**THA 2022** International Conference on

**Moving Towards a Sustainable Water and Climate Change Management After COVID-19**

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**26 - 28 January 2022** **09.00 - 16.30 hrs.** (GMT+7 Bangkok)

# *TC-319S:* "Sustainable groundwater development in Can Tho city, Mekong Delta Vietnam under climate change"


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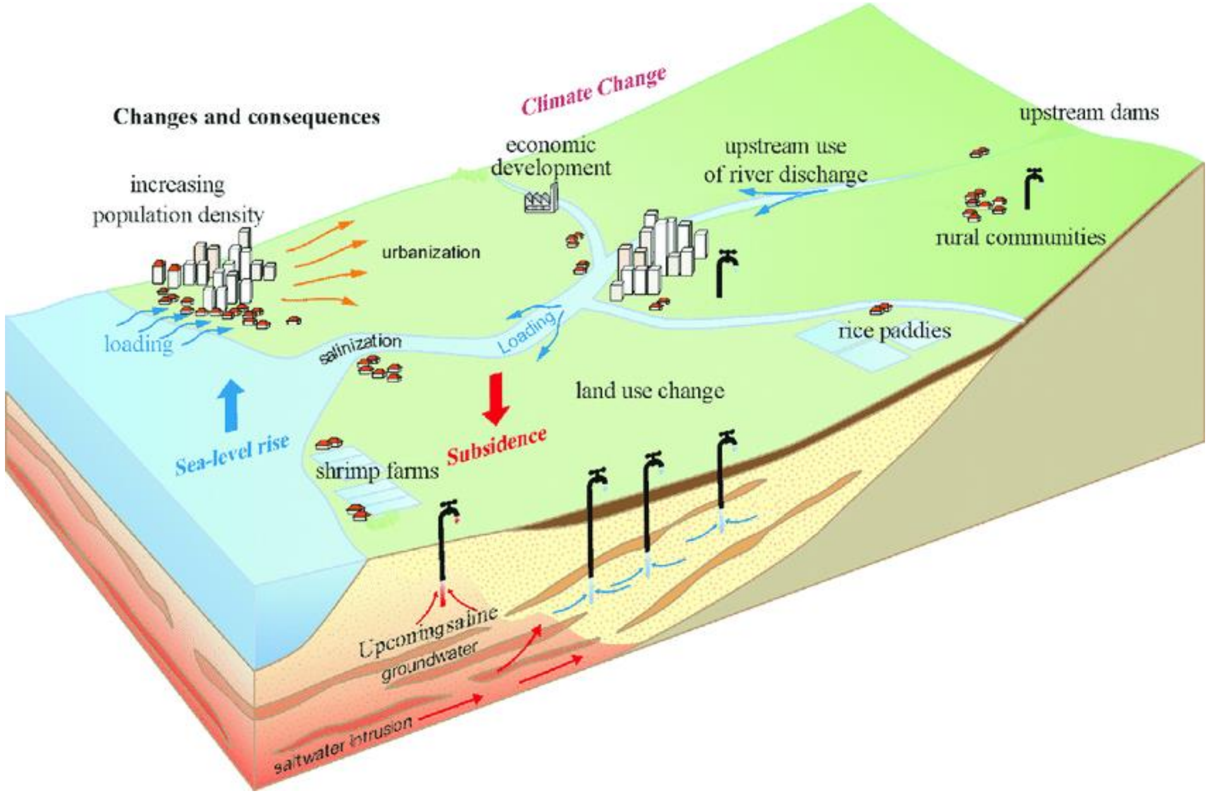
# Background

➢ **GW issues**

- limited renewable freshwater resources (MIE, 2013)
  dam operation, climate change
- increasing water demand in the MD (Wagner, Tran et al. 2012)
  over-abstracted (Ha, Ngoc et al. 2015, Bui T.V, 2013)
- Groundwater issues:
  groundwater depletion
  saline water intrusion
  land subsidence

*"achievement of a sustainable balance between water demand and water supply is a major challenge "?*

Overview of threats to coastal aquifers in the Mekong Delta,Vietnam (MKD) (Delsman, 2015)

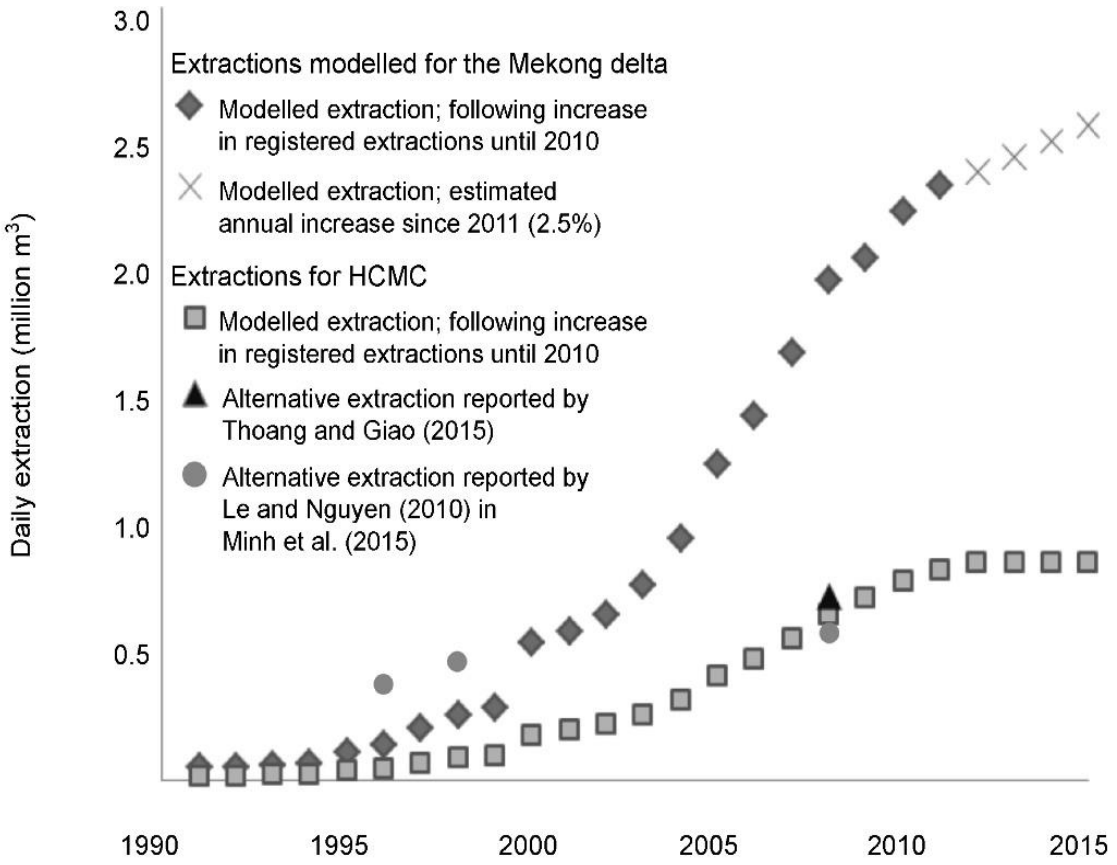


# Background

- Since the 1960s, groundwater exploitation in the VMD to meet domestic, agricultural and industrial needs has dramatically increased (Danh 2008, Wagner et al. 2012) via dug wells, small-scale household tube-wells (LittleJohn 2011).

- Especially in rural and coastal areas where is difficult to access fresh surface water due to increasing salinity concentration in the dry season, this proportion also becomes much higher (Danh 2008, Eastham et al. 2008, Van et al. 2019).

- In 2007, it was estimated there was 465,000 GW wells in the delta that removed a total of 1,229,000 $m^3$/day (DWRPIS 2009). In 2011, There was a million extraction wells with depth of 10 m to 300 m is distributed in whole Mekong region (MONRE 2011).




Annual modelled groundwater extraction in the MKD and HCMC province (Minderhoud et al. 2017)

# Background

- **Research questions**
  - What is sustainable groundwater use under context of climate change in the near future?

- **Objectives**

*The main objective is to* sustainable groundwater use in Can Tho city under climate change scenarios. *Specified objectives include:*

- Construct a **detailed GW model** for the Can Tho city
- *Explore **current situation of groundwater system** in the Can Tho city*
- *Evaluate the proposed mitigation scenarios and recommend **the yield of sustainable GW abstraction** in near future*

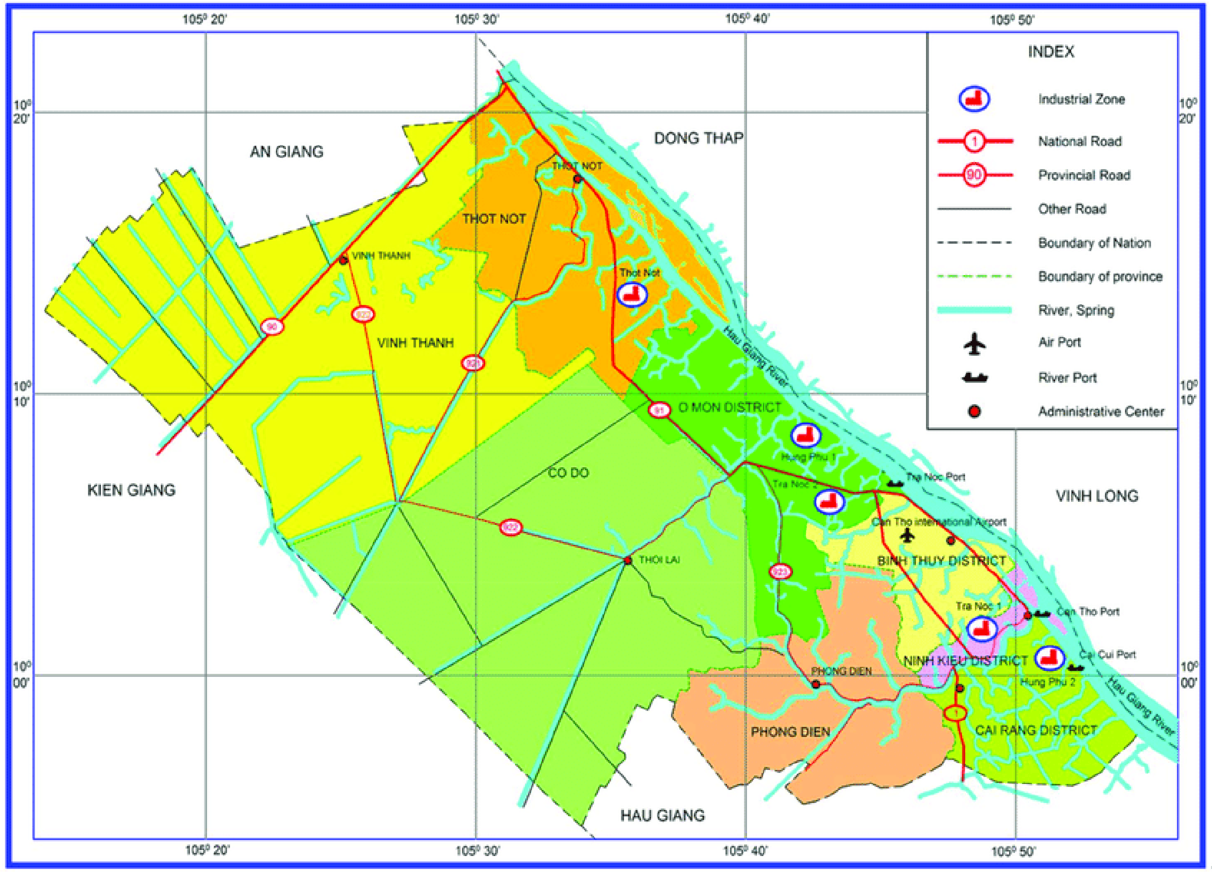
# Study area

- Can Tho is the **largest city** within the Mekong Delta, with a population of around 1.6 million as of 2016

- Located on the south bank of the Hau River, one of **two major branches** of the Mekong River in Vietnam, at a distance of about 80 km upstream of the sea

- The rapid urbanization and growth of population in Can Tho will likely lead to a **significant change in land use, water demand** within and surrounding area of the city

- Groundwater is **a valuable resource** for the community in Can Tho City, mainly supplies for domestic, industry and irrigation

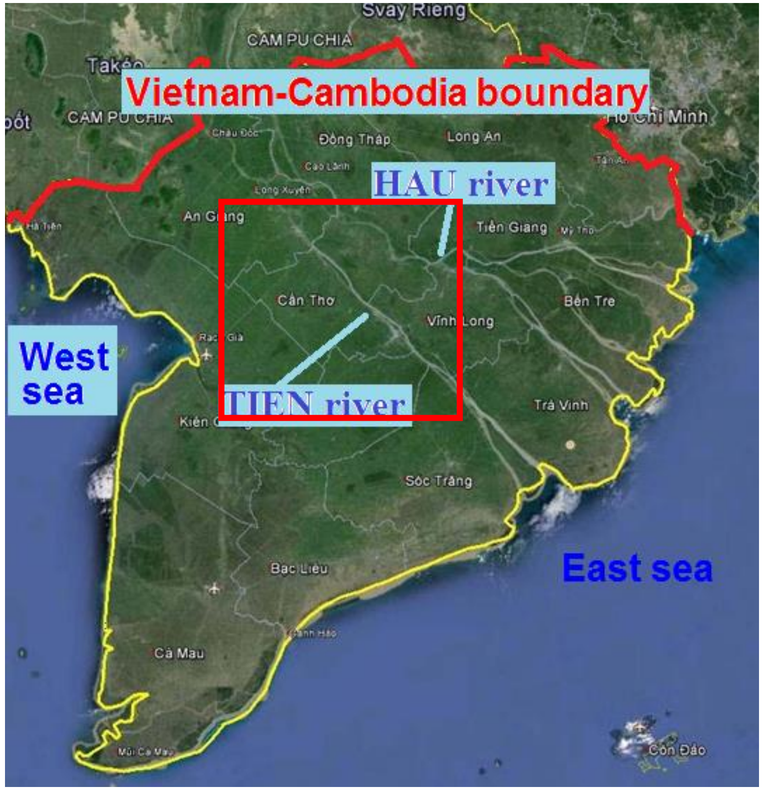



A map of Can Tho city (Ngo et al. 2018)

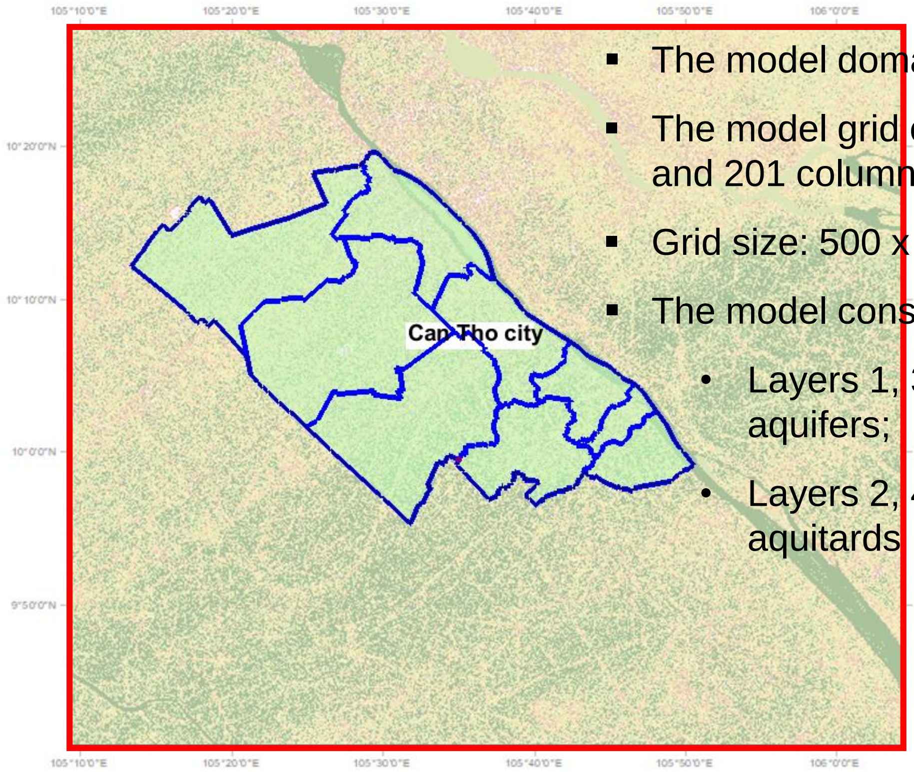
# Materials and methods

## ➢ GW models development

Updated regional model (Vuong, 2013) → GWLs at boundaries of the local model → Develop local model for Can Tho city



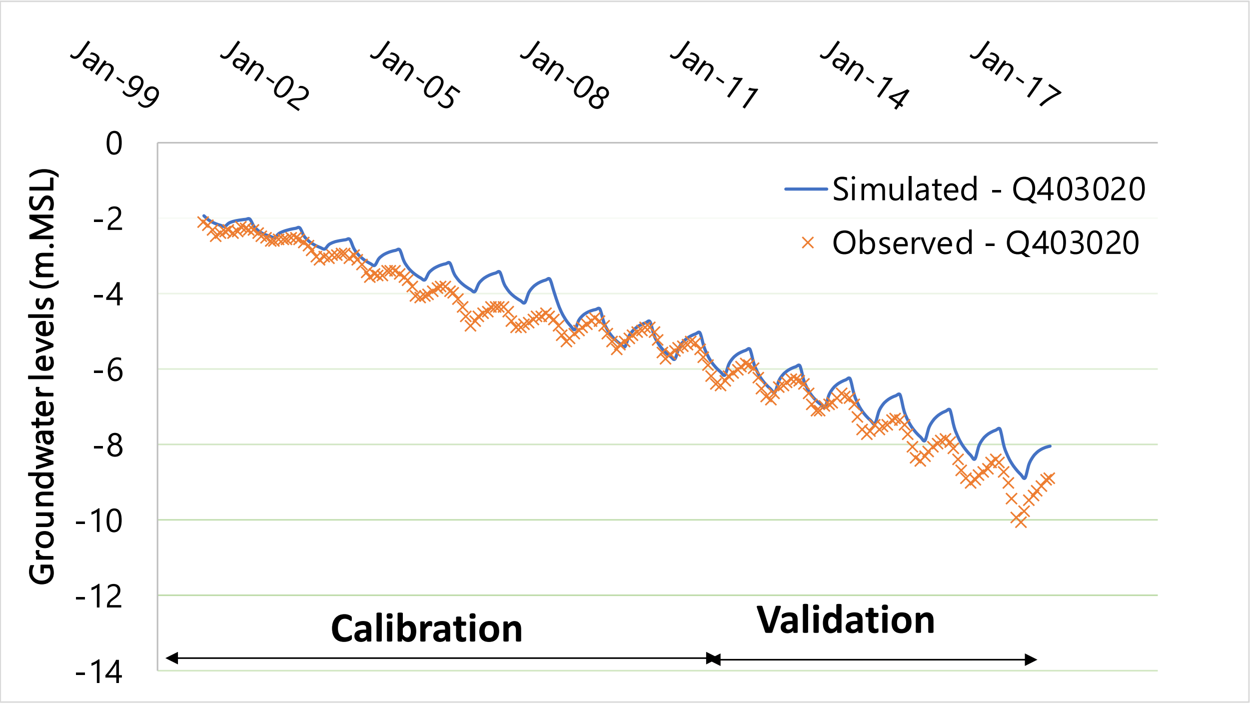

**Simulated period (2000 – 2015)**




- The model domain is of 8,690 km$^2$.
- The model grid consists of 173 rows and 201 columns
- Grid size: 500 x 500 m
- The model consists of 13 layers
  - Layers 1, 3, 5, 7, 9, 11, 13: aquifers;
  - Layers 2, 4, 6, 8, 10, 12: aquitards

# Results

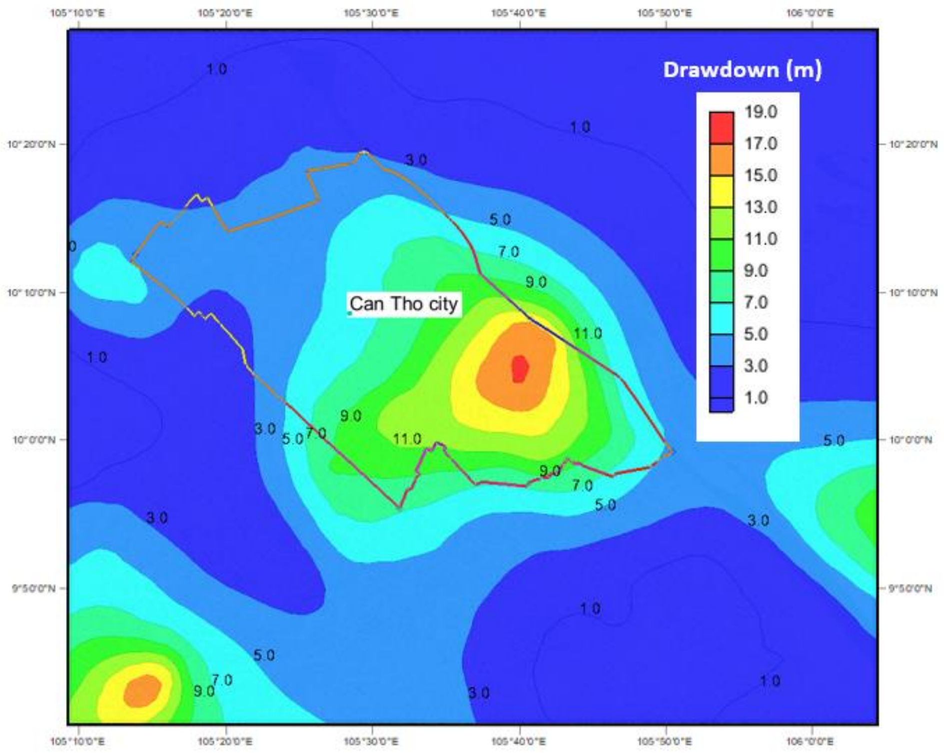
## Calibration/validation results



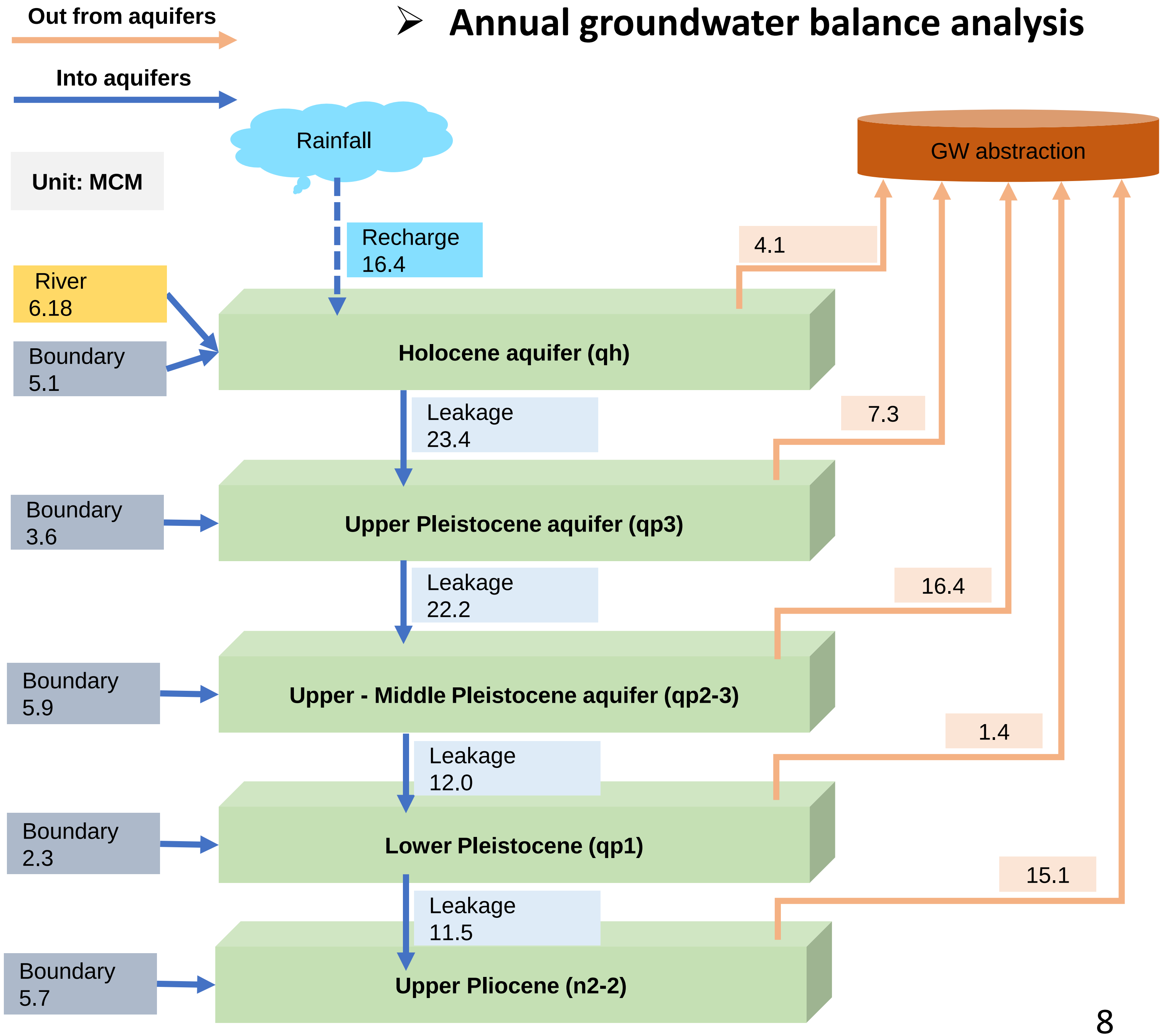

| Aquifer | Obs. wells | Calibration | | Validation | |
|---|---|---|---|---|---|
| | | RMSE (m-MSL) | $R^2$ | RMSE (m-MSL) | $R^2$ |
| qh | Q206010M1 | 0.55 | 0.75 | 0.53 | 0.71 |
| | Q209010 | 0.47 | 0.78 | 0.51 | 0.68 |
| | Q40101T | 0.56 | 0.89 | 0.63 | 0.86 |
| $qp_3$ | Q4022020M1 | 0.67 | 0.81 | 0.63 | 0.81 |
| | Q209020 | 0.86 | 0.75 | 0.96 | 0.72 |
| $qp_{2-3}$ | Q403020 | 0.47 | 0.89 | 0.53 | 0.84 |
| | Q206020M1 | 0.68 | 0.79 | 0.81 | 0.75 |
| | Q209030 | 0.86 | 0.71 | 0.92 | 0.65 |
| $n_{2-2}$ | Q40403Z | 0.75 | 0.68 | 0.82 | 0.59 |
| | Q406040 | 0.98 | 0.64 | 1.02 | 0.57 |
| $n_{2-1}$ | Q206040M1 | 0.88 | 0.61 | - | - |
| | Q40104Z | 0.74 | 0.63 | - | - |
| | Q20904T | 1.12 | 0.58 | - | - |
| $n_{1-3}$ | Q017050 | 1.23 | 0.55 | - | - |

# Results

## ➢ GWLs distribution (March, 2016)



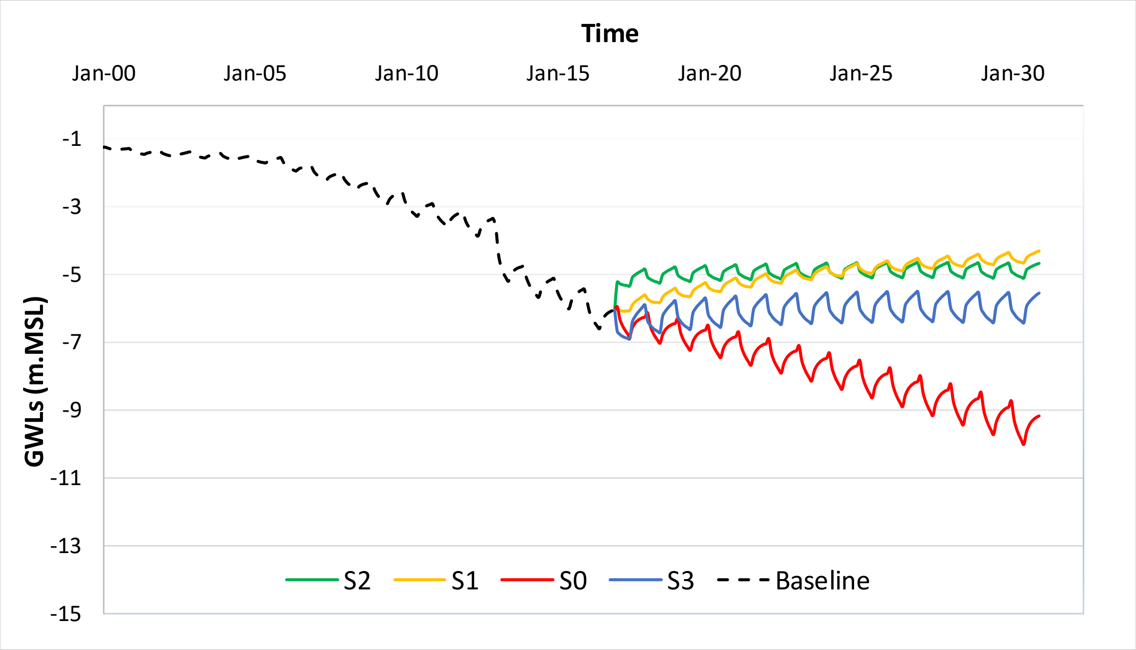

## ➢ Annual groundwater balance analysis



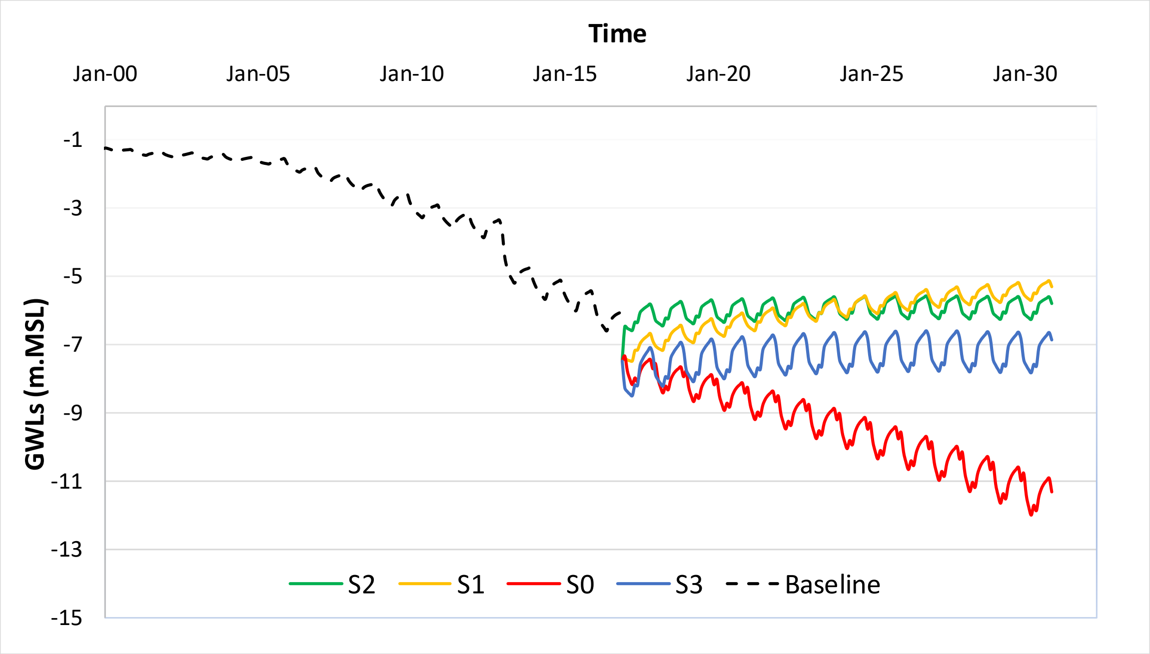
# Results

➤ **Evaluate mitigation scenarios**

Three proposed management scenarios are: business as usual (S0), reduction of abstraction (S1 = 40% of current abstraction, S2=60% of current abstraction) and increase of groundwater recharge (S3 = 125 % of current recharge)




**SSP126 scenario**




**SSP585 scenario**

# Conclusions

- Long term groundwater use will cause significantly storage depletion of the whole GW system and saline movement in northern zone. GW recharge is very limited, i.e., it contributed only 29 % of total groundwater abstraction

- Scenarios by reducing groundwater demand and increase GW recharge presents a dramatically decrease in GWLs. Scenarios, with maintaining development as usual, will lead to a significant drop of GWLs (4-6 m drawdown until 2030).

- The effect of climate change was only considered in groundwater recharge from projected precipitation. The model simulation results indicated smaller effect of climate change on groundwater depletion in comparison to groundwater abstraction

- The estimated sustainable GW abstraction of the aquifer system is 145,000 $m^3/d$ under SSP126 scenario and 125,000 $m^3/d$ in SSP585 scenario with maintaining current pumping network until 2030. Hence need to reduce about 25 to 35 percent on average of current amount of GWU to meet sustainable GW abstraction.

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# Thank You
# For Your Attention
# *Any question?*


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