Assessing the Sustainability of the Population Boom in India: An Econometric Analysis

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Abstract: This paper develops on approaches towards modeling and predicting population statistics in India, and then comparing the predicted population to current resource availability. The paper employs a deep learning model, LSTM (long-short term memory), which is trained on the past 50 years of data of population, GDP, sex ratio, literacy rate, percent of population with electricity, infant mortality rate, birth rate, and fertility rate in India. As all of the time series of the aforementioned variables play—to some extent—a hand in shaping the population of India, the deep learning model takes into account all these factors and renders the predicted population output. The model incorporates 200 fully connected nodes, wherein each presents the output as well as the input to the next node, normalized. The model’s accuracy is measured through metrics such as the root mean square error. The predicted values of the model for the next five years of India’s population are then compared to current natural resource availability in India—namely, water, crude oil reserves, maximum electrical power output, and current grain output. Therefore, this would help in determining the vulnerability of the resources through the coming years and aid in understanding the sustainability of the population boom. Finally, the paper will discuss methods which can be utilized to significantly reduce the probability of rate of resource depletion, especially the ones predicted most vulnerable through the model. Overall, the paper analyses the trends in population to assess future resource availability in India; consequently, discussing methods to avoid potential crisis of loss of the resources.

Keywords: Population, India, Deep Learning, LSTM, Sustainability, Forecasting, Statistics, Computational Economics.

I. INTRODUCTION

The “population explosion” in India has been termed an era defining issue as 1.35 billion (WorldBank)—with an ever-increasing birth rate—individuals live in India, the second most populated and one of the most densely populated countries in the world. This will have direct impact on every aspect of the Indian economy, from a necessary revolution in provision of healthcare, supply of water to re-thinking of the capacity of financial institutions. Through better modelling of this population boom, and hence reliably predicting population growth, India can make more efficient and impactful decisions to address the “population explosion.” India encapsulates 2% of the world’s landmass; however, is home to 21% of all the persons in the world. The current population of India, through its current 1% rate of population growth, is expected to overtake the Chinese population by the year 2027—encompassing 1/6 of the world. This titanic boom, combined with India’s comparatively restricted access to resources has transformed into a paramount concern for the economy. As the gap between individuals and resources continues to widen, it is imperative that the fastest growing economy of the world is able to maintain the sustainability of the demographic and economic thriving. Population, though affected by many factors, is, essentially, a time-based entity—it rises or falls with time and is instantaneously constant. This essential, obvious property of populations can aid in modelling current statistics and predicting future populations in concurrence with other factors. This model puts into use the time variance and effect of other factors (e.g. birth rate) on population by developing a deep learning model which is trained on past data to predict the next 10 years of the population.

II. DATA

The data acquired for the model has been sourced from World Bank’s open database. The team followed best practices of Extraction, Transformation and Loading to heighten the integrity of the data; therefore, heavily assuring the reliability of the predictions. The data obtained includes the past 50 years of population, GDP, sex ratio, literacy rate, percent of population with electricity, Infant mortality rate, birth rate and fertility rate in India. The data is divided into two sects: the x-values of past 8 years of each entity, the y-values of the following 10 years of population. The aforementioned dataset is used for training and predicting.

III. MODEL

The model employed is a branched extension of the conventionally used LSTM model; herein, the utility of multi-variate and multi-step attributes is added to ascertain that the multiple factors affecting the population are also taken into account along with its time-variance. The constructed model is a Long-Short Term Memory deep learning model that utilizes recursive functions for training each node. The sequential model develops through a 50 to 10 fully-interconnected layer which aids in the learning of each node in the module. The model was trained with a batch-size of 80for72 epochs to reduce the root-mean square error of the training set. Finally, the past 8 years of
data—which were not utilized in training to maintain optimum fitting of data—were inputted in the model and the results were obtained.

IV. RESULTS

The training accuracy of the model on normalized data through mean average error is 0.0842 which corresponds to a ~ 0.07% error in the prediction of the population. Though this certainly adds to the uncertainty of the model—yet, it also depicts the high reliability which has been achieved through the multi-time step and multi-variate model. The model predicts a 11.3% growth in population over the next 10 years. This is representative of an increase of 152,882,320 individuals—more than double the current population of UK—with the total population topping 1.5 billion.

V. POPULATION-RESOURCE ANALYSIS

The current availability of the resources was compared to the predicted population. The results of the analysis are as below.

Water
Average Water Supply Per Capita in The Next 10 Years:
928077.6572179636 liters
Total Percentage Decline in Water Availability Per Capita:
10.1549223346208 %
Total Water Consumption Per Day:
194102472960.0 liters

Crude Oil
Total Crude Oil Consumption Per Day:
1709675510.26176 liters
Time Taken by 2028 Population to finish Indian Crude Oil Reserves:
410.53 Days

Energy
Total Wattage Consumption by 2028:
113485137464.0KWH
Maximum Power Possible Left for Export in 2028:
119874796032.0 KWH

Grain
Total Grain Required for Alimentation in 2028:
233177547571.2 Kg per Year
Total Grain Available Per Person (Disregarding Agricultural Use):
186.9 Kg per Year

Possible Consequences of Analyzed Results

Primarily, one of the most crucial elements, the Indian Crude Oil Reserves, are observed to have declined to naught in ~420 days. Though this may not present itself as an explicit problem, as India has the ability to import oil; however, it does portray the dependence of India on external sources. This is may be a concern for national security as it makes India extremely vulnerable to pressure from trade partners. Likewise, the toll on the supply of freshwater in India—for domestic use—also rises in conjunction with the population. Although climate change franticness is not taken into account in the analysis, it would also act as a detriment to sustainable water use in India. Further, the grain consumption also rises exponentially along with India’s booming population.

Though close to 200 kg of grains are available per person—this is disregarding agricultural use. Inclusive of all, India produces 275 million tonnes; however, through the next 10 years, the demand for alimentation will rise to 233 million tonnes—leaving on 42 million tonnes for other uses. On the other hand, the impact on the national electric grid is marginal as it already produces energy to export to countries. However, even the grid is not unaffected from the population boom as it has to cut down on export revenue to support the growing Indian population.

VI. METHODS TO ENSURE SUSTAINABILITY OF RESOURCES

As observed through the predictions and their comparisons to current resources, there are concerns of rapid, untenable growth in population and unsustainable use of resources. However, there are methods which can—explicitly or implicitly—mitigate overuse of resources and impede the population explosion in India. Primarily, a tried-and-tested method of decreasing the growth of population is limiting birth rates in a country. As previously observed in China, the “one-child policy” was employed to reduce the uninhibited growth of population. India may take a similar stance in limiting birth rates—this will ensure a lessening of the growth of population—to make sure the economy is less-intensive of resources. Likewise, another previously-utilized method of reducing resource consumption in an economy is rationing of certain at-risk goods. As observed through the analysis, the current oil reserves of India would only last for a minimal amount of time before running out; therefore, a form of restriction (taxation, quota or slab-tariffs) in consumption of the aforementioned could mitigate the rate of loss of the commodity. Lastly, one of the most effective ways is to change the mindset of overconsumption of resources which prevails. This is the use grass roots efforts in the form of campaigns and schemes to incentivize saving of resources and inherently changing the perception of the consumer. To conclude, though there are foreseeable challenges concerning the population boom in India. There can be the use of preventive and assertive measures to mitigate—and in most cases with great influential ability—to secure a sustainable growth of the population in conjunction with the viability of resources in the nation.

VII. REFERENCES
