Fate and Transport of Chloride Derived From Surface Releases

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Research

- API and Rice Operating Company sponsored an evaluation of chloride (brine) migration from the vadose zone to ground water
- The results of this study showed that computer simulations may be used to justify environmental response actions: site remedies, general closure protocols, or new regulatory initiatives

Purpose and Scope

- Predict impact to ground water quality resulting from surface chloride releases
- Evaluate soil flushing as a surface restoration approach
- Verify model predictions with field data from Lea County
- Simulated more than 2000 different scenarios (Hobbs and Shreveport)

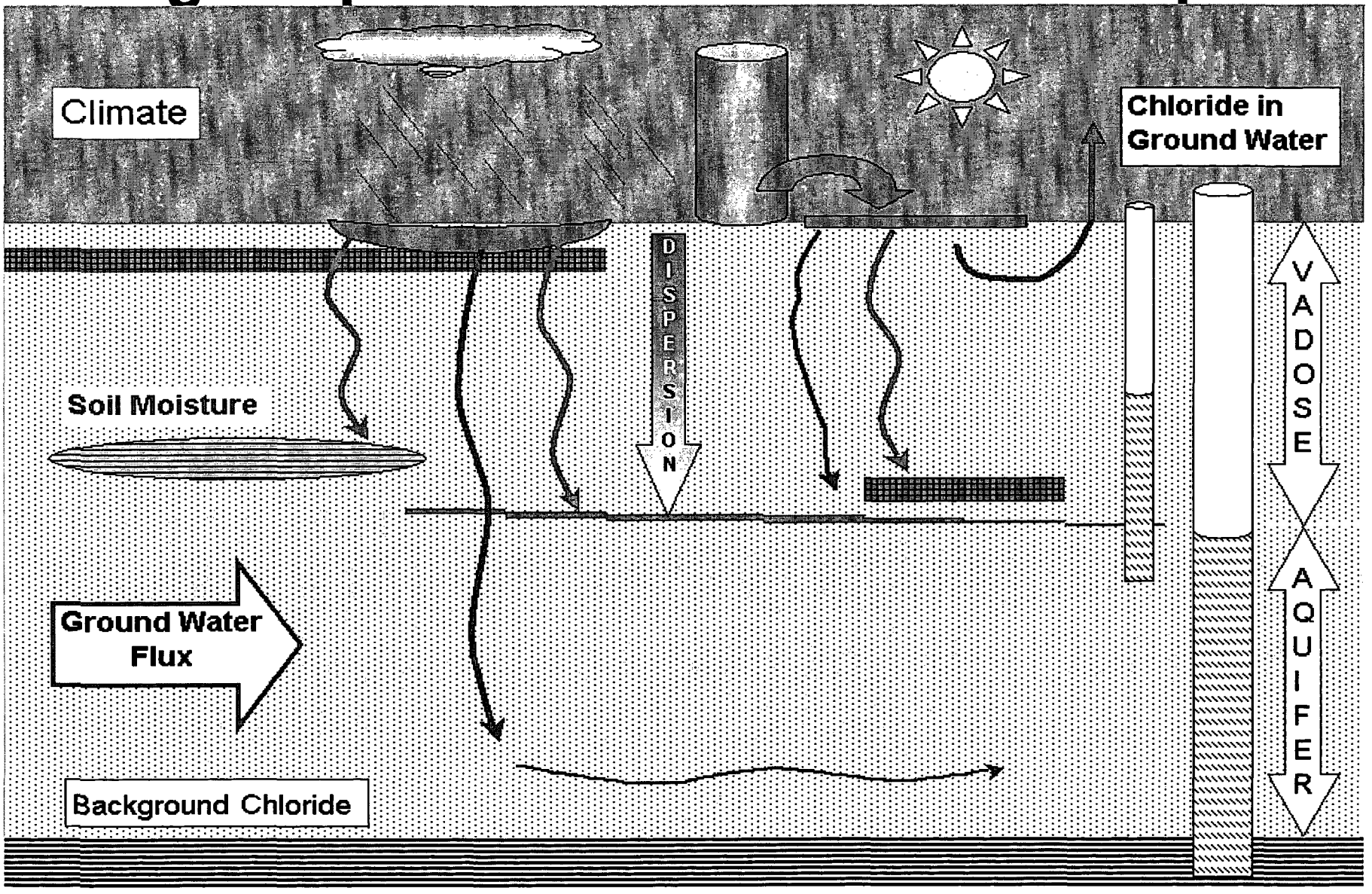
Approach- HYDRUS 1D

- Public domain code
- Successfully used throughout the world
- Employs daily weather data
- Permits heterogeneous profiles (clay, caliche, sand layers)

Approach – Ground Water Mixing Model

- Uses the chloride flux at the bottom of the vadose zone (from HYDRUS) in a simple mixing model
- Assumes a water well at down gradient edge of spill and no vegetation on spill site
- Simple, quick, and conservative
- Validated with MODFLOW simulations

Eight Input Parameters and the Output



Expected Conclusions

- More water recharge yields greater downward chloride movement– more migration in Shreveport than Hobbs
- More clay, thicker vadose zones, or thicker aquifers means less impact to ground water
- Clay at or near the ground surface prevents downward chloride movement

Unexpected Modeling Conclusions

- Soil chloride concentrations many times higher than 250 ppm (NMOCD recommendation) rarely result in ground water impairment
- The volume released is not important – the mass released per unit area is important.
- Flushing chloride from the root zone with water can improve ground water quality
- Simulations run for more than 600 years found no downward movement where shallow clay exists in arid climates

Chloride Migration

- Chloride is a "conservative tracer" it does not degrade nor does it sorb to soil – it moves at the same velocity as water
- Petroleum hydrocarbons sorb to the soil and/or degrade to carbon dioxide and water within a relatively short distance from a release
- If modeling shows that chloride will not migrate then petroleum hydrocarbons will not migrate to ground water

Application of Research to Pits

- Periodic and long-term discharges of brine (and other materials) to unlined pits can cause localized impairment of water-table aquifers
- Computer simulations may be employed to predict a threat to ground water quality posed by restored pits
- Computer simulations can be employed to predict threat to surface soil

Application of Research to Pits

- Reserve/drilling pits contain fine-grained cutting and bentonite clay buried close to the ground surface
- We simulated clay horizons near the ground surface, like a restored pit
- In arid climates, we found that chloride (or benzene or any constituent) migrated upward, not to ground water
- Surface restoration may be difficult under current NMOCD and BLM pit restoration guidelines

Conclusions

- Unlined disposal pits can cause localized environmental impairment under certain conditions
- Properly closed pits, with residual material left in place, pose no threat to human health or the environment
- Temporary drilling/workover pits pose no threat to ground water quality – but closure guidelines need revision to hasten surface restoration