RIHN project 2-4 FR Human Impacts on Urban Subsurface Environments

Reconstruction of the thermal environment evolution in Jakarta from underground temperature profiles (Progress Report)

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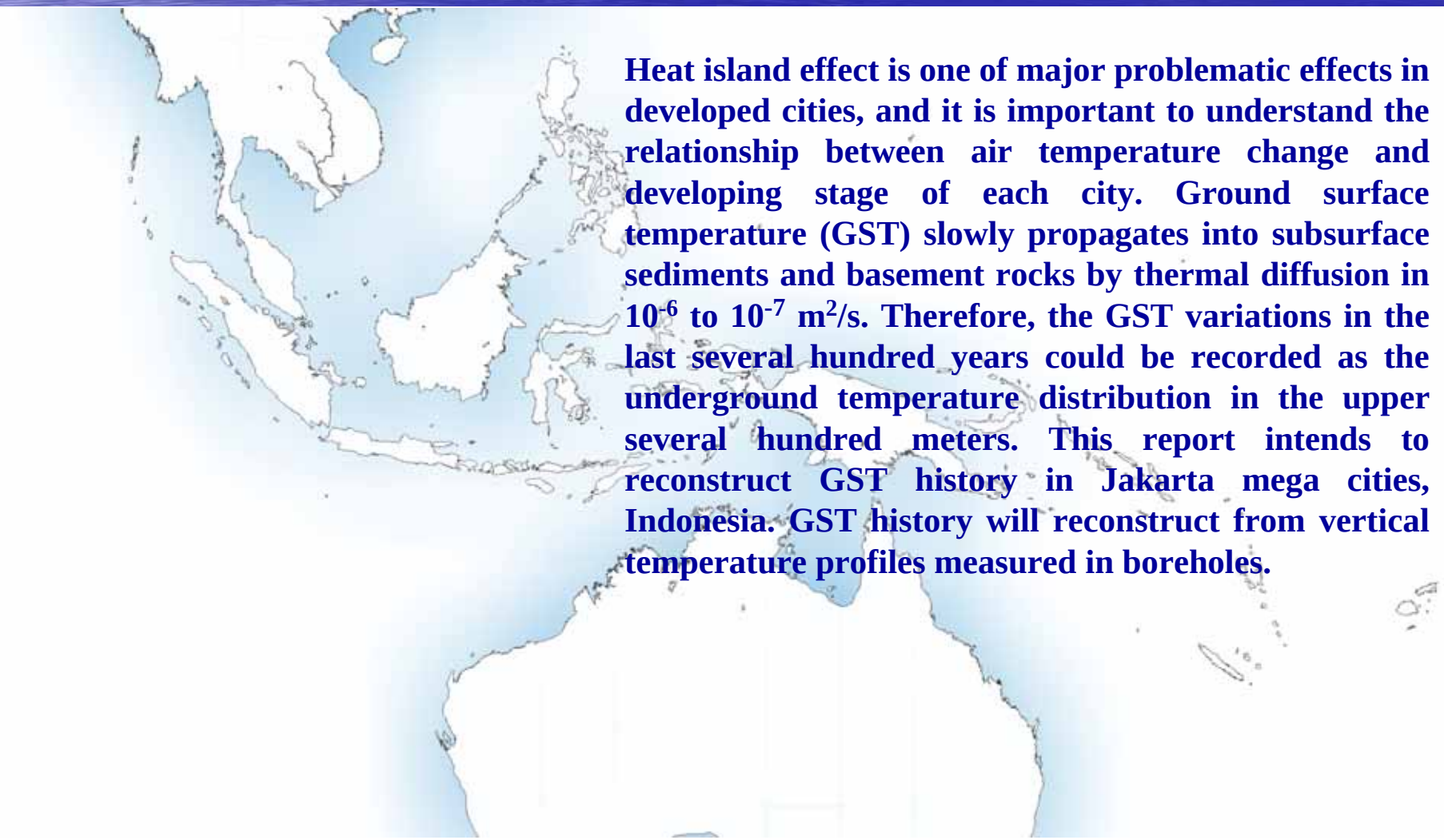
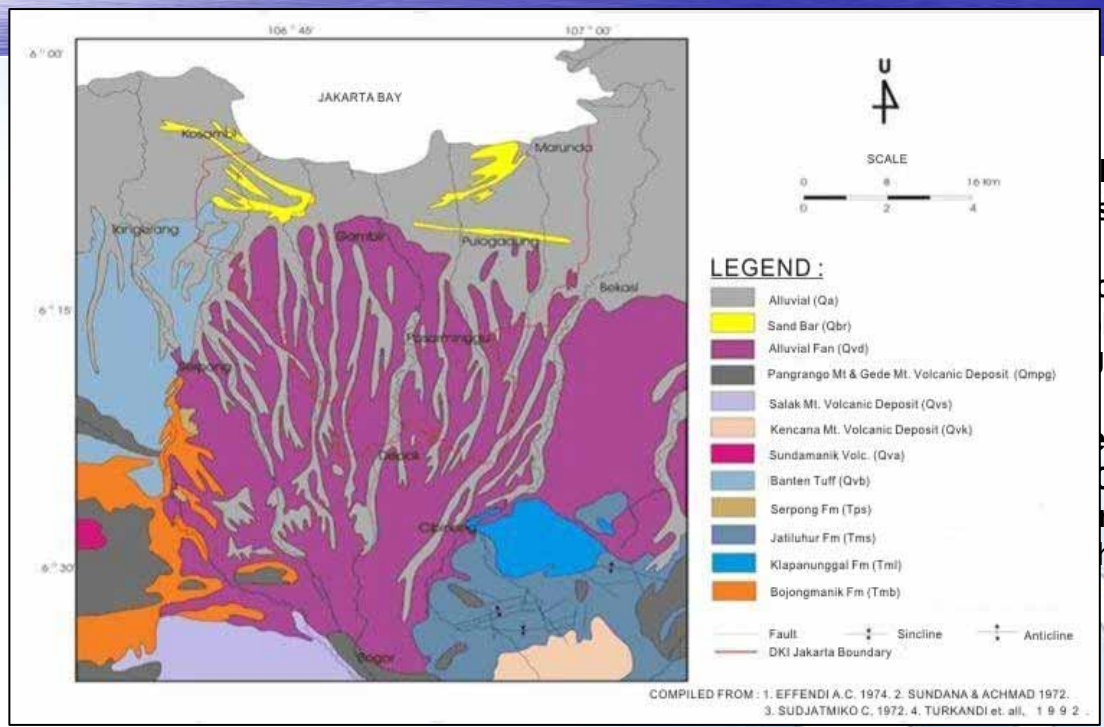
Introduction



Heat island effect is one of major problematic effects in developed cities, and it is important to understand the relationship between air temperature change and developing stage of each city. Ground surface temperature (GST) slowly propagates into subsurface sediments and basement rocks by thermal diffusion in 10^{-6} to 10^{-7} m^2/s. Therefore, the GST variations in the last several hundred years could be recorded as the underground temperature distribution in the upper several hundred meters. This report intends to reconstruct GST history in Jakarta mega cities, Indonesia. GST history will reconstruct from vertical temperature profiles measured in boreholes.

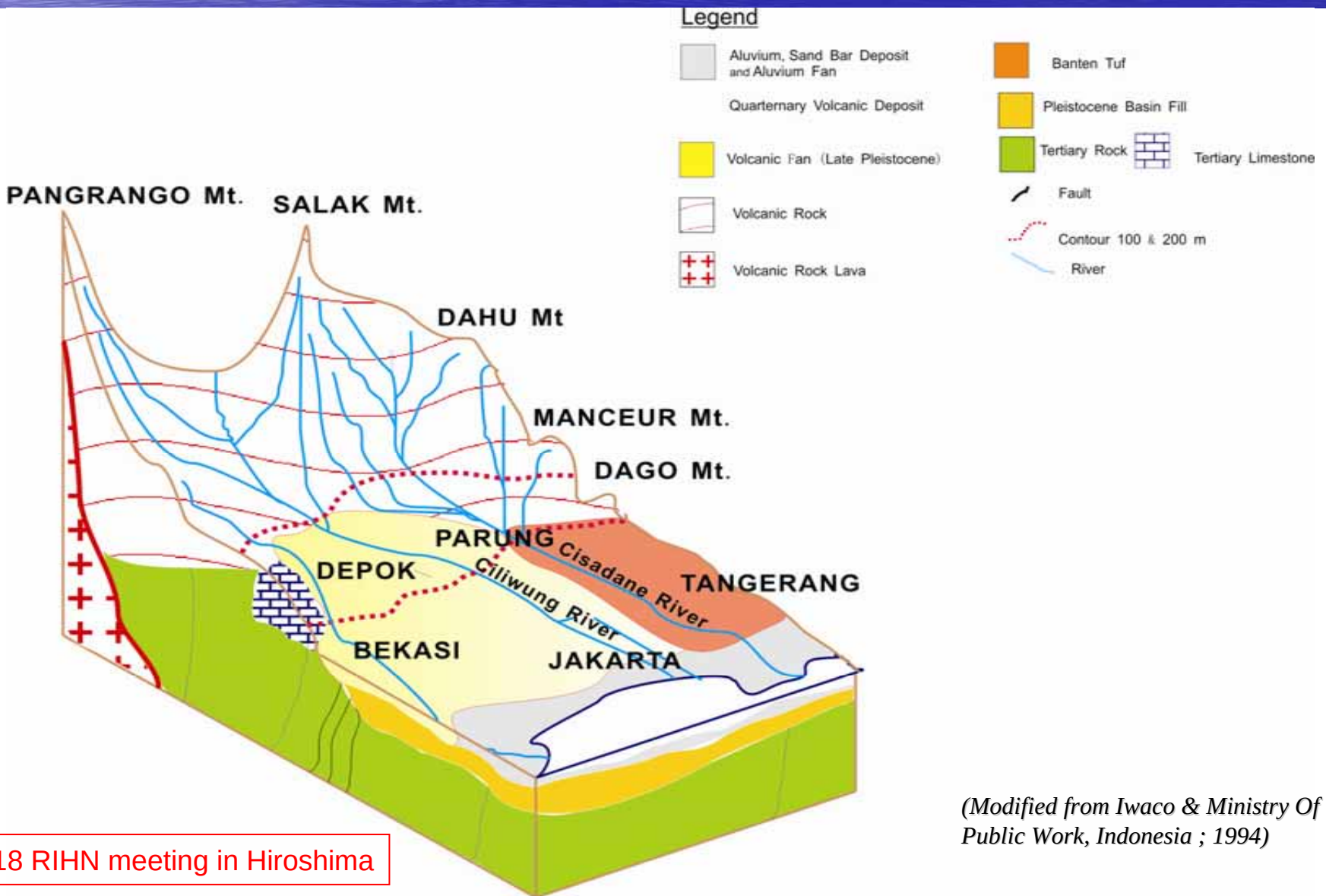
Location and Geological Setting



he most developed basins in Indonesia as s located within the basin, with an elevation between 0 – 1000 m above sea level. Jakarta capital of the Republic of Indonesia, lies on lain of the Java Sea (to the north) and is akarta Bay in the north, West Java province east and Banten province in the west. It is en 106º 33' - 107º 'E longitude and 5º 48' 0" ' S latitude with an area around 652 km^2. rta has a humid tropical climate; annual h between 1500 - 2500 mm due to influence

Greater Jakarta is located in the groundwater basin known as the Jakarta groundwater basin. The base of the aquifer system is formed by impermeable Miocene sediments which also crop out at the southern boundary of the basin. The basin fill, which consist of marine Pliocene and quaternary sand and delta sediments, is up to 300 m thick. Individual sand horizons are typically 1 - 5 m thick and comprise only 20% of the total fill deposits. Silts and clays separate these horizons. Fine sand and silt is very frequent component of these aquifers (Fachry et all, 2003)

Geological Setting
Simplified Model



(Modified from Iwaco & Ministry Of Public Work, Indonesia ; 1994)

JAKARTA, Mega Cities in Indonesia

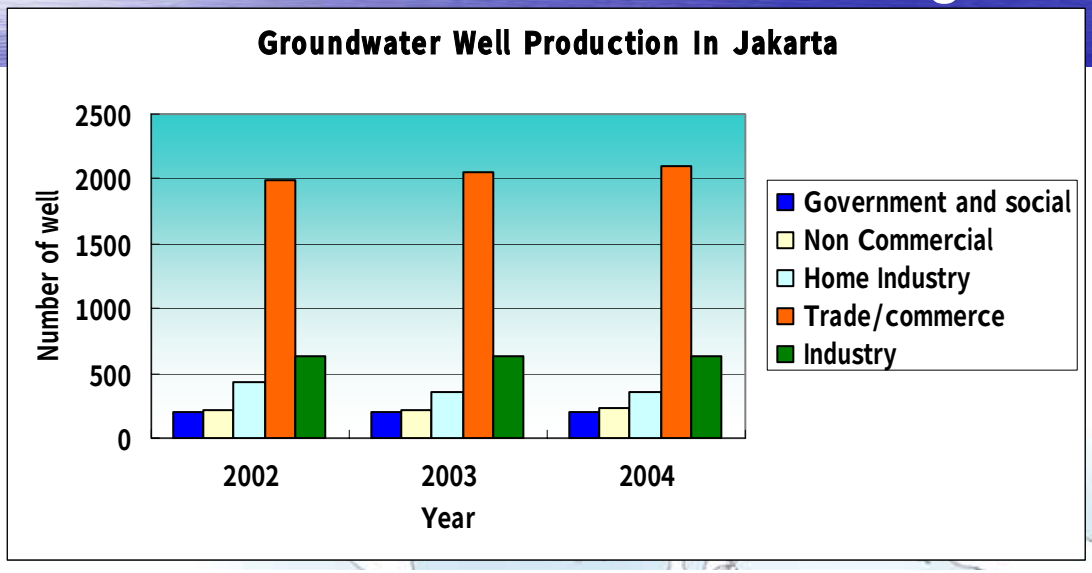
Population Statistics

Year	Population 1950 - 2015	Percentage of urban population (%) 1950 - 2015	Percentage of total population (%) 1950 - 2015
1950	1 452 000	14.7	1.8
1955	1 972 000	17.0	2.3
1960	2 679 000	19.1	2.8
1965	3 297 000	19.6	3.1
1970	3 916 000	19.1	3.3
1975	4 814 000	18.5	3.6
1980	5 985 000	17.9	4.0
1985	6 788 000	15.6	4.1
1990	7 650 000	13.7	4.2
1995	9 161 000	13.0	4.6
2000	11 018 000	12.7	5.2
2005	13 156 000	12.6	5.8
2010	15 341 000	12.7	6.5
2015	17 268 000	12.6	6.9

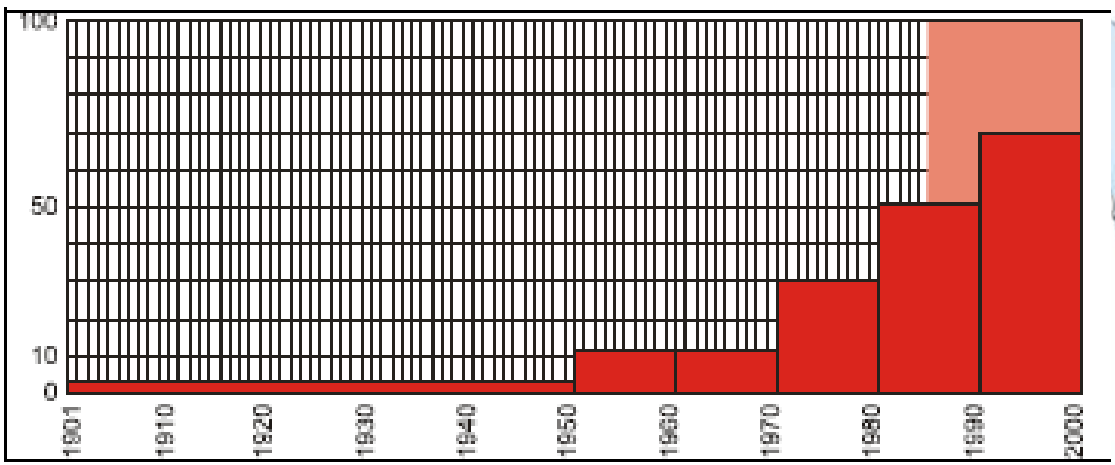
Source: UN 2001

Mega cities can be defined as a city with the human population up to 10 million.

JAKARTA, Mega Cities in Indonesia



- Registered groundwater production in Jakarta area. Total number : 3572 production well. Groundwater production rates in 2004 was 20.844.111 m^3/year
- (Mine Service, Jakarta Metropolitan Gov, 2005)



- Estimated annual groundwater production in the greater Jakarta area
- in million m^3. The production rates after 1985 in particular are of a tentative character
- (Schmidt, 2004)

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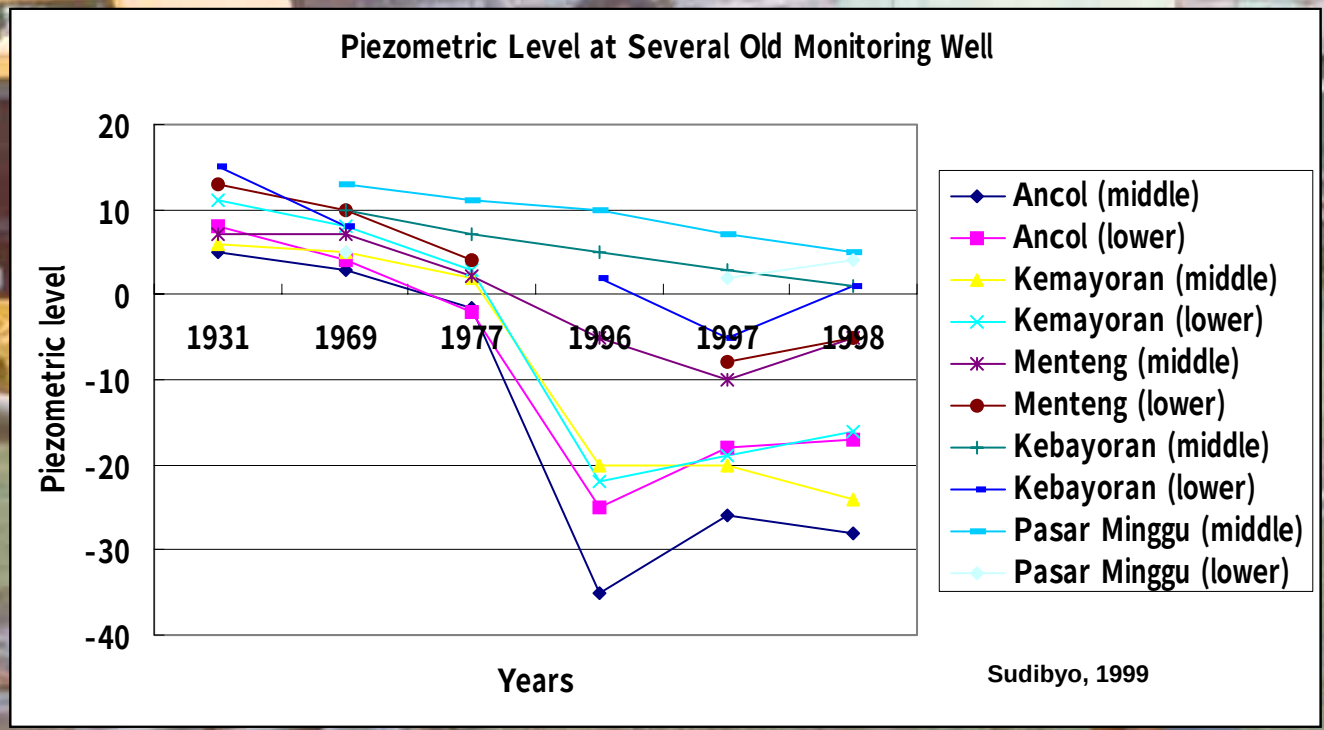
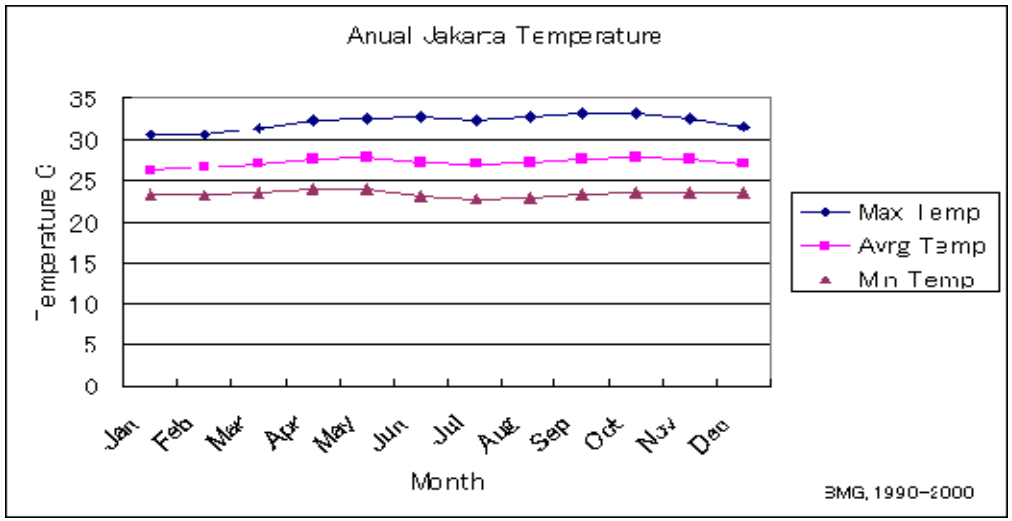


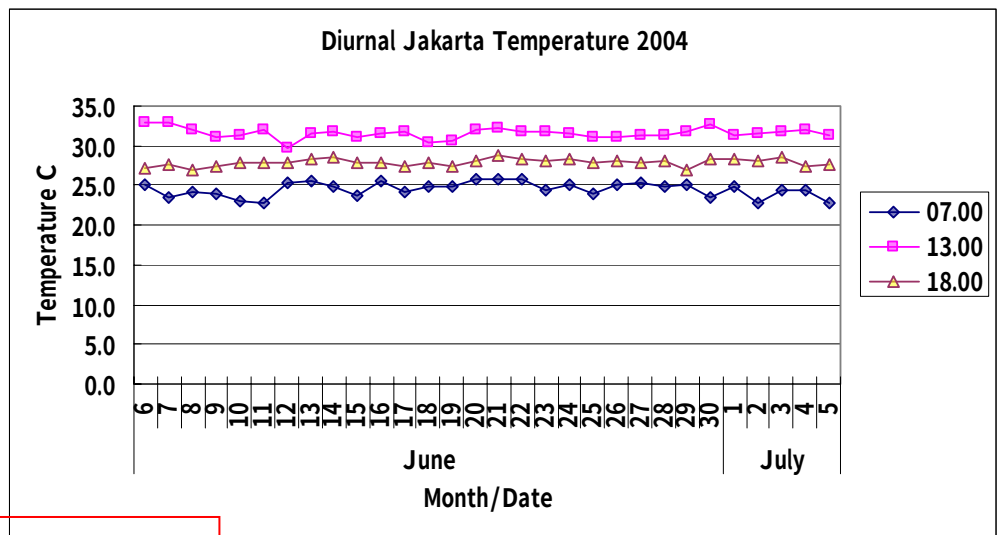
• OBSERVATION WELLS

Location	Monthly Average Water Level -m											Remark
	80	81	82	83	84	85	86	87	88	89	90	m
Kebun Kacang						11.6	11.5	12.4	13.4	13.5	12.9	1.3*
Senayan				10.7	10.6	11.7	12.2	12.7	13.5	15.6	17.1	6.4*
Pulo Gadung							18.7	24.4	25	21.5	23.5	4.8*
Cengkareng I						3.1	6.2	7.7	7.4	6.2	7.2	4.1*
Cengkareng II						29.1	30.5	30.6	31.1	32.9	34.2	5.1*

Source: Research Institute for Water Resources ***Decrease***

Annual and Diurnal Jakarta Temperature





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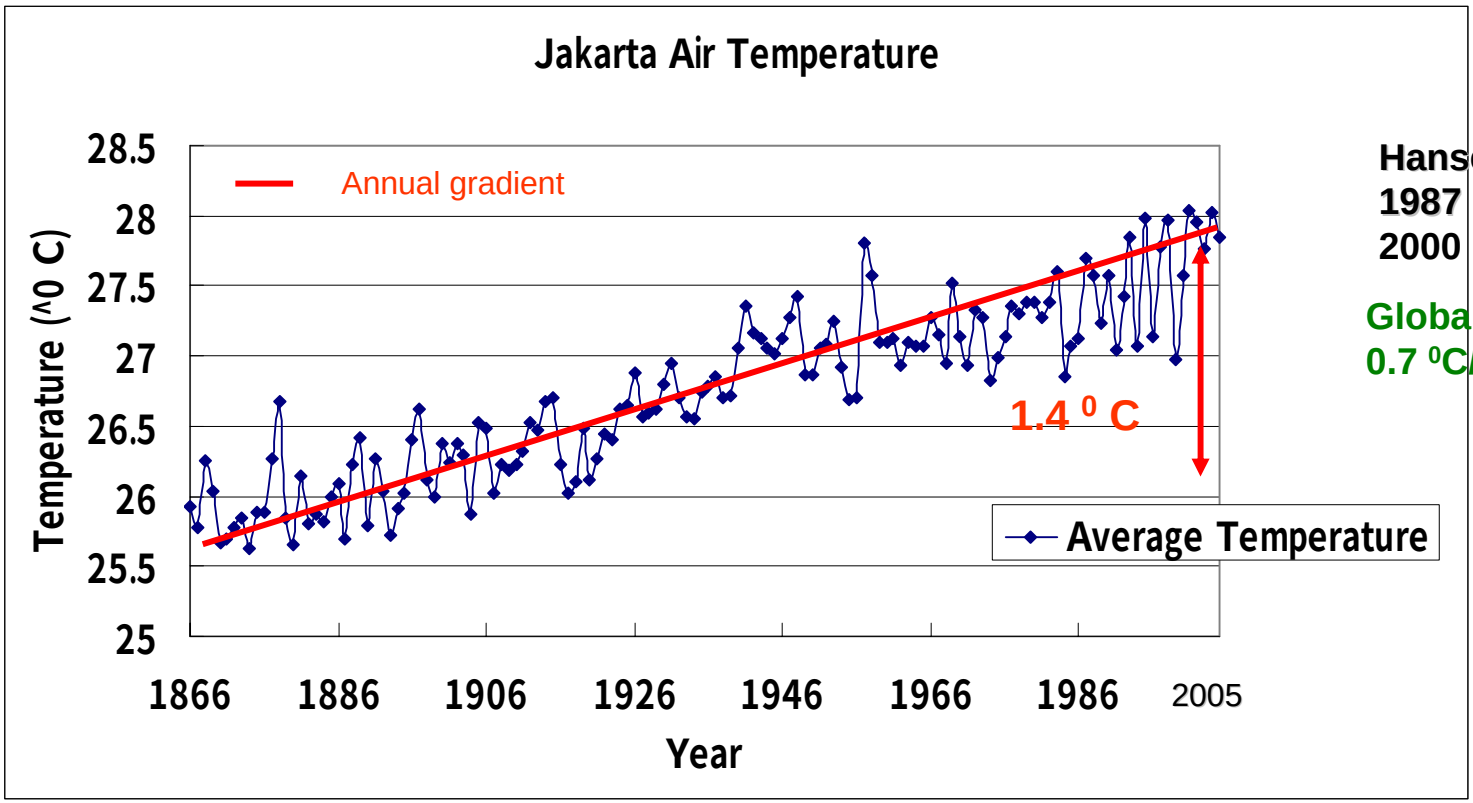
AIR TEMPERATURE AT JAKARTA



Hansen and Lebendeff, 1987 ; Huang et.all, 2000 :

Global warming : 0.5 – 0.7 ^{0}C/100 year

The rest is effect of heat island

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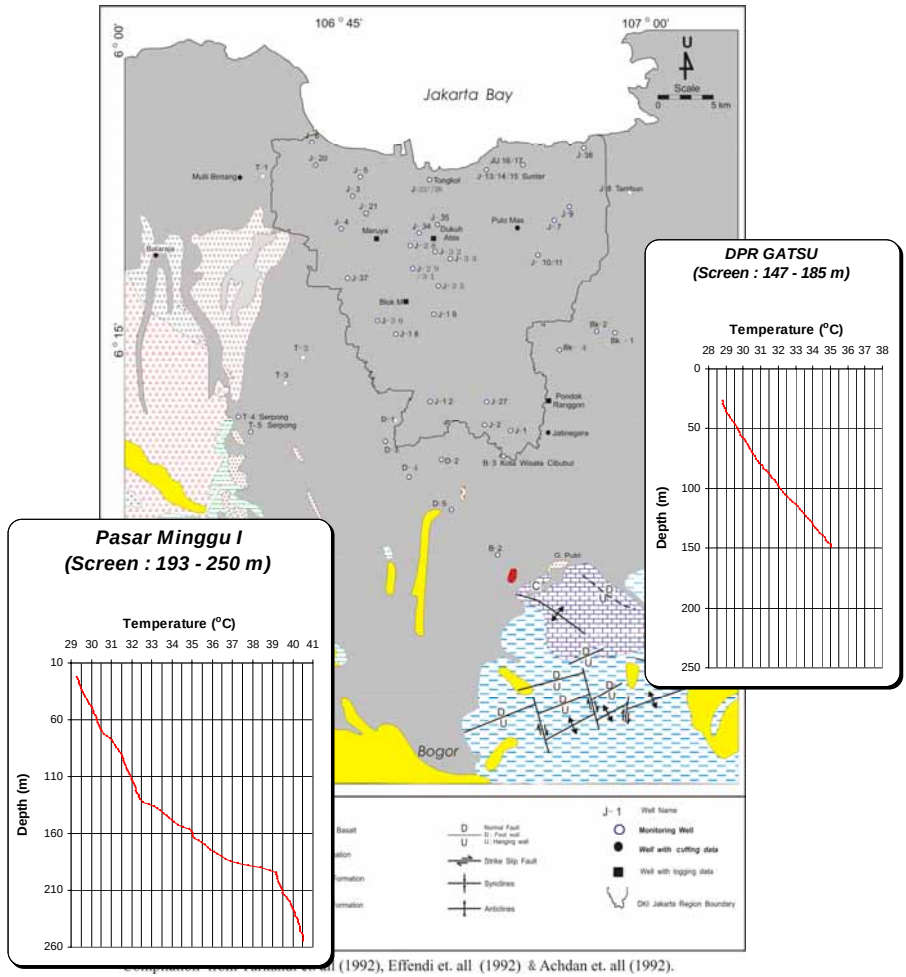
Indonesia Ministry of Environment & NOAA, BMG

Method
Thermal Measurement Data From Borehole Observation Well

The thermal profiles and water levels in 30 selected wells from 56 observation wells (40 – 250 m deep) were measured in the study area, on 4-21 September, 2006. The result will be compared by previous measurement on July, 2004

The thermal-profile measurements were made at 2-m intervals from the water level to the bottom of the hole with a digital thermister thermometer of 0.01 ° C precision.

The boreholes selected are monitoring well, therefore ideal for thermal studies. Due to the time elapsed since their construction, they can be considered to have attained steady-state thermal conditions.



(1992), Effendi et. all (1992) & Achdan et. all (1992).

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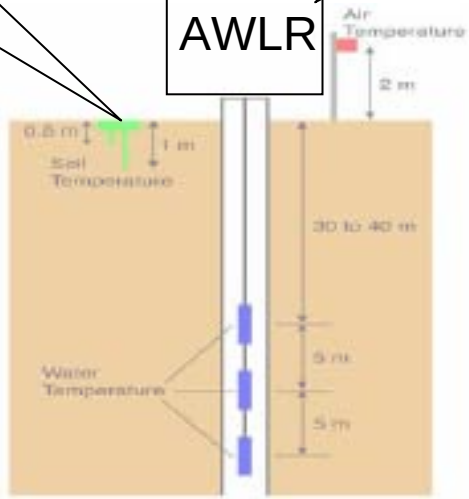
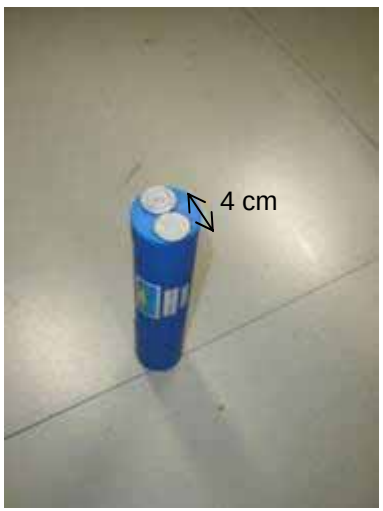
Soil temp measurement
(1 meter above)

Replacement new Water level recorder pressure measurement type

AWLR



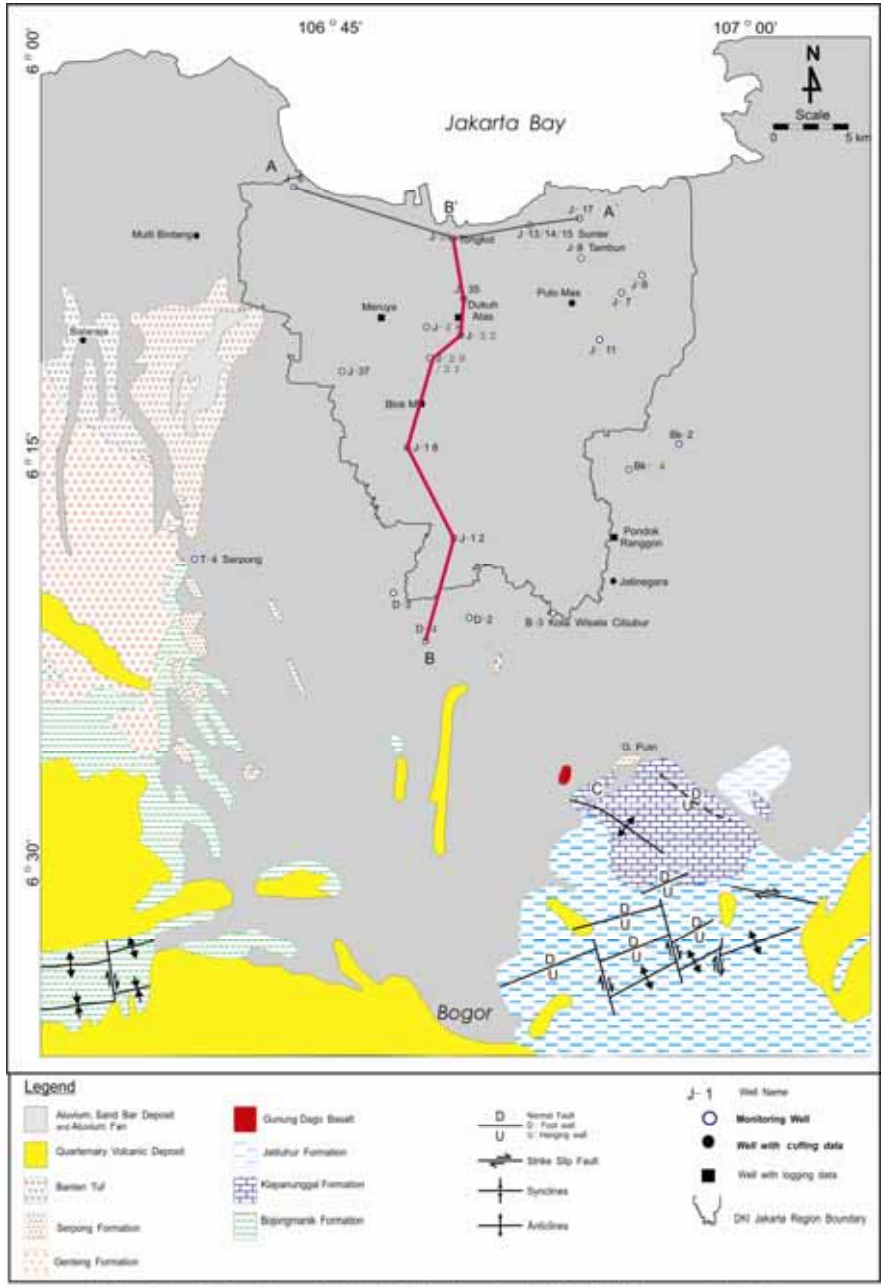
Continuous GST Measurement & Schematic Site Location



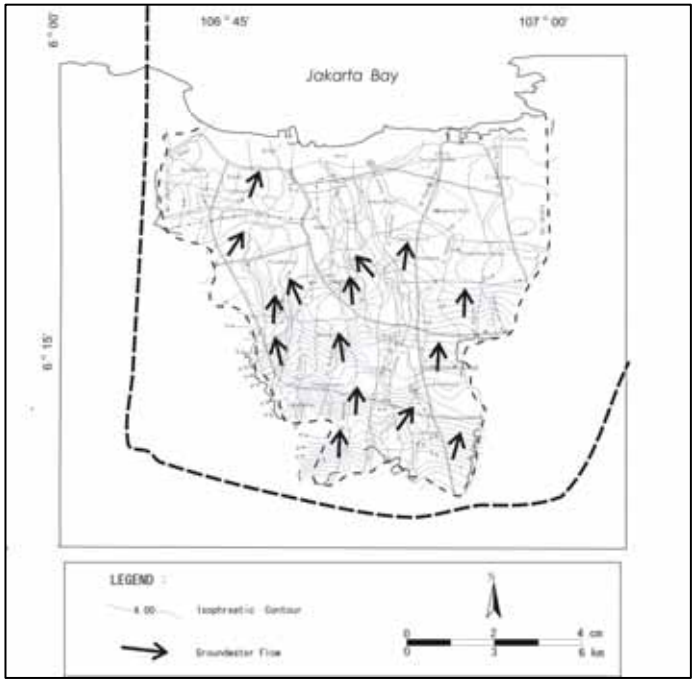
- **It will put on 35 – 40 -45 m under the surface.**
- **Together with automatic soil temperature measurement (50 cm & 1 meter under the surface), automatic air temperature measurement (2 meter) and automatic water level measurement (Pressure system)**

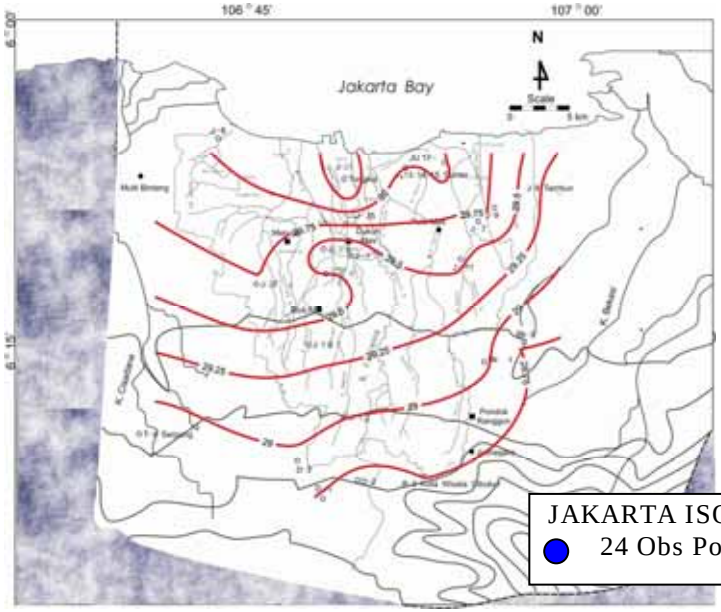
T-D Profile
& Determined Continuous GST Measurement Position
In Jakarta Groundwater Basin

Cross Section South - North

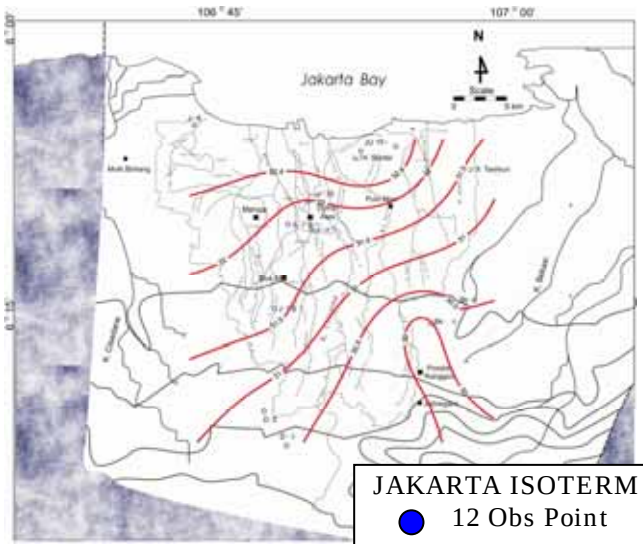


Compilation from Turkandi et. all (1992), Effendi et. all (1992) & Achdan et. all (1992).

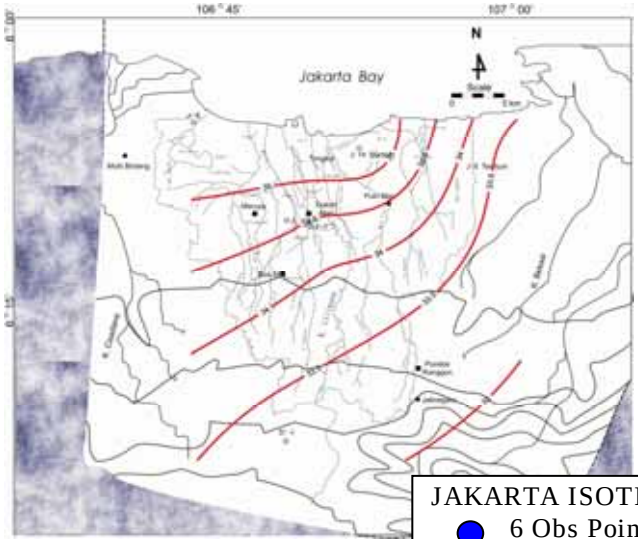




JAKARTA ISOTERM 40 M
24 Obs Point

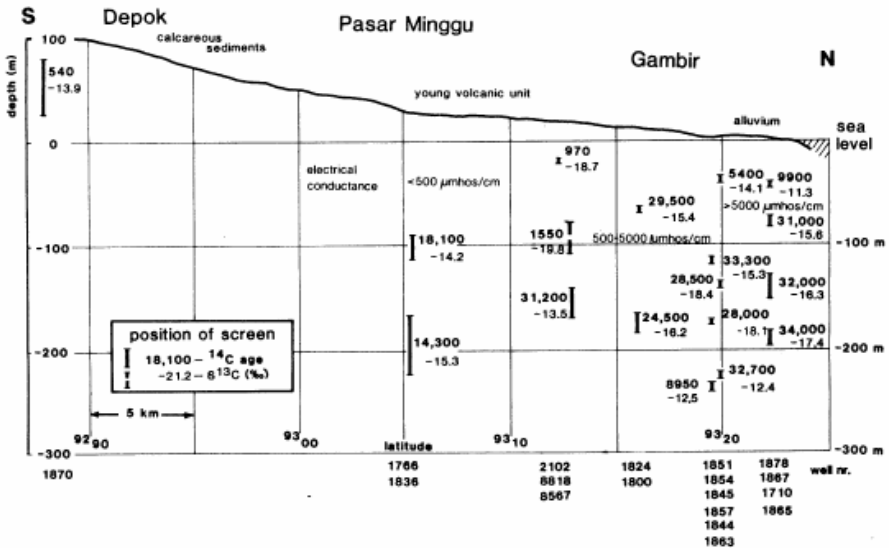


JAKARTA ISOTERM 95 M
12 Obs Point



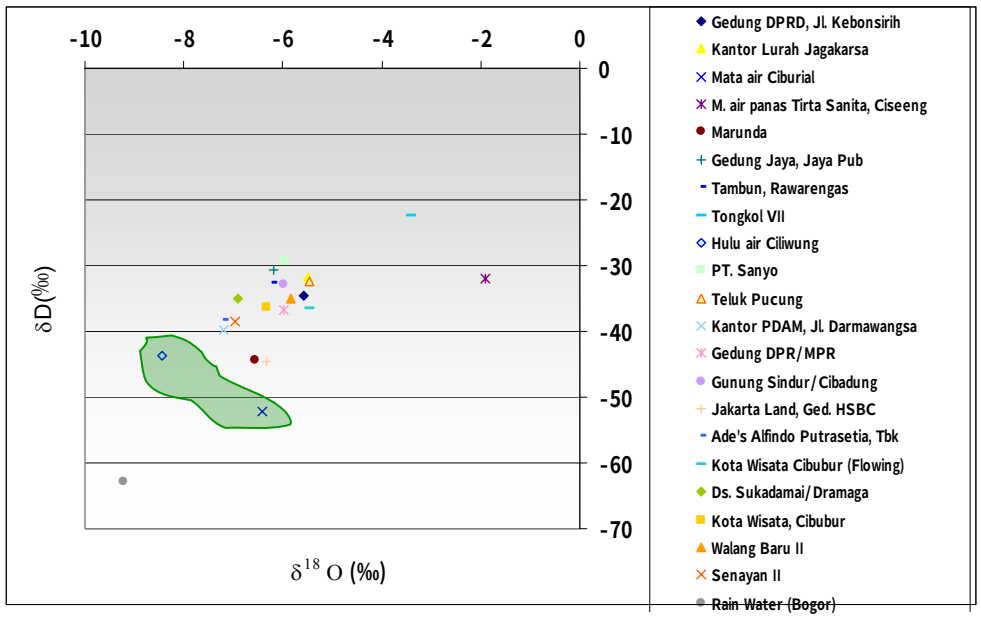
JAKARTA ISOTERM 140 M
6 Obs Point

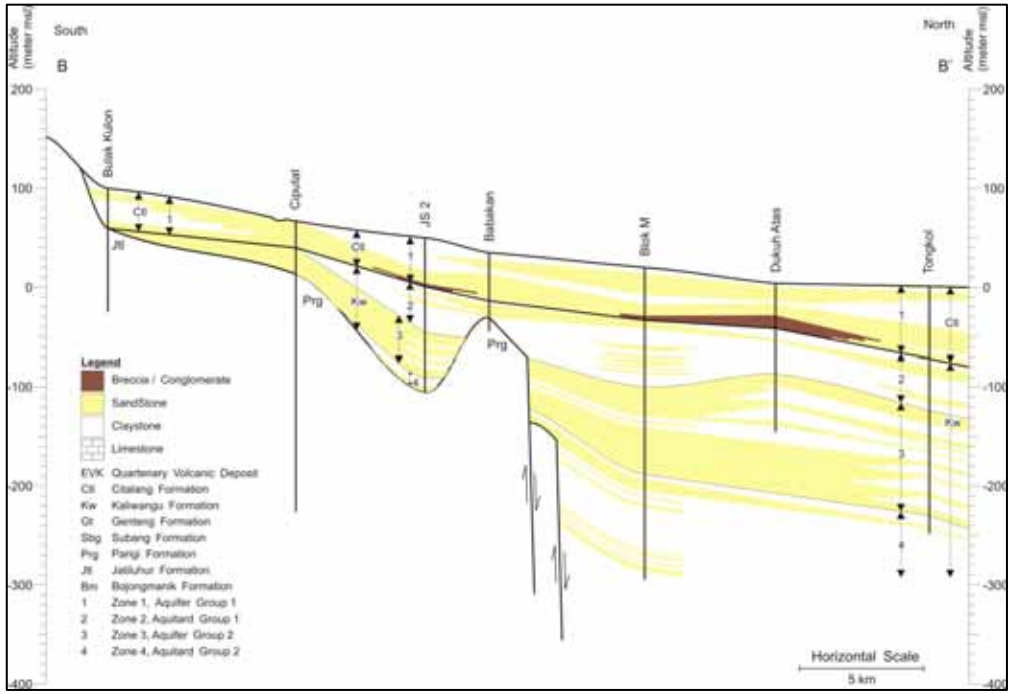
ISOTOPE AS A TRACER

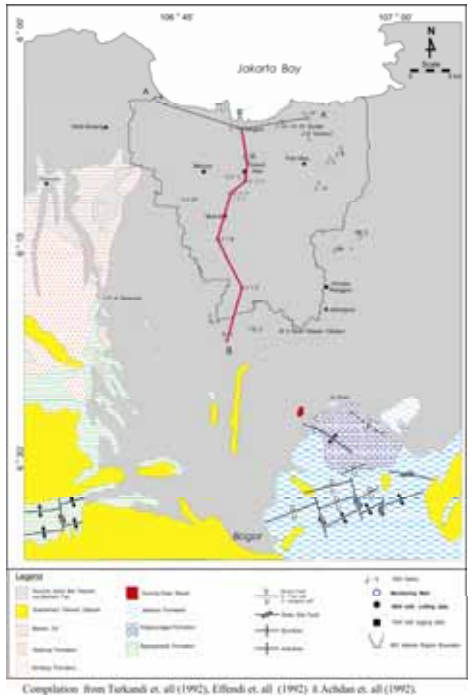


Conventional ^{14}C ages and $\delta^{13}C$ values of representative groundwater samples from the Jakarta City District vs sampling depth (Geyh & Sofner, 1989)

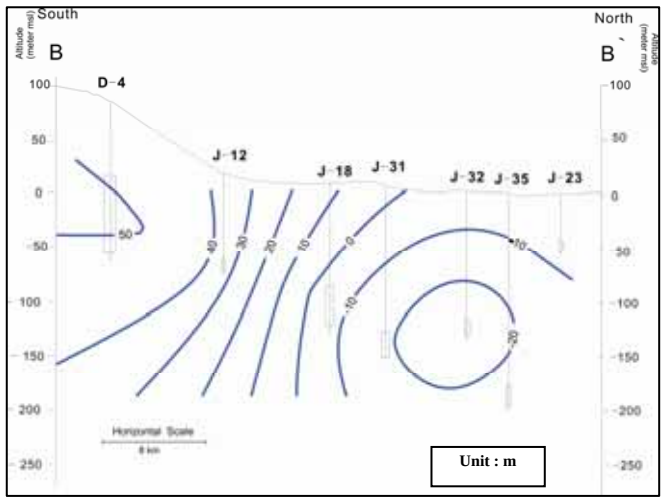
Spring and surface water

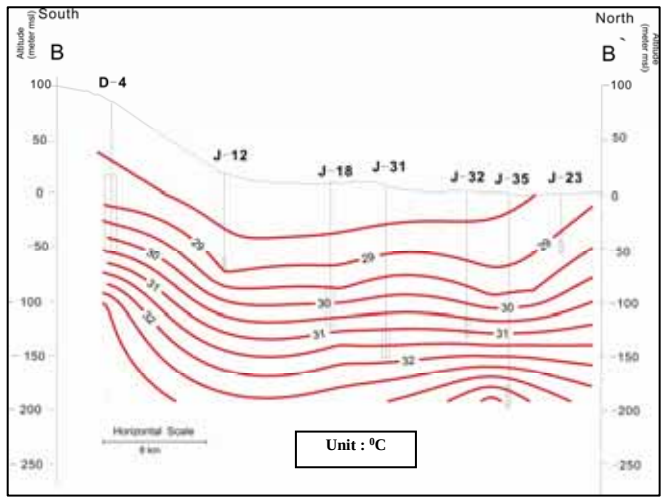




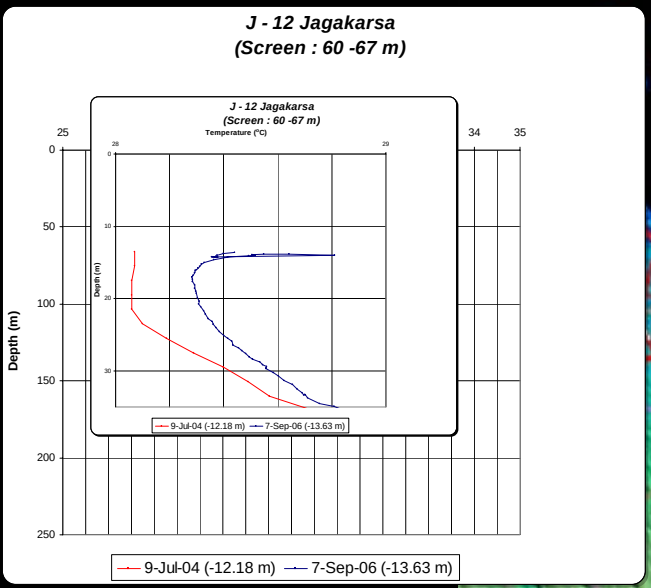


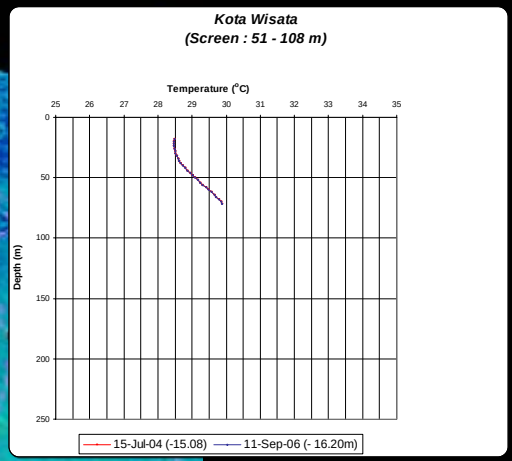
Compilation from Turkandi et. all (1992), Effendi et. all (1992) & Achdan et. all (1992).

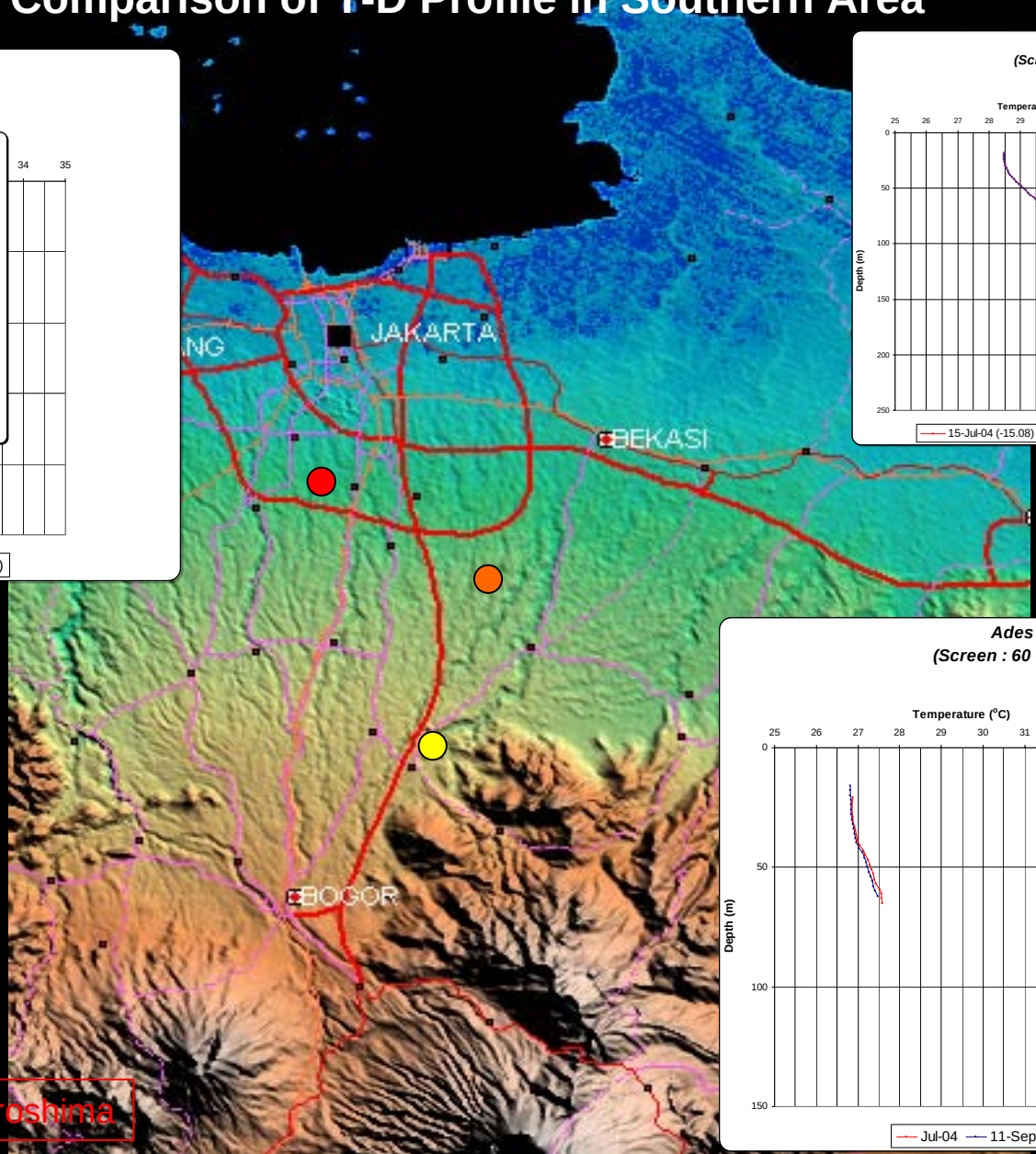


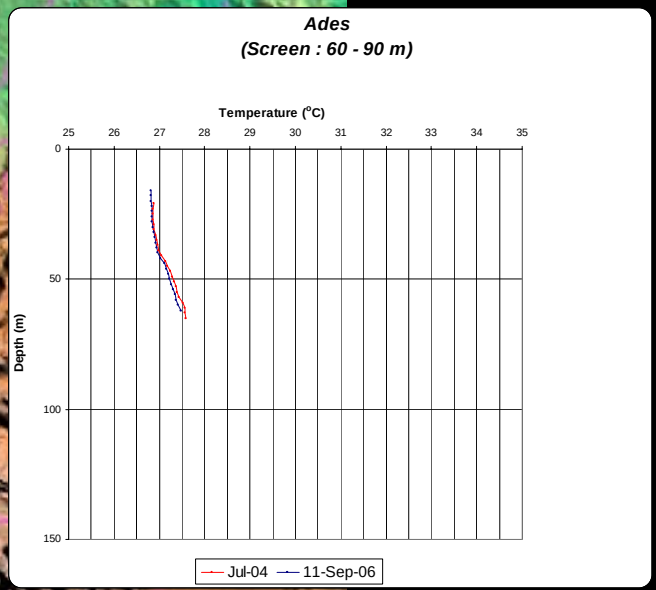


Comparison of T-D Profile in Southern Area









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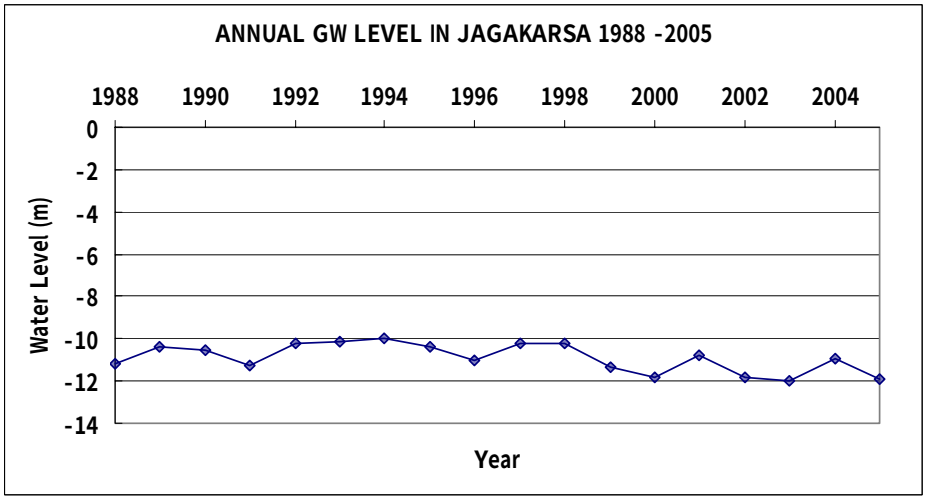

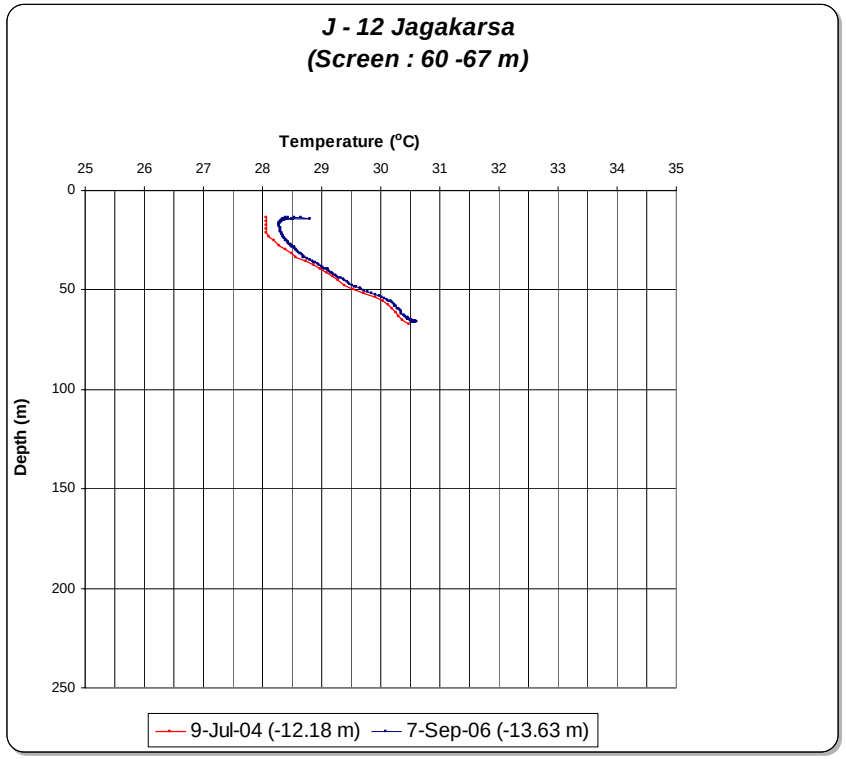

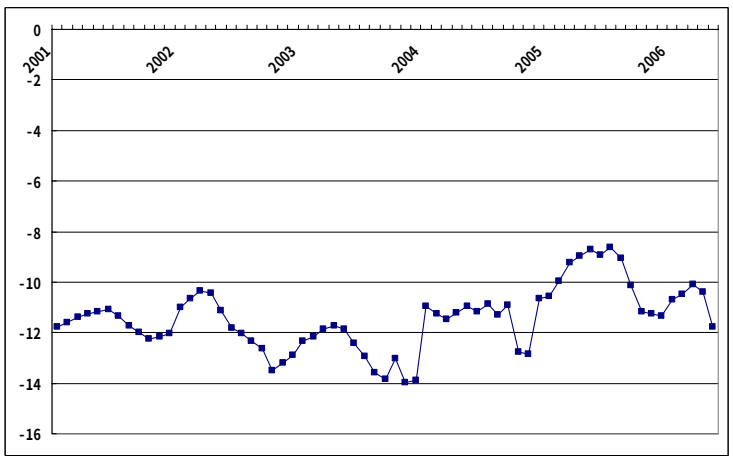

Jagakarsa J-12

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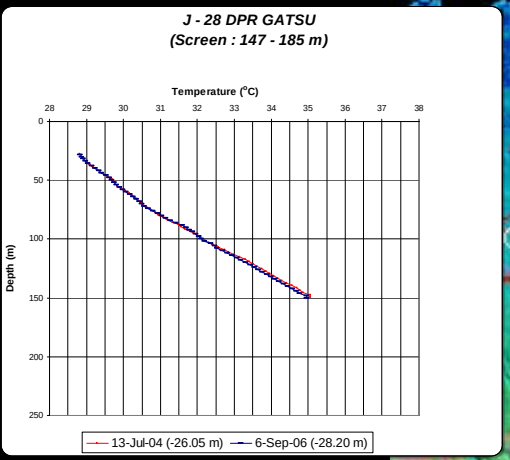
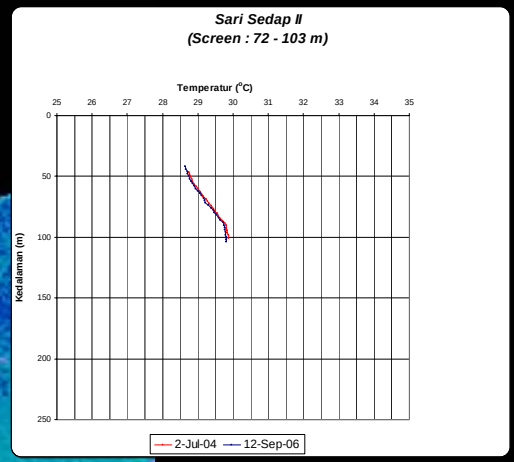
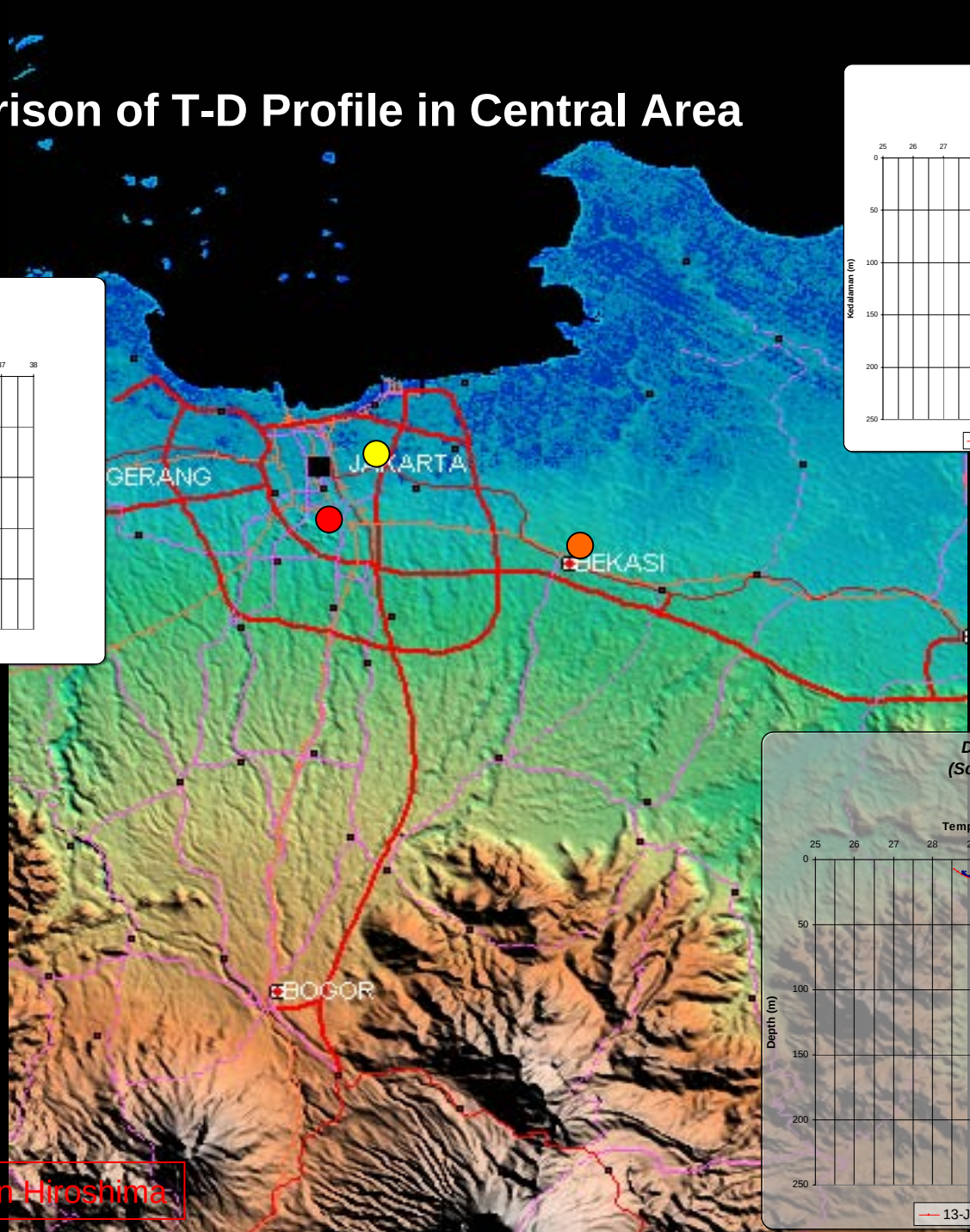
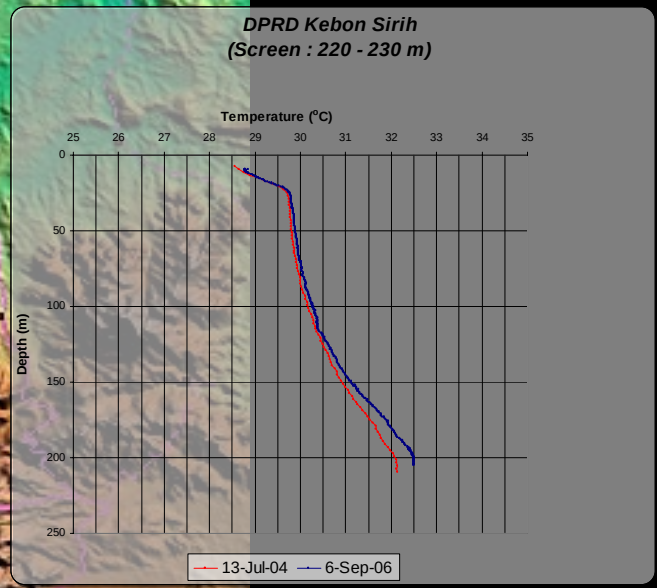
Comparison of T-D Profile in Central Area









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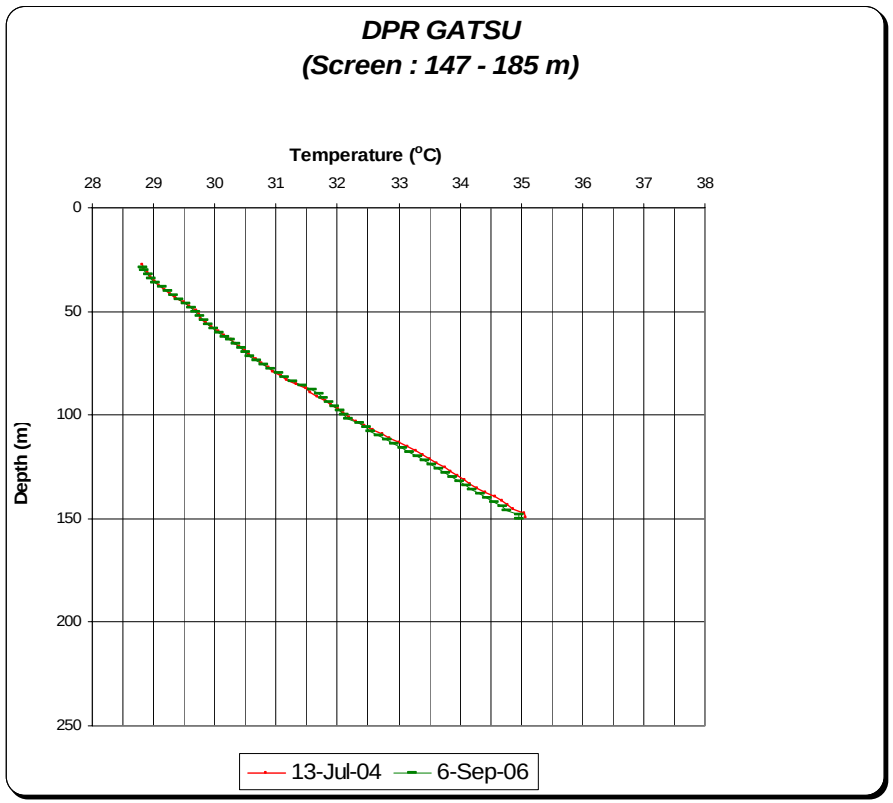
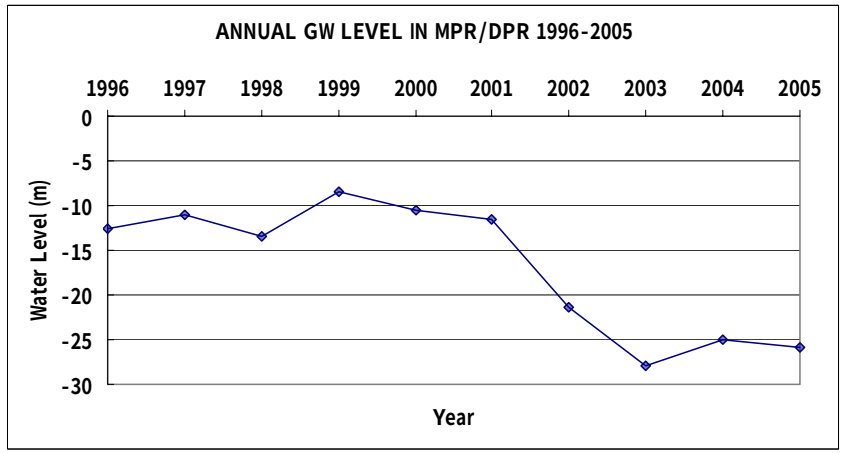
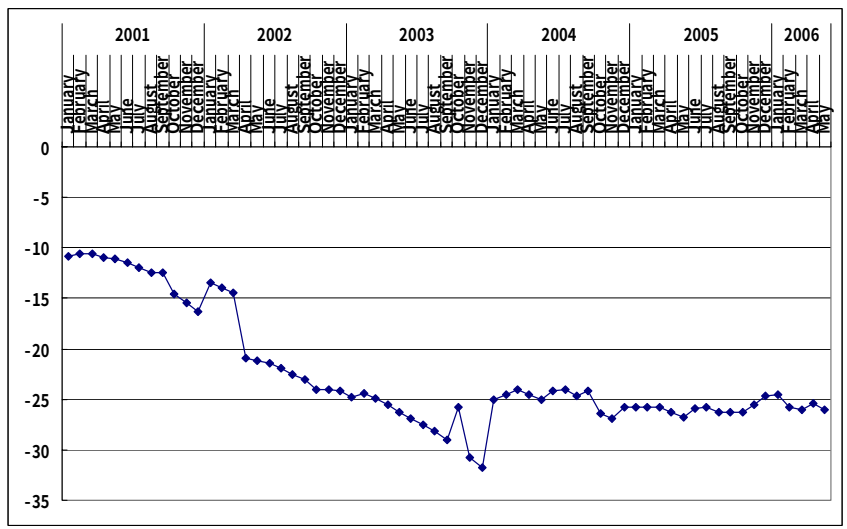
DPR GATOT SUBROTO (Parliament Building) J-28







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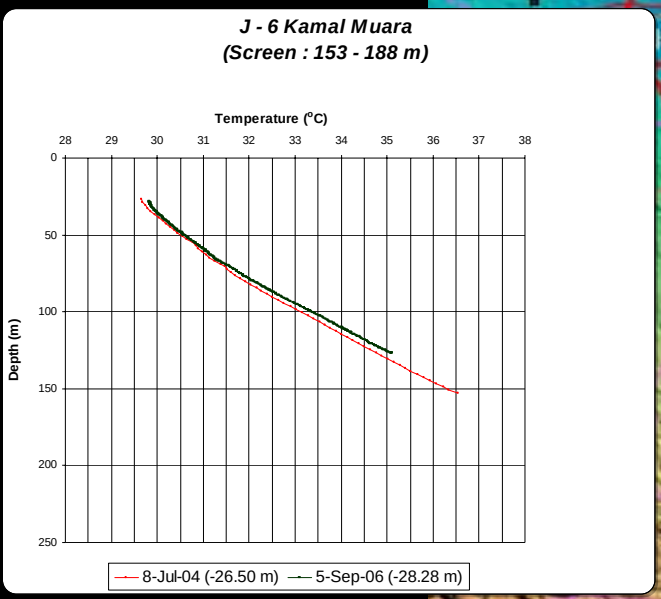
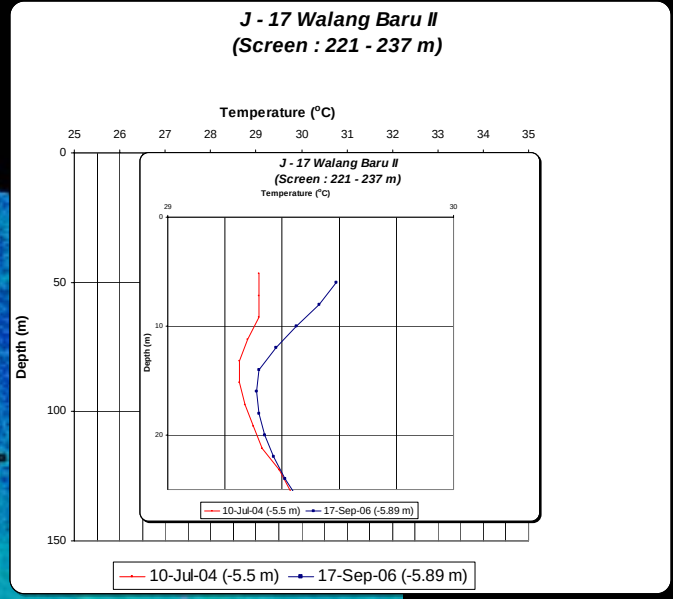
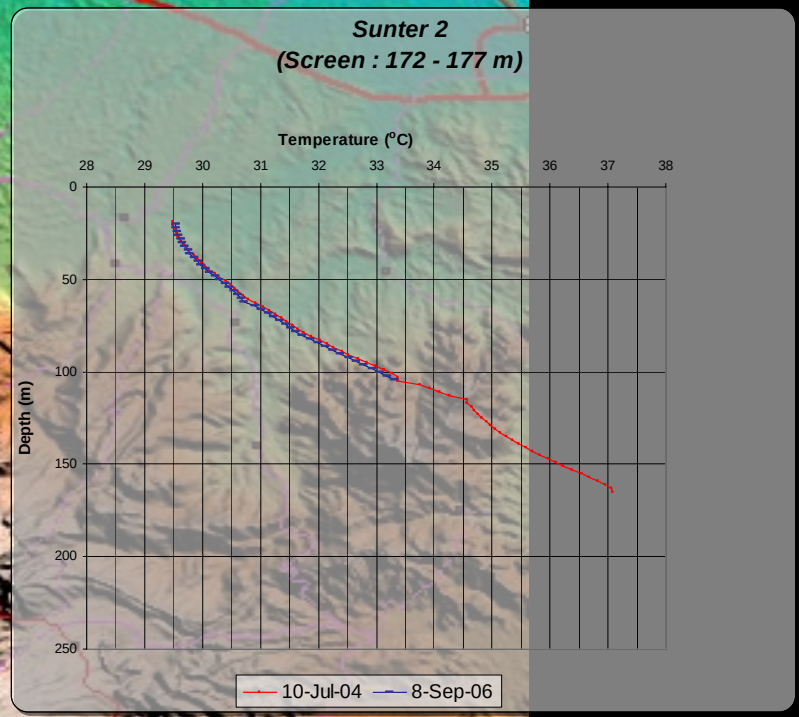
Comparison of T-D Profile in Northern Area







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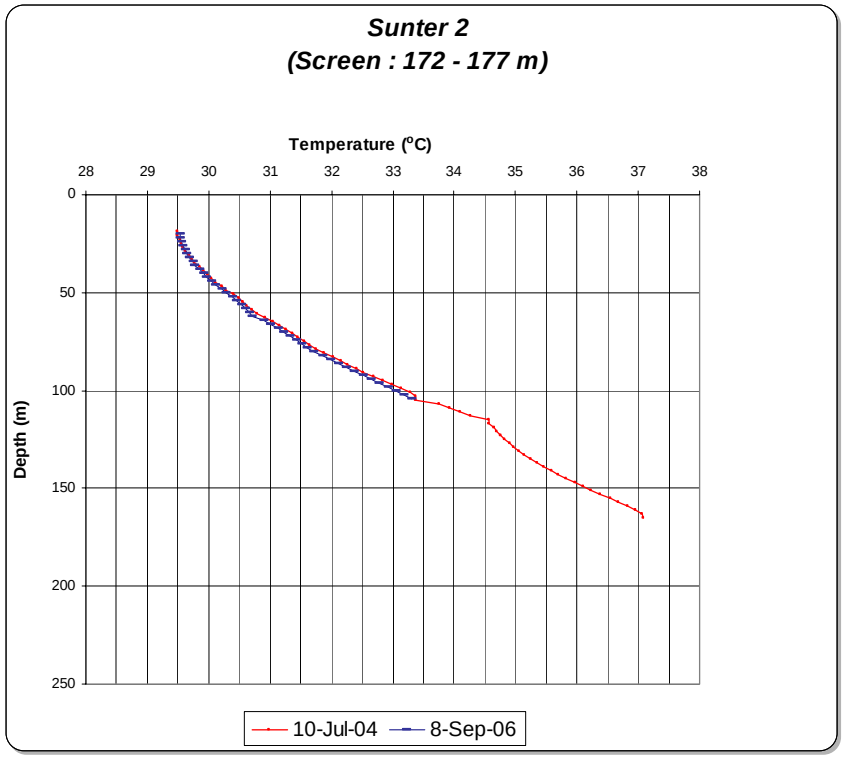
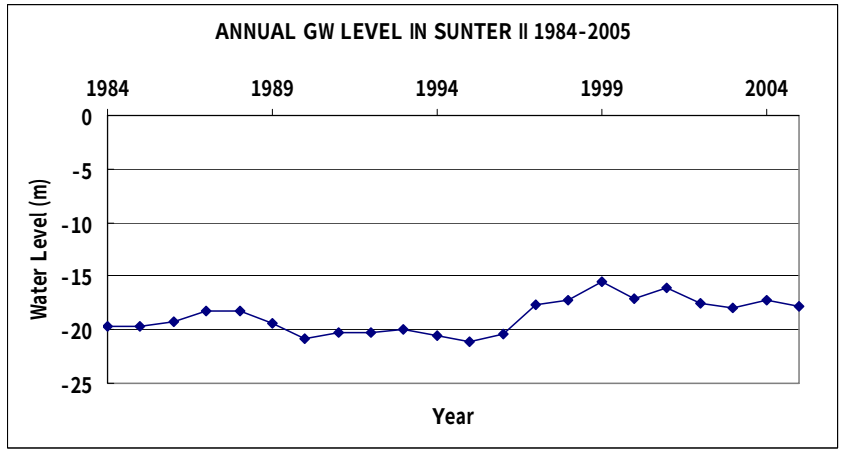
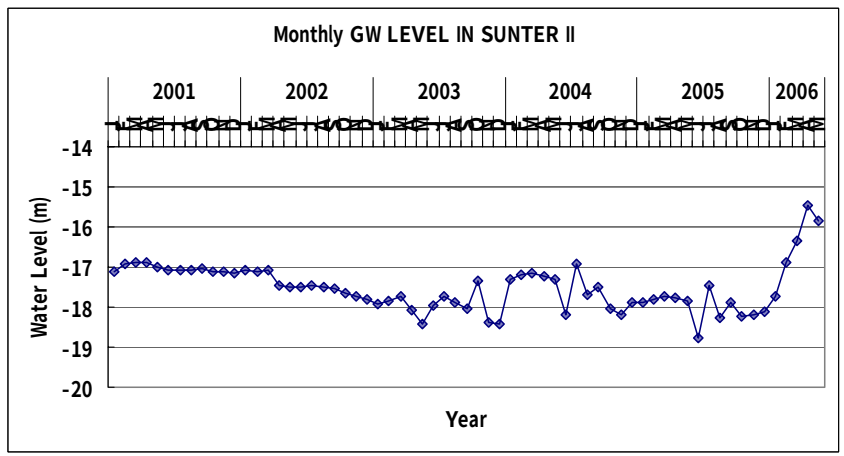
J-14 Sunter II







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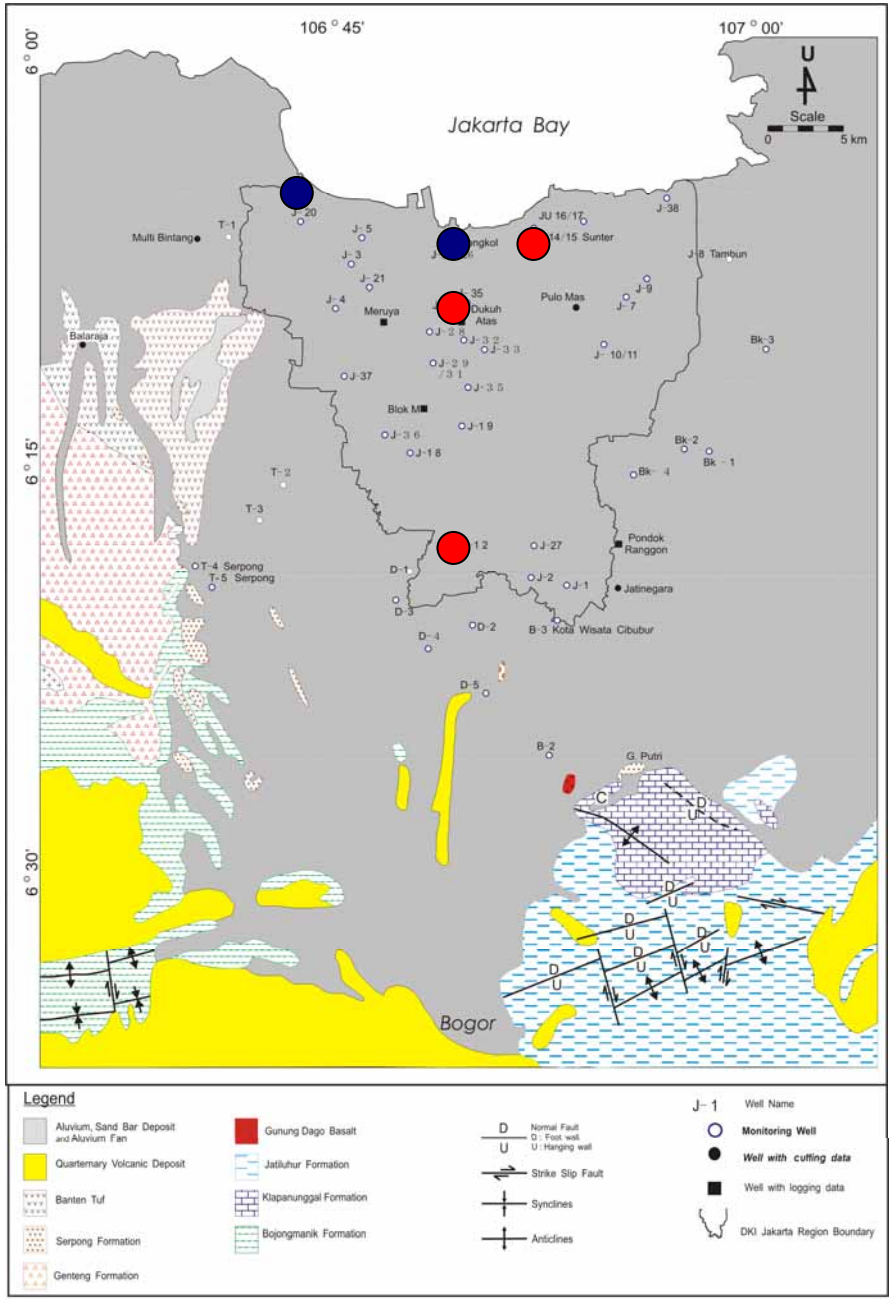


Compilation from Turkandi et. all (1992), Effendi et. all (1992) & Achdan et. all (1992).

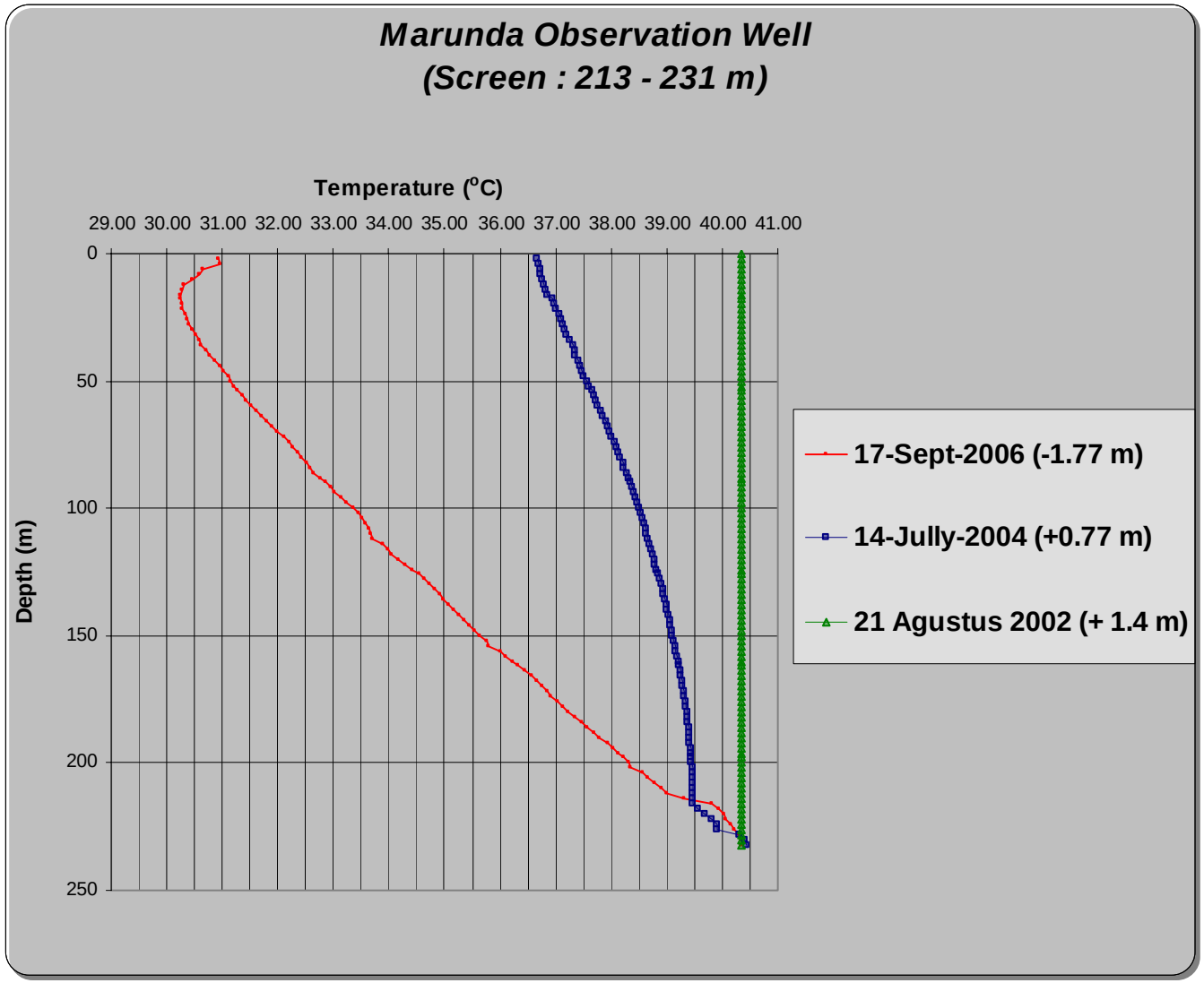
GST Location

Base on Data Analysis from selected observation well

Remarks :

- GST location include automatic water level measurement (pressure system)
- Water level measurement (pressure system) only

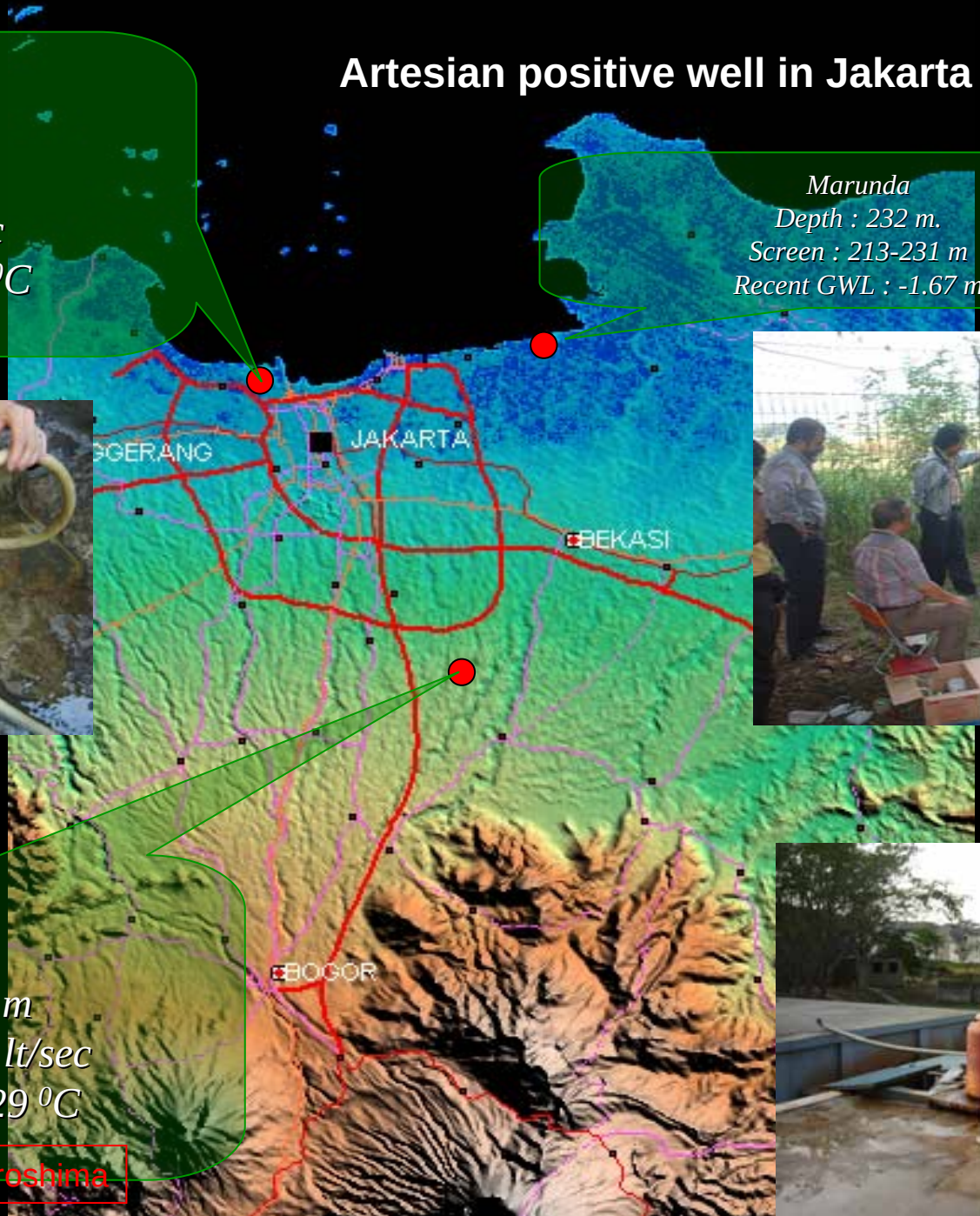
Discussion


Marunda Observation Well
(Screen : 213 - 231 m)
Temperature (°C)
29.00 30.00 31.00 32.00 33.00 34.00 35.00 36.00 37.00 38.00 39.00 40.00 41.00
Depth (m)
0
50
100
150
200
250
17-Sept-2006 (-1.77 m)
14-Jully-2004 (+0.77 m)
21 Agustus 2002 (+ 1.4 m)

Artesian positive well in Jakarta GW Basin

Tongkol XII
Depth : 280 m.
Screen : 267 -278 m
Discharge : 0.2 lt/sec
Water Temp : 36.84 ^{0}C

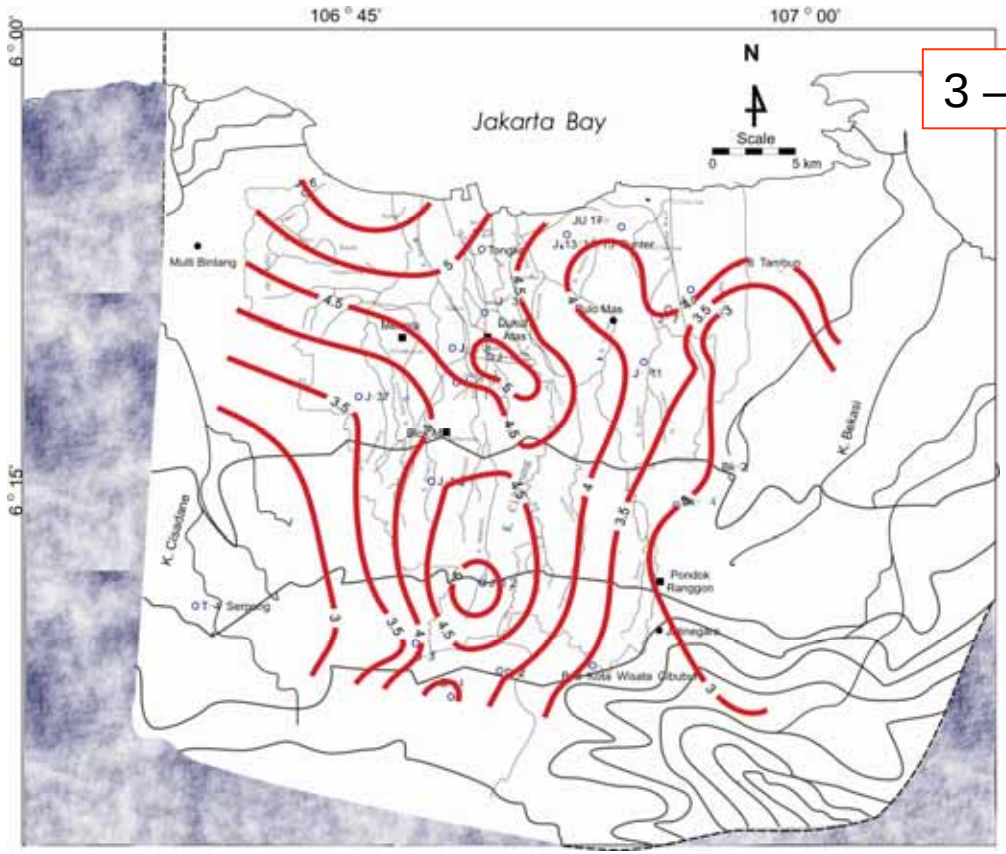
Marunda
Depth : 232 m.
Screen : 213-231 m
Recent GWL : -1.67 m



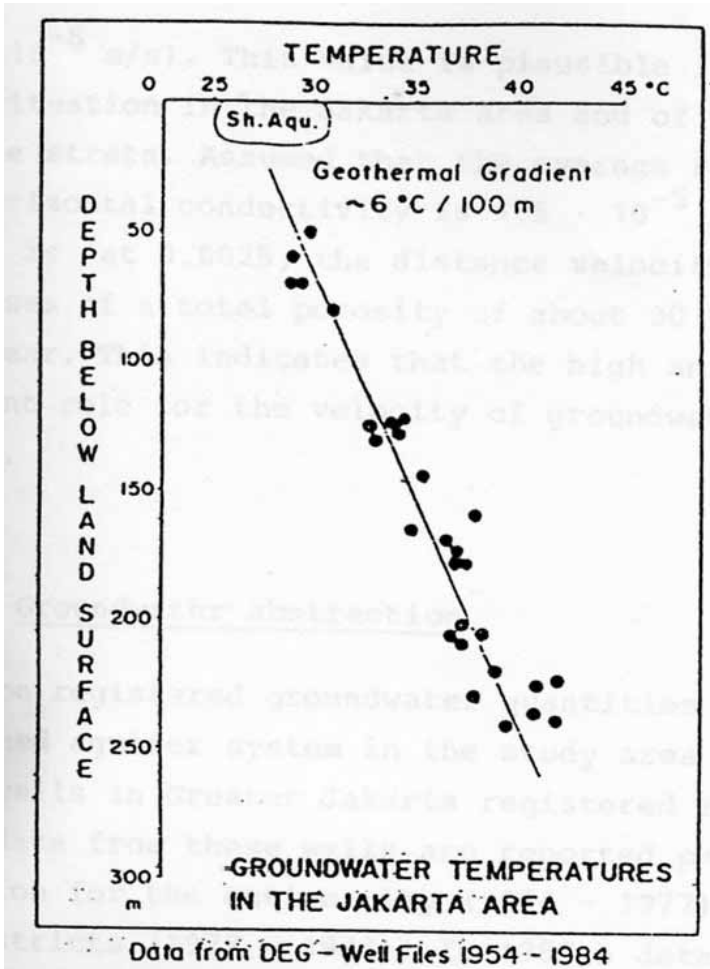
Kota Wisata
Depth : 240 m.
Screen : 230 -240 m
Discharge : + 1.2 lt/sec
Water Temp : 37.29 ^{0}C

H18 RIHN meeting in Hiroshima

Distribution of subsurface temperature gradient.



3 – 5.5 ^{0}C / 100 m



Previous groundwater temperatures measurement in Jakarta (Sofner et.all, 1986) state that thermal gradient was 6^0 C / 100 m.

H18 RIHN meeting in Hiroshima

Due to the previous measurement on July 2004 and September 2006, they can be considered :

1. Effects of surface layer to the subsurface temperature distribution is caught in 0 to -30m depth, the natural regional groundwater flow still remain in the deeper part of the urban area
2. Change of the hydraulic head can be analyzed from T-D profile and show the impact of human activity.
3. High Gradient temperature are indicate in this area.
4. In order to infer past climatic change, the effect of past environmental change in this area should be considered.

THANK YOU FOR YOUR ATTENTION

Also knowing as Ontoredjo, Antareja is a son of Bima and his wife Dewi Nagagini, the daughter of Sang Hyang Antoboga, a god ascetic living in the seventh layer of the earth. From this marriage, a true powerful ksatria, Antareja was born. Educated and trained by his own grand-father, Antareja became an unbeatable warrior.

He was so strong with tremendous magic power. He can live and walking under the earth subsurface, He also by simply licking the footprint of someone, the person would die.