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of the Russian Federation
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The Volga River Basin - history of development and modern hydrological regime under the changing climate

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Volga River Basin – the biggest basin in Europe. Catchment area – about 1360000km^2

Volga River Length – 3531 km

Basin Area – 8% of the RF, 13% of the Europe, 40% of European territory of the RF

Administrative regions – 41 regions

Population – 58 mln, 40% of total population of the RF

Cities – 42% of all cities in the RF, more than 1 mln inhabitants – 7 cities

Industry – 45% of total industrial production of the RF including: 90% - auto, 40% - power output

Agriculture – 50% of total agricultural production of the RF, 38% of total agricultural areas

Volga River Water runoff 1881-2016

Annual average – *253 km^3 / year*;
Maximum year runoff – *389 km^3 (1926)*;
Minimum year runoff – *160 km^3 (1975)*

Volga River Basin – unique geographic location

1. Volga River is from VIII-X Cent. an important trading and transport way from East to West and from South to North.

Since the XV Cent. the importance of the Volga trade route increased, the role of large cities - Kazan, Nizhny Novgorod, Astrakhan grew.

2. From that time to the present day, the Volga River Basin is located within one country

In the XVI Cent. the entire Volga river system was united within the borders of Russia. This unique feature distinguishes the Volga basin from the basins of major European rivers and determines the features of its economical and cultural development.

3. Volga River flows into the largest inland water object in the World – into the Caspian Sea.

This unique feature determines unified ecosystem of the river and the sea and allows us to investigate the practically complete hydrological cycle.

- *Danube River basin – 19 countries*
- *Rhine River basin – 6 countries*
- *Kura River basin – 5 countries*
- *Basins of the Dnieper, Daugava, Neman, Maas , Oder – 3 countries*

Natural conditions at the XIX-XX Cent. – Shallows and Banks

All over the Volga River channel bed became shallow at the XIX Cent. There were 230 well known shallows between towns Tver and Astrakhan, and more than 125 banks – were huge! These huge banks strongly limited shipping in summer period.

Especially perceptible economical losses of shallow banks became in the end of XIX Cent., when there where many big steamships at the Volga River.

Picture of the famous Russian artist ***Ilya Repin***.
"Burlaki na Volge" (Barge Haulers), 1870

Natural conditions at the XIX-XX Cent. – Floods and Droughts

Moscow, 1908

At the beginning of the XX-th Century, there were ***extremely high floods*** and ***prolonged droughts***, causing huge losses to the economy and the population of the country.

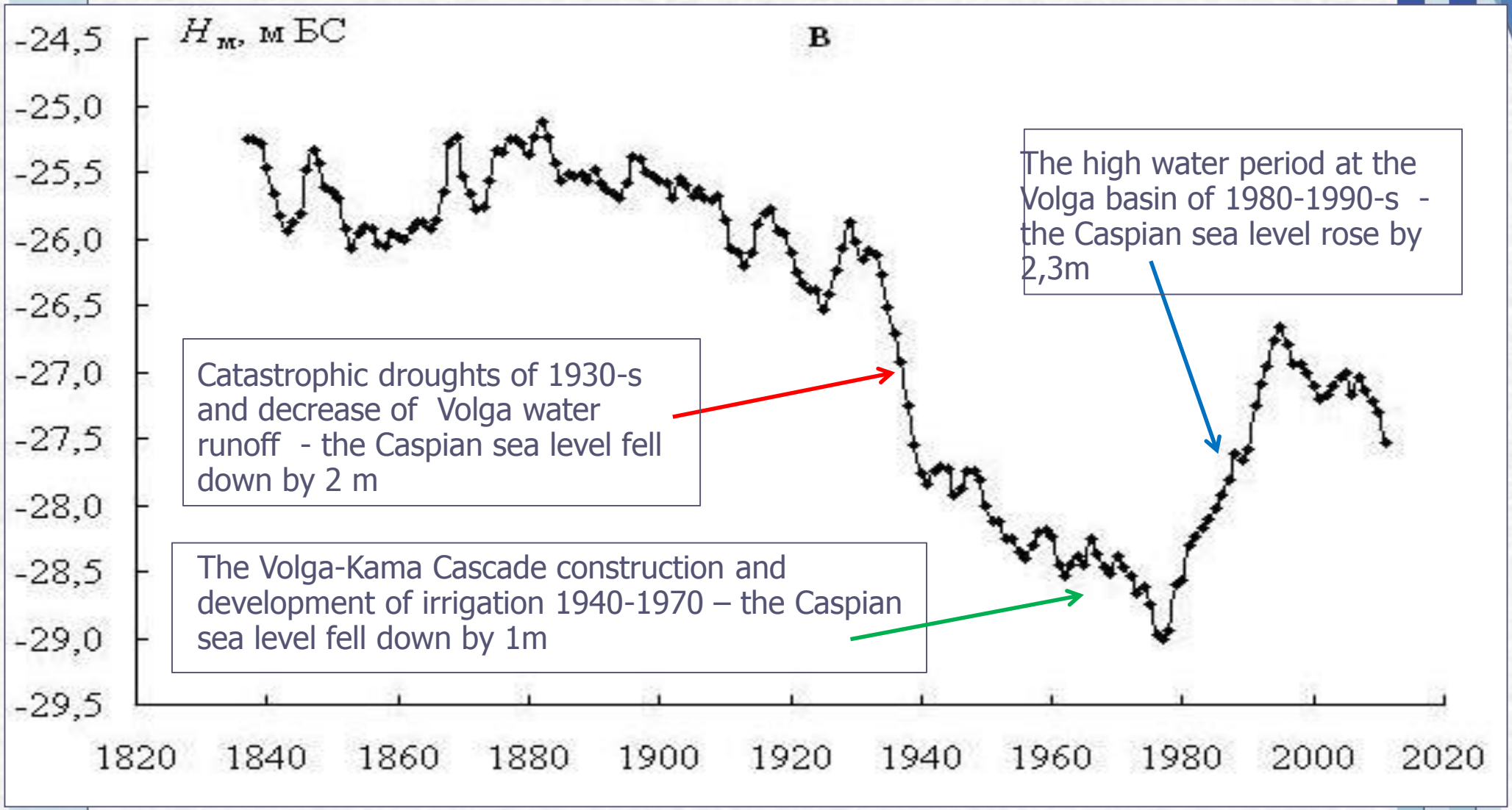
In 1908 and 1926, during ***high floods*** in the Volga basin, huge territories and large cities were flooded.

The droughts of 1921-1922, at the beginning of the 1930s, which were accompanied by terrible ***dry winds***, led to crop failures and catastrophic famine in the Volga region.

Moscow, 1926

Natural conditions at the XIX-XX cent. – Caspian Sea level fluctuations

Annual mean Caspian Sea Level for the period of instrumental observations



Max: -25,2 m BS (1882)
Min : -29,0 m BS (1977)

Volga River Basin – the main challenges at the beginning of the XX Cent.:

Hydrological challenges:

1. Shallows and banks
2. Floods and droughts
3. The Caspian Sea level decline.

Socio-Economical challenges:

4. Rapid development of industry, big cities and population;
5. Development of agriculture and irrigation at the Volga River middle course;
6. Lack of water resources to ensure industry, agriculture and population
7. The need for navigable depth for developing shipping
7. The need for cheap electricity for complex economic development at the Volga River basin.

Response to the challenges:

The construction of the largest geotechnical system – ***Volga-Kama Cascade of Hydroelectric Power Plants*** was started in 1935.

Volga-Kama Cascade (VKC) – 11 great water reservoirs and hydroelectric power plants

WATER :

Useful water capacity of VKC reservoirs – 78km^3.

Full water capacity of VKC reservoirs – 158km^3.

ENERGY:

Total power of VKC – about 12000 MW.

Annual hydro-power generation – 35-40 billion kWh.

Volga River basin – the main results of Volga-Kama Cascade to the end of XX Cent.:

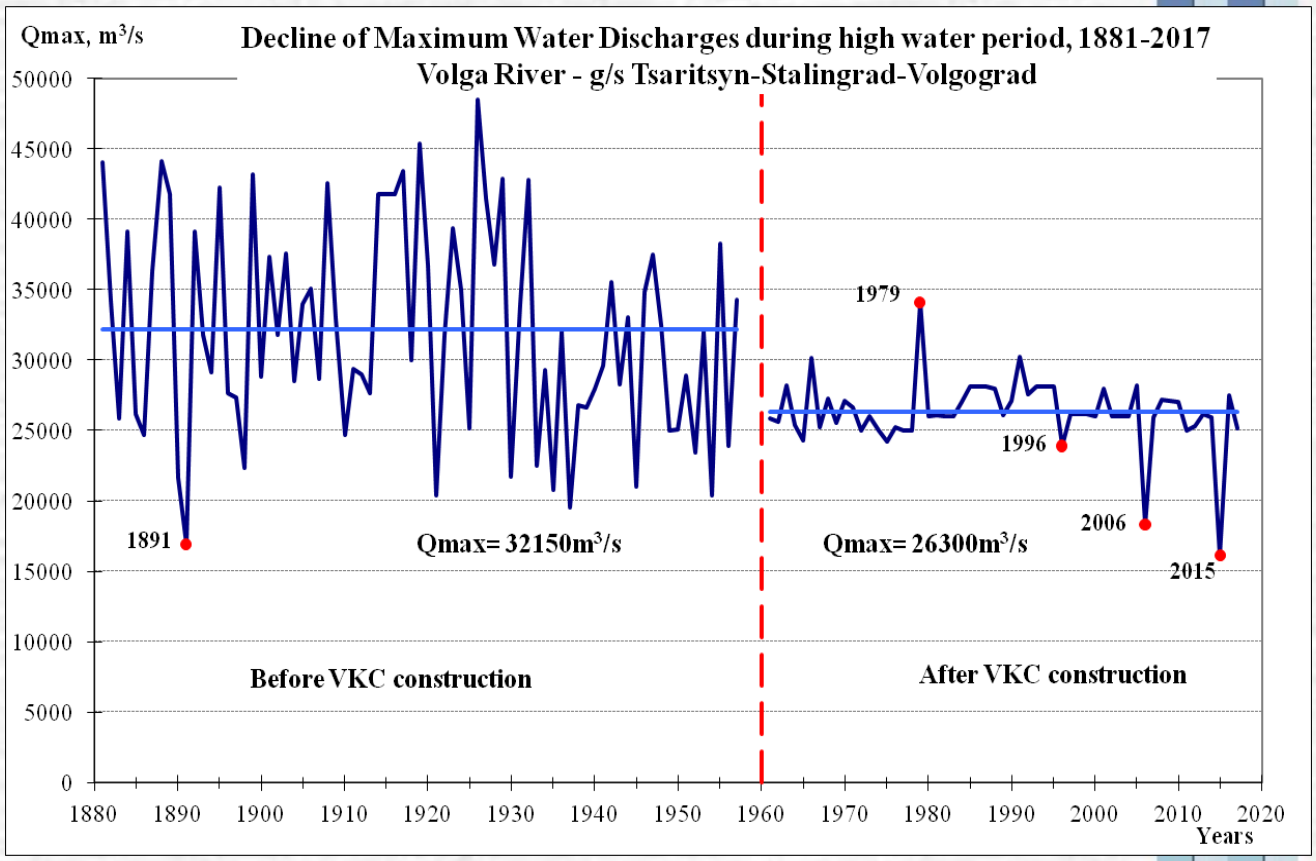
1. ***Guaranteed navigable depth*** about 4,5 m are provided throughout the Volga River from upstream to the Caspian Sea. Unlimited shipping

2. ***Reducing the threat of floods and droughts*** are provided by regulating regime of VKC - seasonal , weekly, daily. Control of high and low waters – one of the main tasks

3. ***VKC cheap electricity enters the Russia's Unified Energy System***. HPPs are the most flexible and can in a matter of minutes significantly increase the volume of generation to cover peak loads in the Unified Energy System

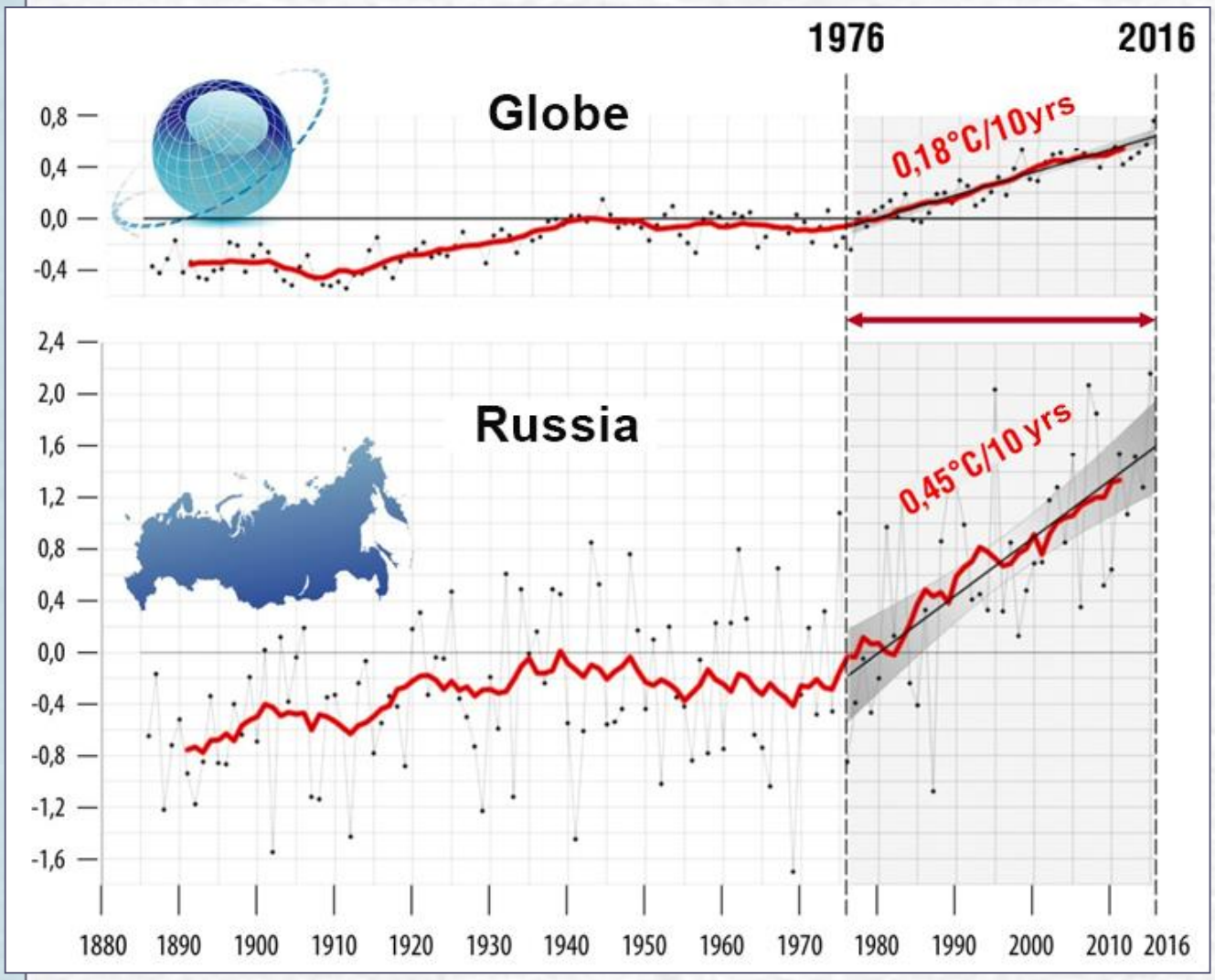
4. Water volume in VKC reservoirs provides ***sustainable water supply*** for the cities (population), industry (plants and factories), agriculture and irrigation.

5. ***Favorable conditions for ecosystem*** – there are ***13 biosphere reserves*** now in the Volga River Basin



Climate changes at the Volga River basin – the new challenge at the beginning of XXI Cent.

Temperature anomaly relative to 1961-1990 average



by Roshydromet data

Warming Rate

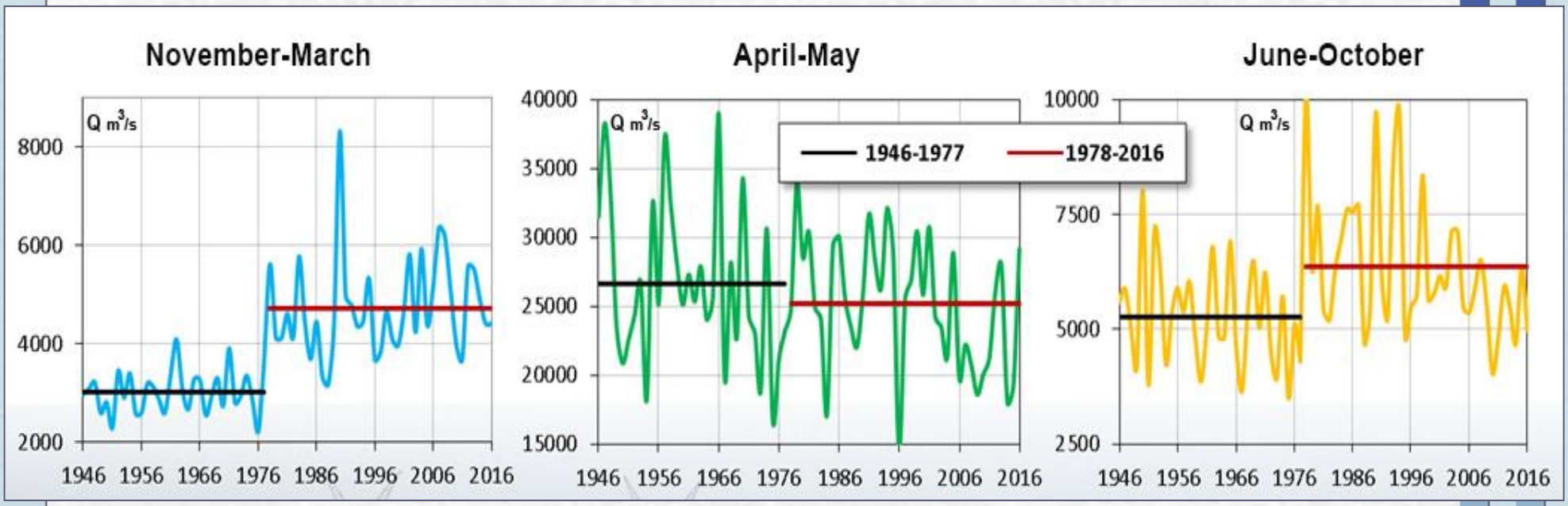
Globe -
0,18ºC/10years

Russia -
0,45ºC/10years

Volga Basin -
0,51ºC/10years

Climate changes and the Volga River runoff – "Rivers are results from the climate" (prof.A.Voeikov)

Seasonal redistribution of the Volga Basin Water inflow to the VKC reservoirs during last 40 years (by Roshydromet data)



- More than twofold increase of winter water inflow
- 50% increase of summer-autumn water inflow
- Slight decrease of spring water inflow

The climate changes caused significant intra-annual water inflow redistribution and the changes in the operative work of VKC . The winter runoff through the HPPs and winter generation increased strongly and it is the serious problem .

Conclusions

- Complex operation of a unique hydraulic-engineering object - Volga-Kama Cascade of HPPs and reservoirs under conditions of changing climate and changing development priorities ***gives rise to new challenges*** for society of Volga River Basin
- The solution is possible only on the basis of an integrated program of measures that will improve the state of water bodies and increase the supply of the population and economic facilities with water resources.
- To search for solutions on behalf of the Russian Government, a complex project was implemented to scientifically justify activities that ensure the rational use of water resources and the sustainable operation of the water management complex of the Lower Volga, the preservation of the unique ecosystem .
- Based on the results of the project, the CONCEPT for the rational use of water resources and the PLAN of activities were developed.
- And just now – in August-2017 - the Russian Government adopted the great program "Conservation and Prevention of Pollution of the Volga River" 2017-2025, based on the conclusions and recommendations of the comprehensive scientific research.
- All these works are financed by the Government of the Russian Federation

Thank you for attention!