

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 resuscitated would be prehistorical.

This project is proving him wrong.

Definitions

- Beginning of mankind : Homo Erectus, -700K, 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 reaches 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 fluctuates a lot. They can go as low as 1K individuals up to 100K
 - We have 3 milestones in our dataset : -700K (lower paleolithic), -50K (higher paleolithic) and -10K (beginning of history)
 - For -10K, the population 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 paleolithic meta populations in Europe. He found 15K individuals in the Aurignacien (-30K). Worldwide, we estimated, as a minimum, we timed this result by 5. As a maximum by 10.
 - For -700K, 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 *PITs* :
 - The underlying assumption is that the *PIT* metrics evolve linearly in between two *PITs*
 - This assumption can be considered true from -700K 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*
- $AB\ yx = \text{Amount of Beings for year } x$
- 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 simple 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-min.csv

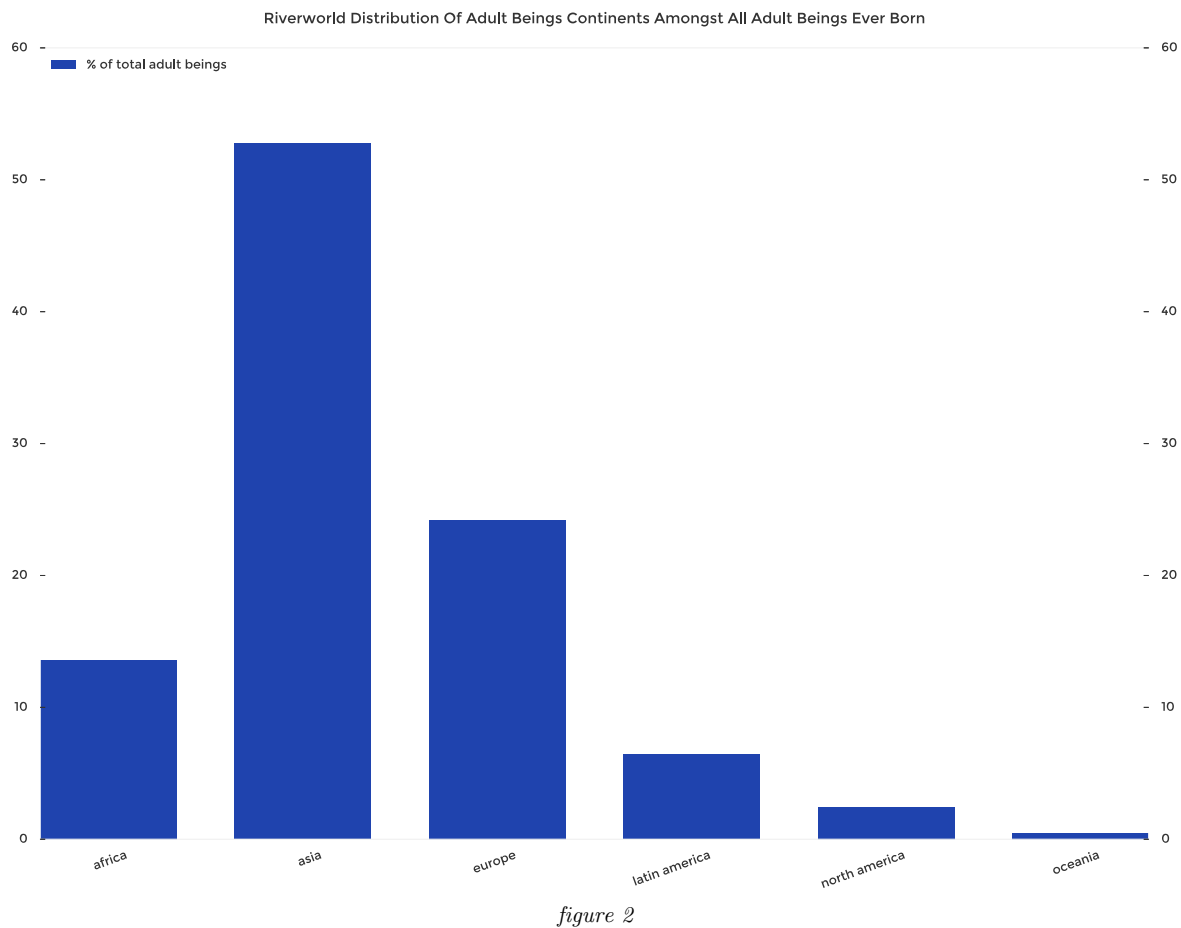
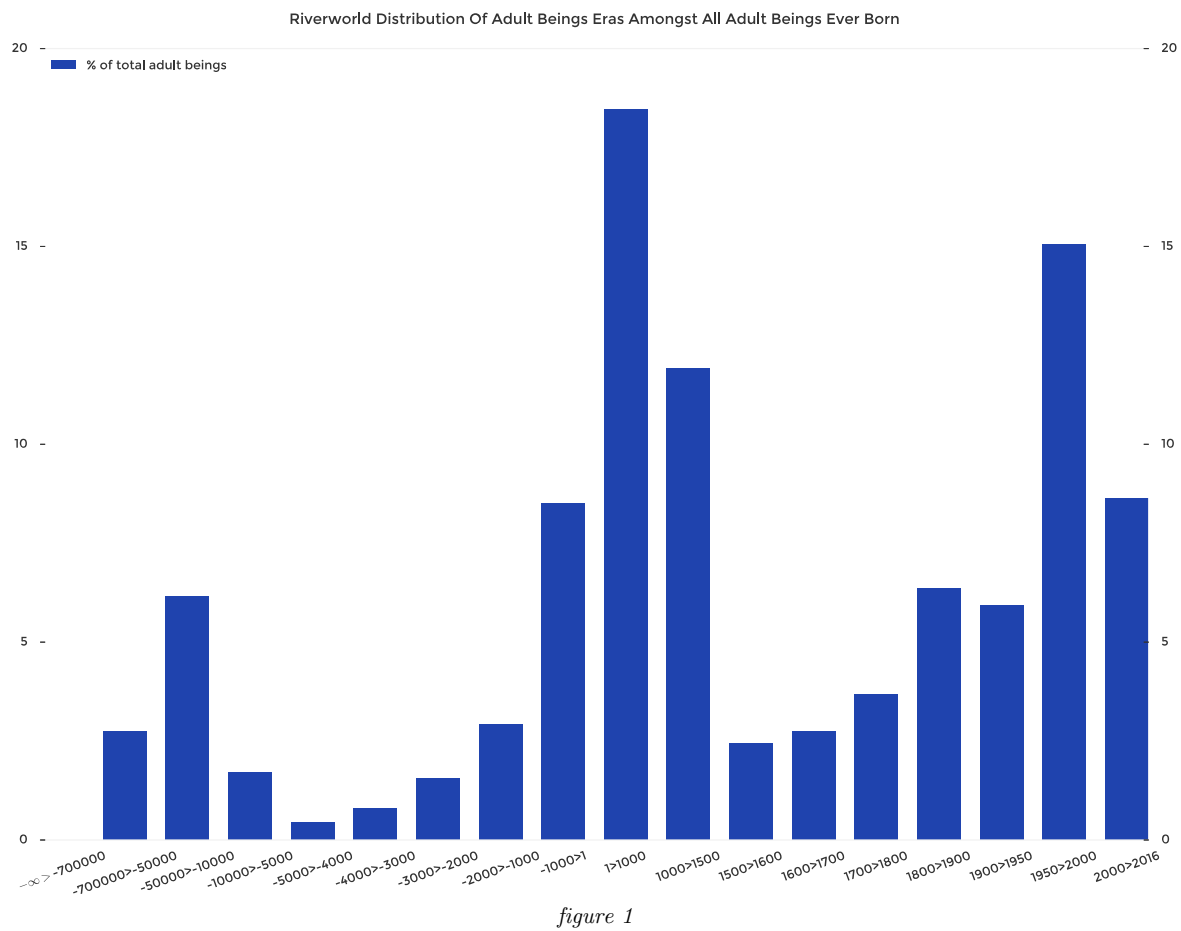
Main Results

Metric	Value
Total beigns ever born	61.7 billions
Total adult beigns ever born	17.6 billions
Proportion of alive beings amongst all beings ever born	11.9%
Median year of adult beings ever born	1000
Median year of beings ever born	1

Proportion Of Adult Beings Amongst All Adults Ever Born

Sub Population	Value
Me	1.62059038245e-09% (1)
Asians	52% (9.31e+09)
Paloelithical era	2.8% (4.9e+08)
Neolithical era	8.9% (1.6e+09)
-10K until the birh of Jesus Christ	22.1% (3.9e+09)
Classical Athens (508 BC - 322 BC) (with civil rights)	0.001% (1.5e+05)
Classical Athens (508 BC - 322 BC)	0.007% (1.2e+06)
Roman Republic (509 BC - 27 BC)	0.022% (3.9e+06)
Western Roman Empire (27 BC - 476 AD)	3.3% (5.9e+08)
After WWII	29% (5.2e+09)

Adult Beings Results



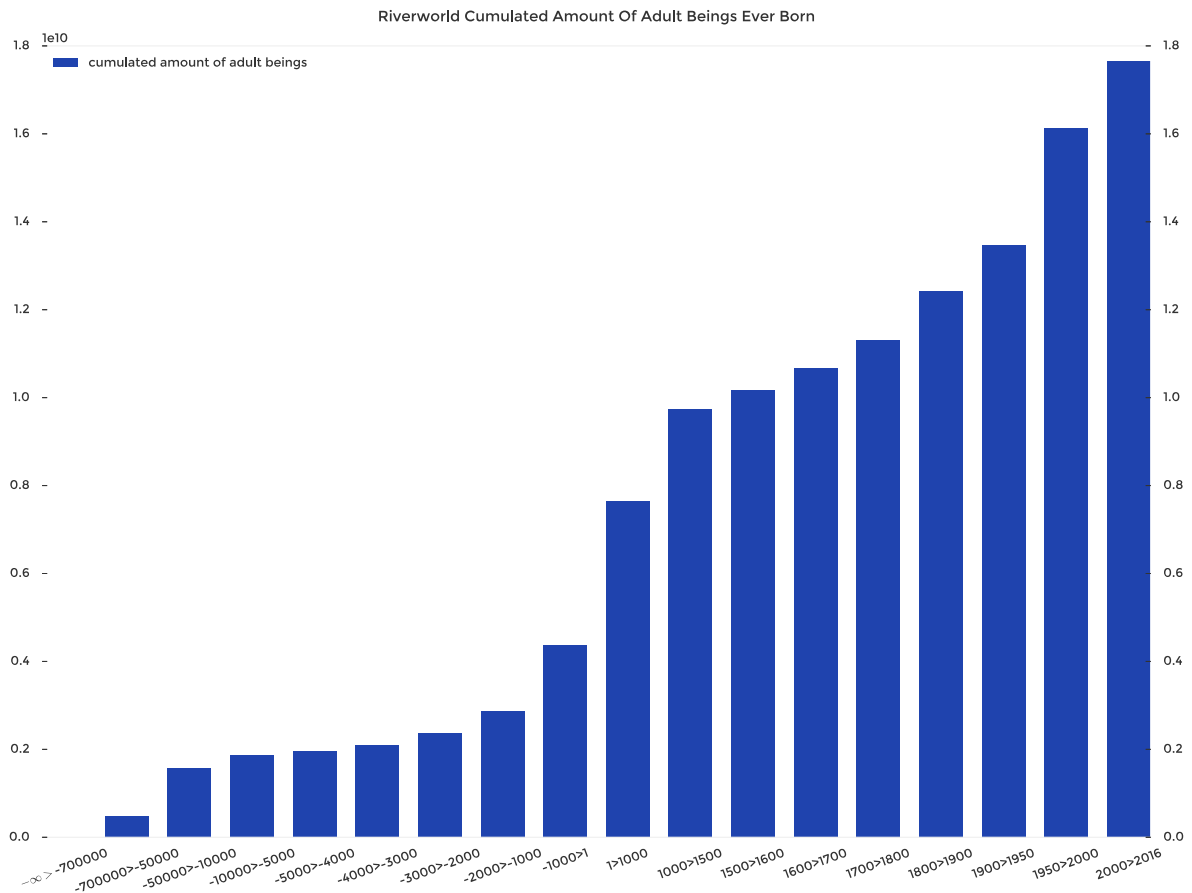
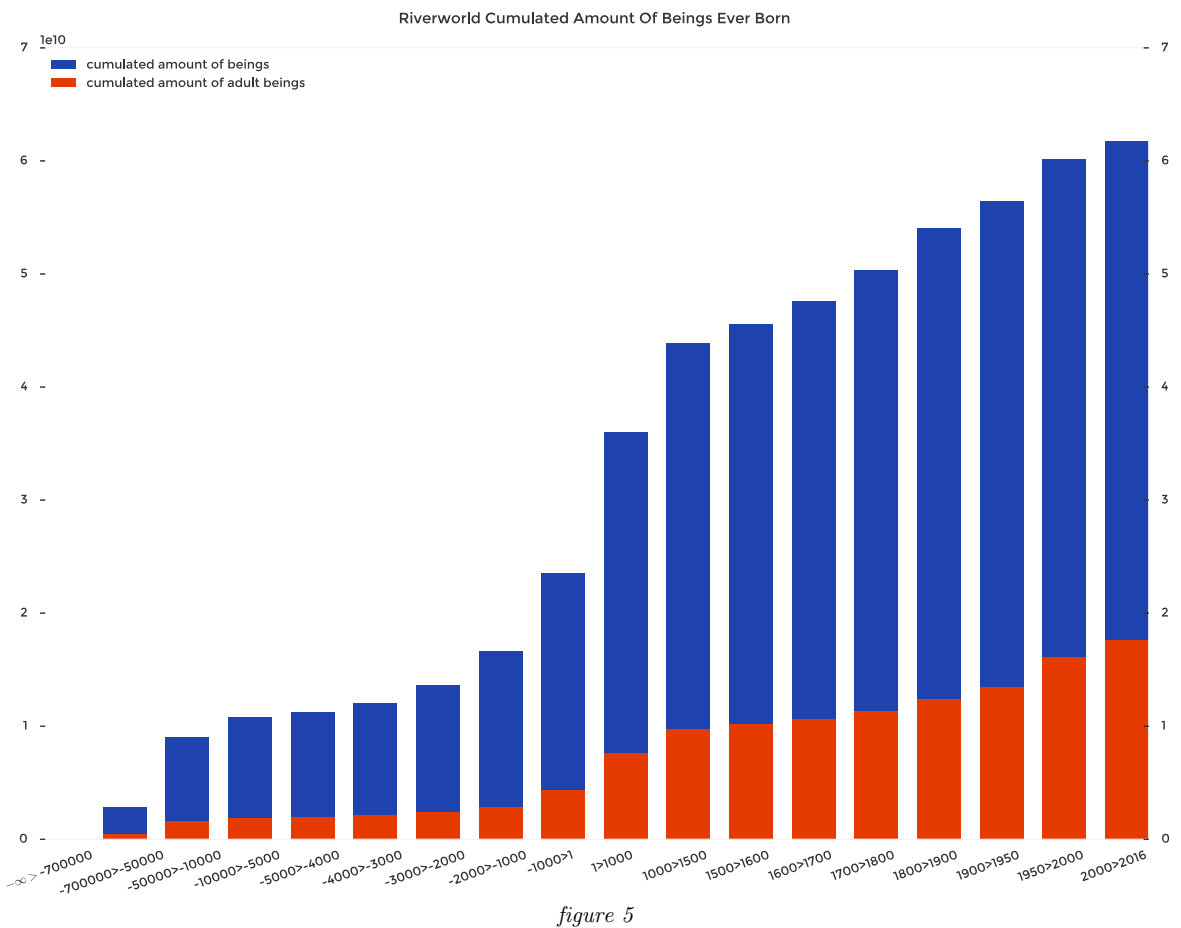
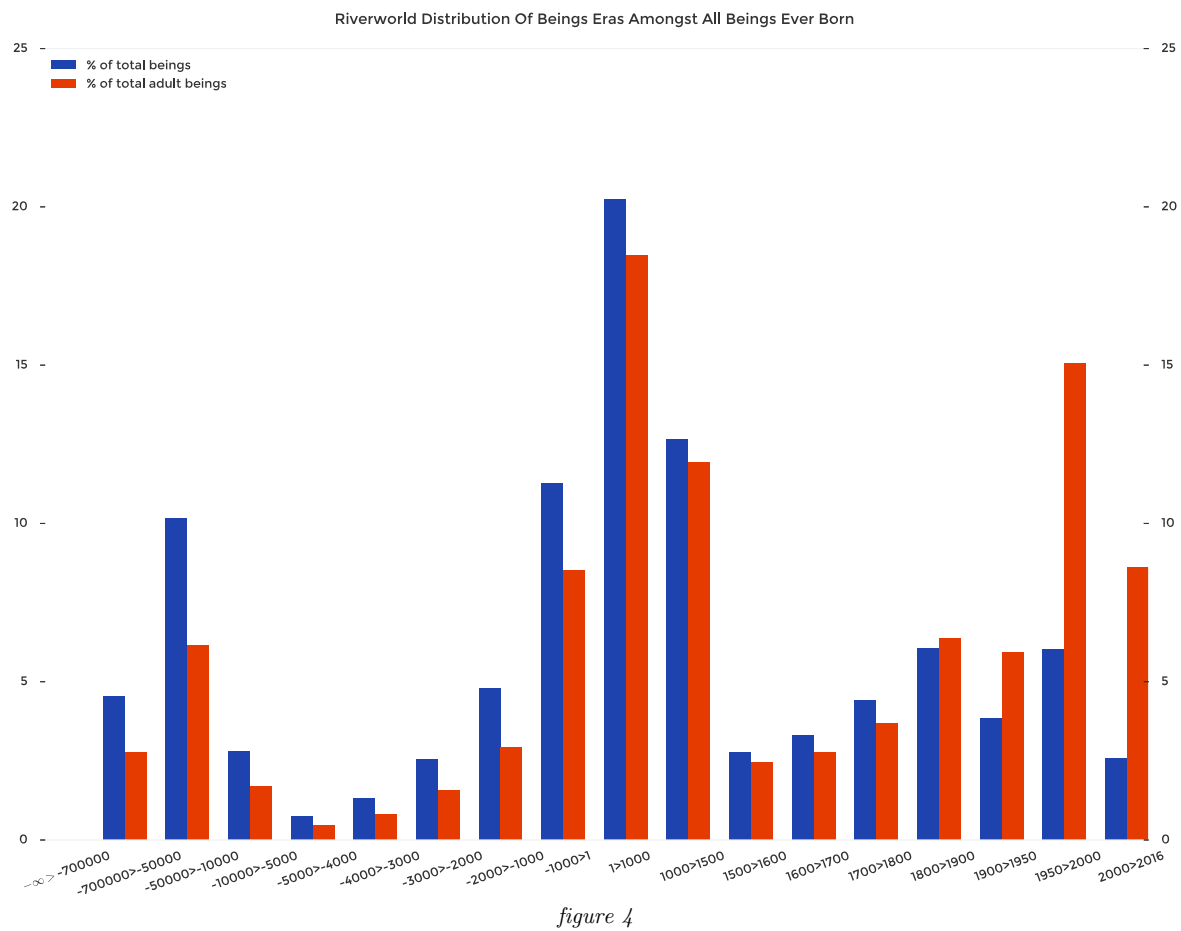


figure 3

All Beings Results



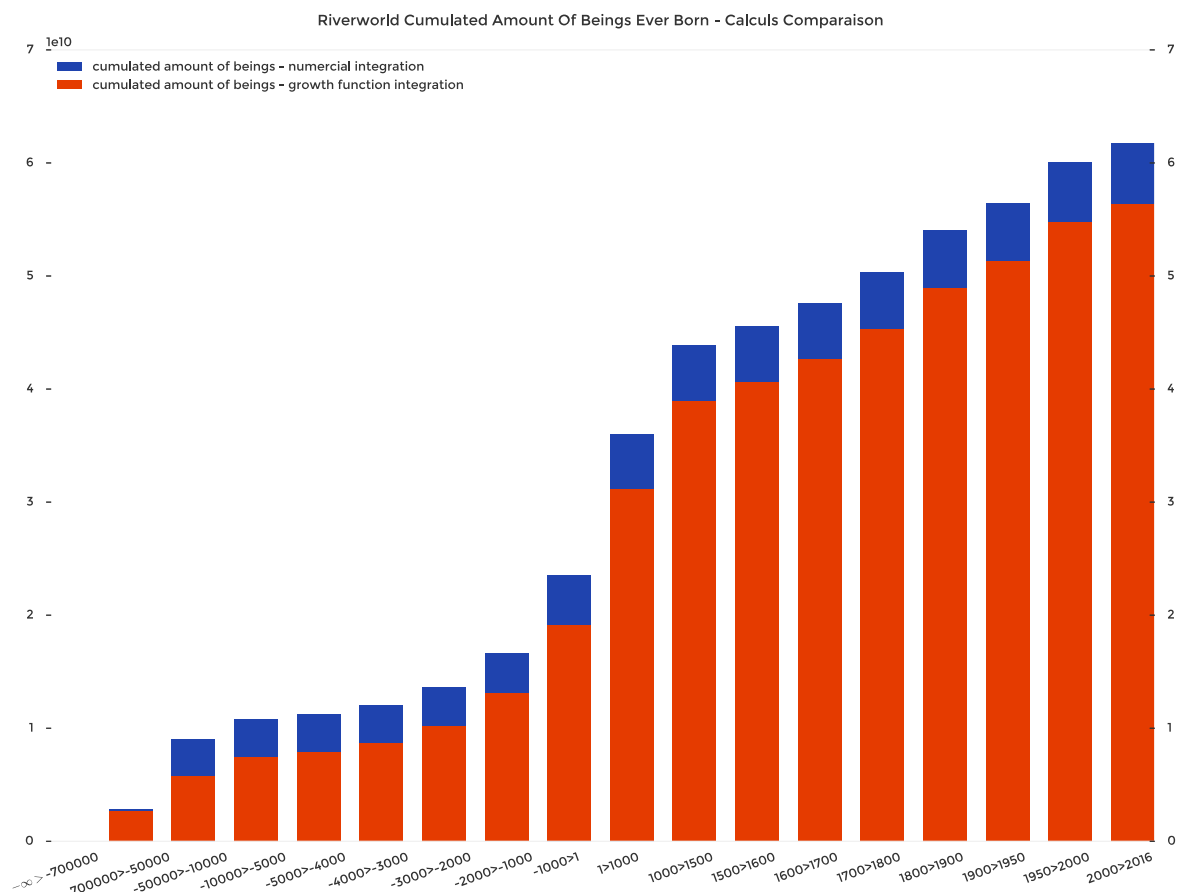


figure 6