MEMORIA

LANDSCAPE METABOLISM – THE ROLE OF EXTERNAL AND INTERNAL NATURAL INPUTS

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Esta es la memoria de un trabajo fin de carrera realizado por el alumno Javier Larrea Posadas en la Universidad Nicolás Copérnico de Torun, Polonia.

INTRODUCCIÓN

El trabajo realizado consiste en la investigación y exposición de los diferentes problemas que asolan la ganadería y agricultura de Polonia, dada que éstas son muy deficitarias en comparación con la de otros países de la Unión Europea, y también teniendo en cuenta en que es un país que recibe mucho dinero y tiene un territorio apto para obtener buenos beneficios de la agricultura y ganadería.

Hay que decir que Polonia es un país que durante toda su historia (principalmente en los últimos 60 años) ha vivido a la sombra de terribles guerras (II Guerra Mundial), y esto ha causado un inmenso retraso en la cultura agraria y ganadera, haciendo que hoy en día se usen métodos de cultivo o técnicas de reproducción que por ejemplo en España no se usan desde hace más de cuarenta años.

Debido a esta carencia de cultura agrícola y ganadera decidí hacer un trabajo centrándome en los posibles fallos que encontrase y también realizando un pequeño análisis de impacto ambiental, investigando las posibles causas de tan retrasada actividad agrícola y ganadera.

A continuación se expone una pequeña memoria del trabajo fin de carrera en la que incluyo:

- Área de trabajo
- Materiales y métodos
- Resultados
- Discusión
- conclusión

ÁREA DE TRABAJO

Todo el trabajo de investigación se realizó en un pueblo llamado Tluchowo, en la región de Kujawsko-Pomorskie (Polonia), ya que según mi tutor era uno de los pueblos que mejor reflejaba la actualidad de la actividad agrícola y ganadera en Polonia.

Polonia

Polonia es un país de Centro Europa que hace frontera con Alemania al oeste, con la República Checa y Eslovaquia al sur, con Ucrania, Bielorrusia y Lituania al norte, y con el Mar Báltico y la región de Kaliningrado al norte. El área total de Polonia es de 312.679 Km^2, haciendo de él el 69º país mas extenso del mundo y el 9º en Europa.

Polonia tiene una población de más de 38 millones, lo que lo hace el 34º más poblado del mundo y el 6º de Europa. Está dividido en 16 provincias llamadas voivodatos, y cada voivodato tiene sus ciudades insignia o poviatos, de las cuales hay 379

Kujawsko-Pomorskie

Es el voivodato situado en la zona media y un poco al norte de Polonia. Sus dos ciudades insignia son Bidgoszcz y Torun (ciudad en la que residía).

Este voivodato fue creado el 1 de Enero de 1999 como resultado de la reforma local del gobierno polaco. Anteriormente fue parte de la realeza prusiana, que posteriormente sería dividida en la región de Kujawsko (cuya capital era Bidgoszcz) y la región de Pomorskie (cuya capital era Torun), y finalmente se unirían para formar el tercer mayor voivodato de Polonia

TŁUCHOWO

Esta comunidad está situada al sureste del voivodato, en la región de Lipno, y bordeando con el voivodato de Masovia. Se sitúa a unos 50 kilómetros de Torun, y tiene un área de 9.867 hectáreas divididas en 1615 ha de bosque, 3137.93 de tierras agrícolas y 210.44 de tierras baldías

Ha sido siempre una zona agrícola, pero en los últimos años se ha producido un importante incremento industrial y textil.

MÉTODOS

Para analizar los resultados y obtener conclusiones, primero hay que saber cuales son los problemas, primero hay que saber como atacarlos. En esta parte de la memoria se incluyen unas tablas que me fueron dadas por mi tutor y que son diferentes ciclos que existen en el medio ambiente para administrar los input y output de un agroecosistema.

El primero de ellos (Fig. 1) representa un agroecosistema en términos espacio-temporales, y también los flujos que existen entre los diferentes sectores que atañen a un sistema agrícola, y sobre todo entre mercado y cosechas, ganado y suelo

El Segundo cuadro (Fig. 2) representa las diferentes relaciones que existen entre la parte económica, natural y social de un ecosistema y que de su correcta correlación depende una buena conservación de dicho sistema

El tercer y último cuadro (Fig. 3) representa la entrada de inputs en un ecosistema y sus relaciones con él para un correcto desarrollo económico. Aquí el ecosistema se divide en ecología del paisaje, calidad medioambiental, valores económicos, valores socio-culturales y manejo y administración del ecosistema y sus beneficios

Fig. 1. Spatial-temporal representation of an agroecosystem. Energy, material and monetary transfers existing between market and the elementary sectors of the farm are represented. (a) small circulation (b) large circulations

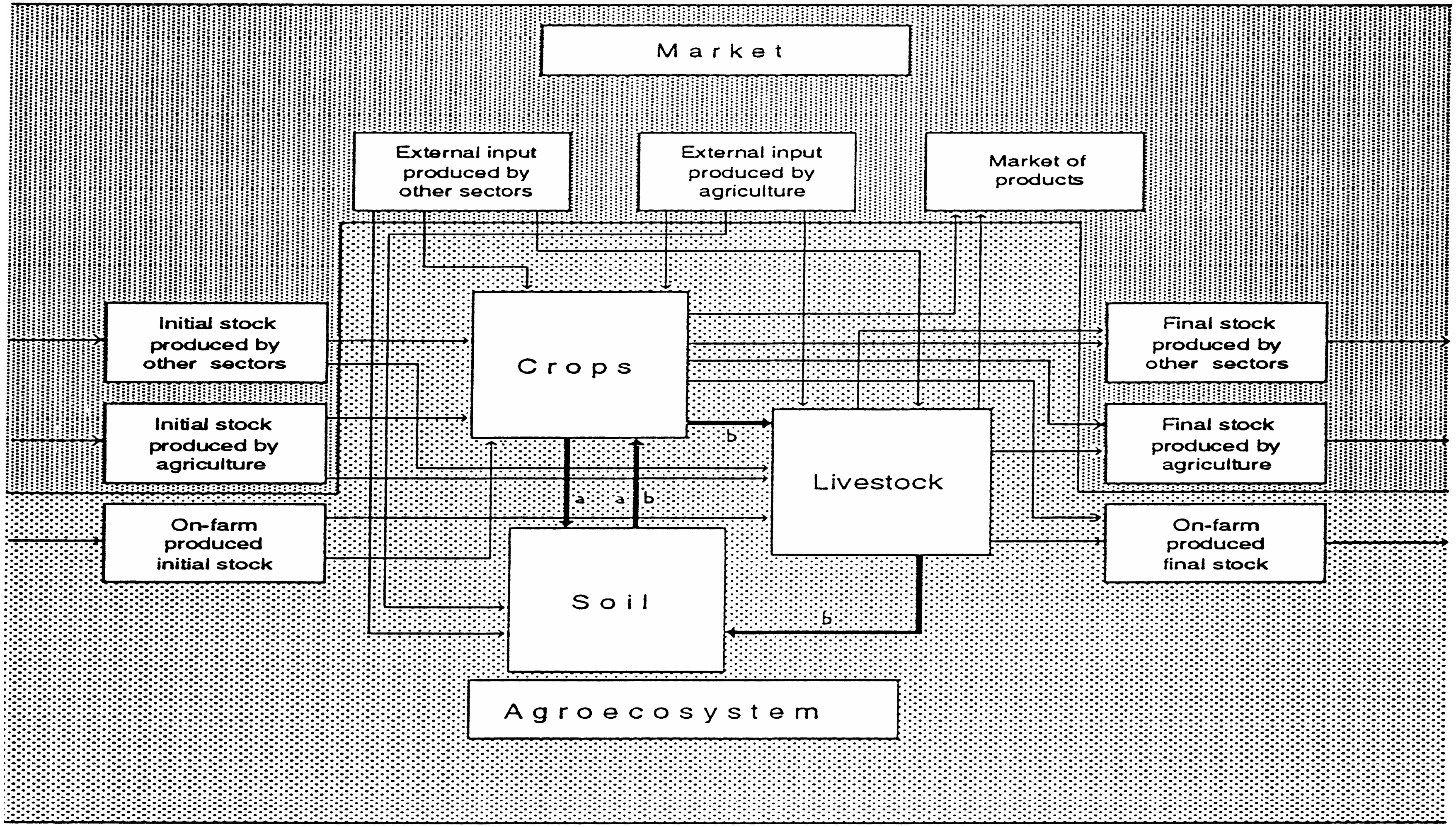


Fig. 2 Socio-economic-environmental system. Structure of Local community gmina

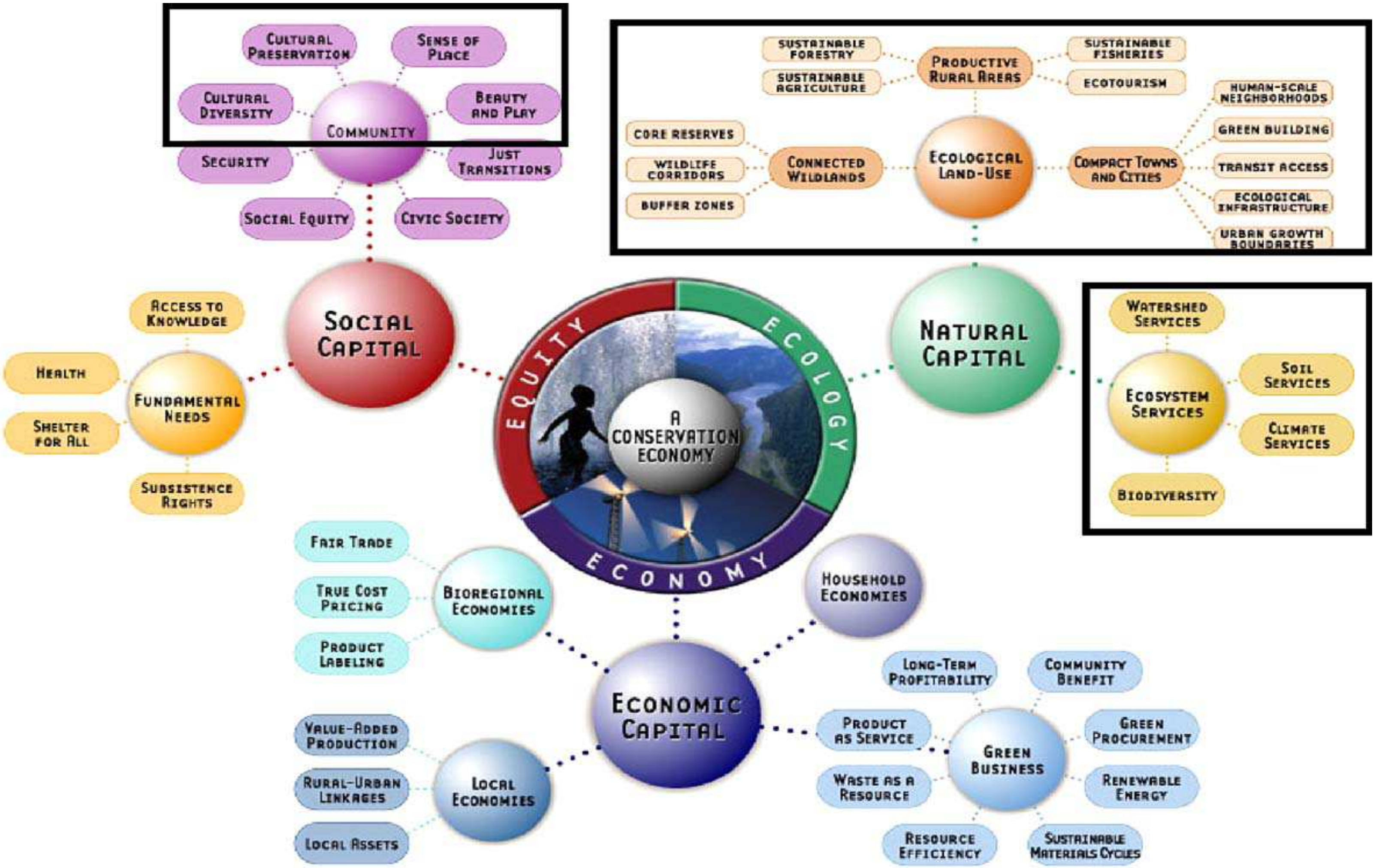
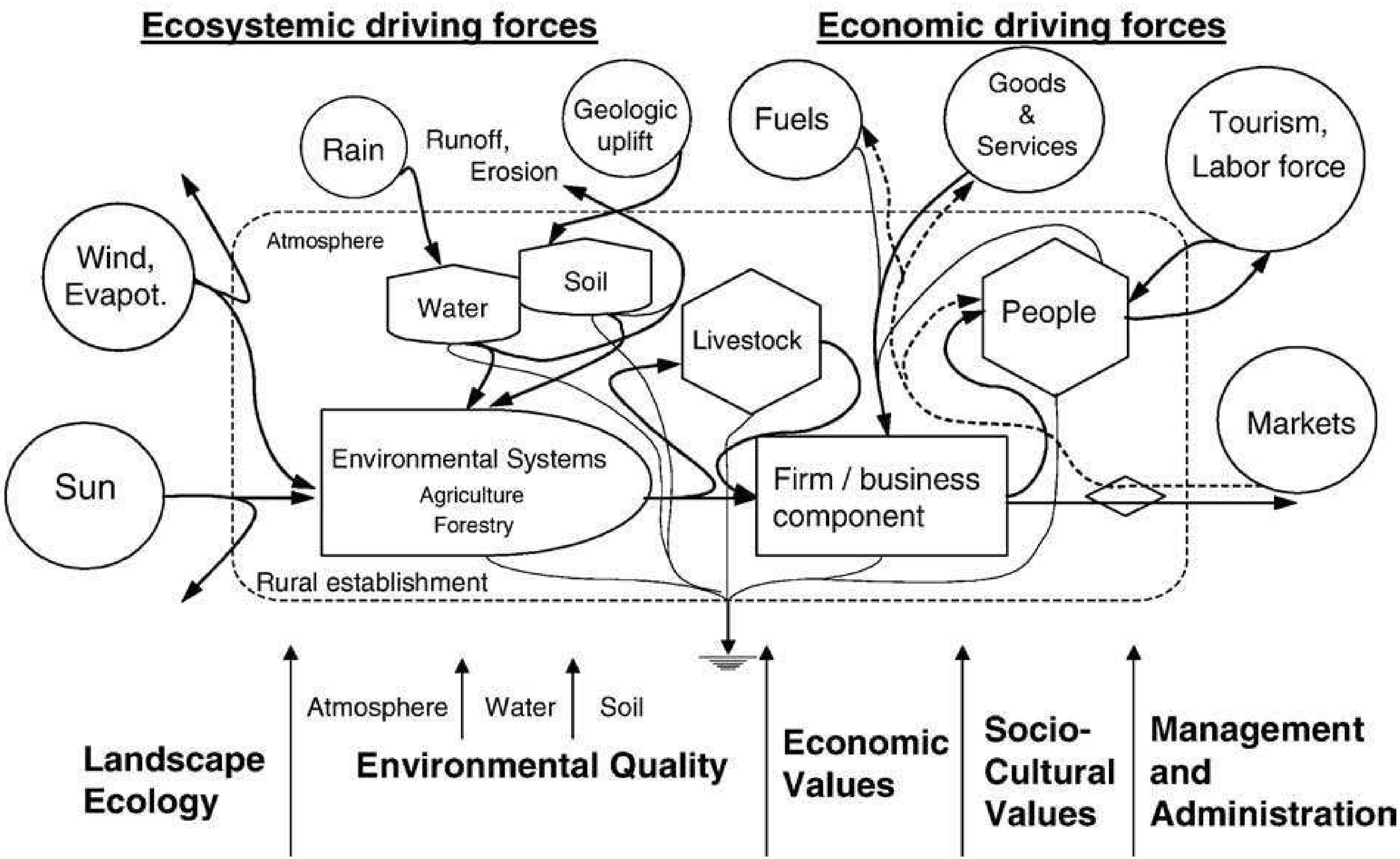


Fig. 3 Level – farm   input/outpuy/development



MATERIALES

A continuación se exponen los datos que fui recogiendo a lo largo de la comunidad de Tluchowo, y que me fueron dados por granjeros de 15 granjas diferentes. A dichos granjeros les pregunté cantidad de animales y kilogramos de cosecha que obtenían, y cantidad de fertilizantes y energía que utilizaban para el funcionamiento de la granja.

La tablas están divididas en 15 columnas, una por granja, y al final hay una tabla final con la suma de todas o la media, dependiendo del dato que mejor me servía para mi propósito final, que es obtener la productividad total de la comunidad

Animales

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Cow Milk	40			24	
Cow Meat	20	70	24	32	
Calves		200			
Pig			950		30
Piglet					
Wild-piglet					
Horses		3			
Goat			3		
Chicken					10
Goose					
Sheep					
Ha	75	63	52	18,32	18,42

	Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Cow Milk					
Cow Meat		12			
Calves					
Pig		30	32	30	85
Piglet			750		
Wild-piglet					
Horses					
Goat					
Chicken					
Goose	10000				
Sheep					
Ha	77,03	13,88	55,5	15,51	34,5

	Farm 11	Farm 12	Farm 13	Farm 14	Farm 15	Total
Cow Milk	25	1		12	10	112
Cow Meat	25	27				210
Calves				8	6	214
Pig		540	87	3	18	1805
Piglet			60	8	26	844
Wild-piglet			130	13	15	158
Horses						3
Goat						3
Chicken			20			30
Goose						10000
Sheep		110				110
Ha	98,31	85,7	16,34	25	35	

Cosechas

	Farm 1 (kg)	Farm 2 (kg)	Farm 3 (kg)	Farm 4 (kg)	Farm 5 (kg)
Sugars beets			**390000**		
Roots			300000		
Straw			90000		
White mustard					
Seeds					
Straw					
Pea					
Seeds					
Straw					
Spring barley		**92000**	**138000**	**18400**	
Seeds		40000	60000	8000	
Straw		52000	78000	10400	
Winter barley					**16100**
Seeds					7000
Straw					9100
Alfalfa					
Seeds					
Straw					
Oat		**26000**			
Seeds		10000			
Straw		16000			
Spring wheat	**29568**		**29568**		
Seeds	10560		10560		
Straw	19008		19008		
Winter wheat	**217500**		**116000**		**11600**
Seeds	75000		40000		4000
Straw	142500		76000		7600
Triticale	**112500**	**144000**	**120000**	**45000**	**30000**
Seeds	37500	48000	40000	15000	10000
Straw	75000	96000	80000	30000	20000
Winter colza					
Seeds					
Straw					
Grass					
Straw					
Maize	**125000**	**990500**			
Silage	125000	990500			
Potatoes					
Mixed cereals	**245232**			**39000**	
Seeds	94320			15000	
Straw	150912			24000	
Rye				**20700**	
Seeds				9000	
Straw				11700	

	Farm 6 (kg)	Farm 7 (kg)	Farm 8 (kg)	Farm 9 (kg)	Farm 10 (kg)
Sugars beets					
Roots					
Straw					
White mustard					
Seeds					
Straw					
Pea					
Seeds					
Straw					
Spring barley	**34500**				
Seeds	15000				
Straw	19500				
Winter barley				**16100**	
Seeds				7000	
Straw				9100	
Alfalfa					
Seeds					
Straw					
Oat		**23400**			
Seeds		9000			
Straw		14400			
Spring wheat					
Seeds					
Straw					
Winter wheat	**150000**		**19500**		
Seeds	60000		10000		
Straw	90000		9500		
Triticale	**30000**	**48000**	**42000**	**30000**	
Seeds	10000	16000	18000	10000	
Straw	20000	32000	24000	20000	
Winter colza	**90000**		**271360**		
Seeds	30000		64000		
Straw	60000		207360		
Grass					
Straw					
Maize				**9000**	**80000**
Silage				9000	80000
Potatoes					
Mixed cereals	**52000**		**135000**	**33800**	
Seeds	20000		55000	13000	
Straw	32000		80000	20800	
Rye	**65800**	**23000**		**11500**	
Seeds	28000	10000		5000	
Straw	37800	13000		6500	

	Farm 11 (kg)	Farm 12 (kg)	Farm 13 (kg)	Farm 14 (kg)	Farm 15 (kg)	Total (kg)
Sugars beets				**170000**		**560000**
roots				100000		400000
straw				70000		160000
Pea						
seeds						
straw						
Spring barley		**184000**		**41400**		**508300**
seeds		80000		18000		221000
straw		104000		23400		287300
Winter barley		**69000**				**101200**
seeds		30000				44000
straw		39000				57200
Alfalfa						
seeds						
straw						
Oat						**49400**
seeds						19000
straw						30400
Spring wheat	**29568**				**23000**	**111704**
seeds	10560				10000	41680
straw	19008				13000	70024
Winter wheat	**217500**	**435000**				**1167100**
seeds	75000	150000				414000
straw	142500	285000				753100
Triticale	**112500**		**56700**	**94500**	**96000**	**961200**
seeds	37500		18900	31500	32000	324400
straw	75000		37800	63000	64000	636800
Winter colza		**402000**				**763360**
seeds		134000				228000
straw		268000				535360
Grass						
straw						
Maize	**125000**					**1329500**
silage	125000					1329500
Potatoes						
Mix cereals	**245232**		**49400**	**31200**	**39000**	**869864**
seeds	94320		19000	12000	15000	337640
straw	150912		30400	19200	24000	532224
Rye					**41400**	**162400**
seeds					18000	70000
straw					23400	92400

Fertilizantes

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Mineral fertilizers	For fields					
Input 1	N-pure component	191,78	165,47	50,43	49,28	45,48
Input 2	P-pure component	41,10	50,53	11,60	20,25	0,54
Input 3	K-pure component	61,64	75,79	11,60	30,38	0,81
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	2,74	63,16	65,93	84,39	
Input 2	P-pure component	0,71	16,42	17,14	21,94	
Input 3	K-pure component	3,18	73,26	76,48	97,89	
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Mineral fertilizers	For whole farm					
Input 1	N-pure component	186,67	124,76	44,13	33,37	30,24
Input 2	P-pure component	40,00	38,10	10,15	13,71	0,36
Input 3	K-pure component	60,00	57,14	10,15	20,57	0,54
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	2,67	47,62	57,69	57,14	0,00
Input 2	P-pure component	0,69	12,38	15,00	14,86	0,00
Input 3	K-pure component	3,09	55,24	66,92	66,29	0,00

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Mineral fertilizers	For fields					
Input 1	N-pure component	86,80	28,47	80,00	104,53	61,79
Input 2	P-pure component	40,00	18,45		29,09	3,67
Input 3	K-pure component	60,00	27,68		60,00	5,51
Input 4	Mg-pure component				88,36	
Input 5	Ca-pure component				16,36	
Natural fertilizers						
Input 1	N-pure component	142,50	2,93	62,50		
Input 2	P-pure component	37,05	0,76	16,25		
Input 3	K-pure component	165,30	3,40	72,50		
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Mineral fertilizers	For whole farm					
Input 1	N-pure component	47,12	25,24	69,16	103,59	54,22
Input 2	P-pure component	21,72	16,36		28,83	3,22
Input 3	K-pure component	32,57	24,54		59,46	4,84
Input 4	Mg-pure component				87,57	
Input 5	Ca-pure component				16,22	
Natural fertilizers						
Input 1	N-pure component	77,36	2,60	54,03		
Input 2	P-pure component	20,11	0,68	14,05		
Input 3	K-pure component	89,74	3,01	62,68		

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 11	Farm 12	Farm 13	Farm 14	Farm 15
Mineral fertilizers	For fields					
Input 1	N-pure component	58,89	71,79	174,15	85,15	62,78
Input 2	P-pure component		15,02	71,20	14,69	60,00
Input 3	K-pure component		22,53	106,80	14,69	60,00
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	46,30	45,06	20,59	12,24	59,45
Input 2	P-pure component	12,04	11,72	5,35	3,18	31,20
Input 3	K-pure component	53,70	52,27	23,88	14,20	64,17
Input 4	Mg-pure component					49,78
Input 5	Ca-pure component					14,00
Mineral fertilizers	For whole farm					
Input 1	N-pure component	46,09	48,62			
Input 2	P-pure component		10,17			
Input 3	K-pure component		15,26			
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	36,23	30,52			
Input 2	P-pure component	9,42	7,93			
Input 3	K-pure component	42,03	35,40			

Herbicidas

	Herbicides(L)	Herbicides(kg)	Fungicides (L)
Farm 1	2,84	0,01	0,47
Farm 2	1,24	0,06	0,08
Farm 3	1,98	0,07	0,54
Farm 4	1,94	0,02	
Farm 5	1,64		
Farm 6			
Farm 7	3,70	0,97	
Farm 8	2,74		
Farm 9	0,90		
Farm 10	0,61	0,20	
Farm 11		0,13	
Farm 12	0,90	0,01	
Farm 13	1,56	0,01	2,31
Farm 14		0,26	
Farm 15	3,20		0,16
Average	1,94	0,17	0,71

Energía

	Electricity (kWh)	Machinery (kg)	Gas (L)	Wood (kg)	Coal (kg)
Farm 1	6061,95	13995,00		9800,00	4000,00
Farm 2	37500,00	12270,00		2450,00	5000,00
Farm 3	60000	21005			2000
Farm 4	3690	9540		4900	7000
Farm 5	6061,95	9727		9800	3000
Farm 6	7500	8792	2000	12250	
Farm 7	7950,00	30562,00		2450,00	1000,00
Farm 8	10000,00	8670,00			6000,00
Farm 9	6000,00	14520,00		24500,00	
Farm 10	7800,00	12840,00		7350,00	15000,00
Farm 11	9600,00	22450,00		2450,00	5000,00
Farm 12	6061,95	11260,00		9800,00	4000,00
Farm 13		21942,00		7350,00	4000,00
Farm 14		10025,00		3920,00	4000,00
Farm 15		15332,00		4900,00	2000,00
Total	168225,85	222930,00	2000,00	101920,00	62000,00

RESULTADOS

Animales

La suma de las hectareas de todas las granjas es de 683.51 ha, y la superficie de la comunidad de Tluchowo es de 3137.93 ha. Así que cogiendo la última columna de los animales y multiplicandola por un factor resultante de 3137.93 / 683.51 = 4.6, obtengo una aproximación del número de animales totales en la comunidad

ANIMALS	TŁUCHOWO
Cow Milk	515,2
Cow Meat	966
Calves	984,4
Pig	8303
Piglet	3882,4
Wild-piglet	726,8
Horses	13,8
Goat	13,8
Chicken	138
Goose	46000
Sheep	506

Cosechas

Aquí hago lo mismo que en el caso anterior

CROPS	TŁUCHOWO (kg)
Sugars beets	**2576000**
roots	1840000
straw	736000
White mustard	
seeds	
straw	
Pea	
seeds	
straw	
Spring barley	**2338180**
seeds	1016600
straw	1321580
Winter barley	**465520**
seeds	202400
straw	263120
Alfalfa	
seeds	
straw	
Oat	**227240**
seeds	87400
straw	139840
Spring wheat	**513838,4**
seeds	191728
straw	322110,4
Winter wheat	**5368660**
seeds	1904400
straw	3464260
Triticale	**4421520**
seeds	1492240
straw	2929280
Winter colza	**3511456**
seeds	1048800
straw	2462656
Grass	
straw	
Fodder material	
Maize	**6115700**
silage	6115700
Potatoes	
Mixed cereals	**4001374,4**
seeds	1553144
straw	2448230,4
Rye	**747040**
seeds	322000
straw	425040

Fertilizantes

En este caso en vez de usar un factor de multiplicación lo que hago es hacer la media aritmética, porque tengo los datos divididos en kg/ha, así que haciendo la media puedo aproximar la cantidad de fertilizantes usado en la comunidad

INPUTS	NAME	INPUT AMOUNT (kg/ha)
Mineral fertilizers	**For fields**	**TŁUCHOWO**
Input 1	**N-pure component**	87,79
Input 2	**P-pure component**	28,93
Input 3	**K-pure component**	41,34
Input 4	**Mg-pure component**	88,36
Input 5	**Ca-pure component**	16,36
Natural fertilizers		
Input 1	**N-pure component**	50,65
Input 2	**P-pure component**	14,48
Input 3	**K-pure component**	58,35
Input 4	**Mg-pure component**	49,78
Input 5	**Ca-pure component**	14,00
Mineral fertilizers	**For whole farm**	
Input 1	**N-pure component**	67,77
Input 2	**P-pure component**	18,26
Input 3	**K-pure component**	28,51
Input 4	**Mg-pure component**	87,57
Input 5	**Ca-pure component**	16,22
Natural fertilizers		
Input 1	**N-pure component**	36,59
Input 2	**P-pure component**	9,51
Input 3	**K-pure component**	42,44
Input 4	**Mg-pure component**	
Input 5	**Ca-pure component**	

Herbicidas

En este caso hago lo mismo que con los fertilizantes

MATERIAL	TŁUCHOWO
Herbicides(L)	6079,46
Herbicides(kg)	547,89
Fungicides (L)	2231,49

Energía

En este caso hago lo mismo que en el caso de animales y cosechas; multiplicar por el factor de conversión 4.6

ENERGY	TŁUCHOWO
Electricity (kWh)	773838,91
Machinery (kg)	1025478,00
Gas (L)	9200,00
Wood (kg)	468832,00
Coal (kg)	285200,00

DISCUSIÓN

Uno de las mejores maneras de analizar un problema es hacer un análisis DAFO, que consiste en un plan estratégico usado para evaluar las debilidades, amenazas, fortalezas y oportunidades que envuelven a un proyecto. Identifica los factores internos y externos que son favorables y desfavorables para lograr un objetivo

Debilidades

1. Aspectos agroalimentarios
    - Bajos ingresos del sector agrícola
    - Bajo capital invertido y dificultad de encontrar dinero para financiar infraestructuras
    - Lenta adaptación a las nuevas tecnologías
    - Alto porcentaje de suelos pobres y ácidos
    - Muchas áreas de cultivo sin utilizar

2. Aspectos medioambientales
    - Escasez de agua
    - Insuficiente nivel de recursos para la biodiversidad en áreas rurales
    - Excesiva acidificación del suelo

3. Aspectos sociales y económicos
    - Técnicas e infraestructuras poco desarrolladas en áreas rurales
    - Elevada tasa de desempleados
    - Baja movilidad ocupacional de los habitantes rurales
    - Bajo nivel de estudios de los granjeros
    - Red de trabajo poco desarrollada en servicios para la población rural

Amenazas

1. Aspectos agroalimentarios
    - Barreras políticas con otros países

2. Aspectos medioambientales
    - Gestión irracional de la agricultura que produce una masiva cantidad de contaminación al medio ambiente

3. Aspectos sociales y económicos
    - Incremento de la pobreza y de la exclusión social en las zonas rurales
    - Limitadas áreas de trabajo para gente que quiere salir del trabajo en el campo
    - Lento crecimiento económico

Fortalezas

1. Aspectos agroalimentarios
   - Amplios recursos agrícolas y su resultante producción potencial
   - Producción agrícola multibanda en escala al país
   - Incremento medio del tamaño medio de las infraestructuras
   - Condiciones ventajosas para el desarrollo de granjas orgánicas

2. Aspectos medioambientales
   - Suelo poco contaminado y relativas buenas condiciones ambientales, lo que puede resultar en una buena calidad de los alimentos
   - Alta biodiversidad de áreas rurales proveyendo una base para la implementación de agricultura adecuada
   - Alto valor natural y turístico del paisaje

3. Aspectos sociales y económicos
   - Densa red de habitantes
   - Diversidad de recursos humanos permitiendo el desarrollo fuera de las actividades agrícolas

Oportunidades

1. Aspectos agroalimentarios
   - Acceso abierto a los productos agrícolas en los mercados
   - Amplias oportunidades con países del tercer mundo (precio más barato)
   - Incremento de la capacidad consumidora de la población, resultante de la petición de demanda de productos agrícolas
   - Conformación del grupo de empresas económicamente viables
   - Gente joven que quiere empezar a trabajar en el sector

2. Aspectos medioambientales
   - Mantenimiento de la alta biodiversidad en las áreas rurales que asegure el turismo y los valores naturales en el paisaje rural

3. Aspectos sociales y económicos
   - Incremento de la atracción de las zonas rurales como áreas para vivir
   - Gente joven que se está yendo a vivir al campo
   - Gran desarrollo de pequeñas ciudades y zonas rurales debido a la emigración de la ciudad

CONCLUSIÓN

Las conclusiones están divididas en tres puntos: medio ambiente, economía y sociedad

Medio ambiente

- Agua: la calidad del agua es muy baja, debido a que las factorías vierten las aguas residuales al río libremente, contaminándolo y haciendo que el agua sea inservible para el uso humano, agrícola o ganadero
- Suelo: el suelo es arenoso y un poco ácido, así que los granjeros deben usar cosechas que se adapten a estas cualidades
- Aire: el aire está bastante contaminado por el abusivo uso de carbón en la vida cotidiana y debido a la refinería de la ciudad vecina (Plock)
- Clima: es uno de los factores más importantes para cosecha y ganado y en esta región es muy frío en invierno (-25ºC) y muy caluroso en verano (30ºC) haciendo de este intervalo un hándicap para la correcta producción
- Paisaje: alta calidad de medio ambiente natural, creando condiciones favorables para el desarrollo de la agricultura, industria y turismo

Sociedad

- Población: bajo nivel de educación y pocos profesionales cualificados. Alto nivel de desempleo, particularmente entre los jóvenes. Bajo nivel de ingresos por los trabajadores lo que hace imposible mejoras en la tecnología del campo
- Instituciones: Pocas instituciones que apoyan el desarrollo agrícola, dando prioridad a las grandes ciudades y favoreciendo el abandono de la vida en el campo

Economía:

- Infraestructuras pobremente desarrollada, particularmente las que conciernen al tratamiento de aguas y de basuras. No hay reciclaje
- Implementación relativamente limitada de las nuevas tecnologías, a pesar de un gran potencial de desarrollo e investigación
- Gran cantidad de propiedades naturales y culturales que atraerían a muchos turistas sin utilizar debido a la pasividad de las instituciones

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LANDSCAPE METABOLISM – THE ROLE OF EXTERNAL AND INTERNAL NATURAL INPUTS

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JUNE, 2011

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FOREWORD

This report is the final resulto f a Project which i did as an Exchange student from Universidad Pública de Navarra (Spain) at the Uniwersytet Mikolaja kopernika in Torun, Poland.

I would like to thank to the UMK and all the people who have helped me by giving advices and inform about the subject of my project. Special thanks to Prof. dr hab. Adam Czarnecki and Anna Lewandowska Czarnecka who have guided me during the whole project and who gave me the right advices to improve the quality of this report. Also special thanks to Adrianna Ostrowicka, Kinga Ostrowicka and Jolanta Kwiecień, who helped me with finding the right information and the translation of the text which were in Polish

Torun, June 2011

Javier Larrea

INTRODUCTION

Living systems are capable of using metabolic energy in order to maintain or even to increase their organization. The dynamic structure of living beings allows them to transfer energy while maintaining their organized complexity. Beyond the maintenance of a far form thermodynamic equilibrium organization, successful evolution also entails that living structures cast themselves into the future by means of reproduction. In this sense, a living being is a highly sustainable system. The thermodynamic model of an organism bears strong similarities with the functional structure of ecosystems, providing useful criteria to what may be understood as sustainability. A diagnose of ecosystems sustainability may be based on properties such as biodiversity and productivity, efficient use of energy and its lowest dissipation. Applying the same idea to economic-ecological systems would require quantifying the organized heterogeneity in space-time, the energy efficiency and local sufficiently at the adequate levels, the closure of biophysical metabolic cycles and, above all, the existing balance between human exploitation of natural resources and the resilient capacity of ecosystems. Joining economics and ecology together in such a sustainability assessment remains a great pending challenge

Considering the landscape as a system, we may define the land matrix as space-time structure resulting from the physical environment, the biological component, its functional relationship and anthropogenic transformations which are expressed in specific land patterns. Landscape as such may be understood from an environmental historical point of view as a territorial expression of the metabolism that any society maintains with the natural systems that sustain it. In order to understand the land use changes that take place in the land matrix, energy and information flows of the metabolic exchange of the economy with its environment can be analysed, so that the main ecological impacts imprinted in the ecosystems may be indentified

The holistic approach views the planet as a whole system and tries to develop the idea of a necessary symbiosis between nature and society. This point of view places the co-evolution of complexity at the highest level of a global ecological hierarchy, i.e. seeing the sun as the biosphere's main energy source and fossil fuels as the main energy resources for the human tecnosphere at present. Three decades ago the pioneering work done in the energy analysis of economic fluxes revealed the substantial decline in energy yields experienced by contemporary agrarian systems brought about with the massive consumption of fossil fuels and other industrial inputs. More recently, several studies are reassessing the role played by traditional agrarian knowledge and practices that ensured sustainable strategies of forest management and the conservation of agricultural landscapes. However, the role played by energy and material throughputs moved by social metabolism as a driving force contemporary land-use changes is still not well understood. I will try to contribute in the dialogue between the economic-ecological accounting of energy flows and the study of land-uses changes as seen from landscape ecology

Traditional agrarian societies organized their land –uses according to different gradients of intensity, always keeping an integrated management of the territory, mainly because their whole subsistence depended on it. In order to offset the loss in energy transformation that inefficient animal bioconversion entails (a process on which they depended to generate draught power and manure) they carefully integrated livestock breeding onto the agricultural, pasture and forest spaces. In an organic-based economy, which depends on photosynthesis to grow almost everything, the larger the population density and volume of trade were, the more necessary it became to manage the local land matrix with the upmost socio-metabolic efficiency. The substitution of that land-based solar energy system by the contemporary one based on burning underground fossil fuels on a large scale has enabled society to overcome the age-old energy dependency on bioconverters. As a result, integrated land-use management has ceased to be a need at a local or regional scale. Both phenomena have taken place side by side and have led to the abandonment of integrated land-use management. Now however, environmental damage caused by this lack off integrated energy-used and land-used management urges us to recover the lost landscape efficiency in a very different economic and environmental context

Landscape complexity arises in nature because the dissipation of energy in space leads to the formation of self-organized structures, and also to a historical succession ruled adaptative selection. A theoretical approach that already exists in ecology enables us to understand that the sustainability of human development is also a direct function of its complexity and in an inverse relationship to its dissipation of energy. When humans increase the dissipated energy, the complexity of the system is reduced and environmental degradation becomes inevitable. In healthy ecosystems the gathering of information at some points rests on the exploitation of other spaces for lower complexity but larger production, though this independent relationship may be established in different ways. A heterogeneous space-time model may allow, as in nature, to keep more mature and organized spaces together with simpler and productive ones in an interdependent structure capable of providing stability to the system.

This suggests the importance of analysing the existing relationship between social metabolism and the functioning of the biophysical matrix in order to identify the mechanisms that link energy dissipation with the complexity of ecological systems. From a landscape ecology standpoint that complexity can be understood as the capacity of the land system to host different species and ecological processes, such a complexity evolves in the interplay between society and nature, and in order to highlight this societal link between energy of material throughputs and land-use changes we introduce the concept of landscape efficiency. By “landscape efficiency” we understand the ways of improving the socioeconomic satisfaction of human needs while maintaining the healthiest landscape ecological patterns and processes, so as to ensure that the natural resources and environmental services offered by the land matrix continue to be enjoyed. We must stress that the alternative to the current unsustainable economic development has to be the implementation of a strategy of enhancing complexity without increasing the dissipative system. Undoubtedly, landscape efficiency becomes a necessary condition for sustainable development

The research focuses on the synergies between sociometabolic energy use and landscape patterns, and starts form the hypothesis that there is a complex and changing relationship between de degree of efficiency in the societal use of energy, the efficiency in land-uses and the environmental quality of ecosystem functioning of the whole land matrix. This leads to the concept of landscape efficiency, which we defines as achieving those forms of economic land-use that meet human needs while enhancing ecological complexity and function. It can be assessed by analysing these three interfaces:

1. Between socio-metabolic energy-use and land-use efficiency
2. Between landscape patterns and ecological processes
3. Between the disturbance exerted by external energy flows moved by social metabolism and the ecological functioning of the whole land matrix.

The study of this three-way relationship from an environmental historical perspective may bring to light key criteria to help me identify the driving forces behind the current global change, so as to redirect their course by means of more sustainable land-use planning.

STUDY AREA

POLAND

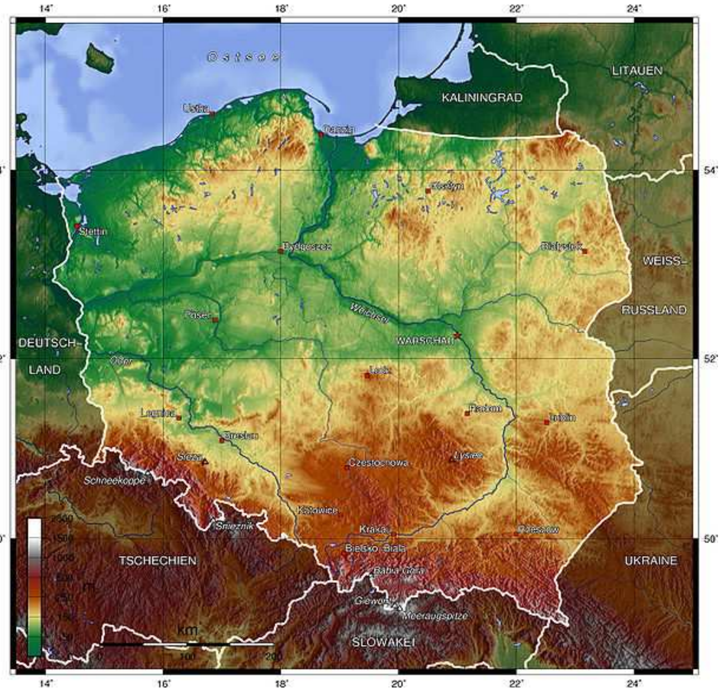
Poland is a country in Central Europe bordered by Germany to the west; the Czech Republic and Slovakia to the south; Ukraine, Belarus and Lithuania to the east; and the Baltic Sea and Kaliningrad Oblast, a Russian exclave, to the north. The total area of Poland is 312,679 square kilometres (120,726 sq mi), making it the 69th largest country in the world and the 9th largest in Europe. Poland has a population of over 38 million people, which makes it the 34th most populous country in the world and the sixth most populous member of the European Union, being its most populous post-communist member.

Geography

Poland's territory extends across several geographical regions, between latitudes 49° and 55° N, and longitudes 14° and 25° E. In the northwest is the Baltic seacoast, which extends from the Bay of Pomerania to the Gulf of Gdańsk. This coast is marked by several spits, coastal lakes (former bays that have been cut off from the sea), and dunes. The largely straight coastline is indented by the Szczecin Lagoon, the Bay of Puck, and the Vistula Lagoon. The centre and parts of the north lie within the North European Plain.

Rising gently above these lowlands is a geographical region comprising the four hilly districts of moraines and moraine-dammed lakes formed during and after the Pleistocene ice age. These lake districts are the Pomeranian Lake District, the Greater Polish Lake District, the Kashubian Lake District, and the Masurian Lake District. The Masurian Lake District is the largest of the four and covers much of northeastern Poland. The lake districts form part of the Baltic Ridge, a series of moraine belts along the southern shore of the Baltic Sea.

South of the Northern European Lowlands lie the regions of Silesia and Masovia, which are marked by broad ice-age river valleys. Farther south lies the Polish mountain region, including the Sudetes, the Cracow-Częstochowa Upland, the Świętokrzyskie Mountains, and the Carpathian Mountains, including the Beskids. The highest part of the Carpathians is the Tatra Mountains, along Poland's southern border.



Land uses

Forests cover 28.8% of Poland’s land area. More than half of the land is devoted to agriculture. While the total area under cultivation is declining, the remaining farmland is more intensively cultivated.

More than 1% of Poland’s territory, 3,145 square kilometres (1,214 sq mi), is protected within 23 Polish national parks. Three more national parks are projected for Masuria, the Cracow-Częstochowa Upland, and the eastern Beskids. In addition, wetlands along lakes and rivers in central Poland are legally protected, as are coastal areas in the north. There are over 120 areas designated as landscape parks, along with numerous nature reserves and other protected areas.

Present day Poland is a country with great agricultural prospects; there are over two million private farms in the country, and Poland is the leading producer in Europe of potatoes and rye and is one of the world's largest producers of sugar beets and triticale. This has led Poland to be described on occasion as the future 'bread basket of the European Union'. However, despite employing around 16% of the workforce, agricultural output in Poland remains low and the industry is characterised as largely inefficient due to the large number of small, independent farms. This situation is likely to soon change for the better with the government debating agricultural reform and currently pursuing the option of auctioning off large tracts of state-owned agricultural land.

Administrative divisions

Poland's current voivodeships (provinces) are largely based on the country's historic regions, whereas those of the past two decades (to 1998) had been centred on and named for individual cities. The new units range in area from less than 10,000 square kilometres (3,900 sq mi) for Opole Voivodeship to more than 35,000 square kilometres (14,000 sq mi) for Masovian Voivodeship. Administrative authority at voivodeship level is shared between a government-appointed voivode (governor), an elected regional assembly (sejmik) and an executive elected by that assembly.

The voivodeships are subdivided into powiats (often referred to in English as counties), and these are further divided into gminas (also known as communes or municipalities). Major cities normally have the status of both gmina and powiat. Poland currently has 16 voivodeships, 379 powiats (including 65 cities with powiat status), and 2,478 gminas.

KUJAWSKO-POMORSKIE

It is situated in mid-northern Poland, on the boundary between the two historic regions from which it takes its name: Kuyavia (Polish: *Kujawy*) and Pomerania (Polish: *Pomorze*). Its two chief cities, serving as the province's joint capitals, are Bydgoszcz and Toruń.

The Kuyavian-Pomeranian Voivodeship was created on 1 January 1999, as a result of the Polish local government reforms adopted in 1998. It consisted of territory from the former Bydgoszcz, Toruń and Włocławek Voivodeships.

The area now known as Kuyavia-Pomerania was previously divided between the region of Kuyavia and the Polish fiefdom of Royal Prussia. Of the two principal cities of today's Kuyavian-Pomeranian voivodeship, one (Bydgoszcz) was historically located in Kuyavia, whilst the other (Toruń) was an important town of Royal Prussia.

The Kuyavian-Pomeranian Voivodeship is bordered by five other voivodeships. These are Pomeranian Voivodeship to the north, Warmian-Masurian Voivodeship to the north-east, Masovian Voivodeship to the east, Łódź Voivodeship across a short boundary to the south, and Greater Poland Voivodeship to the south and west.

TŁUCHOWO

Tłuchowo Gminia is situated in south-eastern part of the Kujawsko - Pomorskie, in Lipno County, along the border with the province of Mazovia.
In the north and west has borders respectevly with Skępe, Wielgieand and Dobrzyń Gminia. In the east, the border is the Skrwa River with the Mochowo Gminia, and in the south bounded with Brudzen Gminia.

Tłuchowo is:
• 32 km from Płock
• 22 km from Lipno
• 40 km from Włocławek
• 20 km from Sierpc
• 14 km from Dobrzyń

The total area of 9,867 hectares of the municipality, as follows:

- Forests - 1,615 ha
- Agricultural land – 3137.93 ha
- Barren land – 210.44 ha

Until recently, they were typically agricultural, but these years, however, there is having a huge increase in economic activity of the residents, with a great deal of new business like sawmill, food shops or clothes stores.

METHODS

For a sustainability assessment it is essential to establish the performances of contrasting agroecosystems, i.e., functioning prevalently on the basis of the flow of either solar or auxiliary energy. There is general agreement that negative environmental impact is lower in agroecosystems which employ less auxiliary energy. The APIs should highlight those forms of organization capable of better exploiting the system's native resources (solar radiation, soil organic matter, atmospheric nitrogen, etc.) rather than imported, non-renewable resources. Hence, the need to establish a methodology capable of evidencing flows of information and energy-matter not only between the farm and the outside world, but also within the farm. Monetary and energy values were used to measure, respectively, the flow of information and the flow of energy-matter. These measures are regarded as sufficiently homogenizing and comprehensive to document patterns of agroecosystem transfers of bio-physical entities and socio-cultural values. With this approach, and using energetic and economic accounting criteria, the farm was studied as both a thermodynamic and economic unit.

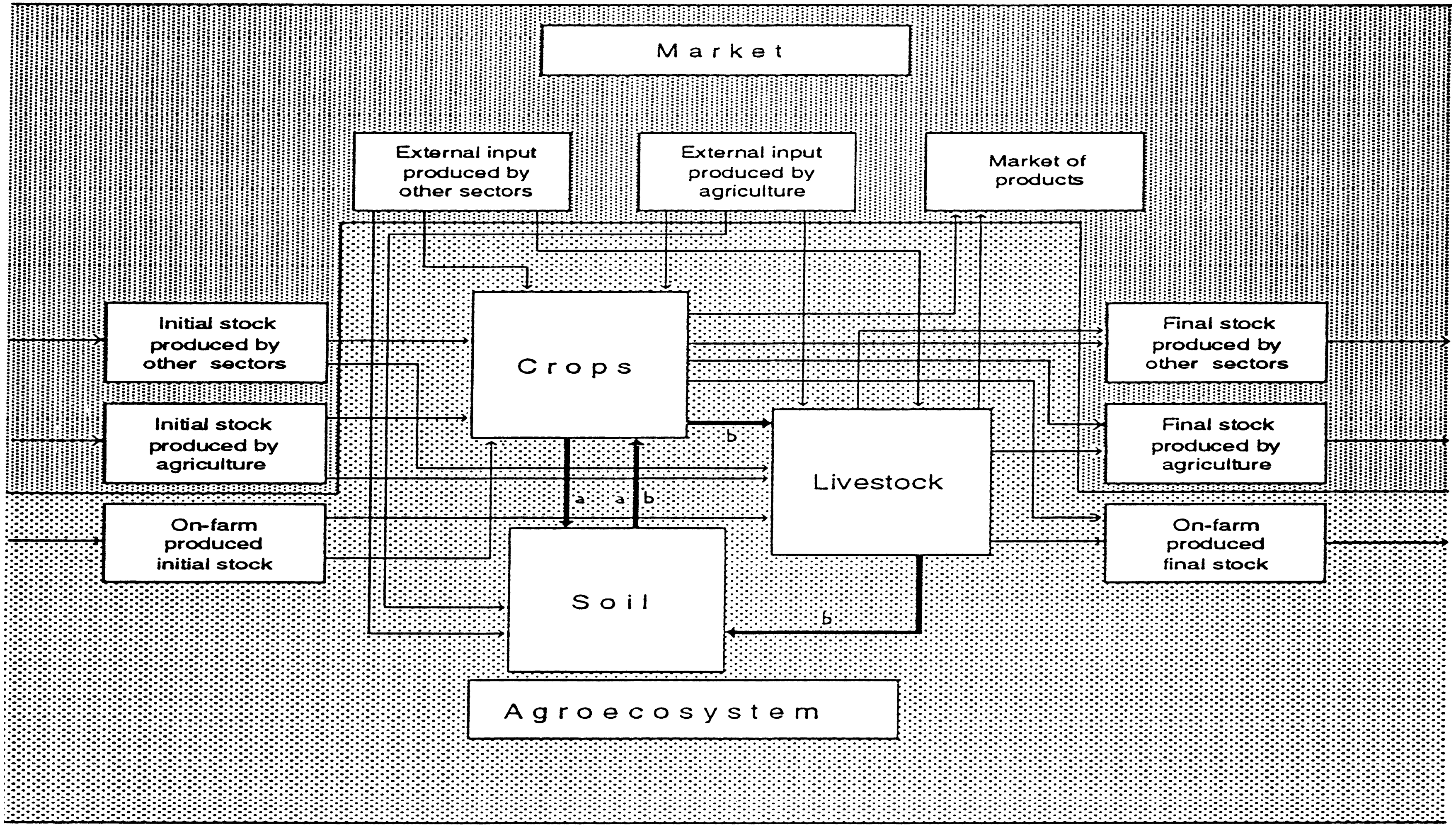
1. The structure of the input/output matrix

The proposed model of a mixed-farming system, which is presented in Fig. 1, has subsequently been implemented into an input/output (I/O) matrix. The core of the model is represented by the three main components into which the farming system is divided: crops; livestock; and soil. This model analyzes the fundamental energy transfers (and the associated allocation of monetary values in terms of market prices) between the crucial agroecosystem components which constitute the most important element for agroecosystem sustainability, i.e., soil fertility. This search for insights into the partitioning of autotrophic energy is known as intermediary agricultural energetic and is regarded, despite its importance, as a neglected field of research.

Each arrow linking two sectors represents both an output for the first sector (from which it originates), and an input for the second sector (to which it is directed). It is thereby possible to produce a budget for the whole agroecosystem of both financial flows and energy and material flows. The methodology can be applied to the farm, considered as hierarchically organized in the following way: individual fields; individual crops; cultivation systems (herbaceous and arboreal) and animal breeding; and whole farm. Each of the three sectors (crops, animals and soil) is an aggregate of elementary units, which, from a basic I/O matrix, can be seen to make up a large number of items, varying from one sector to another. For each item, the material, energy and monetary value flows can be analyzed both to and from the other sectors, and to and from the outside world. Each junction of the network is connected to the outside both in space (the market) and time (previous and subsequent cycles). Each sector is similarly linked to the others: crops and soil exchange water, gas, mineral elements and organic compounds (small circulation). The crop sector supplies the livestock sector with biomasses for re-use and the livestock sector, in turn, supplies manure back to the soil sector (large circulation). Between these three sectors there are on-farm transfers of energy-materials.

According to Draghetti (1948), small and large circulation, activated by solar energy, constitutes the motor of the entire production process. This motor is also fuelled by input from the outside and produces output that can be re-used on the farm (in the same or different sector) or leave the system definitively.

Fig. 1. Spatial-temporal representation of an agroecosystem. Energy, material and monetary transfers existing between market and the elementary sectors of the farm are represented. (a) small circulation (b) large circulations



The market, which is regarded as the external socio-economic environment where the farm is immersed, has been divided into two large parts: the primary sector (i.e., agriculture) and the other sectors. Only the former is capable of using renewable energy, i.e., energy derived from fossil fuels; the latter supply non-renewable energy. The different environmental significance of the input produced by the two sectors is obvious.

The other distinguishing element of the market area (valid also for the farm system) is represented by time. Input can come from previous cycles (either purchased: market; or produced: farm) and, in turn, output can be used in subsequent cycles (with the same purchased/produced distinction), either re-used on the farm or sold.

With this kind of model it is not only possible to measure total input and output, but also internal movements from one sector to another, and even within each sector.

As an example, Table 1 is one of the I/O matrices which were aggregated from the elementary ones built both for energy and monetary values in the two farms studied. In few words, the I/O matrix indicates, sector by sector, what and how much, in terms of both energy and monetary values, has been consumed (reading down the columns) to produce how much and for what purpose (reading across the lines.

2. Agroecosystem performance indicators

A series of APIs are presented. Each of them can be calculated both in terms of energy and monetary value; in addition, they can be 'direct', i.e., obtained as relationships between homogeneous entities: energy/energy; money/money, etc., or 'crossed', i.e., obtained by relating dimensionally different measurements: energy values with monetary values and vice versa.

Since the flows within the farm and between farm and external world may be expressed as energy or as monetary values or as nutrients, all direct APIs can be calculated for each of these flows. Thus, in the presentation of the various APIs below, reference to energy may be replaced by monetary values or by nutrients. Only the field of observation changes, not the model of reasoning.

The case of crossed indicators, however, is different. Each of these has its specific significance and so they must be constructed by opportune combination of the different entities, with reference to the particular objective to be reached.

Clearly all the indicators presented here — which are certainly not exhaustive — can be calculated both at the level of individual production sector and that of farm as a whole.

2.1. The direct agroecosystem performance indicators

By relating each type (or combination) of output to each type (or combination) of input, it is possible to obtain a considerable amount of information on both the circulation of energy (and monetary values) within the farm and the efficiency with which these resources are used, both at the level of individual sector and farm as a whole. In this way, it is possible to evaluate the level of energy dependency of the farm (or of each single sector) both on the world external to the farm and on non-renewable input, in other words, the sustainability level of the farm's agricultural activity.

Without making an overly emphatic distinction, the direct APIs can be subdivided into two large categories:

a) Structural indicators; and
b) Functional indicators.

The first category aims to describe the most relevant (from the environmental point of view) characteristics of agricultural systems and, therefore, to illustrate the differences and similarities between systems, while the second category aims to measure the efficiency of the different systems. All of these indicators are calculated both in energy and in monetary values.

2.1.1. Structural indicators related to input.

In the next lines, each input or output is labelled with a code where 'i' is for input and 'o' is for output and the number indicates the kind of input or output, as reported in the tables.

- Indicator of dependence on non-renewable energy sources (i4/i8): This is without doubt the first and most important API. It is calculated as the ratio between energy from input produced by other sectors (and, therefore, non-renewable: machines, oil, fertilizers, etc.: (i4), and total energy introduced into the system (i8). It tells us to what extent the production process depends on non-renewable energy.
- Indicator of obligatory re-use [(i1a+i2a)/i8]: By relating the sum of energy input outside the entrepreneur's control (i1a + i2a) to total farm input (i8), it is possible to measure what might be called the 'base' energy quota of the agroecosystem; i.e., the energy that the system automatically expropriates in order to function. This is the case, for example, of to the energy of the roots which remain in the soil after the harvest (Janssen, 1984).
- Indicators of immediate voluntary re-use (i1b/i8): This indicator is obtained as ratio of the energy value of voluntary internal transfers (i1b) to the total value of energy introduced into the system (i8); from it, it is possible to have an indication of the extent to which the agroecosystem is consciously following the path of sustainability; i.e., how much newly produced energy the entrepreneur chooses to reintroduce immediately into the production cycle.
- Indicator of deferred voluntary re-use (i2b/i8): This indicator integrates the previous one in that it measures the quota of energy deriving from input produced in previous years (i2b) and voluntarily reintroduced into the system.
- Global indicator of voluntary re-use [(i1b+i2b)/i8]: In order to have a comprehensive idea of the basic choices of the agroecosystem it is possible, of course, to add the two previous indicators together.
- Indicator of farm autonomy (i5/i8): This indicator is merely an extension of the four previous ones in that it indicates to what extent the farm can supply its own energy. In fact, included in the calculation of this indicator are those factors that the farm produced in the course of the previous cycle and thatare used in the current one. It is possible to hypothesize that, in general, low values of this indicator correspond to low values of the indicator of immediate re-use and high values of the indicator of dependence on non-renewable energy sources.
- Indicator of overall sustainability (i7/i8): In actual fact, from the environmental point of view, the indicator of farm autonomy holds no specific significance because it may not be particularly relevant to know whether or not the farm is prevalently self-sufficient in terms of production process energy requirements. Indeed, from the environmental point of view, it makes no difference whether a farm produces all its own energy or buys it from other farms. What is important is that input produced by agriculture is maximized. Herein lies the importance of the indicator of overall sustainability, which, calculated as the ratio of total

agricultural energy input (i7) to total input (i8), is simply the complement to 1 of the indicator of dependence on non-renewable energy sources, to which it may be used as an alternative. What changes is simply the point of view from which the production phenomenon is seen: this indicator encourages a view of the agricultural system as a whole, underlining the importance of the prevalent (or, better still, exclusive) use of completely renewable energy, especially that produced by agriculture. are used in the current one. It is possible to hypothesize that, in general, low values of this indicator correspond to low values of the indicator of immediate re-use and high

2.1.2. Structural indicators related to output

- Indicator of immediate removal (o3/o5): This indicator is the ratio of output destined for final consumption (o3) to gross output (o5) and provides a fairly clear indication of the system's main aims. High values of this indicator may be found for farms prevalently orientated to the market and less concerned with re-establishing the fertility characteristics of the soil at the end of each production cycle.
- Indicator of total removal (o4/o5): The information provided by this indicator — obtained as ratio of net output (o4) to total gross output (o5) — integrates and specifies that from the previous indicator. In fact, from the values of the indicator of total removal it is possible to discover how much output is not immediately destined for re-use on the farm.
- Indicator of obligatory internal destination [(o1a+o2a)/o5]: For this indicator — albeit with reference to output — those considerations made above regarding the indicator of obligatory re-use are again valid.
- Indicator of immediate voluntary internal destination (o1b/o5): Just like the indicator of immediate voluntary re-use considered above, this indicator is capable of characterizing the farm from the point of view of the entrepreneur's interest in following the path of environmental sustainability; however, it could be sensitive to production results.
- Global indicator of immediate internal destination (o1/o5): This represents the complement to one of the indicator of total removal and tells us the total production quota immediately reintroduced into the production cycle.

2.1.3 Functional indicators

These indicators reproduce some of the simplest and most classical indicators of farm efficiency analysis. As such they are obtained as ratios of output values to input values. These indicators can be calculated with reference to both gross output and net output. Just as with structural indicators, functional ones are calculated both in energy and in monetary terms.

- Indicator of gross (net) output from total input (o5/i8; o4/i8): This value is simply the number of GJ of energy (or the ECU) obtained from the production process (gross or net: o5; o4) per GJ (or ECU), from any source, introduced into the system (i8).
- Indicator of gross (net) output from total farm input (o5/i5; o4/i5): This indicator measures the amount of energy (money) produced by the system (o5; o4) for every unit of energy (money) which, produced by the system itself, is reintroduced into the production process (I5).

- Indicator of gross (net) output from annual farm input (o5/i1; o4/i1): Differently from the previous indicator, this one measures the output from only that input produced on the farm itself in the course of the year under examination and immediately reintroduced into the production cycle (i1).
- Indicator of gross (net) output from external non-renewable input (o5/i4; o4/i4): This is certainly the most important functional indicator from the environmental point of view. It tells us how much energy (money) has been produced by the system (o5; o4) for every unit of non-renewable energy (money) introduced into the system (i4). This indicator may drop below parity: in this case the system has produced less energy (money) than it has irremediably destroyed.
- Indicator of gross (net) output from total external input (o5/i6; o4/i6): This indicator measures the productivity of all input from outside the farm, both renewable and not (i6).

2.2. Crossed agroecosystem performance indicators

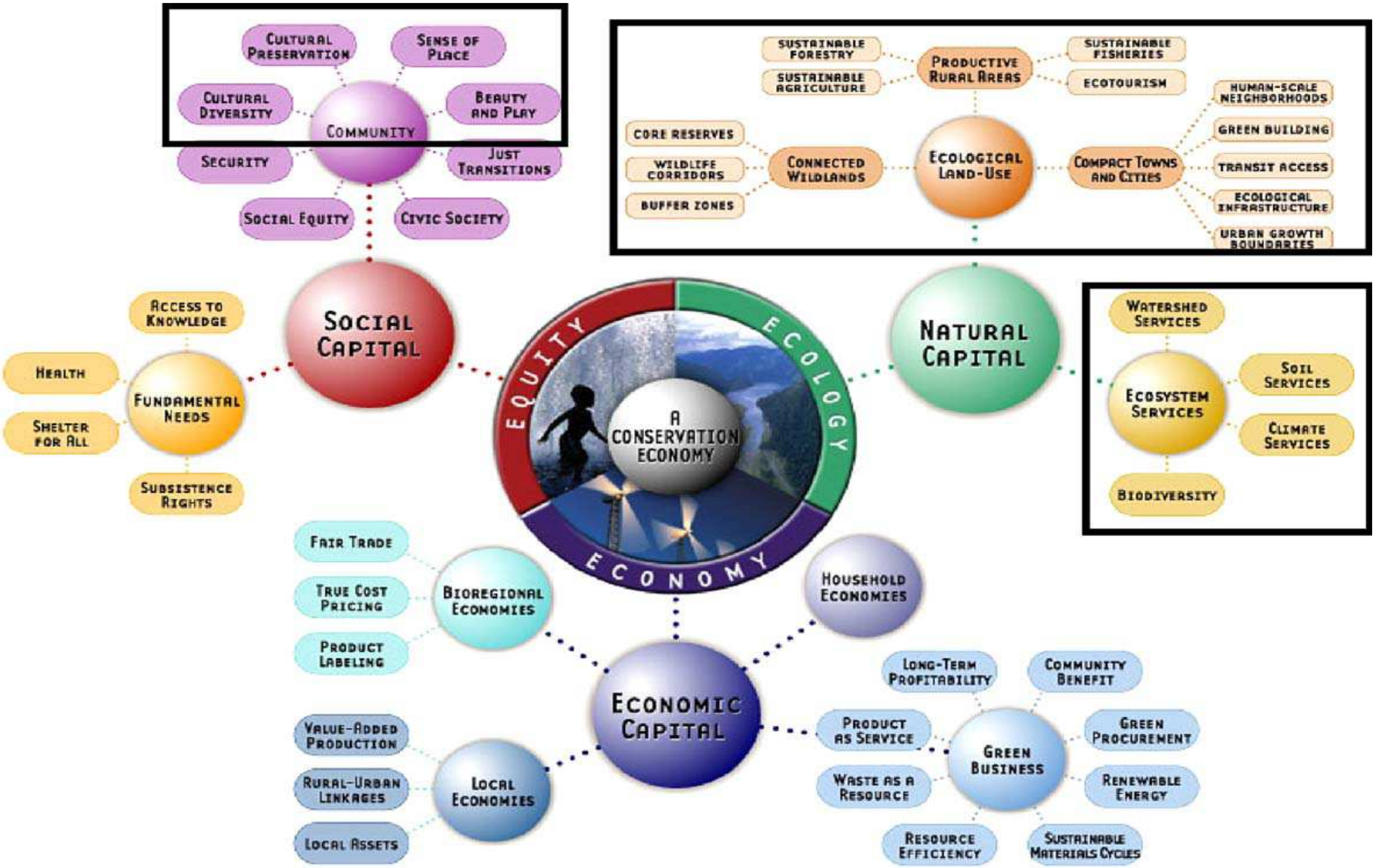
Alongside the direct APIs, calculated in both energy and monetary terms, it is also possible to construct a series of crossed APIs, both by relating output (gross and net) expressed in monetary values to the various kinds of energy input, and by relating energy output (gross and net) to the different kinds of input expressed in monetary values. In the former case (output in monetary values/input in energy) it is possible to evaluate:

a) The gross (and net) economic productivity of the total energy input;
b) The gross (and net) economic productivity of the energy input from outside the farm;
c) The gross (and net) economic productivity of the non-renewable energy input; and
d) The gross (and net) economic productivity of the energy input produced by agriculture. This is expressed in GJ/ECU and tells us how much money is produced per unit of energy introduced into the production process. In the latter case (output in energy/input in monetary values) it is possible to evaluate:
e) The gross (and net) energy productivity of the total monetary input;
f) The gross (and net) energy productivity of the money spent on input from outside;
g) The gross (and net) energy productivity of the money spent on non-renewable input; and
h) The gross (and net) energy productivity of the money spent on input produced by agriculture.

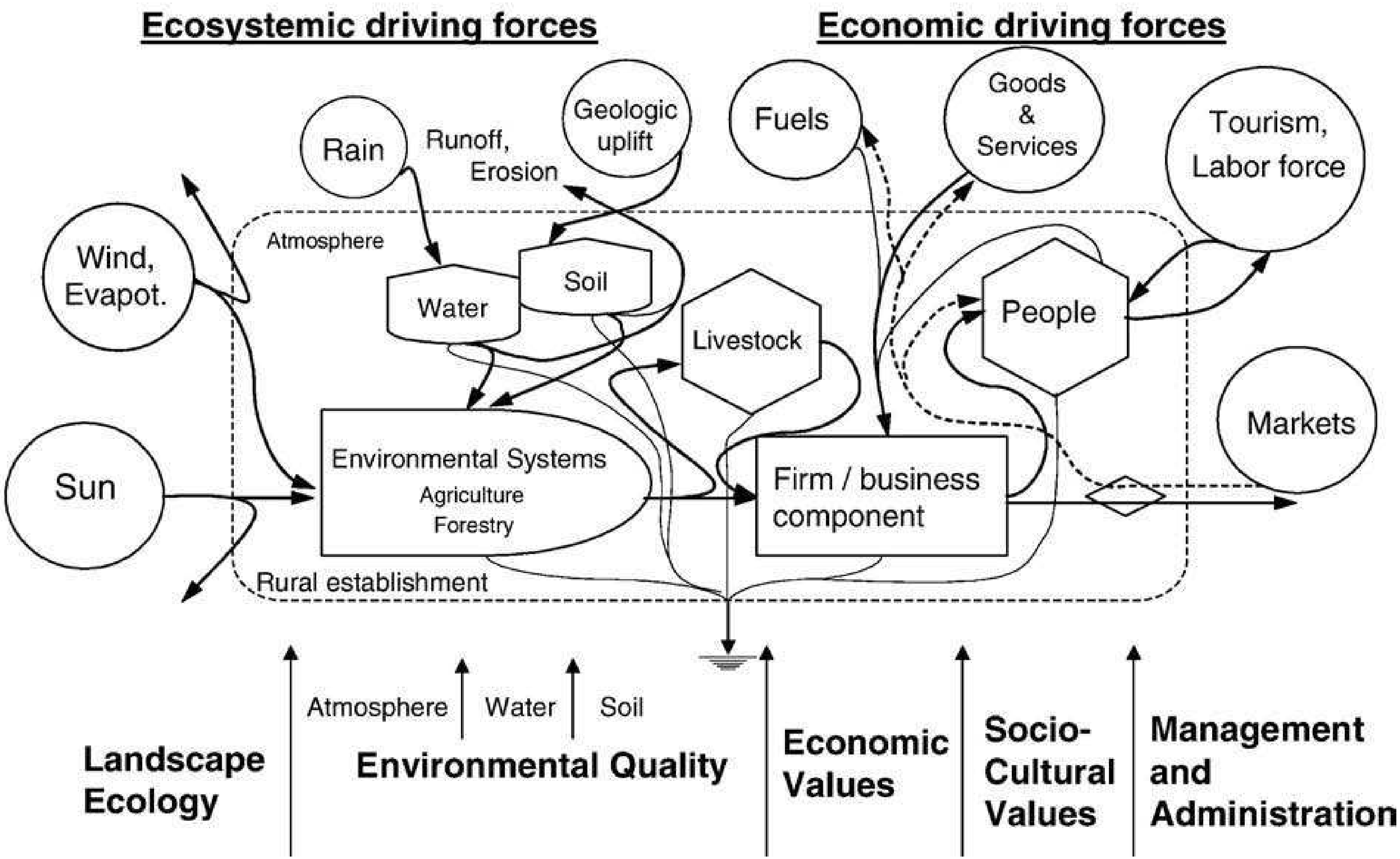
This is expressed in GJ/ECU and tells us how much energy (gross and net) is produced per ECU spent on the acquisition of the various kinds of input.

Clearly these are only some of the APIs that could be proposed, and, once again, each of these ratios can be calculated at both separate sector and whole farm levels.

Socio-economic-environmental system. Structure of Local community gmina



Level – farm input/outpuy/development



MATERIALS

The following data that I am going to present here are the data that I received from the farmers in the different farms in Tłuchowo Gmina. I visited 15 farmers obtaining data from all kind of animals and crops, as well as fertilizers that each farmer used in their lands.
I have divided the tables in 15 columns, one per farm, and the there is another column that is the sum of all these columns. This last column will be use in the results to obtain the total productivity in the Gmina

ANIMALS

	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Cow Milk	40			24	
Cow Meat	20	70	24	32	
Calves		200			
Pig			950		30
Piglet					
Wild-piglet					
Horses		3			
Goat			3		
Chicken					10
Goose					
Sheep					
Ha	75	63	52	18,32	18,42

	Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Cow Milk					
Cow Meat		12			
Calves					
Pig		30	32	30	85
Piglet			750		
Wild-piglet					
Horses					
Goat					
Chicken					
Goose	10000				
Sheep					
Ha	77,03	13,88	55,5	15,51	34,5

	Farm 11	Farm 12	Farm 13	Farm 14	Farm 15	Total
Cow Milk	25	1		12	10	112
Cow Meat	25	27				210
Calves				8	6	214
Pig		540	87	3	18	1805
Piglet			60	8	26	844
Wild-piglet			130	13	15	158
Horses						3
Goat						3
Chicken			20			30
Goose						10000
Sheep		110				110
Ha	98,31	85,7	16,34	25	35	

CROPS

	Farm 1 (kg)	Farm 2 (kg)	Farm 3 (kg)	Farm 4 (kg)	Farm 5 (kg)
Sugars beets			**390000**		
roots			300000		
straw			90000		
White mustard					
seeds					
straw					
Pea					
seeds					
straw					
Spring barley		**92000**	**138000**	**18400**	
seeds		40000	60000	8000	
straw		52000	78000	10400	
Winter barley					**16100**
seeds					7000
straw					9100
Alfalfa					
seeds					
straw					
Oat		**26000**			
seeds		10000			
straw		16000			
Spring wheat	**29568**		**29568**		
seeds	10560		10560		
straw	19008		19008		
Winter wheat	**217500**		**116000**		**11600**
seeds	75000		40000		4000
straw	142500		76000		7600
Triticale	**112500**	**144000**	**120000**	**45000**	**30000**
seeds	37500	48000	40000	15000	10000
straw	75000	96000	80000	30000	20000
Winter colza					
seeds					
straw					
Grass					
straw					
Maize	**125000**	**990500**			
silage	125000	990500			
Potatoes					
Mixed cereals	**245232**			**39000**	
seeds	94320			15000	
straw	150912			24000	
Rye				**20700**	
seeds				9000	
straw				11700	

	Farm 6 (kg)	Farm 7 (kg)	Farm 8 (kg)	Farm 9 (kg)	Farm 10 (kg)
Sugars beets					
roots					
straw					
White mustard					
seeds					
straw					
Pea					
seeds					
straw					
Spring barley	**34500**				
seeds	15000				
straw	19500				
Winter barley				**16100**	
seeds				7000	
straw				9100	
Alfalfa					
seeds					
straw					
Oat		**23400**			
seeds		9000			
straw		14400			
Spring wheat					
seeds					
straw					
Winter wheat	**150000**		**19500**		
seeds	60000		10000		
straw	90000		9500		
Triticale	**30000**	**48000**	**42000**	**30000**	
seeds	10000	16000	18000	10000	
straw	20000	32000	24000	20000	
Winter colza	**90000**		**271360**		
seeds	30000		64000		
straw	60000		207360		
Grass					
straw					
Maize				**9000**	**80000**
silage				9000	80000
Potatoes					
Mixed cereals	**52000**		**135000**	**33800**	
seeds	20000		55000	13000	
straw	32000		80000	20800	
Rye	**65800**	**23000**		**11500**	
seeds	28000	10000		5000	
straw	37800	13000		6500	

	Farm 11 (kg)	Farm 12 (kg)	Farm 13 (kg)	Farm 14 (kg)	Farm 15 (kg)	Total (kg)
Sugars beets				**170000**		**560000**
roots				100000		400000
straw				70000		160000
Pea						
seeds						
straw						
Spring barley		**184000**		**41400**		**508300**
seeds		80000		18000		221000
straw		104000		23400		287300
Winter barley		**69000**				**101200**
seeds		30000				44000
straw		39000				57200
Alfalfa						
seeds						
straw						
Oat						**49400**
seeds						19000
straw						30400
Spring wheat	**29568**				**23000**	**111704**
seeds	10560				10000	41680
straw	19008				13000	70024
Winter wheat	**217500**	**435000**				**1167100**
seeds	75000	150000				414000
straw	142500	285000				753100
Triticale	**112500**		**56700**	**94500**	**96000**	**961200**
seeds	37500		18900	31500	32000	324400
straw	75000		37800	63000	64000	636800
Winter colza		**402000**				**763360**
seeds		134000				228000
straw		268000				535360
Grass						
straw						
Maize	**125000**					**1329500**
silage	125000					1329500
Potatoes						
Mix cereals	**245232**		**49400**	**31200**	**39000**	**869864**
seeds	94320		19000	12000	15000	337640
straw	150912		30400	19200	24000	532224
Rye					**41400**	**162400**
seeds					18000	70000
straw					23400	92400

FERTILIZERS

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Mineral fertilizers	For fields					
Input 1	N-pure component	191,78	165,47	50,43	49,28	45,48
Input 2	P-pure component	41,10	50,53	11,60	20,25	0,54
Input 3	K-pure component	61,64	75,79	11,60	30,38	0,81
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	2,74	63,16	65,93	84,39	
Input 2	P-pure component	0,71	16,42	17,14	21,94	
Input 3	K-pure component	3,18	73,26	76,48	97,89	
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Mineral fertilizers	For whole farm					
Input 1	N-pure component	186,67	124,76	44,13	33,37	30,24
Input 2	P-pure component	40,00	38,10	10,15	13,71	0,36
Input 3	K-pure component	60,00	57,14	10,15	20,57	0,54
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	2,67	47,62	57,69	57,14	0,00
Input 2	P-pure component	0,69	12,38	15,00	14,86	0,00
Input 3	K-pure component	3,09	55,24	66,92	66,29	0,00

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Mineral fertilizers	For fields					
Input 1	N-pure component	86,80	28,47	80,00	104,53	61,79
Input 2	P-pure component	40,00	18,45		29,09	3,67
Input 3	K-pure component	60,00	27,68		60,00	5,51
Input 4	Mg-pure component				88,36	
Input 5	Ca-pure component				16,36	
Natural fertilizers						
Input 1	N-pure component	142,50	2,93	62,50		
Input 2	P-pure component	37,05	0,76	16,25		
Input 3	K-pure component	165,30	3,40	72,50		
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Mineral fertilizers	For whole farm					
Input 1	N-pure component	47,12	25,24	69,16	103,59	54,22
Input 2	P-pure component	21,72	16,36		28,83	3,22
Input 3	K-pure component	32,57	24,54		59,46	4,84
Input 4	Mg-pure component				87,57	
Input 5	Ca-pure component				16,22	
Natural fertilizers						
Input 1	N-pure component	77,36	2,60	54,03		
Input 2	P-pure component	20,11	0,68	14,05		
Input 3	K-pure component	89,74	3,01	62,68		

INPUTS	NAME	INPUT AMOUNT (kg/ha)				
Variable Costs						
		Farm 11	Farm 12	Farm 13	Farm 14	Farm 15
Mineral fertilizers	For fields					
Input 1	N-pure component	58,89	71,79	174,15	85,15	62,78
Input 2	P-pure component		15,02	71,20	14,69	60,00
Input 3	K-pure component		22,53	106,80	14,69	60,00
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	46,30	45,06	20,59	12,24	59,45
Input 2	P-pure component	12,04	11,72	5,35	3,18	31,20
Input 3	K-pure component	53,70	52,27	23,88	14,20	64,17
Input 4	Mg-pure component					49,78
Input 5	Ca-pure component					14,00
Mineral fertilizers	For whole farm					
Input 1	N-pure component	46,09	48,62			
Input 2	P-pure component		10,17			
Input 3	K-pure component		15,26			
Input 4	Mg-pure component					
Input 5	Ca-pure component					
Natural fertilizers						
Input 1	N-pure component	36,23	30,52			
Input 2	P-pure component	9,42	7,93			
Input 3	K-pure component	42,03	35,40			

HERBICIDES

	Herbicides(L)	Herbicides(kg)	Fungicides (L)
Farm 1	2,84	0,01	0,47
Farm 2	1,24	0,06	0,08
Farm 3	1,98	0,07	0,54
Farm 4	1,94	0,02	
Farm 5	1,64		
Farm 6			
Farm 7	3,70	0,97	
Farm 8	2,74		
Farm 9	0,90		
Farm 10	0,61	0,20	
Farm 11		0,13	
Farm 12	0,90	0,01	
Farm 13	1,56	0,01	2,31
Farm 14		0,26	
Farm 15	3,20		0,16
Average	1,94	0,17	0,71

ENERGY

	Electricity (kWh)	Machinery (kg)	Gas (L)	Wood (kg)	Coal (kg)
Farm 1	6061,95	13995,00		9800,00	4000,00
Farm 2	37500,00	12270,00		2450,00	5000,00
Farm 3	60000	21005			2000
Farm 4	3690	9540		4900	7000
Farm 5	6061,95	9727		9800	3000
Farm 6	7500	8792	2000	12250	
Farm 7	7950,00	30562,00		2450,00	1000,00
Farm 8	10000,00	8670,00			6000,00
Farm 9	6000,00	14520,00		24500,00	
Farm 10	7800,00	12840,00		7350,00	15000,00
Farm 11	9600,00	22450,00		2450,00	5000,00
Farm 12	6061,95	11260,00		9800,00	4000,00
Farm 13		21942,00		7350,00	4000,00
Farm 14		10025,00		3920,00	4000,00
Farm 15		15332,00		4900,00	2000,00
Total	168225,85	222930,00	2000,00	101920,00	62000,00

RESULTS

ANIMALS

The sum of the hectares of all the farms is 683.51 ha, and the surface of Tłuchowo Gmina is 3137.93 ha. So if the number of animals in all the farms are the numbers that there are in the last column, I will multiply these numbers by 4.6 $\left(\frac{3137.93}{683.51}\right)$, and I will be able to have an approximation of the total number of each kind of animal in all the Gmina.

ANIMALS	TŁUCHOWO
Cow Milk	515,2
Cow Meat	966
Calves	984,4
Pig	8303
Piglet	3882,4
Wild-piglet	726,8
Horses	13,8
Goat	13,8
Chicken	138
Goose	46000
Sheep	506

CROPS

In this case I do the same operation that I have done in animals. To multiply the total kilograms in all the farms by 4.6 $\left(\frac{3137.93}{683.51}\right)$

CROPS	TŁUCHOWO (kg)
Sugars beets	**2576000**
roots	1840000
straw	736000
White mustard	
seeds	
straw	
Pea	
seeds	
straw	
Spring barley	**2338180**
seeds	1016600
straw	1321580
Winter barley	**465520**
seeds	202400
straw	263120
Alfalfa	
seeds	
straw	
Oat	**227240**
seeds	87400
straw	139840
Spring wheat	**513838,4**
seeds	191728
straw	322110,4
Winter wheat	**5368660**
seeds	1904400
straw	3464260
Triticale	**4421520**
seeds	1492240
straw	2929280
Winter colza	**3511456**
seeds	1048800
straw	2462656
Grass	
straw	
Fodder material	
Maize	**6115700**
silage	6115700
Potatoes	
Mixed cereals	**4001374,4**
seeds	1553144
straw	2448230,4
Rye	**747040**
seeds	322000
straw	425040

FETILIZERS

In this case instead of use a multiplication factor I will do the arithmetic mean, because I have the data divided in kg/ha, so doing the mean I will know the average of amount of fertilizers that it used in Tłuchowo Gminia

INPUTS	NAME	INPUT AMOUNT (kg/ha)
Mineral fertilizers	For fields	TŁUCHOWO
Input 1	N-pure component	87,79
Input 2	P-pure component	28,93
Input 3	K-pure component	41,34
Input 4	Mg-pure component	88,36
Input 5	Ca-pure component	16,36
Natural fertilizers		
Input 1	N-pure component	50,65
Input 2	P-pure component	14,48
Input 3	K-pure component	58,35
Input 4	Mg-pure component	49,78
Input 5	Ca-pure component	14,00
Mineral fertilizers	For whole farm	
Input 1	N-pure component	67,77
Input 2	P-pure component	18,26
Input 3	K-pure component	28,51
Input 4	Mg-pure component	87,57
Input 5	Ca-pure component	16,22
Natural fertilizers		
Input 1	N-pure component	36,59
Input 2	P-pure component	9,51
Input 3	K-pure component	42,44
Input 4	Mg-pure component	
Input 5	Ca-pure component	

HERBICIDES

As in the others parts I have multiplied the average of herbicides used by farmers per hectare by the total hectares of the Gmina, and then I have obtained an approximation of the amount of herbicides used in all the arable lands

MATERIAL	TŁUCHOWO
Herbicides(L)	6079,46
Herbicides(kg)	547,89
Fungicides (L)	2231,49

ENERGY

In this case the last column in the materials is the sum of all the energies used in the different farms. The total surface occupied by the farms in the study is 683.51 ha, and the surface of Tluchowo is 3137. So I will multiply the data of the last column by 4.6 (3137/683), and I will obtain the total energy used in the Gmina in one year

ENERGY	TŁUCHOWO
Electricity (kWh)	773838,91
Machinery (kg)	1025478,00
Gas (L)	9200,00
Wood (kg)	468832,00
Coal (kg)	285200,00

DISCUSSION

One of the best ways to analyse one problem is construct a SWOT analysis, consisting a strategic planning method used to evaluate the **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective.

- **S**trengths: Characteristics of the business or team that give it an advantage over others in the industry.
- **W**eaknesses: Are characteristics that place the firm at a disadvantage relative to others.
- **O**pportunities: *External* chances to make greater sales or profits in the environment.
- **T**hreats: *External* elements in the environment that could cause trouble for the business.

Once defined the way to discuss I am doing the SWOT analysis with the information obtained in the interview in the village of Tluchowo about the environmental, social and economic problems. And also supporting myself with information obtained on internet, books and articles in press.

Strengths

1) Agricultural and food aspects
    - Large land resources and the resulting production potential;
    - Multi-branch agricultural production in the scale of the country;
    - Increasing average size of an agricultural holding;
    - Advantageous conditions for the development of organic farming and other niche products.
2) Environmental aspects
    - Small soil pollution and relatively good environmental conditions, resulting in large development opportunities for the production of high quality food;
    - High biodiversity of rural areas providing a basis for the implementation of agricultural and environmental undertakings;
    - High natural and tourist value of rural landscape.
3) Social and economic aspects
    - Dense inhabitants net;
    - Rich human resources allowing for the development of extra-agricultural activities;

Weaknesses

1) Agricultural and food aspects
    - Low profitability of the agricultural sector;
    - Low capital level and insufficient funding for agricultural holdings;
    - Slow changes in the area structure of the farms;
    - High percentage of poor and acidified soils;
    - Setting aside large areas of farmland;
2) Environmental aspects
    - Low water resources;
    - Insufficient level of recognition of biodiversity resources in rural areas (absence of cross-country inventory of fauna, flora and habitat resources; the available data refer to selected groups of fauna and flora);
    - High soil acidification.
3) Social and economic aspects
    - Undeveloped technical and social infrastructure in rural areas (regional differences);
    - Excess of labour force and high unemployment;
    - Low occupational mobility of rural inhabitants;
    - Low education level among the rural population, including farmers;
    - Poorly developed network of services for the rural population.

Opportunities

1) Agricultural and food aspects
    - Open access of agricultural products to the Single Market;
    - Trade opportunities with third countries;
    - Increase of consumers' purchasing power, resulting from economic growth and resulting in the demand for processed and niche products;
    - Shaping of the group of economically viable holdings;
    - Young labour force on the labour market.
2) Environmental aspects
    - Maintenance of high biodiversity of rural areas to ensure high tourist and natural values of the rural landscape.
3) Social and economic aspects
    - Increase in the attractiveness of rural areas as places of living and areas for leisure activities for inhabitants of Poland and other EU Member States.
    - Young labour force on the labour market;
    - Increase in grass–roots initiatives – Leader;
    - Development of smaller towns as centres and occupational locations for rural areas inhabitants;

Threats

1) Agricultural and food aspects
   - Barriers in trade with third countries;
2) Environmental aspects 30
   - Non-rational agricultural management leading to increased natural environment pollution.
3) Social and economic aspects
   - Increase of poverty and social exclusion in rural areas;
   - Limited opportunities of employment diversification for persons leaving agricultural
   - Activities, resulting from slow economic growth.

In the following pages there will be a research (Attachments and Appendices) of the different parts that are part of the environment, like: Air, water, soil, forest, etc. and also some research of energies like coal or renewable sources.

I will explain each one of this part from the point of view of Europe, Poland, Kujawsko-Pomorskie and Tluchowo respectively. In these points I will explain the lack or surplus of the different natural inputs, and also I will try this issue from an outlook of environmental impact, due to in Poland the air and the water are much polluted. This is because for example in families and factories it is very widespread the use of coal like heater so the amount of pollutants that go to the atmosphere is terribly higher that in another countries, and here the problems of excess of compounds like O3, CO2 or dust in the air.

In question of water the issue is very worrying because the rivers of Poland are one of the most polluted in the European Union, and in fact the pollution that exists in the Baltic Sea is thanks of the contribution of Poland. It is very normal in this region of study that all the factories pour their waste to the river so they are totally polluted. One of the best signals of the degree of pollution is the lack of biodiversity in the river, and the existence of eutrophication in some areas. This process occurs thanks to the discharge of underwater of crop-fields or because of run-off.

In this area is very common run-off and accumulation of water in some areas due to the relief. As is known Poland is very plain country (the only high relief is in the south), so the water in the lands move from the top to the little depressions, creating some wetlands that they receive all the water with a lot of nitrates so finally grow up some plants that destroy the landscape.

ATTACHMENTS

AND

APPENDICES

WATER

VISTULA RIVER (Wisła)

Is the largest river of Poland and of the drainage basin of the Baltic Sea. With a length of 1,047 kilometres and a drainage basin of some 194,500 square kilometres, it is a waterway of great importance to the nations of Eastern Europe; more than 85 percent of the river's drainage basin, however, lies in Polish territory. The Vistula is connected with the Oder drainage area by the Bydgoszcz Canal. Eastward the Narew and Bug rivers and the Dnieper–Bug Canal link it with the vast inland waterway systems of Belarus, Ukraine, and Russia.

The source of the Vistula is found about 24 kilometres south of Bielsko-Biala on the northern slopes of the western Beskid range, in southern Poland, at an altitude of 1,106 metres. It flows generally from south to north through the mountains and foothills of southern Poland and across the lowland areas of the great North European Plain, ending in a delta estuary that enters the Baltic Sea near the port of Gdańsk. The average elevation of the Vistula basin is 180 metres above sea level; the mean river gradient is 0.10 percent, and the mean velocity in the river channel amounts to 0.79 metres per second. In addition to Poland's capital city, Warsaw, a number of large towns and industrial centres lie on the banks of the Vistula. These include Kraków, which was Poland's capital from the 11th century to the close of the 16th, Nowa Huta, Sandomierz, Płock, Toruń, Malbork, and Gdańsk. Numerous centres of tourism and recreation as well as many health resorts flank the Vistula valley. Here and there along the river rise the ruins of medieval strongholds, some of which have been restored.

http://www.thefullwiki.org

Skrwa: The Skrwa River is the left-bank tributary of the Lower. Its length is 41.8 km, and the mean gradient of the valley bottom amounts to 1.79 ‰. The largest tributary of the Skrwa River is the Osetnica River, which is 20 km long. Total area of this basin is 418.4 km2. About 2 $m^{3/}s$ of water flows through the Skrwa River. The mean annual dispositional run-off from the catchment basin was defined to around 28 mln m^3.

Within the area of the basin there are a few dozens of water reservoirs of various sizes, both natural and artificial. Most of the lakes are located within Płock Basin and belong to Gostynin Lakeland. Their total capacity in the catchment area amounts to 38.6 mln m^3.

Physiographic

In the region of Kujawsko-Pomorskie the river runs in a channel 600 to 1200 metres wide, practically devoid of controlling structures; in parts the valley reaches widths up to 9.5 to 14.5 kilometres, with the banks often 60 to 100 metres high. The low gradient of the river channel and abundant sandbanks make navigation difficult; in spring, when the ice cover breaks up and floats downstream, dangerous ice dams may form, causing the flooding of surrounding areas and often destroying embankments and bridges. A spillway step constructed at Włoclawek in 1968 initiated a series of improvements that continued through the 1980s.

From Toruń to its entry into the Baltic, the Vistula has been turned into a fully improved waterway. The 19th-century Bydgoszcz Canal, following an ancient glacial valley, links the Vistula with the Oder, the second largest of Polish rivers. Also near Bydgoszcz the Vistula, having received a left-bank tributary in the Brda, turns north-eastward in its third gap section, cut through the Pomeranian highlands. Above Grudziądz the river finally turns northward to approach the Baltic. After receiving three further tributaries—the Osa from the right and the Wda and the Wierzyca from the left—the Vistula enters Żuławy Wiślane, its delta area, renowned for its splendidly fertile soils. Żuławy is a forestless plain, partly below sea level, threaded by the Vistula and its branches, together with a great number of canals and drainage ditches.

Hydrology

Climatic variations in the Vistula basin cause diversity in runoff and hence marked oscillations in the water level of the river, which averages 12 feet in the upper, 25 feet in the middle, and up to 33 feet in the lower reaches. Protracted low-water periods, lasting from late summer well into spring, are frequent. These hamper or entirely interrupt navigation. Spring floods caused by melting snow and ice in the whole drainage basin and summer floods resulting from heavy rains in the foothill and mountain regions are common features. During the period 1951–80 the mean flow of the upper course of the Vistula averaged about 670.56 cubic metres per second. There are a number of storage reservoirs in the valleys of the mountain tributaries that are intended to counteract excessive floods. Some newer, larger storage basins have been built.

Usually ice forms on the surface of the Vistula in the first half of January, breaking up toward the end of February. In the upper and lower reaches the duration of the ice sheet is from 20 to 40 days, in the middle reach 40 to 60 days, and in the estuary section up to 20 days.

The quality of the Vistula's waters is affected by water-management structures such as dams and hydroelectric plants, by the discharge of municipal and industrial wastewater, and by agricultural and storm runoff. Although the upper reaches of the river remain relatively pure, the lower portions of the Vistula, in common with similar stretches of many of the great rivers of the world, exhibit a high degree of pollution.
The mean annual temperature of the Vistula water is 8° C in the upper reaches and 9° C in the middle and lower reaches; in the middle and lower parts of the river the water is some 2° C warmer than the mean annual air temperature of Poland. In winter the water temperature is 2° to 3° C; in summer it varies from 12° to 15° C. In river sections that are thermally affected by nearby industries, however, as in the regions of Kraków, Warsaw, and Włocławek, the water temperature is apt to be as much as 6° to 10° C or even higher.

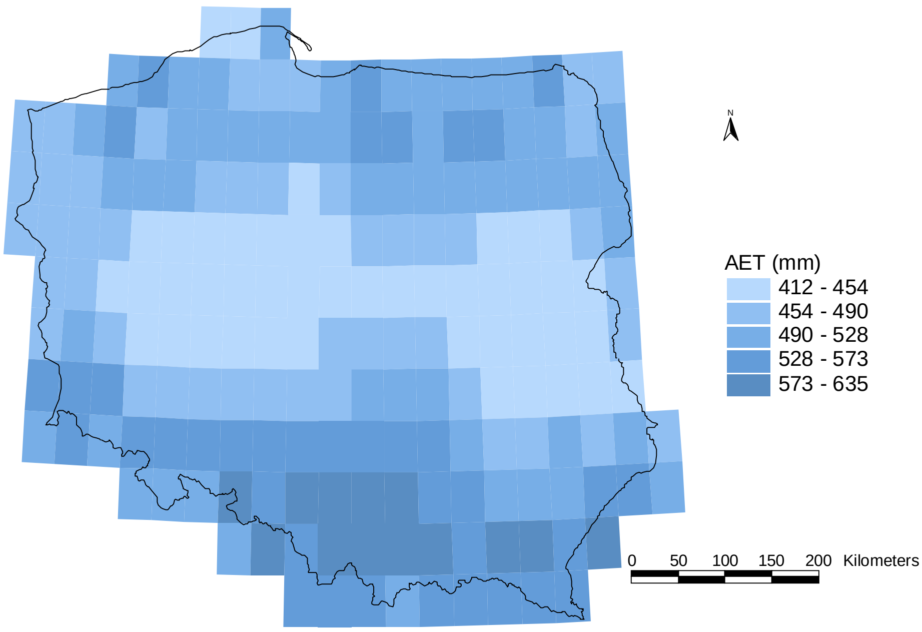
Evapotranspiration

Evapotranspiration (ET) is a term describing the transport of water into the atmosphere from surfaces, including soil (soil evaporation), and from vegetation (transpiration). The latter two are often the most important contributors to evapotranspiration. Other contributors to evapotranspiration may include evaporation from wet canopy surface (wet-canopy evaporation), and evaporation from vegetation-covered water surface in wetlands.

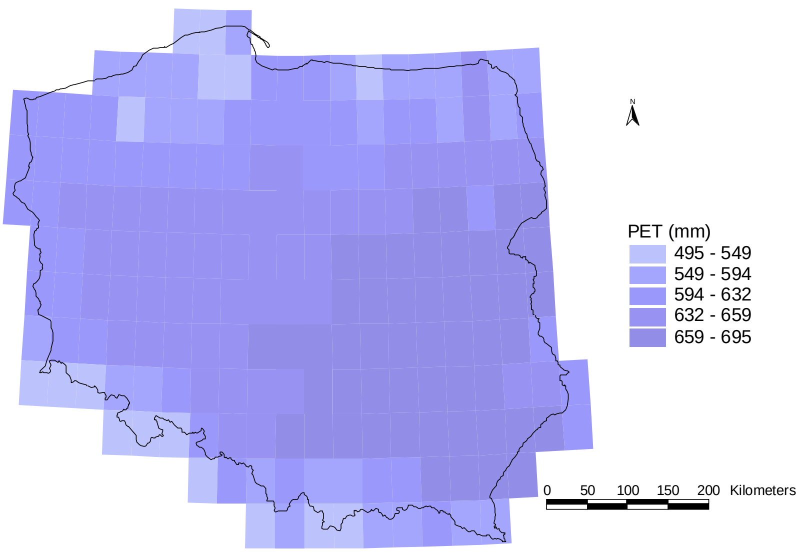
The process of evapotranspiration is one of the main consumers of solar energy at the Earth's surface. Energy used for evapotranspiration is generally referred to as latent heat flux; however, the term latent heat flux is broad, and includes other related processes unrelated to transpiration including condensation (e.g., fog, dew), and snow and ice sublimation. Apart from precipitation, evapotranspiration is one of the most significant components of the water cycle.

The evaporation component of ET is comprised of the return of water back to the atmosphere through direct evaporative loss from the soil surface, standing water (depression storage), and water on surfaces (intercepted water) such as leaves and/or roofs. Transpired water is that which is used by vegetation and subsequently lost to the atmosphere as steam. The water generally enters the plant through the root zone, is used for various biophysiological functions including photosynthesis, and then passes back to the atmosphere through the leaf stomata. Transpiration will stop if the vegetation becomes stressed to the wilting point, which is the point in which there is insufficient water left in the soil for a plant to transpire, or if the plant to atmosphere steam concentration gradient becomes prohibitive to plant physiological processes (e.g. photosynthesis).

Average Actual Evapotranspiration



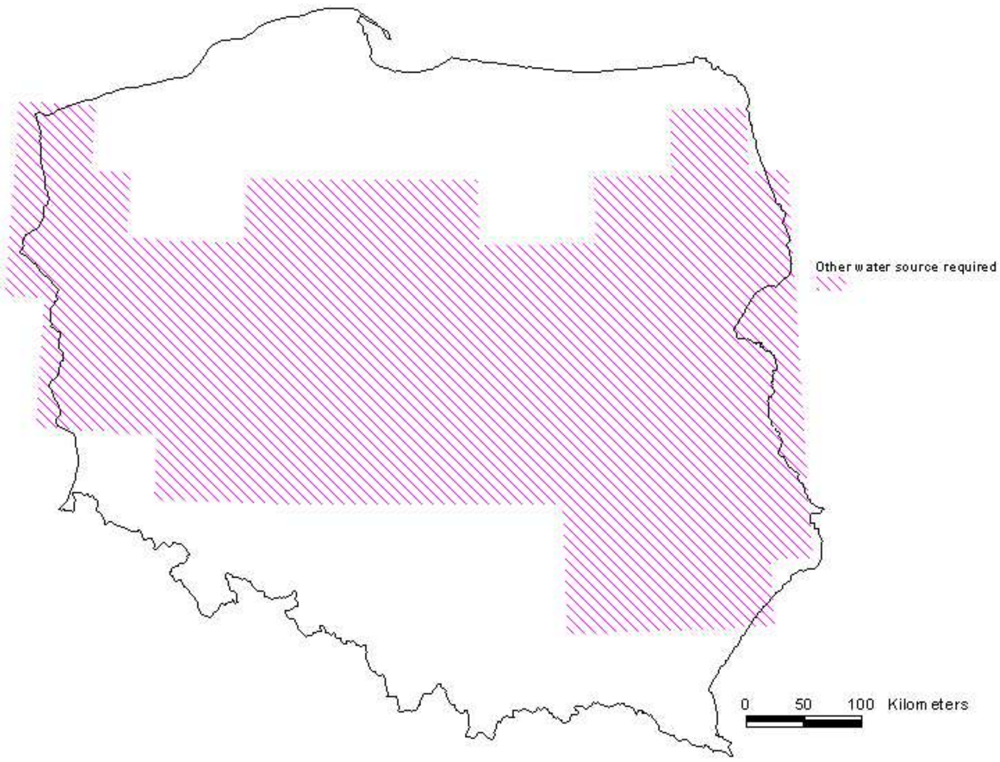
Average Potential Evapotranspiration



PROBLEMS

Poland is considered to be a country with low water resources. The volume of surface water resources varies both annually and multi-annually. Water resources are not evenly distributed; the central part of the country is affected by a water deficit, while the mountain regions in the south are often hit by intensive rainfall. In comparison to other European countries, Poland has low water resources and is characterized by large variations of yearly outflow. This implies the threat of floods and possibility of emergence of hydrological drought as a result of significant deficiency of ground water.
The indicator of water availability for population and national economy, expressed as a quotient of average annual discharge to number of inhabitants, is around 1300 m3/inhabitant/year (the average in Europe: 4500 m3/inhabitant/year) (CSO, 2005). Low capacity of storage reservoirs leads to the fact that they retain only 6% of annual discharge

Areas in Poland with other water source required

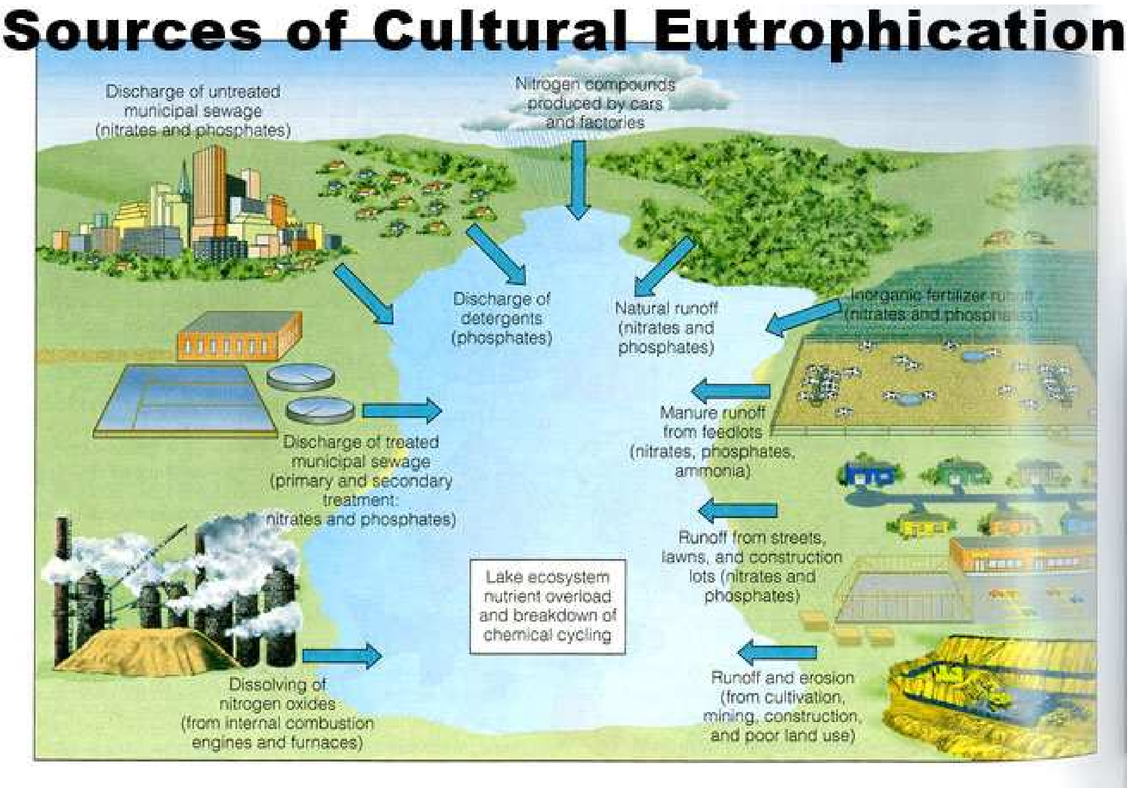


Shallow ground waters, which absorb a considerable amount of pollutants, including widespread pollution of agricultural, livestock breeding, horticultural and municipal origin, are of the lowest quality.
The quality classification of surface and ground waters (CSO, 2005) shows that water of III and IV quality classes prevail (1,193 in 1,566 measurement points), with very little class II water and no class I water. Lake water purity is much higher (CSO, 2005), as 61.7% of lakes have II class of water purity, and only 6.9% has unclassified. The quality of surface and ground water should improve constantly in connection with activities undertaken to limit pollution, from agricultural sources, and to improve sanitation of rural areas.

In reference to the above mentioned issues, the important role of forests in the retention and alleviation of the extreme states of surface and ground water flows, counteracting soil degradation and erosion and turning the landscape into steppe or beneficial modification of hydrological and topoclimatic conditions in agricultural areas needs to be pointed out. In view of the above, the implementation of the National Woodland Extension Plan (1995, 2003) gains on importance, for it becomes an instrument supporting the tasks set forth by the Water Framework Directive.

Eutrophication: Is a syndrome of ecosystem responses to human activities that fertilize water bodies with nitrogen (N) and phosphorus (P), often leading to changes in animal and plant populations and degradation of water and habitat quality. Nitrogen and phosphorus are essential components of structural proteins, enzymes, cell membranes, nucleic acids, and molecules that capture and utilize light and chemical energy to support life. The biologically available forms of N and P are present at low concentrations in pristine lakes, rivers, estuaries, and in vast regions of the upper ocean.

Pristine aquatic ecosystems function in approximate steady state in which primary production of new plant biomass is sustained by N and P released as by-products of microbial and animal metabolism. This balanced state is disrupted by human activities that artificially enrich water bodies with N and P, resulting in unnaturally high rates of plant production and accumulation of organic matter that can degrade water and habitat quality. These inputs may come from untreated sewage discharges, sewage treatment plants or runoff of fertilizer from farm fields or suburban lawns. In some cases the climax stage of algal blooms can release toxic chemicals such as domoic acid to the aquatic environment, creating elevated metabolic risks to a variety of fish and marine mammals.



Marine eutrophication has emerged as one of the major environmental issues, especially for enclosed seas with high river runoff. Such regions are strongly affected by increasing reverie nutrient loads. Eutrophication affects biodiversity and fish stocks as well as human health and the recreational use of coastal zones, and causes massive surface phytoplankton blooms. The Baltic Sea is highly exposed to eutrophication through limited mixing with ocean water and high discharges of inland water fromhit6 river systems. Results of several research projects investigating the eutrophication in the Baltic region showed that without a change in policies, the eutrophication process will increase in the next decades. Nowadays, approximately 75% of the reverie nitrogen and up to 84% of phosphorus loads in the Baltic basin is discharged by the region's three large rivers: the Vistula, the Odra and the Nemunas. From this point of view, Poland is the major country that influences the nutrients balance in the Baltic Sea. The Polish impact on the Baltic Sea is reflected by three issues:

- About 99.7% of Poland's territory belongs to the Baltic Sea drainage basin.
- More than half of the entire basin's population lives in Poland.
- Approximately 40% of the entire basin's farmland is situated in Poland.

The ecological policy of Poland assumes several tools (e.g. National Program for Development of Wastewater Treatment Plants) and actions (e.g. implementation of Nitrate Directive on nitrate sensitive zones) to reduce the impact of river systems entering the sea coast. However, other alternative actions aiming to reduce eutrophication are needed, to be implemented on regional level. Adaptation of the 91/271/EEC EU directive in Poland to limit the highest concentrations of water pollutants after treatment seems to be sufficient to reduce the impact of wastewater treatment plants for both nutrients. Such regulations should be adopted in the largest municipalities as soon as possible.

The estimations of agricultural emissions show hot spots localized in the former Lubelskie and Torunskie voivodships. The biggest emission is related to highest use of commercial fertilizers, high mean livestock density, and small percentage of permanent grassland. Over 95% of livestock farms do not have a manure pit for animal waste storage nor a liquid manure container consistent with the requirements of the EU Directive (CEESA, 2003 report). The actions to reduce the impact of agriculture should therefore include proper storage of animal wastes. Successful reduction of pollution depends on the knowledge of farmers. Investment in education and training is therefore as important as the investment in infrastructure.

Erosion is third important pathway of emission, especially for the mountainous regions. The results show that P-emission caused by erosion is important in the southern, mountainous part of the Odra river system. Application of “Best management practices” on arable land can lead to 40% reduction of this

AIR

A clean air supply is essential to our own health and that of the environment. But since the industrial revolution, the quality of the air we breathe has deteriorated considerably - mainly as a result of human activities. Rising industrial and energy production, the burning of fossil fuels and the dramatic rise in traffic on our roads all contribute to air pollution in our towns and cities which, in turn, can lead to serious health problems. For example, air pollution is increasingly being cited as the main cause of lung conditions such as asthma - twice as many people suffer from asthma today compared to 30 years ago.

The issue of air quality is still a major concern for many European citizens. It is also one of the areas in which the European Union has been most active. Since the early 1970s, the EU has been working to improve air quality by controlling emissions of harmful substances into the atmosphere, improving fuel quality, and by integrating environmental protection requirements into the transport and energy sectors.

As the result of EU legislation, much progress has been made in tackling air pollutants such as sulphur dioxide, lead, nitrogen oxides, carbon monoxide and benzene. However, despite a reduction in some harmful emissions, air quality continues to cause problems. Summer smog - originating in potentially harmful ground-level ozone - regularly exceeds safe limits. Fine particulates also present a health risk which is of increasing concern. Clearly, more needs to be done at local, national, European and international level.

EUROPE

Air Pollution Policy Review 2011-2013

The European Commission has launched a comprehensive review of its air policy building on the 2005 Thematic Strategy on Air Pollution and Clean Air for Europe (CAFÉ) initiative.

CAFE has the following specific objectives:

1. To develop, collect and validate scientific information relating to the effects of outdoor air pollution, emission inventories, air quality assessment, emission and air quality projections, cost-effectiveness studies and integrated assessment modelling, leading to the development and updating of air quality and deposition objectives and indicators and identification of the measures required to reduce emissions;
2. To support the implementation and review the effectiveness of existing legislation, in particular the air quality daughter directives, the decision on exchange of information, and national emission ceilings as set out in recent legislation, to contribute to the review of international protocols, and to develop new proposals as and when necessary;

3. To ensure that the sectoral measures that will be needed to achieve air quality and deposition objectives cost-effectively are taken at the relevant level through the development of effective structural links with sectoral policies;
4. To determine an overall, integrated strategy at regular intervals which defines appropriate air quality objectives for the future and cost-effective measures for meeting those objectives;
5. To disseminate widely the technical and policy information arising from implementation of the programme.

Thematic Strategy on air pollution

INTRODUCTION

Air pollution damages human health and the environment. The need to deliver cleaner air has been recognised for several decades with action having been taken at national and EU level and also through active participation in international conventions. EU action has focused on establishing minimum quality standards for ambient air and tackling the problems of acid rain and ground level ozone. Polluting emissions from large combustion plant and mobile sources have been reduced; fuel quality improved and environmental protection requirements integrated into the transport and energy sectors.

Despite significant improvements, serious air pollution impacts persist. Against this backdrop, the Community's Sixth Environmental Action Programme (***6th EAP***) called for the development of a thematic strategy on air pollution with the objective to attain "*levels of air quality that do not give rise to significant negative impacts on, and risks to human health and the environment*". Following its communication on the Clean Air For Europe programme (***CAFE***) , the Commission has examined whether current legislation is sufficient to achieve the 6th EAP objectives by 2020. This analysis looked at future emissions and impacts on health and the environment and has used the best available scientific and health information. It showed that significant negative impacts will persist even with effective implementation of current legislation.

Accordingly, this thematic strategy on air pollution (the ***Strategy***) establishes interim objectives for air pollution in the EU and proposes appropriate measures for achieving them. It recommends that current legislation be modernised, be better focused on the most serious pollutants and that more is done to integrate environmental concerns into other policies and programmes.

ASSESSMENT OF THE PRESENT SITUATION

Air pollution is both a local and a trans-boundary problem caused by the emission of certain pollutants which either alone, or through chemical reaction lead to negative environmental and health impacts.

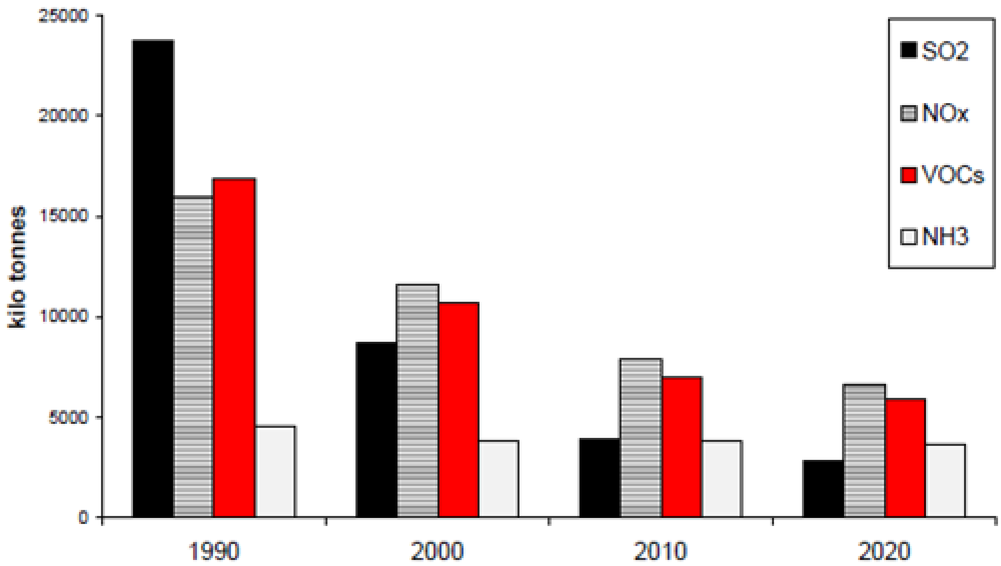
In relation to health, ground level ozone and particulate matter ("fine dust") are the pollutants of most concern. Exposure can lead to impacts ranging from minor effects on the respiratory system to premature mortality. Ozone is not emitted directly but is formed through the reaction of volatile organic compounds (VOCs) and nitrogen oxides (NO_x) in the presence of sunlight. Particulate matter can be emitted directly to the air (so called primary particles) or be formed in the atmosphere as "secondary particles" from gases such as sulphur dioxide (SO_2), nitrogen oxides and ammonia (NH_3).

Ecosystems are also damaged by:

1) The deposition of the acidifying substances (nitrogen oxides, sulphur dioxide and ammonia) which lead to loss of flora and fauna.
2) Excess nutrient nitrogen in the form of ammonia and nitrogen oxides can disrupt plant communities, leach into freshwaters leading in each case to a loss of biodiversity (called “eutrophication”).
3) Ground level ozone that results in physical damage and reduced growth of agricultural crops, forests and plants. Air pollution also causes damage to materials leading to a deterioration of buildings and monuments.

Significant progress has already been made in reducing the main air pollutants. Figure 2 shows the reductions since 1990 in the emissions of nitrogen oxides, sulphur dioxide, volatile organic compounds and ammonia delivered by current policies.

Fig 2 EU-25 land-based emissions of NECD pollutants



These reductions have had positive impacts, although some 55% of all EU ecosystems suffer from eutrophication. Even with the full implementation of existing laws, environment and health problems will persist in 2020 if no further action is taken. While, compared to a baseline situation of 2000, there will be a reduction of around 44% in the area of ecosystems receiving excess acid deposition the current data suggests only a 14% reduction in areas affected by eutrophication due to only modest reductions in ammonia emissions. However, the projections were not able to include potential ammonia emission reductions following the reform of the Common Agricultural Policy and other recent measures. The area of forest affected by excessive levels of ozone will only fall by 14%.

- <u>Agriculture:</u>

Cattle farming, the pig and poultry sectors and the use of mineral fertilisers account for the vast majority of ammonia emissions. Recent reform of the Common Agricultural Policy should bring about a reduction in ammonia emissions from agricultural sources following:

1) The removal of the link between financial support and the obligation to retain specific animal numbers.
2) The removal of incentives towards intensification which will result in a reduction of mineral fertiliser use
3) The introduction of obligatory cross compliance with environmental directives as a condition for the full granting of direct payments.

Further improvements are also expected to result from an effective implementation of certain environmental Directives, such as the Nitrates Directive, the IPPC Directive, the Environmental Impact Assessment Directive and the Water Framework Directive.

However, these improvements could be insufficient to meet the objectives of the Strategy. Given that nitrogen plays a role in several environmental problems, the Commission will pursue a coherent and integrated approach to nitrogen management[21]. Priority will be attached to measures and policies to reduce "excessive" nitrogen use in agriculture and which simultaneously address nitrates in water, and ammonia and nitrous oxide emissions to air. Such policies could address

1) The nitrogen content of animal feedstuffs.
2) Excessive use of nitrogen fertilisers.
3) The promotion of further research into the nitrogen cycle and its environmental implications.

In order to comply with existing and new emissions ceilings for ammonia when the NECD is revised; the Member States will have to prepare plans and programmes to demonstrate how they will meet these new ceilings. The achievement of reduction objectives may require the development of national actions plans, including obligations applicable at farm level, allowing emissions reductions to be phased in over a ten year period or so following the adoption of a revised NECD.

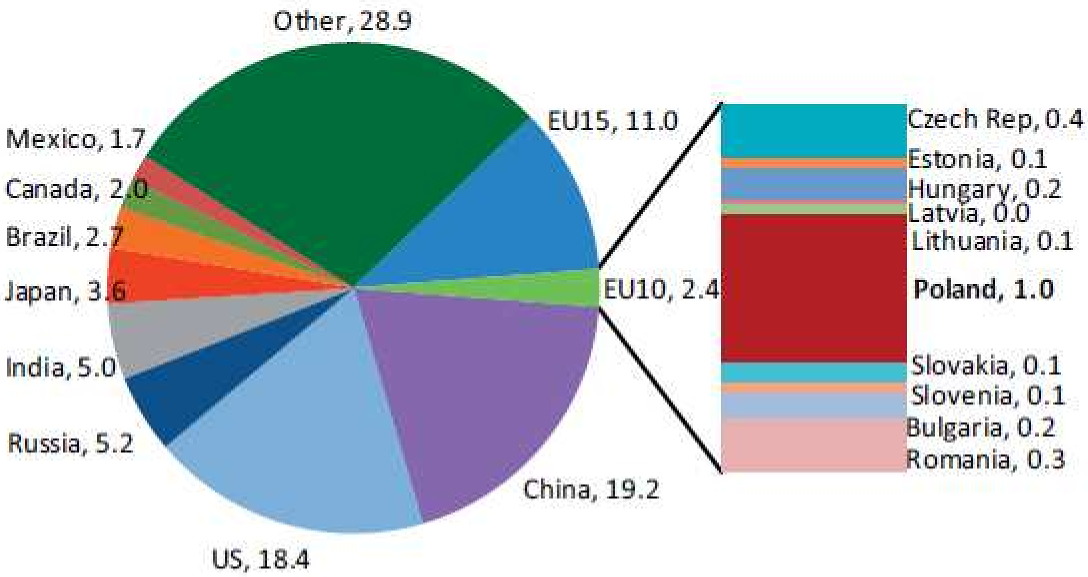
The current Rural Development Regulation and the Commission proposals for rural development for 2007-2013 provide several possibilities to tackle ammonia emissions from agricultural sources. These include measures related to farm modernisation, meeting standards and agro-environment. The Commission urges the Member States to make full use of these measures. In particular, Member States can design agro-environment schemes which go beyond environmental legislative obligations and minimum requirements for fertiliser use identified in rural development programmes. These could also help towards a more effective compliance with the CLRTAP code of good farming practice.

POLAND

Poland is not among the largest emitters of greenhouse gases globally, but its economy is among the least carbon efficient in the EU. Poland's global share in GHG emissions is just 1 percent; and its per capita emissions are about the average for the EU. Poland cut its emissions considerably as a side effect of the restructuring of transition to a market economy, but the link between growth and emissions has re-emerged in recent years. A critical difference in the make-up of Poland's emissions is the dominance of the power sector and its extraordinary dependence on coal. Apart from energy sector, Poland's transport sector has experienced very high rates of emission growth, and energy efficiency, although improving remains below EU averages.

Poland contributes marginally to the global carbon footprint, with a share in global GHG emissions equal to about 1 percent. The EU as a whole is responsible for about 13 percent of global emissions, while China and the US, the largest emitters, are responsible for almost 40 percent of global emissions between them. On a per capita basis, Poland emits about 10 metric tons of CO_{2e} ($tC0_{2e}$) each year, which is the average across the EU (with most countries at between 7 and 15 $tC0_{2e}$ per capita). On average, Europeans emit less than half the greenhouse gases of North American or Australian citizens. Nonetheless, this level remains well above the global average of 7 $tC0_{2e}$ as well as the benchmark of 2, the average global per capita emissions consistent with a 2°C rise in temperature.

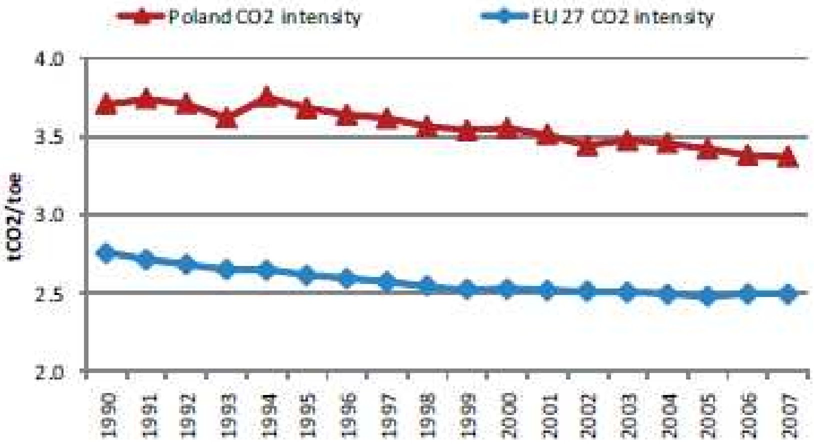
World's largest greenhouse gas emitters, 2005, in percent



Source: World Resources Institute, World Bank staff calculations.

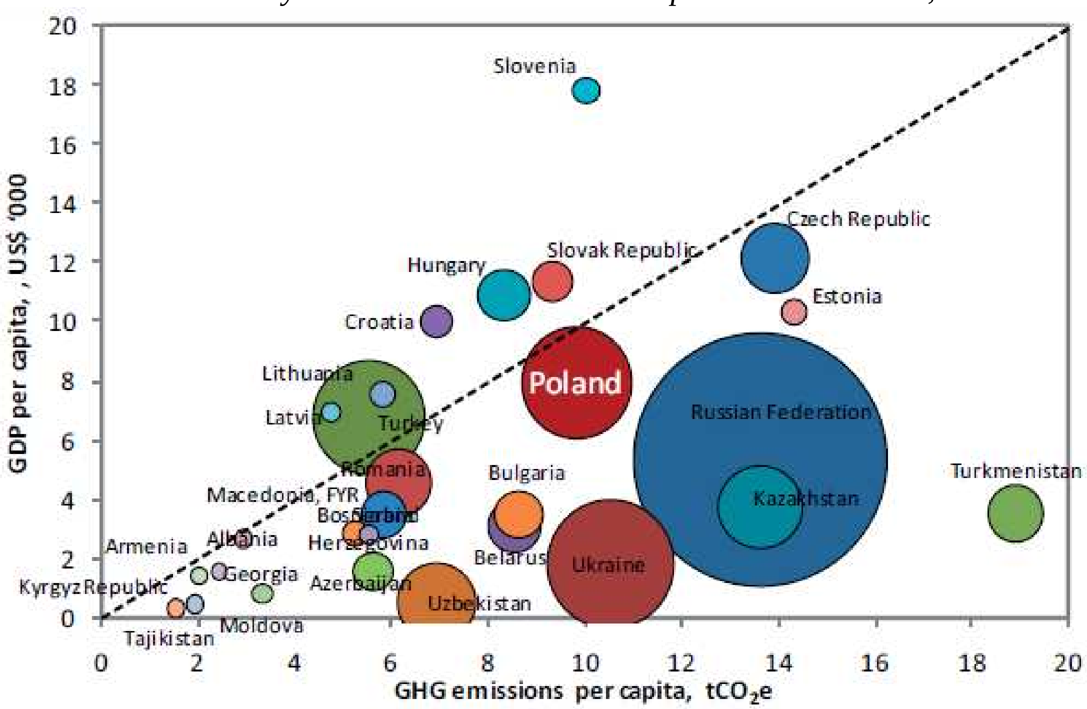
Despite unremarkable overall emissions levels, Poland's economy remains among the least carbon-efficient in the EU. In 2007, around 1.3 metric tons of CO_{2e} were required to produce €1 million in GDP, while the EU average was less than 0.5 $tC0_2$. This high emissions-intensity of the economy is due partly to high amounts of CO_2 generated by the energy consumed but also to the high energy intensity of production in Poland. While in the EU on average, consumption of energy equal to one ton of oil equivalent15 generates 2.5 metric tons of CO_2, in Poland the same ratio is around 3.4, despite the downward trend of carbon intensity in Poland over the last two decades. At the same time, energy used per million Euros of GDP, at 400 tons of oil equivalent, greatly exceeds the EU-wide average of 169 and stands at about the world average. Among transition economies, Poland's performance appears better: its carbon intensity on a per capita basis is situated in about the middle of the countries of Eastern and Central Europe and Central Asia

CO2 intensity of energy use in Poland and EU27



Source: European Commission, World Bank staff calculations

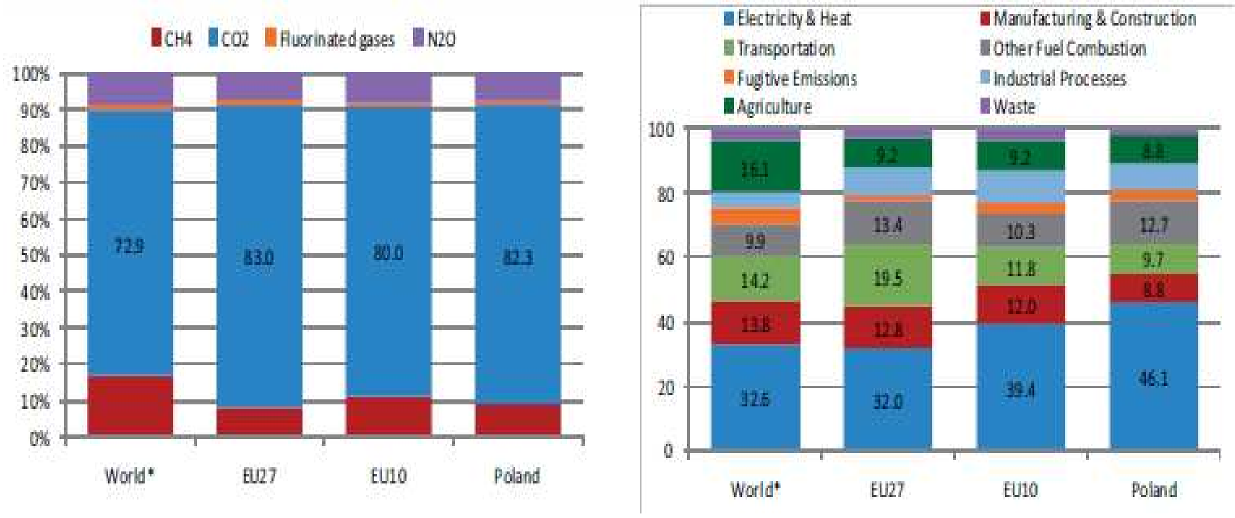
Carbon intensity in Central and Eastern Europe and Central Asia, 2005



Source: World Bank staff calculations.

Poland’s types and sources of greenhouse gas emissions resemble those for the rest of the EU except for the electricity sector. The breakdown of Poland’s greenhouse gas emissions by type of gas shows that its emissions are predominantly CO_2 (with a more than 80 percent share). Compared with the rest of the world, emissions from agriculture are less important in the EU and in Poland. One point of departure from the EU and even from the EU10 is Poland’s greater emissions from the electricity and heat sector

GHG emissions by gas, 2007 *GHG emissions by sector, 2007*



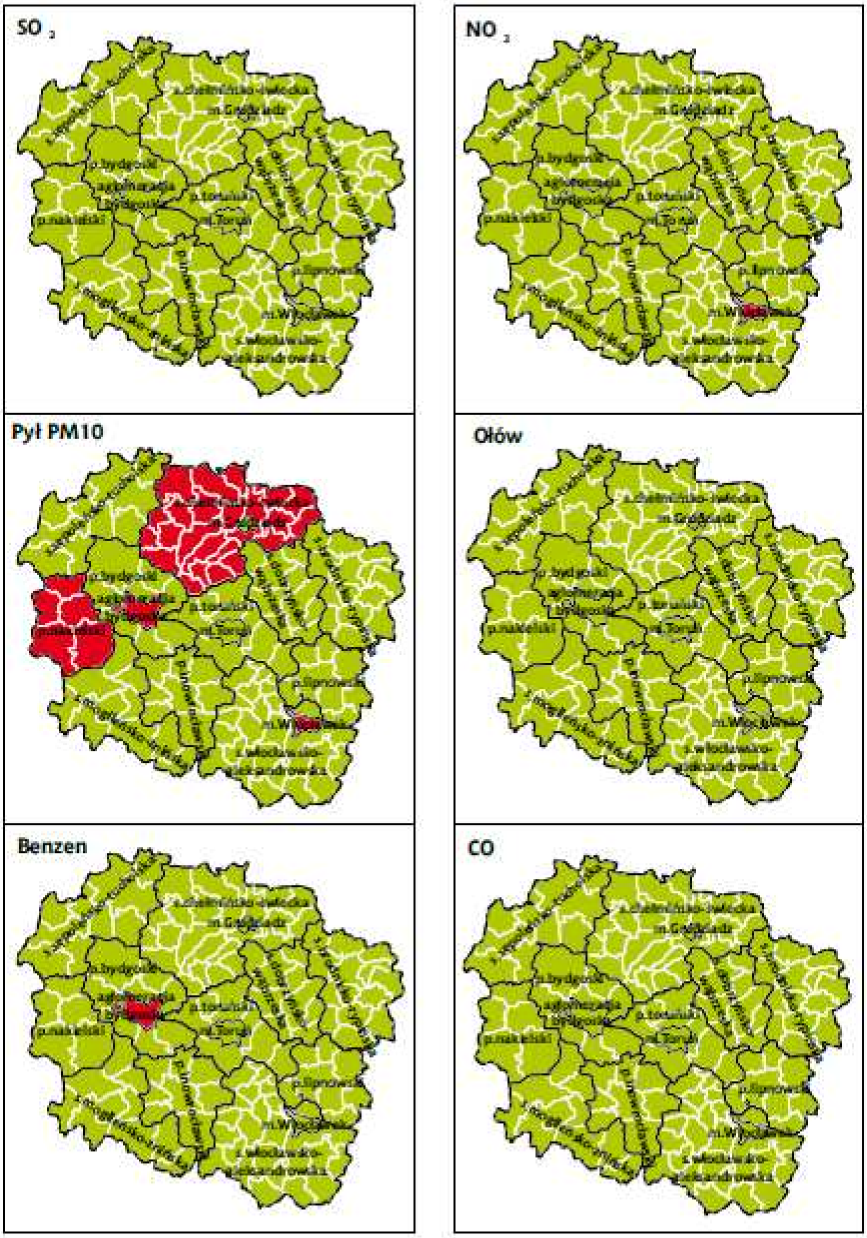
Source: World Resources Institute, European Commission, World Bank staff calculations.

KUJAWSKO-POMORSKIE

In the region of study there are some harmful elements in enough amounts to be able to cause some problems. These elements are:

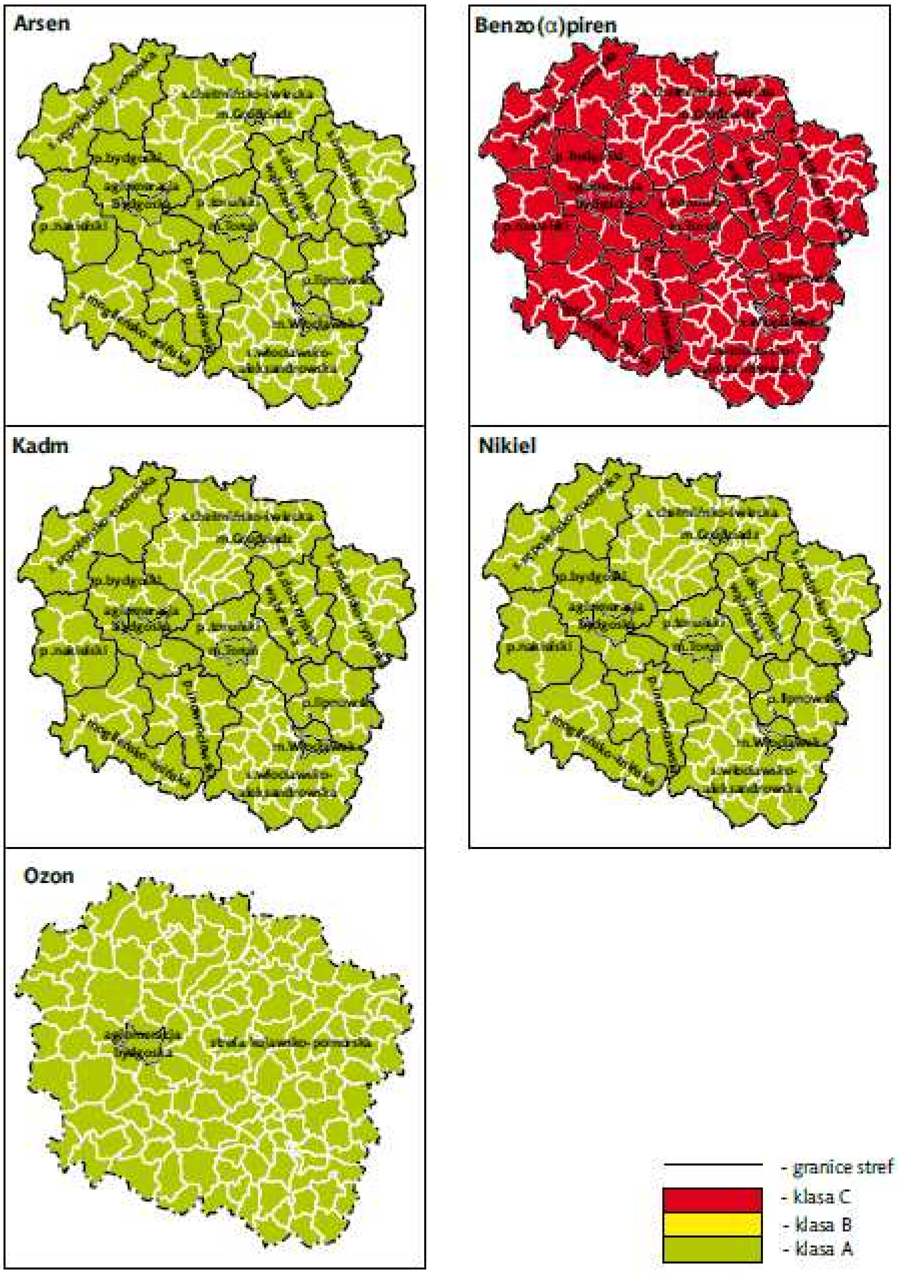
- Sulphur dioxide → SO_2
- Nitrogen dioxide → NO_2
- Ozone → O_3
- Dust → PM10
- Benzene → C_6H_6
- Carbon monoxide → CO
- Plumb → Pb
- Arsenic → As
- Cadmium → Cd
- Nickel → Ni

In the following graph it can see the amounts of each compound in the region of Kujawsko-Pomorskie



Ryc.51. **Klasy stref w województwie kujawsko-pomorskim uzyskane w wyniku rocznej oceny jakości powietrza za rok 2007 (określone dla ochrony zdrowia ludzi według poziomów dopuszczalnych)**

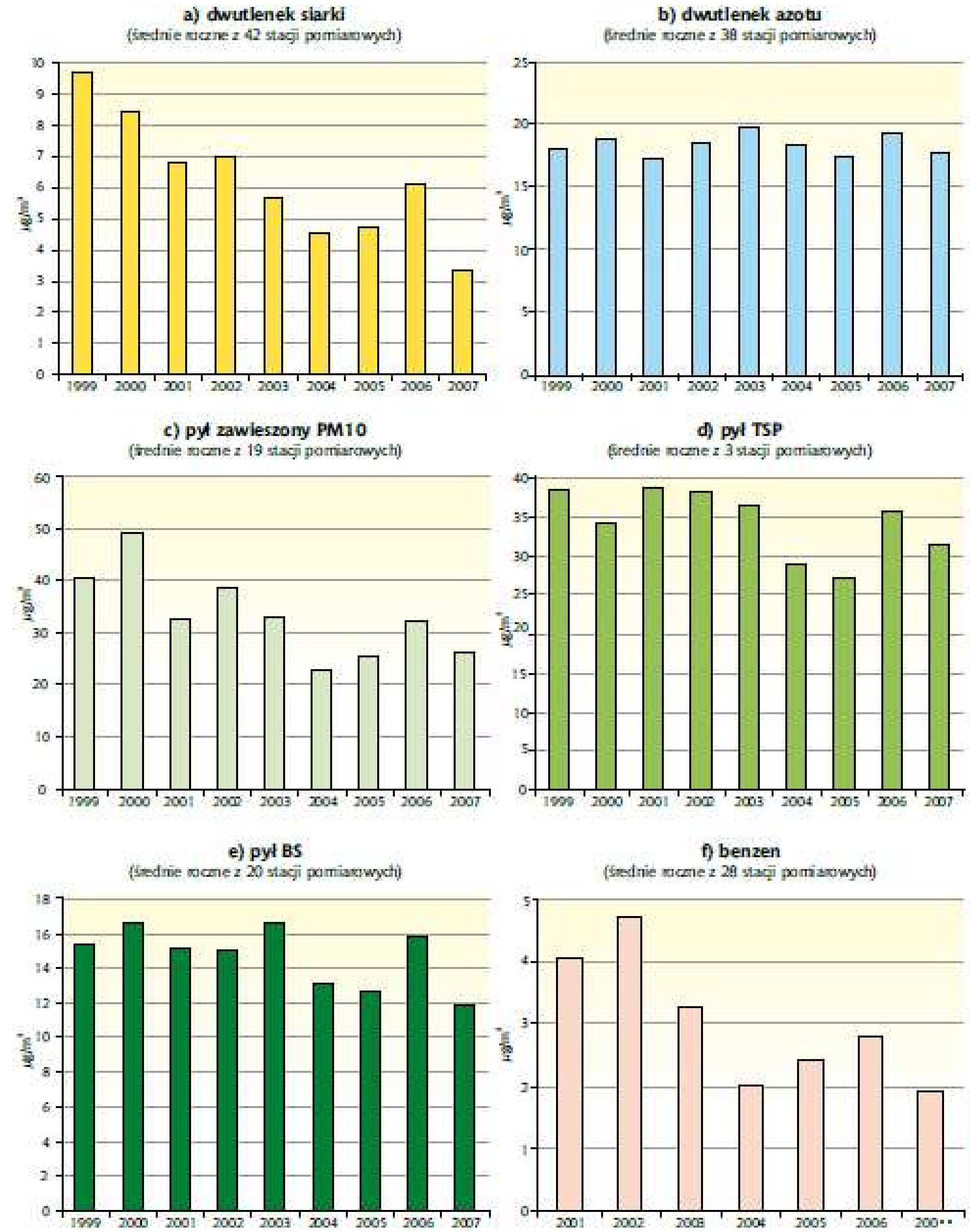
- granice stref
- klasa C
- klasa B
- klasa A



Ryc. 52. **Klasy stref w województwie kujawsko-pomorskim uzyskane w wyniku rocznej oceny jakości powietrza za rok 2007 (określone dla ochrony zdrowia ludzi według poziomów docelowych)**

- Klasa A: if the concentration of pollution, in the area of the zone, don't exceed (is not higher than) the permissible levels,
- Klasa B: if the concentrations of pollution, in the area of the zone, exceed the permissible levels, but don't exceed the amount of permissible levels and margin of tolerance together. (it means, it doesn't exceed the amount when u take into account the margin of tolerance, not only permissible level)
- Klasa C: if the concentrations of pollution, in the area of the zone, don't exceed the permission level with margin of tolerance together, in case when the margin of tolerance is not defined.

Graph of different elements in the atmosphere (SO2, Benzene, different types of dust, etc.).



Ryc. 24. **Stężenia średnie roczne z lat 1999-2007 wybranych zanieczyszczeń ze wszystkich stacji pomiarowych istniejących w 2007 roku w województwie kujawsko-pomorskim**

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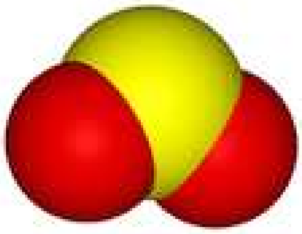
SO_2 (Sulphur dioxide)

Definition: Sulphur dioxide is a gas. It is invisible and has a nasty, sharp smell. It reacts easily with other substances to form harmful compounds, such as sulphuric acid, sulphurous acid and sulphate particles.



Sources: About 99% of the sulphur dioxide in air comes from human sources. The main source of sulphur dioxide in the air is industrial activity that processes materials that contain sulphur, e.g. the generation of electricity from coal, oil or gas that contains sulphur. Some mineral ores also contain sulphur, and sulphur dioxide is released when they are processed. In addition, industrial activities that burn fossil fuels containing sulphur can be important sources of sulphur dioxide.

Sulphur dioxide is also present in motor vehicle emissions, as the result of fuel combustion. In the past, motor vehicle exhaust was an important, but not the main, source of sulphur dioxide in air. However, this is no longer the case.

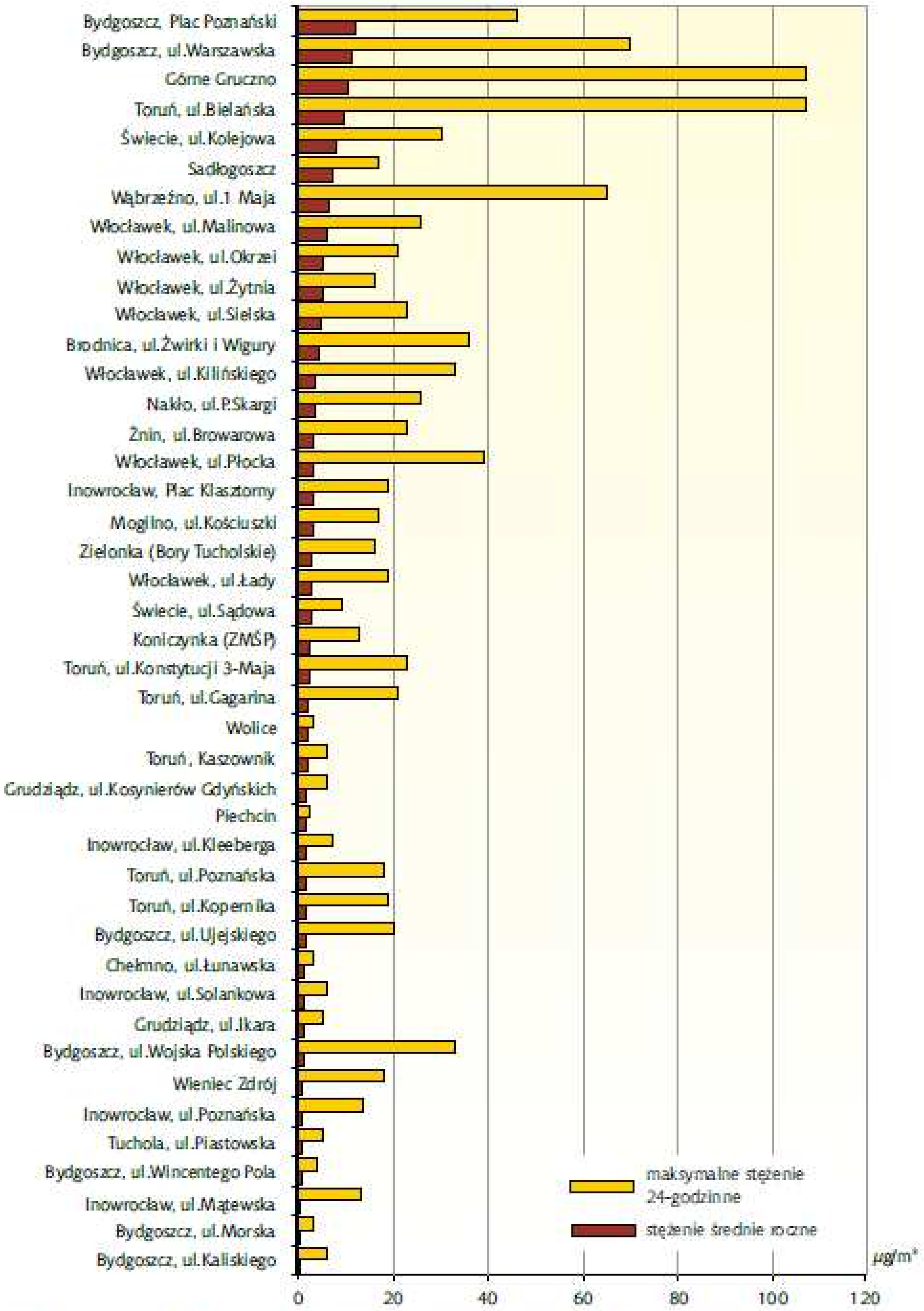
The average permanence of SO_2 at the atmosphere is about a couple of days, and it depends of the quickness with which it forms sulfuric acid (H_2SO_4) by moisture absorption (H_2O), which are dispersed in the environment in rain shape (fog, snow and dew also) causing acidification of the soil and water → *Acid rain*. High concentrations of SO_2 are in a radius less than 20 km of the emitter source.

- *Acid rain*: Is a rain or any other form of precipitation that is unusually acidic, i.e. elevated levels of hydrogen ions (low pH). It can have harmful effects on plants, aquatic animals, and infrastructure through the process of wet deposition. Acid rain is caused by emissions of sulphur dioxide and nitrogen oxides which react with the water molecules in the atmosphere to produce acids. Governments have made efforts since the 1970s to reduce the release of sulphur dioxide into the atmosphere with positive results.

Health Effects: High concentrations of sulphur dioxide (SO^2) can result in breathing problems with asthmatic children and adults who are active outdoors. Short-term exposure has been linked to wheezing, chest tightness and shortness of breath. Other effects associated with longer-term exposure to sulphur dioxide, in conjunction with high levels of particulate soot, include respiratory illness, alterations in the lungs' defences and aggravation of existing cardiovascular disease.

Environmental Effects: Sulphur dioxide and nitrogen oxides are the major precursors of acid rain, which has acidified soils, lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility. Sulphur dioxide also is a major precursor of fine particulate soot, which poses a significant health threat.

Comparison of maximum SO_2 concentration in 24 hours and the annual average



Ryc.25. **Stężenia SO_2 w 2007 roku - średnie roczne i maksymalne 24-godzinne**

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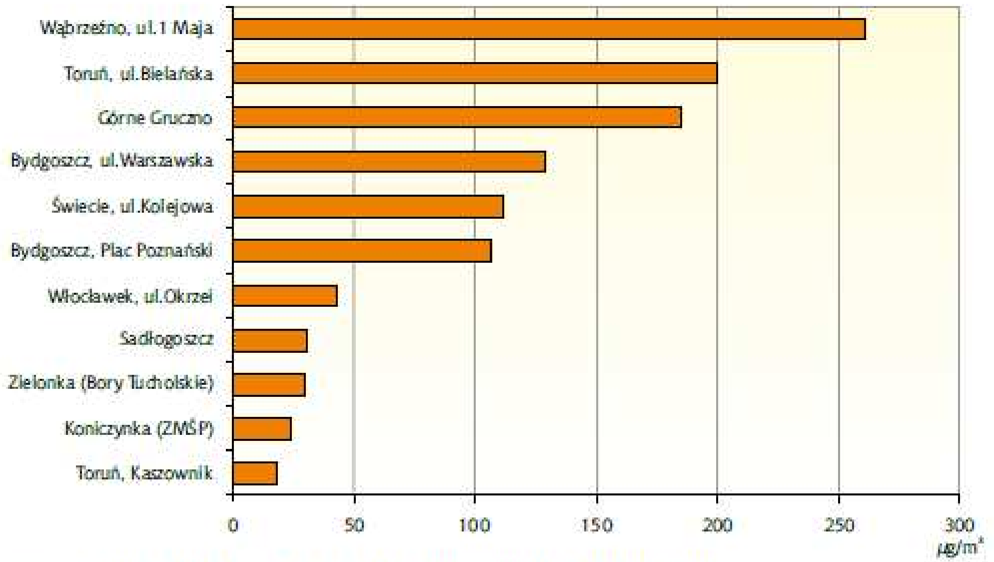
Maximum hourly concentrations of SO_2 in the different regions



Ryc.27. **Stężenia SO_2 w 2007 roku – maksymalne 1-godzinne**

NO_2 (Nitrogen dioxide)

Definition: NO_2 is a reddish-brown gas with a pungent and irritating odour. It transforms in the air to form gaseous nitric acid and toxic organic nitrates. NO_2 also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. It is also a precursor to nitrates, which contribute to increased breathable particle levels in the atmosphere.

Sources: NO2 it is formed in the atmosphere by the oxidation of NO generated in the cylinders of internal combustion engines by direct combination of nitrogen and oxygen.

$$N2(g) + O2(g) \rightarrow 2NO$$

$$2NO(g) + O2(g) \rightarrow 2NO2$$

The biggest source of nitrogen oxides is the use of fossil fuels, although in the manufacturing of nitric acid it is also produced nitrogen oxides. Even in the creation of explosives, L.P. gas and welding process

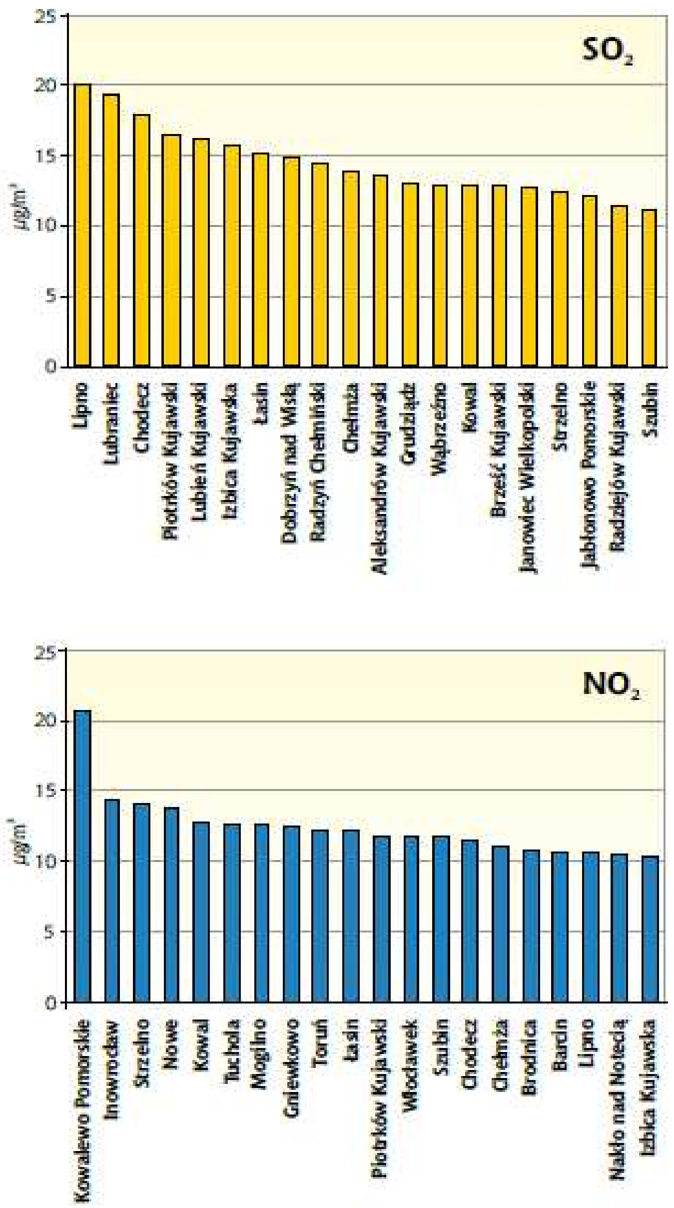
Nitrogen oxides are generated in a natural way by the bacterial activity, volcanic and lightning; however, the amount is very low compared with the anthropogenic origin ones.

The average tenure of nitrogen dioxide in the atmosphere is one day or so.

Health Effects: Short-term exposure may cause increased respiratory illness in young children and harm lung function in people with existing respiratory illnesses. Long-term exposure may lead to increased susceptibility to respiratory infection and may cause alterations in the lung. (Nitrogen oxides also can be transformed in the atmosphere to ozone of fine particulate soot - which are both associated with serious adverse health effects.)

Environmental Effects: Nitrogen oxides help form acid rain. In addition, this pollutant can cause a wide range of environmental damage, including visibility impairment and eutrophication - that is, explosive algae growth which can deplete oxygen in water bodies such as the Chesapeake Bay.

Cities with higher concentrations of SO2 and NO2



Ryc.28. **Średnie stężenia SO_2 i NO_2 w miastach – 2006/2007 (metoda pasywna) dla 20 najbardziej zanieczyszczonych miast**

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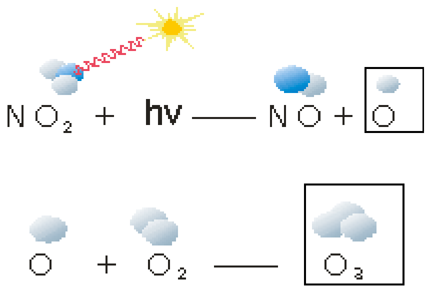
O_3 (ozone)

Definition: Is a triatomic molecule, consisting of three oxygen atoms. It is an allotrope of oxygen that is much less stable than the diatomic allotrope (O_2). Ozone in the lower atmosphere is an air pollutant with harmful effects on the respiratory systems of animals and will burn sensitive plants; however, the ozone layer in the upper atmosphere is beneficial, preventing potentially damaging electromagnetic radiation from reaching the Earth's surface. Ozone is present in low concentrations throughout the Earth's atmosphere. It has many industrial and consumer applications.

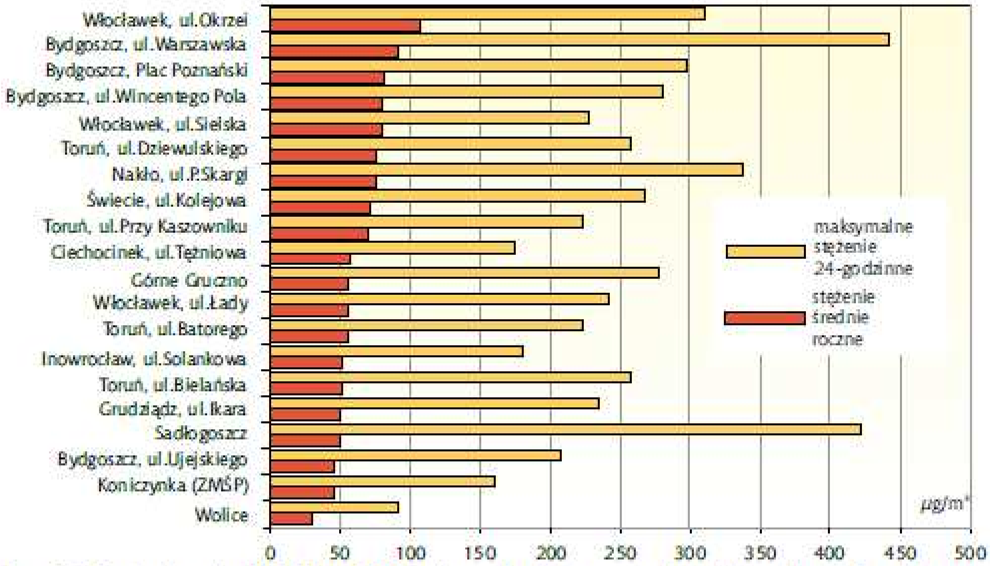
Sources: Ozone is not emitted directly into the air, but is formed by the reaction of volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of heat and sunlight. VOCs are emitted by a variety of sources, including motor vehicles, chemical plants, refineries, and other factories. NOx is emitted by motor vehicles, electric power plants, and other combustion sources. Ozone can be transported into an area from pollution sources found hundreds of miles upwind.



Health Effects: It is a powerful respiratory irritant at levels found in much of the nation during warm weather. Ozone exposure has been linked to increased hospital admissions and emergency room visits for asthma and other respiratory problems. It can also reduce the body's resistance to infection. Long-term, repeated exposure to high levels of ozone may lead to large reductions in lung function, inflammation of the lung lining and more frequent and severe respiratory discomfort. Recent studies have also linked ozone to premature death, though research continues on this topic.
Ozone is especially dangerous for children, the elderly, people with chronic lung and heart disease -- even healthy people who exercise outdoors. Children are at particular risk because their lungs are still growing and developing. They breathe more rapidly and more deeply than adults do, so a greater doze of air pollution may be delivered to their lungs.

Environmental Effects: From late spring to autumn, a lot of plant species are sensitive at ozone, (including crops) and they show characteristics symptoms on the upper leaf. Usually, on the surface of the damaged leaves lesions appear between veins. These lesions can vary between species from discoloration or chlorosis pits reddish or brown that can derive in necrosis affect nerve

Ozone in the different cities of the region (average)



Ryc.37. **Stężenia pyłu PM10 w 2007 roku – średnie roczne i maksymalne 24-godzinne**

Particulate Matters (PM)

Definition: They are tiny subdivisions of solid matter suspended in a gas or liquid. In contrast, aerosol refers to particles and/or liquid droplets and the gas together. Sources of particulate matter can be man made or natural. Air pollution and water pollution can take the form of solid particulate matter, or be dissolved. Salt is an example of a dissolved contaminant in water, while sand is generally a solid particulate.

Sources: Particulate matter (PM) is the general term for the mixture of solid particles and liquid droplets in the air. Some particles are large enough to be visible as smoke or soot. Others are so small they can be detected only with an electron microscope.

- Small particles: Less than 2.5 micrometers in diameter, known in the jargon of air pollution as "PM 2.5". Result from motor vehicles, coal-burning electric power plants, factories as well as from residential fireplaces and wood stoves. Larger "coarse" particles come largely from windblown dust, vehicles travelling on unpaved roads, and crushing and grinding operations. Some particles are emitted directly from their sources, for example, smokestacks and cars. In other cases, gases such as sulphur oxides and nitrogen oxides interact with other compounds in the air to form fine particles. These tiny bits of soot can travel hundreds of miles downwind of the original pollution sources.
- Big: The big particles are between 2.5 and 10 micrometers (from about 25 to 100 times thinner than a human hair). These particles are called PM10 (we say "P M ten", which stands for Particulate Matter up to 10 micrometers in size). These particles cause less severe health effects.

Health Effects: Particulate soot (particularly "fine" particles - see below) has been linked to tens of thousands of premature deaths every year. It also is associated with increased emergency room visits, asthma attacks, decreased lung function and other respiratory problems. Those most at risk include the elderly, people with cardiopulmonary disease such as asthma, and children.

Environmental Effects: Particulate soot is a major cause of reduced visibility in many parts of Europe. It also can cause damage to paints and building materials.

AQI Values	Air Quality Descriptor	Health Concerns*	
		$PM_{2.5}$	PM_{10}
0 - 50	Good	None	None
51 - 100**	Moderate	None	None
101 - 150	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.	People with respiratory disease, such as asthma, should limit outdoor exertion.
151 - 200	Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.	People with respiratory disease, such as asthma, should avoid outdoor exertion; everyone else, especially the elderly and children, should limit prolonged outdoor exertion.
201 - 300	Very Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.	People with respiratory disease, such as asthma, should avoid any outdoor activity; everyone else, especially the elderly and children, should limit outdoor exertion.
301 - 500	Hazardous	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.	Everyone should avoid any outdoor exertion; people with respiratory disease, such as asthma, should remain indoors.

Benzene (C_6H_6)

Definition: Benzene, also known as benzol, is a colourless liquid with a sweet odor. Benzene evaporates into air very quickly and dissolves slightly in water. Benzene is highly flammable. Most people can begin to smell benzene in air at 1.5-4.7 parts of benzene per million parts of air (ppm) and smell benzene in water at 2 ppm. Most people can begin to taste benzene in water at 0.5-4.5 ppm. One part per million is approximately equal to one drop in 40 gallons. Benzene is found in air, water, and soil. Benzene comes from both industrial and natural sources.

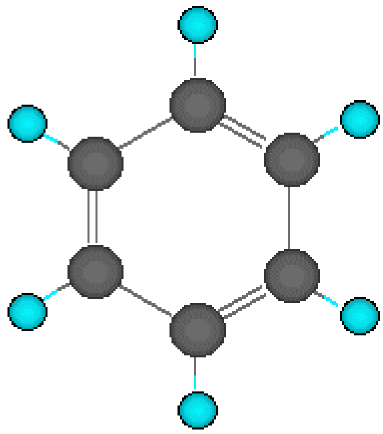
Sources:

Industrial Sources and Uses: Benzene was first discovered and isolated from coal tar in the 1800s. Today, benzene is made mostly from petroleum. Because of its wide use, benzene ranks in the top 20 in production volume for chemicals produced in the United States. Various industries use benzene to make other chemicals, such as styrene (for Styrofoam® and other plastics), cumene (for various resins), and cyclohexane (for nylon and synthetic fibbers). Benzene is also used in the manufacturing of some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides.

Natural Sources: Natural sources of benzene, which include gas emissions from volcanoes and forest fires, also contribute to the presence of benzene in the environment. Benzene is also present in crude oil and gasoline and cigarette smoke.

Health effects: Benzene usually enters the body in one of three ways: skin contact, consumption of tainted water or food, or inhalation. Inside the body, benzene enters the bloodstream and is carried into the bone marrow and fatty tissues. Eventually it passes through the liver, where it is broken down. As a result, harmful metabolites are formed. Some of the health problems caused by benzene exposure are due to the presence of metabolites in the body.

Environmental effects: Usual environmental concentrations of benzene are unlikely to pose any great risk to land animals and, although it has a low to moderate toxicity to water dwelling organisms, only concentrations arising from significant spills are likely to produce major adverse effects. Benzene in the air reacts with other air-borne chemicals and breaks down within a few days. It can be deposited to the ground in rain or snow. It breaks down more slowly in water and soil (weeks) and can pass through the soil into underground water where degradation is likely to be slow, especially at low oxygen levels. It does not build up (bioaccumulate) in plants or animals and is not expected to adsorb to sediment significantly. As a volatile organic compound (VOC), benzene in the air can contribute to the formation of low level ozone, which at high concentrations can damage crops and other plant life and damage materials such as rubber.



http://www.iestiemposmodernos.com/700appletsFQ/romero_quintanilla/Quimica_carbono/ciclicos.htm

Carbon monoxide (CO)

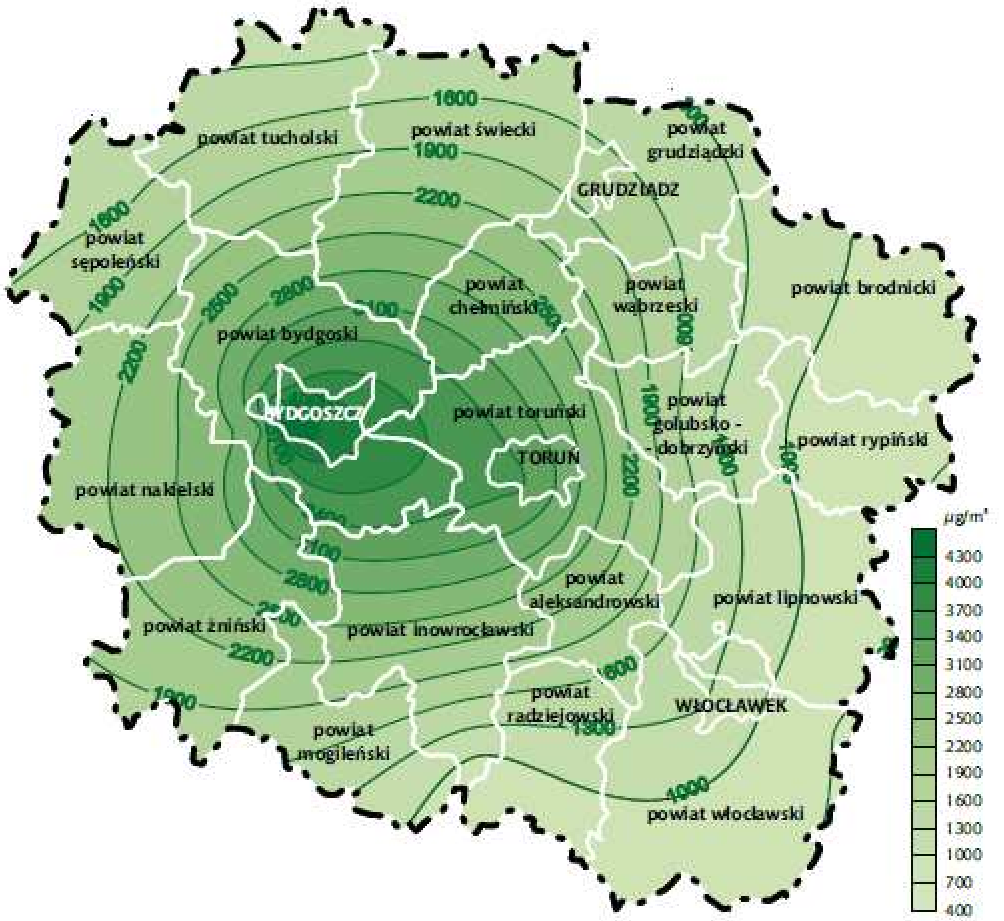
Definition: is an odourless, colourless and toxic gas, because it is impossible to see, taste or smell the toxic fumes, CO can kill before you are aware if it is at home. At lower levels of exposure, CO causes mild effects that are often mistaken for the flu. These symptoms include headaches, dizziness, disorientation, nausea and fatigue. The effects of CO exposure can vary greatly from person to person depending on age, overall health and the concentration and length of exposure.

Sources: Unvented kerosene and gas space heaters; leaking chimneys and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; generators and other gasoline powered equipment; automobile exhaust from attached garages; and tobacco smoke. Incomplete oxidation during combustion in gas ranges and unvented gas or kerosene heaters may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces) can be significant sources, or if the flue is improperly sized, blocked, disconnected, or is leaking. Auto, truck, or bus exhaust from attached garages, nearby roads, or parking areas can also be a source.

Heaths effects: At low concentrations, fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea. Can cause flu-like symptoms that clear up after leaving home. Fatal at very high concentrations. Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake. At moderate concentrations, angina, impaired vision, and reduced brain function may result. At higher concentrations, CO exposure can be fatal.

Environments effects: The effects it has on the environment is little known

The maximum concentration of 8-hour carbon monoxide (8 hours of workday)



Ryc.44. **Maksymalne stężenie 8-godzinne tlenku węgla w 2007 roku w województwie kujawsko-pomorskim (na podstawie 10 stacji pomiarowych)**

Others elements (Lead, Arsenic, Cadmium, Nickel)

Lead: is a bluish-white lustrous metal. It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity. It is very resistant to corrosion but tarnishes upon exposure to air. Lead isotopes are the end products of each of the three series of naturally occurring radioactive elements.

Lead occurs naturally in the environment. However, most lead concentrations that are found in the environment are a result of human activities. Due to the application of lead in gasoline an unnatural lead-cycle has consisted. In car engines lead is burned, so that lead salts (chlorines, bromines and oxides) will originate.

Lead can end up in water and soils through corrosion of leaded pipelines in a water transporting system and through corrosion of leaded paints. It cannot be broken down; it can only convert to other forms. Lead accumulates in the bodies of water organisms and soil organisms. These will experience health effects from lead poisoning. Health effects on shellfish can take place even when only very small concentrations of lead are present. Body functions of phytoplankton can be disturbed when lead interferes. Phytoplankton is an important source of oxygen production in seas and many larger sea-animals eat it. That is why we now begin to wonder whether lead pollution can influence global balances.

Soil functions are disturbed by lead intervention, especially near highways and farmlands, where extreme concentrations may be present. Soil organisms also suffer from lead poisoning, too. Lead is a particularly dangerous chemical, as it can accumulate in individual organisms, but also in entire food chains.

Arsenic: Arsenic appears in three allotropic forms: yellow, black and grey; the stable form is a silver-gray, brittle crystalline solid. It tarnishes rapidly in air, and at high temperatures burns forming a white cloud of arsenic trioxide.

Arsenic can be found naturally on earth in small concentrations. It occurs in soil and minerals and it may enter air, water and land through wind-blown dust and water run-off. Arsenic in the atmosphere comes from various sources: volcanoes release about 3000 tonnes per year and microorganisms release volatile methylarsines to the extent of 20.000 tonnes per year, but human activity is responsible for much more: 80.000 tonnes of arsenic per year are released by the burning of fossil fuels.

The arsenic cycle has broadened as a consequence of human interference and due to this, large amounts of arsenic end up in the environment and in living organisms. Arsenic is mainly emitted by the copper producing industries, but also during lead and zinc production and in agriculture. It cannot be destroyed once it has entered the environment, so that the amounts that we add can spread and cause health effects to humans and animals on many locations on earth.

Plants absorb arsenic fairly easily, so that high-ranking concentrations may be present in food. The concentrations of the dangerous inorganic arsenics that are currently present in surface waters enhance the chances of alteration of genetic materials of fish. This is mainly caused by accumulation of arsenic in the bodies of plant-eating freshwater organisms. Birds eat the fish that already contain eminent amounts of arsenic and will die as a result of arsenic poisoning as the fish is decomposed in their bodies.

Cadmium: Cadmium is a lustrous, silver-white, ductile, very malleable metal. Its surface has a bluish tinge and the metal is soft enough to be cut with a knife, but it tarnishes in air. It is soluble in acids but not in alkalis. It is similar in many respects to zinc but it forms more complex compounds.

Cadmium can mainly be found in the earth's crust. It always occurs in combination with zinc. Cadmium also consists in the industries as an inevitable by-product of zinc, lead and copper extraction. After being applied it enters the environment mainly through the ground, because it is found in manures and pesticides. Naturally a very large amount of cadmium is released into the environment, about 25,000 tons a year. About half of this cadmium is released into rivers through weathering of rocks and some cadmium is released into air through forest fires and volcanoes. The rest of the cadmium is released through human activities, such as manufacturing.

Cadmium strongly adsorbs to organic matter in soils. When cadmium is present in soils it can be extremely dangerous, as the uptake through food will increase. Soils that are acidified enhance the cadmium uptake by plants. This is a potential danger to the animals that are dependent upon the plants for survival. Cadmium can accumulate in their bodies, especially when they eat multiple plants. Cows may have large amounts of cadmium in their kidneys due to this.

Earthworms and other essential soil organisms are extremely susceptive to cadmium poisoning. They can die at very low concentrations and this has consequences for the soil structure. When cadmium concentrations in soils are high they can influence soil processes of microorganisms and threat the whole soil ecosystem.

In aquatic ecosystems cadmium can bio accumulate in mussels, oysters, shrimps, lobsters and fish. The susceptibility to cadmium can vary greatly between aquatic organisms. Salt-water organisms are known to be more resistant to cadmium poisoning than freshwater organisms.

Animals eating or drinking cadmium sometimes get high blood-pressures, liver disease and nerve or brain damage.

Nickel: Nickel is silvery-white, hard, malleable, and ductile metal. It is of the iron group and it takes on a high polish. It is a fairly good conductor of heat and electricity. In its familiar compounds nickel is bivalent, although it assumes other valences.

Most nickel on Earth is inaccessible because it is locked away in the planet's iron-nickel molten core, which is 10 % nickel. The total amount of nickel dissolved in the sea has been calculated to be around 8 billion tonnes. Organic matter has a strong ability to absorb the metal which is why coal and oil contain considerable amounts. The nickel content in soil can be as low as 0.2 ppm or as high as 450 ppm in some clay and loamy soils. The average is around 20 ppm.

Nickel is released into the air by power plants and trash incinerators. It will than settle to the ground or fall down after reactions with raindrops. It usually takes a long time for nickel to be removed from air. Nickel can also end up in surface water when it is a part of wastewater streams.

There is not much information available on the effects of nickel upon organisms other than humans. We do know that high nickel concentrations on sandy soils can clearly damage plants and high nickel concentrations in surface waters can diminish the growth rates of algae. Microorganisms can also suffer from growth decline due to the presence of nickel, but they usually develop resistance to nickel after a while.

WEATHER

Poland has a moderate climate with both maritime and continental elements. This is due to humid Atlantic air which collides over its territory with dry air from the Eurasian interior. As a result, the weather tends to be capricious and the seasons may look quite different in consecutive years. This is particularly true for winters, which are either wet, of the oceanic type, or - less often - sunny, of the continental type. Generally, in north and west Poland the climate is predominantly maritime, with gentle, humid winters and cool, rainy summers, while the eastern part of the country has distinctly continental climate with harsh winters and hotter, drier summers.

Generally, Poland receives all kinds of air masses typical of the northern hemisphere. This results in a variable climate and considerable problems with weather forecasting. Poland's climate is also characterized by substantial weather changes in consecutive years, caused by disturbances in the pattern of main air masses coming to the country. Summer may be hot and dry a few times in a row and then it becomes cool and wet. This phenomenon tends to happen in several-year cycles.

Poland's climate is also strongly influenced by the lowland topography of this part of Europe, stretching from France to Ukraine. Not stopped by any natural barriers, air masses move quickly from the Atlantic or North Sea. Another factor is the country's location, far from vast water bodies (the Atlantic Ocean) and close to extensive land areas (Eurasia). The Baltic Sea is a major contributor to the climate of north Poland while the southern part of the country is also affected by the Black Sea.

Winds: the sea breeze and the halny

The main pressure systems that affect the weather are the Icelandic low (stronger in winter) and the Azores anticyclone (more active in summer) as well as the changing atmospheric fronts from Asia: the East Asian high in winter and the South Asian low in summer. For a major part of the year Poland has predominantly west circulation of winds, caused by the eastward movement of barometric lows from the Atlantic. As a result, on 60 percent of all windy days the winds are from the west, blowing mainly from the area stretching between the Czech Republic and Scandinavia. In the eastern part of the country, the percentage of easterly winds is higher, while in the mountains, southerly winds occur more frequently.

The wind pattern is not uniform throughout the year. In summer months, that are from July to September the winds are mainly westerly, whereas in winter, notably in December and January, easterly winds prevail. In the transitory seasons, both winds occur roughly with the same frequency.

The winds in Poland are typically weak to moderate, their speed ranging from 2 to 10 m/s. Strong and very strong winds occur at the seaside, causing storms, and in the mountains, where their speed may exceed 30 m/s. Hurricanes that uproot trees and blow off roofs are rather unusual.

With its diversified topography, Poland also has local winds. Along the Baltic coast, on a cloudless summer day you can experience a pleasant, invigorating sea breeze which occurs during the day and is felt about 10 km inland. At night its direction reverses: the air moves from the cooler land towards the warmer sea, causing the land breeze.

Wind speed and number of days per month that exceeds the wind speed 10 m/s in Kujawsko-pomorskiego

Ryc.18. **Średnia miesięczna prędkość wiatru [m/s] w 2007 roku na tle średniej wieloletniej w Toruniu**

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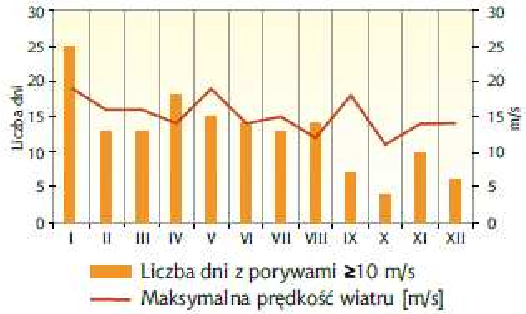

Ryc.19. **Liczba dni z prędkościami wiatru ≥ 10 m/s oraz maksymalne prędkości wiatru w 2007 roku w Toruniu**

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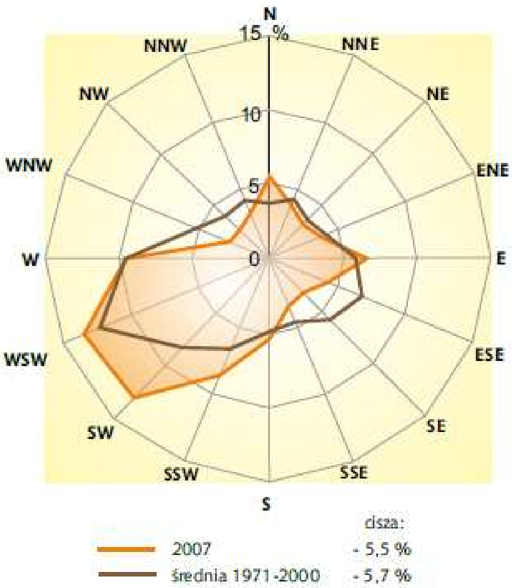
Wind direction in percentage and average wind speed according to their direction and compared with the time interval 1971-2000 in Kujawsko-pomorskiego



Ryc.20. **Częstość kierunków wiatru i cisz [%] w 2007 roku w Toruniu na tle średniej wieloletniej**

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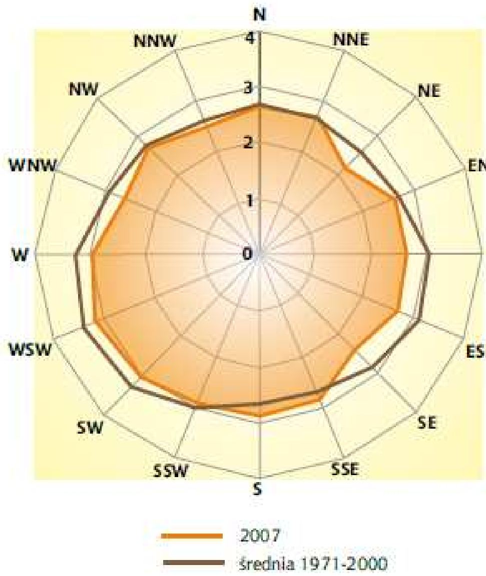

Ryc.21. **Średnia prędkość wiatru (m/s) wg kierunków w 2007 roku w Toruniu na tle średniej wieloletniej**

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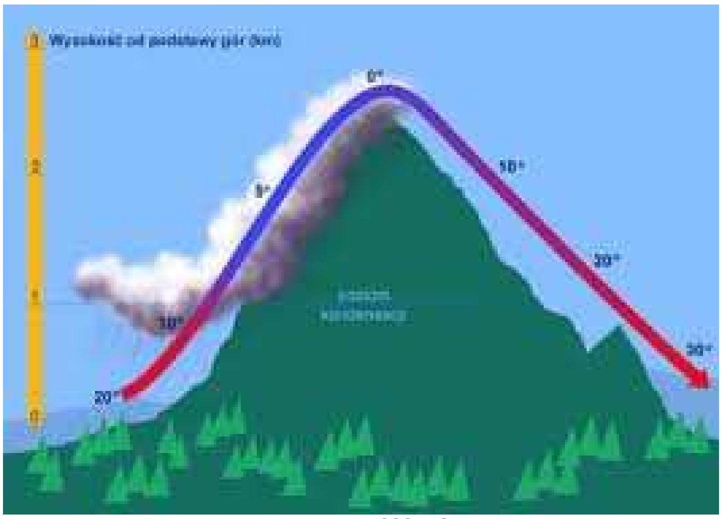
In the mountains, there are mountain-valley winds. The best-known one is the halny, which blows in the Tatras. This kind of wind is not unique to Poland, though; it occurs in all mountains around the world and is called the föhn.

Halny

The halny is a strong and gusty wind, and its effects are higher temperature and lower air humidity on the leeward slopes. It develops when moving air is stopped by a mountain range and forced to rise. The halny is a nuisance for people as it lowers their mental and physical fitness and makes them irritable. It is strong enough to break trees, sometimes over large areas, blow off roofs and knock over fences. In winter it causes sudden thaws leading to floods.



wptatry.republika.pl

Cloudiness and precipitation

A visible effect of the collisions of air masses above Poland is cloudiness. The number of cloudy days is between 60 and 70 percent, which is relatively high. The cloudiest regions are the lake districts in the north and the Sudetes; the least cloudy are Wielkopolska and the Silesian Lowland. The average number of cloudy days a year, with the sky more than 80% overcast, is 120-160; for sunny days, with cloudiness below 20%, it is 30-50.

The heaviest precipitation in Poland was recorded in June 1973 in the Tatra's Hala Gasienicowa. During one rain as much as 30cm of water fell. With Poland's predominantly westerly winds, the highest precipitation occurs on western slopes of mountains and hills. In the Carpathians and Sudetes, the annual precipitation is 800-1400mm. In the lowlands and uplands, it ranges between 400mm and 750mm. Similar levels are recorded in the Pomeranian and Masurian lake districts. This is caused by the proximity of the Baltic Sea, from which humid sea air flows east. The lowest precipitation occurs in the eastern part of Wielkopolska and in Kujawy, a region lying in the rain shadow of the Pomeranian Lake District.

Occasionally, Poland witnesses extraordinary precipitation. In 1901, when winds brought dust from Sahara, a black-brown rain fell. 71 years later the same phenomenon was responsible for orange snow in Zakopane. The maximum precipitation is in summer. At this time of the year it is on average 2-3 times higher than in winter (in the Carpathians, as much as four times higher). The smallest seasonal differences are recorded in the coastal lowlands.

Winter comes to Poland from the north-east. The average annual number of days with snowfall is 30-40 in the country's western and central part, and over 50 days in the north-east. It snows for 120 days a year in the Karkonosze and for 145 days in the Tatras. Snow stays the longest in the mountains (up to 200 days) and in north-west Poland (90-120 days). The western part of the country has the fewest days with snow cover (40-50).

Temperature: heat and frost

The average annual temperature in Poland ranges from 5-7 ºC in the hilly Pomeranian and Masurian lake districts and in the uplands to 8-10 ºC in the belt of the sub-Carpathian basins, the Silesian Lowland and the Wielkopolska Lowland. Only in the upper parts of the Carpathians and Sudetes is it about 0*C (Kasprowy Wierch, -0.8ºC; Mt Sniezka, -0.4 ºC).

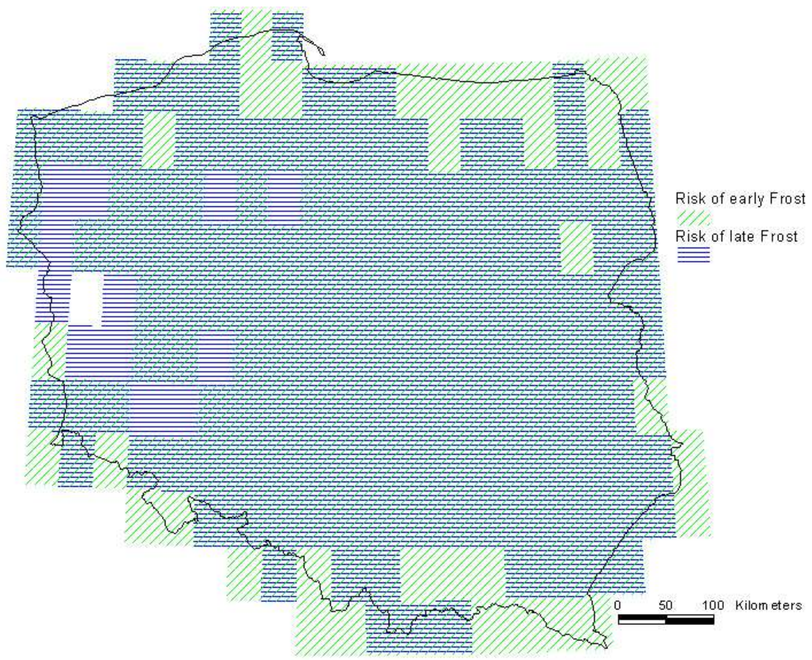
The hottest month is July with the average temperature standing at 16-19*C. The coldest area in July is the mountains, where the air temperature drops as the altitude increases (on average by 0.6 ºC for every 100 metres). In the summit areas of the Tatras and Sudetes, the average air temperature in July is just about 9 ºC. July is also cooler in areas adjacent to the Baltic (about 16 ºC), which is caused by the cold sea waters. The hottest area is central Poland, with the temperatures exceeding 18 ºC.

Hot days, when the temperature exceeds 25 ºC, occur from May to September. Their number increases the further you go from the sea. On average, there are only five such days at the Rozewie Cape and over 40 in the Sandomierz Basin and Lublin Upland.

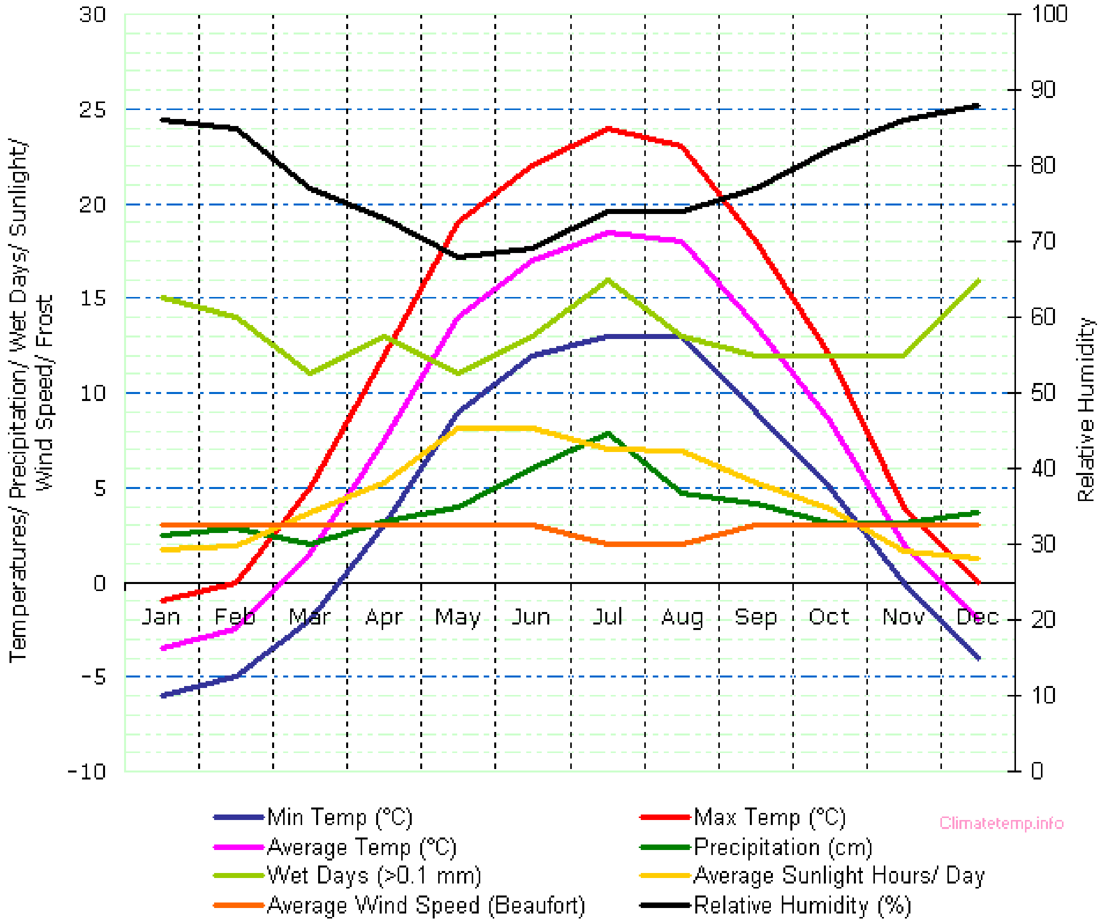
The coldest month in Poland is January. Cold continental air flowing in from the east in January makes the eastern part of Poland one of the coldest areas in the country. Sub-zero temperatures are recorded between November and March. The average annual number of frosty days ranges from about 25 along the lower Odra River and at the seaside to 65 in the Suwalki Lake District; in the mountains, it reaches 132 days on Mt Sniezka and 150 days on Kasprowy Wierch. The number of freeze days, typically in late spring and early autumn, ranges in the lowlands from 90 (at the seaside) to 130, while in the mountains it exceeds 200.

Varying air temperatures affect the length of the vegetation season, during which the average daily air temperature is at least 5 ºC. On average the vegetation season in Poland lasts about 200 days. It is the shortest in the mountains, in the eastern part of the Pomeranian Lake District and in the Masurian and Suwalki lake districts. It is the longest in the Silesian Lowland and along the lower Odra. The lowest temperatures ever recorded in Poland were -41 ºC in Siedlce (in 1940) and -40.6 ºC in the Zywiec Basin (in 1929). The highest temperature, +40.2 ºC, was recorded in Pruszkow near Opole in 1921.

Risk of frost



Poland climate graph



http://www.climatetemp.info/poland/poznan.html

- The average temperature in Poland is 7.7 °C.
- The average temperature range is 22 °C.
- The highest monthly average high temperature is 24 °C in July.
- The lowest monthly average low temperature is -6 °C in January.
- Poland receives an average of 471 mm of rainfall per year, or 39 mm per month.
- On average there are 158 days per year with more than 0.1 mm of rainfall or 13 days with a quantity of rain, sleet, snow etc. per month.
- The driest weather is in March when an average of 20 mm of rainfall occurs across 11 days.
- The wettest weather is in July when an average of 79 mm of rainfall occurs across 16 days.
- The average annual relative humidity is 78.3% and average monthly relative humidity ranges from 68% in May to 88% in December.
- Average sunshine hours in Poland range between 1.3 hours per day in December and 8.1 hours per day in June.
- There is an average of 1676 hours of sunshine per year with an average of 4.6 hours of sunshine per day.

Poland Weather Averages

	Average Minimum Temperatures in Poland (°C)	Average Maximum Temperature in Poland (°C)	Poland Average Temperature (°C)	Average Sea Temp (°C)	Average Precipitation/ Rainfall (mm)	Wet Days (>0.1 mm)	Average Sunlight Hours/ Day	Relative Humidity (%)	Average Wind Speed in Poland (Beaufort)	Average Number of Days with Frost	
Weather in Poland in January	-6	-1	-3.5	-	25	15	1.7	86	3	-	*Average Temperature in Poland in January*
Weather in Poland in February	-5	0	-2.5	-	28	14	1.9	85	3	-	*Average Temperature in Poland in February*
Weather in Poland in March	-2	5	2	-	20	11	3.7	77.0	3	-	*Average Temperature in Poland in March*
Weather in Poland in April	3	12	8	-	32	13	5.3	73	3	-	*Average Temperature in Poland in April*
Weather in Poland in May	9	19	14	-	40	11	8.1	68	3	-	*Average Temperature in Poland in May*
Weather in Poland in June	12	22	17	-	60	13	8.1	69	3	-	*Average Temperature in Poland in June*
Weather in Poland in July	13	24	19	-	79	16	7.1	74	2	-	*Average Temperature in Poland in July*
Weather in Poland in August	13	23	18	-	47	13	6.9	74	2	-	*Average Temperature in Poland in August*
Weather in Poland in September	9	18	14	-	41	12	5.3	77	3	-	*Average Temperature in Poland in September*
Weather in Poland in October	5	12	9	-	31	12	3.8	82	3	-	*Average Temperature in Poland in October*
Weather in Poland in November	0	4	2	-	31	12	1.6	86	3	-	*Average Temperature in Poland in November*
Weather in Poland in December	-4	0	-2	-	37	16	1.3	88	3	-	*Average Temperature in Poland in December*

http://www.climatetemp.info/poland/

Seasons

Poland has as many as six distinct seasons. Apart from the four typical European seasons, there are also two periods described as early spring (przedwiosnie) and early winter (przedzimie). The seasons hardly conform to the calendar pattern. During the przedwiosnie, which is about a month long, the average daily air temperature ranges from 0 ºC to 5 ºC.? Spring in Poland lasts usually about 60 days and comes from the west. The daily temperature at that time ranges from 5 ºC to 15 ºC. This is also when the vegetation season begins in Poland.

The summer, with temperatures above 20 ºC, begins in May and is about four months long. In autumn, the average temperature drops to between 5 ºC and 15 ºC. Almost every year, mid September sees the coming of Polish "Indian summer", which is a warm and sunny transition between summer and autumn. Leaves start to fall off the trees, but you can still feel the wafts of warmth.

Once the trees have lost all their leaves and the days are markedly shorter, przedzimie begins. Temperatures drop below 5 ºC. After about six weeks, winter comes and the frosts don't want to go away for a long time - until late February or early March, and even then przedwiosnie can be felt only in Pomerania and west Poland. The highlanders have to wait for it until mid March, while in the north east early spring arrives another two weeks later.

The seasons are of different length in every geographical region. For instance, summer in north Poland lasts about 2.5 months, while in the south east, centre and south west of the country it is over three months long. Winter length ranges from two months at the seaside and in the west to 3-4 months in the north east and even six months in the Tatras.

This climatic calendar is more complicated, though, as there are plenty of anomalies which make another distinctive feature of Poland's climate. There are many proverbs about the unpredictable weather, especially in March and April. Przedwiosnie may arrive as early as at the beginning of February and, conversely, it can sometimes snow even in September. In January 1982 the air temperature in Wloclawek dropped overnight from 8 ºC to -20 ºC, the record drop since temperatures started to be officially recorded in Poland. On 8 January 1994 the temperature in Cracow's centre stood at 17.3ºC.

Over the last thousand years, Poland's climate has undergone substantial changes. For instance, as late as in the 12th century grapes were grown in many regions. That was when the climate was the mildest. Today, even in Zielona Gora, once noted for its vineyards, you can see just one small plantation maintained for decorative purposes.

The hottest and coldest areas

The hottest part of Poland is the Silesian Lowland, strongly influenced by the Atlantic air. An important factor is also the region's location close to higher-lying areas that stop clouds and moisture, which results in high insolation. The thermal winter period here is only about 60 days long and winters are relatively mild, while summers are sunny and hot, lasting over 100 days, which puts them among the longest in Poland. Average temperature in July exceeds 18.5 ºC. The highest temperatures are recorded near Wroclaw, on the Wroclaw Plain. This is the only area in Poland where the annual average temperature is over 8.5 ºC. Because of this mild climate, the Silesian Lowland has one of the longest vegetation seasons in the country, lasting 220 days.

The coldest spot is the north-eastern corner around Suwalki. With its moraine hills, postglacial lakes and low temperatures, this region bears much similarity to the distant Scandinavia. Harsh and long winters, lasting over four months, earned it the name of Poland's cold pole. The influence of the continental climate manifests itself in very low temperatures in winter and pretty high ones in summer. The average temperatures in the Suwalki region have the biggest amplitudes in Poland, over 23 ºC, which is even more than in the mountains. The average air temperatures in January, the coldest month, are below -5 ºC, the lowest in Poland. In summer the average air temperature drops below 17.5 ºC. The annual average air temperature in the Suwalki Lake District is slightly more than 6 ºC. Predictably, summer here is one of the shortest in Poland, lasting about 60 days. The vegetation season in this harsh climate is about 190 days long, to which the breathtaking wild nature of the Suwalki region has become well adapted.

Comparison of average hours of sunshine (yellow line) and average hours cloudy (blue line) in Kujawsko-Pomorskie

Ryc.22. **Średnia miesięczna liczba godzin usłonecznienia na dzień oraz średnie miesięczne zachmurzenie w oktanach [8-stopniowa skala] w roku 2007 w Toruniu**

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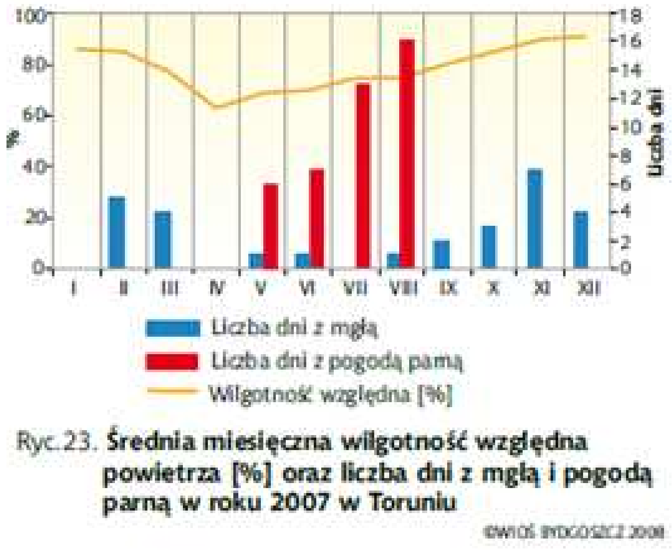
Comparison of foggy days per month (blue column), days of shame (red column) and monthly mean relative humidity (yellow line) in Kujawsko-Pomorskie



Areas with the lowest and highest precipitation

Paradoxically, the driest part of Poland is a region abounding in lakes and rivers - Kujawy. As it lies in a rain shadow, it sees relatively rare rains and snowfalls. Before reaching Kujawy and west Wielkopolska, the prevailing north-west air masses lose their moisture above the higher-lying Pomeranian Lake District. Other factors are the flatness of the terrain and the lack of any sizeable forests. At Lake Goplo, the yearly precipitation is just 300mm, which is the lowest value in the country.

Radically different are the Tatras, where rain, snow or even hail is more likely than sunshine. Rocks and plants are often covered by hoar-frost, rime or dew, collectively referred to as horizontal precipitation. Water circulation in this area is particularly intense. Retained for a short time by the mountains or by a snow cover, water escapes quickly as fog or through crystal-clear mountain streams

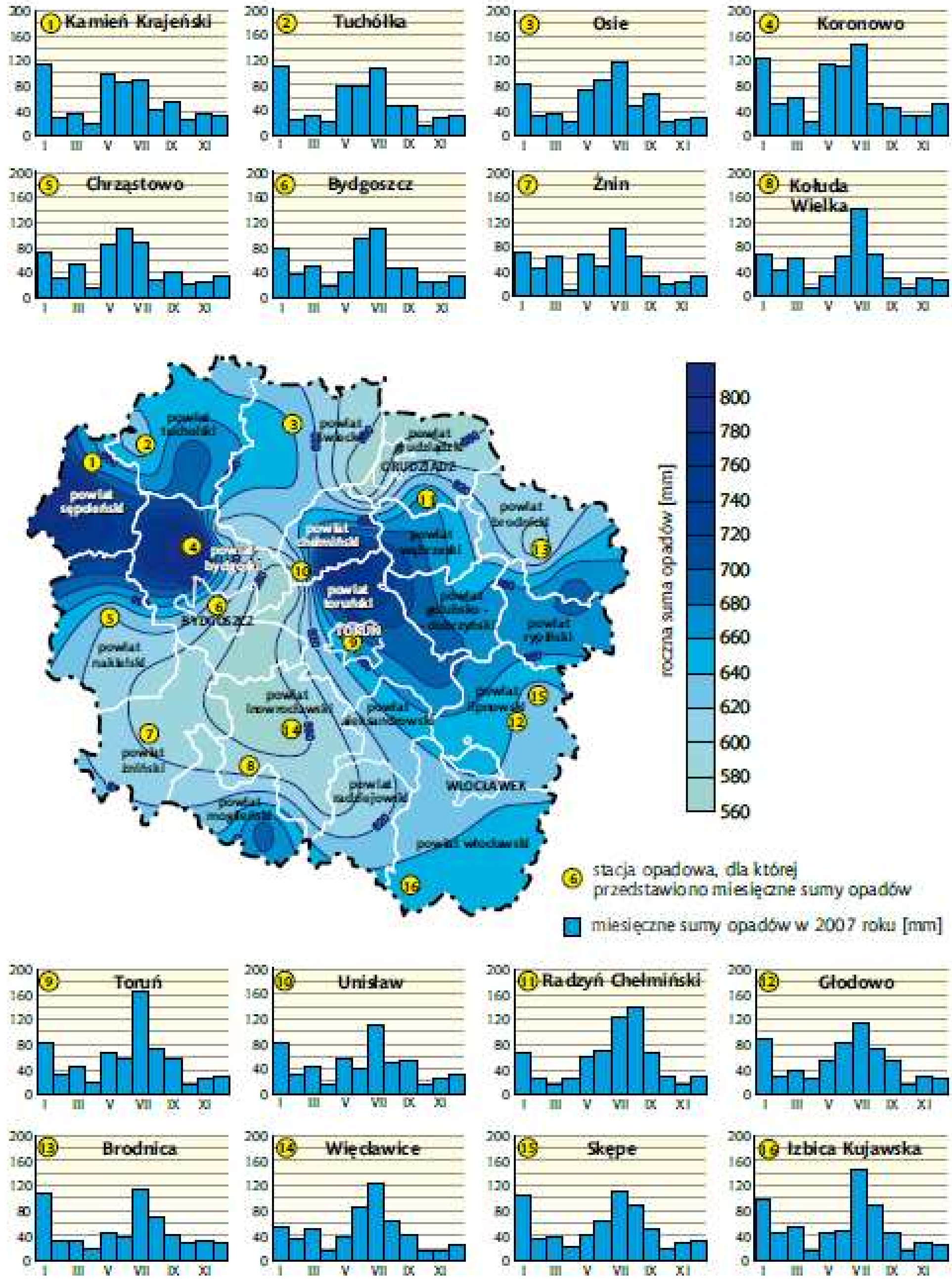
The Tatras have the highest precipitation in Poland. This is particularly evident in the Five Lakes' Valley (Dolina Pieciu Stawow Polskich), where the annual precipitation exceeds 1800mm of water. The period from April to October has more precipitation than the winter half-year. June is usually the rainiest month of the year, while February is the least likely month for any precipitation (in high mountains, it is September). On Kasprowy Wierch, there are annually about 230 days with daily precipitation over 0.1mm and about 50 days when it exceeds 10 mm. The mount also has the longest-lying snow cover. Some snow is blown by winds and when it is warm enough, water evaporates intensively, which makes an impressive sight.

In winter, the Tatras see a curious phenomenon known as temperature inversion. In the valleys, it is colder than in the higher parts of the mountains. The so-called fog seas that develop in depressions make the air above extremely clear, so that the views from the peaks extend over hundreds of kilometres.

Poland has areas of outstanding natural value, both Europeanwide and worldwide. There are still places hardly touched by the civilization, like the wild and desolate Bieszczady Mountains with their spectacular pastures known as poloniny, and the inaccessible flood plains along the Biebrza River, home of many rare bird species, sometimes found nowhere else in Europe.

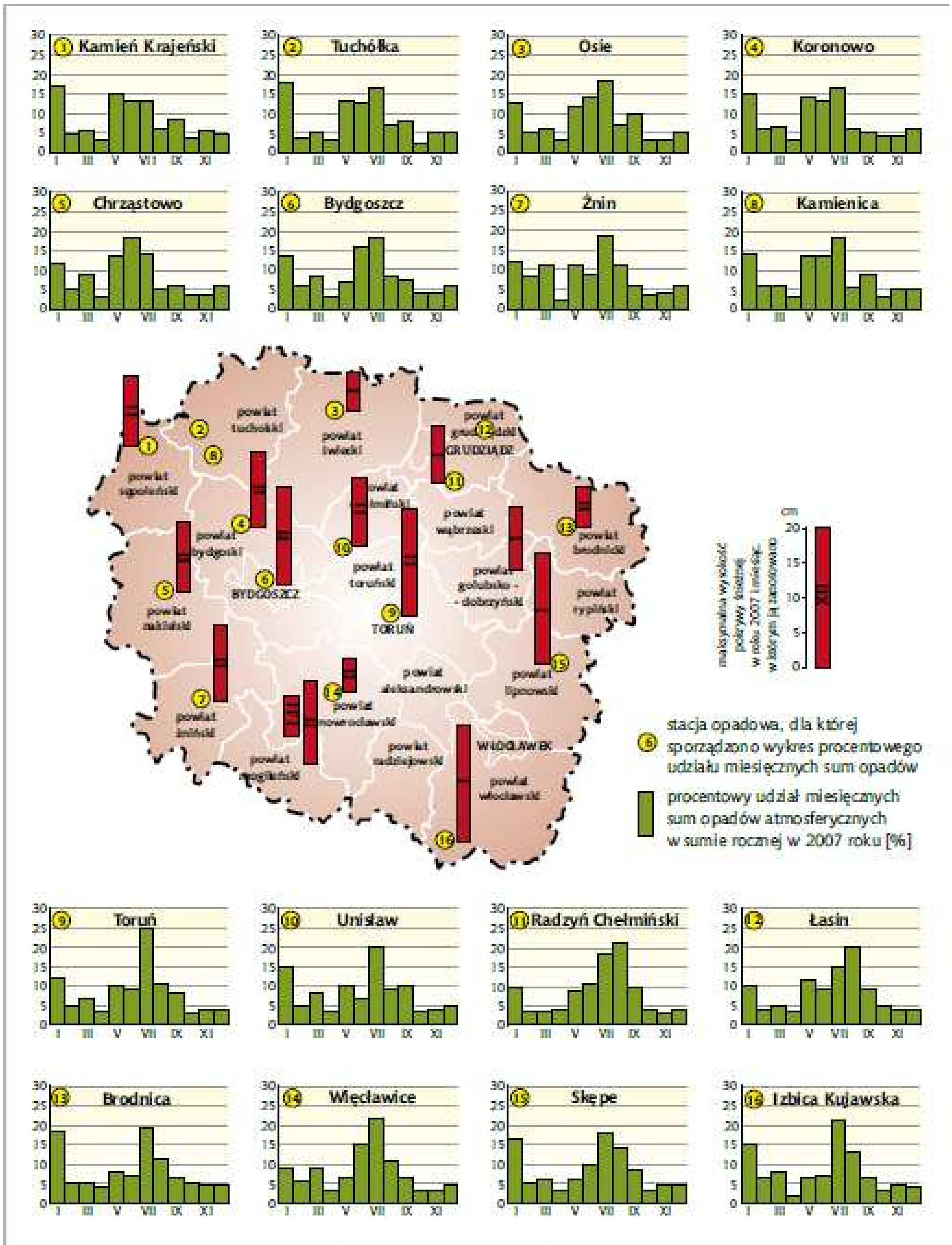
The most valuable gems of Poland's flora include the several hundred ancient oak trees in the Rogalin forest near Poznan.

Precipitation in Kujawsko-Pomorskie



Ryc.15. **Sumy roczne oraz miesięczne sumy opadów atmosferycznych na wybranych stacjach [mm] w 2007 roku**

Percentage of rain and altitude of the snow cover in cm. in Kujawsko-Pomorskie



Ryc.16. **Procentowy udział miesięcznych sum opadów atmosferycznych w sumie rocznej oraz maksymalna wysokość pokrywy śnieżnej [cm] na wybranych stacjach w roku 2007**

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Days with snow per month in Kujawsko-Pomorskie

Tabela 10. Liczba dni z pokrywą śnieżną całkowitą i z przerwami oraz maksymalna wysokość na wybranych stacjach w 2007 r.

Stacja	Liczba dni z pokrywą śnieżną													Maksymalna wysokość [cm]
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	ROK	
Toruń	6	11									2	1	20	16
Unisław	5	7											13	10
Więcławice	5	9	1								1	1	17	5
Grudziądz	4	8											12	9
Kamień Krajeński	4	8									1		13	10
Osie	4	7									1	2	14	6
Skępe	7	7									1		15	16
Brodnica	7	6									1		14	6
Chrząstowo	5	6									1	1	13	10
Strzelno	5	7	2										15	11
Koronowo	5	13										1	19	11
Izbica Kujawska	7	9											16	17

SOIL AND FOREST

Soil

Natural and soil conditions in Poland are worse than the average EU soil conditions. This is the result of the major influence of subsequent glaciations on the soil forming process, which led to the major part of the country being covered with light soils on sandy, permeable ground. These soils do not enable the cultivation of a set of plants similar to the one cultivated by the EU farmers and does not produce comparable yields, especially by demanding species, such as wheat or vegetables. This situation is also an effect of climatic conditions (lower temperatures, shorter vegetation period and less rainfall).

Scoring European soils, classified according to their applicability in agriculture, undertaken on the basis of indicators used in the evaluation of soils in Poland, indicates a better quality of soil in the EU- 15 as compared with Polish soil. The quality of soil in Poland has changed to a considerable extent as compared to earlier comparisons with other EU Member States. Basing on the particle size and water retention in soil in Europe, the estimated difference between soil quality in Poland and in EU-15 runs at about 25%.

Because light soils are coarse-grained, water retention is low, so that with low amount of precipitation, this adversely affects water-soil relations during the growing period, particularly across the Polish Lowland, where water deficits may amount to 250 mm in the growing season.

The important threats related to the condition of the environment include: wind, water surface and ravine erosion, concerning 27.6%, 28.5% and 17.5% respectively of agricultural and forest land, significant decrease of organic matter content in the soil has been noted on 54.4% of arable land area, density and acidification, with 54% of arable land particularly acidic. These problems co-exist with the limitation of water resources in Poland, resulting from unfavourable hydrological conditions – together these factors significantly limit the possibilities of the development of agricultural production.

Another danger is related with the cessation of farming on arable land, which results in complex effects for the environment and landscape. The area of fallow and idle land in the arable land in 2005 was 1,028.6 thousand ha in Poland (CSO, 2006). A part of arable land is excluded from production due to natural conditions (soil quality, relief, water conditions), economic and organizational conditions (for example, choice of production activity by an agricultural producer), and also due to external conditions. At the same time, the preservation of a number of natural habitats, the protection of bird breeding habitats and traditional rural landscape require extensive farming. Thus, when assessing the significance of the problem of agricultural land left behind, not only the scale of the process in time, but also the issue of uniqueness of endangered habitats and species must be borne in mind.

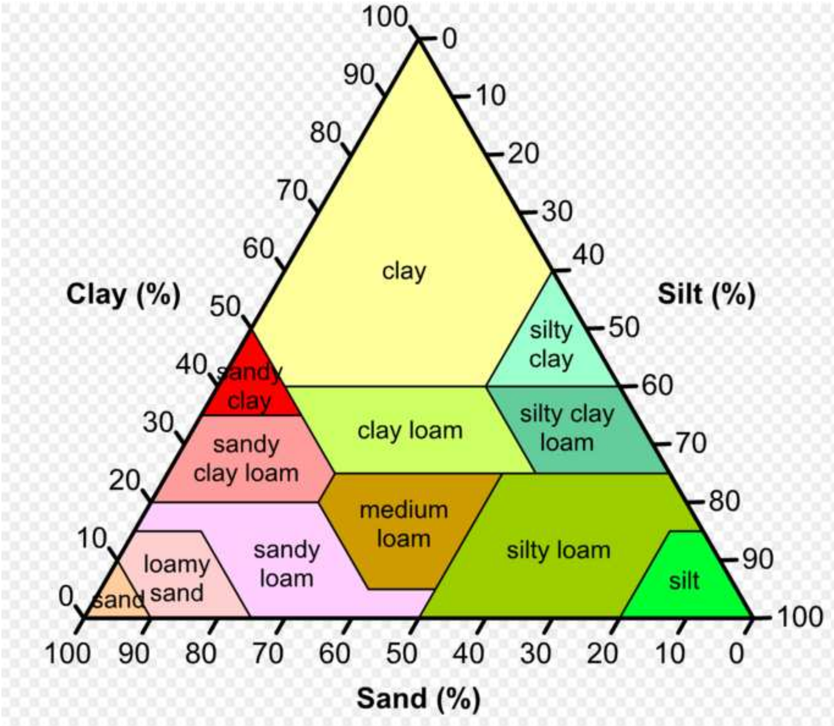
Map of soils in Poland

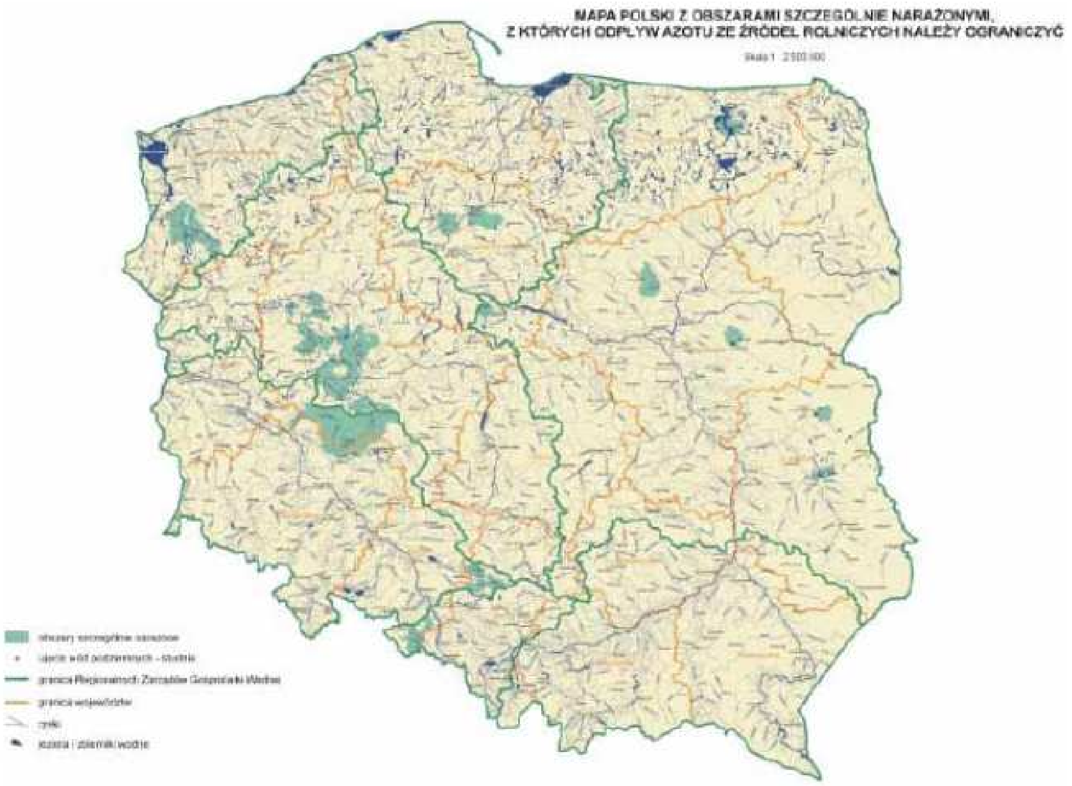
In the region of Kujawsko-Pomorskie the most typical kind of soil is sandy soils. The area is hampered by poor sandy soil. Which is why the primary crops are Rye, Hay and Potatoes. Sandy Soils have a gritty texture and are formed from weathered rocks such as limestone, quartz, granite, and shale. If sandy soil contains enough organic matter it is easy to cultivate, however it is prone to over-draining and summer dehydration, and in wet weather it can have problems retaining moisture and nutrients.

The sandy soils demand frequent irrigation due to the impossibility to store liquids. The kind of plants that develop in this soil suffer drought in a more acute way than clay’s soil, unless in deserts and areas with common drought. As a result of this inability to hold water the nutrients run off the root-area. When the water enter easily in the earth, drag dispersed minerals and drive them deep. Then so the land look like poor with scarce nutrients, and plants do not develop a sufficiently long roots to absorb nutrients

The most typical sub-classes of sandy soils that it can find in this region are:

- Loose sand
- Poor clay sand
- Light loamy sand
- Strong loamy sand


Clay (%)
Silt (%)
Sand (%)
100
90
80
70
60
50
40
30
20
10
0
clay
silty clay
sandy clay
clay loam
silty clay loam
sandy clay loam
medium loam
sandy loam
silty loam
loamy sand
sand
silt


MAPA POLSKI Z OBSZARAMI SZCZEGÓLNIE NARAŻONYMI,
Z KTÓRYCH ODPŁYW AZOTU ZE ŹRÓDEŁ ROLNICZYCH NALEŻY OGRANICZYĆ

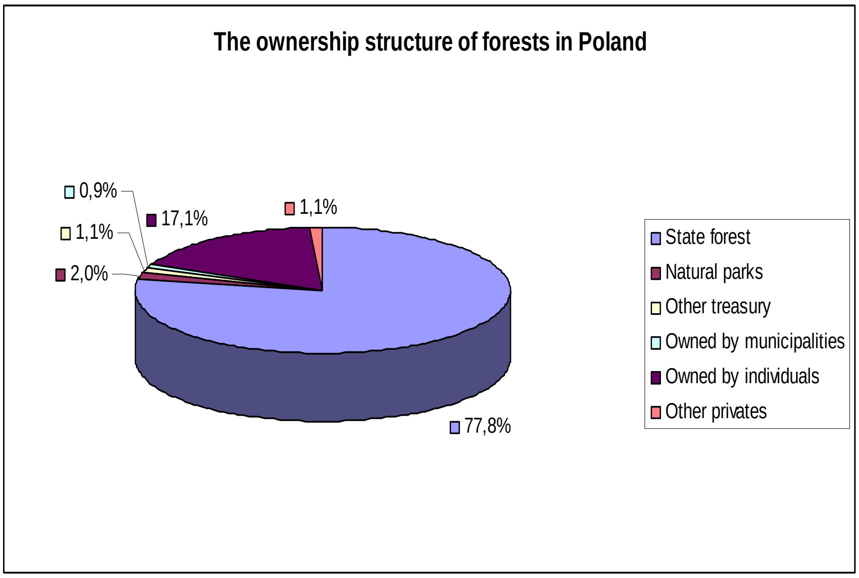
Forest

Today, the Polish forestry model is highly appreciated in whole Europe. Also in the country, many vocational groups may envy foresters their management efficiency, effective performance and good opinion in society. However, their greatest satisfaction is the fact that, despite many threats, Polish forests develop and their resources, as well as ecological and biological values, expand.

Polish foresters have long stopped viewing forests as a source of raw wood. Today everybody knows that so-called non-productive forest functions are in many cases more important than wood production. Global forests play a tremendous role in total carbon balance in nature, and consequently, in the greenhouse effect causing, among other things, increased amounts of carbon dioxide in the atmosphere.

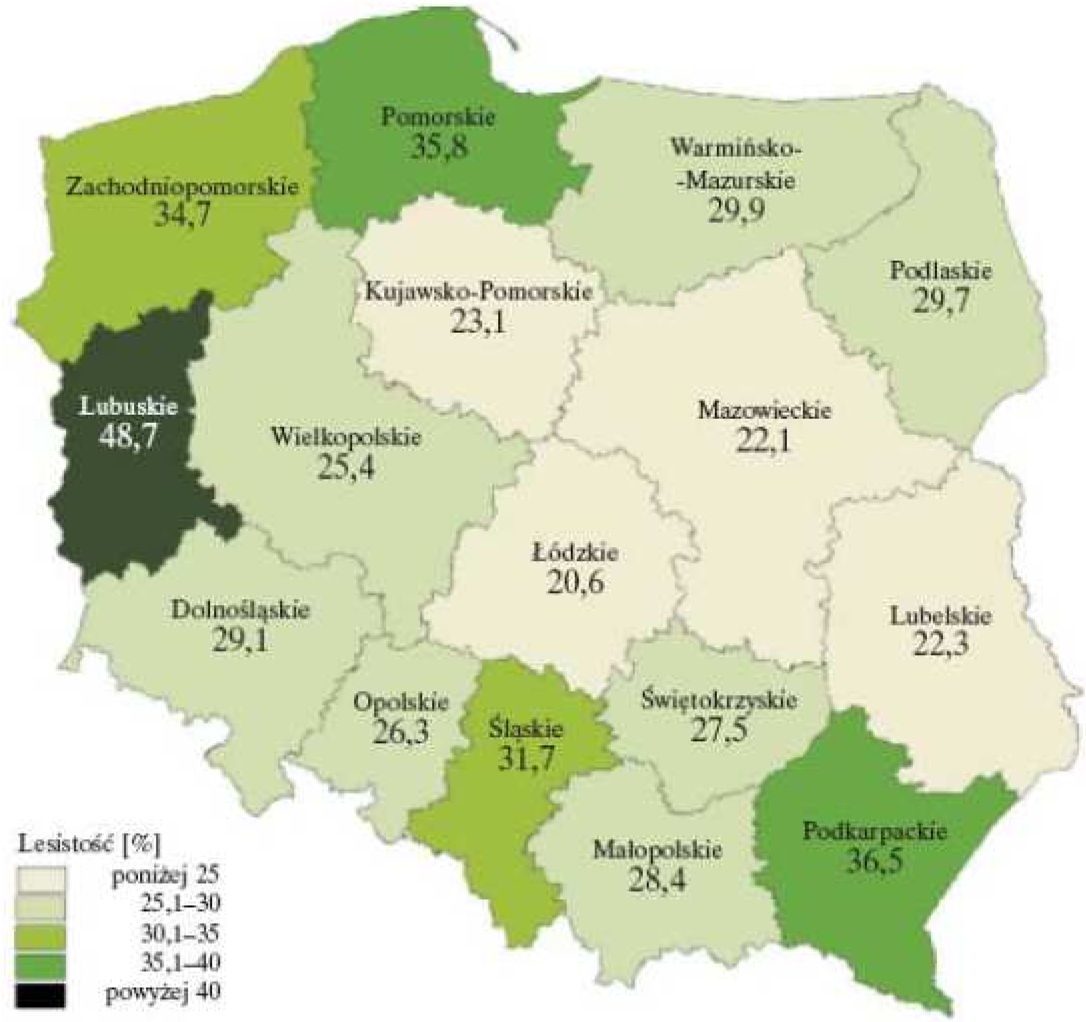
Forests protect not only climate, but also water resources. One hectare of a broadleaved forest may retain and then gradually release to the environment 500,000 m3 of water, and this is important taking into account that the most of the soil is sandy, so there is a problem with the water retention. The forest is also the biotope of billions of organisms, sometimes the last one where they can find food and conditions for survival. People can also draw inspiration and pleasure from the charm of forests. They are the favourite place of millions of Poles and foreign tourists seeking relax and recreation.

Forestry and the related industrial branches are also important elements of the national economy. The State Forests NFH gives employment to many people. It is a natural commercial partner of wood processing plants. It also cooperates with local communities and non-governmental organizations.



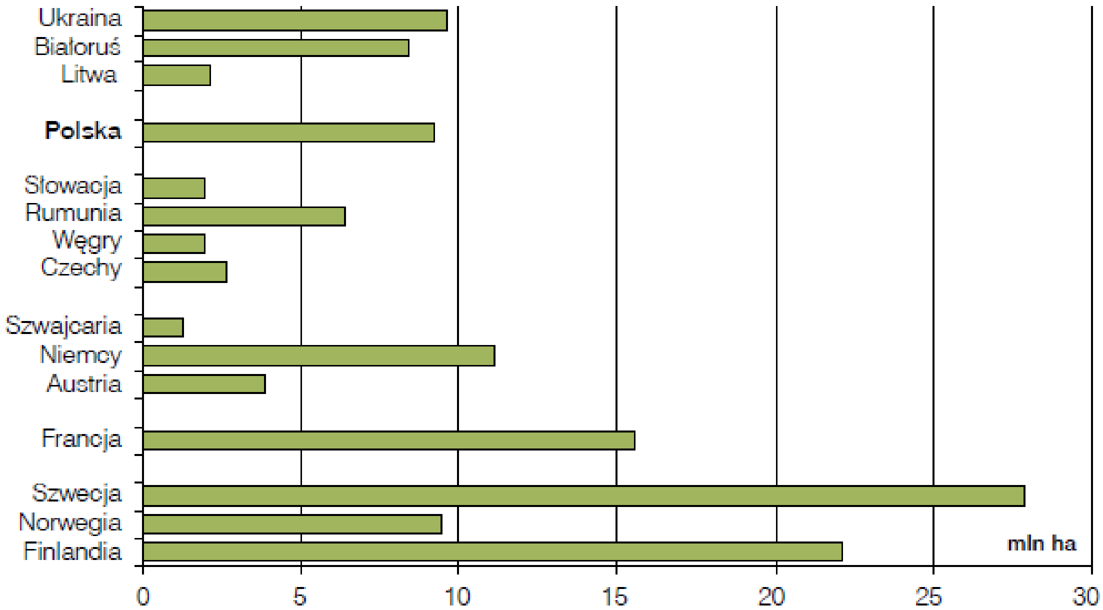
Polish forests cover about 30% of Poland's territory, and are mostly owned by the state. Western and northern parts of Poland as well as the Carpathian Mountains in the extreme south, are much more forested than eastern and central provinces. The most forested administrative districts of the country are: Lubusz Voivodeship (48.7 %), Subcarpathian Voivodeship (36.5 %), and Pomeranian Voivodeship (35.8 %). The least forested are: Łódź Voivodeship (20.6 %), Masovian Voivodeship (22.1 %), and Lublin Voivodeship (22.3 %).

Poland's forest cover by voivodship

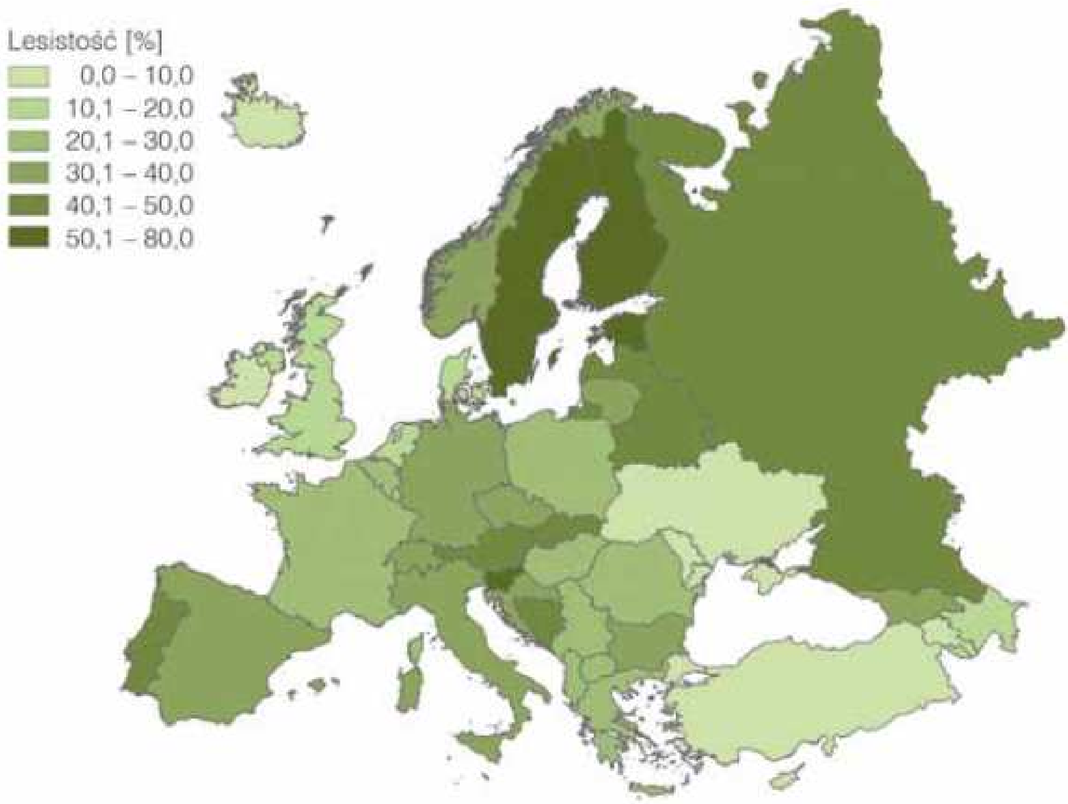


Forest in Poland occupies the poorest soil. Coniferous type accounts for 54.5%, whereas broadleaved type accounts for 45.5% (out of that, alder and riparian forests account for 3.8%). A number of forested zones are now protected by the Polish government and, in many cases, they have become tourist destinations. Over the years, many of the largest Polish forests have been reduced in size, and that reflected on the structure of forest inhabitation

Total forest area (SoEF 2007)



Forest cover of Europe (SoEF2007)



Forest utilisation

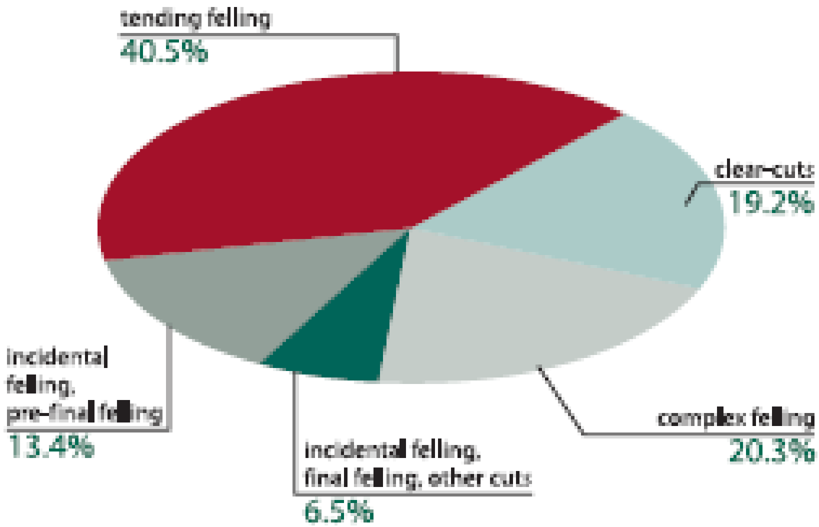
Structure of timber harvest by category of cut

The use of forests as a renewable resource of raw material is driven, not only by market demand, which ensures economic conditions for forest management, but also by silvicultural needs and the principles by which the structure of forest resources is regulated. Forest utilisation is pursued at a level determined by natural conditions of timber production, in accordance with the principle of the persistence of forests and augmentation of their resources.

The amount of timber (gross merchantable timber) to be harvested in a Forest District is defined in a cutting plan set for a 10-year period. The final yield is the prescribed maximal volume of timber in a given Forest District to have been harvested in mature stands ready for regeneration. The anticipated volume of timber obtained in intermediate cutting in younger stands is approximate only and undergoes changes depending on the current silvicultural and sanitary needs.

The total volume of timber (under bark) harvested in 2008 in the State Forests amounted to 32.549 million m^3 including 30.695 million m^3 of net merchantable timber (102.3 % of the approximated annual cut) of which 14.140 million m^3 (94.1 % of prescribed cut) was obtained from final felling and 16.555 million m^3 (110.5 % of prescribed cut) – from intermediate felling.

In 2008, 5.9 million m^3 of merchantable timber was harvested under the clear-cut system which corresponds to 19.2 per cent of total harvest. The cutting area totalled 25,800 hectares and was the lowest since the 1980s, with 43,000 hectares of clear-cut area. In the last decade, the clear-cutting was applied on over 27,500 hectares. The reduction in the size of clear-cut area is indicative of the progress in the ecologisation of forest management and their use is often the result of large-scale damage to forests induced by wind, drought, fungal infection or insect outbreak.

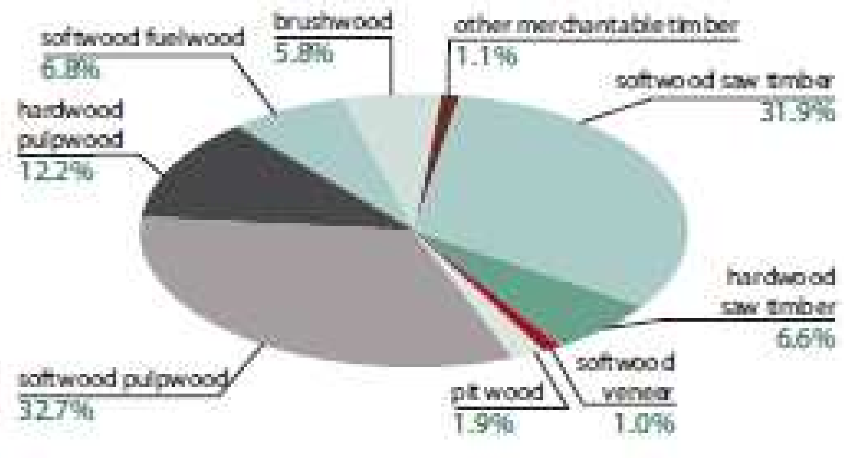


Volume of harvest of merchantable timber in the State Forests by category of utilisation in 2008

Auxiliary and additional activity

In 2008, the auxiliary activity of the State Forests included: harvest of fuel wood and utility stump wood – 98 m^3 (compared to 125 m^3 in the previous year) and Christmas trees – 64,500.

In the framework of additional activity, the State Forests carried out management on 12,956 hectares of meadow and agricultural lands and on 312 hectares of fish ponds. It provided transport and workshop services, carried out trading and manufacturing activities.



Share of timber assortment groups in the 2008 sales

RELIEF

The natural landscape of Poland can be divided broadly into three relief groups: the lowlands, the highlands, and the mountains. The eastern extremes of Poland display characteristics common to Eastern Europe, but the rest of the country is linked to Western Europe by structure, climate, and the character of its vegetation. The lowland characteristics predominate: the average elevation of the whole country is only 173 metres above sea level, while more than three-fourths of the land lies below 198 metres.

Poland’s relief was formed by the actions of Ice Age glaciers, which advanced and receded over the northern part of the country several times during the Pleistocene Epoch (from about 2,600,000 to 11,700 years ago). The great and often monotonous expanses of the Polish lowlands, part of the North European Plain, are composed of geologically recent deposits that lie over a vast structural basin.

In the southern part of the country, by contrast, older and more diverse geologic formations are exposed. The mountainous arc of the Carpathians, dating from the mountain-building Palaeogene and Neocene periods (from about 65 to 2.6 million years ago), dominates the topography. Around the northern rim of the Carpathians lie a series of structural basins, separating the mountain belt proper from a much older structural mass, or foreland, that appears in the relief patterns of the region as the Bohemian Massif, the Sudeten, and the Little Poland Uplands (Wyżyna Małopolska).

The relief structure can be divided more specifically into a series of east-west–trending zones. To the north lie the swamps and dunes of the Baltic Sea coast; south of these is a belt of moraines terrain with thousands of lakes, the southern boundary of which marks the limit of the last ice sheet. The third zone consists of the central lowlands, whose minimal relief was created by streams issuing from the retreating glaciers. This zone is the Polish heartland, the site of agriculture in places where loess has been deposited over the relatively infertile fluvioglacial deposits.

Drainage and soils

Virtually the entire area of Poland drains to the Baltic Sea, about half via the Vistula River and a third via the Oder River. Polish rivers experience two periods of high water each year. In spring, melted snow swells the lowland rivers. The presence of ice dams (which block the rivers for one to three months) and the fact that the thaw first strikes the upper reaches of the northward-flowing rivers intensify the effect. The summer rains bring a second maximum about the beginning of July.

There are some 9,300 Polish lakes with areas of more than 1 hectare, and their total area is about 3,108 square km, or 1 percent of the national territory. The majority, however, are found in the northern glaciated belt, where they occupy more than 10 percent of the surface area.

The lack of a good drainage system is a big problem in Poland especially in the region of Kujawsko-Pomorskie, due to the relief is minimal so a lot of the amount of water is retained in the depressions of the land and these retentions cause the appearance of unwanted wetlands, that they are very bad for the develop of a good quality of crops and also it is a good factor to has eutrophication (it will explain in water discussion)

COAL

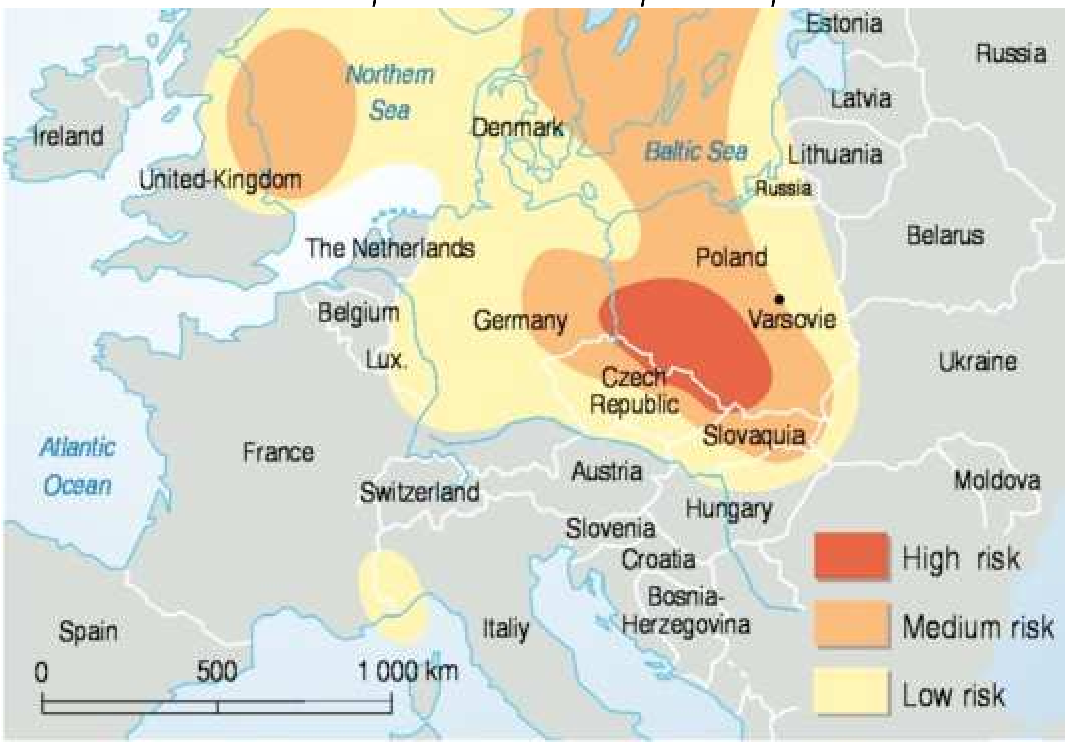
Coal is a combustible black or brownish-black sedimentary rock normally occurring in rock strata in layers or veins called coal beds or coal seams. The harder forms, such as anthracite coal, can be regarded as metamorphic rock because of later exposure to elevated temperature and pressure. Coal is composed primarily of carbon along with variable quantities of other elements, chiefly hydrogen, with smaller quantities of sulphur, oxygen and nitrogen.

Coal begins as layers of plant matter accumulate at the bottom of a body of water. For the process to continue the plant matter must be protected from biodegradation and oxidization, usually by mud or acidic water. This trapped atmospheric carbon in the ground in immense peat bogs that eventually were covered over and deeply buried by sediments under which they metamorphosed into coal. Over time, the chemical and physical properties of the plant remains were changed by geological action to create a solid material.

The wide shallow seas of the Carboniferous period provided ideal conditions for coal formation, although coal is known from most geological periods. The exception is the Coal gap in the Lower Triassic, where coal is incredibly rare: presumably a result of the mass extinction which prefaced this era. Coal is even known from Precambrian strata, which predate land plants: this coal is presumed to have originated from algal residues.

Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide releases. Gross carbon dioxide emissions from coal usage are slightly more than those from petroleum and about double the amount from natural gas. Coal is extracted from the ground by mining, either underground by shaft mining through the seams or in open pits.

Risk of acid rain because of the use of coal



http://www.treehugger.com/

Uses in Kujawsko-Pomorskie

Environmentally speaking, Poland - the powerhouse coal-producing country, has experienced much conflict of interest over the years. While coal has produced much economic wealth for this country, the Poles and the environment have suffered greatly at the hands of pollution.

Coal mining in Poland has been a long-standing industry. The first official coal mine was established in 1776 in Szczakowa. Today, in the central region of the country, the Silesian Basin is the main mining area. Poland produces about 140 million tons of coal annually which generates most of Poland's revenue. The main trade partners are within Europe, which include Germany, France, Italy, and others. The Poles themselves use the fuel in energy production. In fact, 93% of Poland's energy production comes from the use of coal.

However, with the use of this natural resource came nature's woe. It was feared in the early 1990s that the excessive use of coal would cause serious environmental damage. But the fear of economic disruption still outweighed the environmental ramifications; therefore the pollution issue was not brought to an abrupt halt. Tests later conducted in the Silesian mining region showed greater cases of respiratory and circulatory problems, higher lead content in children's blood, and more cases of cancer. Large amounts of agricultural land were deemed unfit for farming due to industrial waste. 65% of Poland's river water was found to be polluted enough to corrode industrial equipment according to one 1990 report. The Vistulas River was a main contributor to Baltic Sea pollution.

Today the issue of reforming the coal mining industry is a touchy subject, but the Polish government has made fair progress in the resolution of the pollution problem. Among their moves was to recently institute a coal mining restructuring law in 2003 which closed down certain collieries. In 2002, five coal mining companies were merged into one - Kompania Welglowa - which became the largest mining company in Europe. But moves to reform the industry are not an all-too-recent endeavour. As early as the late 1980's these moves began taking effect. One such was the State Environmental Protection Inspectorate of 1991 which managed industries prone to polluting.

While Poland is made rich by the mining, use and export of this natural resource, there are negative consequences of such an industry for the environment. This country's government has commendably made moves to more effectively manage and reduce the mining and use of coal. Hopefully, one day, Poland will be able to more heavily rely on other means of income and greatly reduce the use of coal, thus playing their part in saving the environment.

Coal as fuel

Coal is primarily used as a solid fuel to produce electricity and heat through combustion. When coal is used for electricity generation, it is usually pulverized and then combusted (burned) in a furnace with a boiler. The furnace heat converts boiler water to steam, which is then used to spin turbines which turn generators and create electricity. Another efficient and clean way of coal combustion in a form of coal-water slurry fuel (CWS) was well-developed in Poland and Russia (since the Soviet Union time). CWS significantly reduces emissions saving the heating value of coal

Coking and use of coke

Coke is a solid carbonaceous residue derived from low-ash, low-sulphur bituminous coal from which the volatile constituents are driven off by baking in an oven without oxygen at temperatures as high as 1,000 °C (1,832 °F) so that the fixed carbon and residual ash are fused together. Metallurgical coke is used as a fuel and as a reducing agent in smelting iron ore in a blast furnace. The product is cast iron and is too rich in dissolved carbon, and so must be treated further to make steel.

Refined coal

Refined coal is the product of a coal-upgrading technology that removes moisture and certain pollutants from lower-rank coals such as sub-bituminous and lignite (brown) coals. It is one form of several pre-combustion treatments and processes for coal that alter coal's characteristics before it is burned. The goals of pre-combustion coal technologies are to increase efficiency and reduce emissions when the coal is burned. Depending on the situation, pre-combustion technology can be used in place of or as a supplement to post-combustion technologies to control emissions from coal-fuelled boilers.

Industrial processes

Finely ground bituminous coal, known in this application as sea coal, is a constituent of foundry sand. While the molten metal is in the mould the coal burns slowly, releasing reducing gases at pressure and so preventing the metal from penetrating the pores of the sand. It is also contained in mould wash, a paste or liquid with the same function applied to the mould before casting. Sea coal can be mixed with the clay lining (the "bod") used for the bottom of a cupola furnace. When heated the coal decomposes and the bod becomes slightly friable, easing the process of breaking open holes for tapping the molten metal.

RENEWABLE ENERGIES

Introduction

Due to the negative impact of conventional energy on the environment as well as running out of fossil fuels, more and more importance is put on the development of renewable energy. According to the report by Global Wind Energy Council (GWEC) and the report by The European Wind Energy Association EWEA
2009, wind energy experiences the greatest increase in installed power compared to all other energy production technologies.

Water power plants worldwide produce about 16% of global electric energy, the most of which is produced by Brazil, Canada, China, the USA and Russia. In Poland the most common are small water power plants (power below 5 MW)

Poland is a country where energy is obtained mostly from coal. Joining the EU imposed a duty on Poland to adjust emission parameters to those binding in all EU countries. In 2001 the Ministry of Environment created a special programme aimed at harmonisation of Polish and European standards on pollution emission and percentage of alternative (renewable) energy per total electric power production in the country. This programme was named "The Strategy for the Development of Renewable Energy Sources" (OZE). The strategic aim was to increase the percentage of renewable sources energy in the country fuel and energy balance to 7.5% in 2010 and to 14% in 2020 in the structure of primary energy carriers' usage.

In terms of energy management, ensuring ecological safety means that environmental effects of fuel resources exploitation need to be minimised. It needs to be ensured that renewable energy, in the amount relevant to the country's technological and economic potential, takes part in meeting growing energy needs of society and economy

The production of renewable energy in the Kujawsko-Pomorskie Voivodeship

The Kujawsko-Pomorskie Voivodeship is the leader in the production of alternative energy in Poland. In 2005 total energy obtained in the region from biogas power plants, biomass power plants, wind power plants, water power plants as well as coal and biomass power plants reached 31.36% of energy from produced in
Poland. In the following years this value reached respectively: 27.65% (2006) and 25.79% (2007). By May 2008 the participation of Kujawsko-Pomorskie Voivodeship in the production of alternative energy in Poland was 35.46%

Wind power

The analysis of wind energy zones in Poland (Fig. 4) shows that the Kujawsko-Pomorskie Voivodeship is situated in good and very good zones. In addition, various research articles such as Riso National Laboratory show that wind conditions in the Kujawsko-Pomorskie Voivodeship are similar to those in Germany and are not much different from the conditions registered in Denmark and Holland.

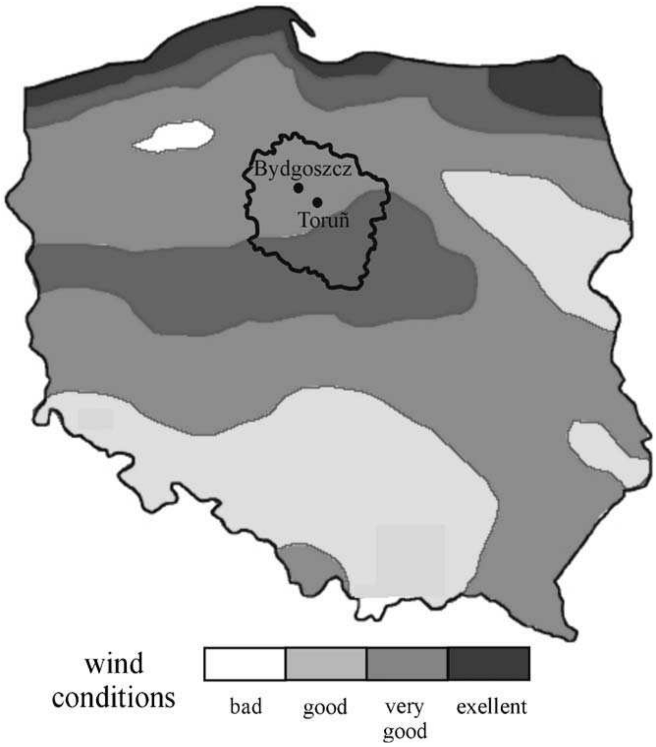
In the Kujawsko-Pomorskie Voivodeship winds tend to blow mainly from the western direction (Fig. 5 represents the wind rose for Torun), their mean speed reaches 4–5 m/s, which is sufficient to install wind power plants. The favourable climate conditions mean that in the future wind energy will be the strongest developing branch of alternative energy in the Kujawsko-Pomorskie Voivodeship.

Since 2002 between 11 and 20 new wind power plants are installed in the Kujawsko-Pomorskie Voivodeship every year.

According to the data obtained from sociometric surveys there are 96 wind power plants operating in the Kujawsko-Pomorskie Voivodeship.

Fig. 6 shows the location of wind power plants and wind farms in the Kujawsko-Pomorskie Voivodeship. Wind energy has developed well in the south (Radziejo´w District) and in the centre of voivodeship. It is due to good wind conditions as well as interest among farmers.

Fig.4 Wind energy zones in Poland



The investment process of power plant construction lasted between 4 and 36 months, the investment costs varied between 0.3 and 1.6 million PLN, which was mostly covered by credit. The main problems of investment realization are the high cost of investment, resistance of the local community, administration problems (too long waiting time for the construction permit, an excessive amount of required documentation, unclear law regulations), difficulties in getting connected to high power line as well as problems with obtaining the right equipment.

For example, energy production out of wind was started in 2003 in the Radziejo´w District, this district has at the moment the highest number of wind power plants (58). According to the information provided by the District Office in Radziejow, there are more and more problems with obtaining the appropriate location for investment as well as with connecting power plants to the power network due to its high overloading. Despite these difficulties, the investors from the district area are still trying to implement projects of this kind. The total predicted power of wind power plant generators is to reach 2540MW

Fig. 5 Wind rose for Torun

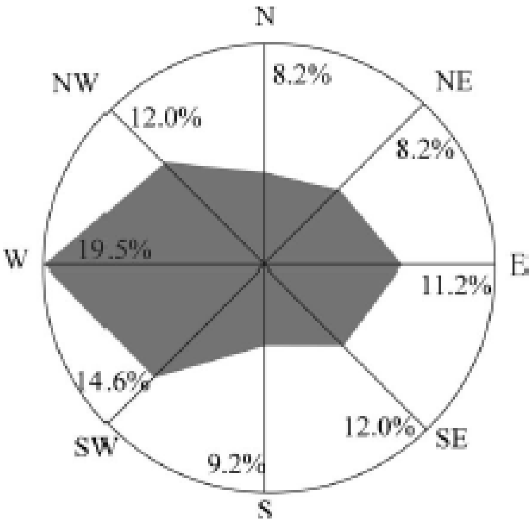
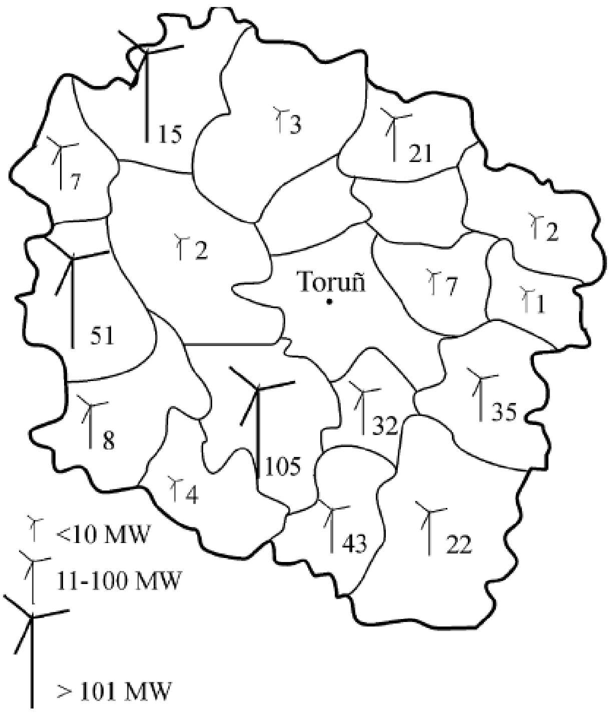


Fig. 6 Wind power plants and wind farms

One research showed that 90% of participants are planning to extend their power plants in the near future. Among them 55% are planning to install 1 power plant, 36% 2 power plants and 9% 3 or more power plants. The highest number of wind power plants is planned to be erected in Inowrocław District (105), followed by Nakło District (51), Radziejo´w District (43), Lipno District (35) and Włocławek District (32) (Fig. 7)

Fig. 7 Planned wind power plants and their total power



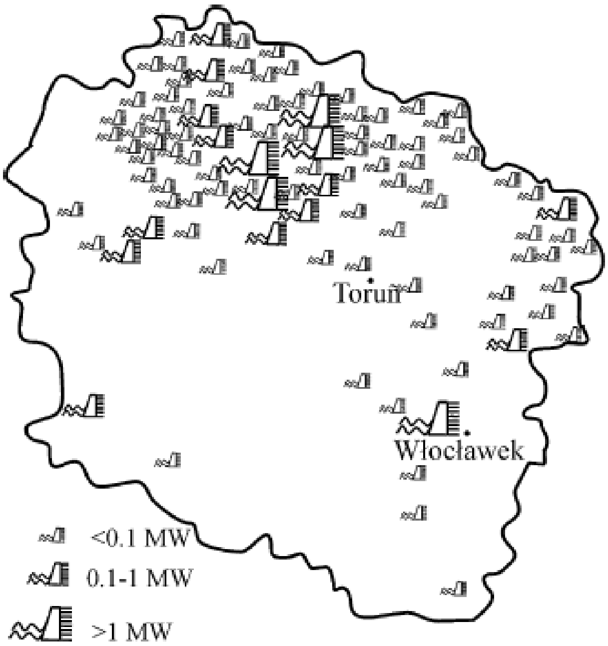
Hydropower

In the Kujawsko-Pomorskie Voivodeship there are currently 103 water power plants operating (Fig. 5), located mostly in the northern and eastern parts of voivodeship. It is related to numerous watercourses, dams and canals situated in this area. The majority of power plants are small objects that favourably influence retention in a given area. The biggest power plant in the voivodeship is Power Plant Włocławek (stage of fall on the Vistula River). The stage of fall consists of the following parts: frontal earth dam, 10-bay weir closed by steel sheathed bolts, a power plant and navigation sluice of dimensions 12x115 m, designed for the flow capacity of 6 million tons/year as well as a fish pass located in the dividing pillar between the weir and the power plant. In the power plant there operate 6 Kaplan turbines of installation power 160.2MW

In the survey “The state of water power plants in the Kujawsko-Pomorskie Voivodeship”, the participants say that the majority of discussed power plants are situated on rivers, 70%, 20% are located on river dams, and the remaining ones use different watercourses. The time of investment realisation took between 3 and 72 months (years 2002–2008). The investment realization costs were contained within 0.04–6 million PLN. The power plants created recently are mostly financed using loans and credit (about 60%), however, the owner’s capital is more considerable when compared to wind power plants. A vast majority of owners (93%) sell power to energy companies. The Vistula River is a hydrographical axis of the voivodeship, flowing 205.3 km through its area, of which 21.7 km is through the Włocławek Reservoir. Even though the voivodeship area is typical lowland, it is possible to successfully develop small power plants on numerous watercourses, improving water retention and at the same time preventing steppe formation.

About 60% of participants of the survey ‘‘The State of Water Power Plants in the Kujawsko-Pomorskie Voivodeship”, are going to extend the already existing or install a new hydropower plant, with the money mainly sourced from loans and credit. According to The Kujawsko-Pomorskie Voivodeship Environmental Protection Programme, so-called Small Retention Programme is to be realised in the area of voivodeship by 2015. This programme stipulates that new 528 investments are to be created on reservoirs and watercourses of the region. Taking into consideration the current location of small water power plants (mainly in the northern part of voivodeship) as well as a higher total of annual rainfall in the northern areas of our region, it can be expected that this area will continue to be used to implement such investments

Fig.5 Water power plants in the Kujawsko-Pomorskie Voivodeship



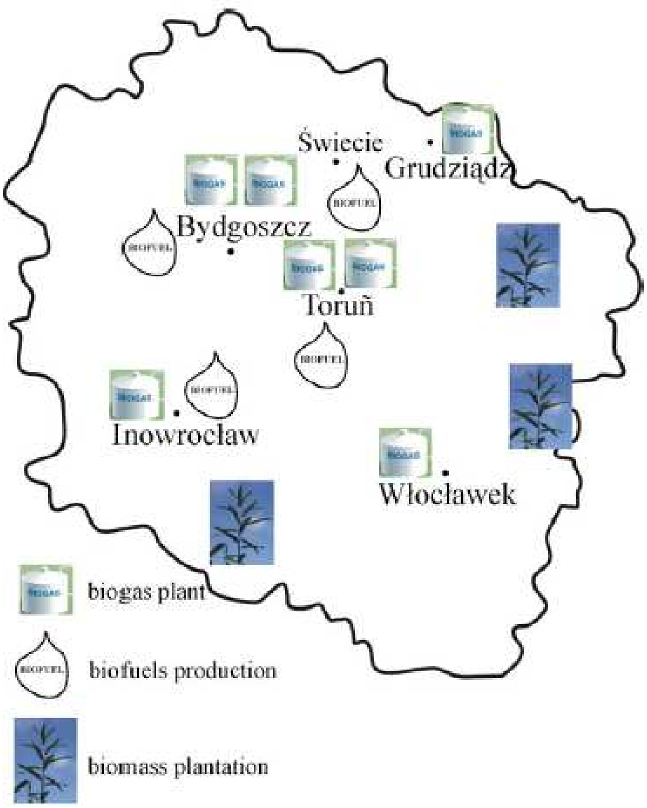
Biomass

In the Kujawsko-Pomorskie Voivodeship there are more and more places where energy plants are cultivated (mostly energy willow) Fig. 7 shows the biggest plantations in the Kujawsko-Pomorskie Voivodeship. In 2007 the areas of individual energy crops (ha) were: spring and winter rapeseed: 2419, corn: 51.4, winter triticale: 31.8, oats: 14.7, energy willow: 7.4, sugar beet: 2.1. It needs to be pointed out that virtually every household that burns coal to produce heat also uses biomass in a smaller or bigger amount (mostly wood).

In the Kujawsko-Pomorskie Voivodeship it is also the big companies that start to use the ‘‘green’’ energy. Thermal Power Plant in Swiecie is an example. In 2003 the company Polish Energy Partners S.A. built a modern circulating steam fluidised boiler CFB (Circulating Fluidised Bed) of capacity 234 t/h for ‘‘Saturn’’ power plant in Swiecie. It is the biggest CFB boiler in Poland, enabling biomass combustion as well as supplementary hard coal combustion in any proportions. The most of biomass used for energy production consists of paper production and wood treatment waste. Additionally, the company buys sawdust and bark, mainly from local saw mills. In 2008 biomass provided 60% of all the fuels used in heat and power plant ‘‘Saturn’’.

In the Kujawsko-Pomorskie Voivodeship there are a number of biogas plants using municipal waste and activated sludge from a sewage treatment plant. The biggest biogas plant is situated in the north part of Torun´ within the grounds of the Municipal Waste Disposal Site. In December 1999 the work was completed and permit obtained to use the biogas plant in Torun´. Also, a company Biogaz Inwestor was created. In 2001 the maximum technical and exploitation parameters were achieved. The area of 11 ha of the waste disposal site at Kociewska Street in Torun´ was subject to gas exploitation. In this area 40 gas wells of 15 m depth were drilled and a network of suction leads was installed. In April 2002 further 3 ha of the waste disposal site were subject to gas exploitation as 12 more biogas wells were built and connected to the network.

Fig. 6 Biomass energy in the Kujawsko-Pomorskie Voivodeship.



The further stage of biogas installation extension consisted of building 17 biogas wells and suction gas network, which commenced work on 28th of August 2007. At present, 67 wells are exploited, from which about 300,000 m3/month of waste site gas is obtained of average composition:

- CH4 (methane) – 55%,
- CO2 (carbon dioxide) – 36%,
- O2 (oxygen) – 1% and
- N2 (nitrogen) – 8%.

The total value of energy produced throughout a year stays at the level of 11,000 kWh, with the highest values reached in 2004 and 2005 (12,327 kWh). In 1998–2006, 22.5 million m^3 of biogas was utilised, including 12 million m^3 methane, which corresponds to 22,897 Mg of hard coal. Combustion of such an amount of coal leads to the emission of 1004 Mg of CO_2, 357 Mg of SO_2, 29Mg of NO_x and 502 Mg of dusts. In Torun biogas is also obtained in the Municipal Sewage Treatment Plant. Created during the fermentation of surplus sludge, biogas is combusted in two gas engines. Electricity generating sets have power of 2x300 kWe. Biogas installation consists of a gas container of volume of 2700m^3 and a torch to burn excess gas. Created during fermentation gas is then subjected to desulphurisation and dehydration in scrubbers.
In addition, there are 2 biogas plants in Bydgoszcz and one in the vicinity of respectively Grudziadz, Inowrocław and Włocławek (Fig. 6).

In the register of producers of liquid biofuels and biocomponents the data valid on 14th of May 2009, four companies from the Kujawsko-Pomorskie Voivodeship are mentioned. Further development of biofuel production in the voivodeship is possible due to the agricultural character of economy as well as a high number of distilleries. In the near future the energy companies operating within the Kujawsko-Pomorskie Voivodeship plan to extend the power production based on biomass. The company-Grupa Energa started implementing a programme “An Energy Safe Commune-Energy Biogas”. In co-operation with the communes of central and northern Poland (including the Kujawsko-Pomorskie Voivodeship), the company wants to build a few hundred biogas plants. The first biogas plants are due in 2010

The Torun energy company, Energetyka Cergia S.A. aims to gradually replace hard coal with biomass. It is estimated that initially at least 200,000 tons of biomass will come from energy plants cultivations. Energy plants cultivations would be continually developed so that the amount of biomass in combusted fuel would increase regularly. Due to the experiences in plant cultivation in Poland, it is assumed that plantations of such energy plants as energy willow will be developed

Since January 2006 the Torun company Biogaz Inwestor as well as the Section of Chemical Proecological Processes, Faculty of Chemistry of Nicolaus Copernicus University are the partners of the European project BIOGASMAX, the name of which is the acronym of *BIOGAS AS TRANSPORT FUEL–MARKET EXPANSION TO YEAR 2020 – AIR QUALITY*. The project is planned for the years 2006–2009 and involves 28 partners from 8 European countries. The basic goal of BIOGASMAX project is to support the European community to become less dependent on traditional oil based fuels and to reduce the greenhouse gases’ emission by acquiring knowledge about efficient production, distribution and use of biogas in a transport sector. In this case it is essential to investigate the possibilities of biogas production from various substrates and their mixtures, analysing the production process and quality of obtained solid and liquid products, which also need to be managed in an environmentally safe way. One of the mentioned projects will be the construction of biogas plant in Torun, the substrate for which is to be corn silage with the addition of other substrates (e.g. carrot pomade which is a by-product from a juice factory). Another possible substrate is post-distillation broth from an ethanol plant. This substrate seems to be more economic since its management is currently difficult for the distillery. The target efficiency of the plant is estimated at 1200 m^3/h of biogas of methane content of about 10 million m^3/year, which after purification provides about 700 m^3/h of biofuel, containing about 98% of methane. This amount would be sufficient to power 85 city buses CNG (at present there are 135 city vehicles), due to run in the area of Torun. At the same time, the post-fermentation sediment (annually about 50,000 Mg) can be used as a fertiliser due to its high quality

Future

The Kujawsko-Pomorskie Voivodeship is the place where the highest amount of renewable energy in Poland is obtained. It contains 96 wind power plants, 103 water power plants, 7 biogas plants, 4 biofuel producing plants, 3 big plantations of energy willow and numerous biomass (mostly wood) boilers. In the near future it is planned that renewable energy based on wind, water and biomass will continue to develop.

According to ‘‘Environmental Protection 2007’’, the area of fallow lands within arable land in the Kujawsko-Pomorskie Voivodeship is 20,000 ha, there are 4400 ha of degraded land and 43,100 of uncultivated land.

These areas could be used to a great extent for renewable energy production – either by energy plants cultivation or by constructing wind power plants. In case of degraded land it is possible to carry out soil reclamation using energy plants.

The prospective investors in the Kujawsko-Pomorskie Voivodeship, similarly to the rest of Poland, are put off by initially high investment capital expenditure of renewable energy sources technology and high costs of investment preparation in relation to running costs. Moreover, the lack of precisely defined economic and tax mechanisms in the Polish budget and financial politics as well as the lack of strategies, programmes and schedules for using means from ecological and quasi-budget funds deter investors and hamper a stable development of the renewable energy sector at the lowest costs. It is due to the lack of knowledge about the location of resources, the procedures to follow when locating investment, access to technology and funding as well as unfamiliarity with renewable energy sources throughout various administrations stages.

The installations using the renewable energy in the Kujawsko- Pomorskie Voivodeship are typically local and do not require a centralised technical infrastructure. Being small and scattered technologies, they are naturally linked to politics, strategy

CONCLUSIONS

The conclusions are going to be divided in three points: Environmental, economic and social.

1. Environmental:
   - Water: The quality of the water is very low because of the factories near the river that throw the sewage freely to the river, polluting them, and making almost impossible the use for the farm and human life.
   - Soil: The soil is sandy and a little bit acid so the farmers must harvest crops that they can adjust to these characteristics.
   - Air: The air is quite polluted because of the abusive use of coal, and also because in the city of Plock there was a refinery
   - Weather: Is one of the most important factors for the crops and livestock, and in this country is very cold with a very hard winter
   - Landscape: high quality of the natural environment (quality of soils, natural raw material resources, forest resources, underground waters), creating favourable conditions for the development of agriculture, industry and tourism.

2. Social:
   - Inhabitants: Low level of education and professional qualifications of population. High level of unemployment, particularly among youth. Low level of incomes of the population
   - Institutions: inadequate development of institutions supporting business in powiat centres. Favourable distribution of settlement network, particularly the size, potential and location of centres of government as well as medium size and powiat cities creating good conditions for serving the population. Institutions supporting business located in centres of regional government

Economy:

- Poorly developed technical infrastructure, particularly concerning water-sewage and waste storage management
- Relatively limited implementation of modern technologies, with a relatively large research and development potential (staff, laboratories)
- Natural and cultural properties for the needs of tourism under-utilised;

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