DEMO Site 7

Monitoring at Menashe Infiltration Basin Hadera, Israel

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MARSOL Lavrion Workshop Athens, 16 – 18 March 2016

Monitoring and Investigation Technologies

Menashe site - overview

What do we Monitor?

Production wells: groundwater levels and water quality

(frequency: once a year, or before and after MAR events)

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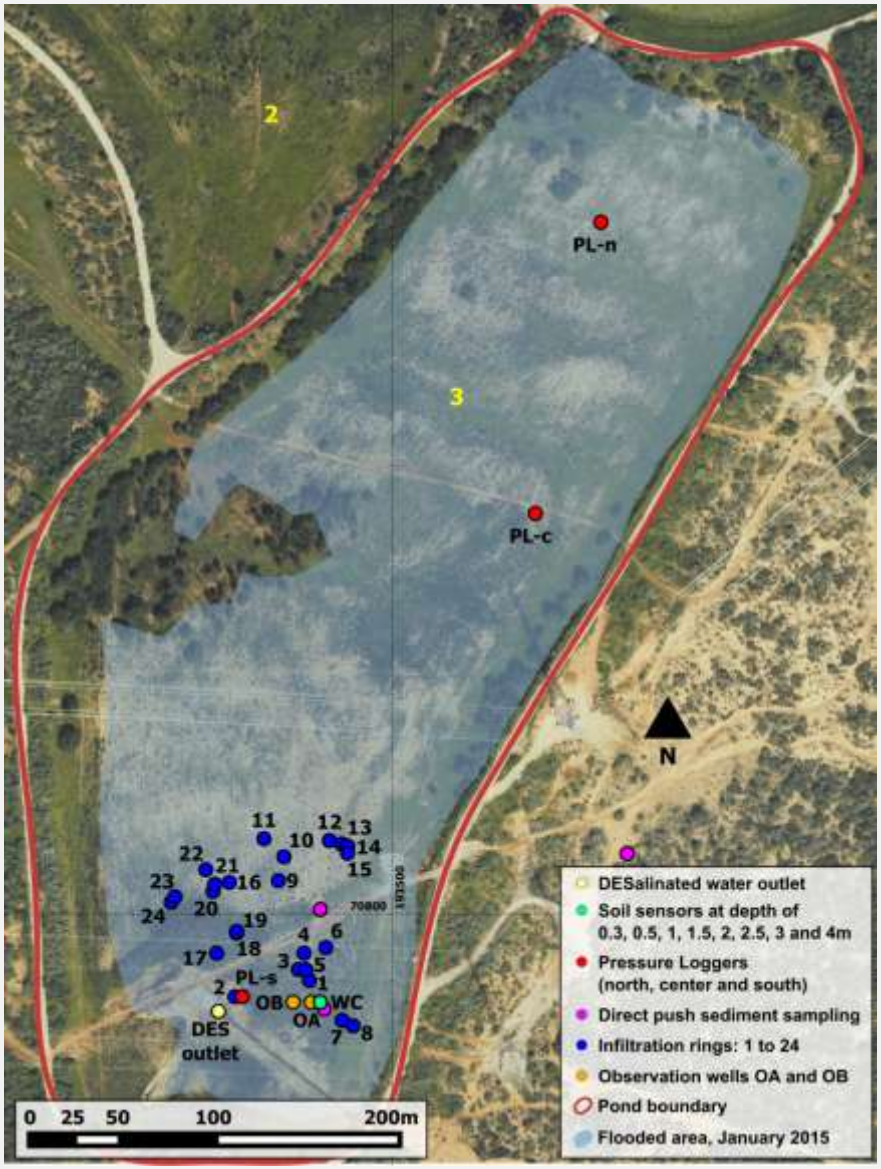

Infiltration pond

Pond surface:

levels, EC and T (cont. during MAR)

water quality (few times during MAR)

Infiltration rates

Single-ring infiltrometers

(few times during MAR)

Vadose zone:

WC, bulk EC and T (continuously)

pore water (few times during MAR)

GW observation wells:

levels, EC and T (continuously)

water quality (every 3 months)

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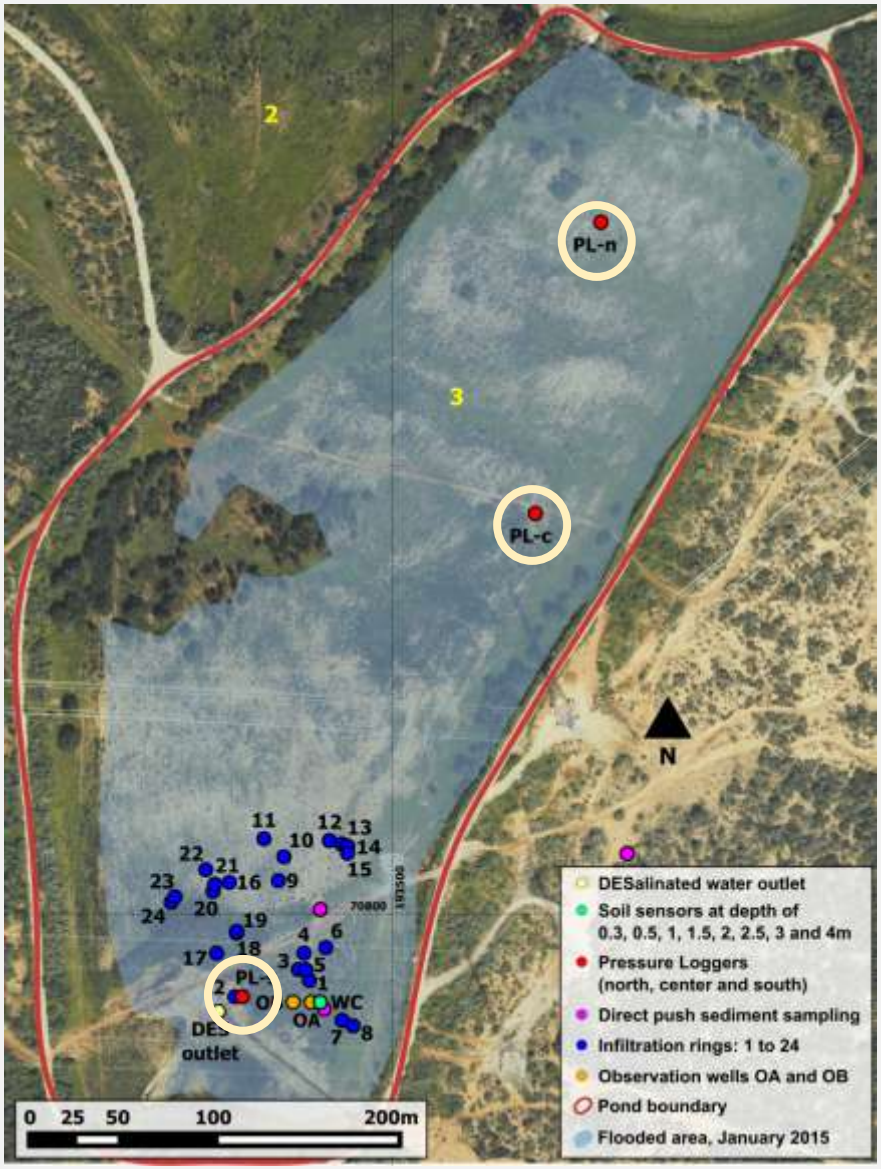

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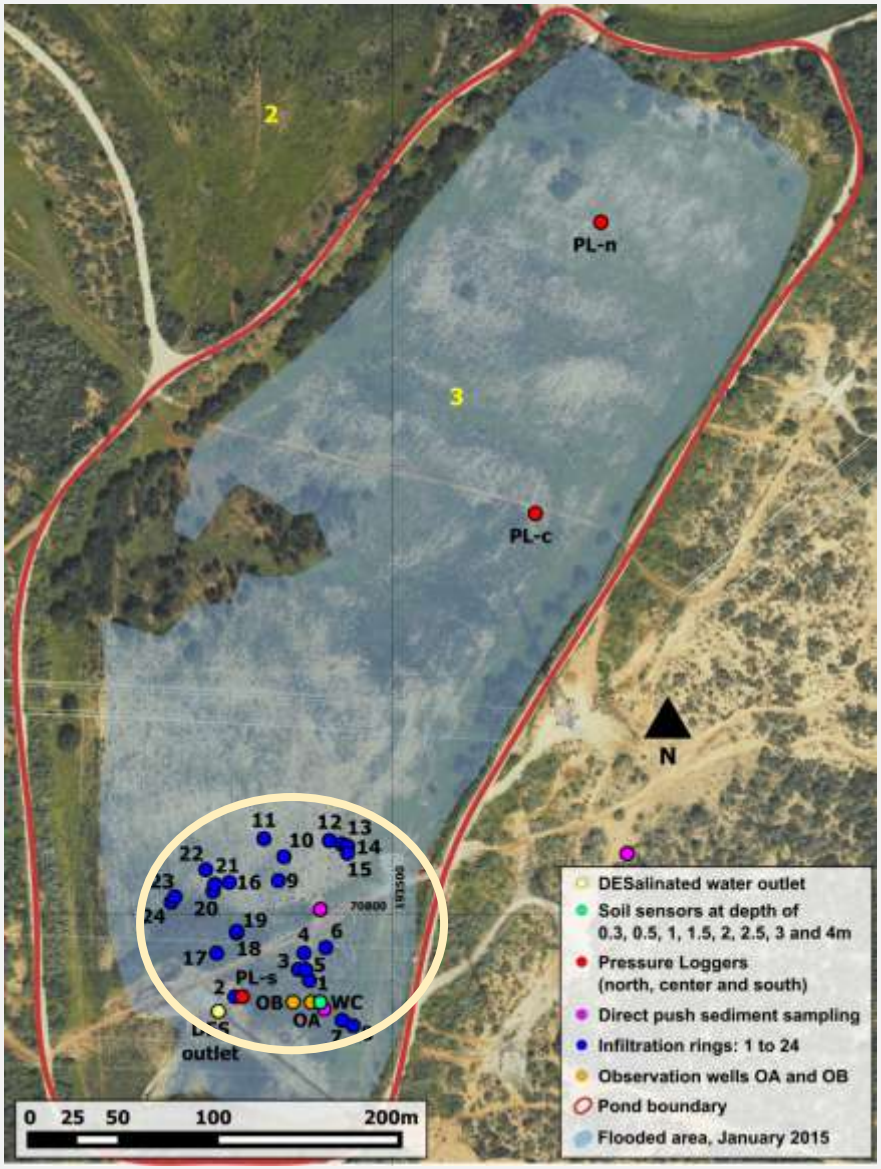

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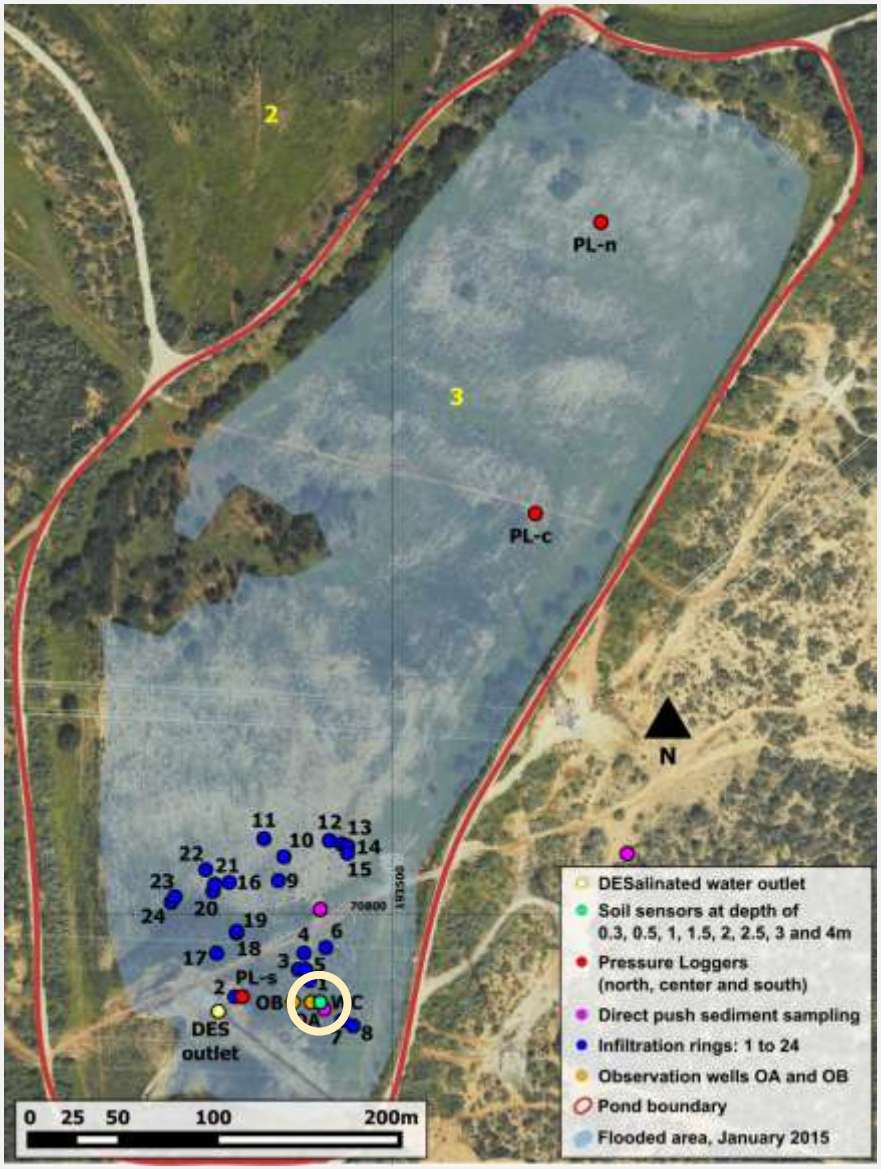

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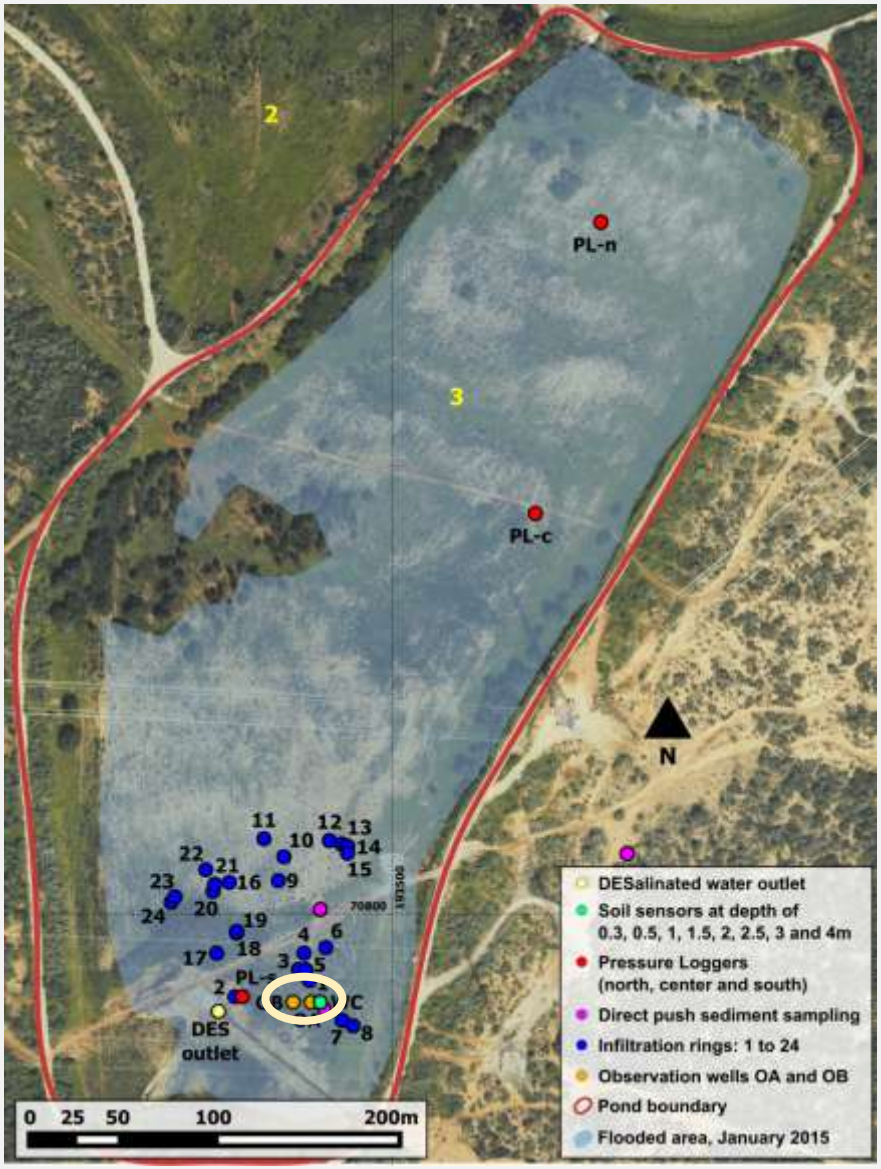

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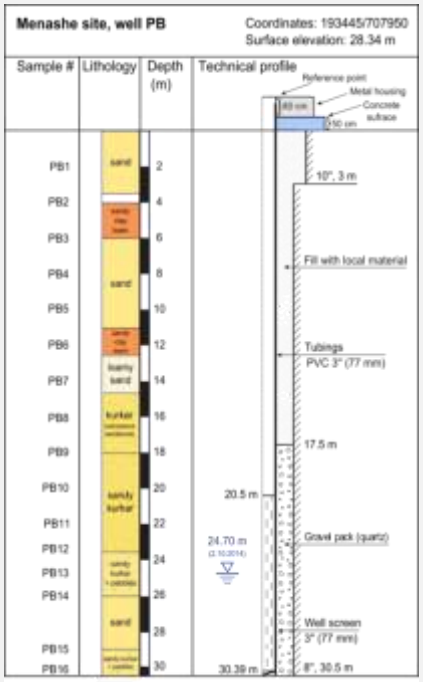
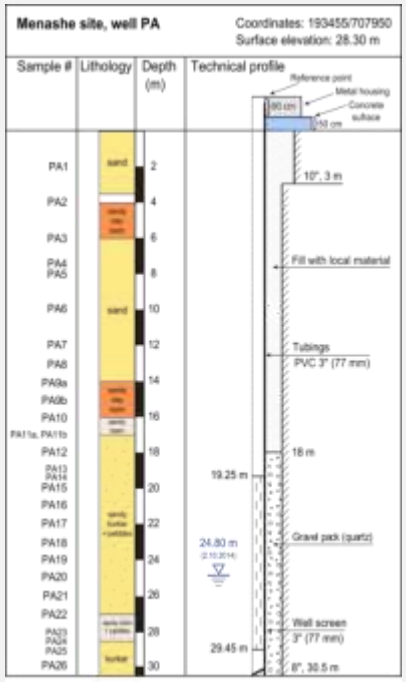
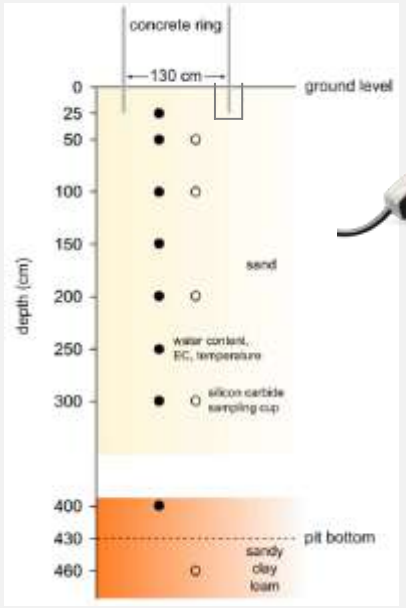
Monitoring system – GW & VZ



CTD Diver (SWS)





soil sensors (Decagon)

silicon suction cups (UMS)

Monitoring MAR January 2015

Database (WP9 deliverable)

MS Access based

ID	ID_IWS	Name	Use	X_ITM	Y_ITM	Altitude_(m_amsl)	Original_BH_Depth	Updated_BH_Depth	Top_of_Screen_1	Bottom_of_screen_1	Top_of_Screen_2	Bottom_of_screen_2	Top_of_Screen_3
19370781	99999999	PA	ARO observation	193454	707930	28.34	30.5	30.5	19.25	29.45			
19370782	99999999	PB	ARO observation	193446	707930	28.24	30.5	30.5	20.5	30.4			
2032009	20914202	Hadera 1	Mekorot Production	192739	709548	23.13	88.1	83.63	74	83.63			
2032010	21014301	Hadera 2	Mekorot Production	193045	710480	27.4	114	85	54	85			
2032011	21114301	Hadera 3	Mekorot Production	193282	711188	24.64	84	83.2	41.4	55.62	65.77	83.32	
2032012	20914302	Hadera 4	Mekorot Production	193526	709772	43.83	94	94	57.1	94			
2032028	21014309	Hadera 5a	Mekorot Production	193866	710875	37.27							
2032026	20914407	Hadera 6	Mekorot Production	194028	709965	37.89	93	90.5	58.5	88.5			
2032027	21014308	Hadera 7	Mekorot Production	193821	710496	36.14	105	88	54.49	66.16	69.17	76.09	79.09
2032001	21214201	Keisaria 1	Mekorot Production	192236	712489	14.75	114.5	92	29	34	40	46	52
2032025	21114303	Keisaria 4	Mekorot Production	193456	711509	18.42	70	70	46.96	55.96	55.96	66	
2212002	20914012	Keisaria 6	Mekorot Production	190134	709509	8.99	39.1	39.1	31.54	37.6			
2212003	20914013	Keisaria 7	Mekorot Production	190145	709184	9.24	46.5	45.5	25.3	28.33	36	45.5	
2282010	20714401	Menashe 10	Mekorot Production	194165	707664	17.96	61.3	61.3	35.2	55.2			
2282012	21114502	Menashe 12	Mekorot Production	195693	711089	34.44	66.5	52.7	32.4	52.7			
2282017	21014406	Menashe 13a	Mekorot Production	194464	710931	31.64	88	70	54.89	67			
2282014	21014307	Menashe 14	Mekorot Production	193592	710255	43.98	100	97.7	58.77	90			
2282015	21014202	Menashe 15	Mekorot Production	192889	710030	24.69	86	85	56.8	81			
2282039	21114417	Menashe 16a	Mekorot Production	194059	711292	31.66	68.5	67	47.98	64.99			
2282028	20914406	Menashe 18a	Mekorot Production	194596	709740	38.48	100	100	63	72	75.5	96.5	
2282027	22514501	Menashe 1a	Mekorot Production	193079	709322	29.12	92	92	48	63	68	74	84
2282026	20914308	Menashe 20	Mekorot Production	193518	709405	38.88	98.8	97.3	68.3	91.3			
2282031	20814313	Menashe 21	Mekorot Production	193818	708457	36.87	89.2	89.2	65.2	87.2			
2282032	20914405	Menashe 22	Mekorot Production	194342	709501	37.94	95.38	89	60.8	89			
2282033	20714406	Menashe 23	Mekorot Production	194379	707861	19.05	75	75	44.54	52.75	57.75	68.94	70.94
2282034	21114416	Menashe 24	Mekorot Production	194440	711198	25.96	90.4	89	55	73.8	74.3	83	
2282035	21014405	Menashe 25	Mekorot Production	194667	710414	36.66	104.5	100.5	90	99			
2282037	20814407	Menashe 26	Mekorot Production	194079	708611	35.62	86	84.5	51.73	72.73	76.98	81.98	
2282038	20814406	Menashe 27	Mekorot Production	194253	709126	34.52	84	81	51.75	70.75	76	79	
2282041	20814301	Menashe 2a	Mekorot Production	193050	708636	28.69	92	90	58	71.3	71.8	87	
2282003	20914203	Menashe 3	Mekorot Production	192778	709083	13.63	78.38	78.38	30.18	38.55	43.05	49.7	53.22
2282004	20814203	Menashe 4	Mekorot Production	192588	708586	13.11	78	74.5	36.7	38	42.5	34.5	
2282036	20714308	Menashe 5a	Mekorot Production	193063	707718	13.83							
2282006	20814205	Menashe 6a	Mekorot Production	192970	708017	14.27	78.5	66.6	41.4	66.4			
2282030	20814312	Menashe 7a	Mekorot Production	193609	708767	38.22	98	97.75	61	91			
2282040	20914309	Menashe 8a	Mekorot Production	193554	709025	44.25	96.5	93	58.09	68.32	71.82	92	
2282009	20814204	Menashe 9	Mekorot Production	192851	708277	18.43	83	83	47.5	52.5	55.5	60.5	62
2212005	21014010	Sedot Yam 2	Mekorot Production	190242	710621	6.77	21.5	21.5	16.5	20.5			
2212006	21014011	Sedot Yam 3	Mekorot Production	190227	710315	8.4	24	20	13.7	20			

Well_Catalog | VadoseZoneSurfaceCatalog | Water_Level | Pumping | Sensor_Field_Data | Water_Quality | PZ

GW & VZ catalog

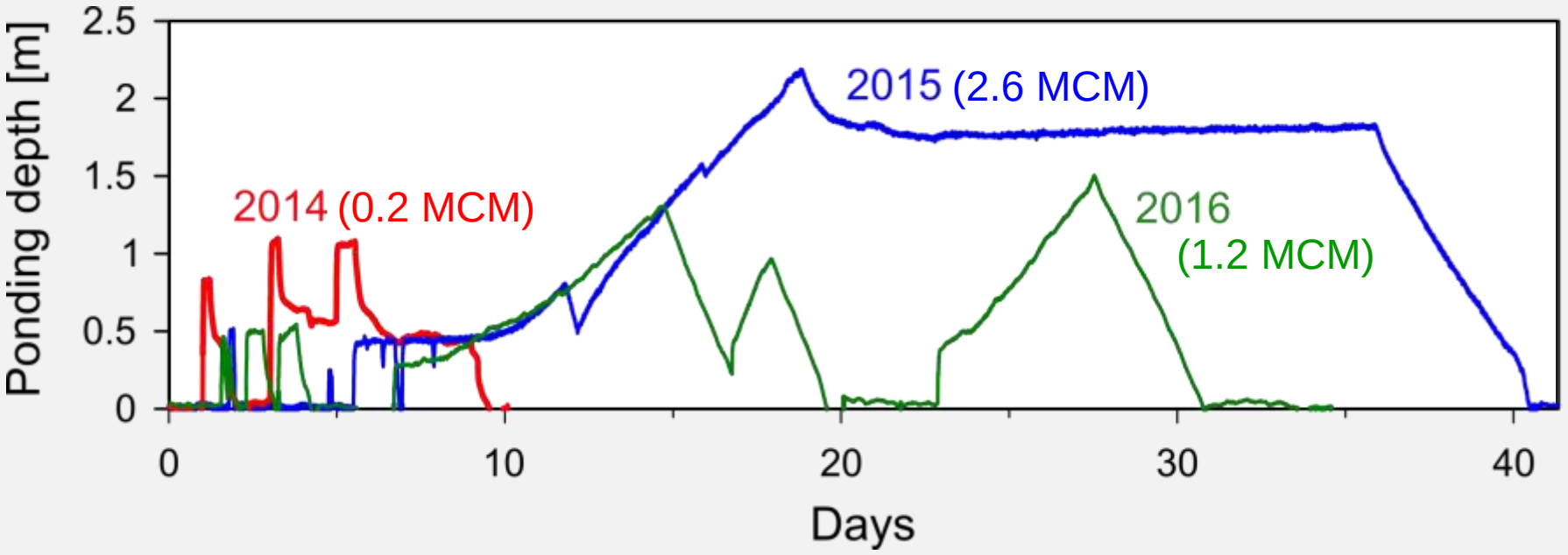
Water level and pumping

Sensors data

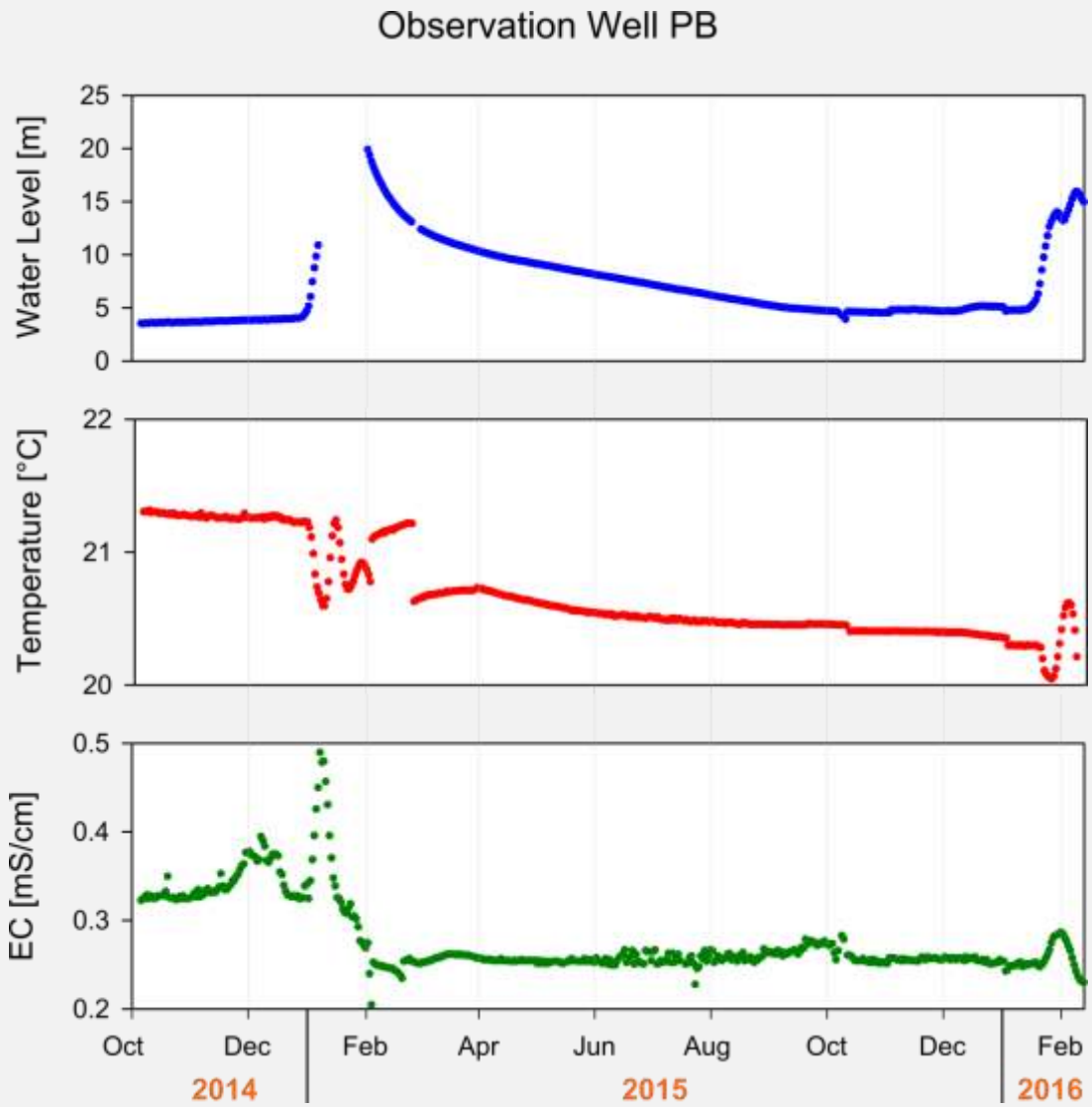
Water quality

Data (few examples)

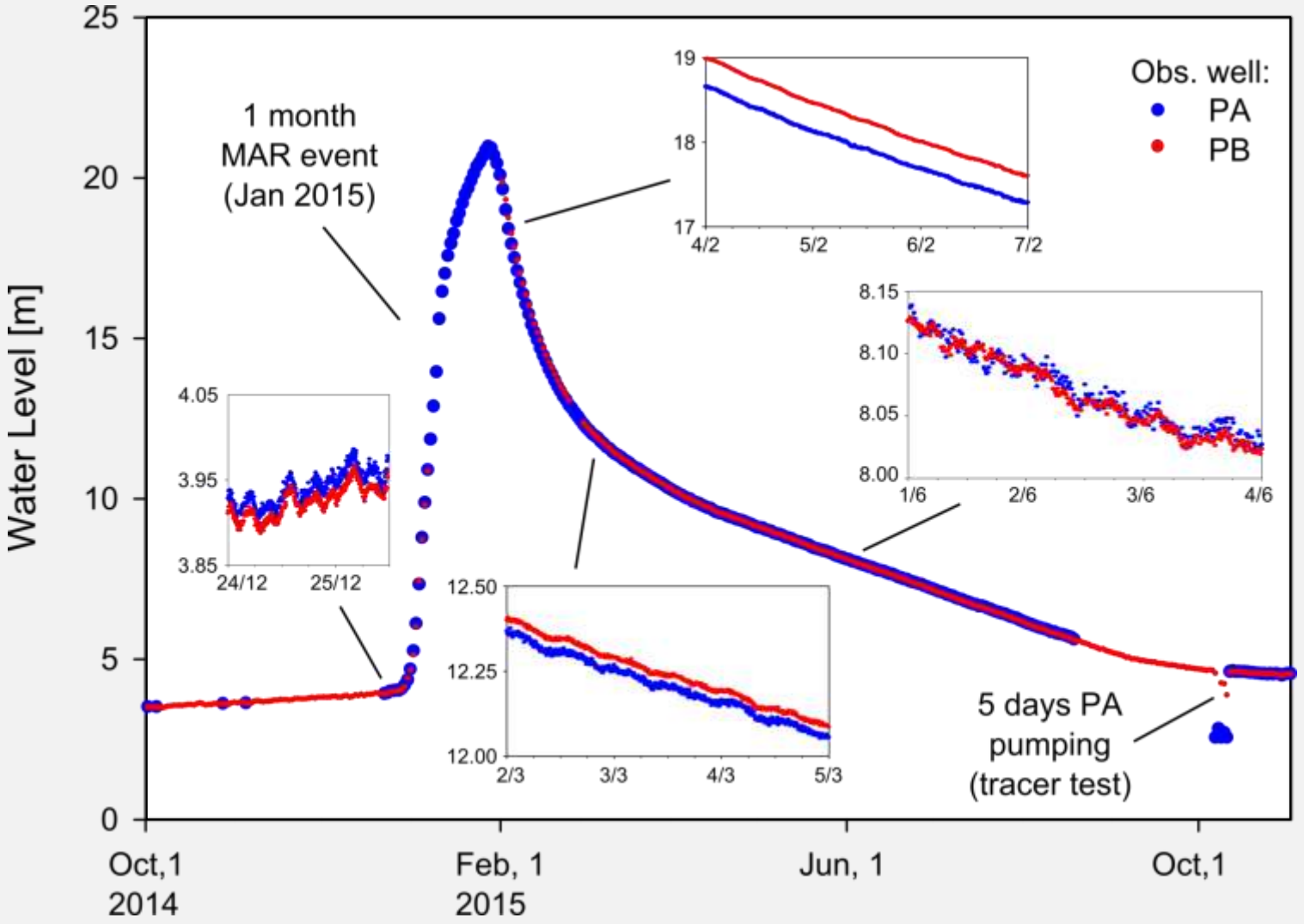
Ponding depth during three MAR events



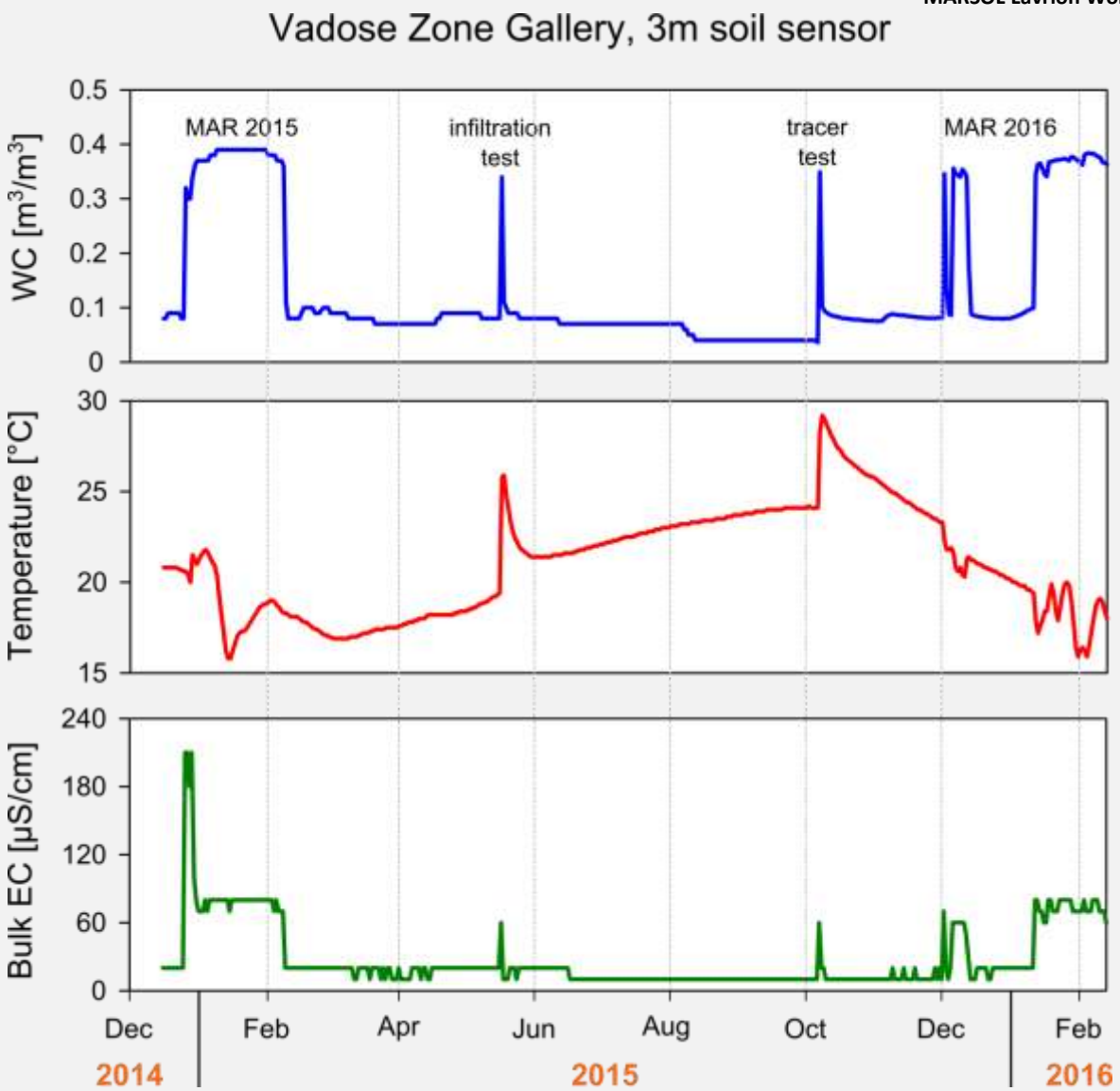
GW Observation wells



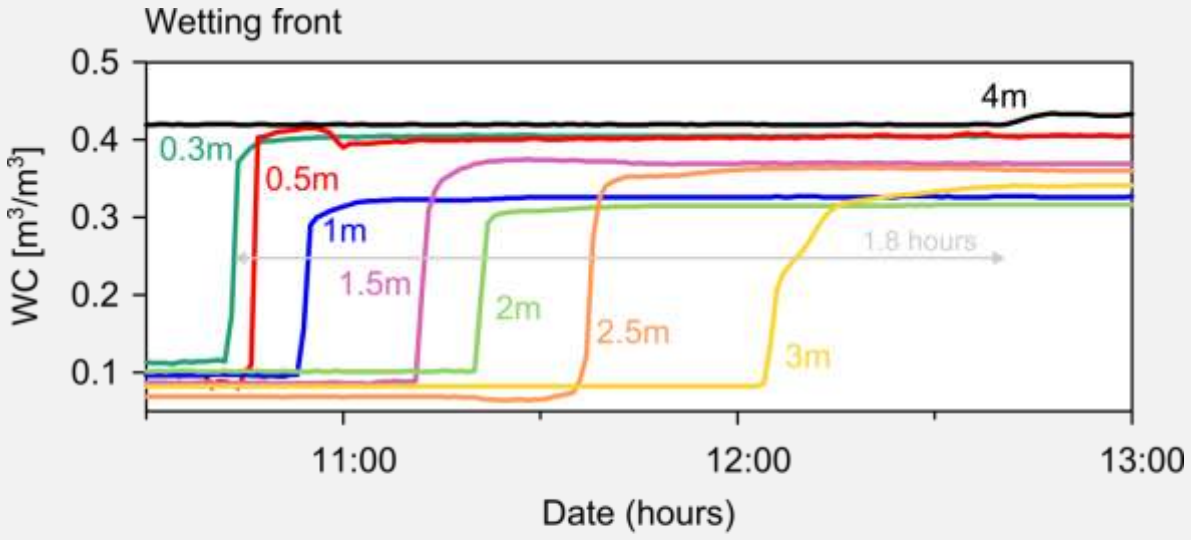
GW Obs. wells during MAR 2015

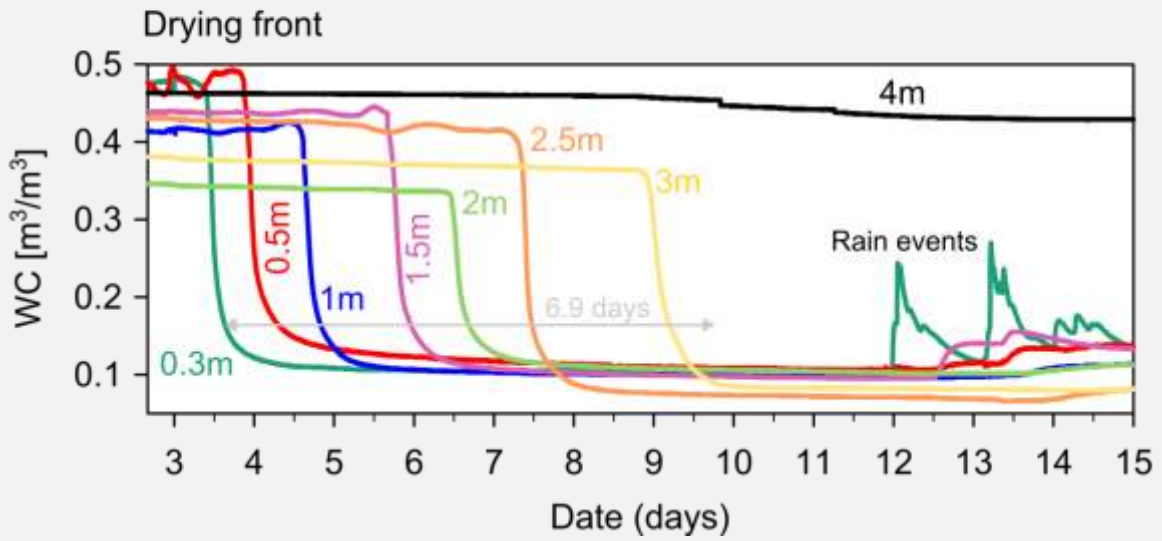


Vadose zone gallery

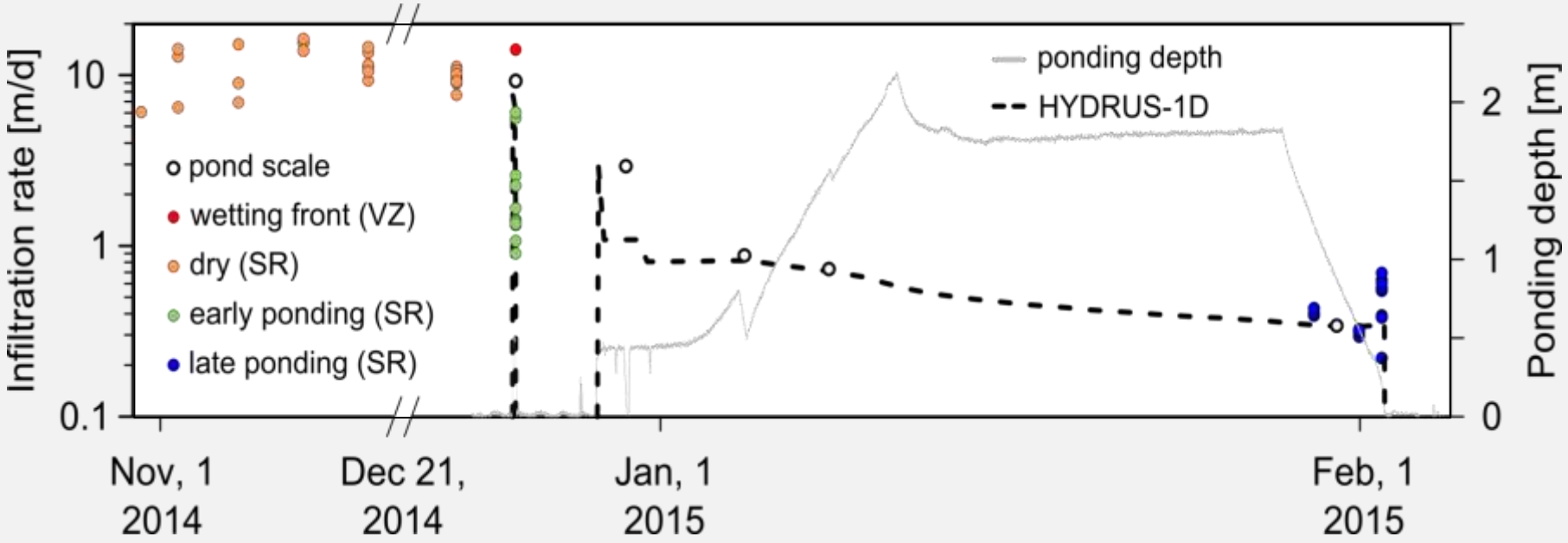


Vadose zone WC during MAR 2015





Infiltration rates (pond and local scales)

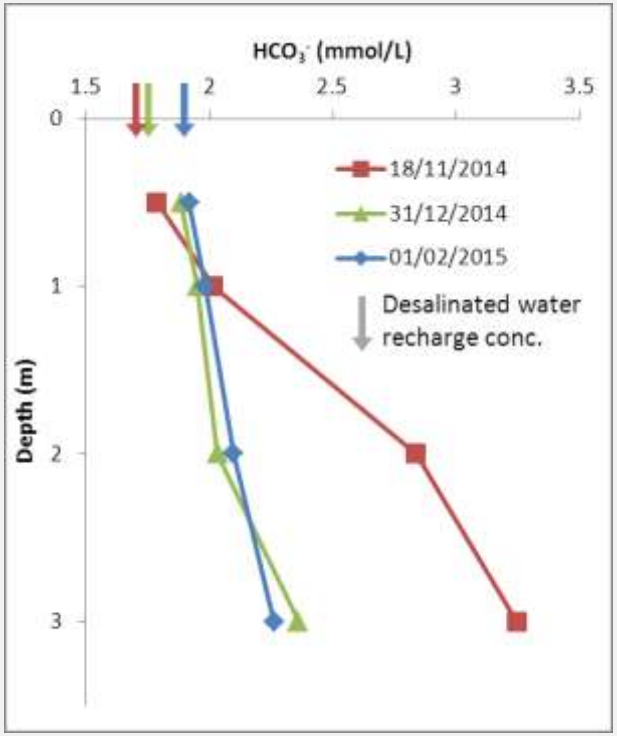


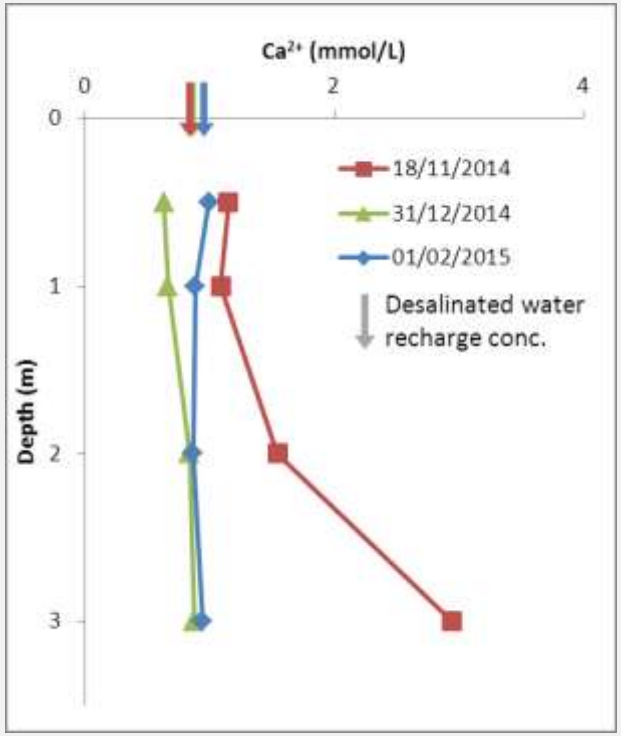
Geochemistry – suction cups (upper vadose zone sampling)

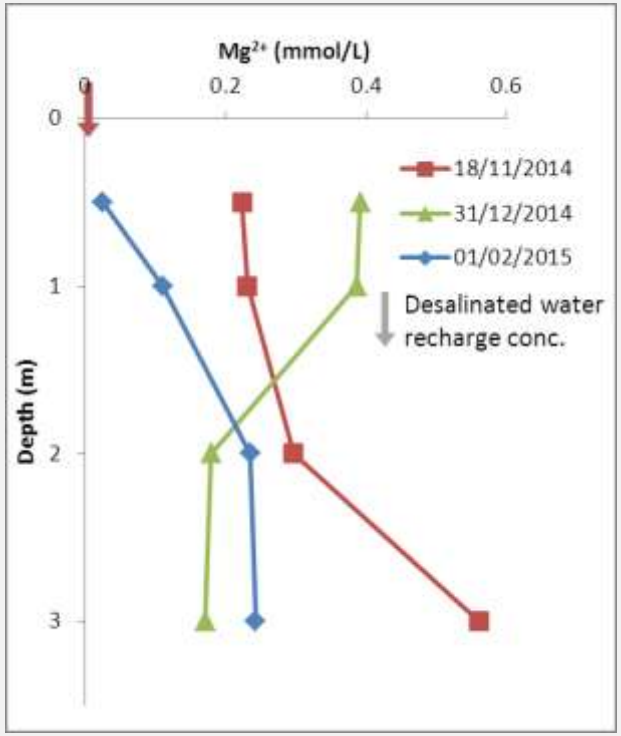
18/11/2014 – Dry sediment water from the beginning of infiltration

31/12/2014 – After 1.5 days of infiltration

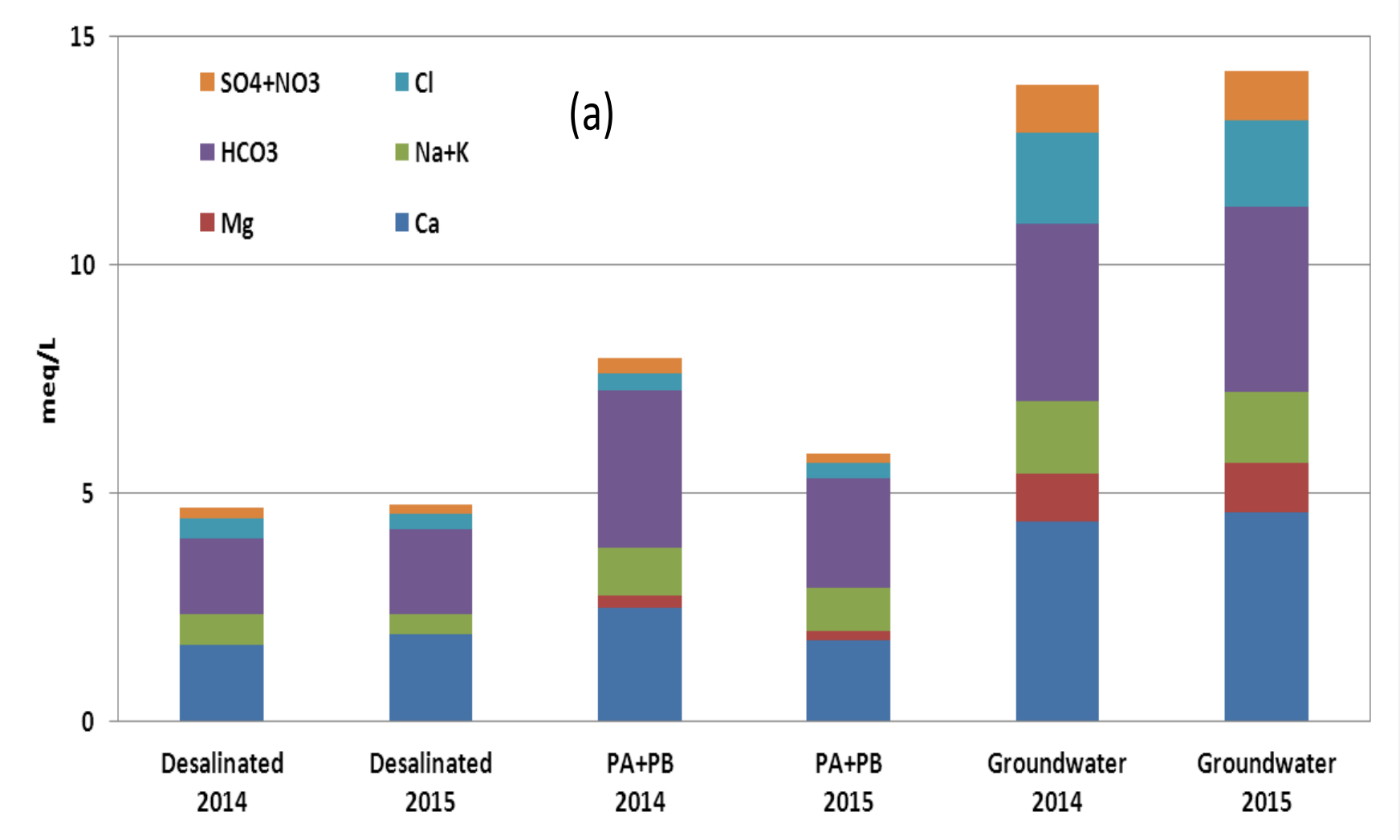
01/02/2015 – After 34 days of infiltration



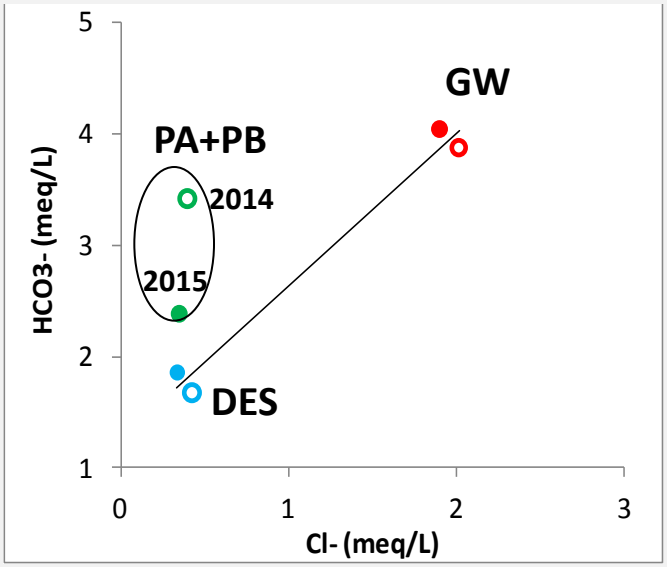


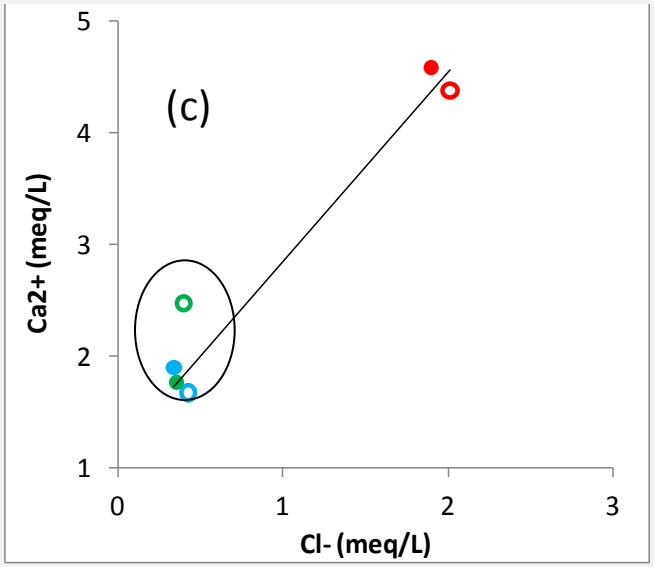


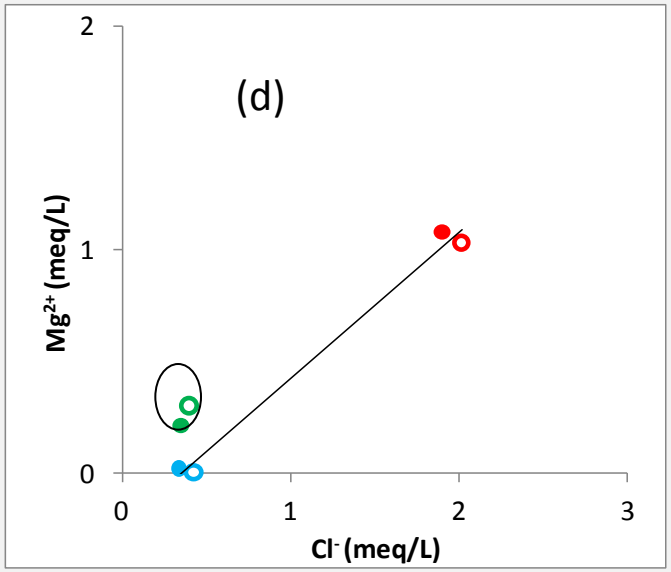
4 characteristic types of water

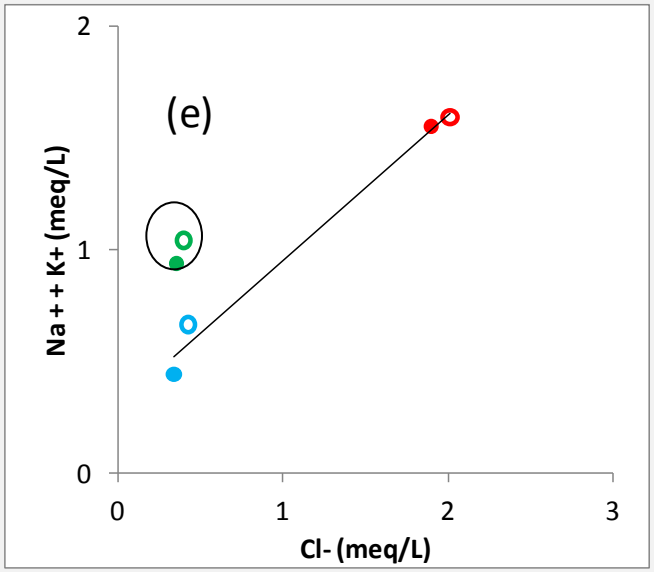


Shallow groundwater under the pond are not a mix

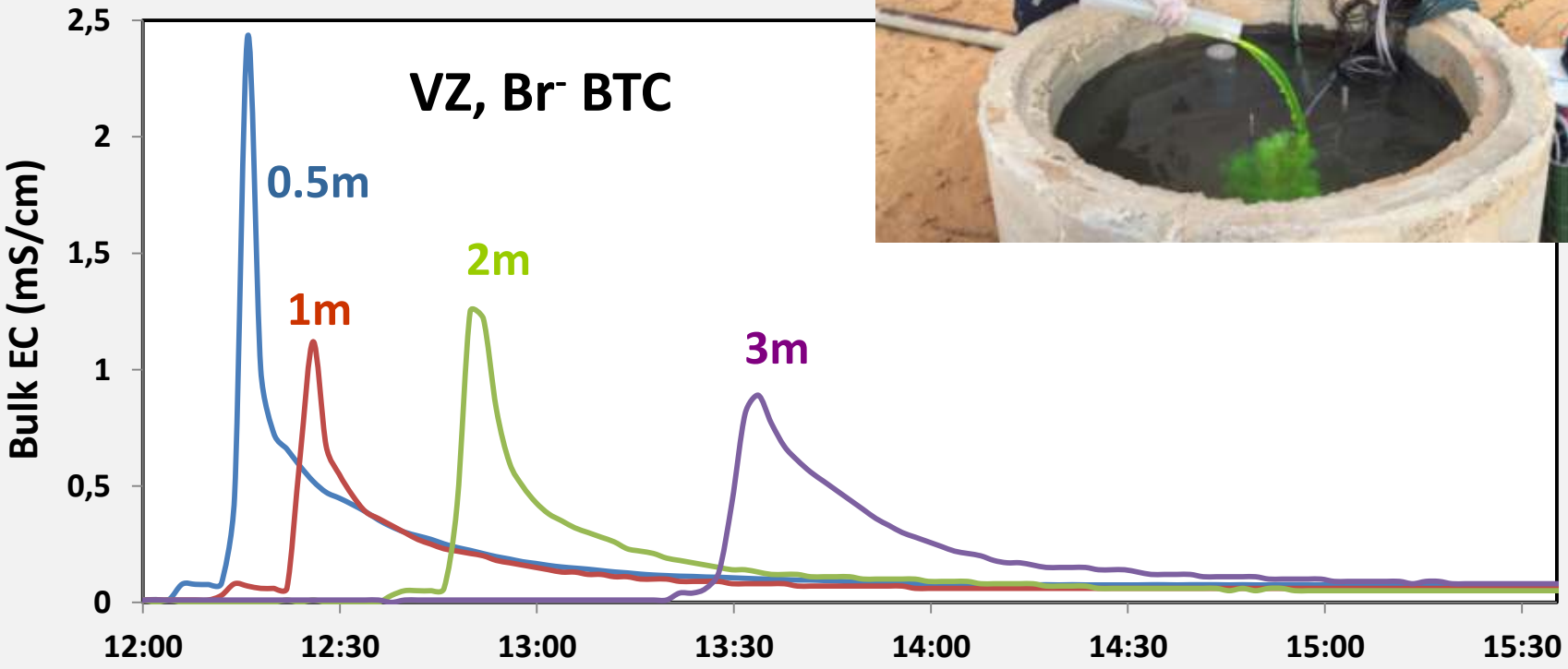




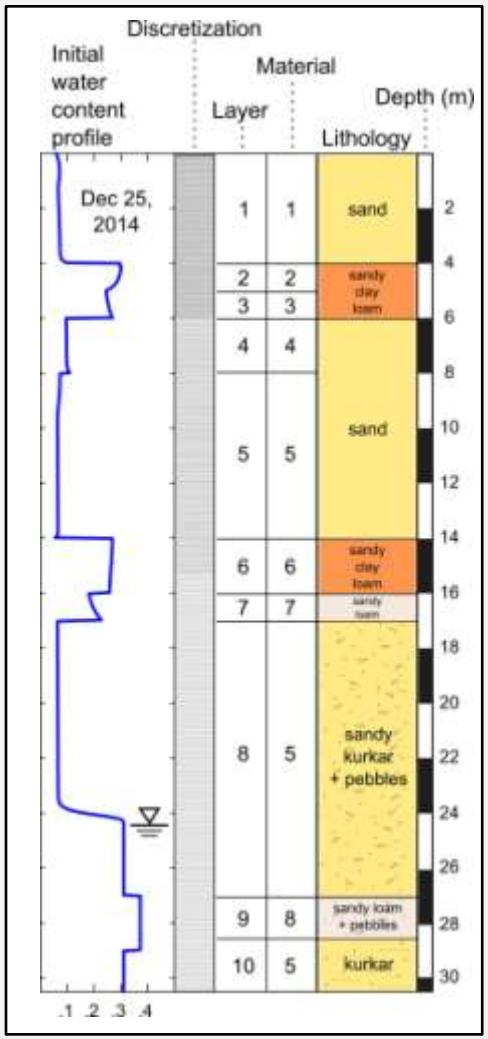


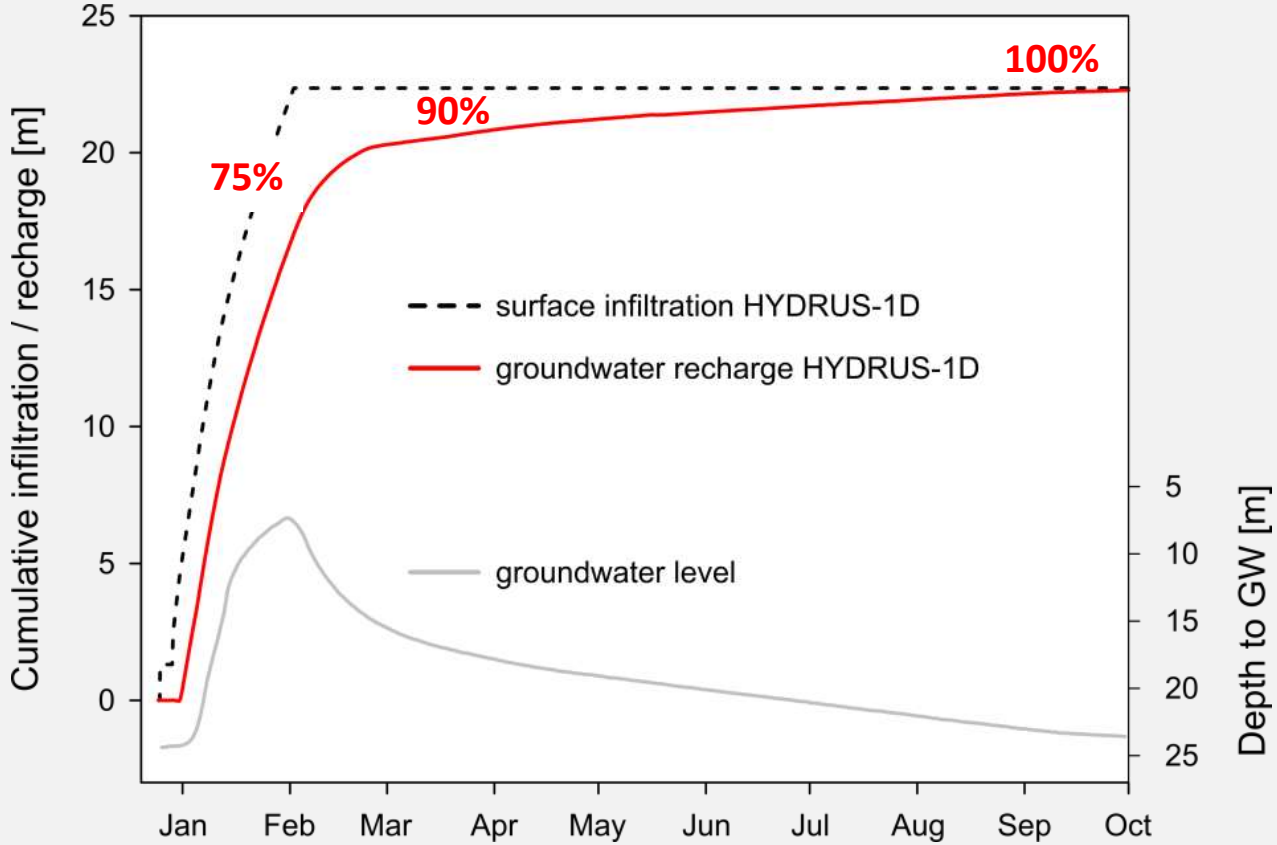


Using the monitoring system for controlled experiments



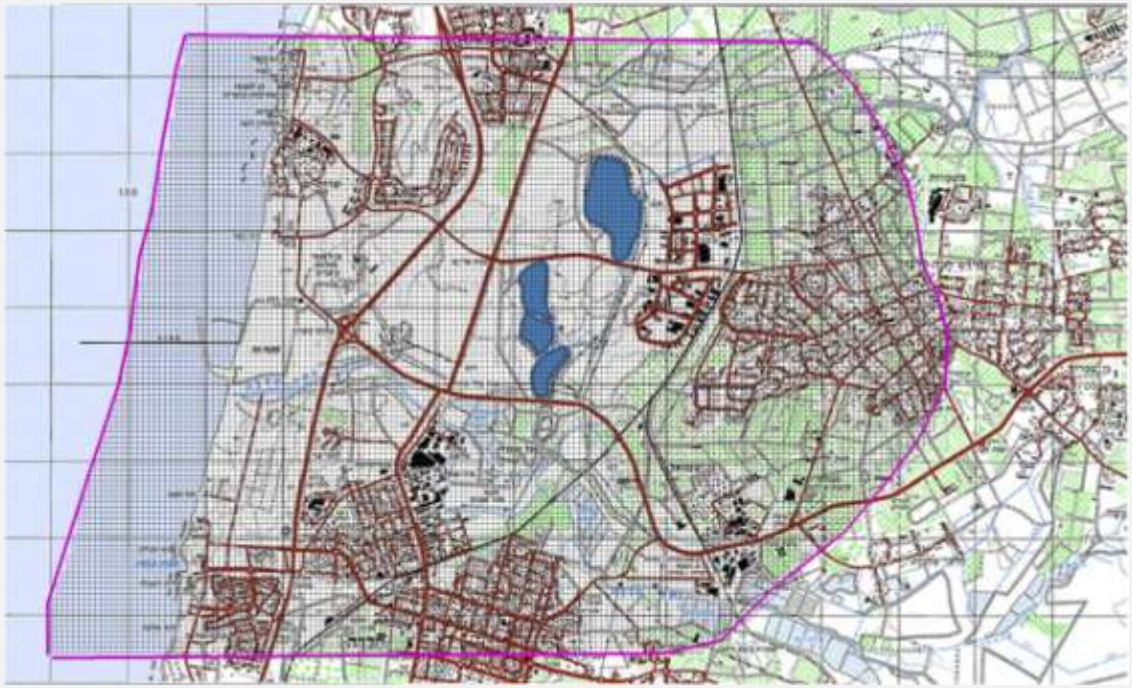
VZ modeling using the monitored data



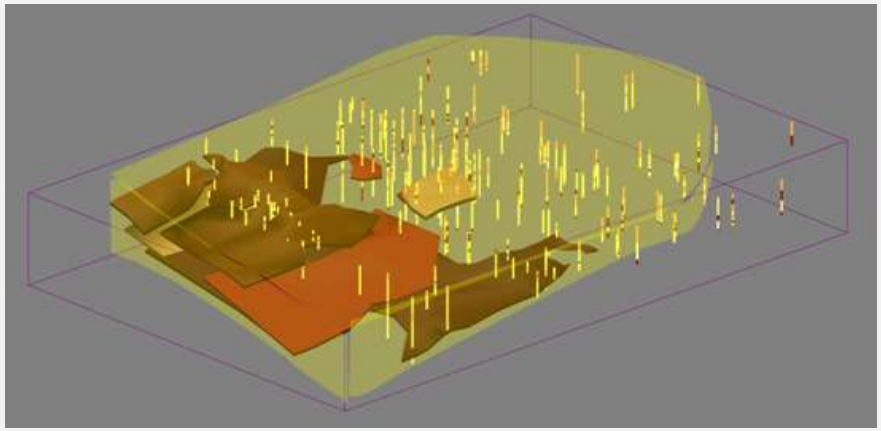


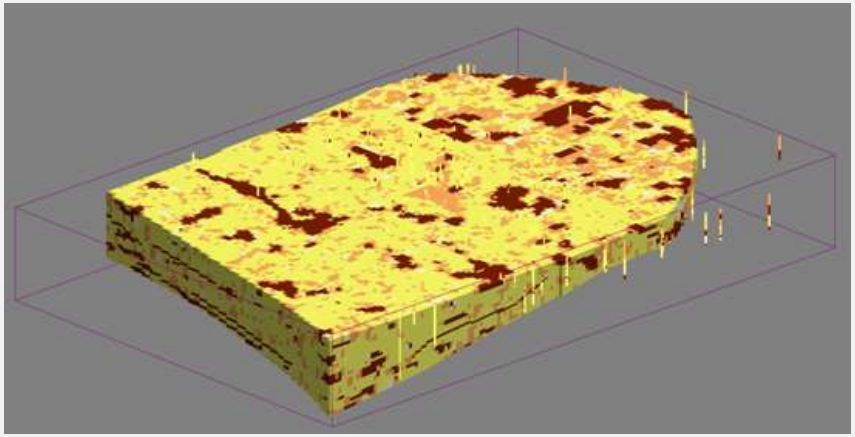
Ganot et al. (submitted, *J. Hydrol.*),
Monitoring and modeling infiltration-recharge dynamics of managed aquifer recharge with desalinated seawater

GW Modeling (MEK)



- Propose - MAR scenarios
- ~ 70 km^2
- MODFLOW (GMS)
- Geostatistical + deterministic aquifer material distribution





DBPs due to chlorinated desalinated seawater (BGU)

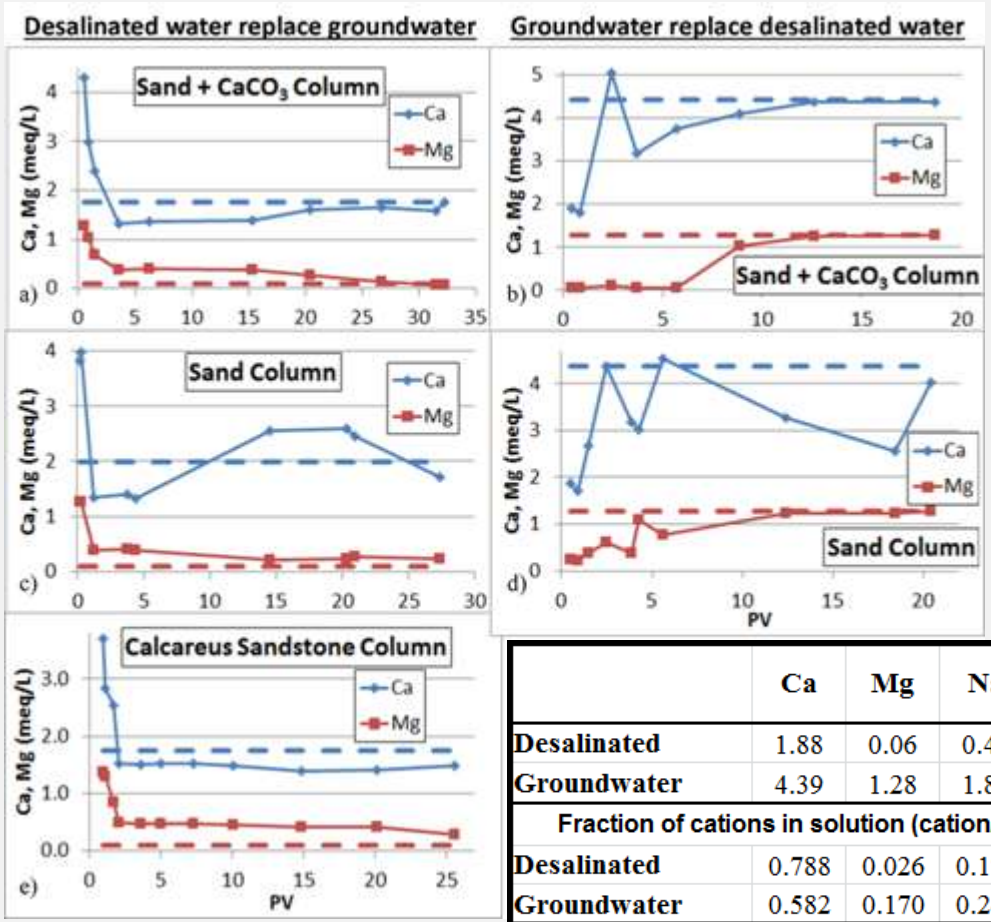
	Sample	THM				Water isotopes	
		$CHCl_3$	$CHCl_2Br$	$CHClBr_2$	$CHBr_3$	δ^2H (‰)	$\delta^{18}O$ (‰)
Field samples	Well PA					10.861	1.540
	Well PB		+			10.718	1.275
	P-0.5				+	11.499	1.490
	P-1.0					11.185	1.429
	P-2.0		+	+	+	10.746	1.325
	P-3.0		+	+	+	10.818	1.377
Reference values	DSW	Not detected	Not detected	Not detected	Not detected	11.339	1.414
	Well M6	Not analyzed				-18.408	-4.485
	Well M9					-18.475	-4.508

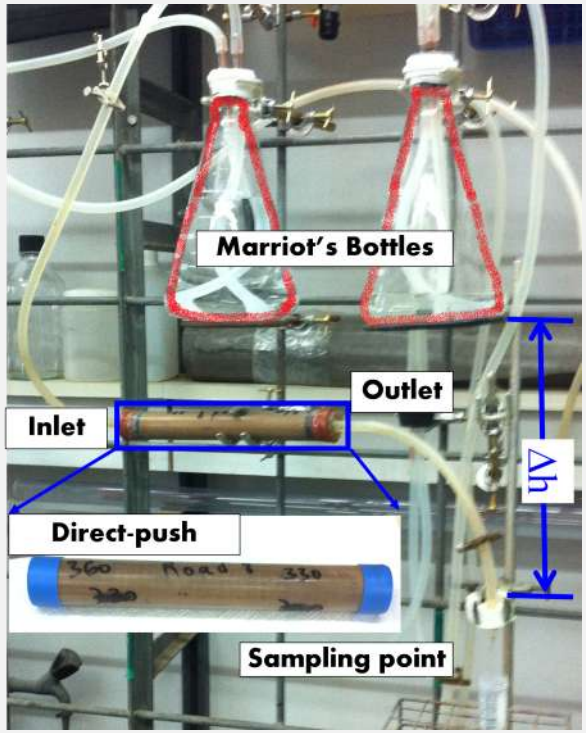
Summary & Conclusions

- **The vadose-zone and groundwater monitoring system in the infiltration pond is continuously operating since the October 2014** Monitoring is automated; Data collection is manual
- **Monitoring is maintained by robust commercial sensors**
- **Water quality data (VZ suction-cups, GW sampling) is non-continuous and manually-based**
- Deep unsaturated-zone monitoring (5-20 m) is needed for a better characterization and understanding of vadose-zone processes during MAR

Column experiments

Ronen-Eliraz et al. (in review, *STOTEN*),
Simulating Managed Aquifer Recharge by Column Experiments with Alternating Desalinated Water and Groundwater





	Ca	Mg	Na	K	B	Sum Cation	Ca/Mg	Ca/Na	Ca/K
Desalinated	1.88	0.06	0.41	0.01	0.023	2.39	30	4.6	199
Groundwater	4.39	1.28	1.82	0.05	0.004	7.55	3.4	2.4	89
Fraction of cations in solution (cation/sum of cation):									
Desalinated	0.788	0.026	0.172	0.004	0.010	1			
Groundwater	0.582	0.170	0.241	0.007	0.001	1			
Ratio of fractions:									
GW/DES	0.7	6.6	1.4	1.6	0.1				
DES/GW	1.4	0.2	0.7	0.6	17.9				

How?

approaches to Subsurface