

Climate change in Ukraine: Review of publications and researches.

Ukrainian scientists, officials and community investigate the problem of climate changes in such aspects:

1. Regional feature of climate change in Ukraine.
2. Models for climate change prediction development.
3. Reaction of crops on climate change and agrotechnology adaptation.
4. Adaptation of water resources management to climate change
5. Effects of climate changes on biodiversity.
6. Estimation of emissions and sinks of GHG in Ukraine.

According to IPCC, climate system changes are unequivocal, as is now evident from observation of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. And climate of Ukraine is involved in these system changes (Fig.1).

2008 Global Temperature

Posted January 21, 2009

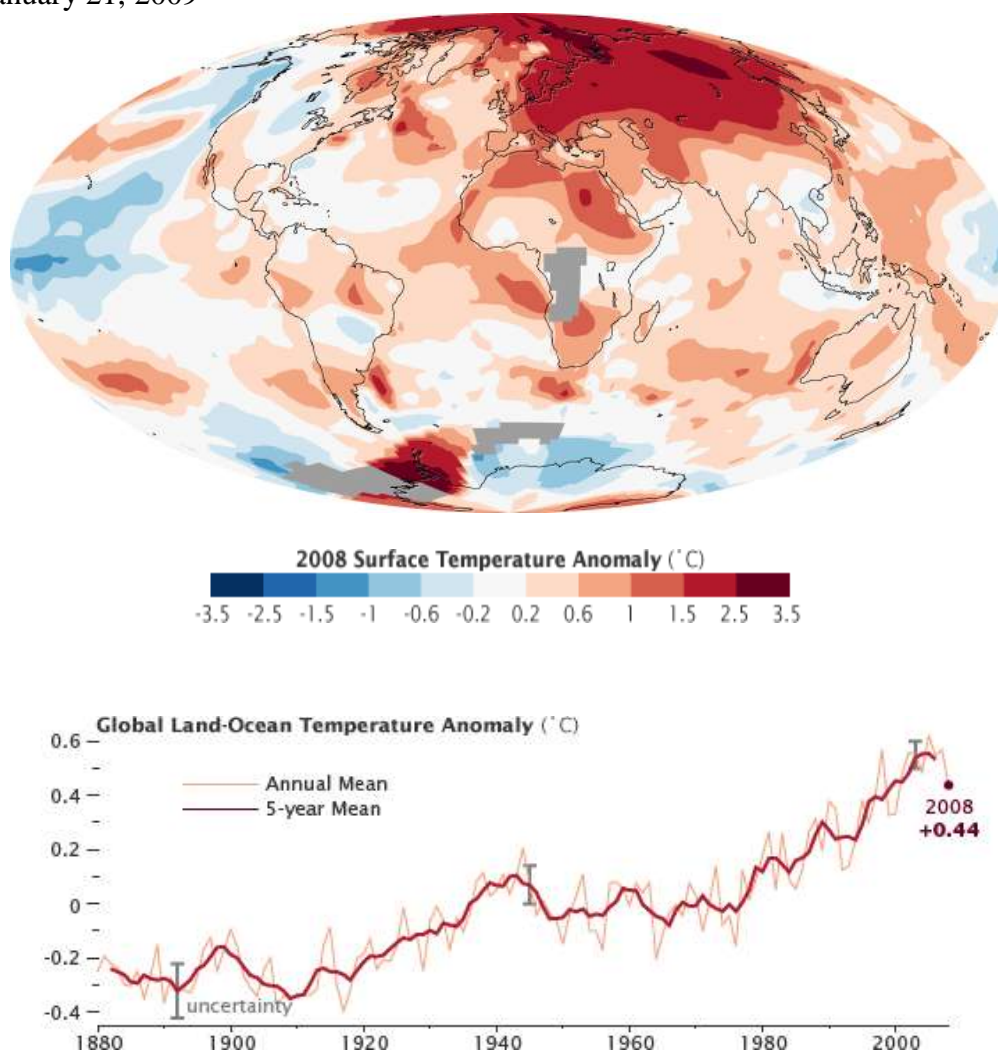


Fig.1. Global Land-Ocean Temperature Anomaly (<http://earthobservatory.nasa.gov>)..

At the same time, Ukrainian scientists guess that the most of global average warming over the past 50 years is ***likely due to*** anthropogenic GHG increases. Actually, global warming is a result of a combination of climate changes natural cycles with anthropogenic effects on climate, including GHG emission.

They acknowledge that general processes of climate changes take place in Ukraine like in the whole world. Rate of these changes (according to IPCC) is estimated at $0,76^{\circ}\text{C}$ (on the basis of air surface layer temperature for 1850-1899 and 2000-2005 comparison). And this rate increase in last decades. Prediction values of temperature increase to the end of 21 century will amount $1,8-4,0^{\circ}\text{C}$ with extreme values $1,1-6,4^{\circ}\text{C}$ (Липинский и др., 2007).

Hydrometeorological Service of Ukraine (public institution) has generalized data on main climate forming factors on the territory of Ukraine, has made analysis of regional climate peculiarities according to basic meteorological characteristics for all period of instrumental measurements. The main attention has been paid to meteorological characteristics detailed elaboration for the last climatic period. The results of this activity have been published partly in fundamental monograph "Climate of Ukraine" (Клімат України, 2003), in the book "Spontaneous meteorological events for the last 20 years" («Стихійні метеорологічні явища за останні 20 років», 2006), and in large series of scientific publications (see the List of publications...).

As a result, Ukrainian investigators recognize that climate of Ukraine dynamics to a considerable degree succeed to the global climate changes characteristics features:

- climate of Ukraine (as the whole Earth) is warming for all period of instrumental measurements;
- linear trend of air surface layer regional temperature coincides with global parameters according to direction and rate;
- warming distinguishes itself with irregularity of air surface layer temperature increasing – periods with fast temperature increase alternate with periods of its slowing down, and even – with temperature fall; in such periods waves of cold cause light night frosts which is especially danger for economy;
- on the territory of Ukraine seasonal trend of temperature and its latitudinal distribution were revealed.

Observations for the last century showed the largest trend in north-east part of Ukraine (about 1°C), in Forest (Polissia) and Forest-Steppe (Lisostep) zones it was $0.7-0.9^{\circ}\text{C}$, in Steppe zone – $0.2-0.3^{\circ}\text{C}$, at the same time the most intensive increase of temperature was in winter (1.2°C) and in spring (0.8°C). In other seasons warming was insignificant (in summer – $0.2-0.3^{\circ}\text{C}$). Accordingly to climate changes in all Europe, effect of "decontinentalization" was revealed in Ukraine as well. It has manifested itself in decrease of air surface layer temperature seasonal trend and some extreme meteorological events reiteration (droughts, sand storms, etc.). At the same time, a reiteration of other spontaneous events has increased (danger heavy shower, flash floods, strong thaws, early night frosts, number of squalls).

These features are evidences of the predominance of global warming in climate formation in Ukraine. As the climate originality in Ukraine, heterogeneity and unsynchronism of warming were revealed. Air temperature in surface layer increased in those regions and in those months that were cool before. But in regions with more high temperature background (phone) temperature of air in surface layer did not change in fact. Negative trend of days' amount with frost was revealed as well.

Amount of precipitation on the territory of Ukraine for this period changed also unevenly. Some increase in amount of precipitation (by 15 %) took place in south-east more dry regions and slight decrease (by 5%) – in north-west more wet regions. The most wet periods were in 1966-1970 and 1976-1980, when annual sum of precipitation exceeded 120 % of norm at all territory of Ukraine (in Forest, Forest-Steppe and Steppe zones).

Some transformation in global atmospheric circulation that determined main features of regional atmosphere were revealed in last decade. It was the result of Atlantic climate influence strengthening on Climate of Ukraine. Inasmuch as this process is prolonged, Atlantic effects strengthening will remain further. Especiall such effects will take place in winter period, making it more mild and more close to West European one.

It is necessary to note two very important peculiarities in present-day climate of Ukraine, which manifest themselves in all seasons of a year. First of them – abrupt daily air temperature drops by 10-15°C during 1-2 days. Such sharp cold spell and sharp warming are accompanied with all kind of danger and spontaneous meteorological events. Second one – increasing of frequency and intensity of storm rainfalls, which take place in separate days of different seasons. Such extreme weather conditions cause a higher sensitivity of people to present-day climate.

Thus, global warming that is revealed reliably for the period of instrumental measurements is the deciding factor of climate forming in Ukraine. And one of the main causes of present-day increase of average annual temperatures in air surface layer is an essential strengthening of natural cycling processes by anthropogenic factors. Quantitative parameters of climate changes in Ukraine in last years are increasing, and in winter average monthly temperature increase reached 2°C in central regions of Ukraine

It was also revealed that large-scale atmospheric circulation of air in last decades and regional circulation over territory of Ukraine formed by it essentially differ from the situation on the beginning of XX century. Thus, all territory of Ukraine was in winter under effects of Siberian maximum at the beginning of century. However, in the middle of century only eastern part of Ukraine was under its effects, and now an influence of the Siberian anti-cyclone became essentially less over the territory of Ukraine. As the Azores anti-cyclone jut moving to the east the all territory of Ukraine found itself under this anti-cyclone effects (Клімат України, 2003; Дмитренко та інші, 2001; Кузьбіда, 2002; Польовий та інші, 2003; Martazinova, Magerich, 1996; Snizhko, Scherban', Kovalenko, 2006; Snizko, Kuprikov, 2006 and others).

Among predictive researches related with climate changes the activity of Marine Hydrophysics Institute attracts some special attention (Єремєєв, Єфімов, 2003). In a frame of a general climate changes problem it develops the separate direction – regionalization, related with studying forthcoming changes in climatic characteristics in separate regions in XXI century. According to these scientists estimations, in XX century average winter temperature of air increased in North-East and South-East sub-regions of Ukraine by 2.7–2.8°C, in North-West – by 1.1–1.7°C. All these estimations are statistically reliable. In accordance with air temperature increase the amount of frosty days decreased by 5–10%. Air humidity increased by 10–25%. Relatively less changes of precipitation were observed. In Crimea tendencies of temperature and humidity changes were the same, but their absolute values were less. It is related with (apparently) the Black Sea effects. According to these scientists prediction (Fig.2) increase of winter temperature on the south of Ukraine can reach 2.0-2.8-3.0°C at the end of XXI century.

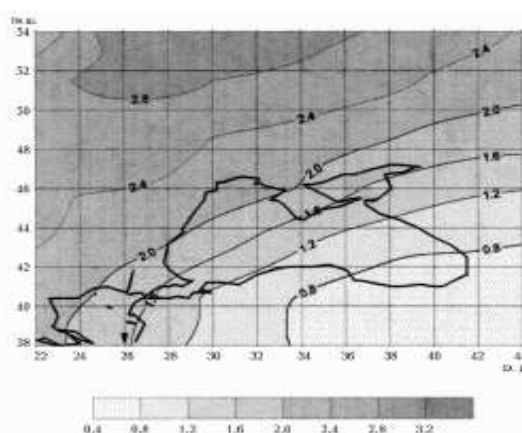


Fig.2. Prediction of winter temperature of air for the period 2079-2099 in compare with real temperature in 1961-1990 (model HadCM2).

Investigations of changes in duration of warm and vegetation periods in Ukraine under a possible effect of global warming were carried out by scientists of Kyiv National University named after

Taras Shevchenko (Сніжко та інші, 2007; 2008; Скриник, 2007; 2008; Skrynyk, 2007; Скриник О.А. і Скриник О.Я., 2006). They have revealed a tendency of increasing in vegetation period duration for the last 20 years. However this tendency is very heterogeneous for all territory of Ukraine. Cyclic recurrence in vegetation period duration at 7-8 years has been also revealed. At general tendency of an increasing of vegetation period duration there are essential regional differences. On the west and north of Ukraine vegetation period increase due to more early transition through $+5^{\circ}\text{C}$ in spring and less visible (but significant) more early transition through $+5^{\circ}\text{C}$ in autumn. On the east and south a vegetation period also come earlier, but it decrease much more in autumn. So, transition of the temperature through $+5^{\circ}\text{C}$ in spring becomes earlier in all Ukraine, that is climate warming manifests itself more strongly at the end of winter and at the beginning of spring.

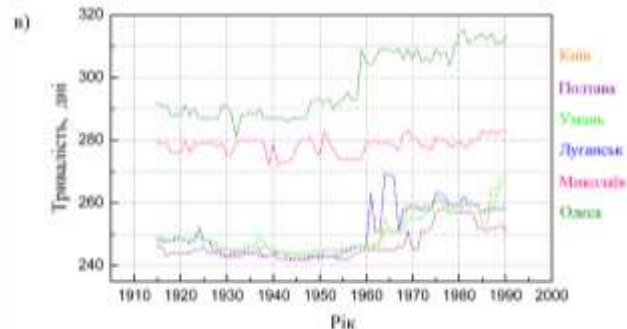


Fig.3. Changes in duration of frost-free period for the last century (Скриник, 2006, 2007, 2008; Сніжко та інші, 2007, 2008).

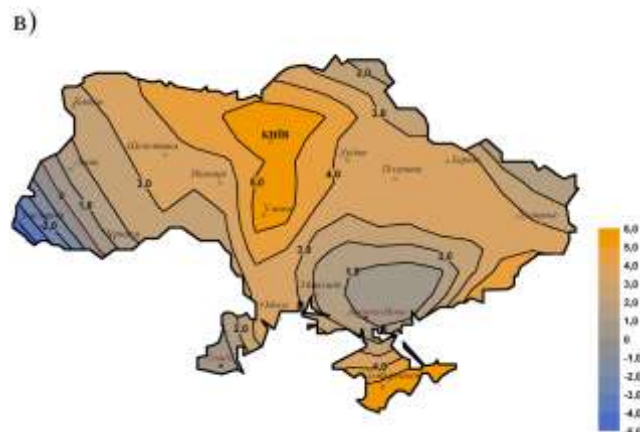


Fig.4. Duration of frost-free period : trends of changes (days/10 years) for the period 1955-1990 (Сніжко, Заболоцька, Скриник, 2008).

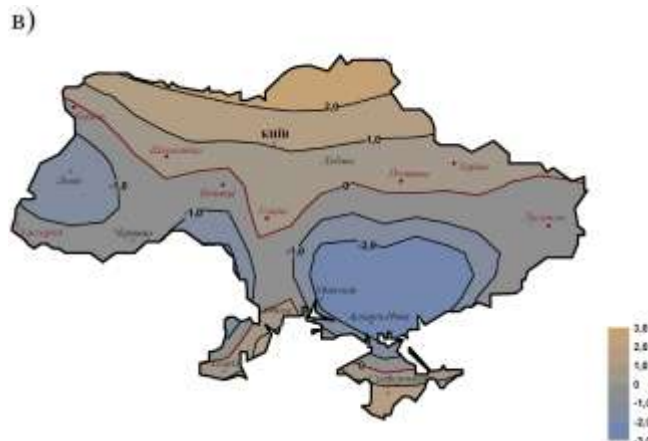


Fig.5. Duration of vegetation period: trends of changes (days/10 years) for the period 1955-1990 (Сніжко, Заболоцька, Скриник, 2008).

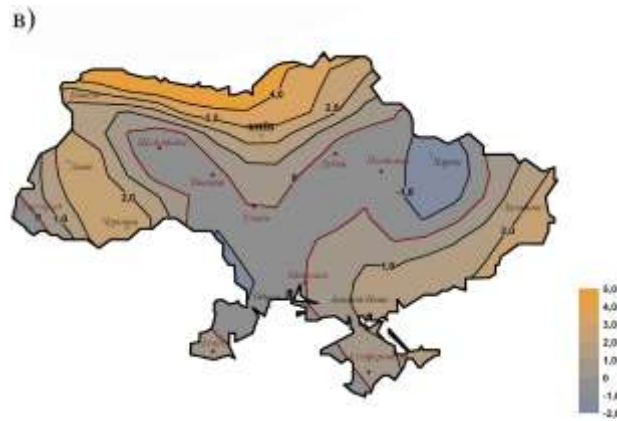


Fig. 6. Duration of active vegetation period (more +10°C): trends of changes (days/10 years) for the period 1955-1990 (Сніжко, Заболоцька, Скриник, 2008).

The same scientists studied changes in winter period precipitation in the Carpathian Mountains for the last 20 years (Snizhko, Scherban, 2008). The tendency of precipitation amount increase (and accordingly – snow storage increase in mountains), especially on north-east slopes (till 170-220 mm, maximum till 340 mm) has been revealed. So, a threat of strong flash floods increase more intensively in the Dnister River basin, and less slightly – in the basins of Danube river tributaries.

Investigations and estimations of climate changes effects on crops productivity and on agrotechnologies adaptation are concentrated in Ukrainian Hydrometeorological Centre (Кульбида, 2001, 2002, 2004, 2006; Адаменко, 2005) and at Odessa Agroecological University (Полевой, Кульбида, 2001; Полевой та інші, 2001, 2007 та інші). Those scientists forecast crops yields (especially – winter wheat) due to heat resources and amount of precipitation increase. At National University of Bioresources and Nature Management (Григорюк та інші, 2007, 2009; Чайка та інші, 2007, 2008) studying is concentrated on phytosanitary situation decrease on the fields with crops and yield losses.

Investigations and estimations of climate changes effects on different branches of Ukrainian economy are carrying out in Odessa Agroecological University. Such scientists as Dr. Polevoy A.N., Stepanenko S.I., Shkolny E.P., Loboda N.S., Khohlov V.N. work with this problem. In 2009 they work with project “Prediction of changes in regional climate and its effects on Ukrainian economy”.

Problems of water resources changes due to climate changes are investigated in the system of the State Committee for Water Management (SCWM). Thus, on the instructions of European Commission N.B.Zakorchevna (2008) investigated problems of water resources management adaptation to climate changes. Since 2008 according to SCWM initiative and support of “Water Initiative” of EEC UN National Political Dialog on integration management of water resources (**NPD-IWRM**) started. Such collaboration of international organizations and countries – EU members with central governmental bodies, scientific organizations, NGO and other interested sides in Ukraine devoted to water resources management to present-day climate changes. Catastrophic flash floods that took place in summer 2008 at the west of Ukraine acknowledge that it adaptation problem is very important for our country.

During 2008 two actions, devoted to this problem was carried out with a support of Water Initiative of EEC UN. First meeting (25 April, 2008) attended more than 60 representatives of international organizations, central governmental organizations (Supreme Council, Ministry of Nature Protection, Ministry of Emergency Situation, etc.), scientists, NGOs, mass media, etc. Participants have underlined importance of the problem for livelihoods and economy of Ukraine. At October 8, 2008, second meeting of National Political Dialog took place in the frame of

International water forum AQUA-2008. This time participants concentrated their attention on concrete questions of climate changes in Ukraine, especially on catastrophic flash floods in the West Ukraine. In 2009 activity of National Political dialog will continue. Active popularization of the adaptative measures to climate changes and water resources management carry out Global Water Partnership – Ukraine (Demidenko A.) and Ukrainian Centre of Environmental and Water Projects (www.ucewp.kiev.ua). Quantitative estimation of water runoff in Ukraine carry out Ukrainian Research Hydrometeorological Institute, Ukrainian Hydrometeorological Centre, and scientists of Kyiv National University (Куприков, Снижко, 2005; Snizhko, Kuprikov, 2006).

Series projects devoted to biodiversity problems and climate changes have been made by Ukrainian Land Resources Management centre:

1) Projection of Species- and Species-Climate Based Models on to the GLOBIO Ukraine Region, and Scenarios Development

ULRMC- Netherlands Environmental Assessment Agency
2007-2008

Outcome: species based GLM-scenarios by 2030 and 2050; BioModel web-page
Details - http://biomodel.org.ua/?page_id=2

2) Development and publishing bilingual (English-Ukrainian) manual on biodiversity modelling for national and regional educational purposes specially

ULRMC-NEAA
2008

Outcome: Landscape Ecology: Textbook on Application of Pressure Based Biodiversity Modelling for National and Regional Educational Purposes"

Details - <http://www.ulrmc.org.ua/events/2008/july.html>

3) Developing a Species Based Model for Biodiversity Assessment in Russian-Speaking Countries of the Pan-European Region

ULRMC-NEAA (renamed RIVM)
2005-2006

Outcome: cartographic-scenarios, Searchable System

Details - <http://www.ulrmc.org.ua/services/eebio/index.html>

4) Biodiversity Indicators for National Use Agrobiodiversity, Ukraine
UNEP-GEF-WCMC-RIVM-ULRMC

2003-2005

Outcome: package of indicators/indices in IFS-format, Searchable System of IFSs by categories of pressures including 'climate change'

Details - <http://www.ulrmc.org.ua/services/binu/index.html>

GHG as the factor of climate changes:

According to all IPCC reports, GHG concentration in atmosphere and their effects continue to increase as a result of human activity. Dioxide of carbon (CO₂) concentration in the period since 1750 increased more than by 30%. Rate of its increase is now unprecedented for the last 20 thousands years. About of three fourth of anthropogenic CO₂ emission into atmosphere during last 25 years take place due to fossil fuel incineration. Other part of GHG emission depends on land use changes (especially deforestation).

Methane (CH₄) concentration in atmosphere increased more than by 150% in periods since 1750, and now it continues to growth. About a half of current methane emission has anthropogenic character.

Concentration of nitrous oxide (NO₂) in atmosphere increased by 17% in the period since 1750, and it continues to growth as well. Approximately one third of present-day NO₂ has anthropogenic character (agricultural lands, chemical industry, livestock fatten-up enterprises).

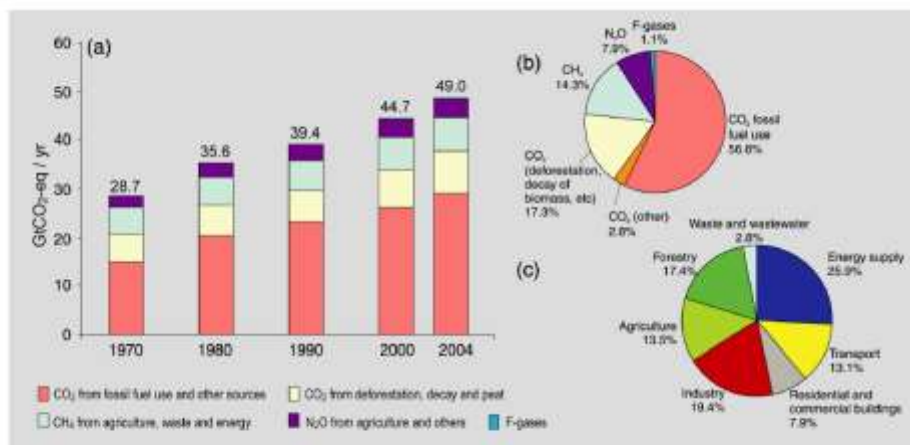


Figure SPM.3. (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.⁵ (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO₂-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO₂-eq. (Forestry includes deforestation). {Figure 2.1}

Fig.7. Global anthropogenic GHG emission.

Ukraine ratified in 1996 Frame UN Convention on Climate Changes and took on itself duties to investigate this problem at the territory of state, including GHG anthropogenic emission. To-day our state is on the tenth place according to GHG emission in the world after USA, Russian Federation, Japan, Germany, Canada, Great Britain, France, Italy, and Austria. But in basic 1990 it was at fifth place. Such changes was caused by Ukrainian economy recession after former Soviet Union disintegration (Fig.8).

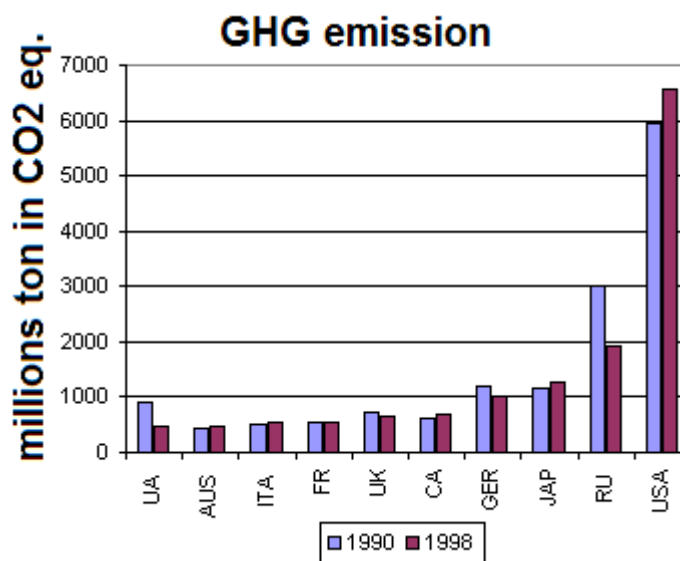


Fig.8. GHG emission in the world.

Ukraine signed up Kyoto protocol in 15 March 1999. According to this Protocol Ukraine may not decrease of GHG emission so far. Statistical data shows that during last years GHG emission in Ukraine is on the level 41-44% from the level of 1990. Economic growth of Ukraine is not accompanied with proportional growth of GHG emission. That is because of our economy develops now in the conditions of high prices for energy resources and necessity of their rational use.

Ukrainian government forms and realizes the national policy for the climate changes problem. According to our duty before FCCC, Ukraine published in 1998 the First National Communication on Climate Change, and in 2006 – Second National Communication.

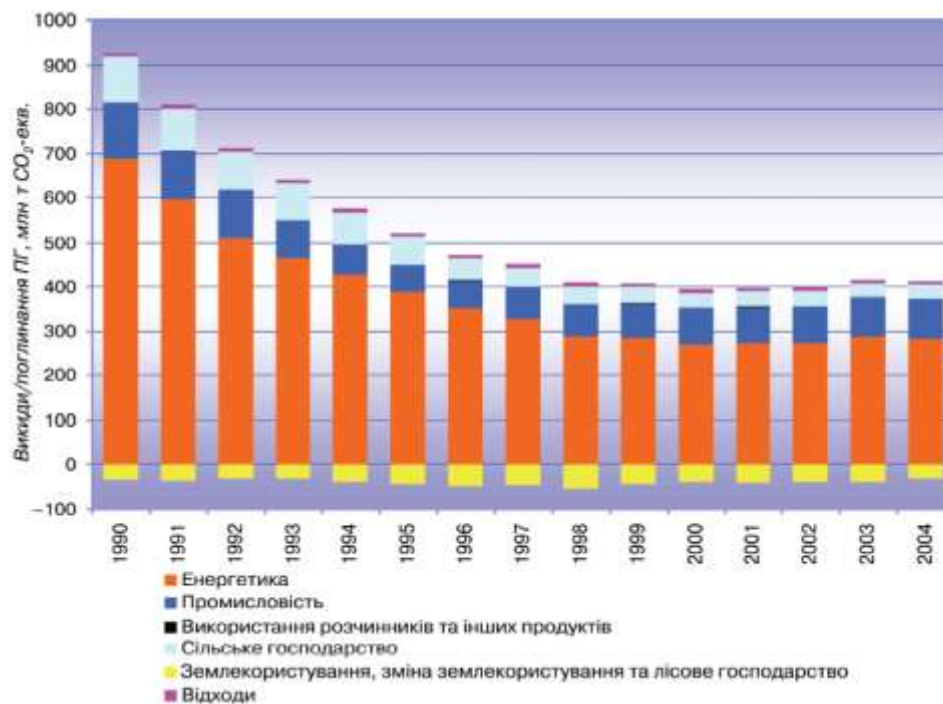


Fig.9. Emission/sink of CO², CH⁴, and NO² in Ukraine according to the sources of emission in 1990-2004.

Government of Ukraine is the active participant of international negotiation process. Agreements for collaboration were reached with USA, Canada, World Bank, The Netherlands, Finland, and Switzerland. Ukraine also participates in an implementation of join programmes on environment protection together with UNDP, GEF, UNECE, USAID.

According to last cadastre data, after the period of permanent decrease of GHG emission that lasted since 1990 till 1997 the period of stabilization became (on the level of 41% from emission in 1990). For the period since 1990 till 2004 decrease of GHG emission amounted:

- carbon dioxide – from 685.5 to 284.8 million t, or by 2.4 times;
- methane – from 151.2 to 74.1 million t CO₂-eq., or by 2 times;
- nitrous oxide (NO₂) – from 54.6 to 22.3 million t. CO₂-eq., or by 2.5 times.

For ensuring realization of all conditions that are necessary for effective participation in the Kyoto mechanisms The National plan of measures suppose:

- creation of national system for emission and absorption inventory;
- creation of GHG emission and absorption calculation system;
- formation of an infrastructure for projects of join implementation;
- work out of a national system for GHG emissions trade;
- regular preparation of national communication;
- work out national and regional plans for climate changes consequences mitigation;
- creation of a data basis of environmentally safe technologies.

Prediction of GHG emission in Ukraine is shown at Figures 9-11:

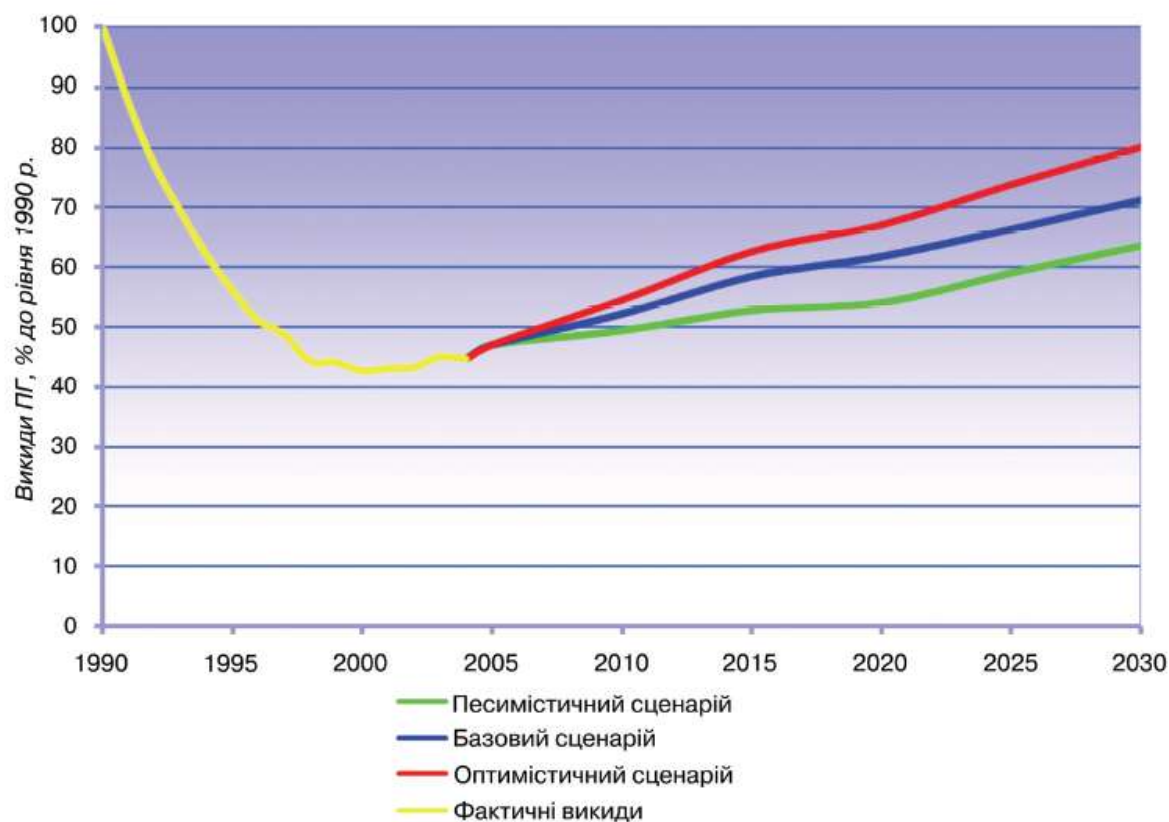


Fig.10. Prediction of GHG emission in Ukraine according to development scenarios.

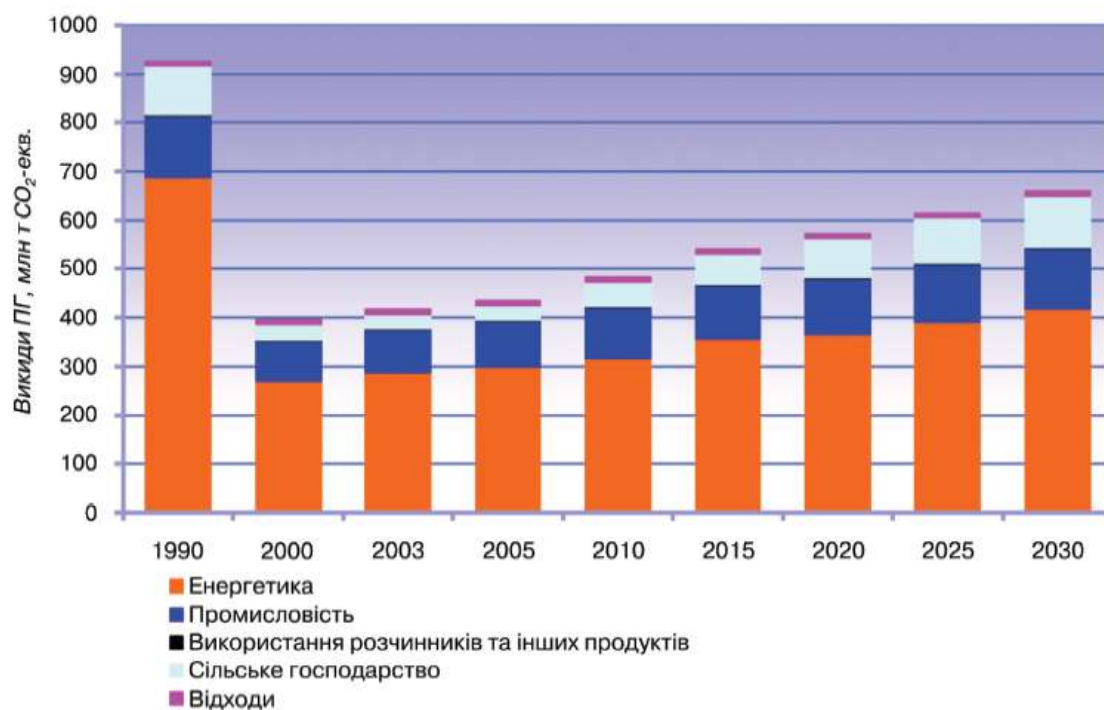


Fig.11. Dynamics of emission structure changes in Ukraine in sectors.

Investigations of the problem of GHG emission with Remote Sensing carry out Centre of Aerospace Research of Earth (Lyalko V.I, 2007, 2009), “Pryroda” and other organizations in the NKAU system.

Supreme Council (“Verhovna Rada”) considers new law “On climate changes in Ukraine”.