Russian GDP 2030: Scenarios Under Pollutant Emissions Constraints

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Russian GDP 2030: scenarios under pollutant emissions constraints

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Abstract: The paper's theoretical significance is based on the system conceptual view concerning GDP growth under environmental restrictions. The primary point of the paper is how environmental constraints restrict or push up GDP growth. The authors evaluate the nature of the interdependence between GDP growth and carbon dioxide emission, wastes, effluent emission, nitrogen effluent emission, emissions in total for the 2000-2018. GDP growth scenarios until 2030 were built under the emissions and waste reduction targets (+-20% from the existing level). The authors use the Kaya equation methodology for the modelling GDP under environmental constraints. There is a negative trend towards a decline in the ecological investments impact on Russia's GDP. It is necessary to carefully analyze the possible reasons for reducing the impact of the ecological investments on GDP. Total emissions and CO_2 emissions strongly correlated with total investments in air protection to the GDP; these emissions have the most influence on the GDP level. The investments in water and land protection will grow until 2030. The paper approved the results from previous researchers that the results indicate that most of the variations in CO2 emissions are determined by variations in GDP, so reducing CO2 emissions in the long run can be achieved by continuously increasing GDP. The authors look in the future hoping that Russia would be brave to change ways concerning environmental protection from "extreme and post-crises management" into investments into ecological protection to prevent cataclysms and disasters. It is shortsighted for future try to change something after a disaster has happened.

Keywords: Russia GDP growth; Environmental constraints; Nitrogen emissions; Effluent emissions; CO_2 emission, Environmental policy

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1. Introduction

One of the urgent problems of modern economic theory is the coordinated definition of the parameters of ecology and economics in a unified calculation system, especially in connection with the sharp increase in the influence of human economic activity on the planet's climate and biosphere (ES, 1992). Nowadays, the "benefit" for the economy has become inextricably linked with the "harm" to the environment (OECD, 2019). It reinforces the illusion that the economy and the environment are separate and leads to the fact that politicians ignore environmental problems or contribute to their destruction for the sake of economic growth, even though there have been some justifications for a close interaction of economic and ecological factors (Costanza R, 1989, Daly H.E., 2007).

From the late 80th scientists all over the World the questions of air pollutions sharply aroused (Khan et al, 2020), (Cai et al, 2018). Thus, Seinfeld said that urban air pollution is comprised of a highly complex mixture of gaseous and particulate components. People would improve science to achieve sustainable growth for future generations (Seinfeld, J. H., 1989). Liangpeng Wu and Zaiwu Gong emphasized that if target goals concerning reducing CO2 emissions are achieved, this could recover GDP growth (Wu and Gong, 2020).

The society should build a new economic growth model upon solid incentives. In Russia, annual economic losses caused by the damage of the environment amount to 4-6 per cent of the GDP (MERF, 2017). The ecological situation in the Russian populated areas (15% of the total country area) is assessed as unfavorable in environmental parameters (Bocharnikov V. Huettman F., 2019). Water quality continues to remain unfavorable. As a result of the contamination from drinking water with chemicals and microorganisms, the risk of mortality (on average 11 thousand cases annually) and morbidity of the population (on average 3 million cases annually) increases. Over 30 bil. tons of production and consumption waste has been accumulated due to economic and other activities. Nowadays, in Russia 340 areas of environmental damage have been identified, which are a source of potential threat to the life and health of 17 mln. people (SESRF, 2017). Approximately 4 bil. tons of production and consumption waste are generated annually 55-60 mln. tons of a solid municipal waste. The amount of waste is increasing; thus, 15 thousand sanctioned waste disposal sites occupy about 4 million hectares, annually increasing by 300 - 400 thousand hectares (SESRF, 2017). Consequently, nowadays the Russian authorities tries to find a way to achieve the greening of the economy and reduce energy intensity (Yan J et al, 2019) (MERF, 2017)(BED, 2019). It is recognized that the increase in anthropogenic pressures on the environment increases the risks to Nature (SSTD, 2016). Russia’s new economic security strategy considers preserving a healthy ecological environment as the primary task for Russian citizens’ welfare (ES, 2017). Thus, in the “State report concerning ecological protection of the Russian Federation in 2018" noted: "The volume of production and consumption waste generation in 2018 fell in “mining" 6,850.5 mln.t., or 94.2% of the total amount of waste generated”. “For such activities as “manufacturing”, “mining”, polluted wastewater prevails; their shares in the total volume of wastewater amounted in 2018 to 74.81%, 56.60%, respectively, 851.4 th. tons., or 28% of all emissions from stationary sources; “processing industries” 3,756.2 th. tons, or 22%” (SR, 2018). These types of economic activities make the most significant contribution to the growth of GDP. Russia 2025 environmental safety strategy emphasized the obligatoriness of the restrictions on Russia's GDP growth and it’s forecast for the future (Proskuryakova L, 2019). The objectives of the strategy primary tasks: a) prevention of pollution of surface and ground waters, improvement of water quality in polluted water bodies and restoration of aquatic ecosystems; b) preventing further pollution and reducing the level of atmospheric air pollution in cities and other settlements; c) efficient use of natural resources, increasing the level of utilization of production and consumption waste (MERF, 2017). It should be understood that the increase in greening primarily goes through the definition of environmental restrictions on polluting factors, that negatively affect economic indicators. Therefore, an essential task of long-term planning of the economy is to predict the interrelation between economic growth and ensure greening requirements to find a balance between these indicators (Steblyanskaya A. et al, 2019).

The authors' logic for investigating the environmental constraints to Russia's GDP growth the following:

(1) To understand the state of the problem: trends in environmental restrictions and targets;

(2) How do the settings of emissions and wastes reduction targets affect the GDP growth?

(3) To develop an algorithm for predicting the impacts of environmental restrictions on the Russian economic growth until 2030.

In this study we analysed the Russian GDP growth for 2000-2018 and have made a forecast until 2030. The authors agree that all types of pollutants resulted in production and consumption play an incredible role in the sustainable ecologically-oriented economy.

The authors begin the paper with an overview of Russia's annual economic losses caused by the deterioration of the environment and related economic factors. The second part represents the sample data and methodology. The third part is the presentation of the obtained results of Russia's sustainability modelling.

1.1. Literature review concerning economic development under environmental constraints

P. Krugman (1991) has emphasized that environmental restrictions should be used for regional economic growth (Krugman P.R., 1991). Grossman G.M., Krueger A.B. have highlighted the importance of ecological resources' role in economic growth (Grossman and Krueger (1995). Toshihiko Masui (2004) has proved the GDP downward trend derived from the environmental constraints on CO2 reduction under the Kyoto Protocol (Masui., 2005). Ahdi Noomen Ajmi (2013) has showed that energy consumption and CO2 emissions has very close interrelations for the United States and France (Ajmi, 2015). Lee, Jung Wan (2013) have investigated the FDI impact on increased CO2 emissions in the G20 economies (Tang et al, 2020). Ouyang Yaofu and Li Peng (2018) have studied the endogenous relationships among financial development and energy consumption in China by applying a GMM panel VAR approach with panel data of 30 Chinese provinces over the period 1996Q1–2015Q4. The unidirectional Granger causality running from energy consumption to financial development has been identified in the central region (Ouyang and Li, 2018). In the same context, the Chinese economists Yi Kong and Honglin Yang (2018) have constructed a model of economic growth under the triple constraints of environment, capital and carbon-based energy. They have introduced factors such as energy intensity, labor force and technological level into production function. Under certain conditions, improving the efficiency of environmental protection investment can be beneficial to decrease the growth rate of the pollution intensity (Kong and Yang, 2018). Chaolin Gu et al. (2020) has provided three scenarios under environmental constraints: accelerated economic development, emission reduction constraint, and low-carbon oriented. The result has revealed that rapid economic growth and sufficient energy supply will foster China urbanization in all three scenarios (Gu et al, 2020). Hongzhang Chen and Haiwen Yang (2020) have measured the structural factors influencing China's provincial energy efficiency under resource and environmental constraints (Chen and Yang, 2020). Congrong Yao et al. (2015) has showed that economic growth was the primary factor for increasing CO2 emissions (Yao et al, 2015).

The relationship between the consumption of renewable energy, carbon dioxide emissions, and GDP is substantiated in the many research works (Yao et al, Acheampong, 2018, Meier and Rauch, 2000, Aye and Edoja, 2017). Tzeremes, Panayiotis (2020) and Ozcan Burku et al. (2020) have investigated the nexus among total factor productivity, energy consumption and CO_2 emissions in G20 countries for time series data from 1971 to 2017 by employing a time-varying causality test. The researchers found nonlinear causality among the variables (Tzeremes, 2020, Ozkan, 2020).

In Russia, since the mid-80s of the 20th century, the research questions concerning environmental restrictions on economic growth was actively discussed (Ivanov et al, 2012, Bobyle and Perelet, 2013). E. A. Zhalsaraeva et al. (2019) concluded, that environmental restrictions should be interconnected with the levels of regional and districts authorities (Zhalsaraeva et al, 2019). The mechanism for managing the potential ecological production reserves should be developed with limitations according to the green passport system as a system of maximum permissible concentration (MPC) of pollutants (Bedritskiy, 2012). Nowadays, there is a need to find a balance between the interests of the Russian economy and the reduction of pollution (Korhonen and Lyakin, 2017, Golub, 2007). Bityukova, V. R., Kasimov, N. S. and Vlasov, D. V. research concerned how cities emissions influence GDP. The authors emphasized that GDP level would depend on effluent and nitrogen emissions (Bityukova et al, 2010). Chubarova, Larin and Lezina in their study concluded that decreasing nitrogen dioxide emission is one of the primaries for sustainable economic growth otherwise the people suffer and already nobody would concern about monetary gain (Chubarova et al, 2010). Environmental pollution, climate changes problems, global warming and worsening quality of the environment based on the industrial outputs, where emissions play a vital role. Thus, environmental degradation sufficiently reduces the potential of sustainable development (Burakov and Bass, 2019).

2. Methodology

2.1. Data

The authors have developed a methodology for evaluating the emissions and wastes on Russian GDP growth between 2000-2018. The authors have used data from Russian Statistical Yearbook, 2019 from Federal State Statistics Service (Rosstat, 2019), where actual data concerning emissions of sulfur dioxide (SO2), nitrogen dioxide (NO), carbon dioxide (CO_2), volatile organic compounds (VOC), ammonia emissions (NH3) (th. ton), volumes of waste generated production and consumption (mln.t), volumes of contaminated wastewater (bil. m. cub), GDP (mln. Rub), and population indicators could be found. Emissions and wastes reduction goals for Russia see in **Tab. 1**

Tab. 1 Emissions and wastes targets, Russia

Name	Source	2019 fact	2030 goal
Emissions	Federal State Statistics Service, Environmental Protection in Russia, 2020[1]	11251 th. t.	2077 th. t. [2] (90% share from the 1990)
Carbon dioxide emissions	Federal State Statistics Service, Environmental Protection in Russia, 2020	8607 th. t.	50% less than in 2019
Effluent emissions	Federal State Statistics Service, Environmental Protection in Russia, 2020, “Water protection codex of Russian federation №74-FZ” (from 3 June 2006).	37,7 billion cubic meters	50% less than in 2019
Nitrogen effluent emissions	Federal State Statistics Service, Environmental Protection in Russia, 2020	2877 th. t.	50% less than in 2019
Wastes	Federal State Statistics Service, Environmental Protection in Russia, 2020, Industrial development strategy for processing, recycling and disposal of industrial and consumer waste for the period up to 2030[3]	7751019 th.t.	7,4 The average annual increase in capital construction facilities in the industry of waste processing

Data and complete calculations see at https://github.com/rufimich/GDP_enviromental/

2.2. Methodological base

The research analysis based on the Kaya’ methodology. The authors use the Kaya equation principle for the modelling GDP under environmental constraints (Kaya, 1990) (Oberheitmann A., 2013).

The calculation was carried out according to the formulas:

$$E_X = \frac{E_X}{I_{X\prime}} \cdot \frac{I_{X\prime}}{TC_{X\prime}} \cdot \frac{TC_{X\prime}}{TC} \cdot \frac{TC}{GDP} \cdot \frac{GDP}{P} \cdot P \qquad (1)$$

Were,

E_X -Emissions (Emissions, Carbon dioxide emissions, Effluent emissions, Nitrogen effluent emissions, Wastes)

I_X - Investments in ecological protection (for emissions and carbon dioxide-air, for wastewater-water, for waste and nitrates-land and waste disposal)

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[1] Federal State Statistics Service, Environmental Protection in Russia, 2020 URRL: https://rosstat.gov.ru/storage/mediabank/nmV0UuE3/Ochrana_2020.pdf (date of access: 08.06.2021)

[2] Base scenario https://www.rbc.ru/business/23/03/2020/5e73c8739a7947f53f4f3a06

[3] The strategy of the regional industrial policy of the Russian Federation until 2024 and for the period up to 2035, URL: minpromptorg.gov.ru (date of access: 08.06.2021)

TC_X- Total costs (investment and current costs) for environmental treatment
TC -Total environmental costs
GDP – Gross Domestic Product
P -population

Thus, in the forecast, it is possible to link environmental costs, emissions, and GDP per capita into a one formula:

$$\frac{GDP}{P} = \sqrt[|X|]{\prod_X \frac{E_X}{\frac{E_X}{I_{X'}} \cdot \frac{I_{X'}}{TC_{X'}} \cdot \frac{TC_{X'}}{TC} \cdot \frac{TC}{GDP} \cdot P}} \qquad (2)$$

This is the basic formula for forecasting. The calculated parameters can be determined using regression models. In particular, if we know the relative change $\frac{I_{X'}}{TC_{X'}}$, $\frac{TC_{X'}}{TC}$, $\frac{TC_{X'}}{GDP}$compared to the previous month, it is possible to decide on the relative change in the controlled emissions in the next month close to the current according to the formula (the influencing parameters were determined using Lasso regression with a=0.001):

$$ln\left(\frac{{E_X}^{next}}{E_X}\right) = F\left(\frac{\frac{I_{X'}}{TC_{X'}}}{\frac{I_{X'}}{TC_{X'}}^{prev}}, \frac{\frac{TC_{X'}}{TC}}{\frac{TC_{X'}}{TC}^{prev}}, \frac{\frac{TC_{X'}}{GDP}}{\frac{TC_{X'}}{GDP}^{prev}}, ln(Year)\right) + \varepsilon \qquad (3)$$

As a result, the authors checked a lot of simulations under six scenarios.

Three scenarios assume state control over the share of total environmental costs in the GDP structure $\frac{TC}{GDP}$ (maintaining the current trend, increasing relative to the current trend by 20%, decreasing relative to the current direction by 20%).

The other three scenarios assume state control over the share of investments in the environment in the structure of GDP $\frac{I}{GDP}$ (maintaining the current trend, increasing relative to the current trend by 20%, decreasing relative to the current trend by 20%).

The simulations are carried out by the Monte Carlo method (10,000 random scenarios), taking into account the random distribution of the calculated parameters (a =95%) (Manno, 1999) (Metropolis and Ulam, 1949).

Regression equation determined the controlled current trends:

$$\ln(Y) = F(Year, \ln(Year)) + \varepsilon \qquad (4)$$

It used an additional regression dependency for scenarios with control of total environmental costs:

$$ln\left(\frac{I_{X'}}{TC_{X'}}\right) = F\left(\frac{TC_{X'}}{GDP}, Year\right) + \varepsilon \qquad (5)$$

$$ln\left(\frac{\frac{E_X}{I_{X'}}}{\frac{E_X}{I_{X'}}^{prev}}\right) = F\left(\frac{\frac{I_{X'}}{TC_{X'}}}{\frac{I_{X'}}{TC_{X'}}^{prev}}, \frac{\frac{TC_{X'}}{TC}}{\frac{TC_{X'}}{TC}^{prev}}\right) + \varepsilon \qquad (6)$$

The simulation was carried out according to the algorithm in **Fig. 1**

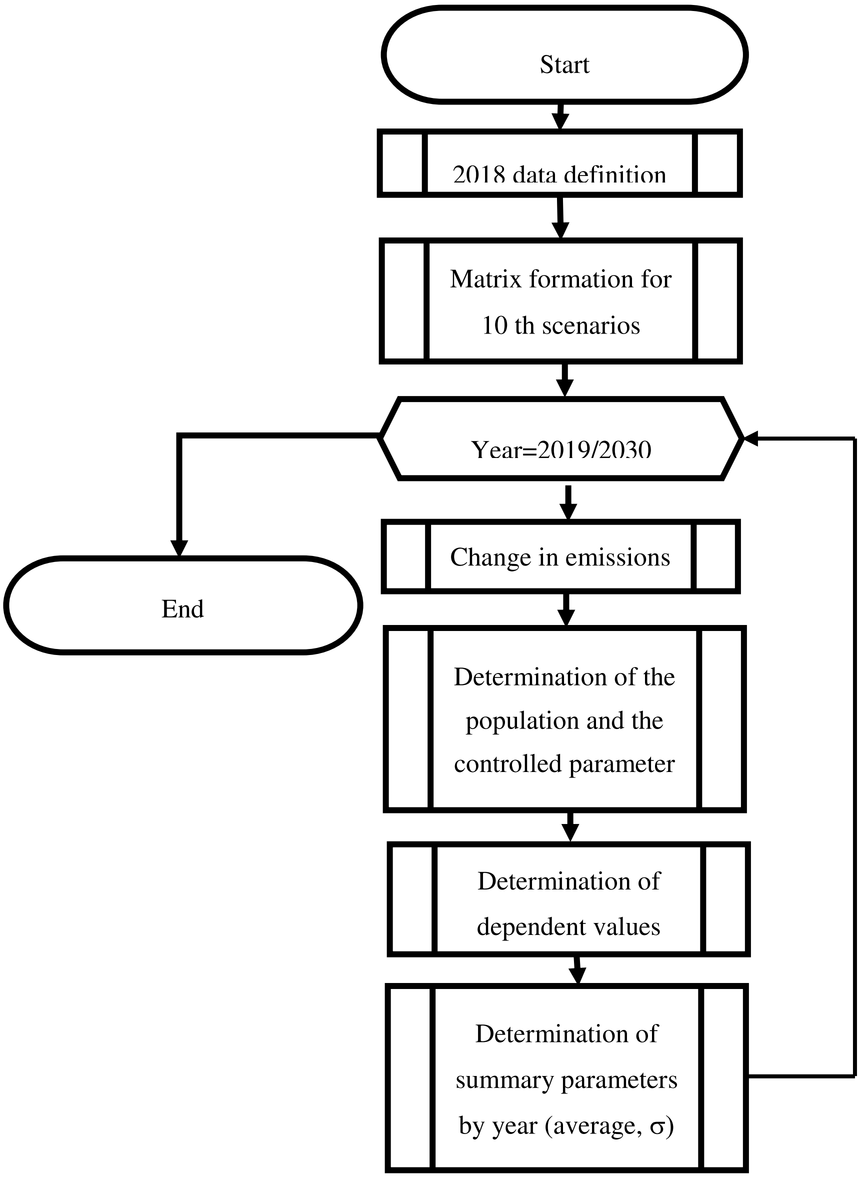

Fig. 1 Research algorithm

3. Results

3.1. Analysis results

The share of the investments into ecological protection to the total investments into environment see in **Fig. 2**

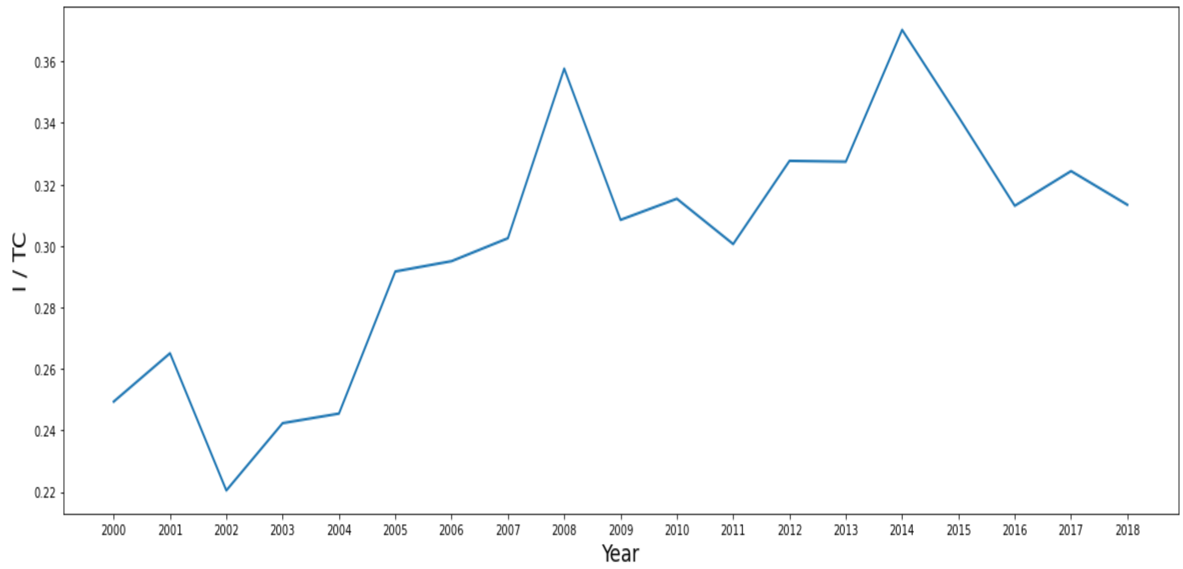

Fig. 2 Share of the investments into ecological protection to the total environmental costs, Russia

Fig. 2 shows that the share of ecological investments in the structure of total environmental costs is growing. It was changed from 0,25 in 2000 till 0,31 in 2018 with the minimal level 0,22 in 2000. The peaks are the crises of 2008 and 2014. Thus, after the financial crisis, enterprises save and reduce their investments. Companies increase environmental costs only after accidents and major man-made emergencies, that is, in fact, "extinguishes fires". The costs of maintaining the environment are much less than the post-crisis ones. Since 2000, oil has become more expensive, companies have made super-profits, and companies have more money to invest in solving environmental problems. Increasing in costs in 2011-2014 may be caused by the implementation of new gas projects "Power of Siberia", "YAMAL-LNG" and " Sakhalin-2".

For further calculations, the authors use the next indicators:

- I / TC – Investments into environmental protection/ Total environmental costs;
- TC / GDP – the share of environmental costs in GDP;
- GDP / P – GDP per capita

Investments changes to the previous year’s see in **Fig. 3**

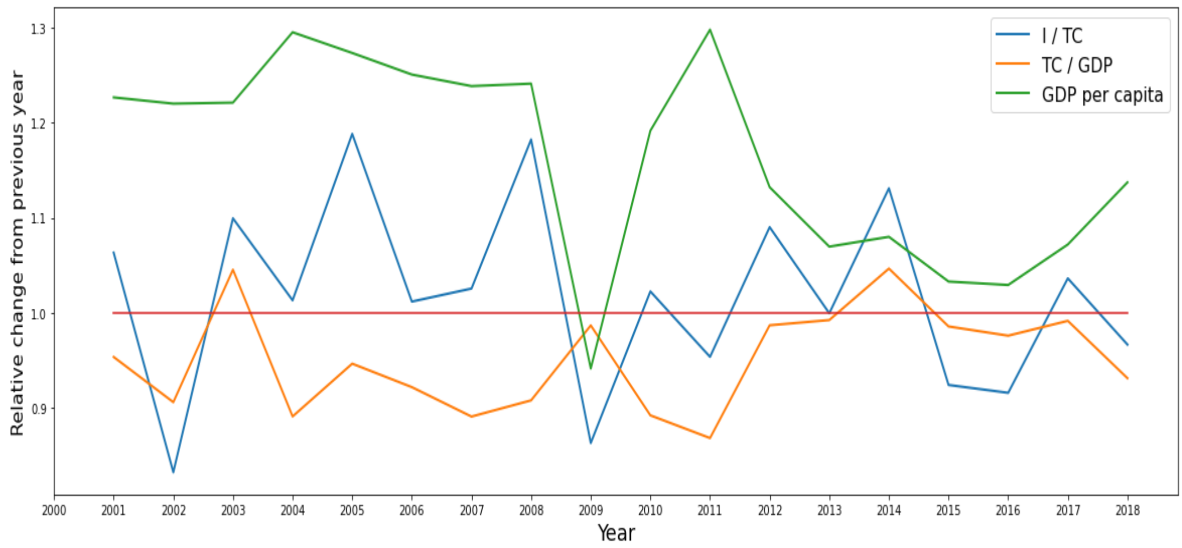

Fig. 3 I / TC, TC / GDP, GDP / P – GDP share to the previous years.

In **Fig. 3** we can see that GDP per capita as a whole is growing from 2015. The share of investments in environmental protection has been relatively low over the entire period and has been falling sharply since 2014. The share of environmental costs in GDP fell from 2005 to 2008, as well as in 2010, 2011 and 2015. The share of investments in total environmental protection expenditures compared to the previous year from 2011 fall down with a slight increase in 2011 and 2017. Thus, the low investment trend to the water and land purification could show us the future risks. After the global crisis in 2008, the indicators failed to reach the pre-crisis level. Investments for water, earth and air protection see in **Fig. 4.**

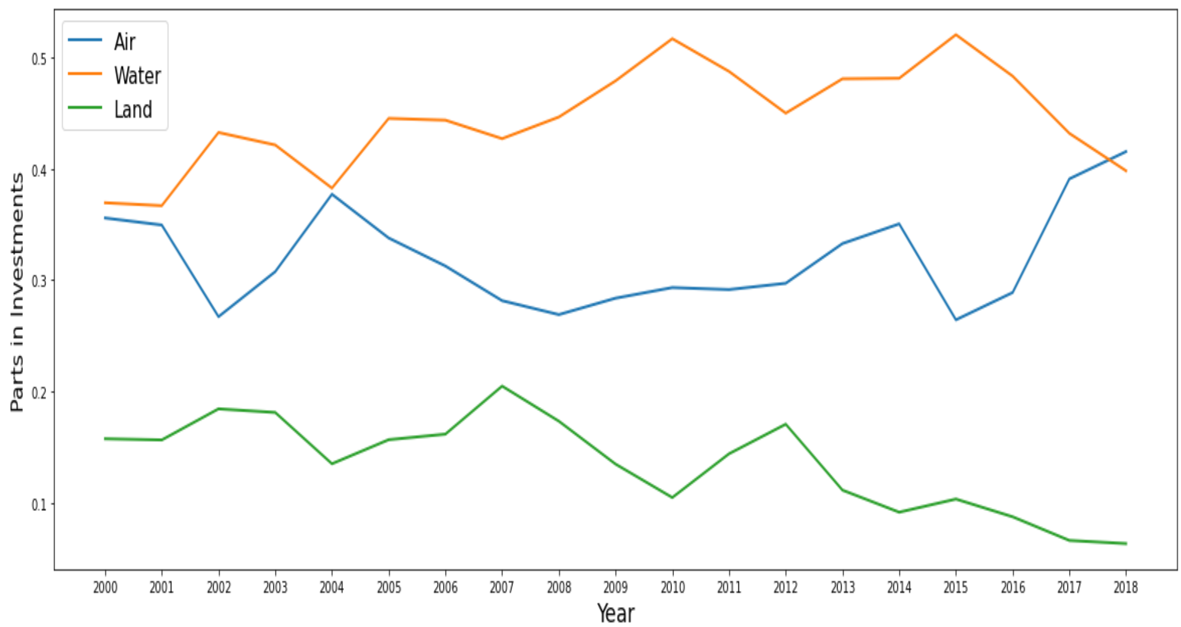

Fig. 4 Investments for water, land and air protection.

Fig. 4 shows that the structure of investments in the Russian Federation environment not equal. As we see, the investments in water purification prevail, while investment in land purification not enough. In April 1999, it was adapted the Federal Law "On the Protection of

Atmospheric Air" (96-FZ), which establishes the legal basis for the atmospheric air protection and is aimed at implementing the constitutional rights of citizens to a favorable environment and reliable information about its condition. By 2018, there has been a trend towards an increasing in the share of investments in air purification cause the tendency to give more attention to the CO2 pollution all over the World and in Russia particularly. Parts in the current expenditures towards environmental purification see in **Fig. 5**

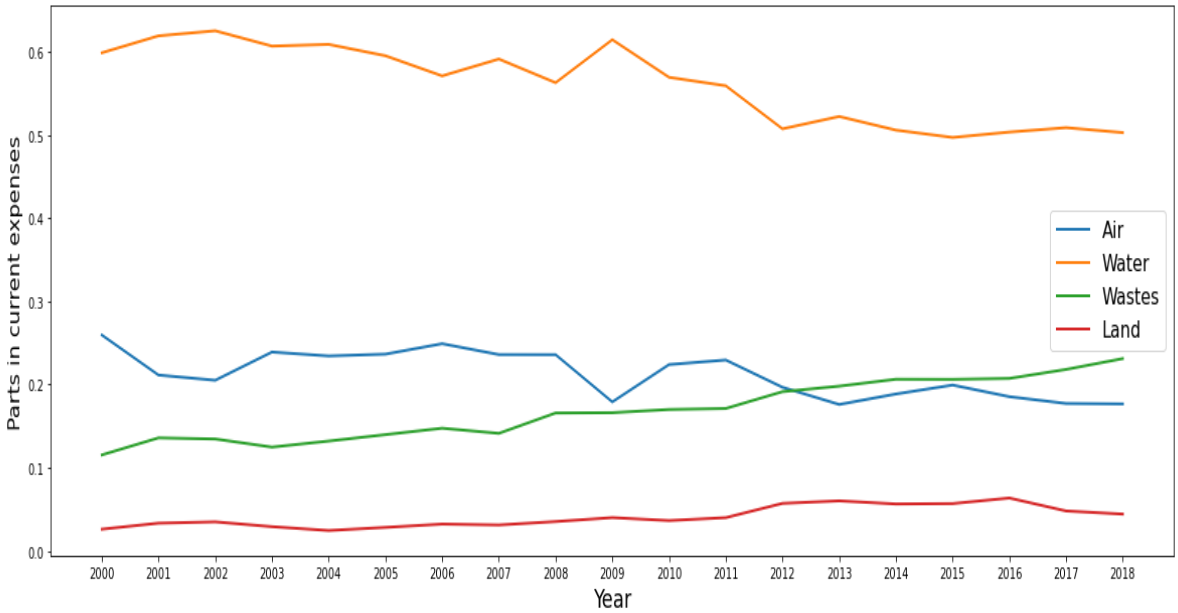

Fig. 5 Share of the current expenses into environmental purification to the total environmental investments

Fig. 5 shows that expenditures for waste products utilization has upwards trends. Waste products utilization is a huge problem in Russia. Government tries to push up measures towards purification, however, result is not successful yet. Expenditures for water purification decreased from 2009 year constantly. Share of the emissions to the previous years could be seen in the **Fig. 6**

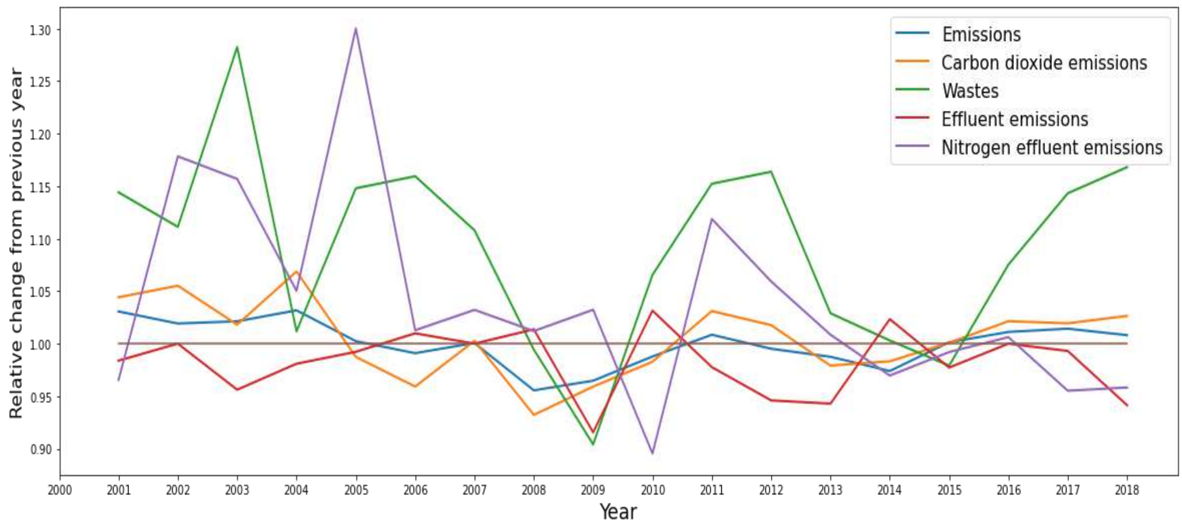

Fig. 6 Share of the emissions to the previous years

Fig. 6 shows that from 2013 CO2 emissions, waste product emissions have an upward trend while effluent emissions have the downward trend. If it is higher than 1, for example, 1.1, then this element has grown by 10% compared to last year. In general, there is a decrease in comparison with 2000 years. The decrease in waste products utilization expenditures is significantly associated with an increase in the share of investments in water and land purification, as well as with an increase in total environmental costs in GDP in the past period. The situation is observed in connection with the introduction of new more stringent standards, the re-profiling or closure of some production facilities. For nitrates, their relative growth is associated only with the growth of GDPPC. As for the effluents, we can say that their increase in the next period is significantly associated with the upward trends in the total costs of water purification in the previous period. Investment situation to the previous year's see in **Fig. 7**

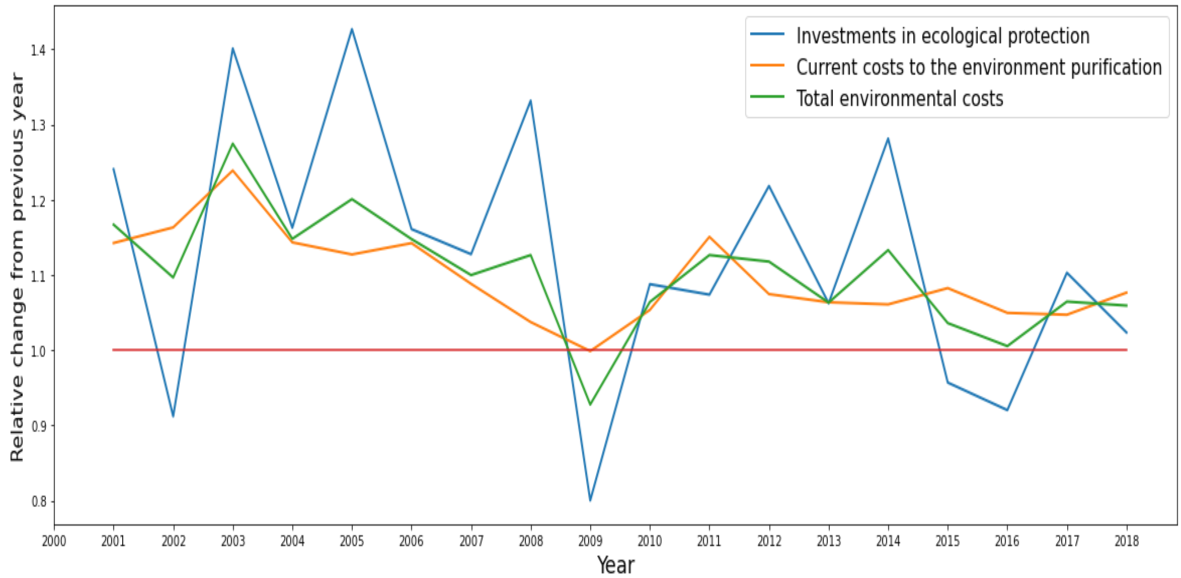

Fig. 7 Share of investments to the previous periods

Fig. 7 shows the dropped level of investments in 2002, 2009, 2015 and 2016. Here you need to look at whether the value is higher or lower than 1. If it is higher than 1, for example, 1.1, then this element has grown by 10% compared to last year. In general, there is a decrease in comparison with 2000 years. Total investments in the environment protection have downward trends, while current expenditures to the environment purification increased. Investments to the environment protection to the previous years were unstable trends through all period. The main impact or the main lack of investment compared to previous periods is related to the protection of land. In part, there was a reallocation of funds from land to water and to air, that is, there was an intra-group movement. Current costs to the environment purification see in **Fig. 8**

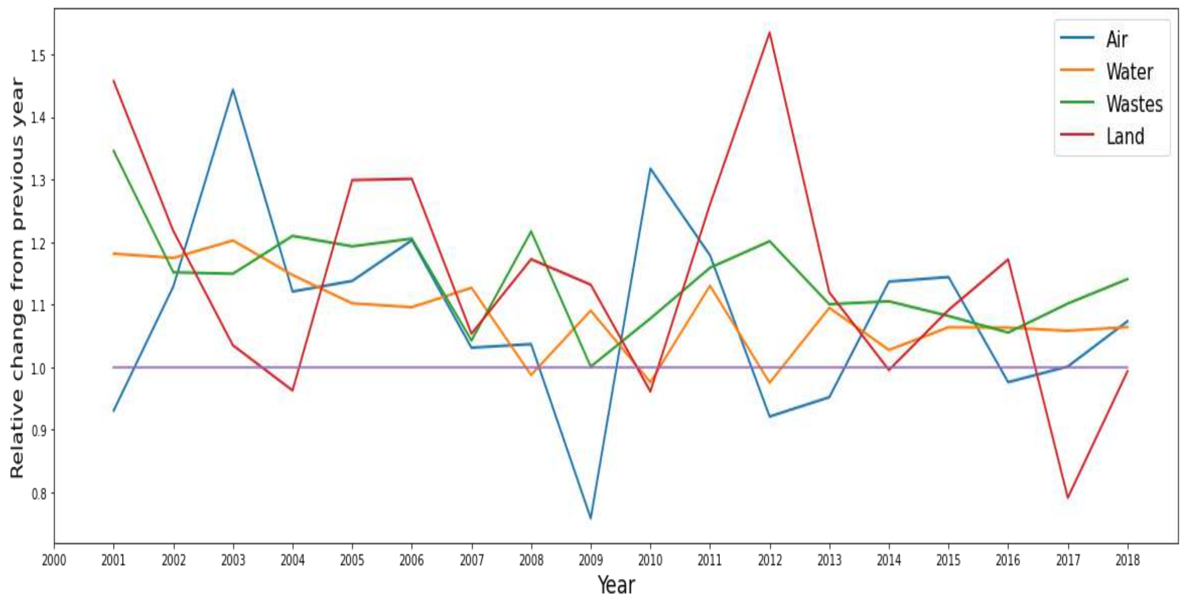

Fig. 8 Current expenses into environment purification

Fig. 8 shows the share of current costs into the ecological protection. As we see, in Russia the waste expenses gradually decreased through the last twenty years. The indicators of waste management efficiency were classified by the authors into two groups: the intensity of wasted generation and the efficiency of waste utilization. From the point of view of waste management, the most effective country where the difference between the intensity of waste generation and the efficiency of waste utilization is the smallest and the system is closed to equilibrium (Mikhailov et al. 2017).

Share of the total environmental costs in the GDP see in **Fig. 9.** Last trends that current expenditures for the purification increased in compare with other periods.

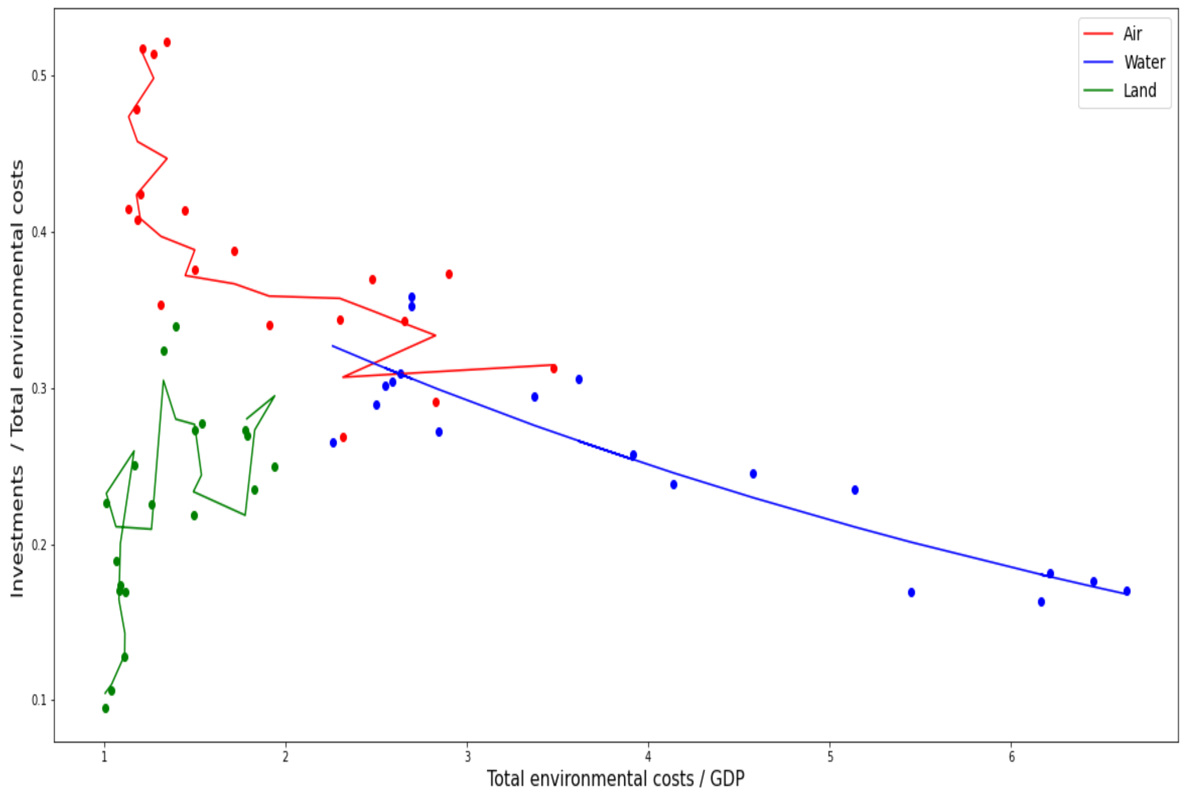

Fig. 9 Total environmental costs / GDP

The intermediate regression shown in the **Fig. 9** examines the relationship between total costs and investments. The blue and red lines (air and water purification costs) show that an increase in total environmental costs in the GDP structure does not lead to a proportional increase in investment in the environment. The ratio of investments to total costs is reduced. The opposite trend is observed with investments in land cleaning, they are steadily growing. This means that the increase in total costs for air and water purification is primarily associated with an increase in current costs for restoration, and an increase in land costs is associated with an increase in investments.

The authors analyze these coefficients: I/TC, I_{Air}/TC_{Air}, I_{Water}/TC_{Water}, I_{Land}/TC_{Land}, TC/GDP, TC_{Air}/GDP, TC_{Water}/GDP, TC_{Land}/GDP, GDPPC.

Strong correlation the authors was observed in the next models:

1. Emissions ~ TC_{Air}/GDP + lnYear (Prob (F-statistic): 0.00197)
2. CO_2 emissions ~ TC_{Air}/GDP (Prob (F-statistic): 0.0648)
3. Wastes ~ I_{Water}/TC_{Water} + I_{Land}/TC_{Land} + TC/GDP (R-squared 0,723, Prob (F-statistic): 0.000684)
4. Effluent Emissions ~ TC_{Water}/GDP (Prob (F-statistic): 0.0166)
5. Nitrogen Effluent Emissions ~ TC_{Land}/GDP (Prob (F-statistic): 0, 000364)

Thus, we see those emissions and CO_2 emissions have a strong correlation with Total investments in air protection to the GDP. Wastes have a strong correlation with investments into water to the total investments into the water restoration, investments into the land to the total investments into land restoration and Total investments to the GDP. Effluent Emissions have strong correlation with total investments into the water to the total investments into water restoration. Nitrogen Effluent Emissions have a strong correlation with total investments into land restoration to the GDP. Some preliminary tests with descriptive statistic table and a correlation matrix see in Supplementary materials. In all models, the forecast curve declines. This suggests that the increase in the share of investments in the environment in total environmental costs compared to last year is associated with a relative decrease in all types of analyzed emissions. This relationship is least observed in effluents. The red vertical lines are the acceptable range of values according to the model from the previous paragraph. Emissions and CO2 emissions and effluent emissions/ Investments into environment planned to be at the same level till 2028. The share of the waste products will increase. Please, see supplementary materials. Nitrogen effluent emissions will decline till 2028. CO2 emissions/ current investment into environmental restoration planned to be at the same level till 2028. The share of the waste products will increase. Please, see supplementary materials. Emissions, effluent emissions and Nitrogen effluent emissions will decline till 2028. Emissions and CO2 emissions and effluent emissions/ Total investments into environment planned to be at the same level till 2028. The share of the waste products will increase. Please, see supplementary materials. Nitrogen effluent emissions will decline till 2028. Detailed tables see in Supplementary materials.

3.2. Forecasting results

The most controversial question concerning this research is what the most influence GDP- real investments to the environmental protection or current cost for plugging holes in the ecological hazards' cases. We modelled investments into environmental conversation as a share to the GDP level (see **Fig. 10**).

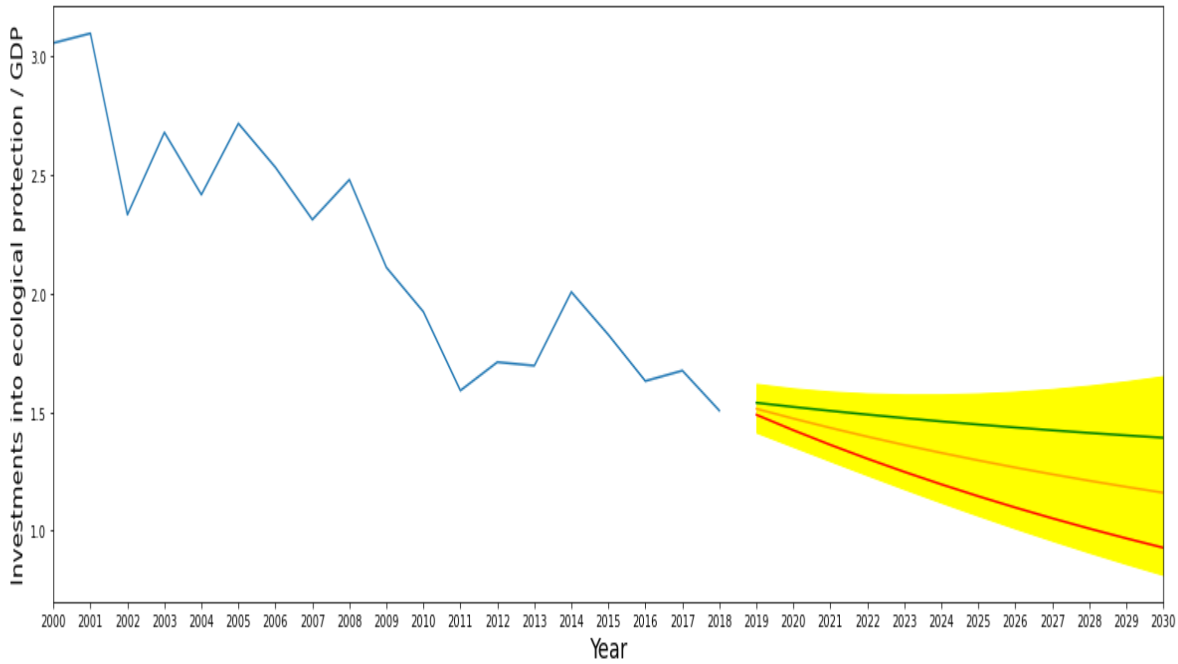

Fig. 10 Investments into ecological protection / GDP

Fig. 10 shows that the green level indicates increasing investments to the ecological protection till 20% and the red level line indicates the GDPPC forecast, if investments in environmental treatment decreased by 20%. However, there is a negative trend towards a decline in the ecological investments impact on Russia's GDP. It is necessary to carefully analyse the possible reasons for reducing the impact of investments in the environment on GDP. Investments in air pollution treatment see in **Fig.11**

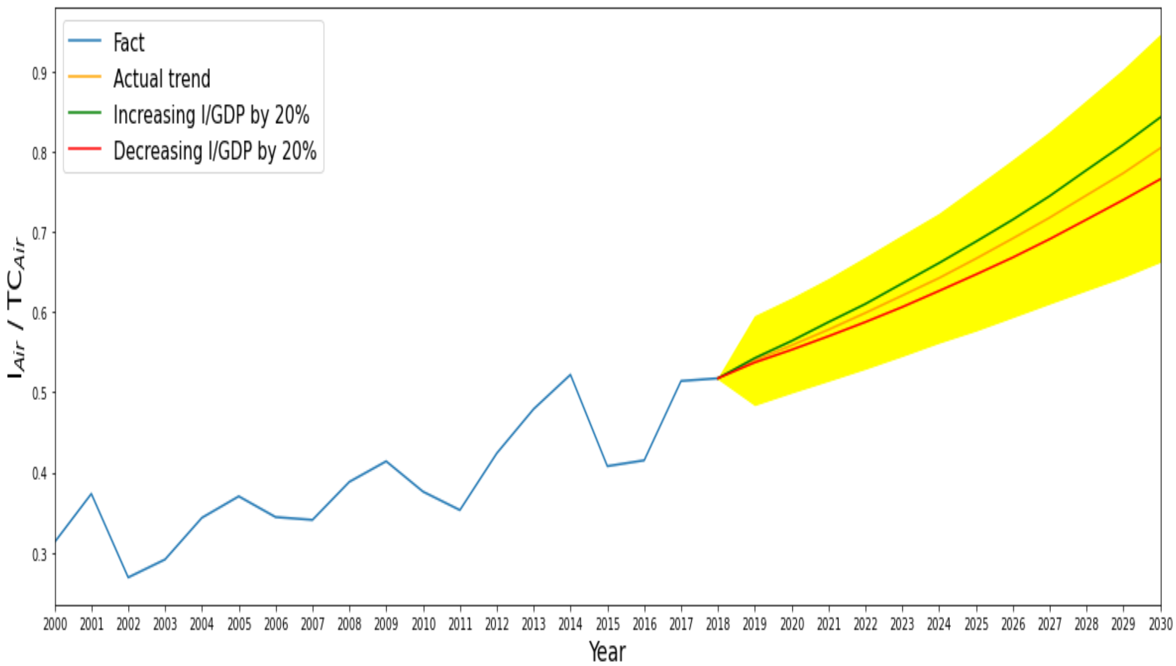

Fig. 11 Investments in air pollution treatment

Fig. 11 shows scenarios with changes into investment in air pollution treatment. Thus, total emissions and CO_2 emissions strongly correlated with total investments in air protection to the GDP; these emissions have the most influence on the GDP level.

We have modeled changes in investment into water treatment (see **Fig. 12**).

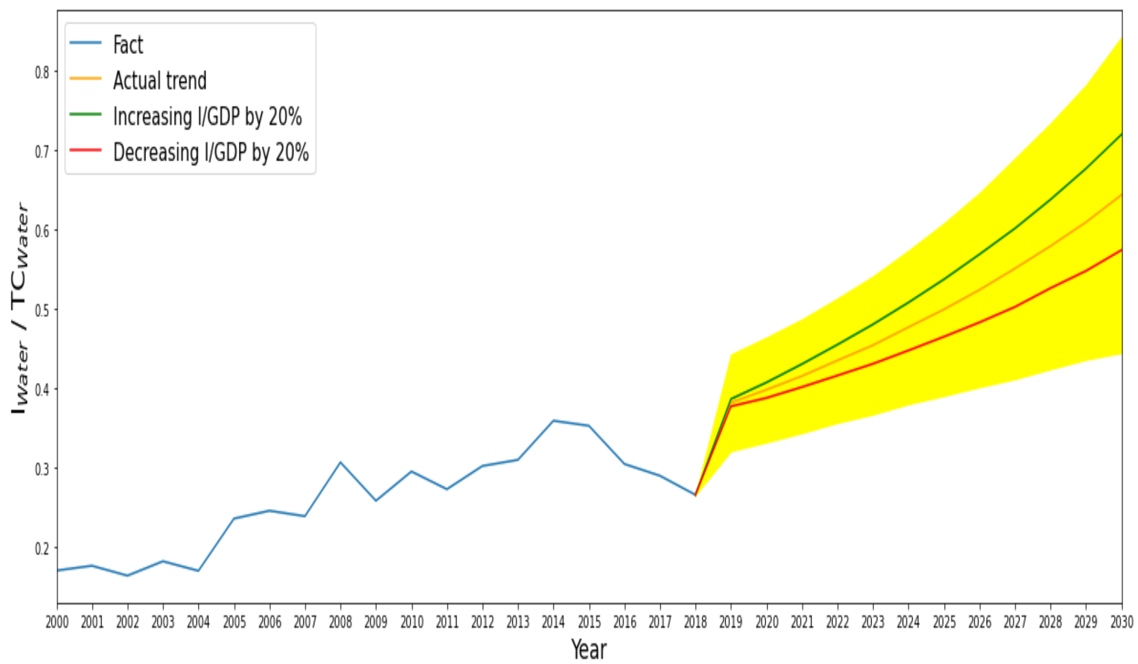

Fig. 12 Investments into the water protection

Fig. 12 shows that the share of the investment part in water treatment costs will grow.

In 2016, high and extreme pollution of surface waters was registered in thirty-three Russian regions. In June 2021 it was strictly changed "The Water Code of the Russian Federation" (74-FZ), where was emphasized that dumping into water bodies is strictly prohibited. Decree of the Government No. 728 of 22.05.2020 approved the Rules for monitoring the composition and properties of wastewater. Furthermore, the Government decree uniform requirements for deadlines and plans for reducing discharges into water bodies. Also, it updates the existing system of compensation for environmental damage. Thus, investments in water protection will only grow in Russia.

We have modeled the situation of changing investments in land cleaning and waste treatment (see **Fig. 13**)

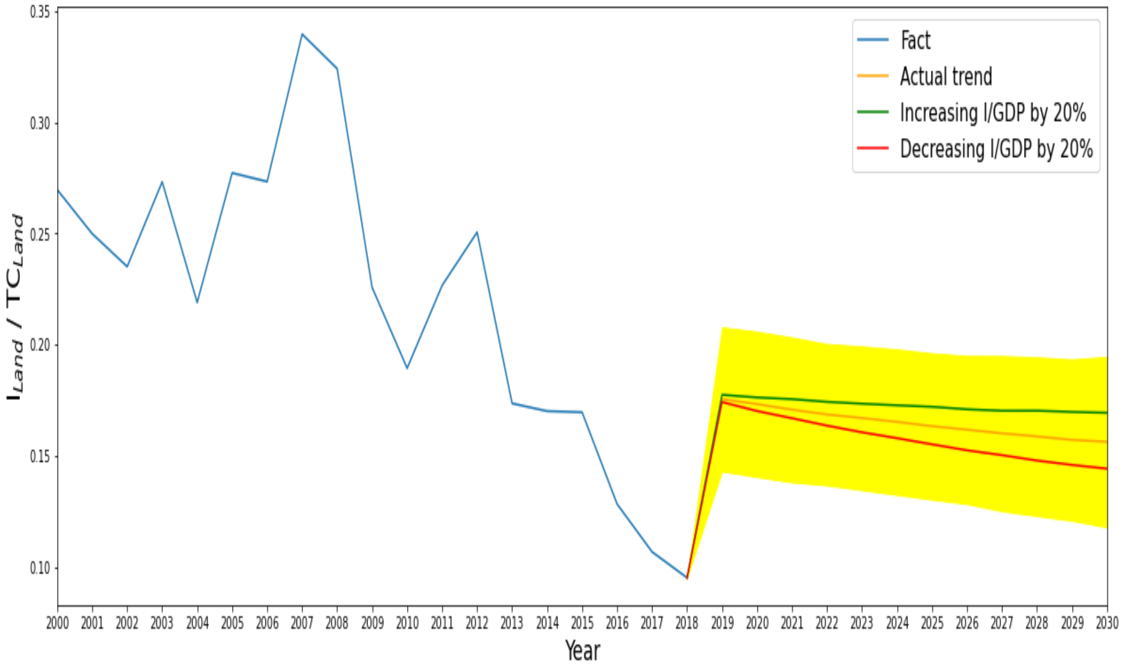

Fig. 13 Investments into the land cleaning and waste treatment

Fig. 13 shows investments in land cleaning and waste treatment would have a downward trend. The garbage crisis in Russia is a systemic environmental crisis developed in the Russian Federation in solid household waste management in the late 2010s. At the beginning of 2019, large-scale "garbage" protests were held in thirty regions of Russia. Even though the reform in the field of waste management in Russia began to be implemented in 2015, its interim results in 2019 indicated a systemic crisis. The waste management infrastructure is not created by either the state or business, illegal waste disposal continues without quality and quantity control. 16 % of the population consider landfills to be among the most acute environmental problems. Regional authorities often ignore the adopted laws and legal acts, which do not correspond well with the real state of things and do not have financial support. The lack of liability measures in the development of regulatory legal acts further aggravates the situation. The Public Chamber of the Russian Federation on the situation for 2018 stated that private enterprises failed to implement a waste management system. The subjects of the Russian Federation, like previously municipalities, actually failed to cope with their powers. Practice has shown that no state or business structure can create an effective system for protecting land in 2018. A "garbage reform" process was started in Russia in January 2019, it provides for significant changes in the rules for handling municipal solid wastes (IFC, 2012).

We also have modeled emissions till 2030 (see **Fig. 14**).

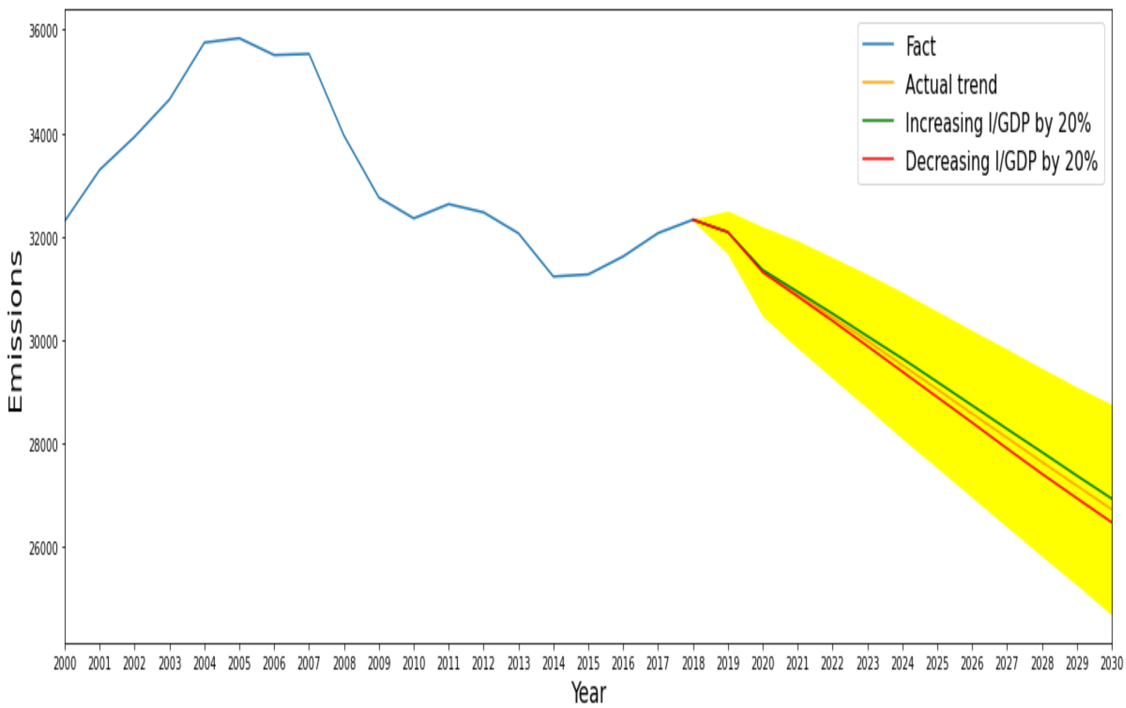

Fig. 14 Emissions forecast

Fig. 14 shows a decline in emissions by implementing strict government policies in emissions and introducing tough measures to track violators. We also have identified the most likely scenarios in carbon dioxide emissions till 2030 (see **Fig. 15**).

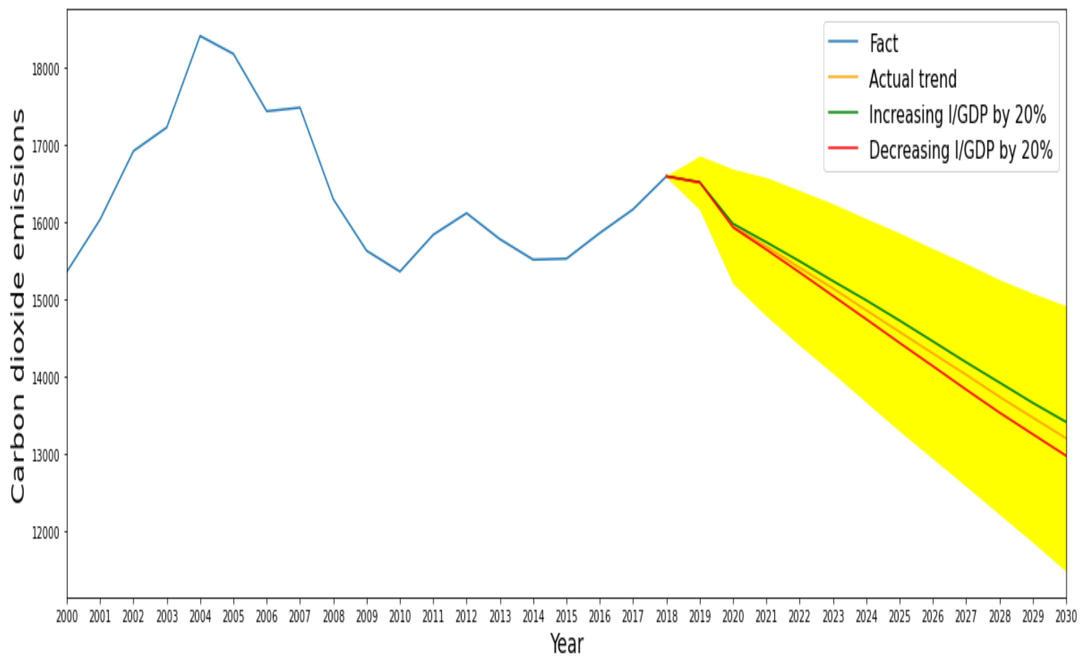

Fig. 15 Carbon dioxide emissions forecast

Fig. 15 shows a decline in carbon dioxide emissions possibly by implementing strict government policies in emissions and introducing harsh measures to track violators.

The priorities of actions in the field of GHG emissions reduction provide for a set of measures to improve the energy efficiency of the economy, which should be aimed at simultaneously reducing costs and GHG emissions, reducing environmental and climate risks and increasing competitiveness of production (Porfiriyev, 2020).

We have identified the most likely scenarios in waste products emissions till 2030 (see **Fig. 16**)

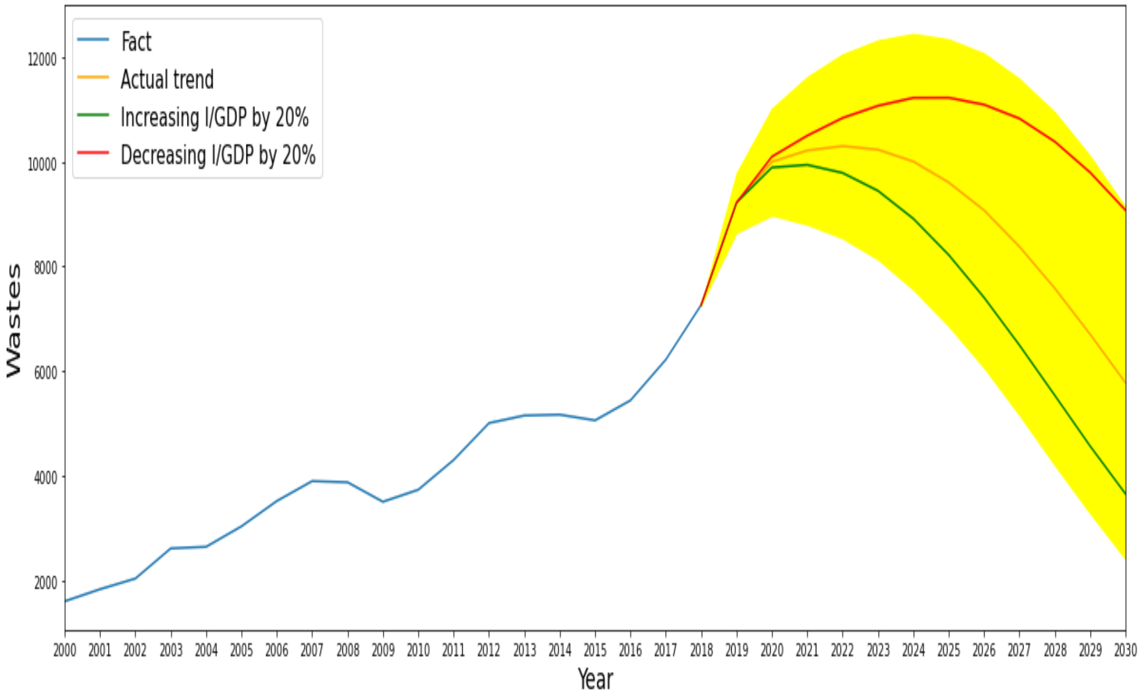

Fig. 16 Waste product emissions forecast

Fig. 16 shows that polluting products will decrease with an increase in garbage disposal or other pollutants. In the event of a decrease in investment, the level of pollution will increase dramatically. We have modeled effluent emissions till 2030 (see **Fig. 17**)

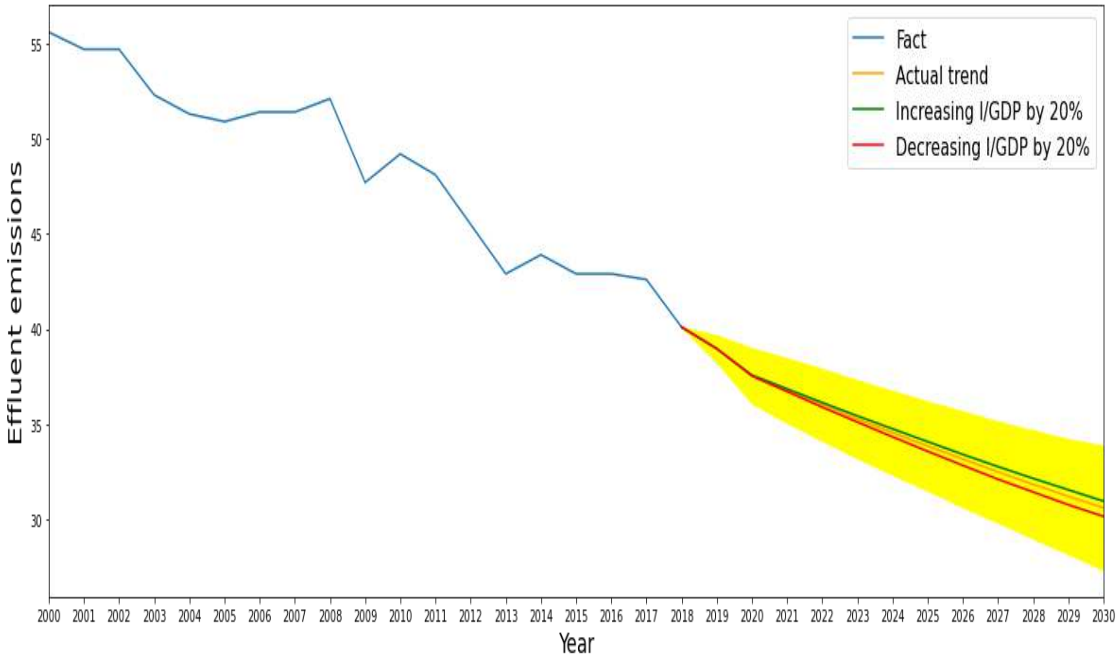

Fig. 17 Effluent emissions forecast

Fig. 17 shows that the decline in effluent emission usage. Due to planning the closure of hazardous production facilities, the trend introduces a more stringent monitoring system for cleaning. Nitrogen effluent emission scenarios see in **Fig. 18**.

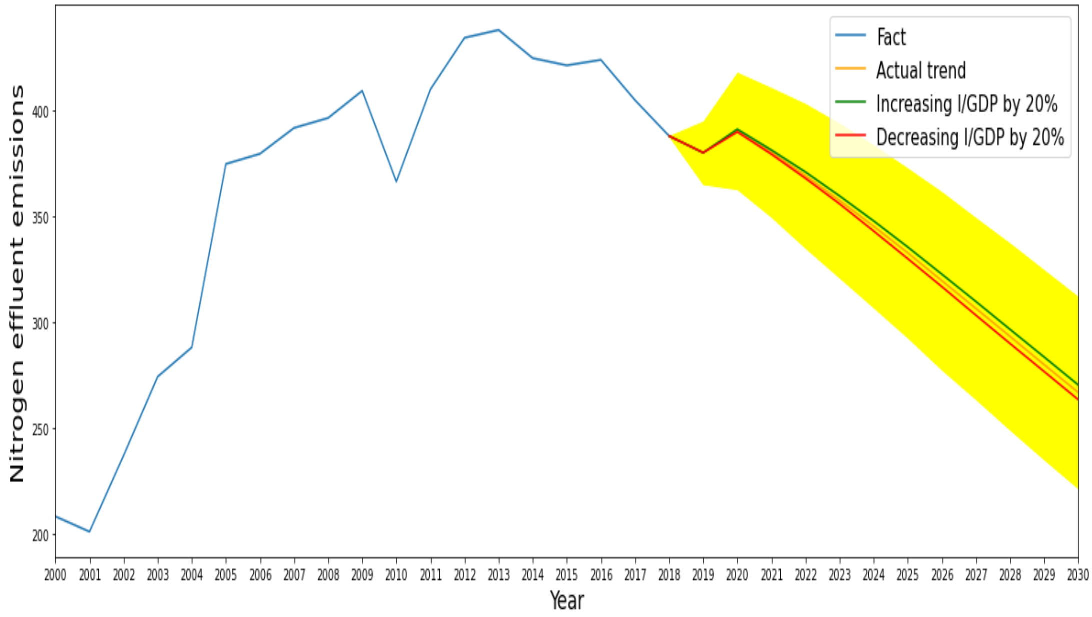

Fig. 18 Nitrogen effluent emissions forecast

Fig. 18 shows that the decline in the use of nitrates in Russia will be due to a change in fertilizers policy and implementation. However, despite the European Nitrate Directive (ND) being issued almost thirty years ago, groundwater nitrate contamination is still a serious threat to ecosystems and human health (EU Commission 1991). Nitrate trends over eleven years show that most regions present steady or increasing concentrations, highlighting how contamination can affect previously impaired situations. Nitrates are nitric acid salts that accumulate in food and water when nitrogen fertilizers are too high in the soil. Nitrates and nitrites cause many diseases in humans. In Russia it could be the nitrates emissions decrease trend implemented. This is possible by recycling a considerable amount of nitrate products, or switching to new environmentally friendly fertilizers. In 2020 in Russia new Law "On Restricting the Turnover of Nitrous Oxide in the Russian Federation”[4] emphasized planning to use new environmentally friendly non-nitrate kinds of fertilizers.

4 Discussion and conclusions

The Russian Federation has declared as a national contribution to the implementation of the Paris Agreement the retention of net GHG emissions in the country below 70-75% from 1990, with a likely shift of the targets to 60-65% 2030-2035. At the same time, over the past 10 years, the average annual rate of economic growth in Russia did not exceed 1%, leading to stagnation of the population’s real incomes. The program documents set out the tasks of

[4] Federal Law No. 472-FZ of December 29, 2020 " On Restricting the Turnover of Nitrous Oxide in the Russian Federation”, URRL Федеральный закон от 29 декабря 2020 г. № 472-ФЗ “Об ограничении оборота закиси азота в Российской Федерации” (garant.ru) (date of access: 16.05.2021)

accelerating the dynamics and industrial complexes modernization. With the technological lag, the problem is that these problems may conflict with the limits on GHG emissions (Porfiryev et al, 2020). However, “the past is not a Russian future” and the complexity of futures thinking comes to light when elements of our different scenarios are combined to generate more comprehensive pictures of what Russia might look like in 2030 (Chaillot Paper, 2020).

The findings of the study are multifaceted and impressive:

1. The authors calculated regression models, evaluating the measure and nature of their interdependence between GDPPC and carbon dioxide emission, wastes, effluent emission, nitrogen effluent emission and other types of emissions.
2. GDP growth scenarios were built under the emissions and waste reduction targets (+-20% from the existing level).
3. Increasing the total investment in environmental protection will not bring any results, if it is not an investment into ecological conservation. Thus, for Russia it is necessary to understand how to increase the total cost for ecological protection by increasing the part of investment into ecological protection. It is essential to review the structure of investments in environmental protection and shift the focus from operational costs to investment costs. It is essential to eliminate the consequences of emergency situations, and to invest in programs related to the prevention of environmental accidents and reducing emissions.
4. There is a negative trend towards a decline in the ecological investments impact on Russia's GDP. It is necessary to carefully analyze the possible reasons for reducing the impact of investments in the environment on GDP. Total emissions and CO_2 emissions strongly correlated with total investments in air protection to the GDP; these emissions have the most influence on the GDP level. The investments in water protection will grow until 2030.
5. Total emissions and CO_2 emissions strongly correlated with total investments in air protection to the GDP. Results show a decline in carbon dioxide emissions possibly by implementing strict government policies in emissions and introducing harsh measures to track violators.
6. Wastes discharges have a strict correlation with investments into the water to the total investments into the water restoration, investments into the land to the total investments into land restoration and total investments to the GDP. Results show that polluting products will decrease with an increase in the garbage disposal or other pollutants. In the case of a decrease in investment, the level of pollution will increase dramatically. If Russia optimized its waste-oriented policy and implements modern technologies, by 2025 it could recover up to 45% of waste (IFC, 2012).

7. Effluent emissions have rigorous closeness with total investments into the water to the total investments into water restoration. Nitrogen effluent emissions have a strong correlation with total investments into land restoration to the GDP.

The paper approved the results from previous researchers that the results indicate that most of the variations in CO_2 emissions are determined by variations in GDP, so reducing CO_2 emissions in the long run can be achieved by continuously increasing GDP (for example, see Pejović et al, 2021, Porfiryev et al, 2020). The authors look in the future hoping that Russia would be brave to change ways concerning environmental protection from “extreme and post-crises management” into investments into ecological protection to prevent cataclysms and disasters. It is shortsighted for future try to change something after a disaster has happened.

Declarations' section

(a) Ethics approval and consent to participate.

Not applicable

(b) Consent for publication

This manuscript has not been published and is not under consideration for publication elsewhere.

(c) Availability of data and materials

Data and complete calculations could be found at https://github.com/rufimich/GDP_enviromental/

(d) Competing interests

The Authors have no conflicts of interest to disclose.

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(f) Authors' contributions

Alina Steblyanskaya – thesis writing, data analysis; Ai Mingye- supervision, validation; Artem Denisov- Python calculations, program analysis

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Abbreviations used in the Study:

bil.t. – billion tons
bil m. cub – billion cubic meters
CO_2-Carbon Dioxide
GDP- Gross Domestic Product
GDPPC– Gross Domestic Products per capita
mln.ton.-million tons
mln. Rub. - million Rubbles
mln. cub. m. – million cubic meters
P- Population
Stocks-wastes of water drains
th. t. – thousand tons
th. Rub. – thousands of Rubbles
UN- United Nations
Wastes- production and consumption wastes
I/TC – Investments into environmental protection/ Total environmental costs;
TC /GDP – the share of environmental costs in GDP;
GDPPC – GDP per capita
MPC - maximum permissible concentration
I_{Air}/TC_{Air} - Investments in air protection/ Total environmental costs to the air restoration
I_{Water}/TC_{Water} - Investments in water protection/ Total environmental costs to the water restoration
I_{Land}/TC_{Land} - Investments in land protection/ Total environmental costs to the land restoration
TC_{Air}/GDP - Total environmental costs to the air restoration /GDP
TC_{Water}/GDP - Total environmental costs to the water restoration /GDP
TC_{Land}/GDP - Total environmental costs to the land restoration /GDP

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