Atelier « Risques »

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REUT & Risques?

Enjeu: Gérer durablement les espaces cultivés en préservant les ressources en eau en:

- quantité **- qualité**

Ré-utilisation d'eaux usées traitées (REUT) pour l'irrigation …

+

- réduit la consommation d'eau
- recycle un déchet
- diminue la pollution des rivières
- participe à la fertilisation

-

Exposé Rémi Declercq
Rémi lombard

- réglementation contraignante?
- Coûts, acheminements, traitements…
- risques chimiques et pathogènes

Endotoxines,microplastiques, contaminants émergents…

Entrée STEP Sortie STEP

Statistics	Total		NoV GII		NoV GI		Enterovirus		Adenovirus		E. Coli		Enterococci	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT	IN	OUT
Mean	4.80E+07	1.20E+07	2.60E+06	9.90E+05	9.30E+06	2.00E+06	2.40E+06	1.60E+06	3.30E+07	7.60E+06	2.10E+07	2.20E+05	2.9E+06	4.40E+04
Removal	-74.00%		-62.60%		-78.40%		-34.60%		-77.10%		-98.90%		-98.50%	

(La Rosa et al, 2010)

Quels Risques?

Risque= exposition à un danger
peut couvrir divers domaines: santé, environnement, économique, sociologie

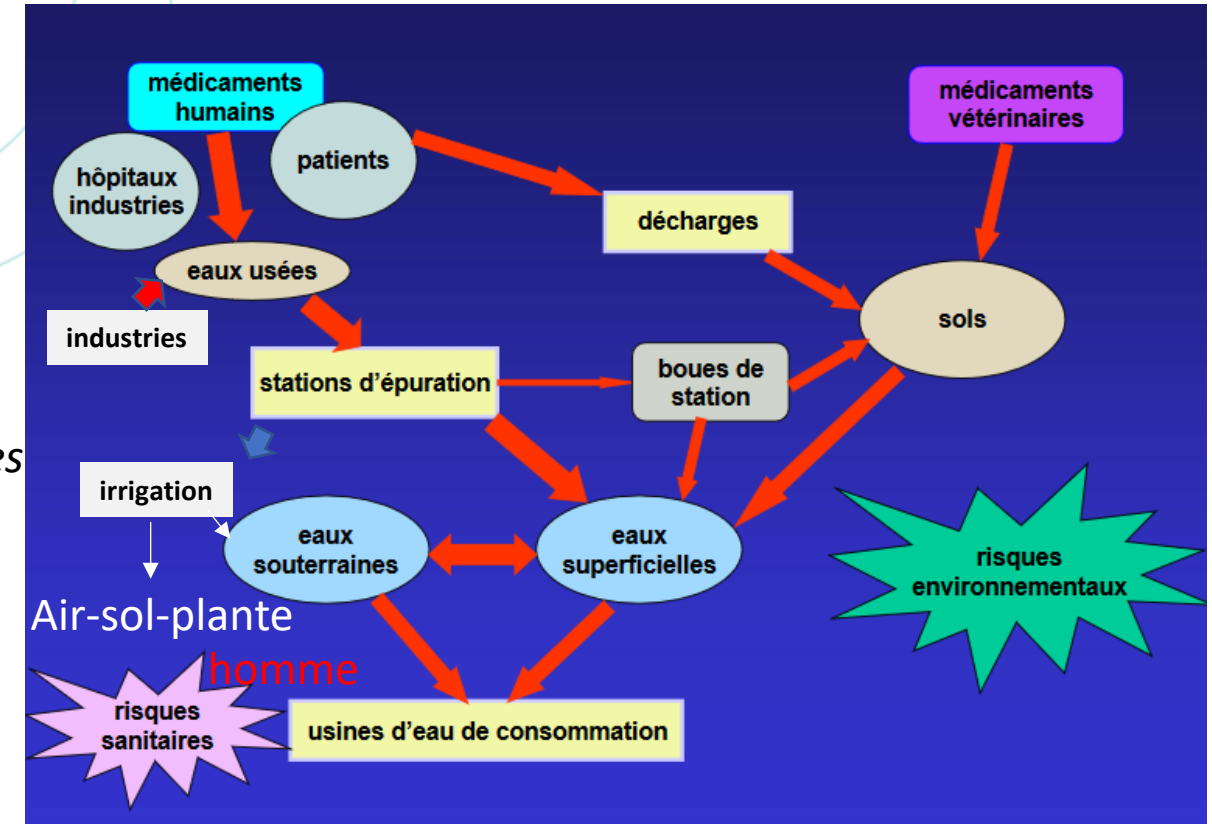
Risques sanitaires

Pathogènes

chimiques

différentes méthodes pour l'évaluer

QMRA
Exposé Isabelle Albert



D'après Gouillé et al, 2013

Risques environnementaux

µpolluants

physique

Exposés Dominique Patureau

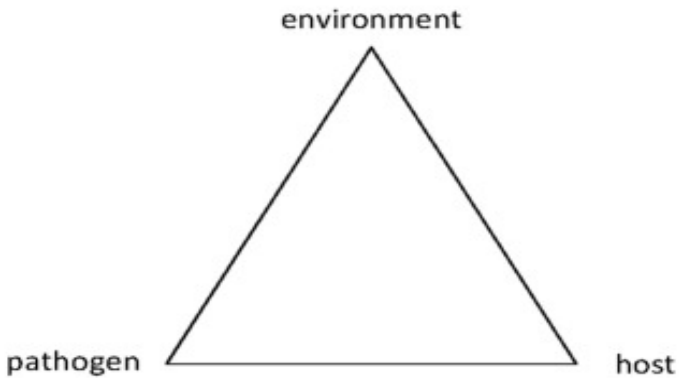
Sandrine Andres

Suivant l'usage de la REUT (urbain, agricole), le type de pratique (aspersion, goutte à goutte) => les questions d'impact ≠

Risque sanitaire dépend:

- Des concentrations des contaminants
- Du niveau de traitement des eaux,
- Degré d'exposition des populations (5 catégories/activités, ANSES)
- De la sensibilité des populations (+ âge,…)
- Des conditions environnementales (climatiques, (survie des pathogènes))

Contamination par: ingestion, inhaltation, contact



Beaudequin et al, 2015

Fig. 5. Epidemiological triangle.

Survie de divers organismes dans certains milieux environnementaux à une température entre 20 et 30 °C (OMS)

pathogène	Durée de vie (jours)		
	Eau	**cultures**	**sol**
Virus Entérovirus	50	15	20
Bactéries			
Coliformes thermotolérants	30	15	20
Salmonella spp.	30	15	20
Shigella spp.	10	5	ND
Protozoaires Oocystes de Crytptosporidium	70	2	75
Helminthes Œufs d'Ascaris	Années	30	Années

loudhaief

Risques environnementaux

4. Soil impact of agricultural reuse

The agriculture reuse practice is not free from adverse reactions to the environment, especially in the soil. WW irrigation, even treated, can alter the physical, chemical, and microbiological properties of the soil, as well as introduce different types of contaminants. Several studies have demonstrated modifications in soil characteristics by long and short periods of agricultural reuse practice (Adrover et al., 2012; Bastida et al., 2017; Becerra-Castro et al., 2015; Broszat et al., 2014; Chevremont et al., 2013a, 2013b; Farhadkhani et al., 2018; Galvis et al., 2018; Ibekwe et al., 2018; Jaramillo and Restrepo, 2017; Morugán-Coronado et al., 2013; Rusan et al., 2007; Urbano et al., 2017; Wafula et al., 2015; Zolti et al., 2019). Changes in pH, salinity, organic matter (OM), and nutrients content are usually observed on WW-irrigated soil. They influence biotic and abiotic factors, which are directly related to fertility and consequently to soil productivity (Elifantz et al., 2011).

Leonel and Tonetti, 2021 STOTEN

Table 2 Total permissible limits of heavy metals in drinking water and diseases associated with the surplus amount

Heavy metals polluting the water quality	Permissible limits in drinking water according to WHO (mg/L)	Permissible limits in effluent water according to WHO (mg/L)	Diseases associated with the excess amount	Exposure routes	References
Arsenic	0.01	5.0	Skin, lung, bladder, kidney cancer, skin manifestations, gastrointestinal disorders, neurological effects, hormone disruption and infertility, psoriasis	Inhalation and ingestion	Kinuthia et al. (2020) Kumar et al. (2021); Punshon et al. (2017); Jyothi (2020)
Cadmium	0.005	0.003	Psychological disorders, gastrointestinal disorders, central nervous system complications, immune system deficiencies, DNA impairment, cancer, Itai-itai disease, osteoporosis, respiratory dis-ease	Ingestion of contaminated food and water and, to a significant extent, through inhalation and cigarette smoking	Kinuthia et al. (2020); Briffa et al. (2020); Zhang and Reynolds (2019); Genchi et al. (2020); Jyothi (2020)
Chromium	0.1	0.05	Gastrointestinal ulceration, nausea and vomiting, fever, diarrhea, toxic nephritis, liver damage, gingivitis, bronchitis, pneumonia, lung cancer	Inhalation and ingestion	Kinuthia et al. (2020); Briffa et al. (2020); Jyothi (2020)
Iron	1.0	2.0	Genetic disorder, hemorrhagic necrosis	Ingestion	Yuen and Becker (2020); Jaishankar et al., 2014; EPA 2002.
Lead	0.01	0.05	Hypertension, miscarriages, premature and low births, renal impairment, brain injury, abdominal pain	Inhalation through the nose and ingestion through drinking water and soil	Wani et al. (2015); Goel et al. (2005); Kinuthia et al. (2020); Briffa et al. (2020); Jyothi (2020),
Mercury	0.006	0.001	Down's syndrome, affects the reproductive system, speech defects, memory loss, tremors and muscle incoordination, deafness, vision complication	Inhalation, ingestion and dermal contact	Kinuthia et al. (2020); Briffa et al. (2020); Jyothi and Farook (2020).
Copper	2.0	0.25	Insomnia, anxiety, agitation, restlessness, fatigue, jaundice, dizziness	Ingestion	Sharma et al. (2012); Briffa et al. (2020); WHO 2003 Taylor et al. (2020). (Agoro et al., 2020)
Nickel	0.07	0.02	Lung embolisms, asthma, respiratory failure, heart disorders, dizziness, increased possibilities of cancer	Inhalation and ingestion	Kinuthia et al. (2020); Briffa et al. (2020); Jyothi (2020)

Review

Wastewater reuse for crop irrigation: Crop yield, soil and human health implications based on giardiasis epidemiology

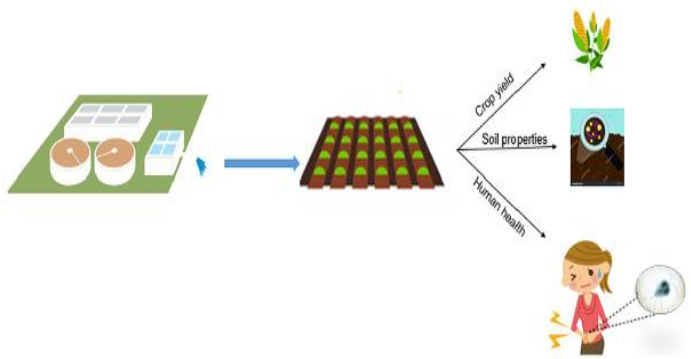
Lays Paulino Leonel, Adriano Luiz Tonetti *

School of Civil Engineering, Architecture and Urbanism - FEC, at UNICAMP (State University of Campinas), Avenida Albert Einstein, 951, Cidade Universitária "Zeferino Vaz", P.O. Box 6021, 13083-852 Campinas, SP, Brazil

HIGHLIGHTS

- Water demand is growing twice as fast as the human population.
- Agriculture is the major water consumer on the planet.
- Wastewater is an alternative to supply the water demand of agricultural sector.
- Safe wastewater reuse must consider impacts on environmental and human health.

GRAPHICAL ABSTRACT



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Risk assessment of contaminants of emerging concern in the context of wastewater reuse for irrigation: An integrated modelling approach

Riccardo Delli Compagni [a], Marco Gabrielli [a], Fabio Polesel [b, c], Andrea Turolla [a], Stefan Trapp [b], Luca Vezzaro [b], Manuela Antonelli [a, *]

[a] *Politecnico di Milano, Department of Civil and Environmental Engineering (DICA), Piazza Leonardo da Vinci 32, 20133, Milano, Italy*
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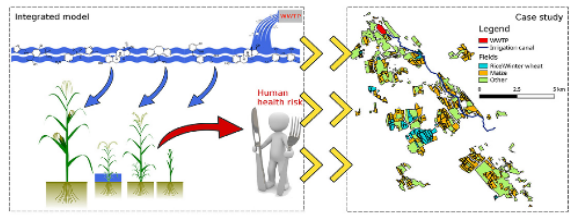
[c] *DHI A/S, Agern Allé 5, 2970, Hørsholm, Denmark*

HIGHLIGHTS

- An integrated model was developed to describe CEC fate in irrigation systems.
- Good agreement between predictions and *in situ* measurements and literature data.
- Human health risk was predicted for four tested crops irrigated with reclaimed wastewater.
- Health risk alert was shown for sulfamethoxazole and 17-α ethinylestradiol.

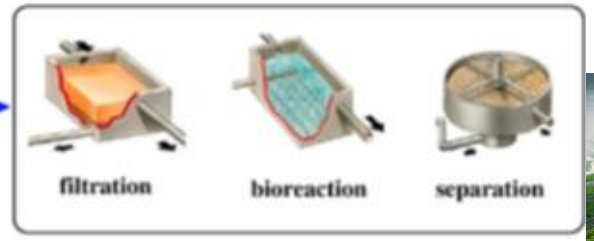
GRAPHICAL ABSTRACT

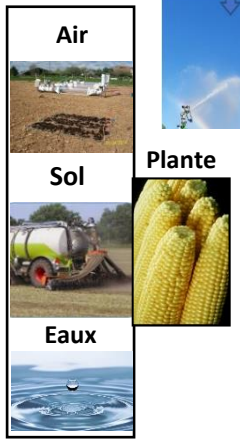


Objectif de l'atelier

Identification des verrous à lever sur les aspects "risques" en lien avec la pratique de ré-utilization d'eaux usées traitées

- 1 pathogène -1 modèle dose-réponse: comment combiner pathogène-contaminant?
- des contaminants émergents où pas encore de seuils: endotoxines… comment évaluer le risque?
- quelles données minimales sont nécessaires pour les modèles? (calibration & validation)
- Quelles approches pour prioriser les risques? / homme et aussi/ environnement?
- …





Présentations

- *Rémi Declercq (Ecofilae) & Rémi Lombard-Latune (Reversaal)*
  Ecofilae - Solutions pour valoriser vos eaux usées

1) Comprendre la règlementation (actuellement axée /risque microbien/homme)

- *Isabelle Albert (MIA: modélisation, maths applis AgroParisTech en vidéo)*
  MIA Paris - Isabelle Albert (inrae.fr)

2) **Évaluation quantitative du risque alimentaire de la production à la maladie humaine (QMRA)**

Ex:Exposé de Gaspar Massiot -> atelier modélisation 20/10


Pause 15min

- *Dominique Patureau (LBE)*

3) **Les autres risques: flux de contaminants apportés à l'environnement (sol) par la reuse**

- *Sandrine Andres (INERIS)*

4) **Evaluation du risque chimique pour l'environnement et l'homme**

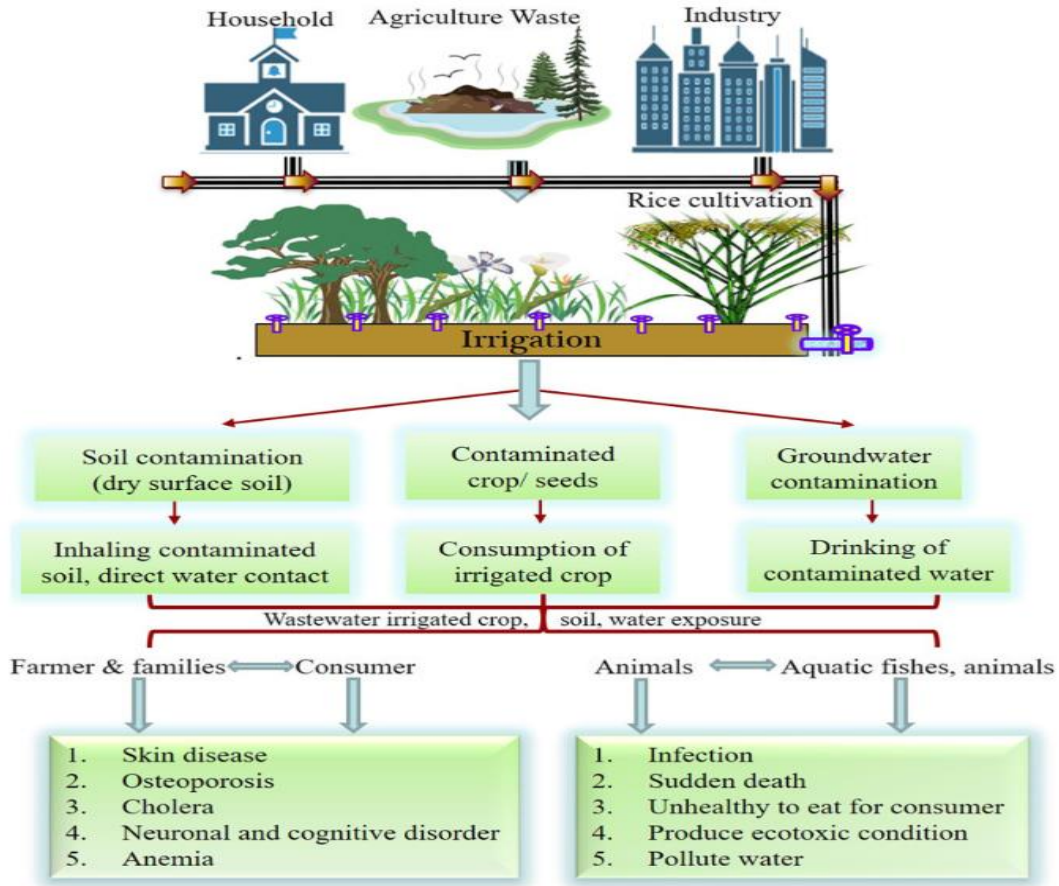


Fig. 2 Exposure pathway representing serious health concerns from wastewater-irrigated crops