

THE EVALUATION OF THE REAL ALPHA VALUE IN BRAZIL AND ITS PROJECTION UNTIL THE YEAR 2050

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When a cost–benefit analysis is applied to the optimization of practices involving radiation protection, the alpha value is used to determine the amount of money required to be invested in a practice to minimize radiation doses to acceptable levels. The alpha value is often linked to the gross domestic product (GDP) per capita, so the monetary reference value of person-Sievert can often be different in each country. Evaluation of the alpha value in Brazil was performed in 1993 and 2000 making use of the procedure advised by ICRP to produce projections up to 2015 and subsequently in 2004 by using the procedure recommended by the IAEA. This paper, in response to the social and economic situation in Brazil, calculates the alpha value and compares it with the projections of the 1993 and 2000 papers and includes a dollar correction to take account of the differences in the purchasing power from that time. This procedure illustrates the significant gap of value in use and that the actual value should be two to three times higher. By GDP per capita, the authors could calculate the alpha value updated to various countries including the European Union and compare them with the official value currently in use. In conclusion, it is believed that all countries that adopt an alpha value should upgrade it to the present day.

INTRODUCTION

When a cost–benefit analysis is applied to the optimization of practices involving radiation protection, the alpha value is used to determine the amount of money required to be invested in a practice to minimize radiation doses to acceptable levels. The alpha value is often linked to the gross domestic product (GDP) per capita, so the monetary reference value of person-sievert can often be different in each country.

In 1992, a technical paper was presented in II Regional Congress of Nuclear and Radiological Protection.⁽¹⁾ On that occasion, a projection up to the year 2025 was shown based on the economic development prospective made by IBGE.⁽²⁾ At that time, Brazil was facing an increasing rate of devaluation, and this led the authors to present three approaches: Historic Realistic, Government Institution and Historic Optimistic.

Population growth

In 1997, the IBGE⁽²⁾ report predicted that the expected population growth up to 2025 would lead to 218 million inhabitants, which is significantly lower than the one projected in the aforementioned 1992 technical paper, which was 288 million inhabitants. The recent IBGE publication⁽³⁾ considers a

linear increase of the Brazilian population from 2015 to 2050 from which the projected population for the year 2025 is 216.7 million.

GDP growth

In 1997 the IBGE⁽²⁾ reported the Brazilian Government projections to year 2000 and beyond a GDP growth rate of 4.1% per year, although the International Monetary Fund (IMF) has projected a different rate of 2.5%. However, the current economic climate in Brazil has predicted a decrease in the GDP during the year 2012–15, and the government foresees a recovery only from year 2018.

In the previous technical paper⁽⁴⁾, it was observed that the government's predicted population growth of 1% per year did not occur and the GDP had an irregular growth as shown in Figure 1.

Due to these facts and the previous projections based on different assumptions, this paper reports on new research with the results projected to 2050 and comparisons made with the results from earlier technical papers.

BRIEFING OF THE PREVIOUS PAPER

IBGE's new population growing projections⁽³⁾ considered a growing rate of 1.36% during the 2000–04

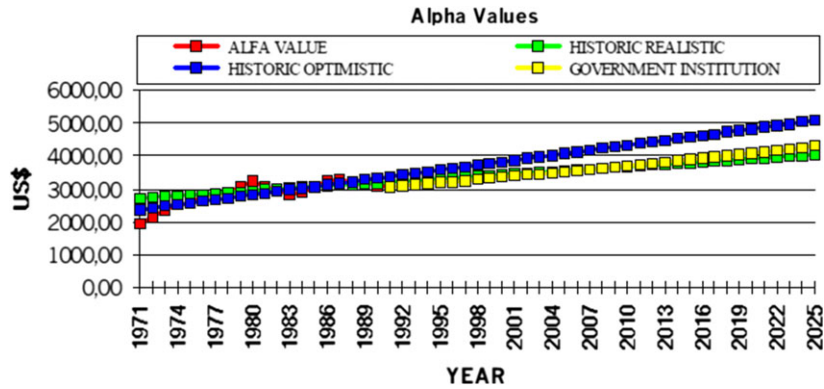


Figure 1. Alpha Value—earlier technical paper.⁽⁴⁾

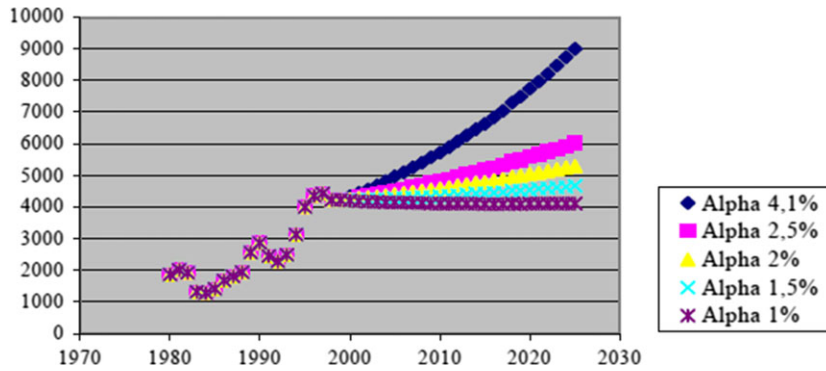


Figure 2. Alpha value till 2025.

Table 1. Alpha value x GDP growing.

Alpha value US\$	9000	6000	5300	4700	4100
GDP growth	4.1%	2.5%	2.0%	1.5%	1.0%

period, 1.17% during 2005–09 and 0.98% during 2010–25. Figure 2 shows predicted values up to 2015, considering a growing rate of 4.1%, 2.5%, 2.0%, 1.5% and 1.0%, for Curves 1–5, respectively.

The alpha value was calculated according to the policy used by IAEA as described by Stockell et al.⁽⁵⁾

It is important to note that the alpha value for 1998 was 3100, and in 2025 the alpha value will assume the values showed in Table 1.

RESULT OF THE PRESENT PAPER

From a Brazilian Governmental Institution, “Instituto Brasileiro de Geografia e Estatística, IBGE”,⁽⁶⁾ the

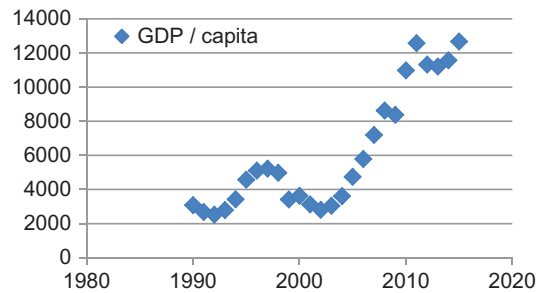


Figure 3. GDP per capita (Brazil).

GDP per capita from 1990 to 2014 is shown in Figure 3.⁽⁶⁾

From the publication⁽³⁾ the authors have obtained the population of several countries in 2015 and a projection for 2050 and 2100. In this paper, they consider only the projection to 2050.

The population growth during the considered period is assumed linear as showed in Figure 4.

As in the previous technical paper⁽¹⁾, three different projections to 2050 were evaluated as shown in Figure 3.

Historic optimistic

In the first projection, the authors did a linear growth using the peak occurred in 1990, 1995 and 2012. They do not use the 2011 peak because it seems out of the curve tendency.

Government institution

In the second projection, the authors have considered a medium linear curve starting from the curve placed in Figure 3.

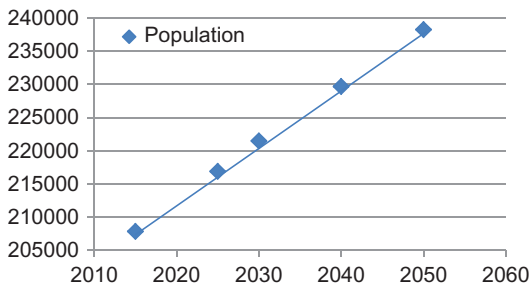


Figure 4. Population growth from 2015 to 2050 in Brazil.

Historic realistic

The third projection also was a linear curve that the authors consider pessimist growth that start in 2015 curve of Figure 5 and in 2050, it has a value less than the second projection and equal to the difference between the first and the second projection (Figure 5).

Again, the alpha value was calculated according the policy used by IAEA as described by Stockell et al.⁽⁵⁾

In Table 2 the results of alpha value are for typical years.

From the publication⁽⁷⁾ the authors have obtained the GDP, and from publication⁽³⁾ they have obtained the population of several countries and then have obtained the alpha values as shown in Table 3.

DISCUSSION

In 2015 the alpha value is 15% higher than the governmental official value of US\$ 10000. It is higher than in earlier years even for a growth of 4.1% in GDP per capita for all the three projection and the authors think that this is due to the large growth of GDP from 2004 to 2010 (Figure 3).

The result that the growth in GDP was more than the optimistic hypothesis of 4.1%⁽⁴⁾ until 2025 is considered due to the US\$ devaluation to the Brazilian currency in the late 1990s and early 2000s. The average growth rate of GDP until 2015 is 2.5%.

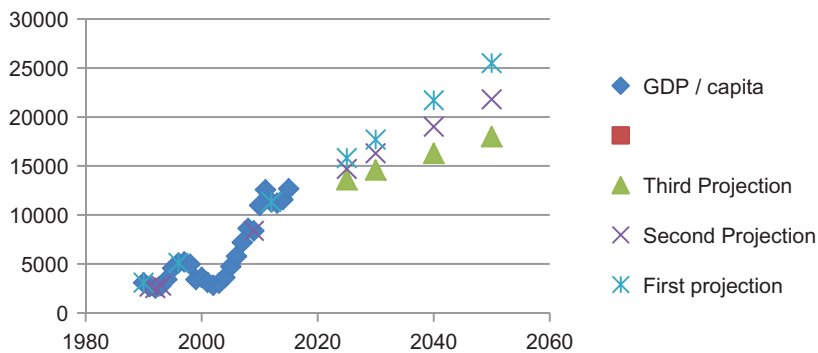


Figure 5. The projections of GDP growth.

Table 2. Alpha values (person-Sv).

Year	2015	2025	2030	2040	2050
Projection 1	11 500	15 400	17 200	21 100	24 800
Projection 2	11 500	14 300	15 800	18 500	21 200
Projection 3	11 500	13 200	14 200	15 800	18 100

Table 3. GDP, population, GDP/capita, alpha.

Country	GDP (US\$) x10 ⁶	Population x10 ⁶	GDP/capita ⁽⁸⁾ (US\$)	alpha
Brazil	2 353 025	208	12 670	11 500
USA	17 418 925	322	54 100	52 800
Japan	4 616 335	127	36 300	35 400
Mexico	1 282 725	127	10 100	9900
UK ⁽⁹⁾	3056	64	6000	5900
European Union ⁽¹⁰⁾	18 495 349	507.4	36 330	35 400
Netherland	—	—	41 500	40 500

Table 4. Average dollar depreciation from 1990 until 2025 as function of real α value variation in Brazil.

Projection 1	Projection 2	Projection 3
6.6%	5.8%	5.0%

Since 2015, the Brazilian GDP growth rate is very small or even negative, and the government hopes that by the year 2018, the economy will begin to recover.

Assuming a GDP growth rate of 2.5% per year until 2025, it is assumed that the values shown in Table 2 above US\$ 6000 shown that Table 1 will be induced by the depreciation of the US dollar.

Therefore, considering the three projections from Table 2, the average dollar depreciation per year from 1990 until 2015 for each projection in this paper is shown in Table 4 as a function of the real alpha variation in Brazil.

Presently, the alpha value for Japan is US\$25000, and for USA and European Community it is US\$20000. Table 3 demonstrates that the alpha values need to be reviewed and increased by a factor between 40% and 164%, except for the European Community for which the value needs to be reduced by 30%.

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