Sources and fate of nitrogen in the southern San Joaquin Valley floor

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The content of nitrogen, and nitrate in particular, of some ground- and surface-water supplies is of much concern because of the potential health hazard to infants (methemoglobinemia) and to livestock. It also may contribute to the eutrophication (over-enrichment) of surface bodies of water and may delay the ripening of certain fruits, vegetables, and other crops.

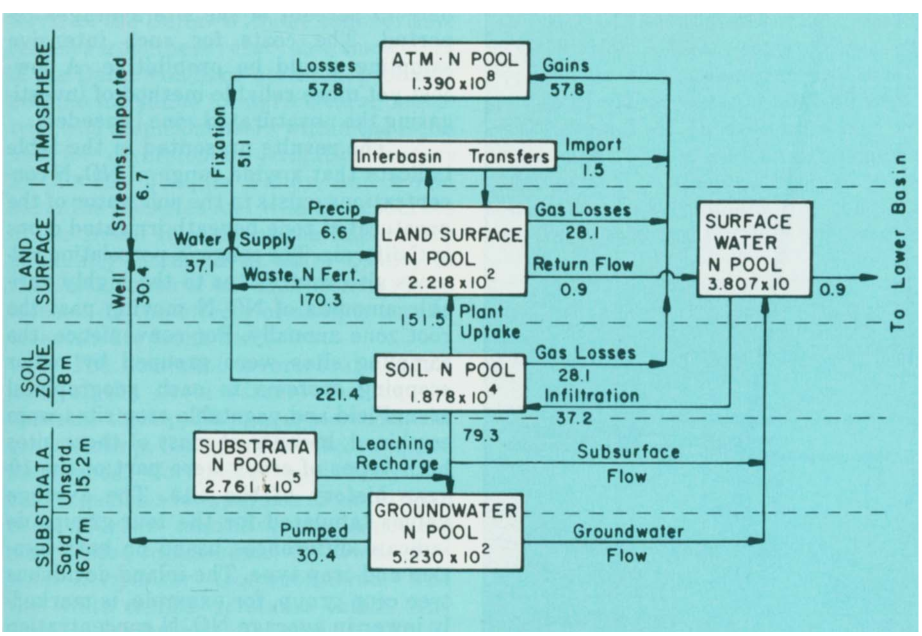
Nitrogen has accumulated in some ground waters and soil profiles as the result of nitrates from native deposits and from normal decomposition of organic matter. Man's activities are a relatively new cause of nitrogen contamination from such sources as industrial and domestic sewage effluent, nitrogen fertilizer residues, and animal wastes from large cattle feeding and dairy operations.

The agricultural industry often has been singled out as a major contributor of excess nitrogen in the environment. However, a closer look at nitrogen fertilization and associated agricultural practices may more accurately assess agriculture's contribution to potential nitrogen pollution of our water supplies.

Findings from field studies in the southern San Joaquin Valley show some evidence that man-controlled urban and agricultural practices do have an impact on the nitrogen content of waters there. One study by the California Department of Water Resources (DWR) reported that variability of nitrogen content in effluent appeared to depend more on the soil series and geographical location of the tile systems than on agricultural practices. In another study, however, the DWR found greater amounts of nitrogen discharged in drainage water from fertilized plots than from nonfertilized ones. These conflicting results may be partly attributed to the difficulty of differentiating native soil N from applied N, and the comparatively short time that tile drainage has been practiced in this valley. The DWR studies also found that denitrification in the soil apparently reduces the amount of nitrogen found in tile drainage effluents.

The Fresno ground-water recharge research center of the U.S. Department of Agriculture reported greater nitrate content of ground waters under an urban area than under the surrounding agricultural zone. However, over an 18-year period the nitrate under the agricultural zone increased at a faster rate than under the urban zone. In a different study, they found that soil-nitrate concentrations below crop root zones and nitrate contents of the ground water were closely related and were associated with crop type and nitrogen management.

A more extensive survey was recently conducted in the southern portion of the San Joaquin Valley by the U.C. Department of Land, Air, and Water Resources. Typical nitrogen concentrations were obtained from many nitrogen analyses of water samples taken from wells and surface waters in the area. Similar data were obtained from numerous soil analyses. Volatilization and denitrification, fixed N and precipitation, crop uptake, and residual N were estimated according to the rationale used in similar studies. Mineralization of native soil N (organic matter) was considered in the soil nitrogen pool. These nitrogen values, along with estimated annual volumes of pumped water, streamflow, return flows, and soil and crop data, were used to evaluate where the nitrogen comes from and where it goes.



Nitrogen pools and fluxes within a 1,771,750-hectare unit in the lower San Joaquin Valley, based on the 1971 level of development. Masses of nitrogen in the pools and the numbers near the pathways that represent fluxes of nitrogen between various pools are in thousands of metric tons per year.

The flow chart demonstrates that the sources of N are manifold and the transfer pathways are exceedingly complex. The soil N pool is particularly important, because this portion of the environment receives much of the N loading. The fate of nitrogen in the soil is determined to a large degree by the amounts recycled back to the land surface by plant uptake and to the atmosphere by gaseous losses. The remainder is subject to leaching losses to surface- and ground-water bodies.

Of this remainder, the analysis indicates that the major sources of N contributed to water bodies are fertilizer residues (45%), applied water (19%), N fixed from the atmosphere (13%), industrial wastes (10%), animal wastes (6%), municipal wastes (5%), and rainfall (2%). More important is how these excesses are disposed of—through point or nonpoint discharges. A large source, such as N fertilizer residue, when spread over a large surface area may not contribute as much to the level of concentration as other waste disposed of in a smaller area.

It appears that N will accumulate in certain portions of our environment (geosphere, hydrosphere, atmosphere, biosphere) when nitrogenous wastes are disposed of or applied in such quantities as to overload nature's capacity to degrade and consume nitrate. The cycle of synthesis, consumption, harvest, excretion, and decay of nitrogen is at a delicate balance, and we are challenged to manage our resources so as to minimize pollution of the environment.

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