

# Green GDP Calculation Methods and Practical Applications Based on an Environmental Perspective

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**Abstract.** In using the traditional GDP to measure the health of the country, the impact of ecological pressures is ignored. As the economy grows and the ecological environment deteriorates, it forces us to shift to green GDP to measure the health of the economy so that it can reflect sustainable growth in the economic environment. To address the many challenges of green growth and sustainable development, this paper evaluates the relationship between GDP and resources and the environment by using the development of a green GDP model. We have chosen an accounting model of (GGDP), using which we include the cost of environmental pollution, the cost of resource depletion, and the cost of environmental improvement. This model is then monetized and the final model obtained provides a new method for quantifying the cost of environmental and resource degradation, demonstrating that GGDP can be used as a primary measure of economic health and can measure the impact on climate mitigation.

**Keywords:** GGDP, GDP, Evaluation System.

## 1. Introduction

Due to technological and social advances, human activities are having an increasing impact on the natural environment. Total global calendar year GDP has increased 69 times from \$1.39 trillion in 1960 to \$96.1 trillion in 2021. Between 1990 and 2021, the nominal GDP of the United States increased by 2.9 times. Over the past 30 years, the US has maintained a near-global economic growth rate and still maintains a 23.7% global share in 2021. In addition, World Meteorological Organization (WMO) data shows that the global concentration of carbon dioxide, the most important greenhouse gas, has reached 413.2 ppm in 2020, 149% of pre-industrial levels. Currently, the traditional method of measuring a country's level of economic activity and progress is GDP or gross domestic product or GNP, neither of which takes the environment into account when assessing economic levels. [1] These methods are calculated purely on the basis of whether they benefit production in the present, without considering whether a good natural environment and natural resources will be preserved for future generations. Modern man seeks immediate profit at the expense of the environment. Since GDP does not measure the sustainability of growth, it cannot be a good measure of social welfare. With the rise of heterogeneous public attitude/opinions, the emergence of more and more ecological and environmental issues, increased media attention, and the depletion of natural resources, the idea of replacing GDP as the main indicator of economic health with GGDP has emerged. GGDP not only measures economic growth, but also incorporates the consequences of economic growth. [2] Green GDP is the final outcome of economic activity in a country or region after taking into account the impact of natural resources (mainly land, forests, minerals, water and sea) and environmental factors (including ecology, natural environment, human environment, etc.), i.e., the cost of resource depletion and environmental degradation incurred in economic activity is deducted from GDP. The concept of Green GDP was developed in the early 1990s to compensate for the shortcomings of traditional GDP in calculating the economic costs of ecology, including the depletion of natural resources, environmental pollution and so on. When these conditions arise, humans spend a lot of time and money to restore the ecological environment, which in turn has a negative effect on human welfare.

Green GDP, on the other hand, implements the indicators of the concept of sustainable development, i.e. development that meets the needs of the present without posing a danger to the ability of future generations to meet their needs. In recent years, Green GDP has become a mainstream measure and is an important basis for countries around the world in formulating and implementing sustainable development strategies.

## 2. The basic fundamental of SIR models

Green GDP is the portion of total GDP that is contributed to without increasing ecological pressure. The green GDP indicator is calculated by subtracting the cost of natural resource consumption from the traditional GDP indicator and then subtracting the cost of environmental depletion. The following model has been chosen to account for green GDP:  $\text{Green GDP} = \text{Traditional GDP} - (\text{Environmental pollution cost} + \text{Resource depletion cost}) + \text{Environmental improvement cost}$ . Environmental pollution costs, also known as environmental degradation costs, refer to the economic and property losses and environmental protection costs caused by environmental pollution. Most studies have considered the cost of carbon emissions and ignored the cost of SO<sub>2</sub>, a major air pollutant that has a significant impact on air quality and human health, as well as the environmental damage caused by water and solid waste pollution. Therefore, in order to improve the scientific accuracy of the accounting model, the air pollution account, represented by CO<sub>2</sub> and SO<sub>2</sub> emissions, the water pollution account, represented by wastewater emissions, and the solid pollution account, represented by solid waste emissions and solid waste storage, are chosen to measure the environmental pollution costs.

Resource depletion costs are the value of resources consumed in economic activity. Since fossil energy and water resources play an important role in the energy mix of economic activities, but fossil energy is non-renewable and water resources are renewable but generally have a long regeneration cycle, take the US for example, Renewable inland fresh water resources per capita (m<sup>3</sup>) 1998-2021 (renewable per capita) The overall reduction in inland fresh water resources (m<sup>3</sup>) is shown in Figure 1; in China, for example, annual fresh water extraction is increasing year on year. The model therefore selects fossil energy consumption and water consumption to measure the cost of resource depletion.

Environmental improvement cost refers to the positive economic benefits of using waste or improving the condition of the natural environment, including the production value of comprehensive waste use and the ecological benefits of landscaping. And because of the rapid urbanization in previous decades, the type of land cover has changed significantly and forest resources have been consumed excessively, but with the strengthening of people's awareness of environmental protection in recent years, there are countries where Forest coverage rate (forest coverage rate) has increased as a whole (e.g. China), so in countries where the forest coverage rate has increased the forest coverage rate can be chosen as a measure of Countries with declining forest cover can be considered as having degraded their forest resources due to economic activities, excessive urbanization, etc., and have not taken effective measures to protect their forest resources in a timely manner, so this indicator is classified as Resource depletion cost in these countries (e.g. the USA). [3]

There are many potential downsides to the global adoption of the GGDP, including resistance and efforts to change the status quo. However, the potential benefits of climate mitigation (e.g., increased citizen awareness, government policy, etc.) cannot be ignored, and it is worth replacing GDP with the GGDP model for long-term global sustainability.

The first obstacle is that the GGDP is an indicator that implements the concept of sustainable development and takes into account the environmental consequences of economic development, but for many developing countries, especially developed countries, economic growth is at great risk of environmental pollution and if advanced measures and instruments are not adopted in a timely and scientific manner and sufficient funds are invested to deal with pollutants, then the GGDP is likely to decline.

The second resistance is the uncertainty of the GGDP. Previous studies have found that there is some uncertainty in green GDP indicators and that they do not provide accurate statistics for

government officials. [4-5] And because green GDP accounting requires extensive data collection, there are problems with data collection and analysis, making it difficult to replicate. In addition, data cost collection time and financial resources can be another issue. Sometimes, the costs of data collection outweigh the benefits. As a result, some studies may not take into account all environmental adjustments for green GDP accounting. This leads to oversimplification of the problem and underestimates the correct cost of natural resource depletion and environmental damage. [6]

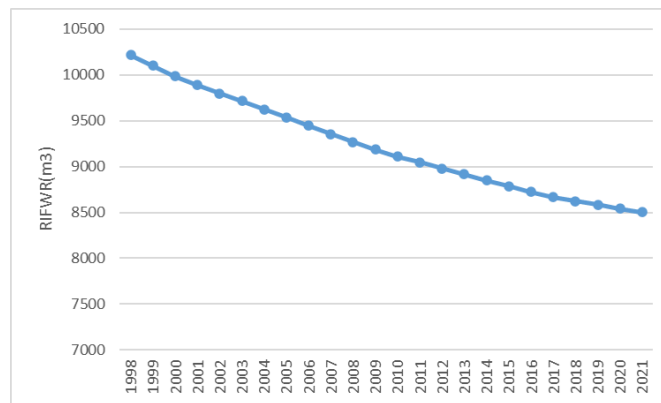


Figure 1. Renewable inland freshwater resources per capita in the United States, 1998-2021

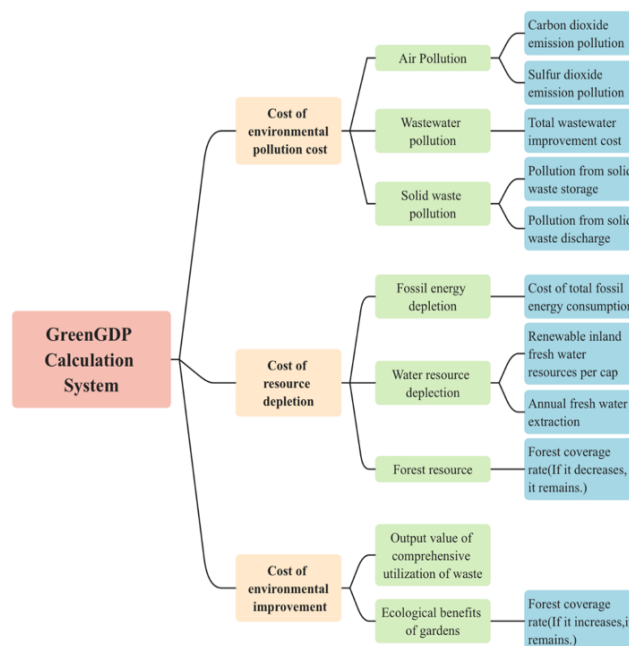


Figure 2. Accounting system of Green GDP

The system for calculating green GDP is shown in Figure 2. To make the above model easily understood by the public and able to be linked to traditional GDP data, it is necessary to monetize the calculation of the above model, i.e. to convert the Amount in it into a cost, specifically using CO2 emissions and the price of carbon, CO2 emissions per unit of electricity and the price of electricity, and natural resource consumption as a percentage of GNI, calculated as follows: Green GDP = GDP - (CO2 emissions in kilotons x total CDM (average price in kilotons) - (CO2 emissions per unit of electricity x 74 kWh of electricity x price of 1 kWh of electricity) - (GNI/100 x natural resource consumption as a percentage of GNI); or simplified as [2]:

$$\text{Green GDP} = \text{GDP} - (\text{KtCO}_2 * \text{PCDM}) - (\text{CIE} * 74 \text{KWh} * \text{Pelect}) - ((\text{GNI}/100) * \% \text{NRD})$$

### 3. Results

#### 3.1. Data sources

Using this method, the GGDP for China and the US for 1998-2021 was calculated as shown in Table 1 below.

#### 3.2. Analysis of experimental results

From 1998-2021 China's GDP grew at an average annual rate of 1.12589 and GGDP at an average annual rate of 1.13207; the US GDP grew at an average annual rate of 1.04018 and GGDP at an average annual rate of 1.04014.

**Table 1.** America and China GDP&GGDP

Year	American GDP (Trillion Dollars)	American GGDP (Trillion Dollars)	China GDP (Trillion dollars)	China GDP (Trillion dollars)
1998	9.06	9.0284	1.03	1.0029
1999	9.63	9.5861	1.09	1.0599
2000	10.25	10.1705	1.21	1.1687
2001	10.58	10.5117	1.34	1.2985
2002	10.93	10.8829	1.47	1.4296
2003	11.46	11.3914	1.66	1.6128
2004	12.22	12.1228	1.96	1.8746
2005	13.04	12.9275	2.29	2.1821
2006	13.82	13.7205	2.75	2.6127
2007	14.47	14.3721	3.55	3.3636
2008	14.77	14.6106	4.59	4.2744
2009	14.48	14.4240	5.1	4.9256
2010	15.05	14.9769	6.09	5.7918
2011	15.6	15.4958	7.55	7.1134
2012	16.25	16.1754	8.53	8.2418
2013	16.84	16.7507	9.57	9.3125
2014	17.55	17.4673	10.48	10.2508
2015	18.21	18.1721	11.06	10.9042
2016	18.7	18.6526	11.23	11.0899
2017	19.48	19.4231	12.31	12.1473
2018	20.53	20.4303	13.89	13.6922
2019	21.38	21.2815	14.28	14.1102
2020	21.06	20.9868	14.69	14.5072
2021	23.32	23.2190	17.73	17.3933

In summary, it can be concluded that GGDP can replace GDP as the main measure of economic health, and that the size of GGDP can directly reflect the effect of economic development on environmental improvement or degradation at a macro level. GGDP provides a macro-level indication of the relationship between environmental change and economic development, and growth in each country's economic index, GGDP, is inevitably accompanied by an improvement in the environment. If GGDP is used as the main indicator of economic health, then both the protection of the natural environment and economic development are concerned in the governance of the country, both of which are in full view [7-8]. A green and environmentally friendly economy is the future global economic development trend. In the early days of national economic development, the main goal was to raise the overall standard of living of the people and to pursue a large total GDP; but now, according to an environmental report issued by the United Nations: the world is facing three major crises: climate change, loss of biodiversity and environmental pollution, and the earth is becoming fragmented and riddled with holes because of the blind pursuit of higher GDP [9]. The natural

environment is the foundation of economic development and the safeguard of any country or nation. Any country in the world should balance the economy and the environment and join hands should the global crisis, the world can only get better and better [10].

#### 4. Conclusion

In this paper, we have developed a sound system for measuring green GDP:  $\text{Green GDP} = \text{Traditional GDP} - (\text{Environmental pollution cost} + \text{Resource depletion cost}) + \text{Environmental improvement cost}$ , which includes in its assessment the costs of water, air and solid waste pollution and the depletion of various natural resources as well as social and public health costs. This is then monetised so that it can be linked to GDP and is simpler for people to accept.

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