RIVERWORLD BEINGS

Characterisation of the population of beings of **Riverworld**.

Riverworld is a fictional planet and the setting for a series of sci-fi books written by **Philip José Farmer**.
Riverworld is an artificial environment where all humans (and pre-humans) ever born who died after reaching 5 years old are reconstructed.
Most of the resurrected awaken in a body equivalent to that of their 25 year old selves, in perfect health and free of any previous genetic or acquired defects.

A friend of mine made fun of the book concept and claimed half of the beings ressucitated would be prehistorical.

This project is proving him wrong.

Definitions

- Begining of mankind : Homo Erectus, -1500K, assuming all beings on Riverworld can walk
- End of mankind : 2016. In the book, all people die in 1983 after interacting with an alien civilisation.
- Child Mortality *CM* : death of infants and children under the age of 5
- Infant Mortality *IM* : death of infants and children under the age of 1
- Life Expectancy *LE* : average time a being is expected to live
- Life Adult Expectancy *LAE* : average time a being is expected to live if he reachs 5 years old

Datas

- Dataset compiled amongst considered sources :
  - until now, conservative estimations for pre modern times : `./data/population-min.csv`
  - until now, optimistic estimations for pre modern times : `./data/population-max.csv`
  - until now, average estimations for pre modern times : `./data/population-avg.csv`
  - including 2070 projections `./data/population-future.csv`
- The dataset consists of Point In Times (*PIT*)
- For each *PIT*, these metrics are available : year, beings count in millions, *LE*, *LAE*, *CM* and continental proportions
- Depending on sources, *CM*, *IM*, *LE* and/or *LAE* are provided or not. Some datas have been extrapolated. Underlying model : $LE = CM * 5/2 + LAE * (1 - CM)$
- Case of beings count in prehistorical times :
  - Beings counts estimation flucuates a lot. They can go as low as 1K individuals up to 100K
  - We have 3 milestones in our dataset : -1500K (lower paleolithic), -50K (higher paleolithic) and -10K (begining of history)
  - For -10K, the poulation count is within the magnitude of the millions according to most of the sources. We kept the McEvedy estimation of 4 millions.
  - For -50K, we kept the higher estimation of Jean-Pierre Bocquet-Appel from his study of upper paleolithical meta populations in Europe. He found 15K individuals in the Aurignacien (-30K). Wordlwide, we estimated, as a minimum, we timed this result by 5. As a maximum by 10.
  - For -1500K, we've assumed the population could not be higher than in -50K. We assumed the population at that time would be the population of -50K / 2.
- Case of *LE* et *CM* for prehistorical times :
  - As for beings counts, the *LE* estimations vary greatly
  - The Kaplan study suggest hunter gatherer modern societies tell us how prehistoric men lived and died. The study suggests the *ALE* is around 50 years and the *CM* around 0.5
  - For reference, the *CM* of 1900 is 0.4 and the Scheidel estimation of Classic Rome *CM* is 0.5

- We cowardly derived the *CM* of pre Roman times to 0.6

Calculus

- Linearity in between *PIT*s :
  - The underlying assumption is that the *PIT* metrics evolve linearly in between two *PIT*s
  - This assumption can be considered true from -1500K to 1700, from 1700 to 1900, from 1900 to 1950 and from 1950 to today
  - The *PIT* resolution in the dataset is consistent with this observation
  - We then assume numerical midpoint integration is a reasonable estimation
- For the period *PIT 1 => PIT 2*
- *AB yx = Amount of Beings for year x*
- Elapsed Time *ET = y2 - y1*
- Average Amount of Beings for Period *AABP = (AB y2 + AB y1) / 2*
- *LAE* for Period *LAEP = (LAE y1 + LAE y2) / 2*
- Proportion of Adult Beings To Be for Period *PABTBP = 1 - ((CM y1 + CM y2) / 2)*
- Thus Amount of Beings who were Born for Period *ABP = ET * AABP / LAEP*
- Thus Amount of Adult Beings who were Born for Period *AABP = ET * AABP * PABTBP / LEP*
- Another calculus method is to use a simpe model of population growth :
  - *AB y1 = Ce^(r * y1)* and *AB y2 = Ce^(r * y2)*
  - By integration, *ABP = ET * (AB y2 - AB y1) / (ln(AB y2) - ln(AB y1)) / LEP*
  - This method proved to be very similar to the naïve numerical integration we selected (cf Report - Figure 6)

Results

- The last report : `./output/(min|max|future)/report.pdf`
- The last plots : `./output`

Sources

- https://en.wikipedia.org/wiki/Human_evolution
- https://ourworldindata.org/child-mortality
- https://ourworldindata.org/infant-mortality
- https://en.wikipedia.org/wiki/Life_expectancy#Variation_over_time
- https://en.wikipedia.org/wiki/World_population#Past_population
- https://ourworldindata.org/world-population-growth
- http://www.unm.edu/~hkaplan/KaplanHillLancasterHurtado_2000_LHEvolution.pdf
- https://en.wikipedia.org/wiki/Prehistoric_demography
- https://en.wikipedia.org/wiki/World_population_estimates
- http://www.evolhum.cnrs.fr/bocquet/jas2005.pdf
- https://www.princeton.edu/~pswpc/pdfs/scheidel/040901.pdf
- https://scholarspace.manoa.hawaii.edu/bitstream/handle/10125/17288/AP-v47n2-190-209.pdf
- https://ourworldindata.org/world-population-growth
- http://www.math.hawaii.edu/~ramsey/People.html

Install

- `pip install --upgrade pip`
- `pip install -r requirements.txt --user`
- Fonts used in this project : `./resources/fonts`
- PDF dependencies :

- mac : `brew cask install wkhtmltopdf`
- linux : `apt-get install wkhtmltopdf`

Run

- Configuration is loaded from `config.ini`
- `python riverworld.py min|max|avg|future`
- all at once : `python riverworld.py min;python riverworld.py max;python riverworld.py avg;python riverworld.py future`

Credits

- Author : Lucas Mouilleron, http://lucasmouilleron.com
- Thanks to : Jean-Benoît Bourron, Romain Charlassier

RESULTS

Dataset used : `population-future.csv`

Main Results

Metric	Value
Total beigns ever born	72.1 billions
Total adult beigns ever born	25.1 billions
Proportion of alive beings amongst all beings ever born	13.9%
Median year of adult beings ever born	1800
Median year of beings ever born	1

Proportion Of Adult Beings Amongst All Adults Ever Born

Sub Population	Value
Me	1.38613497992e-09% (1)
Asians	54% (1.37e+10)
Paloelithical era	4.3% (1.1e+09)
Neolithical era	4.3% (1.1e+09)
-10K until the birh of Jesus Christ	11.2% (2.8e+09)
Classical Athens (508 BC - 322 BC) (with civil rights)	0.001% (1.5e+05)
Classical Athens (508 BC - 322 BC)	0.005% (1.2e+06)
Roman Republic (509 BC - 27 BC)	0.015% (3.9e+06)
Western Roman Empire (27 BC - 476 AD)	2.3% (5.9e+08)
After WWII	43% (1.1e+10)

Adult Beings Results

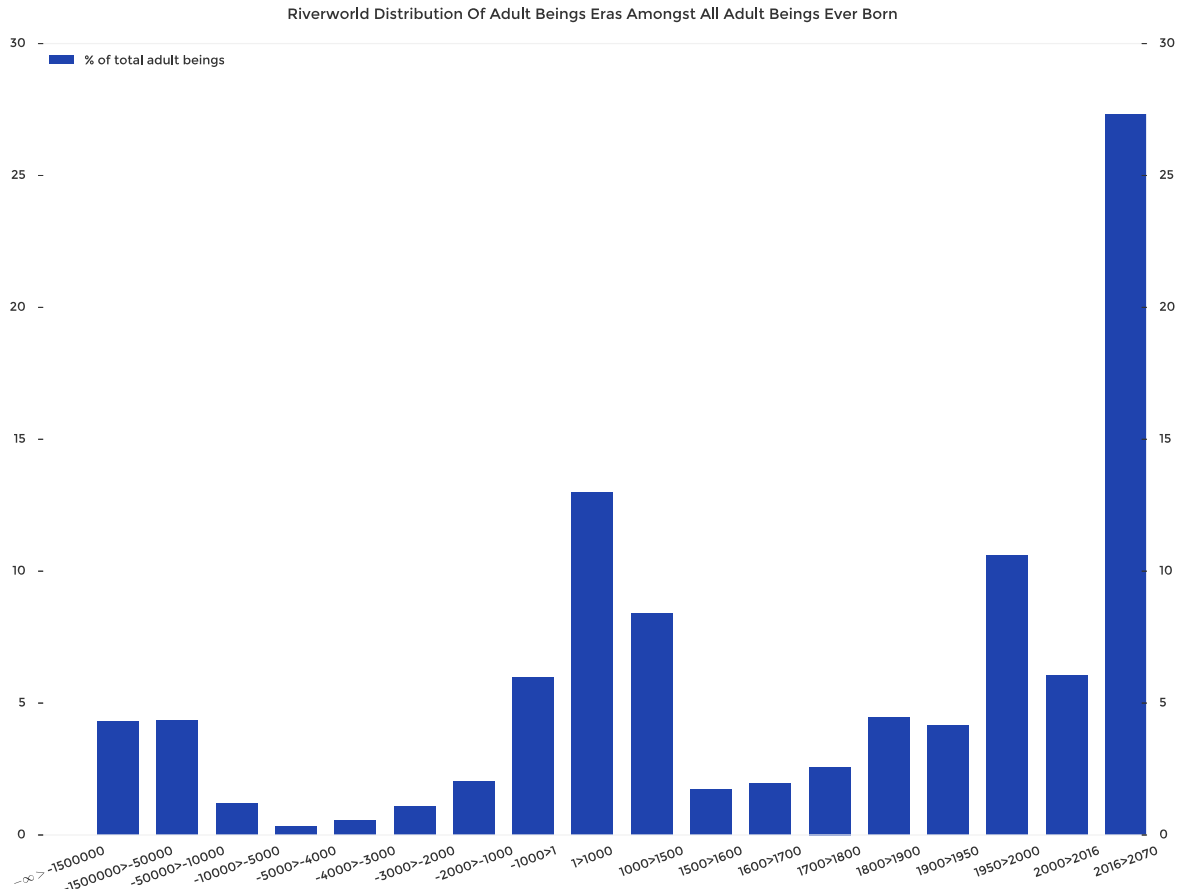

figure 1

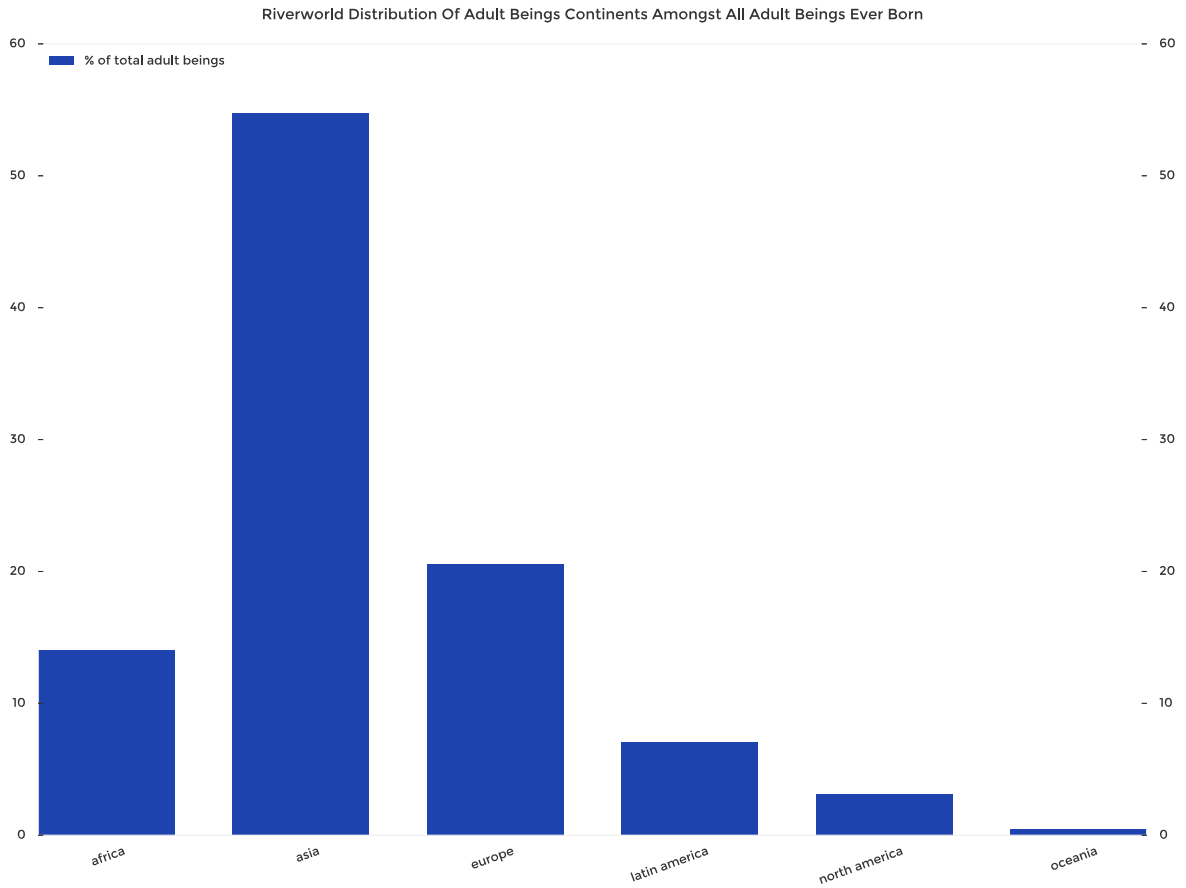

figure 2

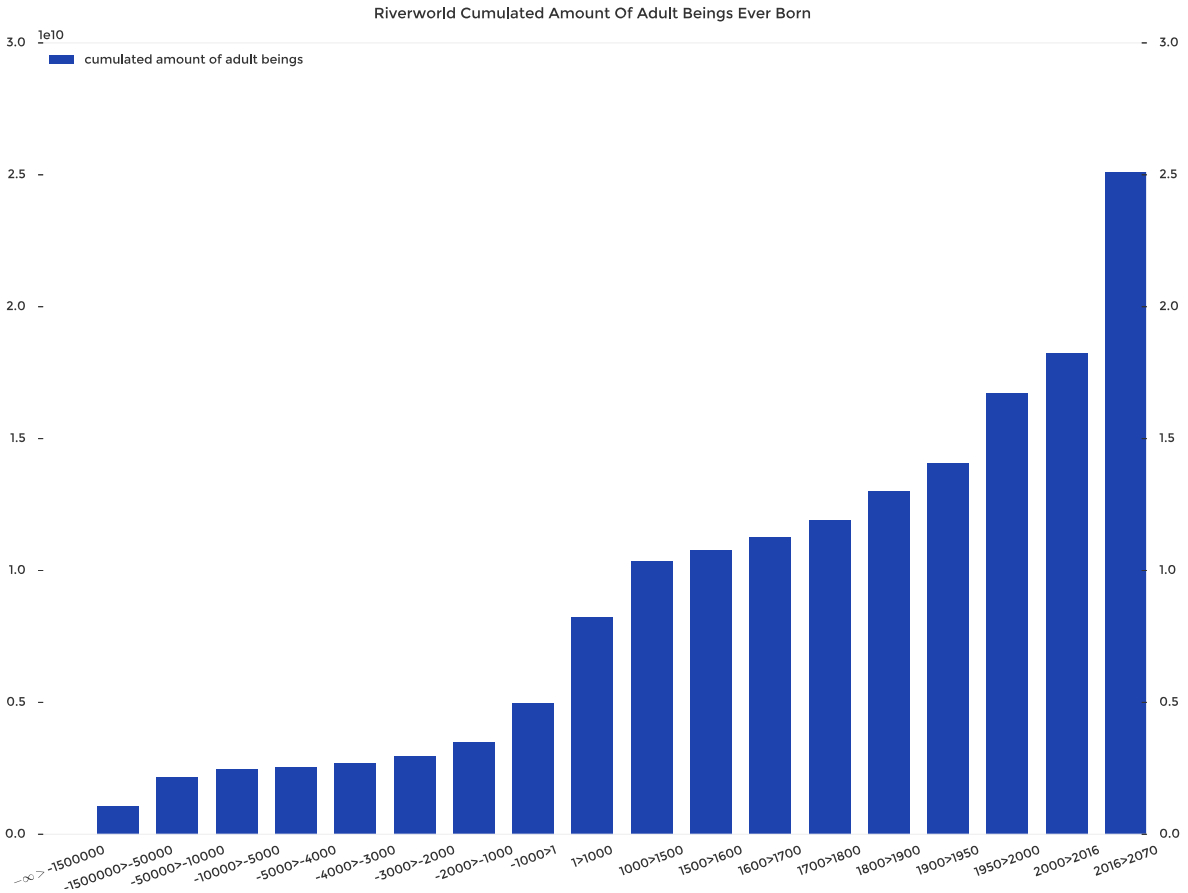
Riverworld Cumulated Amount Of Adult Beings Ever Born
1e10
cumulated amount of adult beings
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-∞>-1500000
-1500000>-50000
-50000>-10000
-10000>-5000
-5000>-4000
-4000>-3000
-3000>-2000
-2000>-1000
-1000>1
1>1000
1000>1500
1500>1600
1600>1700
1700>1800
1800>1900
1900>1950
1950>2000
2000>2016
2016>2070

figure 3

All Beings Results

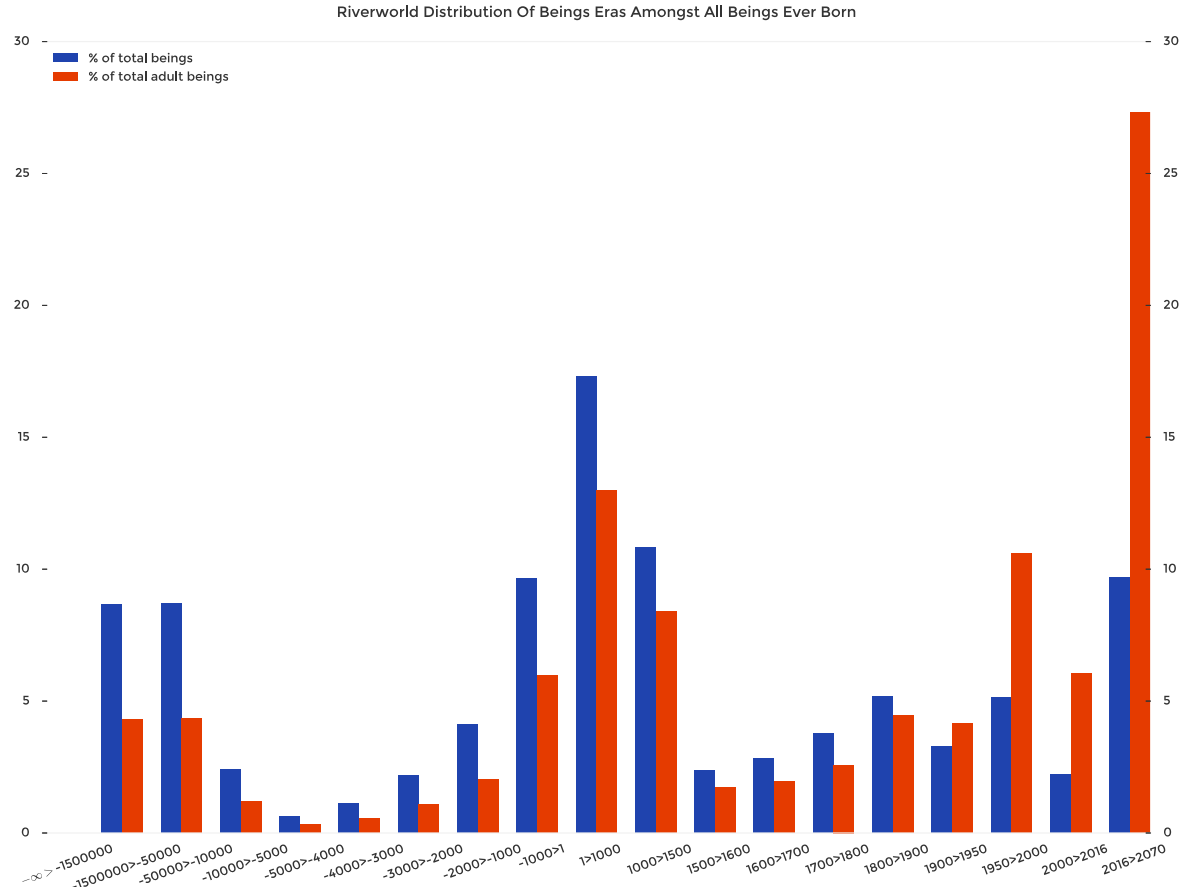

figure 4

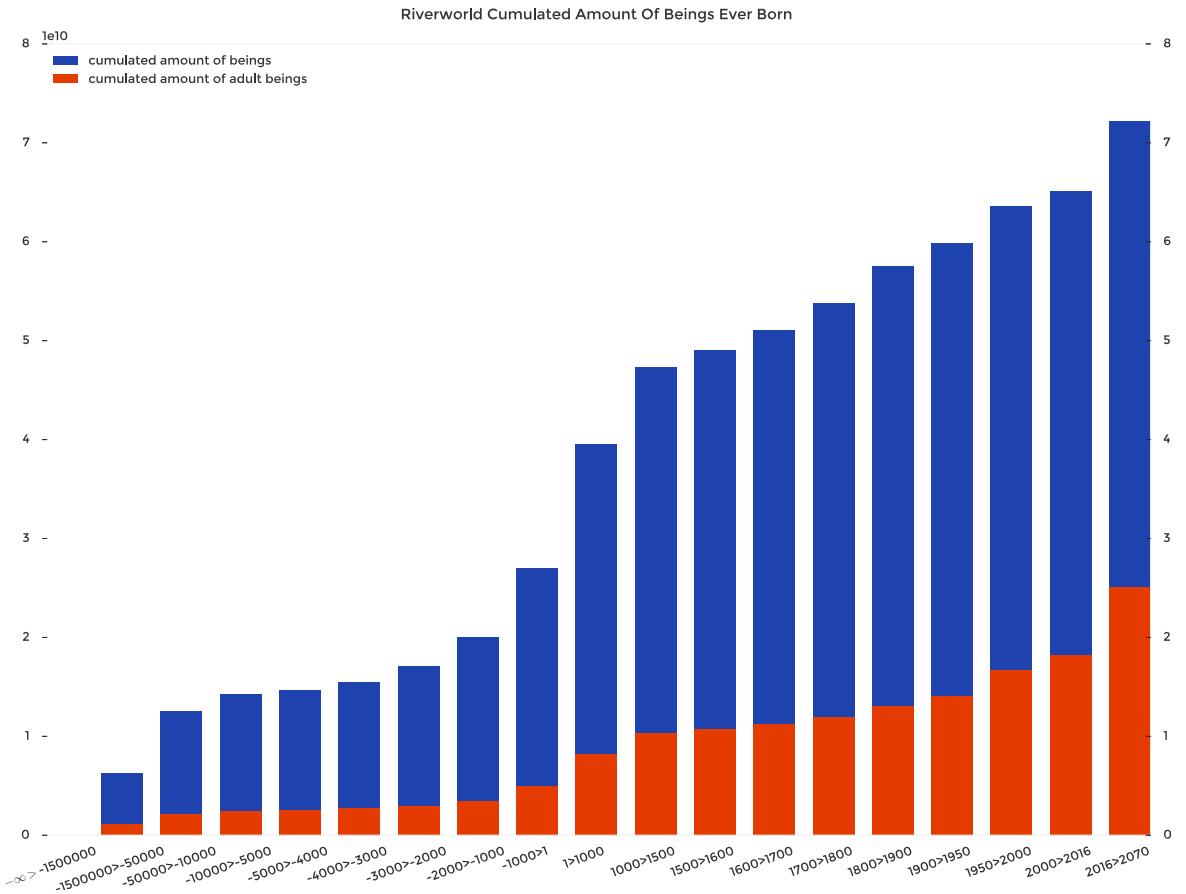

figure 5

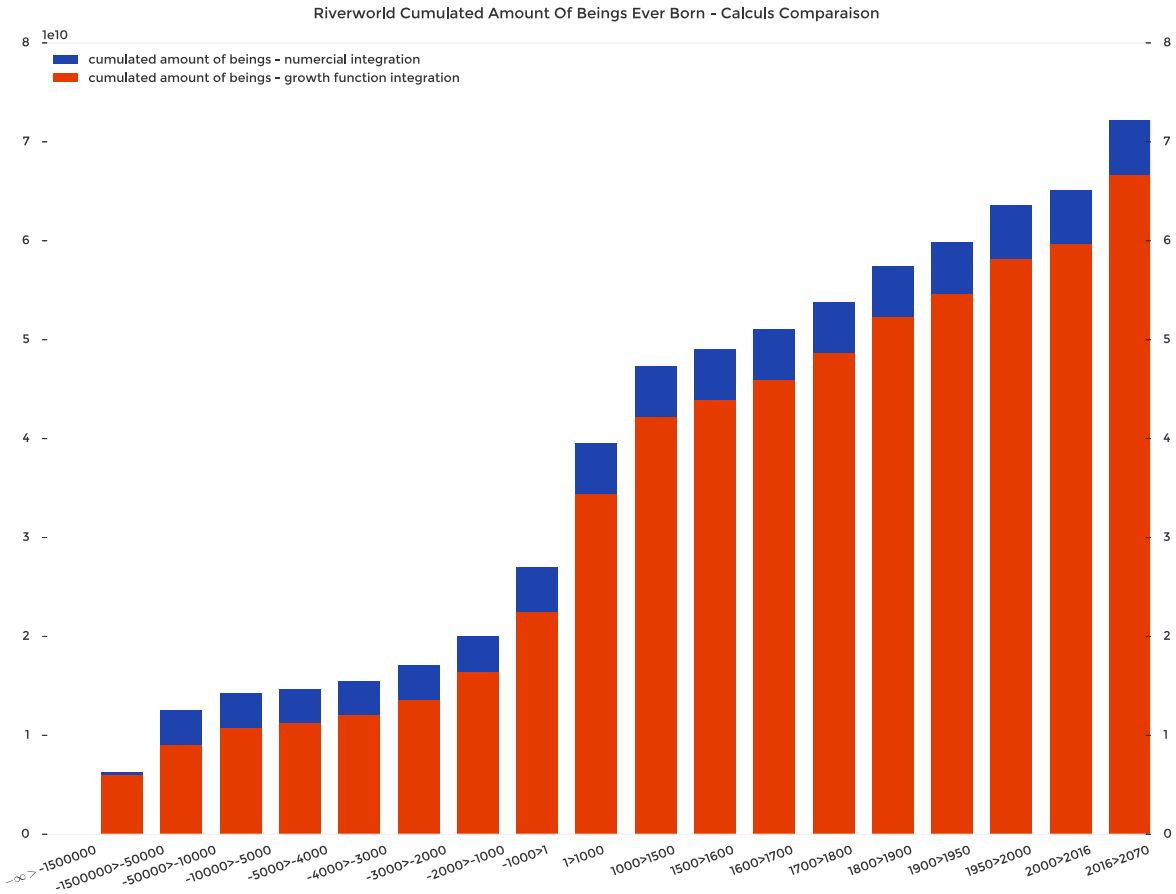
Riverworld Cumulated Amount Of Beings Ever Born - Calculs Comparaison
1e10
cumulated amount of beings - numercial integration
cumulated amount of beings - growth function integration
0
1
2
3
4
5
6
7
8
-∞>-1500000
-1500000>-50000
-50000>-10000
-10000>-5000
-5000>-4000
-4000>-3000
-3000>-2000
-2000>-1000
-1000>1
1>1000
1000>1500
1500>1600
1600>1700
1700>1800
1800>1900
1900>1950
1950>2000
2000>2016
2016>2070

figure 6