

WATER MANAGEMENT IN WATER-SCARE REGIONS

THE ISRAELI CASE STUDY

Prof. Dr. Benny Chefetz

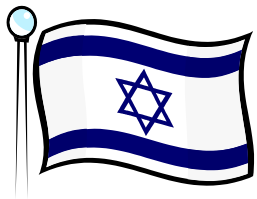
Director General

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Ministry of Agriculture and Food Security, ISRAEL



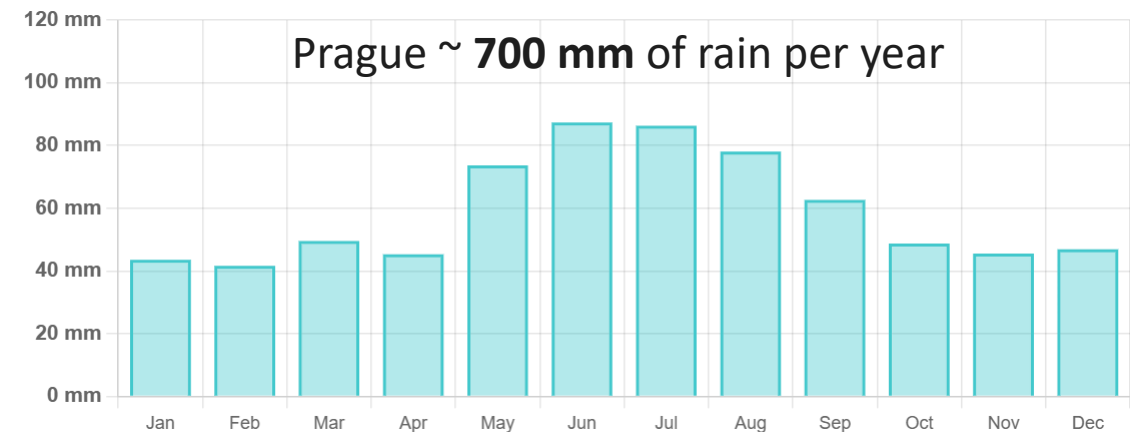
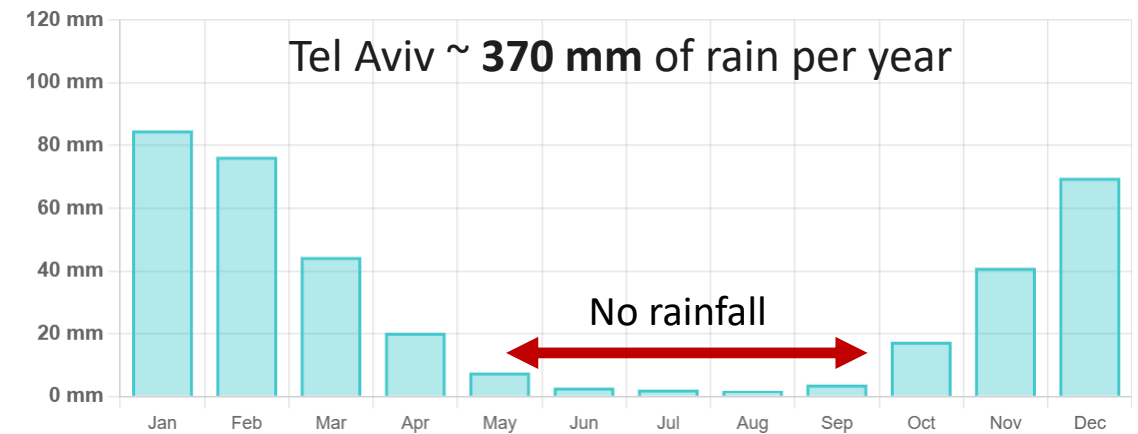
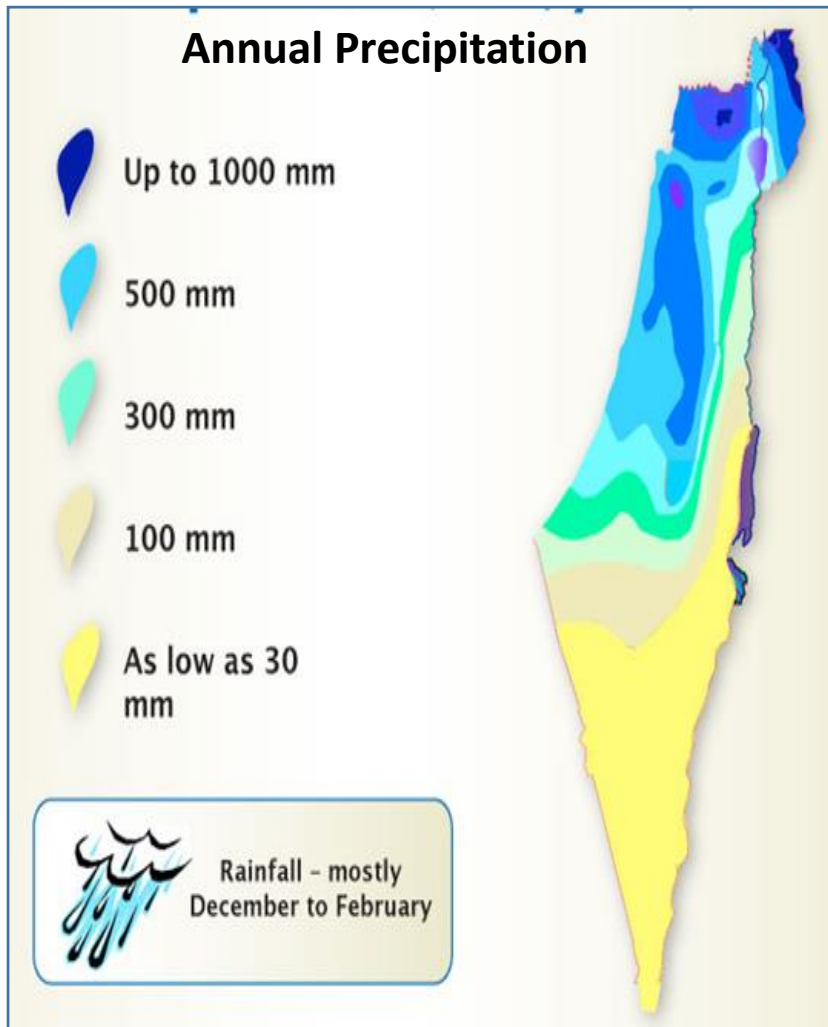
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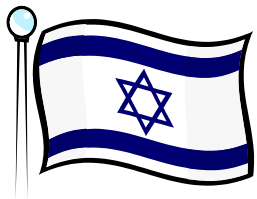




Climate: arid, semi-arid, no summer rainfall

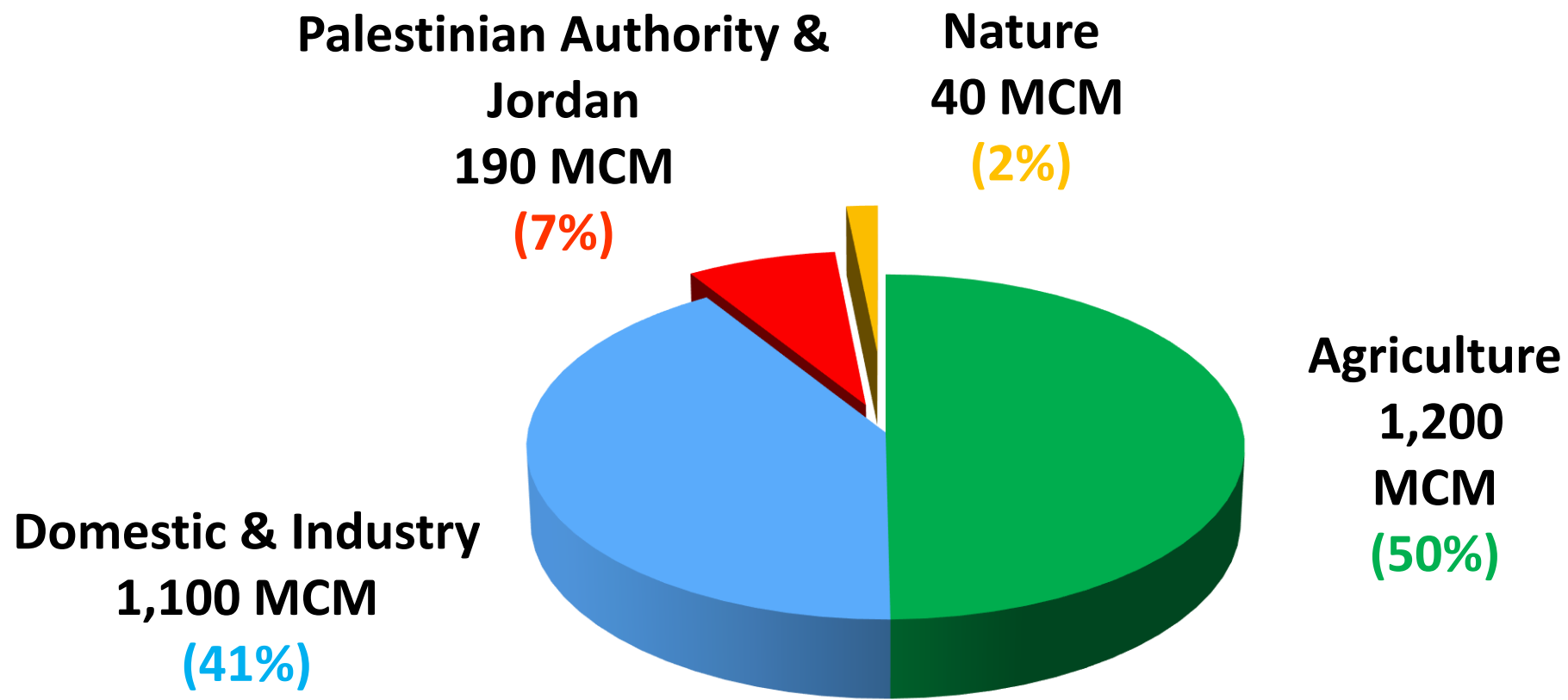
→ **irrigation is a MUST**



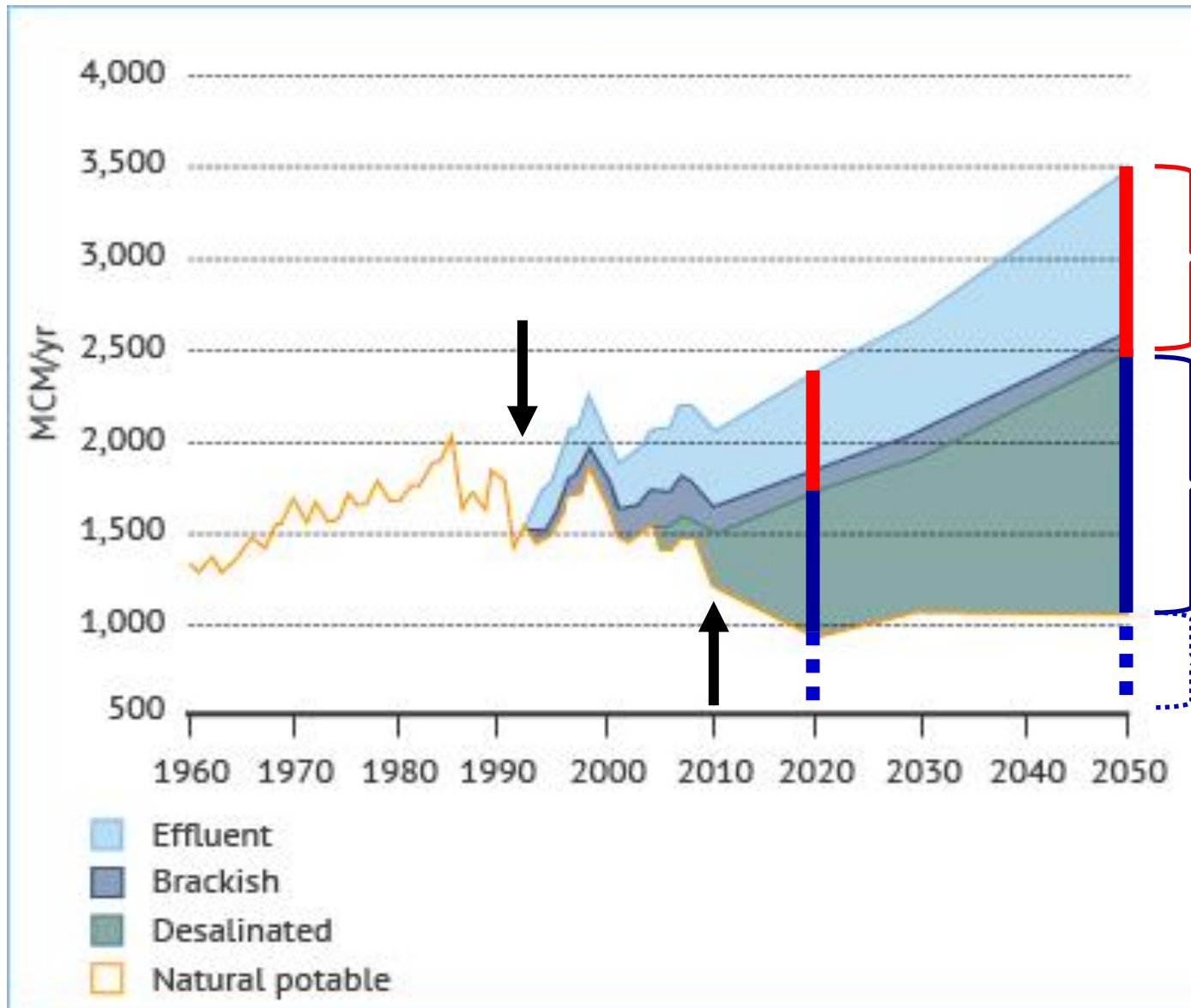


Water Supply (Israel) by sector

Total: ~2,600 million cubic meter (MCM)



ISRAEL (and the whole Middle East) = absolute water scarcity



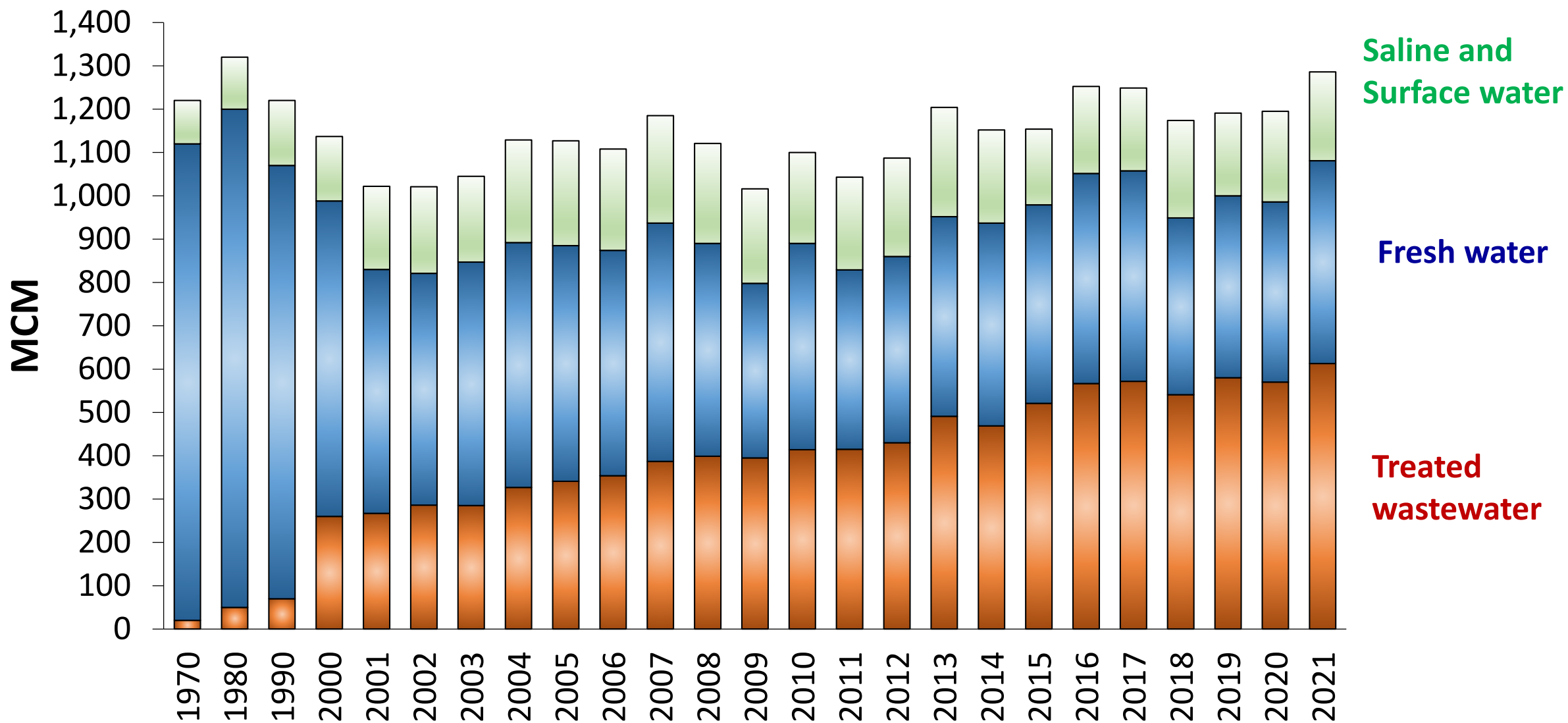
treated wastewater
= irrigation water

desalinated sea water
= potable water

ground/surface water



Water consumption by Ag according to source





Treated wastewater is a new source of water

Great solution !!!

Maintaining fresh water resources

Ensuring public health

Economic growth engine for the Ag sector

Cost-effective water supply

Sustainable supply of water for the Ag sector

BUT

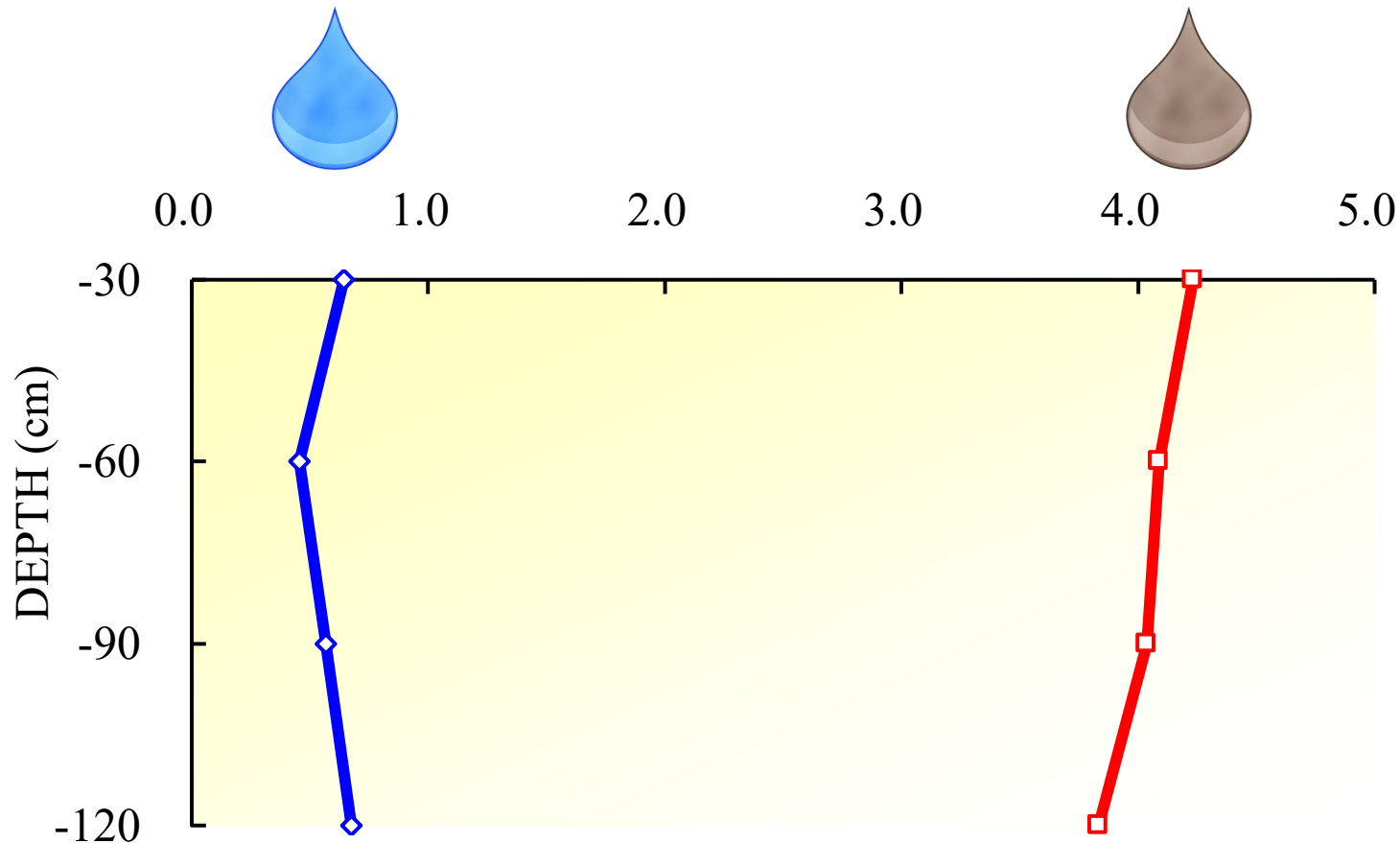


Negative aspects

(long-term irrigation with treated wastewater):

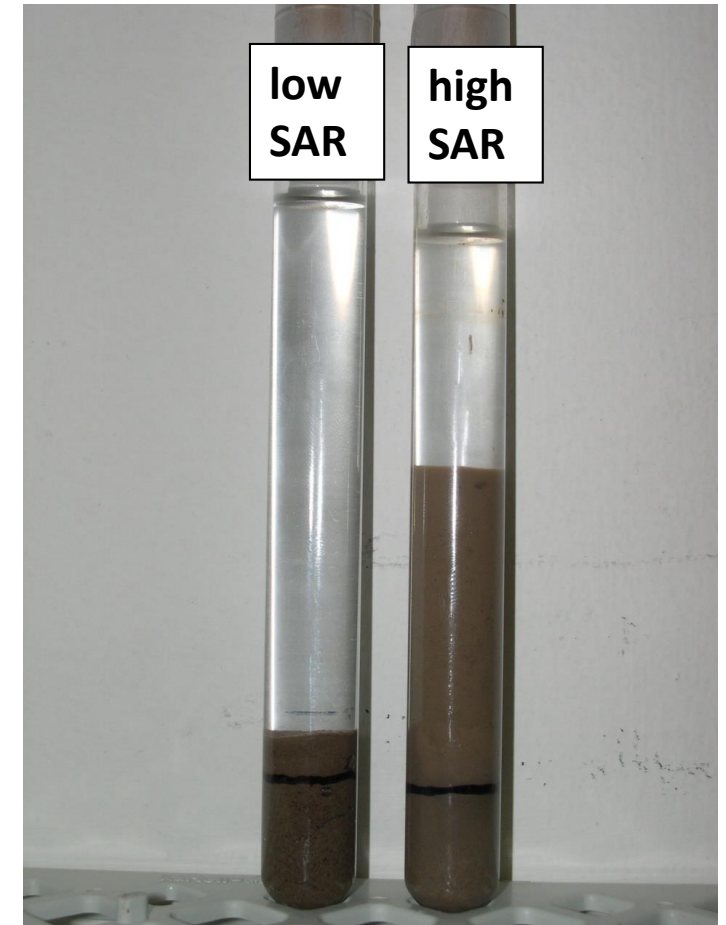
- Elevated salinity → osmotic effect
- Toxicity of specific elements (Chloride, Boron, Sodium)
- High Na^+ concentration → high SAR (sodicity) values
- Water repellent → water percolation
- Particulate matter → clogging of irrigation equipment

High Na^+ concentration \rightarrow high SAR (sodicity) values \rightarrow affecting soil properties



Israel Ministry of Agriculture - National Wastewater Survey

swelling/shrinking





Reclaimed Wastewater



Damage to Avocado by Boron (B)
(Anat Lowengart-Aycicegi et al.)

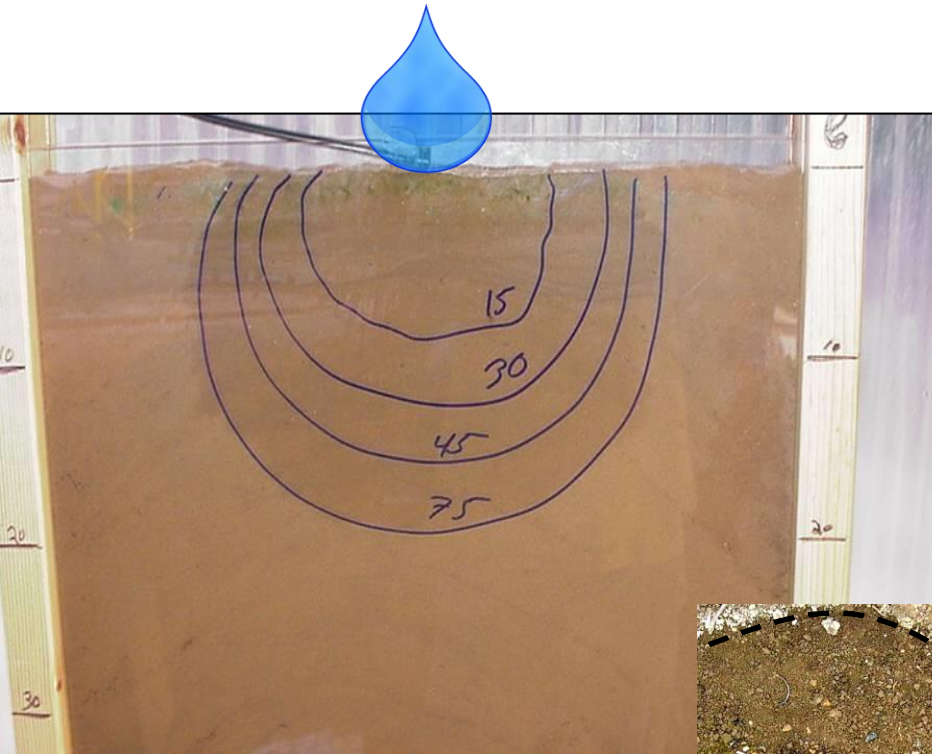
Fresh water



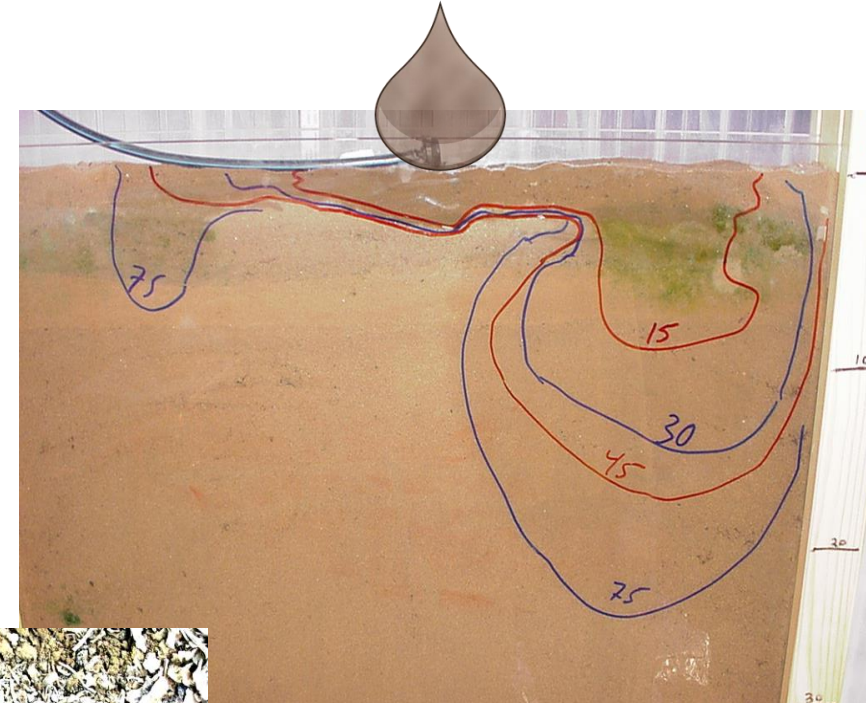
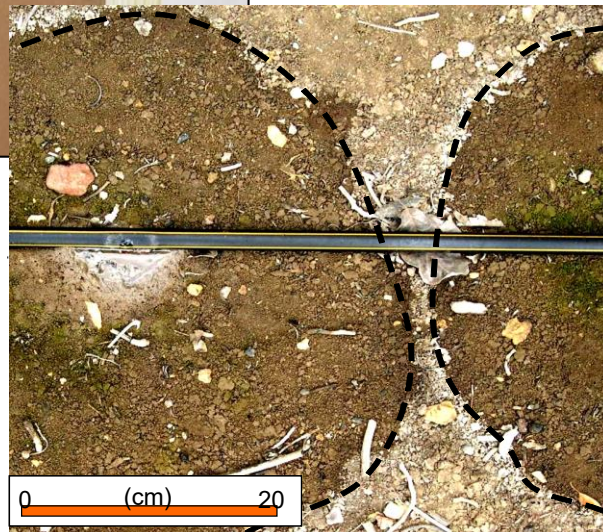


Water repellent → water percolation

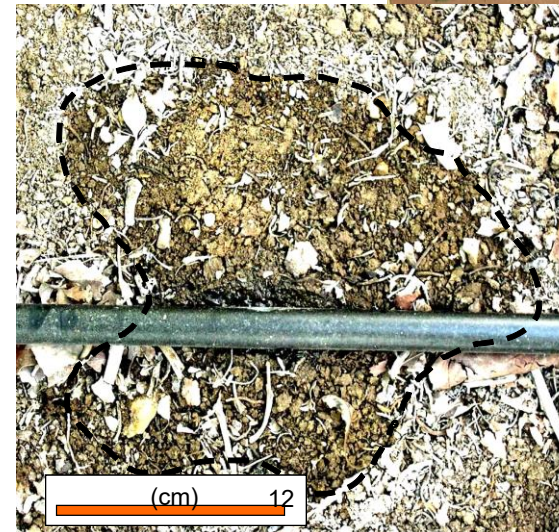
(Chen and Tarchitzky)



Fresh water



**Reclaimed
Wastewater**





Potential damage to irrigation equipment

biofilms → clogging of drippers



E. Kenig, Israel Ministry of Agriculture

REGULATION: The use of treated wastewater for **irrigation**

BOD	mg/L	10
TSS	mg/L	10
COD	mg/L	100
Fecal coliforms	MPN/100 mL	10
Dissolved oxygen	mg/L	>0.5
Residual chlorine	mg/L	1
pH		6.5-8.5
Total nitrogen	mg/L	25
Ammonia	mg/L	20
Total phosphorus	mg/L	5
EC	dS/m	1.4
SAR	(meq/L) ^{0.5}	5
Chloride	ppm	250
Sodium	ppm	150
Boron	ppm	0.4
Fluoride	ppm	2

Soil & Plant Health

High quality treated wastewater
(10/10, BOD/TSS)

Disinfection + filtration + fecal coliforms 10
MPN/100 mL unlimited irrigation

Medium quality of treated wastewater
(20/30 to 60/90, BOD/TSS)
must have 3 barriers for irrigation

Low quality of treated wastewater
(>60/90, BOD/TSS)
cannot be used for irrigation



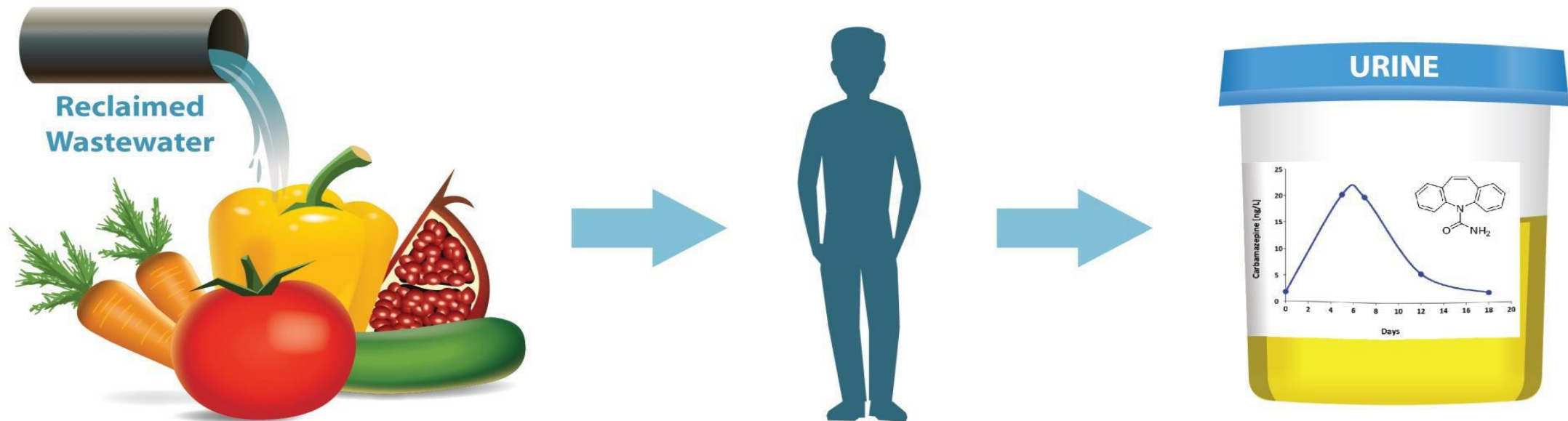
Treated wastewater: quality standards/regulations

No guidelines

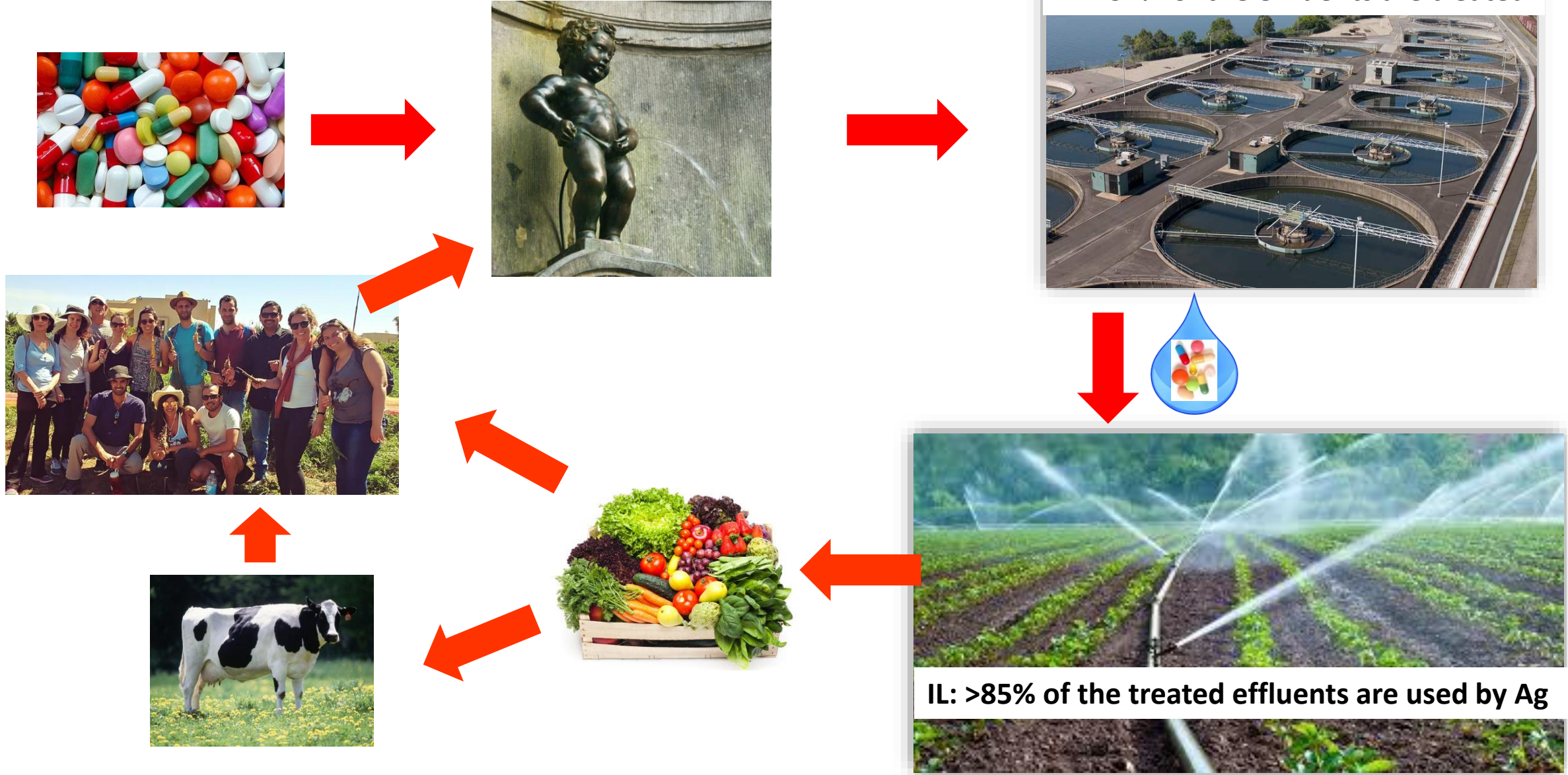
**for pharmaceuticals and/or personal care products in
treated wastewater
used for irrigation**



Introduction of **pharmaceuticals, personal care products, PFAS and other chemicals** (present in reclaimed wastewater) to our produce (→ consumers)



Exposure scheme



Human Exposure to Wastewater-Derived Pharmaceuticals in Fresh Produce: A Randomized Controlled Trial Focusing on Carbamazepine

Ora Paltiel,^{*,†,‡,§} Ganna Fedorova,^{§,||} Galit Tadmor,^{†,§,||} Geffen Kleinstern,^{†,§} Yehoshua Maor,[§] and Benny Chefetz^{§,||}

Environment International 143 (2020) 105951



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Environment International

journal homepage: www.elsevier.com/locate/envint



Involuntary human exposure to carbamazepine: A cross-sectional study of correlates across the lifespan and dietary spectrum

Michael Schapira^a, Orly Manor^a, Naama Golan^b, Dorit Kalo^c, Vered Mordehay^b, Noam Kirshenbaum^b, Rebecca Goldsmith^{a,d}, Benny Chefetz^{b,*,1}, Ora Paltiel^{a,*,1}



NDC 0078-0509-05 Rx only

Tegretol[®] 200mg
carbamazepine USP

100 tablets

PHARMACIST: Dispense with Medication Guide attached or provided separately.

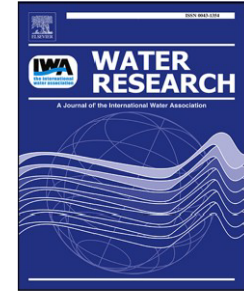
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Water Research

journal homepage: www.elsevier.com/locate/watres



Wastewater-derived organic contaminants in fresh produce: Dietary exposure and human health concerns

Evyatar Ben Mordechay^{a,b,1}, Tali Sinai^{a,c,1}, Tamar Berman^d, Rita Dichtiar^c,
Lital Keinan-Boker^{c,e}, Jorge Tarchitzky^a, Yehoshua Maor^b, Vered Mordehay^a, Orly Manor^f,
Benny Chefetz^{a,*}

Consumption → Exposure → Risks

Exposure assessment approach



$$\text{conc. in edible crop}_{(i)} \times \text{consumption of the crop}_{(i)}$$

Scenarios

Mean
exposure

High exposure

Worst-case
exposure

Mean concentration (**produce**)

×

Mean consumption (**produce**)

Maximum concentration

×

Mean consumption

Maximum concentration

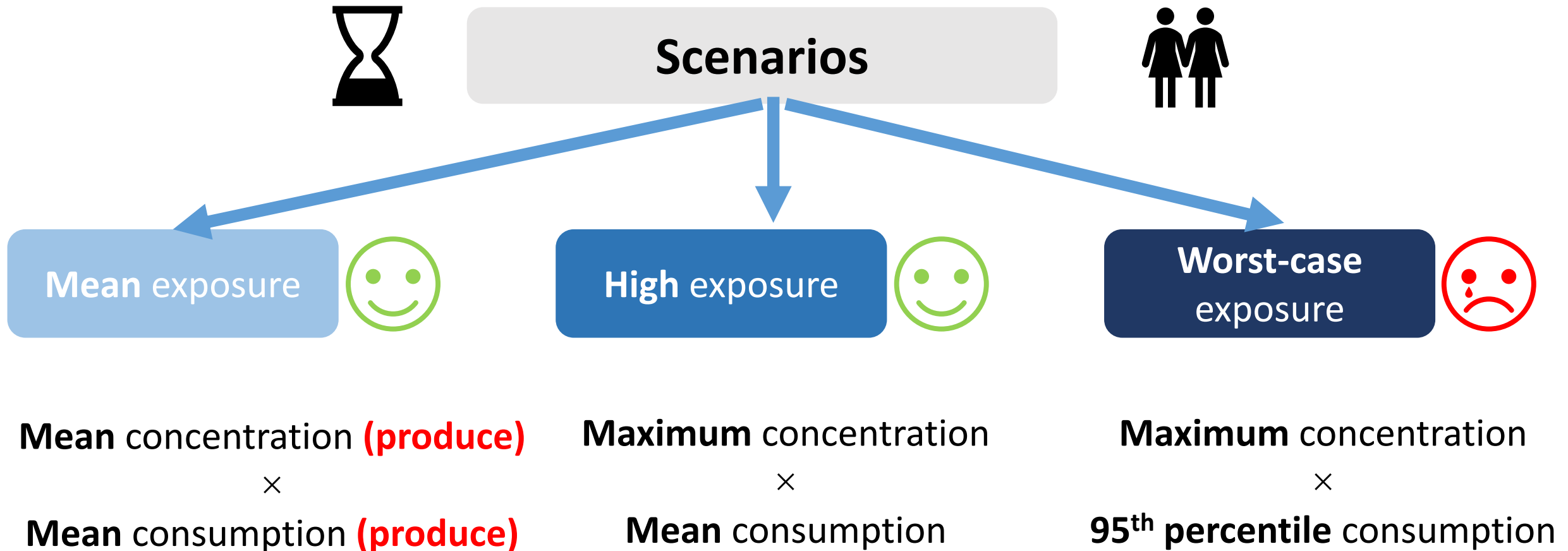
×

95th percentile consumption

Human exposure (ng/person*day)

Class	Compound	Mean	High	Worst-case	Worst-case exposure scenario			
		General population n=2808			Males n=1341	Females n=1467	Vegetarians n=126	Arabs n=491
Analgesics	4-Aminoantipyrine	3	20	110	110	120	230	70
	Acetaminophen	1	10	60	60	60	70	110
Antiarrhythmics	Atenolol	1	30	160	170	160	190	280
	Bisoprolol	0	1	7	7	7	8	10
	Metoprolol	0	1	7	7	7	8	10
	Sotalol	0	10	50	50	50	60	80
Anticonvulsants	Carbamazepine	870	5,700	27,200	27,600	26,600	31,300	46,100
	Dihydroxy-carbamazepine	50	170	800	800	790	990	1,200
	Epoxide-carbamazepine	510	4,100	19,500	19,700	19,000	22,700	33,600
	Gabapentin	4	50	230	240	230	270	390
	Lamotrigine	570	6,200	29,100	29,500	28,400	33,700	50,200
Antidepressants	Diazepam	10	120	610	600	660	1,200	400
	Venlafaxine	5	50	250	270	230	210	410
Antimicrobials	Enrofloxacin	0	3	10	10	10	10	20
	Sulfamethoxazole	20	30	160	150	200	200	70
	Thiabendazole	1	10	60	60	60	70	100
	Trimethoprim	0	10	80	60	80	130	40
Antiparasitic	Crotamiton	1	20	80	80	80	100	130
Corrosion inhibitor	Benzotriazole	10	200	930	940	910	1,100	1,600
Hypolipidemics	Bezafibrate	160	310	2,500	2,600	2,400	520	3,700
	Warfarin	-	1	8	7	10	10	3
Psychoactives	Caffeine	20	250	1,400	1,500	1,300	1,200	1,900
	Cotinine	1	6	30	50	10	20	50
	Nicotine	40	380	2,100	2,200	2,100	2,100	3,000
Sweetener	Aspartame	2	40	220	210	220	300	300
Sum →		2,300	17,700	85,700	87,000	83,700	96,700	143,800

$$\text{Hazard quotient} = \frac{\text{Exposure level (current study)}}{\text{ADI or TTC (literature data)}}$$



ADI, hazard quotients for **worst-case** exposure scenario

Class	Compound	<u>General population</u>	<u>Vegetarians</u>	<u>Arabs</u>
		ADI based	ADI based	ADI based
Analgesics	4-Aminoantipyrine	NA	NA	NA
	Acetaminophen	0	0	0
Antiarrhythmics	Atenolol	0.01	0.01	0.01
	Bisoprolol	NA	NA	NA
	Sotalol	NA	NA	NA
	Carbamazepine	1.13	1.30	1.92
Anticonvulsants	2OH-carbamazepine	0	0	0
	EP-carbamazepine	NA	NA	NA
	Gabapentin	NA	NA	NA
	Lamotrigine	0.04	0.04	0.06
Antidepressants	Diazepam	0.06	0.11	0.04
	Venlafaxine	NA	NA	NA
Antimicrobials	Enrofloxacin	0	0	0
	Sulfamethoxazole	0	0	0
	Thiabendazole	0	0	0
	Trimethoprim	0	0	0



Main findings and conclusions

- Irrigation with treated Wastewater is a **MUST**;
- Quality of reclaimed wastewater **MUST** be **IMPROVED**;
- Irrigation with treated Wastewater → **exposure** of the Ag ecosystem to various **contaminants of emerging concern**;
- For **mean** and **high exposure** sensations → **no human health concerns were predicted**.
- For the **worst-case scenario**, hazard quotients **indicating possible human health concerns**;
- **What next – Better** Regulation, Treatment & Agricultural practices.



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