

2. Major trends of meteorological parameters change determining crop evapotranspiration by example of "Fergana" weather station

2.1. Standard method of evapotranspiration assessment

Method FAO Penman-Monteith (1998) is a standard method of evapotranspiration evaluation based on comparison with reference evapotranspiration from grass surface.

Recommended by FAO Penman-Monteith equation with regard for aerodynamics equation is as follow:

$$ET_o = \frac{0,408\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0,34u_2)} \quad (1)$$

where

- ET_o – reference evapotranspiration [$\text{mm}/\text{day}^{-1}$];
- R_n – net radiation on plant surface [$\text{MJ m}^{-2} \text{day}^{-1}$];
- G – soil heat flow density [$\text{MJ m}^{-2} \text{day}^{-1}$];
- T – average daily air temperature at height 2 m [$^{\circ}\text{C}$];
- u_2 – wind speed at height 2 m [m s^{-1}];
- e_s – saturation vapor pressure [KPa];
- e_a – actual pressure [KPa];
- $(e_s - e_a)$ – saturation vapor pressure deficit [KPa];
- Δ – vapor pressure curve [$\text{KPa } ^{\circ}\text{C}^{-1}$];
- γ – psychrometric constant [$\text{KPa } ^{\circ}\text{C}^{-1}$].

FAO issue (56) "Crop evapotranspiration" includes formula and tables allowing determine parameters in equation (1) based on several meteorological factors.

2.2. Meteorological factors determining evapotranspiration

Meteorological factors determining evapotranspiration provide energy of vapor creation and remove water vapor from the evaporating surface. Major of them in FAO terms are as follows (1998):

Solar radiation

Evapotranspiration process is determined by amount of existing energy for water evaporation. Main source of energy turning water into vapor is solar radiation. Evaporation surface position in the space and year season determine potential radiation reaching evaporating surface.

Air temperature

Solar radiation absorbed by atmosphere and heat radiated by the earth increase air temperature. Physical heat of the air transmits energy to plants and controls evapotranspiration rate. Under sunny warm weather water losses for evapotranspiration are more than under cool and cloudy weather.

Air humidity

Since sun and air energy is main driven force of water evaporation, difference between water vapor pressure at evaporating surface and in the air is decisive factor of vapor transfer. Well wetted fields in dry arid regions require huge amount of water due to excessive energy and drying strength of atmosphere. In humid tropic regions, in spite of high energy, high air humidity reduce need in evapotranspiration. In this environment air is close to saturation by vapor so less additional water is accumulated and evapotranspiration is less compared with arid regions.

Wind speed

Vapor removal process mostly depends on wind and air turbulence that transfers huge mass of air over evaporating surface. Evaporating water air over evaporating surface is gradually saturated by water vapor. If this air is no permanently replaced by drier one, driven force of vapor removal and evapotranspiration becomes weaker.

2.3. Major trends of meteorological parameters change

Major trends of meteorological parameters change can be considered by example of "Fergana" weather station for 1970-2001. These data characterize vast territory of Fergana valley partly covering Uzbekistan, Kyrgyzstan and Tajikistan (Table 1, Fig.1).

Table 1 | Major trends of meteorological parameters change from beginning to the end of period 1970-2001 ("Fergana" weather station)

Meteorological parameters	Signs	Unit	Major trends of meteorological parameters change from beginning to the end of period 1970-2001		
			Total for 32 years	including:	
				April-September	October-March
Air temperature	Tav	°C	+ 0,9	+ 0,4	+ 1,4
Precipitation	P	mm	+ 36	+ 21	+ 15
Relative air humidity	RH	%	+ 0,58	+ 1,44	- 0,27
Duration of solar shining	n	hour/day	- 0,23	- 0,56	+ 0,11
Wind speed	u ₂	m/s	- 0,46	- 0,71	- 0,25
Evaporation from water surface (ГГИ-3000)		mm		- 115	
Reference evapotranspiration	ET _o	mm	- 114	- 114	0
Deficit of moistening	(ET _o -P)	mm	- 150	- 134	-16

Assessment of above parameters with regard for their impact of reference crop evapotranspiration and other crops consumption shows that for the period of 1970-2001 trend of moistening deficit (difference between reference crop evapotranspiration and precipitation) reduction is found. Separate deficit peaks at the end of this period do not exceed peaks at the beginning of period and depend mostly on solar activity. Evaluation by example of one weather station can't give comprehensive picture for all region but it shows glacier diminishing threat to agricultural production sustainability.

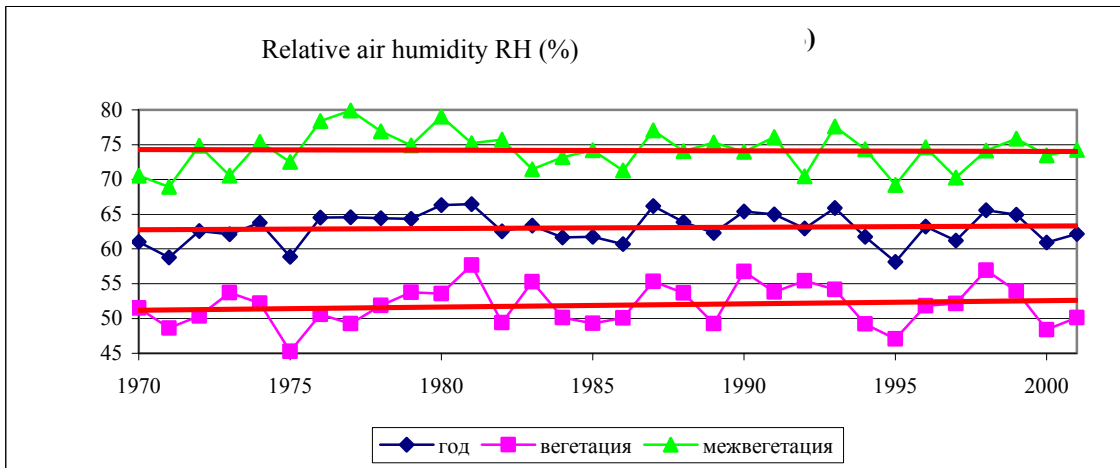
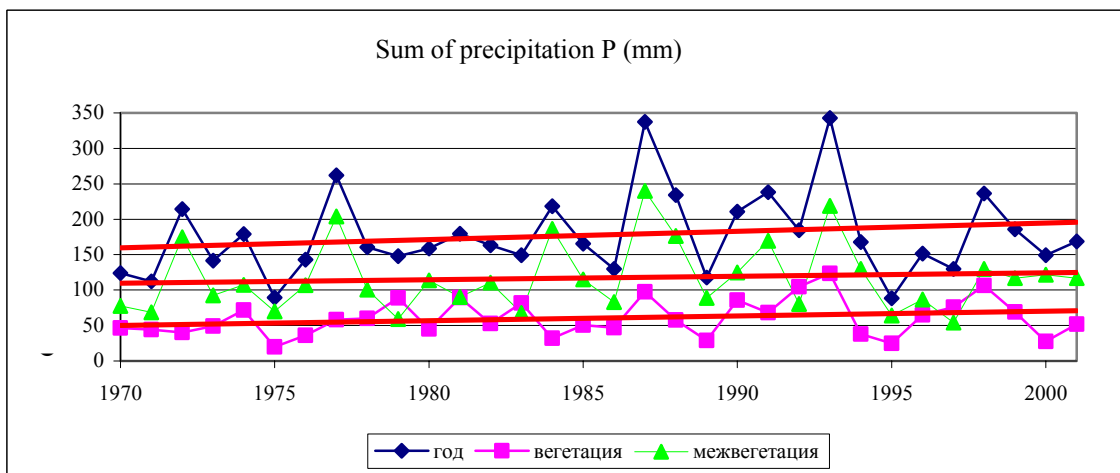
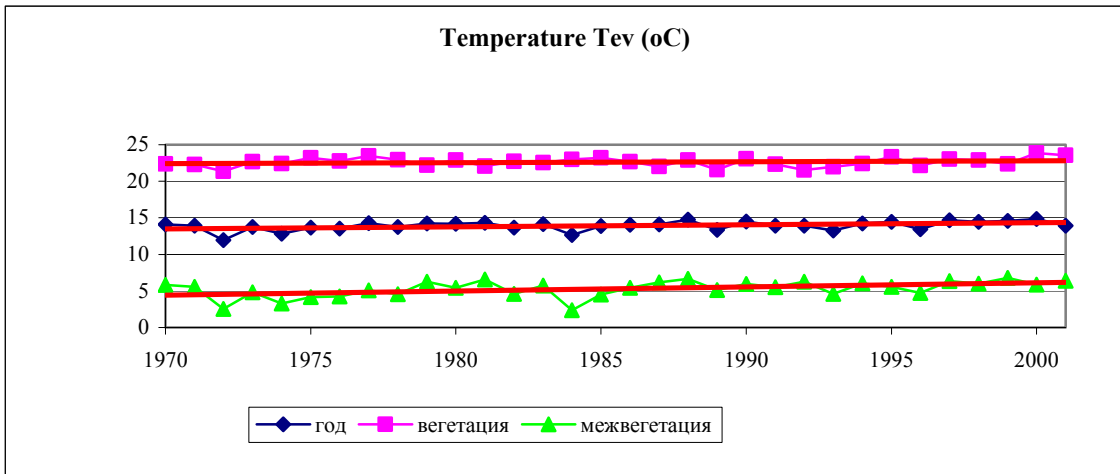


Fig. 1 | Trend of major meteorological parameters changes (weather station "Fergana", 1970-2001)

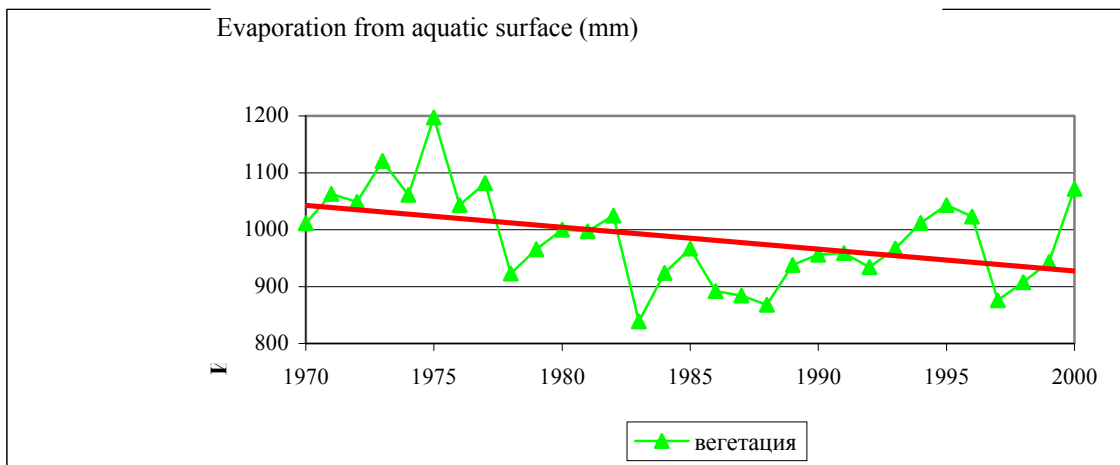
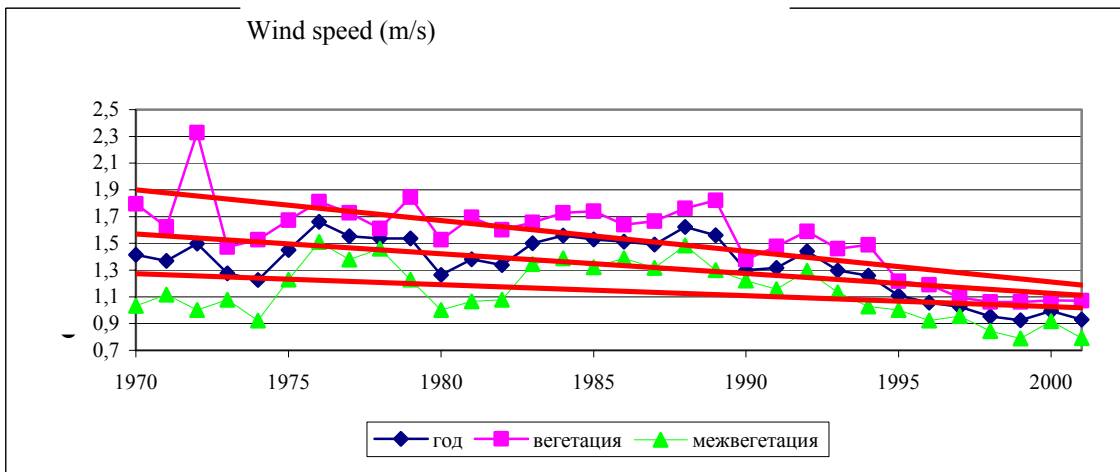
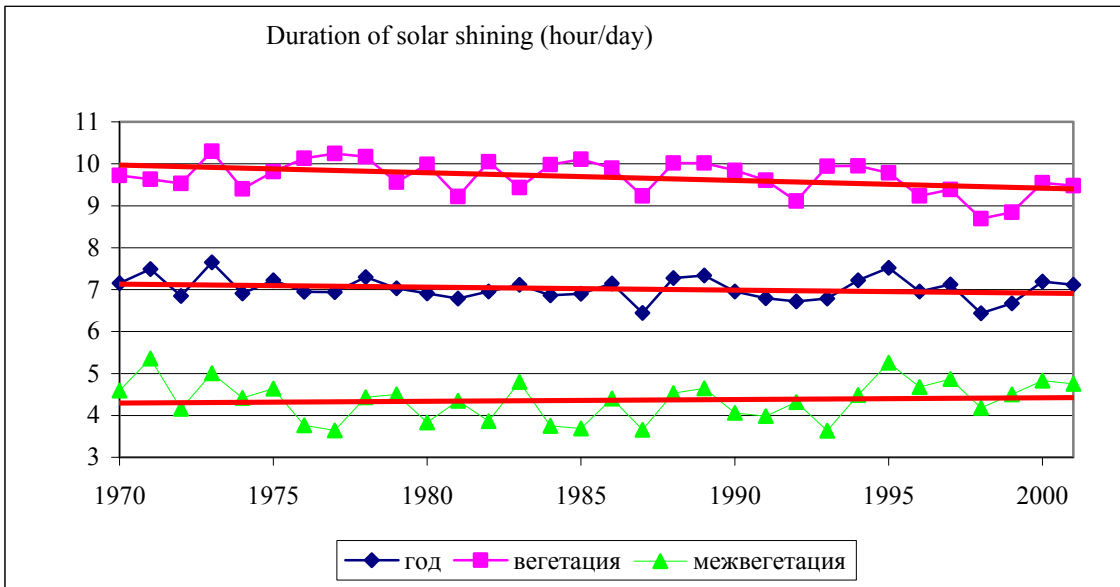


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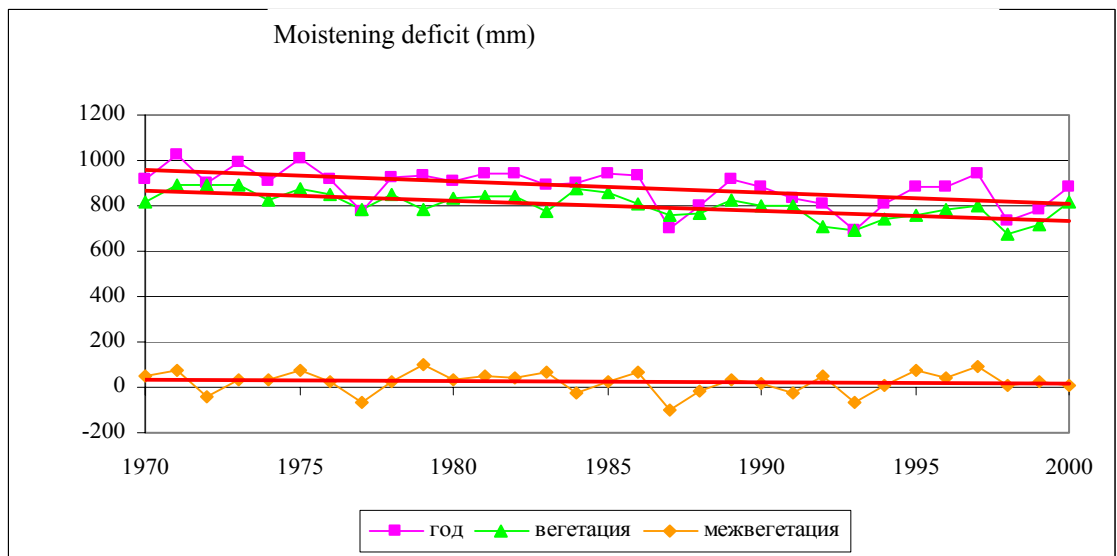
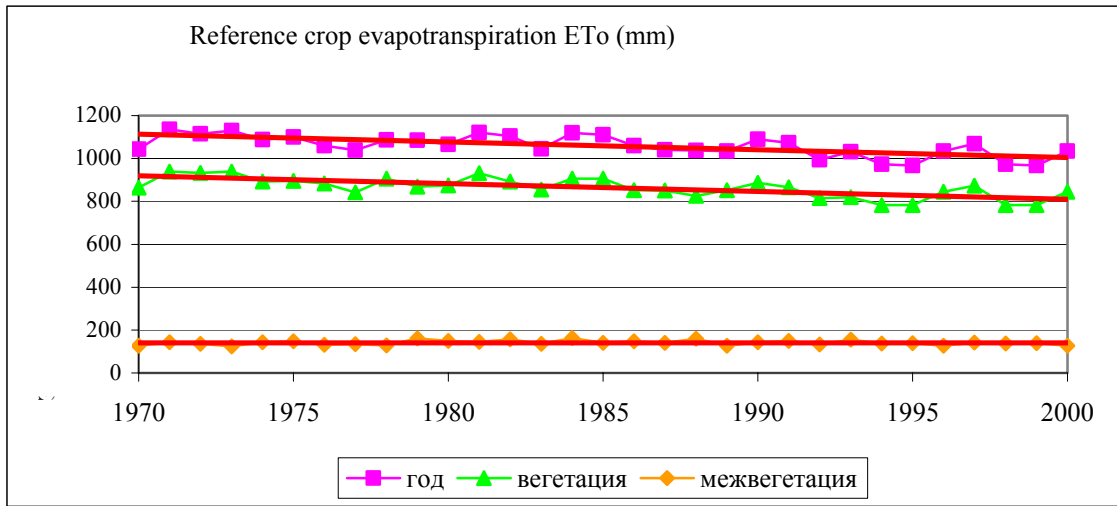


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