Dust storms, drought and desertification in the Southwest of Buenos Aires Province, Argentina

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The study relates the widespread phenomenon of dust storms to the complex processes of desertification, contributing to the knowledge of these processes from the study of a critical case, the Southwest of Buenos Aires Province, Argentina’s semiarid Pampas region.

It describes the area’s current situation related to its generalized drought & desertification, designs actions, & contributes with recommendations for implementing a program for the area’s gradual recovery.

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This work is based on the hypothesis that desertification deepens drought & dust storm processes and impacts. Knowing and controlling desertification in places affected by drought, where dust storms originate would help mitigate intensity and magnitude of dust bowls, which deteriorate habitat at the global scale. Knowing the dynamics, causes, symptoms and consequences of desertification processes in their places of origin makes it possible to design strategies for recovering and controlling desertification-affected areas.

Local recovery measures are the only mechanism able to mitigate drought, reduce soil particle emissions and the magnitude and impact of dust bowl phenomena at planetary and local scales.
The meteorological phenomenon known as “dust storm” or “sandstorm” is common in hyperarid, arid and semiarid regions, resulting from a combination of climate, weather and substratum. Dryland soils are very dry and loosely held on the surface; particularly after a prolonged drought.

The SW-BAP becomes an important center of particle emission, comparable to other internationally well-known areas like the Sahara, the main terrestrial source of airborne dust, particularly the Bodélé Depression and the drylands of Mauritania, Mali and Algeria in the Sahel. The dry environments of China, Arabian Peninsula, Iran, Pakistan and India also contribute greatly to dust storm formation.

Figure 3.3: Global pattern of dust frequency estimated from the synoptic present weather records for the period of January 1974 to December 2012. Source: Shao et al. (2013).

Natural phenomena typical of drylands, like drought and hard winds, contribute to emergence of dust storms, but it is when these phenomena converge with poor land use practices, resulting from mismanagement of cultivated land and rangelands, that a great increase in dust storm magnitude and impact is observed. Overgrazing and woodcutting are responsible for most of the desertification of rangelands. Cultivation practices inducing accelerated wind erosion are most responsible in rainfed croplands, by exposing dust and sand to winds which remove soil organic matter and the nutrient-rich lightest particles, thereby reducing agricultural productivity.

These areas have fragile, delicately balanced ecosystems. Their desertification makes soil less resilient to wind during prolonged drought.
Arid and semiarid regions comprise about 70% of Argentina’s territory. This ranks Argentina as ninth in the world in terms of percentage of drylands and as one of the 14 countries where these lands occupy over 1 million km². The popular, albeit distorted, image of Argentina is that of “Humid Pampas”. Reality is that three-quarters of the country are drylands and face desertification. Of the 276 million ha that constitute Argentina’s continental territory, 60 million ha are affected by different soil degradation and desertification processes, with progress estimated at 650,000 ha year⁻¹. About 30% of Argentina’s population live in regions under moderate to severe erosion.
In this context, SW-BAP becomes a paradigmatic place in South America, where a process that had manifested between the 30’s and 50’s in Argentina’s pampas got magnified in recent years, transforming the area into one comparable to USA’s 30’s dust bowl, with similar effects upon producers’ impoverishment, productive soil loss and damage to infrastructure and urban areas.
The area is a transition between ecological systems in semiarid and humid climates, and belongs to Monte and Espinal phytogeographic provinces.

It is a transition environment between Humid Pampa and the Patagonic stepes. Mean annual temperature below 18 ºC, classified according to Köppen-Geigen as Type Bsk.

These characteristics restrict its primary productivity, clearly lower than in the rest of BAP.
The study region covers 6.5 M ha & hosts 550,000 people. In 2002 there were 7,825 farms. Irrigated lands are devoted to horticultural production (sunflower, wheat, corn & sorghum for silage. Non-irrigated zones have a mixed production system (beef cattle-wheat), because of rainfall variability.

Beef cattle (mainly Polled Hereford), representing 15% of the total in BAP, was introduced to the area in the mid 70’s because, at the beginning of this decade, sheep were not reared mainly due to low wool and lamb prices.

Farms are small in size: farms of up to 500 ha represent about 60%. There is no income diversification and this favors overexploitation and land abandonment.
Mean annual rainfall in Stroeder, over the last 70 years (1940-2009) was 379 mm. In 50% of years, rainfall was below the mean. Since 1997, eight successive years have been above the mean, and some values doubled the annual average (808, 851 and 850 mm in 1997, 2001 and 2004, respectively). In 2004, wheat yield, according to producers, was exceptional (3,000 kg ha⁻¹ vs. a mean of 1,000 to 1,200 kg ha⁻¹). From 2005 to 2009, rainfall was below the average, except in 2006 when it exceeded it by 87 mm, but its distribution was inadequate for winter crops. In 2009 rainfall was 183 mm, the lowest value over the last 70 years. This reflects the natural pattern of high rainfall variability in drylands within and between years.
Soils have predominance of aeolian material and presence of a petrocalcic layer of various thicknesses ("tosca") generated by CaCO$_3$ migration into the soil through water infiltration.

The SW-BAP is one of the areas most endangered by wind erosion (Bouza et al., 2012)
Over 20 cm of soil has blown away and sand accumulates in fences.

The loss of 1 cm of soil in SW-BAP produces an average wheat yield reduction of 50 kg ha\(^{-1}\). Of the 3,161,403 ha used for wheat cropping, 20.2% presented a historical soil loss of about 10 cm. As a consequence, mean annual wheat yield loss was about 320,000 t, equivalent to U$S 57.6 million at July 2012 wheat price. Patagones stands out with 69% of the 222,620 ha under wheat cropping affected by wind erosion. Because of wind erosion and the strong droughts of the last years, this district shows a widespread desertification process (Silenzi et al., 2011).
Soil stays suspended in the atmosphere, reaching Bahia Blanca city and up to 400 km into the Atlantic Ocean.

NASA satellite image showing the effects of blasted material transported to the Atlantic Ocean.
Desertification in the area is a consequence of drought and mismanagement

The area has dry summers and rainy autumns, which is the pattern to which the traditional agricultural system was adapted. In wet cycles, producers increase stocking rate and wheat-sown area using the same practices of the humid pampa (tillage methods - disk plough) inappropriate for the area, because they leave soil exposed to winds. This technique is practiced in the area since field cultivation began 100 years ago, reproducing the same farming practices as in the neighboring humid pampas (1,065 mm year\(^{-1}\) in 1901-2000). As a consequence of dry cycles, land is abandonment and fields eroded & covered by sand and invasive plants.

- Unplanned woody species removal
- Uncontrolled fires and high-stockig-rate grazing following fire
- Non-sustainable macroeconomic policies
But mainly because of non-sustainable macroeconomic political & social processes

It is a clear example of how environmental conditions and extraterritorially-generated social policies trigger an environmental crisis of magnitude, with enormous costs to be first assumed by local producers, and then affecting urban settlements and their adjacent areas.

80- Circular 1050: Producers purchased tools ... debts increased with indexation
83- hyperinflation
90- free peso-dollar convertibility, with one-to-one parity... ensued a sharp intensification of economic concentration in agriculture... left producers in debt, with little production capacity
Upon the exit of convertibility, medium and large producers could pay their debts, aided by good crops and high prices
93-94- Mortgage bonds (Cédulas Hipotecarias)... medium and small producers (<500 ha) could no longer get over their losses.

Producers face not only the current climate emergency but decades of impoverishment and decapitalization. Today, a large percentage of them have left the fields and are dedicated to providing services.
Climatically unfavorable years and the country's situation (hyperinflation, convertibility) led the producers to get into financial debt, poverty and land abandonment.

The importance of the desertification process described for SW-BAP is manifested by the speed with which it happened and the serious effects it had on natural and social systems in a short time period.
Given the data on the area’s natural reality, where the only certainty is rainfall variability, emphasis should be on sustainable management, which involves a change in producers’ and decision makers’ mentality. Both have been responsible for the profound landscape’s shape changes observed. Proposals were made for cleared (livestock production) and non-cleared lands (direct sowing), livestock production integration, appropriate stocking rate use and fodder shrubs cultivation.

The area requires deep structural changes in production systems and their management, including the need to immediately protect zones unaffected by desertification and prevent soil blasting, and to continue to protect and recover moderately affected fields.
Muchas Gracias!!!

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