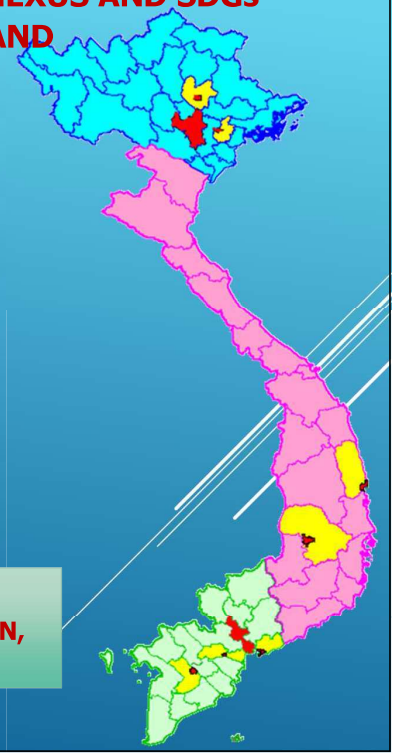
THA 2019 INTERNATIONAL CONFERENCE ON WATER MANAGEMENT AND CLIMATE CHANGE TOWARDS ASIA'S WATER – ENERGY – FOOD NEXUS AND SDGs
23-25 JANUARY, 2019 - BANGKOK THAILAND

# GROUNDWATER PROTECTION IN LARGE CITIES OF VIETNAM



**BUI TRAN VUONG**
NATIONAL CENTER FOR WATER RESOURCES PLANNING AND INVESTIGATION,
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT, VIETNAM

## CONTENT

# PROJECT INFORMATION

## PROJECT'S OBJECTIVES

Assessment of groundwater resources in order to propose technical solutions for protection groundwater for large cities.

## PROJECT ACTIVITIES

**Investigation and assessment of groundwater resources**

| Distribution | Quantity | Quality | Self- protection ability | Problems on GW resources |
|---|---|---|---|---|

**Groundwater protection solution**

| Recharge protection zoning | Prohibited and limited zoning | GW abstraction Planning | GW monitoring network | GW artificial recharge |
|---|---|---|---|---|

**GW database**

| Monitoring database | Synchronization in database management |
|---|---|

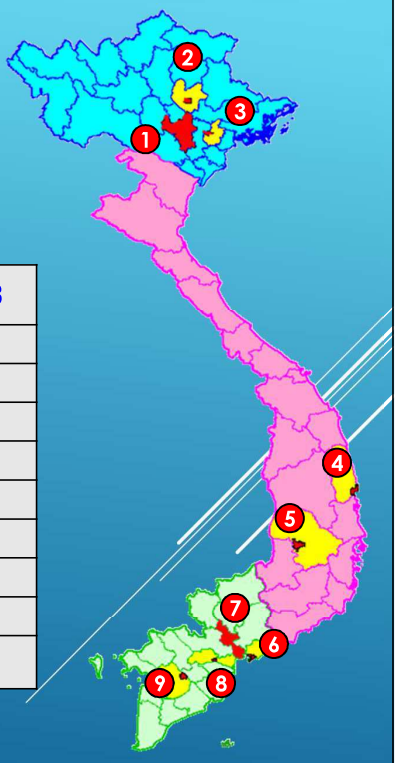
# PROJECT INFORMATION

## Study areas and implementation time

Phase I (2013 - 2018): 9 large cities

Phase II (2019 - 2025): The rest cities

| STT | Cities | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|
| 1 | Hanoi | x | x | x | x | x | |
| 2 | Thain Nguyen | | | | x | x | x |
| 3 | Hai Duong | | | | x | x | |
| 4 | Quy Nhon | | | | | x | x |
| 5 | Buon Me Thuot | x | x | x | x | x | |
| 6 | Vung Tau | | | | | x | x |
| 7 | Hochiminh | x | x | x | x | x | |
| 8 | My Tho | | | x | x | x | x |
| 9 | Can Tho | | | | | x | x |



# MAIN RESULTS

**In 9 key large cities**

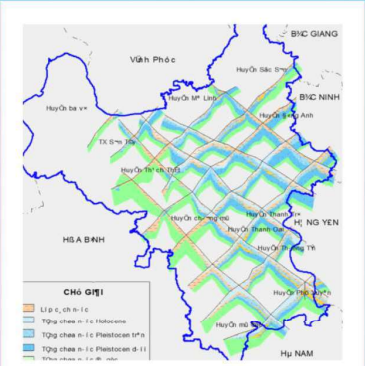
- There are 36 aquifers that need to be protected;
- GW potential is **24.482.830** $m^3$/day
- Safe yield is **8.427.942** $m^3$/day
- The amount of GW abstraction is **2.617.914**$m^3$/day by 1.142.611 wells.

1. Depletion
2. Pollution
3. Lan surface subsidence
4. Saline intrusion

# MAIN RESULTS Ha Noi capital

**GW resources**

- 16 aquifers, of which 4 aquifer (qh; $qp_2$; $qp_1$; $n_2$) need to be protected.
- GW potential: 10.042.588 $m^3$/day.
- Safe yield 4.076.365 m3/day.
- GW abstraction amount 1.248.037 $m^3$/day với 753.517.




**GW protection solutions**

- Areas needs to be protected: 61km2 of outcropt area and 218km2 of weak self-protection areas
- Well head protection zones for 21 GW supply plants
- GW abstraction must be limited at 19 areas in qh aquifer and at 16 areas in qp aquifer
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 1.245.700; 1.565.700; and 1.665.700 $m^3$/day, respectively.
- The completed GW monitoring consists of 217 existing monitoring wells and 107 new added monitoring wells.
- 6 areas are recommended to implement a pilot project on artificial recharge

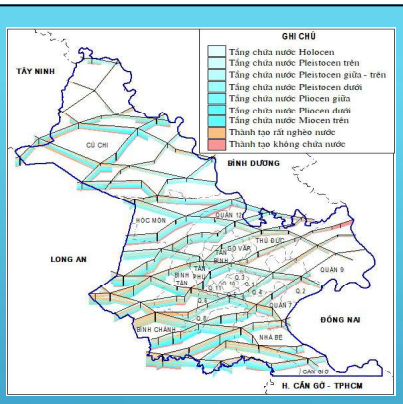
# MAIN RESULTS HOCIMINH CITY

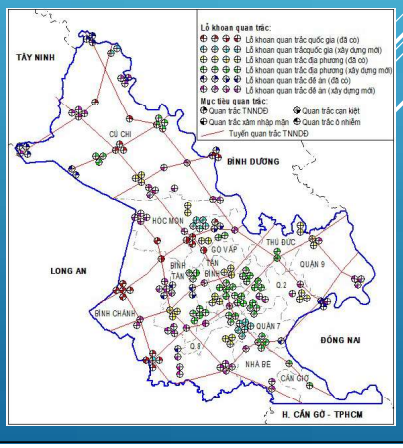
## GW resources

- 7 aquifers, of which 6 aquifers qh, $qp_3$, $qp_{2-3}$, $qp_1$, $n_2^2$ và $n_2^1$ need to be preotected
- GW potential is **4.728.178** $m^3$/day
- Safe yield: **1.582.546** m3/day
- GW abstraction amount: **577.076** m3/day from **342.657** wells.

## GW protection solutions

•Areas needs to be protected: 361$km^2$ of outcropt area
•Well head protection zones for 7 GW supply plants
•GW abstraction must be limited at 50 areas
•The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 577.077; 440.000; 440.000 $m^3$/day, respectively.
•The completed GW monitoring consists of 68 existing monitoring wells and 116 new added monitoring wells.
•1 areas are recommended to implement a pilot project on artificial recharge



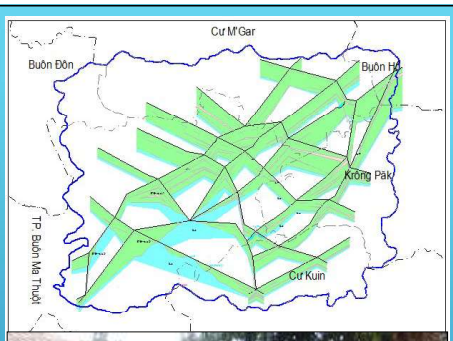

# MAIN RESULTS Buôn Mê Thuột city

## GW resources

- 3 aquifers, of which fractured basalt aquifer is need to be protected
- GW potential **742.807** m3/day
- Safe yield **361.460** m3/day
- GW abstraction amount **342.530** m3/day from **3.522** wells

## GW protection solutions

- Areas needs to be protected: 109 $km^2$ of week-self protected areas
- Well head protection zones for 7 GW supply plants
- GW abstraction must be limited at 34 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 342.530; 350.530 m3/day; and 361.460 $m^3$/day, respectively
- The completed GW monitoring consists of 24 existing monitoring wells and 29 new added monitoring wells.
- 5 areas are recommended to implement a pilot project on artificial recharge



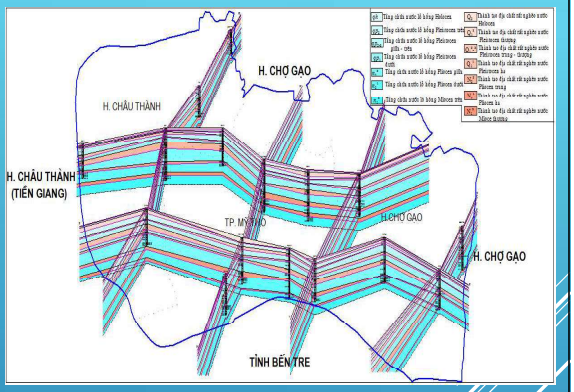

# MAIN RESULTS Đô thị Mỹ Tho

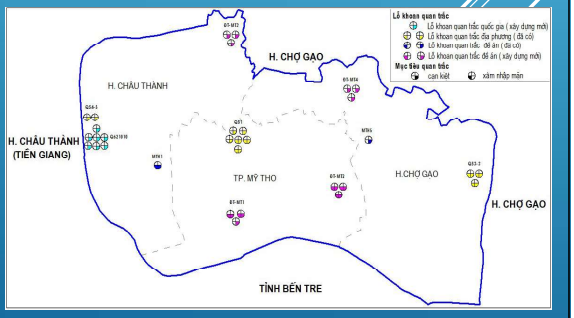
## GW resources

- 7 aquifers, of which 2 aquifers are needed to be protected
- GW potential **791.119** m3/day
- Safe yield **279.809** m3/day
- GW abstraction amount **58.427** $m^3$/day from **5.003** wells

## GW protection solutions

- Well head protection zones for 3 GW supply plants
- GW abstraction must be limited at 22 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 61.267; 62.557; and 65.848 $m^3$/day, respectively
- The completed GW monitoring consists of 13 existing monitoring wells and 32 new added monitoring wells.
- 1 areas are recommended to implement a pilot project on artificial recharge



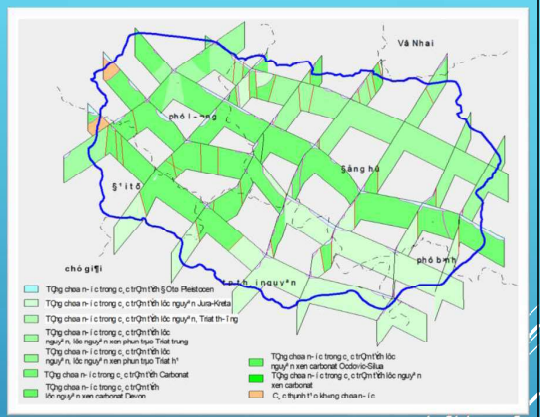

# MAIN RESULTS Thái Nguyên city

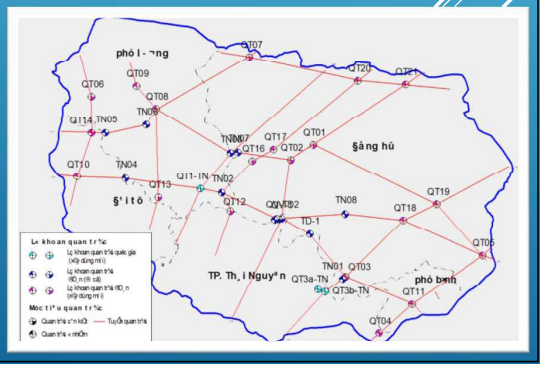
## GW resources

- 10 aquifers, of which 4 aquifers are needed to be protected
- GW potential **882.214** m3/day
- Safe yield **264.664** m3/day
- GW abstraction amount **24.900** $m^3$/day from **1.866** wells

## GW protection solutions

- Areas needs to be protected: 163$km^2$ of outcropt area and 64 $km^2$ of weak self-protection areas
- Well head protection zones for 4 GW supply plants
- GW abstraction must be limited at 38 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 58.000; 88.000 m3/day and 95.100 $m^3$/day, respectively.
- The completed GW monitoring consists of 25 existing monitoring wells and 26 new added monitoring wells.





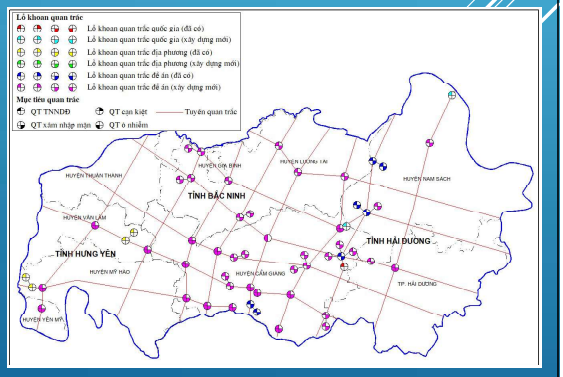
# MAIN RESULTS Hải Dương city

## GW resources

- 5 aquifers, they are all needed to be protected
- GW potential **1.461.825** $m^3$/day
- Safe yield **502.940** $m^3$/day
- GW abstraction amount **47.154** $m^3$/day from **2.760** wells

## GW protection solutions

- Areas needs to be protected: 162$km^2$ of outcropt area and 223 $km^2$ of weak self-protection areas
- Well head protection zones for 3 GW supply plants
- GW abstraction must be limited at 18 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 102.364 $m^3$/day.
- The completed GW monitoring consists of 13 existing monitoring wells and 43 new added monitoring wells.
- 1 areas are recommended to implement a pilot project on artificial recharge

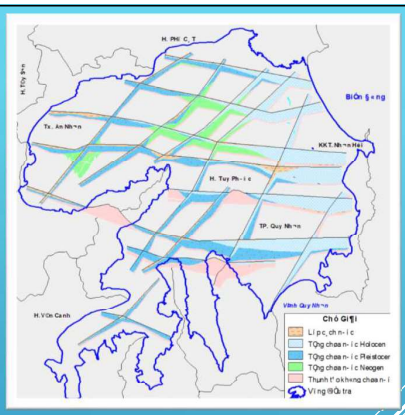

# MAIN RESULTS Quy Nhơn city

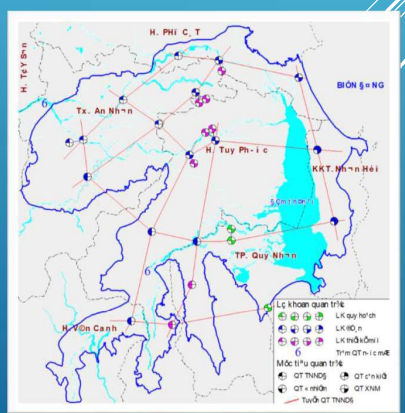
## GW resources

- 3 aquifers, they are all needed to be protected
- GW potential **803.114** $m^3$/day
- Safe yield **254.581** $m^3$/day
- GW abstraction amount **106.828** $m^3$/day from **11.090** wells

## GW protection solutions

- Areas needs to be protected: 171 $km^2$ of outcropt area and 144 $km^2$ of weak self-protection areas
- Well head protection zones for 8 GW supply plants
- GW abstraction must be limited at 38 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 111.588; 121.468 and 140.568 $m^3$/day, respectively.
- The completed GW monitoring consists of 16 existing monitoring wells and 11 new added monitoring wells.
- 1 areas are recommended to implement a pilot project on artificial recharge



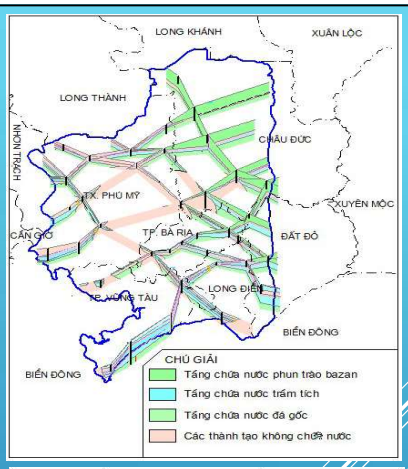
# MAIN RESULTS Vũng Tàu city

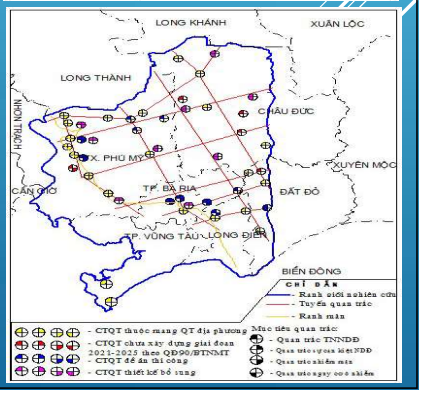
## GW resources

- 6 aquifers, they are all needed to be protected
- GW potential **374.377** $m^3$/day
- Safe yield **140.296** $m^3$/day
- GW abstraction amount **89.577**$m^3$/day from **25.963** wells

## GW protection solutions

- Areas needs to be protected: 46 $km^2$ of outcropt area and 81 $km^2$ of weak self-protection areas
- Well head protection zones for 2 GW supply plants
- GW abstraction must be limited at 227 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 99.639; 115.709 and 139.812 $m^3$/day, respectively.
- The completed GW monitoring consists of 56 existing monitoring wells and 26 new added monitoring wells.
- 2 areas are recommended to implement a pilot project on artificial recharge



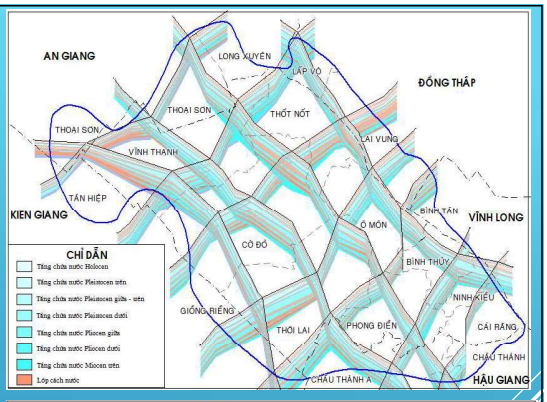

# MAIN RESULTS Cần Thơ city

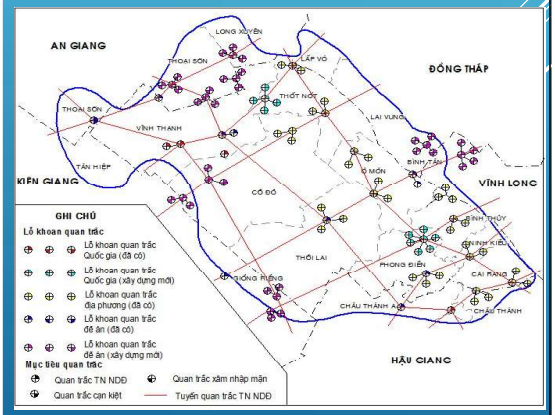
## GW resources

- 7 aquifers, of which 6 aquifers are needed to be protected
- GW potential **3.673.259** $m^3$/day
- Safe yield **965.281** $m^3$/day
- GW abstraction amount **127.956** $m^3$/day from **50.673** wells

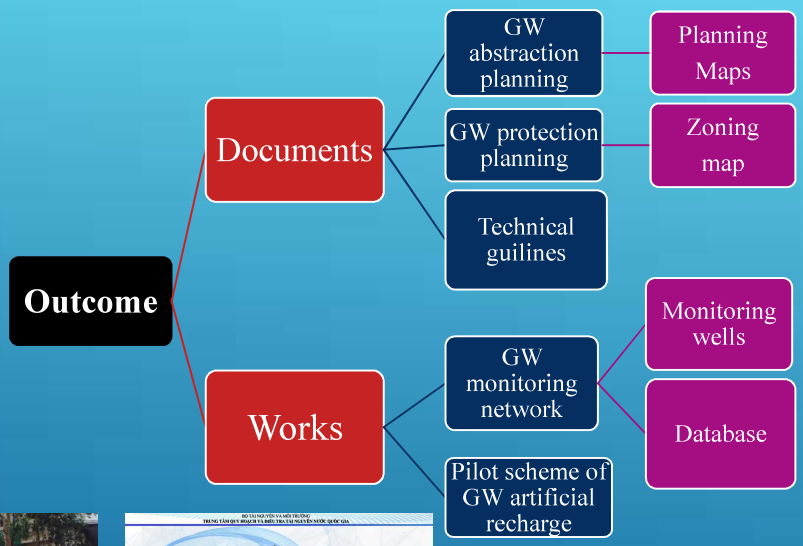
## GW protection solutions

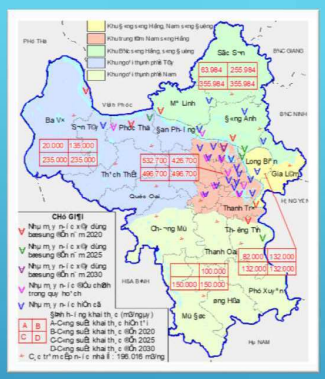
- Areas needs to be protected: 15 $km^2$ of outcropt area
- Well head protection zones for 7 GW supply plants
- GW abstraction must be limited at 58 areas
- The sustainable amount of GW abstraction for year 2020, 2025 and 2030 are 145.251; 161.137 and 161.137 $m^3$/day, respectively.
- The completed GW monitoring consists of 50 existing monitoring wells and 50 new added monitoring wells.
- 1 areas are recommended to implement a pilot project on artificial recharge

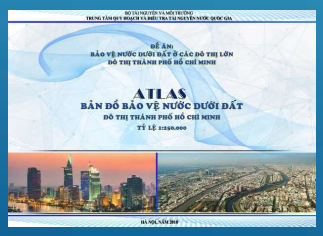


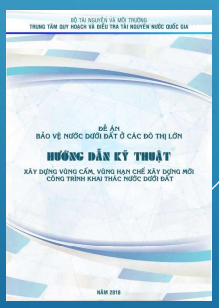



# MAIN RESULTS Project outcome







# MAIN RESULTS Project outcome

| No | Output for each city |
|---|---|
| **I** | **Final Report** |
| **II** | **Thematic reports** |
| 1 | Report on the structure of the aquifers to be protected |
| 2 | Report on the assessment of groundwater potential of aquifers to be protected |
| 3 | The report on assessement of the groundwater quality issues of the aquifers to be protected |
| 4 | Report on assessment of the self-protection ability of aquifers to be protected |
| 5 | The report on assessment of the impact of groundwater abtraction on aquifers to be protected |
| 6 | Report on identification of conditions and causes of groundwater pollution and salinity intrusion of aquifers to be protected |
| 7 | Report on the planning of exploitation and use of groundwater resources |
| 8 | Report on the planning of prohibited and restricted areas from groundwater exploitation |
| 9 | Report on the planning of protection zones of groundwater exploiting works |
| 10 | Report on proposal of groundwater monitoring network for the aquifers to be protected |
| 11 | Report on assessement of the possibility of artificial recharge for aquifers to be protected |
| **III** | **Maps on the scale of 1/25.000** |
| 1 | Maps of the structure of the aquifers |
| 2 | Map of groundwater resources of aquifers to be protected |
| 3 | Maps of groundwater potential of aquifers to be protected |
| 4 | Maps of groundwater quality of aquifers to be protected |
| 5 | Maps of self-protection ability of aquifers to be protected |
| 6 | Maps of impact zoning of groundwater abtraction on aquifers to be protected |
| 7 | Maps of risk zoning of pollution and saltwater intrusion of aquifers to be protected. |
| 8 | Maps of planning of exploitation and use of groundwater resources |
| 9 | Maps of planning of prohibited and restricted areas from groundwater exploitation |
| 10 | Maps of planning of protection zones of groundwater exploiting works |
| 11 | Maps of planning of groundwater monitoring network for the aquifers to be protected |
| 12 | Maps of possibility zoning of artificial recharge for aquifers to be protected |

# CONCLUSION

The condition of existence and distribution of aquifers in 9 major urban centers were clarified. It is estimated that the potential of underground water in 9 urban areas was 24,482,830 $m^3$/day and total safe yield was 8,427,942 $m^3$/day.

The situation of groundwater exploitation, polluion sources and the risk of salinity intrusion and their impacts on groundwater resources land in 9 major cities were inventoried

Technical solutions for protection, prevention and mitigation of groundwater depletion, pollution and saline intrusion in 9 key urban centers were proposed

Technical guidelines for protection groundwater investigation in order to improve institutions, policies and laws on water resources were developed.

A complete database of groundwater resources was available in nine major cities

**Thank you for your attention**