المركز الوطني للمياه والطاقة العربية المتحدة National Water and Energy Center United Arab Emirates University

# Dynamics of Groundwater Levels and Quality in ASR Systems

**Mohsen Sherif** 

National Water and Energy Center United Arab Emirates University

Project Funded by Sharjah Electricity and Water Authority (SEWA)



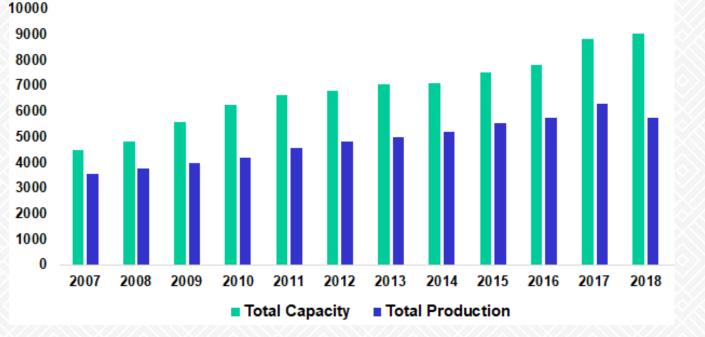
March 17th, 2021



# **Desalination Capacity and Production in GCC**

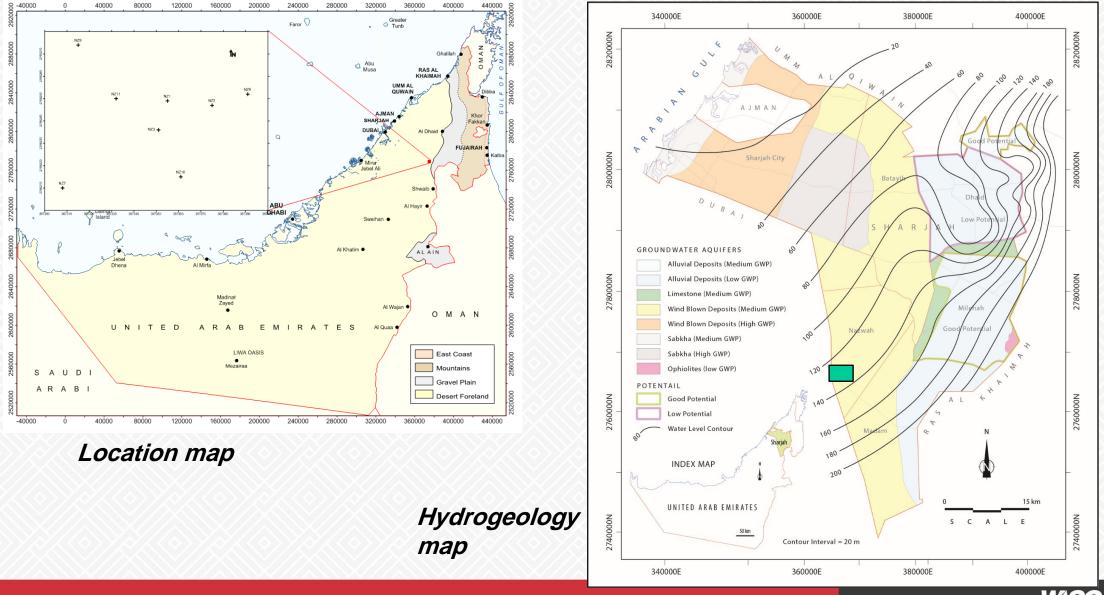
- □ Total capacity (2018) =9.03 bm<sup>3</sup>/year
- **Total production (2018) = 5.75 \text{ bm}^3/\text{year}**
- □ The cost of desalination reduced significantly
- Electricity Generation
- Demand Fluctuation
- **Development of Freshwater Strategic Reserves**

Capacity Vs Production Comparison for GCC Countries (MCM/Yr)





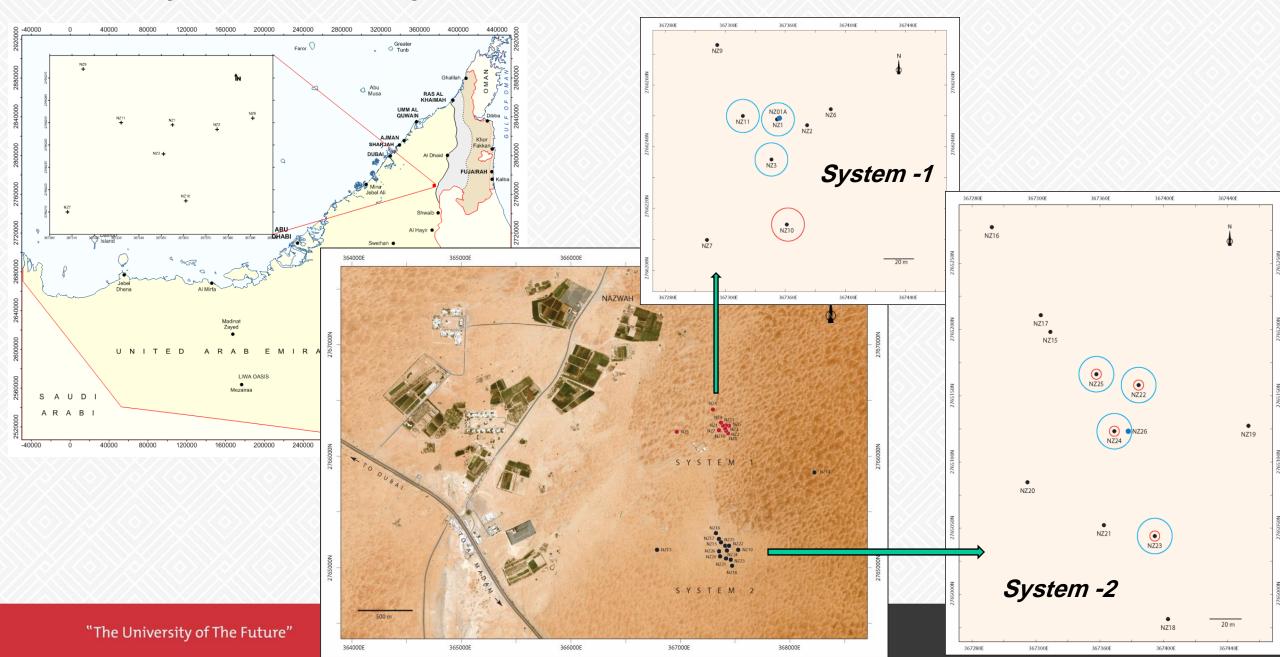
# **ASR-System in Sharjah Emirate- Nazwah**





# **ASR-System in Sharjah Emirate- Nazwah**





# **Operation Schedule and Water Level Measurements**

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367440E

367400E

367280E

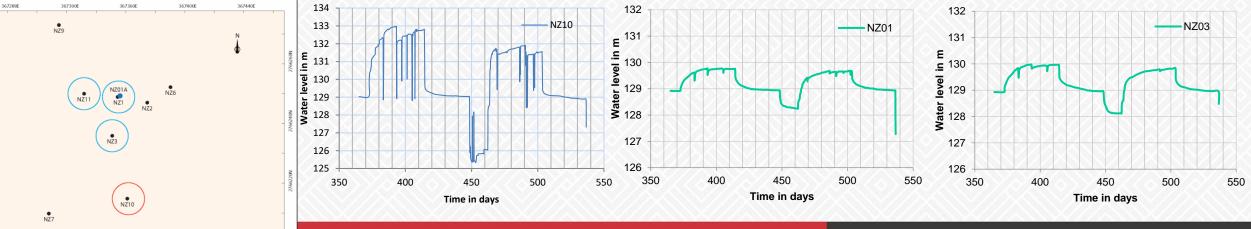
367300E

367360E

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جامعة الإمارات العربية المتحدة United Arab Emirates University

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()				m³/day		(m³)						m³/day		(m <sup>3</sup> )
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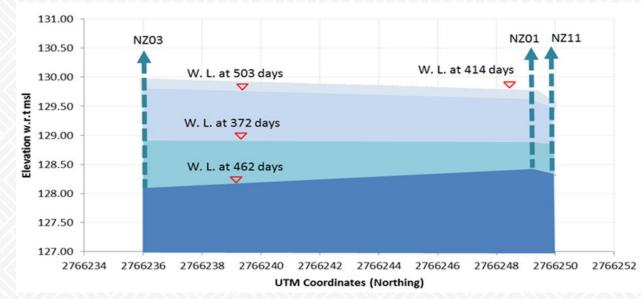


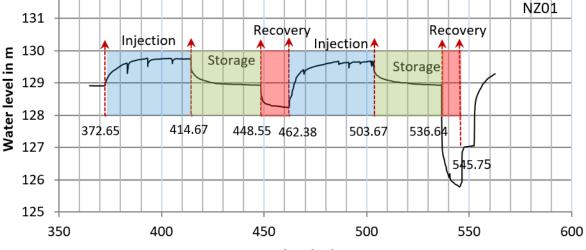
# **Analysis of Groundwater Levels**

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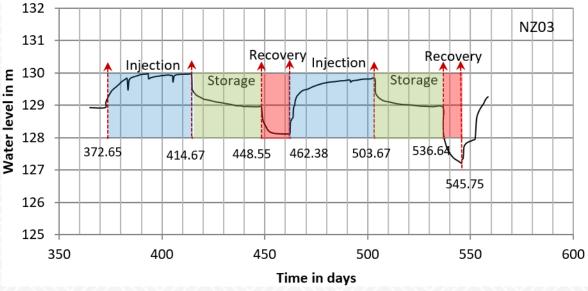
132 NZ11 131 Recovery Recovery Injection Injection E 130 Storage Storage Water level in 129 128 536.64 372.65 448 55 414.67 462.38 503.67 127 545.75 126 125 350 400 450 500 550 600

Time in days





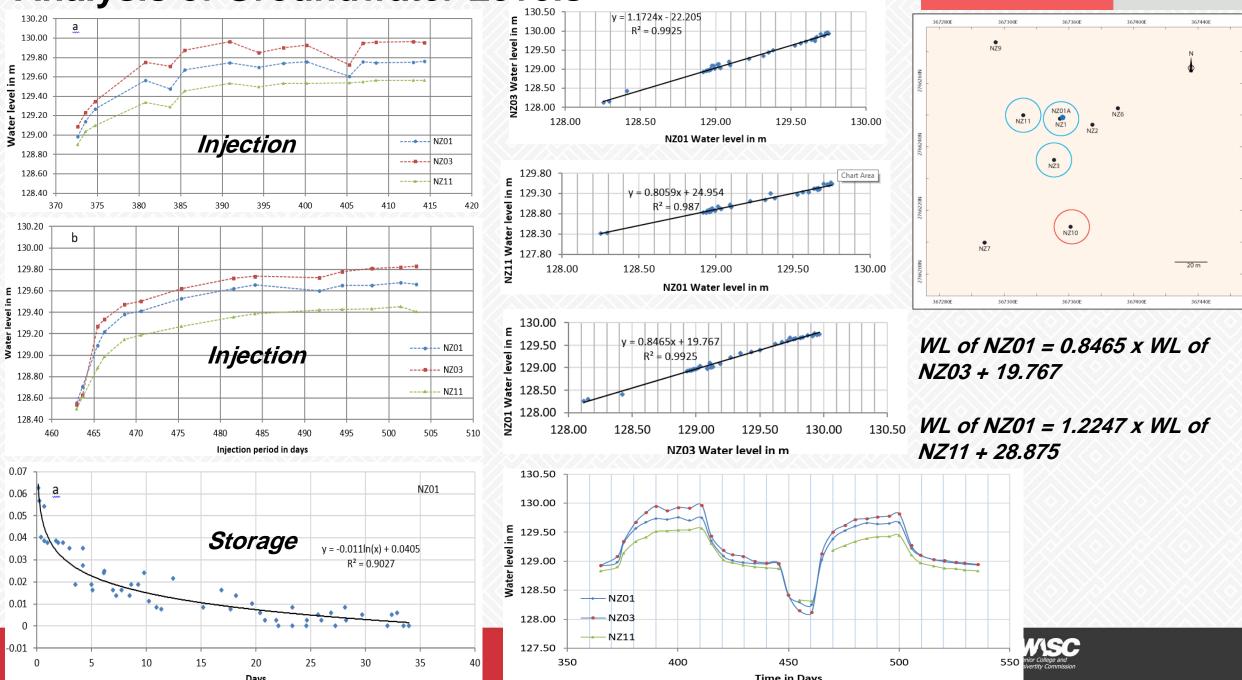
Time in days



Senior College and Univertity Commission

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# **Analysis of Groundwater Levels**



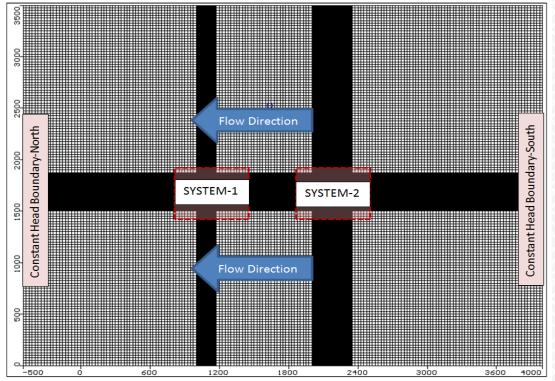
المركز الوطني للمياه والطاقة

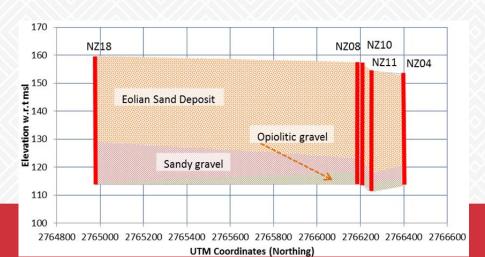
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# **ASR Simulation – MODFLOW**





Hydraulic Conductivity Inputs for Nazwa ASR Pilot System-1 Model\*

Model Layer	Longitudinal	Transversal	Vertical		
	Conductivity (K <sub>x</sub> )	Conductivity (K <sub>y</sub> )	Conductivity (K <sub>z</sub> )		
	[m/day]	[m/day]	[m/day]		
Layer 1	38.88	3.888	0.389		
Layer 2	3.888	0.389	0.039		
Layer 3	0.389	0.039	0.0039		

\* After SEWA, Schlumberger 2009.

Aquifer parameters

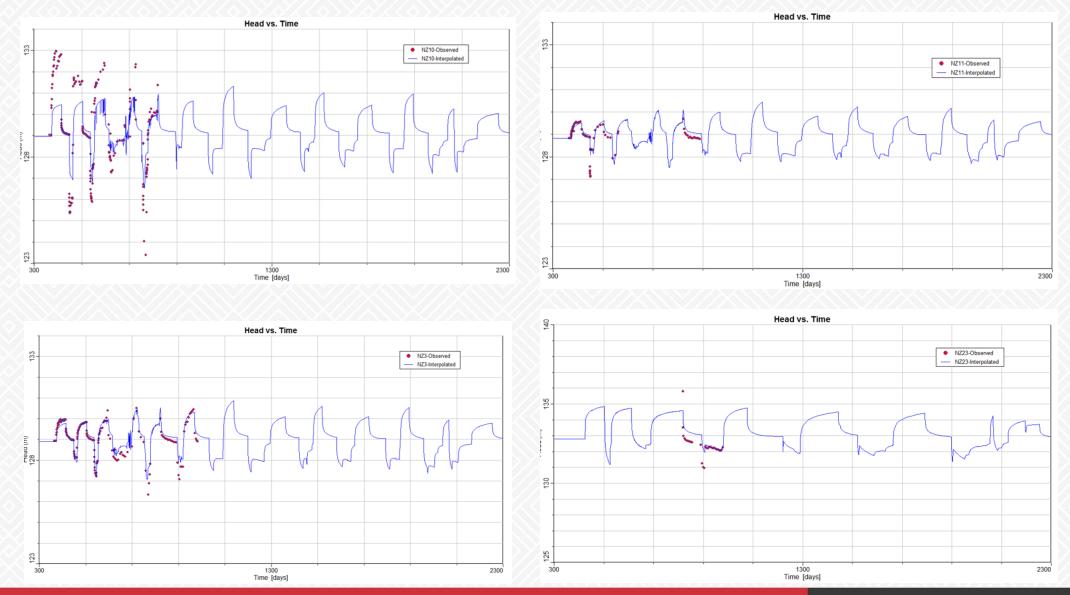
Parameter	Value
K <sub>z</sub> /K <sub>x</sub> anisotropy	0.01
$K_z/K_y$ anisotropy	0.1
Total porosity	0.3
Effective porosity	0.23
Specific yield, S <sub>y</sub>	0.15
Specific storage coefficient $S_s$	0.0035

#### Calibrated aquifer parameter

Parameter	Value		
K <sub>x</sub> /K <sub>z</sub> anisotropy	0.01		
$K_y/K_z$ anisotropy	0.1		
Total porosity	0.25		
Effective porosity	0.15		
Specific yield, S <sub>y</sub>	0.1		
Specific storage coefficient Ss	0.001 l/m		
Constant Head boundary (South)	136.4m		
Constant Head boundary (North)	124.9m		

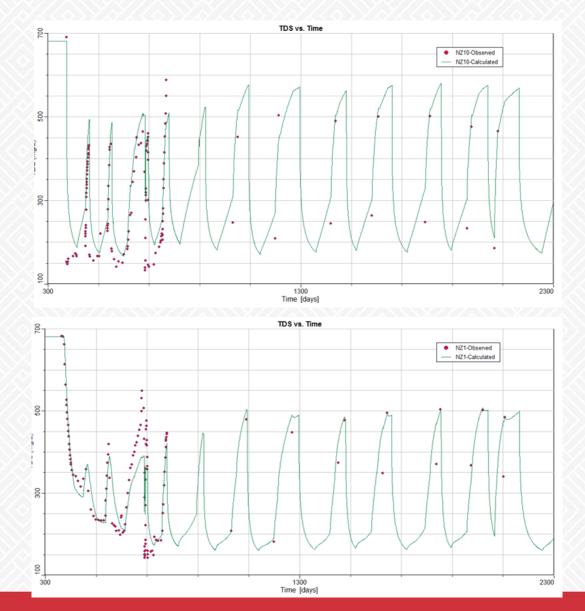


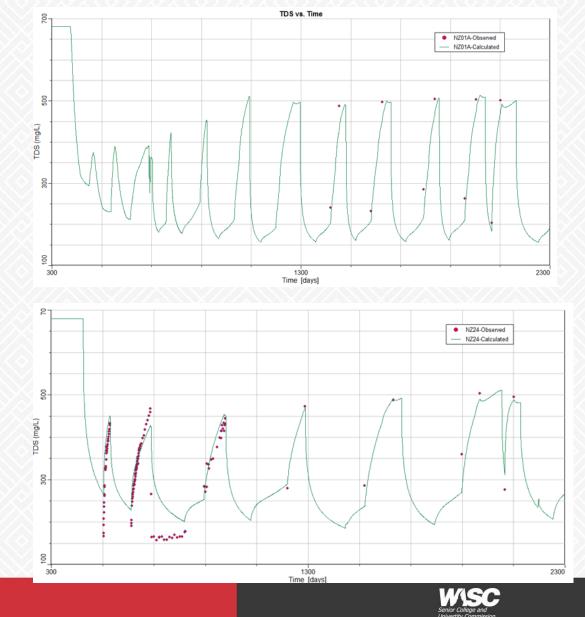
# **ASR Simulation – MODFLOW: Water Levels**



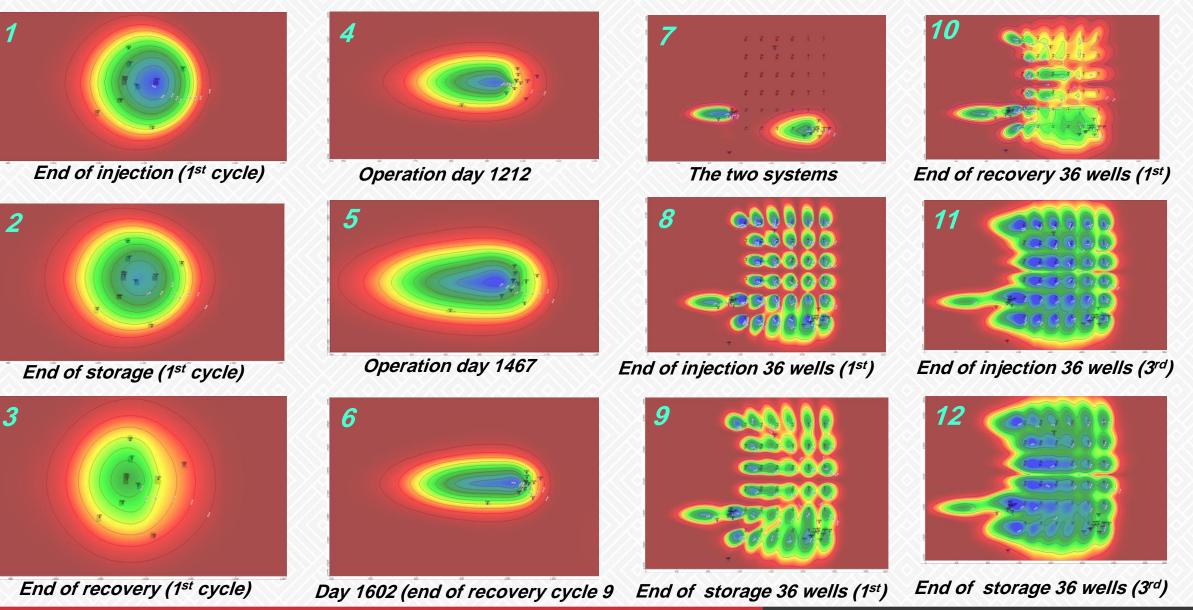


# **ASR Simulation – MODFLOW: Salinity**





## Plume development in single and multiple wells in ASR





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### **Dynamics of Water Levels in ASR System**

420000 E 425000 430000 435000 W-4 W-6 ASR W-2 000 • 0 0 0 O W-1 W-3 W-7 W-5 а ш 0 - Start ---- 23 days ----- 83 days ----- 113 days ----- 173 days ----- 250 days 20 ASR n W-06 W-01 W-02 W-03 W-04 W-05 
 Water table amsl (m)

 0

 2

 0
W-07 Variation of water levels Nell Field under injection and recovery- Vertical view Basement Kalba Well F -5 429900 430000 430400 430100 430200 430300 **UTM Coordinate-Easting** W-4 - W-3 W-1 - ASR (Undisturbed) •••• W-4 ----W-3 •••• W-1 ••••• ASR (Disturbed) Wadi Al Hav 15 Wadi Hald Wadi Ham Irrigation Wells (m) 10 Ism Modeled Area UNITED ARAB EMIRATES Time variation of water load 50 km levels under injection Coastline Head w.r.t. ----and recovery in ASR .......... and other observation 425000 E 420000 E 430000 E 435000 E wells 0 -5 50 100 250 150 200 0 Simulation period (days)



# **Concluding Remarks**

- ASR systems provides a feasible option for storage of the excess of water and recovery during high demand .
- ASR projects can not be duplicated each project has its own characteristics and operation parameters. The presented results are specific of the studied areas.
- Aquifer geological, hydrogeological and hydrochemical characteristics must be carefully Investigated.
- Variable density flow models would provide better simulation of ASR systems.



# Thank you

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