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Estimates of Progress Toward Achieving Sustainable Development Goal-7 by 2030: Insights From Household Cooking Fuel in BRICS Nations

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The reliance on polluting fuels has sparked global concerns over the environmental and health consequences of pollution. This paper delves into the progress of BRICS nations toward achieving Sustainable Development Goal 7 by 2030, with a specific focus on clean cooking. The analysis reveals a significant decrease in the use of polluting fuels in Brazil, India, China, and South Africa. Moreover, it highlights the encouraging emergence of electricity as a popular fuel in rural areas of China and South Africa, indicating a positive and promising shift towards cleaner energy sources.

I. Introduction

Over the past decades, the *BRICS* bloc, comprising Brazil, Russia, India, China, and South Africa, has significantly contributed to the net global emissions of greenhouse gases (Azevedo et al., 2018). Regardless of economic growth, the *BRICS* nations have considerable income inequity and large populations that are at risk from rising energy prices. The *BRICS* nations must transition from polluting fuels to clean (modern energy) fuels and achieve significant reductions in household emissions (Gerasimchuk et al., 2019).

In 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development. One of its crucial goals, Sustainable Development Goal 7, is to “ensure access to affordable, reliable, sustainable, and modern energy for all.” The achievement of this goal is heavily reliant on the energy initiatives and collaboration of the *BRICS* bloc. As the most powerful association of developing nations, the *BRICS* bloc accounts for nearly 42% of the world’s population, 27% of its land area, and more than one-quarter of the global gross domestic product (Siddiqui, 2016). This underscores the urgent need and potential impact of the *BRICS* nations on global sustainability.

The outbreak of the *COVID-19* pandemic in December 2019 disrupted emission patterns worldwide. All these reasons favour the need to estimate the progress of *BRICS* nations towards achieving Sustainable Development Goal 7 in relation to household fuel choices of clean and polluting fuels.

Through extensive analysis of the WHO’s Household Air Pollution Database (WHO, 2023), we use the Expert Modeler Forecasting technique, which considers both Autoregressive Integrated Moving Average (*ARIMA*) and Exponential Smoothing (*EXSMOOTH*) models on populations mainly using clean or polluting fuels for cooking and individual fuel categories to estimate the progress of *BRICS* nations towards achieving Sustainable Development Goal 7 with reference to household fuel choice of clean and polluting fuels for cooking. In addition to reporting estimates for the first time for six distinct fuel categories—kerosene, gas (liquefied petroleum gas), electricity, biomass, charcoal, and coal—we also provide estimates of the overall use of clean and polluting fuels. In addition, we provide predictions from 2021 to 2030, indicating a potential scenario in which the trends observed between 1990 and 2020 persist. Since this study only examines the primary fuel used for cooking, we must acknowledge that the overall number of people using polluting fuels for cooking is undoubtedly higher than the population using them exclusively. Apart from this introduction, the paper is structured as follows: The methodologies are presented in Section II, the results are discussed in Section III, and the paper is concluded in Section IV.

II. Methods

The World Health Organization’s Household Air Pollution Database provided the data used in this analysis. Our estimates do not currently consider stove-stacking (Gould & Urpelainen, 2018) because the database used for this

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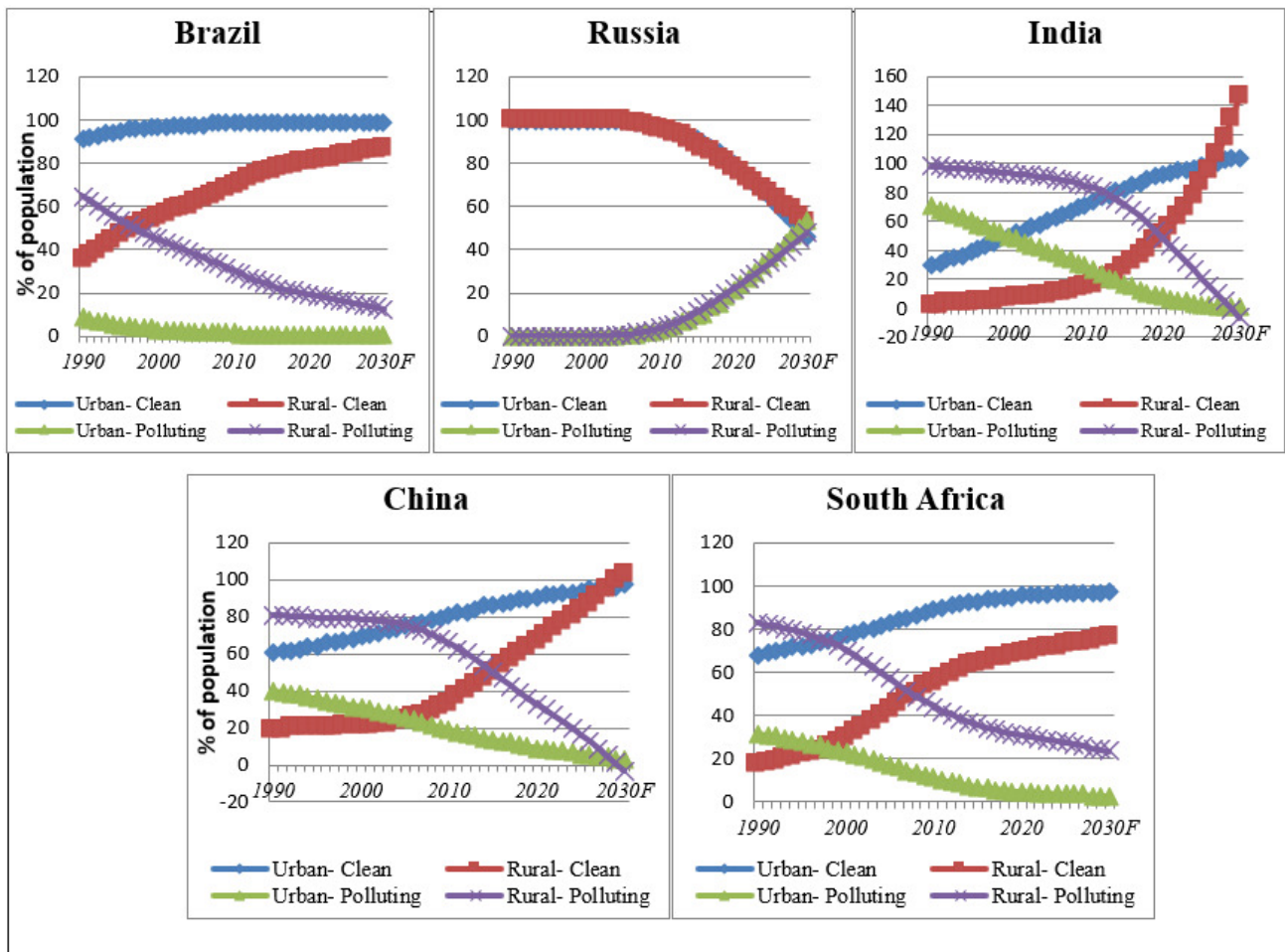


Figure 1. The BRICS nations mainly using clean and polluting fuels for cooking (in percentages)

Source: Authors' own compilation based on raw data from the WHO Household Air Pollution Database (2023)

study lacks complete information on the types of solid fuel stoves and supplementary cooking fuels. We only include data that provides individual fuel breakdowns for the following six fuel types: (1) kerosene, (2) gas, (3) electricity, (4) biomass, (5) charcoal, and (6) coal. Surveys conducted prior to 1990 are excluded from this analysis. Data for overall “polluting” and overall “clean” fuel use are derived directly from the database. However, using the Expert Modeler, which considers both *ARIMA* and *EXSMOOTH* statistical models, we have produced new estimates for 2030 based on the current trends in fuel types and the use of clean and polluting fuels for cooking from 1990 to 2020.

III. Results

A. BRICS nations progress toward using clean fuels for cooking

A1. Brazil's progress toward using clean fuels for cooking

The percentage of the population that cooks primarily with polluting fuels in rural areas decreased from 64.59% in 1990 to 18.96% in 2020 and is projected to decrease further to 12.83% by 2030. In urban areas, it decreased from

8.80% in 1990 to 1.03% in 2020 and is projected to only slightly increase to 1.30% in 2030, as illustrated in [Figure 1](#). There have been substantial decreases in the number of people using polluting fuels, from 35.40 million in 1990 to 7.61 million in 2020 and expected to increase to 9.25 million by 2030, as illustrated in [Figure 2](#).

A2. Russia's progress toward using clean fuels for cooking

The percentage of the population that cooks primarily with polluting fuels in rural areas increased from 0% in 1990 to 22.37% in 2020 and is projected to increase further to around 47.6% by 2030. In urban areas, it increased from 0% in 1990 to 20.70% in 2020 and is projected to tremendously increase to 54.05% by 2030, as illustrated in [Figure 1](#). The number of people using polluting fuels for cooking has increased from absolutely nil in 1990 to 34.56 million in 2020. This number is projected to increase tremendously to reach 84.97 million by 2030, as illustrated in [Figure 2](#).

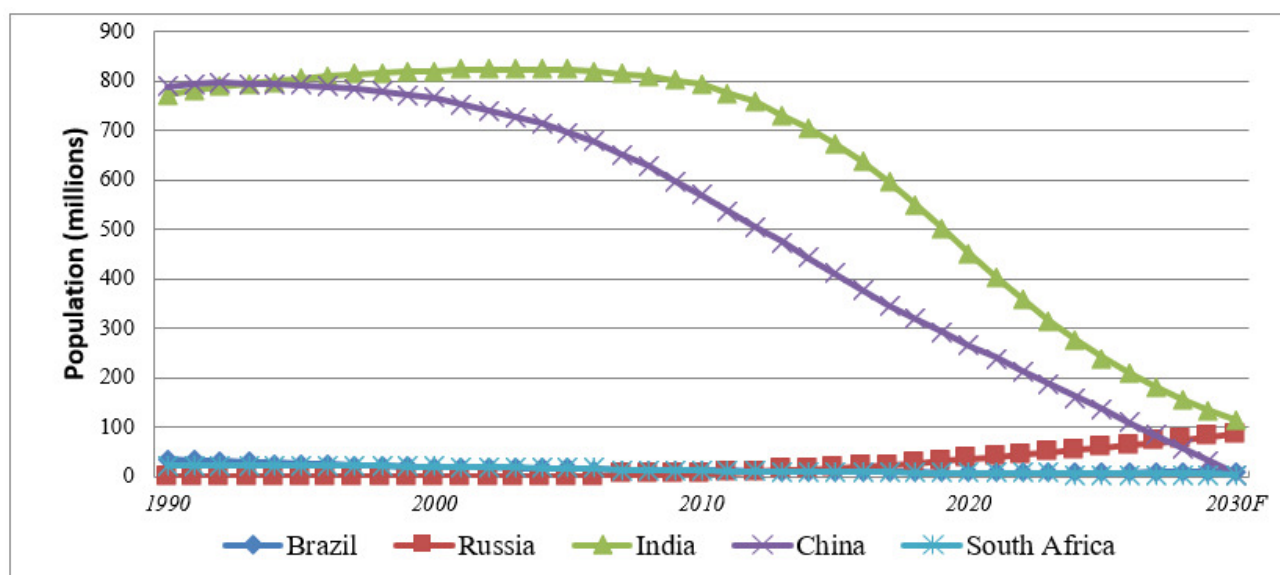


Figure 2. The BRICS population mainly using polluting fuels for cooking (in millions).

Source: Authors' own compilation based on raw data from the WHO Household Air Pollution Database (2023)

A3. India's progress toward using clean fuels for cooking

As illustrated in [Figure 1](#), the percentage of people who cook primarily with polluting fuels in rural areas decreased from 97.70% in 1990 to 48.50% in 2020 and is projected to decrease further to 4.6% by 2028. In urban areas, it declined from 70.60% in 1990 to 7.87% in 2020, estimated to further drop to 0.25% by 2030. As illustrated in [Figure 2](#), the percentage of the population primarily using polluting cooking fuels does not provide a complete picture, as the number of people using polluting fuels increased from 772.70 million in 1990 to a peak of 819.74 million in 2001, then declined to reach 455.69 million in 2020 and is estimated to decrease further to 114.45 million by 2030.

A4. China's progress toward using clean fuels for cooking

As illustrated in [Figure 1](#), the percentage of people mainly using polluting fuels for cooking decreased from 80.60% in 1990 to 32.49% in 2020, projected to be eliminated in rural areas by 2030. In urban areas, it declined from 39.80% in 1990 to 9.08% in 2020 and is projected to further decline to 2.82% by 2030. This does not tell the whole story, as the projected number of people mainly using polluting fuels by 2030 will be 5.63 million, as illustrated in [Figure 2](#).

A5. South Africa's progress toward using clean fuels for cooking

As illustrated in [Figure 1](#), the percentage of people in rural areas mainly using polluting fuels for cooking decreased from 82.90% in 1990 to 31.09% in 2020 and is projected to decrease further to around 23.61% by 2030. In urban areas, the usage rate declined from 31.80% in 1990

to 4.47% in 2020 and is projected to decrease to 2.68% by 2030. As illustrated in [Figure 2](#), there have been substantial decreases in the number of people using polluting fuels, from 21.41 million in 1990 to 7.18 million in 2020. This number is projected to decrease to 4.73 million by 2030.

B. The changing fuel mix in BRICS nations

B1. Cooking fuel use in Brazil

As illustrated in [Figure 3](#), the significant decrease in the use of polluting fuels was the major driver for the steady increase in the use of gaseous fuel as the primary cooking fuel, from 75.42% in 1990 to 96.06% in 2020. Between 1990 and 2020, the usage of biomass dropped from 22.20% to 1.85%, respectively. Among the clean fuels, the share of electricity has been negligible, and its use has consistently decreased from 1990 to 2020, whereas kerosene and coal are used by none of the people as the main cooking fuel. If the current trends continue, more people are expected to switch from polluting fuels to gaseous fuels as their main fuel by 2030.

B2. Cooking fuel use in Russia

As illustrated in [Figure 3](#), the percentage of people who cook with gaseous fuel rose steadily from 67.80% in 1990 to 81.77% in 2010. However, there was a decline between 2010 and 2020, with the percentage falling to 63.37% in 2020. The percentage of people who used electricity has drastically dropped from 30.74% in 1990 to 7.43% in 2020. These significant increases in the use of coal and biomass seem to be the main cause of the decline in the use of gas and electricity. By 2030, the primary use of gaseous fuels is expected to drop to 28.87% if current trends hold true, while the percentage of biomass is expected to increase to

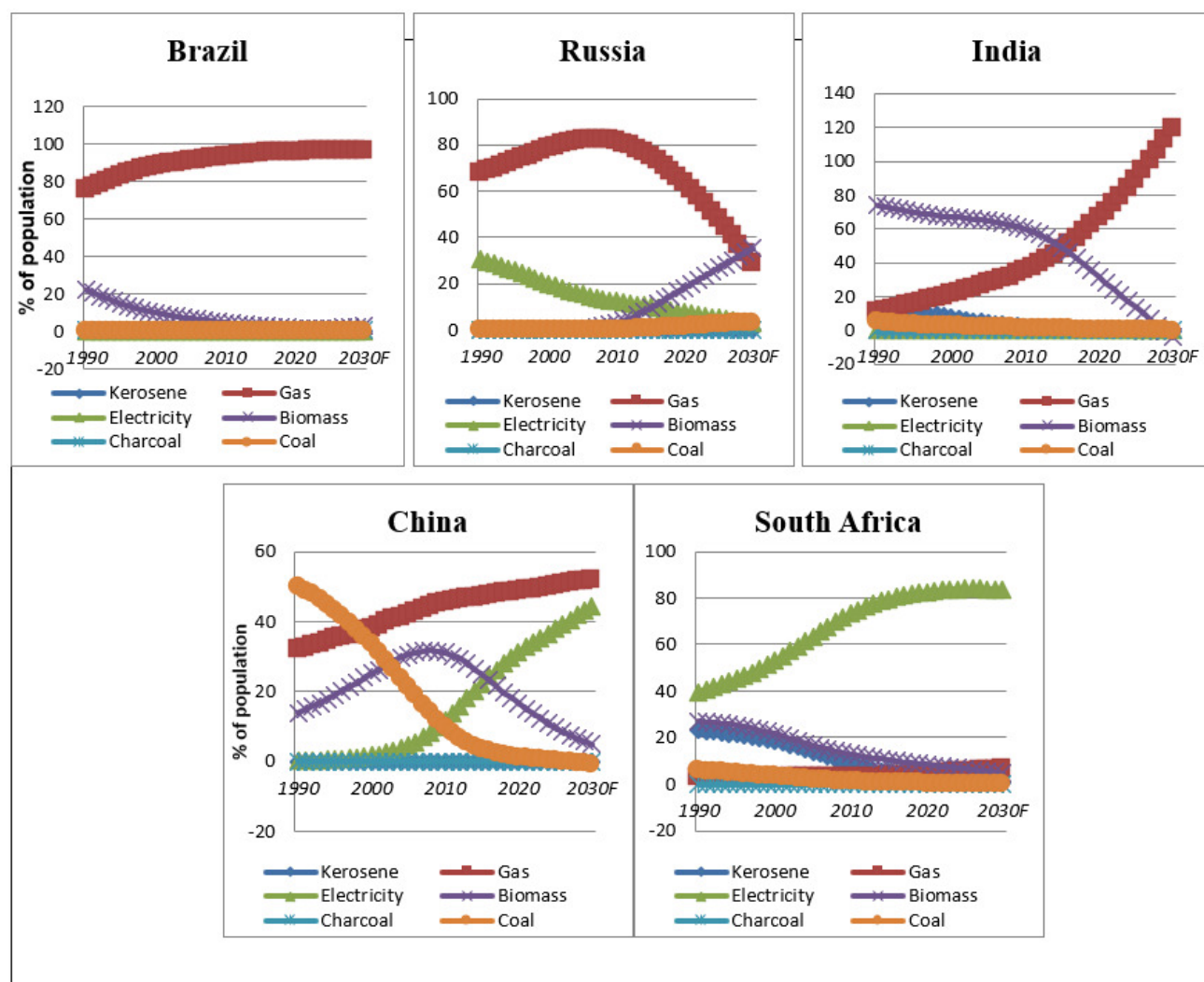


Figure 3. Changing fuel mix in BRICS nations (In percentages)

Source: Authors' own compilation based on raw data from the WHO Household Air Pollution Database (2023)

35.35%. This means that approximately one out of three Russians will cook with polluting fuels.

B3. Cooking fuel use in India

As illustrated in Figure 3, gaseous fuels have been the most widely used primary cooking fuel since 2016, surpassing biomass fuels. The percentage of gaseous fuels used increased from 10.60% in 1990 to 66.95% in 2020. This significant decline in the use of polluting fuels appears to be the main cause of increases in the use of gaseous fuels. The use of kerosene has decreased from 9% in 1990 to 0.30% in 2020; biomass dropped from 74.20% in 1990 to 31.57% in 2020. Likewise, the use of coal decreased from 4.73% in 1990 to 0.32% in 2020. This is probably the outcome of extensive and coordinated government initiatives (subsidies) to encourage the use of gas as an alternative to the commonly used polluting fuels. Among clean fuels, the share of electricity as the main fuel for cooking has been negligible. If the observed trends continue, 100% of the population will be relying on gaseous fuels for cooking in India by 2030.

B4. Cooking fuel use in China

Over the past 20 years, China has made great strides toward replacing polluting fuels with clean fuels as the primary fuel for cooking. Between 1990 and 2020, the percentage of gaseous fuels used rose steadily from 31.90% to 48.75%. The use of electricity for cooking also increased from 0.30% in 1990 to 31.40% in 2020. If the observed trends continue, electricity is projected to rise to 44.4% by 2030, meaning two out of five people will be using it for cooking. This increase was largely driven by infrastructural development. If the observed trends continue, more than 96% of the population will be relying on clean fuels (gaseous and electricity combined) for cooking by 2030, as illustrated in Figure 3.

B5. Cooking fuel use in South Africa

As shown in Figure 3, the percentage of gaseous fuels used for cooking has only marginally increased from 2.84% to 4.30% between 1990 and 2020 and is expected to reach 6.41% by 2030. The primary cooking fuel type shifted from

polluting fuels to electricity, which increased dramatically from 39.45% in 1990 to 82.63% in 2020. If the current trends hold true, the primary use of electricity is predicted to rise to 83.41% by 2030, while biomass is predicted to fall to 4.75%. This means that approximately four out of five South Africans will depend on electricity for cooking by 2030. This is probably the outcome of coordinated government initiatives to encourage the use of electricity instead of polluting fuels such as the commonly used kerosene and biomass.

IV. Conclusion

The *BRICS* countries have made great strides toward using clean fuels for cooking, with the exception of Russia, which has shown an increasing trend toward using polluting fuels. Brazil, India, China, and South Africa have completely phased out polluting fuels, with the exception of Russia, where one in three people will still rely on them for cooking by 2030. In China and India, gaseous fuels have become the most popular fuel, while in Brazil and South Africa, electricity is the most popular fuel. If the observed

trends continue, a higher percentage of women and children living in rural areas of Brazil, India, China, and South Africa are expected to live a better life free from exposure to indoor air pollutants and socioeconomic burdens. This is probably the outcome of the government's coordinated efforts to encourage the use of gaseous fuels and electricity as alternatives to polluting fuels, as well as the advancements in the clean energy sector.

The study shows significant progress made by the *BRICS* nations on specific elements of Sustainable Development Goal 7. This would result in satisfactorily accomplishing one of the three objectives of Sustainable Development Goal 7, which is "access to clean cooking" by 2030. This accomplishment will starkly contrast with the global community, which seems far off track toward reaching universal access to clean cooking by 2030 (Stoner et al., 2021), with some 1.9 billion people still without access to clean cooking by 2030 (International Energy Agency & World Bank, 2023).

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