ASSESSEMENT OF GROUNDWATER VULNERABILITY IN YANGON CITY, MYANMAR

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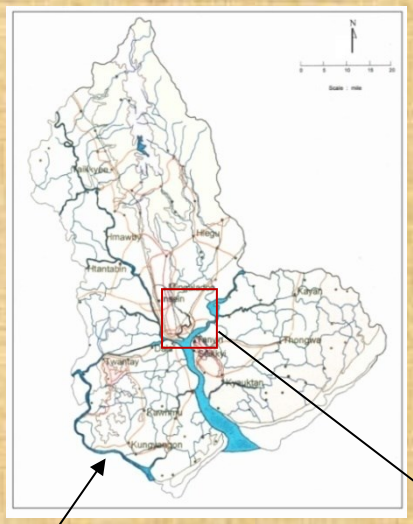
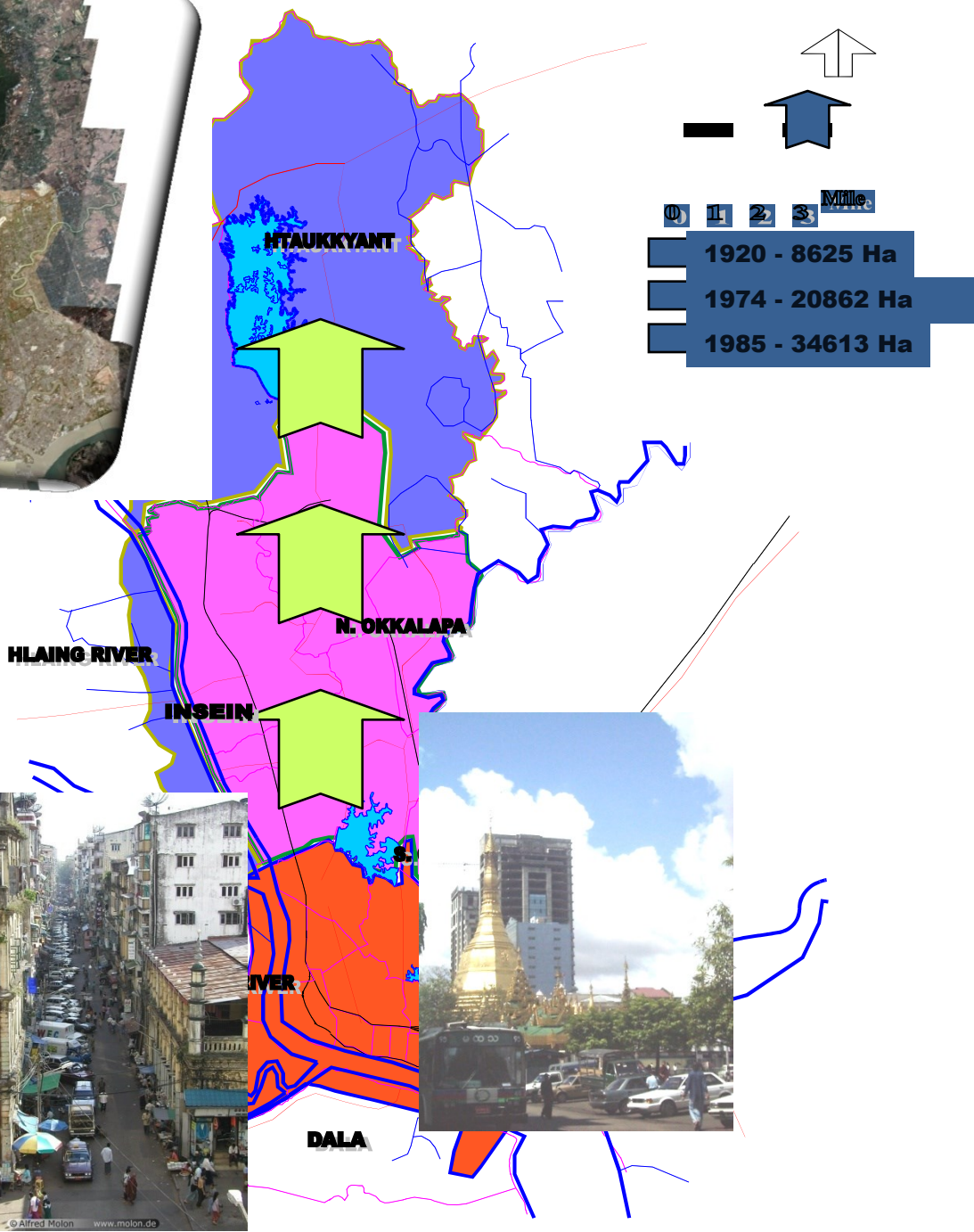
YCDC Area



Yangon Division

Union of Myanmar

URBAN PLANNING HISTORY OF YANG

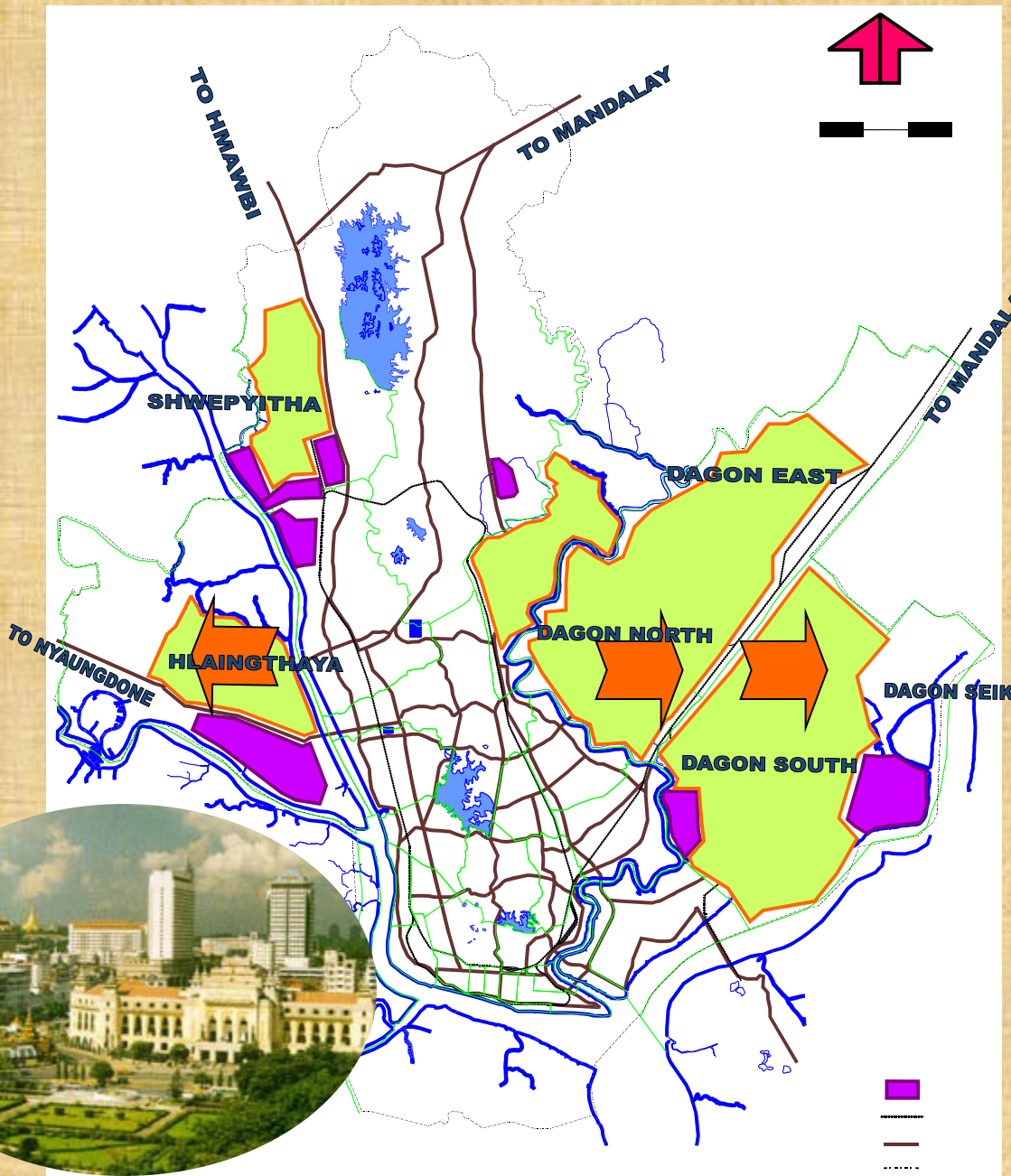


It had expanded gradually in N-S direction in 1960s and 1980s

Source: Hlaing Maw Oo, 2007

URBAN PLANNING HISTORY OF YANGON

- rapidly in E-W direction . developing new suburbs in 1990s through the present time.
- in an attempt to balance the elongated south to north growth of the city limits, development of new towns in the east and west



Source: Hlaing Maw Oo, 2007

Types of water resources in Yangon area

1.Surface water

Reservoirs

- Gyobyu (started from 1940)
- Hlawga (started from 1906)
- Phugyi (started from 1992)
- Ngamoeyeik (started from 2007)

Lakes and ponds

- Kandawgyi Lake (1879-1906)
- Innya Lake (1884-1906)

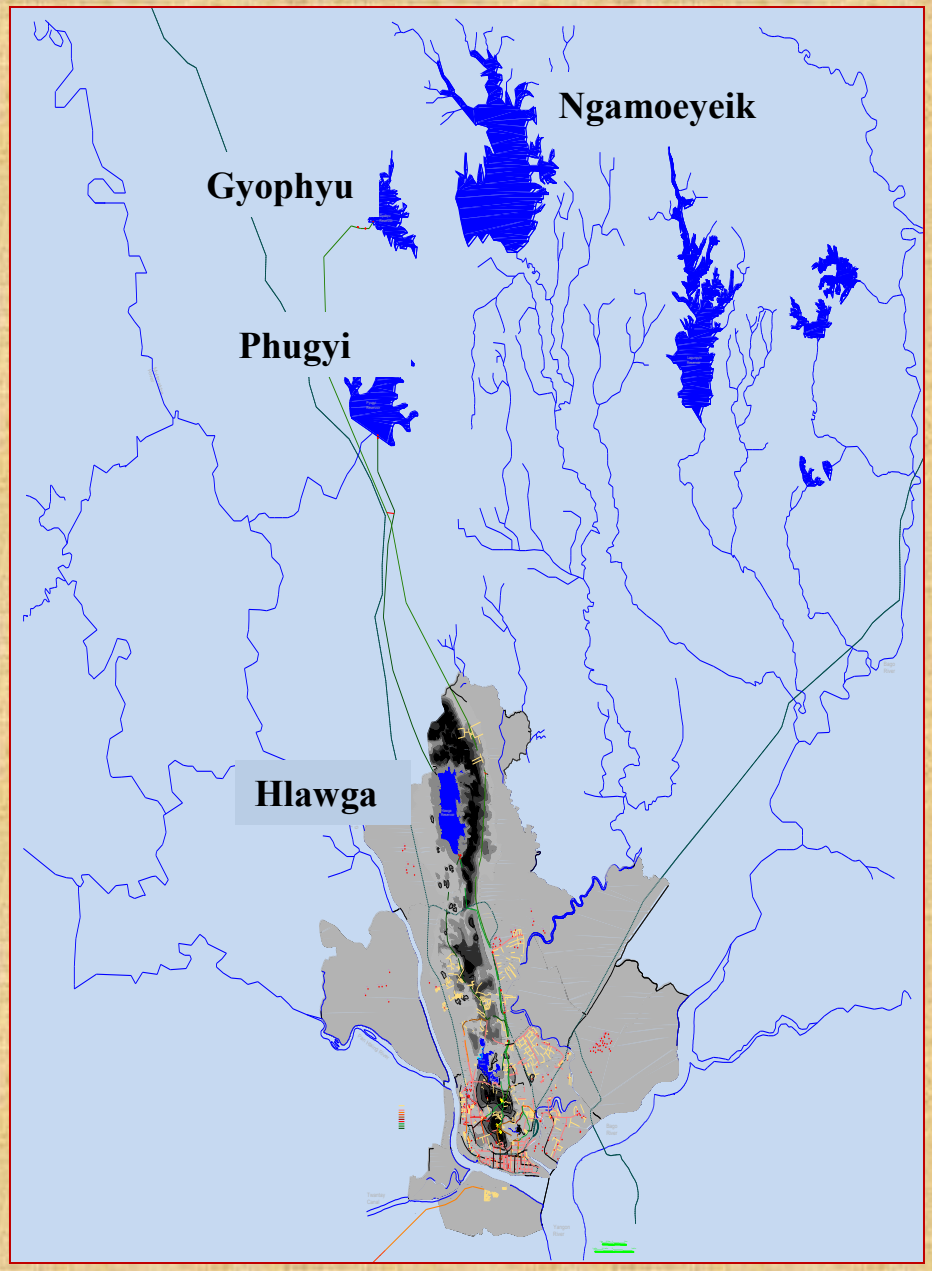
Lakes and ponds

2.Ground water

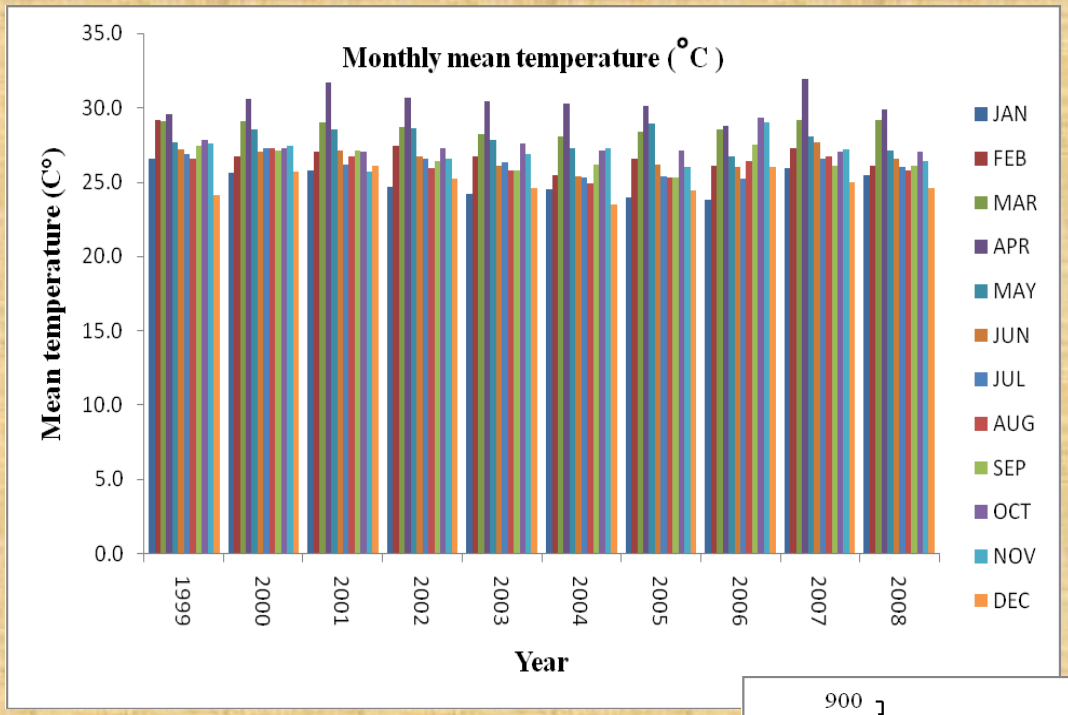
Open wells (hand-dug wells)

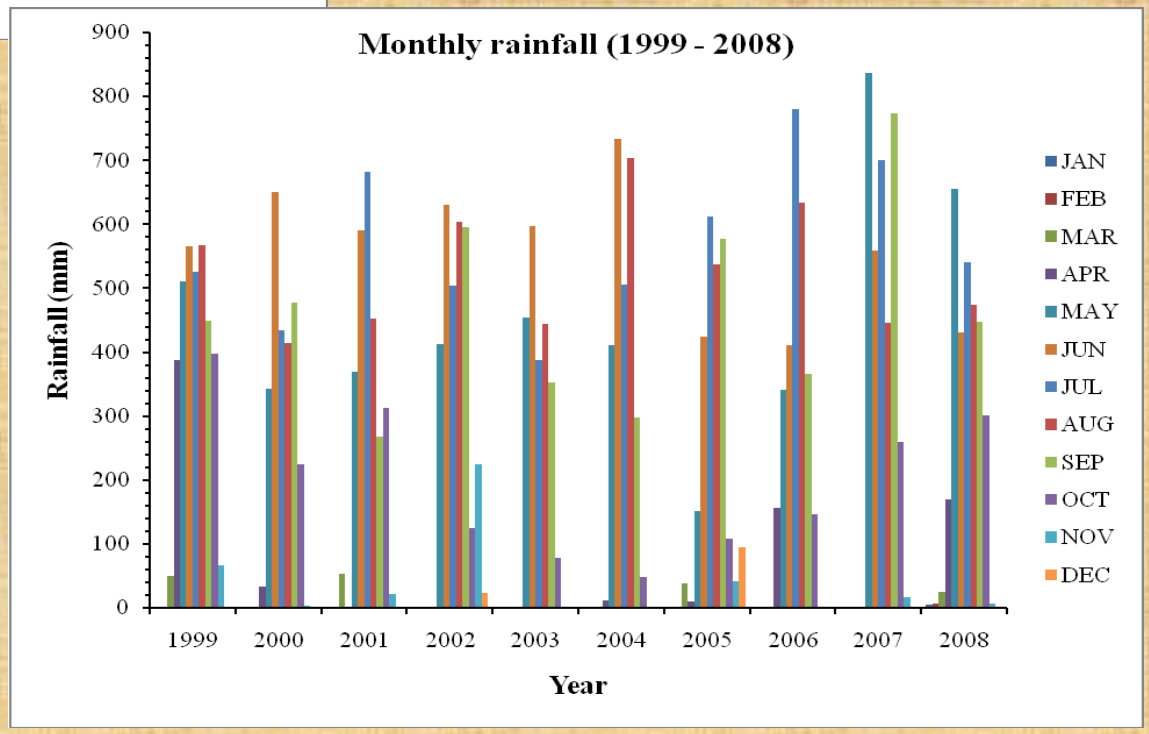
Tube wells

- ***30 wells (1842)***
- YCDC tube-wells

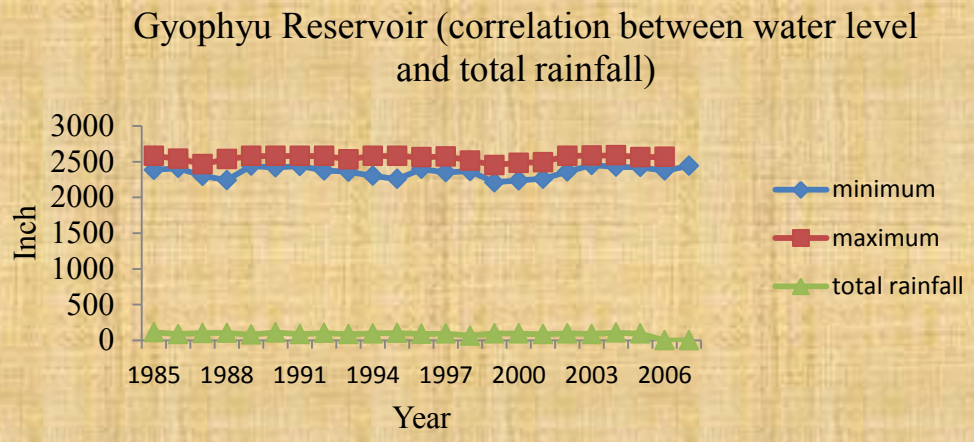


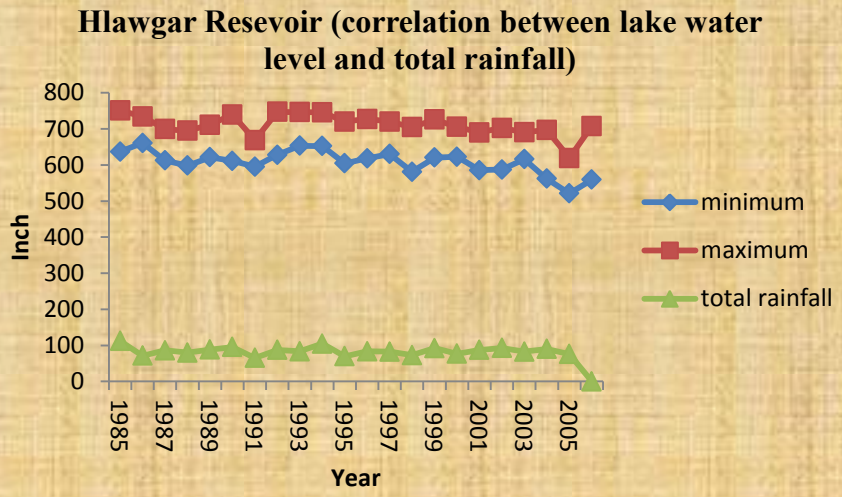
Monthly Temperature and Monthly Rainfall

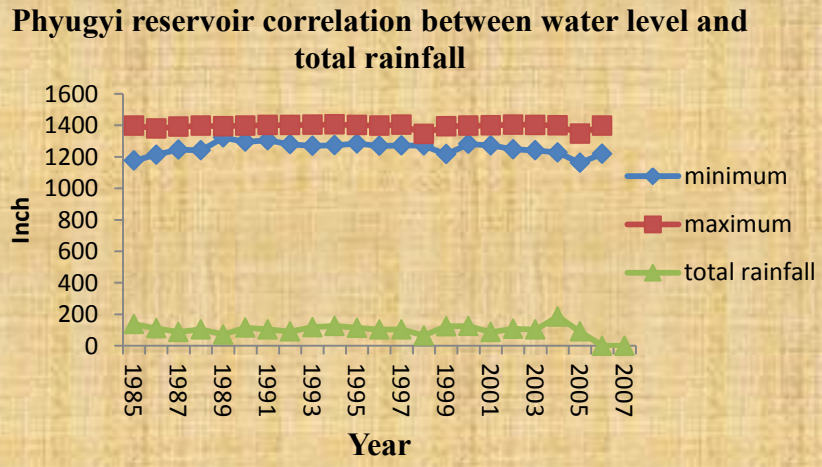




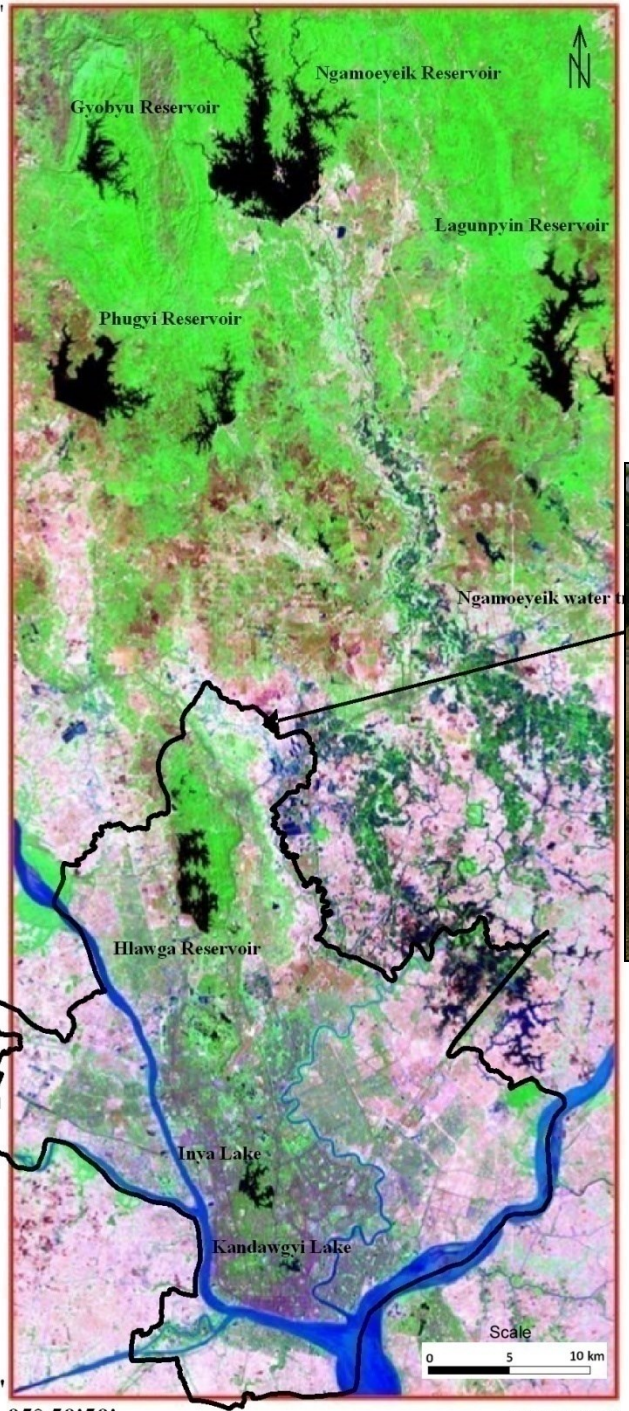
- Monthly mean temperature is essential in water usage
- Water demand in township is mainly depend upon variation of temperature







Correlation of water level and total rainfall

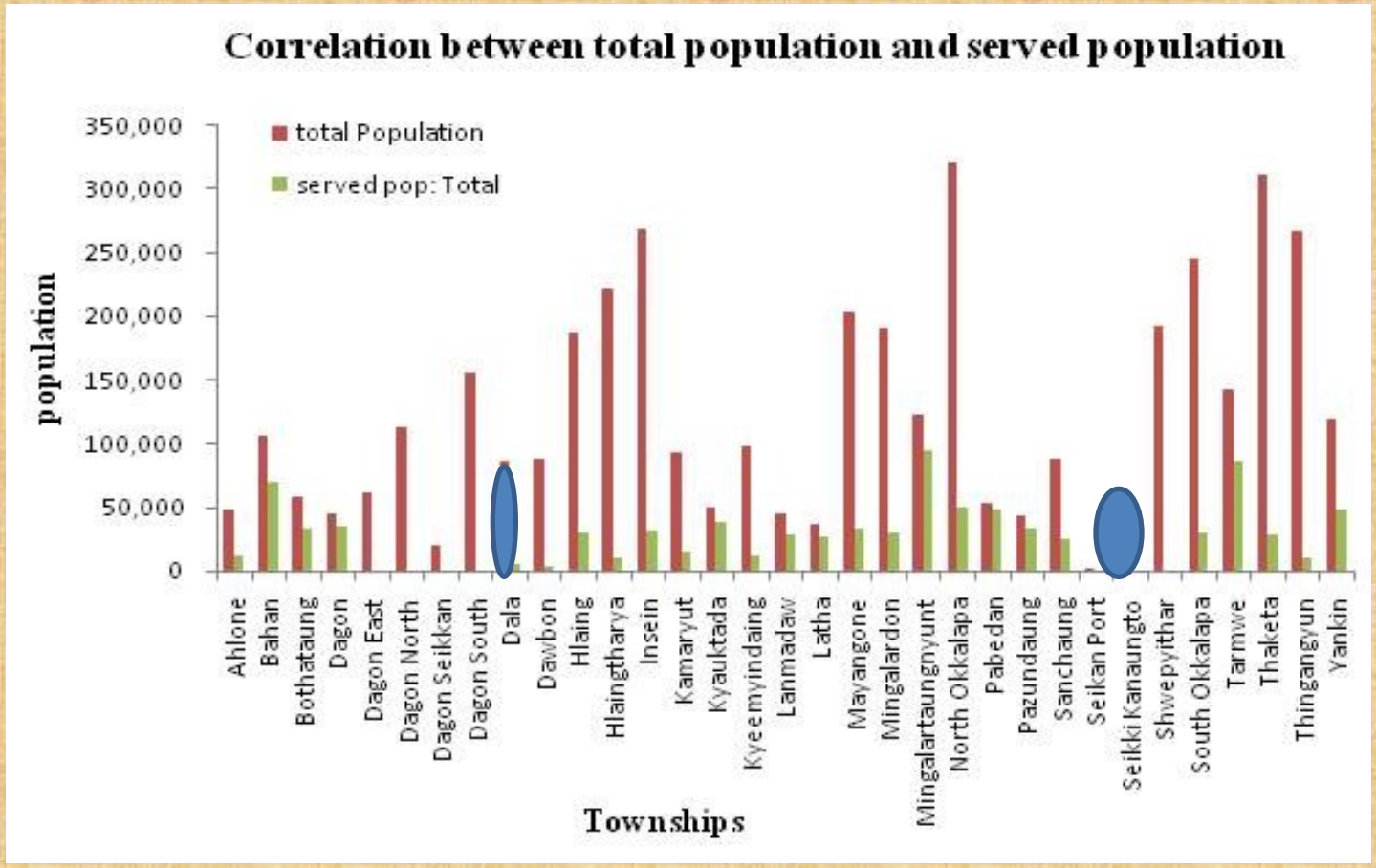

17° 27' 36"
Ngamoeyeik Reservoir
Gyobyu Reservoir
Lagunpyin Reservoir
Phugyi Reservoir
Ngamoeyeik water
Hlawga Reservoir
Inya Lake
Kandawgyi Lake
Scale
0 5 10 km
16° 43'47"
95° 59'59"
96° 20'48"


ရန်ကုန်မြို့တော်ရေပေးဝေရေးစီမံကိန်း(ငဒိုးရိပ်)
ရေသန့်စင်စက်ရုံ

Water supply in Yangon area (2010)

Water resources

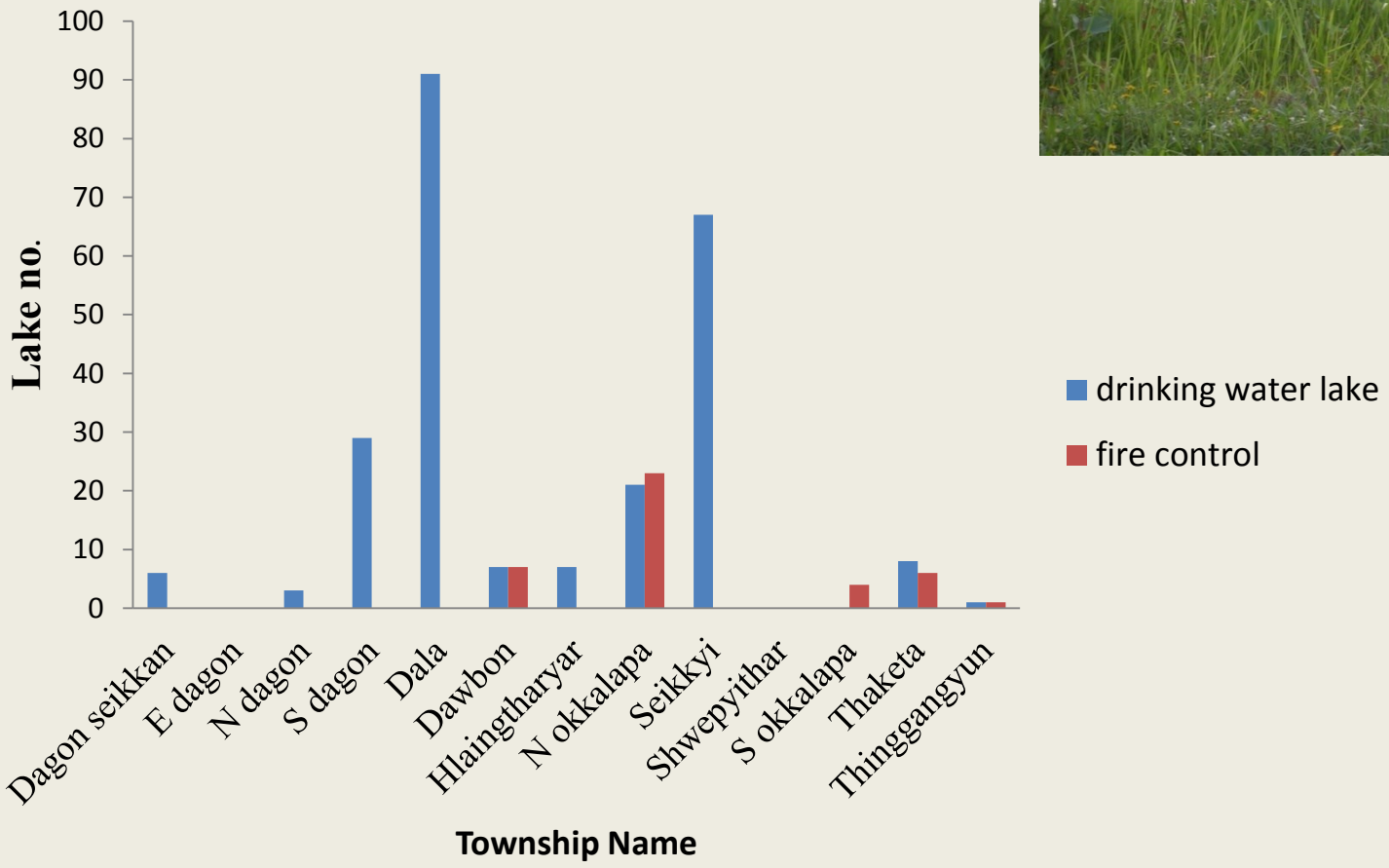
Surface water (reservoirs)	
• Gyobyu	27 MGD
• Phugyi	44 MGD
• Hlawga	14 MGD
• Ngamoeyeik	90 MGD
Ground water	
• About 400 tube wells over	20 MGD
• Lakes and ponds	
Total	over **195 MGD** **(Million gallon per day)**

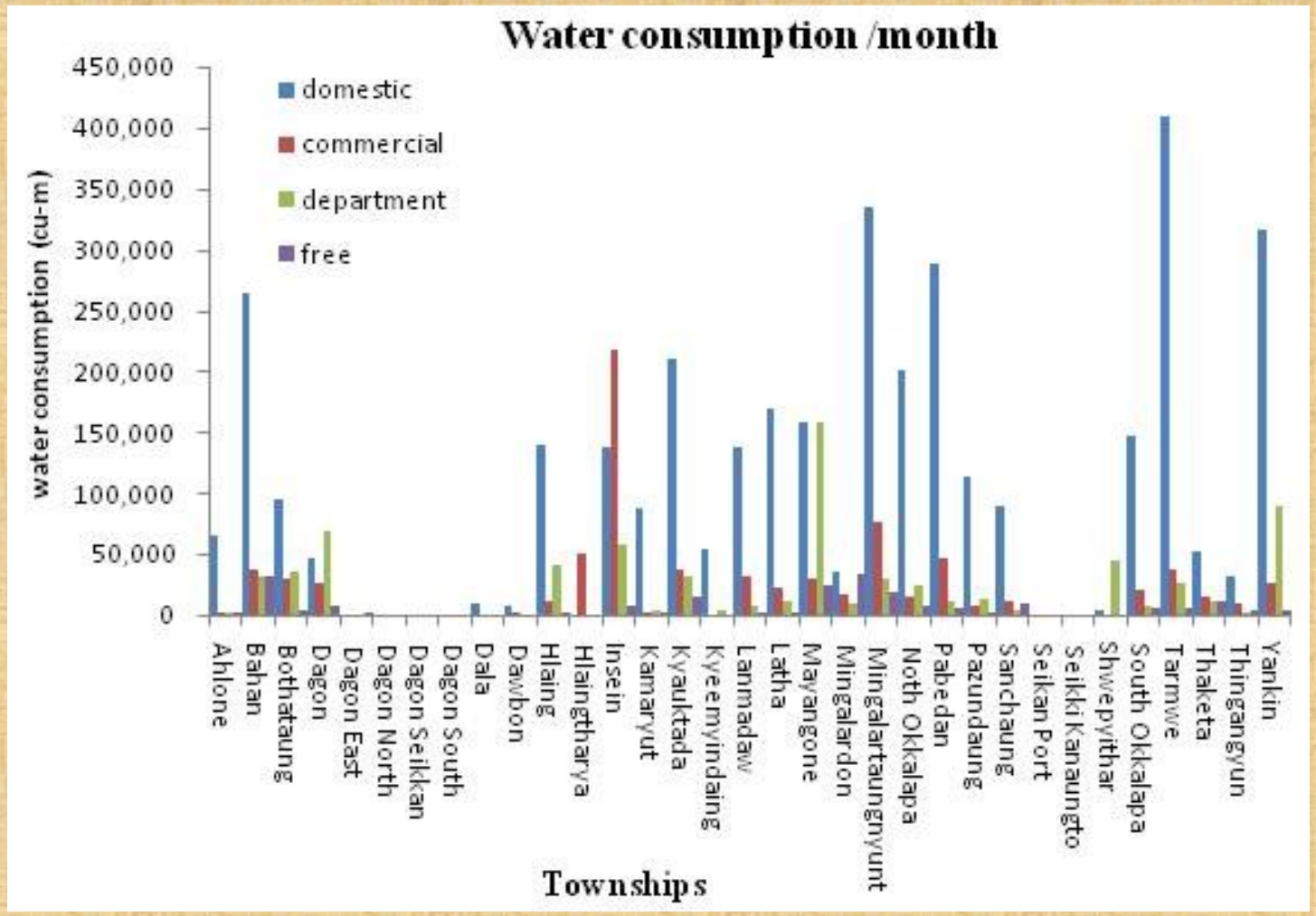


Depending on total population and served population data analysis every townships show the lack of water sufficiency. Half of total population of Bahan, Botahtaung, Dagon, Kyauktada, Lanmadaw, Latha, Mingalartaungnyunt, North Okkalapa, Pabedan, Pazundaung, and Tarmwe have access to YCDC water supply.

Ahlone, Hlaing, Hlaingtharyar, Insein, Kamaryut, Kyeemyintdaing, Mayangone, Mingalardon, North Okkalap, Sanchaung, South Okkalapa and Thaketa get only small amount of or limited water supply.

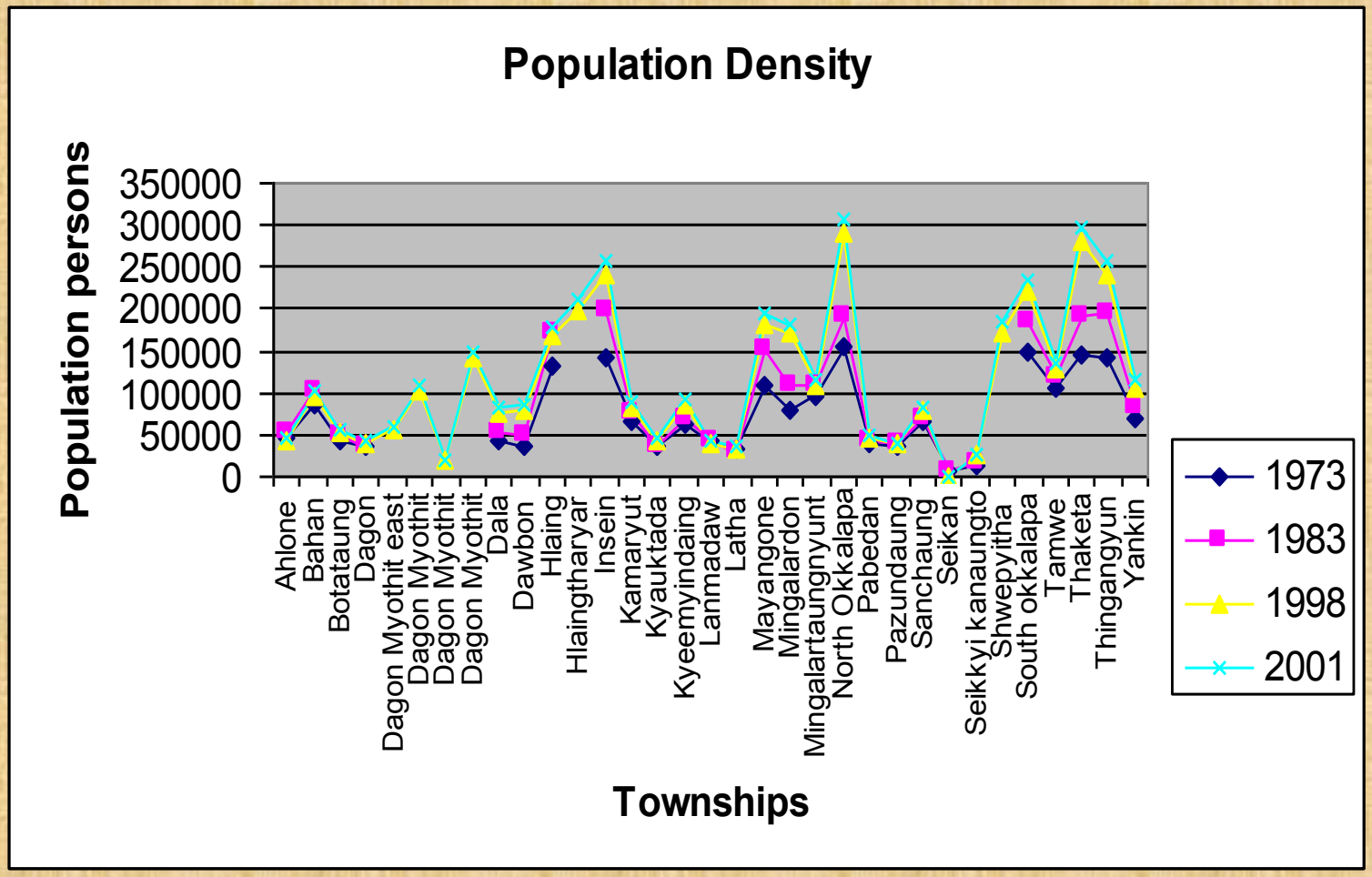
Drinking water lake in Yangon Area





The domestic water consumption per month is increased in Ahlone, Tarmwe, Yankin, Bahan and Pabedan Townships. Utilization for commercial purposes in Insein is increased more than the other townships. Departmental water consumption per month is found to be high in Dagon, Mayangone, Yankin and Insein.

As population density increases, an ever-increasing demand on water resources and an ever increasing complexity of management issues are created.

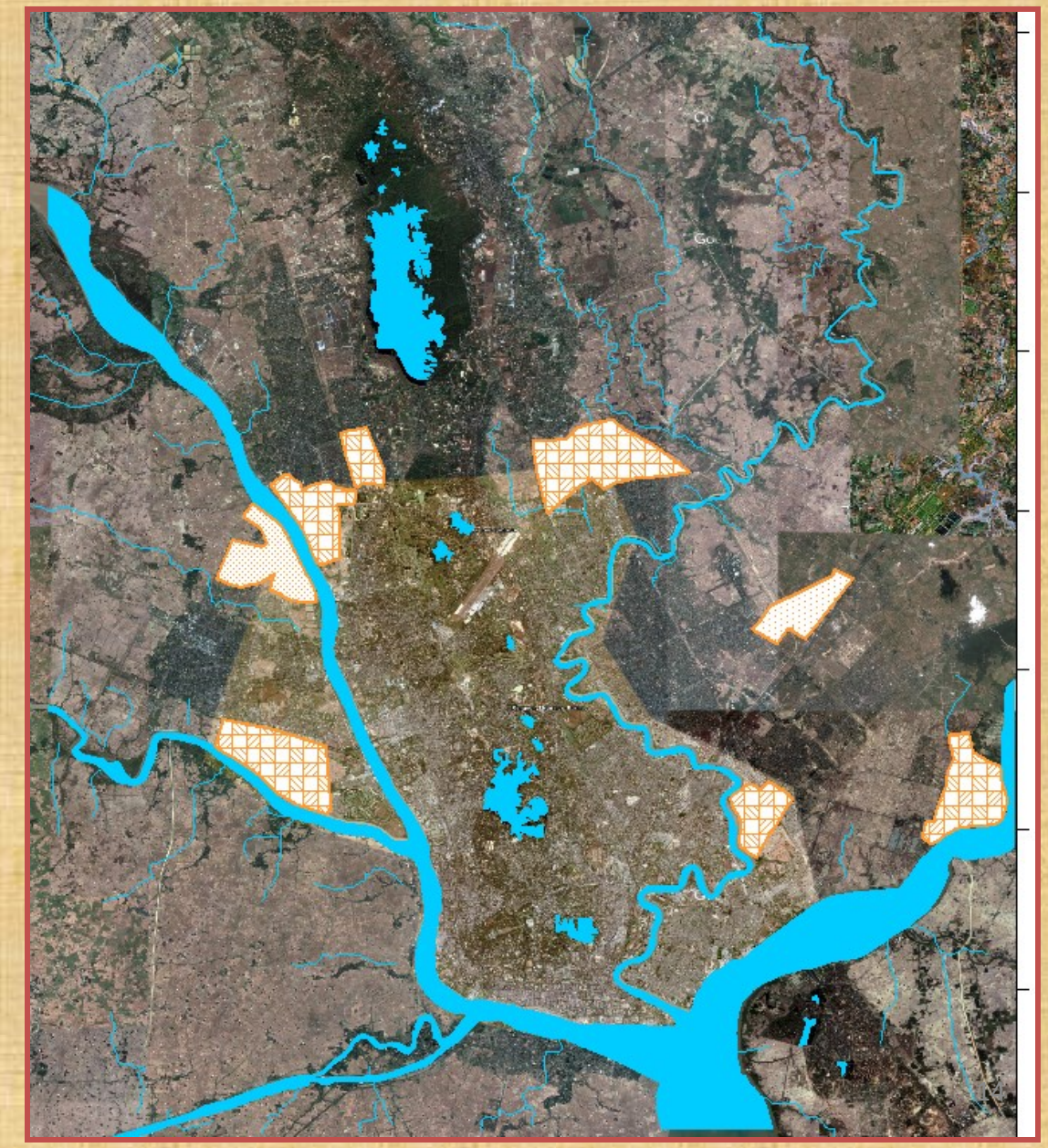


Urban expansion coupled with population growth accelerated the deterioration of environment and degradation of quality of groundwater.

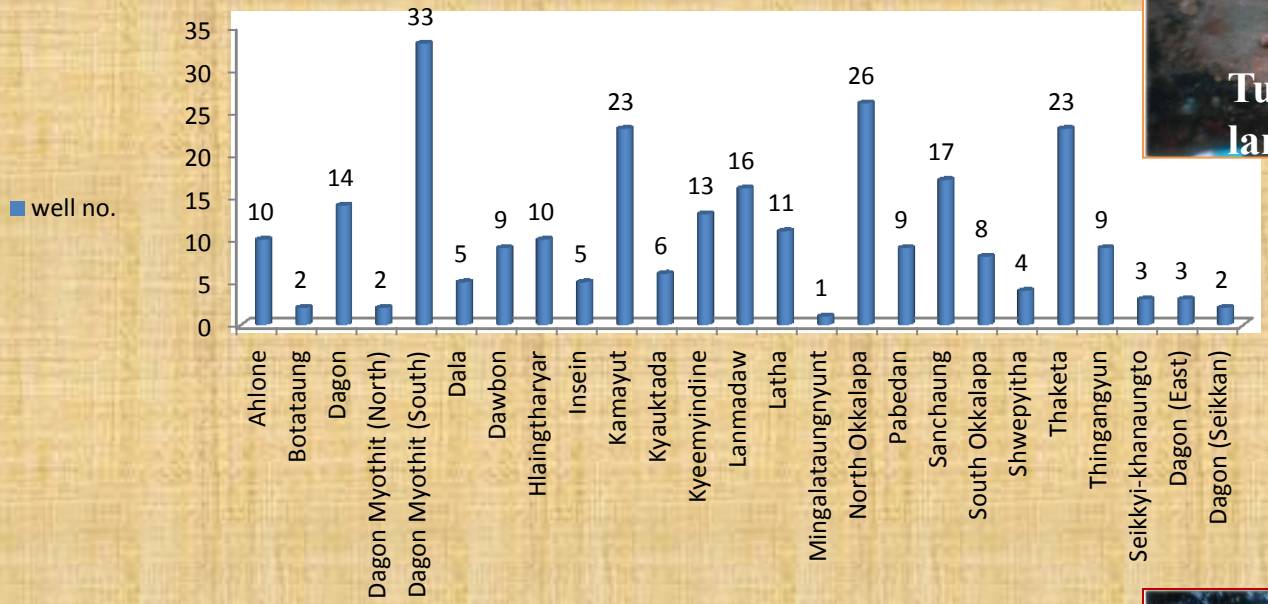
Location of Industrial zones

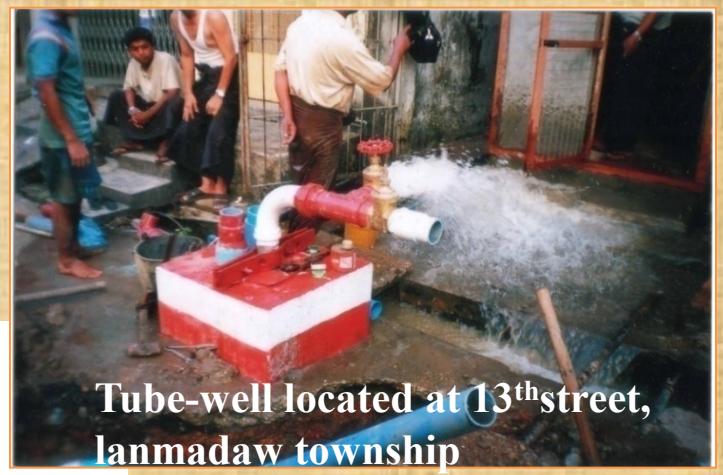
Industrial zones

Proposed industrial zones



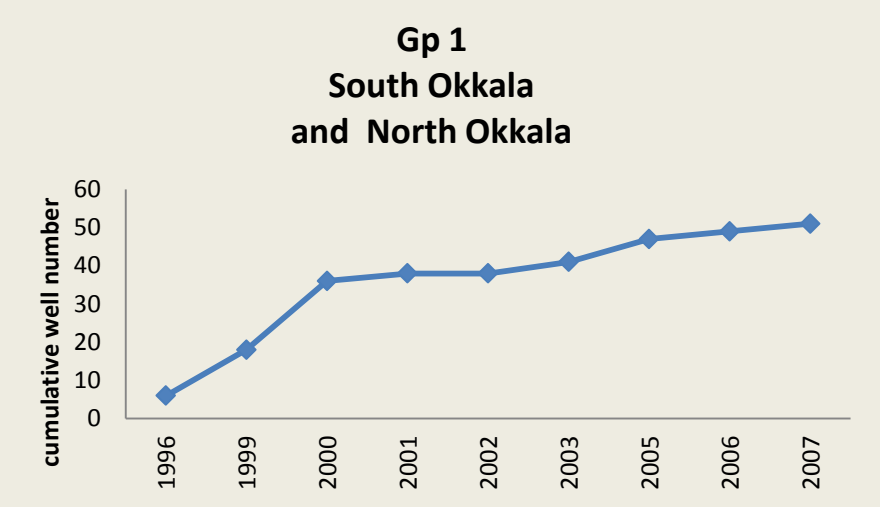
YCDC's tube-wells in Townships

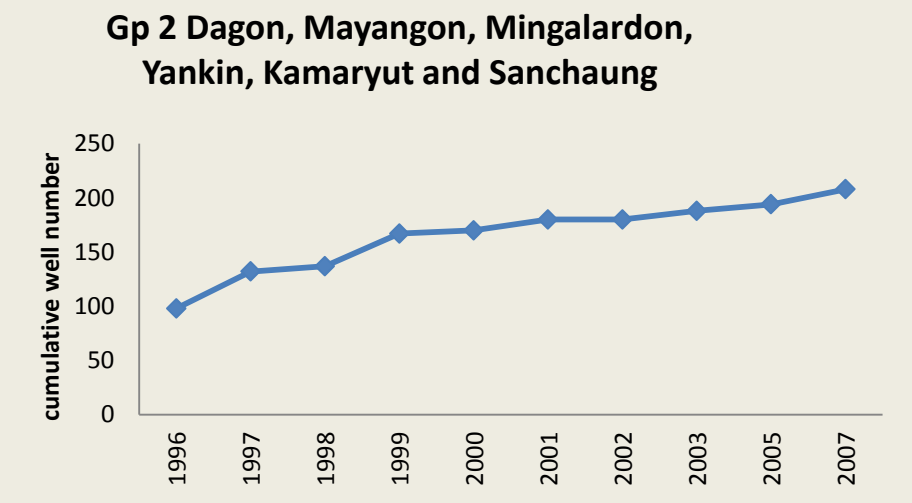


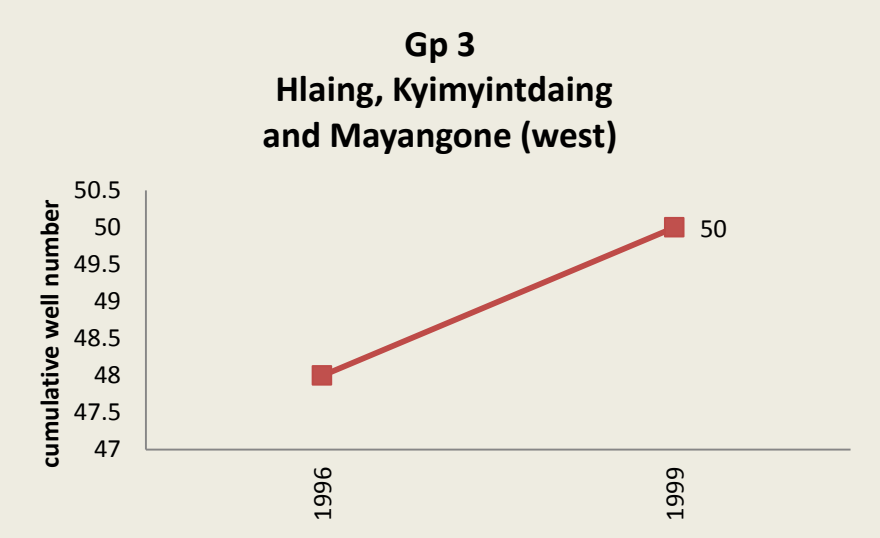

Tube-well located at 13thstreet, lanmadaw township

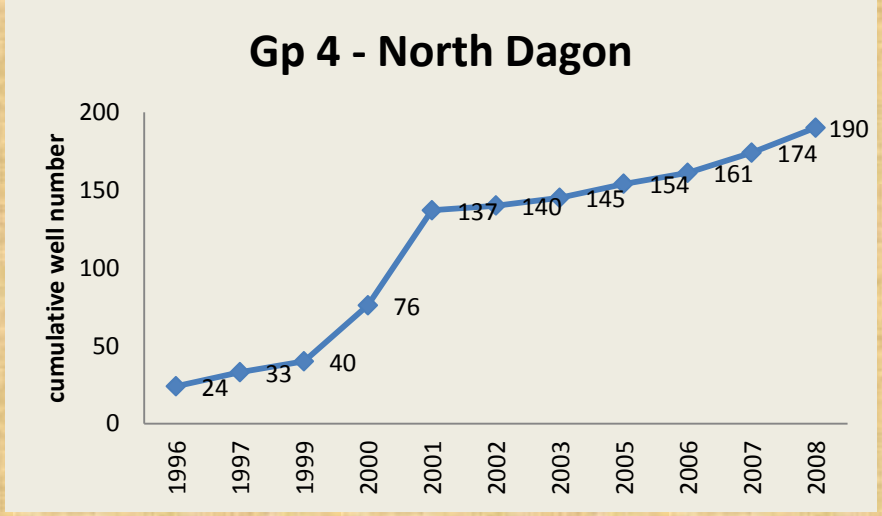

Tube-well located at in front of the railway station, kyauktada township

Water wells in townships (1996-2008)

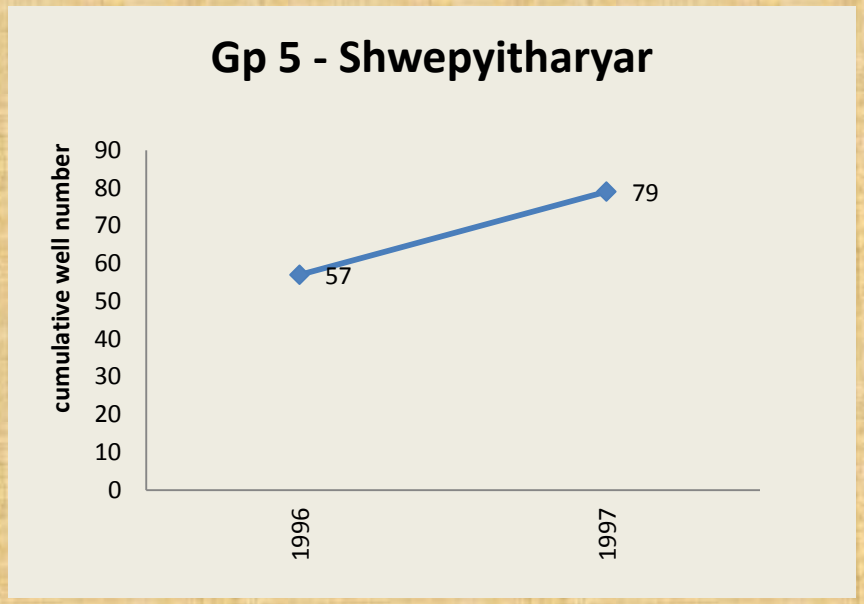


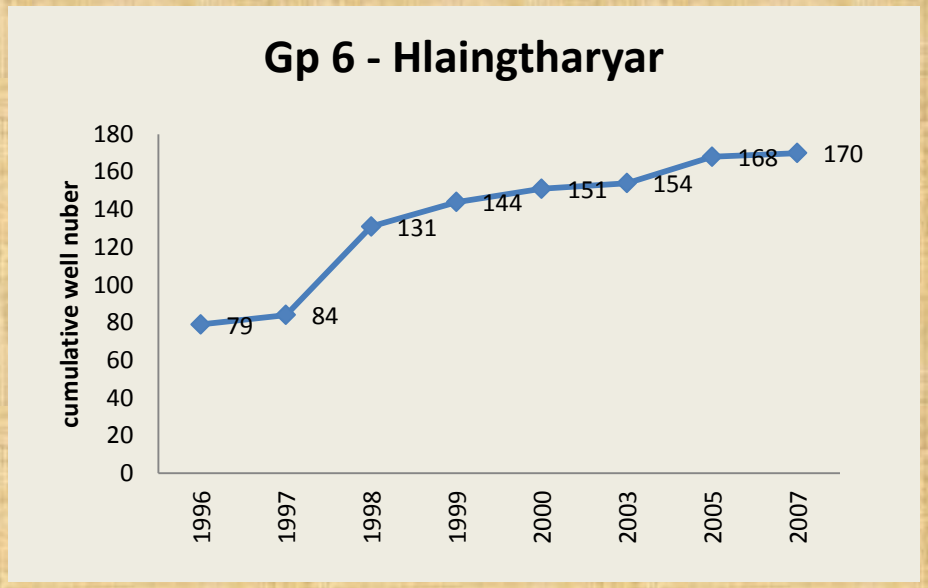


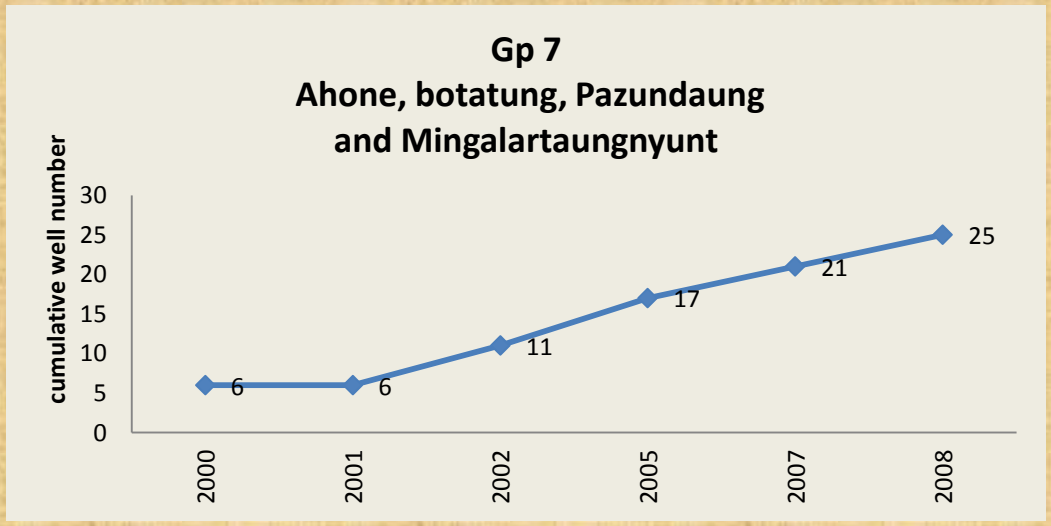


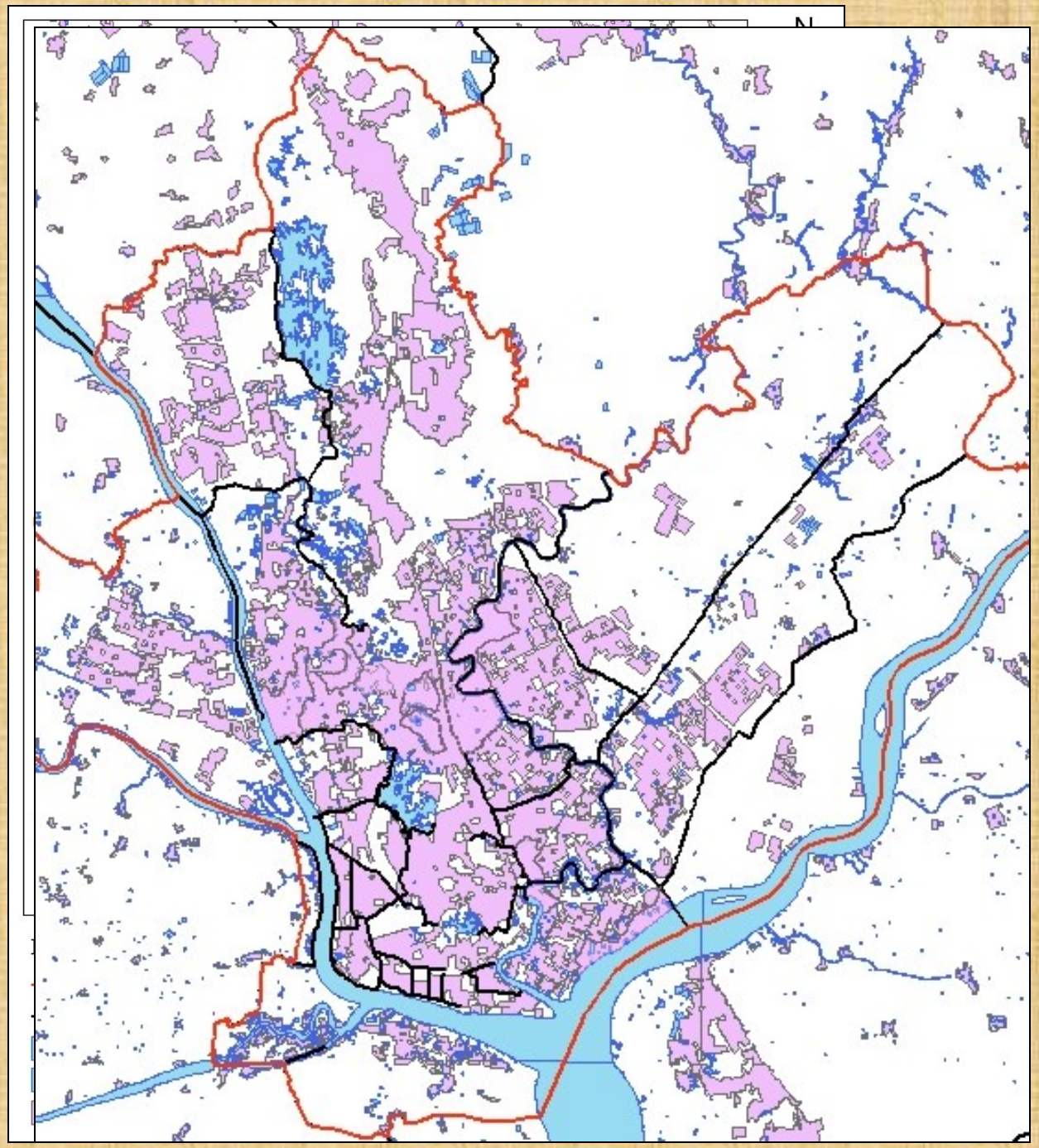


Water wells in townships (1996-2008)





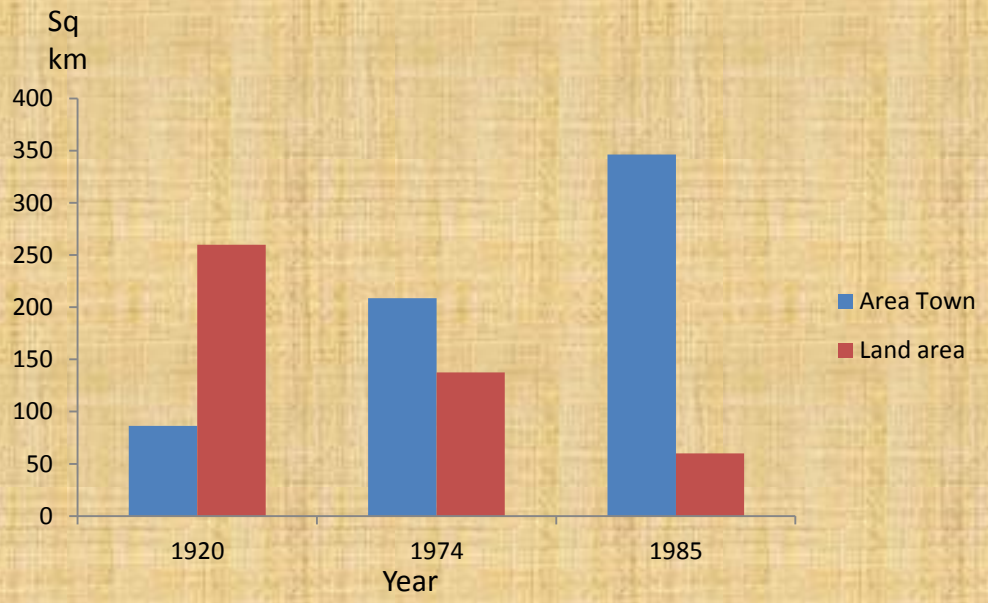




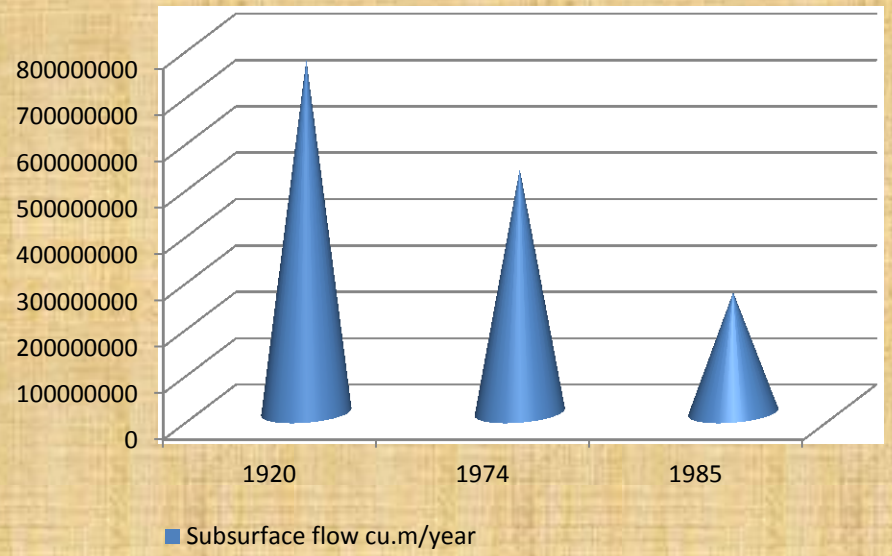
Built up area occupied many areas of water resources especially lakes and ponds

Water Budget

Urban growth and land area reduction



Subsurface flow cu.m/year



Total land area = 480 sq.km

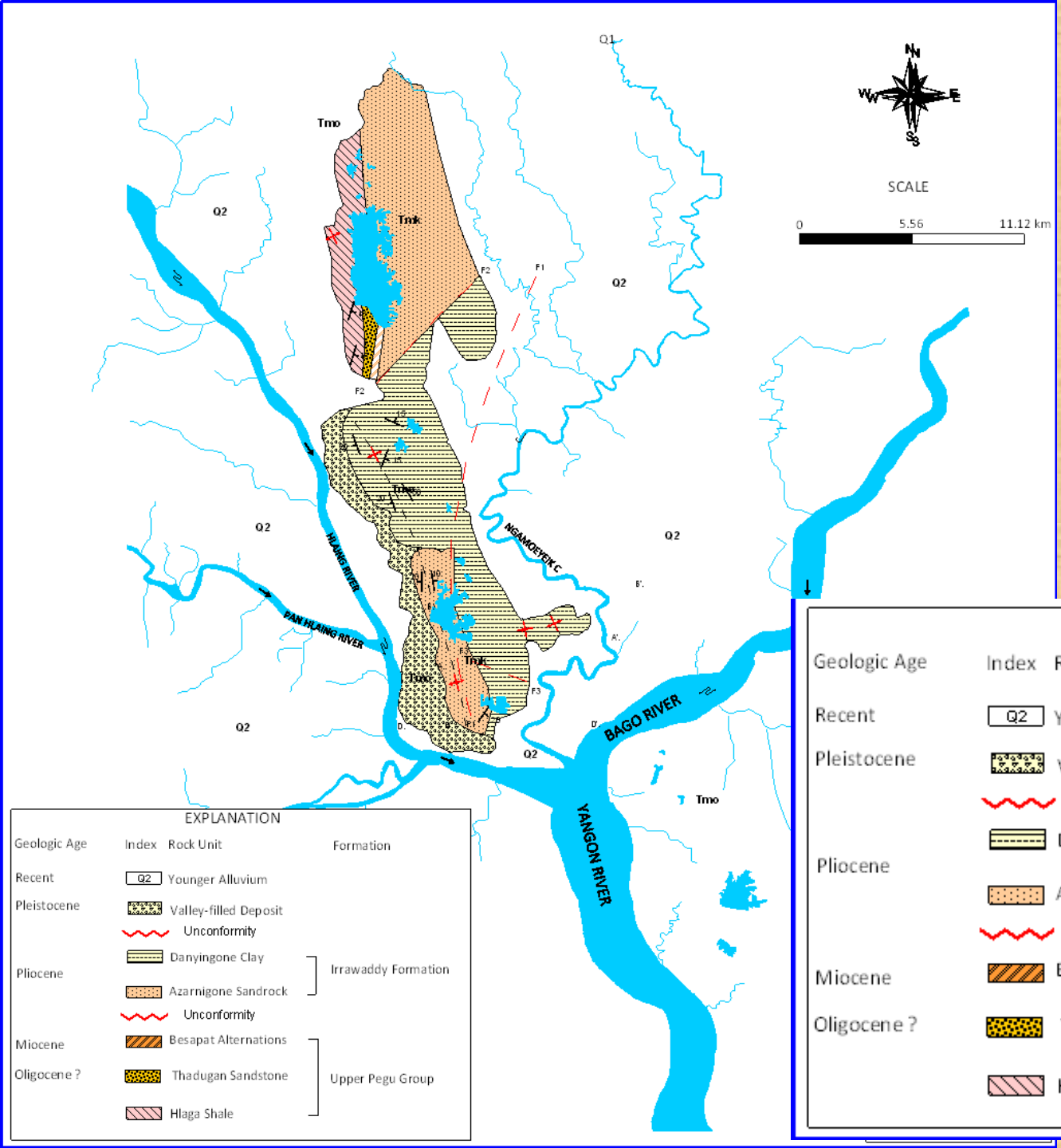
Year	Area sq ft (Town)	Land area	Subsurface flow (recharge)
1920	86.25	393.75	759738839.6
1974	208.62	271.38	523626479.5
1985	346.13	133.87	258301558

Potential sources of groundwater contamination

Increase in households through population growth, economic activities and lifestyle changes directly transform the condition of the water resources. Controlling factors for the deterioration of water resources are interaction of **climate, topography and drainage system, geology, population density and land-use.**

Geology

Geological Map of Yangon City (Win Naing, 1972)



EXPLANATION
Geologic Age
Index
Rock Unit
Formation
Recent
Q2
Younger Alluvium
Pleistocene
Valley-filled Deposit
Unconformity
Pliocene
Danyingone Clay
Azarnigone Sandrock
Irrawaddy Formation
Unconformity
Miocene
Besapat Alternations
Oligocene ?
Thadugan Sandstone
Upper Pegu Group
Hlaga Shale

Hydrogeology

Aquifer (Rock)

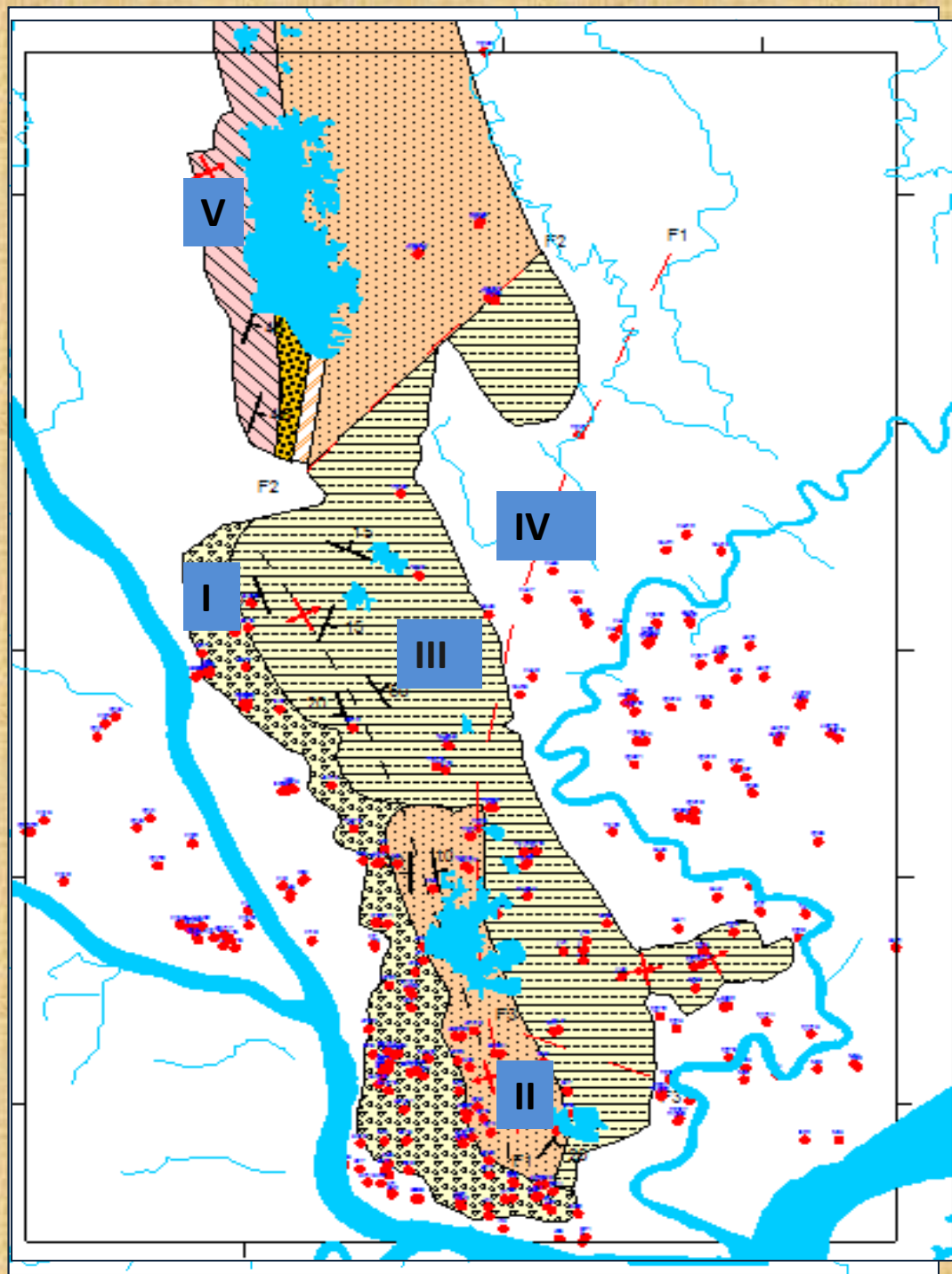
- Upper Pegu Group (Thadugan Sandstone, Hlawga Shale, Besapat Alternations)
  - Limited in Thadugan sandstone
- Irrawaddy Formation (Arzanigone Sandrock, Danyingone Clay)
  - Mainly Arzanigone sandrock

Aquifer (Alluvium)

- Valley-filled deposit
  - Important aquifer in the western part of the study area
- Younger alluvium
  - Widely distributed

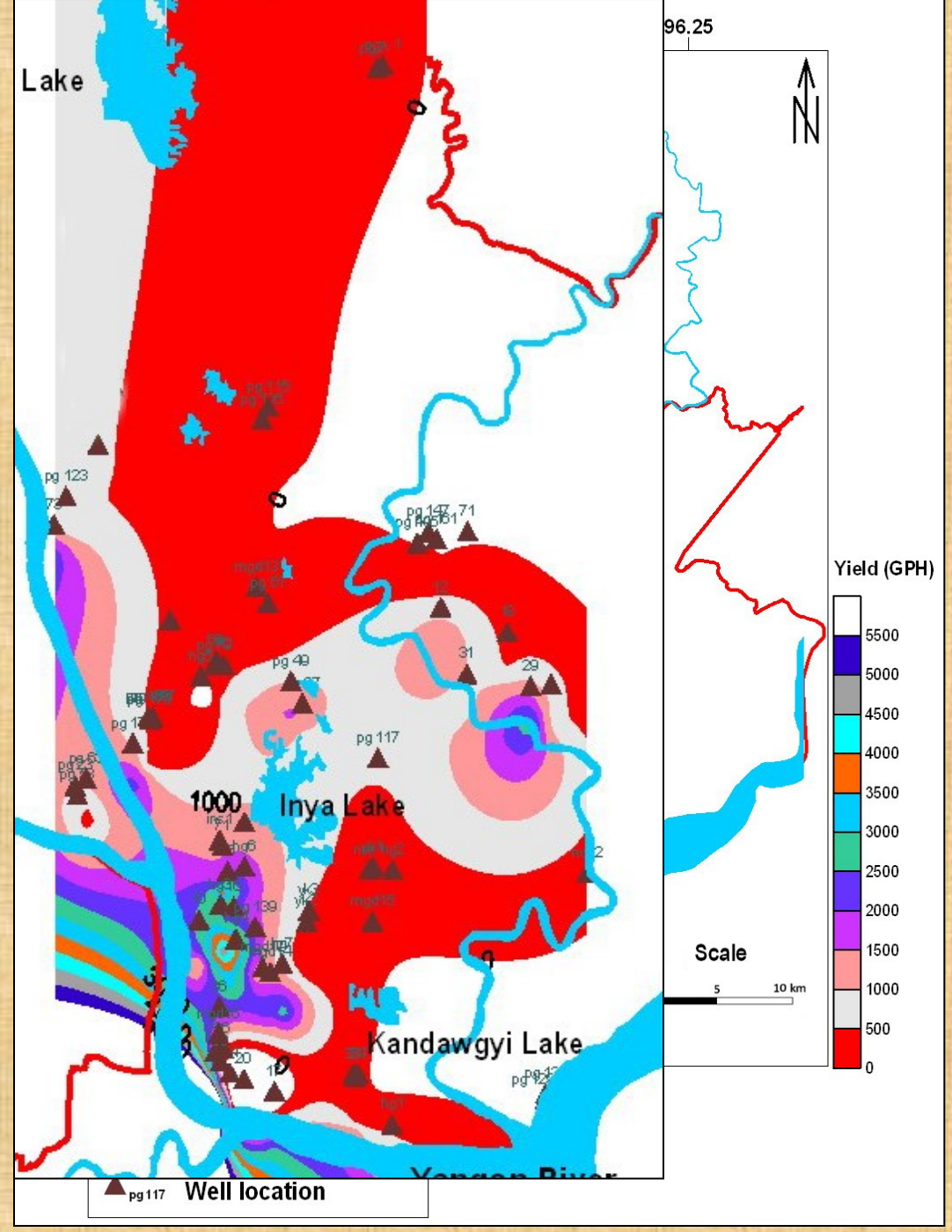
Well locations in different lithology

I - valley-filled deposit
(good water quality)
II - Arzanigone sandrock
(good water quality)
III- Danyingone clay
IV - Younger Alluvial deposit
V – Thadugan sandstone



Types of aquifer	depth (feet)	soil types	Types of aquifer	depth (feet)	soil types
Arzanigone sandrocks	90-110	sand	Valley-fill deposits	125-157	coarse sand and gravel
	80-137	sand		118-170	fine gray
	170-200	sand		114-147	clay sand and gravel
	145-170	fine sand		82-129 /134-145	coarse sand and gravel
	70-100	sand		206-290	sand and gravel
	420-480	sand blue		104-170	sand and gravel
	460-490	fine to medium sand		213-243 /253-273	coarse sand and gravel
Danyingone clays	130-264	coarse sand and gravel		90-118/139-164	sand and gravel
	334-385	gray sand		130-160	sand and gravel
	185-210	blue clay and coarse sand		140-180	sand and gravel
	105-130	sand and gravel		110-130	medium sand and yellow
	110-140	medium sand	Alluvial	126-156	Sand
	295-335	medium sand		274-364	gravel and sand gravel
	480-510	sand blue		151-221	coarse sand and gravel
	247-280	coarse sand and gravel		101-127	sand and gravel
	223-261	coarse sand and gravel		105-125	sand with fine gravel
	370-390	medium sand and blue		100-130	sand fine and yellow
	430-470	fine sand		335-365	medium sand and gritty
	40-60	sand and gravel		600-630	sand and gravel
	100-148	medium sand and gravel		570-590	sand and gravel
	200-295	sand yellow and gravel		520-580	sand
	325-350	medium sand blue		320-400	medium sand blue

Assessment of groundwater vulnerability



Groundwater specific yield map and its wells locations

Depending upon this map, the specific yield is abundant in the south-west and western part of this study area.

Water quality

- Unbalance between discharge and recharge may cause groundwater quality degradation
- Over-exploitation can also disturb the saltwater and fresh water interface, leading to local or regional saline contamination

TDS distribution (Total Dissolved Solid)

Excellent

less than 300 mg/litre

Good

between 300 and 600 mg/litre

Fair

between 600 and 900 mg/litre

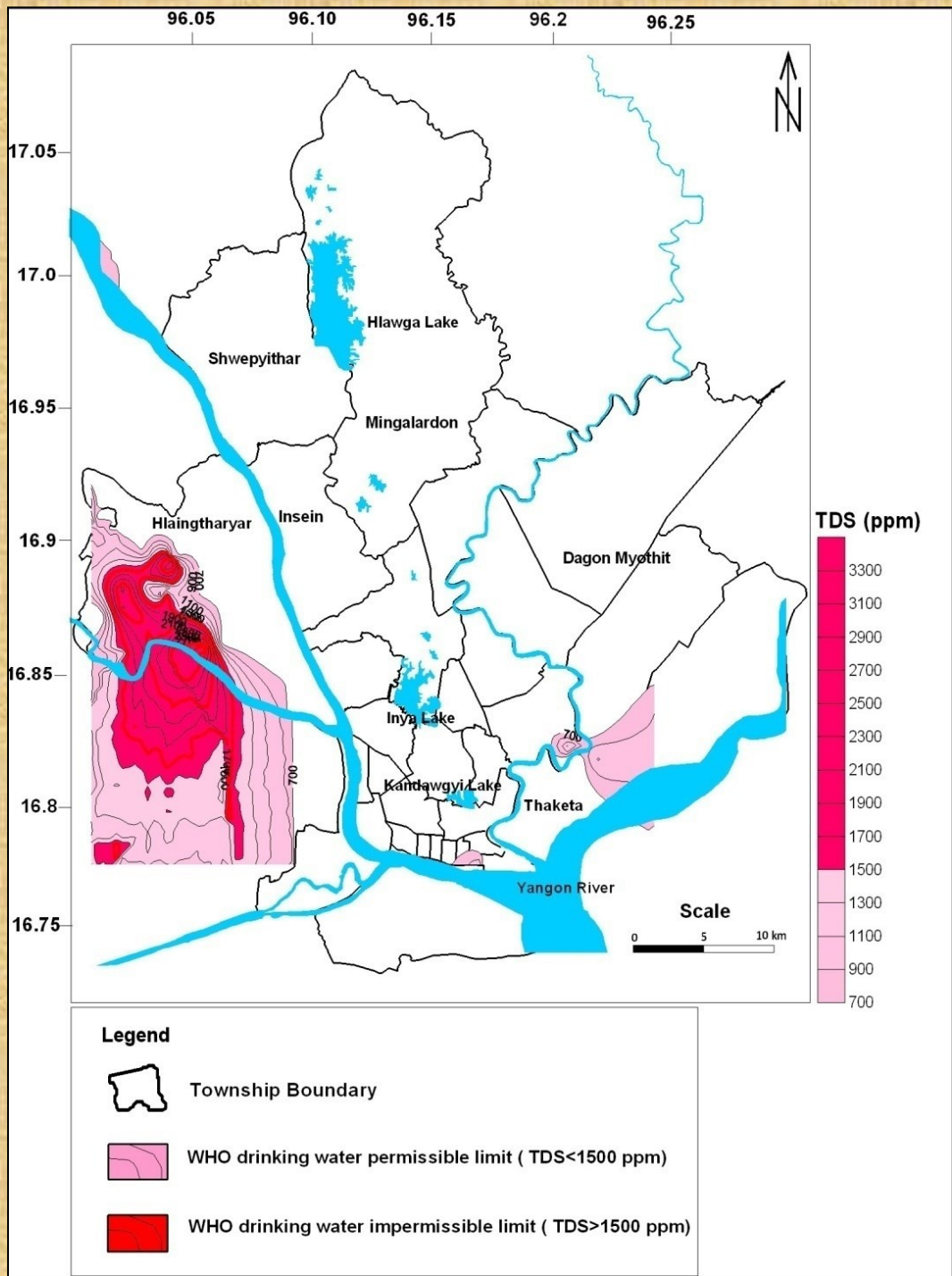
Poor

between 900 and 1200 mg/litre

Unacceptable

greater than 1200 mg/litre

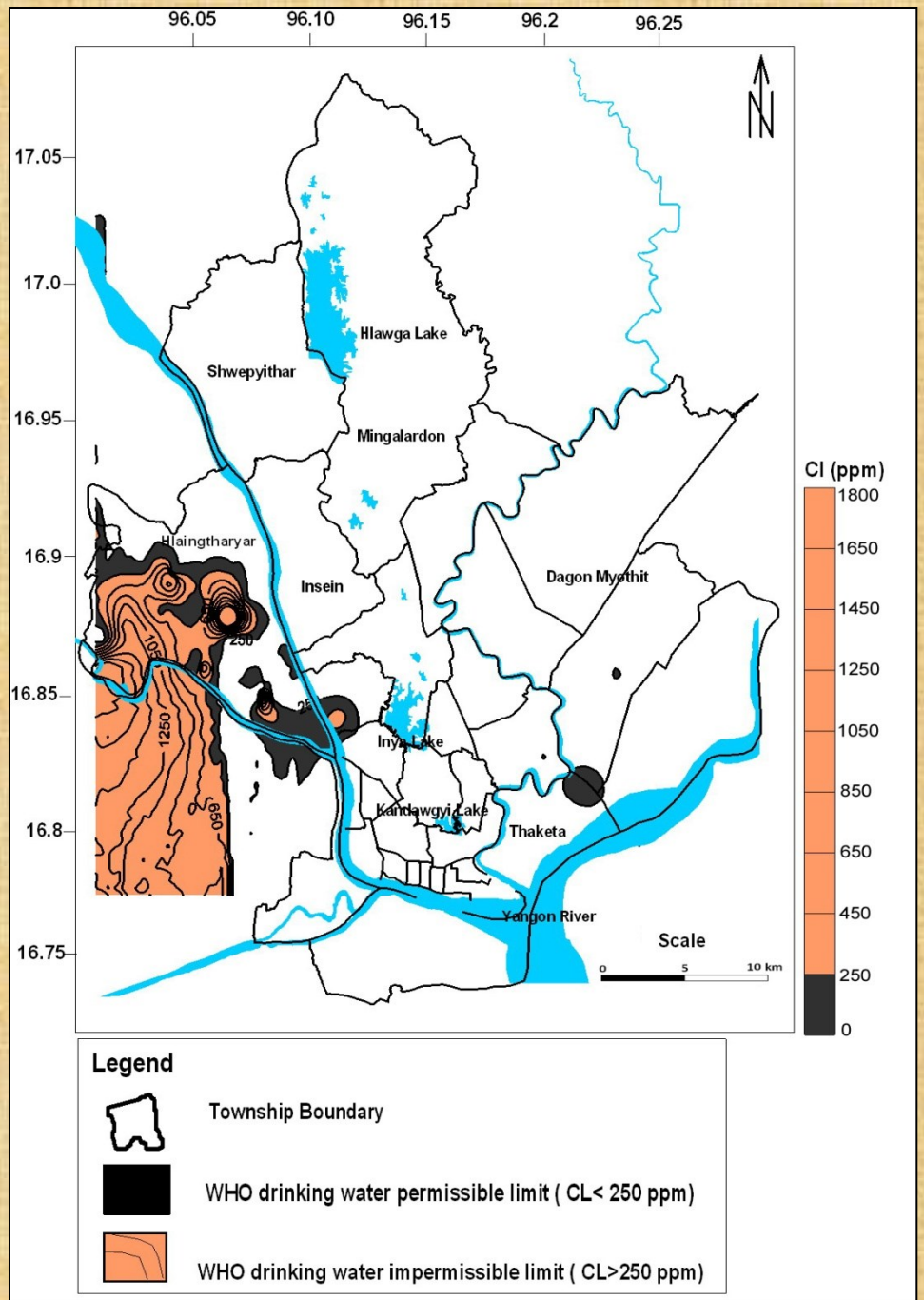
Over pumping of groundwater will cause the intrusion of saline water to the well in the area to the tidal river and chaung.



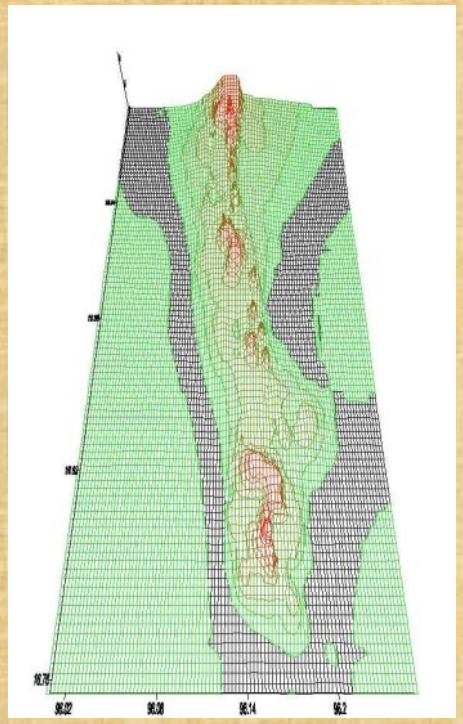
Chloride distribution

- **Chloride originates from natural sources, sewage and industrial effluents, and saline intrusion.**
- **Guideline value of Chloride is 250 mg/litre**

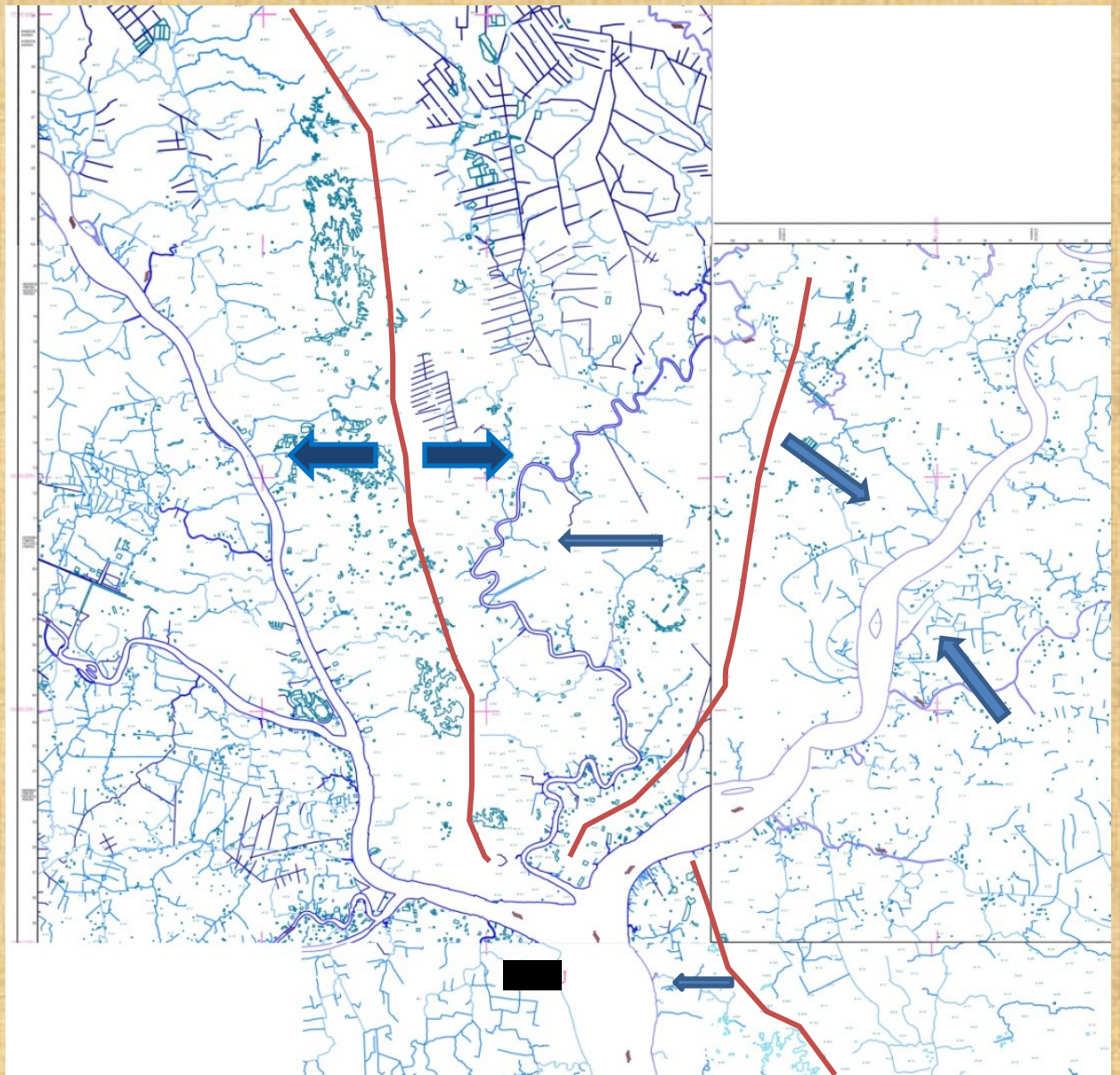
•This presentation reveals the quality of groundwater in terms of Total Dissolved Solid (TDS) and Chloride (Cl)

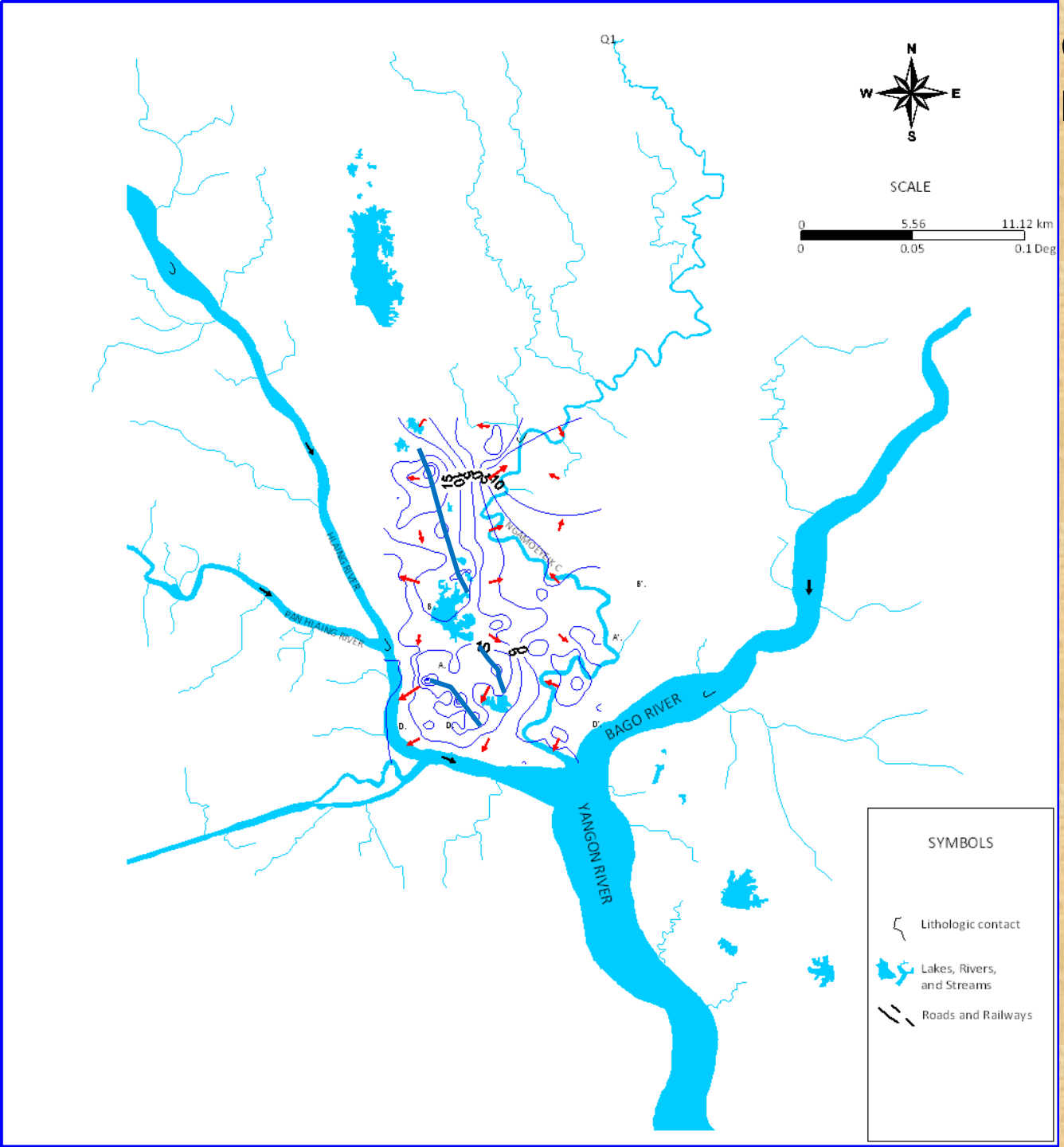


Drainage Coverage Map of the Study Area



Yangon-Mingaladon Ridge is main watershed for Hlaing River and Ngamoeyeik Creek

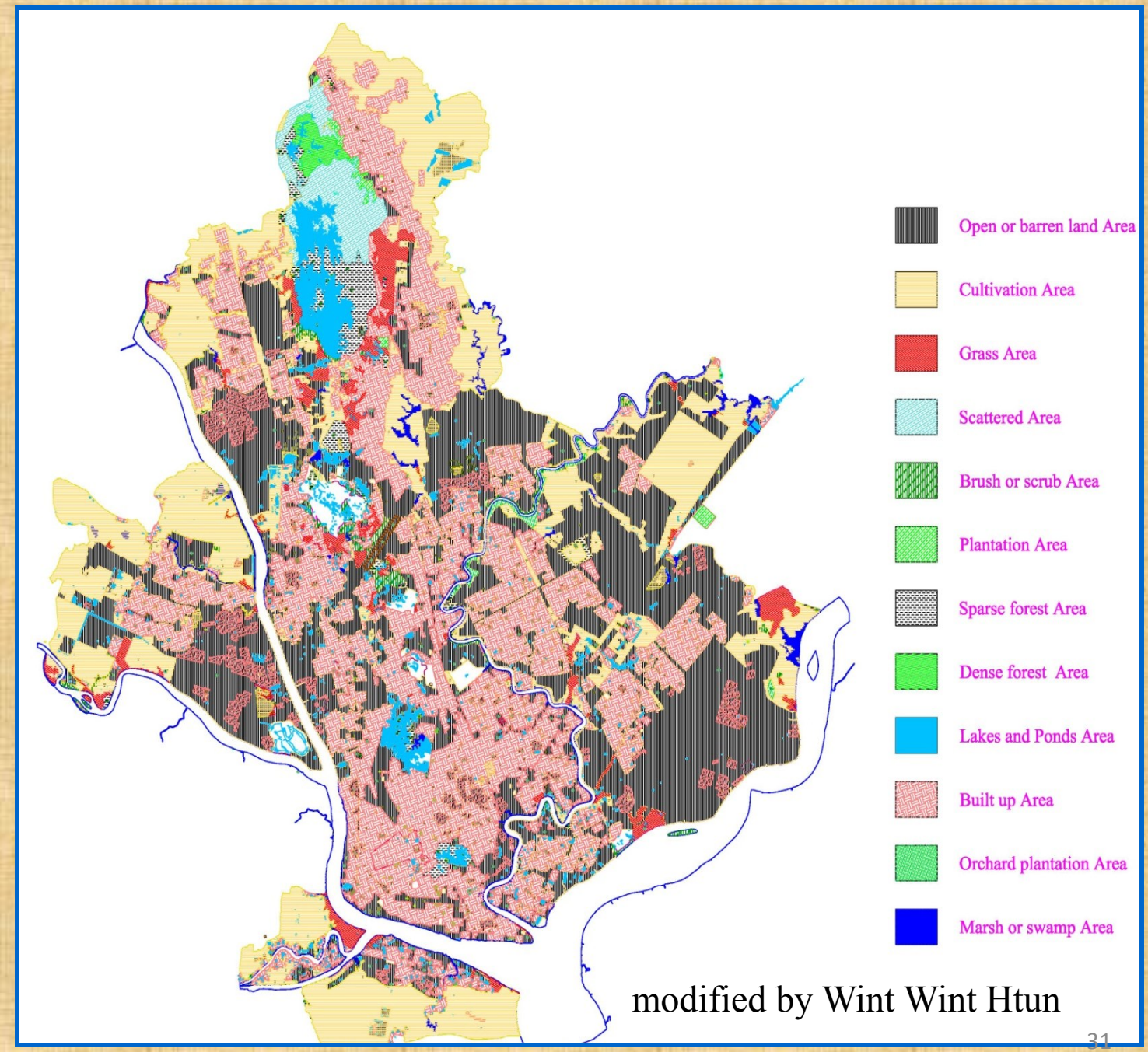




Contour map showing potentiometric level

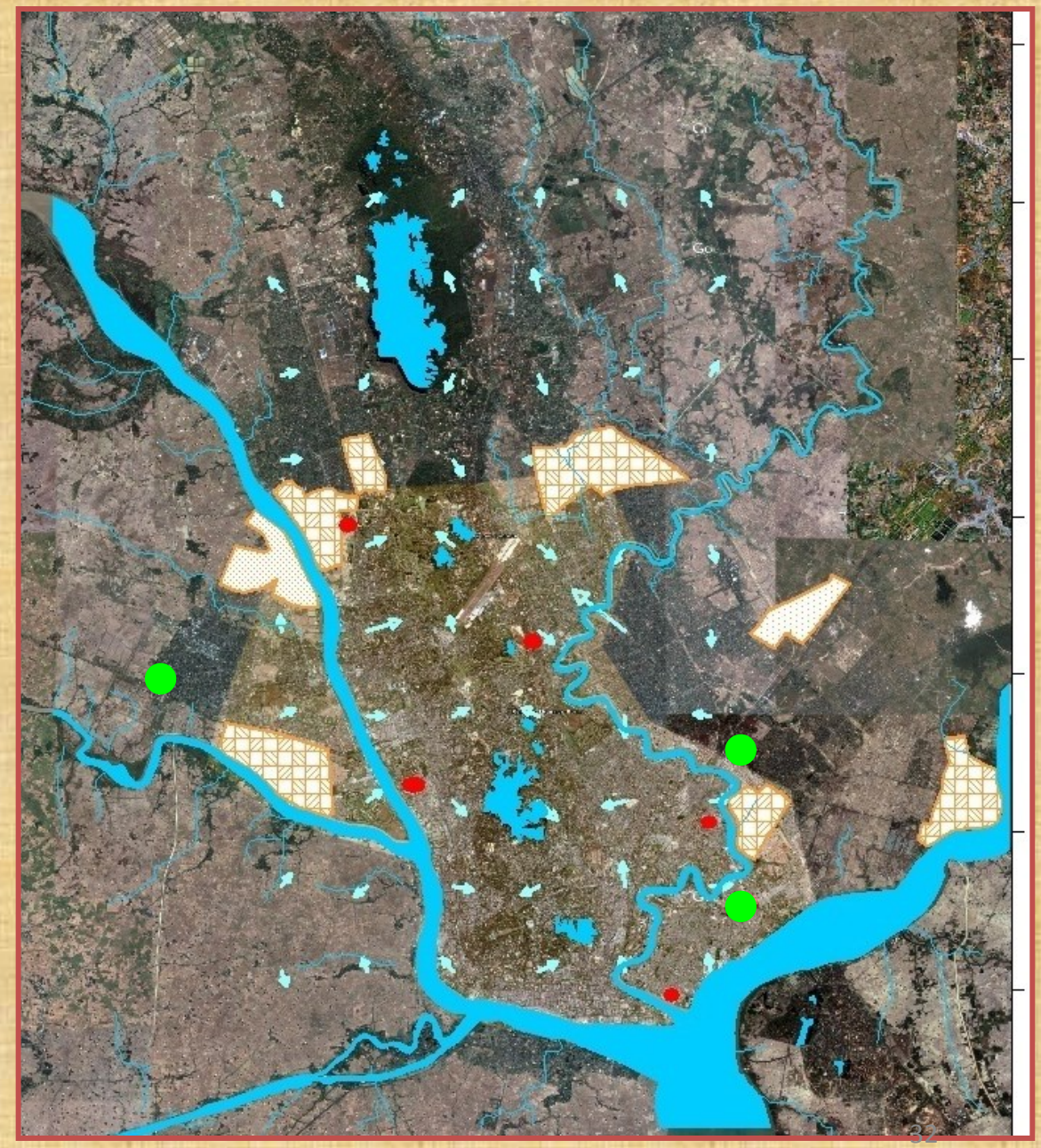
- Topography normally controls the subsurface water flow.
- However, permanent reservoirs like Innya and Kandawgyi can feed water into the local aquifers continuously

(modified after Win Naing and Maung Maung1996)



modified by Wint Wint Htun

Figure showing Industrial zones, solid waste disposal sites and groundwater flow direction



Old solid waste disposal site

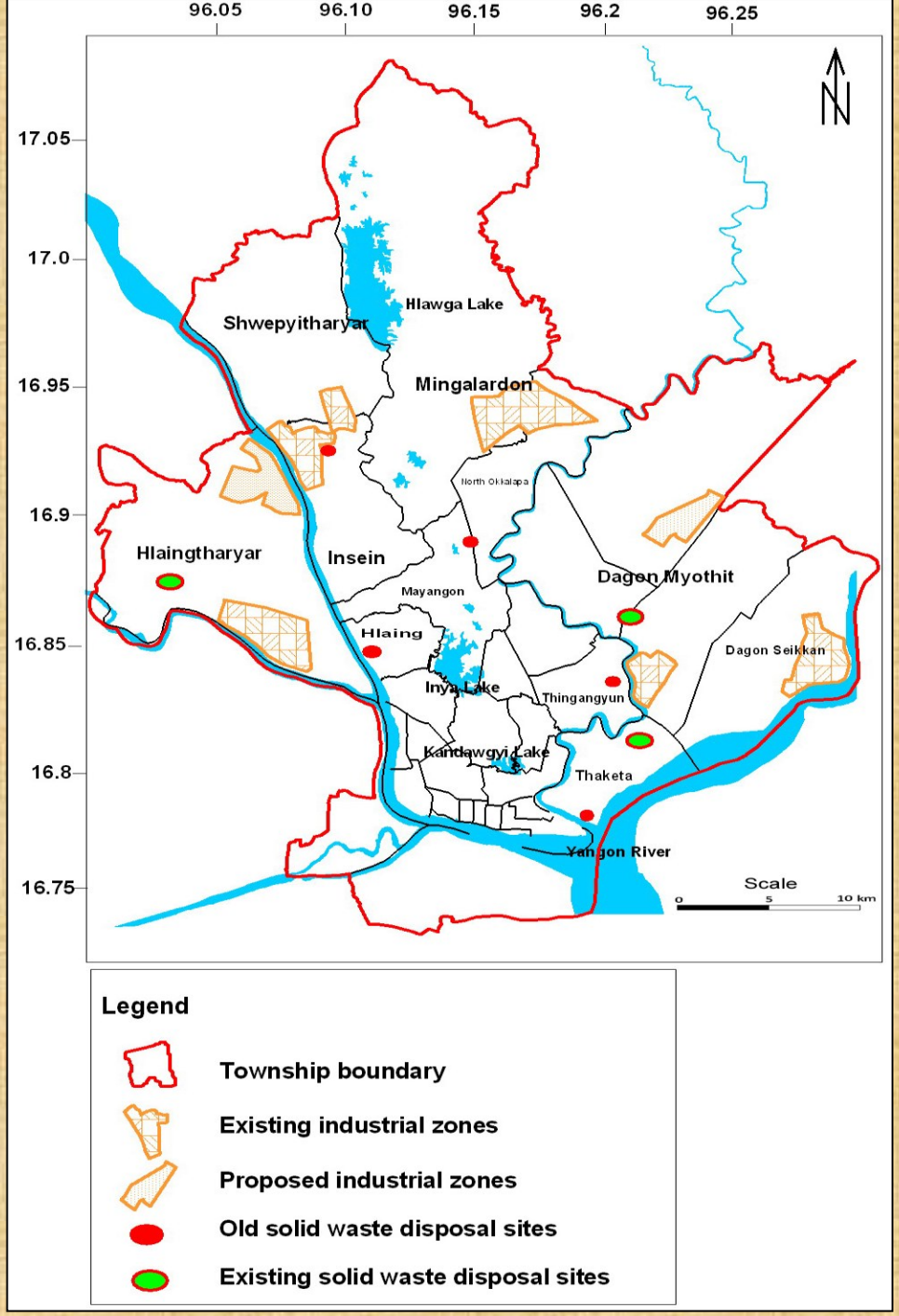
Existing solid waste disposal site

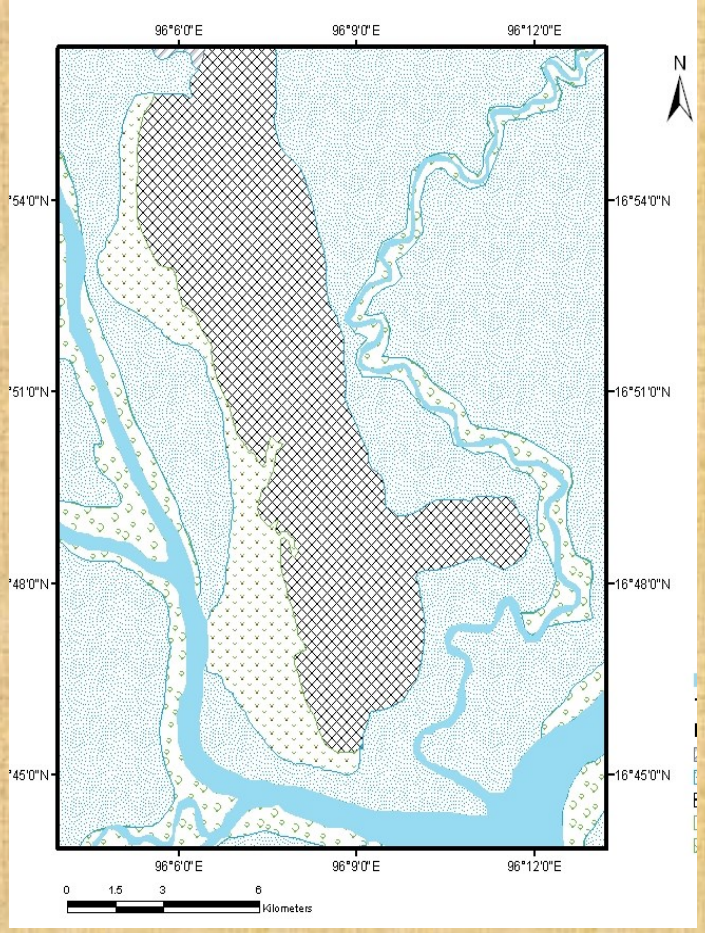
Industrial zones

Proposed industrial zones

Main solid waste disposal sites And industrial zones

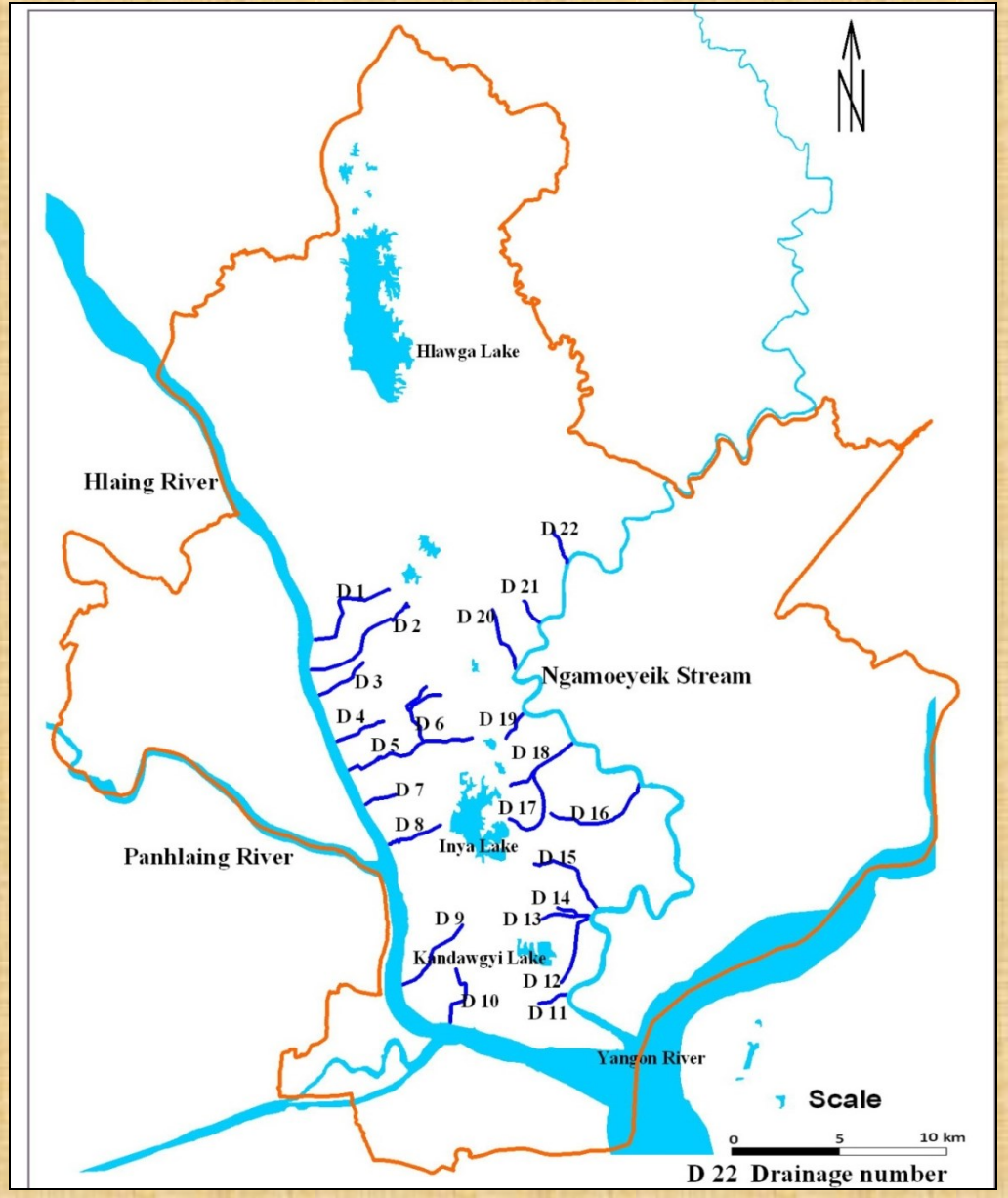
Waste disposal sites are located at the area of shallow water-table aquifers situated at the depth of 40 ft below the surface.





Low lying areas are high vulnerable to flooding during rainy season. But the southern city may have further problems.

Flooding



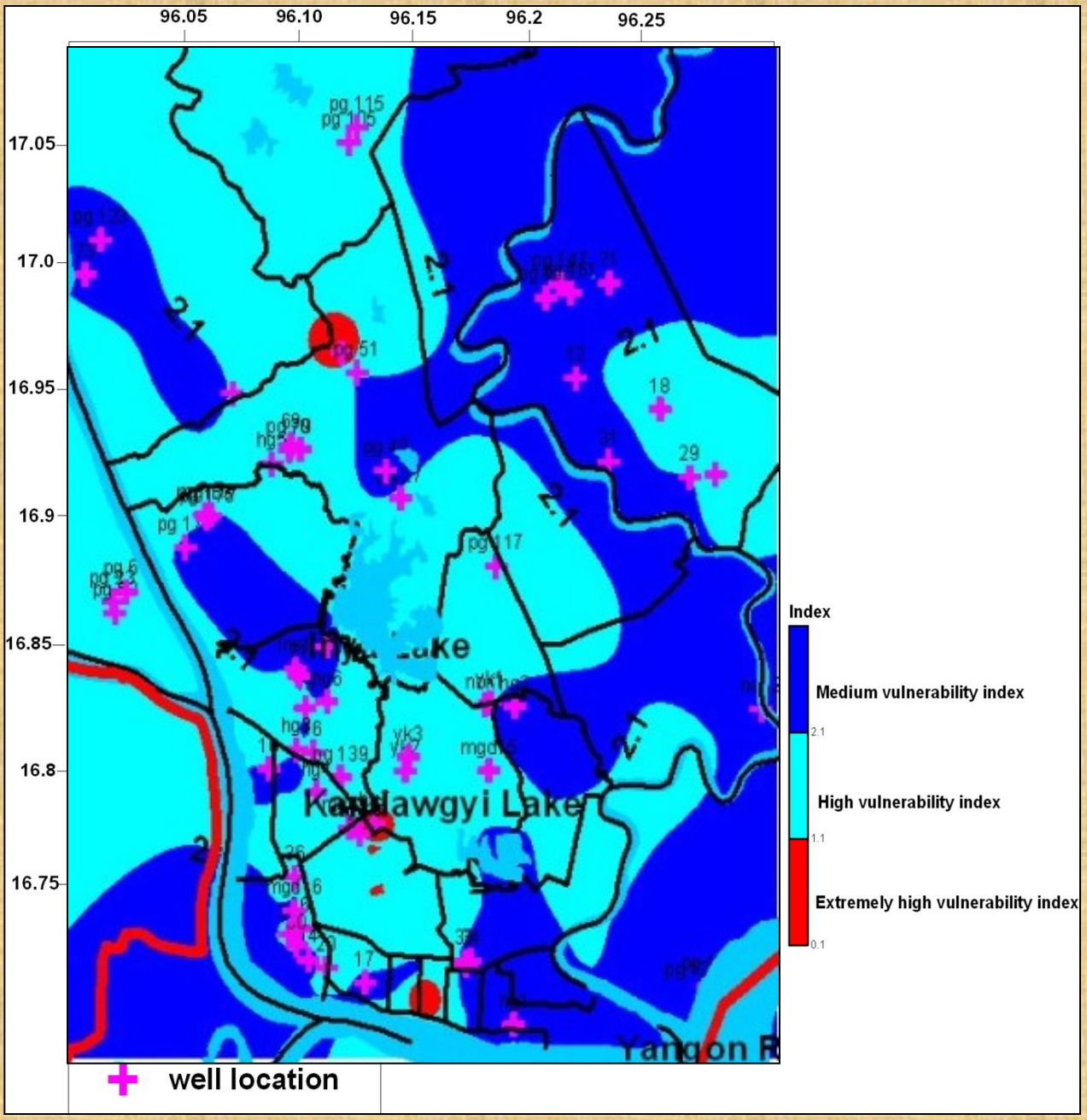
All 22 drainage channels present in Yangon are polluted. Channel water pollution is rather high in dry season when the surface run-off by rain water is absent. Channels passing through the densely populated area are highly polluted and they will contaminated the groundwater lying below.

Groundwater vulnerability assessment

- Aquifer vulnerability index (AVI)
- The Vulnerability Index is one of the methods simplest, fast and easy to quantify the vulnerability, since so single it uses the hydraulic conductivity and the thickness of the layers of different material that are on the level of the water.

$$c=\Sigma bi / Ki \qquad \text{for the layers } i = 1, 2, 3,\ldots,i$$

- where:
- bi: it is the thickness of each layer of the ground water,
- Ki: it is the hydraulic conductivity of each layer, and
- c: it is total the hydraulic resistance by ft of depth (inverse of Ki, [time]),



Groundwater vulnerability assessment map and its wells locations

Groundwater vulnerability index map by using **AVI (aquifer vulnerability index) method** for reconnaissance studies.

The area of very high vulnerability include some parts of Latha (Alluvial), Dagon (Valley-fill deposits), and Insein (Danyingone Clays)

Groundwater management tools

TECHNICAL TOOLS	0	1	2
Resource Assessment	Basic knowledge of aquifer	Conceptual model based on field data	Models linked to decision-support and used for planning and management

Management Process

$$\frac{\text{Capacity}}{\text{Demand}} \rightarrow \text{Factor of safety}$$

Capacity → Resources: Surface and subsurface water

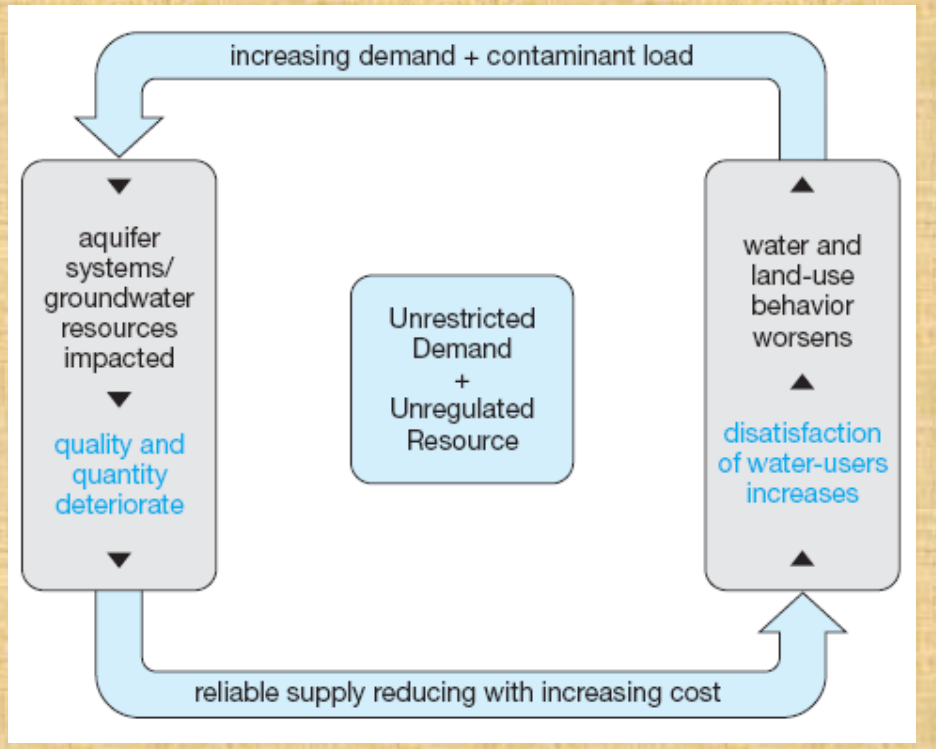
Resources: Surface and subsurface water ↔ Interaction with the environment

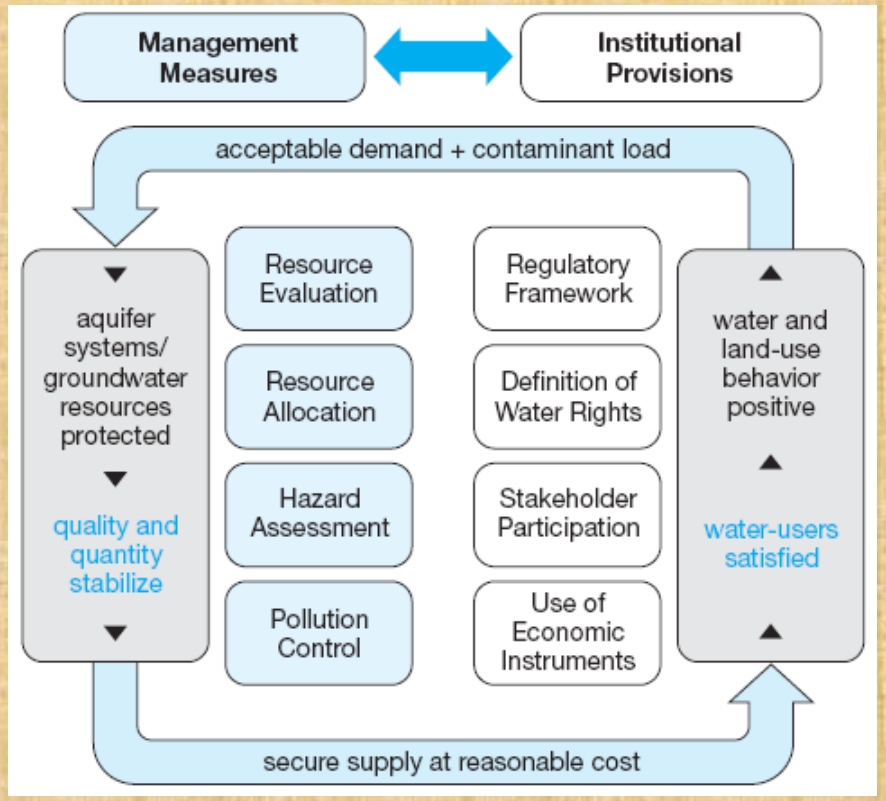
Demand → Water utilization: urbanization and industrial development

Water utilization: urbanization and industrial development ↔ Interaction with the environment

Water shortage (4-5-2008) After Nargis

Challenge in groundwater use





Thank you very much
for
Your kind Attention