# Quantitative and Qualitative Analyses of Global Gridded Gross Domestic Product Datasets

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## Introduction

Global gridded datasets on gross domestic product (GDP) are valuable for many different types of research, but it can be difficult to determine which dataset would best fit for a potential project. The objective of this research is to conduct a qualitative and two quantitative analyses of six global gridded GDP datasets and present the analyses in a way that a researcher would be able to compare the datasets and use the analyses to determine what dataset would be best suited for their potential project.

## Background

- GDP is the monetary measure of all final goods and services in a certain time period
- GDP measured in Purchasing Power Parity (PPP)
- A gridded dataset in the context of this research refers to a square grid overlain on a map in which each grid cell holds a value of GDP for the area it overlies
- Dataset selection criteria: Gridded format, global coverage, GDP variable

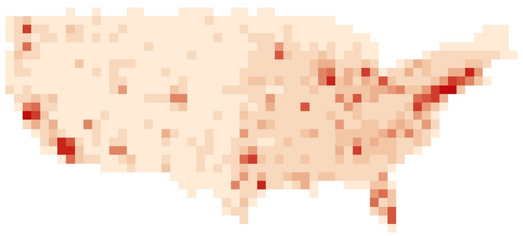

*Figure 1:* Example of 1º resolution gridded GDP of contiguous United States from the GECON dataset

## Methods

*Quantitative Analysis 1– comparison to BEA*

- Official GDP retrieved from Bureau of Economic Analysis (BEA) for years 2005 and 2010
- Six datasets were downloaded and converted to usable format and imported to ArcGIS Pro
- Using ArcGIS Pro, national GDP for the US was summed for the BEA dataset and the datasets
- The national totals of the datasets were then scaled to official GDP of their respective year and a county and state analysis was performed
- Tables were created to present findings (see *Table 1*)

*Quantitative Analysis 2– pixel level correlation*

- A fishnet was created using the GECON dataset with a cell resolution of 1 degree
- Zonal statistics was run with the GECON 1 degree fishnet and the original, unscaled datasets
- The datasets were then consolidated to the coarsest, 1 degree resolution so the pixel values can now be compared between datasets

*Qualitative Analysis*

- Relevant information on datasets was determined
- Information was gathered from respective literature and dataset descriptions
- Table created to present findings (see *Table 2*)

## Results

*Table 1:* Unscaled national totals for each dataset. GDP presented for year 2005 or 2010 based on availability. GDP in millions of current dollars.

| | 2005 | 2010 |
|---|---|---|
| Bureau of Economic Analysis GDP | $13,036,637 | $14,992,052 |
| GECON v. 4.0 | $12,579,700 | |
| Kummu, 2018 | $14,525,250 | |
| Ghosh, 2010 | | $16,336,583 |
| Murakami, 2016 | | $12,752,039 |
| Peduzzi, 2010 | | $11,561,205 |

*Table 2:* Qualitative analysis of global gridded GDP datasets

| Dataset | Yetman, 2004 | G-Econ v. 4.0 | Kummu, 2018 | Ghosh, 2010 | Murakami, 2016 | Peduzzi, 2010 |
|---|---|---|---|---|---|---|
| **Dataset Years** | 1990, 2025 | 1990, 1995, 2000, 2005 | 1990 - 2015 | 2010 | 1980 - 2100, 10 yr timesteps | 2010 |
| **Format** | Raster | GRID, ASCII, Excel | Raster | Raster | Raster, Tabular | Raster |
| **Spatial Level** | National | National, Subnational | National, Subnational | National, Subnational | National | Subnational |
| **Spatial Resolution** | 0.25º, 0.5º, 1º | 1º | 5 arc minute, 30 arc second for 1990, 2000, 2015 | 30 arc second | 0.5º | 30 arc second |
| **Number of variables** | 2 | 2 | 1 | 2 | 4 | 1 |
| **Variables** | Climate, Population | Climate, Land Area Population | Population | Luminosity, Population | Climate, Population, Hazard, SSP's | Population |
| **Historical or Future Projection** | Historical, Future | Historical | Historical | Historical | Historical, Future | Historical |
| **Methods Summary** | Grids use national GDP and projections based on the SRES B2 Scenario, 1900-2100 dataset, and Global Population of World v2 (GPW).GDP per capita applied to each grid cell of GPW. Linear downscaling method used to downscale the aggregated population and GDP. | Methodology varies by country. Uses Gross Cell Product instead of GDP. GCP by grid cell = (population by grid cell) x (per capita GCP by grid cell). | Temporal interpolation and extrapolation used for missing values. Found ratio between population weighted national and reported sub national GDP. Final GDP per capita was calculated by multiplying the ratio with the reported national GDP. | Regression models used to calibrate the sum of lights to official measures of economic activity. Unique coefficients were derived. Coefficients with the sum of lights provided estimates of total economic activity | 1980–2010 estimated by downscaling actual populations and GDPs by country. 2020–2100 estimated by downscaling projected populations and GDPs under three shared socio-economic pathways (SSPs). | GDP in allocated in proportion to population. Distinguishes between urban and rural population. |

## Conclusion

The first quantitative analysis shows that the accuracy of the datasets when compared to BEA statistics is not exact and scaling the national totals of the datasets to BEA statistics is important to separate the effects of patterns and amounts to allow for an accurate state and county comparison. The cell by cell comparison in the second quantitative analysis is valuable when determining the correlation between two datasets. The qualitative analysis table is useful for determining at a glance which dataset would fit predetermined criteria for a project.

## References

Ghosh, T., "Shedding Light on the Global Distribution of Economic Activity." *The Open Geography Journal*, vol. 3, no. 1, 2010, pp. 147–160., doi:10.2174/1874923201003010147.

Kummu, M., Taka, M., Guillaume, J., (2018), Gridded global datasets for Gross Domestic Product and Human Development Index over 1990–2015, https://doi.org/10.1038/sdata.2018.4

Murakami, D. ,Yamagata, Y., (2016) Estimation of gridded population and GDP scenarios with spatially explicit statistical downscaling, https://arxiv.org/abs/1610.09041.

Nordhaus, W.D., and X. Chen. (2016), Global Gridded Geographically Based Economic Data (G-Econ), Version 4, http://doi.org/10.7927/H42V2D1C.

NOAA, Ghosh, T., Powell, R., Elvidge, C. D., Baugh, K. E., Sutton, P. C., & Anderson, S. (2010).

Yetman, G., Gaffin S.R., Xing, X., (2004), Global 15 x 15 Minute Grids of the Downscaled GDP Based on the SRES B2 Scenario, 1990 and 2025, https://doi.org/10.7927/H4NC5Z4X

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