POLAND

1. PHYSIOGRAPHY

With a surface area of 312 700 km2 Poland ranks among Europe's larger countries. Poland's territory is divided into 16 voivodships and 2 459 communes. Poland lies in Central Europe in the drainage basins of the Vistula (Wisla) and the Oder (Odra) river, in the Lowland zone, between the Baltic Sea and Carpathian Mountains. Poland's roughly square-shaped territory stretches from Mt. Opolonek in the south (49ºlatitude north) to the Rozewie headland in the north (54º50' latitude north). Its westernmost and easternmost points lie at 14º07' and 24º08' east longitude. Poland's location in the middle latitudes determines its climate, vegetation, soils etc.

Poland lies in a zone of transition between western Europe, mountainous and sea-penetrated, with diverse landscapes and regions, and the more solid and less heterogeneous block of eastern Europe.

Poland is bounded in the north by the Baltic Sea and Russia, sharing borders with Lithuania, Byelarus and Ukraine in the east, Czech and Slovak Republics in the south and Germany in the west.

With average height of 173 m, as compared to the European average of 330 m above the sea level (the lowest of all continents), Poland is largely a lowland country. 91.3% of its area lies in the lowland zone; upland and typically mountainous areas account for 7.7%, and 1% of its territory, respectively. However, even the lowlands are hilly in character having been shaped by the activity of continental glaciers (lake districts in the northern part of the country); true plains are only found in central Poland.

2. CLIMATE AND RAINFALL

Poland's climate is moderate i.e., intermediate between maritime and continental climates. Poland frequently finds itself in the zone of atmospheric fronts; the result are either fairly wet and mild winters, with average monthly temperature of around 0°C, or heavy and dry winters, with average monthly temperature of -10°C. A similar variation in air temperatures and precipitation occurs in the summer season, especially during the vegetation period. Hot and dry summers (with less than 20 mm of rainfall in June, July and August) may alternate with cold and wet summers with a monthly rainfall up to 150 or even 200 mm.

The prevailing western winds considerably increase air temperatures in areas lying along the Vistula and Oder Rivers but their impact on eastern regions of the country is in general negligible.

Annual isotherms range between 6.5°C and 8.5°C; average temperatures in January and June temperatures are range from - 1 °C to - 5 °C, 17°C to 19°C, respectively. Average monthly amplitudes of temperature calculated on the basis of average monthly temperature range between 19°C in the west and 22°C in the east. In the lowland region the vegetation season with average temperature of over 5°C lasts from 190 to 220 days.

Average annual rainfall is 583 mm and in most regions of the country ranges between 500 and 600 mm. In smaller areas in the uplands and the mountains along Poland's southern border annual rainfall may reach as much as 800 - 1500 mm; Central Poland receives 450 - 550 mm, the coastal zone 500 - 600 mm. Two-thirds of annual rainfall occurs in the summer. Snow accounts for two thirds of winter (December - March) precipitation.

During the growing season potential evapotranspiration in most of the country exceeds precipitation. Only in the mountain zone and the seacoast average precipitation is high enough to satisfy the requirements of agricultural plants.

Crops cultivated in Poland in general do not require irrigation during the growing season. However, in areas of light soil dry spells are likely to occur leading to substantial losses in yields. Preventive measures include cultivation suitable crops and appropriate crop rotation; improvement of water conditions is achieved by raising water retention in the soil profile. Nevertheless, irrigation in areas of light soil appears to be necessary, especially in areas sown with valuable crops.

In contrast, areas with heavier soils require draining especially in the spring, in places where the ground-water level does not subside sufficiently early, which has an adverse effect on yields. In such cases drainage is the most appropriate method of soil amelioration.

Grasslands usually encountered in river valleys and areas of local low relief having a relatively high ground-water table also require draining. While rapid runoff of surplus water, especially in the spring, makes possible earlier development of the plants it also increases the risk of greater soil moisture deficiency during the growing season, intensified by high water consumption of grassland plants. In such cases irrigation is needed to meet the additional water requirements of grassland plants in the growing season to ensure sufficiently high yields; the drainage system consists of open ditches and drains while additional water requirements are met through sub-irrigation as well as flooding and borderstrip irrigation.

3. POPULATION AND SIZE OF FARM HOLDINGS

With over 38 million inhabitants and population density at 119 people/km² Poland is one of the more populated countries in Europe.

Some 30% of the population live in rural areas making their living from agriculture.

The prevailing form of ownership of the land is private property. Until 1989 roughly 25% of the land was under a system of state farms most of which were dismantled following the political transition of 1989.

Farm holdings vary widely in terms of size. The relevant figures for 1999 were as follows:

Area of farm holding	Percentage of all farm holdings
Less than 1 hectare	2.5%
1 - 5 ha	52.8%
5 - 10 ha	27.3%
Over 10 ha	17.4%

A visible tendency towards increasing the number of smaller farm holdings is being registered in recent years in favour of larger holdings with an area of 20 - 50 hectares. Change is stimulated by government policy.

Crop structure is as follows: cereals - over 51%, potatoes - 12.9%, industrial crops - ca 7.2% of all arable land. Wheat is the main cereal crop, at 2.43 million ha, followed by barley and oats, at 1.23 and 0.67 million hectares. The area under wheat and barley is steadily increasing while an opposite tendency is registered for sugar beet, potatoes and oil plants.

4. LAND RESOURCES

The total land area of Poland is 30,450,000 ha. The two main forms of land use are agriculture and forestry. Farmland and forests jointly occupy nearly 88% of Poland's territory. Farmland, which accounts for 60.1 % includes arable land and permanent grassland, at 14,829,000 and 3,891,00 hectares respectively.

The area of farmland is steadily shrinking. Since 1979 it decreased by 1,786,000 ha to 18,784,000 ha in 1997.

This decline, coupled with population increase, has led to the decrease in the per capita acreage of farmland: from 0.54 ha per person in 1980 to only 0.45 ha in 1997.

Permanent grassland, both permanent meadows and pasture, occupy about 3,900,000 ha, 12.5% of Poland's territory .

Meadows in Poland are to a large extent non-natural. They developed as a result of clearing of riverside forest or conversion of former ploughland into grassland. Natural concentrations of meadows occur only locally, mainly in the mountains.

Peatlands are found in many river valleys and lowland areas. Most of them were drained and converted into grassland (Table 1). Despite this, peatlands still retain many nature values and need to be protected. This presents a challenge to agriculture and management of drainage irrigation systems.

Table 1. Utilisation of peat bogs

Type of utilisation	Acreage (thousand ha)	Share [%]
Peat bogs in natural state	120.0	8.8
Meadows	960.0	70.7
Forests	120.0	8.8
Former peat bogs (with adjoining areas)	150.0	11.0
Protected peat bogs	6.1	0.4
Extraction area	2.5	0.2

On Poland's territory there are over 8,000 lakes of over 1 ha in area. Most of them are of glacial origin. The largest number of lakes is found in the Pomeranian and Masurian Lake Districts. Acreage occupied by surface waters in 1997 was 826,000 ha, 2.6% of area of Poland. In comparison to 1980, this area increased as a result of the construction of several new reservoirs. Some of them were built for irrigation purposes.

Other forms of land use i.e., areas of development, and wasteland account for 6.0% of Poland's territory. All of these forms of land use show a growing trend.

Poland has many different soils. Sandy formations (20% of particles less than 0.2mm in diameter) occupy about 50 % of the total area. Their water properties depend upon the depth of the ground-water table, substratum soil profile layers, and content of silt particles less than 0.02 mm in diameter. Appropriate agrotechnical and land reclamation (water conservation) measures are necessary for the improvements of these soils. The main type of soils include swampy boulder loam, organogenic soils developed on peat, alluvial soils, silty and loess formations. More data on soil types in Poland are shown in Table 2.

Table 2. Parent rock - soil types in Poland

Parent rock of soils (types)	Percentage of total acreage of soil [%]	Percentage of acreage of farmland [%]
1. Gravels	0.9	0.5
2. Loose and light weakly loamy sands	34.6	24.8
3. Deep loamy sands and overlying loose sands	10.2	12.4
4. Loamy sands on more cohesive base	7.3	8.6
5. Sandy clays	8.5	10.2
6. Medium and cohesive clays	9.6	13.2
7. Loams	0.8	1.0
8. Loam deposits of water origin	4.2	4.6
9. Loess and loessic deposits	3.5	4.8
10. Alluvial deposits	4.7	5.8
11. Limestone rock (rendzina)	1.1	1.6
12. Massive rock of different origin	6.1	3.9
13. Organic and mineral-organic sediments	8.5	9.6

It is thought that reclamation measures are indispensable to bolster agricultural production by improving crop environment and consequently, increasing soil productivity. Both draining and irrigation measures have to be considered.

Average quality of Poland's soil is fairly low. Only about 23% of arable soils may be considered good or very good (classes I - IIIb), while poorest soils (classes V - VI) account for over 30% of Polish ploughland. Soil quality classification in grasslands is even less favourable: class I - III

soils account for only about 15%, class IV soils - for 38%, while class V - VI soils are most widespread, accounting for as much as 47% of total area of grassland.
In some regions of the country, particularly in the south and southwest, extensive areas of soils have suffered chemical degradation as a result of excessive accumulation of trace elements in surface layers.

About 4% of farmland contains higher amounts of heavy metals. This may be qualified as slight contamination. The total acreage of farmland classified as chemically degraded (in a varying degree) is about 150,000 ha, i.e., less than 1% of the total area.

Despite the development of agriculture and industry Poland still retains many areas valuable for nature. Of special value are wetland areas characterized by high biodiversity. A part of them has been drained and is used extensively for agriculture as low yield meadows and pasture. Extensive areas are under legal protection. Some restrictions in agricultural use have likewise been introduced in areas of infiltration, important for the recharging of aquifers and in areas of drainage basins of particular importance for good water quality in rivers.

5. WATER RESOURCES

Poland is one of the European countries with quite limited water resources. Renewable resources of surface water, i.e., mean annual outflow from the area of Poland, is 1580 m3 per capita as compared to the European index of 4560 m3. To make things worse Poland's poor water resources are substantially variable in time and space.

Figure 5 presents the spatial distribution of multiannual average figures for surface water resources, calculated per inhabitant.

In Poland's climatic conditions peak flows in rivers occur in spring while lowest levels are recorded in autumn and winter. The ratio between the maximum and the minimum average monthly outflow from the area of Poland is about 2.3. The same ratio is considerably higher for some rivers reaching double digit figures in mountain streams and smaller lowland rivers. Momentary flows vary even more. For example, in the case of the Wisloka river, the ratio between the minimum and maximum flow is as high as 1 : 1000. Precipitation is similarly unevenly distributed in space and time. Average annual precipitation in Poland is around 600 mm but in some years it may fall below 400 mm or exceed 800 mm. Much larger differences become apparent when short-term precipitation is analysed. They are responsible for the frequent occurrence of extreme phenomena such as floods and drought.

It is estimated that floods in the Vistula catchment area occur on the average every 5 years as compared to every 7 - 10 years in the Odra catchment. Surplus water in agriculture results not only from floods but also from long - lasting excess moisture levels in the soil. As late as in the 19th century Europe experienced periods of starvation caused by wet years. The last great flood occurred in the Odra basin in July 1997 causing incalculable economic and social losses. At the same time many regions of the country suffer from severe atmospheric, hydrological or soil drought leading to serious losses for the national economy, and in particular, for agriculture. It has been estimated that the drought of 1992 which affected almost the entire territory of Poland caused an at least 20% decrease in yields.

Water deficit in agriculture is strongly felt in the central belt of the Polish lowlands. According to statistical data from the late 1970s the acreage of override agricultural land was around 4 million ha. This poor condition of the land is caused by extensive deforestation done in the past as well as by improper management of the water resources.

It is believed that protection of water resources must consist of storing as much water as possible from the spring meltwater and from periods of intensive precipitation. The condition of the water

system could be significantly improved by the conscious and appropriate shaping of the agricultural landscape.

Agriculture poses a threat to the quality of surface- and groundwater. Substances are eroded from farmland and leach into waters; they include mainly, organic matter, phosphorus and nitrogen compounds from artificial and organic fertiliser used in agriculture, toxic substances originating from herbicides and insecticides used in agriculture and forestry. It is estimated that over 50% of the nitrogen load and 40% of the phosphorus compound load in water runoff comes from agriculture.

Water intake has been increasing steadily exceeding in volume over the last several decades reaching 15 km³ annually in late 1970s. In the 1980s it levelled off due to economic recession even decreasing slightly early in the 1990s (Table 3). To a large extent this was achieved by the introduction of economic standards imposing more economic use of water.

Table 3. Water intake for economic requirements [km³/year]

Intake	Year				
	1980	1985	1990	1995	1998
Total	14.18	15.45	14.25	13.27	13.80
Including : Industry	10.14	10.92	9.55	8.88	9.10
Municipal economy	2.72	2.93	3.00	2.87	2.85
Agriculture and forestry	1.32	1.61	1.69	1.52	1.43

6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE

The first hydraulic projects for agricultural purposes were undertaken in Poland during the Middle Ages. Embankments were built to protect lowland areas against flooding and ditches were constructed to drain water from swampy areas. But the largest area was drained after the 1945. Annually, over 200 thousand hectares of agricultural land were drained for some years, as may be seen from Table 4.

Nowadays reclamation of new land has practically stopped. No more than 10 000 hectares of arable land is drained annually at present.. Drainage in river valleys has ceased. Most of the reclamation projects undertaken are associated with the reconstruction of irrigation systems, construction of water reservoirs or weirs to increase the water level in some rivers.

Table 4. Average area drained annually in Poland

Years	The area drained [hectares per year]
1951 - 1955	95 000
1956 - 1960	102 000
1961 - 1965	245 000
1966 - 1970	260 000
1971 - 1975	205 000
1976 - 1980	120 000
1981 - 1985	72 000
1986 - 1990	102 000
1991 - 1995	20 000

Nevertheless, it is worth noting that a substantial area of agricultural land in Poland is fitted with hydraulic structures, mainly for soil dewatering. The type and number of land reclamation (land improvement) structures is shown in Table 5.

Table 5. Land reclamation (land improvement) structures

Land reclamation area and structures	Units	Amount
Area ameliorated	Thousand hectares	6 690
• arable land	Thousand hectares	4 725
• grassland	Thousand hectares	1 965
Area irrigated	Thousand hectares	480
• arable land	Thousand hectares	62
• grassland	Thousand hectares	418
Hydraulic structures managed by farmers		
• ditches and small watercourses	Km	283 746
• pipes (without sprinkler irrigation)	Km	8 211
Hydraulic structures managed by the State		
• regulated rivers and canals	Km	49 588
• unregulated rivers	Km	24 796
• leeves (embankments)	Km	8 371
• pumping stations	number/m^3 . s	592/170
• water reservoirs	number/mln.m^3	185/170

As may be seen from Table 5 most of the agricultural land is drained without possibility to irrigate. Covered plastic or ceramic drains have been installed for dewatering arable soils. Irrigation systems were installed primarily in orchards and vegetable gardens. Grasslands, mainly those found in river valleys, have been drained by open ditches. About 25% of the drained grassland may be irrigated. The subirrigation system is the only method used for irrigating grasslands.

Agriculture development plans foresee that some 2 mln hectares of farmland will be taken out from agricultural production. This applies mainly to poor soils or river valleys of high nature value. It is estimated that some 10% of irrigation-drainage systems will be dismantled. Consequently, no larger irrigation or drainage projects are planned for construction in the coming years.

Irrigation is carried out in smaller areas, mainly in orchards and in vegetable gardens. At the same time action is being taken to renaturalize a part of the drained river valleys and introduce solutions designed to increase retention capacity, some of it targeted on water conservation.