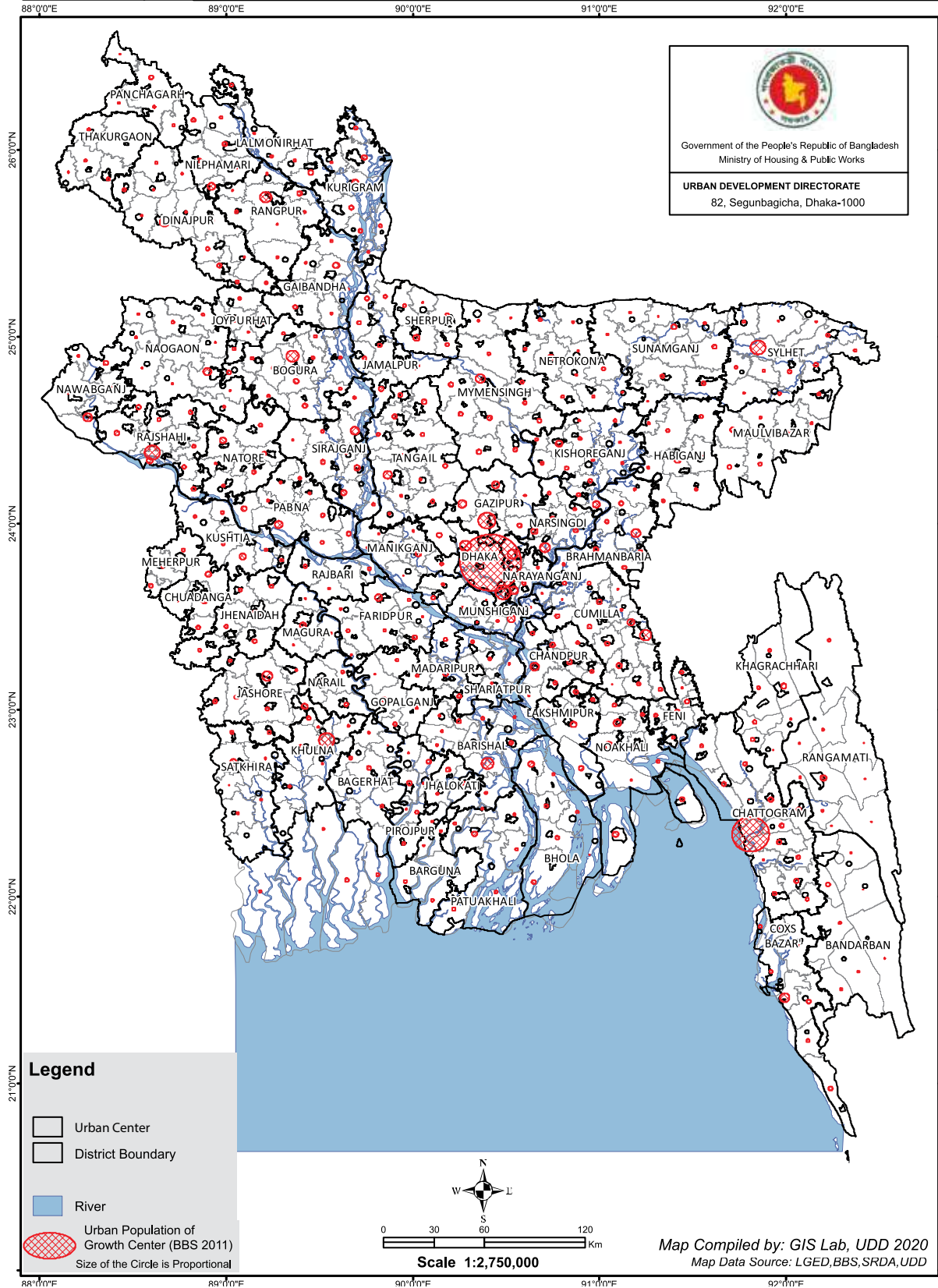
Information Map 39 Embankment and Historical Riverine Displacement in Bangladesh (Based on Satellite Image)



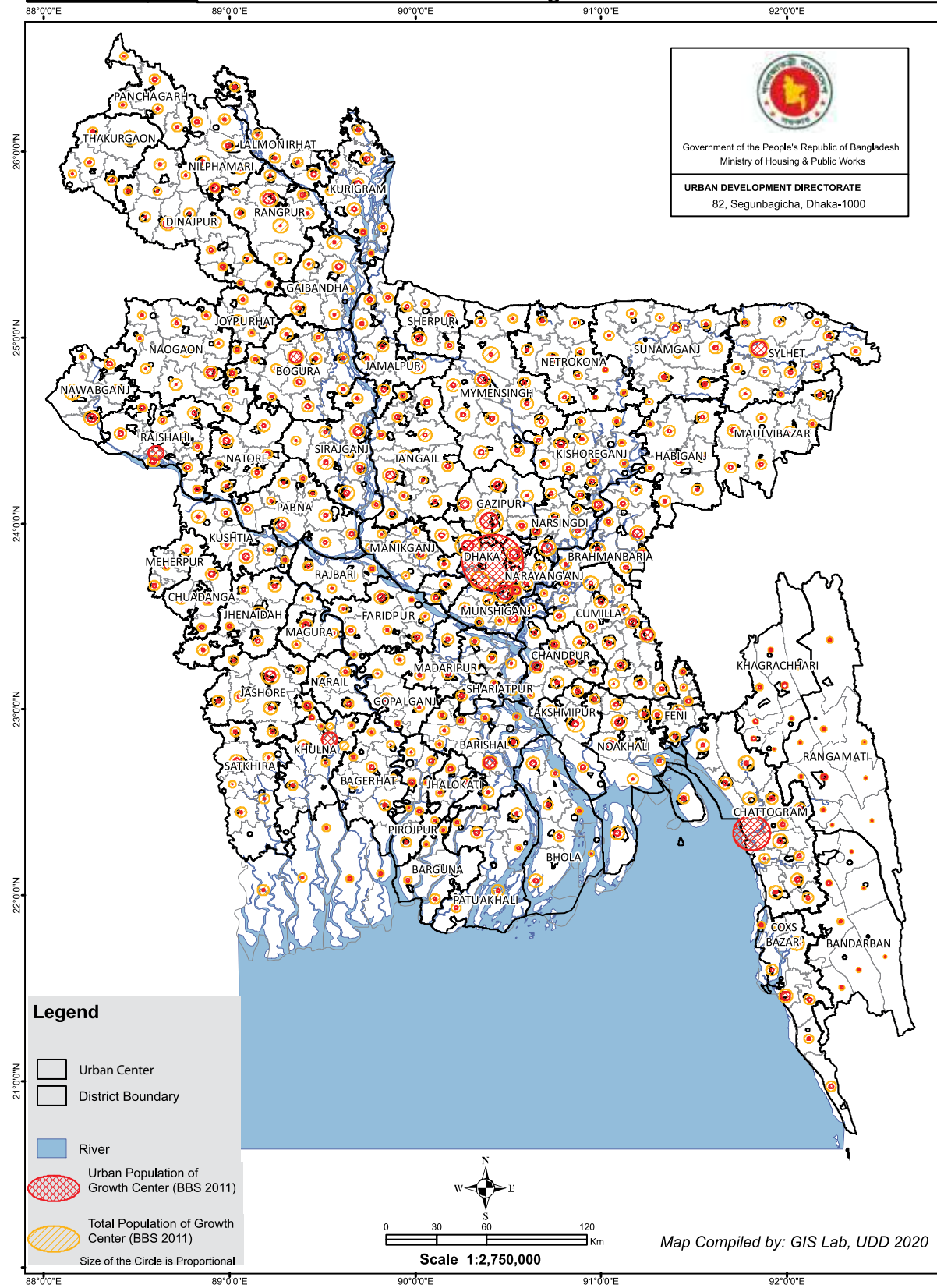
Information Map 40 Total Population of Growth Center in Bangladesh



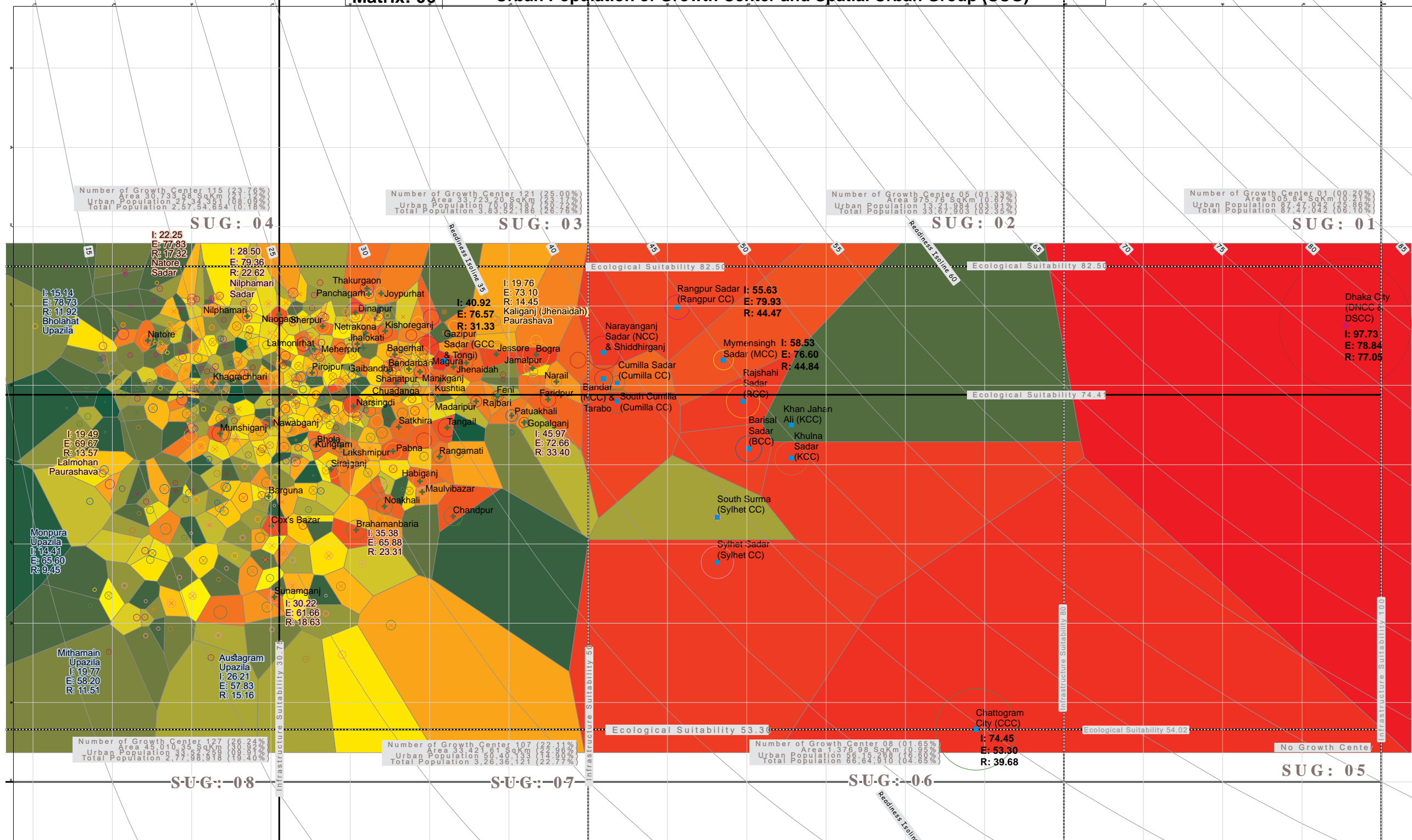
Information Map 41 **Urban Population of Growth Center in Bangladesh**



Information Map 42 **Urban Population and Total Population of Growth Center in Bangladesh**



Matrix: 06 Urban Population of Growth Center and Spatial Urban Group (SUG)



Size of the circle represent urban population of growth center

I: infrastructure-Service Suitability
E: Ecological Suitability
R: Readiness Score

Representing Urban Population
Low 1,023 Monpura High 87,47,042 Dhaka City

City Corporation Name
District HQ Name
Paurashava Name
Upazila Name

Legend

Administration Type
Capital
City Corporation HQ
District_HQ
Paurashava_HQ
Upazila_HQ
Readiness_Iso_Quant_Line

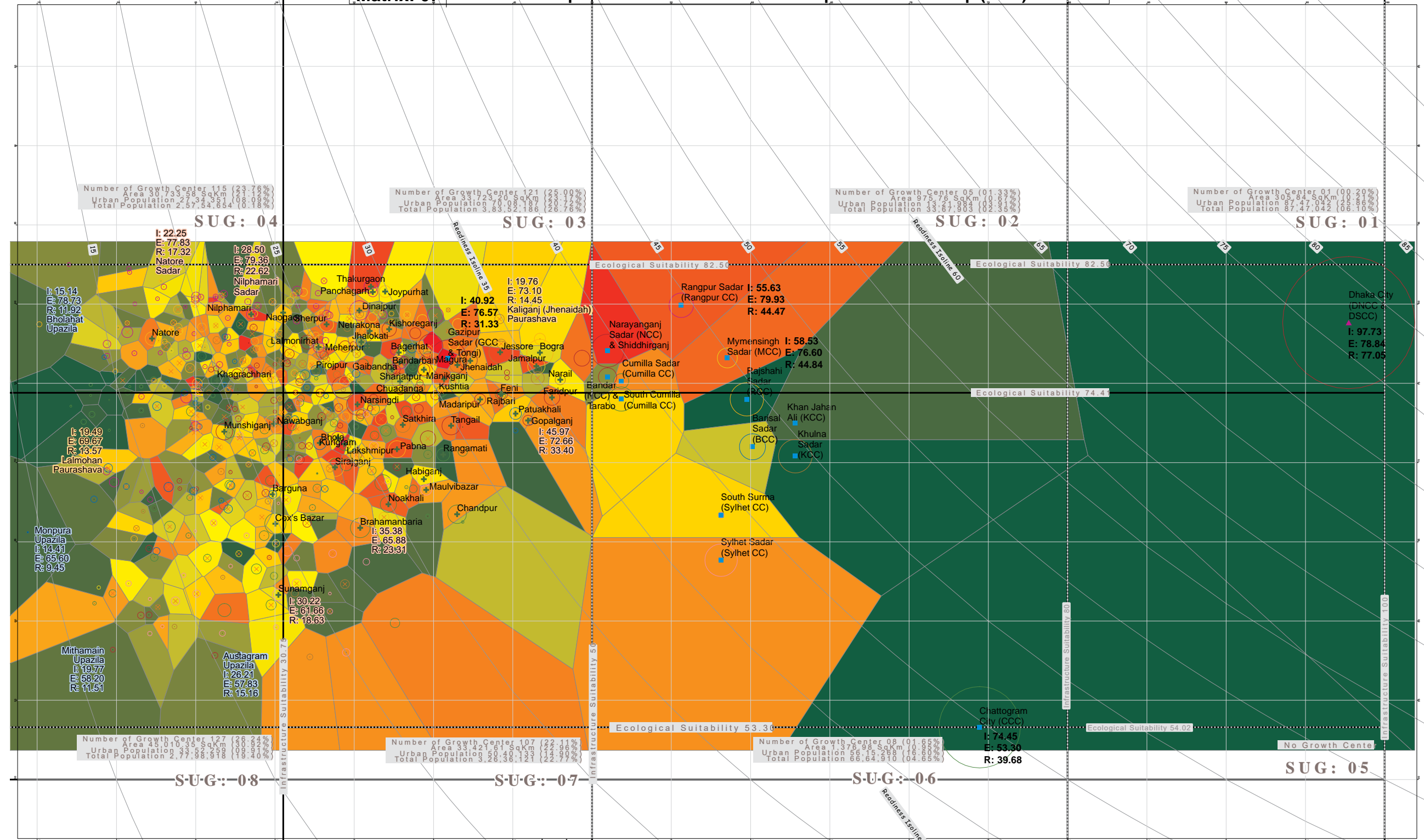
Ecological Suitability 00
Ecological Suitability 100
Ecological Suitability 50
Ecological Suitability 53.30
Ecological Suitability 74.41
Ecological Suitability 82.50

Infrastructure-Service Suitability 00
Infrastructure-Service Suitability 30.75
Infrastructure-Service Suitability 80
Infrastructure-Service Suitability 100
Infrastructure-Service Suitability 50

Division

10 Barisal
20 Chattogram
30 Dhaka
40 Khulna
50 Rajshahi
60 Rangpur
70 Sylhet
80 Mymensingh

Matrix: 07 Rural Population of Growth Center and Spatial Urban Group (SUG)



Number of Growth Center 115 (23.76%)
 Area 30,733.58 SqKm (21.10%)
 Urban Population 27,343,591 (81.00%)
 Total Population 33,511,866

Number of Growth Center 121 (25.00%)
 Area 33,723.20 SqKm (23.17%)
 Urban Population 76,088,187 (90.72%)
 Total Population 83,871,186

Number of Growth Center 05 (01.33%)
 Area 875.76 SqKm (0.61%)
 Urban Population 3,361,904 (4.00%)
 Total Population 83,871,186

Number of Growth Center 01 (00.20%)
 Area 305.84 SqKm (0.21%)
 Urban Population 87,47,042 (25.89%)
 Total Population 335,111,866

Number of Growth Center 127 (25.40%)
 Area 45,010.10 SqKm (31.40%)
 Urban Population 3,740,000 (11.28%)
 Total Population 33,111,866

Number of Growth Center 107 (21.83%)
 Area 33,421.61 SqKm (23.42%)
 Urban Population 29,130,133 (34.73%)
 Total Population 83,871,186

Number of Growth Center 08 (01.60%)
 Area 1,375.98 SqKm (0.98%)
 Urban Population 66,15,263 (7.89%)
 Total Population 83,871,186

No Growth Center



I: Infrastructure-Service Suitability
 E: Ecological Suitability
 R: Readiness Score

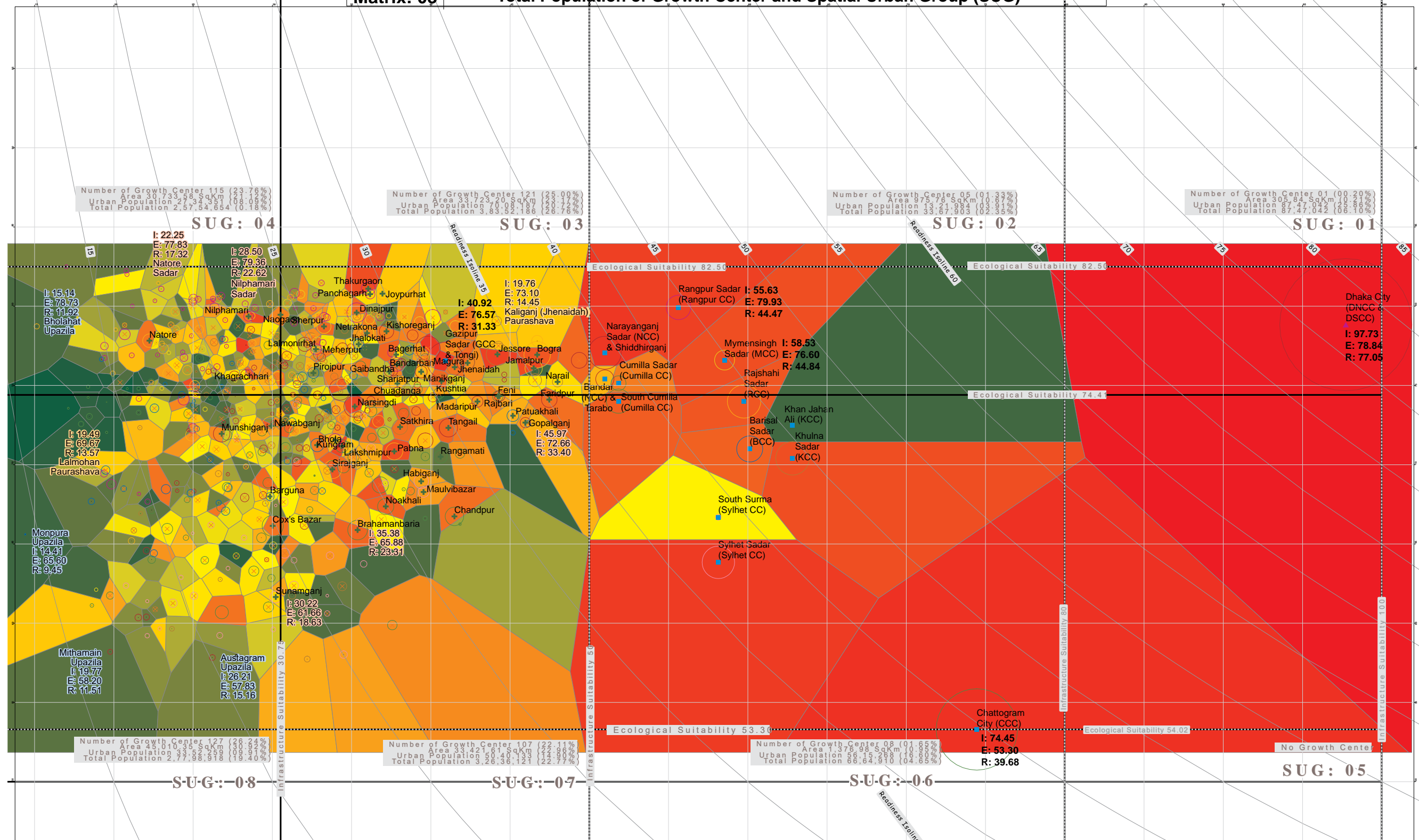
Representing Rural Population
 Size of the circle represent urban population of growth center
 City Corporation Name
 District HQ Name
 Paurashava Name
 Upazila Name

Legend
 Administration Type
 Capital
 City Corporation HQ
 District_HQ
 Paurashava_HQ
 Upazila_HQ
 Readiness_Iso_Quant_Line

Ecological Suitability 00
 Ecological Suitability 100
 Ecological Suitability 50
 Ecological Suitability 53.30
 Ecological Suitability 74.41
 Ecological Suitability 82.50
 Infrastructure-Service Suitability 00
 Infrastructure-Service Suitability 30.75
 Infrastructure-Service Suitability 80
 Infrastructure-Service Suitability 100
 Infrastructure-Service Suitability 50

Division
 10 Barishal
 20 Chattogram
 30 Dhaka
 40 Khulna
 50 Rajshahi
 60 Rangpur
 70 Sylhet
 80 Mymensingh

Matrix: 08 Total Population of Growth Center and Spatial Urban Group (SUG)



Number of Growth Center 115 (23.76%)
 Area 30,733.58 SqKm (21.19%)
 Urban Population 2,583,435 (8.09%)
 Total Population 2,57,54,654 (0.18%)

Number of Growth Center 121 (25.00%)
 Area 33,723.70 SqKm (23.17%)
 Urban Population 70,081 (2.27%)
 Total Population 3,83,92,186 (1.28.76%)

Number of Growth Center 05 (01.33%)
 Area 875.76 SqKm (0.61%)
 Urban Population 1,27,934 (0.39%)
 Total Population 3,27,803 (0.11%)

Number of Growth Center 01 (00.20%)
 Area 305.64 SqKm (0.21%)
 Urban Population 87,474 (2.69%)
 Total Population 3,27,803 (0.10%)

Number of Growth Center 127 (25.82%)
 Area 45,010.35 SqKm (31.60%)
 Urban Population 33,835,998 (10.66%)
 Total Population 3,17,96,918 (10.40%)

Number of Growth Center 107 (22.11%)
 Area 33,421.61 SqKm (23.60%)
 Urban Population 50,40,403 (15.69%)
 Total Population 3,26,36,121 (10.60%)

Number of Growth Center 08 (01.60%)
 Area 1,378.98 SqKm (0.98%)
 Urban Population 56,15,268 (16.86%)
 Total Population 3,33,66,910 (10.80%)

No Growth Center



Size of the circle represent urban population of growth center
 I: infrastructure-Service Suitability
 E: Ecological Suitability

Representing Total Population
 Low 23,67,421
 High 87,47,042
 Dhaka City
 City Corporation Name
 District HQ Name
 Paurashava Name

Legend
 Administration Type
 Capital
 City Corporation HQ
 District HQ
 Paurashava HQ
 Upazila HQ

Ecological Suitability 00
 Ecological Suitability 100
 Ecological Suitability 50
 Ecological Suitability 53.30
 Ecological Suitability 74.41
 Ecological Suitability 82.50

Infrastructure-Service Suitability 00
 Infrastructure-Service Suitability 30.75
 Infrastructure-Service Suitability 80
 Infrastructure-Service Suitability 100
 Infrastructure-Service Suitability 50

Division
 10 Barishal
 20 Chattogram
 30 Dhaka
 40 Khulna
 50 Rajshahi
 60 Rangpur
 70 Sylhet
 80 Mymensingh