Improving irrigation quality of Kuwait native shallow groundwater using phytoremediation

Dr. Hana'a Burezq and Dr. Amjad Aliewi
Presented by: Dr. Amjad Aliewi (Co-author)
Kuwait Institute for Scientific Research

WSTA 13th Gulf Water Conference
"Water in the GCC: Challenges and Innovative Solutions"
Kuwait Institute for Scientific Research (KISR), State of Kuwait
12-14 March 2019

Overview

- Introduction
- Objectives
- Materials & Methods
- Results and discussion
- Conclusions

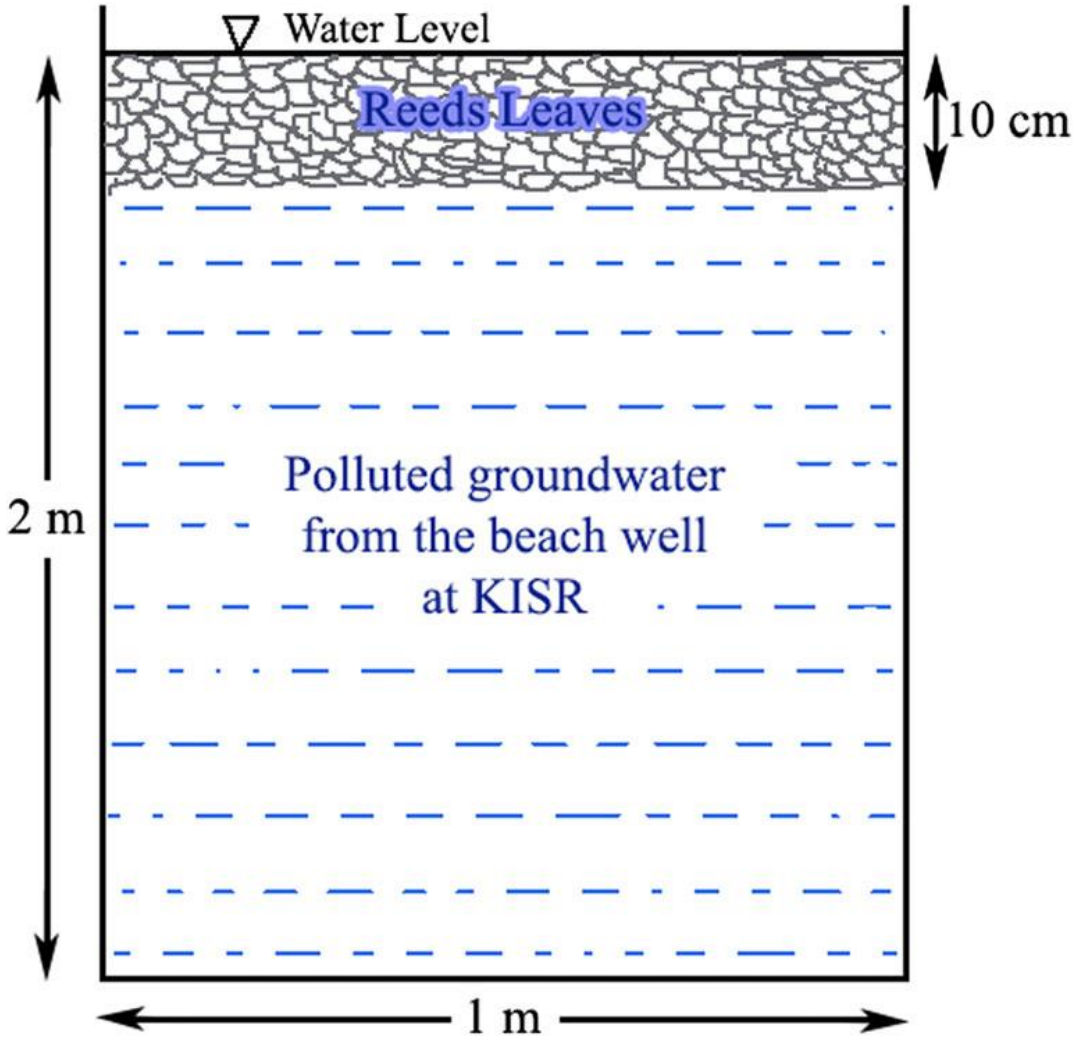
Introduction

- The rapid increase of the level of pollution in soil and shallow groundwater environment due to various industrial and agricultural activities has become a serious issue in Kuwait.
- This type of pollution has reduced the efficiency of native groundwater to irrigate crops in Kuwait and affected the health of residents.
- Phytoremediation has emerged since the 1980s as a sustainable and promising treatment technology for soil and groundwater pollution problems.
- Phytoremediation is a treatment technology, which utilizes the abilities of plants and their associated microorganisms to remove and degrade pollutants in soil and groundwater.

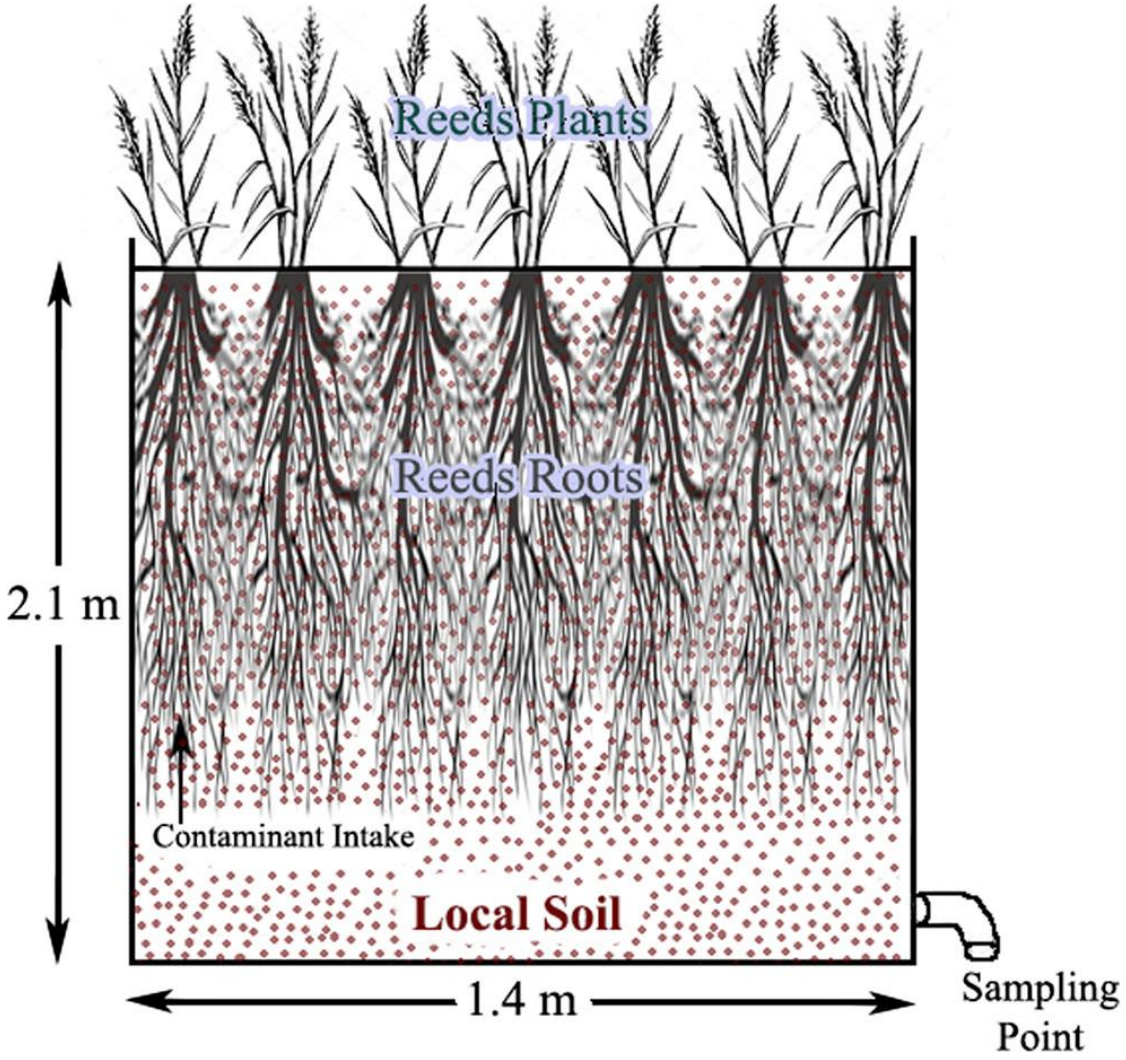
- The aim of this research is to investigate the potential of reed plants as phytoremediation technology to enhance degradation and mineralization of the pollutants (e.g., heavy metals, N compounds, and salts) in the native shallow groundwater in order to increase irrigation efficiency.
- This is an important issue for Kuwait, which suffers from shortages of suitable water resources for irrigation and agricultural lands.
- The reed plants were chosen because they are available and common in the desert of Kuwait.

Materials & Methods

Lab experiment

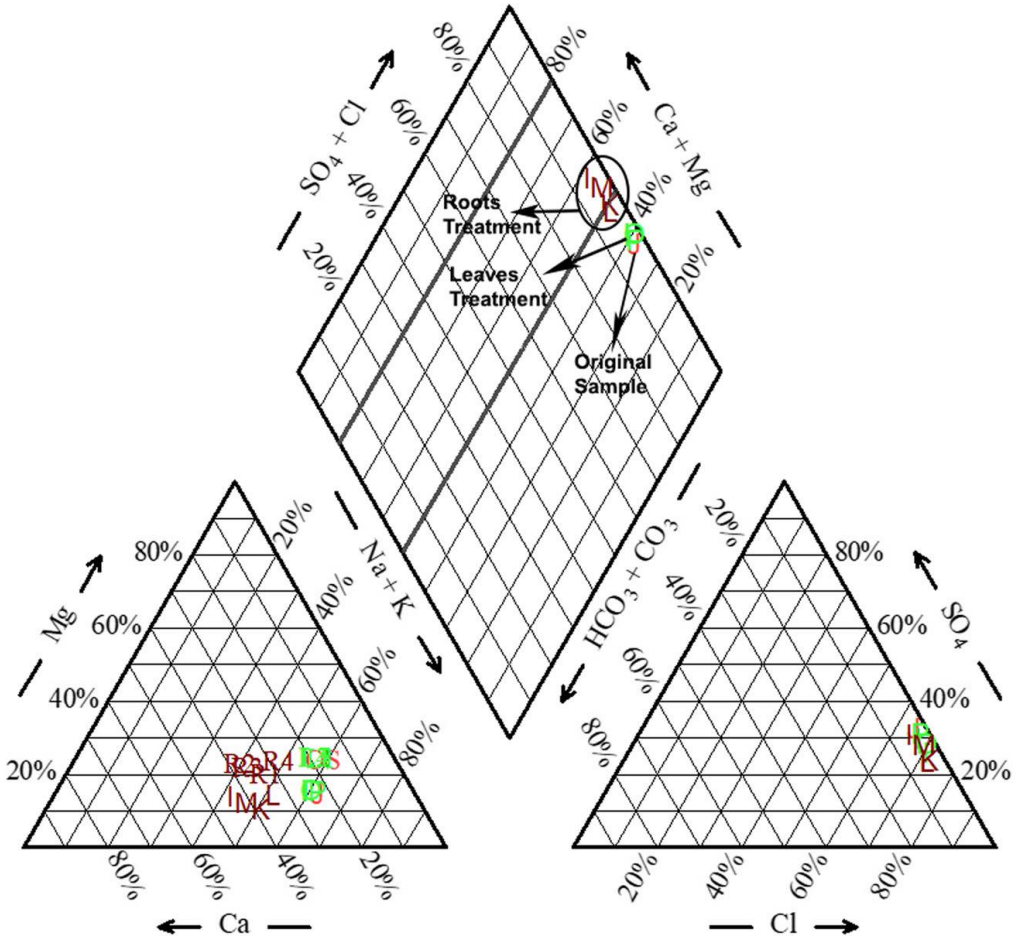


Field experiment



Results

- Original sample: alkaline water with SO_4/Cl salt domination
- Leaf treatment: alkaline water with less domination of SO_4/Cl salts
- Root treatment: earth alkaline water with less SO_4 salt domination. Not dominated by Cl ions and to be less dominated by SO_4 ions as salts, this means that on Piper diagram (Fig. 3) the roots managed to push the water type.



Cont., Results

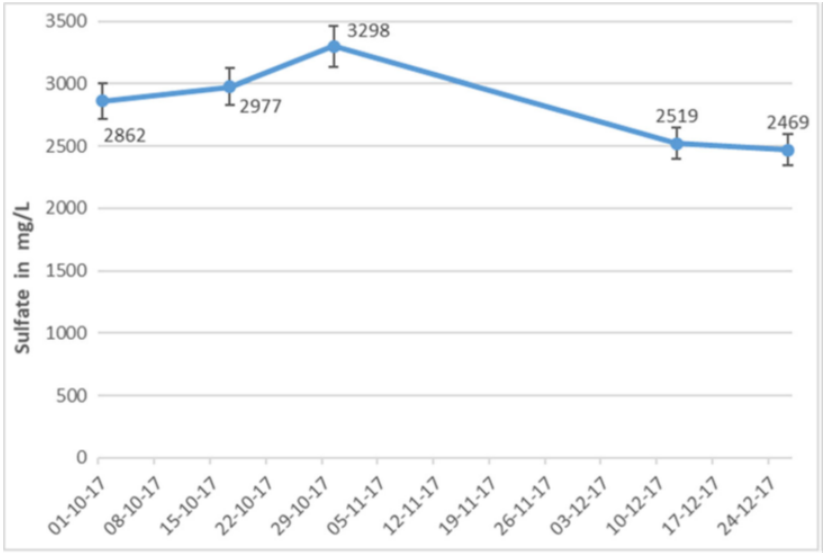
Table 3 Concentration of salt ions (mg/l) after using reed plants

Elapsed time (weeks)	Na^+		Cl^-		SO_4^{2-}		K^+		TDS	
	R	L	R	L	R	L	R	L	R	L
Original	2720	2720	4148	4148	2862	2862	40.8		11,675	11,675
4		3069				3298				11,796
8	925		1740	–	793		18.04		11,632	
10	838	2648	1519	–		2519				11,632
12	805	2594	1430	–	644	2469	10.5		4024	11,291
Standard deviation*	1062		764		1140		5.6		3780	

L, leaves; *R*, roots

*For treatment values

Cont., Results



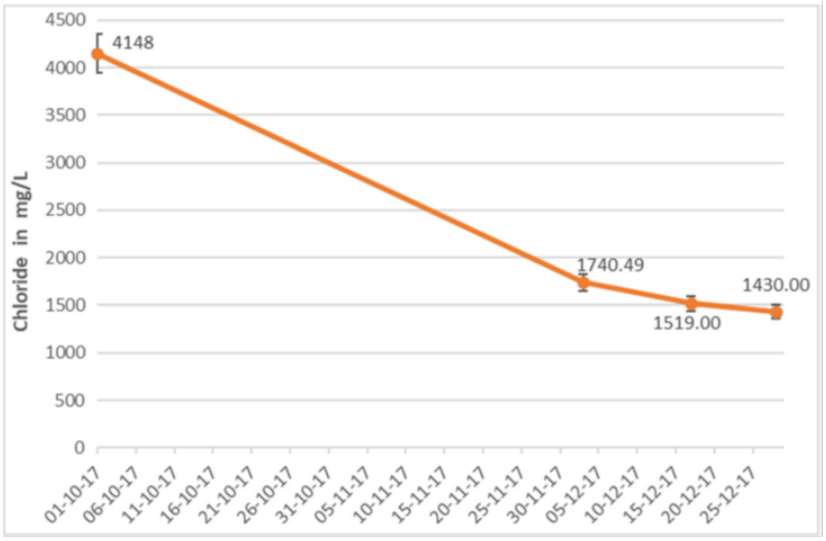


Table 4 Concentration of N compounds (mg/l) after using reed plants

Elapsed time (weeks)	NH_4^+		NO_3^-	
	R	L	R	L
Original	10.1	10.1	115	115
4		2.63		61.1
8	0.67	< 0.1	< 0.1	< 0.1
10	0.24	< 0.1	< 0.1	< 0.1
12	< 0.1	< 0.1	< 0.1	< 0.1
Standard deviation*	1.8		30.5	

L, leaves; *R*, roots

*For treatment values

Table 5 Concentration of F and Li (mg/l) after using reed plant

Elapsed time (weeks)	F^-		Li^+	
	R	L	R	L
Original	2.3	2.3	0.23	0.23
4	0.32	2.06	0.20	0.14
8	0.28	1.85	0.17	0.13
10	0.17	1.9	0.03	0.12
12	0.17	1.77	0.03	0.12
Standard deviation*	0.9		0.06	

L, leaves; *R*, roots

*For treatment values

Cont., Results

Table 6 Concentration of some heavy metals (µg/l) after using reed Plants

Elapsed time (weeks)	Fe		Al		Zn		Cd	
	R	L	R	L	R	L	R	L
Original	7.96	7.96	71.32	71.32	15.1	15.1	1.1	1.1
4		1.8		39.7		7.1		0.3
8	< 0.01		35.94		15.1	3.7	< 0.1	< 0.1
10	< 0.01	0.29		22.47				
12	< 0.01	0.16	33.51	19.02	< 0.2		< 0.1	< 0.1
Standard deviation*	0.37		17		5.44		0.1	

L, leaves; *R*, roots

*For treatment values

Conclusions

Table 7 Summary of reduction of specific pollutants by reed plants

Parameter	Unit	Original sample	Leaves outflow	Reduction	Root outflow	Reduction
TDS	mg/l	11,675	11,291	3%	4024	66%
Cl	mg/l	4148	–	–	1430	66%
SO_4	mg/l	2862	2469	14%	644	78%
Na	mg/l	2720	2594	5%	805	70%
K	mg/l	40.8	–	–	10.5	74%
NH_4	mg/l	10.1	< 0.1	100%	< 0.1	100%
NO_3	mg/l	115	< 0.1	100%	< 0.1	100%
F	mg/l	2.3	1.77	23%	0.32	86%
Li	mg/l	0.23	0.12	48%	0.03	100%
Fe	µg/l	7.96	0.16	98%	< 0.01	100%
Zn	µg/l	15.1	3.7	76%	< 0.2	100%
Cr	µg/l	4.18	1.19	72%	0.47	89%
Co	µg/l	0.53	< 0.1	100%	< 0.1	100%
Cu	µg/l	3.1	1.13	64%	1.88	39%
Al	µg/l	71.32	19.02	73%	33.51	53%
Cd	µg/l	1.1	< 0.1	100%	< 0.1	100%

Acknowledgements

The authors are grateful to Kuwait Institute for Scientific Research for supporting financially and administratively the activities of this research.

Final Remarks

The reeds plant is very effective in reducing level of salinity and pollution in shallow groundwater resources.