



Institute of Technology of Cambodia

Regeneration process analysis of the resin Haix used from Arsenic affected community in Cambodia

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initiative for sustainable development in Asian countries

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Introduction

- Arsenic is odorless and tasteless semi metal that occurs naturally in the rock and soil (FAO, 2006)
- The arsenic pollution in the groundwater became a serious problem on health of Cambodian people (Uy, 2010)
- The consumption over long period of time of arsenic water in excess of 10 micrograms per liter can lead to Arsenicosis (WHO, **2011**)
- Seeing this issue, different water sources are used currently by the community such as: well, surface water, water from SARSAC, rain water, etc.

Introduction

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Identify regeneration condition for exhausted Haix used in the affected community of Cambodia

- To optimize the best pH for generation process
- To analyze the presence of Arsenic in Haix before and after the treatment at different pH
- To test the performance of regenerated resin

Arsenic Contamination

- Found in the groundwater system and can infiltrate to underground aquifers
- UNICEF (2009), arsenic in Cambodia was confirmed between 1990 and 2000 cooperated with MRD and MIME
- Testing the water from about 16,000 tube wells for arsenic in 7 central provinces bordering the Mekong and Bassac rivers (including Kandal, Kampong Cham, Kratie, Kampong Chhnang, Kampong Thom, Prey Veng and peri-urban Phnom Penh provinces) found that an estimated 320,000 people in 1,600 village are most at risk (MRD, UNICEF, Kanchan Arsenic Filter Evaluation of Applicability to Cambodia, September, 2008).

Arsenic contamination level in Cambodia (Arsenic Center, 2009)

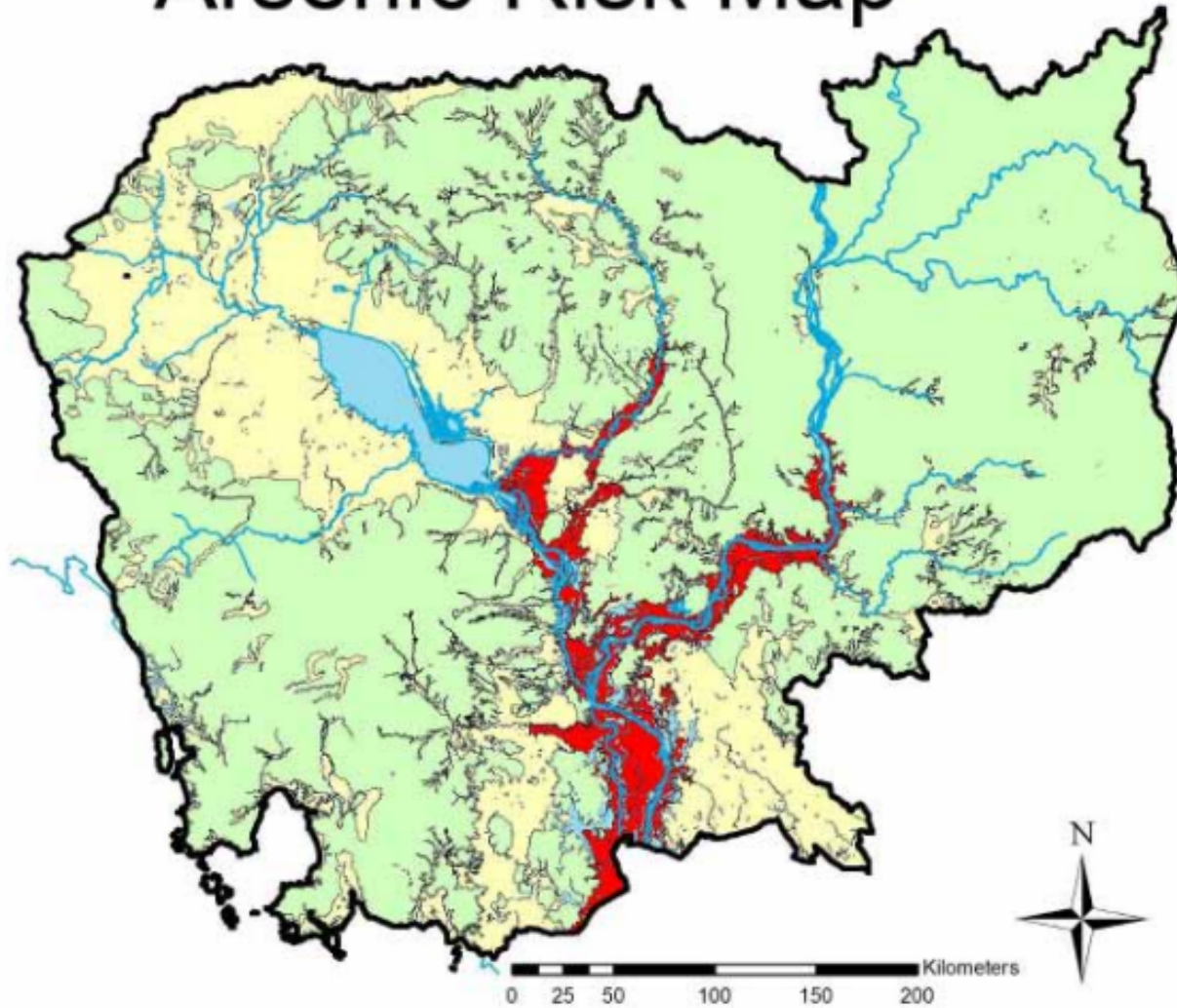
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Provinces	Total wells tested	As >50 ppb	10 < As ≤ 50 ppb	As ≤ 10 ppb
Kandal	4,779	2,260	503	2,015
Peri-urban PP	612	33	109	470
Kampong Cham	1,576	218	88	1,270
Kampong Chhang	662	24	69	569
Kratie	1,248	94	116	1,038
Prey Veng	1,712	267	162	1,283
Kampong Thom	828	15	89	724
Kg.Speu	529	0	17	512
Otdar Mean Chey	147	0	2	145
Stung Treng	343	1	24	318
Svay Rieng	1,326	8	424	894
Krong Pailin	114	4	5	105
Preah Vihear	58	0	5	53
Pursat	1,236	0	26	1,210
Siem Reap	74	0	0	74
Takeo	429	0	18	411
Total	15,673	2,924	1,657	11,092

Arsenic Pollution site in Cambodia

Arsenic Risk Map

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(UNICEF, 2009)



Arsenicosis

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What is Arsenicosis?

- WHO, the common symptoms are Leukomelanosis (rain-drop pigmentation on skin) and Nodular Keratosis

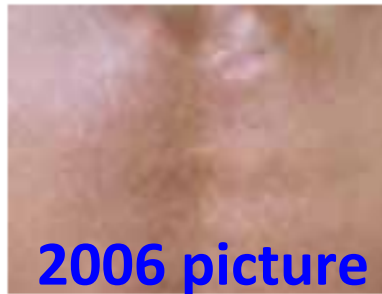
Arsenicosis Symptoms Identified in Kandal Province, (UNICEF, 2009)



Arsenical Nodular Keratosis: a picture from Kandal province- this woman and her family have similarly affected and her symptom has recently lead to cancer, reported by PDRD As team.



Arsenical Nodular Keratosis: a picture from Kandal province- a man with his son has serious problem with cancer; his son was operated with support from RDI.



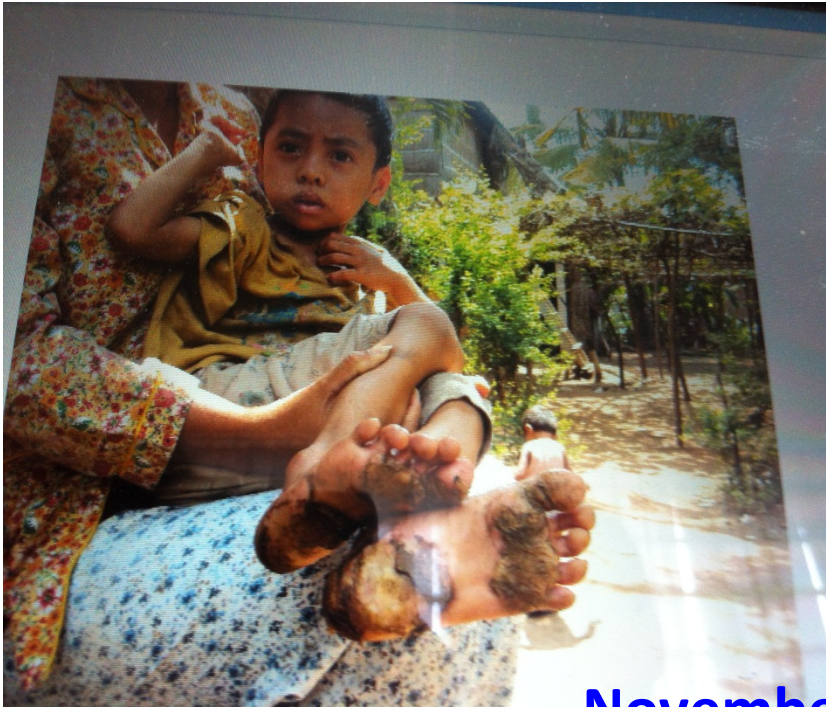
2006 picture

Arsenical Leukomelanosi- picture from Kandal province.



Arsenicosis Symptoms Identified in Preaek Traeng

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November, 2013 picture

Further stakeholder analysis is a need for long term solution such as: Source Identification, socio-economic study, involvement of stakeholders...

Bad Effect from Arsenic Contamination

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- Dermal lesions such as hyperpigmentation and hypopigmentation
 - Skin cancer,
 - Bladder and lung cancers and
- Agricultural production. Change, complexity, uncertainty

Arsenic awareness

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- Khaira, P., (2009) estimated that up to a million people in Cambodia are at risk.
- Not much people are aware of arsenic and received mitigation and education
- Scientific attention in Cambodia so far has tended to focus on technical solutions.

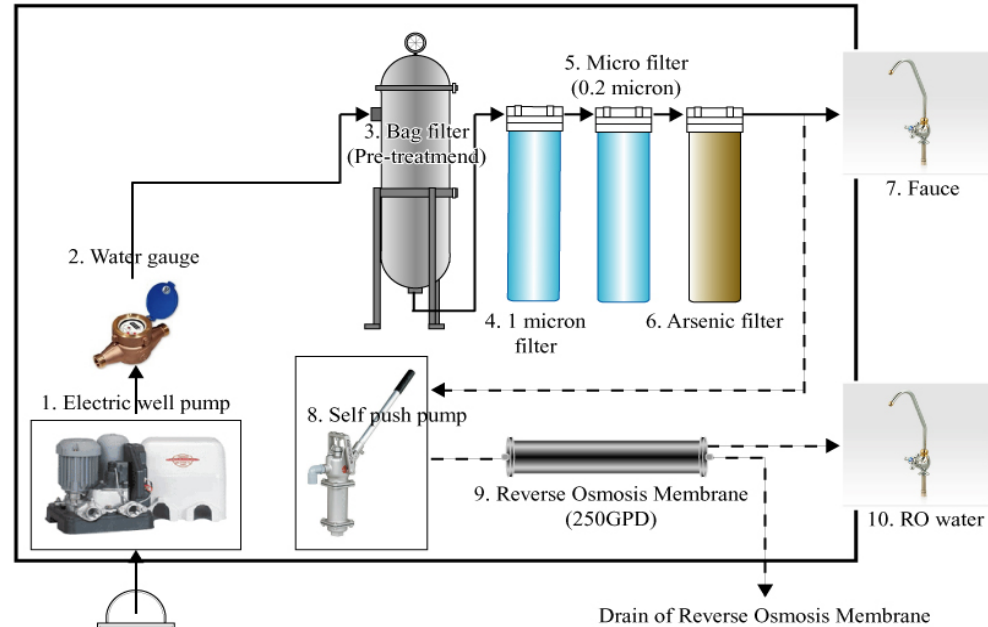
Drinking Water Sources for Community 13

- KAP (Knowledge, Attitude, Practice) survey by UNICEF (2009) surface water is the source of drinking water
 - 40% relied on surface water
 - 22% relied on tube-wells in dry season and 17% in the rainy season
 - And approximately 13% relied on unprotected shallow wells

Our Past experiences

Removing Arsenic from Groundwater using High Performance Iron Adsorbent in Cambodia:

- The analysis results indicated that around 95% of As was removed in average by using the equipments, which ranged from 89-100%
- Efficacy is good, but effectiveness is a challenge and the system need more research on it application

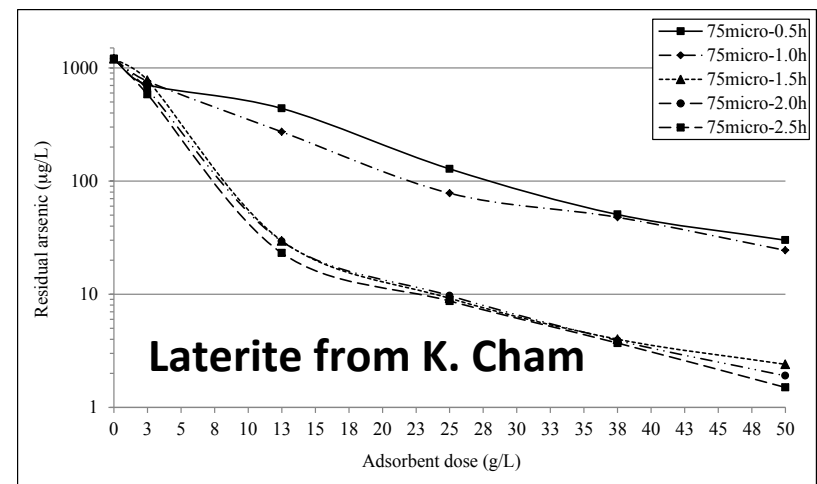
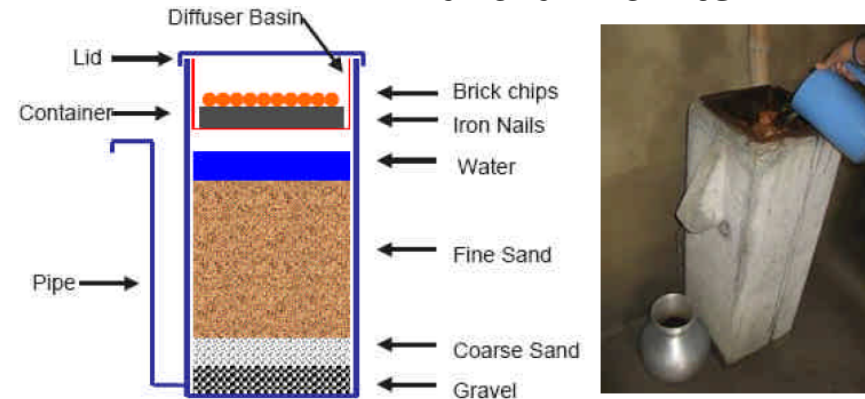


Our research experiences

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- Air oxidation of arsenic
- Kanchan Arsenic Filter Evaluation of Applicability to Cambodia: The average removal percentage is in the 95-97% range, difficult for high As concentration water
- Laterite as an adsorbent material for removing arsenic from polluted groundwater in Cambodia (Local resources: Efficacy is high (respect WHO standard))

Kanchan As filter



Drinking Water Sources for Community

- **SARSAC:**

Supported by: Dr. Arup Sengupta, (Haix), Lihigh University, US and Japan International Cooperation agency



Sustainable arsenic removal system for affected communities (SARSAC)

Water test after Sarsac installed



Haix Regeneration

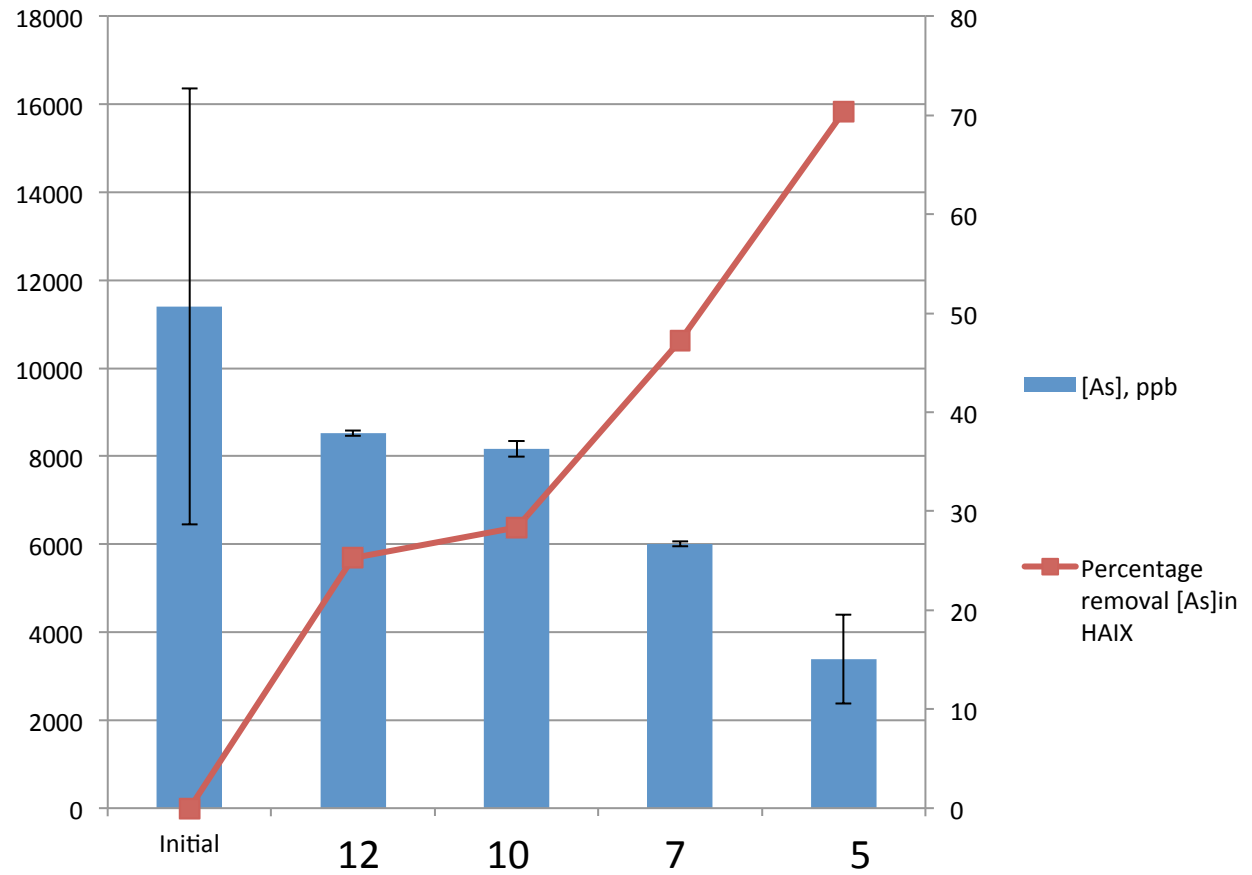
- pH treatment for pH ranging from base to acidic condition: 12, 10, 7, and 5
- Testing the initial concentration of Arsenic present in the saturated resin
- Testing the arsenic concentration present in the treated resin
- Then, the regenerated resin is tested with Arsenic spike solution of 583 ppb
- Experiment of testing was conducted through the analysis with Atomic absorption spectroscopy (AAS) with HVG
- Experimental process: pH remains near 12.0; spent alkali is collected. After a thorough rinse with As-free water, the media is subjected to two bed volumes of dilute HCl solution to neutralize the media so that resultant solution pH is down to 10, 7, and 5; subsequently, the spent acid is collected.

RESULTS

Table showed that arsenic concentration and ferric oxide concentration in the Haix was down slowly but much concentration was released to acid medium.

Samples	A(n=3)	B(n=3)	C(n=3)	D(n=3)
Statistic	pH-12	pH-10	pH-7	pH-5
[As], (ppb)	8519±65	8165±190	6013±61	3385±102
[FeOH], ppm	1898±28	1614±32	1457 ±76	1565±340

The initial concentration of As in Haix: 11403 ppb



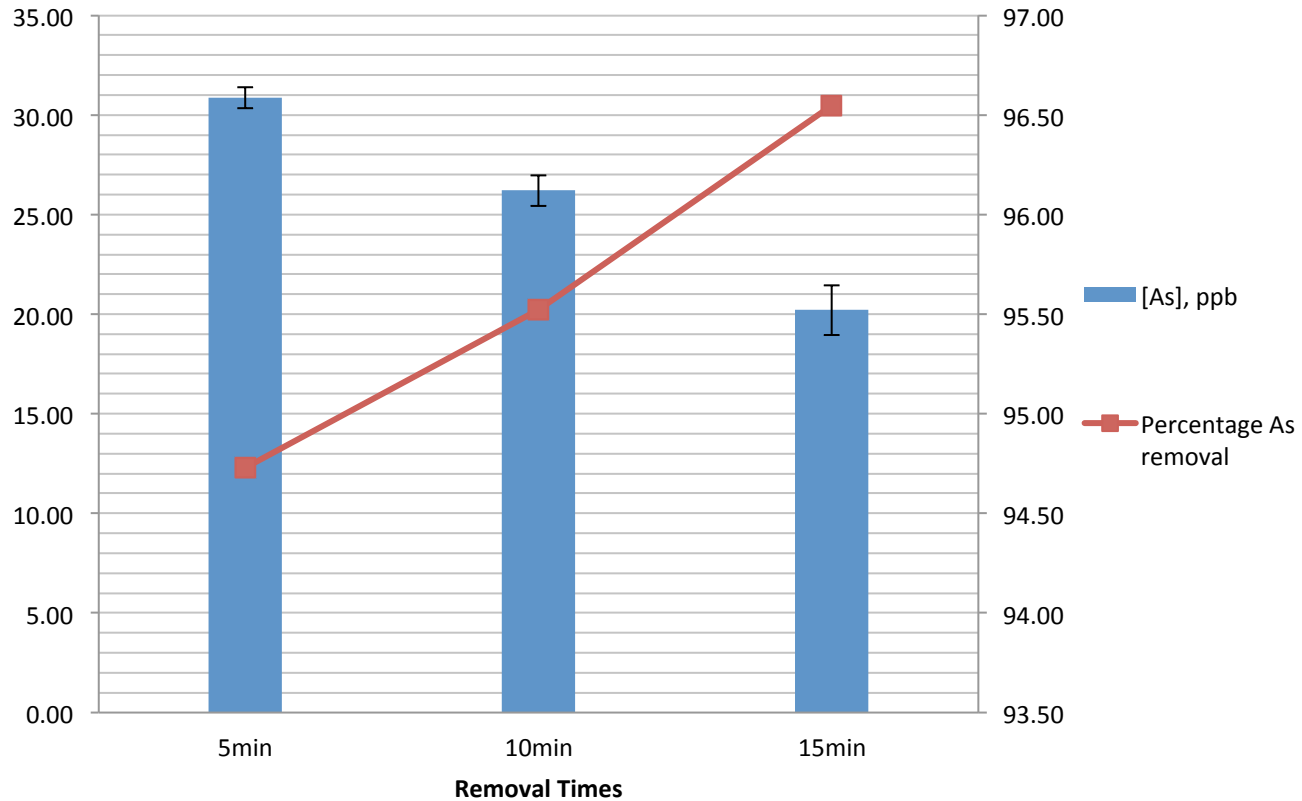
Removal performance of As in HAIX at different pH treatment

Result of resin HAIX testing after regeneration

After regeneration, resin HAIX was tested ability remove arsenic with different time 5min, 10min, 15min.

Test ability resin HAIX after regeneration

Samples	N=9		
Removal Time	5min	10min	15min
[As], ppb	31.36±0.58	27.11±1.16	21.22±1.07



Performance of arsenic concentration after test removal with solution $[As]_{in}=583ppb$ and percentage abilities remove As of regenerated Haix

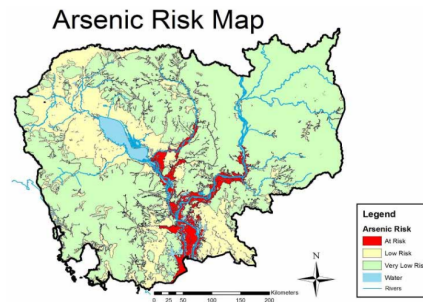
CONCLUSION

- The arsenic concentrations attached to the arsenic-saturated resin was 11403 ppb and it decreases to 3385 ppb at the optimized pH of 5
- As the results of experimental, this regeneration process allows the removal of arsenic from HAIX around 70%.
- The regenerated resin has still performed well for removing the arsenic from the contaminated water since it can remove the As more than 95%. The resin is again active.
- it is concluded that the regeneration technique has been established for exhausted resins HAIX used in the arsenic-affected community in Cambodia

Next ...

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- 3 more systems are being installed through the support of AUN/Seed-Net JICA with the support from Lehigh University, USA
- 1 system is going to be installed in LAO in collaboration with National University of Lao through the same fund
- Standardize the regeneration system
- One more system to be installed in Lvea Torng Village of Kandal province
- Family scale system SARSAC
- Aresenic occurrence in In Mekong river of Cambodia





Thanks very much. . .