Based on the impact of GGDP accounting model on national subsequent development

Zifeng Wang *, Yu Chen, Zhufeng Jiang
East China jiaotong university Nanchang, China
* Corresponding Author Email: 1628547454@qq.com

Abstract. The ecological environment is closely related to the quality of human life. In recent years, more and more people have realized the importance of protecting the ecological environment. Therefore, the selection of GGDP as the evaluation standard of national development level is more suitable for the sustainable development of human beings. This paper makes an in-depth study on the impact of using GGDP accounting model on the subsequent national development. First of all, we refer to the current three convincing GGDP accounting models, and select the most suitable GGDP model through quantitative indicators, and we have optimized some details on the existing GGDP model. Then, proving that GGDP replaces GDP can slow down the rate of global warming and reduce the frequency of natural disasters. Second, we illustrate the potential benefits of climate mitigation and the negative impact of efforts to change the status quo from multiple aspects, fully demonstrating that the choice of GGDP is worthwhile. Finally, we have analyzed its impact on China in terms of policy, energy use structure, index system and public awareness of environmental protection.

Keywords: GGDP model, Optimization of energy use structure, Climate change mitigation, Sustainable development.

1. Introduction

Green GDP (also known as GGDP) accounting aims to generate a deep understanding of the value of resources and the environment by improving the current accounting practices, and then change the economic behavior. The use of resources and environment is quantified through economic form, so that green GDP accounting not only reflects the net growth, but also quantifies the negative impact on the environment in the process of social wealth creation, which can more accurately reflect the real situation of national economic development. According to the research results of China, from 1991 to 2003, the proportion of GGDP in GDP reached about 10%.[1] Currently, the increase of global warming rate has increased from one million years to one degree Celsius in a hundred years. Therefore, in recent years, carbon neutral and green development have been widely discussed. At present, there are four calculation methods for green DGP: from the perspective of production, income, the sum of labor remuneration, net production tax and operating surplus after deducting the surplus value after environmental input, and the formula is adjusted in the final GDP value.[2] At present, these four methods have different priorities, each with their own advantages and disadvantages. At present, System of Environment Economic Accounting is recognized by many scholars, which has certain reference significance.

2. Selection of GGDP Model

2.1. Statement of existing GDP model

2.1.1 Model 1

To keep the real economic system unchanged, only the accounting method needs to be changed, that is, the GDP accounting model that adjusts the environmental cost of the SNA accounting results:

$$GGDP_{it} = GDP_{it} - \sum_{j=1}^{n1} R_{ijt} - \sum_{j=1}^{n2} E_{ijt} \tag{1}$$

Where $\sum_{j=1}^{n1} R_{ijt}$ represents the accumulation of natural resource consumption and reduction in each province over the years, $\sum_{j=1}^{n2} E_{ijt}$represents the accumulation of environmental degradation costs in each province, n1 represents the number of resource consumption types, n2 represents the number of environmental degradation cost types, i represents the province, j represents the type of natural resource consumption or environmental degradation costs, and t represents the year. [3]

2.1.2 Model 2

keep the current accounting method unchanged, only the economic system itself needs to be changed, that is, try to restore the real economic system to the "green economy" state through simulation technology, and think that the GDP of the green economic system is the GDP accounting model of green GDP:

$$GGDP = Y_0 = \sum_{j=1}^{n} p_j^* Q_j^* - \sum_{j=1}^{n} \sum_{i=1}^{n} p_j^* q_{ij}^* \tag{2}$$

The total green output of the jth sector $= p_j^* Q_j^*$; The jth sector green intermediate consumption $= \sum_{i=1}^{n} p_j^* q_{ij}^*$.The green added value of sector j$= p_j^* Q_j^* - \sum_{i=1}^{n} p_j^* q_{ij}^*$; Total national green output $= \sum_{j=1}^{n} p_j^* Q_j^*$.National green intermediate consumption $= \sum_{j=1}^{n} \sum_{i=1}^{n} p_j^* q_{ij}^*$;.Here, Q_j^* and p_j^* are implicit functions of Q_0.[4]

2.1.3 Model 3

a model with innovative accounting ideas:

$$\begin{aligned} GreenGDP = GDP &- (KTCO_2 \times PCDM) \\ &- (Twaste \times 74kWh \times Pelect) \\ &- (\frac{GNI}{100} \times \%NRD) \end{aligned} \tag{3}$$

where the first deduction presents the costs of CO_2 pollution (as CO_2 emissions times carbon market price), second the opportunity costs of one tonne of waste that could be used in the production of electrical energy), and a third is the adjusted savings of natural resource depletion as a percentage of the gross national income per country.[5]

2.2. Considering the evaluation model of the GGP model and establishing the evaluation model of objective analysis of the impact indicators

We choose the five factors of operability, theoretical analysis, climate correlation, universality, and recognition as the evaluation indicators to score. The full score of each indicator is 10. Each indicator puts forward the evaluation criteria, and finally draws the radar map. The largest one is considered the best model.

2.2.1 Evaluation criteria for each index

2.2.1.1 Operability: measure index M1.

The huge amount of data required in the model calculation process increases the workload of government, enterprises and other management personnel. Secondly, it is difficult to determine the cost boundary of environmental governance. For this reason, we choose M_1 as the operability measure: $M_1 = \frac{\sum_{i=1}^{n} C_i}{n}$ Where C is the data acquisition difficulty of each statistic, and n is the corresponding number of data.

2.2.1.2 Theoretical analysis: measurement index M2.

Model 1: There is no real market in most natural resources, and the calculation of resource consumption reduction is very controversial. Moreover, there is no consistency between the two accounting systems of "revealing preference method" and "stating preference method" in the nature of price, and the economic valuation is more subjective.

Model two: "green mining quantity", "output effect" measurement method is difficult to solve.

Calculation formula $M_2 = \mu_1 * \eta_1 + \mu_2 * \eta_2$ where η_1 is the core logic compliance and η_2 is the branch logic compliance.μrepresents importance, at this coefficient selection as 0.8 and 0.2.

2.2.1.3 Climate correlation: the measurement index M3.

we believe that the proportion of indicators directly related to climate in the GDP expression. The more the proportion of total indicators, the stronger the climate correlation, because too many intermediate quantities will generally lead to a decline in correlation. The direct impact factors of climate include carbon emissions, precipitation, and so on. Calculation formula:$M_3 = \frac{n}{N}$

2.2.1.4 Universality: the measurement index M4.

our group considered four major industrial types, including: labor-intensive In terms of capital-intensive, technology-intensive and resource-intensive industries, statistics are made through the number of industries involved in the model and the industrial coverage. The calculation formula is:$M_4 = \frac{\sum_{i=1}^{4} F_i}{4}$,Where a represents the industrial coverage rate involved in the model

2.2.1.5 Recognition degree: the measurement index M5.

the measurement index M5 is evaluated according to the evaluation of the model in the cited literature and the amount of actual application calculation. Calculation formula: $M_5 = \frac{N_1 \times \eta + N_2}{N}$where N1 is the number of cited documents, the percentage of recognition, and N2 is the number of practical applications.

2.2.2 Radar drawing

The image is as follows:

Fig 1. Radar drawing

Note: The score of each item is the full score of the measurement index *, and the full score is 10;

2.2.3 Area calculation and conclusion

2.2.3.1 Radar chart area calculation formula and calculation:

$$S = \frac{\sin\left(\frac{2\pi}{5}\right)}{2} \times \frac{\sum_{i=1}^{5}\sum_{j=1}^{5} X_i \times X_j}{2}, (i \neq j)$$
$$S1 = 168.8126928239 \tag{4}$$
$$S2 = 157.87553244376$$
$$S3 = 194.01571456944$$

2.2.3.2 Conclusion:

The calculation results show that the comprehensive score of model three is the highest, and the scores of each index are relatively small, which is a relatively comprehensive model. Therefore, we choose model three as the basic model of this paper.

2.3. Optimization of GDP model

The model is convenient to calculate the results and conforms to the core idea of green GDP research. But without considering the environmental protection expenditure, it is more reasonable to subtract the environmental protection expenditure from the existing model, and the government environmental protection expenditure is also convenient to obtain. The optimized model is:

$$\begin{aligned} GreenGDP = GDP - (KTCO_2 \times PCDM) \\ - (Twaste \times 74kWh \times Pelect) \\ - \left(\frac{GNI}{100} \times \%NRD\right) - G \end{aligned} \tag{5}$$

G represents environmental protection expenditure.

3. Impact of Replacing GDP With GDP on World Climate

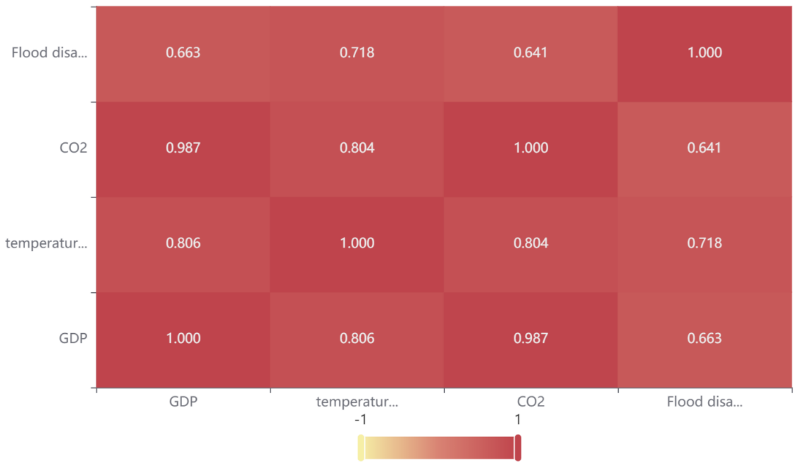

Fig 2. Correlation of GDP, temperature, extreme climate represented by flood disaster and carbon dioxide emissions.

3.1. Univariate polynomial regression model of GGDP, GDP and probability of global extreme climate

$$\begin{aligned} N_{flood} = 0.0026 \times GDP^3 - 0.5062 \times GDP^2 \\ + 31.0730 \times GDP - 436.6518 \\ + \varepsilon_N \end{aligned} \tag{6}$$

$$\begin{aligned} N_{flood} = 0.0027 \times GGDP^3 - 0.5055 \times GGDP^2 \\ + 29.8010 \times GDP - 387.6174 \\ + \varepsilon_N \end{aligned} \tag{7}$$

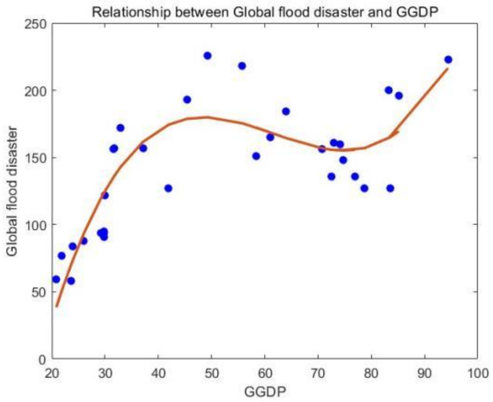

Fig 3. Relationship between Global flood disaster and GGDP

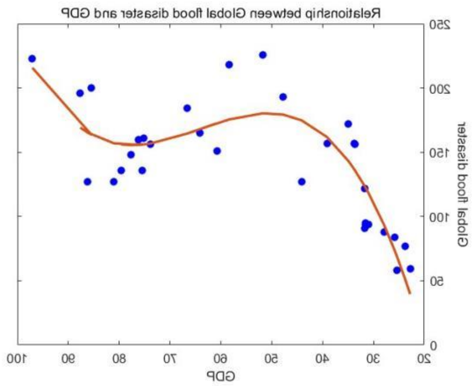

Fig 4. Relationship between Global flood disaster and GDP

When analyzing the impact of GGGP, GDP and flood disaster, it is helpful for quantitative analysis to obtain the derivative of these two formulas [6]:

$$\frac{d(N_{flood})}{dGDP} = 0.0081 \times GDP^2 - 1.011 \times GDP + 29.801 \tag{8}$$

$$\frac{d(N_{flood})}{dGGDP} = 0.0078 \times GGDP^2 - 1.024 \times GGDP + 31.073 \tag{9}$$

3.2. Index model of GGDP, GDP and global carbon emissions

3.2.1 The calculation formula

We consult the literature, find out the relationship between GDP and carbon dioxide emissions, and make data fitting according to the calculation formula proposed by it. The calculation formula is:

$$Ln(CO_2) = \mu_1 Ln(GDP) + \mu_2 + \varepsilon_0 \tag{10}$$

whereμ_1, μ_2 is constant, andε_0 is disturbance coefficient. Using the undetermined coefficient method, the world carbon dioxide emissions and world GDP data are brought in, and the final calculation formula is[7]:

$$Ln(CO_2) = 0.4035 \times Ln(GDP) + 15.5486 + \varepsilon_{CO_2} \tag{11}$$

3.2.2 The relationship between GGDP and CO2 emissions

The relationship between GGDP and CO2 emissions can be calculated by introducing this formula into the accounting model of GGDP:

$$Ln(CO_2) = 0.3896 \times Ln(GGDP) + 15.6222 + \varepsilon_{CO_2} \tag{12}$$

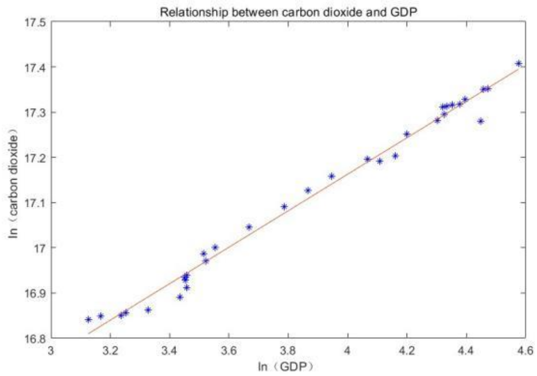

Fig 5. Relationship between Carbon dioxide and GDP

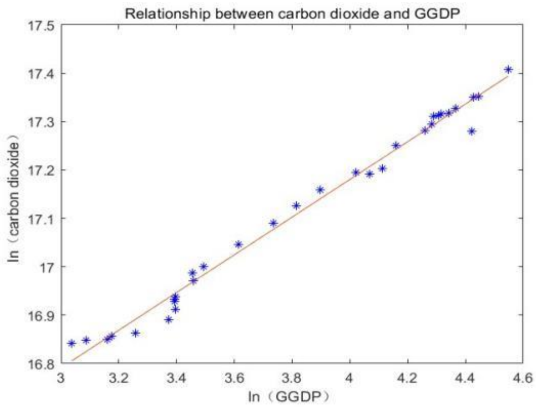

Fig 6. Relationship between Carbon dioxide and GGDP

3.3. Comprehensive conclusion

Increasing carbon dioxide emissions per trillion of GGDP increases the amount of carbon dioxide per trillion of GDP emissions from 15.271K to 14.764K by 3.3%. Choosing GGDP can slow the rate of global warming. Similarly, the number of natural disasters per trillion of GGDP increased from 9.707 to 7.903, and the probability of natural disasters decreased by 18.6%.

4. The Practical Application and Impact of GGDP Model in China

4.1. Specific accounting value of model application in China:[9][10]

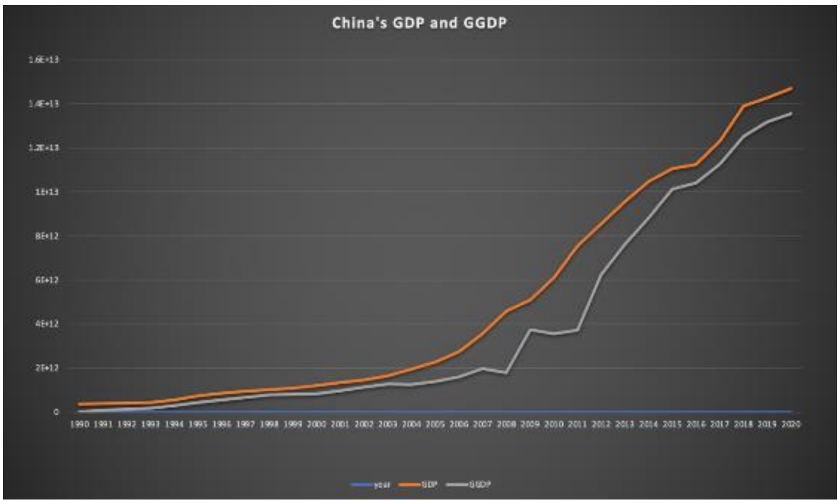

Fig 7. China’s GDP and GGDP

4.2. Promotion of structural transformation of energy and other natural resources

4.2.1 Energy classification:

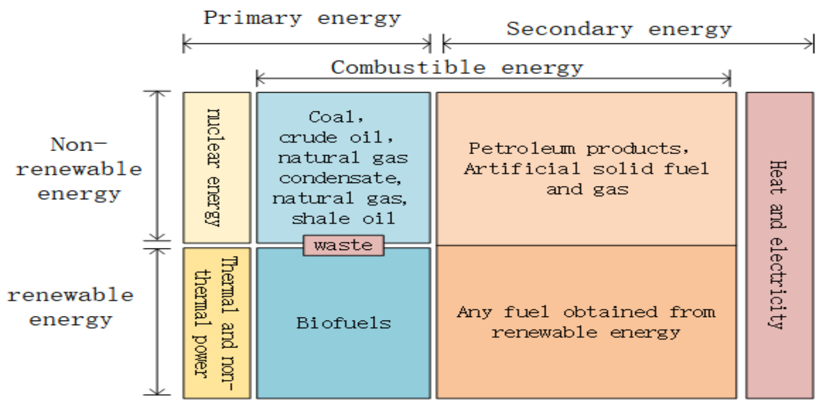

Fig 8. Energy classification

4.2.2 Analysis of the relationship between the proportion of GGDP to GDP and the structure of energy consumption:

We need to increase the proportion of GGDP to GDP and increase the net economic gain.

Select the model to use:

$$\ln GGDP_{it} = \alpha_{0i} + \beta_{1i} \ln ENERG_{it} + \mu_{it} \tag{13}$$

$$\ln GAP_{it} = \alpha_{0i} + \beta_{1i} \ln ENERG_{it} + \mu_{it} \tag{14}$$

where $\ln GGDP_{it}$ represents the logarithm of green GDP at time t, $\ln GAP_{it}$ represents the logarithm of the gap between the green GDP and standard GDP indicator at time t, $\ln ENERG_{it}$ stands for total energy consumption at time t, and μ_{it} is the error term while i and t denote country and time respectively.

$$\begin{aligned}\ln GAP_{it} = \alpha_{0i} + \beta_{1i} \ln FFUEL_{it} + \beta_{2i} \ln NGAS_{it} \\ + \beta_{3i} \ln OIL_{it} + \beta_{4i} \ln RENEW_{it} \\ + \mu_{it}\end{aligned} \tag{15}$$

where $\ln GAP_{it}$ again represents the logarithm of the gap between the green GDP and standard GDP .

indicator at time t, $\ln FFUEL_{it}$ stands for fossil fuel consumption at time t, $\ln NGAS_{it}$ stands for natural gas consumption at time t, $\ln OIL_{it}$ stands for oil and petroleum consumption at time t, $\ln RENEW_{it}$ stands for renewable and biofuel consumption at time t, and μ_{it} is the error term while i and t denote country and time respectively. [11]

We use the control variable method to analyze the impact of each energy on the difference between GGDP and GDP. The research results show that the increase of energy consumption will affect the increase of GDP and green GDP. In addition, solid fuel and oil have a much greater impact on the difference between green GDP and GDP than renewable resources and natural gas, which is a cleaner form of energy and is worth extensive use. In the same way, the use of bioenergy, new energy, renewable energy, etc. to replace traditional fossil energy. It can effectively increase the proportion of GGDP to GDP.

To sum up, while pursuing the growth of GGDP, China is bound to gradually transform its energy use structure, replace fossil energy, solid fuel, etc. with clean energy, continue to promote the development of new energy, and increase investment in the energy storage industry.

4.2.3 Conception of future energy structure

We put forward the concept of the proportion of energy structure in the future based on the comprehensive consideration of China's current national conditions.

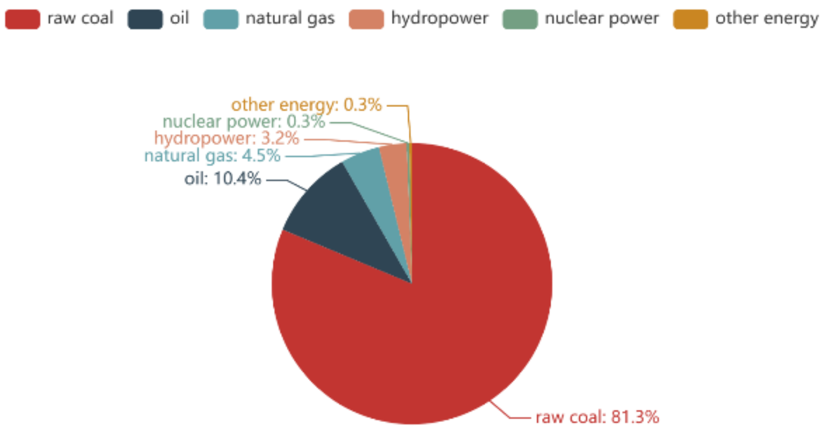

Fig 9. China's current energy structure

We predict the future energy structure within ten years after changing to GGDP as the development index:

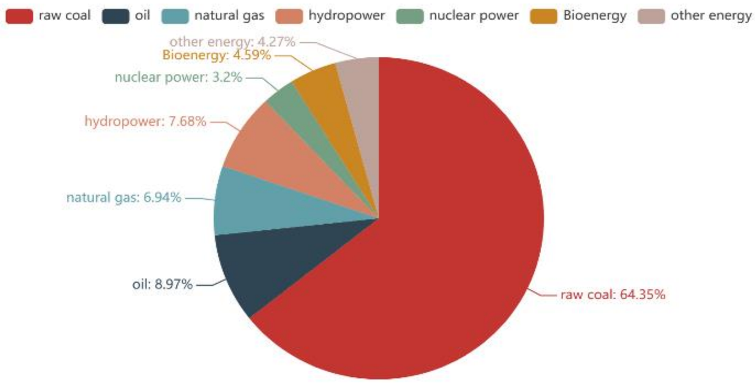

Fig 10. The future energy structure within ten years after changing to GGDP

4.3. Impact of social capital, human capital and technological innovation on green development

Refer to the comprehensive evaluation model of green development:

$$\ln W_{it} = \beta_0 + \eta_1 \ln Y_{it} + \eta_2 (\ln Y_{it})^2 + \delta \ln S_{it} + \sum_{j=1}^{3} \gamma_j \ln N_{jit} + \varepsilon_{it} \tag{16}$$

$$\ln M_{it} = \alpha_0 + \sum_{k=1}^{n} \sigma_k \ln X_{kit} + \varepsilon_{it} \tag{17}$$

Among them, W, Y, S and N are the factors that affect the comprehensive pollution index, per capita income level and social capital by other variables such as technology and environmental governance; I and t are regions and years;β, η, δ and γ, ε_{it} are coefficients of each variable, and 5 is a random disturbance term. The model logarithmizes the data to eliminate the influence of heteroscedasticity.

This model analyzes the impact of social capital, technological innovation and environmental governance investment on the EKC curve. The coefficients of social capital, the number of labor dispute cases accepted in the current period, and technological innovation are – 0.0657, – 0.0547, – 0.052, respectively, indicating that technological innovation and social capital have the effect of reducing environmental pollution; The coefficient of total investment in environmental pollution control is positive, revealing that the greater the total investment in environmental pollution control is, the more serious the environmental pollution is. The table results show that the impact of social capital on the EKC curve is greater than the impact of technological innovation. For every 1% increase in the social capital represented by the marriage and divorce rate and the number of labor dispute cases accepted in the current period, the comprehensive pollution index decreases by 0.0657% and 0.0547% respectively, which is greater than the reduction effect of technological innovation on the comprehensive pollution index by 0.052%.

The following three points are analyzed for the conclusion of this model:

Take social capital as the leading factor to promote the development of human capital and technological innovation. Optimize the industrial structure, strengthen the awareness of green innovation, actively build a green ecological chain, promote the green development mode of low energy consumption and low pollution, accelerate the establishment and improvement of the green development system from the perspective of social capital, advocate the concept of green development, build a new type of green production and consumption system, and help human capital and technological innovation to promote China's green development process.

4.4. Establish work assessment indicators with green GDP as the core

The main purpose of implementing GGDP accounting is to replace the "baton" of economic activities and guide people to build economic activities on the basis of natural resources and environmental protection. Therefore, this reform must be combined with the reform of the assessment indicators of government work. At present, the assessment of government performance at all levels is actually based on the per capita GDP and the growth rate of GDP. "The output value is the hero". After the implementation of GGDP accounting, the assessment of government performance can use green GDP as an auxiliary evaluation index. Because green GDP can comprehensively and comprehensively reflect the relationship between economic growth, resource utilization and environmental protection, the larger its value is, the better it is to deal with the relationship between the three, the more the total benefits of social long-term development, and the more prominent the government's political achievements will be. Using green GDP to assist in assessing government performance, its guiding role can urge the government to pay attention to and deal with the relationship between economy, resources and environment, rather than self-destruction for the pursuit of immediate, local and temporary economic benefits.

4.5. Enhance public awareness of the necessity of implementing environmental economic accounting, which will be widely publicized and educated

Help people realize the limitations of the current national economic accounting system. Because it does not reflect the contribution of natural resources to economic development and the damage of human economic activities to the ecological environment, it has brought serious harm to the sustainable development of social economy. In this process, it is especially necessary to guide people to understand the role of nature in social and economic development, and make people realize that it is necessary to make rational use of natural resources and respect the objective development law of nature itself. For China, to implement the sustainable development strategy, it is necessary to carry out the accounting of green GDP, and truly make the environment and economy develop in parallel, so as to achieve the goal, it is also the common goal of all mankind.

4.6. Establishment of environmental resource accounting indicator system and data collection system

In order to implement green national economic accounting in China, it is necessary to establish corresponding environmental resource indicator system and data collection system. At present, the relevant departments of the Chinese government have carried out some work around environmental resources accounting. Unfortunately, the government has not included this accounting into the national economic accounting system, nor put forward clear and specific requirements for the provision of this data, so it has not attracted the attention of these departments. At the same time, there is also a lack of unified and standardized requirements for the caliber and methods of environmental and resource accounting, which leads to greater randomness of accounting. We suggest that the National Bureau of Statistics, together with the environmental protection department and the relevant resource management department, should design a set of environmental resource indicator systems with internal links that are both suitable for the international development trend and in line with China's current national conditions according to the requirements and account design of environmental economic accounting, and on this basis, design and develop the corresponding statistical statements, implement the reporting unit, and make clear the accounting caliber, accounting method, and data quality Specific requirements and standards.

4.7. Gradually implement green accounting

The establishment of a green national accounting system is conducive to reflecting the impact of changes in the environment and resources on the total indicators, but it cannot fully reflect the changes in the social environment and resources. At present, the boundary of accounting is not clear enough. For example, as a part of intermediate consumption, various environmental protection and governance inputs included in the cost of enterprises are deducted in the calculation of gross domestic product and not reflected in the adjustment of environmental economic accounting, so it is impossible to comprehensively, objectively and accurately reflect the input of the whole society for the environment. Therefore, along with the reform of the national economic accounting system, the current accounting methods should also be reformed to reflect the cost expenditure for environmental protection and governance in the cost accounting and accounting information disclosure of enterprises.[3]

5. Potential Benefits of Climate Mitigation and Negative Impact of Efforts Required to Replace the Status Quo

5.1. Potential benefits

Reduce the impact of extreme weather such as floods, droughts and sandstorms on human life, which has been proved above.

Sustainable development (use=regeneration) improves the stability of the number of biological species, maintains high biodiversity, and improves the self-repairing ability of the ecosystem. Under the same resource conditions, it can develop for many more years.

Promote the development of tourism, agriculture, animal husbandry and other ecological industries.

Slow down the rising speed of sea level, protect the available land resources, establish the three-dimensional scatter diagram of time, sea level height and temperature, which shows that the sea level will rise with the rise of temperature. The previous text has explained that compared with GDP, GDP can slow down the change of climate, which also shows that it can slow down the rising speed of sea level.

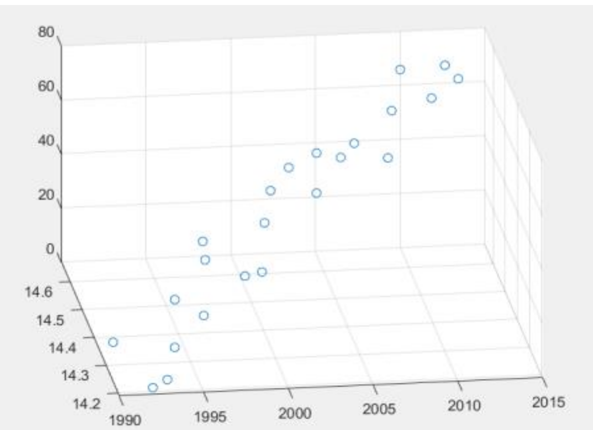

Fig 11. 3D scatter plots of time, sea-level height, and temperature

5.2. Negative effects

The number of jobs and GDP brought by new energy are not enough to offset the loss caused by the disappearance of traditional industries (Hoover Institute report).

The large amount of funds invested in research and development in the early stage will delay economic development for a period of time.

The cost of many resource-consuming industries will increase, so that they are in a weak position in trade.

References

[1] Deng Chunsi. Research on Green GDP Accounting System and Measurement Methods. 2006. Yanshan University, MA Thesis

[2] Chinese National Bureau of Statistics. Research on the impact of social capital on China's green development

[3] Wang Feng, et al. "Population density, energy consumption and green economic development - empirical analysis based on provincial panel data." Resources and environment in arid areas 31.01 (2017): 6-12 doi: 10.13448/j.cnki.jalre.2017.002.

[4] Wang Yongyu, and Guo Liping "Research on Theory and Method of Green GDP Accounting." Statistical Research 27.11 (2010): 77-84 doi: 10.19343/j.cnki.11-1302/c.2010.11.013

[5] Stjepanović, Saša, Daniel Tomić, and Marinko Škare. "A new approach to measuring green GDP: a cross-country analysis." Entrepreneurship and sustainability issues 4 (2017): 574-590.

[6] The World Bank, https://www.worldbank.org/en/home

[7] Congregado Emilio, et al."The environmental Kuznets curve and CO2 emissions in the USA: Is the relationship between GDP and CO2 emissions time varying? Evidence across economic sectors." Environmental science and pollution research international 23.18(2016). doi:10.1007/s11356-016-6982-9

[8] Chinese Academy of Environmental Planning. [Technical Guidelines for Green GDP (GGDP/EDP) Accounting]

[9] China Emission Accounts and Datasetshttps://www.ceads.net.cn/

[10] Anqi LI,and Yu ZHAO."Multidimensional Discuss on The Challenge of China's Energy Structure Transition".Proceedings of the 6th Academic Conference of Geology Resource Management and Sustainable Development.Ed.. Aussino Academic Publishing House, 2018, 594-600.

[11] ŠKARE, Marinko, Daniel TOMIĆ, and Saša STJEPANOVIĆ. "Energy Consumption and Green GDP in Europe: A Panel Cointegration Analysis 2008-2016." Acta Montanistica Slovaca 25.1 (2020)