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Feedlots and Pollution—A Growing Threat to Water Resources of Agro-Production Zone in Argentina

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Beef cattle feeding operations or feedlots are known to generate large accumulations of manure in feedlot pens, manure storage areas, effluent storage lagoons, and manure amended soil. These areas may act as punctual pollution sources for surface and groundwater if they are not properly designed and managed. At present, the great development of this activity in the humid region of Rolling Pampa (Argentina's agro-productive area) jeopardizes essential water resources in the region.[1]This plain reaches 30 m above sea level and it is located in hilly landscape among numerous water courses such as rivers, valleys, and ditches. In addition, two of the most polluted rivers in the world, Reconquista and Matanza-Riachuelo, are part of this region which has a high population density.[2] The growing presence of feedlots in the upper basins of these rivers means a severe threat, because it increases pollutant levels in this already damaged system.

The main manure exportation processes are infiltration and surface runoff. In feedlot pen soils, 68% of rainfall water runs off across the feedlot surface and a lower percentage is infiltrated in the soil, reaching the water table.[3] The composition of the runoff solution manure or effluent (dissolved organic matter, high concentrations of nutrients such as nitrogen (N) and phosphorus (P), salts, nonsteroidal hormones, heavy metals, and pathogens) explains why feedlots are considered as point sources of water pollution.

Effluents collected immediately after a rain event in holding ponds (our current research issue), mostly contain nitrogen in its reduced states and phosphorus as soluble phosphate. The concentration of organic nitrogen (org-N), ammonia (NH_4^+-NH_3) and total phosphorus (PT) exceed water quality guidelines (Argentine law 389/98 almost equivalent with Canadian CCME guidelines) by a large magnitude (6.8; 5.1 and 59.3 folds, respectively). Nitrogen and phosphorus are the nutrients in manure of most concern because they can cause eutrophication of surface water and nitrate (NO_3^-) can leach into groundwater. Furthermore, the high value of BOD and COD obtained, which far exceeded the limits for its discharge into surface water (35.91 and 43.2 folds, respectively) and by absorption soil (18.0 and 10.8 folds, respectively), indicates that it is necessary to carry out a waste-treatment process. Another important aspect of this issue is biological contamination. Feedlot runoff has significantly higher concentration of fecal streptococci and enterococci microorganism than extensive lowland production systems, which used to be the predominant cattle system up to feedlots' arrival.[4]

Although soils in the Rolling Pampa plain are deep, well developed and often relatively impermeable due to presence of a textural B horizon of great thickness, accumulation of solid manure and effluents could lead to groundwater pollution. Published evidence shows that groundwater pollution is closely linked to particular characteristics of the manure-soil interface which reduces substantially soil moisture flux and manure solution leaching. Field tests in sandy loam texture soils have shown that the manure−soil interface is thin (approximately 2 mm thick) and highly compacted, protecting the soil below.[3] However, contaminants can move through the soil matrix by diffusion or beyond preferential paths, reaching the underlying aquifers across the interface. This is common in wet climate soils, with high clay content such as Typic Argiudoll, which are frequent in this region.

The main groundwater resources are Puelche and Epipuelche aquifers. The former is semi confined, located in the "Puelche Formation" or "Puelche Sands", characterized by medium to fine-grained quartzose sands, of fluvial and marine origin. Epipuelche is above this stratum, consists of brown and dark reddish clayey and sandy silts, rich in calcium carbonate in the shape of concretions and layered beds. This sediment belongs to the Pampeano Group which comprises two formations. Ensenada Formation is older whereas Buenos Aires Formation is younger. The latter includes phreatic water (Figure 1). The Epipuelche aquifer is recharged by direct infiltration of rainfall and is recharge source of Puelche aquifer when its water potential is greater. Therefore phreatic water pollution indicates a potential risk of pollution from deeper aquifers. In our current

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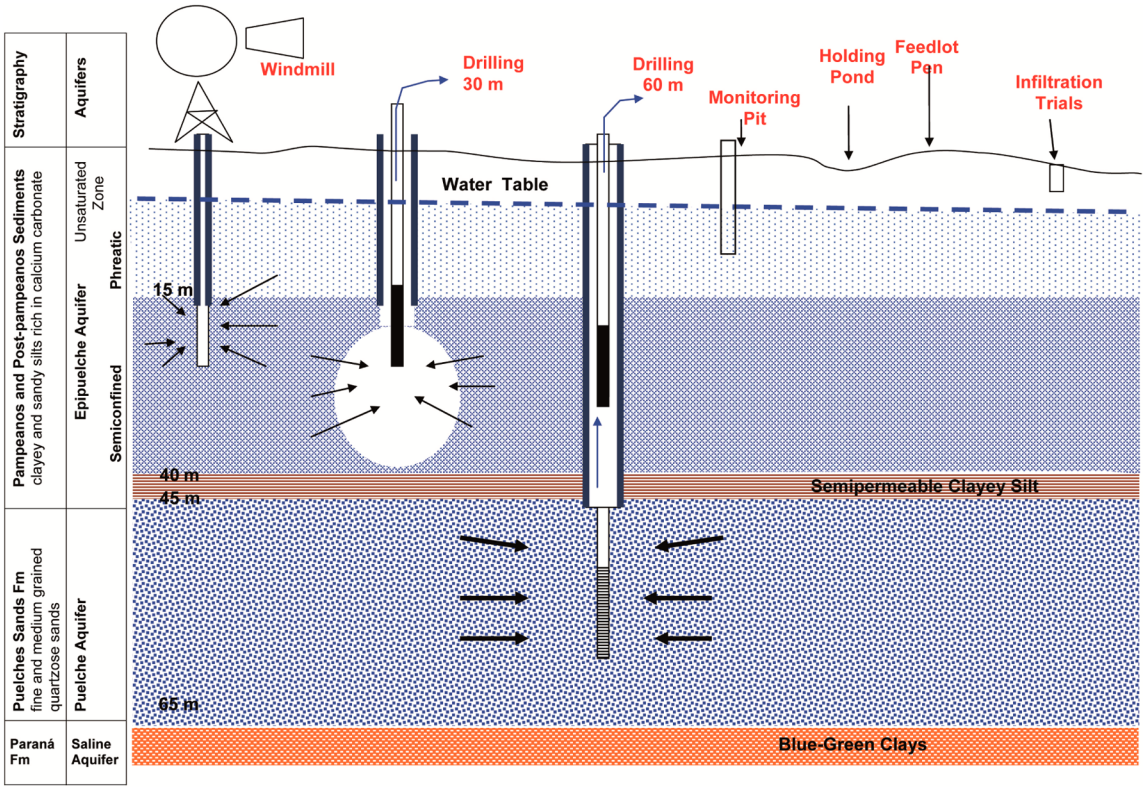

Figure 1. Hydrogeologic profile and perforations carried out for water feeding and quality control in a region feedlot.

research, we have found extremely variable (5.23−135 mg·L^{-1}) concentrations of nitrate (NO_3^-) in water table underlying the feedlot. The average value significantly exceeds (3 fold) the value obtained in agricultural fields in the area, and quite often, the proposed guideline value for drinking water quality (45 mg·L^{-1}). Phosphorus shows a similar behavior to NO_3^-, with variations in groundwater between 90 and 9210 μg·L^{-1}, significantly higher than those recorded in agricultural fields. The hydrochemical of the mentioned underlying aquifers (Epipuelche and Puelche) does not show variation by feedlot use. This may vary by changes in the direction of the underlying flux resulting from its overexploitation.

Variations in the quality of phreatic water constitute an early warning about contamination of both aquifers and water courses of discharge areas. Thus, it may be conclude that in spite of favorable soil conditions, other actions must be designed in order to protect surface and groundwater in this Argentine region. Otherwise, an essential resource for its economy and society will be seriously threatened.

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Notes

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