Antibiotics in the Global Livestock Industry

Trends, projections, and policy recommendations

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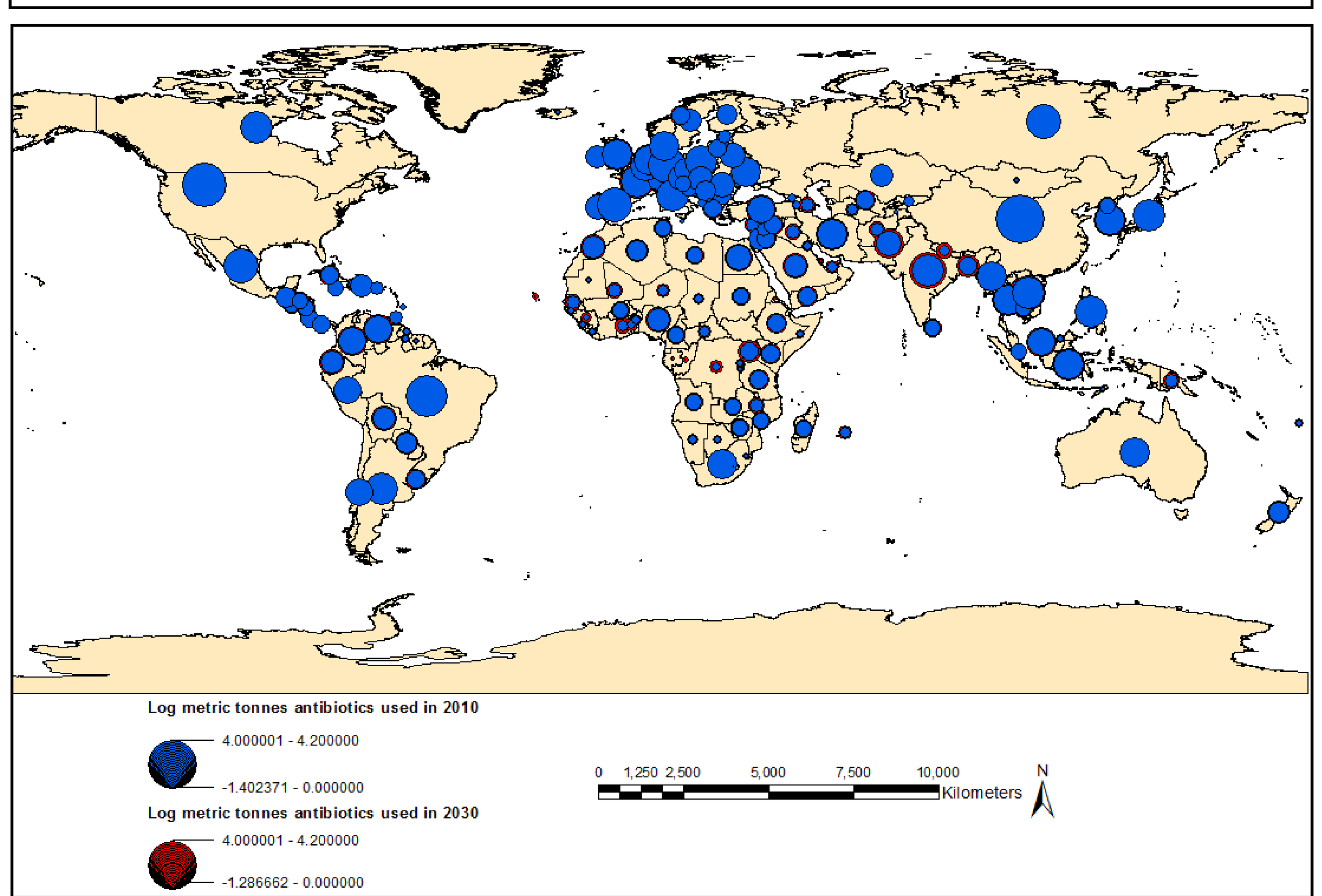
Introduction

In 2010, 63,151 (±1,560) metric tons of antibiotics were used in global livestock agriculture, comprising an estimated upwards of 50% of the volume of medically important antibiotics used globally.[1,2] Antibiotic use in livestock agriculture is thus a substantial contributor to the risk of emergence of antibiotic resistant bacteria pathogenic to humans. This problem is only expected to get worse in the future; by 2030 global use of antibiotics in livestock agriculture is projected to total 105,596 (±3,605) metric tons, a 67% increase over 2010 figures.[1] In most countries of the world, data is poor and there is no data available on current and projected cumulative antibiotic use across their livestock industries. Van Boeckel et al and Robinson et al. provide a methodology for estimating antibiotic use in countries in which data is unavailable which will be used to do so in this project. [1,3] To mitigate the risk of emergence of antibiotic resistance, policies need to be deployed to curtail the use of antibiotics across livestock industries around the world, particularly the use of antibiotics as growth promoters (AGP), by which animals are routinely administered low doses of antibiotics to speed up weight gain and improve productivity.[2,4] However, AGP curtailment is not equally appropriate in each country, as projected productivity impacts from AGP phase-out and antibiotic use density (mg antibiotics/kg meat) differs across the countries of the world.[5] This project will attempt to inform AGP phase-out policy by identifying the countries with lower projected productivity impacts given their antibiotic use density level.

Methods:

Projecting Global Antibiotic Use by Country

Antibiotic use in livestock production by country can be modelled using meat production figures, the proportion of extensive ("backyard" farming) or intensive production (industrial farming), coefficients estimating antibiotic use density by animal and production system, and future projections for these figures, using the following equation: $Abx = Prod(\%_{pork,int}*\beta_{pork,int}+\%_{chicken,int}*\beta_{chicken,int}+\%_{beef,int}*\beta_{beef,int}+\%_{pork,ext}*\beta_{pork,ext}+\%_{chicken,ext}*\beta_{chicken,ext}+\%_{beef,ext}*\beta_{beef,ext})$[1,3,] Data on livestock production by animal species is from the Food and Agriculture Organization (FAO, 2015) data on GDP per capita is from World Bank (2016), proportions of countries' livestock sectors that are intensive and extensive is estimated using methodology described in Robinson et al, and coefficients estimating antibiotic use density by animal and production system are calculated using methodology described in Van Boeckel et al.[1,3,7,8] These data were joined with a World Countries shapefiile from ESRI (2017) and used to create a graduated symbol map.

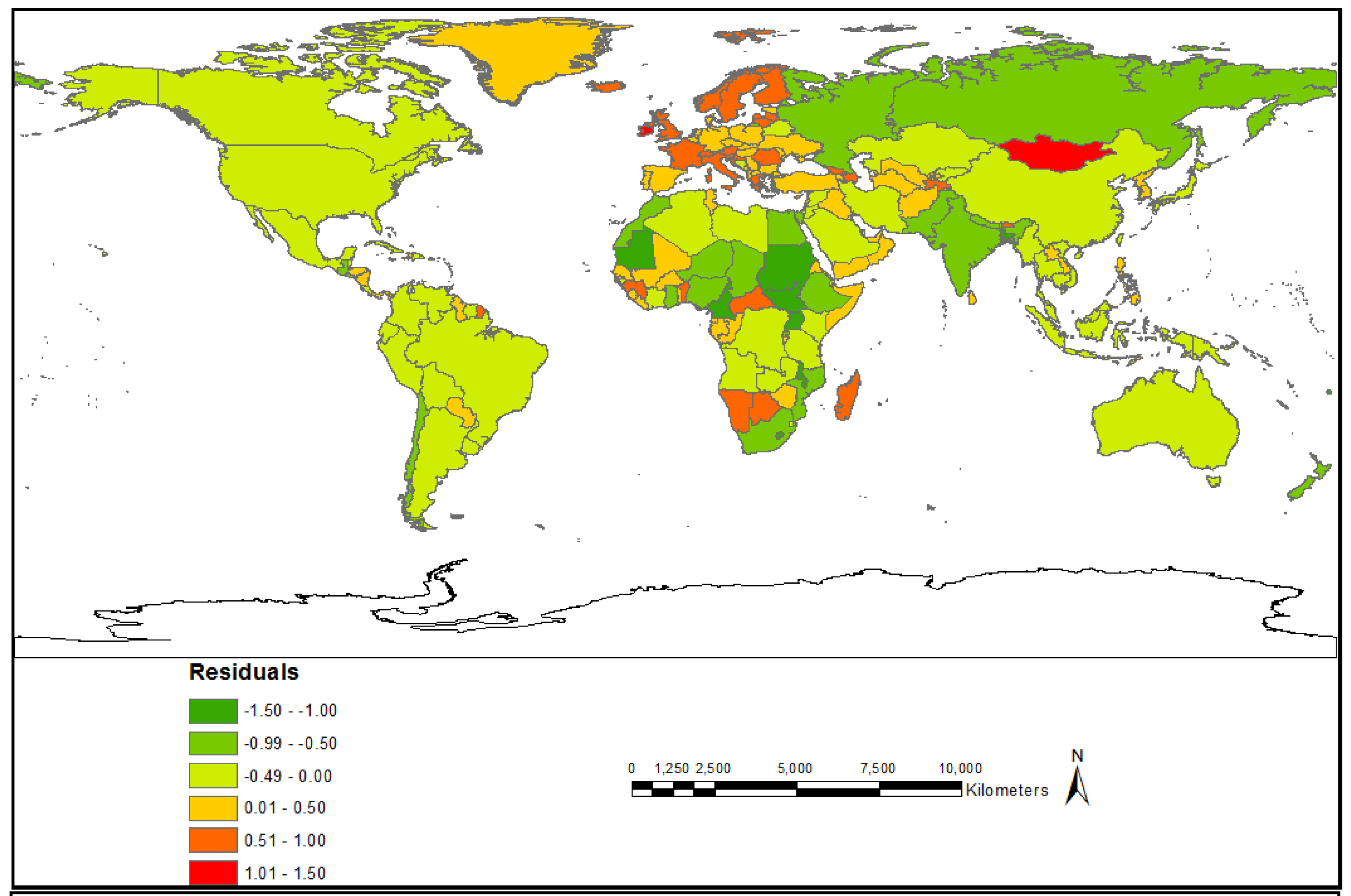


Map 1. Caption: Estimated antibiotic use in livestock production in 2010 and projected antibiotic use in livestock production in 2030 by country.

Methods:

Modeling Projected Productivity Impact from AGP Phase-out as a Function of Antibiotic Use Density

Projected impact on livestock sector productivity from AGP phase-out as a function of antibiotic use density (mg/kg meat) is modeled using data on productivity projections from OECD (2016), previously calculated values of antibiotic use by country, and total meat production figures from FAO (2015). A linear regression model was generated using R statistical software and the residuals for each country were calculated and added to the dataset. These data were joined with a World Countries shapefiile from ESRI (2017) and used to generate a choropleth of the residuals. Countries with a negative residual are projected to suffer greater productivity losses from AGP phase-out given their antibiotic use density level, while countries with a positive residual are projected to suffer smaller productivity losses from AGP phase-out given their antibiotic use density level.



Map 2. Caption: Residuals from regression of projected AGP phase-out productivity impact as a function of antibiotic use density (mg/kg meat).

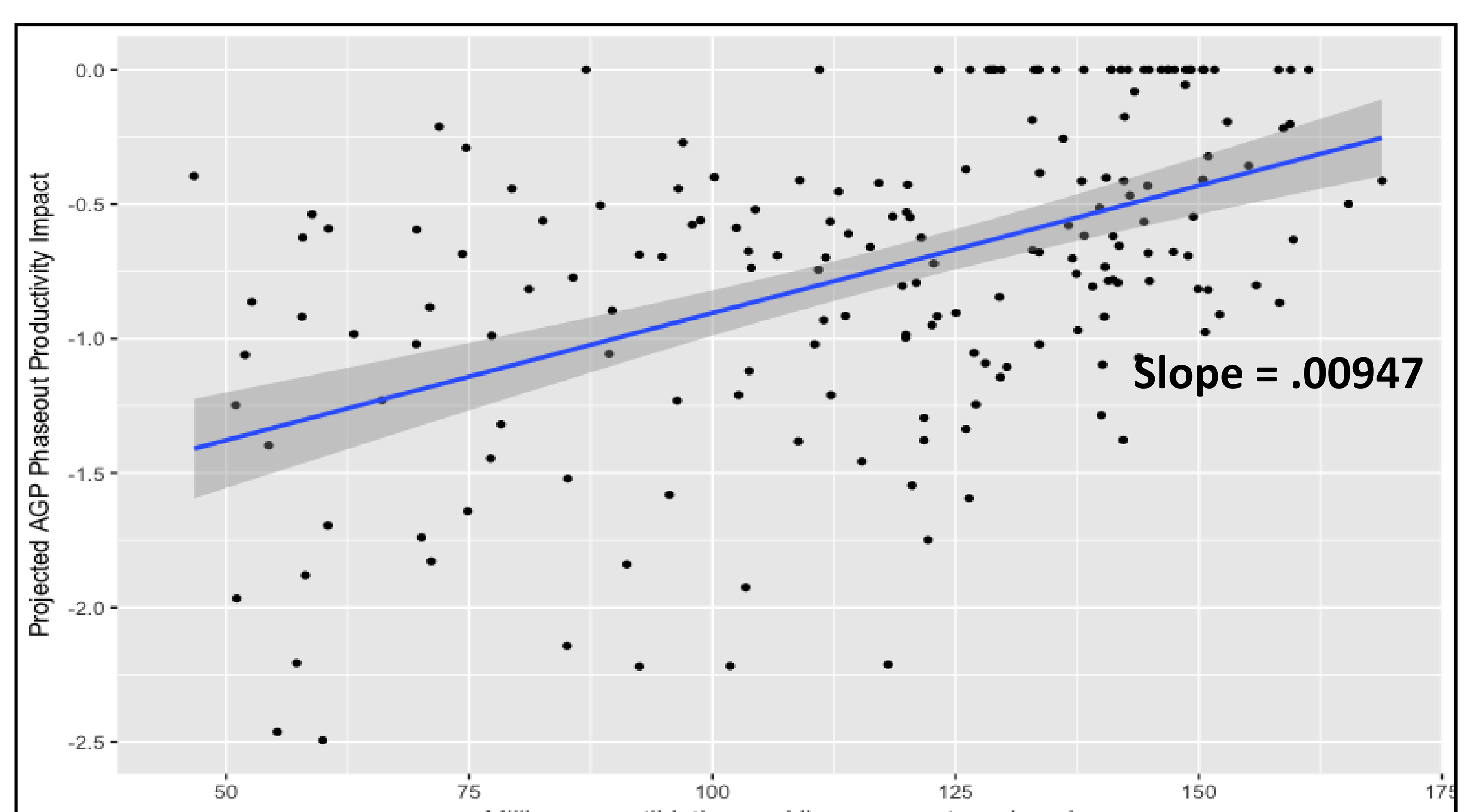


Figure 1 Caption: Scatterplot of projected AGP phase-out productivity impact as a function of antibiotic use density (mg/kg meat).

P-value < .0001, R^2 = .2491

Results

In the 2010-2030 time period, antibiotic use in livestock production is projected to increase in every country. However, this increase is projected to be concentrated in the developing world, more specifically in South Asia and parts of Sub-Saharan Africa, especially West and Central Africa. India in particular is projected to increase its antibiotic use by ~592 metric tonnes.

In the linear regression of projected productivity impact from AGP phase-out as a function of antibiotic use density (mg/kg meat), for every additional milligram of antibiotics per kilogram of meat, projected productivity impact from AGP phase-out was reduced by .00947%. This relationship was statistically significant with a p-value of <.0001. Countries with negative residuals, projected to suffer greater productivity losses from AGP phase-out given their antibiotic use density level are spread pretty widely around the world, while countries with positive residuals, projected to suffer smaller productivity losses from AGP phase-out given their antibiotic use density level are concentrated in Europe, West/Central Asia, and parts of Africa.

Discussion

Developing countries, particularly South Asia, are projected to see the largest increases in antibiotic use in their livestock industries through 2030. This phenomenon is in part attributable to South Asia's projected 4.4% annual increase in meat consumption over the same time period.[5] This is a region that is undergoing rapid economic growth and secularization of religious groups traditionally opposed to meat consumption, so this projection is not surprising. As South Asia and other parts of the developed world demand more meat, it is crucial that policymakers consider ways to limit increases in antibiotic use to prevent the emergence of antimicrobial resistance. However, this situation is somewhat more complicated: antibiotic use limits make the most sense in countries in which such a policy would be most efficient: countries projected to suffer greater productivity losses from AGP phase-out given their antibiotic use density level should be less of a focus that countries projected to suffer smaller productivity given their antibiotic use density level . Some of these countries with smaller projected productivity losses are relatively well off, while this is not the case for others in this group, so equity must also be taken into account by policymakers.

Works Cited

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