LETTERS

*Edited by* **Jennifer Sills**

# *Venezuelan science in dire straits*

Barrios (slums) in Venezuela.

IT IS HARD to find words that adequately describe the tragic state of Venezuelan science. The government's policies seem specifically designed to sabotage research and innovation. Based on data from the Science Citation Index and Scopus, from 1998 to 2008, there was a consistent increase in scientific production, which coincided with the highest crude oil prices per barrel ever recorded in Venezuela's history. This honeymoon period ended in May 2009 when former President Hugo Chávez, during a national broadcast, stated: "Researchers should stop working on obscure projects, and instead should go into the barrios (slums) to make themselves useful" (*1*).

Shortly after Chavez's words, Venezuelan scientists started facing budget cuts and ever-increasing pressure from government institutions trying to politicize funding. Several notable researchers and professors were blacklisted, threatened, and even fired (*2*), while thousands of young talents were forced to emigrate because of lack of work opportunities, in what is considered the largest brain drain ever recorded in Venezuela's history (*3*). This, along with a devastating economic landscape caused by a sudden decrease in oil prices (which has endured), initiated an accelerated decay in scientific production, as evidenced by various publication indexes (*4*).

After the historical peak in publications in 2008, publications indexes started to reveal a rampant decrease in peer-reviewed manuscripts, which has become more noticeable in the past 2 years, dropping by 24.9% in the Science Citation Index and by 21.12% in Scopus. For a comparison, by 1998 Venezuela had published 69% more than its neighboring country of Colombia as per Index Medicus/Medline records; however, for 2013 Colombia had surpassed by 222% the scientific production of Venezuela (*5*). This dire situation of Venezuelan science has worsened considerably as a product of a combination of factors, which include the lack of scientific training and background of government authorities, the politicization of science, and an unprecedented economic crisis. Venezuela is the only South American nation whose scientific output is declining, and it ranks among the lowest current citation impact weighted by research field in the region (*6*). For the year 2000, according to the World Intellectual Property Organization database, Colombian residents submitted 75 patent applications, whereas Venezuela had only filed 56. Strikingly, this gap increased in 2011 with Colombia filing 183 requests in contrast to Venezuela, which filed 33.

Because of the drop in oil prices and rising government debt, the Venezuelan economy has fallen into a downward spiral of problems, including a state of hyperinflation and extreme shortages of goods. Accessing foreign currency in Venezuela has become a complicated task because of the government's stringent currency exchange control system, which embraces an intricate scheme of different "official" rates (*7*). This has left local laboratory equipment and reagent suppliers and importers with no other option than selling their products at prices determined by the reticent and illegal black market rates, making prices inaccessible to the already constrained budgets of most research laboratories.

Our internal stocks of reagents have dried up, and the unbridled insecurity and violence that have taken over the country have precluded foreign commercial providers from complying with their maintenance and repair contracts, leading to a massive deterioration of Venezuela's research infrastructure. Because of the intimate historical relations between medical research laboratories and the health care system in Venezuela, this situation has also affected patient care. Diagnostics are most affected, but treatment is as well. Failure to access reagents and other consumables has led to a collapse in many public health programs (*8*). The health system is struggling with the chikungunya epidemic, because of the lack of reagents for serological testing and primers for PCR-based diagnosis.

Most research laboratories in Venezuela are surviving today thanks to regional and cross-continental collaborations and networking with other groups around the globe. However, most basic science programs in Venezuela are currently destined to disappear.

Despite the ominous ongoing public health and medical research crisis, the government has failed to call for an emergency plan or to prioritize the importation of scientific and research materials. There is no evidence of a sound commitment to scientific freedom. What will be the fate of science in Venezuela? It remains to be seen.

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# Population growth: Peak probability

IN THEIR REPORT "World population stabilization unlikely this century" (10 October, p. 234; published online 18 September), P. Gerland *et al.* used a United Nations (UN) 2012 assessment to support their claim that the population will not peak this century, despite our earlier work indicating that it will (*1*–*3*).

The UN assumptions used by Gerland *et al.* are mainly based on statistical extrapolation, whereas our approach is based on substantive reasoning and assessments of alternative arguments (*4*). For example, a changing education structure means that young Nigerian women are more educated than their elders, implying likely near-term fertility declines. The UN assumes constant fertility at 6.0 for 2010 to 2015, but the newest Demographic and Health Survey shows that it has already decreased to 5.5 in 2010 to 2013. The population increase for Nigeria from today's 160 million to 914 million in 2100 expected by the UN is thus unrealistic. For China, the UN assumes that fertility will only increase in the future. We assume, like many Chinese scientists and institutions (*5*), that it will decline and stay low in the coming decades. On balance, we therefore still expect the end of world population growth this century.

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# Population growth: Limits of food supply

IN THEIR REPORT "World population stabilization unlikely this century" (10 October, p. 234; published online 18 September), P. Gerland *et al.* omit one of the major determinants of population growth: the food supply. More than 200 years ago, Malthus (*1*) famously asserted that the growth of a population will always outrun its ability to feed itself. Yet, in their projections of world population growth, Gerland *et al.* use as their independent variables only measures of fertility, life expectancy, and age at death. They conclude that "the projected population of Africa [is] between 3.1 and 5.7 billion with probability 95% by the end of the century," with no mention of agricultural limits. In fact, much of the continent's area is desert or rain forest (where nutrients are largely stored in living biomass rather than in the soil) and could not be made arable. The agricultural soils that do exist are relatively infertile compared with those of other inhabited continents.

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## TECHNICAL COMMENT ABSTRACTS

### Comment on "Control profiles of complex networks"

*Colin Campbell, Katriona Shea, Réka Albert*

■ Ruths and Ruths (Reports, 21 March 2014, p. 1373) find that existing synthetic random network models fail to generate control profiles that match those found in real network models. Here, we show that a straightforward extension to the Barabási-Albert model allows the control profile to be "tuned" across the control profile space, permitting more meaningful control profile analyses of real networks.

Full text at http://dx.doi.org/10.1126/science.1256492

### Response to Comment on "Control profiles of complex networks"

*Justin Ruths and Derek Ruths*

■ Campbell, Shea, and Albert propose an adaptation of the Barabási-Albert model of network formation that permits a level of tuning of the control profiles of these networks. We point out some limitations and generalizations of this method as well as highlight opportunities for future work to refine formation mechanisms to provide control profile tuning in synthetic networks.

Full text at http://dx.doi.org/10.1126/science.1256714