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LIVESTOCK FACILITIES AND POLLUTION OF WATER RESOURCES IN VENEZUELA: CURRENT STATUS

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SUMMARY

The main objective of this paper was to analyze the current status of the relationship between livestock facilities in Venezuela and the pollution they can cause to water resources used for human or animal consumption. Briefly, it is informed about the geographic and economical situation in Venezuela, and about the high risks of ecosystems contamination with products derived from the oil industry and from the uncontrolled use of pesticides, either for agricultural or animal practices. It is underscored that countless laws and decrees have been approved in Venezuela with the aim of protecting and defending the environment, nonetheless, in the daily practice these laws are not applied and most ecological crimes go on with impunity. In general, uncontrolled runoff from livestock facilities are discharged into rivers or lakes without treatment, which leads to high levels of water pollution mainly with pesticides and fertilizers. In addition, pathogenic microorganisms, carried out for those runoffs, can potentially infect either humans or animals, with high risk for their health. Finally, so far none Venezuelan city has a sewage-treatment plant working to treat the used waters before dumping them into a water resource, nonetheless it was recently started the construction of two Sewage Treatment Plants in Carabobo and Aragua States respectively, with the aim of cleaning waters of Valencia Lake.

Key Words: Livestock facilities; water pollution; legislation; pathogenic agents.

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INSTALACIONES GANADERAS Y CONTAMINACIÓN DE RESERVORIOS DE AGUA EN VENEZUELA: ESTADO ACTUAL

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RESUMEN

El objetivo central de este trabajo fue analizar e informar sobre la relación entre las instalaciones dedicadas a la ganadería bovina en Venezuela y la contaminación que le pueden ocasionar a ríos y reservorios de agua, usados para consumo humano o animal. Se informa brevemente sobre la situación actual geográfica y económica de Venezuela así como sobre los altos riesgos existentes de contaminación de los ecosistemas por derivados de la explotación petrolera y por el uso indiscriminado de pesticidas, tanto para uso agrícola como pecuario. Se resalta que en Venezuela hay numerosas leyes y decretos aprobados con el propósito de proteger y defender el medio ambiente, no obstante, estas legislaciones en la práctica no son aplicadas y por lo común hay impunidad cuando se cometen delitos ecológicos. Se notifica que las aguas de correntías que se originan en fincas ganaderas y en cultivos agrícolas, generalmente son descargadas a los ríos o lagos sin pretratamiento ni control, lo cual conduce a elevados niveles de contaminación del agua con pesticidas y fertilizantes y a que agentes patógenos, transportados por esas aguas, puedan potencialmente infectar a los humanos o a animales, poniendo en peligro la salud. Finalmente, prácticamente ninguna ciudad de Venezuela tiene en funcionamiento una planta de tratamiento de aguas servidas antes de ser lanzadas estas aguas a ríos o lagos, aunque recién se han iniciado los trabajos de construcción de Plantas de Tratamiento de Aguas Residuales ubicadas en el Estado Carabobo ("La Mariposa" y "Los Guayos") y en el estado Aragua ("Taiguaguay") con fines de saneamiento de las aguas del Lago de Valencia.

Palabras clave: Ganadería; contaminación del agua; legislación; agentes patógenos.

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INTRODUCTION

Venezuela is located in the northern part of South America facing the Caribbean Sea, it has an area of 916,455 Km^2 and a population of 26 million inhabitants, 40% of these live in urban areas (Almanaque Mundial 2004). The country shows a rich variety of ecosystems from snow capped mountains in the Andes Range to the hot and humid Llanos or lowland plains, a region located in the central and eastern states which has numerous rivers and wetlands on a surface of 280,000 Km^2. In addition, Venezuela has numerous rivers including the mighty Orinoco River which is the 8^{th} longest river of the Americas with 2,740 Km, and two main lakes Maracaibo (13,500 Km^2) and Valencia (375 Km^2), the last one being a closed basin surrounded by industrial, agricultural and urban areas.

The Venezuelan economy is largely based on the oil extraction, the country is the 5^{th} largest oil exporter of the world, and the oil industry has had a significant impact on the pollution of the environment around the oil fields (http://www.monagasdigital.com). Around 90% of the population is located in a central-north-eastern strip with cities like Valencia, Maracay, Caracas, Puerto la Cruz, and Cumaná where the daily demand of fresh water is quite higher. Partially due to this fact, in the last four decades governments were motivated to build several dams not only as a source of drinking water, but also for power generation and agricultural uses (see Quare).

Actually, the lifetime of several of these dams has been shortened due to the daily discharge of silt and sediments. In general, dams kill a river's ecosystem by cutting off its flow, and it has been demonstrated in several countries, e.g. Brazil, China, Egypt, and Venezuela, that after a dam is built some endemic diseases like schistosomiasis increase their incidence and spread into new endemic areas (Hunter *et al*., 1993; Bergquist, 2002). In the Venezuelan case and since 1940, the construction of numerous dams has also led to the flooding and destruction of valleys, forests, agricultural fields, and to the disappearance of several villages.

In Venezuela the agricultural activities are carried out on 30,071,191.77 hectares (74,275,863.25 acres) (37% agriculture, 18% cattle and 9.3% mixed) which are dedicated mainly to the

cultivation of rice, corn, sorghum, coffee, cacao, sugar cane, tobacco, horticulture and fruits (República de Venezuela. OCEI, 1998). In addition, the total cattle population is estimated in 13,056,023 heads with 60% of the population concentrated in four States: Zulia, Barinas, Guárico and Apure (República de Venezuela. OCEI, 1998).

Most of these States that concentrate cattle herds simultaneously are regions highly dedicated to the extraction and processing of oil, therefore the possibility that their rivers, lakes, and reservoirs are contaminated with either chemicals and wastes from the oil industry or pesticides, fertilizers and runoff from agricultural and livestock facilities is really high.

This fact is aggravated because most people of developing countries lack a national conscience about the necessity of avoiding the pollution of their water resources and preserve them for future generations, and the sense of collective responsibility that it implies. On the contrary, a community could has the interest and even a project for preventing or reducing the levels of pollution in their water resources or aquifers, but there are limitations with the financial support of the project by government institutions. Even though all these situations that promote and facilitate the contamination of water resources with industrial or agricultural wastes, it is worth to mention that actually 76% of nation's population has pipeline distribution of drinking water and that 53% of that population receives adequate sewage services (González and Vega, 1997).

Besides, most political leaders of Venezuela have shown concern about the quality of fresh water supplied to the population, even the Liberator Simón Bolívar who issued several decrees in order to preserve and to conserve soils and water sources, e.g. the Decree of Chuquisaca, issued on 12-19-1825 (Sánchez Murillo, 1995).

More recently, the government in the new Venezuelan Constitution of 1999 also established the same concern about the water resources, e.g. in article 304: "All waters are commodities of public domain of the Nation, essential for life and for the development, and water sources are not susceptible of private property in Venezuela" (República Bolivariana de Venezuela, 1999).

QUARE. Main damsbuilt in Venezuela. Period 1958-2000.

Damn	State of Location	Capacity*	Uses
Cumaripa	Yaracuy	147	Flood control, agriculture
La Becerra	Guárico	575	Flood control, agriculture
Guárico	Guárico	1840	Flood control, agriculture
Las Majaguas	Portuguesa	345	Flood control, agriculture
Camatagua	Aragua	1,250	Flood control, agriculture
El Cigarrón	Guárico	221.5	Flood control, agriculture
El Guamo	Monagas	87	Flood control, agriculture
Atarigua	Lara	N. A.	Flood control, agriculture
Dos Cerritos	Lara	216	Domestic, industrial
El Isiro	Falcón	193	Domestic, industrial
Lagartijo	Miranda	103	Domestic, industrial
Pueblo Viejo	Zulia	116	Domestic, industrial
Macarao	D.F.	47	Domestic, industrial
Suata	Aragua	45	Agriculture
Taiguaiguai	Aragua	91.5	Agriculture
Maticora	Falcón	550	Agriculture
Tamanaco	Guárico	264.5	Domestic, agriculture
Clavellinos	Sucre	156	Domestic, agriculture
Tulé	Zulia	390	Flood control, domestic
Guanapito	Guárico	56	Domestic
Agua Fría	Miranda	6.4	Domestic
Raúl Leoni o Guri	Bolívar	21,500	Generate power
Santo Domingo	Barinas	5.4	Generate power
Macagua	Bolívar	N. A.	Generate power
Uribante	Táchira	N. A.	Generate power
Guanare- Masparro	Portuguesa	N. A.	Domestic, agriculture

* Capacity in millions of cubic meters of water. N.A.: data not available.

The main objective of this article is to review the actual situation of policies, legislations, and projects applied in Venezuela in order to control the pollution of fresh water resources, lakes, rivers, reservoirs and aquifers, with contaminants like runoff and chemical or biological wastes discharged from livestock facilities.

Legislation

Venezuela is a nation with a prolific amount of laws dedicated to the protection of its environment, among the more relevants are: Organic Law for the Environment (1976), Law for Forests Soils and Waters, Organic Law for the Territory (1983), Law for the Protection of Wild Fauna, Penal Law for the Environment, Law of Fishery and Aquaculture, and Law for the Biological Biodiversity. In addition, the National Congress, State Governments, and even Mayors, have often approved and issued hundreds of decrees and resolutions with the aim of protecting the environment. However, laws *per se* are not enough to protect an ecosystem, water sources, forests, or to convince people of the sustainable agriculture, because in the country these laws and decrees are not enforced, even though numerous ecological crimes and disasters daily occur.

In addition, many people lack not only the knowledge about these laws, but also knowledge about the importance of protecting the environment and preserve it for future generations. Nonetheless, all these legal documents have allowed two important facts in Venezuela: **a)** the creation in 1977 of a National Ministry to protect the environment and to coordinate the water resources (Natural Resources and Environment Ministry or MARN), and **b)** that 46% of the national territory has been protected for future generations after being legally classified as national parks, national monuments, forest reserves or protected areas for watersheds.

Livestock facilities and pollution of water resources in Venezuela

Technically speaking, water pollution is divided into two types:

1) point-source pollution or waste dumped by sewage plants and factories and

2) nonpoint-source pollution which is also called polluted runoff (Parfit, 1993).

For many reasons the latter is the largest problem, not only in Venezuela but also worldwide. Livestock facilities, those dedicated to milk and beef production, cause both types of pollution in Venezuelan States like Zulia (mainly in the Maracaibo's Lake Southern Region), Guárico and Barinas, because these states have the largest amounts of cattle and the highest levels of milk production (República de Venezuela. OCEI, 1998).

The components of the polluted runoff discharged from livestock facilities can be divided in a) chemicals and b) organic or biological. Among the chemicals are insecticides, acaricides, herbicides, detergents, and disinfectants which are often applied on cattle herds or on premises and pastures respectively. A cautious estimate of no less than 95 millions liters of pesticides are applied each year in Venezuela only to control cattle ectoparasites (this figure was calculated under the assumption that each animal is sprayed once a month with only 15 lt of pesticides).

These chemical wastes form an uncontrolled runoff which often ends in streams and rivers around farms and in the case of Zulia State into the waters of the Maracaibo's Lake.

In addition, the limits of pesticides allowed in tap water for human consumption in Venezuela are higher (organic chlorines less than 200 µg/lt, and no more of 100 µg/lt for organic phosphoric compounds, according to Gaceta Oficial Nº 5021, of 1985, when compared with those in France where the limits for these pesticides are between 0.1 and 0.5 µg/lt.

The manure discharged from different dairies, calving houses, and grazing lands is the main component of organic runoff, which spreads not only animal wastes but also pathogenic microorganisms like rotaviruses, bacteria and parasites. For instance, *Cryptosporidium* and *Giardia* are among the most important pathogenic protozoan parasites carried out by water and wastes from livestock facilities to rivers, lakes, and water reservoirs, and this contaminated water is later pipelined to cities for household consumption (Widmer *et al.*, 1996; Smith and Rose, 1998; Olsen *et al*., 2004).

Since *Cryptosporidium* oocysts are quite small (4.5 to 5.5 µm in diameter) and strongly resistant to the most commonly used disinfectants and chlorination of drinking water (Luna *et al*., 2002), the parasite is able to pass into the domestic tap water which explains the numerous outbreaks of waterborne cryptosporidiosis often reported in the USA, Canada and UK (Widmer *et al*., 1996; Smith and Rose, 1998; Olsen *et al*., 2004). *Cryptosporidium* oocysts have also been diagnosed in cattle feces collected in Venezuela (Surumay and Sandoval, 2000a; Surumay and Sandoval, 2000b) but so far none epidemiological study have been carried out in the country to study the incidence of this parasite, the density of *Cryptosporidium* oocysts per litre of water collected at different water reservoirs or its role as a zoonotic agent that infects humans through fresh water consumption (Olsen *et al*., 2004).

Livestock facilities play a major role in the pollution of rivers and reservoirs because very often these activities are established around or next to those water resources, which in Venezuela should not occur because it is outlawed. Besides, these organic wastes contribute to the 30% of all the phosphorus charges dumped into continental waters, whereas agriculture contributes with a 17%.

A recent report from Dianela Parra, President of the Venezuelan National Assembly Environmental Commission, alerted that contaminated waters discharged from pig houses are been daily dumped into the water reservoirs that provide drinking water to Caracas, the capital city (Parra, 2001). The reason for this contaminative process is that pig houses were built close and around the water reservoirs without a sewage-treatment plant.

Another source of water pollution in Venezuela is the use of excessive amounts of fertilizers, insecticides and herbicides applied in agriculture, in particular those used in horticulture. This is a common fact in Quibor Valley, Guarico and Sanare areas, Lara State since the 80s where around 4,500 hectares are cultivated year around with tomato, onions, potato, garlic or peppers, and the control of crop plagues and weeds is annually carried out with pesticides instead of using an appropriate integrated plague management program (Ferrer, 1982). Among the most common chemical groups of pesticides used are: organic phosphoric

compounds, triazines, carbamates, and bipiridil (Gramoxone), and among the fertilizers most commonly used are: urea, ammonia sulphate and ammonia nitrate.

A similar case has been reported from the Guárico River and its reservoir where residues of organic chlorine pesticides have been detected (Silvestre *et al*., 1982). This chemical control is a practice that has been used for the last 30 years in those areas (Ferrer, 1982), and it has led to serious consequences for the ecosystems and for the population, e.g.

a) Chemical runoff pollution of rivers and of artificial water reservoirs, either used for agricultural irrigation or for human consumption in cities like Tocuyo, Quíbor and Barquisimeto,
b) Strong suspect that the excessive use of crop pesticides in the zone is the cause of numerous birth defects detected in newborns at this region. A similar situation has been reported at the Brownsville area, Texas, USA (Parfit *et al*., 1993),
c) It triggers high levels of insect resistance to the commonly used insecticides, and
d) It causes drastic reduction of bird predators which favors a fast increase in rodent populations.

Some Programs to Control Water Pollution

The Orinoco river watershed, the Maracaibo Lake basin, and other important rivers basins require a pragmatic and rapid program of conservation of forests and vegetation where rivers pass by and to limit riverbanks development by builders. It is well know that destruction of forests and agricultural practices around rivers causea negative effect upon the quality and quantity of the water charged by a river.

In addition, an excess of fertilizers dumped into a river or a reservoir causes an accelerated damage to the water quality due to changes in the physical, chemical and biological characteristic of the water. These changes mainly lead to algae proliferation, an increase in turbidity and a high reduction of free water oxygen.

In the last three decades it has been observed a dramatic reduction of water supply for urban and agricultural uses in Venezuela which

is due to the steadily destruction of forests, in particular in the central-north-eastern zone where dwells 90% of the population (FAO, 1993; Centeno, 2001). Thus, in the 70s, in Venezuela, 245,000 hectares were deforested each year, and in the 80s that figure rose dramatically to 600,000 hectares per year (Centeno, 2001). In addition and according to FAO, Venezuela had a rate of deforestation for the period 1991 to 1995 twice that of Brazil and Colombia respectively, and thrice that of Perú (FAO, 1997).

For the period 1990-1995 the destruction of Venezuelan forests continued to a rate of 500,000 hectares each year (Centeno, 2001). If this rate of deforestation is kept for the next decades, Venezuela will become a desert in less than a century (Centeno, 2001), which obviously will have dramatic consequences for the supply of water, either for agricultural or domestic use as for hydroelectric power.

Unfortunately, In the face of this severe destruction of forests there is not a vigorous official program oriented to monitor, control and to preserve the environment in the watershed of most Venezuelan river systems. Thus, the process of deforestation with an anthropogenic origin also increases the process of land erosion, which simultaneously causes that sediments are removed and carried by rivers into water reservoirs leading to a reduction in their lifetime.

As important efforts to control water pollution in Venezuela can be mention first the case of Maracaibo Lake, and second the Cojedes River basin. In the first case, it was founded the Maracaibo Lake Conservation Institute (ICLAM) which has several programs to preserve and to decontaminate this lake fresh water. For instance, ICLAM in association with Pequiven (a Venezuelan oil company) has presented a project on recycling industrial effluents and sewage before dumping it into the lake.

In the second case, a similar project of effluents and water recycling from the Barquisimeto and Cabudare metropolitan area was recently presented in order to decontaminate and to make clean the Cojedes River.

Besides, it is worth to mention the establishment in 1964 of an Institute for the Conservation of the Valencia Lake (INCOLAGO),

which with short official support has several programs for water control and research in order to control the pollution and contamination of this closed lake watershed.

Finally, it was recently started the construction of two Sewage Treatment Plants in Carabobo and Aragua States respectively, with the aim of dumping all sewage and polluted waters from two main cities, Valencia and Maracay, into these plants, to treat it, and then either to dump these treated waters to the Valencia Lake or to use it for agricultural irrigations. This project would be a good start to be copied for other Venezuelan cities in order to reduce drastically the pollution of rivers and lakes in the West Central Venezuelan regions.

CONCLUSIONS

- There is a steady process of pollution and contamination of most water systems in Venezuela.

- In the last three decades national governments have shown great concern about the damage caused by humans to rivers, water reservoirs, lakes and aquifers, which have led to the approval of numerous laws and decrees in order to limit or control such damage. Nonetheless, those laws are not enforced and crimes against the ecosystems are a daily problem.

- Most water reservoirs that supply drinking water to many Venezuelan cities show high levels of pollution with pesticides and fertilizers due to its excessive use in agriculture and livestock practices.

- In the last decade it has been detected a constant increase in the rate of deforestation, which is leading to the rapid destruction of tropical forests, to erosion, and to a high reduction in availability of fresh water for urban centers.

- Some programs of control of water pollution are been applied in few areas in Venezuela and so far few Venezuelan cities have a sewage-treatment plant to treat the used waters before dumping them into a river or lake.

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