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Arkadiusz RYBAK

CHARACTERIZATION OF NATURAL-HYDROLOGICAL CONDITIONS WITHIN THE VISTULA DELTA /ZULAWY REGION/

1. General features of the Zulawy region

The region of the Vistula delta, known as Zulawy, is located within the Gdansk Coastal area and borders with the Kaszubian Lakeland to the west, the Kociewie and Ilawa lakelands to the South, the edge of the Elblag Heights to the East, and is separated from Gdansk Bay by the sandy Vistula bar. As a physiographic unit, Zulawy is the delta of Vistula, Nogat, and Szkarpawa, a holocene lowland plain created by river sedimentation over a period of several thousand years. It is shaped as an irregular triangle 50 kms long with a maximum width of 60 kms. The course of sedimentation in the Vistula valley is shown in Fig. 1. The area of the Vistula valley encompasses also the Walichowo and Kwidzyn valleys.

From the point of view of geological structure, the Zulawy region is located in the South-Western part of the Peribaltic Lowland. Erosion, exertion, and tectonic processes taking place in the cenozoic era have so strongly deformed the surface of challe rocks that this region is geologically distinct from the neighbouring uplands, and therefore it is also geomorphologically different from them.

Zulawy is an almost flat plain made of alluvial material. Depression areas account for some

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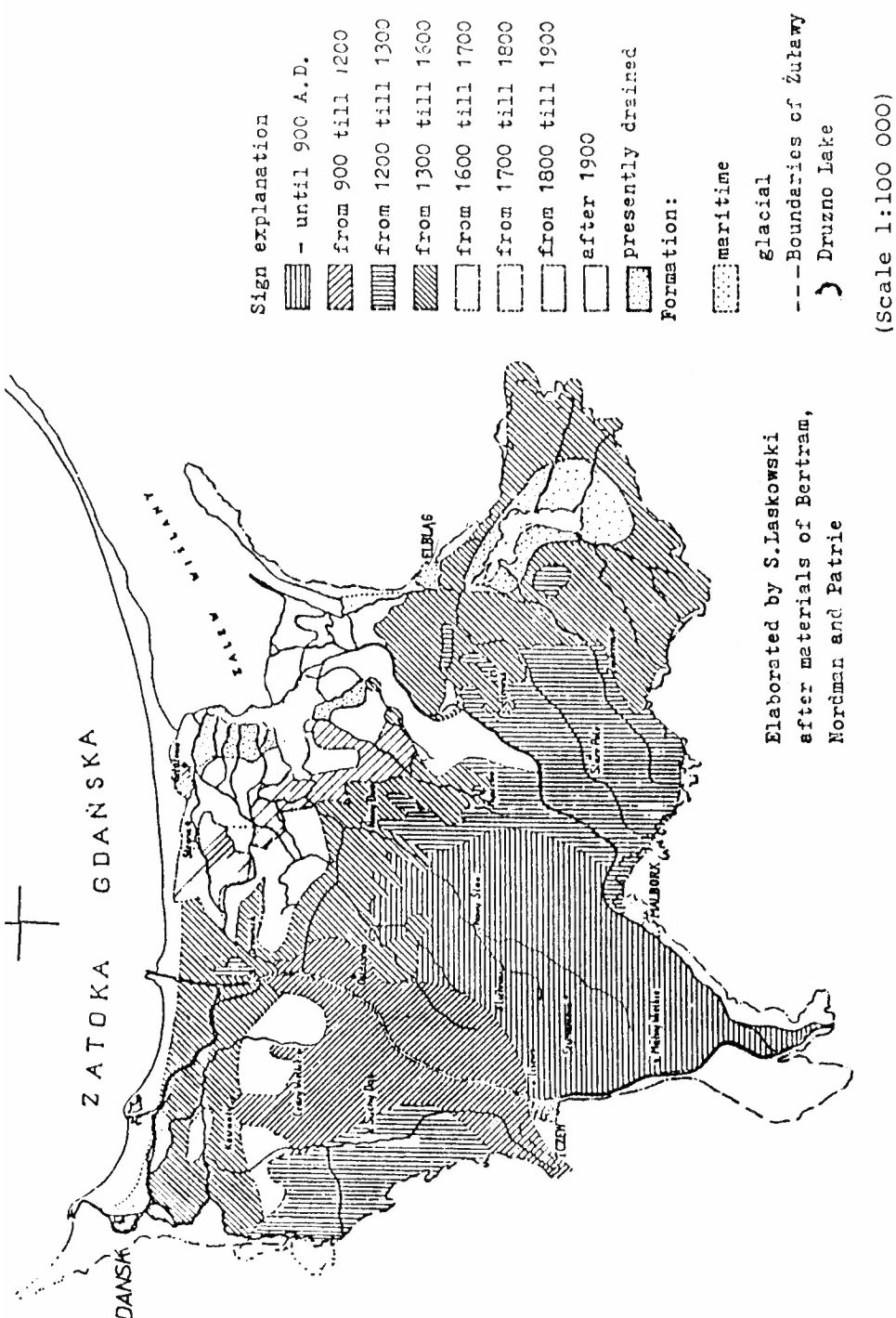

FIGURE 1 Temporal course of creation of the Vistula delta

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28 % of the delta's surface. The greatest singular depression area can be found near Druzno Lake; its surface is 181 sq. kms. Within this area, the lowest point, at - 1.8 m, is located in Karczowiska Dolne.

The region is divided by the Vistula and Nogat into three main parts: Gdansk Zulawy; Great Malbork Zulawy; and Elblag Zulawy /Fig. 2/. Each of these parts has its separate hydrographic system. Gdansk Zulawy is located in the basin of the Martwa /Dead/ Vistula; Great Malbork Zulawy in the basin of the Szkarpawa and of some smaller rivers; and Elblag Zulawy in the basins of the Nogat and Elblag rivers. Some authors also distinguish smaller units, such as Steblewo, Stegna, and Szkarpawa or Fiszewo Zulawy.

Climatically, Zulawy lies within the reach of the Baltic climates. In some publications, though, this region is treated as a separate climatic area because of the specific local climate, shaped to a large extent by the energy exchange processes occurring between the atmosphere and the surface. Specific physiographic conditions of the Vistula delta formed by such factors as proximity to the sea, flat land, water conditions, fertile Zulawy silts, and sea climate find their reflection in the special character of vegetation and land use. Zulawy is an agricultural region par excellence, with a great productive potential being especially significant on the national scale. Subregions and microregions distinguished within the area considered are shown in Fig. 3.

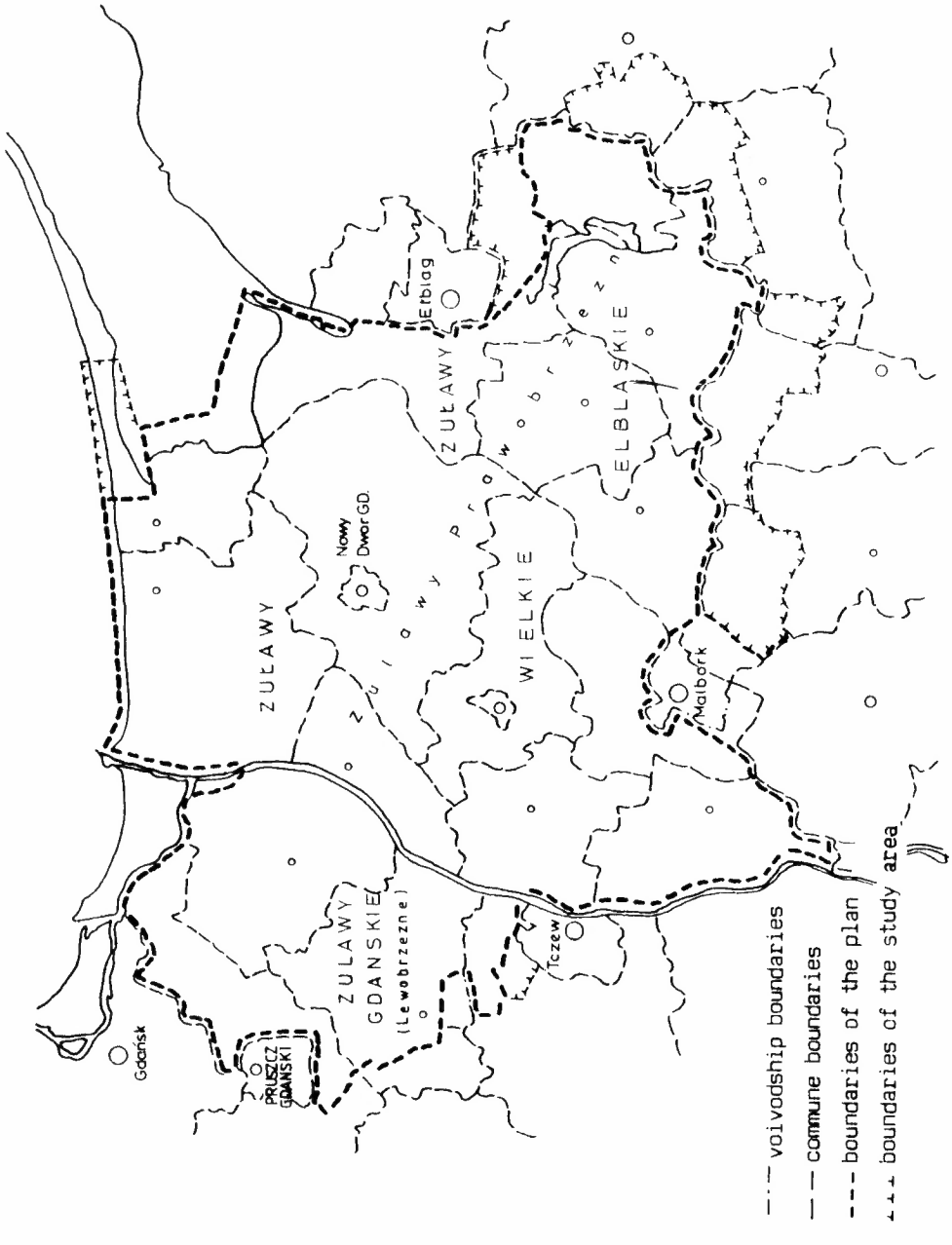

FIGURE 2 Administrative partition of the Zulawy area

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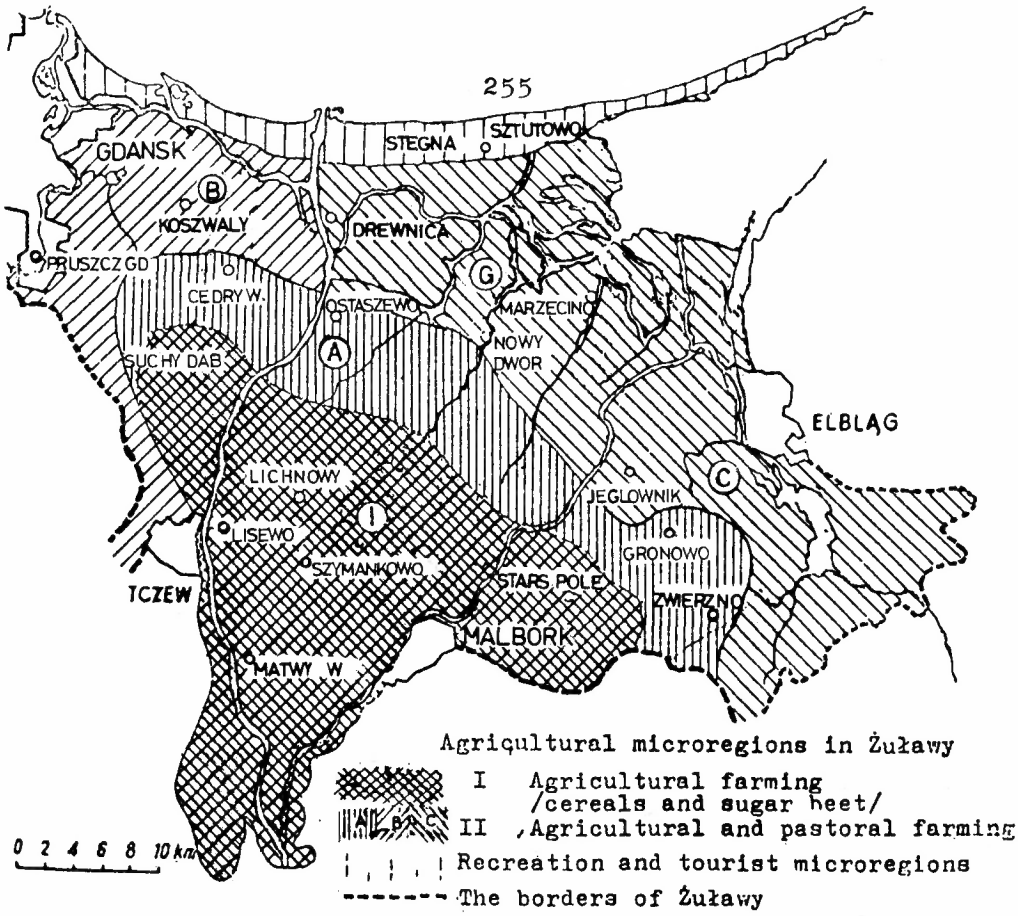

FIGURE 3 Agroecological regionalization (according to the "Programme of economic development and principles of further management of the Żuławy Gdánskie region")

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2. Characteristics of the agricultural production space of Zulawy

Zulawy of the Vistula delta is a region with specific natural and technical conditions and a complicated water and drainage system. The surface breakdown in terms of agricultural use is as follows:

Zulawy, total surface	In agricultural use	Ploughland	Permanent grasslands
2119.96 sq.kms	1552.88 sq. kms	1001.10 sq. kms	551.78 sq.kms

In spite of differentiation of the Zulawy soils with respect to origin, structure, and properties characteristic for alluvial soils /silts/, their vast majority offers high utility in agricultural production and that is why they are considered one of the best soils in Poland. According to T. Witek, the following soil types are distinguished within the Zulawy area:

Soil type		Surface share
1. Silts with weakly pronounced profile		1.22 %
2. Turfy-brown silts		63.60 %
3. Silt black earths /humus silts/		16.74 %
4. Hydrogenic silts, together		12.20 %
a. gley silts	1.40 %	
b. swamp silts	1.45 %	
c. marshy silts	9.35 %	
5. Other, i.e.		4.22 %
sea silts		
brown and podzolic soils from pleistocene material		
black earths developed from sands		

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podzolic soils
destroyed soils
6. Dune sands 2.02 %

Table 1 below presents the surface shares of various quality classes of soils within the Vistula delta Zulawy.
Wheat-proper, i.e., good soils, account for over 75 % of all ploughland, an index value that can be equalled by only very few regions in Poland, and which indicates a capacity of growing even very demanding crops. By comparison, the same value for the whole of Elblag voivodship is approximately 63 % and for the whole of the country approximately 26 %.

Table 2, on the other hand, presents the indices of agroecological conditions of the Zulawy communes, serving to assess the quality of agricultural production space as well as average soil quality index values. Since state farms took over somewhat better soils after World War II, the private farm averages are a bit below the overall averages shown is Table 2. It should be noted, though, that the utility of soils is not homogeneous over the whole area of Zulawy, hence the division into High Zulawy /South-Western part/ encompassing surfaces greater than 2.5 m above sea level and low Zulawy /North-East/, i.e., areas mainly below this elevation, called periodepressive and depressive.

The elevation structure of the Vistula Zulawy area is as follows:

Above sea level

10.0 m - 5.0 m	5.0 m - 2.5 m	2.5 m - 0.0
12.3 %	25.0 %	30.9 %

Below sea level

0.0 - -1.0 m	-1.0 m - -1.8 m
26,6 %	5.2 %

The spatial distribution of this elevation structure is presented in Fig. 4.

Properties of soils, which are fertile but difficult to cultivate, can be improved only through combined action of agrotechnology and land improvment /drainage and/or irrigation/ measures, as well as securing adequate equipment for cultivation. Results of analyses indicate that soils of Zulawy have unsatisfactory acidity. Some 24 % of the silts are quite or even very acidic, with the pH value below 5.5; approximately 49.7 % of them are slightly acidic, with pH values between 5.5 and 6.5; and finally 26.5 % of the silts are at least neutral, i.e., their pH is greater than 6.5.

Besides that, Zulawy silts are poor with respect to absorbable potassium. Soils that are satisfactory with that respect constitute some 16.5 % of the total surface, those with medium level of potassium 33.9 % of the surface, and those below the average 49.6 %. Thus, approximately 67 % of all soils require increased potassium fertilizer application.

On the other hand, availability of absorbable phosphorus is very high. Soils with good availability of phosphorus constitute some 53.7 %,

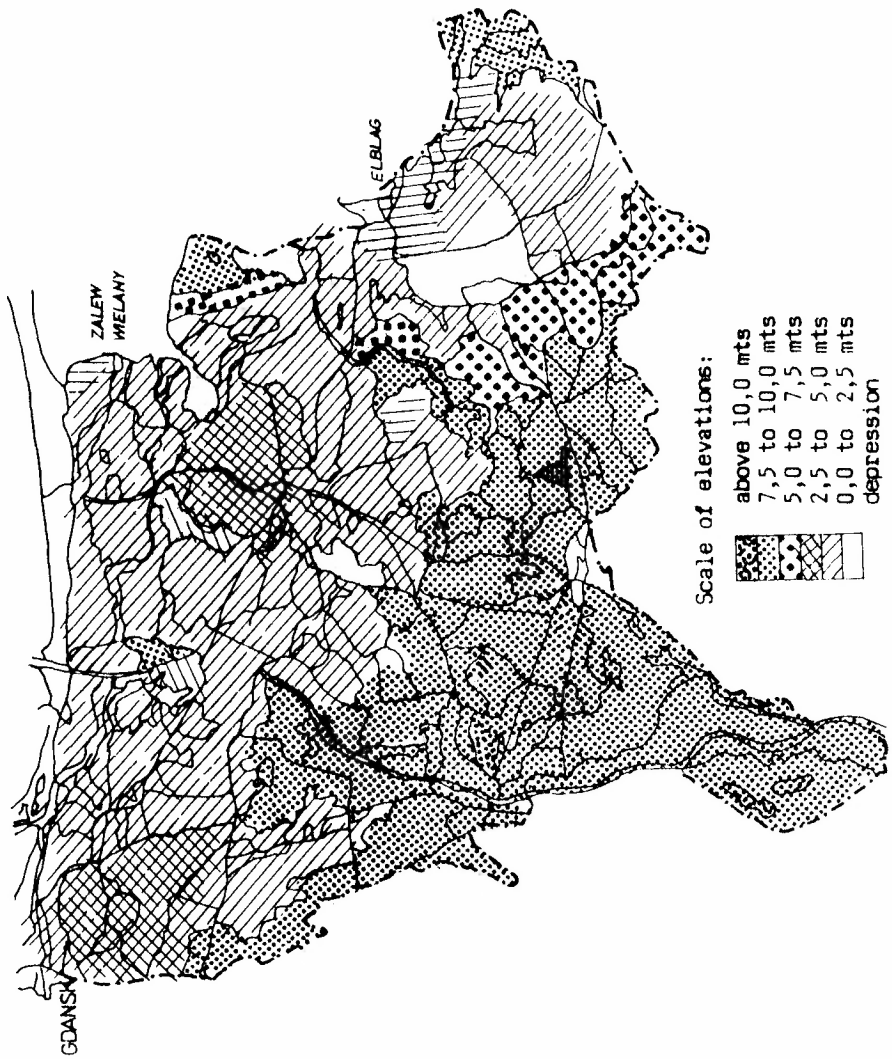

FIGURE 4 Hypsometry of the Vistula delta Zuławy

while those having medium levels of this element only 18.5 %.

Average fertilizer use has until now been 242 kg NPK per hectare and 210 kgs CaO per hectare. These values, though, are undoubtedly influenced greatly by the availability of various fertilizers. In order to improve the soil acidity index and potassium availability level and to attain the crop yields assumed, it is necessary to increase the supply volumes of lime, potassium, and nitrogen fertilizers.

3. Influence of natural environment on agricultural production

This rich productive environment requires a treatment different from that applied to other regions of the country since natural, technical, and social conditions existing within the territory considered dictate a particular economic model of activity. It should be emphasized that no region of Poland has similarly strong connections of producers, nature, and technique as found within the Zulawy area.

In general, the climate of the Southern and central parts of Zulawy is akin to that of the surrounding uplands. Coastal areas have typical sea-influenced climate, which extends from the coastline 15 kms into the mainland. Average precipitation sums from four meteorological stations for the period 1891-1930 along with those from five stations together with temperatures for the period 1954-1965 are shown in Table 3. These statistics, however, do not portray adaquately we and dry years, which are difficult periods for agriculture

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from the productive as well as organizational point of view.

On the basis of data gathered in the Stare Pole weather station over the 20 year period 1954-1973 concerning yearly and growing-season /April-October/ precipitation volumes, it has been established by this author, using criteria specially adopted, that only 5 years in this period could be called average, while there were 9 relatively wet and wet years, and 6 relatively dry and dry years. It should be noted that similar results can be obtained using just growing-season proper data. Average climatic data for the growing season and for the whole year, accounting for the period 1953-1966, obtained from the weather station in Stare Pole indicate the average growing season /April-October inclusive/ precipitation to be 37.66 cm. The dry-years average of the same period, i.e., for 6 years, is just 27.13 cm, while the wet-years average is 48.36 cm. The minimum of growing-season precipitation over this period was reached in 1964, where only 21.88 cm of rain occurred, while the maximum was reached in 1960 with 59.47 cm of precipitation.

A similar situation is observed for sunshine and average temperatures in the area considered. The numbers of sunshine hours during the growing season ranges from 1095 hours /1962 - a wet year/ to 1586 hours /1959 - a dry year/. The 14-year average of the number of sunshine hours is 1285. It should be noted that as many as 464.6 hours, i.e., 36 % of the average total, occurs during June and July.

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Average daily temperature during the growing season over the period of 14 years is 12.6 °C. The annual maximum occurred in 1963, with 13.6 °C, and the minimum in 1962 with 11.8 °C. Average relative air humidity during the growing season is 81 %, ranging from 77 % for the dry years subset to as much as 85 % in the wet years.

Frosts in May are dangerous only in sporadic cases. Over the period of 14 years, only once did temperatures in May drop below -7 °C. Comparison of numbers of days with spring ground frosts indicates, however, that in the central part of Zulawy the danger of ground frosts is 20 % higher than at the seaside and in the depression areas.

Average precipitation levels calculated for multiannual periods is sufficient or even optimal for cereal crops and for industrial crops. The situation turns much worse, though, in the years with lower precipitation, when there may occur insufficient water availability in critical periods, during which some plants could be especially sensitive to water shortages.

High Zulawy - Southern and Central - has lower precipitation, but, owing to sufficient air humidity and high groundwater levels, water shortages are not felt. Dry years happen to be more advantageous for some crops, especially for cereals, this fact being related to unsatisfactory regulation of water conditions, especially within the depression and peridepression areas. Most of the annual precipitation occurs in July and August and in October and November, the least in April and May. Oftentimes there is a drought in spring and there are rains during harvest and potato lifting,

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which creates obstacles to smooth organization of field work. Thus activity peaks often cumulate in a way making it impossible to properly organize work /see, for instance, Table 3 years 1960, 1967, 1970, 1972/ even when increased mechanization of production processes are introduced.

The geographical location of the Vistula delta Zulawy /its proximity to the sea, surrouding heights, and elevation structure/ exerts significant influence upon the specific nature of local climate, furthermore differentiated between the depression, low, and Southern - High Zulawy. This is to some extent related to the inflow of cool air from above the Baltic Sea over the territory of Zulawy, which extends the period of spring cold weather, especially in the depression areas. Maritime influence in the same region causes a decrease of amplitude of annual temperature changes, delays the onset of spring, and extends the autumn season.

Percentage points distribution of precipitation in particular agrotechnical periods of the year are as follows:

Winter season /Dec., Jan., Feb./	17.0 %
Spring season /March, April, May/	17.9 %
Summer season /June, July, Aug./	39.8 %
Autumn season /Sept., Oct., Nov./	26.3 %

Extremum values of precipitation within these periods are the following:

Spring season: from 4.47 cm in 1978 to 16.45 cm in 1962

Summer season: from 2.25 cm in 1982 to 34.22 cm in 1981

Autumn season: from 8.04 cm in 1979 to 29.61 cm in 1974

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Winter season: from 1.75 cm in 1972 to 12.86 cm in 1958

These significant differences of precipitation levels in particular periods undoubtedly decisively influence the possibility of carrying out technical activities related to crop raising during optimum humidity periods, these periods being in some years very short. Such differences condition also the degree of crop losses due to diseases - in the case of cereals these are diseases of leaves, stalk, and spikes - as well as harvest and storage losses.

4. Influence of human activities - drainage, irrigation, and land improvement installations

Specific environmental conditions prevailing in Zulawy, formed in the Vistula valley and in the Vistula delta, stem not only from its different natural setting, but also from the existence of a unique, at least on this country's scale, very special network of water economy and land improvement installations. This network features a differentiated density of channels and ditches cutting through the land and more than 100 pumping stations functioning within it; see Fig. 5.

According to K. Cebulak, the network mentioned serves two purposes: one strategic, related to water economy; and the second tactical, related to land improvement. Within the specific area of Zulawy, i.e., in the Vistula valley and Vistula delta, water economy should secure artful water flow control combined with proper distribution of water related also to agricultural use and agricultural land improvement. This task is complicated because although the valley and delta areas are a

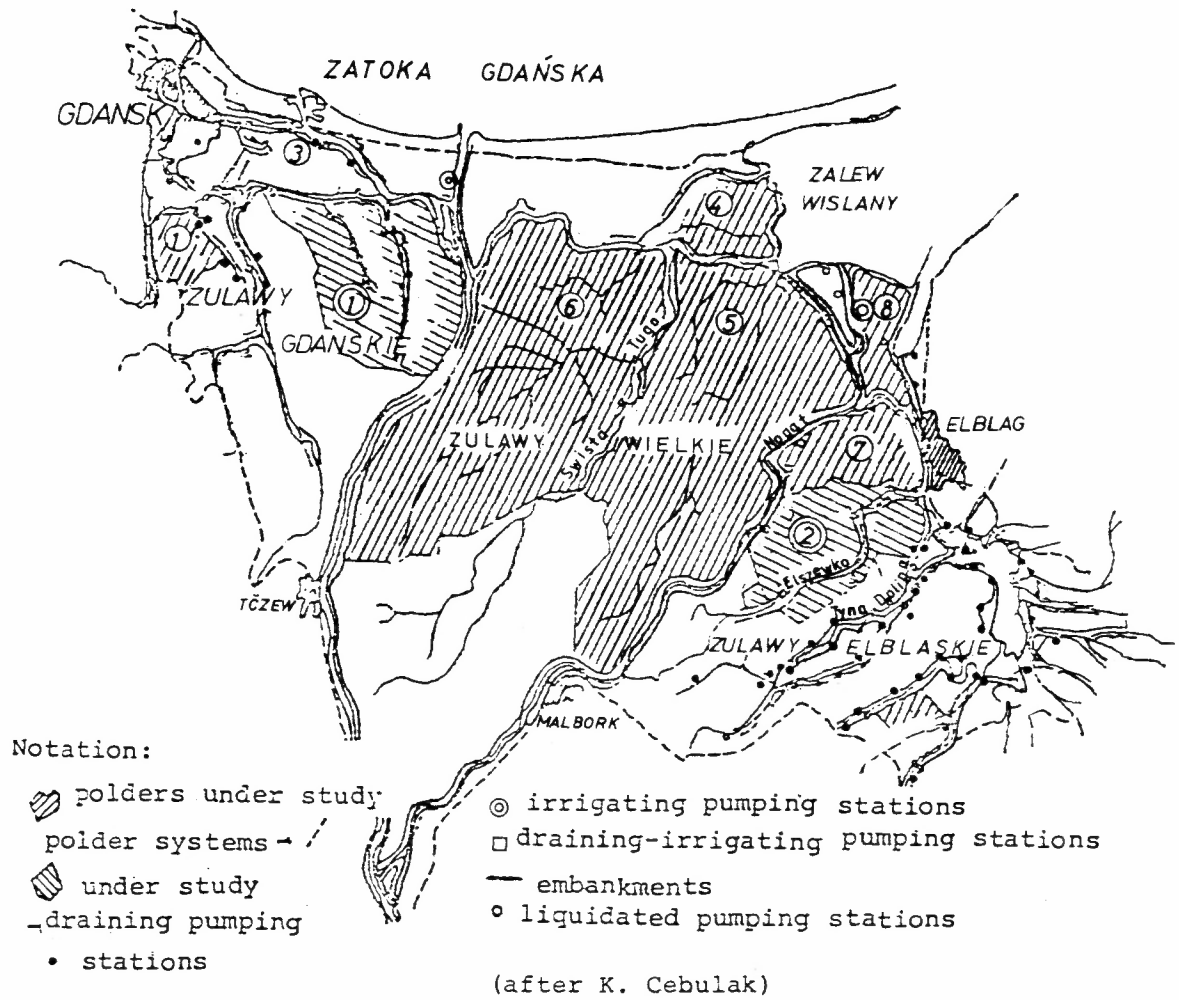

FIGURE 5 Hydrography of Zulawy. Status of hydrotechnical installations

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flatland, still important differences of elevation occur, as already mentioned since the minimum is at -1.8 m and maximum at 10 m.

Conscience human activity reflected through construction of channels and their embankments can be observed as early as the thirteenth century, and it gained much in intensity with the settlement of Dutch Mennonites brought to Zulawy in the sixteenth century. The problem is to control knowledgeably the water levels in the soil with regard to a rational set of productive activities within the agricultural farms. Water and land improvement economy is conducted within the definite natural and installation system of Zulawy, whose goal is to maintain the land-and-water environment balance.

The Zulawy system has a complex structure and is organized around a functional hierarchy shown in Fig. 6. It is very complicated in its activity and in its development, and rational running as well as effective use of the system require high levels of technical, technological, and organizatinal culture. Many specialists justly conclude that it is mainly through the advance of water and land improvement systems and their functional technical bettering that the agriculture of Zulawy can gain most importantly. Natural water conditions of this area are shaped by precipitation and evapotranspiration, and therefore also by the spatial distribution of soil types with their natural properties of water retention as well as by the density of water flows, from which water infiltrates to the surrounding land.

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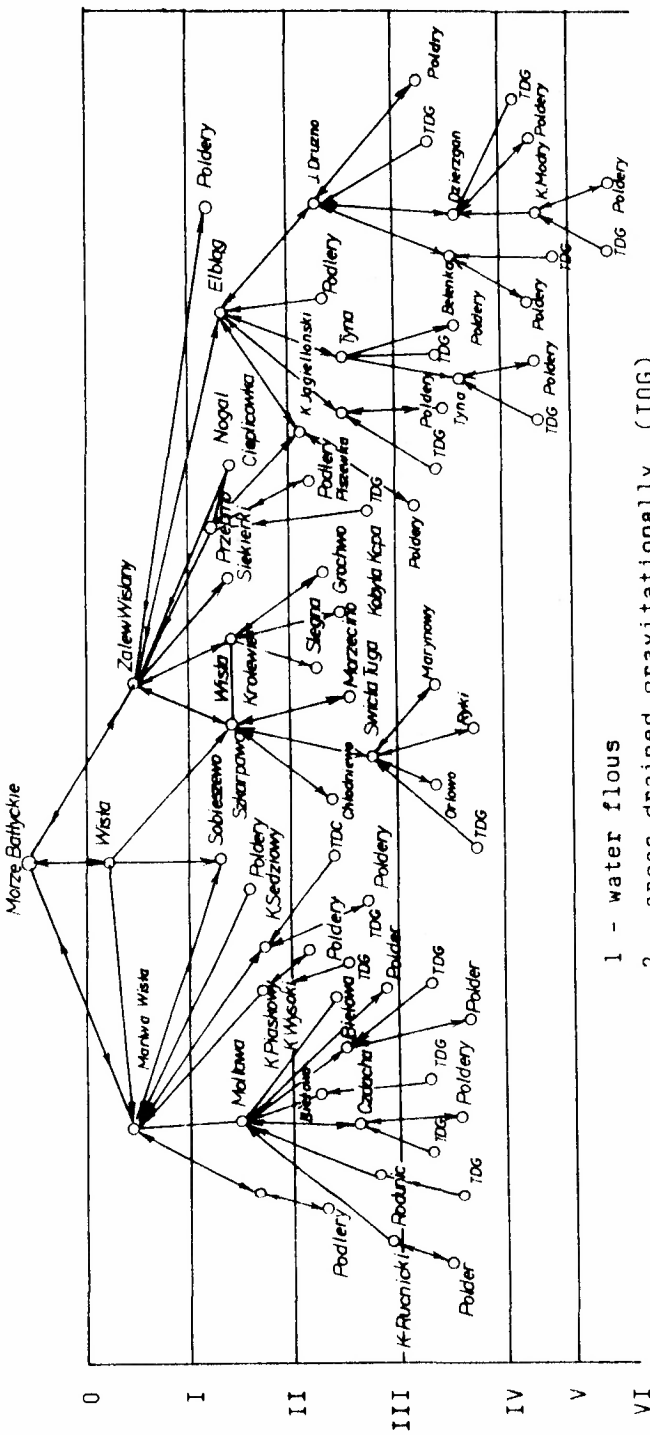

FIGURE 6 Functional structure of water /drainage-irrigation/ and land reclamation system in Zulawy, as of 1974

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5. Final remarks

Zulawy of Vistula is the region commonly, though mistakenly, assigned the agricultural production space with the most favorable soil and climate conditions for cultivation. The special character of Zulawy is exemplified by the fact that, in contrast to other regions of the country, dry years bring higher crop yields than wet years. Yield differences among those years in which the same precipitation levels occurred indicate the singular importance of temporal precipitation distribution not only in the four agrotechnical periods of the year, but even in the particular biological development phases of individual plant species. This fact can be exemplified by the data of the years 1971-1972.

Similarly, high humidity during seed preparation, especially for autumn sowing, is important not only for allowing determination of optimal seed time, but also for insuring homogeneous and not graded sprouting. This condition has decisive importance for crops in Vistula Zulawy, especially such autumn sown crops as rapeseed, wheat, and barley. In some years, with too much precipitation in the late summer and autumn season, preparation of fields for autumn fertilizer application for winter crops is very difficult or even impossible at the optimal point of time, especially in view of specific features of heavy soils of the Zulawy area. Such situations occurred, for instance, in 1970, 1978, and 1984.

In light of considerations presented here, the natural environment of the Vistula valley and Vistula delta Zulawy can be characterized by the

following positive and negative features:

I. Three positive features

a. Excellent phytoclimate, especially in the late spring and early summer particularly during the periods of continental weather.

b. Fertile retentive and absorptive soils on the majority of the region's area.

c. Large subsurface and surface water resources.

II. Four negative features:

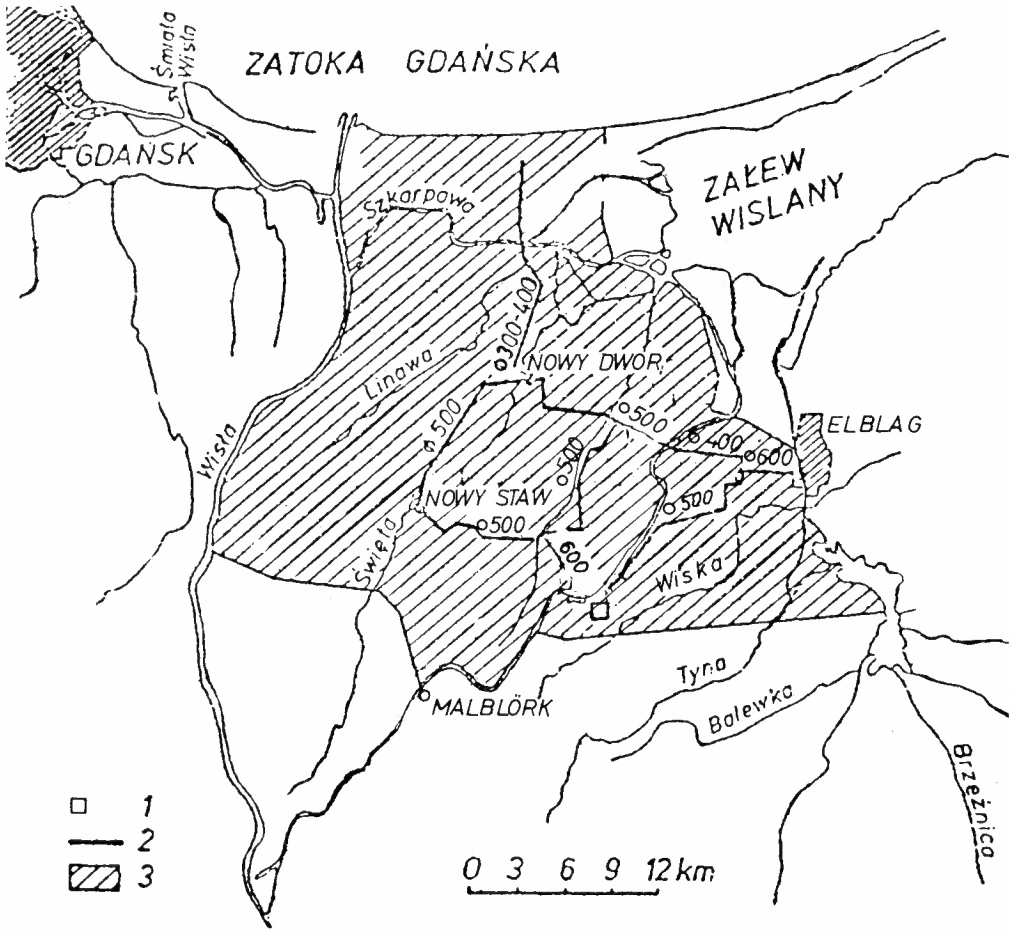
a. Disadvantageous phytoclimate in early spring and in mid-spring, delaying plant development.

b. Rainy, wet late autumn periods.

c. Too high groundwater levels falling off too late, but sometimes also too quickly.

d. Drought periods occurring sometimes, harmful for some plants that cannot develop their root system in time or that by their very nature are shallowly rooted.

Keeping in mind the highly random course of weather patterns in Zulawy, special attention should be paid to soils and to optimization of farm technology as well as improvement of agriculture infrastructure together with the overall agricultural service system.



1 - water source and improvement station
2 - main line
3 - area of the supply system reach

FIGURE 7 Central Zulawy water supply line

References, all in Polish

1. GÓRSKI, P., ed /1971/72/ Information Bulletin of the Voivodship Station of Plant Protection. Gdansk.

2. LASKOWSKI, St. /1957/ Zulawy in the light of agricultural research. Roczniki Nauk Rolniczych T66, series D.

3. LASKOWSKI, St. /1967/ Natural-agricultural regionalization within the Vistula delta Zulawy. Zeszyty Naukowe WSR Szczecin, No. 6.

4. MAJEWSKI, M. /1969/ Hydrographic development of the Vistula delta in the historical period. Przeglad geograficzny, No. 1.

5. PODOSKI, K. /1960/ Gdansk voivodship in the period 1945-1959. Publication of: Towarzystwo Rozwoju Ziem Zachodnich Gdansk.

6. Problems of intensification of cereal production /July 1973/ Joint report. In: Materialy na konferencje naukowo-techniczna SITR, Malbork.

7. Protection of environment and intensification of agricultural production /March 1972/. Joint report. In: Materialy z konferencji naukowo-technicznej, Gdansk.

8. RYBAK, A. /1969/ Natural and economic aspects of raw material acquisition for flax processing in Malbork. Ph. D. dissertation.

9. RYBAK, A. /1973/ Natural and organizational conditions of cereals production in Gdansk voivodship. In: Materialy z konferencji naukowo-technicznej, Malbork.

10. Vistula Delta Zulawy. Joint report. Publication of: Gdanskie Towarzystwo Naukowe. Przymorze Gdanskie series, No. 3, Gdansk.

11. WITEK, T. /1959/ Soil map of Vistula Zulawy, scale 1:100 000 Pulawy.

12. WITEK, T. /1961/ Initial study of the evolution of Vistula Zulawy silts. Roczniki Nauk Rolniczych, 82 - A -3.

13. WÓJCIK, P. /1973/ Agriculture of the Zulawy region in Vistula delta. Zeszyty Naukowe ART Olsztyn, special issue No. 107.

Table 1

Type of agricultural land use	Surface in sq. kms	% shares of particular soil quality classes							
		I	II	III		IV		V	VI
				a	b	a	b		
Ploughland	1001	1.6	20.3	37.5	20.5	12.4	5.0	2.0	0.7
Meadows	275	0.3	55.4	30.6		8.4		2.2	3.1
Pastures	277	1.4	28.1	37.2		19.7		8.7	1.9
Totals	1553	1.3	28.4	49.0		16.1		3.3	1.9

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Table 2

Name of commune	Index of the agricultural production space value, in points	Average soil quality index
Elblag	82.1	1.20
Gronowo Elblaskie	87.7	1.32
Markusy	84.0	1.38
Nowy Dwór	95.7	1.36
Ostaszewo	98.6	1.40
Stegna	93.7	1.31
Sztutowo	92.4	1.26
Lichmowy	99.9	1.40
Malbork	96.1	1.33
Miloradz	93.9	1.34
Nowy Staw	97.8	1.34
Stare Pole	93.9	1.34
Cedry Wielkie	95.8	1.25
Pruszcz Gdanski	82.6	1.11
Pszczólki	90.3	1.20

Table 3. Average precipitation volumes for 1891 - 1930 /after Wiszniewski/ and precipitation volumes together with temperatures for 1954-1971 /after A.Rybak/.

Name of station	period	months												Annual precipitation	Growing slason precipitation
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
						PRECIPITATION:									
Malbork	1891-1930	28	28	30	36	49	57	71	69	53	41	38	35	535	376.0
Elbląg	"	39	33	35	40	53	62	82	77	63	51	51	46	632	428.0
N.Dwór	"	49	29	31	37	44	52	76	85	67	52	54	53	629	413.0
Pruszcz	"	34	26	30	34	46	52	69	65	54	44	40	42	536	364.0
St.Pole	1954-1965	21.7	23.0	15.5	24.0	42.2	57.4	83.6	79.8	58.8	36.6	36.6	39.3	518.5	382.5
Elbląg	"	30.2	34.0	22.2	40.6	56.7	65.5	104.1	95.0	89.7	49.1	48.9	48.9	684.9	500.7
N.Dwór	"	26.8	28.8	19.9	33.4	50.4	57.4	93.3	80.0	65.5	44.5	43.8	53.9	597.7	424.5
Miłocin	1965-1971	24.0	18.0	20.0	38.0	47.0	49.0	59.0	68.0	62.0	36.0	57.0	34.0	512.0	359.0
Pruszcz Kwidzyń	1954-1965	22.1	26.8	19.8	28.9	43.6	54.7	78.8	81.6	56.7	31.0	32.7	38.6	515.5	375.3
						TEMPERATURES:									
St.Pole	1954-1965	-3.0	-3.6	0.2	5.6	11.0	15.7	17.0	16.4	13.1	8.6	3.3	-0.5	7.0	12.4
N.Dwór	"	-3.0	-2.4	0.2	6.2	11.1	15.5	17.1	16.6	13.4	8.7	3.8	-0.1	7.2	12.6
Elbląg	"	-2.6	-3.4	0.5	6.3	11.4	15.9	17.2	16.4	13.3	8.8	3.3	-0.2	7.2	12.7
Miłocin	1956-1971	-3.1	-2.8	0.5	5.9	11.0	15.6	16.9	16.1	12.9	8.6	3.2	1.0	6.9	12.4
Pruszcz Kwidzyń	1954-1965	-2.7	-2.9	1.2	6.9	12.1	16.7	17.9	17.1	13.4	8.9	3.6	0.0	7.4	13.2

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Table 4. Multiannual averages of crop yields in the whole of agriculture and in the state farms of Żuławy in the period 1961-1983

OVERALL/STATE AGRICULTURE periods	Coreals together			Wheat			Sugar beets			Winter rapeseed			Grasslands		
	Yelds 10^2kgs/ hectare	Extremal values in the period		Yelds 10^2kgs/ hectare	Extremal values in the period		Yelds 10^2kgs/ hectare	Extremal values in the period		Yelds 10^2kgs/ hectare	Extremal values in the period		Yelds 10^2kgs/ hectare	Extremal values in the period	
		min	max		min	max		min	max		min	max		min	max
Overall agriculture, averages of periods:															
1961-65	24.1	20.0	28.5	25.5	20.7	29.9	268	222	313	15.6	11.9	22.0	39.8	31.7	53.6
1966-70	29.9	23.8	35.2	30.9	23.5	36.6	347	304	390	19.6	10.3	24.9	55.3	47.8	63.4
1971-75	32.9	27.8	38.1	33.8	27.8	39.6	340	319	359	21.5	15.0	29.7	66.5	51.5	71.3
1976-80	34.6	23.8	44.2	37.06	32.0	46.2	279	177	353	22.8	17.8	28.9	71.08	69.9	79.1
1981	27.5			35.1			235			19.8			63		
1982	31.6			37.4			280			18.1			67		
1983	37.1			42.8			350			21.2			72		
State agriculture, averages of periods:															
1961-65	24.0	18.8	31.4	25.5	19.7	31.3	244	183	288	15.7	12.8	23.0	31.9	26.1	45.2
1966-70	30.2	22.3	36.2	30.8	22.2	37.2	326	282	374	20.2	10.6	26.4	43.6	34.0	53.0
1971-75	32.2	26.4	38.7	33.7	26.5	39.9	318	292	349	22.2	15.2	30.5	58.7	44.0	66.3
1976-80	35.4	23.8	48.9	37.4	28.2	49.7	279	161	323	23.4	28.4	30.5	71.1	56.0	

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