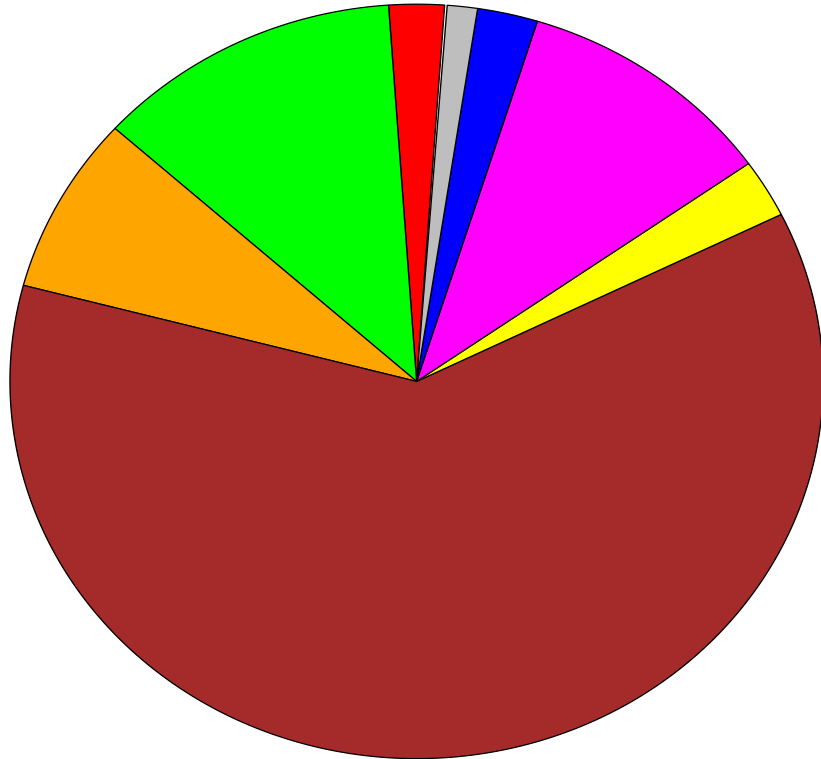


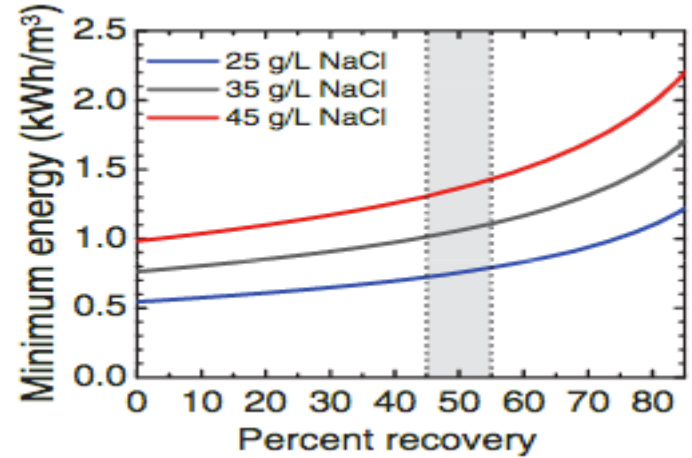
Simulating the effect of brine from desalination plants on the salinity of the Persian/ Arabian Gulf

**Hamed D. Ibrahim and Elfatih A. B. Eltahir
MIT CEE**

World distribution of desal capacity (seawater)



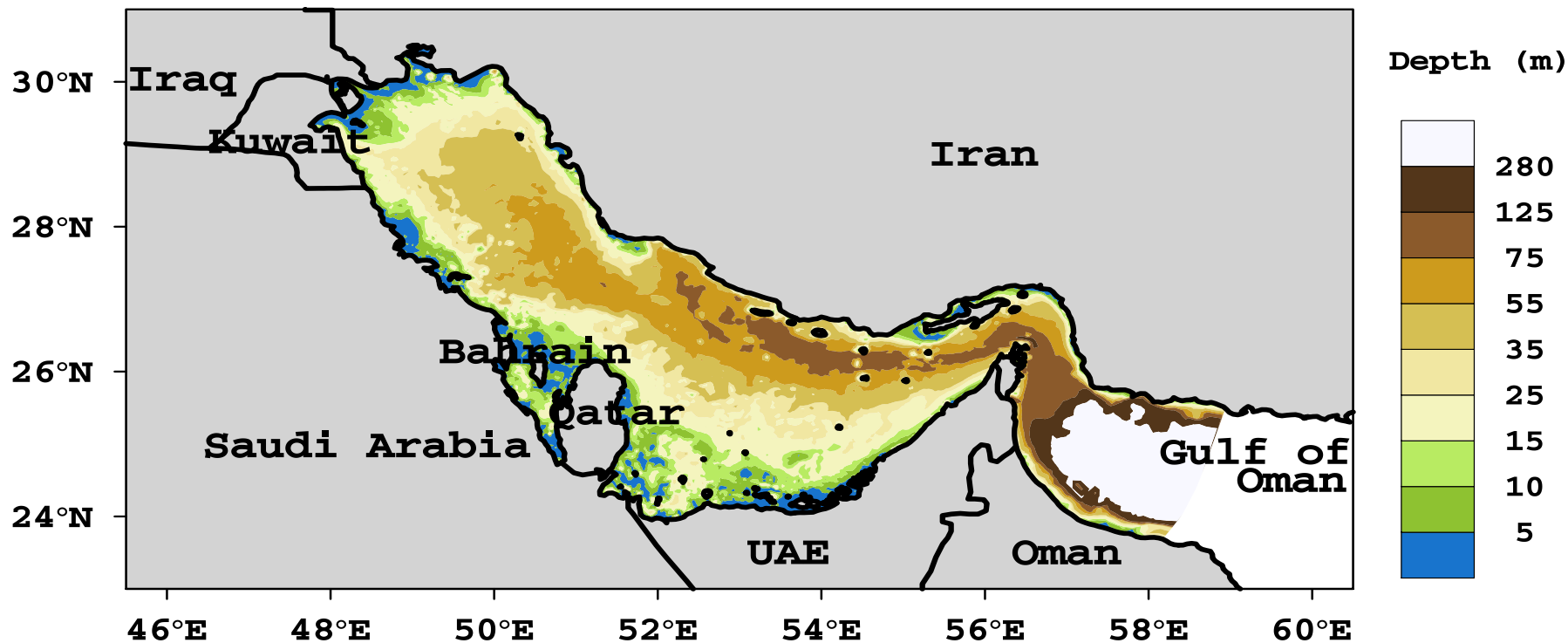
● 2.2	L. America	● 12.2	Europe
● 7.6	Asia/Pac.	● 61.4	M.E. (GCC)
● 2.5	N. America	● 10.4	M.E. (non GCC) & N. Afr.
● 2.4	Caribbean	● 1.2	Sub-Saharan Africa



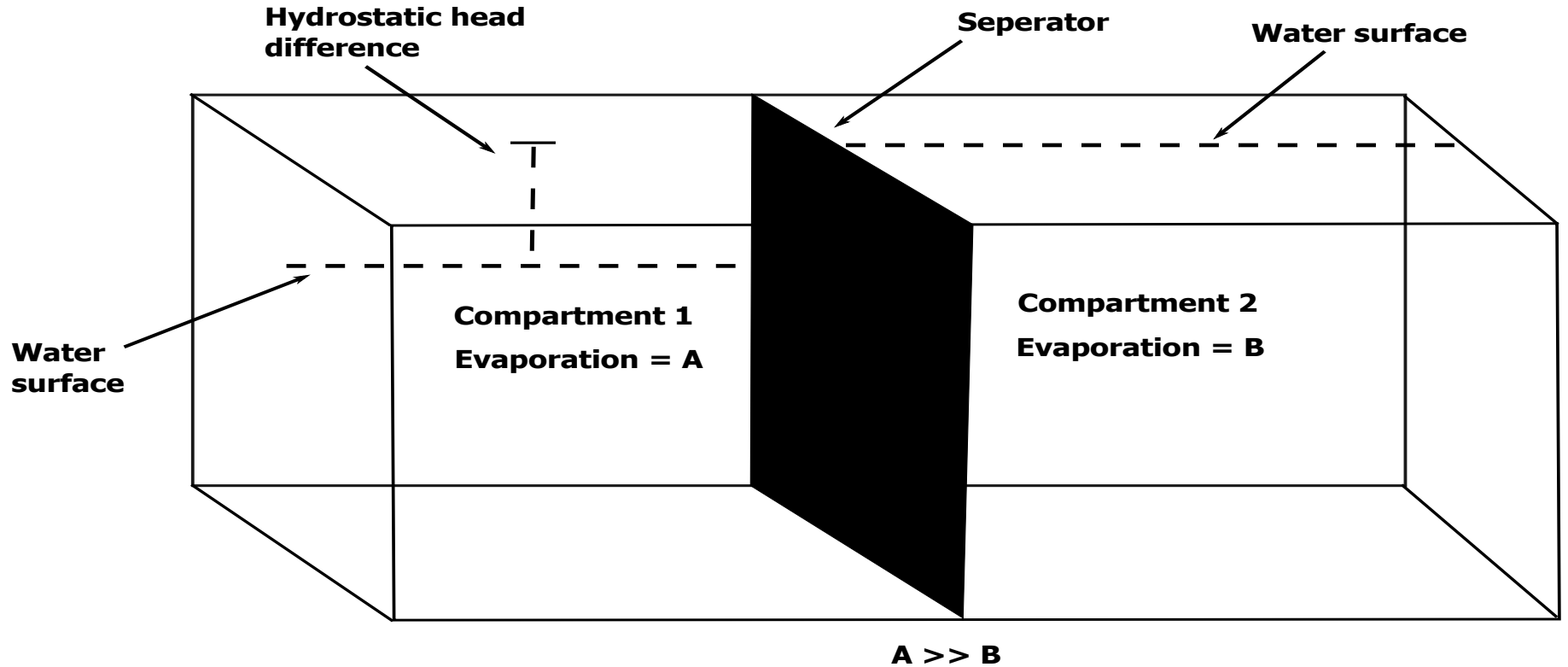
(Menachem Elimelech and William A. Phillip, 2011)

(Lattemann, 2010)

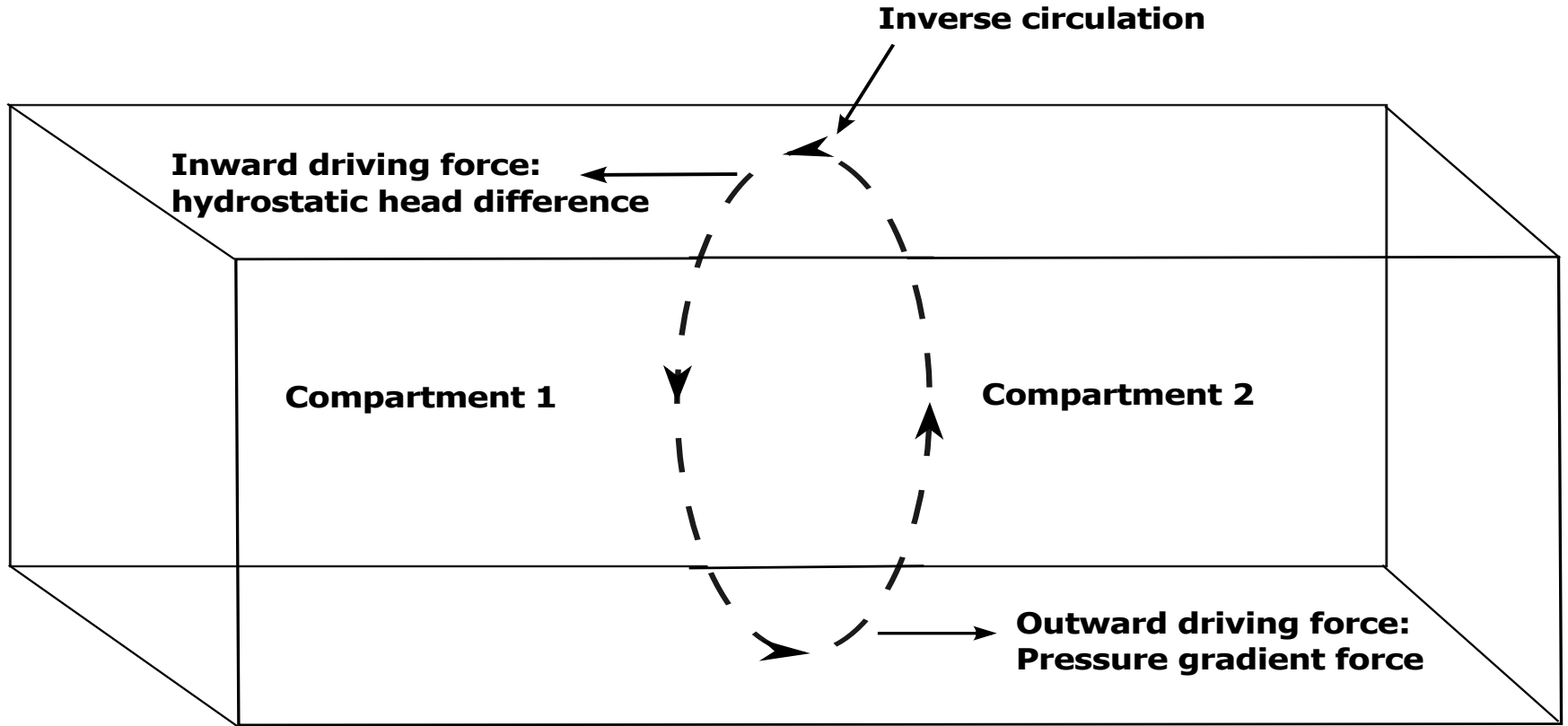
The gulf: depth profile



The gulf: physics



The gulf: physics



Research method: GARM

Gulf-Atmosphere Regional Model (GARM)

MIT Regional Climate Model (MRCM)

Rectilinear grid

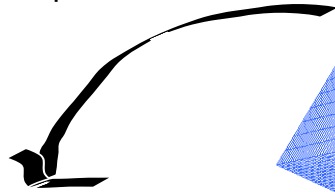
118 x 118 x 18 (30km)

Atmosphere -to- Ocean

Wind stress

Evaporation-precipitation flux

Heat fluxes

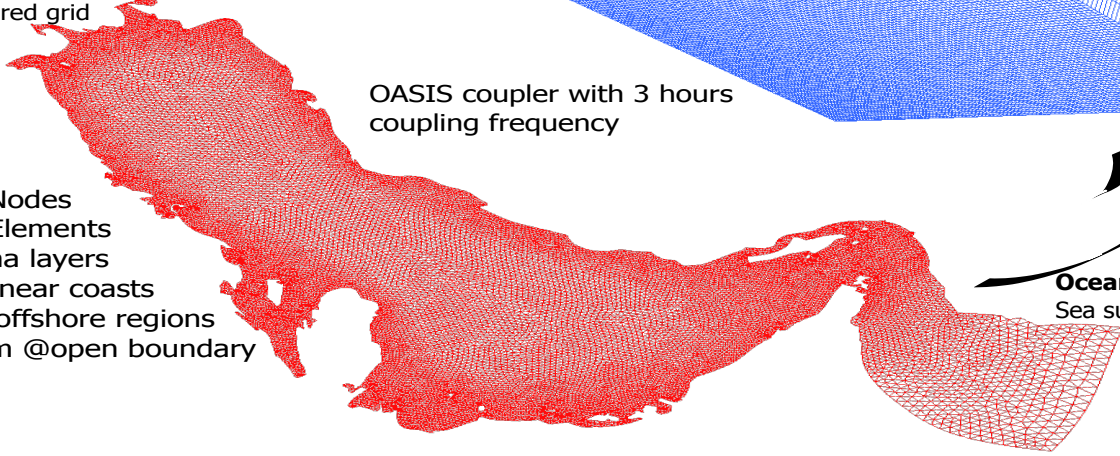
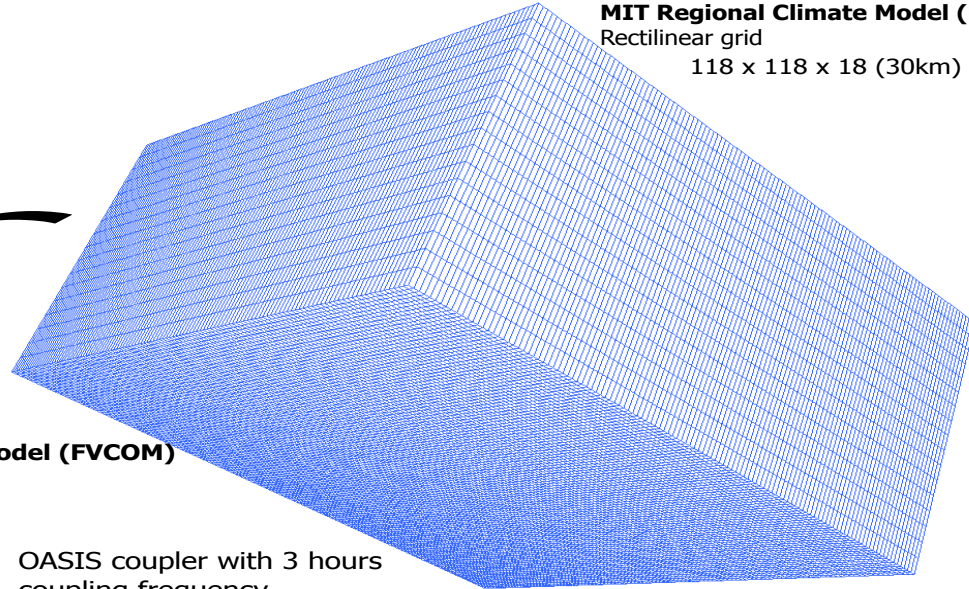


Finite Volume Community Ocean Model (FVCOM)

Unstructured grid

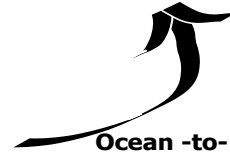
16607 Nodes
31616 Elements
30 Sigma layers
2-3 km near coasts
5km in offshore regions
10-15km @open boundary

OASIS coupler with 3 hours
coupling frequency



Ocean -to- atmosphere

Sea surface temperature (SST)



(Xue and Eltahir, 2015)

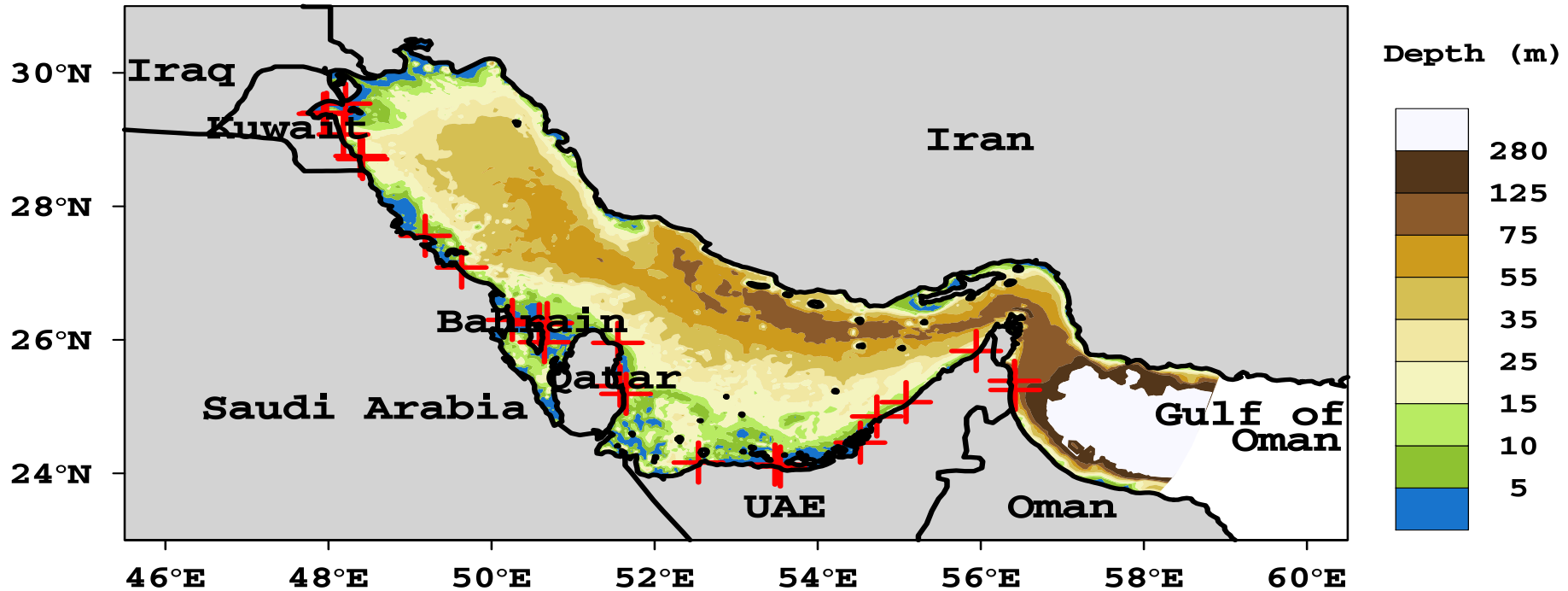
Desal experiment design: plant capacity > 100,000m³/day

Country	Location	Project name	Capacity(m ³ /d)	Status
Bahrain	Muharraq	Al Hidd 3	272,760	O
Bahrain	Ad Dur IWPP	Ad Dur IWPP	218,000	O
Bahrain	Al Hidd	Al Hidd 1	136,380	O
Kuwait	Ra's az Zawr	Az Zour N/S	622,400	O+C
Kuwait	Subiya	Subiya 1-3	454,600	O
Kuwait	Kuwait City	Doha SWRO	227,300	C
Kuwait	Shuaiba	Shuaiba N	204,390	O
Kuwait	Shuwaikh	Shuwaikh RO	136,260	O
Kuwait	Az Zour South	Az Zour S 2-3	261,840	O
Qatar	Ras Laffan	Ras Laffan 1, B-C	741,160	O
Qatar	Doha	Um Al Houf	545,250	C
Qatar	Ras Abu Fontas	Ras Abu Fontas	654,606	O
Saudi Arabia	Al Jubail	Al Jubail	1,011,814	O+C
Saudi Arabia	Ras Al Khair	Ras Al Khair	1,025,000	O+C
Saudi Arabia	Al Khobar	Al Khobar	432,580	O
UAE	Jebel Ali	Jebel Ali	636,440	O
UAE	Shuweihat	Shuweihat 1-2	913,346	O
UAE	Qidfa	Al Fujairah	874,460	O
UAE	Al Taweelah	Al Taweelah A-B	1,226,950	O
UAE	Umm Al Nar	Umm Al Nar B	503,061	O
UAE	Fujairah	Al Fujairah 1	306,500	O
UAE	Mirfa	Mirfa IWPP	140,000	C
UAE	Al Mirfa	Al Mirfa	102,144	O
UAE	Ras Al Khaimah	Ras Al Khaimah	100,000	C

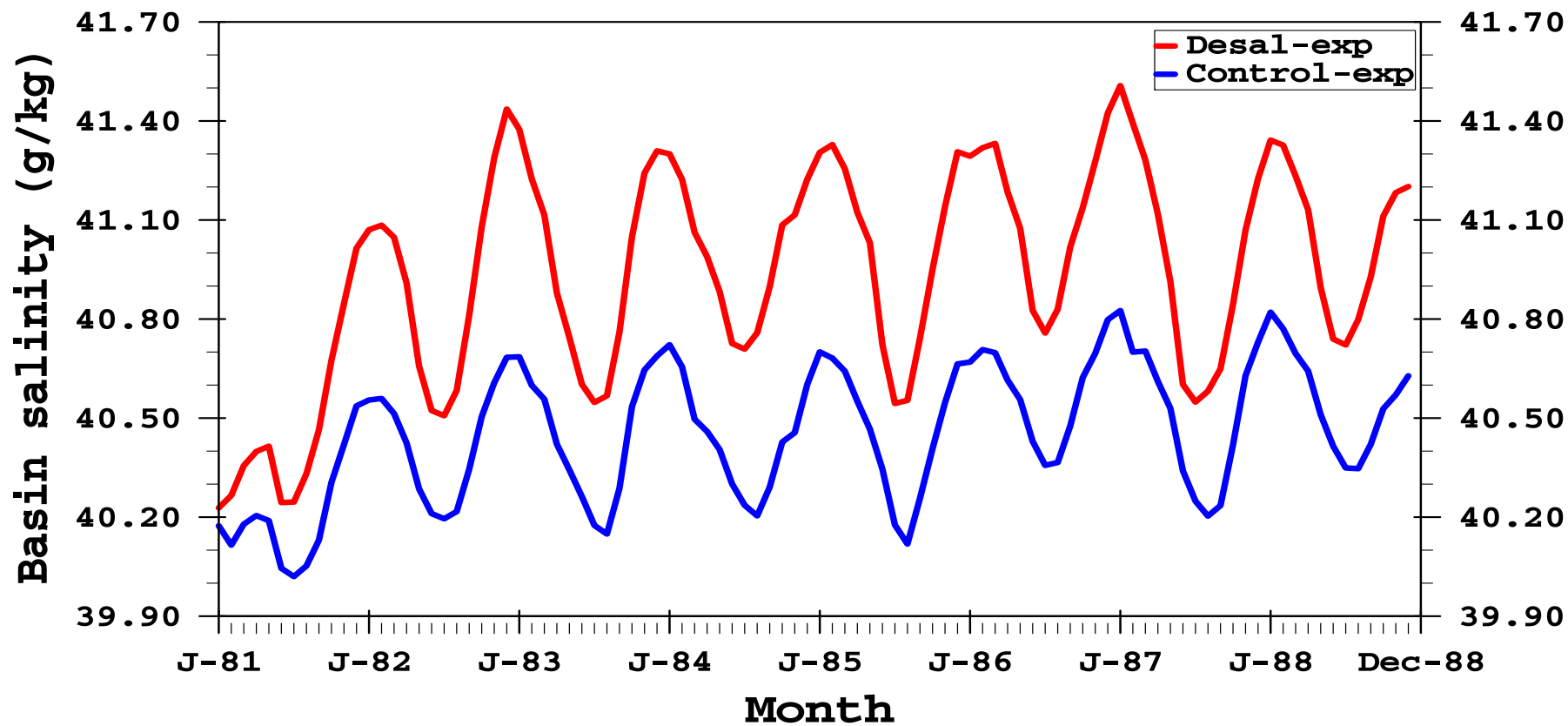
**O=online, C=construction. Total=11,747,241m³/d
=4,287,742,965m³/yr**

(Desaldata [GWI and IDA], 2016)

Desal experiment design: plant capacity > 100,000m³/day



Result: salinity



Result: desal experiment - control

-1.00 2.00 5.00 8.00 11.0



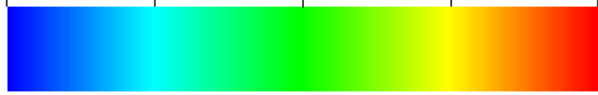
Salinity (g/kg)



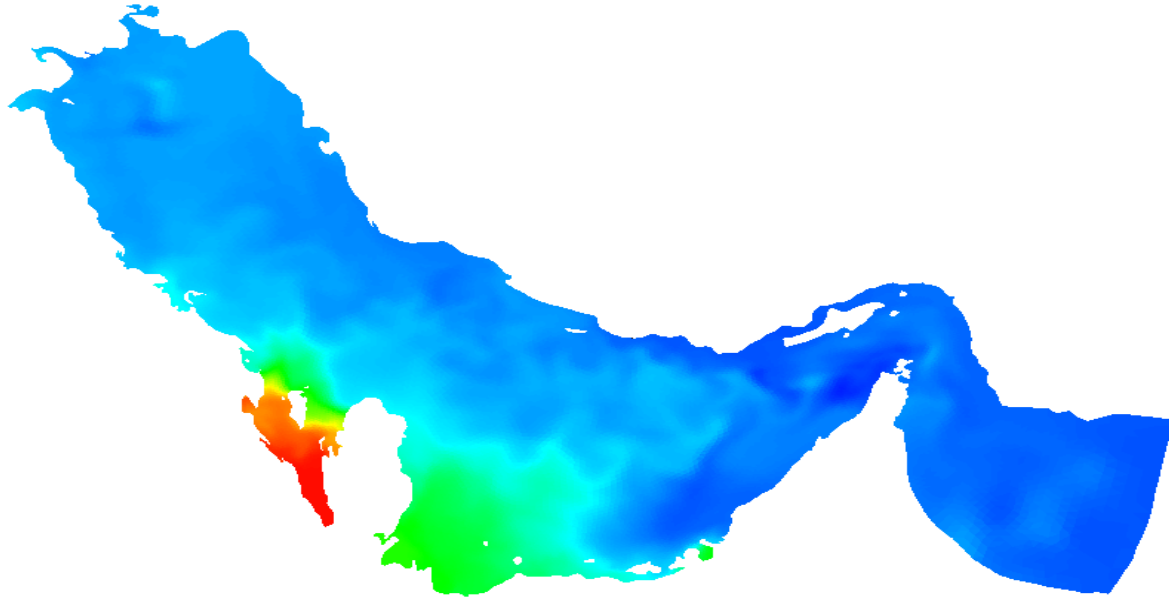
Day=1

Result: desal experiment - control

-1.00 2.00 5.00 8.00 11.0



Salinity (g/kg)



Conclusions

- Effect of desalination on the salinity of the Gulf is more significant at regional scale than at basin scale
- Regional effect on marine life
- Higher energy consumption in affected regions

Thank you for your time!