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Title: Determination of the water irrigation quality on the heavy metals concentration in agricultural soil and maize cultivated in the Valle del Mezquital, Hidalgo, Mexico

Author: Edgar VÁZQUEZ-NÚÑEZ, Mario HERRERA-TELLEZ

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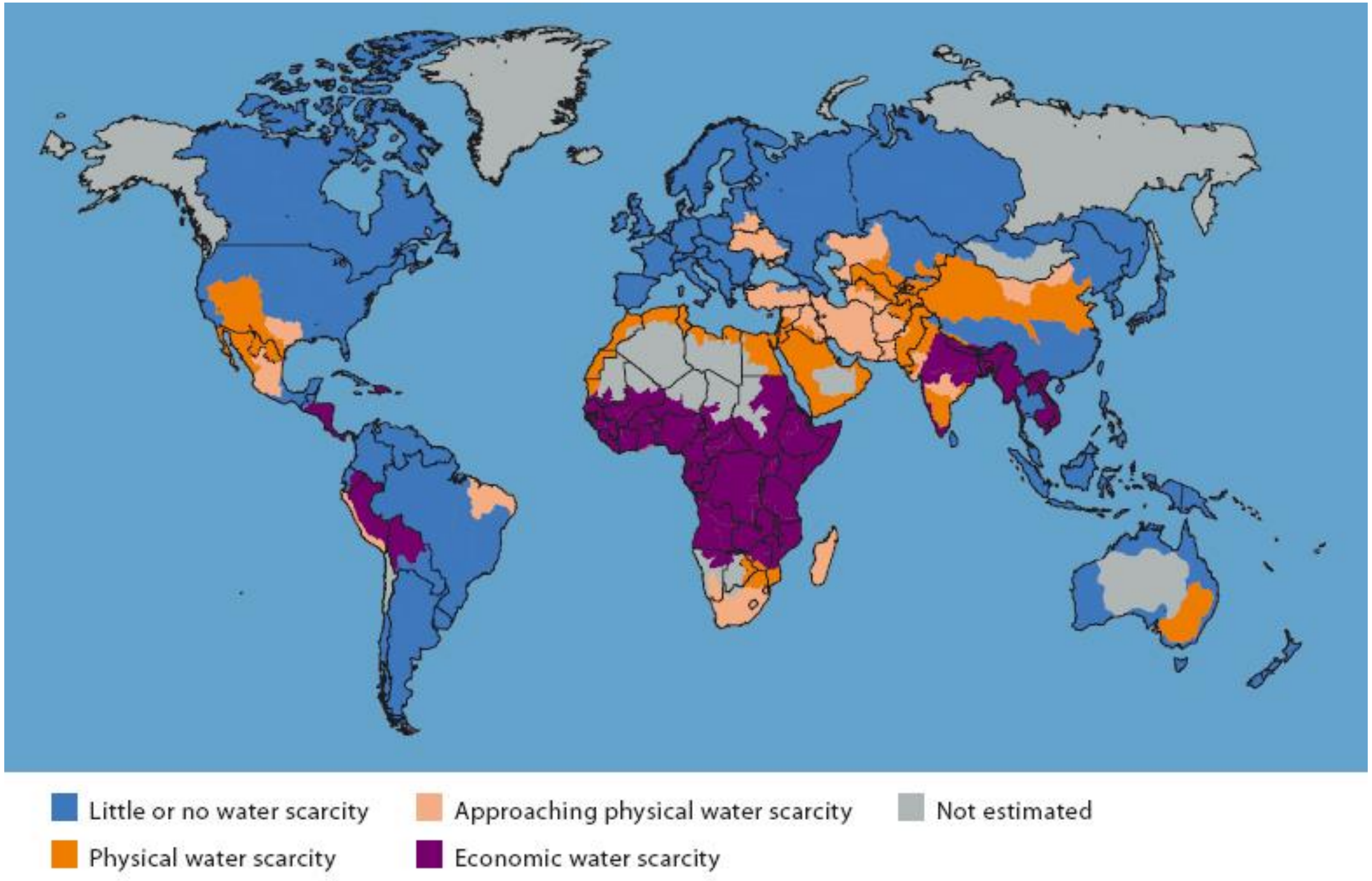
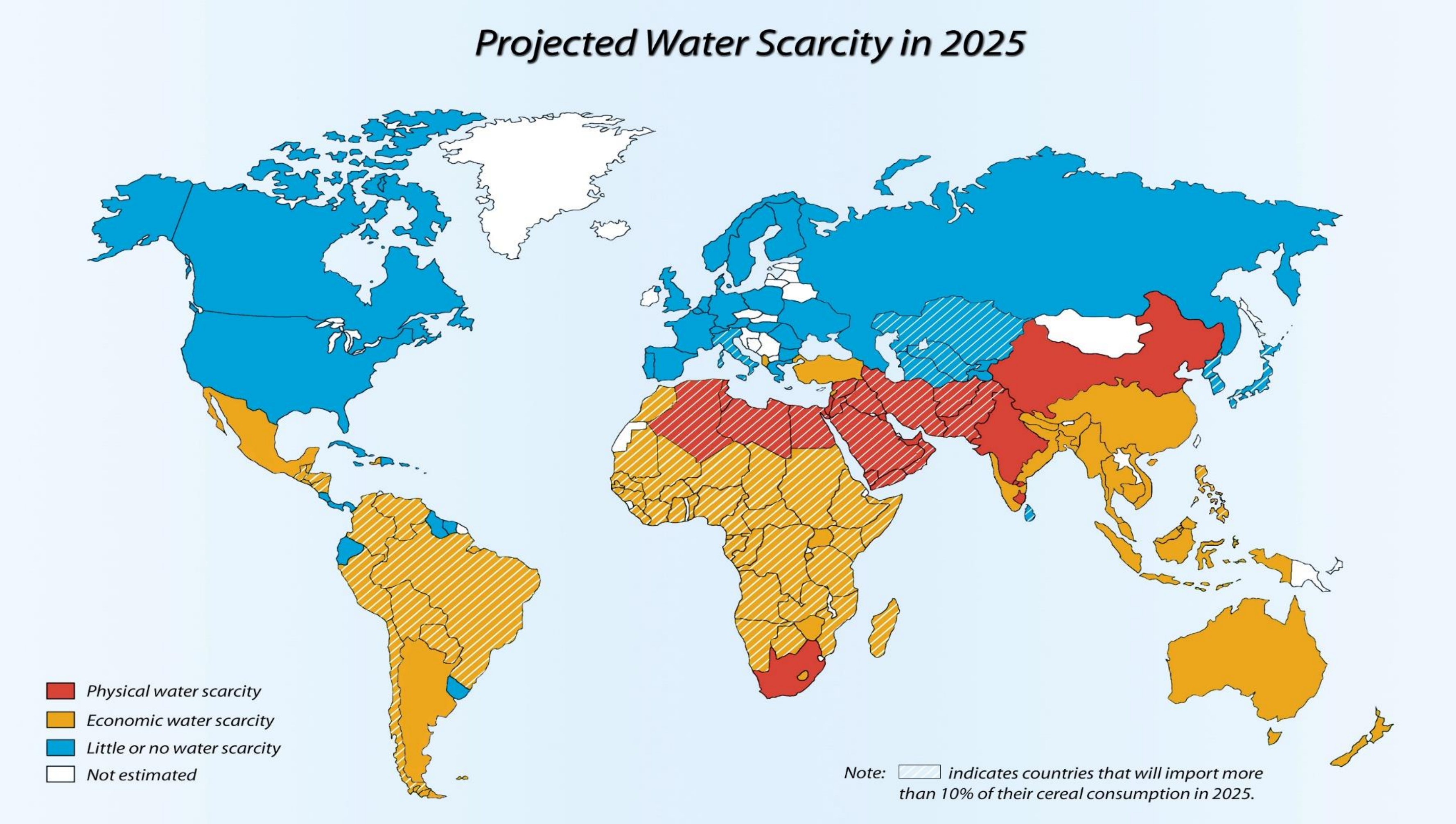
Content

Edgar Vázquez-Núñez*, Mario Herrera Tellez

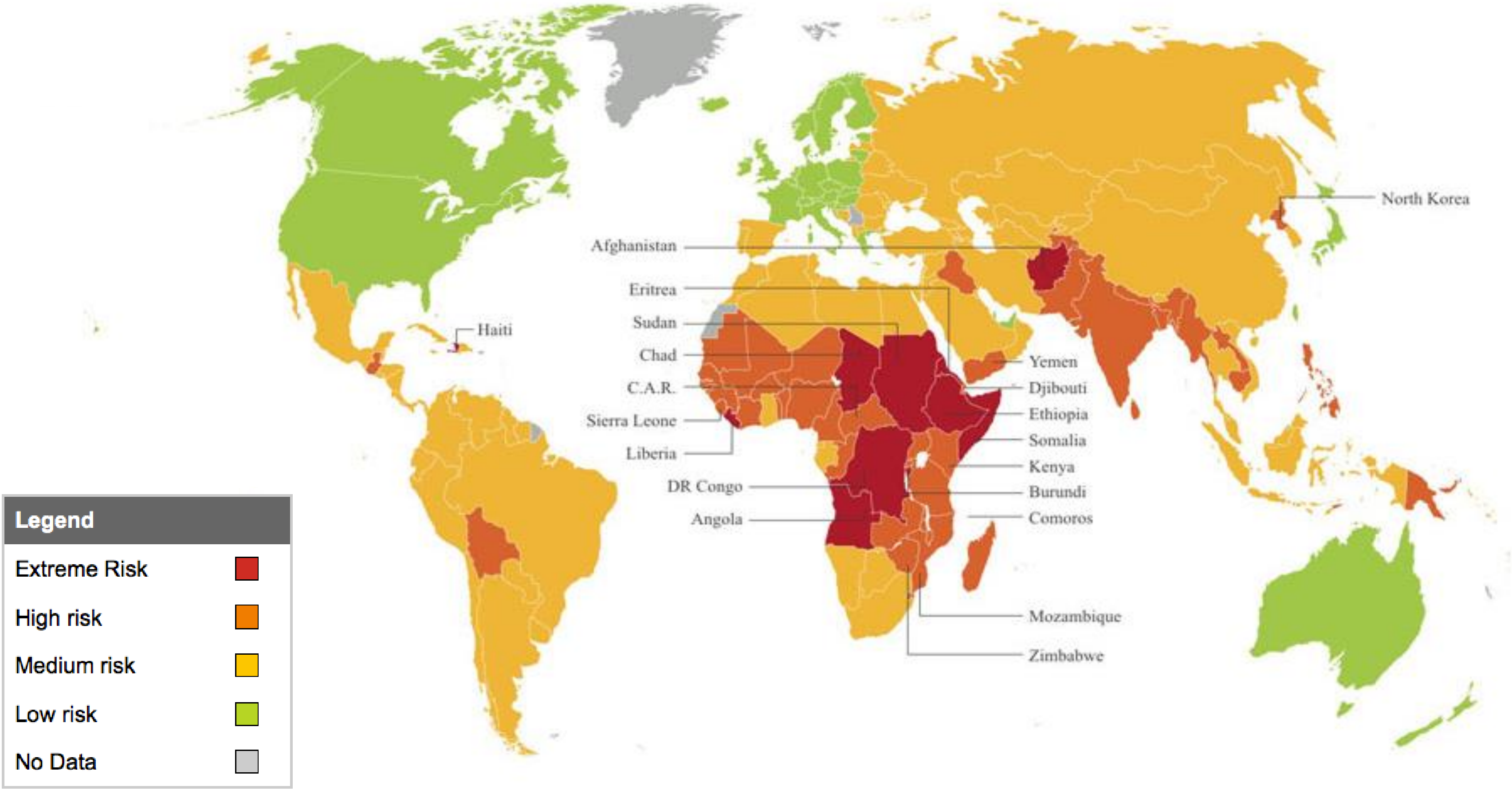
Areas of physical and economic water scarcity





IWMI, 2010; Cosgrove 2014

Food security risk Index - 2011



Maplecroft, 2011; Bernahuer 2012

Factors Influencing Water Scarcity

- Hydrologic Cycle
- Population Growth
- Poverty
- Use Patterns
- Contamination

MEXICO FAST FACTS

Area	Total: 1,964,375 sq.km
Climate	From tropical to desert
Natural Resources	Petroleum, silver, copper, gold, lead zinc, natural gas and timber
Land use	Arable land 12.98%; permanent crops 1.36%, other 85.66% (2011)
Population	116,220,947 (Jul 2013)

Crop production of:

- Sugar Cane
- Corn
- Sorghum
- Wheat
- Bean (**1.04 billion of tons**)

Use of wastewater in agricultural practices

Valle del Mezquital
Mezquital Valley

Cultivated area:
134,000 ha

Antiquity:
91 years in continual operation

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CONAGUA, 2014

Warm humid | Humid | Subhumid | Dry

Average temperature: **16 °C**.

Minimun : **4 °C** – January
Maximun : **27 °C** – April and May

Raining season:
June to September **800 mm** per year

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Irrigation data for the Mezquital Valley

Irrigation Systems	Area (ha) covered ❖	Cultivated ✤	Water Volume (10^6 m^3 a^{-1})
District 03 (Tula)	45,214	55,258	1,148
District 100 (Alfajayucan)	32,118	22,380	651
Private units	5,375	5,450	4,000
TOTAL	82,707	83,088	5,799

❖ Covered area refers to irrigable land with irrigation infrastructure
✤ Cultivated area includes some areas with more than one crop per year

SAGARPA, 2016

Yield * increase due to wastewater, Mezquital Valley

Crop	Untreated water	Natural water	% of Increase
Maize	5	2	**150**
Barley	4	2	**100**
Tomato	35	18	**194**
Oats	22	12	**83**
Chili	12	7	**71**
Alfalfa	20	7	**271**
Wheat	3	2	**50**

*** Yield in Ton ha^{-1}**

Sewage Treatment Plant
Atotonilco, Hidalgo

Plant area 160 ha

Duty 36 m^3/seg

Irrigated area 88,000 ha

Sludge generated 643 ton/ day

CONAGUA, 2012

Question…

What is the effect of wastewater treated on the metals concentration in soil and maize (*Zea mays*) cultivated in an agricultural soil of the Valle del Mezquital?

The aim of this study was to evaluate the effect on the wastewater treatment used for watering maize cultivars on the metals concentration in soil and plant. Cultivars irrigated with non polluted water was used as control

Results

Physical and chemical values for the analyzed soils

Site	EC[a] (ds m^{-1})	pH	WHC[b] (g kg^{-1} soil)	Carbon (mg kg^{-1} soil)		Total N (mg kg^{-1} soil)	Particle size distribution (%)			Textural classification
				Organic	Inorganic		Clay	Silt	Sand	
S1	2.3	7.9	900	23481	1435	2658	350	280	370	Clay loam
S2	2.6	7.5	680	19542	1682	1689	340	290	370	Clay loam
S3	2.1	7.0	735	16580	650	890	300	250	450	Clay loam

S1: soil irrigated with no treated wastewater
S2: soil irrigated with anaerobically wastewater treated
S3: soil irrigated with rainwater
[a] EC: electrolytic conductivity
[b] WHC: water holding capacity

Physical and chemical values for water samples

Water	EC[a] (μmhos cm^{-1})	pH	TSS[b]	VSS[c]	FSS[d]	TDS[e]	Turbidity (NTU)	COD[f] (mg L^{-1})	Total N (mg L^{-1})	Total P (mg L^{-1})
			(mg L^{-1})							
NTR-W	0.93	7.4	190	128	62	0.53	265	348	36.5	9.5
ADG-W	0.69	7.6	36	24	12	0.47	48	150	17.8	6.5
CTR-W	-	6.4	-	-	-	-	-	-	-	-

NTR-W: no treated wastewater
ADG-W: anaerobically digested water
CTR-W: rainwater
[a] CE: electrolytic conductivity
[b] TSS: total solved solids
[c] VSS: volatile suspended solids
[d] FSS: fixed suspended solids
[e] COD: chemical oxygen demand

Determined values for soil, maize and water samples

Sample	B	K	Cr	Cd	Cu	Fe	Mn	Ni	Zn	Pb
					mg $kg^{-1} ds^{*}$					
S1	139.4	125.1	45.6	2.5	17.3	20159.5	451.7	23.4	61.7	7.5
S2	126.2	158.3	32.5	1.9	9.8	14769.4	326.8	12.3	38.2	4.2
S3	354.5	251.7	ND	ND	2.7	19860.2	344.4	16.3	40.2	ND
					mg $kg^{-1} db^{**}$					
Mz-S1	4.2	35.2	5.2	2.1	7.2	72.3	134.0	3.2	45.2	ND
Mz-S2	3.8	43.7	8.0	ND	4.3	89.4	82.6	7.7	87.6	ND
Mz-S3	3.5	39.8	ND	ND	6.7	82.1	79.5	7.0	35.1	ND
					mg L^{-1}					
NTR-W	0.52		0.022	0.0034	0.014	1.5	.05	.21	.64	0.32
ADG-W	0.32		0.025	0.0042	0.004	0.65	0.10	0.003	0.113	0.12
CTR-W	1.2	15	ND	ND	ND	4.0	21	ND	ND	ND

M2-S1: maize irrigated with non treated wastewater
Mz-S2: maize irrigated with anaerobically digested wastewater
Mz-S3: maize irrigated with unpolluted water
*ds: dry soil
**db: dry biomass

Conclusion

The irrigation with wastewater of agricultural soils in the Valle del provides high amounts of organic matter (C and N), showing positive effects in terms of high crop yields and reducing costs by eliminating the use of fertilizers, however at long term it could bring negative effects by increasing salinity and compaction in soils.

the concentration of heavy metals in the irrigation water did not exceed the limits according to the Mexican environmental standards; however, the application for long time could increase the concentration in the soils, affecting the future of crop production.

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University of Guanajuato

Edgar Vázquez-Núñez*, Mario Herrera Tellez

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