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WATER RESOURCES AND FOOD SUPPLY SYSTEMS

VOZHEHOVA R.A. – Doctor of Agricultural Sciences, Professor, Academician of National Academy of Agrarian Sciences of Ukraine, Director
orcid.org/0000-0002-3895-5633
Institute of Climate-Smart Agriculture of the National Academy of Agrarian Sciences

Problem statement. Water is an important component of food supply systems because it ensures their sustainability, and high-quality water resources are a precondition to produce safe and high-quality food products.

Figure presents a schematic model of the close relationship between water resources and constituents of any food supply system. This proves the special importance of this natural resource in food security of any country. This model proves the importance of water in the food supply system, but it is necessary to take into account the potential of water ecosystems today, and current concerns regarding planning the effective operation of such systems [1].

Results. Global water resources use has increased sixfold over the recent century and continues to increase steadily by about 1 % per year, driven by factors such as population growth, economic development, and consumption patterns. Climate change, together with a more uneven and unstable supply of water resources, will further complicates the situation in the regions where these resources are already under severe loads.

At the same time, the quality of water deteriorates due to the increase in the temperature of water resources, the decrease in dissolved oxygen content and corresponding decrease in self-purification ability of freshwater reservoirs. In addition, there is a risk of contamination and pathogen infestation of water resources due to floods or increased concentrations of pollutants during dry periods.

Given the importance of water in food supply systems, there is every reason to change the rules of the game for them, as noted by the UN Secretary-General's special representatives at the Food Systems Summit.

A number of international and domestic legislative documents, which are aimed at preventing catastrophic climate changes, include measures to achieve ecologically and economically expedient transformations in all sectors of the economy, including agriculture. One of the most important documents is the Paris Agreement, which, unfortunately, does not even mention water resources, although it is clear to everyone that they are an important component

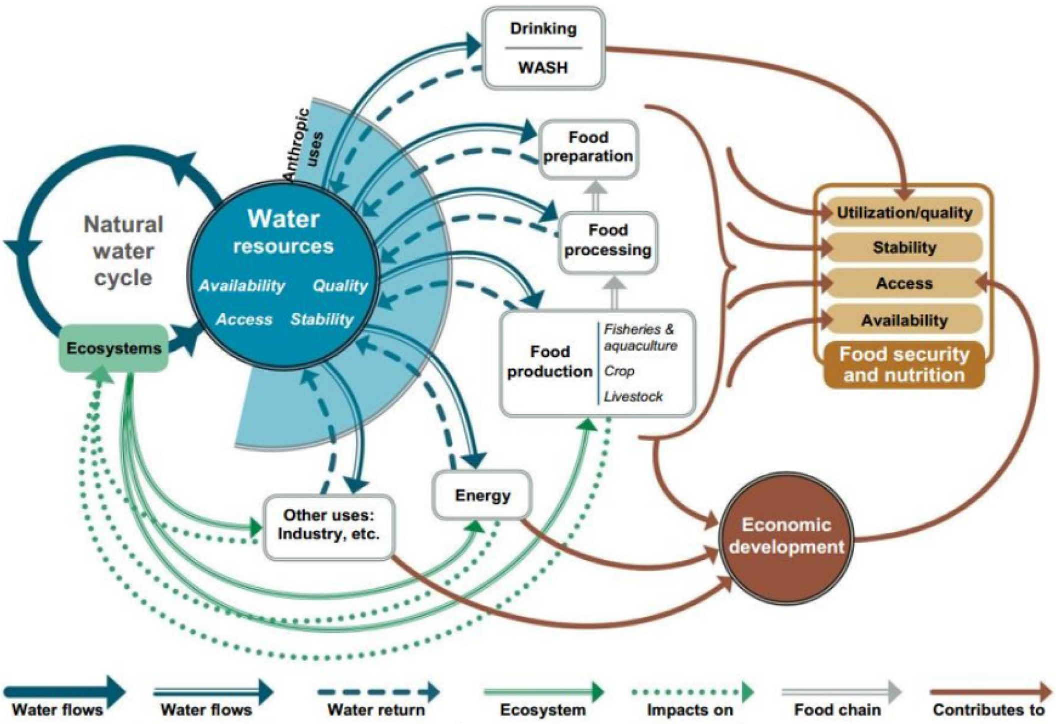


Figure 1. The model of linkage between water and food supply systems (Source: HILPE 2015)

of many strategies for adaptation and mitigation of climate change effects. On the other hand, water resources not only play an important role in adaptation to climate change, but they could also be taken as a unifying factor for all Sustainable Development Goals (SDG) by 2030.

Today, Ukraine has already presented the draft of the Second National Definition of Contribution to the Paris Agreement. Declaring at the national level not to exceed 35 % of greenhouse gas emissions in 2030 compared to 1990 levels, or, in other words, to reduce greenhouse gas emissions by 65 % in 2030 compared to 1990. For Ukraine, such a sectoral policy will contribute not only to the reduction of greenhouse gas emissions, but also create significant economic, food and social opportunities, reduce the level of air, soil and water pollution, which will positively affect the process of decarbonization of all sectors of the economy and the balanced and ecologically safe functioning of food supply systems A number of positions of the Second National Definition of Contribution to the Paris Agreement also apply to agriculture, namely:

- Increment of the share of agricultural lands where minimal tillage and no-till systems are applied;
- Transfer to extended release fertilizers;
- Increment of organic agriculture share in the land use up to 3 % by 2030;
- Increment of biogas production and use.

An important constituent of the mentioned second contribution should be questions regarding the rational use of water in various food systems, especially in the conditions of increased climate aridity and reconstruction of irrigation systems. There should be soil-protecting, water-saving and biologically optimal irrigation regimes applied under innovative methods of agricultural crops water supply use.

Based on long-term observations of global temperature values, scientists of the Goddard Institute for Space Research have made a forecast of average global temperature changes until 2025, certifying about a constant increase in starting from 1850 (Fig. 2) [2, 3].

The studies by domestic scientists within the framework of the Ukrainian-German project confirm the forecasts of climatic changes towards an increase in the temperature regime, the dynamics of precipitation and evaporation from the soil surface for various natural and climatic changes by 2070 (Fig. 3) [4]. Forecasts indicate that modern production processes increase the risks of efficiency and balanced functioning of food supply systems.

Taking into account the existing climate changes and insufficient implementation of climate-oriented policies on the global scale, it is expected that in the future agriculture will face risks, a significant part of which will be related to the qualitative and quantitative characteristics of water resources. Scientists predict, and practice confirms the statement, that climate change will increase fluctuations in precipitation, surface, and groundwater supplies, affecting the water demands of crops. Most of the territories will need artificial irrigation, and significant territories will be flooded requiring artificial drainage and disposal of residual surface and subsurface waters. This will be an important condition for the further development of agriculture in the direction of its climate orientation through the greening and balancing of agro-production systems.

Of the total volume of water resources used in the world, almost 70 % are used for agriculture, of which 85 % are used in irrigated agriculture. Owing to these resources, 40 % of the global agricultural production is produced on the irrigated lands.

The scientists of our Institute conduct studies on improving monitoring of the development of agricultural plants under conditions of climate change and different water stress levels (Fig. 4) using modern diagnostic methods. This monitoring allows one to respond on time to the problems that arise on the field through the application of appropriate measures.

Valley Scheduling [5] remote irrigation control includes:

Weather forecast for each field;

Soil moisture content on the level of field and crop rotation;

Soil moisture control in the plant's root system zone;

Irrigation scheduling for each field.

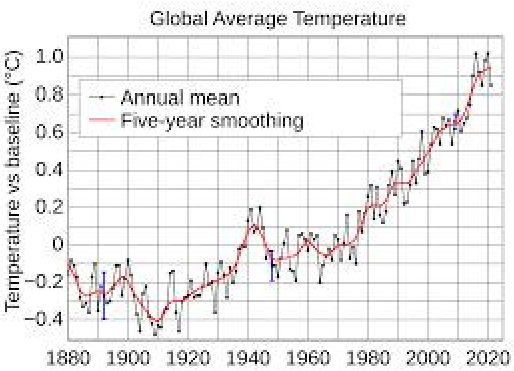
The results of such a monitoring allow getting analysis of spectral bands for the experimental field of the Institute of Climate-Smart Agriculture of NAAS by the values of:

Normalized difference vegetation index (*a*),

Plants density (*b*),

Water stress index (*c*),

Soil moisture control device on crops (*d*).



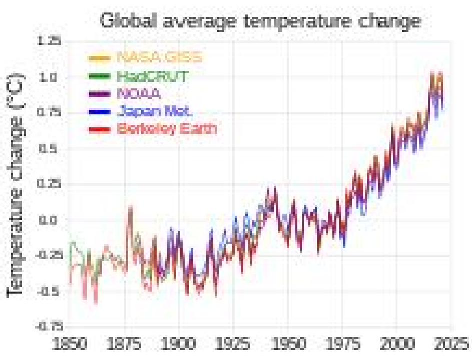


Figure 2. Forecasts of global temperature regime indices (Goddard Institute for Space Research)

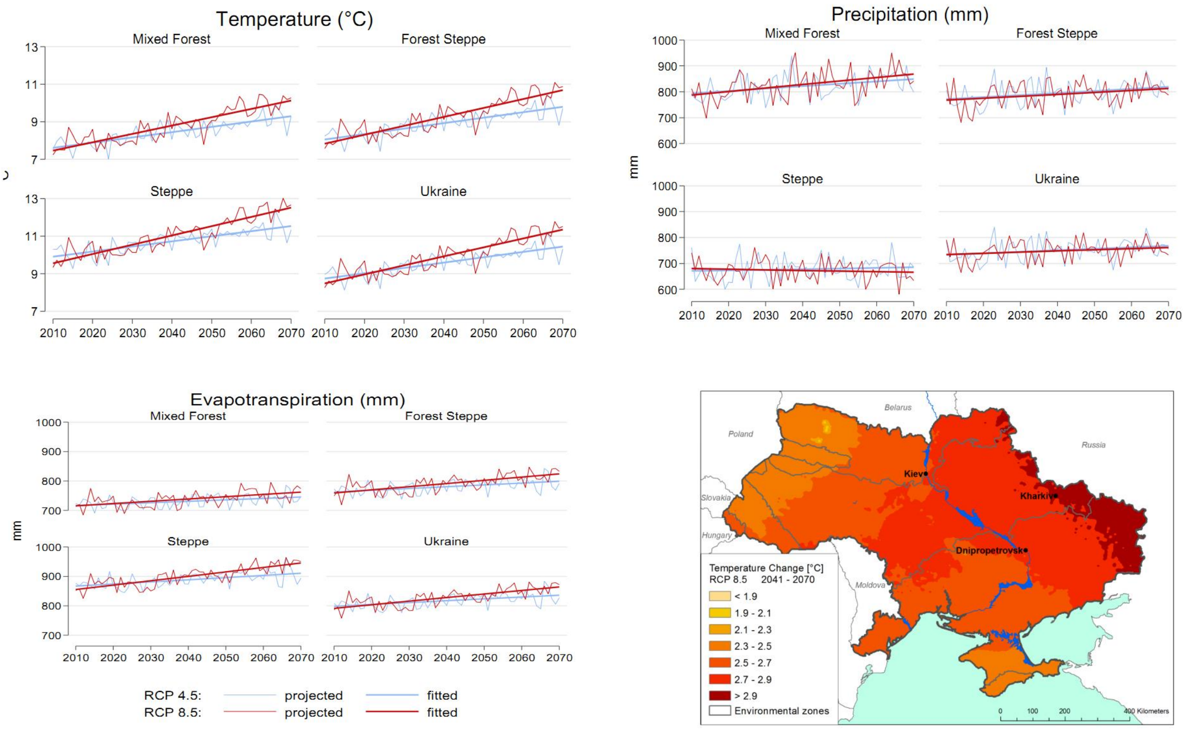


Figure 3. Forecasted climate change for 2010–2070 in different soil-climatic zones of Ukraine under scenarios RCP 4.5 and RCP 8.5 (German-Ukrainian agropolicy dialogue, 2016)

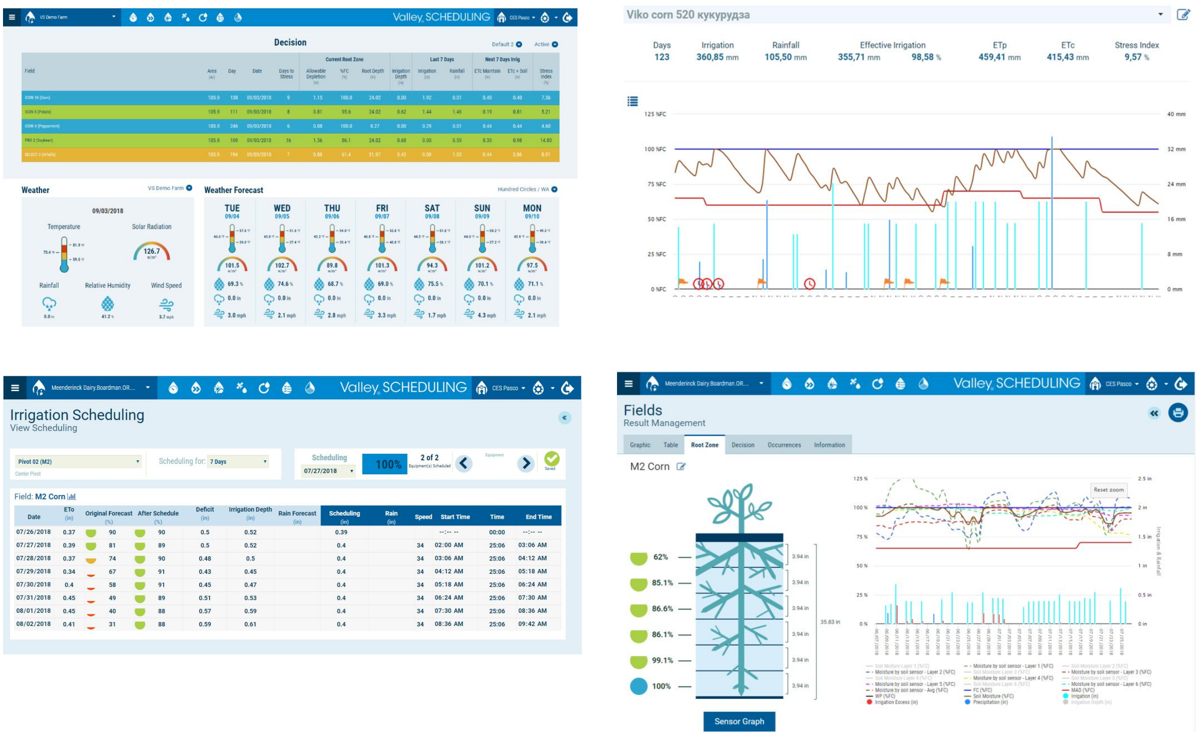


Figure 4. Valley Scheduling irrigation remote control system

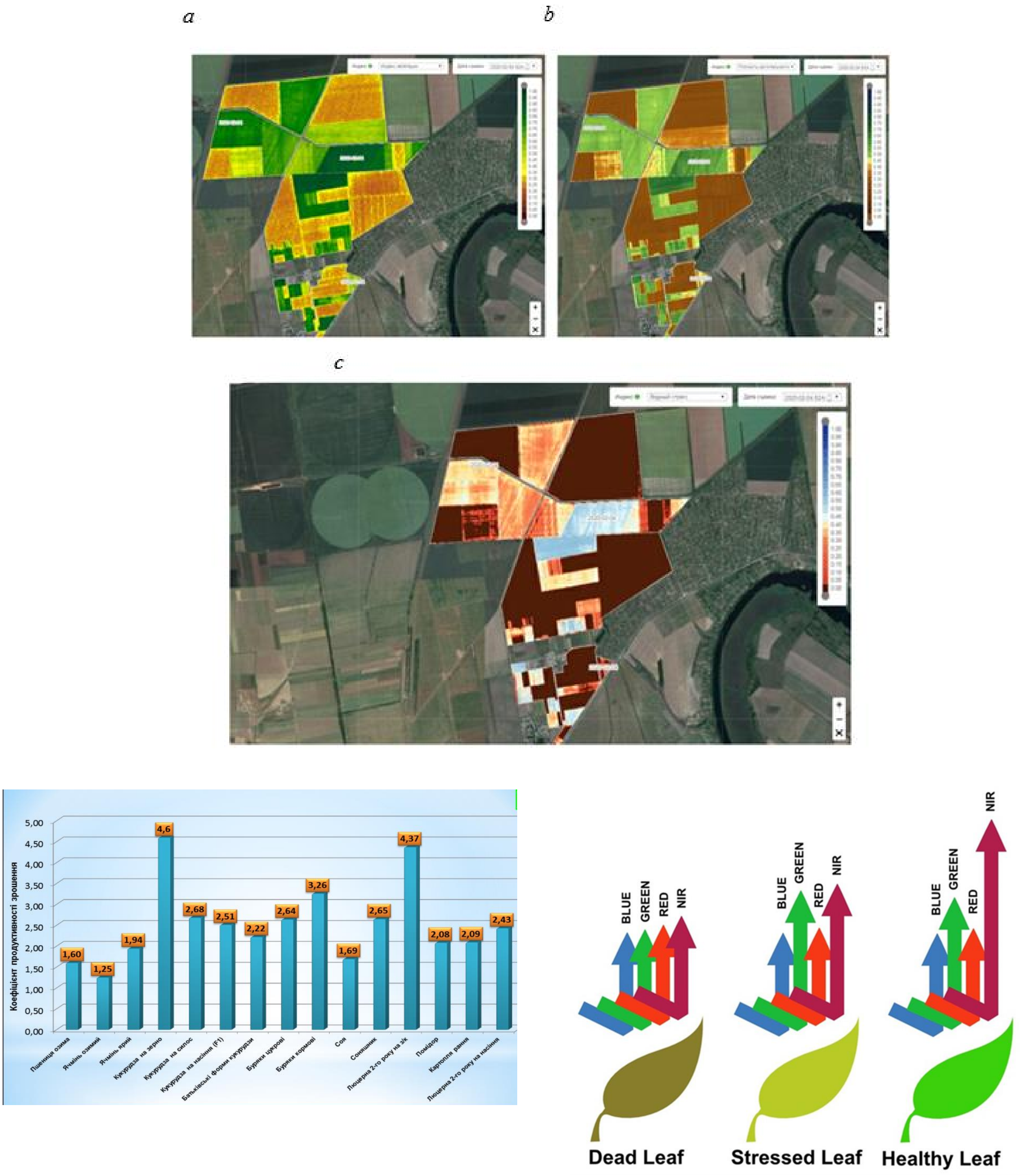


Figure 5. The results of spectral analysis of the experimental field

Conclusions. The main measures developed by the scientists of our Institute and adapted to modern climatic conditions and state policy in the direction of mitigating the effects of climate change on the functioning of food supply systems a there is a rational use of water resources in these systems:

- preservation of water ecosystems and functions;
- improving the management of water resources in agriculture by increasing the resilience of non-irrigated food supply systems to climate changes under rational use of water resources in irrigated agriculture;
- improve the systems of tillage, fertilization and plant protection of crops plant breeding to ensure the efficiency of transpiration processes, resistance to climatic changes, storage, and application of science-intensive irrigation technologies and methods of watering crops;
- reduction of non-productive expenditures outside food supply system for infrastructure maintenance, irrigation systems, product processing and transportation;
- providing farmers with information on weather factors and forecasts, soil monitoring systems, irrigation water and crop quality, as well as price policy on domestic and global markets;
- increasing the ecological sustainability of food supply systems through effective monitoring of the impact of functioning food supply systems on natural

resources, the state of the environment and the quality of manufactured products;

- increasing the ecological sustainability of food systems and their impact on the environment and the quality of produced products.

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