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I. ЧОВЕК И БИОСФЕРА

ВЛИЯНИЕ НА ЕСТЕСТВЕНИ И ПРЕДИЗВИКЯНИ ОТ ЧОВЕКА ИЗМЕНЕНИЯ НЯ РЕЧНИЯ ПОТОК И КЛИМАТА ВЪРХУ ЕКОСИСТЕМИ В БАСЕЙНА НА СРЕДНА ЕЛБА

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THE IMPACT OF NATURAL AND HUMAN-INDUCED CHANGES IN THE RIVER FLOW AND THE CLIMATE ON FLOOD PLAIN ECOSYSTEMS IN THE MIDDLE ELBE RIVER BASIN

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Abstract: The complex ecological researches (hydrology, vegetation, soils, unconfined ground waters) were made in the broad-leaved forest zone of Central Europe nature reserves located on the banks of the rivers Elbe (Germany). The natural and antropogenical conditions of terrestrial ecosystems along the course of the rivers (regulated and natural flow) were compared. The significant negative influence of low-dammed (low-confined hydrotechnic) construction and small reservoirs on vegetation and soils of floodplain was revealed. On the basis of analysis of the trends of mean annual water level, flow and atmospheric precipitation on the multi-years series on the rivers the significant influence of natural long-term variability of watering on vegetation dynamics in the floodplains has been discovered. The own Assessment method of consequences change of river flow regime under building small and middle hydrotechnical constructions for floodplain ecosystems is submitted.

Key words: regulated river, flood-plain, ecosystem, soil, vegetation, nature conservation.

INTRODUCTION

Consequences of influence of scale hydrotechnical construction (with high of dam 15-20 m): dams, reservoirs, channels on the large and average rivers of former Soviet Union (Volga, Kama, Dnieper, Don, Sheksna, Amu Darya, Syr Darya etc.) is marked on distance more than 100 km lengthways on current and in strip till 5-10 km deep into both banks of the river (Avakyan and all., 1987).

At the same time influence on floodplain and river-delta ecosystems small dams (small and middle low-dammed hydrotechnical construction) which much more often meet on the European continent, is investigated insufficiently (Henrichfreise, 1995; 1996;, Hochwasserschutzmassnahmen ..., 1988). And it is connected to the objective causes. Similar breaking in landscapes frequently have non-salient character. They safficienty restricted in space (only in floodplain) and differ long, long-term and latent processes from visual observation.

Negative processes in ecosystems of floodplain after construction SHC, start to show visually only after long time period. That is why, only in last years studying as initial stages of processes, and their consequences remote in time connected to hydrotechnical transformations 30-50 years of XX century has become possible. The opportunity evidently has appeared to visual estimate disturbed in soil and vegetative covers, and also in distribution of GWT.

Besides all over the world came to comprehension of that the new approach to paecellation and conservation of reserved areas in floodplain and deltas is necessary. Has become completely clearly, that simple measures of preservation against direct antropogenic impact, such as cuttings down, overgrazing, pollution, fires and so forth, are not capable to keep an ecosystem of floodplain. By development and planing of various hydrotechnical measures it is necessary to consider, that floodplain ecosystems are intrazonal. It means, that in their development and functioning is main the hydrological factor. In natural conditions the hydrological regime of the river determines regime of ground waters in floodplain and water regime of floodplain biotopes, forming and functioning of ecosystems. Factors, socalled indirect antropogenic impact (change of hydrological regime of the rivers and watering accumbent territory), lead to full change of one ecosystems with others. The ecosystems changing natural, normally less valuable in economic attitude, less diversity and low production.

The Federal Agency for Nature Protection of Germany in cooperation with Water Problems Institute Russian Academy of Sciences and Moscow State Lomonosov-University has carried out scientific investigations the influence of low and average hydrotechnic constructions of river (low-dammed, navigable channels and sluice with afflux 4-10 m) on floodplain ecosystems in connection with changes of floodplain reservations in Germany part of the Elbe river[1].

MATERIALS AND METHODS

The annual field researches were carried out since 1996 for 2001 on 6 permanent model profiles, length from 300 m to 1 km, which located in protected reserve areas in upper Elbe river with confluent Saale: "Aken"/275.0 Elbe-km, "Cossvig" / 238.45 Elbe - km, "Rosslau" / 257.25 Elbe-km, "Nienburger Wald" / 27.4 Saale - km, "Hohendorfer Busch" Calbe / 22.6 Saale - km, "Kleinrosenburg" / 3.9 Saale - km (Fig. 1).

To estimate influence SHC on ecosystems, work was carried out on two directions: 1) perennial changes of atmospheric precipitation and river flow in areas of works estimated, including features of flooding of floodplain at regulated and 2) were studied laws of transformation of environment in temporary at regulated: the basic tendencies of development of natural complexes were determined, communities - indicators and indicator change of their structure were established, evolution-dynamic series of natural complexes for various regimes of functioning floodplain (Henrichfreise, Kouzmina, 1998; Kouzmina, 2003; Kouzmina et all., 2000) were under construction.

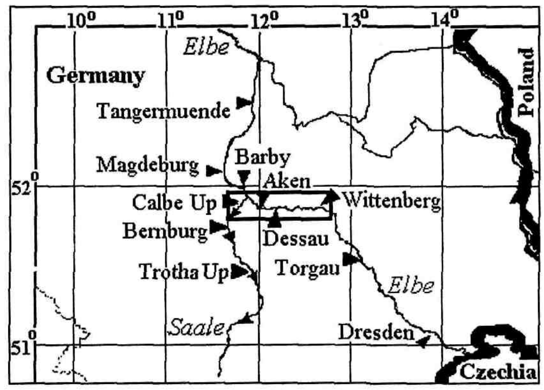


Fig. 1. Arrangement of hydrological posts in basin mean Elbe and area of field investigations.

During scientific and expert work we used methods of historical, ecological, geographical analogues, methods of geobotanical indication, ecological profiling, statistical processing etc.

The impact of hydrotechnical construction and regulated flows upon the landscape status of floodplains was studied by means of such methods, as comparative geobotanical landscape profiles, detailed description of key areas (soils, GW, vegetation), repeated examination of model profiles: boring up to GW, description of vegetation, soil sampling for chemical analyses (Zaidelman, 1987). To determine changes in alluvial soils, an original method was employed as based on estimating the moisture content soil level and intensity of its fluctuations in seasonal and long-term cycles taking into consideration morphological, physico-chemical and chemical properties of soils.

The "dominant" typology in studying dynamics of vegetation cover in floodplains has been used. In this work were analyzed more than 600 own geobotanical description, more than 50 own soil profiles and numerous boring till GW.

For revealing of multi-year dynamics of water content of the rivers we used data of stationary observation for level and charge of water of the rivers and channels officially published in hydrological year-books (Jahrbuch fuer, 1904, 1938; 1940, 1943; Gewaesserkundliches, 1940; 1951, 1963; 1964, 1992; Deutsches, 1990, 1997) and also hydrological data given to us by Federal Administration for Water and Ship-management of Germany and German Federal Institute of Hydrology.

[1] Field research was supported and fundings by Federal Agency for Nature Protection of Germany (BfN, Bonn). In field works in Germany Dr. Henrichfreise - staff BfN and Dr. S.Avetjan - scientist of soil faculty of the Moscow State University under Lomonosov were participated.

Different communities of organisms have, as a rule, different tolerance to deterioration of inhabitant conditions while the separate biological organism has significant plasticity to extreme hydroclimatic meanings, which has been worked out during evolution. It happened because the conducting role in ecosystems life is played by limiting allowable maximal and minimal meanings of the basic limiting environmental factors.

For evaluation of the state and dynamics of floodplain ecosystems we analyzed only annual average, monthly average and multi-years monthly average meanings of the discharges and levels of water, also absolute annual and monthly maximal and minimal meanings. Long-term annual and seasonal dynamics of atmospheric precipitation on these hydrological posts was analyzed besides.

The influence of low-dammed construction was estimated by comparison of landscapes state and ecosystems in sites, similar in physical-geographical conditions for regulated and natural river parts.

The study were carried out in different periods of river water content: in drought period, in catastrophic summer flooding, under average multi-years of water level, high and low average multi-years of water level in river.

CHANGE OF A RIVER FLOW AND CLIMATE

The objective of studies was to identify trends in the dynamics of water flow and level as a factor responsible for flood plain ecosystems in the middle Elbe river basin. A comprehensive analysis made it possible to study the data on annual maximum, minimum and mean water flow and level, obtained for a long period of time in 8 discharge sites (Fig.1), including Barby, Aken, Wittenberg, Torgau, Dresden, Kalbe-Grisene, Bernburg and Halle-Trota.

The data on long-term and seasonal dynamics of air temperature were taken only for the northwestern (Magdeburg) and southeastern (Dresden) parts of the region under study.

It is worthy of note, that in this region there exists a significant stable tendency towards increasing the minimum water flow (Table 1, r_{min} = +0.26 - +0.41 with б = 0.1 – 0.001) as associated with seasonal redistribution of atmospheric precipitation (Kuzmina, Treshkin, 2002). It is especially increased in the winter period (r= +0.3 - +0.44 with б = 0.1-0.01, Table 1, Fig.2). One should be emphasized, that in the last tens years the water flow in the drought period and particularly in winter has been increased to a considerable extent in the major territory of Russia (Shiklomanov, Georgievskiy, 2003). This is explained by climate warming especially in the winter period.

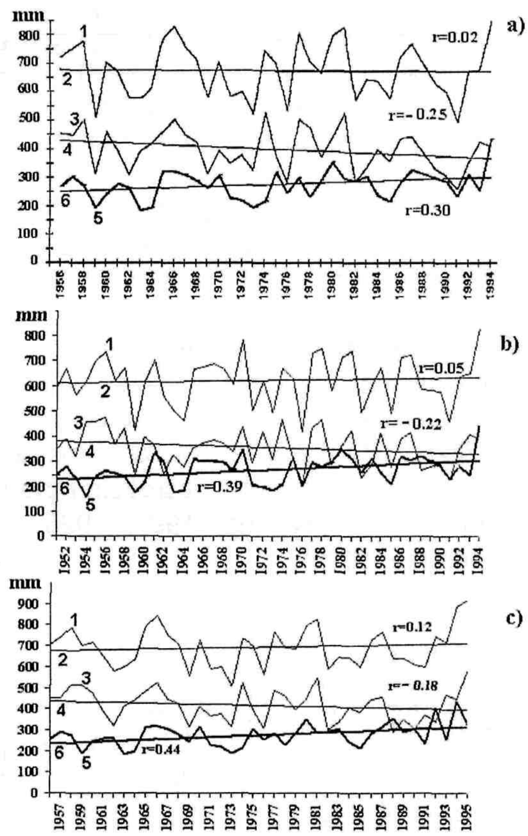


Fig 2. The multi-years dynamics and seasonal change of atmospheric precipitation in the middle Elbe river basin: a) Aken/Elbe (Kouzmina and Treshkin 2002), b) Dresdem/Elbe, c) Calbe-Grizehne/Saale.

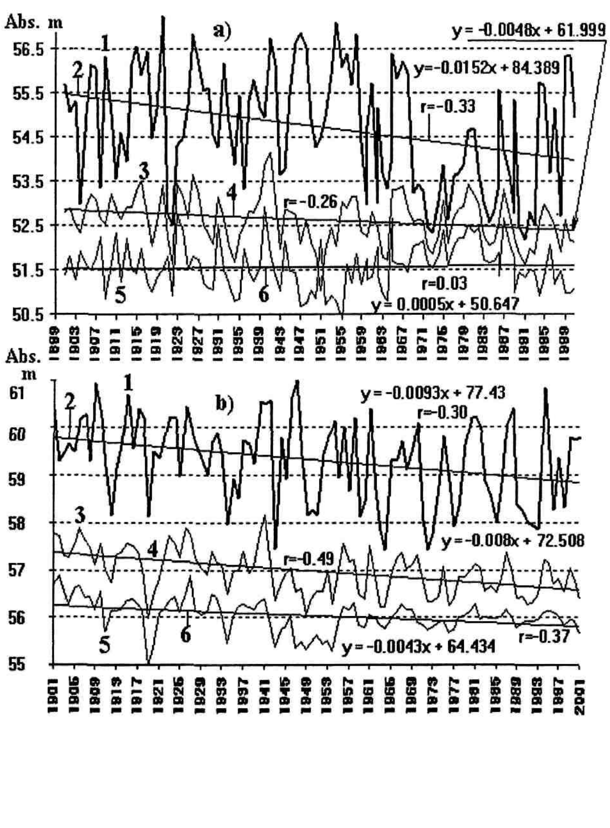
The sum of atmospheric precipitation: 1 - annual total precipitation, 3 - precipitation of the summer season, 5 - precipitation of the winter season, 2 and 4 and 6 - linear trends correspond curve with their coefficients of correlation. However, in contrast to the upper Danube (Bavaria) and Seim river (Central Russia), where the water flow was undoubtedly increased in the drought period (Kouzmina,

Table 1. The analysis of trends of the long-term changes of annual values of the flow, water levels and atmospheric precipitation in basin of the river Elbe.

River	Sites		Folw, m³/s				Water level, m				Precipitations, mm					Descriptions
		Value	Period	Years	Trend	r	Period	Years	Trend	r	Value	Period	Years	Trend	r	Availability SD
Elbe	Barby	Max.	1900-2001	102	-	0.11	1901-2001	101	-	**0.31**	Year	1956-1994	39	+ (0)	0.01	Is not present
		Aver.	1900-2001	102	+ (0)	0.01	1901-2001	101	-	**0.50**	Summer	1956-1994	39	-	0.24	
		Min.	1900-2001	102	+	**0.26**	1901-2001	101	-	**0.58**	Winter	1956-1994	39	+	**0.30**	
Elbe	Aken	Max.	1936-2001	66	-	0.14	1899-2001	103	-	**0.33**	Year	1956-1994	39	+ (0)	0.02	Is not present
		Aver.	1936-2001	66	- (0)	0.05	1899-2001	103	-	**0.26**	Summer	1956-1994	39	-	0.25	
		Min.	1936-2001	66	+	0.10	1899-2001	103	+ (0)	0.03	Winter	1956-1994	39	+	**0.30**	
Elbe	Torgau	Max.	1936-2001	66	-	**0.23**	1901-2001	101	-	**0.28**	Year	1956-1997	31	+	0.17	Is not present
		Aver.	1936-2001	66	- (0)	0.09	1901-2001	101	-	**0.58**	Summer	1956-1997	31	-	**0.35**	
		Min.	1936-2001	66	+	**0.20**	1901-2001	101	-	**0.58**	Winter	1956-1997	31	+	0.16	
Elbe	Dres-den	Max.	1852-2001	150	-	**0.27**	1852-2001	150	-	**0.24**	Year	1956-1995	40	+	0.12	· Is not present
		Aver.	1852-2001	150	+	0.11	1852-2001	150	-	**0.43**	Summer	1956-1995	40	-	0.18	
		Min.	1852-2001	150	+	**0.40**	1852-2001	150	-	**0.58**	Winter	1956-1995	40	+	**0.44**	
Saale	Calbe Up	Max.	1932-2001	70	+ (0)	0.07	1901-2001	101	- (0)	0.09	Year	1951-1994	44	+ (0)	0.05	Dam is higher than a post in 0.5 km. The flow is changed by dam.
		Aver.	1932-2001	70	+	0.15	1901-2001	101	- (0)	0.08	Summer	1951-1994	44	-	0.22	
		Min.	1932-2001	70	+	**0.41**	1901-2001	101	+ (0)	0.08	Winter	1951-1994	44	+	**0.39**	

r – hereinafter correlation coefficient of linear trend from curve long-term levels, flow or precipitation.
* - the bold font for tables1 gives coefficients of correlation with a significance (α) from 0.1 up to 0.001.

2003), in the middle Elbe river basin the water level exhibits a tendency towards its constant decrease (Table 1, r= –0.24 –0.58 with б = 0.01-0.001). The water level is decreased here (Fig. 3) in dependence on decreasing the base level of erosion (Jahrling, 1994; 1995; 1996; Henrichfreise, 1996).



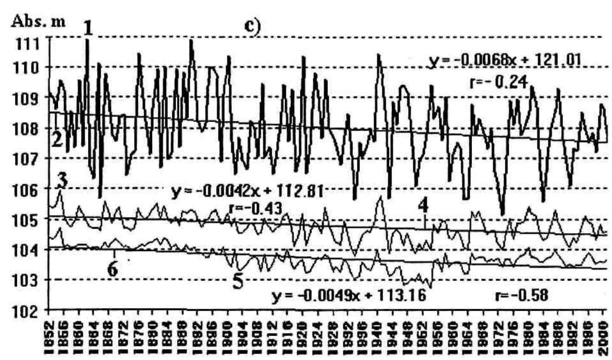


Fig. 3. Multi-years dynamics of the water levels in the middle Elbe river basin: a) hydropost Aken/Elbe (1899-2001), b) hydropost Bernburg/Saale (1901-2001), c) hydropost Dresden/Elbe (1852-2001). Values of the water levels: 1 - absolute maximum, 3 - average, 5 - absolute minimum; 2 and 4 and 6 - linear trends correspond curve with their coefficients of correlation.

It was testified by our field observations for distribution of groundwater level, soils and vegetation within the area of "Middle Elbe" reservation.

Special methods were employed to determine the impact, exerted by changes in the water regime such as the plant indicators and key areas, indication of soil destroying by morphological features of oxidation-reduction reactions in soils (Henrichfreise, Kuzmina , 1998).

The human-induced effects are most likely the main reasons of decreasing the water level in the region under study: dredging and strengthening the banks both in the Elbe river and in its tributaries; a number of dammed tributaries with completely regulated flow; the great amounts of water are taken to meet economic and domestic requirements (Jahrling, 1994, 1995, 1996).

Being exemplified by two 35-years periods for Aken discharge site (1896-1930 and 1967-2001), composed of similar years with much and little water, the absolute maximum and mean maximum water levels underwent the greatest changes in the 20th century. The decrease in mean floods was estimated to 1.8 m and absolute maximum floods were decreased by 0.89 m (Fig.4).

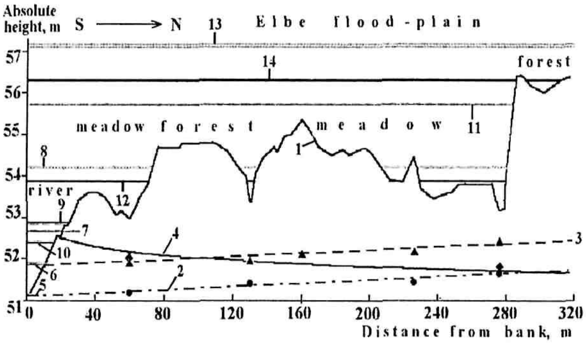


Fig. 4. Fluctuation of ground waters (GW) and water level (WL) for long-term periods on a model ecological profile in flood-plain of the natural river Elbe, in "Mittlere Elbe" national park (hydrometric station Aken/Elbe 275 km – natural flow).

In numbers is designated: 1 – relief (total levelling), 2-8 GW (measured and trend) and WL (measured) during researches, 2 - GW on drougth period (20.05.1998), 3 - GW on summer period 18.05.1999 (near average WL), 4 – GW in an initial phase of a flood water period (25.07.2001), 5 - WL on drougth period (20.05.1998) – 51.14 m, 6 - - WL 18.05.1999 – 51.91 m (near average WL), 7 - WL 25.07.2001 – 52.68 m (initial phase of a flood water period), 8 - maximal flood WL 1998 (high water), 9 – 10 - average WL 1896-1930 (52.87 m) and 1967-2001 (25.39 m), 11 – 12 - average flood WL 1896-1930 (55.79 m) and 1967-2001 (53.9 m), 13 – 14 - maximal flood WL (rare highest water) 1896-1930 (57.24 m) and 1967-2001 (56.35 m). According to the data of "Aken" discharge site, from the beginning of the 20th century the mean annual water levels have being declined by 0.48 m, but the mean and absolute minimum water levels even increased by 0.38 and 0.08 m respectively. As a result, the flood plain ecosystems in "Aken" profile revealed changes in hydromorphic conditions, being partially waterlogged in lower parts and dried in middle and upper parts of the floodplain.

Apart from the above trends, in the long-term dynamics there is a tendency towards decreasing the values of maximum water flow and level in the middle Elbe river basin (Table 1). The decline of maximum floods (6 = 0.1 – 0.001) is reflected in decreasing the maximum water level to a more considerable extent than the maximum water flow (Fig. 3, 5).

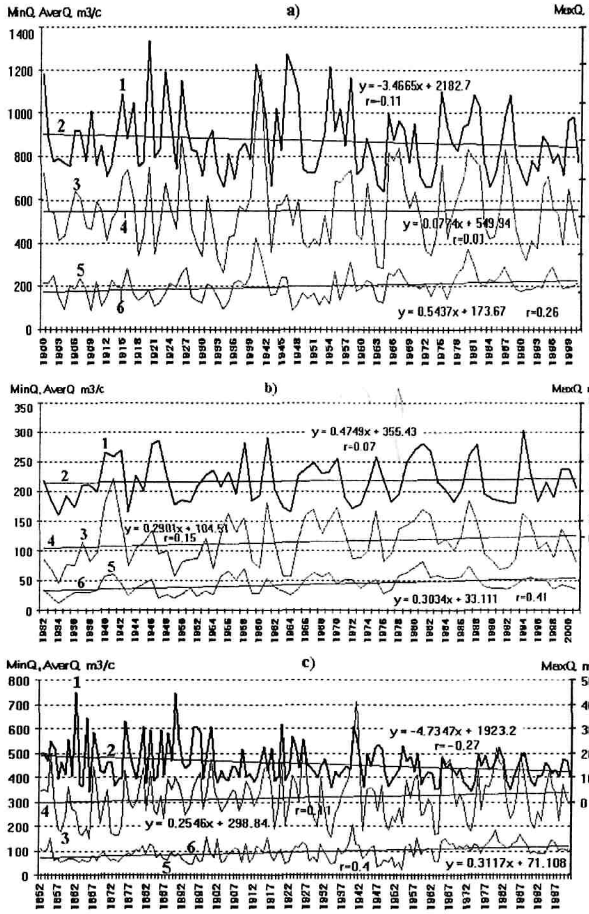


Fig. 5. Multi-years dynamics of the flows in the middle Elbe river basin: a) hydropost Barby/Elbe (1900-2001), b) hydropost Calbe-Grizehne/Saale (1932-2001), c) hydropost Dresden/Elbe (1852-2001).

Values of the flows: 1 - absolute maximum, 3 - average, 5 - absolute minimum; 2 and 4 and 6 - linear trends correspond curve with their coefficients of correlation.

Due to decreasing the absolute maximum water flow (in flooding) and increasing absolute minimum water flow (in the drought period) in the Elbe river and its tributary Saale the fluctuation amplitude of annual water flows became decreased as well (Table 1).

Thus, in the long-term dynamics of precipitation, water flow and water level the trends should be identified, which are as follows:

- significant seasonal redistribution of precipitation towards their increasing in the winter period on the background of insignificant increasing their annual amount;
- significant stable tendency of increasing the minimum water flow;
- significant decreasing the maximum water flow and level in the long-term dynamics;
- decreasing the fluctuation amplitude of annual water flows for the last 70-150 years;
- significant decreasing the maximum, minimum and mean water levels.

Let's consider the long-term and seasonal dynamics of air temperatur[2]e in the middle Elbe river basin (Table 2; Figs. 6, 7, 8). As seen from Fig. 6a, in Magdeburg (from 1947 to 2003) one can observe a considerable increase in the mean annual temperature with a rather high correlation coefficient (r= +0.30) of linear trend by 95% (б = 0.05). In Dresden (from 1967 to 2003) such trend has a higher correlation coefficient (r= +0.33) by the same significance (Fig. 6b). In Magdeburg the mean annual temperature becomes higher at the expense of its increasing in the winter period (Table 2, r=+0.23, б=0.1), on the contrary, in Dresden it is usually increased in the summer from April to September (Table 2, r=+0.40, б = 0.05). Besides, the fluctuation amplitude of absolute minimum temperatures gets significantly declined in Magdeburg (r=-0.22 in summer and r=+0.24 in winter with б=0.10, Table 2, Fig. 8a). The frosts become weakened in the cold winter period but late frosts can occur in the summer.

[2] **The multi-years dynamics of air temperature and its seasonal distribution for Magdeburg and Dresden has been studied by using the data, taken in WMO.**

Thus, the following trends in distribution of mean annual and seasonal temperatures may be identified in Magdeburg and Dresden:

- a significant increase in mean annual temperature at the expense of its increasing in one of the seasons: in Magdeburg in the winter and in Dresden in the summer;
- a significant increase in mean annual temperature in the summer with vegetation period from April to September in Dresden (r= +0.40, б = 0.05) and their insignificant increase in Magdeburg (r= +0.13).
- a significant decrease in the fluctuation amplitude of absolute minimum temperature in Magdeburg, where the frosts are weakened in the winter, but late frosts can occur in the summer.

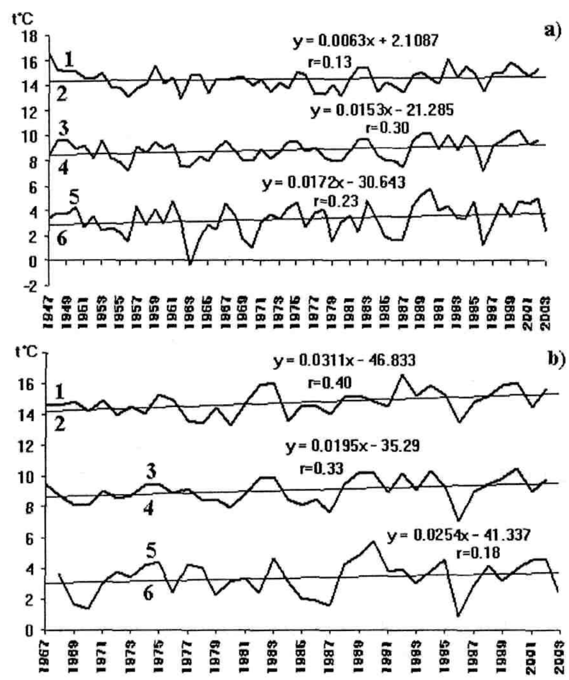


Fig. 6. Multi-years dynamics of the average annual (1), average summer (3) and average winter (5) values of temperature of an air for Magdeburg (a) since 1947 for 2003 and Dresden (b) since 1967 for 2003. 1, 3, 5 - fact data of mean temperatures of an air, 2 and 4 and 6 - linear trends correspond curve with their coefficients of correlation.

The above conclusions relating to the long-term dynamics of the temperature regime should be only conditionally distributed for the whole middle Elbe river basin, because the air temperature in such cities as Magdeburg and

Table 2. The analysis of trends of the long-term changes of annual values of the atmospheric precipitation and temperature of an air in basin of the river Elbe.

Sites	Value	Period	Precipitations, mm				Period	Aver. t°C of an air				Min. t°C of an air				Max. t°C of an air			
			Years	Trend	r	α		Years	Trend	r	α	Years	Trend	r	α	Years	Trend	r	α
Magdeburg	Year	1947-2003	56	+ (0)	0.03	H	1947-2003	56	+	**0.30**	0.05								
	Summer	1947-2003	56	+ (0)	0.08	H	1947-2003	56	+(0)	0.13	H	57	-	**0.22**	0.10	57	+	0.16	H
	Winter	1947-2003	57	+ (0)	0.08	H	1947-2003	56	+	**0.23**	0.10	57	+	**0.24**	0.10	57	+	0.08	H
Dresden	Year	1956-1995	40	+ (0)	0.12	H	1967-2003	36	+	**0.33**	0.05								
	Summer	1956-1995	40	+	0.18	H	1967-2003	36	+	**0.40**	0.05	37	+(0)	0.03	H	37	+	0.20	H
	Winter	1956-1995	40	+	**0.40**	0.01	1967-2003	37	+	0.18	H	37	-(0)	0.10	H	37	+(0)	0.05	H

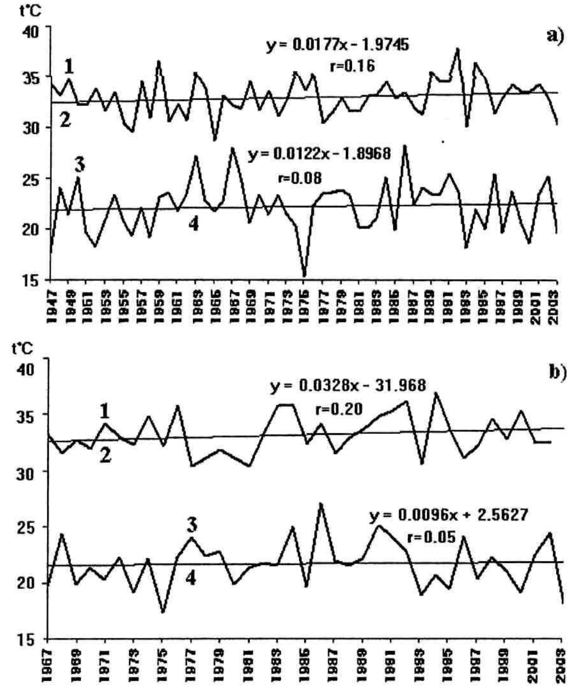


Fig. 7. Multi-years dynamics of the absolute maximum summer (1) and absolute maximum winter (3) values of temperature of an air for Magdeburg (a) since 1947 for 2003 and Dresden (b) since 1967 for 2003. 1 and 3 - fact data of absolute maximum temperatures of an air, 2 and 4 - linear trends correspond curve with their coefficients of correlation.

Dresden is highly dependent on intensive industrial and social activities of urban population in infrastructure. At the same time, the tendencies revealed for long-term dynamics of precipitations, flow and water levels in region of researches it is authentically possible to distribute to all basin of the middle Elba.

INFLUENCE ON FLOOD-PLAIN ECOSYSTEMS

It is evident, that the flooding frequency on various flood plain terraces is quite different. Our observations showed, that the degradation is the most significant on middle and upper flood plain terraces, covered by willow and oak-ash trees. In view of this, we decided to evaluate changes in flooding frequency of the upper Elbe flood plain. The topographic maps for every profile helped determining absolute altitudes of the upper river terraces (Table 3). The key areas on upper terraces of the Elbe river were elelevated by 3.5 m above the mean annual water level in the river and by 5.2 m above the water level in the drought period (Fig.4). According to hydrological data the years were defined, when the upper flood plain terraces, covered by oak-ash forests, have been intensively flooded. The investigation results let us identify some changes in flooding frequency of upper flood plain terraces, which can be considered as a serious cause for ever increasing degradation of the most valuable broad-leaved forests. It was also established, that the upper floodplain is characterized by sharply expressed periodical flooding (Kouzmina, 2003).

So, since 1856 there were constantly changing 15-years periods of maximum (from 6 to 9 years) and minimum (from 1 to 5 years) floods on the upper terraces of the Elbe river (Table 3). In the areas, where the tree stands suffered from degradation (Grisene, Barby, Aken), the flooding frequency was changed, being minimum within three 15-years periods (0-3 years) since 1960, including 2002 as a year of disastrous flooding. Such changes should be explained as affected by human activities, for instance, the construction of local reservoirs, filled with river water, or an artificial rise of the water level in tributaries of the Elbe river basin. Due to decreasing the floods frequency on upper flood plain terraces combined with decreasing the base level of erosion (Barby, Aken) and precipitation amount in the summer, the groundwater depth becomes lower during the vegetation period and has an adverse effect on the oak-ash trees in the reserved areas.

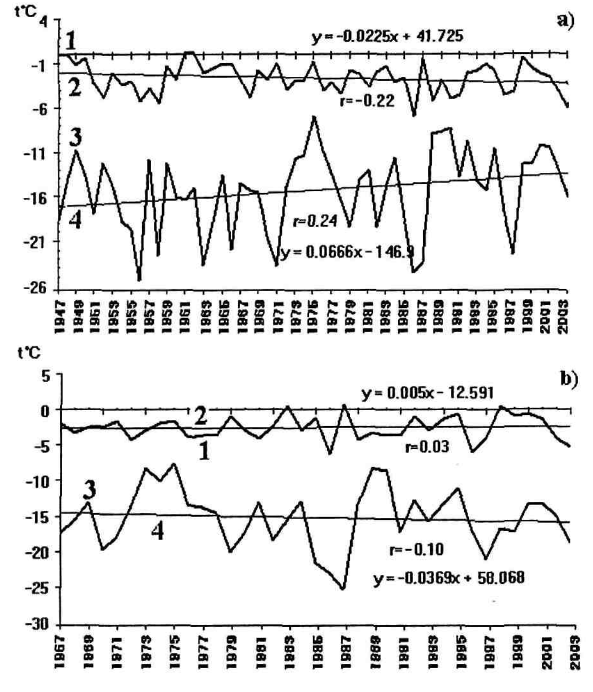


Fig. 8. Multi-years dynamics of the absolute minimum summer (1) and absolute minimum winter (3) values of temperature of an air for Magdeburg (a) since 1947 for 2003 and Dresden (b) since 1967 for 2003. 1 and 3 - fact data of absolute minimum temperatures of an air, 2 and 4 - linear trends correspond curve with their coefficients of correlation.

Because of summer floods so typical for the Elbe river basin, the water supply of plant communities is declined to a considerable extent. However, as it was indicated above, in the last years the *redistribution of precipitation* towards increasing in the winter period is observed in the Elbe river basin; due to this fact the long-term mean temperature gets higher to weaken the frost in winter. As a result, reducible gley horizons are formed within the soil layer of 1 m. in depth and remain in soil during the vegetation period. Such horizons are toxic for wood-shrubby communities and serve a cause of their degradation (Zaidelman, 1987, Henrichfreise, Kouzmina, 1998; Kouzmina, 2003).

Hence, it should be emphasized that, different trends in changing the plant communities are characteristic of different flood plain terraces of the Elbe river basin. Due to decrease in the base level of erosion and the groundwater depth the plant communities of Salix alba are highly degraded on the middle flood plain terrace. But the changes in flooding regime of the upper terraces (Aken, Barby, Table 3) as well as in seasonal distribution of precipitation (Table 1) and air temperature lead to drying the valuable oak forests composed of Quercus robur, which are extremely rare in flood plains of Europe.

On higher elements (56.6-57.0 abs.h.m, Fig.9) of the floodplain in the regulated part of the river Saale (on previous middle floodplain, on upper floodplain, on riparian levees) we noticed everywhere very intensive introduction of hydromorphous weed plant species: *Polygonum amphibium, Ranunculus repens, Girsium arvense, Thalictrum spp., Rumex spp., Alopecurus pratensis, Filipendula ulmaria, Glyceria maxima, Molinia caerulea*. The biodiversity on typical and dry meadows is reduced. The clay horizons are forming in the top parts of soil profiles (10-90 cm) and they move upwards along profile. It is feasible to observe an essential expansion of *Phragmites australis* from lower (and flooded now) relief elements into meadows of former middle and upper floodplains.

In conditions of increase GWT and their more stable change during of year Hydromorphic and Weed plant species become indicators of antropogeneous change under influence of low-dammed construction.

By our researches is determined that for *the rivers, regulated cascades of dams*, because of increase of average level of water and redistribution of annual flow, is established equal position GWT under forest and meadow, fluctuations GWT on seasons are considerably reduced, and frequently do not exceed voltage

Table 3. Reduction of flooding frequency of upper-level floodplain from a middle of the 70-th years in basin of the river Elbe.

Years		Quantity of years of flooding of upper level floodplain and tendency				The natural tendency of flooding of upper level floodplain	Quantity of years of flooding of upper level floodplain and tendency			The changed tendency of flooding of upper level floodplain
River	Period,	Elbe			Saale		Saale	Elbe		
Station	Years	Dresden	Torgau	Wittenberg	Bernburg		Grizehne	Barby	Aken	
NN+m		108.5	81.5	68	62.0		56.2	52.5	56.0	
1856 - 1870	15	8 +				+				
1871 - 1884	15	5 -				-				
1885 - 1899	15	9 +				+				
1900 - 1914	15	1 -	4 -	1 -	4 -	-	1 -	1 -	4 -	-
1915 - 1929	15	6 +	8 +	6 +	6 +	+	3 +	4 +	6 +	+
1930 - 1944	15	2 -	5 -	4 -	3 -	-	3 +	2 -	3 -	-
1945 - 1959	15	6 +	8 +	6 +	5 +	+	2 -	5 +	8 +	+
1960 - 1974	15	2 -	2 -	3 -	2 -	-	1 -	0 -	3 -	-
1975 - 1988	15	6 +	7 +	8 +	5 +	+	2 -	0 -	0 -	- !!!
1989 - 2003	15	4 -	3 -	3 -	2 -	-	2 -	1 -	3 -	- !!!

in 1-1.5 m (Fig. 9) while up to regulated they compounded from 4.5 up to 6.5 m (Fig. 4). There is deterioration of a condition of populations of floodplain oak - groves of the upper flood-plain terraces and their full death; the most valuable, typical and most diversity elm-oak forests systematically disappearing on the European plain because of originating a toxic gley in upper (less than 1-1.5 m) horizons of soils and reductions of voltage fluctuation

The human-induced regulating the river flows reveals great changes in functional relationship between relief elements, the water level in river and groundwater table in GWT (Kouzmina et. all, 2000; Kouzmina, Treshkin, 2002).

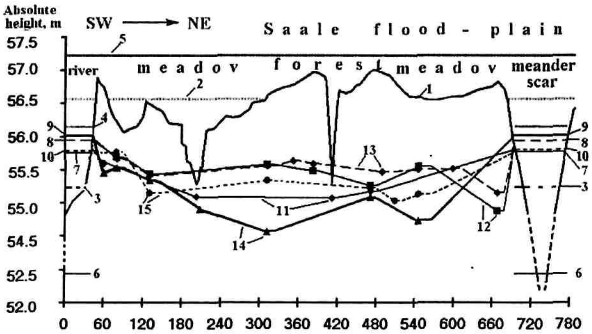


Fig.9. Fluctuation of ground waters (GW) and water level (WL) in flood-plain of the regulated river Saale, in "Hohendorfer Busch" national park (hydrometric station Calbe-Grizehne/Saale – regulated flow).

In numbers is designated: 1 – relief (total levelling), 2 – maximal flood WL 1896-1930 (rare highest water), 3 – average flood WL 1896-1930 (ofter high water), 4 - maximal flood WL 1997 (high water), 5 - maximal flood WL 1999 (high water), 6 - average WL 1896-1930, 7-15 WL (measured) and GW (measured and trend) during researches, 7 – low WL 12.09.1997 (drougth period), 8 – summer WL 16.05.1999 (near average WL 1991-1999), 9 – summer WL 22.08.2000 (near average WL 1991-1999), 10 – low WL 31.07.2001 (drougth period), 11 – GW on drougth period 12.09.1997, 12 - GW on summer period 15.05.1998 (WL near average 1991-1999), 13 - GW on summer period 16.05.1999 (WL near average 1991-1999), 14 - GW on summer period 22.08.2000 (WL near average 1991-1999), 15 - GW on drougth period 31.07.2001. floodplain. The former high relief elements (3d floodplain terrace) are subjected to underflood being transformed into lower floodplain levels. The soils and vegetation start changing towards the higher hydromorphism.

The successional process is quite different in floodplain ecosystems depending on intense anthropogenic effects, time and the regulating extent of the river flow.

- In case of anthropogenic raising the water level in river and GWL in floodplain (over 1.5 m in low-water period) in the absence of annual floods the mire communities, which are not typical for floodplains and ecosystems are formed: *Querco-Ulmetum → Alnetum glutinosae → Sparganietum erecti → Typhetum angustifoliae*.

- In case of the presence of continuous floods depending on head of water (2-2.5 m) natural floodplain levels display a dynamic change downwards: *Querco-Ulmetum → Salicetum albae → Phalaridetum arundinaceae → Phragmitetum australiae → Bolboschoenetum maritimae*; moreover, the whole complex of floodplain ecosystems can be restored owing to new more elevated territories, that haven't been included into the foodplain, if any territories are available.

CONCLUSIONS

1. Regulated of SHC lead to stabilization of humidifying regime and to change of fluctuations GWL in floodplain that produces change of all components of ecosystems, change of soil and vegetative covers.

2. In the XX century there is a tendency in redistribution of precipitation towards their increasing in the winter period and decreasing in the summer to be an evidence of changes, taken place in soil-ground conditions within the floodplain of the middle Elbe river.

3. At the end of the XX century a trend of decreasing the fluctuation amplitude of water flow and level is observed in the middle Elbe river basin. This is a serious cause for increasing the groundwater depth in the vegetation period, for the gley formation in upper and middle soil horizons and hence for injuring the natural wood-shrubby vegetation in the river floodplain.

4. The values of mean and maximum water flow and water level underwent the greatest changes, being highly decreased for a long period of time.

5. The clearly expressed constantly changing 15-years summer periods are identified to show the maximum and minimum flooding frequency of the upper flood plain terraces in the middle Elbe river basin. From the end of 70s in 20th century the periodically changing frequency of floods has being destroyed and leads to degradation of forest communities on the upper flood plain terraces.

6. Carried out field and office studies have allowed to develop estimation procedure of consequence change of river flow regime for floodplain ecosystems, consisting from the solution of problems blocks:

- First of all it is the analysis of changes of water regime for all period of tools observation (fluctuation in time annual-average, -maximal and -minimum water levels and water discharges) and revealing of directed authentically significant trends (or their absence);
- Revealing of similar and seasonal changes of atmospheric precipitation for surveyed regions with definition of authentically significant trends (or their absence);
- Comparison of characteristics of water regime for regulated and natural (is "conditional" natural) flow and their parts;
- Revealing of flooding frequency of floodplain and breaking of these rhythms (repeatability of floodings for biotopes of various ecological levels);
- Revealing of crisis values of fluctuation amplitude of GWT, on the basis of comparison those for natural and disturbed communities;
- Revealing of transgression in distribution of gley horizons and character ferruginization in soil profile (on the basis of a procedure of indication of soil transgression on morphological criterions of redox reactions proceeding);
- Construction of evolutionary-dynamic series of natural complexes for various regimes functioning of floodplains;
- Revealing of plant-indicators and indicator role of structure communities at various changes of water regime.

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