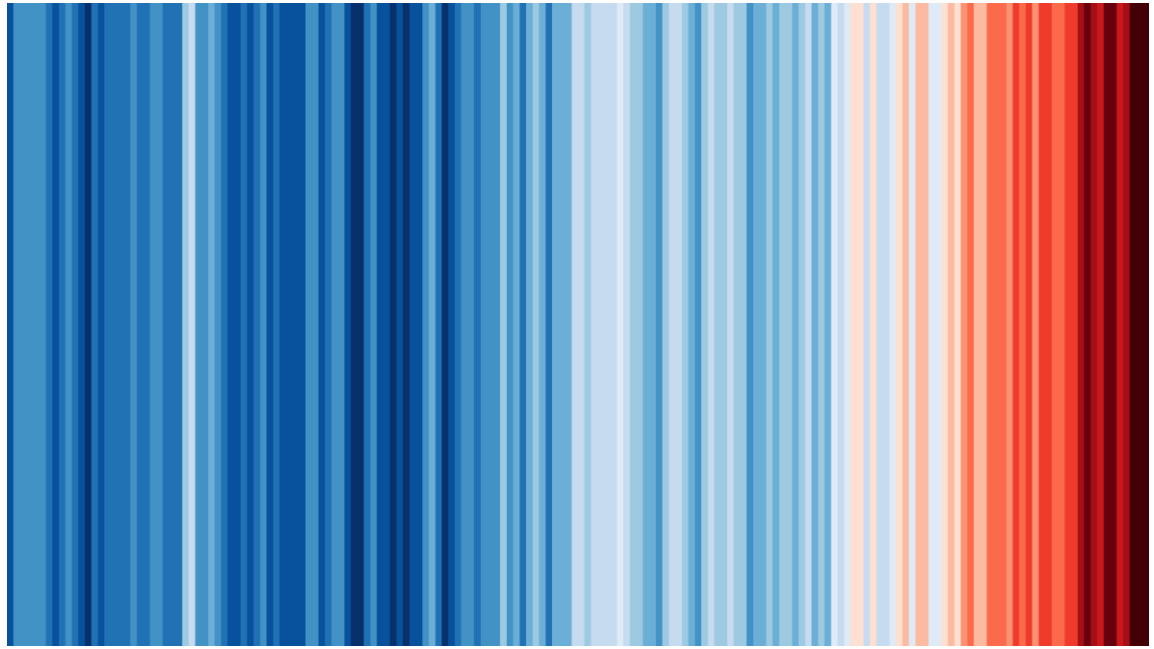
Water Resilience in Europe Key Challenges, Policies, and Strategies



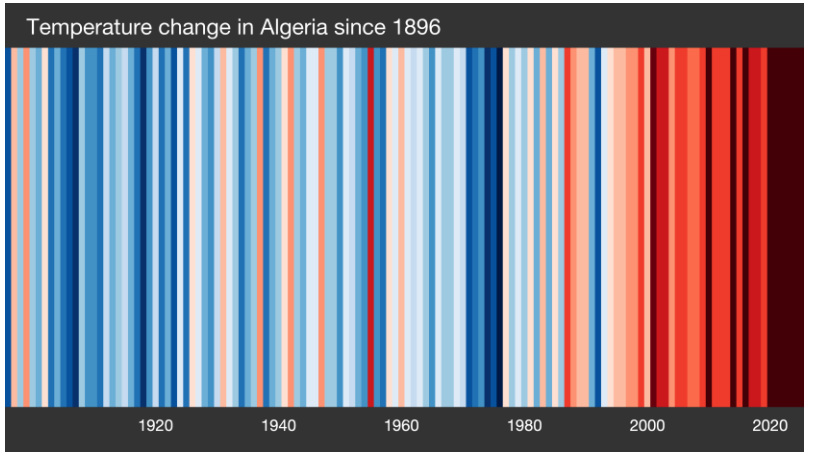
Ksymena Rosiek Ph.D.
Krakow University of Economics
Faculty of Finance
Department of Sustainable Finance

Climate strips

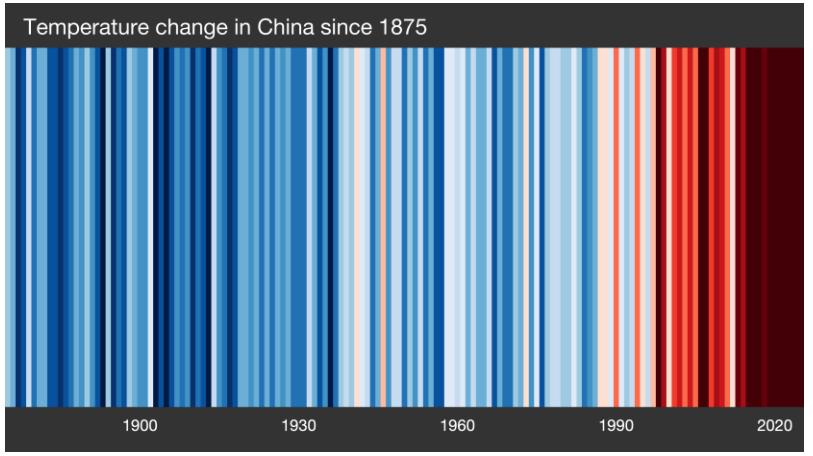


World

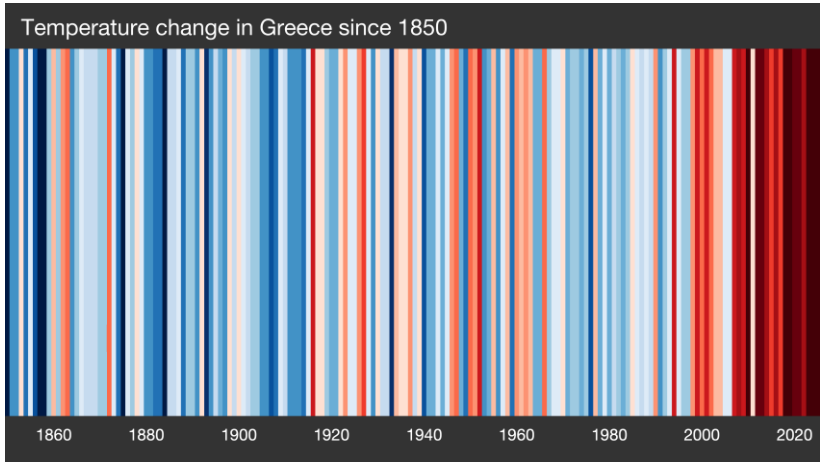
Africa



Asia

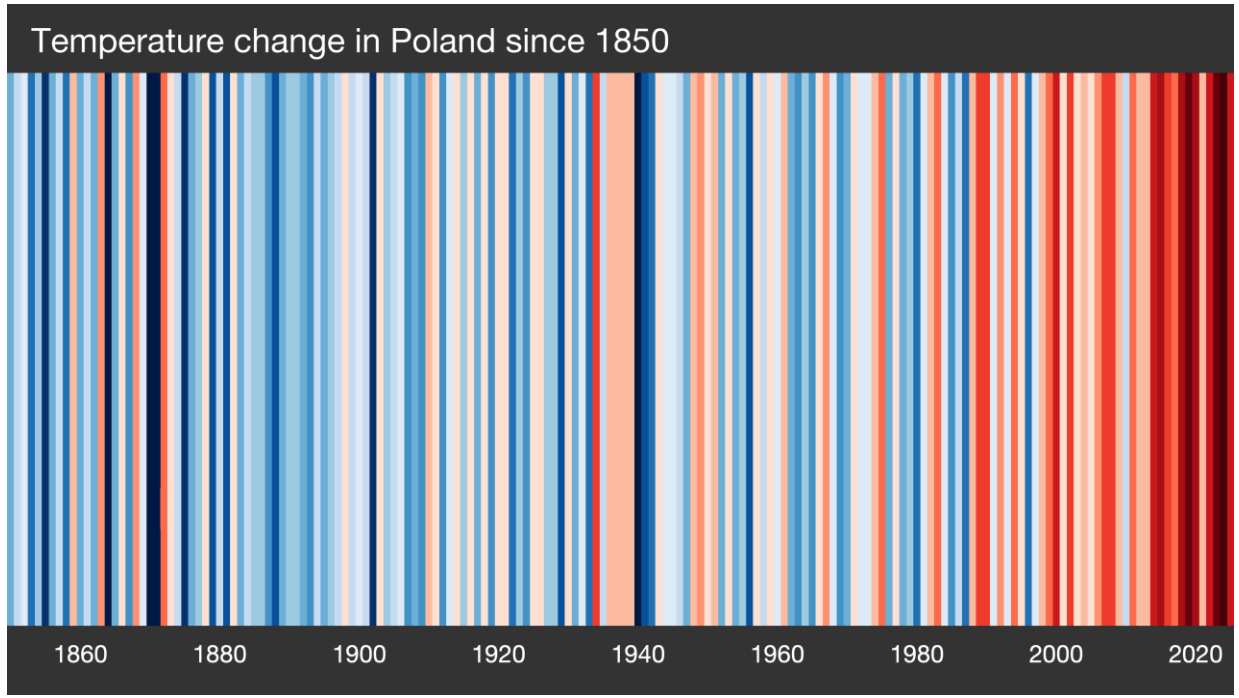


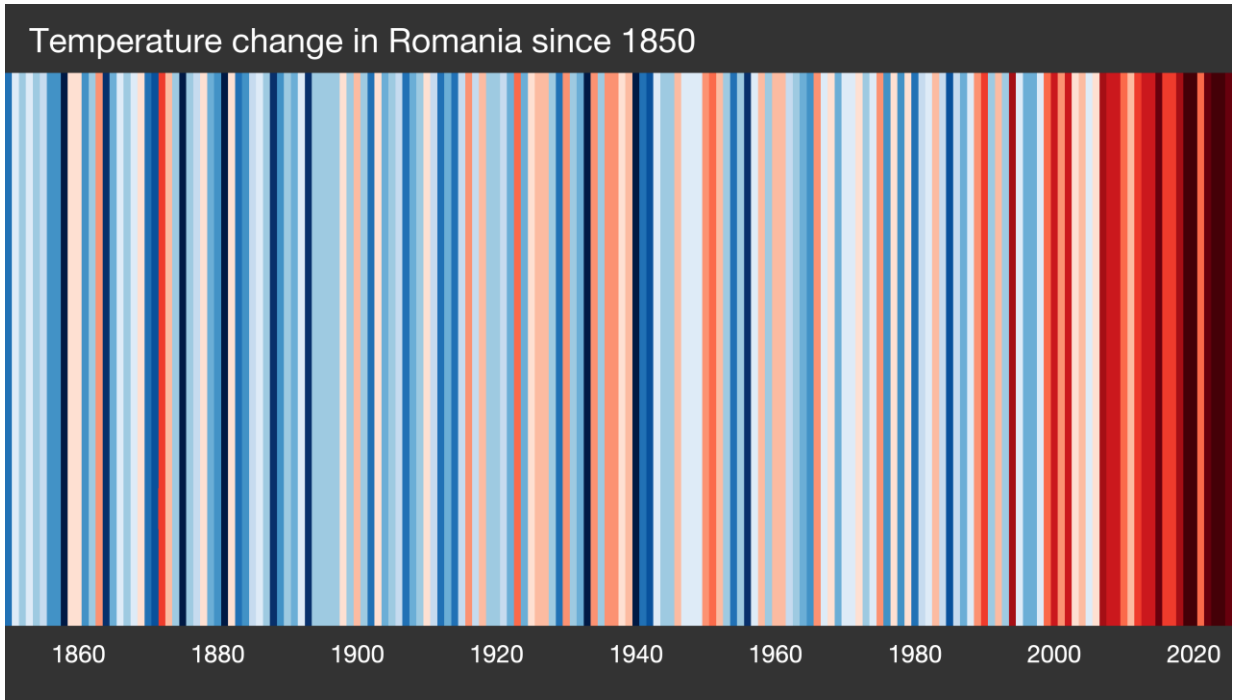
Europe

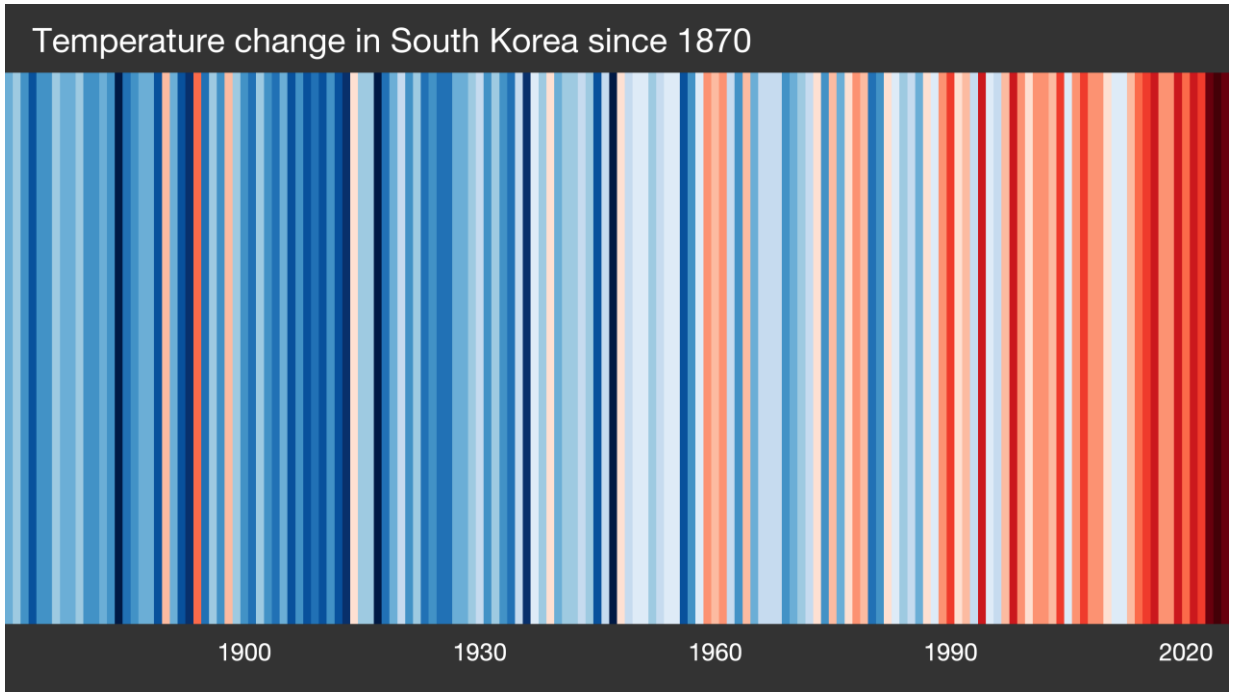


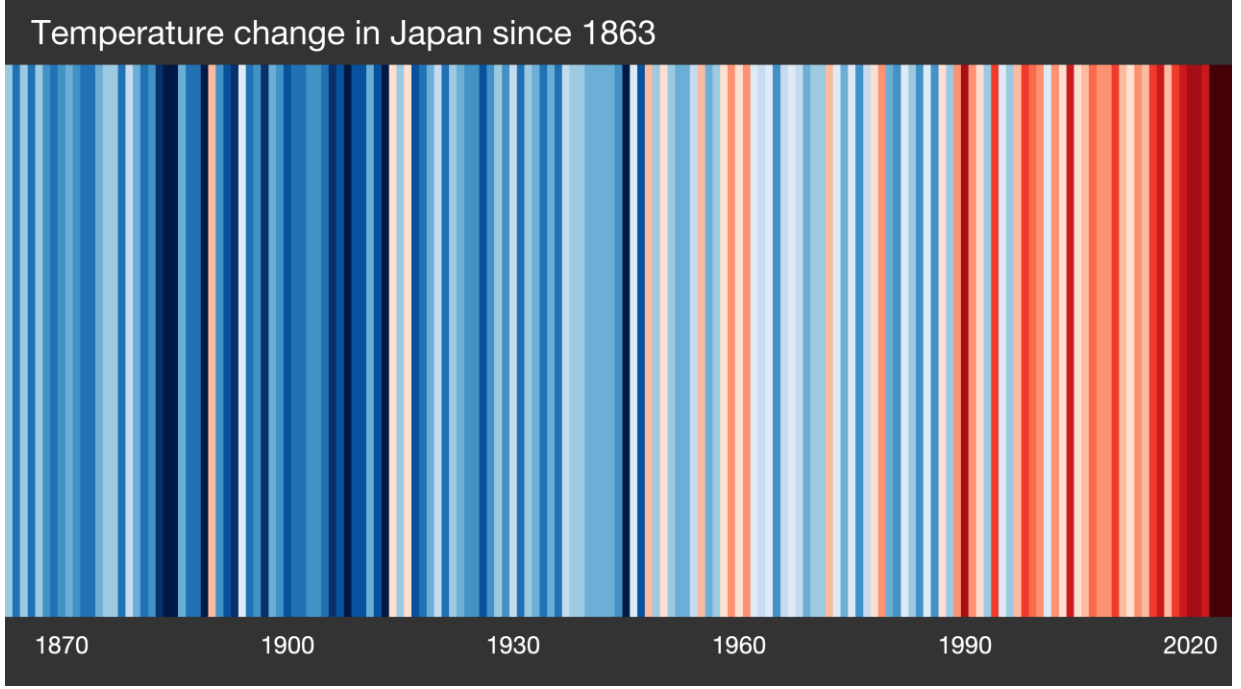
https://showyourstripes.info/l/globe

3


Temperature change in Poland since 1850
1860
1880
1900
1920
1940
1960
1980
2000
2020


Temperature change in Romania since 1850
1860
1880
1900
1920
1940
1960
1980
2000
2020

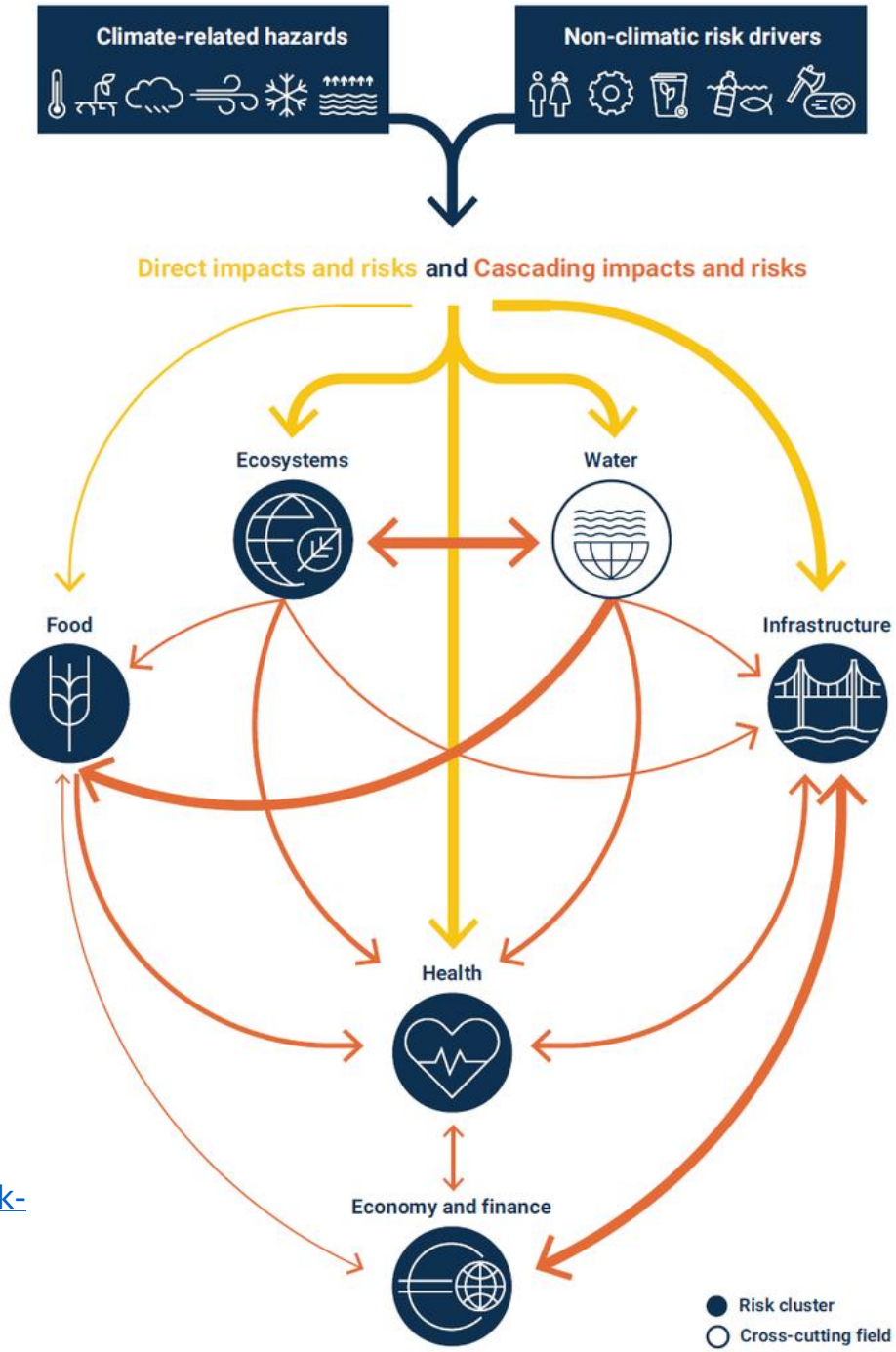

Temperature change in South Korea since 1870
1900
1930
1960
1990
2020


Temperature change in Japan since 1863
1870
1900
1930
1960
1990
2020

Climete change &weder ivents in Europe

- **Europe is the fastest-warming continent on Earth.** Over the past three decades, temperatures in Europe have increased more than twice as fast as the global average.

- **Climate change is increasing the frequency and intensity of many extreme weather events across Europe**, particularly heatwaves and heavy precipitation, while exacerbating drought risks in several regions.



https://climate-adapt.eea.europa.eu/en/eu-adaptation/assessing-climate-risks/climatic-risk-drivers?utm_source

https://climate.copernicus.eu/esotc/2025

LECTURE OVERVIEW

WATER RESILIENCE IN EUROPE

KEY CHALLENGES · POLICIES · STRATEGIES

WATER

ECONOMY

ECOSYSTEMS

Water · Economy · Ecosystems

01 · CHALLENGES

Too much water. Too little water.

DROUGHT + SCARCITY

Low river flows
Depleted soil moisture
Competing water demand

FLOODS + EXTREME RAIN

Overloaded drainage
River overflows
Critical service disruption

Can the same region experience both extremes in one year?

Water scarcity affects much of Europe

32%

EU population affected in at least one quarter of 2023

28%

EU land area affected in at least one quarter of 2023

Water Exploitation Index Plus (WEI+)

Above 20%: water stress

Above 40%: severe stress

Source: EEA, 2023 seasonal WEI+ data

01 · CHALLENGES

Water scarcity patterns differ by region

SOUTHERN EUROPE	Irrigation, tourism, persistent drought
CENTRAL EUROPE	Seasonal drought, flood variability, retention
NORTHERN / ATLANTIC	Local stress in cities and coastal areas



Impact of climate change in different regions of Europe

01 · CHALLENGES

Poland and Climate Risk Challenges

COUNTRY PERSPECTIVE

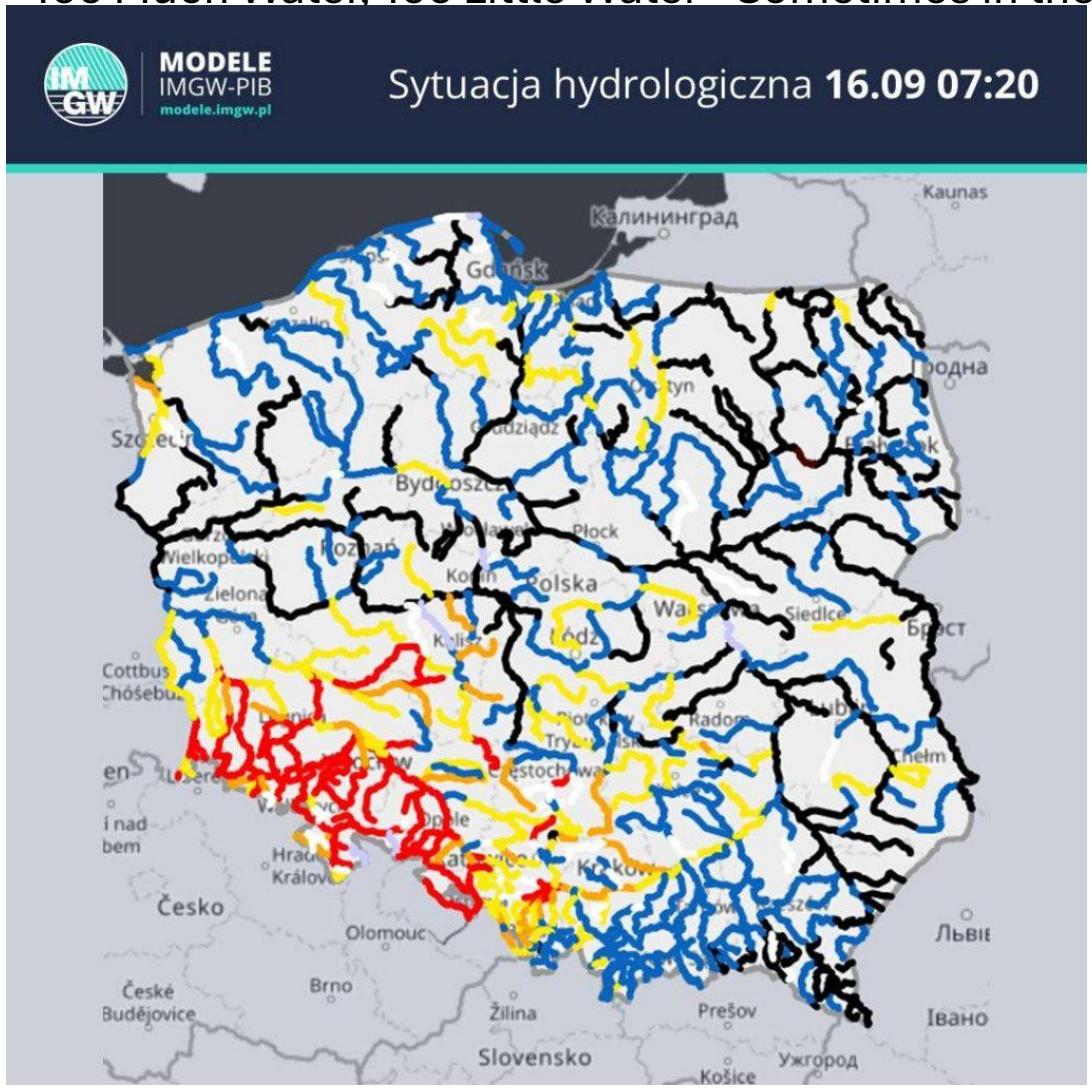
FLOODS

DROUGHTS

HYDROLOGY

Floods · Droughts · Changing hydrological conditions

Too Much Water, Too Little Water - Sometimes in the Same Place

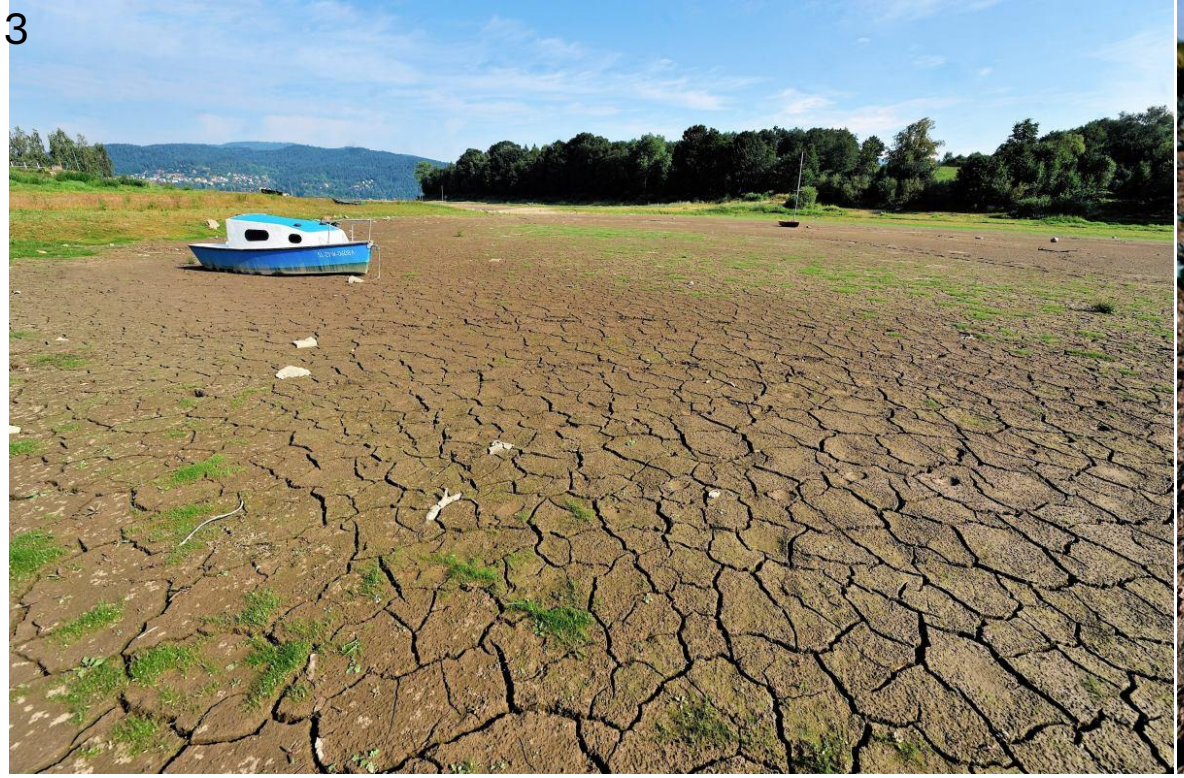


2024





FLOOD IN POLAND 2024



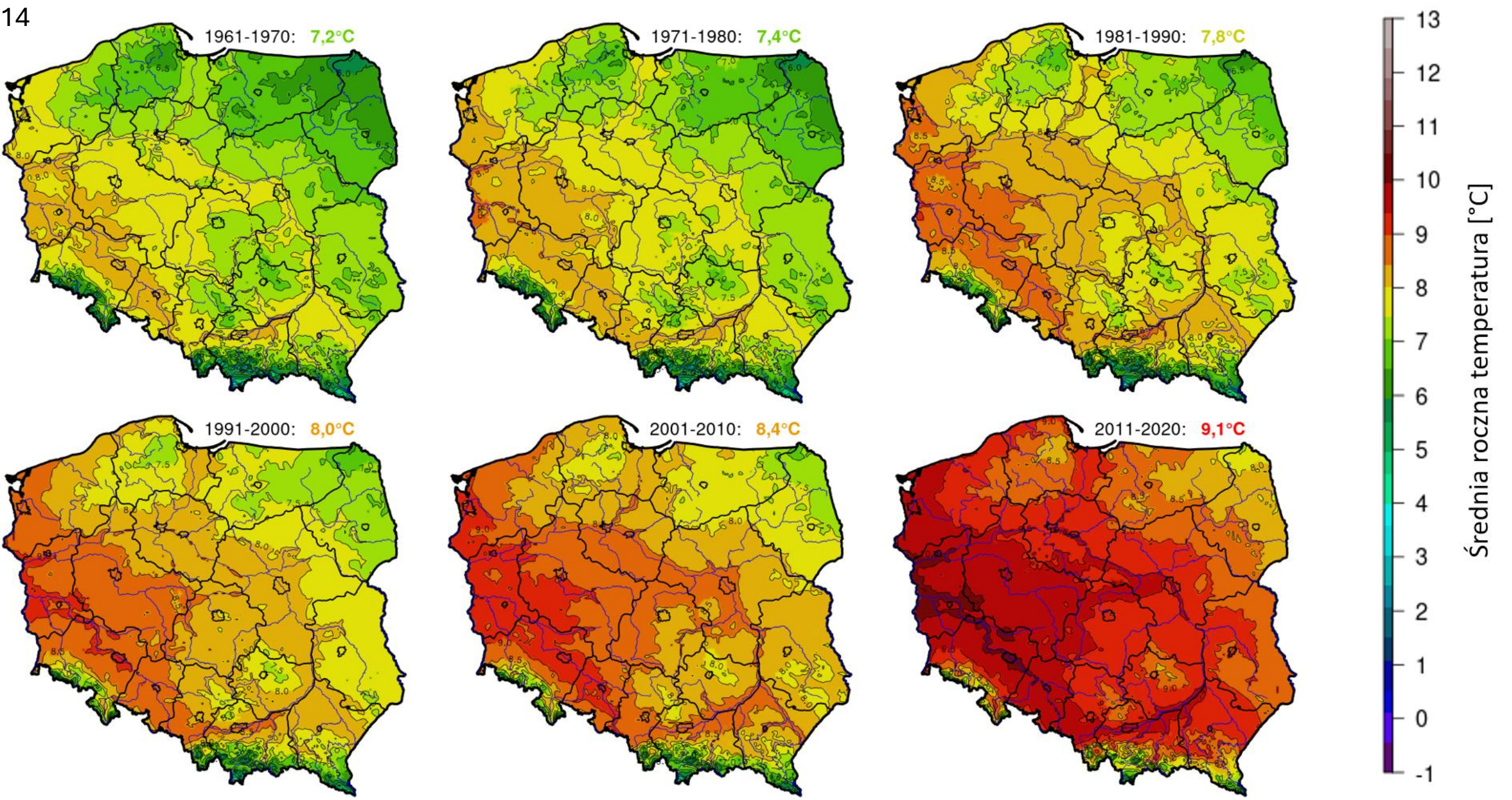
Żywiec artificial lake summer 2026



Poland summer 2026



Żywiec artificial lake summer 2015



CHANGES IN THE ANNUAL AVERAGE TEMPERATURE ON THE MAP OF POLAND

Europe and Climate Risk Challenges

EUROPEAN PERSPECTIVE

HAZARDS

EXPOSURE

VULNERABILITY

Spatial exposure · Economic losses · Water scarcity

Flood risk is more than a physical hazard

HAZARD

Floods and intense rainfall

×

EXPOSURE

Assets located in harm's way

×

VULNERABILITY

Sensitivity and low coping capacity

Higher risk can arise even without a stronger flood hazard.

Climate extremes impose large economic losses

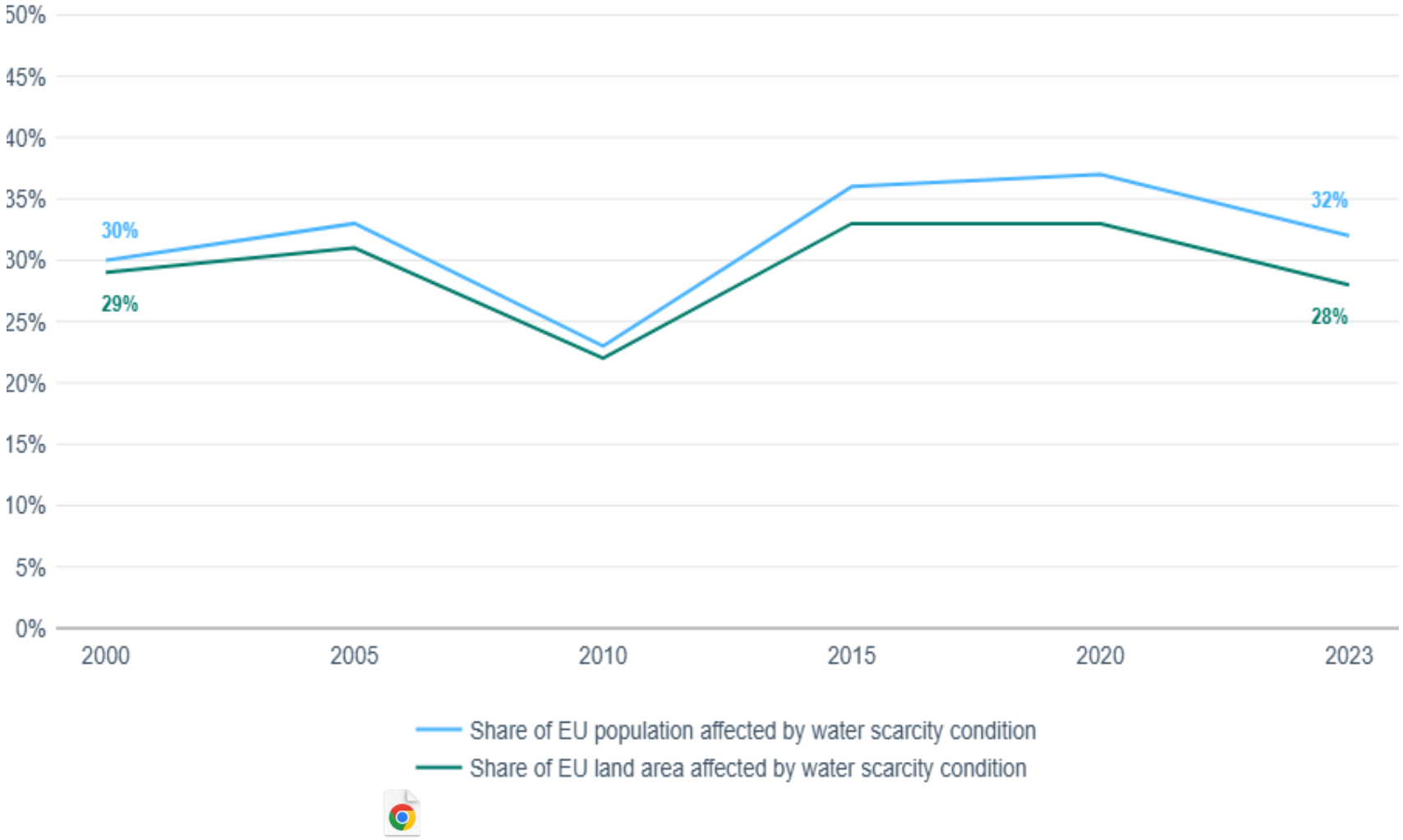
€822bn

Estimated EU losses
1980–2024

Illustrative composition by hazard



Area and population affected during at least one quarter of the year by water scarcity conditions in the EU, measured by the water exploitation index plus



Water scarcity conditions in Europe _ Indicators _ European Environment Agency (EEA).html

The Water exploitation index plus (WEI+) measures **water consumption** as a percentage of renewable freshwater resources at river basin or subunit levels, across each quarter of the year.

WEI+ values above 20% indicate that water resources are under stress and therefore water scarcity conditions prevail. Values above **40% signal water stress is severe, and the level of freshwater use may be unsustainable**

Groundwater: a hidden pillar of security

≈2/3

of EU drinking water supplied by groundwater

77%

groundwater body area in good chemical status

91%

groundwater body area in good quantitative status

Major pressures

Nitrates and pesticides | Over-abstraction | Slow aquifer recovery

Source: EEA, Europe’s State of Water 2024

A water hazard can disrupt an entire economy

CLIMATE	WATER SYSTEM	INFRASTRUCTURE	ECONOMY	SOCIETY
Drought or intense rain	Scarcity or flooding	Service disruption	Production losses	Health and inequality

Resilience planning must address cascading failures.

Water security and water resilience are different

WATER SECURITY

Are water needs met?

Availability · Quality
Access · Affordability

WATER RESILIENCE

Can the system cope with shocks?

Absorb · Recover
Adapt · Transform

Security is a condition. Resilience is a capability.

Three capacities of a resilient water system

01

ABSORB

Maintain essential functions

Emergency storage and backup

02

ADAPT

Adjust to changing conditions

Flexible operating rules

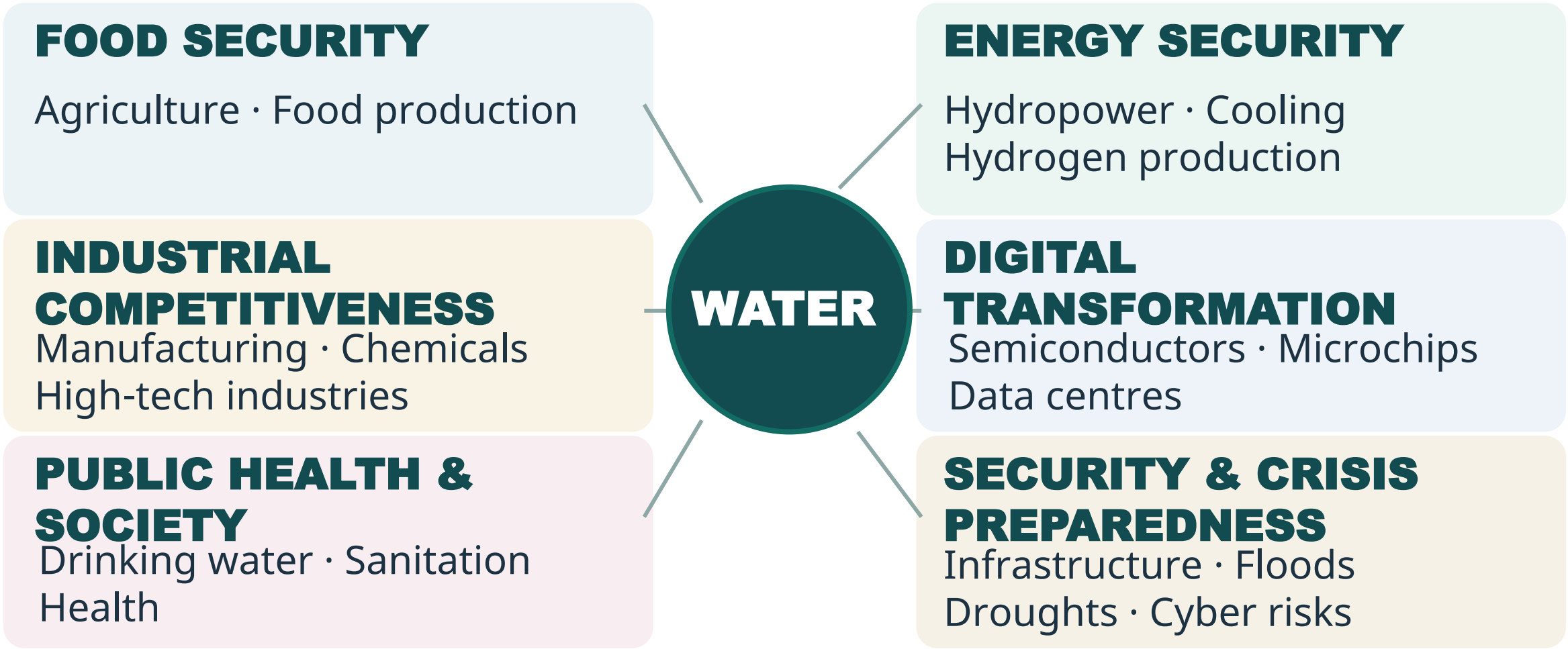
03

TRANSFORM

Change the development path

Land use and river restoration

Water as a critical resource for Europe



03 · EU POLICY

Existing EU Regulations Remain in Force

REGULATORY FOUNDATIONS

PROTECTION

IMPLEMENTATION

RESILIENCE

From water protection towards systemic resilience

Governance operates across different scales

RIVER BASIN

Hydrology, water allocation, ecological flows

COUNTRY / REGION

Laws, rights, public funding, risk management

CITY / UTILITY

Land use, leakage, drainage, emergency response

EU water policy: from protection to resilience

2000	**Water Framework Directive**	Water status and river basins
2007	**Floods Directive**	Flood risk management
2020	**Water Reuse Regulation**	Minimum reuse requirements
2025	**Revised wastewater rules**	Treatment and pollutants
2025	**Water Resilience Strategy**	System-wide priorities

Water Framework Directive: the river-basin cycle

ASSESS → PLAN → ACT → MONITOR

Core principles

Good water status · No deterioration · Public participation

Flood and drought planning must connect

FLOOD PLANNING

Hazard and risk maps
Exposure and vulnerability
Risk management plans

DROUGHT PLANNING

Water balance monitoring
Priority uses and allocation
Demand management

Shared levers: land use · storage · restoration · communication

The European Water Resilience Strategy (2025)

THREE STRATEGIC OBJECTIVES

01

RESTORE THE WATER CYCLE

Healthy ecosystems • natural retention • protection from pollution

02

BUILD A WATER-SMART ECONOMY

Efficiency • circularity • innovation • investment

03

CLEAN AND AFFORDABLE WATER

Reliable supply • sanitation • inclusion • preparedness

Restore natural systems + modernise the economy + protect people

Paradigm Shift [1]

Traditional water-management perspective	Water-resilience perspective after 2025
Provide sufficient water of appropriate quality for legitimate uses	Maintain the capacity of ecosystems, society and the economy to function despite changing water conditions
Water as an environmental/natural resource	Water as a critical resource
Environmental and utility policy	Security + economic + industrial + environmental + social policy
Respond to current demand	Manage future demand and risk
Supply–demand balancing	Water Efficiency First
Historical hydrological conditions	Climate scenarios, uncertainty and systemic risk

Paradigm Shift [2]

Traditional water-management perspective	Water-resilience perspective after 2025
Water infrastructure	Water system + ecosystems + land use + infrastructure
Water authorities and utilities	Whole-of-government and whole-of-society responsibility
Investment in additional supply	Demand reduction → efficiency → reuse → supply as last resort
Protect individual water bodies	Restore the entire water cycle, source-to-sea

The question is no longer only: “Do we have enough water?”
The question becomes: “Can Europe continue to function when water conditions change?”

Five enablers of the Water Resilience Strategy

GOVERNANCE	Coordination and implementation
FINANCE	Investment and affordability
DIGITAL	Better data and smart tools
INNOVATION	Research, skills and technology
PREPAREDNESS	Risk awareness and response

Water Efficiency First changes the investment question

SUPPLY-LED APPROACH

How can we provide more water?

EFFICIENCY-FIRST APPROACH

Do we really need more water?

DECISION-MAKING PRIORITY

1. **AVOID DEMAND**
2. **REDUCE DEMAND**
3. **IMPROVE EFFICIENCY**
4. **REUSE WATER**
5. **INCREASE SUPPLY**

Assess water balances, climate scenarios and vulnerability before expanding supply.

From managing water bodies to restoring the water cycle

INTEGRATED SOURCE-TO-SEA PERSPECTIVE

Catchment › Soil › Groundwater › River

Wetland › City › Coast › Sea

NATURE-BASED HYDROLOGICAL FUNCTIONS

Store | Slow | Infiltrate | Purify | Reuse | Release

Water security is also critical-infrastructure security

CLIMATE HAZARDS

Drought · Flood
Extreme heat

→

WATER SYSTEMS

Water supply
Wastewater ·
Reservoirs

→

SYSTEMIC IMPACTS

Energy · Food
Industry · Health

ADDITIONAL SECURITY THREATS

Cyberattacks · Sabotage · Deliberate contamination · Cascading failures

Water availability becomes an economic location factor

TRADITIONAL QUESTION

Where are labour, energy, infrastructure and markets?

→

NEW QUESTION

Will sufficient water be available under future climate conditions?

WATER-DEPENDENT INDUSTRIES

Semiconductors	Data centres	Hydrogen
Batteries	Energy	Food processing

Water resilience becomes part of industrial and spatial policy.

Water availability becomes an economic location factor

TRADITIONAL QUESTION

Where are labour, energy, infrastructure and markets?

→

NEW QUESTION

Will sufficient water be available under future climate conditions?

WATER-DEPENDENT INDUSTRIES

Semiconductors	Data centres	Hydrogen
Batteries	Energy	Food processing

Water resilience becomes part of industrial and spatial policy.

STRATEGIES

BUILDING WATER RESILIENCE

AVOID · SAVE

REUSE · RETAIN

DIVERSIFY

Demand management · Retention · Adaptation

A portfolio for drought and scarcity

AVOID DEMAND	Water-aware land use and crop choices
SAVE WATER	Network repairs and process efficiency
REUSE	Safe municipal and industrial reuse
RETAIN	Soils, wetlands, aquifers and recharge
DIVERSIFY	Additional supply when justified

Flood resilience needs a portfolio of measures

PREVENT

Risk-sensitive land-use planning

PROTECT

Levees, storage and diversion

ABSORB

Floodable public spaces

PREPARE

Warnings, response and insurance

Grey, blue-green and hybrid infrastructure

GREY

Pipes · tanks · channels

Defined hydraulic capacity

BLUE-GREEN

Wetlands · bioswales · parks

Multiple ecosystem services

HYBRID

Surface routes + engineered storage

Complementary performance

CASE STUDIES

RESILIENCE IN PRACTICE

NETHERLANDS

POLAND

SPAIN · CZECHIA

European approaches · Local solutions · Lessons learned

Four countries: four resilience approaches

NETHERLANDS	River flooding	Make more room for rivers
SPAIN	Water scarcity	Reuse treated wastewater
POLAND	Urban runoff	Restore retention and ecosystems
Czek Republic	Natural Wetland	Trast the nature

Netherlands: make room for the river





https://www.rijkswaterstaat.nl/en/projects/iconic-structures/room-for-the-river#new-approach-to-river-flooding

https://www.uu.nl/en/research/water-climate-and-future-deltas/storylines/flood-risk-management/integrated-flood-risk-management-in-practice/room-for-the-river

POLAND Krosno Odrzańskie

- presentation prepared by: Mayor Grzegorz Garczyński and Plenipotentiary for Climate Resilience Magdalena Bobryk, with the substantive support of Ilona Biedroń, PhD, Eng. from IMGW-PIB



https://renaturyzacja.imgw.pl/2026/03/26/wspolpraca-imgw-pib-z-samorzadami-wspolny-glos-o-bezpieczenstwie-wodnym-i-adaptacji-do-zmiany-klimatu/

Wetland restoration

- The Brdy region in the Czech Republic. **In 2018, a revitalization project was launched** in the local park, aimed at constructing and restoring vital wetlands-a project with a budget of 30 million crowns **(1.2 billion USD).** Planning, consultations, negotiations, and the processing of official documentation began.

- **Seven years** later, it turned out that all that effort had been for nothing: **a family of beavers** built the dams in just two days –

- in the perfect location,

- and completely free of charge







https://kopalniawiedzy.pl/wiadomosci/nauki-przyrodnicze/panstwo-nie-radzilo-sobie-przez-7-lat-bobry-zalatwily-problem-w-2-dni

Clker-Free-Vector-Images z Pixabay

© Archiv AOPK ČR

Spain: reclaimed water for agriculture

CASE 2 · WATER SCARCITY

WASTEWATER TREATMENT → **STORAGE** RESERVOIR → **PUMPING** SOLAR POWER → **FARMLAND** IRRIGATION

100,000

m^3/year additional reclaimed water

435

hectares served by the scheme

Investments for increasing the availability of reclaimed wastewater by the Campo Alto de Lorca irrigation community

- Additional reclaimed water supply: approximately 100,000 m^3/year
- Irrigated area supported: 435 hectares
- Infrastructure: storage reservoir, pumping station and pipeline
- Solar-powered pumping station



https://www.imcur.com/

https://eu-cap-network.ec.europa.eu/good-practice/investments-increasing-availability-reclaimed-wastewater-campo-alto-de-lorca_en

Digital tools support anticipatory decisions

01

OBSERVE

Sensors, meters, remote sensing

02

FORECAST

Hydrological and climate models

03

DECIDE

Early warning and operating rules

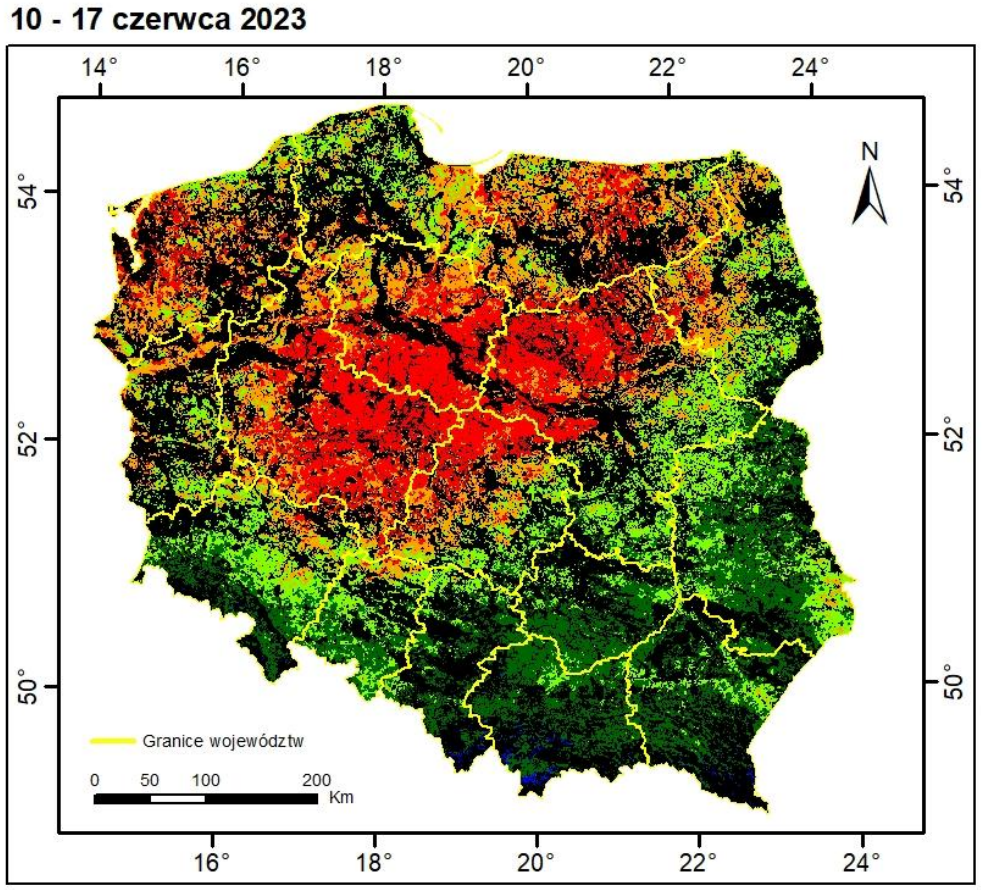
04

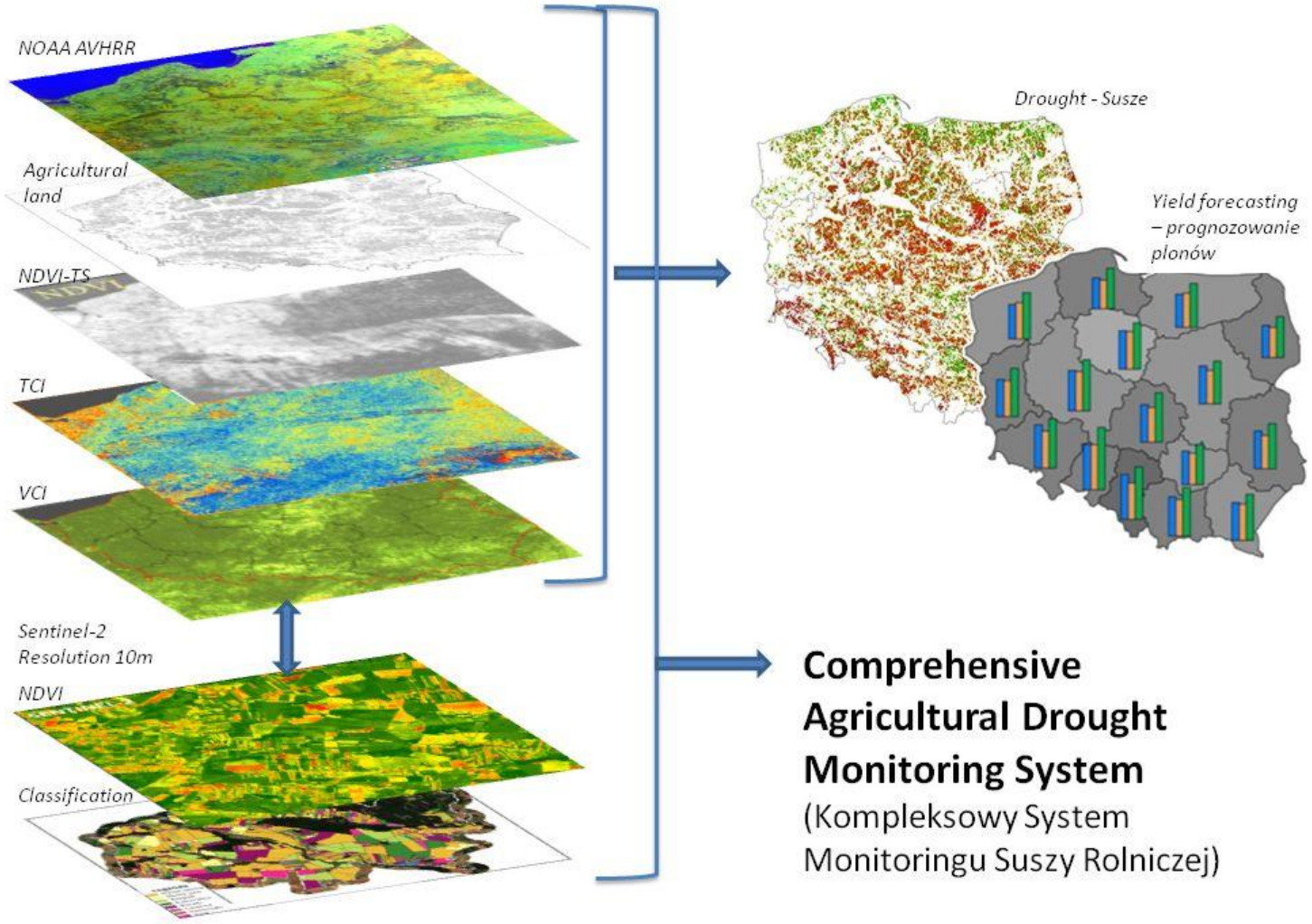
LEARN

Evaluate results and update plans

Better data cannot substitute for coordinated governance.

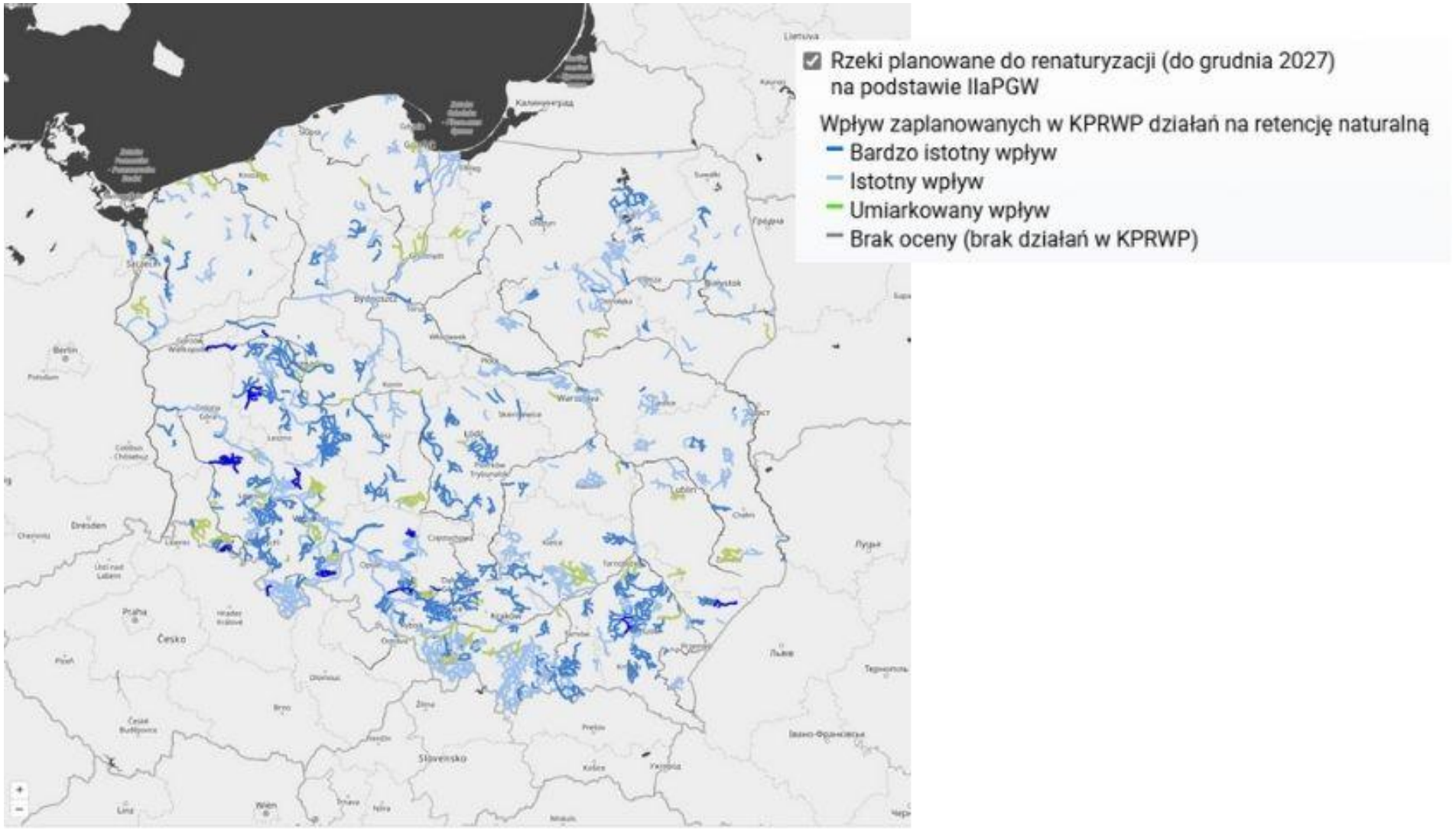
Drouth in Poland





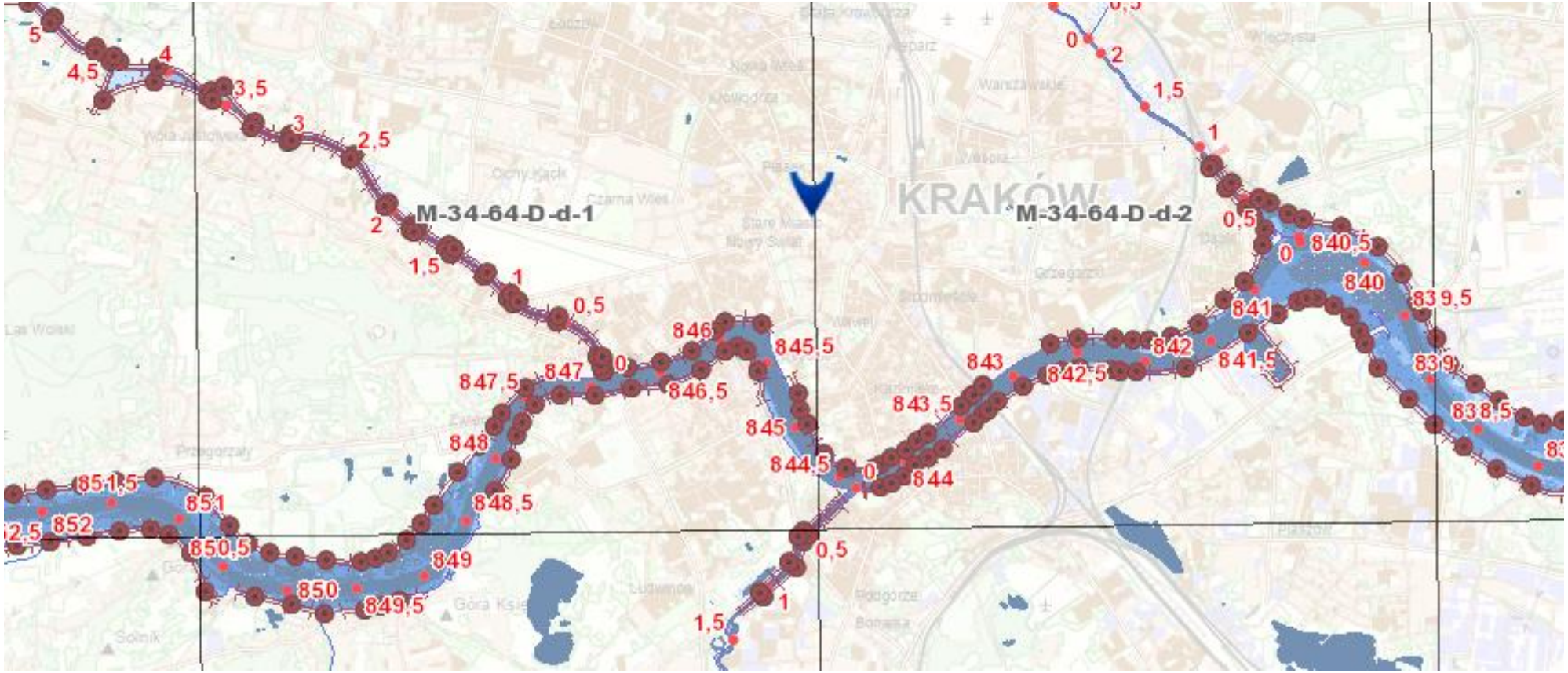
https://www.igik.edu.pl/pl/nauka-i-badania/obszary-badawcze/satelitarny-monitoring-suszy-rolniczej-i-redukcji-plonow/satelitarny-system-monitorowania-suszy-rolniczej/

Poland river renaturation program



- https://renaturyzacja.imgw.pl/serwis/?warstwy=dzialania-renaturyzacyjne-poligony,dzialania-renaturyzacyjne-linie,rzeki-do-renaturyzacji-do-grudnia-2027,dzialania-renaturyzacyjne-punkty

ISOK Internetowy System Osłony Kraju (Online Country Protection System)



https://wody.isok.gov.pl/imap_kzgw/?moduleId=gpMZP

ECONOMICS OF WATER RESILIENCE

FINANCING AND VALUATION

FINANCING

VALUATION

RISK

Investment · Risk · Long-term societal benefits

Financing water resilience: beyond public infrastructure

€55bn

Annual capital investment

€23bn

Estimated annual investment gap

€15bn+

EIB planned financing, 2025–2027

A DIVERSIFIED WATER-RESILIENCE INVESTMENT ECOSYSTEM

- Public & private finance
- Green & blue bonds
- Blended finance
- Water as a Service
- Nature credits
- Insurance & risk transfer

From historical hydrology to climate-informed decisions

CONVENTIONAL DESIGN

Historical rainfall
Historical flows
Past water demand

→

RESILIENCE-BASED APPRAISAL

Climate scenarios
Socio-economic change
Cascading risks

ROBUST DECISIONS UNDER UNCERTAINTY

The future cannot be designed from historical averages alone

The cost of action versus inaction

INVEST TODAY

Capital costs and maintenance
Land, monitoring and governance
Risk reduction and co-benefits

DELAY OR DO NOTHING

Expected flood and drought losses
Business and service interruption
Ecosystem degradation

Total Economic Value of nature-based solutions

DIRECT USE

Recreation and water supply

INDIRECT USE

Flood mitigation and purification

OPTION VALUE

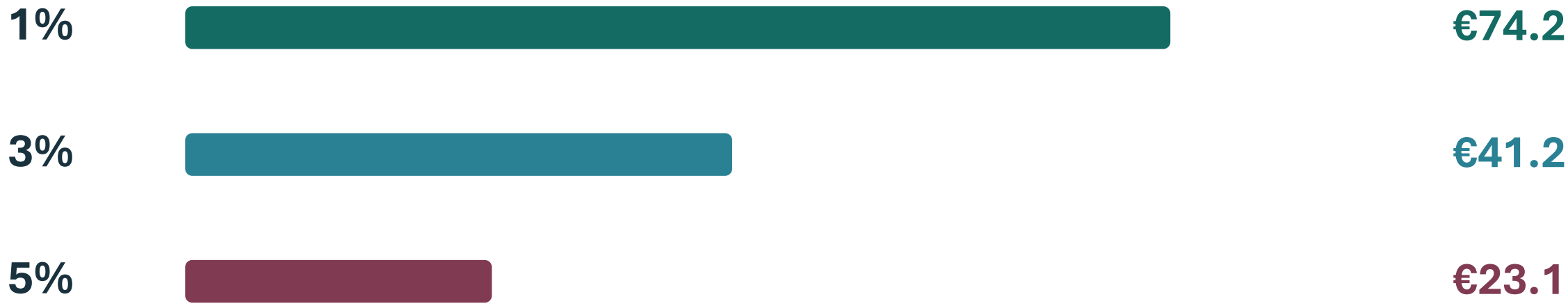
Future flexibility and potential use

NON-USE VALUE

Existence and bequest values

Discounting changes the weight of future benefits

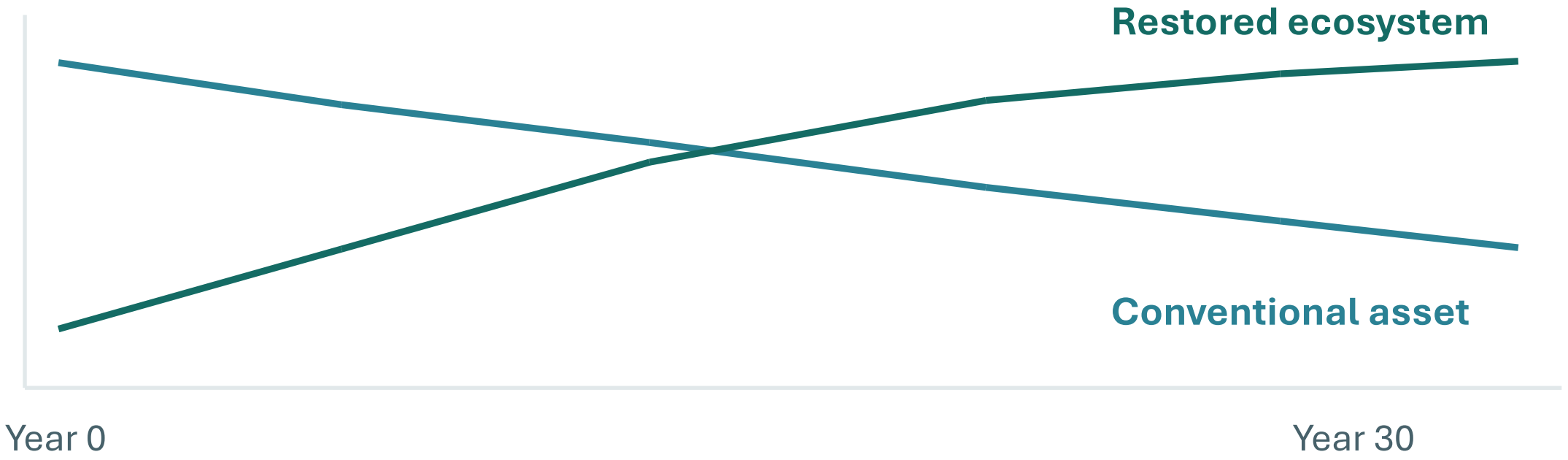
Present value of a €100 benefit received in 30 years



The social discount rate is an economic and ethical choice.

Residual value: depreciation versus maturation

Illustrative functional value over a 30-year horizon



Financing gap: who pays and who benefits?

WHO PAYS?

Municipal budgets
Water utilities
Private developers
EU and national programmes

WHO BENEFITS?

Households and businesses
Downstream communities
Ecosystems and visitors
Future generations

Positive economic NPV ≠ positive financial NPV.

Towards a water-resilient Europe

01	**RESILIENCE IS SYSTEMIC**	Water quantity, quality and economic activity are linked.
02	**INTEGRATED SOLUTIONS MATTER**	Policy, governance, technology and nature must work together.
03	**LONG-TERM VALUE MATTERS**	Account for future risks and multiple societal benefits.

Can Europe change how it values water?

Thank you for your attention

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Faculty of Finance
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05 · APPLIED DISCUSSION

How would you make a city water-resilient?

Flash floods increase. Summer droughts worsen. The budget is limited.

A Expand conventional drainage

B Invest in blue–green infrastructure

C Reduce water demand and losses

D Combine measures strategically

What evidence would you need before deciding?

REFERENCES

Selected sources and further reading

- EEA · Europe’s State of Water (2024)
- EEA · Water scarcity and WEI+
- European Commission · Water Resilience Strategy
- Commission Recommendation · Efficiency First
- Climate-ADAPT · Sokołówka River (Łódź)
- European Investment Bank · Water