Managed Aquifer Recharge in the Salt Affected Risk Area in the Northeastern Region, a Case Study of Huai Saibat Watershed, Khon Kaen Province, Thailand

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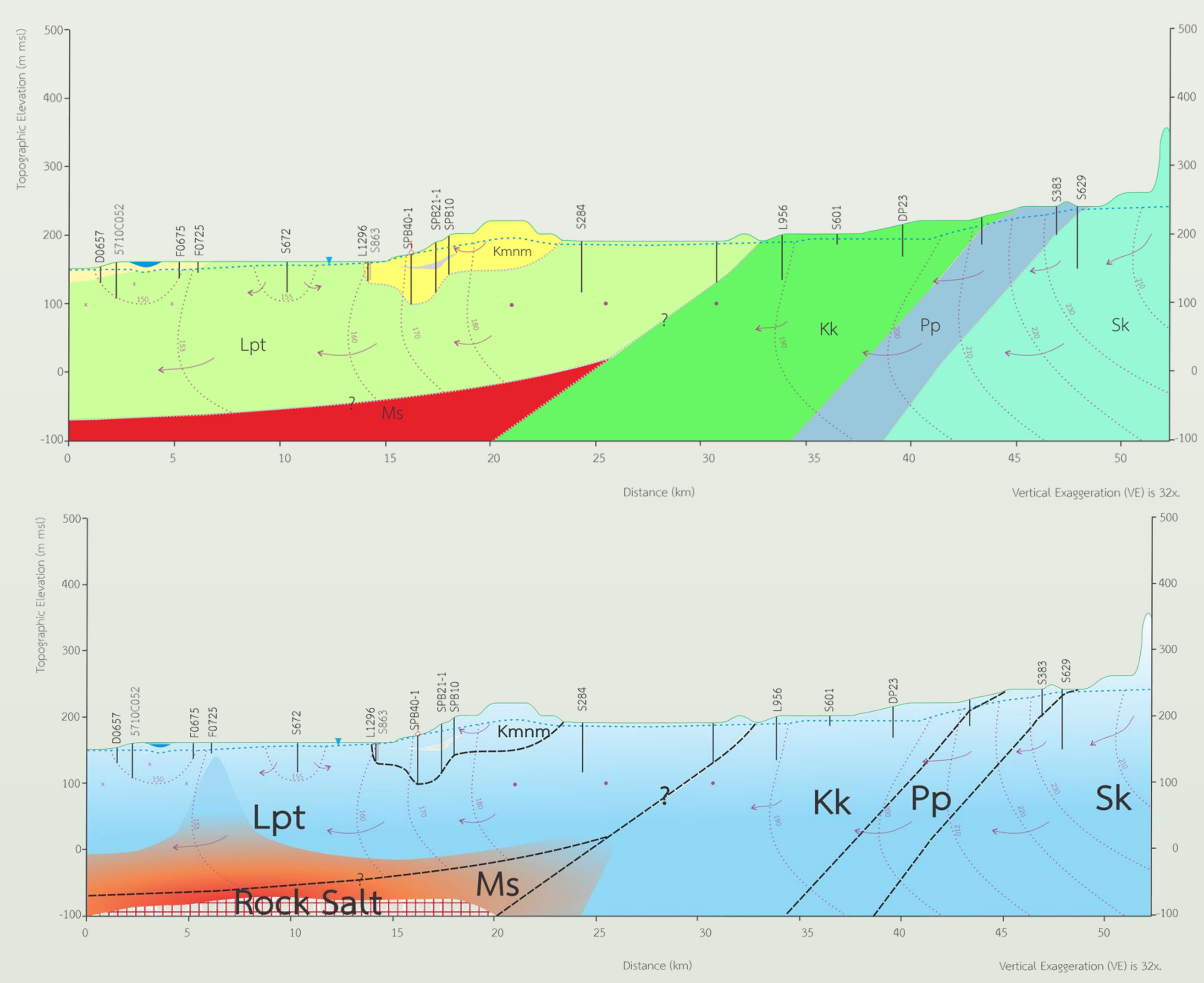
Managed Aquifer Recharge (MAR) has been implemented in many countries and many regions throughout Thailand to enhance the potential of groundwater in water stress areas, including the northeastern region where is a highly risk of saline groundwater and saline soils commonly found. **Huai Saibat watershed** was selected for investigating hydrogeologic environments and develops MAR suitability maps and designs for the MAR systems. Two detailed study areas of MAR construction were selected in unconsolidated (primary porosity aquifer) and consolidated aquifers (dual porosity aquifer).

Hydrogeology of Huai Saibat Watershed



Haui Saibat watershed is underlain by sand and gravel deposits, sandstone and siltstone of Phu Thok (Lpt) and silt stone, clay and rock salts of the Maha Sarakham (Ms) Formations at averaged depth of about 100-200 m below the groundsurface. The brine and saline groundwater developed due to occurrence of rock salts and groundwater flow systems within the aquifers occurring in the deeper aquifers in the central and southern parts, and in the shallow aquifer in the southern part of the watershed (Figure 1). Huai Kudthing flow groundwater system was selected to be the detail study area for implementing MAR systems and evaluating the impact of MAR using numerical models simulation.

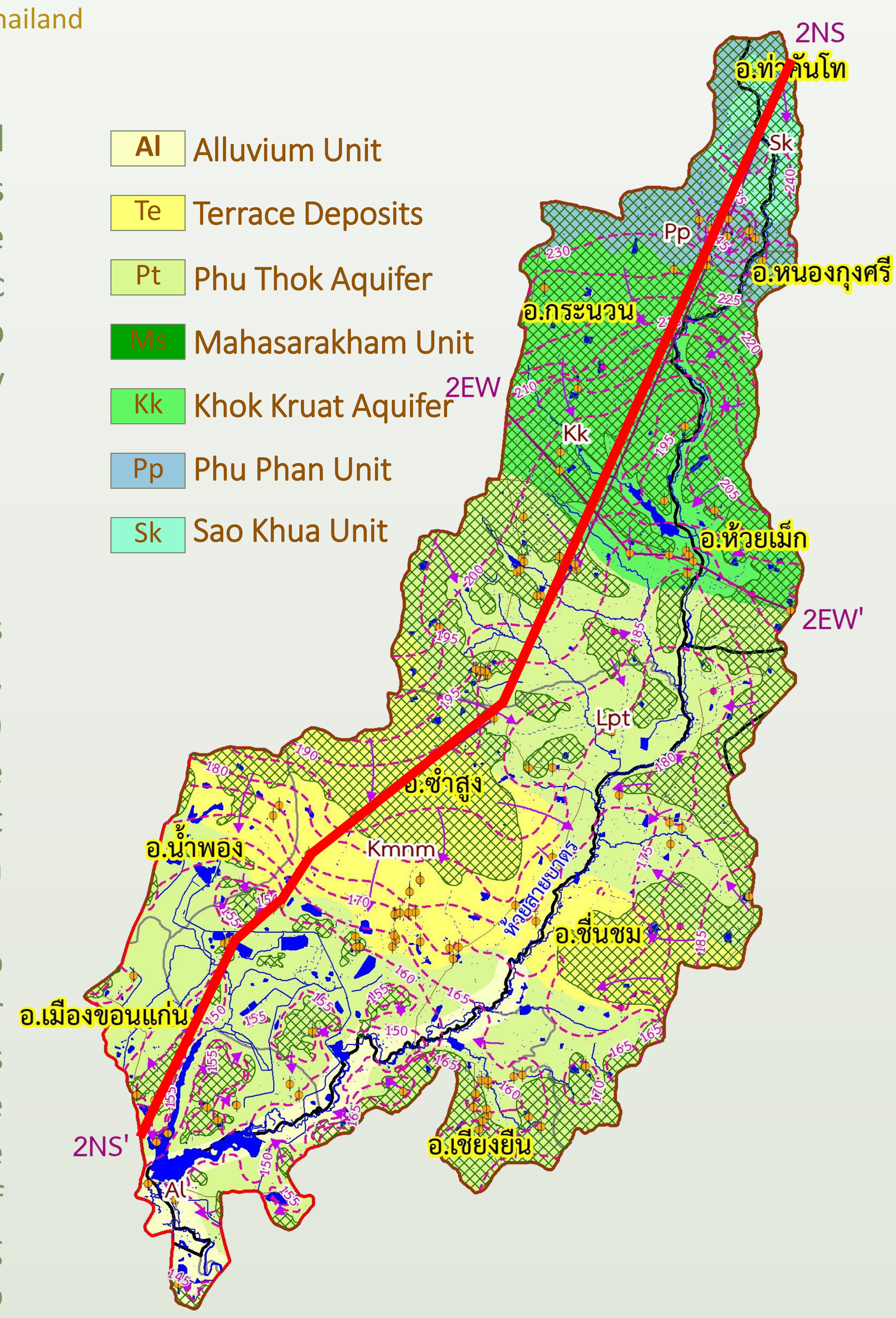


Figure 1 Hydrogeological map of Huai Saibat Watershed.

Methodology

This study implement the 4 shallow MAR methods, and installed the monitoring system in two pilot sites, namely unconsolidated rock aquifer and fracture rock aquifer (Table 1). Then used the MODFLOW and MT3D models to simulated the impact of MAR on flow and salt transport. The calibrated model was used to projected the long term impact of MAR and non MAR in the next 30 years scenarios.

Table 1 Selected detailed study areas.

Area 1	Area 2
Fractured rock aquifer (Lpt)	Unconsolidated rock aquifer (Kmnm)
Underlain by rocksalt	Underlain by rocksalt
Hilly area in flood plain	Terrace deposit
TDS of GW 500-1,500 mg/l	TDS of GW <500 mg/l
Occurrence of salt crust	-
Use water for irrigated GAP vegetable farm	Use water for irrigated GAP vegetable farm

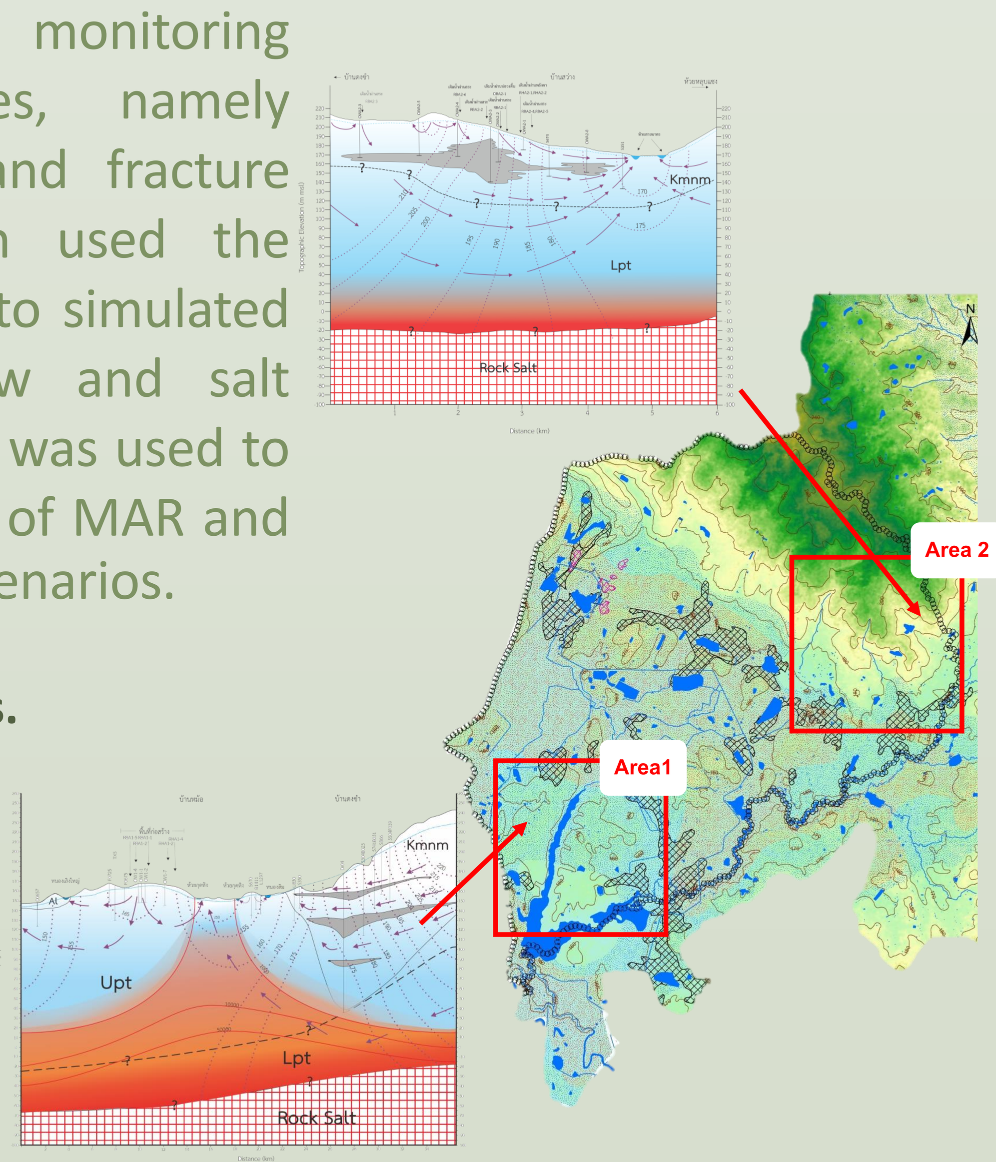
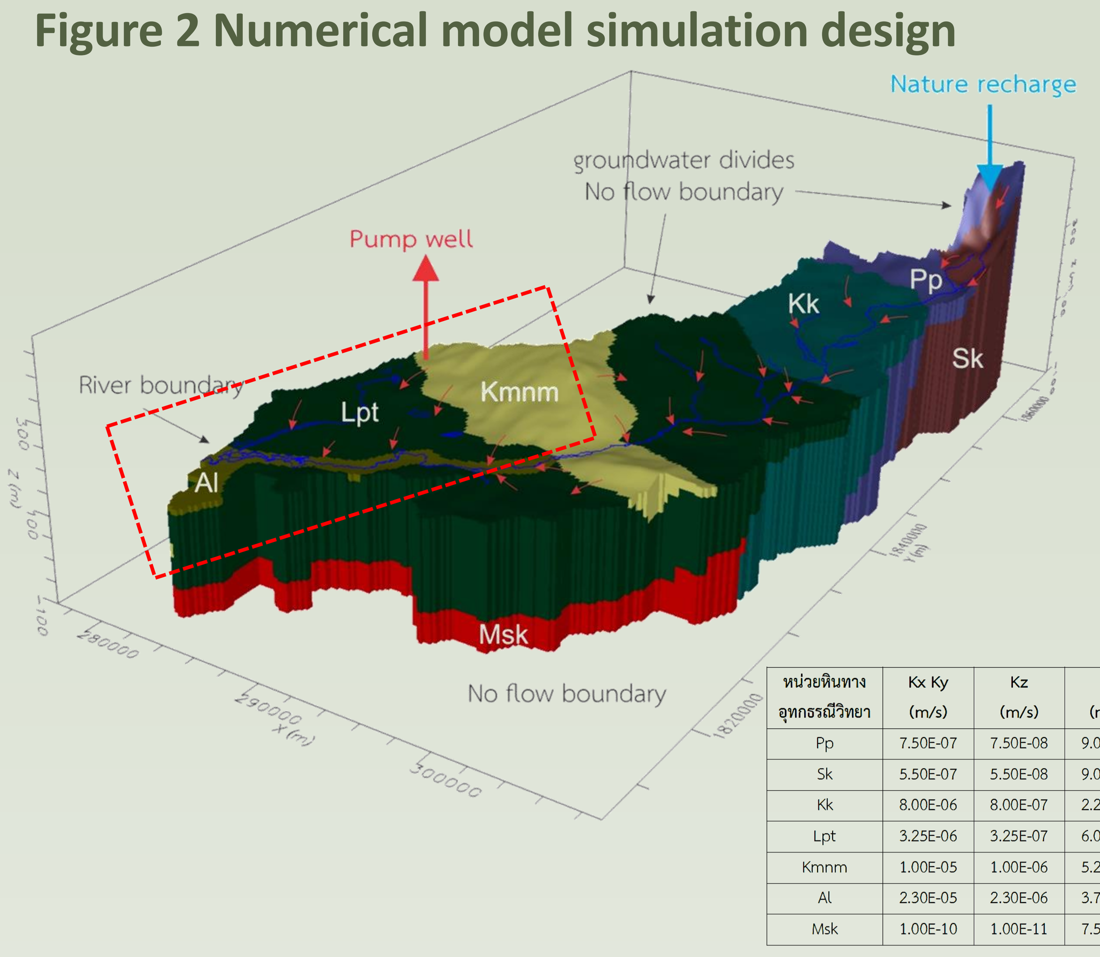
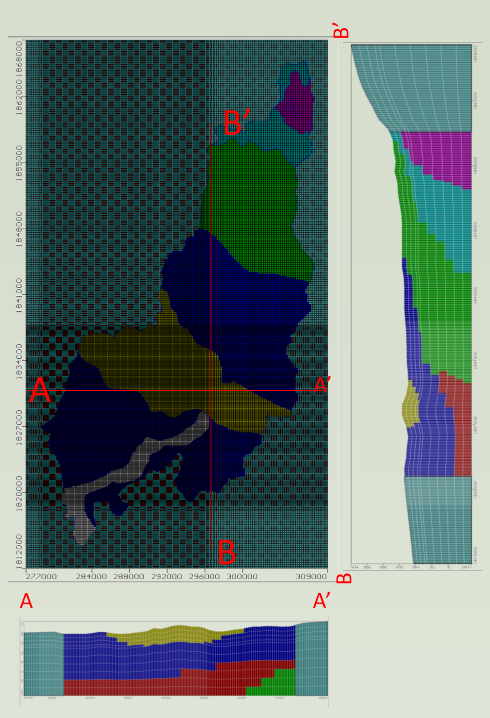


Figure 2 Numerical model simulation design





หน่วยหินทางอุทกธรณีวิทยา	Kx Ky (m/s)	Kz (m/s)	Ss (m^{-1})*	Sy	eff.por	Tot.Por	Dispersivity (m)
Pp	7.50E-07	7.50E-08	9.00E-05	0.09	0.15	0.17	10
Sk	5.50E-07	5.50E-08	9.00E-05	0. 09	0.15	0.17	10
Kk	8.00E-06	8.00E-07	2.25E-04	0.09	0.15	0.3	100
Lpt	3.25E-06	3.25E-07	6.00E-04	0.105	0.15	0.2	50
Kmnm	1.00E-05	1.00E-06	5.25E-03	0.3675	0.2	0.21	150
Al	2.30E-05	2.30E-06	3.75E-03	0.09	0.2	0.22	200
Msk	1.00E-10	1.00E-11	7.50E-07	0.0075	0.001	0.0015	30

Results

The flow and salt transportation simulations show that the current groundwater budget of the watershed is about minus 2 MCM/year, due to highly use of groundwater, and poses a large impact on the lowering of groundwater levels in the future. The critical water level (>8 m) area covers an area of 74.16 km^2 and saline groundwater covers area of 69.80 km^2. The projection scenarios for the next 30 years of without MAR scenario show that the water level will be lowered continuously and extend the critical arear to 169.88 km^2. The MAR construction simulation scenario shows that critical areas is lower than without MAR scenario (Table 2, Figure 3).

Table 2 Result of critical water level and saline groundwater areas from the model projection scenarios.

	Critical water level area			
	Current	10 yr	20 yr	30 yr
Critical water level area (km^2)	74.16	129.88	153.92	169.88
Percent (%)	11.02	19.30	22.87	25.24

	Saline groundwater area			
	Current	10 yr	20 yr	30 yr
Saline groundwater area (km^2)	69.8	62.48	55.64	52.08
Percent (%)	10.37	9.28	8.27	7.74

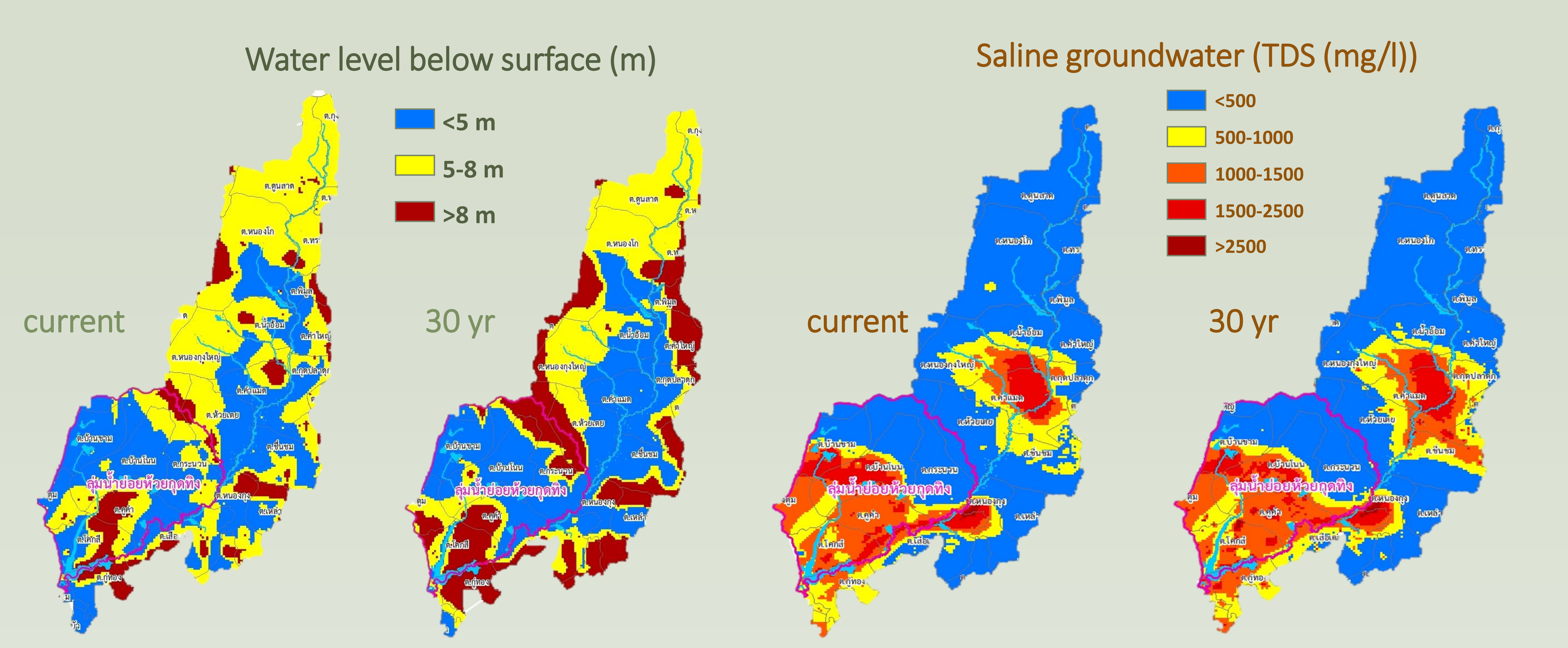


Figure 3 Result of critical water level and saline groundwater areas from the model projection scenarios, current and 30 years.

Acknowledgement

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