Rakhmonov K.R., PhD
associate professor
Land hydrology department
National University of Uzbekistan named after Mirzo Ulugbek
Uzbekistan, Tashkent
Erlapasov N.B., PhD
associate professor
Hydrometeorology and environmental monitoring department
National University of Uzbekistan named after Mirzo Ulugbek
Uzbekistan, Tashkent
Rapikov B.R.
PhD candidate
Land hydrology department
National University of Uzbekistan named after Mirzo Ulugbek
Uzbekistan, Tashkent

REPRESENTATIVE CONCENTRATION PATHWAYS (RCP) – IMPACT OF CHANGES IN ATMOSPHERIC GREENHOUSE GAS CONCENTRATIONS ON THE HYDROLOGICAL REGIME OF THE CHIRCHIK RIVER

Abstract. *Today, several climate projections have been developed that represent an increase in the amount of greenhouse gases. These projections serve to model atmospheric chemistry as the first step in developing climate scenarios. One of them is called RCP (Representative Concentration Pathways).*
Key words: *Climate change, climate projections, climate models, greenhouse gases, Chirchik river, hydrological regime, forecast.*

Introduction. Today, there are the following types of RCPs:
1. RCP 2.6 (IMAGE)
2. RCP 4.5 (MiniCAM)
3. RCP 6.0 (AIM)
4. RCP 8.5 (MESSAGE)

RCP 2.6 is a projection developed by the IMAGE modeling team of the Netherlands Environmental Assessment Agency. Based on this projection, greenhouse gas concentrations are assumed to change at very low levels in the future. In particular, the level of exposure to radiation will reach a value of about 3.1 W/m^2 in the middle of the 21st century and will decrease to 2.6 W/m^2 by 2100.

RCP 4.5 is a projection developed by the MiniCAM modeling team at the Joint Global Change Research Institute (JGCRI) at the Pacific Northwest National Laboratory. This is the stabilization scenario, in which total radiation exposure is stabilized by 2100 by adopting a range of technologies and strategies to reduce greenhouse gas emissions.

RCP 6.0 is a projection developed by the AIM Modeling Group at Japan's

National Institute for Environmental Studies (NIES). This is also a stabilization scenario, and after 2100 the radiative effect will be relatively stabilized through actions and measures taken to reduce the amount of greenhouse gases.

RCP 8.5 is a projection developed by the MESSAGE modeling group of the International Institute for Applied Systems Analysis (IIASA) in Austria and the IIASA Integrated Assessment Framework. Based on this projection, the concentration of greenhouse gases will increase at high levels over time.

In turn, the change in the concentration of greenhouse gases in the atmosphere according to the above projections will lead to an increase in the average temperature on the Earth's surface. We can see this in the table below.

№	RCP	Increase in average temperature on Earth (year 2100), °C
1	RCP 2.6 (IMAGE)	1,0 (0,9-2,3)
2	RCP 4.5 (MiniCAM)	1,8 (1,7-3,2)
3	RCP 6.0 (AIM)	2,2 (2,0-3,7)
4	RCP 8.5 (MESSAGE)	3,7 (3,2-5,4)

Results and discussion. Carbon dioxide, a product of anthropogenic activity, is added to the natural carbon cycle. Every year, there is a natural cycle of many millions of tons of carbon between the atmosphere, oceans and land cover. The trade-offs in this vast and complex natural system are precisely balanced. During the 10,000 years before the industrialization period, the amount of carbon dioxide in the atmosphere changed by about 10%. But during the last 200 years, that is, since 1800, its amount has increased by 30%. Considering that half of the anthropogenic carbon dioxide emissions are absorbed by the oceans and plants, its amount in the atmosphere increases by 10% every 20 years.

In the table below, we can see the change in carbon dioxide levels up to 2100 under different RCP projections (Table 2)

Table 2

RCP projections of carbon dioxide (CO_2) concentrations change to 2100

№	Years	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	1900	295,800	295,800	295,800	295,800
2	1910	299,700	299,700	299,700	299,700
3	1920	303,025	303,025	303,025	303,025
4	1930	307,225	307,225	307,225	307,225
5	1940	310,375	310,375	310,375	310,375
6	1950	310,750	310,750	310,750	310,750
7	1960	316,273	316,273	316,273	316,273
8	1970	324,985	324,985	324,985	324,985
9	1980	338,360	338,360	338,360	338,360

10	1990	353,855	353,855	353,855	353,855
11	2000	368,865	368,865	368,865	368,865
12	2005	378,813	378,813	378,813	378,813
13	2010	389,285	389,128	389,072	389,324
14	2020	412,068	411,129	409,360	415,780
15	2030	430,783	435,046	428,876	448,835
16	2040	440,222	460,845	450,698	489,435
17	2050	442,700	486,535	477,670	540,543
18	2060	441,673	508,871	510,634	603,520
19	2070	437,481	524,302	549,820	677,078
20	2080	431,617	531,138	594,257	758,182
21	2090	426,005	533,741	635,649	844,805
22	2100	420,895	538,358	669,723	935,874

From the table above, we can see that by 2100, the lowest change in the amount of carbon dioxide is observed in the RCP 2.6 projection, while the highest change is observed in the RCP 8.5 projection. In order to further analyze the obtained results, the data of the table were expressed in a graphic form (Fig. 2).

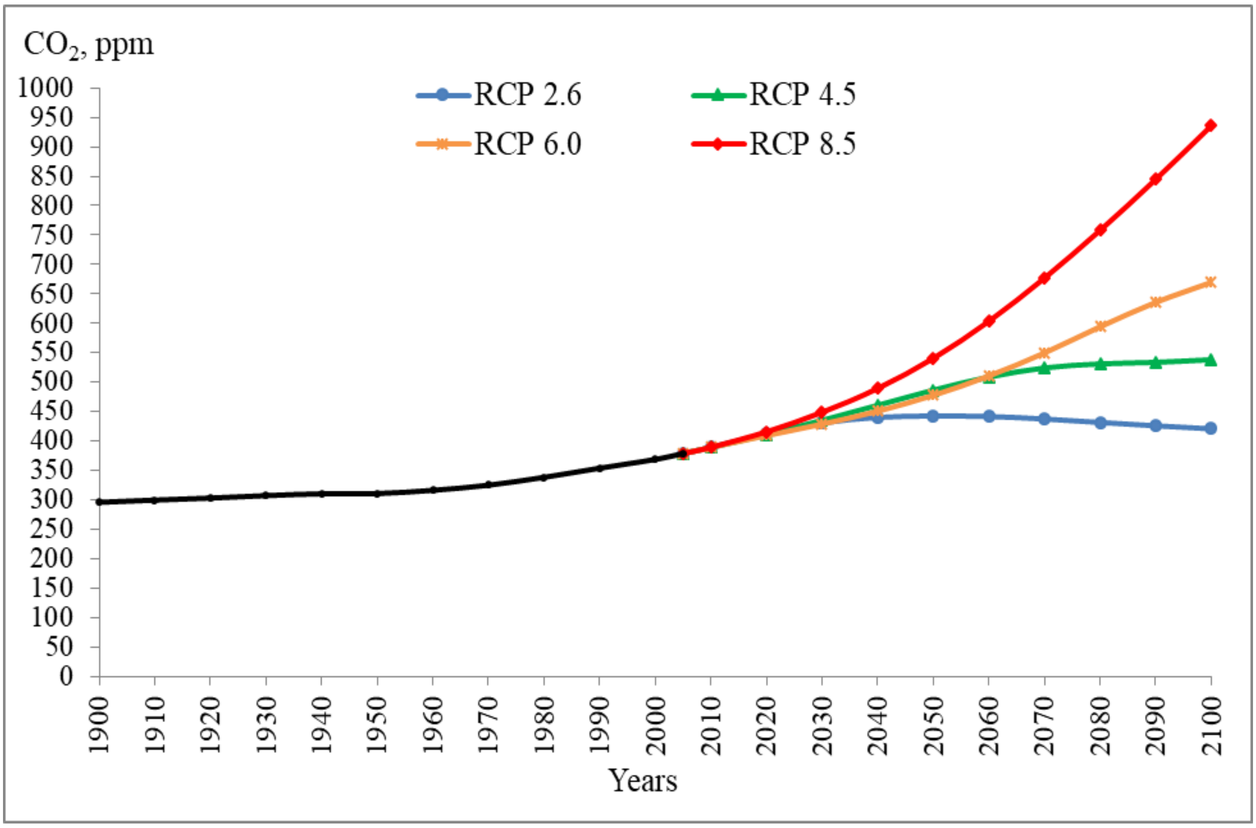

Figure 2. Graph of carbon dioxide (CO_2) change to 2100 according to RCP projections

Since the beginning of industrialization, the amount of methane in the atmosphere has increased by 2.5 times. The increase in the amount of greenhouse gases is characterized by the amount of gases released during the use of methane and coal mines and the extraction of natural gas. Today, the contribution of methane emissions to the "increased greenhouse effect" is 20% compared to previous times. The rapid increase in methane levels began later than the rise in carbon dioxide, but its contribution to total emissions is increasing rapidly. It should be noted that the average storage time of methane in the atmosphere is 12 years, while carbon dioxide is more resistant to it, that is, it is stored for a long time.

In the table below we can see the change in the amount of methane gas (CH_4) by the year 2100 under different RCP projections (Table 3)

Table 3

Changes in methane (CH_4) concentrations up to 2100 under RCP projections

№	Years	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	1900	879,500	879,500	879,500	879,500
2	1910	923,750	923,750	923,750	923,750
3	1920	977,750	977,750	977,750	977,750
4	1930	1036,250	1036,250	1036,250	1036,250
5	1940	1088,250	1088,250	1088,250	1088,250
6	1950	1147,250	1147,250	1147,250	1147,250
7	1960	1247,000	1247,000	1247,000	1247,000
8	1970	1385,750	1385,750	1385,750	1385,750
9	1980	1547,750	1547,750	1547,750	1547,750
10	1990	1693,630	1693,630	1693,630	1693,630
11	2000	1751,023	1751,023	1751,023	1751,023
12	2005	1753,735	1753,735	1753,735	1753,735
13	2010	1773,128	1767,098	1768,688	1778,675
14	2020	1730,518	1801,434	1785,791	1923,671
15	2030	1600,215	1829,908	1795,924	2132,014
16	2040	1527,098	1841,803	1840,651	2399,245
17	2050	1451,540	1833,094	1894,850	2739,985
18	2060	1365,106	1800,511	1939,391	3076,135
19	2070	1310,651	1744,739	1961,826	3322,341
20	2080	1285,405	1671,829	1940,166	3489,839
21	2090	1268,282	1613,554	1819,142	3638,592
22	2100	1253,628	1576,346	1649,396	3750,685

As can be seen from the table and graphic data, the amount of methane gas in the atmosphere will also have the highest value in the RCP 8.5 projection (3750,685). In the lowest rate of methane gas content is observed in the RCP 2.6 projection, and its absolute amount is equal to 1253,628. In order to analyze the changes in more detail, a graph of the change in the amount of methane gas (CN_4)

according to the RCP projections until 2100 was drawn (Figure 3).

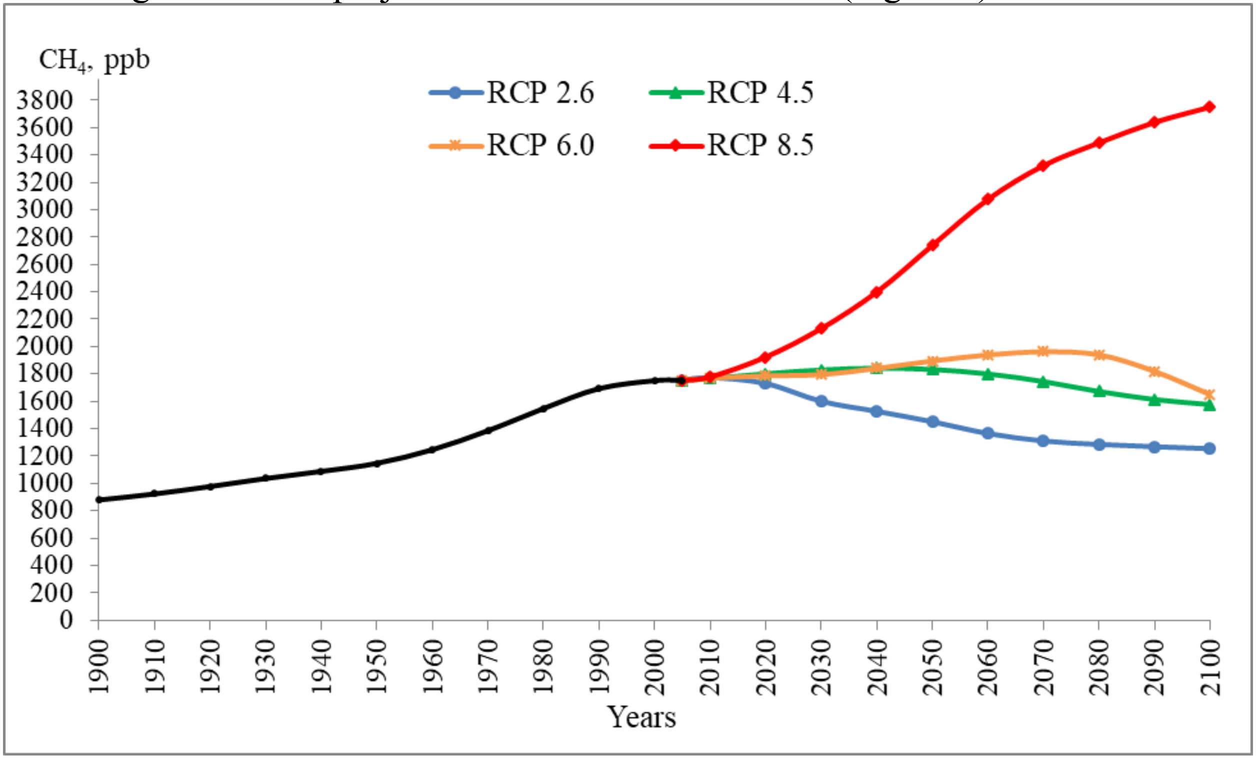

Figure 3. Graph of changes in methane gas (CH_4) to 2100 according to RCP projections

20% of the greenhouse effect is caused by nitrogen oxides, some gases emitted from industrial enterprises, and ozone. Today, the amount of nitrogen oxide has increased by 16%, which is mainly due to the use of intensive forms of agriculture.

Nitrogen oxides are also projected to change under the RCP projections, and unlike other greenhouse gases, their changes will not be dramatic (Table 4).

Table 4

Changes in nitrogen oxide (N_2O) concentrations up to 2100 under RCP projections

№	Years	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
1	1900	279,800	279,800	279,800	279,800
2	1910	280,975	280,975	280,975	280,975
3	1920	282,925	282,925	282,925	282,925
4	1930	284,975	284,975	284,975	284,975
5	1940	286,725	286,725	286,725	286,725
6	1950	289,000	289,000	289,000	289,000
7	1960	291,400	291,400	291,400	291,400
8	1970	295,200	295,200	295,200	295,200
9	1980	301,383	301,383	301,383	301,383
10	1990	309,485	309,485	309,485	309,485
11	2000	315,850	315,850	315,850	315,850
12	2005	319,440	319,440	319,440	319,440

13	2010	322,957	322,967	323,071	323,061
14	2020	329,208	329,983	330,202	331,514
15	2030	334,297	337,118	337,159	341,960
16	2040	338,758	344,139	345,339	354,035
17	2050	341,896	350,608	354,592	367,220
18	2060	343,192	356,322	364,714	380,716
19	2070	343,744	361,314	375,515	394,227
20	2080	344,161	365,511	386,465	407,702
21	2090	344,261	369,068	396,859	421,357
22	2100	344,016	372,274	406,265	435,106

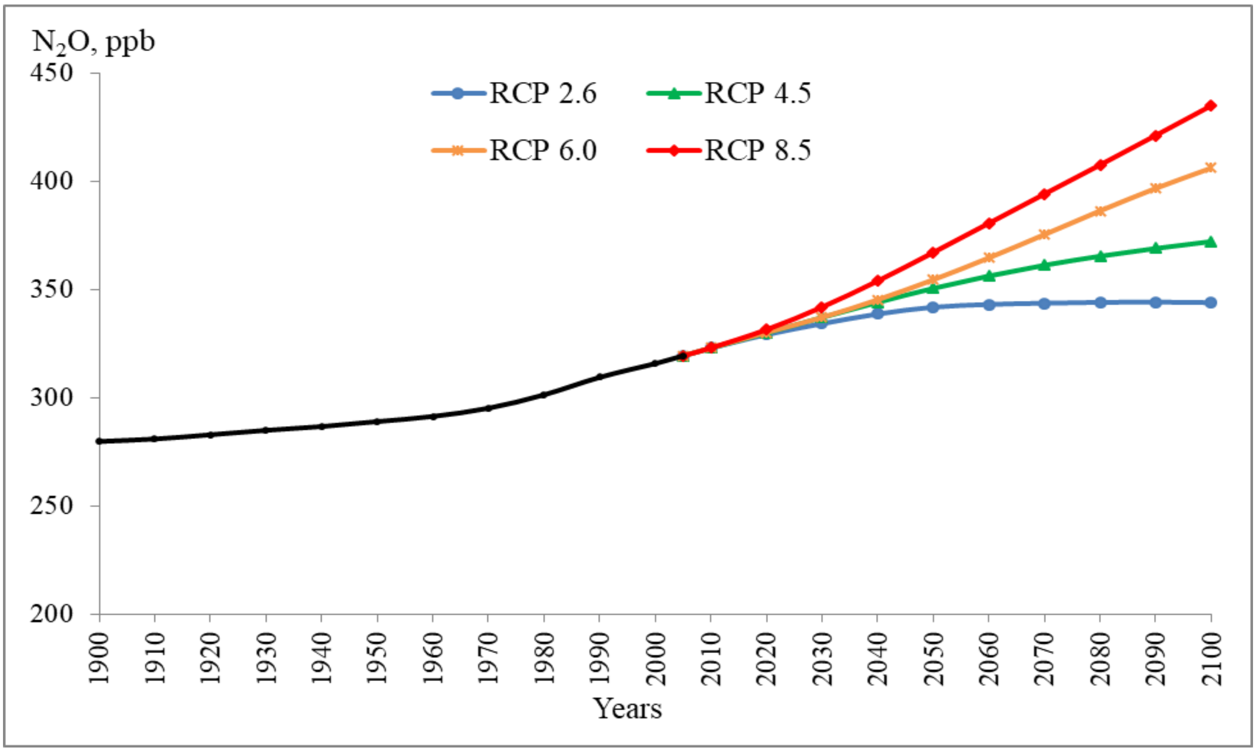

Figure 4. Graph of changes in nitrogen oxide (N_2O) concentrations to 2100 according to RCP projections

In the next part of the research work, the change in the equivalent concentration of carbon dioxide (CO_2) was analyzed. The analysis of changes was carried out based on the following two criteria:

1. CO_2 equivalent concentration - taking into account only greenhouse gases accepted under the Kyoto Protocol;

2. CO_2 equivalent concentration - taking into account all gases in the atmosphere.

Based on the data in the graphs above, it can be said that if all gases in the atmosphere are taken into account, the change in CO_2 equivalent concentration under the RCP 8.5 projection will be drastic. We can see that the changes in the remaining projections are close to each other on both criteria. To compare these changes, the period 1900-2005 was set as the base period for all projections.

Conclusions. CO_2, which is considered the most important anthropogenic greenhouse gas worldwide, also accounts for the majority (70 percent) of greenhouse gas emissions in Uzbekistan, mainly due to the energy industry. However, there are two other main greenhouse gases in Uzbekistan: methane (CH_4) and nitrous oxide (N_2O). These are 24 and 6 percent of the total amount of greenhouse gases in Uzbekistan, respectively. Agricultural production is the main source of methane and nitrogen oxide emissions. In this case, 90 percent of nitrous oxide is released from fields where nitrogen fertilizer is applied, and 10 percent of methane gas is released from rice cultivation and livestock farming.

Irrigated agriculture is used on almost 8 million hectares of land in five countries located in Central Asia. It is worth noting that irrigation water not only contributes to plant development, but also significantly affects soil, plant, and atmospheric cycles occurring at field and landscape scales in all ecosystems.

The most common type of irrigation in the Aral Sea region is push irrigation. Suppression of fields affects not only hydrological, but also microbiological processes in the soil, carbon and nitrogen cycle to some extent. In wet soil conditions after field irrigation, soil bacteria convert fertilizer nitrate into molecular nitrogen, nitrogen (II) oxide, and nitric oxide (NO). In addition, irrigated rice fields are a major source of atmospheric methane.

In addition, climate change and the greenhouse effect have a significant impact on river water resources. Including:

- the distribution of the amount of flow throughout the year;
- to the variability of the flow;
- to the sources of saturation of the river;
- the type and amount of atmospheric precipitation in the basin, etc.

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