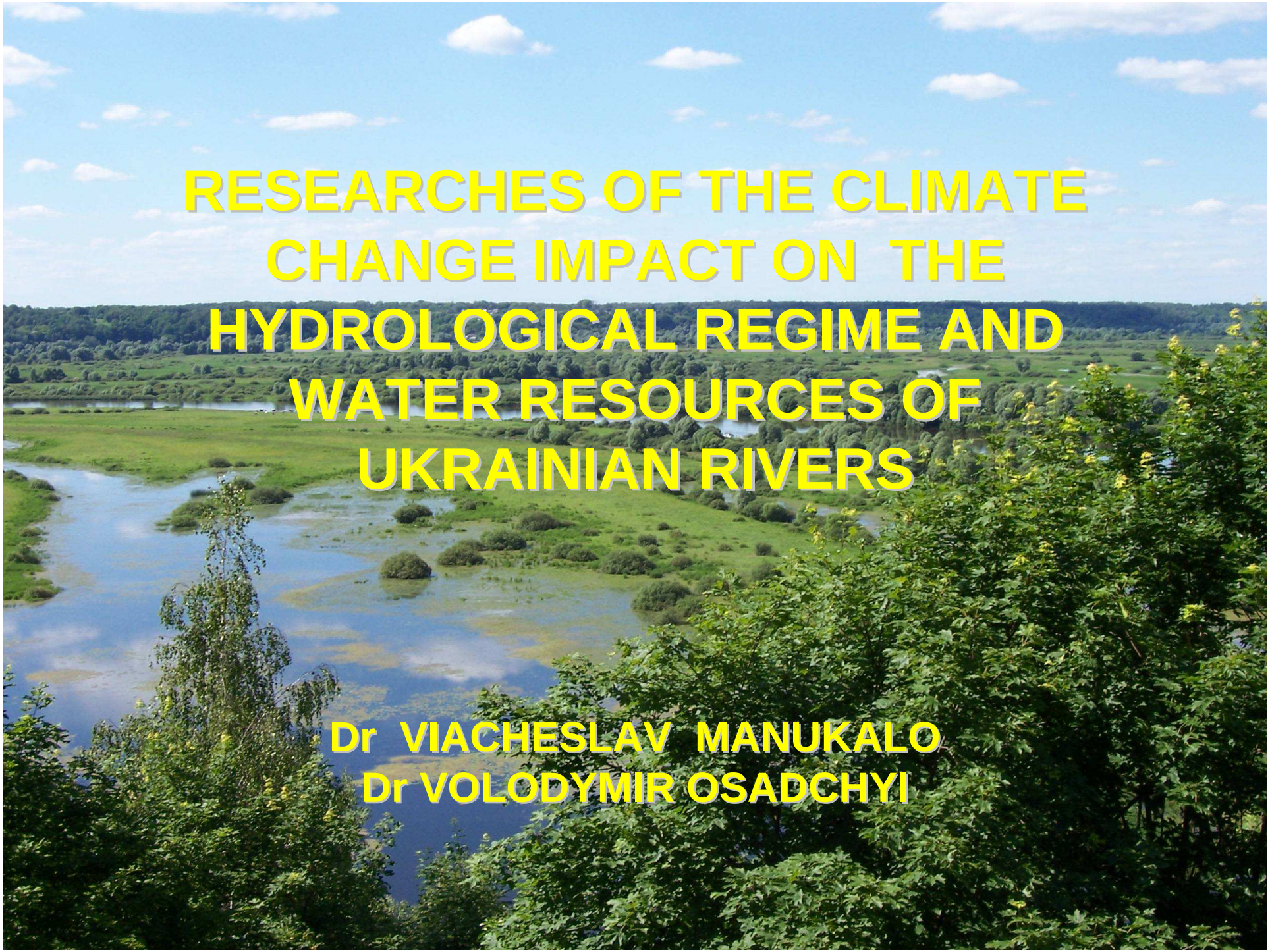


RESEARCHES OF THE CLIMATE CHANGE IMPACT ON THE HYDROLOGICAL REGIME AND WATER RESOURCES OF UKRAINIAN RIVERS

Dr VIACHESLAV MANUKALO
Dr VOLODYMIR OSADCHYI

OBJECTIVES OF PRESENTATION

- present information about climate researches undertaking in the State Hydrometeorological Service
- present some results of studies of climate change effect on hydrological regime and water resources of river basins located in different natural zones of Ukraine
- present the most likely affected Ukrainian economical sectors by impact of climate changes
- present further directions of activities in order to eliminate an effect of negative impact of climate changes

“RIVERS ARE THE PRODUCT OF THE CLIMATE”

***A. I. VOEYKOV* – RUSSIAN CLIMATOLOGIST**

“ANYBODY WHO CAN SOLVE THE PROBLEMS OF WATER WILL BE WORTHY OF TWO Nobel PRICES, ONE FOR PEACE AND ONE FOR SCIENCE”

PRESIDENT J.F. KENNEDY

LIST OF UKRAINIAN SCIENTISTS WHOSE RESEARCHES ARE SUMMARIZED AND PRESENTED IN THIS PRESENTATION

- ***CLIMATE RESESARCHES:***

  M. BARABASH

  V. BABICHENKO

  V. MARTAZINOVA

- ***RESEARCHES OF CHANGES OF HYDROLOGICAL REGIME AND WATER RESOURCES*:**

  A. SHERESHEVSKYI

  V. MANUKALO

  V. OSADCHYI


BE
Main river basins and neighboring countries of Ukraine
PL
RU
Forest zone
Басейн Десни
Басейни притоків Середнього Дніпра
Mixed forest-steppe zone
SK
Басейн Дністра
Басейн Південного Бугу
Басейн Сіверського Дінця
Carpatians
HU
RO
MD
Басейн Тиси
Басейни Прута, Сирета
Steppe zone
Басейни річок Приазов"я
Басейни річок Причорномор"я
RU
RO
Українська ділянка Дунаю
Басейни річок Криму
Crimea
Київ
Харків
Дніпропетровськ
Запоріжжя
Одеса
Дунай
Дніпро
Поділ об"єктів України за зонами гідропрогностичної відповідальності

NATURAL CHARACTERISTICS OF UKRAINE

- **AREA – 603.7 sg. km**
- **CLIMATE TYPES – GENERALY, MODERATE-CONTINENTAL TYPE, IN SOUTHERN COST OF CRIMEA – SUBTROPICAL TYPE**
- **AVERAGE ANNUAL PRECIPITATION DISTRIBUTION – FROM 300 mm IN SOUTH - EAST TO 1500 mm IN CARPATIANS MOUNTAINS**
- **NATURAL ZONES: FOREST (20% OF TERRITORY), MIXED-FOREST-STEPPE (35%), STEPPE (40%), MOUNTAINS (5%)**
- **TOTAL AVERAGE ANNUAL RUNOFF – 209.23 CUB. KM (49.0 CUB. KM FORMED IN UKRAINE)**
- **POTENTIAL WATER RESOURCES IN A YEAR PER AN INHABITANT – 1.6 CUB. KM**

AVERAGE ANNUAL RUNOFF OF MAIN UKRAINIAN RIVER BASINS

River basins	Average annual runoff, km^3		
	Total	Formed in Ukraine	Inflow from other countries
Bug	1.4	1.4	
Danube	133.8	10.8	123.0
Dnister	10.7	9.7	1.0
Southern Bug	3.2	3.2	
Dnipro	53.5	19.1	34.4
Siversky Donets	4.81	2.96	1.85
Black and Azov Seas river basins	1.82	1.82	
Total	209.23	48.98	160.25

LEGAL AND INSTITUTIONAL BASIS OF CLIMATE CHANGE RESEARCHES IN UKRAINE

- **Ukraine signed the UN Framework Convention on Climate Change in June 1992; Ukrainian Parliament ratified it in October 1996**
- **Observation data of the State Hydrometeorological Service is the principal source of information about present climate and its possible changes**
- **To strength climate research activity the National Climate Program was adopted by Ukrainian Governmental in 1997. The program has been implemented during 1998-2003**

INSTITUTIONS INVOLVED IN THE IMPLEMENTATION OF THE NATIONAL CLIMATE PROGRAM

- **State Hydrometeorological Service was nominated as the governmental body responsible for coordination of researches**
- **Ukrainian research hydrometeorological institute – principal scientific organization**
- **Kyiv National Taras Shevchenko University and Odesa Hydrometeorolgical Institute**
- **Institute of Geography and Marine Geophysical Institute of the National Academy of Sciences**

USED METHODS

IN ORDER TO ASSEST PRESENT CHANGES:

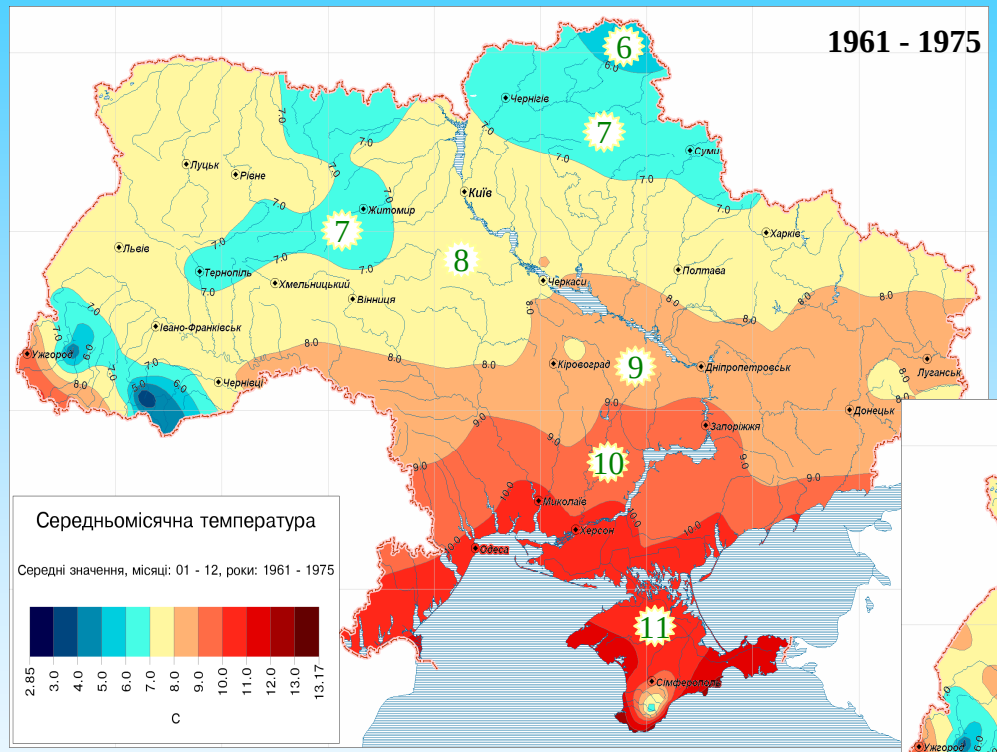
- **COMPLEX STATISTICAL ANALYSIS OF LONG-TERM AIR TEMPERATURE AND PRECIPITATION DATA (FOR 80 AND MORE YEARS) AS WELL AS RIVER FLOW DATA (FOR 50 AND MORE YEARS)**

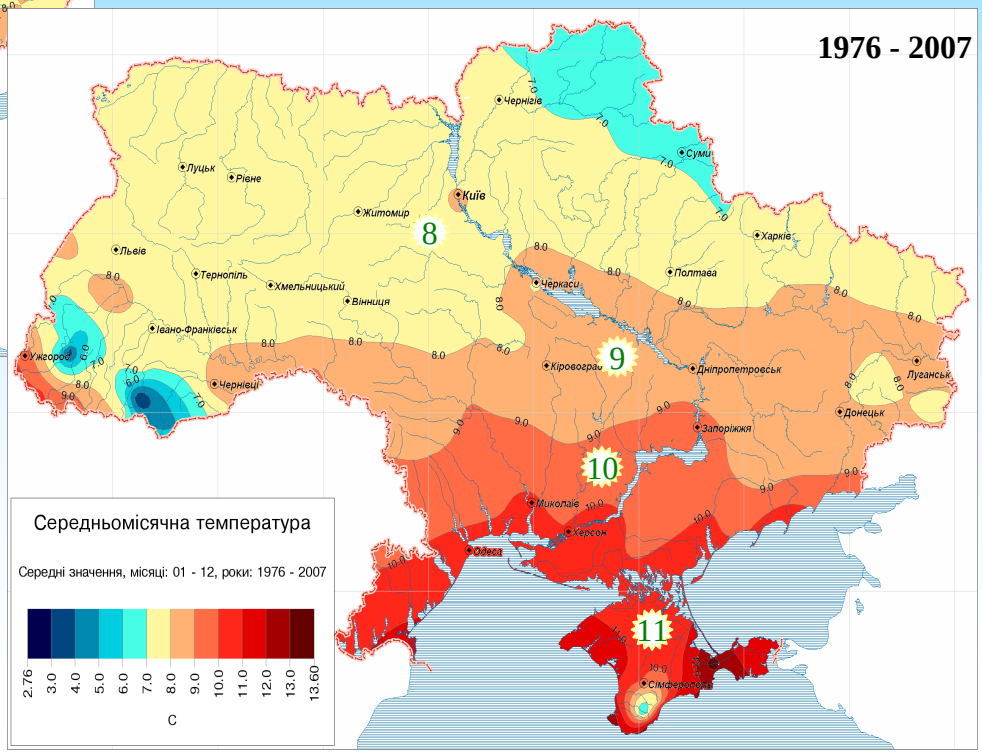
IN ORDER TO PROJECT EXPECTED CHANGES:

- **ATMOSPHERIC GENERAL CIRCULATION MODELS (HadCM3, GFDL, ECHAM) WITH:**
- **a) STATIONARY VARIANT OF CO2 GROWTH – DOUBLING CO2;**
- **b) NON STATIONARY VARIANT OF CO2 GROUTH**

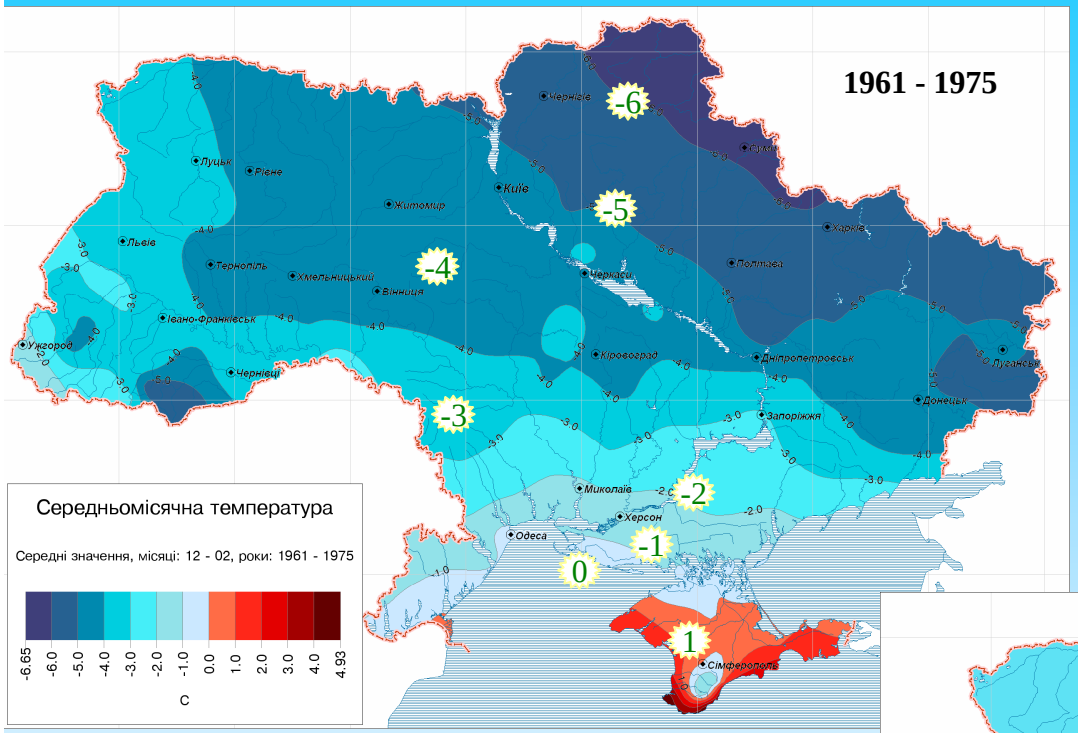
Peculiarities of air temperature regime in Ukraine

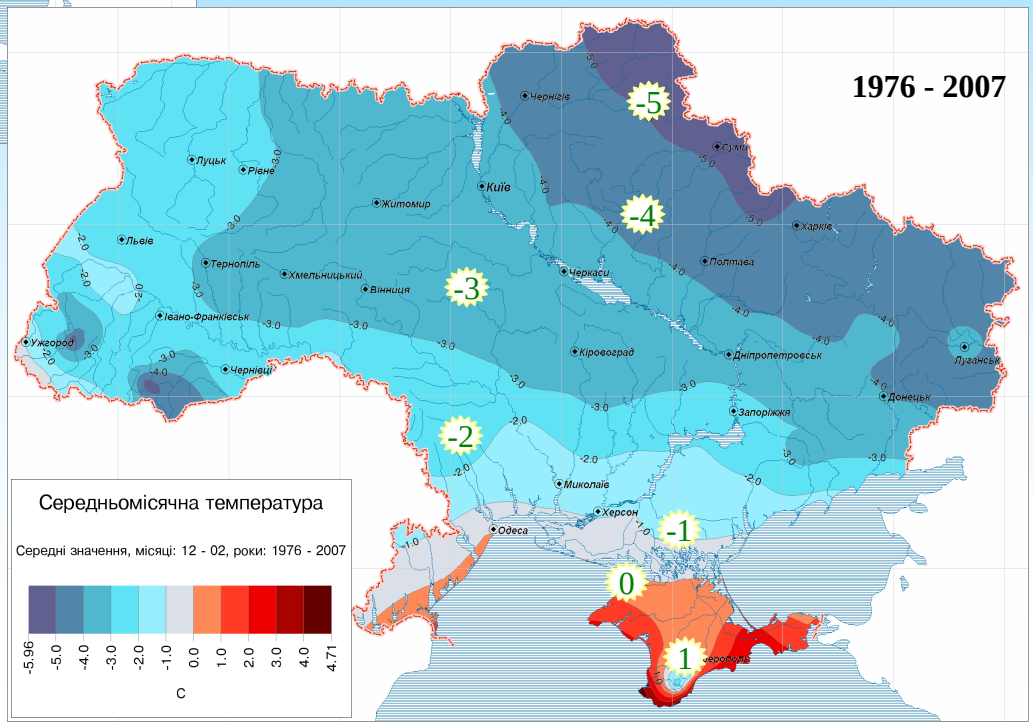
Mean annual air temperature in Ukraine



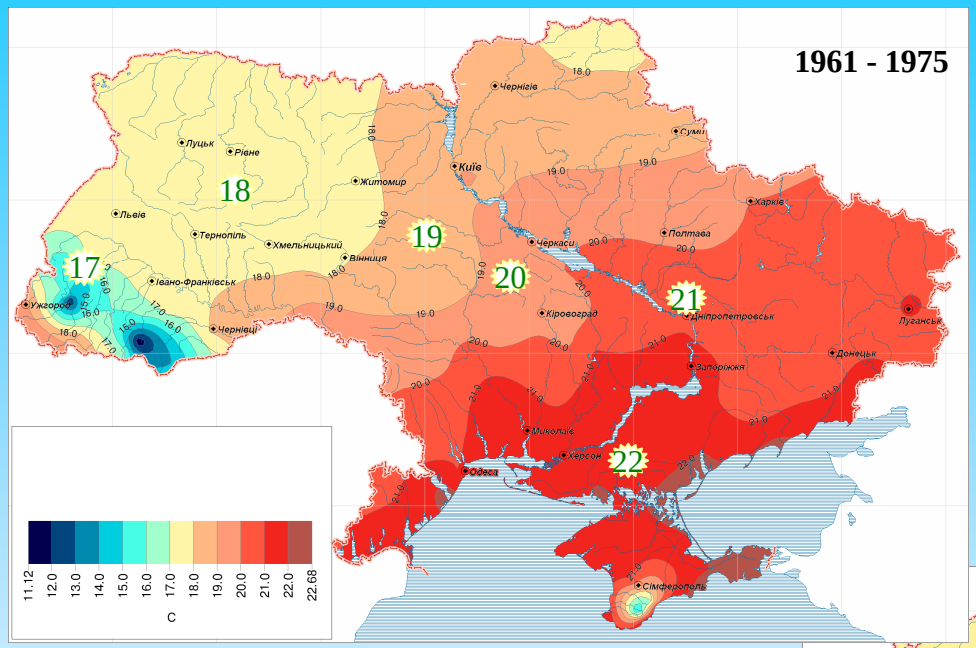


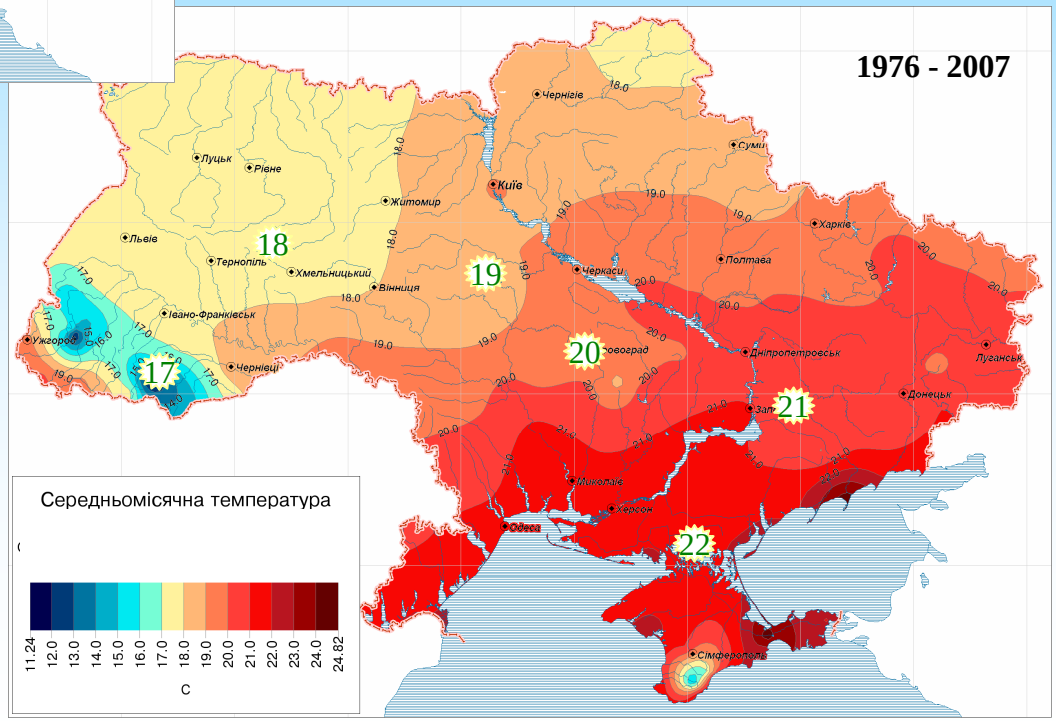
Mean air temperature in Ukraine (winter)



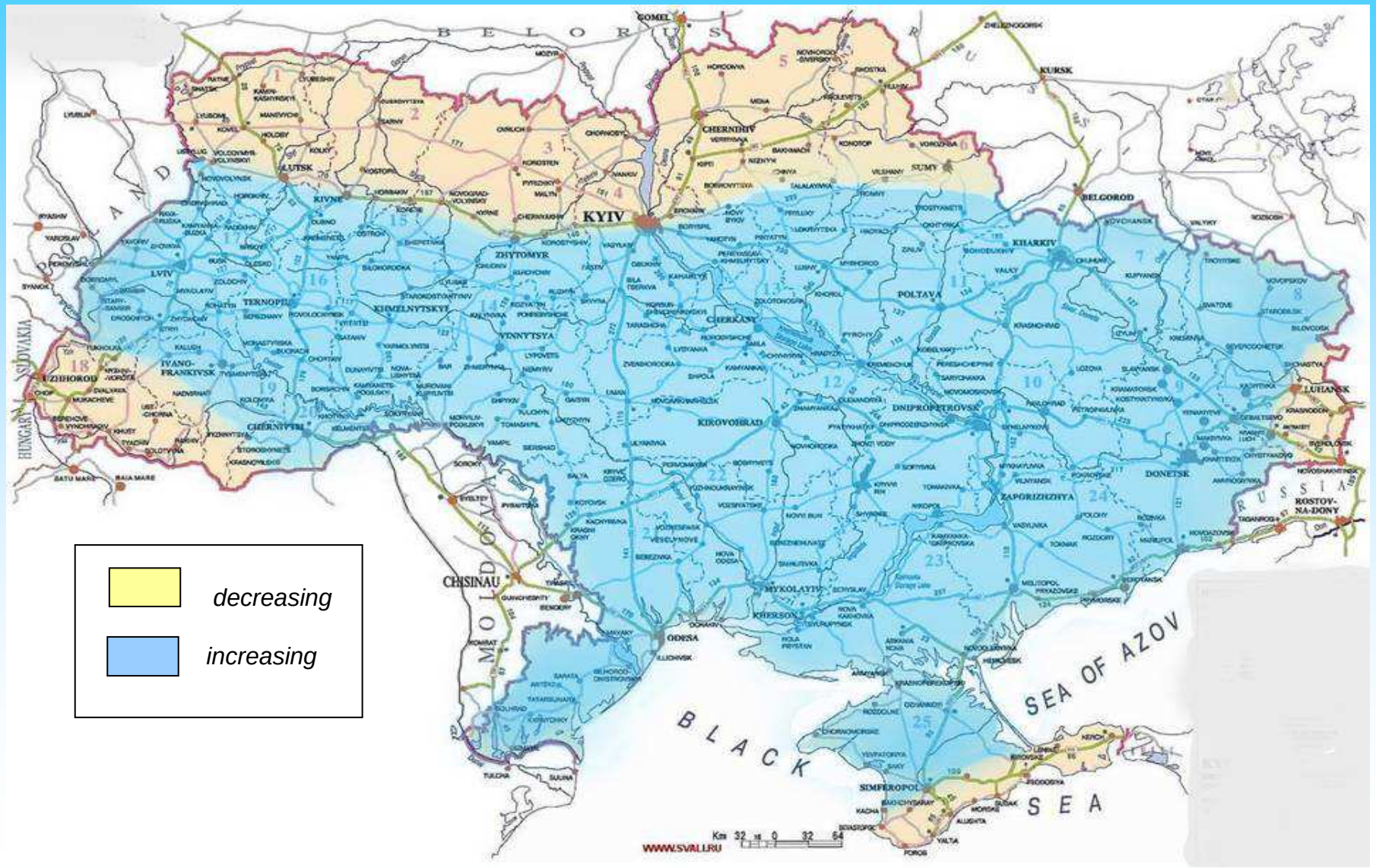


Mean air temperature in Ukraine (summer)





CHANGE IN THE ANNUAL PRECIPITATION SUM



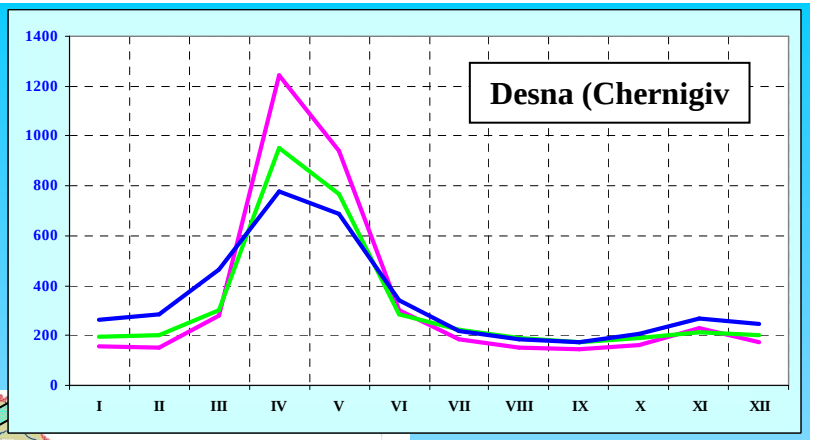
REGRESSION'S EQUATION OF TRENDS OF MEAN ANNUAL DISCHARGES

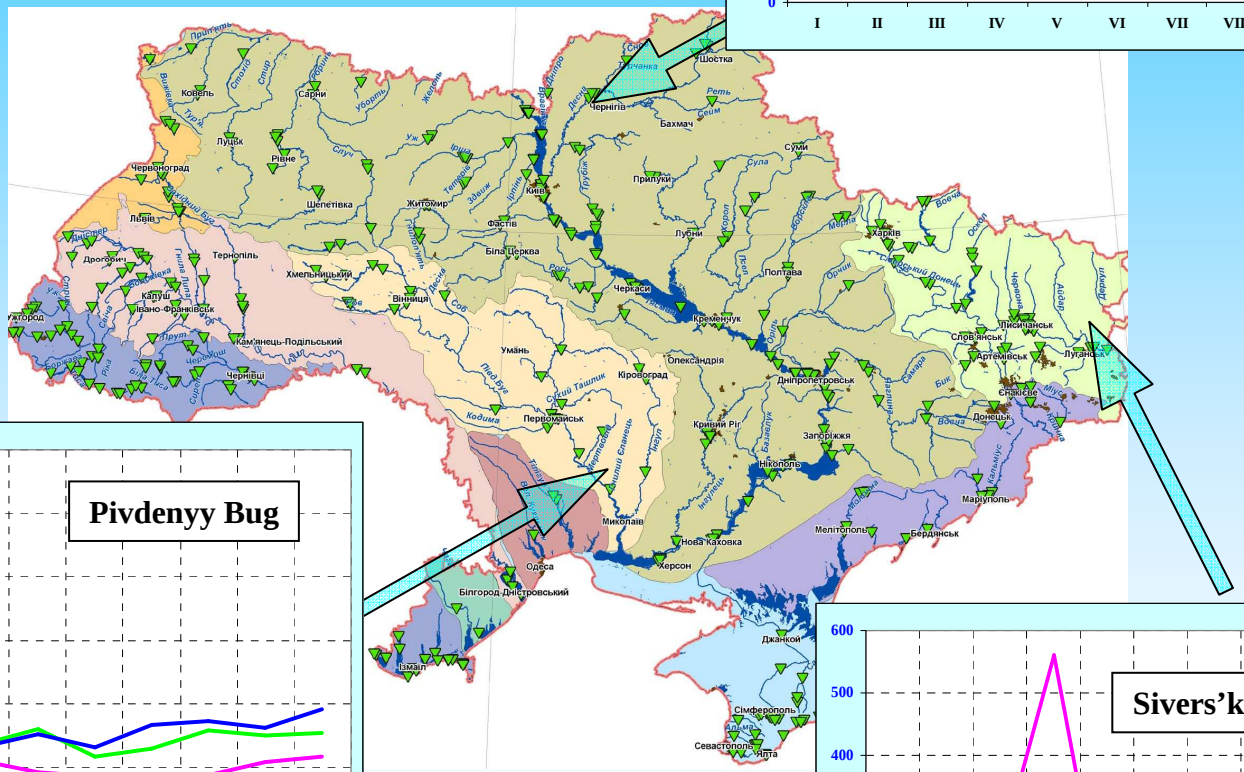
River – Station	Observ. period	Regression
Dnipro – Kyiv HEP	1928-2003	Y = 0.47X + 163
Desna – Chernigiv	1895-2003	Y= 0.02X + 328
Siverskyi Donets	1923-2003	Y = -0.04X + 48.3
Pivdennyi Bug	1914-2003	Y = 0.10X + 85.5
Prut –Chernivtsy	1895-2003	Y = -0.43X + 100
Psel – Zapsilia	1950 - 2003	Y = -0.37X + 43.3
Uzh - Uzhgorod	1947 - 2003	Y = -0.04X + 30.2
Dnister – Zalischyk	1895 - 2003	Y = -0.17X + 236
Latorisa -Mukachev	1847 - 2003	Y = -0.12X + 22.7

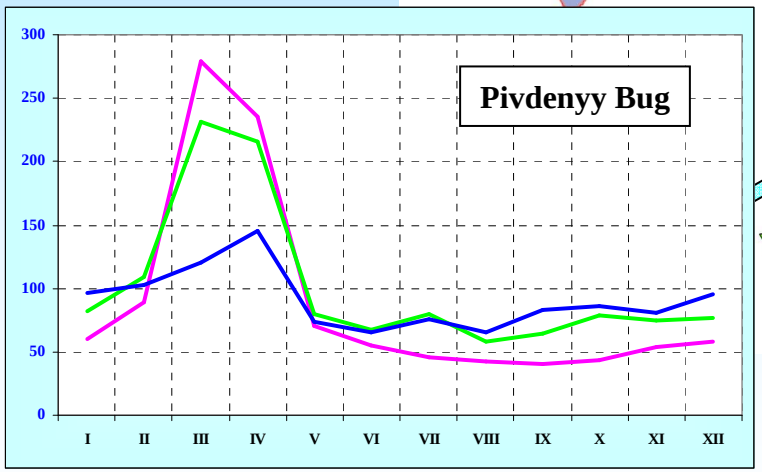
REGRESSION‘S EQUATION OF TRENDS OF MEAN SEASON’S DISCHARGES

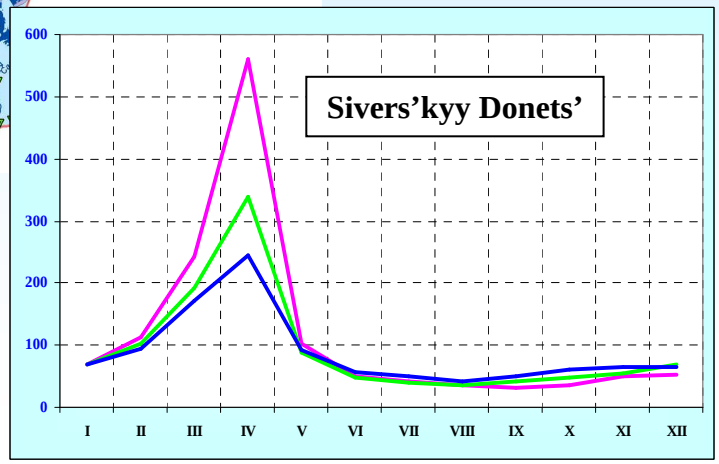
RIVER-STATION	DECEM.-FEBR.	MARCH-JUNE	JULY-NOVEMB.
Dnipro – Kyiv	Y=7.28X + 460	Y=-7.33X+ 2131	Y=3.63X+ 556
Desna–Chernigiv	Y=1.91X + 142	Y=-1.36X+ 626	Y=1.86X+ 134
Siverskyi Donets	Y=2.71X + 324	Y=-3.82X+ 112	Y=0.91X+ 97.5
Pivdennyi Bug	Y=2.86X + 87.5	Y=-3.72X+98.5	Y=1.13X+ 77.7
Prut –Chernivtsy	Y=3.67X + 111	Y=-5.25X+140	Y=1.33X+ 106
Psel – Zapsilia	Y=2.49X + 55.7	Y=-2.85X+78.5	Y=1.33X+ 106
Uzh - Uzhgorod	Y=3.77X + 28.2	Y=-3.45X+50.0	Y=-0.42X+ 33.5
Dnister–Zalischk	Y=3.00X + 182	Y=-2.68X+176	Y=-0.39X+ 167
Latorisa-Mukach	Y=3.55X + 37.9	Y=-2.93X+61.2	Y=-0.69X+ 67.0

Q, m³/s

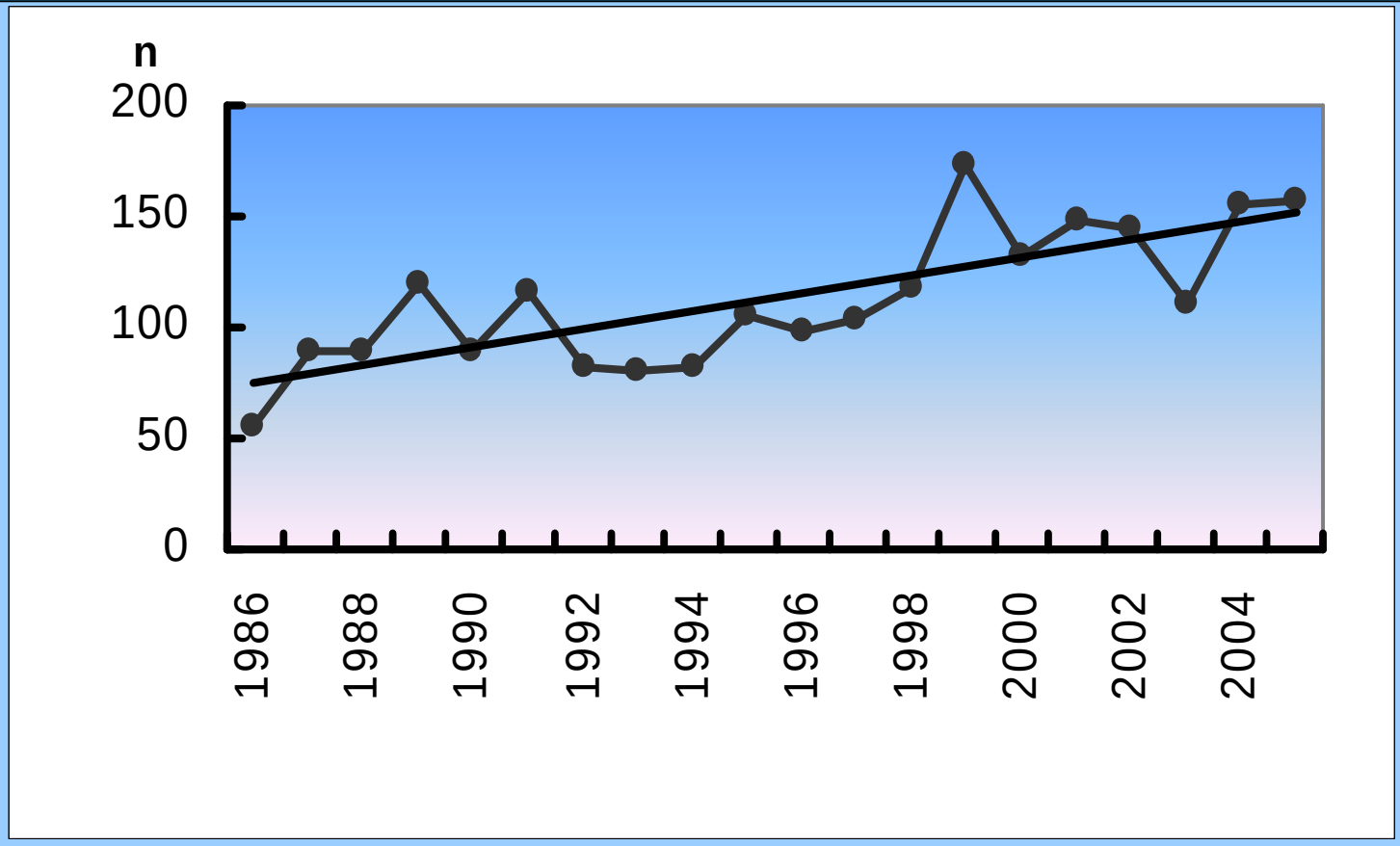








1931-1960 1961-1990 1991-2008



Annual fluctuations of severe hydrometeorological events at the territory of Ukraine. Number of cases (n) and linear trend.

Consequences of severe hydrometeorological events

EVALUATION OF EXPECTED CHANGES IN HYDROLOGICAL REGIME

- **NORTHERN PART OF TERRITORY (FOREST ZONE):**

  A) 15-25% RISE OF MEAN ANNUAL RUNOFF; B) RISE OF WINTER RUNOFF AND FALL OF SPRING RUNOFF

- **SOUTH AND SOUTH-EASTERN PART (FOREST-STEPPE AND STEPPE ZONES):**

  A)30-50% DECREASING MEAN ANNUAL RUNOFF;

  B) ABOUT 50% OF ANNUAL FLOW IS PASSED IN WINTER MOUNTHS; C) INCREASING DROUGHTS RISK

- **CARPATHIANS MOUNTAIN RIVERS:**

  INCREASING FREQUENCY OF EXTREM FLOODS

ASSESSMENT OF DNIPRO RIVER RUNOFF CHANGE AT THE KAHOVKA HPP, CUB. M/S /by A. Shereshevskyi/

scenario	probability %	mean annual flow	winter (December March)	spring (April – June)	Summer-Autumn (Jul.–Nov.)
Natural river runoff	5 50 95	2470 1620 1070	1970 1060 650	5380 3050 1680	1780 1000 590
GFDL, stationary CO2 growth	5 50 95	3120 1700 730	5880 2580 870	3000 1380 680	2140 900 300
GFDL, non–stationary CO2 growth	5 50 95	710 230 150	1030 380 160	750 300 100	580 300 160

THE MOST LIKELY EFFECTED SECTORS BY IMPACT OF CLIMATE CHANGES

- **AGRICULTURE IN THE SOUTHERN PART OF TERRITORY**
- **HUMAN SETTLEMENTS AND INDUSTRY WATER SUPPLY IN SOUTHERN AND SOUTH-EASTERN PART OF TERRITORY**
- **EXTREM HYDROMETEOROLOGICAL EVENTS PREVENTION IN THE MOST PART OF TERRITORY**
- **GETTING WORSE OF WATER QUALITY IN WATER BODIES IN SOUTHERN AND SOUTH-EASTERN PART OF TERRITORY**

DIRECTIONS OF FURTHER RESEARCHES

- **DEVELOPMENT OF COMPLEX WATER BALANCE MONITORING INCLUDING DATA ABOUT: RIVER FLOW; EVAPORATION FROM SOIL, LAND AND WATER SURFACE; SOIL WATER SUPPLY; WATER EQUIVALENT OF SNOW PACK**
- **ASSESSMENT OF EXPECTED CHANGES IN HYDROLOGICAL REGIME AND WATER RESOURCES USING NEW ACHIEVEMENTS IN THE AREA OF CLIMATE CHANGE MODELLING**
- **STRENGTHEN OF INTERDEPARTMENT RESEARCHES OF THE REGIONAL CLIMATE CHANGES IMPACT ON WATER-RELATED SECTORS OF ECONOMY**
- **PREPARATION OF RECOMMENDATION ADDRESSED ON ELABORATION OF ADAPTATION MEASURES**

DIRECTIONS OF FURTHER ACTIVITIES

- **preparation the new Climate Program of Ukraine** ***ldraft of Program has been prepared by the Ukrainian Hydrometeorological Institute***
- **development of the hydrometeorological and forecasting observation system meet expected climate changes**
- **development of the interdepartmental and international cooperation in the area of elaboration of adaptation measures**
- **elaboration of the National Action Plan aimed the adaptation of economy sectors and population to the climate change impact on water resources**


Thank you very much
for your attention and
patience !