

MONITORING SYSTEM, DATABASE AND POSSIBLE SCENARIOS AS ESSENTIAL BACKGROUND FOR ADAPTATION PLANNING, REDUCING VULNERABILITY AND RISK DISASTER – SHARING OF POLISH EXPERIENCES



Polish Geological Institute
National Research Institute



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ENVIRONMENT PROTECTION INSTITUTE
NATIONAL RESEARCH INSTITUTE



Institute of Meteorology and Water Management
National Research Institute



Institute of Soil Science and Plant Cultivation
State Research Institute



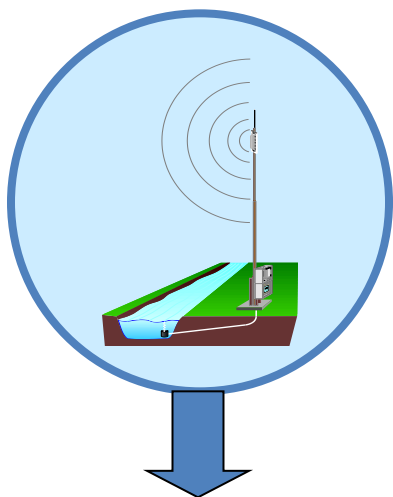
Weather monitoring and forecasting

TOMASZ KNOPIK

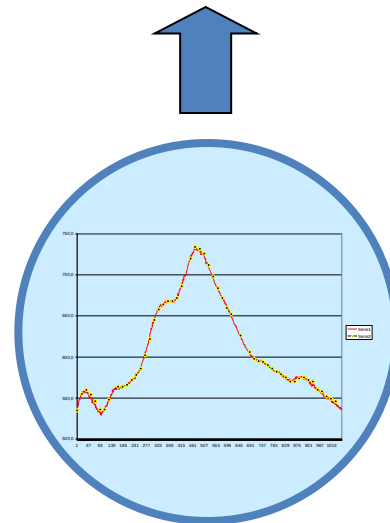
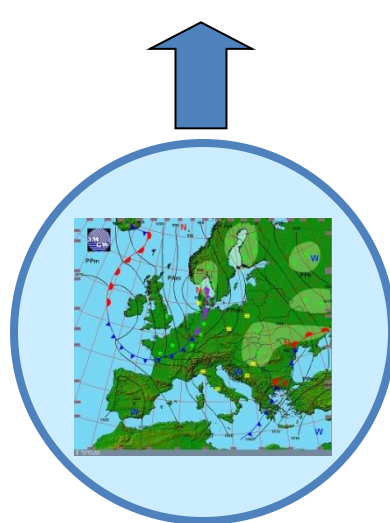
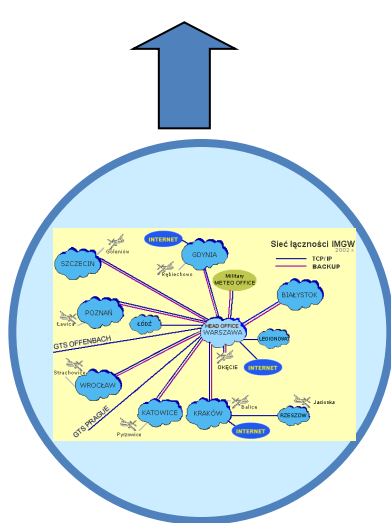


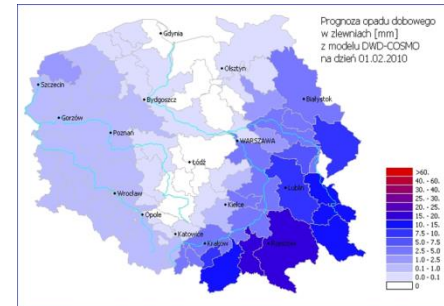
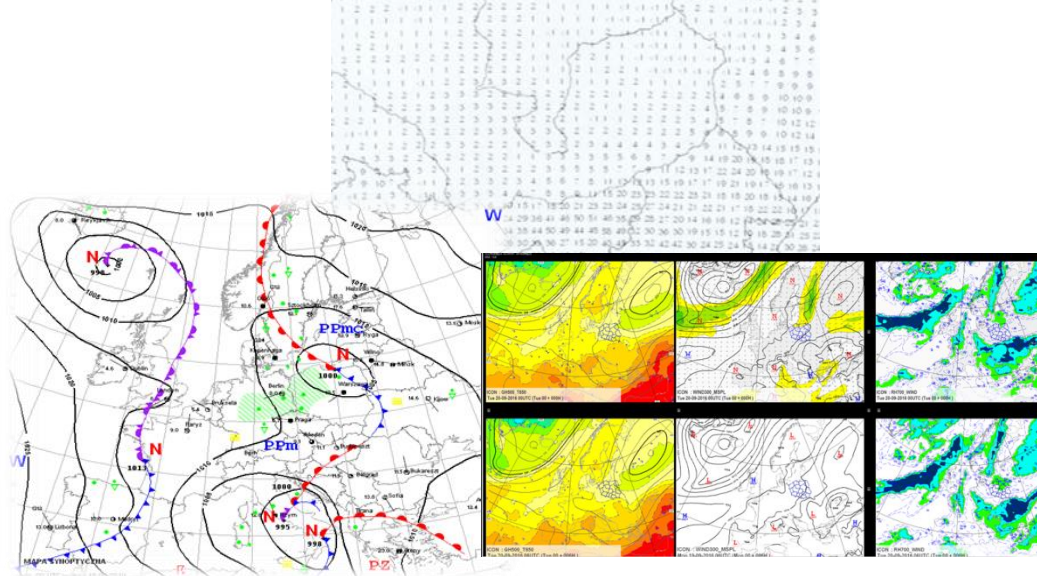
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The National Hydrological and Meteorological Service – wide range of measurement and detection systems



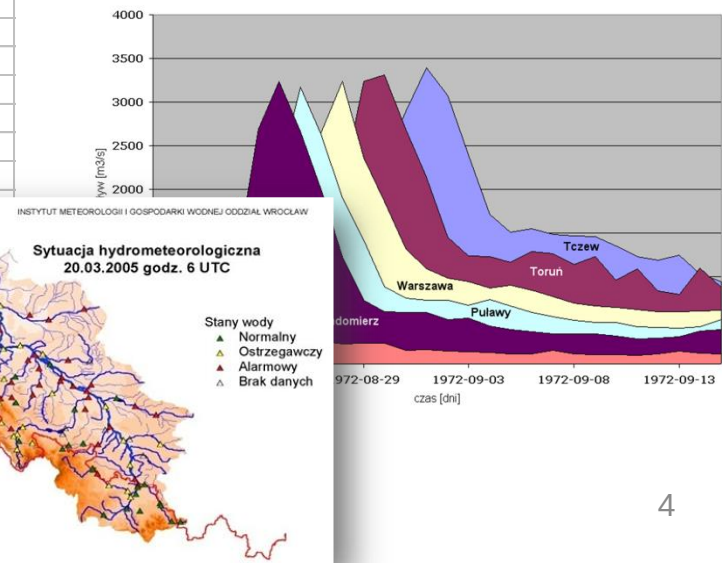
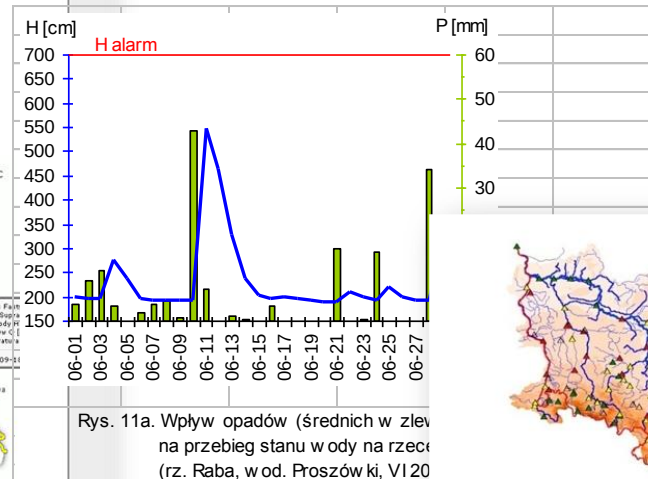


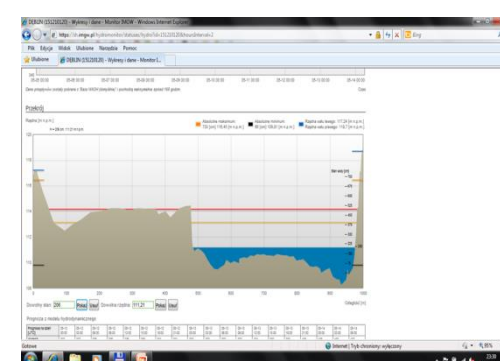
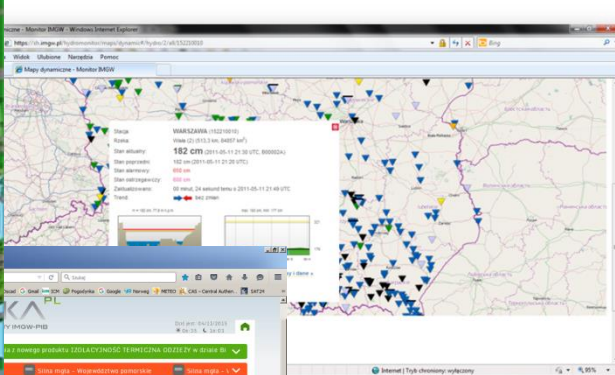
The National Hydrological and Meteorological Service – provide both meteorological and hydrological services

GAZ ETB

- » Baltic Sea 24h forecast
- » Baltic Sea 3 days forecast
- HYDROLOGICAL SITUATION**
- » Severe phenomena
- » Water stage bulletin
- » Weekly hydrological bulletin
- » River icing stage

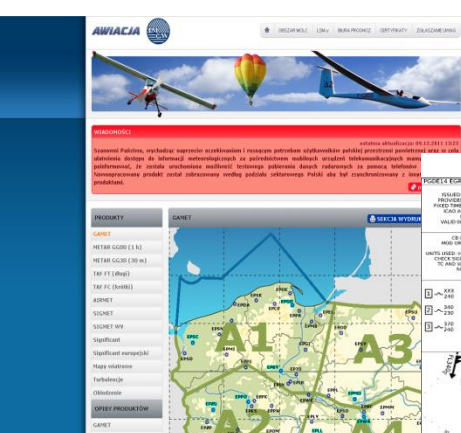
STAGE, DISCHARGE AND WATER TEMPERATURE IN RIVERS



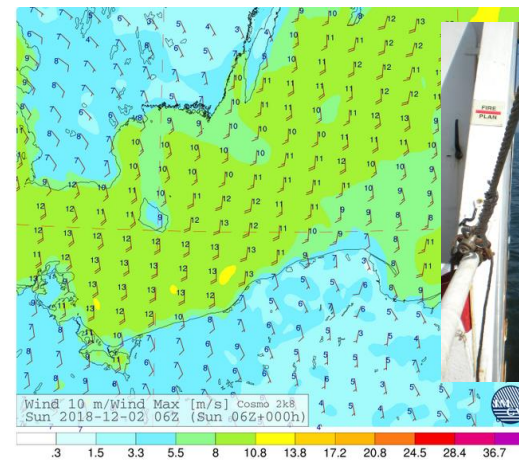
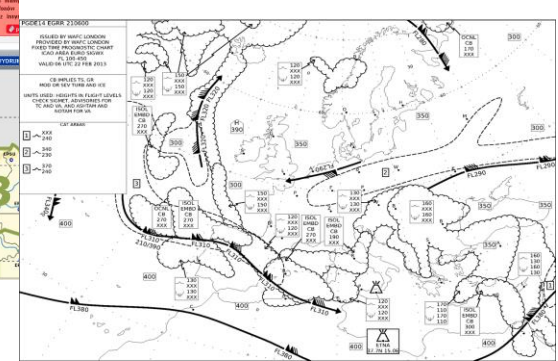


General measurements and forecasting service

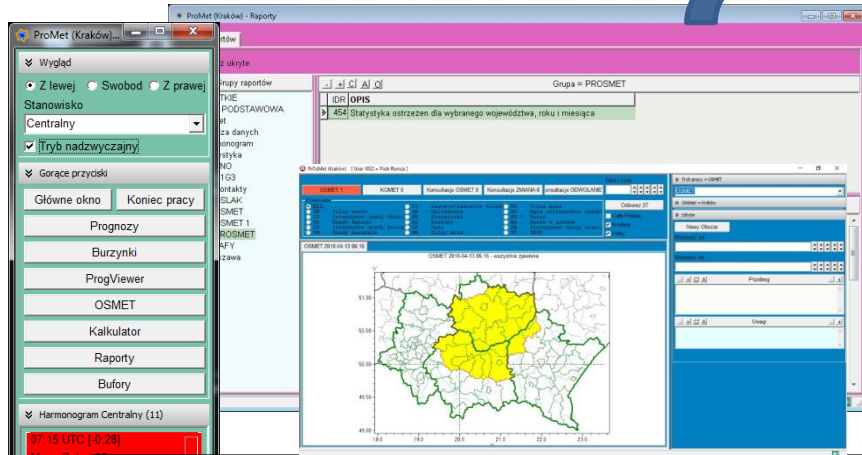
The National Hydrological and Meteorological Service – provide multiscope services – general, marine, aviation



Meteorological service for Aviation

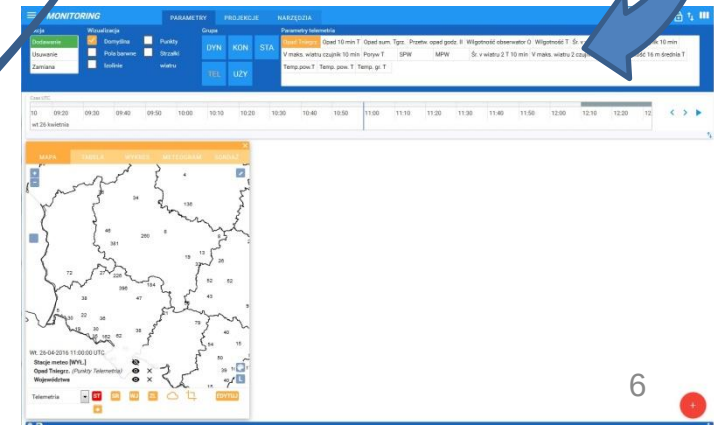
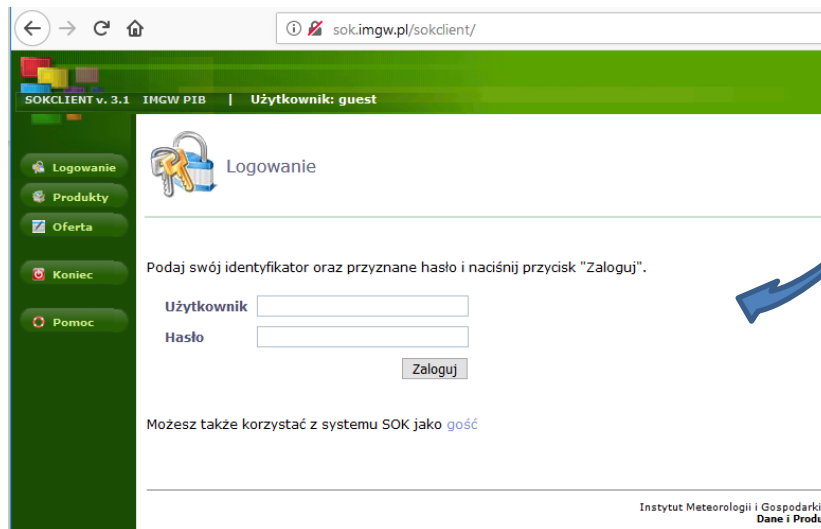
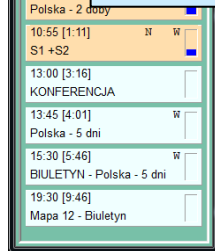


Marine measurements and forecasting service



- ✓ One software to forecasts edition
- ✓ One weather forecasters support software
- ✓ One customer service and products distribution system
- ✓ One database

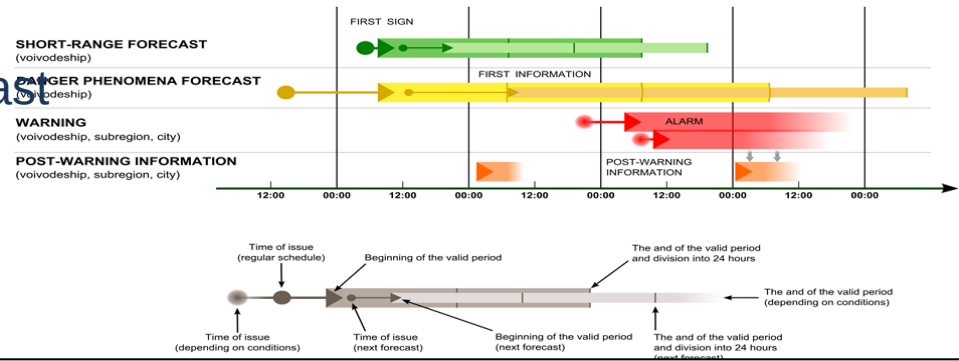
The National Hydrological and Meteorological Service – fully standardized system of forecast offices operation



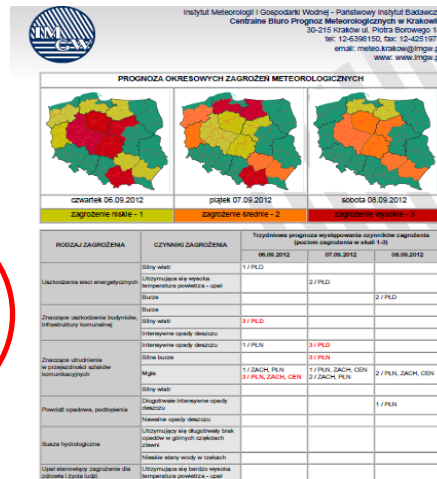
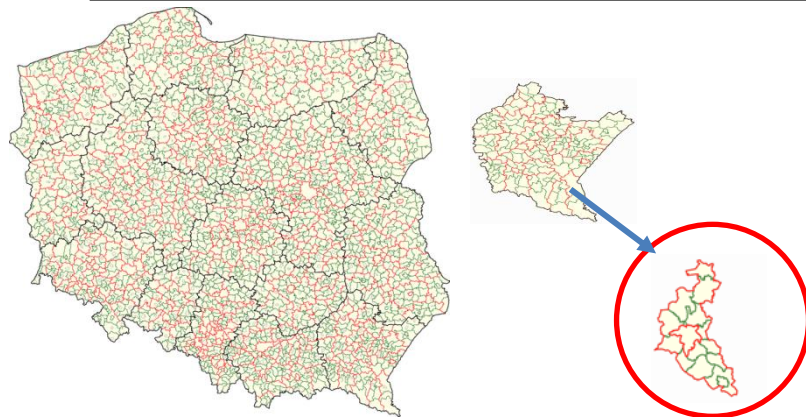
- #### IV. **Post-warning** information – forecast up to 3 hours



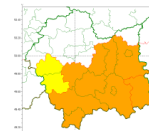
MULTISTAGE WARNING SYSTEM



**The National Hydrological and Meteorological Service
– provide multistage warning system**

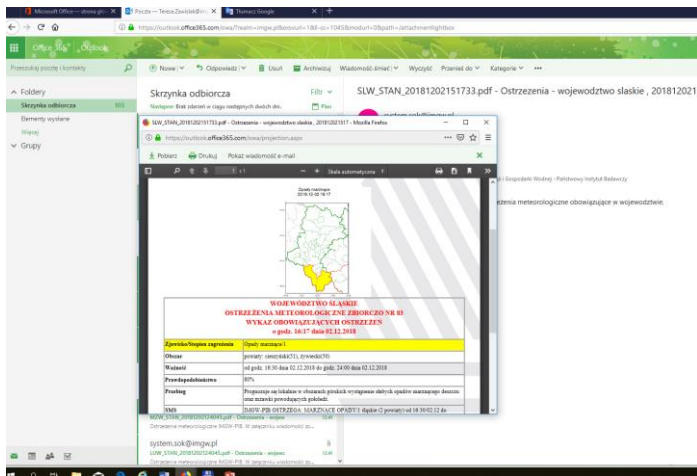


Zasięg ostrzeżeń w województwie



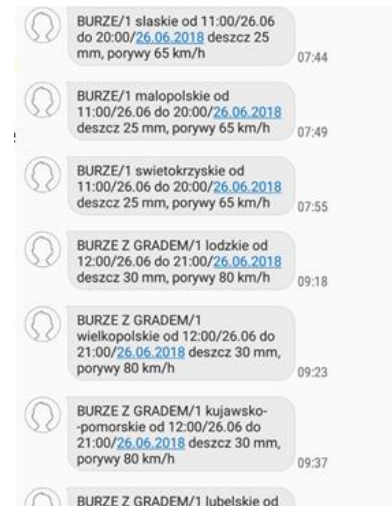
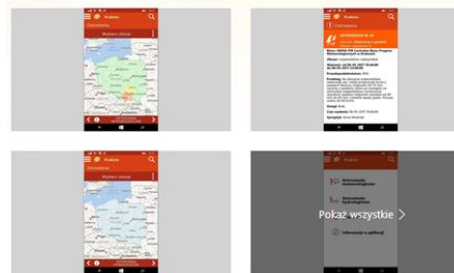
WOJEWÓDZTWO MAŁOPOLSKIE OSTRZEŻENIA METEOROLOGICZNE ZBIORCZO WYKAZ OBOWIĄZUJĄCYCH OSTRZEŻEŃ o godz. 07:06 dnia 08.06.2018	
Zjawiska/Stopień zagrożenia	Burmę z gradem 1
Opis:	powiaty: maki, wadowicki
Ważność:	od godz. 12:30 dnia 08.06.2018 do godz. 18:30 dnia 08.06.2018
Przewidywanocięć	80%
Przebieg:	Przewidywane wystąpienie burz z opadami deszczu, lokalnie także grad. Suma opadów wyniesie od 20 mm do 30 mm, a porępy wiatru do 65 km/h.
ŚMŚ R50	Woj. małopolskie (3 powiaty), DKGW-PiB wydał ostrzeżenie pierwszego stopnia o burzach z gradem
Zjawiska/Stopień zagrożenia	Burmę z gradem 2
Opis:	powiaty: bocheński, boleski, limanowski, myślenicki, nowosolski, nowotarski, Nowy Sącz, tarnowski, Tarnobrzeg, Tarnobrzeg, Tarnobrzeg
Ważność:	od godz. 12:30 dnia 08.06.2018 do godz. 19:30 dnia 08.06.2018
Przewidywanocięć	80%
Przebieg:	Przewidywane wystąpienie burz z opadami deszczu, lokalnie także grad. Suma opadów wyniesie od 20 mm do 35 mm, a porępy wiatru do 65 km/h.
ŚMŚ R50	Woj. małopolskie (10 powiatów), DKGW-PiB wydał ostrzeżenie drugiego stopnia o burzach z gradem
Zjawiska/Stopień zagrożenia	Burmę z gradem 3

Crisis Management Centers



SMS system

Zrzuty ekranu



The National Hydrological and Meteorological Service – multiple warning dissemination system

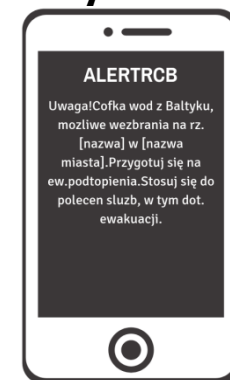
Regional Warning System – in cooperation with The Ministry of the Interior – any warning, mobile application



Alert Warning System – in cooperation with the Government Centre for Security



State of immediate life threat,
Everyone in the affected area



Ground- water

**AGNIESZKA KOWALCZYK,
MAŁGORZATA WOŹNICKA,
MICHAŁ WYSZOMIERSKI**



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In Poland monitoring and groundwater research is carried out by:



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The Polish Hydrogeological Survey

as part of **The Polish Geological Institute**

Monitoring

Database

Research
& analysis

Possible short and long-terms scenerios - GWL



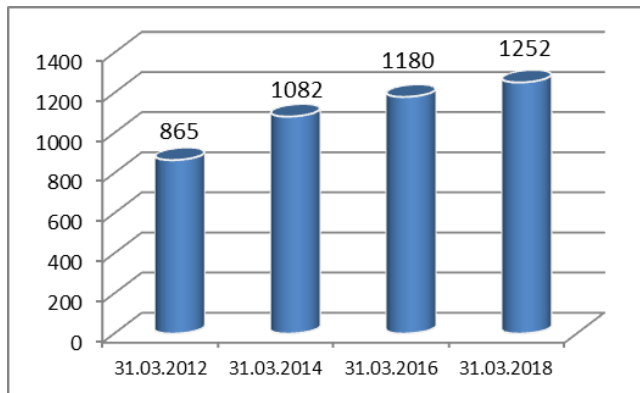
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Good Monitoring – basis for reliable diagnosis



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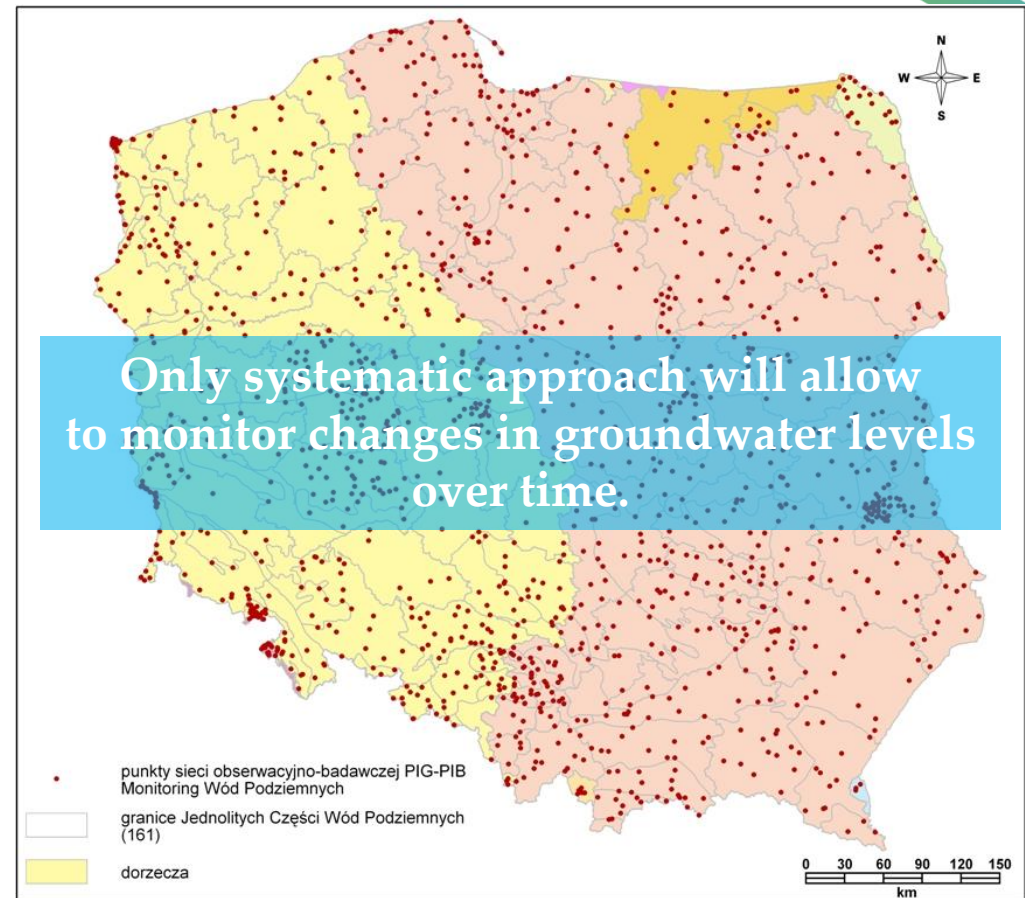
Number of PHS groundwater observation points

≈ Quantitative monitoring

- daily measurements (constant – on line)
- weekly measurements

≈ Chemical monitoring

≈ Research monitoring



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PHS Databases:



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- The Groundwater Monitoring database
- The HYDRO Bank
- Intake Database
- GIS DB of the main groundwater reservoirs
- GIS DB of The Hydrogeological
Map of Poland 1:50 000
- Disposable Groundwater Resources Database

**PHS data processing
system (SPD PSH)**
searching and viewing
of data

e-PSH browser

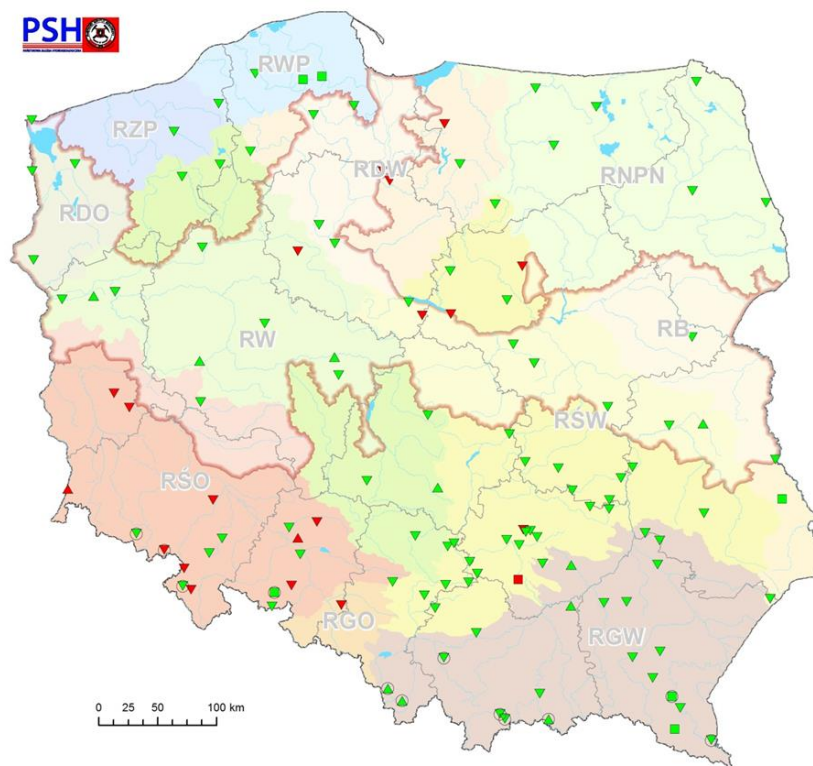
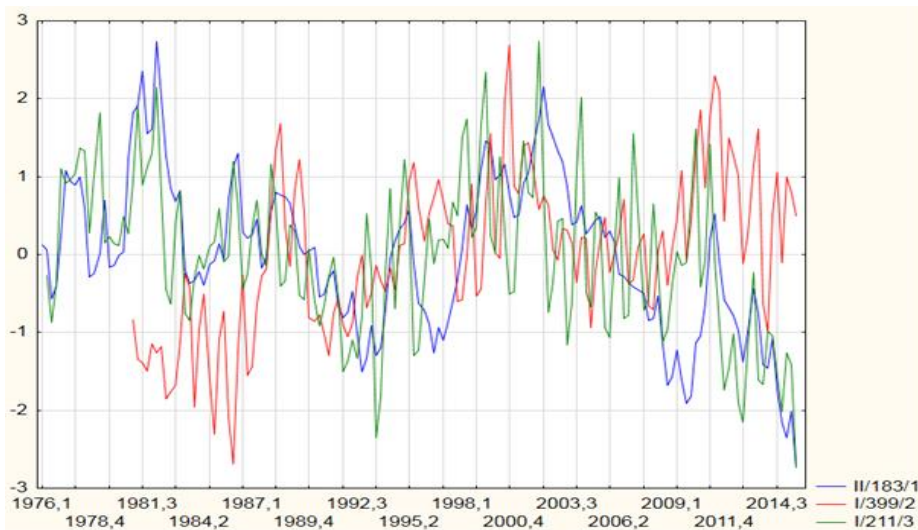
From parameterization to risk assessment



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Investigation of drought due to the various indexes:

- Low groundwater index – k_n
- Standardized Groundwater Level Index



Podział regionalny zwykłych wód podziemnych*:



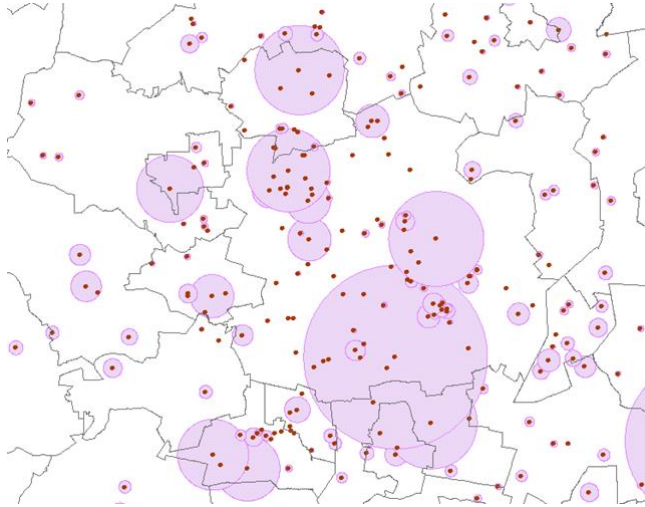
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Maps & reports



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PHS provides information about localizations of **alternative groundwater supplies**.

As far PHS has done such work for:

- cities and agglomerations,
- agricultural lands,
- forests.



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Dedicated maps

Flooding map risk of Poland - areas at high risk of flooding from groundwater

GIS layer provided as shp or WMS

<https://spdpsht.pgi.gov.pl/PSHv7/>

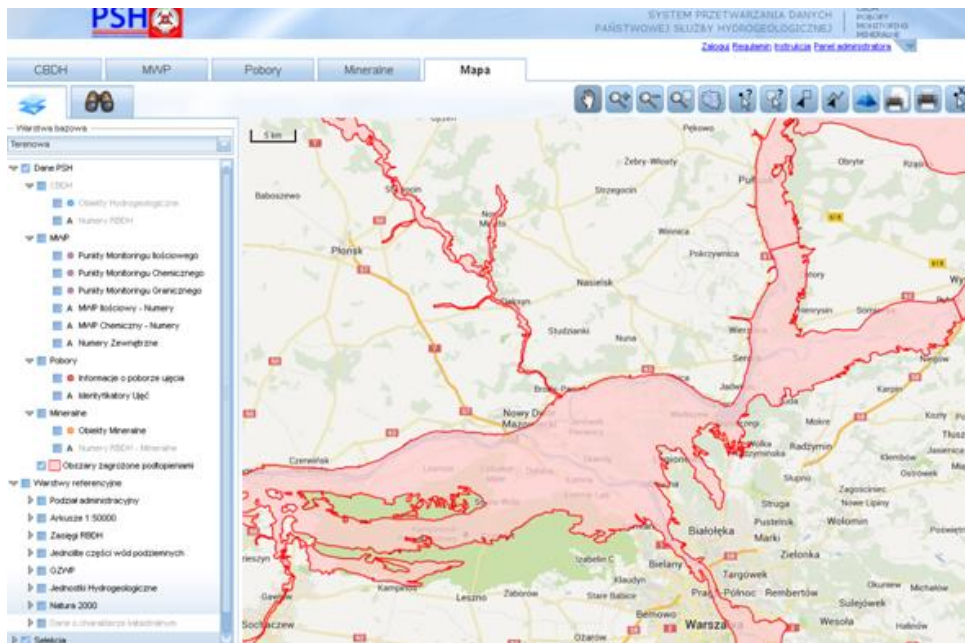
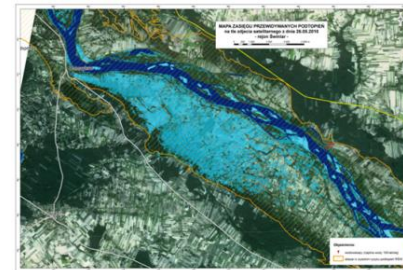
www.PSH.gov.pl

www.geoportal.gov.pl

www.pgi.gov.pl



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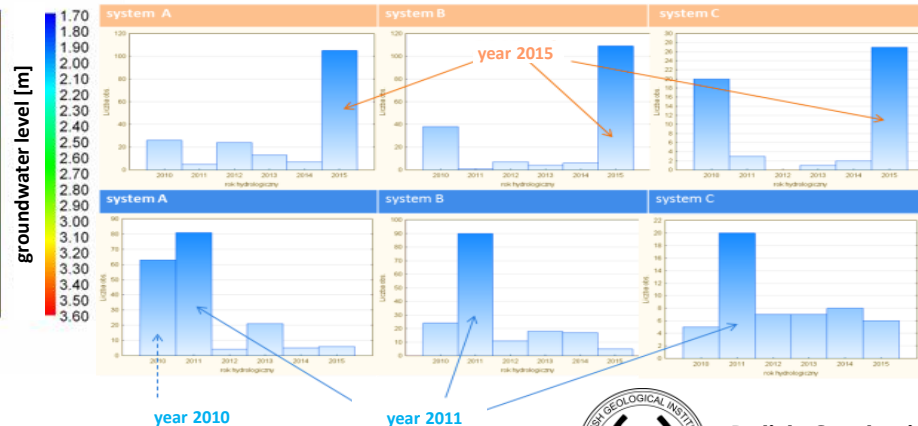
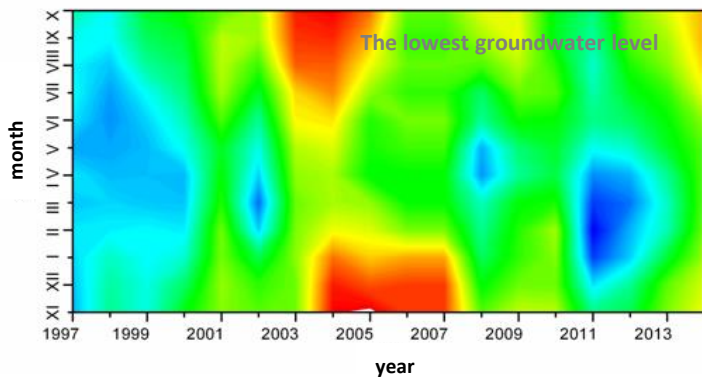
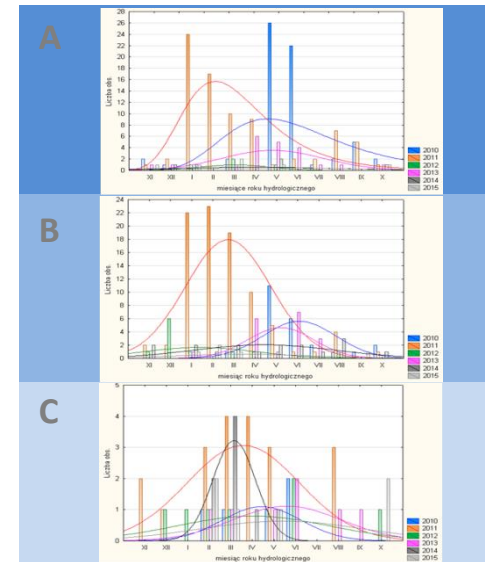
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Investigation of low and high groundwater level periods in the past



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- Spatio-temporal analysis of extreme GWL values
- Analysis of the reaction to the drought and flood in distinguished (due to the depth of aquifer) hydrogeological systems across the country
- Indicating areas most vulnerable to drought in groundwater
- Distinguishing between natural and anthropogenic trends in GWL variability



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Research & analysis

Maps & reports

Distinguishing between natural and anthropogenic trends in GWL variability

High groundwater levels
- flooding

groundwater level

Low groundwater levels
- drought

Possible scenarios

Extrem scenarios

'wet conditions'

'dry conditions'

**short and long-term
forecast of GWL**

Forecast of groundwater chemical status



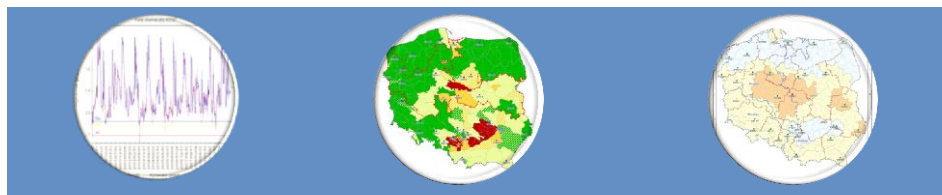
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Warning - hydrogeological situation shortterm forecasts



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**GWL
FORECAST** **WATER
RESOURCES
FORECAST** **RISK
FORECAST**

Early Warnings System



Normal procedure

one forecast per three months



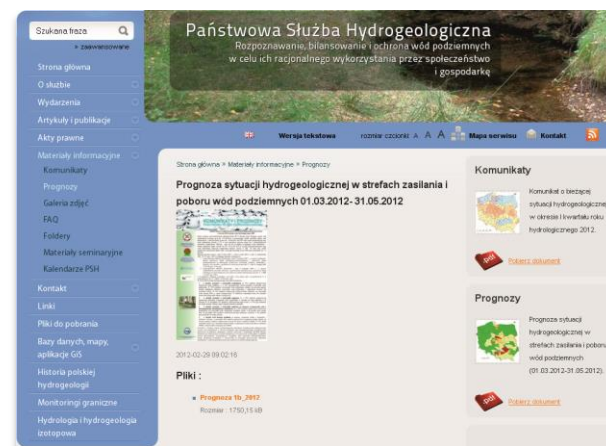
Special procedure

one forecast per month



Alarm

one forecast per week



Forecasts available @
www.psh.gov.pl



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Example map of drought risk from the recent short-term forecast of GWL – shallow aquifers

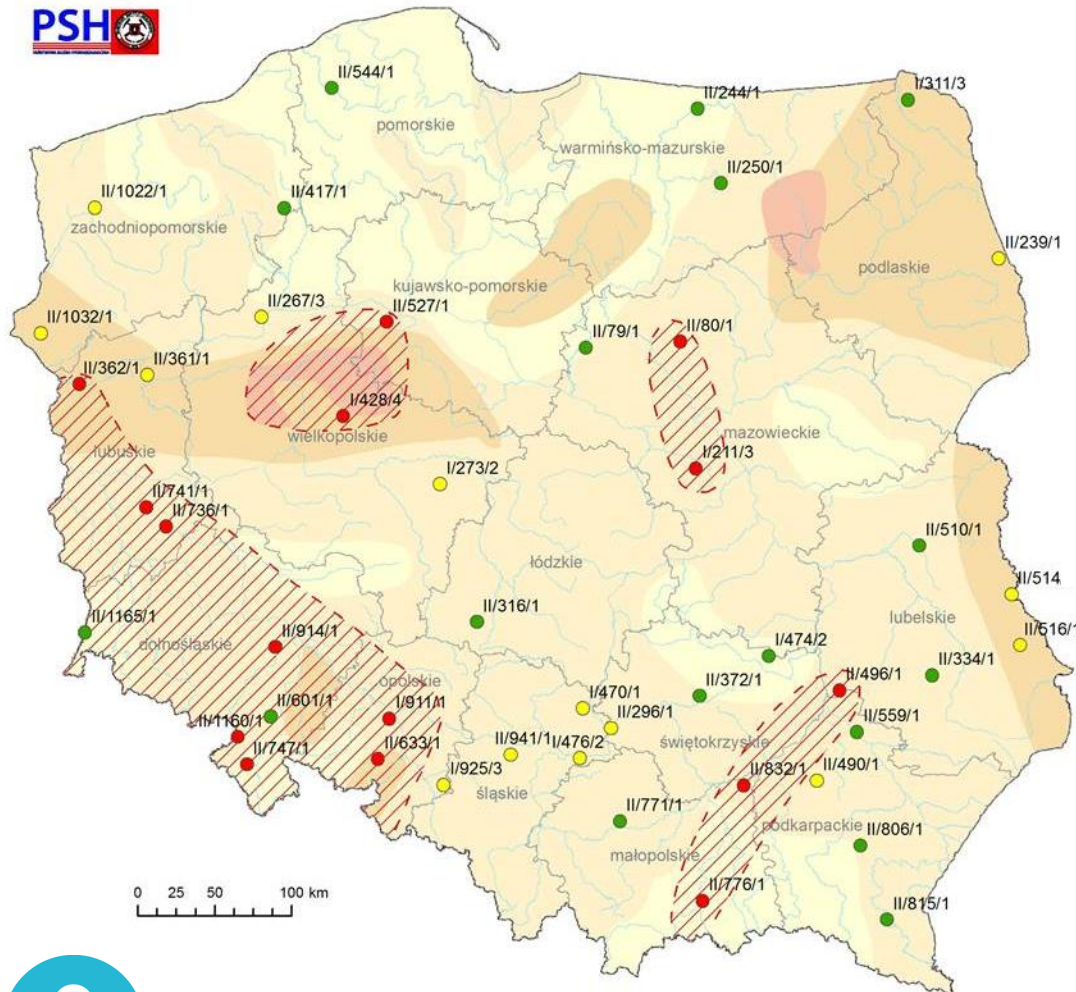
Short-term forecast of risk related to groundwater



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Forecast for the February 2019 - scenerio B

1/211/3 selected representative points of the groundwater monitoring network

risk index distribution:

- no hazard
- low groundwater levels hazard
- forecasted low groundwater levels

 areas with forecasted low groundwater levels according to "B" scenario

Number of hydrological lows in years 1951-2000
(source: The Meteorology and Water Management Institute):

	<7		16-23
	8-15		>24

 borders of voivodeships

 borders of Poland



Current forecasts are published on the PHS
website @ <http://www.psh.gov.pl/>



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Agrometeorological and phenological service as an example of climate change monitoring

**MAŁGORZATA
KĘPIŃSKA-KASPRZAK**



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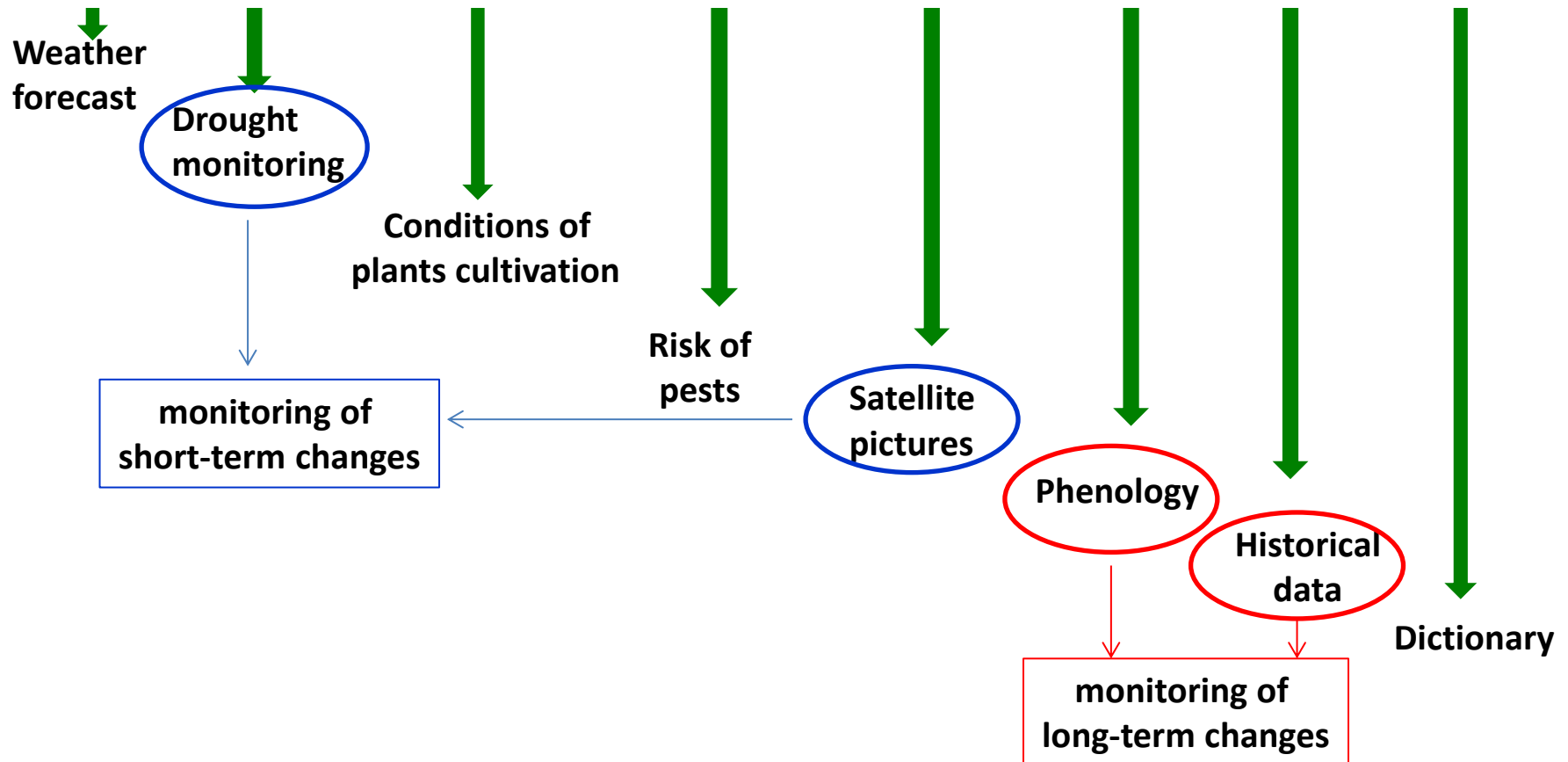


AGROMETEO
POGODYNKA

SERWIS IMGW-PIB
DLA ROLNIKÓW



Pogoda Monitoring suszy Warunki uprawy roślin Zagrożenie agrofagami Obrazy satelitarne Fenologia Dane historyczne Słownik



Drought monitoring for 389 districts in Poland



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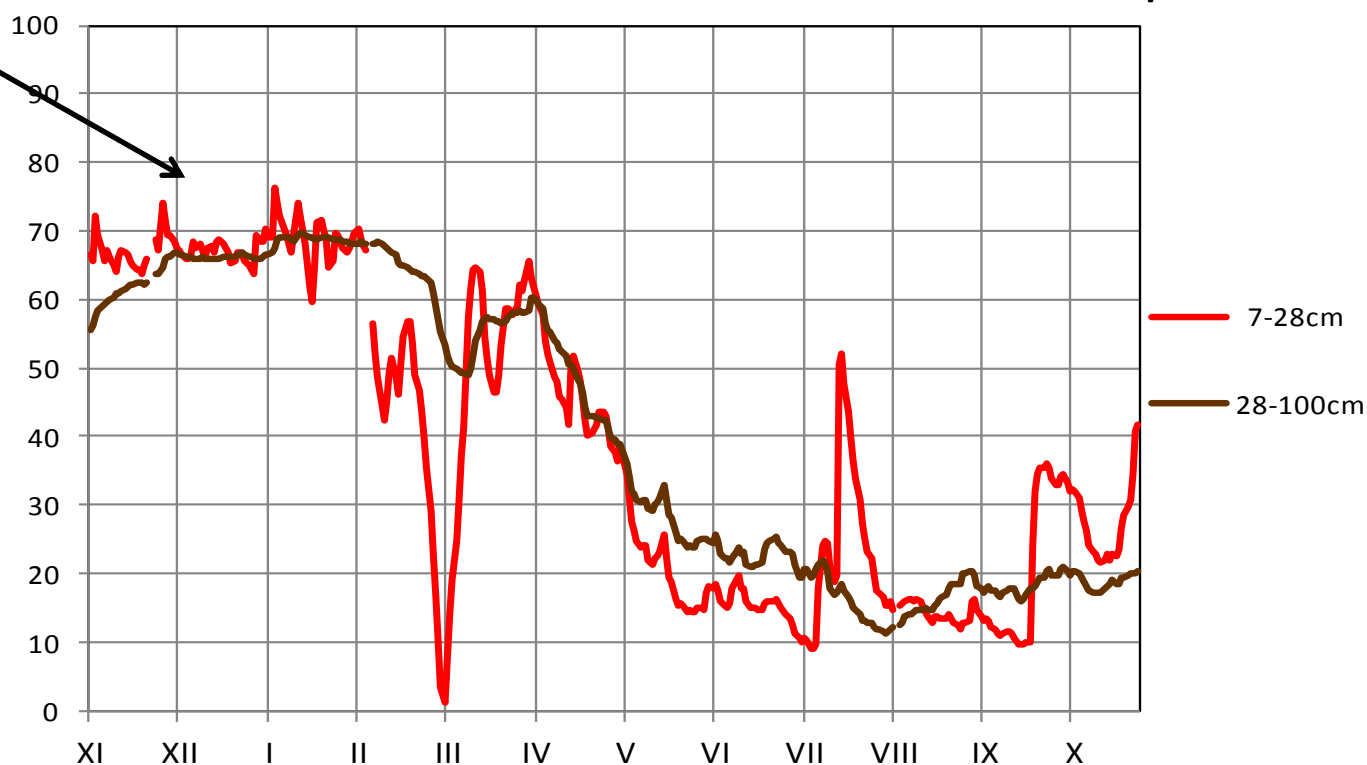


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Soil moisture in Swiebodzin district in 2018 on different depths



Satellite pictures

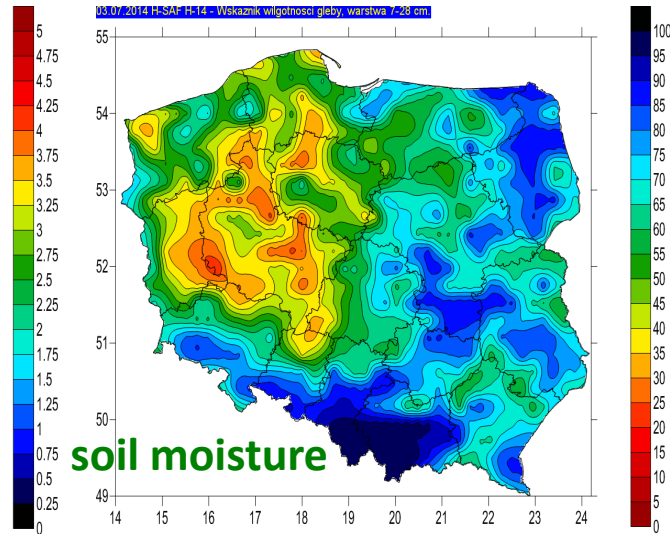
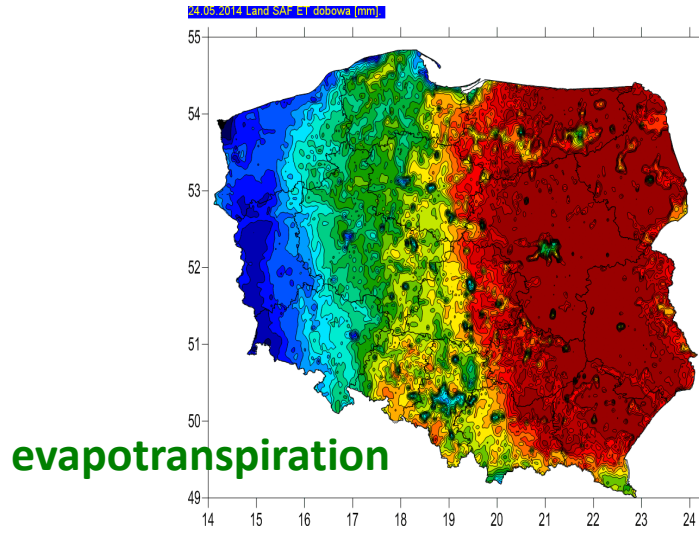


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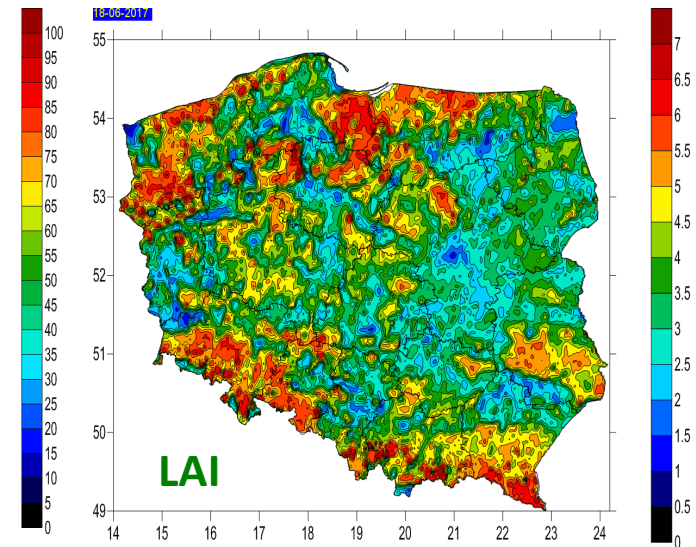
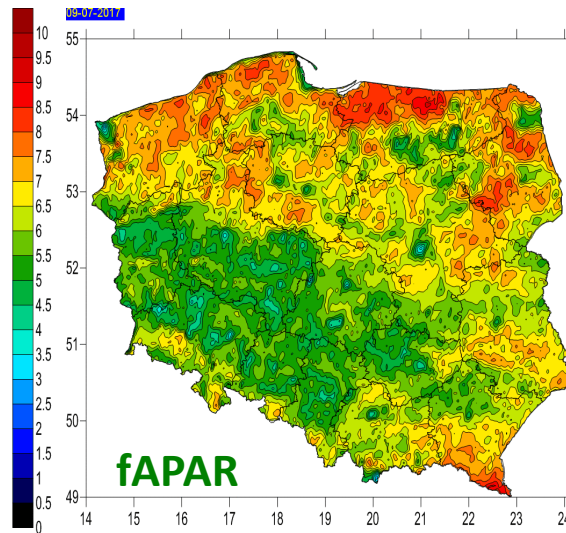
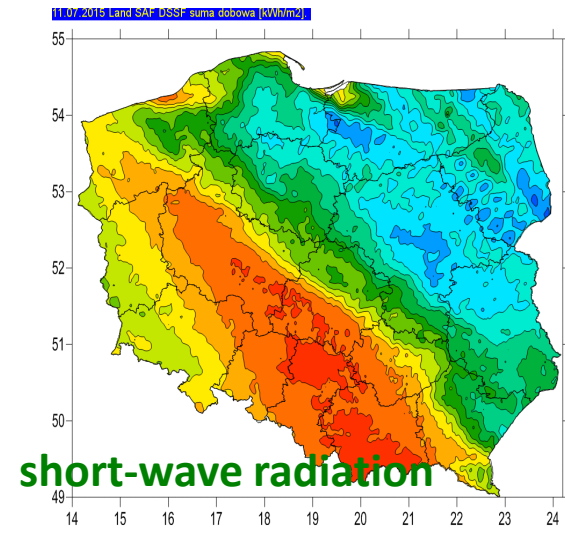


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allow for drought monitoring and plant conditions monitoring



Phenology



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Phenological service:

- since 2007
- 51 stations in the whole Poland
- 10 wild plants observed (Common Hazel, Coltsfoot, Bird Cherry, Common Dandelium, Silver Birch, Common Lilac, Horse Chestnut, Black Locust, Small-leaved Lime, Common heather)
- 5 phenophases observed
- 7 phenological seasons determined (earliest spring, early spring, spring, early summer, summer, early autumn, autumn)

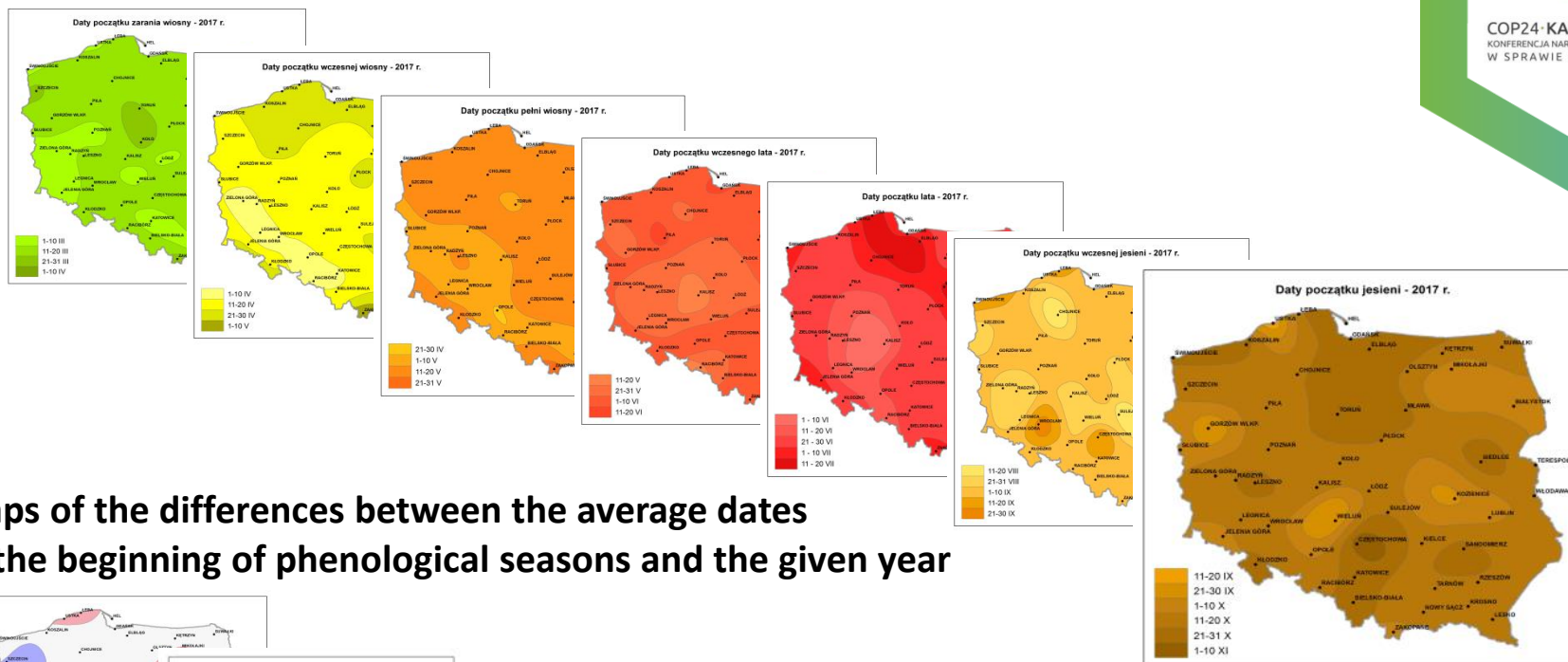
Maps of the beginning of phenological seasons



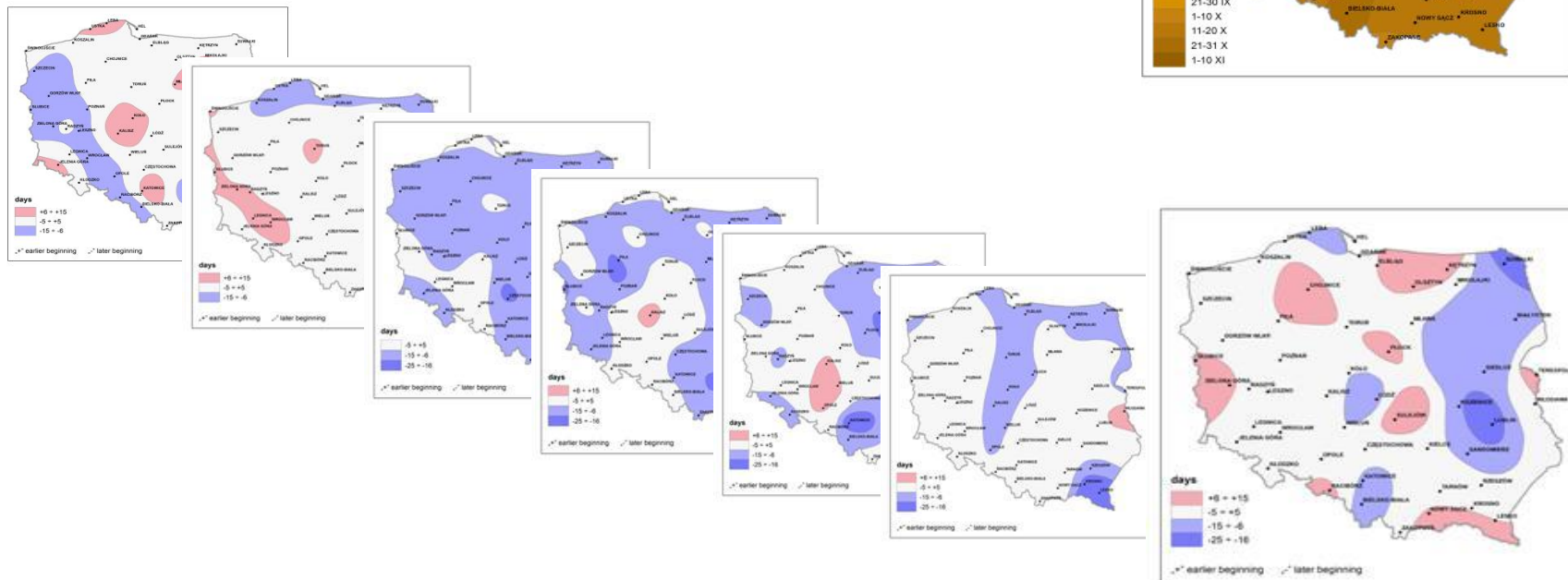
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Maps of the differences between the average dates of the beginning of phenological seasons and the given year



Variability of phenological phases in Poland in years 2007-2016



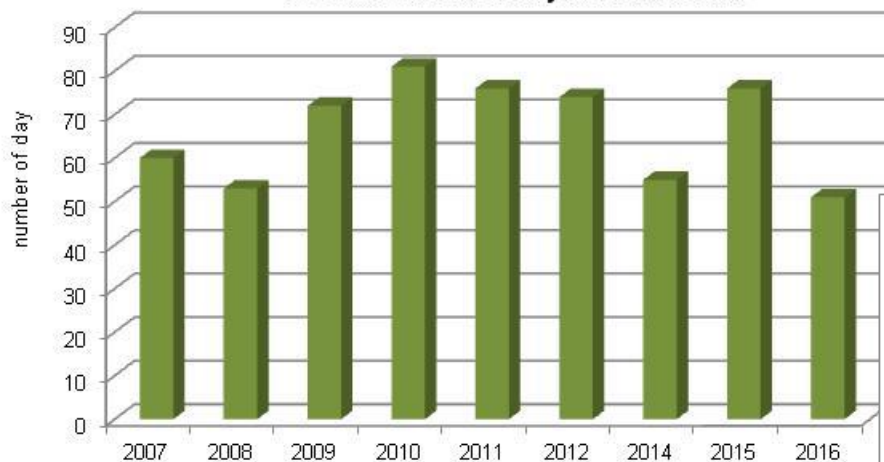
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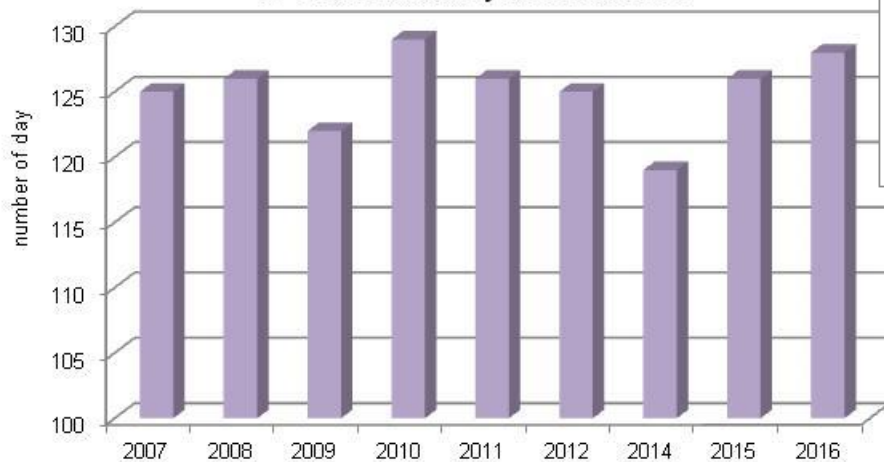
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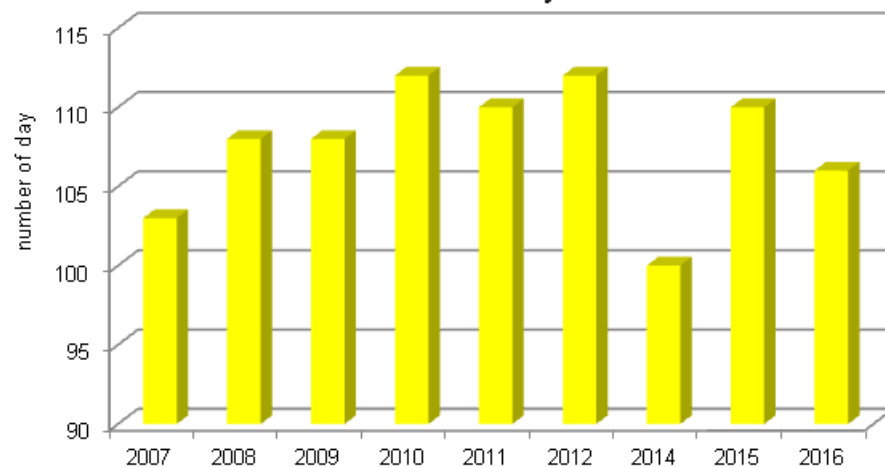
Average dates of flowering
of Common Hazel in years 2007-2016



Average dates of pruning
of Silver Birch in years 2007-2016



Average dates of flowering
of Common Dandelium in years 2007-2016



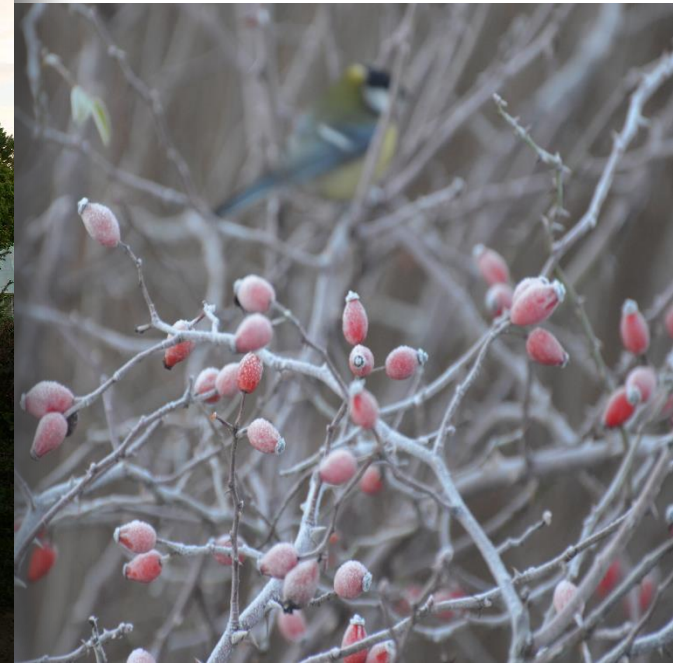


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Automatic station of phenological observations



Historical data

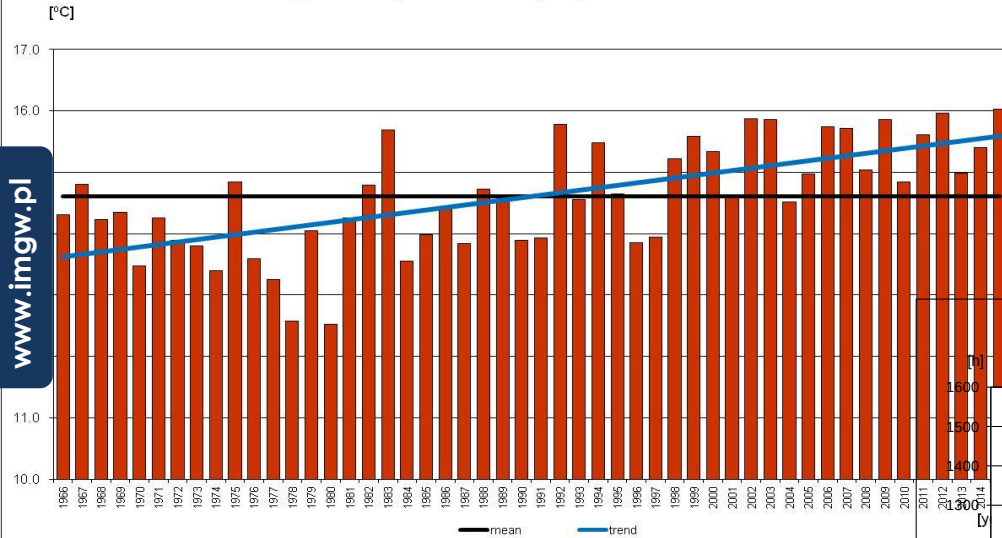


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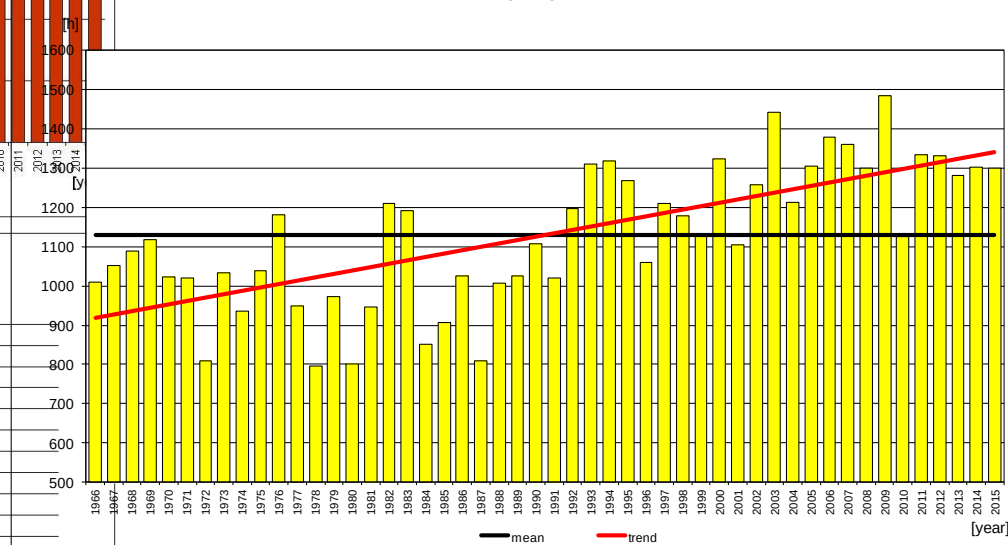


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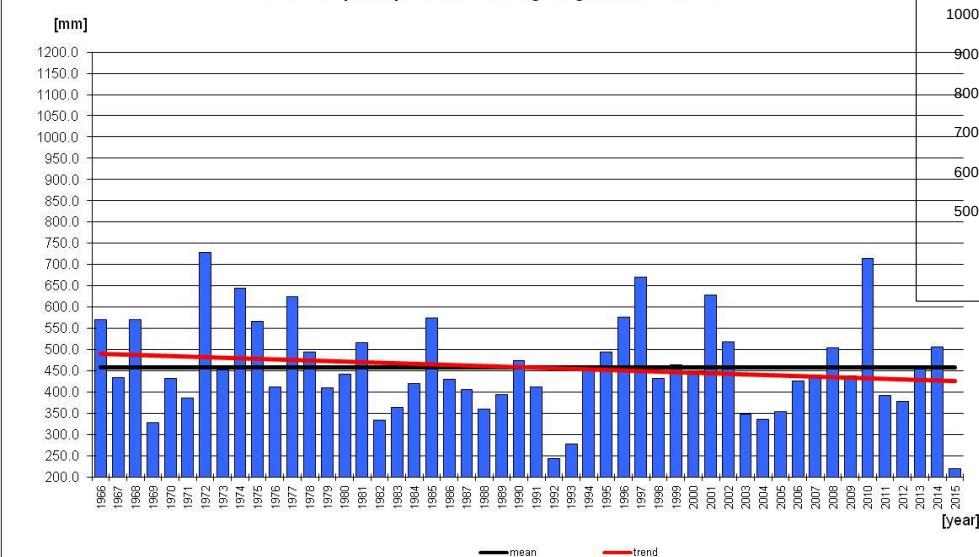
Average air temperature during vegetation season



Sum of sunshine hours during vegetation season



Sum of precipitation during vegetation season



Land- slides

**JACEK
RUBINKIEWICZ**



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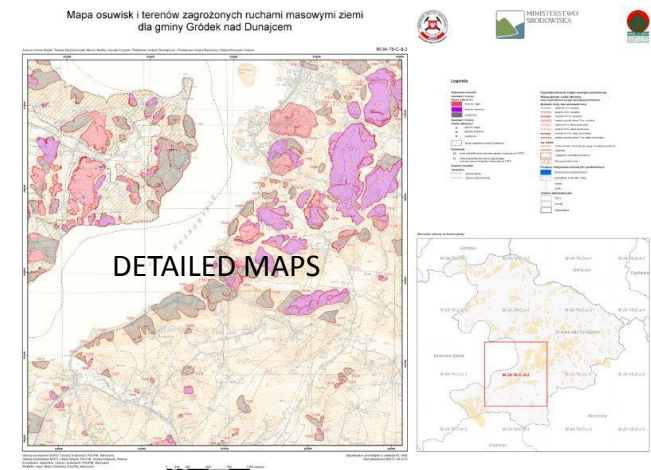
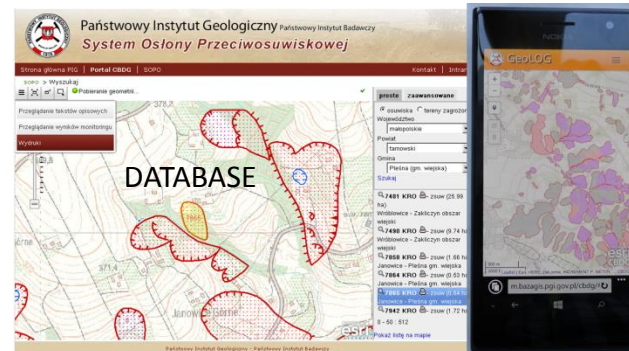
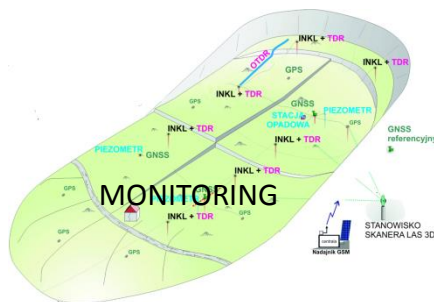


SOPO – Landslides Counteracting System

- ✓ COLLECTING DATA FOLLOWING UNIFIED INSTRUCTION
- ✓ PREPARING DETAILED LANDSLIDE MAPS
- ✓ SOPO LANDSLIDE DATABASE
- ✓ MONITORING SYSTEMS ON SELECTED LANDSLIDES
- ✓ SUSCEPTIBILITY MAPS, RISK ANALYSIS,

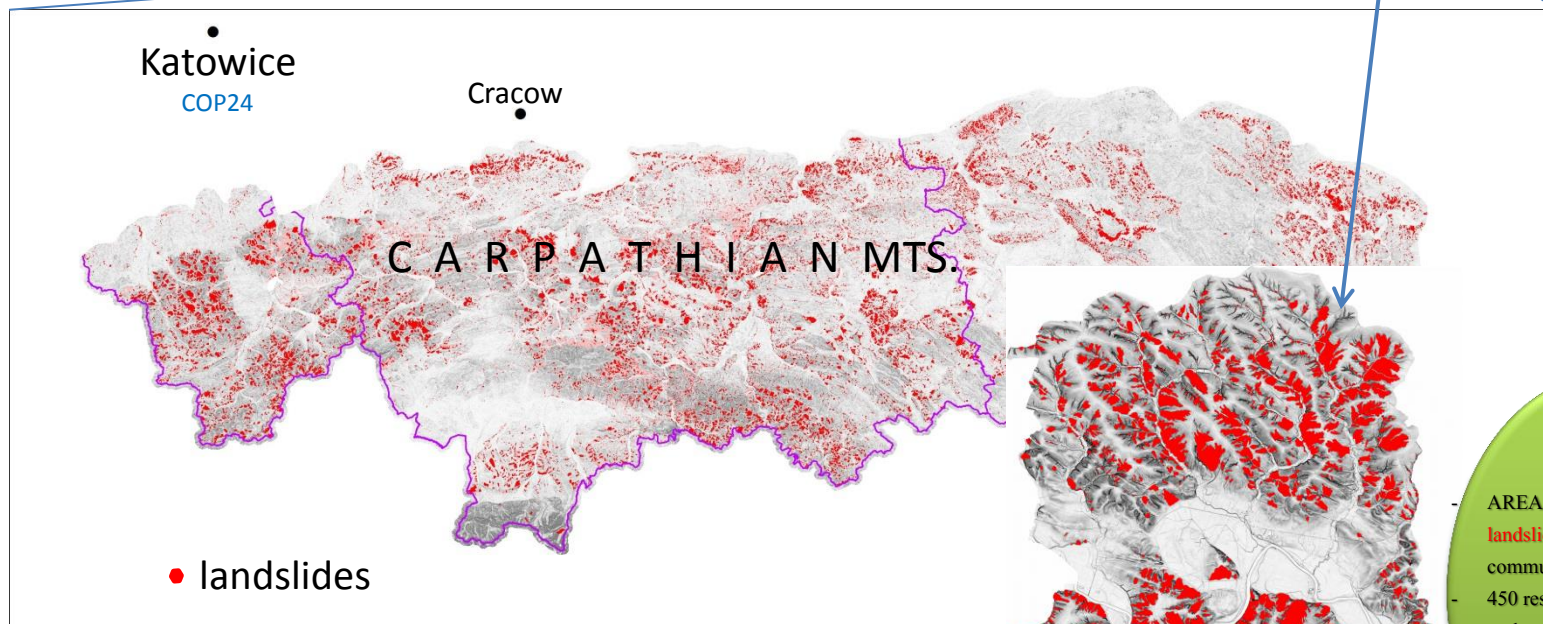
RECIPIENTS: - VARIOUS LEVELS OF ADMINISTRATION

- COMPANIES
- CITIZENS





SOPO DATABASE - Landslide inventory consists **61 251** landslides to date



Dubiecko community

- AREA 154, 26 sq km – **1623** landslides covering **16%** of the community
- 450 residential building on landslides (10% damaged)
- 6 km road sections
- 34,5 km of power line sections

Carpathians covers 5% of territory of Poland
but accumulates 95% of landslides

CLIMATE CHANGES

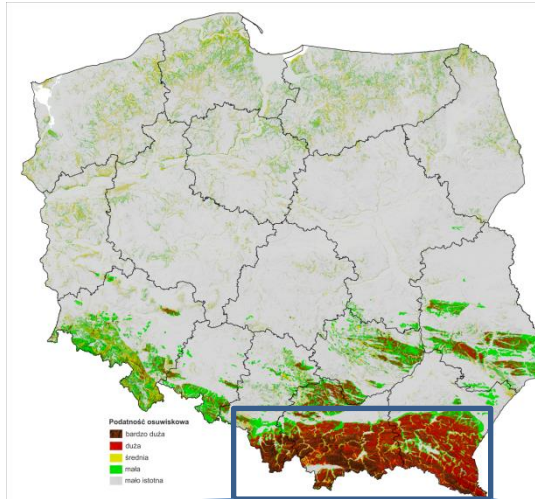
INCREASED NUMBER OF LANDSLIDES RELATED TO HEAVY RAINFALLS AND LONG-LASTING PRECIPITATION



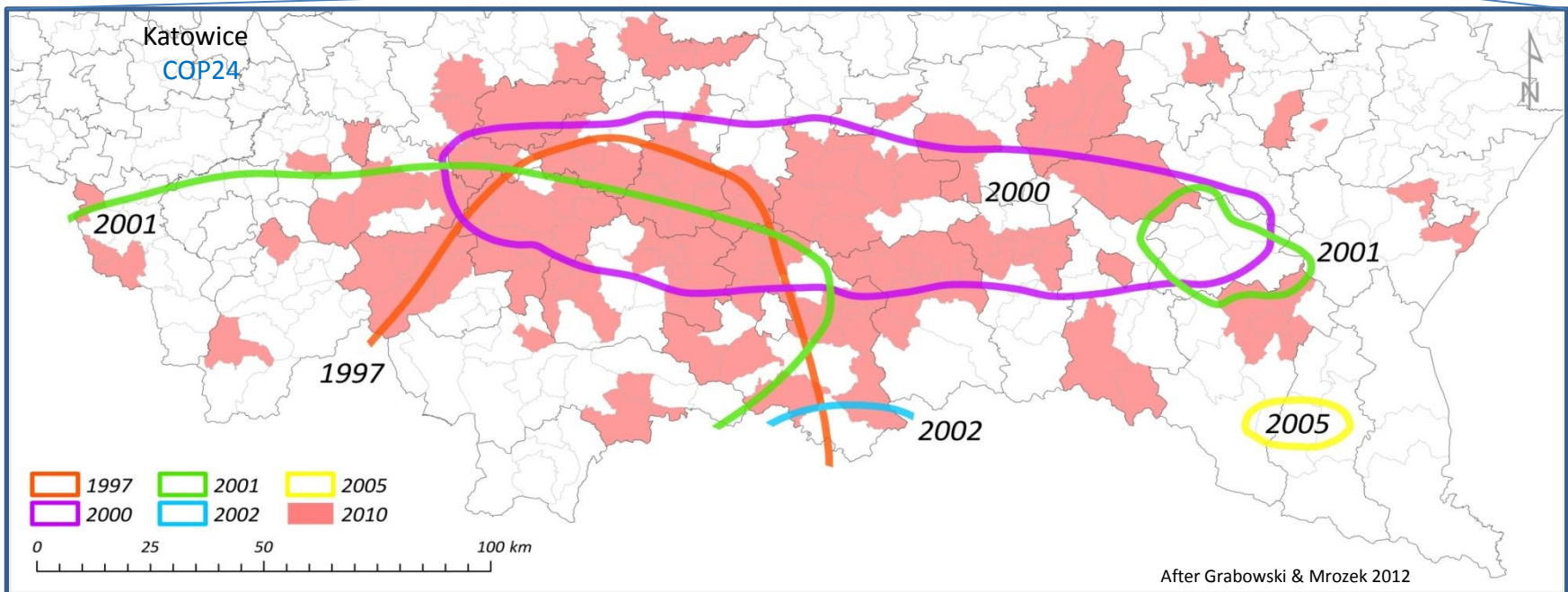
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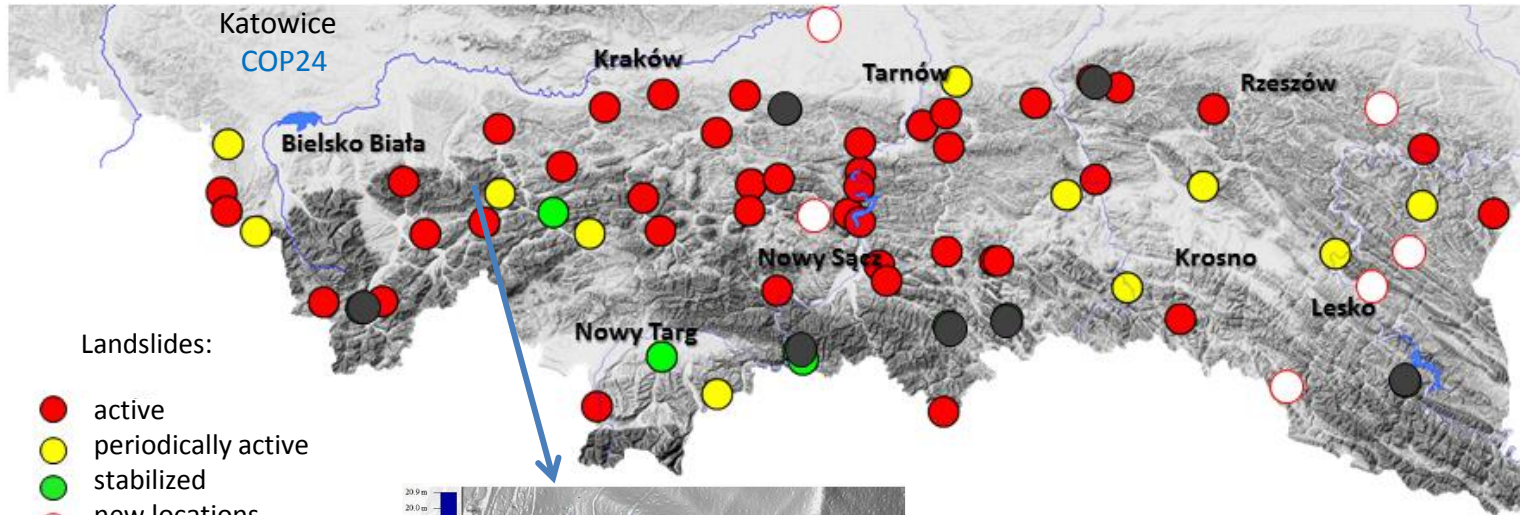
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W SPRAWIE ZMIAN KLIMATU



Landslide susceptibility map of Poland (1:500 000) after Wojciechowski et al.



Landslide monitoring locations in Poland (Carpathians)

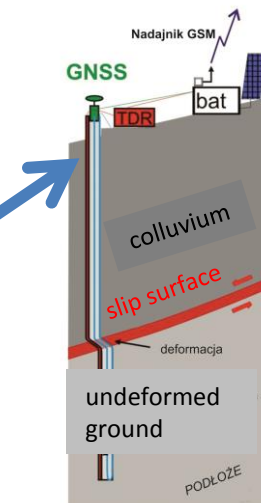
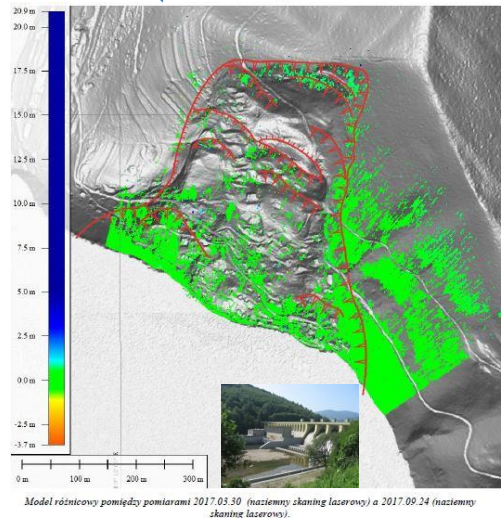


Landslides:

- active
- periodically active
- stabilized
- new locations
- cancelled monitoring



Ground (terrestrial)
laser scanner



Inclinometer system

Coastline

**GRZEGORZ
UŚCINOWICZ**



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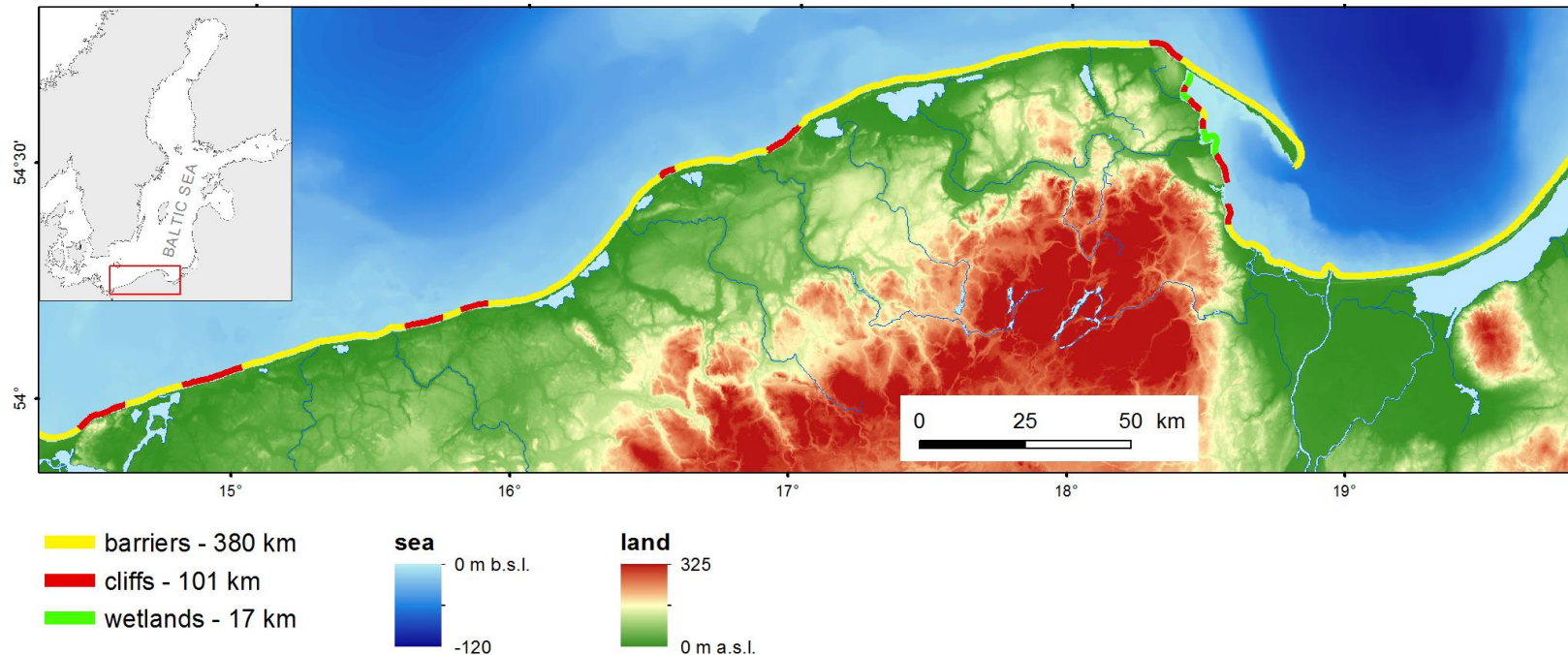
The Southern Baltic Coast



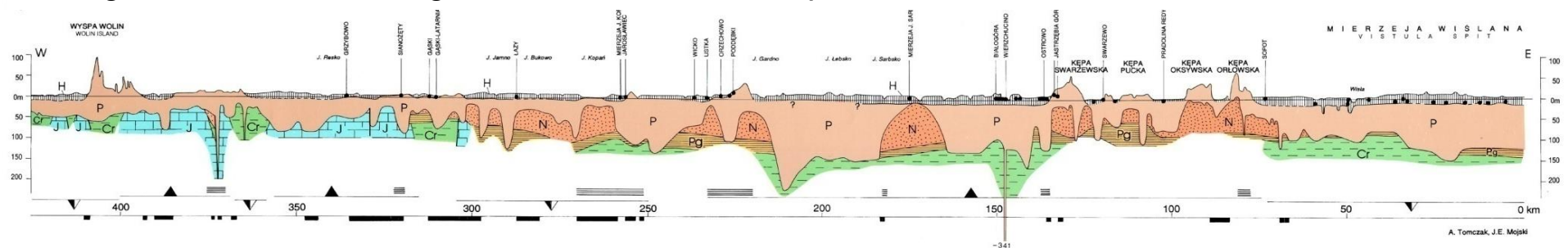
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Geological cross-section along the Southern Baltic coast (*acc. to: Geological atlas of the Southern Baltic, PGI – NRI, 1995*)



The need of coastal research



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Methods of coastal research



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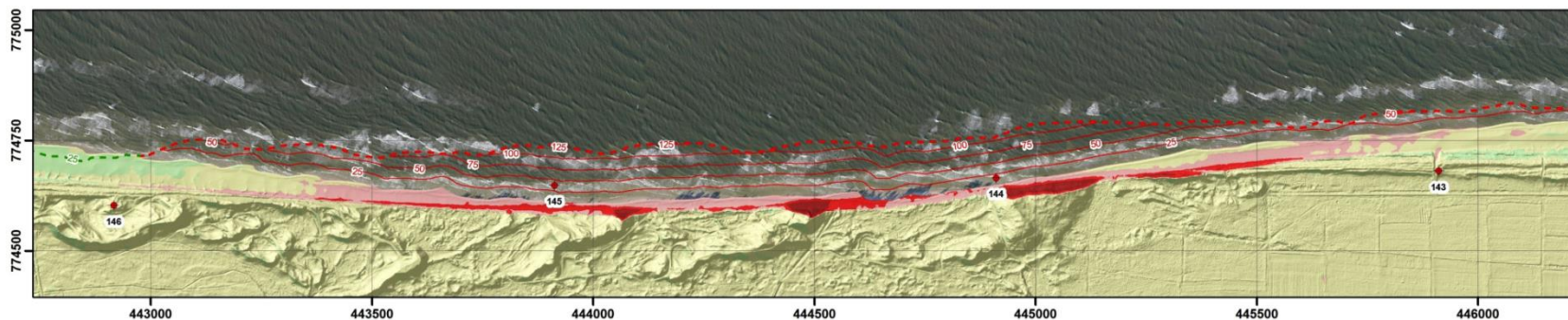
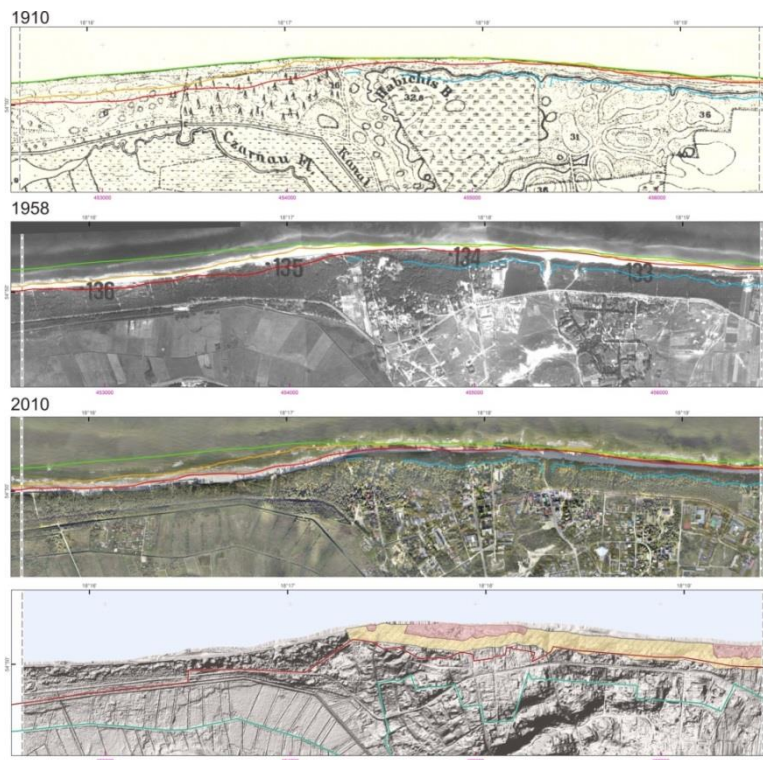
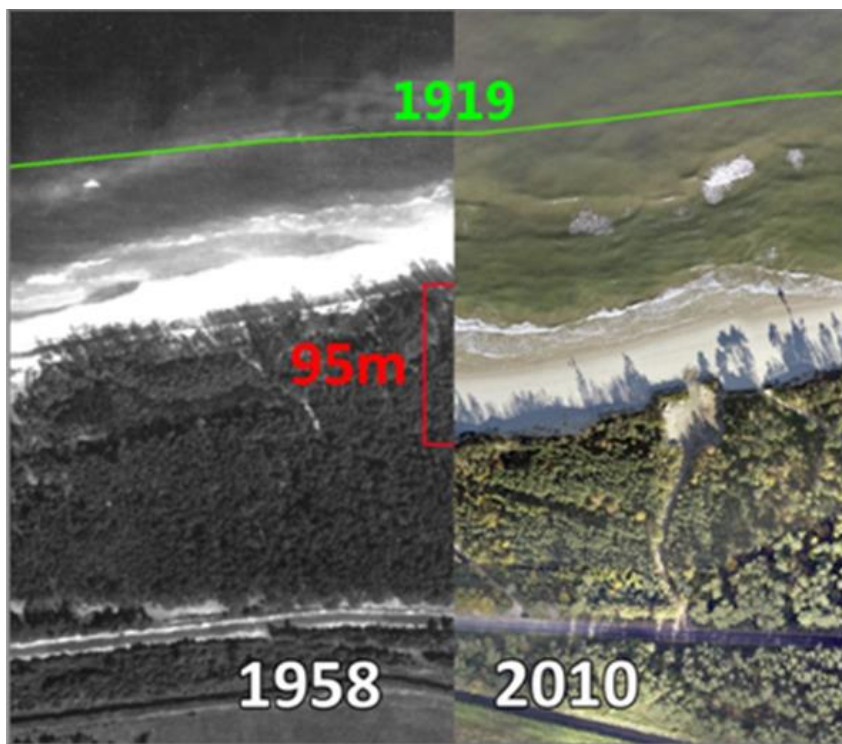
Data implementation -reconstruction-



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Data implementation -forecasts-

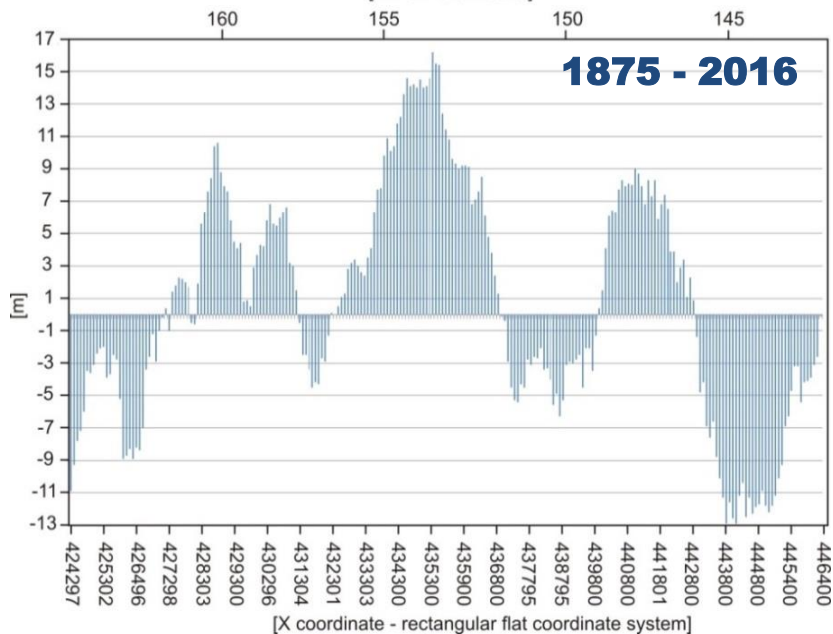
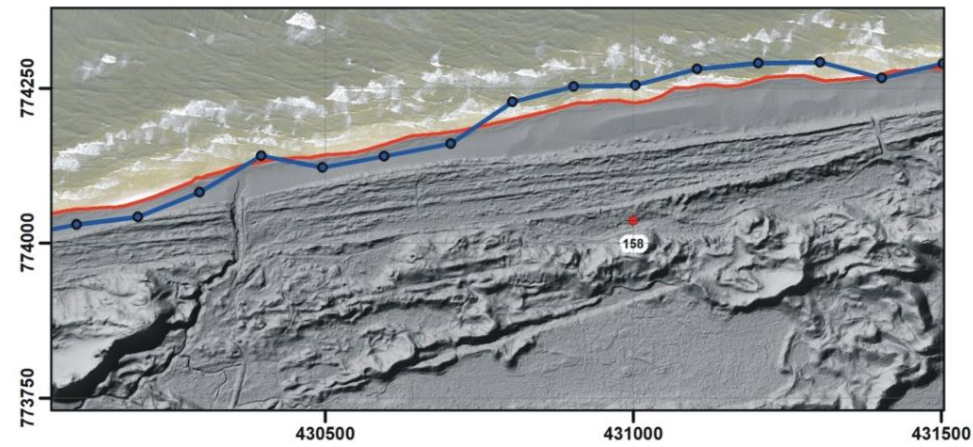


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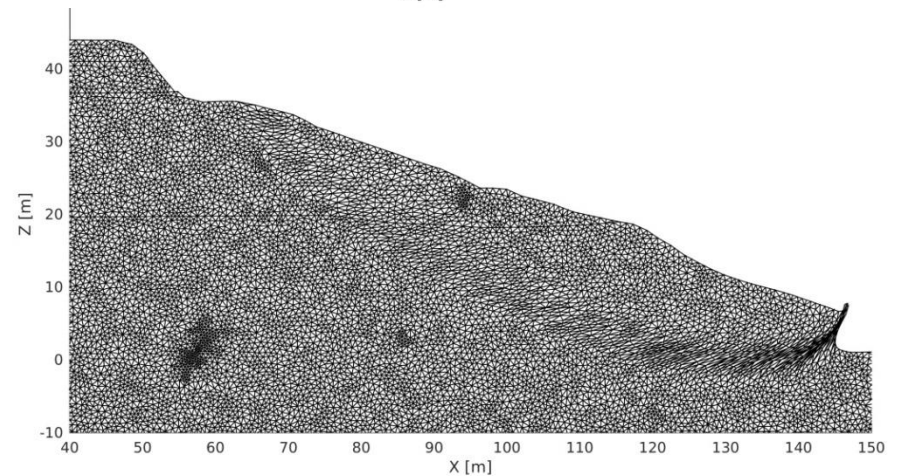
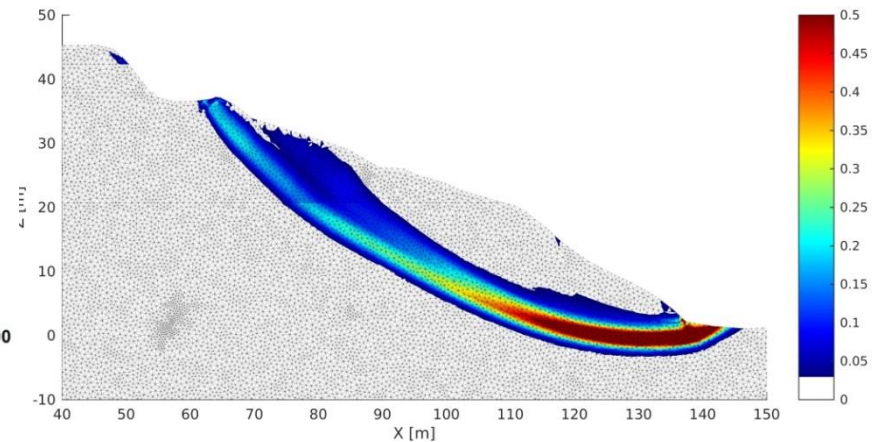


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Prediction of shoreline changes



Cliff coast stability analysis



Paleocli- mate

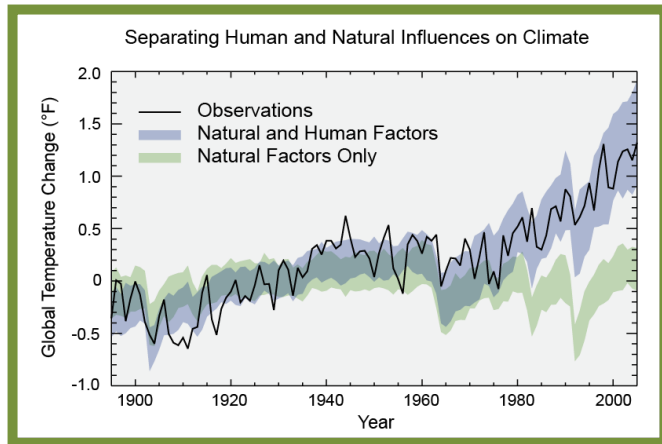
**WOJCIECH
GRANOSZEWSKI**



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Natural versus man-induced climate changes

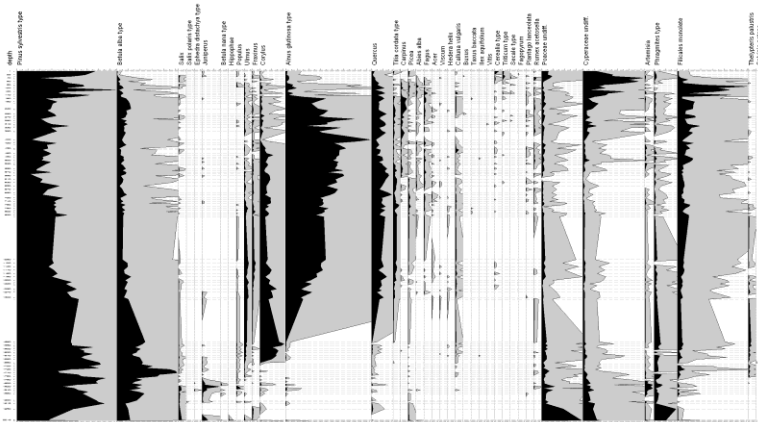


Source: WP of United States Environmental Protection Agency

Palaeoclimate studies:

Vegetation - is one of the most sensitive indicators of climate changes. Fluctuations of vegetation in the past interglacials (without or with very weak human impact) tell us how deep the vegetational-climatical changes can be.

The most important lesson from the past teach us that climate changes might be of great variety and include: drop/rise in temperature, in precipitation (droughts / floods), rise /drop in sea levels (the coastline during the last interglacials went significantly further South in C Europe comparing to the present one), changes in monsoon system. Some of the palaeoclimate changes were substantially bigger than those we are facing nowadays. It gives a chance to be prepared for them.



Ca. 12 000 yrs long vegetational changes in W Poland archived in lake sediments



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Agricultural Drought Monitoring

This part of presentation was prepared in frame of long-term IUNG-PIB program Task 1.7

JERZY KOZYRA

KATARZYNA ŻYŁOWSKA

RAFAŁ PUDEŁKO

PIOTR KOZA

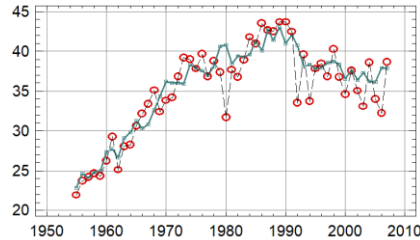
ANDRZEJ DOROSZEWSKI



Institute of Soil Science and Plant Cultivation
State Research Institute



Statistical models describing yield-weather indices
relations during vegetation season



Temporal and soils specific climatic water deficit threshold
indicated drought conditions for 14 crops

Variety of field crops	Soil category	Sixty-day period													
		21.IV	1.IV	15.IV	21.IV	1.V	15.V	20.V	21.V	1.VI	15.VI	20.VI	21.VI	1.VII	15.VII
Winter cereals	I	-133	-140	-148	-158	-169	-182	-198	-215	-233	x	x	x	x	x
	II	-154	-161	-169	-179	-190	-203	-219	-236	-254	x	x	x	x	x
	III	-192	-199	-208	-218	-230	-243	-258	-275	-293	x	x	x	x	x
	IV	-219	-226	-235	-246	-259	-272	-287	-302	-319	x	x	x	x	x
Spring cereals	I	-130	-134	-139	-147	-157	-170	-187	-205	-225	x	x	x	x	x
	II	-148	-152	-157	-165	-176	-189	-206	-224	-244	x	x	x	x	x
	III	-176	-182	-187	-195	-206	-219	-236	-255	-275	x	x	x	x	x
	IV	-199	-203	-209	-216	-227	-241	-259	-279	-301	x	x	x	x	x
Grain maize	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	III	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	IV	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Silage maize	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	III	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	IV	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rape and turnip rape	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	III	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	IV	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Soil category

- Category I
- Category II
- Category III
- Category IV

GIS

Crop Drought definition
based on CWB threshold
for 4 category of soils,
14 crops and
14 reports per year

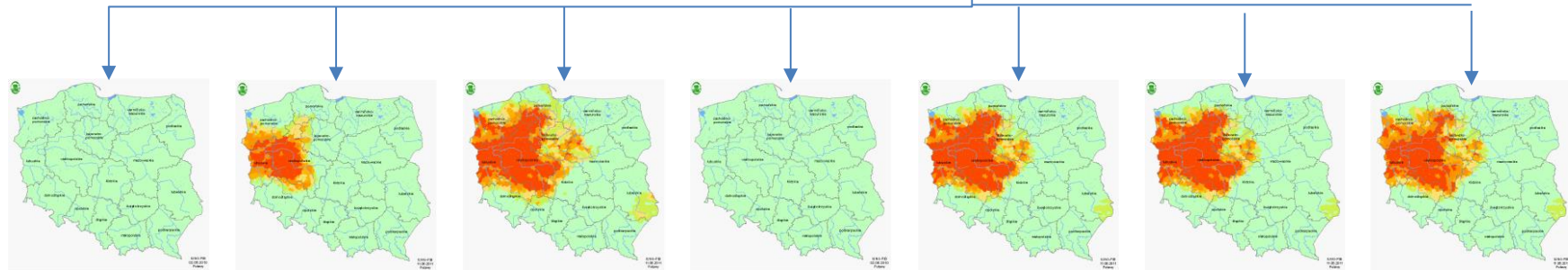
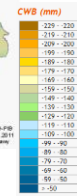
GIS

% of soil affected by drought (NUTS-5)

Map of susceptibility of soils to drought

Meteorological stations used in ADMS

CWB for monitoring period



Sugar beet

Fruit trees

Fruit shrubs

Rape and turnip rape

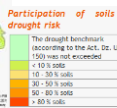
Strawberries

Spring cereals

Winter cereals

Agricultural Drought Monitoring System in Poland - how it's working

<http://www.susza.iung.pulawy.pl/en/>



Agricultural Drought Monitoring System – Climatic water balance

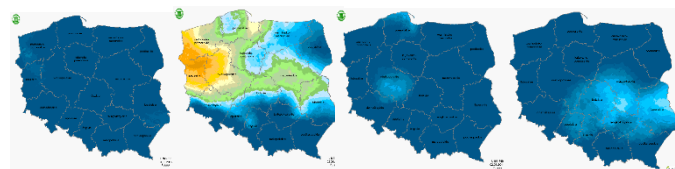
KBW [mm]

	-209 - -200
	-199 - -190
	-189 - -180
	-179 - -170
	-169 - -160
	-159 - -150
	-149 - -140
	-139 - -130
	-129 - -120
	-119 - -110
	-109 - -100
	-99 - -90
	-89 - -80
	-79 - -70
	-69 - -60
	-59 - -50
	> -50

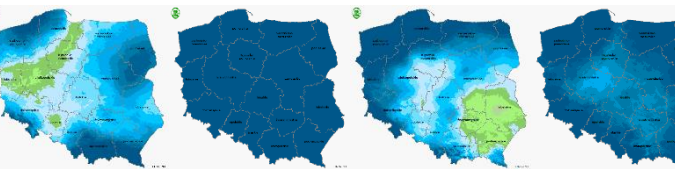
2009 2010 2011 2012 2013 2014 2015 2016 2017 2018



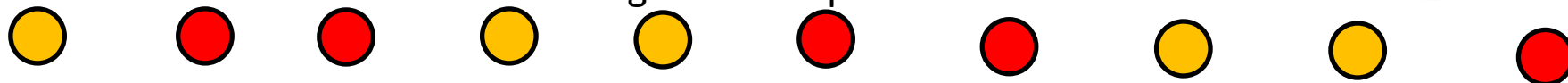
April and May



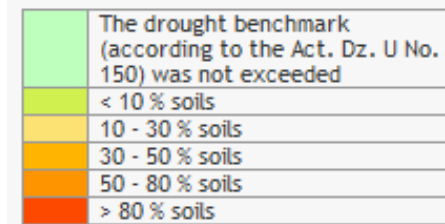
June and July



August and September



Winter wheat drought risk area (losses higher than 20% of average yield)



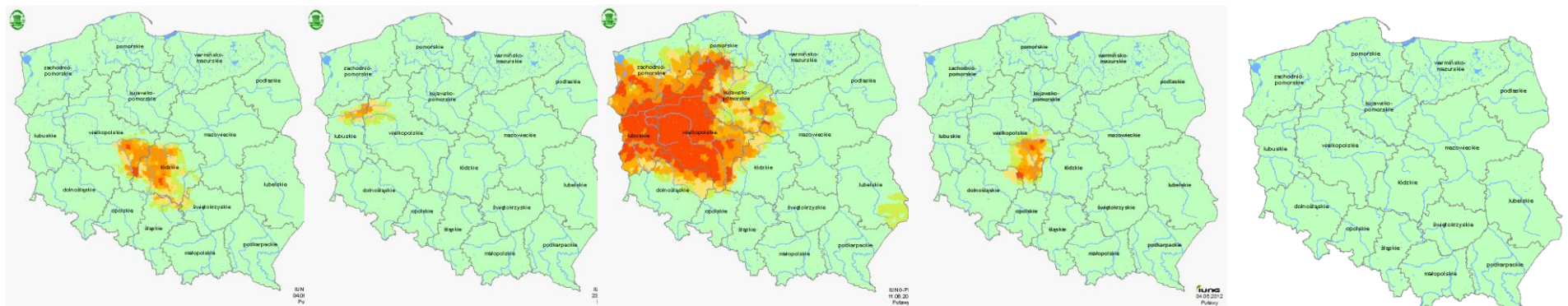
2009

2010

2011

2012

2013



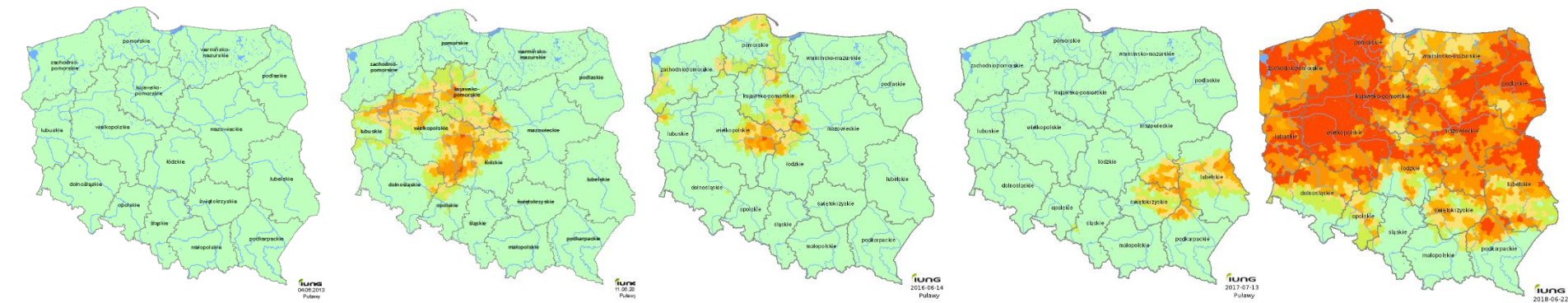
2014

2015

2016

2017

2018



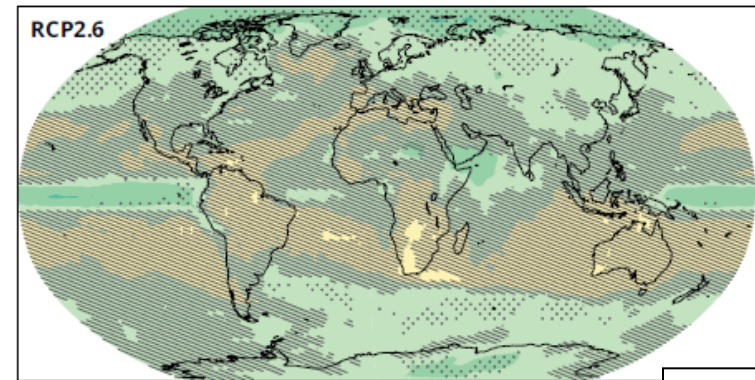
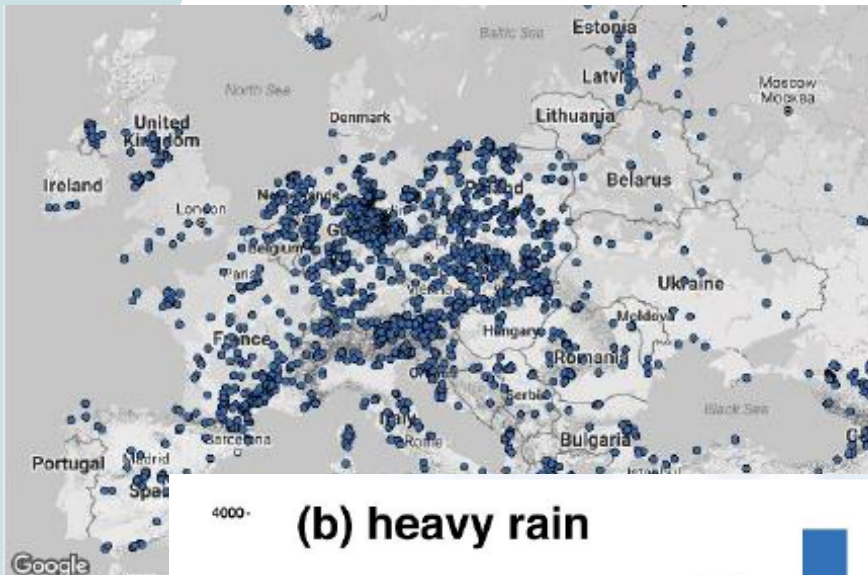
Methodology for economic assessment of climate change impacts and adaptation in the water management sector in urban areas

ANNA DUBEL

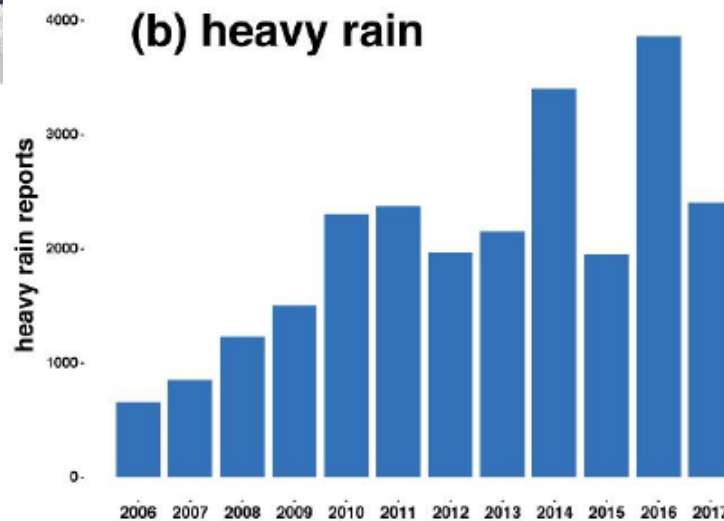
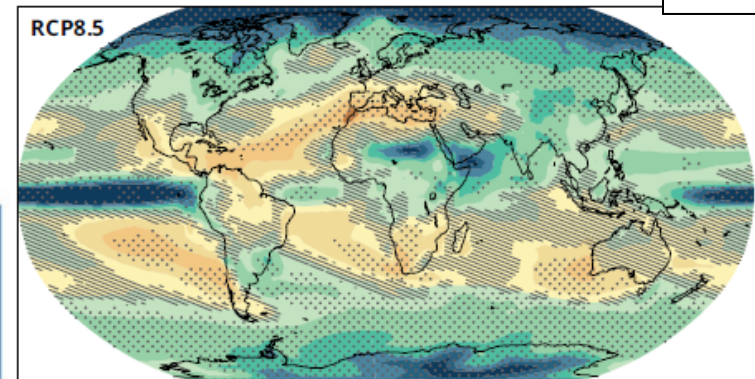


Climate challenge

Precipitation – one of the main climate risk factors



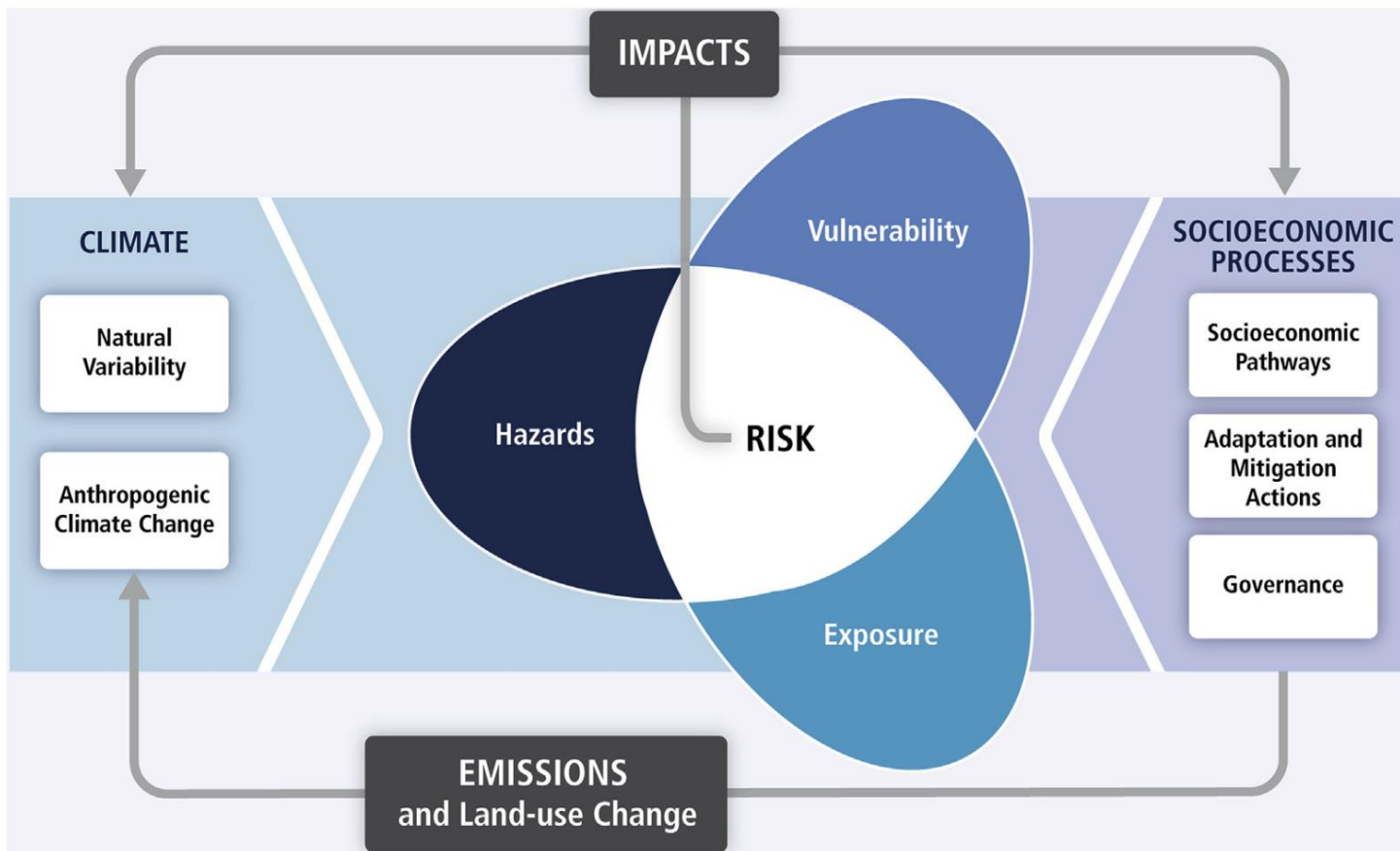
Rainfall



Source: Annual Report 2017, European Severe Storms Laboratory (ESSL)
e.V, Weßling, 2018.

Source: T. F., Qin, D., Plattner, G.-K., et al. (eds), *Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge; New York.

Climate and disaster risk assessment method



Source: IPCC 2014

Multi-dimension challenge

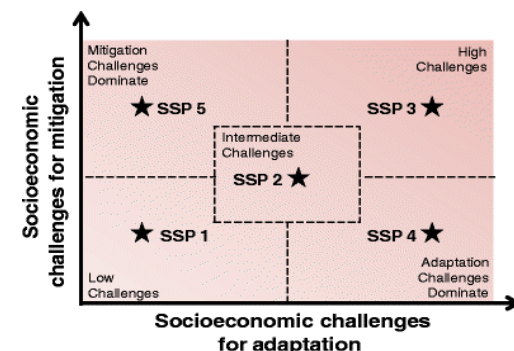
SECTORS
Agriculture
Forestry
Health
Energy
Transport
Water management
Tourism
Biodiversity

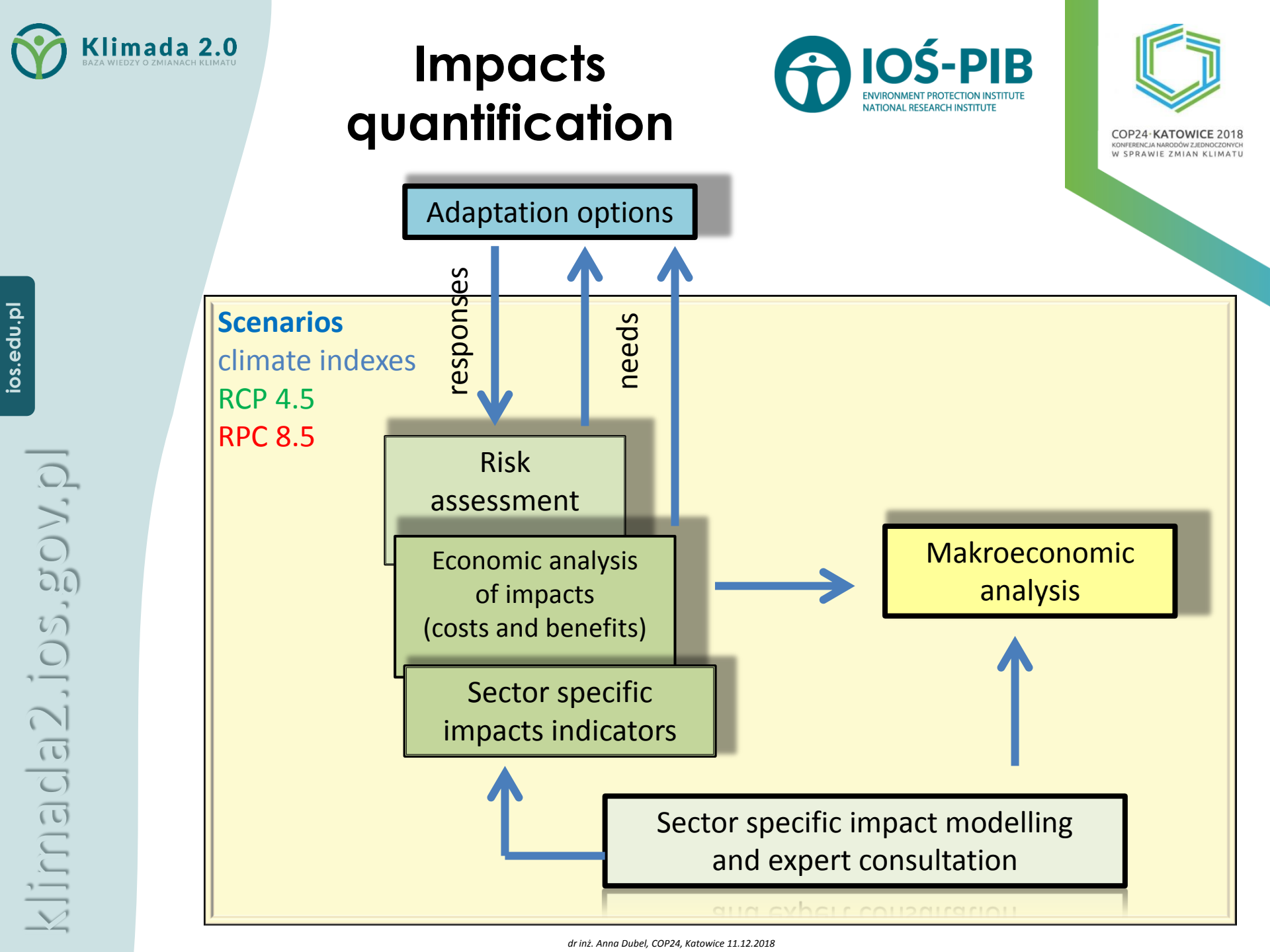
SUB-SECTORS
orchards
winter crops
summer crops
...
road transport
rail transport
...
population
population 65+

DATABASES
FHM
FRM
BDL, GUS
geoportals
...

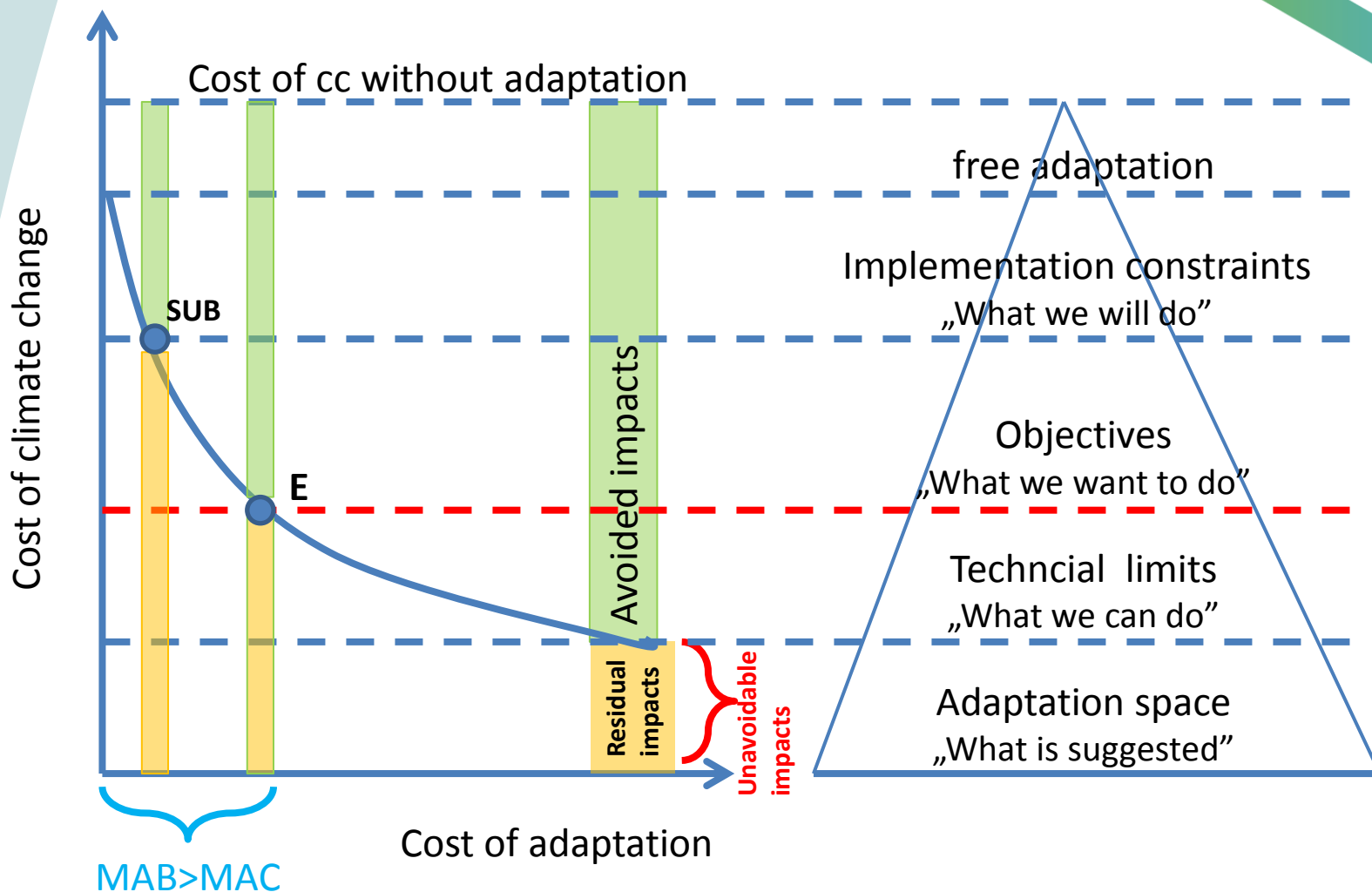
- **sectors**
- **hazards** (any climate related changes)
- **vulnerability**, adaptation potential and capacity
- **exposure** (elements at risk/assets)
- **timescale**: sudden-onset (e.g. flooding, storms)
slow-onset (e.g. sea level rise, desertification) events
- **probability of occurrence** (e.g. low-probability, high impact events)
- **uncertainties** about future climate change, future development paths affect climate change impact estimates
- **trade-offs**: adaptation/mitigation, adaptation options
- **equity**: who gains and who loses
- **cross-sectoral** interrelations

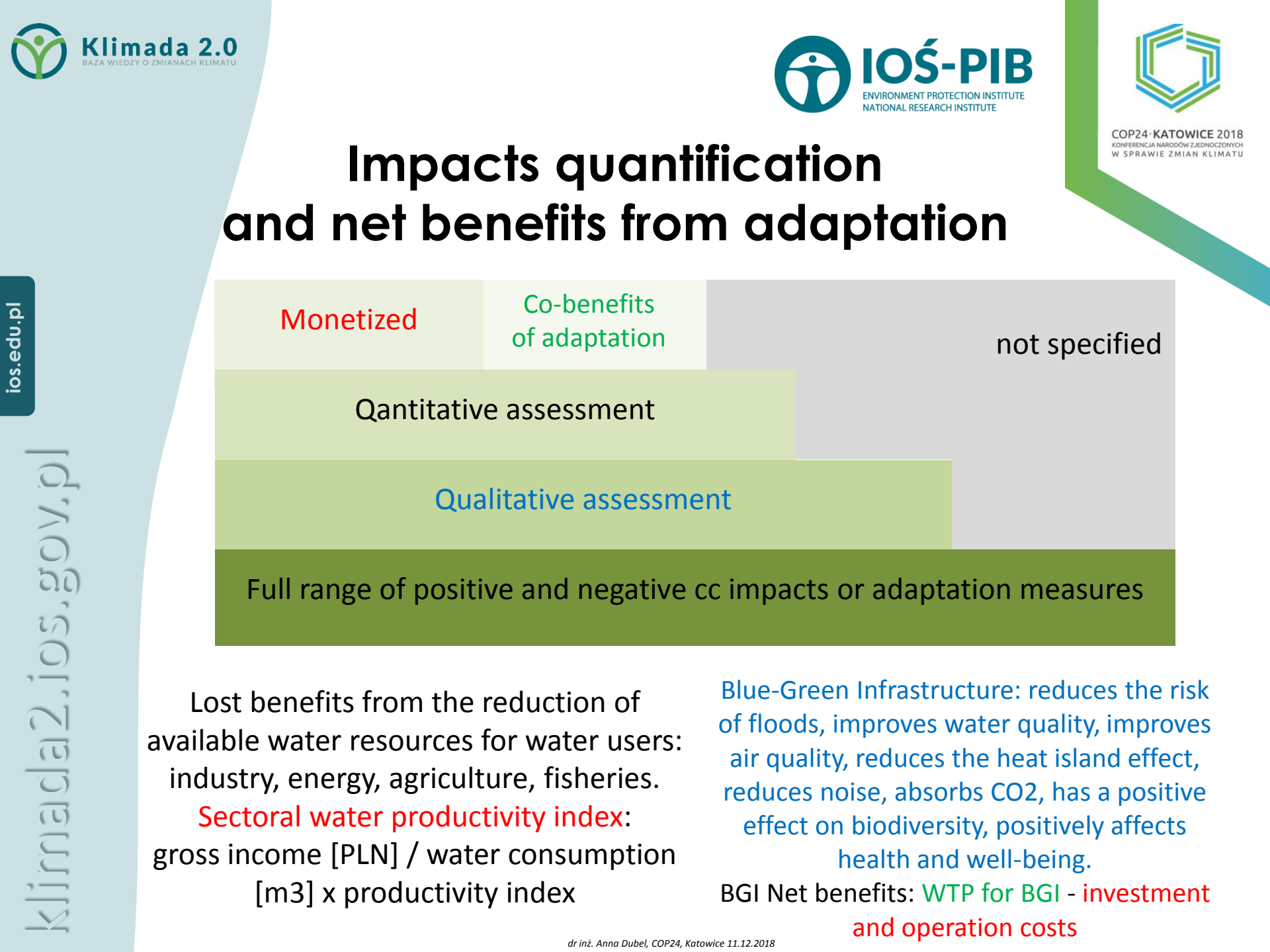
HAZARDS
Flood
Drought
Water scarcity
Heat-waves
Storms
Frost
Landslides
Strong wind
High/low temperature
High/low precipitation
...





Costs of climate change and adaptation





Impacts quantification and net benefits from adaptation

Lost benefits from the reduction of available water resources for water users: industry, energy, agriculture, fisheries.

Sectoral water productivity index:
gross income [PLN] / water consumption
[m3] x productivity index

Blue-Green Infrastructure: reduces the risk of floods, improves water quality, improves air quality, reduces the heat island effect, reduces noise, absorbs CO2, has a positive effect on biodiversity, positively affects health and well-being.

BGI Net benefits: **WTP for BGI** - investment and operation costs

Economic assessment of climate change impacts: methods

- data mining, trends analysis
- primary research
- impact modelling
- expert consultation
- costs of extreme events
- costs of sector specific impacts
- transfer methods
- ecosystem services approach
- benefits valuation
- economic valuation methods
- costs and benefits of action and inaction

Assessment

needs

tools

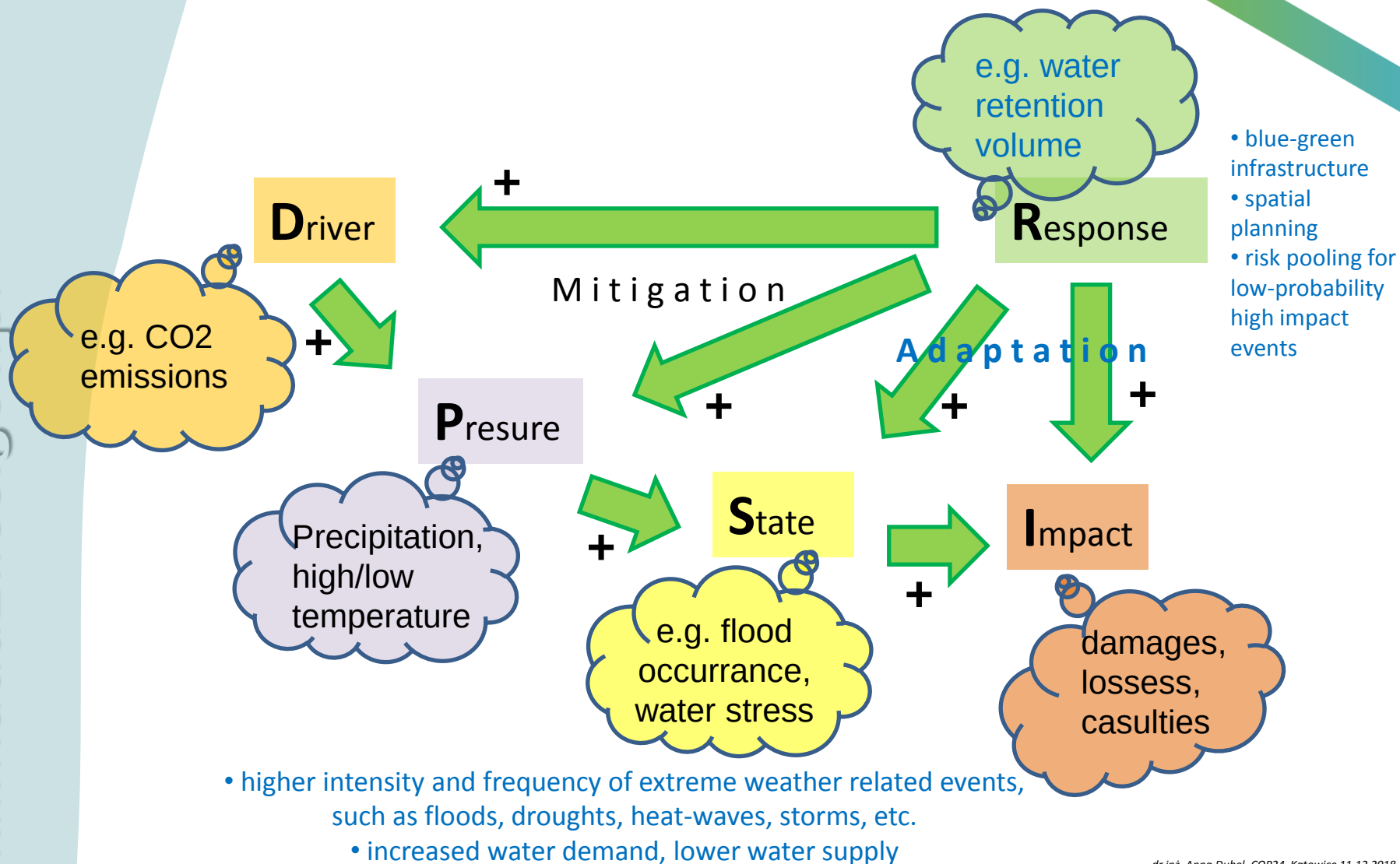
disaster risk management,
policy and strategy
development and
assessment,
insurance, financing losses,
financing mitigation and
adaptation measures,
participatory decision
making, private or public
investment decisions, cross
country comparisons, etc.

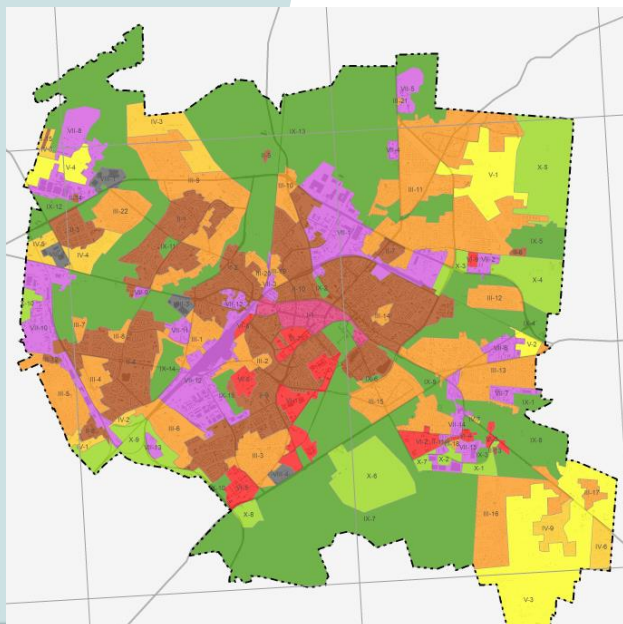


Source: IIASA and Zurich Insurance (2015) Turning knowledge into action: processes and tools for increasing flood resilience. Zurich, Switzerland

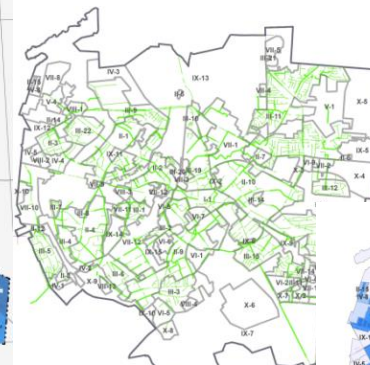
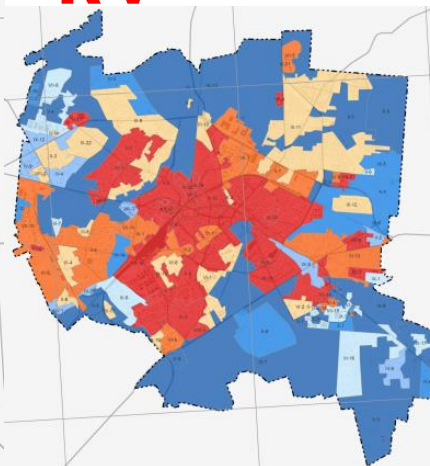
Support of adaptation decision making through economic analysis

Impacts analysis and assessment

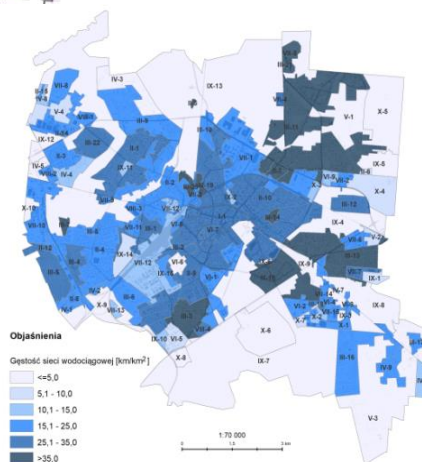




RV



RE

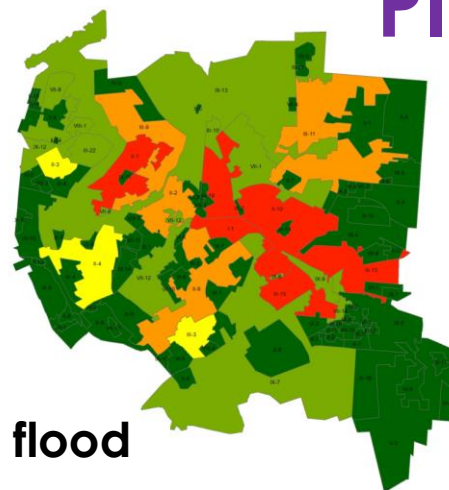
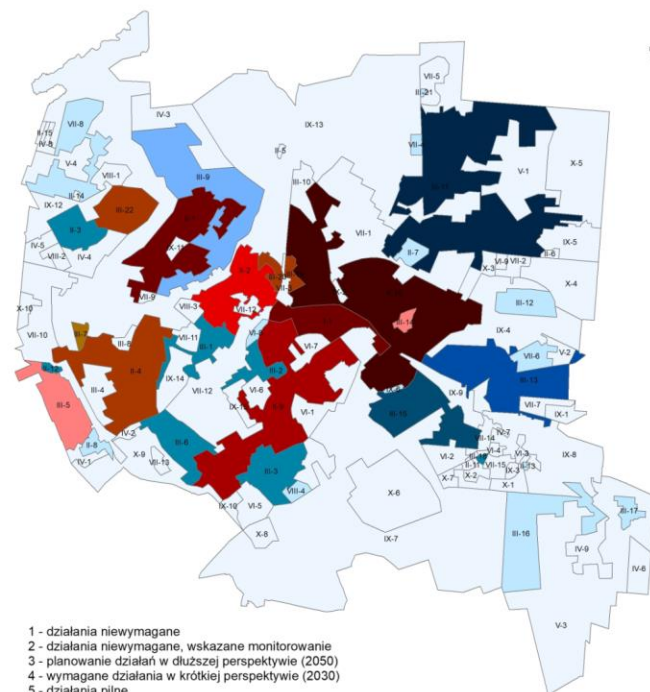


Objaśnienia
Gęstość sieci wodociągowej [km/km²]

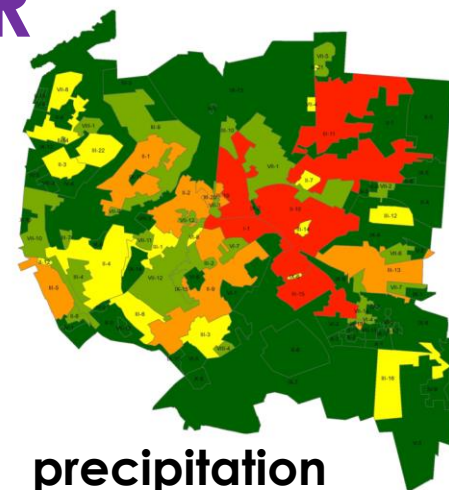


RISK ANALYSIS

PIR

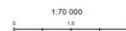


flood

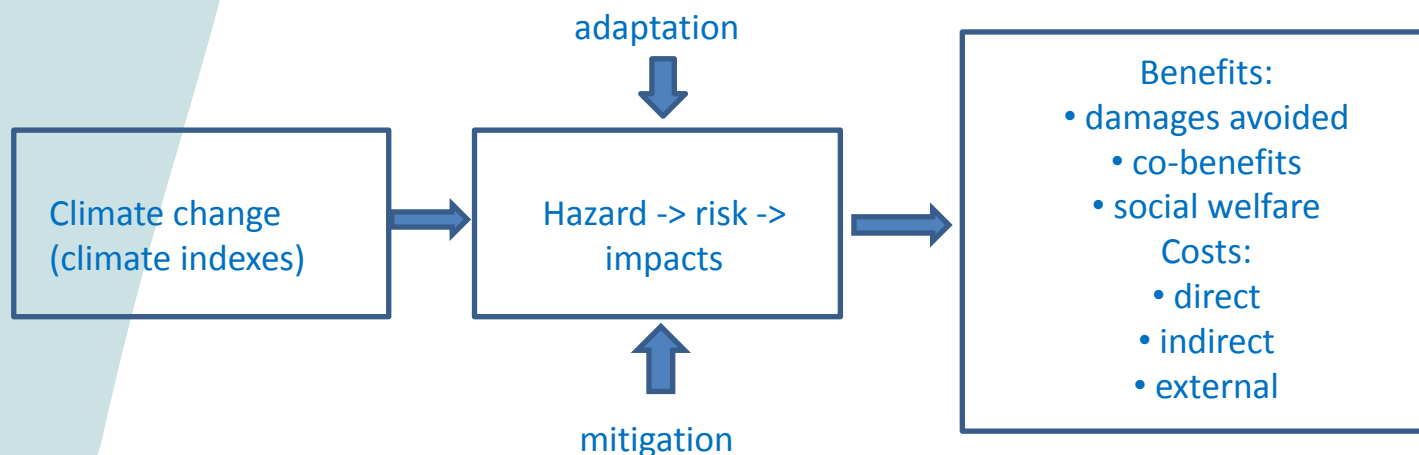


precipitation

PIR - OPADY
ekstremalnie niskie
niskie
umiarkowane
wysokie
bardzo wysokie



- 1 - działania niewymagane
- 2 - działania niewymagane, wskazane monitorowanie
- 3 - planowanie działań w dłuższej perspektywie (2050)
- 4 - wymagane działania w krótkiej perspektywie (2030)
- 5 - działania pilne



For each analysed **SECTOR** (e.g. agriculture, water management, energy,...)

for each relevant (identified) climate related **HAZARD** (e.g. flood, drought, precipitation, extreme temperature, winds, storms, water stress, etc.)

for each defined **space unit** (e.g. land use unit, municipality)

for each relevant **exposure-vulnerability** impact indicator, taking into account adaptation potential and adaptive capacity total **cost** per space unit will be calculated.

sector:	water management	
RH:	flood	
space unit:	land use unit	
category	Element / impact indicators	unit
RE+RV	damages / lossess of various land use categories	PLN/km2
RV: Adaptation Potential	investments in water infrastructure per km of water and sewage network	PLN/km of network
Climate Cost Avoided	damages / lossess avoided in response to the investments in water infrastructure	PLN/km2