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Biochar: Production, Characterization and Applications

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Arsenic removal from drinking water by means of low cost biochars derived from miscanthus and coconut shell

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ARSENIC REMOVAL FROM DRINKING WATER BY MEANS OF LOW-COST BIOCHARS DERIVED FROM MISCANTHUS AND COCONUT SHELL

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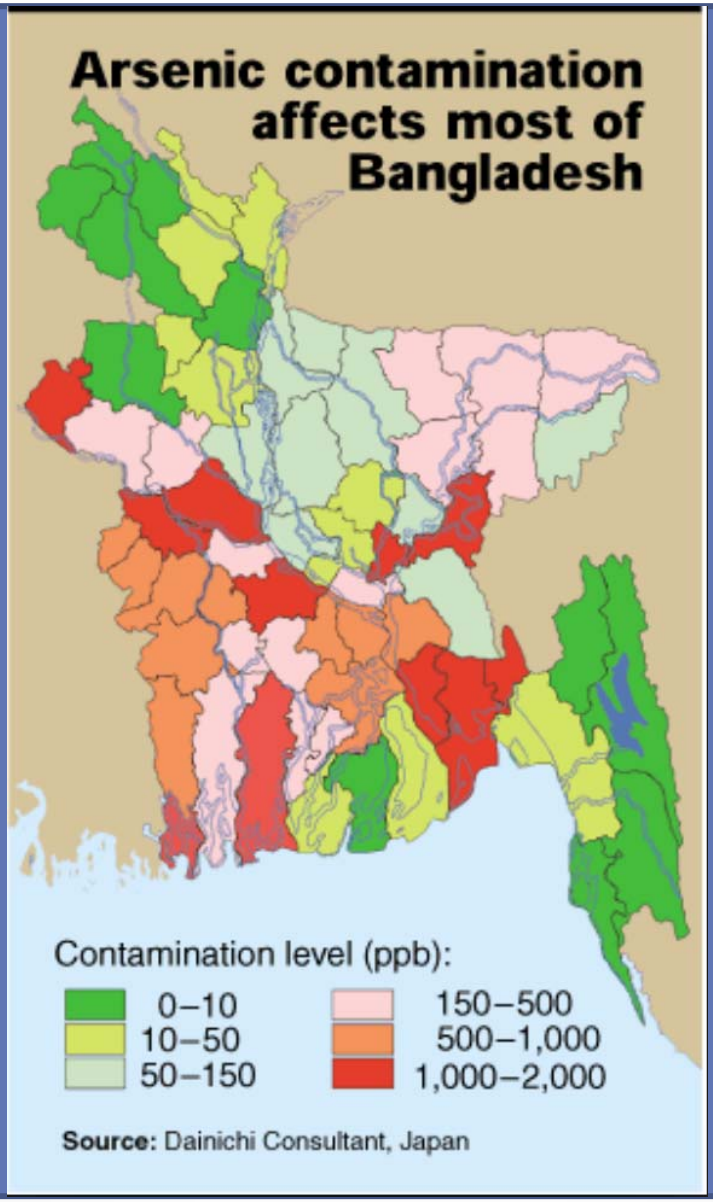
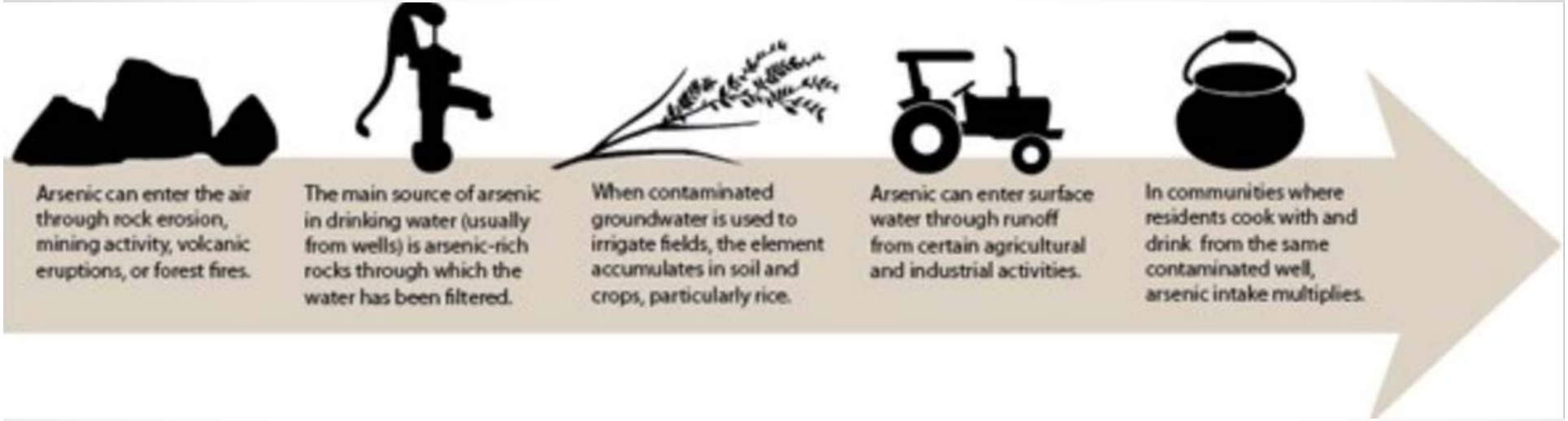
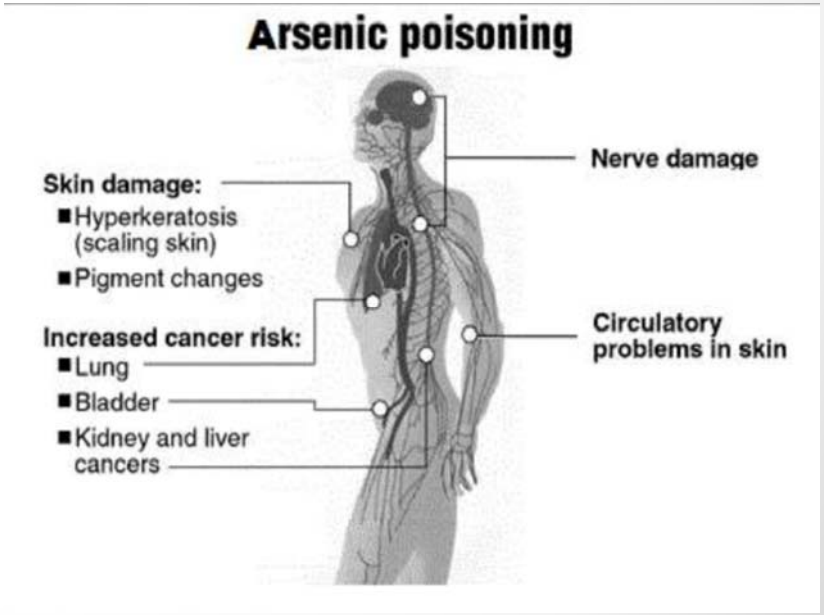
ARSENIC POISONING OF GW (Conc >50 ppb)



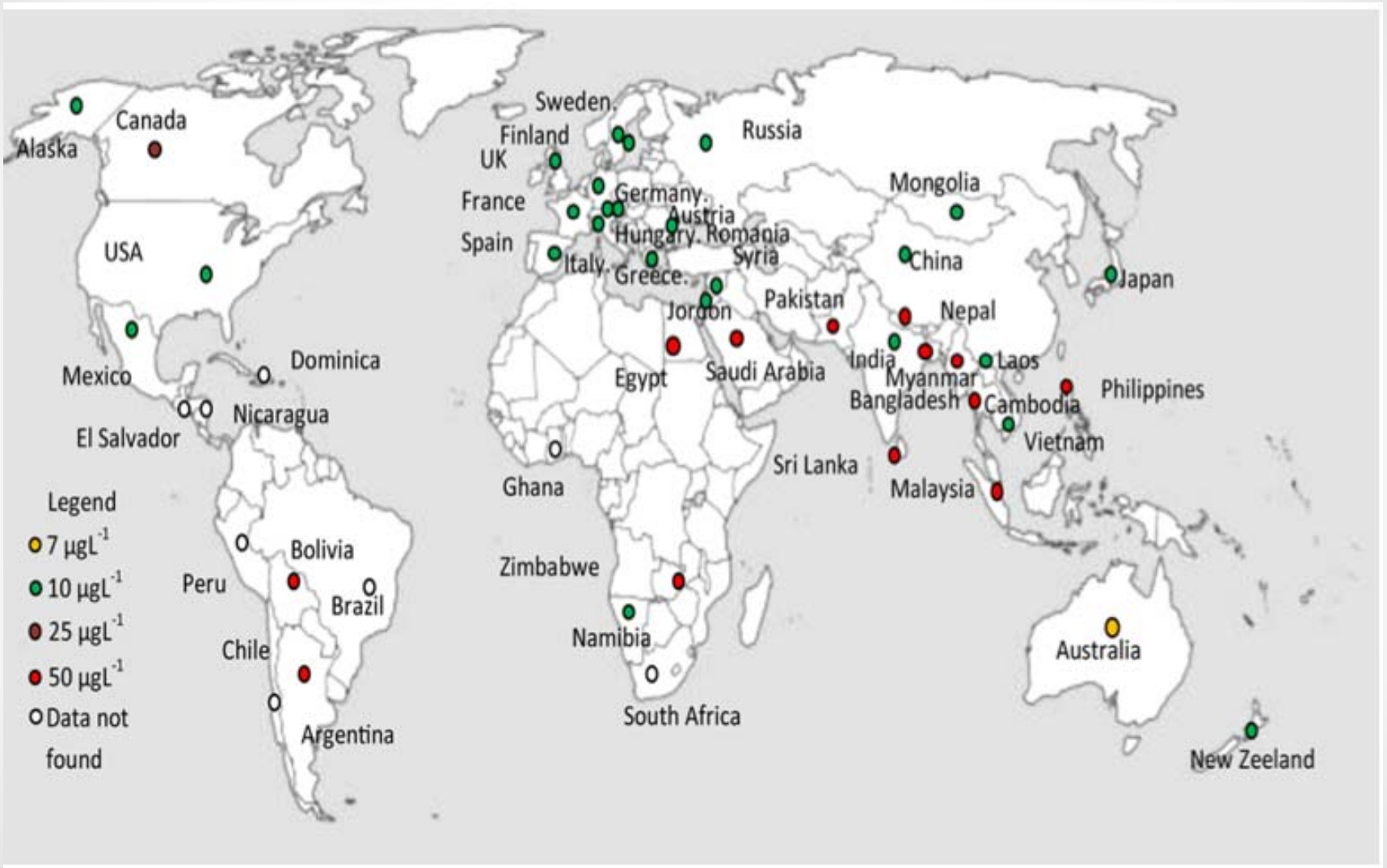
ARSENIC toxicity and guidelines



- **> 200 M people at risk** of chronic poisoning
- **IARC: group I**
- **WHO guidelines: 10 ppb**



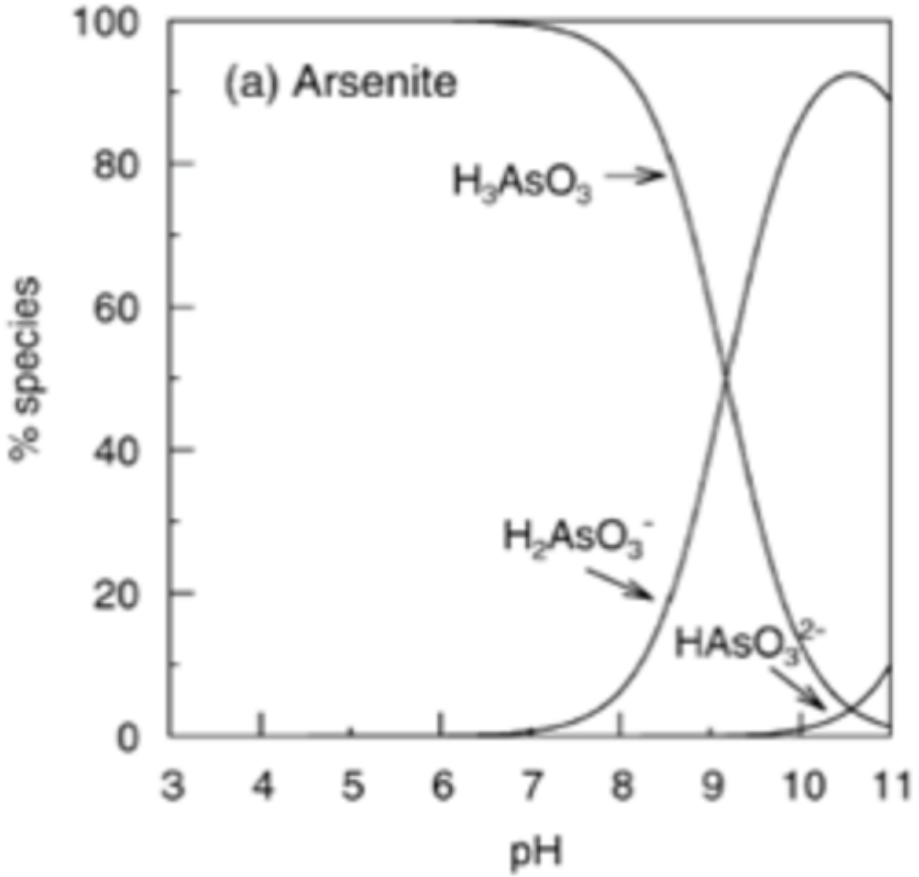
MAXIMUM ALLOWED CONCENTRATION IN DW



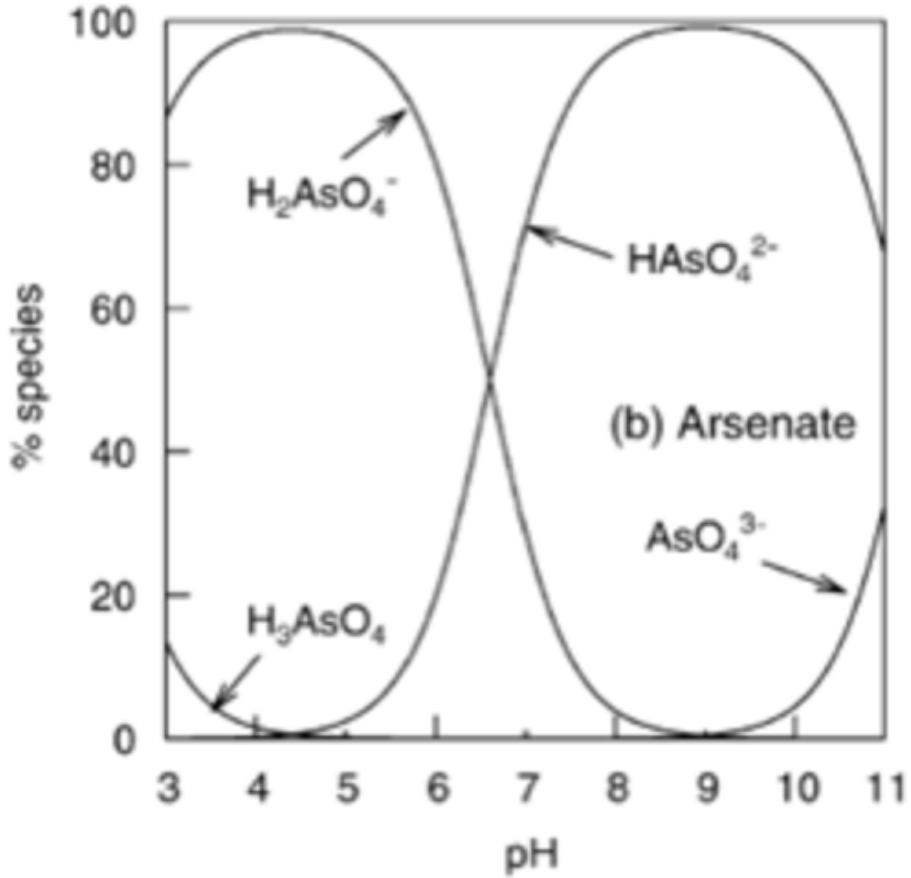
ARSENIC SPECIATION IN WATER

TOXICITY

As (III) + ← - **As (V)**



a)



b)

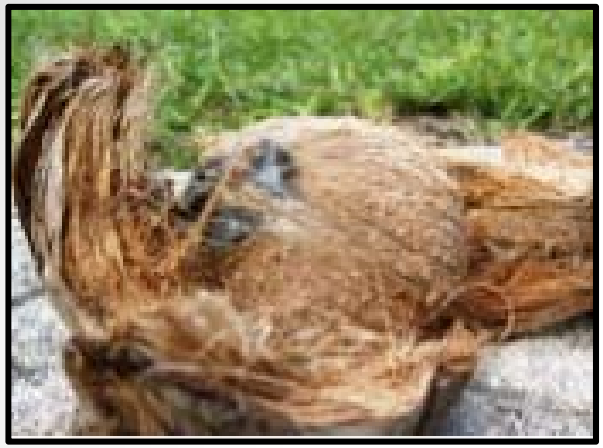
APPROACH AND AIM OF THE RESEARCH

- **In Bangladesh 77 M people suffer the effect of As poisoning**

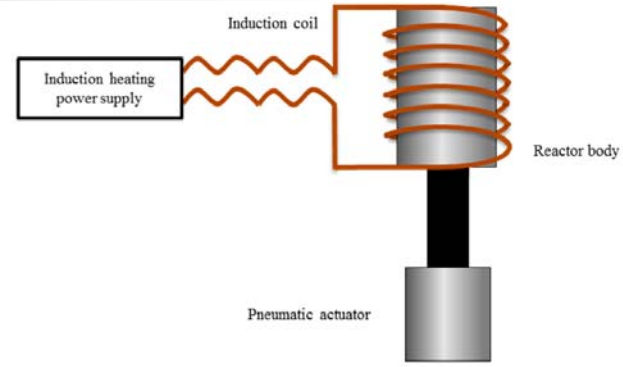
- **AIM**: find a simple and not expensive technical solution to lower As concentration below 50 ppb

- **APPROACH**: adsorption on a low-cost biochar deriving from a local biomass

BIOCHAR PRODUCTION



Coconut shell + Miscanthus → **NOT activated biochar**



Jiggled Bed Reactor (JBR)

feedstock	Temperature [°C]	time (h)	yield
Coconut Shell	700	2	28 %
Miscanthus	800	2	23 %

BIOCHAR CHARACTERIZATION

	BET Analysis	Pores		
	Specific Surface [m^2/g]	pore volume [cm^3/g]	pore dimension [Å]	ashes
commercial GAC	1 339	0,646	19,310	2 %
Coconut Shell biochar	428	0,212	19,781	2 %
Miscanthus biochar	208	0,098	18,879	8 %

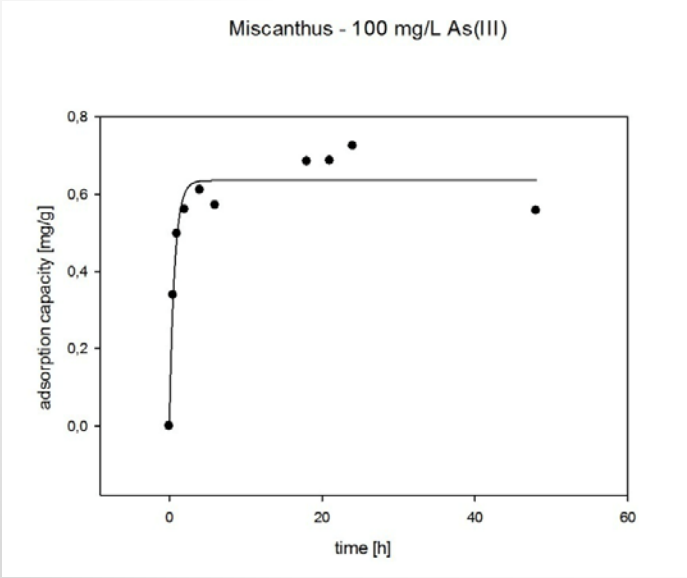
ADSORPTION TESTS

EQUILIBRIUM TIME | ADSORPTION KINETICS | ADSORPTION ISOTHERMS | Na EFFECT

- **As (III)** - $NaAsO_2$ and As_2O_3
- **As (V)** - $HAsNa_2O_4$

BATCH TESTS:

- pH: **8**
- Temperature: **25 °C**
- S/L ratio: **1:10**



C_0 = 100 mg/L	As	equilibrium time [h]
commercial GAC	III	2
Miscanthus	III	18
Coconut Shell	III	6

ADSORPTION TESTS

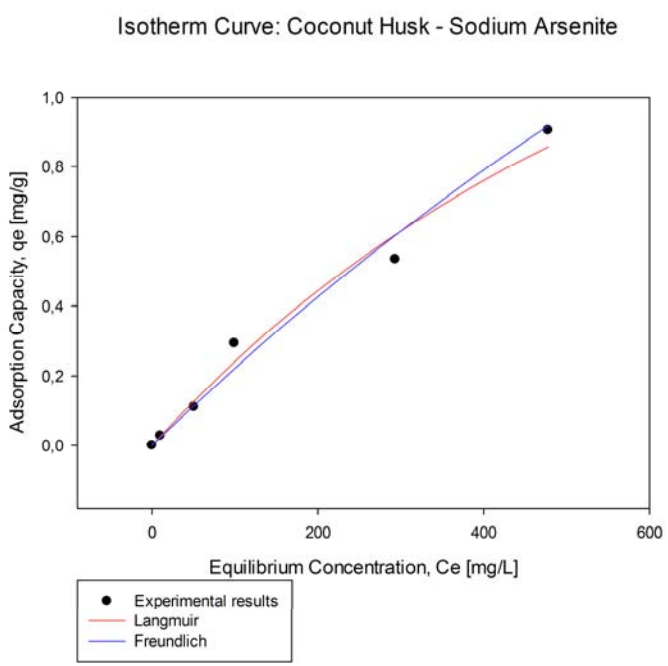
EQUILIBRIUM TIME → **ADSORPTION KINETICS** → ADSORPTION ISOTHERMS → Na EFFECT

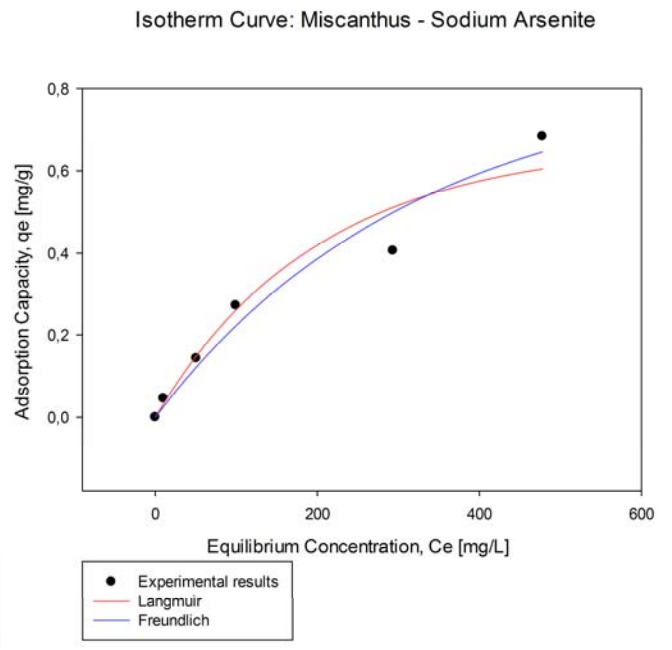
C_0 = 100 mg/l As(III) – $NaAsO_2$	PSEUDO 1st ORDER		PSEUDO 2nd ORDER	
	R_I^2	K_1 [min^{-1}]	R_{II}^2	K_2 [g/mg min]
Miscanthus biochar	0,855	0,0196	**0,994**	**0,1763**
Coconut Shell biochar	**0,964**	**0,0214**	0,447	0,0468

ADSORPTION TESTS

EQUILIBRIUM TIME → ADSORPTION KINETICS → **ADSORPTION ISOTHERMS** → Na EFFECT

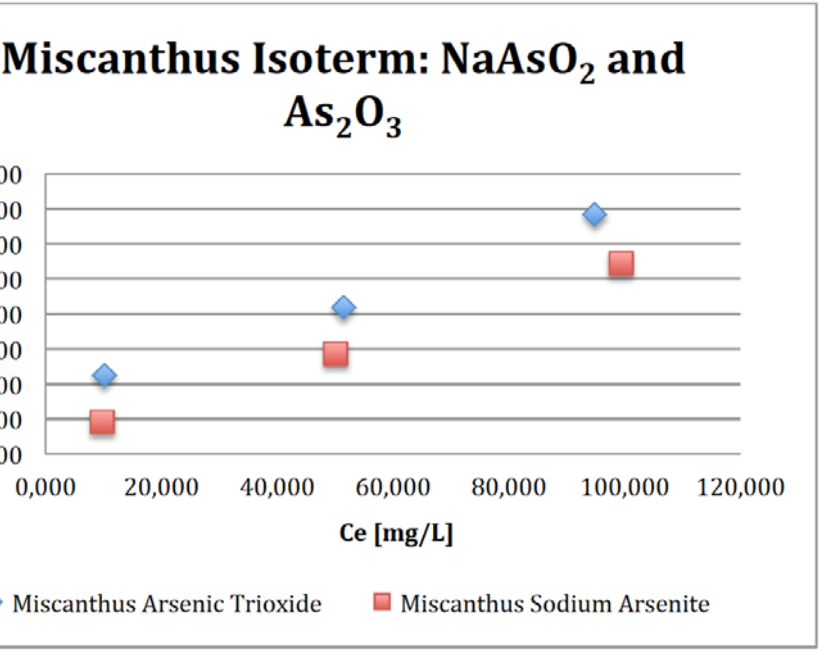
As(III) – $NaAsO_2$	FREUNDLICH			LANGMUIR		
	R^2	K_F [mg/g]	n	R^2	K_L [L/mg]	q_0 [mg/g]
commercial GAC	0,988	0,0036	1,1179	0,611	0,0010	2,6123
Miscanthus biochar	**0,987**	**0,0102**	**1,4806**	0,849	0,0039	0,9365





ADSORPTION TESTS

EQUILIBRIUM TIME | ADSORPTION KINETICS | ADSORPTION ISOTHERMS | Na EFFECT



Adsorption capacities for Miscanthus and sodium arsenite and arsenic trioxide

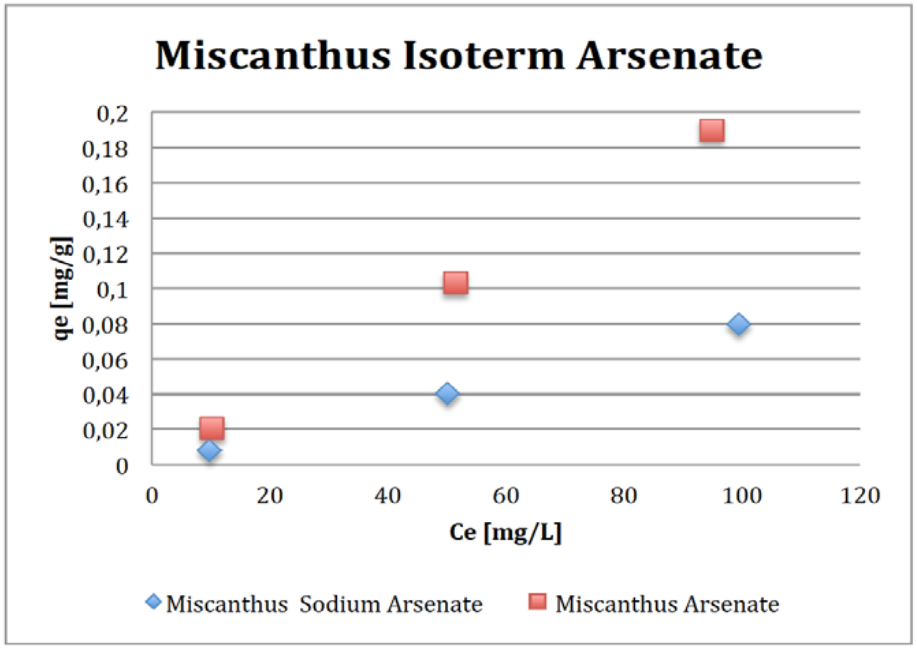


Chart 5.20 - Adsorption capacities for Miscanthus and sodium arsenate and arsenate

CONCLUSIONS

SORPTION could be an interesting solution for As removal

BUT other biomasses should be investigated as low-cost biochar feedstocks

Mischantus biochar could be used as **pre-treatment** to reduce As concentration

Sodium effect should be quantified through further studies

Column tests are necessary for a reliable assessment