

The Water Evaporates and the Salt Does Not, So Even Drinkable Water Kills the Land

— irrigating with water at **500** mg/L, drinkable, at **1000** mm a year leaves **5.0000** t of salt per hectare each year
— the crop limit of **0.5** per cent is reached in exactly **14** years — without drainage, better water only buys time
— [Paper 408]

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— *From thinking to syncing.* —

Abstract

Salinisation sounds like something that follows from using salty water. This paper shows that drinkable water does it too—the single fact that salt does not evaporate reaches the limit in 14 years. No new theorem or law is claimed. First, water at 500 mg/L applied at 1000 mm a year brings **5.0000** t of salt onto a hectare (Section 2). Second, the water leaves by evaporation and the salt does not leave at all (Section 1). Third, and this is the core of the paper. A one-metre root zone weighs 14000 t, so after 50 years the soil is **1.7857** per cent salt (Section 2). Fourth, the crop limit of 0.5 per cent is reached in exactly **14** years (Section 3). Fifth, halving the salinity of the water only doubles the number of years. Without drainage nothing stops (Section 4). Sixth, the separator is whether there is an exit or not (Section 5).

Scope of this paper (scope note): No new theorem or law is claimed——salt accumulation under irrigation, the leaching fraction and crop salt tolerance are all known in soil science.No agriculture is designed——cropping and irrigation schedules are not given. Only one mass balance.No soil chemistry is built——ion exchange, precipitation and sodicity are not the subject. Only the balance of total salt.The crop limit is not claimed——0.5 per cent is representative and varies greatly with crop and salt.Groundwater is not treated——capillary rise from a rising water table is not the subject, and it works in the direction of hastening the outcome.Rainfall is not included——natural leaching by rain is ignored, being small in arid regions.Relation to earlier papers: Paper 386 showed that solubility and dissolution rate are different-root——here the water balance and the salt balance are different-root.Paper 395 showed that sound is trapped——here salt is trapped.Paper 389 showed that length, not thickness, is what binds——here the presence of an exit, not the water quality.Paper 300 showed that same-root and different-root can be decided——the water budget and the salt budget are different-root by that criterion.What is added is putting a number on the annual salt load, giving the soil salinity at three elapsed times, bracketing the year at which the limit is reached, showing that better water only extends the time, and placing the separator at “exit or no exit”.

1. Notation and the Question

Setting: apply water of salinity c to a field of area A at a depth I . The annual salt input is

$$M = c I A$$

Take $c = 500$ mg/L, $I = 1000$ mm a year and $A = 1$ ha. Take the root zone as 1 m deep at a bulk density of 1400 kg/m³.

Observation 1.1

water has two exits.Evaporation and drainage——salt has only one.

Observation 1.2

evaporation removes only the water.The dissolved salt stays——distillation, happening every day in a field.

Observation 1.3

so without drainage the salt only accumulates. Input with no output——what matters is the accumulated amount, not the concentration.

Question: how salty must the water be for salinisation to occur?

2. Even Drinkable Water Brings Five Tonnes a Year

Computation 2.1: irrigating one hectare with water at 500 mg/L (computed in this paper).

Years	Accumulated salt [t/ha]	Soil salinity [%]
1	5.0000	0.0357
10	50.0000	0.3571
50	250.0000	1.7857
100	500.0000	3.5714

Observation 2.2

this is the core of the paper. Water at 500 mg/L is drinkable——and still brings five tonnes of salt onto a hectare each year, reaching 1.7857 per cent soil salinity in fifty years.

Observation 2.3

a one-hectare root zone one metre deep weighs 14000 t. The denominator——250 t is 1.79 per cent of it.

Observation 2.4

a century reaches 3.5714 per cent. Sea water is about 3.5 per cent salt——the field would hold, as dry salt, the same fraction the sea holds dissolved.

Observation 2.5

salinity is exactly proportional to the years.From 0.0357 to 3.5714 in a straight line—with no saturation and no plateau.

Observation 2.6

the concentration acts only on the rate of input.It does nothing to stop it—however dilute, the limit is reached eventually.

3. The Limit Is Reached in Exactly Fourteen Years

Computation 3.1: near the crop limit of 0.5 per cent (computed in this paper).

Years	Soil salinity [%]	Against the 0.5 % limit
13	0.4643	below
14	0.5000	exactly
15	0.5357	above

Observation 3.2

the boundary is bracketed from both sides.0.4643 at thirteen years, 0.5357 at fifteen—exactly 0.5000 at fourteen.

Observation 3.3

that is within one working life of farming.Fourteen years—the person who cleared the land sees it turn white.

Observation 3.4

0.5 per cent is a representative figure. It varies greatly by crop——what does not move is that the accumulation is proportional and that the limit is eventually passed.

Observation 3.5

a rising water table makes it faster. Capillary rise brings salt from below——this estimate does not include it.

Observation 3.6

the same shape has recurred historically. The shift from wheat to barley in Mesopotamia——this paper does not argue history, but the shape is the same.

4. Better Water Only Buys Years

Observation 4.1

halve the salinity and the annual input halves. 2.5 t/ha——and the limit arrives in twenty-eight years.

Observation 4.2

a tenth of the salinity gives 140 years. Longer than a working life——and still not stopped.

Observation 4.3

water quality postpones the problem. It changes a constant of proportionality——it does not solve it.

Observation 4.4

solving it requires giving the salt an exit. Drainage, that is, leaching—to hold the soil at c times the water's salinity, drain a fraction $1/c$ of the applied water.

Observation 4.5

a factor of two needs a half, a factor of five a fifth. The leaching fraction—extra water, above what the crop uses, applied in order to be thrown away.

Observation 4.6

the shape is that of Paper 389. There length rather than thickness was what bound—here the exit rather than the water quality. In both, the easier thing to fix is not the one that acts.

5. Separator: Is There an Exit or Not

Observation 5.1

separator—is there a path by which salt leaves, or none.

Condition	Salt outflow	Long-run salinity	Remedy
With drainage	yes	settles at a value	leaching fraction $1/c$
Without drainage	no	diverges	water quality cannot solve it

Observation 5.2

the second row is only a question of time. It grows proportionally—“still fine” does not mean fine indefinitely.

Observation 5.3

the first row reaches a steady state. Input balances output—and only there does the water quality set the final salinity.

Observation 5.4

this separator can be tested. Measure the salinity of the drainage—compare what comes in with what goes out.

Observation 5.5

to be honest—both 14 years and 1.7857 per cent are a balance ignoring rainfall, groundwater and ion exchange. The real number of years will differ—what does not move is that salt does not evaporate and that without an exit the accumulation grows linearly.

Observation 5.6

one last thing—“use better water” has the shape of a remedy without being one. It lowers a rate—reducing the inflow and creating an outflow are different things.

6. Roll Call and Closing

1. Two exits for water, one for salt (Observation 1.1): evaporation carries only water.
2. 5.0000 t/ha a year (Computation 2.1): from drinkable water.
3. The root zone weighs 14000 t (Observation 2.3): the denominator.
4. 1.7857 per cent after 50 years (Computation 2.1): a lifetime and a half.
5. 3.5714 per cent after 100 (Observation 2.4): the salinity of sea water.
6. The limit at exactly 14 years (Computation 3.1): bracketed by 13 and 15.
7. Half the salinity, 28 years (Observation 4.1): only a postponement.
8. A tenth, 140 years (Observation 4.2): still not stopped.
9. The leaching fraction is $1/c$ (Observation 4.5): extra water is required.

10. The exit is what acts (Observation 5.1): not the water quality.

Closing: salinisation sounds like something that follows from using salty water—but drinkable water does it too. Water has two exits, evaporation and drainage; salt has only drainage—evaporation removes only the water and the dissolved salt stays: distillation, happening every day in a field. So without drainage the salt only accumulates, and what matters is the accumulated amount rather than the concentration. Water at 500 mg/L is drinkable—and irrigating one hectare with it at 1000 mm a year brings **5.0000 t** of salt each year. A one-hectare root zone one metre deep weighs 14000 t, so fifty years give **1.7857** per cent and a century **3.5714** per cent—the same fraction sea water holds dissolved. The salinity is exactly proportional to the years, with no saturation and no plateau: the concentration acts on the rate of input and does nothing to stop it. The crop limit of 0.5 per cent is reached in exactly **14** years—bracketed by 0.4643 per cent at thirteen years and 0.5357 at fifteen. That is within one working life: the person who cleared the land sees it turn white. A rising water table makes it faster still, and this estimate does not include capillary rise. Better water only buys years—halve the salinity and the limit arrives in twenty-eight years; take a tenth and it is 140 years, longer than a working life and still not stopped. Water quality changes a constant of proportionality and postpones the problem without solving it. Solving it requires giving the salt an exit: to hold the soil at c times the water's salinity, drain a fraction $1/c$ of the applied water—a half for a factor of two, a fifth for a factor of five, applied above what the crop uses in order to be thrown away. As in Paper 389, the easier thing to fix is not the one that acts. One thing does the separating—is there a path by which salt leaves, or none. With drainage, input balances output and a steady state is reached; only there does the water quality set the final salinity. Without drainage the salinity diverges and water quality cannot solve it. The second case is only a question of time, and “still fine” does not mean fine indefinitely. It can be tested: measure the salinity of the drainage and compare what comes in with what goes out. To be honest—both 14 years and 1.7857 per cent come from a balance ignoring rainfall, groundwater and ion exchange, and the real number of years will differ. What does not move is that salt does not evaporate and that without an exit the accumulation grows linearly. One last thing—“use better water” has the shape of a remedy without being one. It lowers a rate. Reducing the inflow and creating an outflow are different things.

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