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)



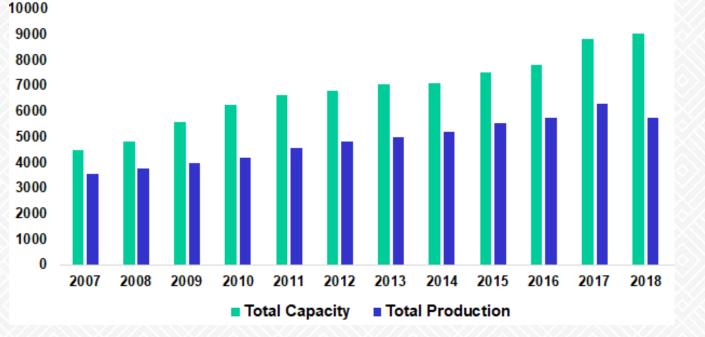
March 17th, 2021



Desalination Capacity and Production in GCC

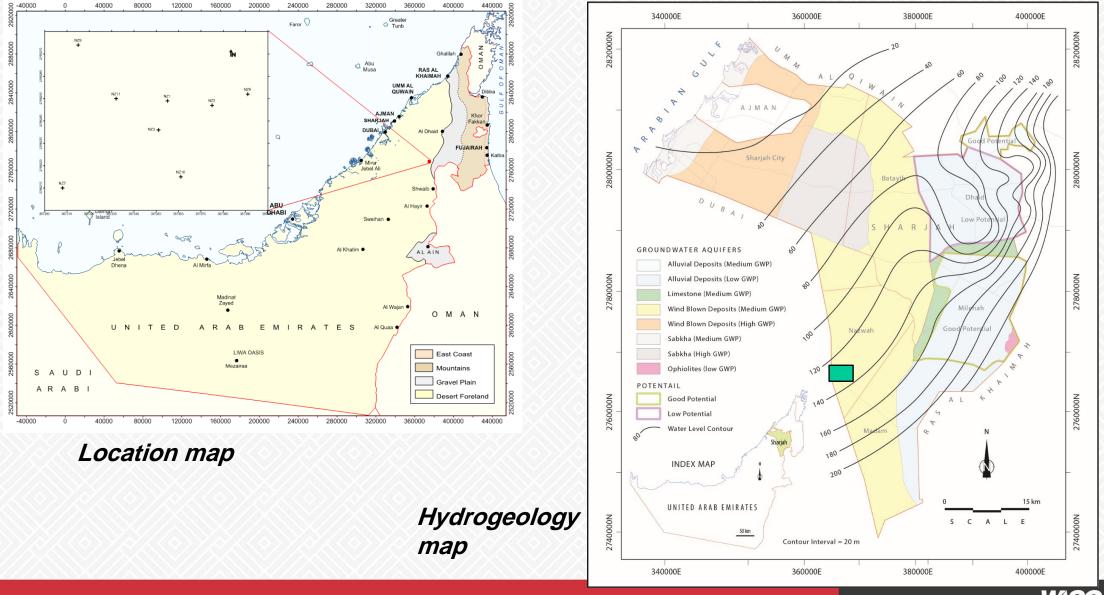
- □ Total capacity (2018) =9.03 bm³/year
- **Total production (2018) = 5.75 \text{ bm}^3/\text{year}**
- □ The cost of desalination reduced significantly
- Electricity Generation
- Demand Fluctuation
- **Development of Freshwater Strategic Reserves**

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





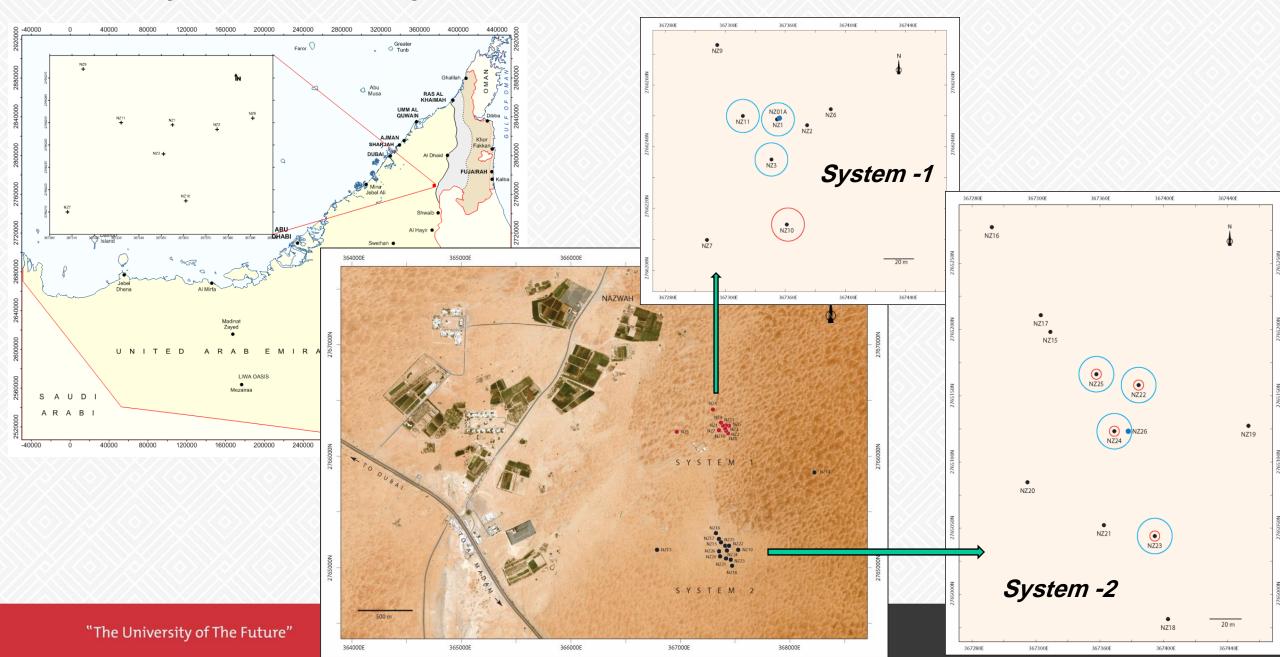
ASR-System in Sharjah Emirate- Nazwah





ASR-System in Sharjah Emirate- Nazwah





Operation Schedule and Water Level Measurements

20 m

367440E

367400E

367280E

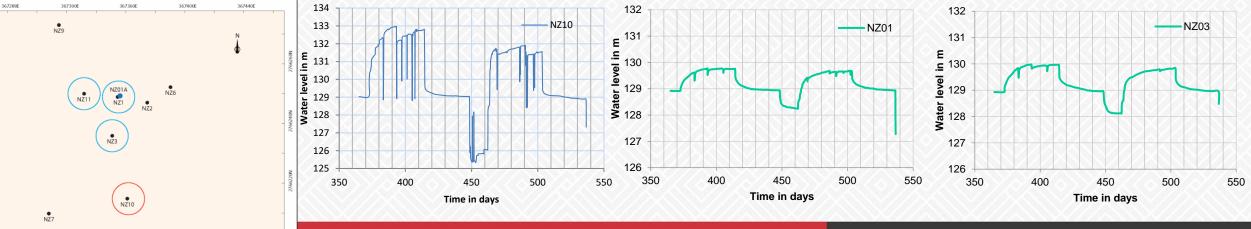
367300E

367360E

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Active well	Injection/Reco	Start	End	Pumping	Days	Total	Cycle	Active well	Injection/Reco	Start	End	Pumping	Days	Total
/	very/Storage	Date	Date	rate		volume				Date	Date			volume
()				m³/day		(m³)						m³/day		(m ³)
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/'	Storage	17/12/2011	27/02/2012		72		-,		-					
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<u> </u>	,				-	ļ!			Standby		22/10/2011		5	
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,	Standby	10/10/2012	31/10/2012		21		8	NZ23, 24, 25, 26	Recovery	12/06/2012	31/10/2012	-873	141	124034
NZ1A, NZ10	Injection	31/10/2012	27/11/2012	748	27	20215			Standby	31/10/2012	05/11/2012		5	
, ,	Storage	27/11/2012	27/11/2012		0		Cycle-7	NZ23, NZ24, NZ26	Injection	05/11/2012	27/11/2012	823	22	18127
NZ1,NZ1A, NZ10	Recovery	27/11/2012	06/01/2013	-672	40	26883			Storage	27/11/2012	27/11/2012		0	
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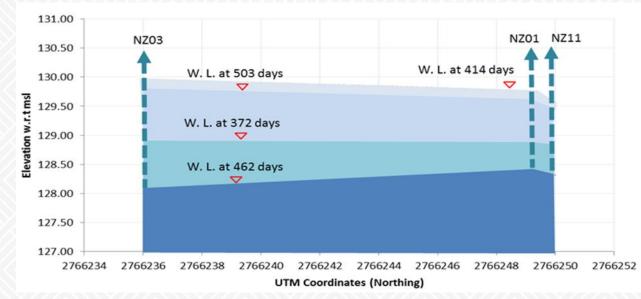


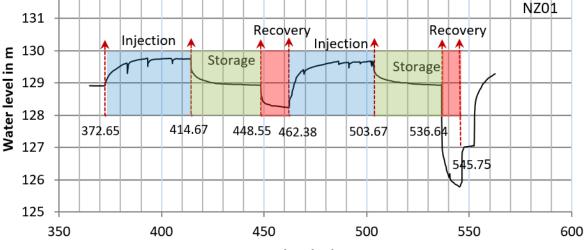
Analysis of Groundwater Levels

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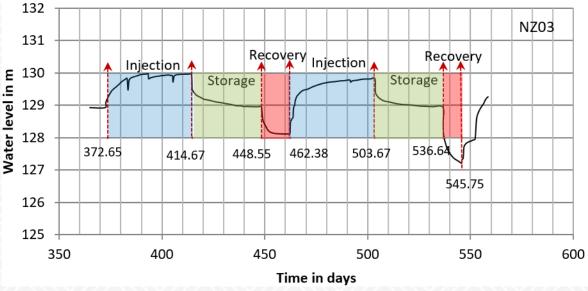
132 NZ11 131 Recovery Recovery Injection Injection E 130 Storage Storage Water level in 129 128 536.64 372.65 448 55 414.67 462.38 503.67 127 545.75 126 125 350 400 450 500 550 600

Time in days





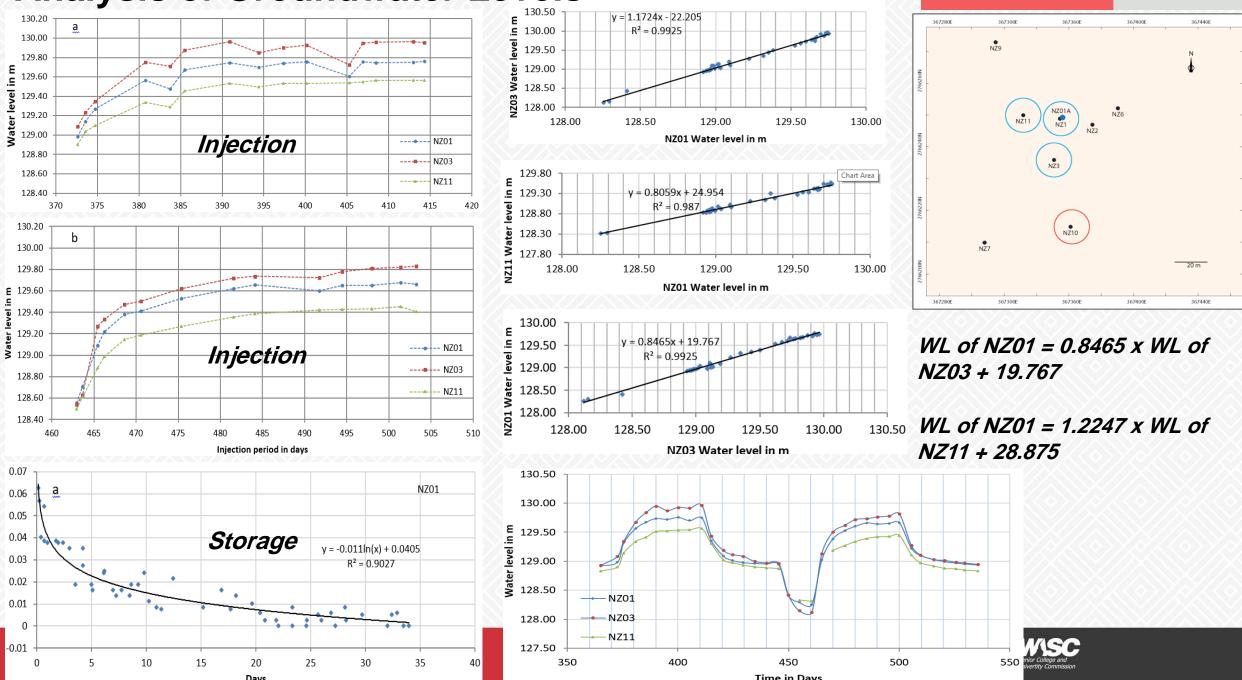
Time in days



Senior College and Univertity Commission

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Analysis of Groundwater Levels



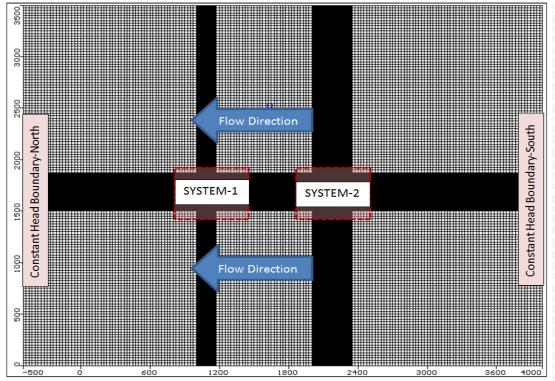
المركز الوطني للمياه والطاقة

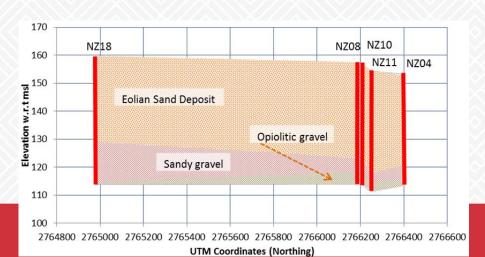
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ASR Simulation – MODFLOW





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

Model Layer	Longitudinal	Transversal	Vertical		
	Conductivity (K _x)	Conductivity (K _y)	Conductivity (K _z)		
	[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

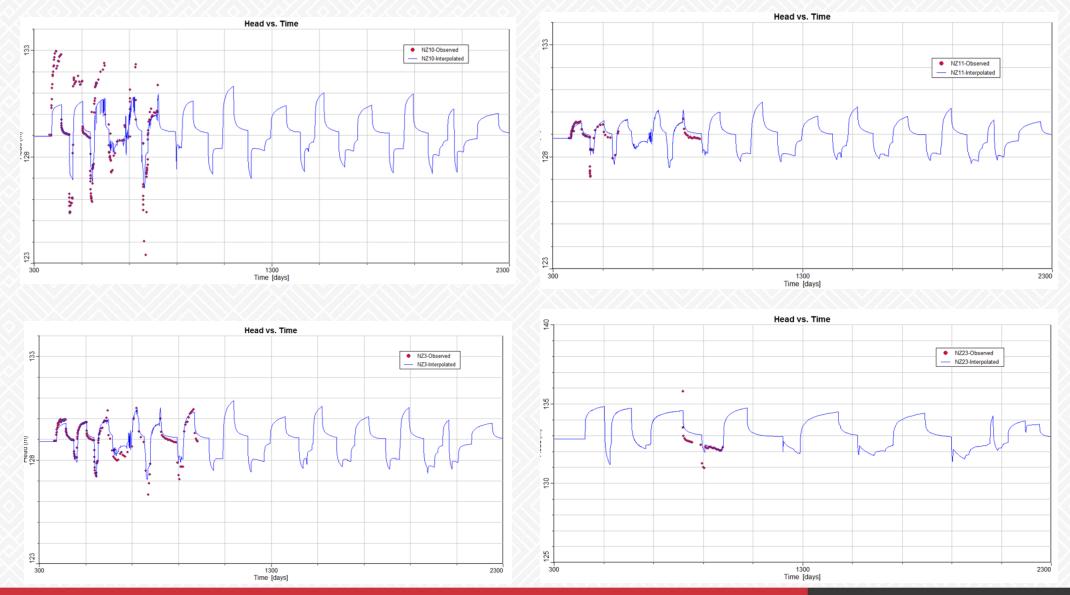
Parameter	Value
K _z /K _x anisotropy	0.01
K_z/K_y anisotropy	0.1
Total porosity	0.3
Effective porosity	0.23
Specific yield, S _y	0.15
Specific storage coefficient S_s	0.0035

Calibrated aquifer parameter

Parameter	Value		
K _x /K _z anisotropy	0.01		
K_y/K_z anisotropy	0.1		
Total porosity	0.25		
Effective porosity	0.15		
Specific yield, S _y	0.1		
Specific storage coefficient Ss	0.001 l/m		
Constant Head boundary (South)	136.4m		
Constant Head boundary (North)	124.9m		

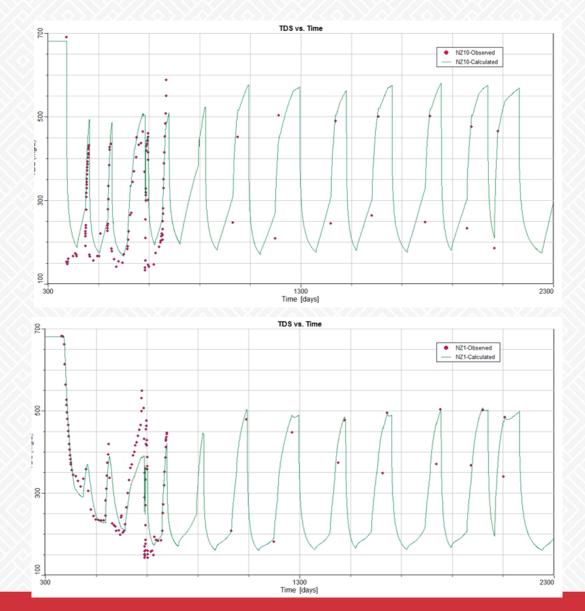


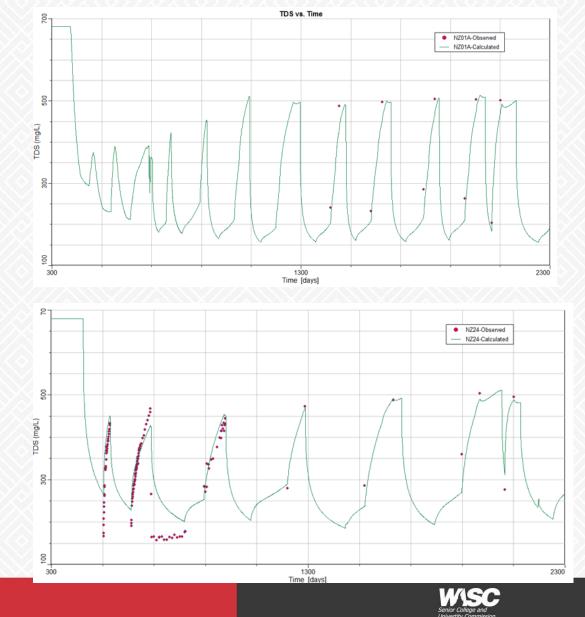
ASR Simulation – MODFLOW: Water Levels



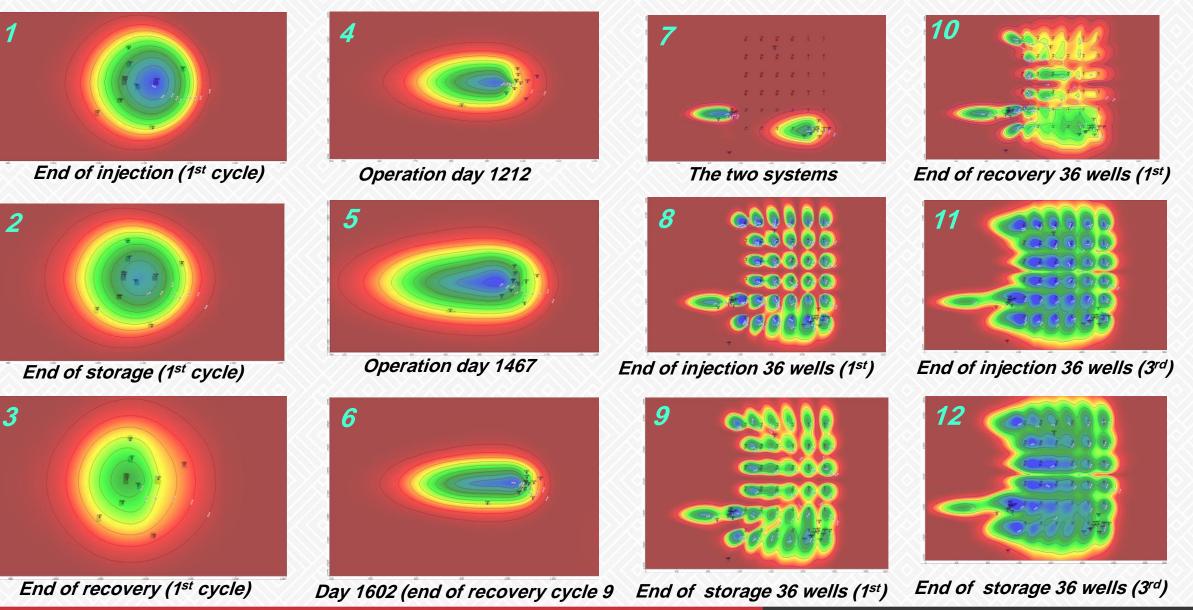


ASR Simulation – MODFLOW: Salinity





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)

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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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