

# RIVERWORLD BEINGS

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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* = 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://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/Life_expectancy#Variation_over_time)
- [https://en.wikipedia.org/wiki/World\\_population#Past\\_population](https://en.wikipedia.org/wiki/World_population#Past_population)
- <https://ourworldindata.org/world-population-growth>
- [http://www.unm.edu/~hkaplan/KaplanHillLancasterHurtado\\_2000\\_LHEvolution.pdf](http://www.unm.edu/~hkaplan/KaplanHillLancasterHurtado_2000_LHEvolution.pdf)
- [https://en.wikipedia.org/wiki/Prehistoric\\_demography](https://en.wikipedia.org/wiki/Prehistoric_demography)
- [https://en.wikipedia.org/wiki/World\\_population\\_estimates](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

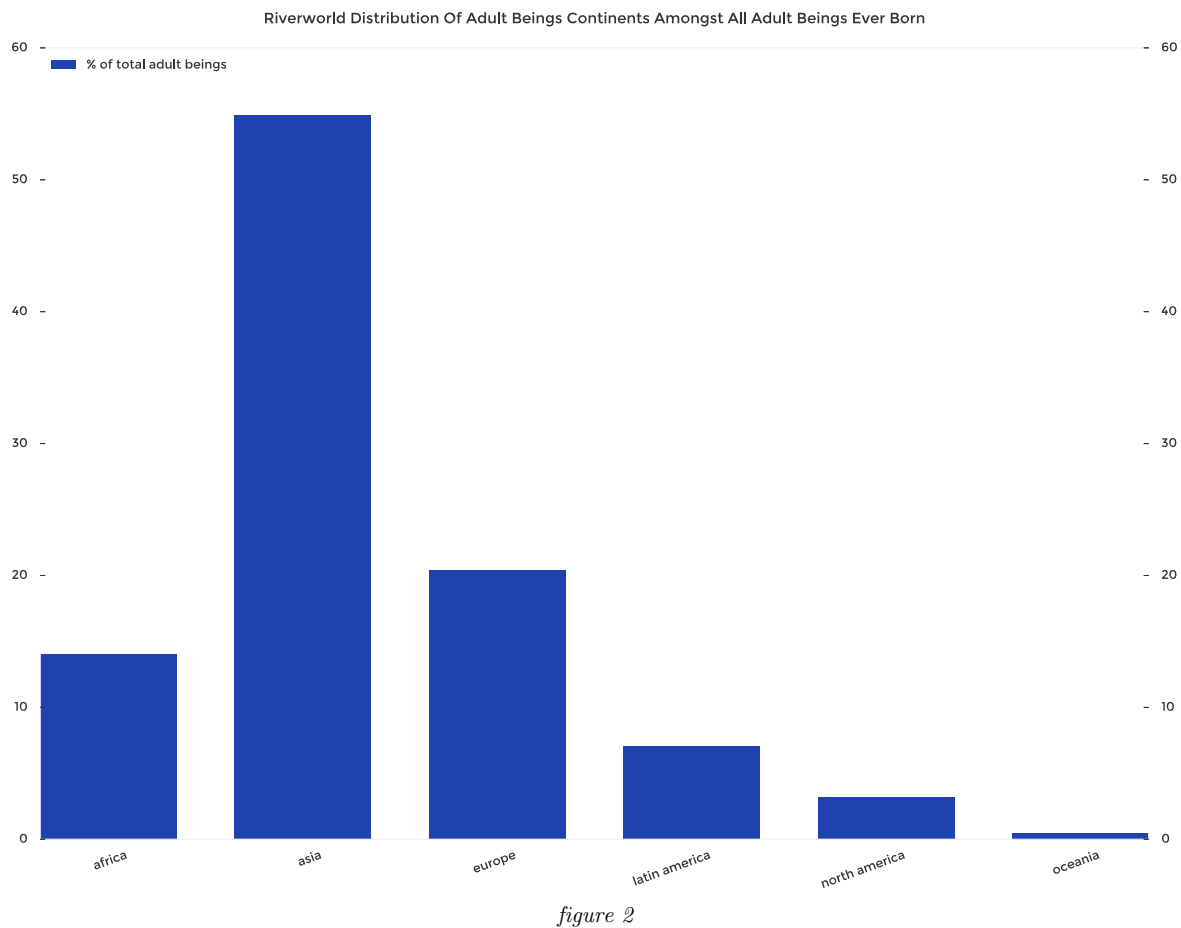
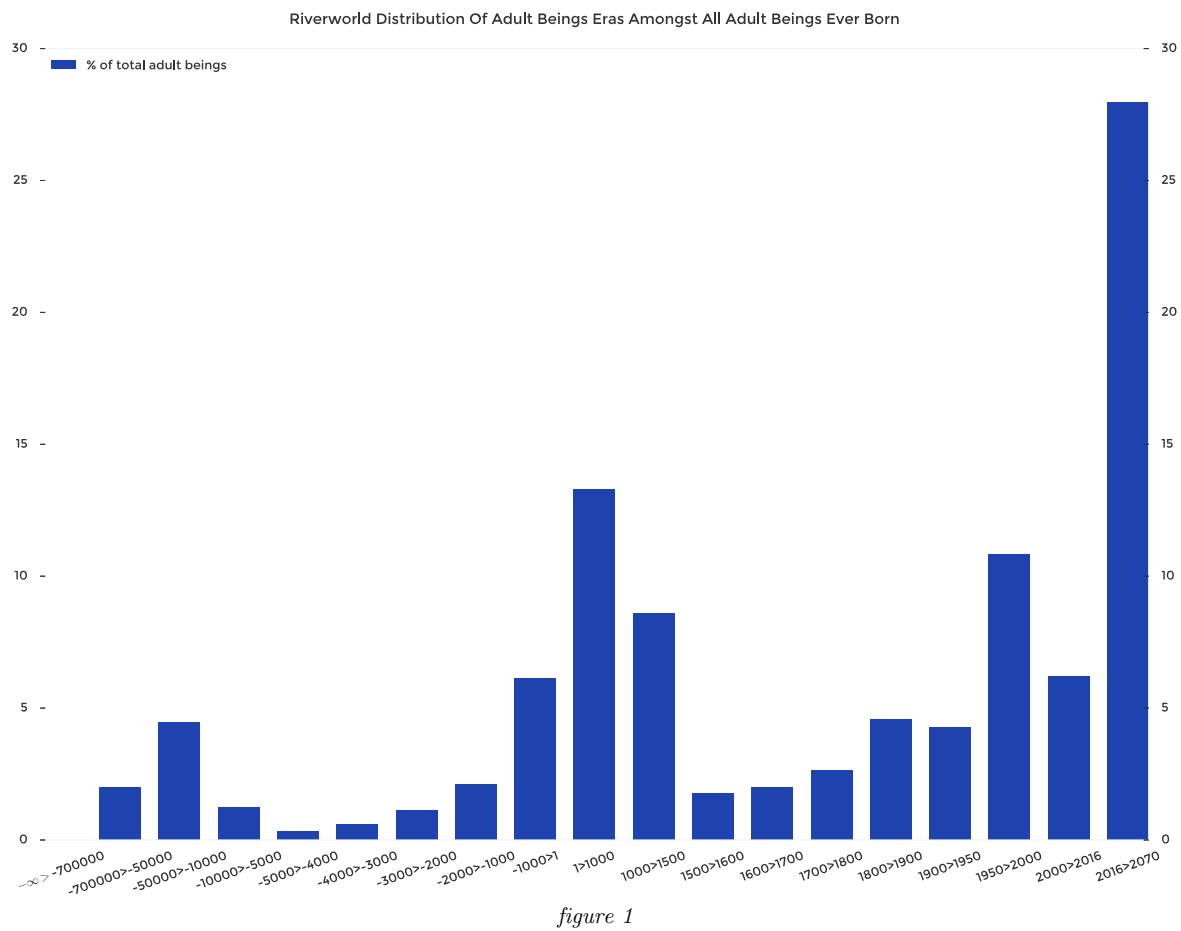
## Main Results

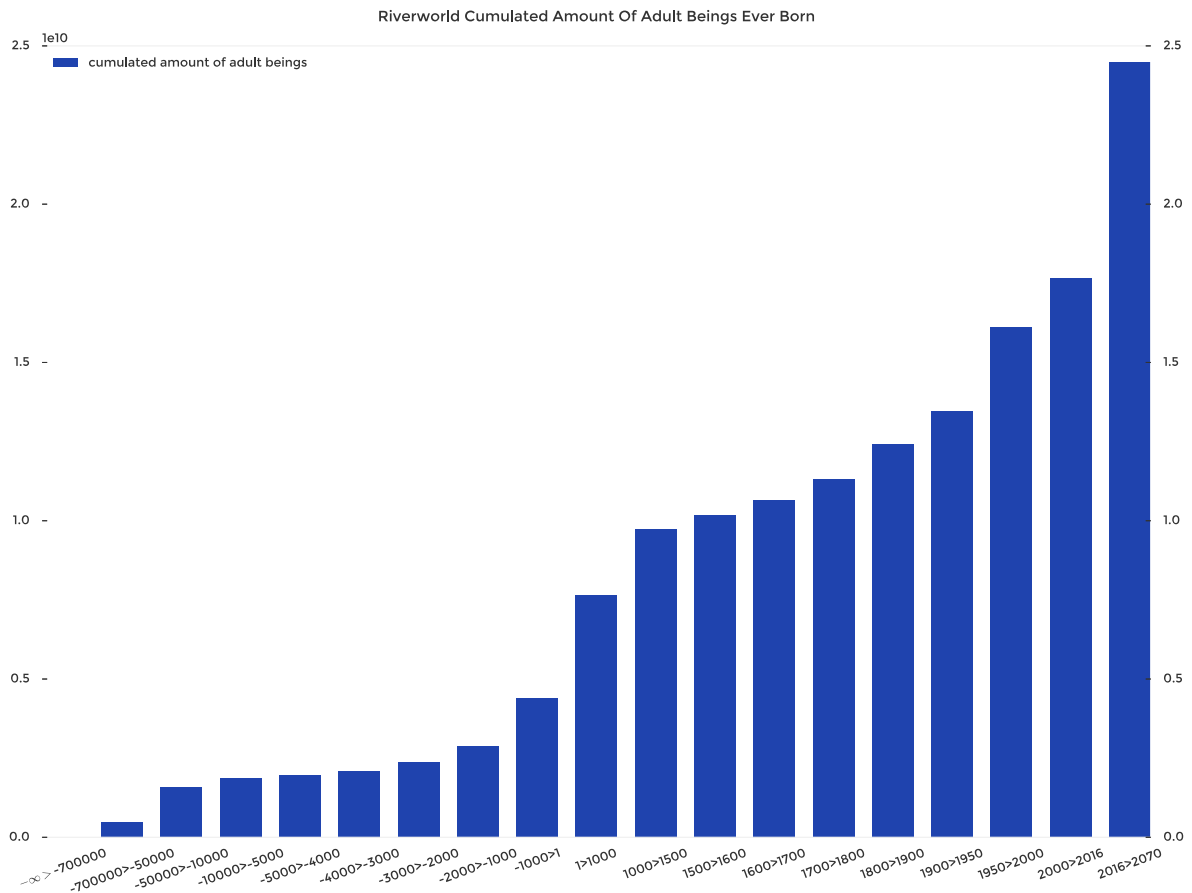
Metric	Value
Total beigns ever born	68.7 billions
Total adult beigns ever born	24.5 billions
Proportion of alive beings amongst all beings ever born	14.6%
Median year of adult beings ever born	1800
Median year of beings ever born	1

## Proportion Of Adult Beings Amongst All Adults Ever Born

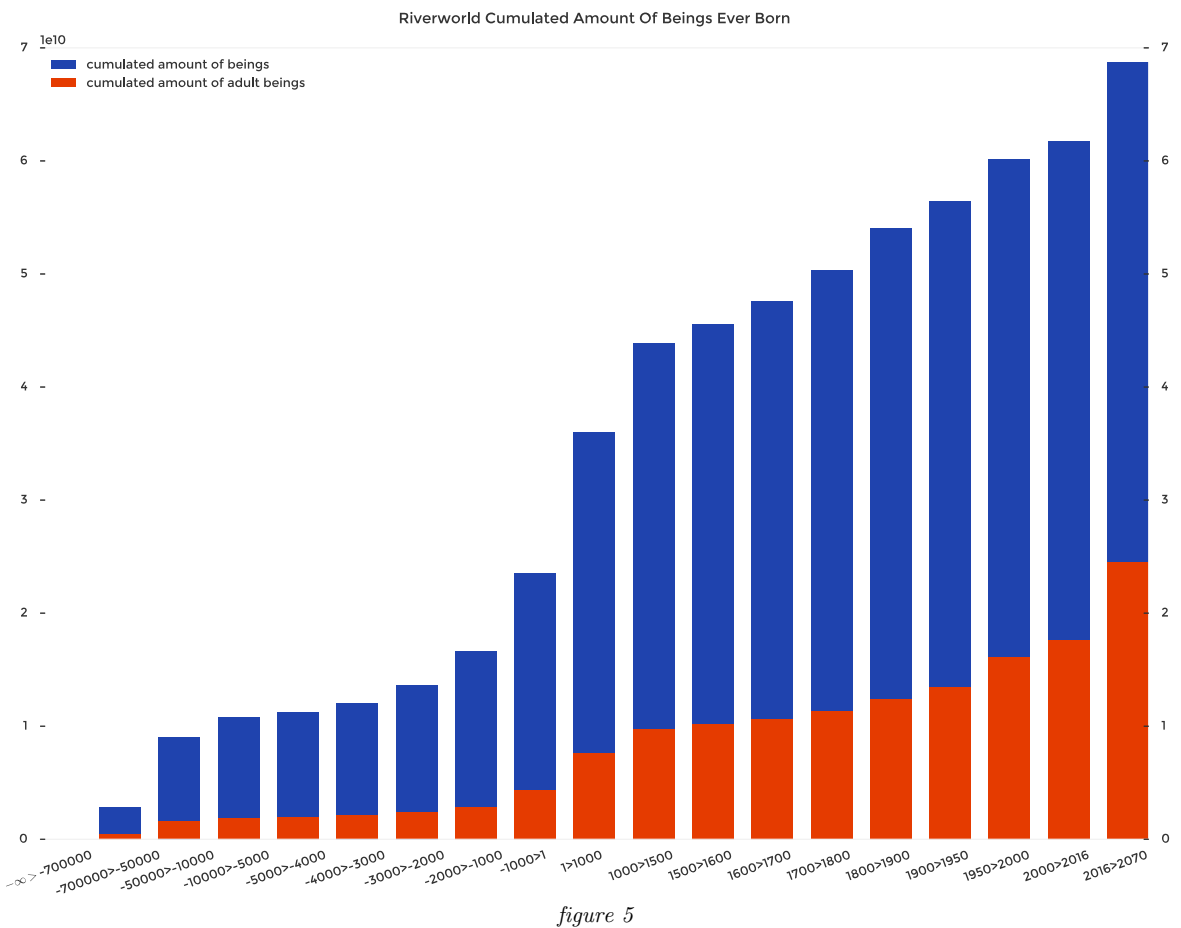
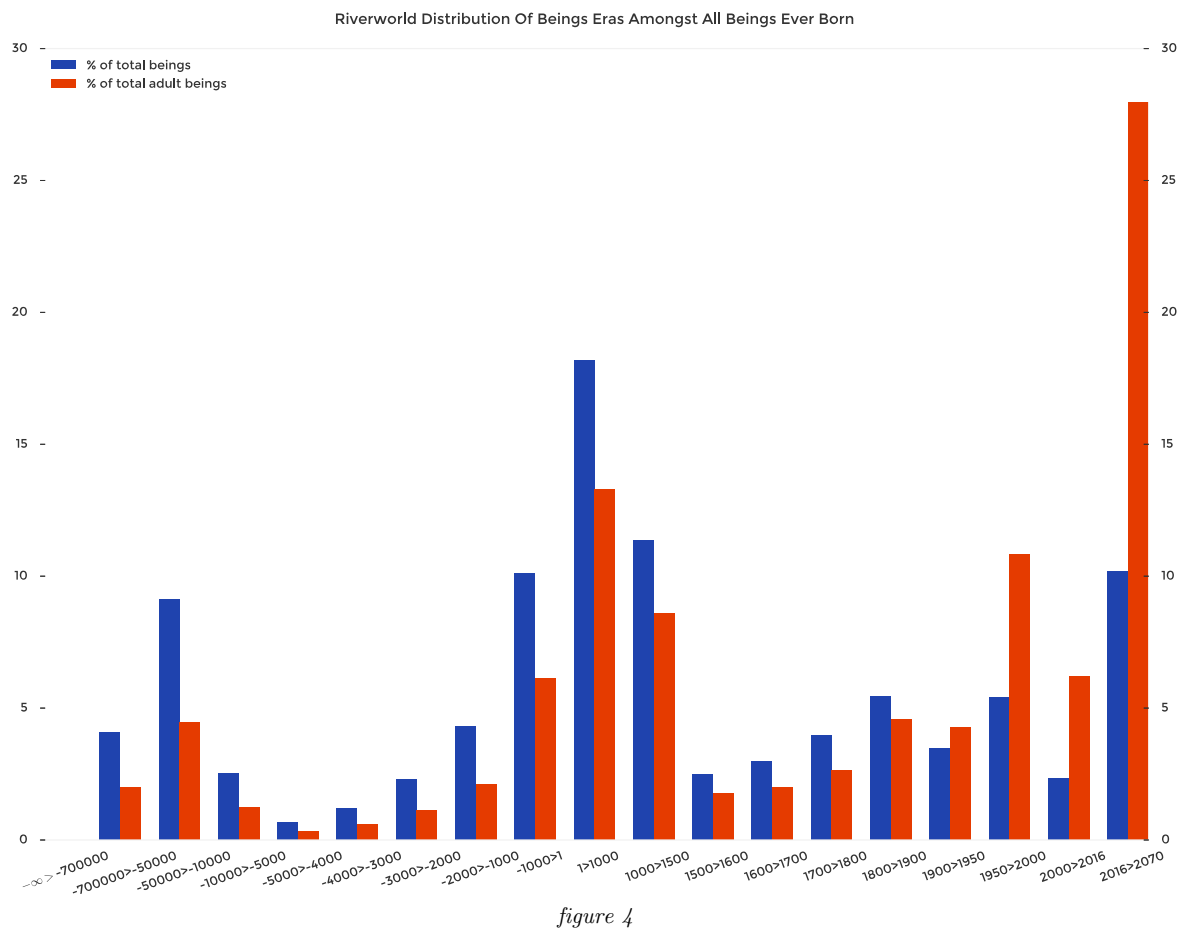
Sub Population	Value
Me	1.45566992136e-09% (1)
Asians	54% (1.34e+10)
Paloelithical era	2.0% (4.9e+08)
Neolithical era	6.4% (1.6e+09)
-10K until the birh of Jesus Christ	15.9% (3.9e+09)
Classical Athens (508 BC - 322 BC) (with civil rights)	0.001% (1.5e+05)
Classical Athens (508 BC - 322 BC)	0.005% (1.2e+06)
Roman Republic (509 BC - 27 BC)	0.016% (3.9e+06)
Western Roman Empire (27 BC - 476 AD)	2.4% (5.9e+08)
After WWII	49% (1.2e+10)

# Adult Beings Results





# All Beings Results



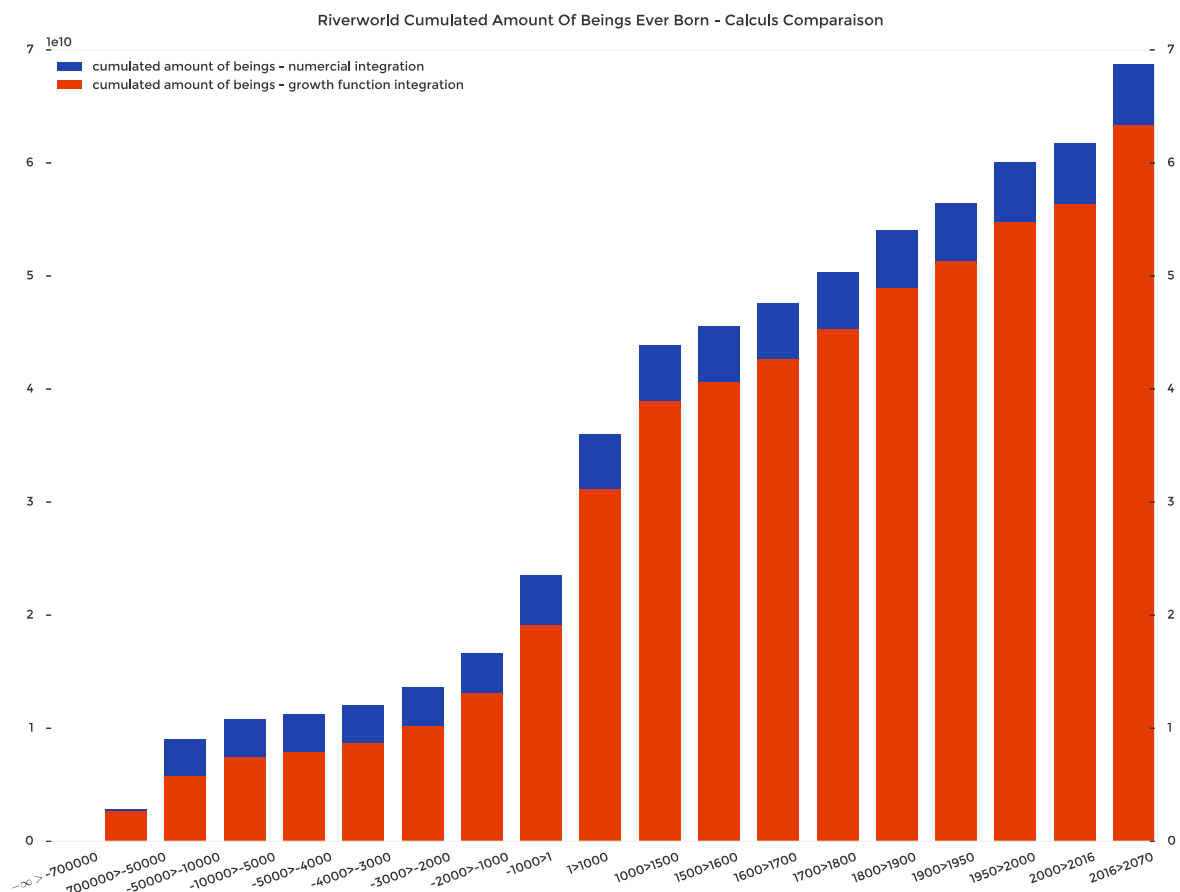


figure 6