Hydrology
of the Czech Republic

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Water on the Earth

- surface – 510 mil. km^2 – 360,7 mil. km^2 = 70,7% ocean

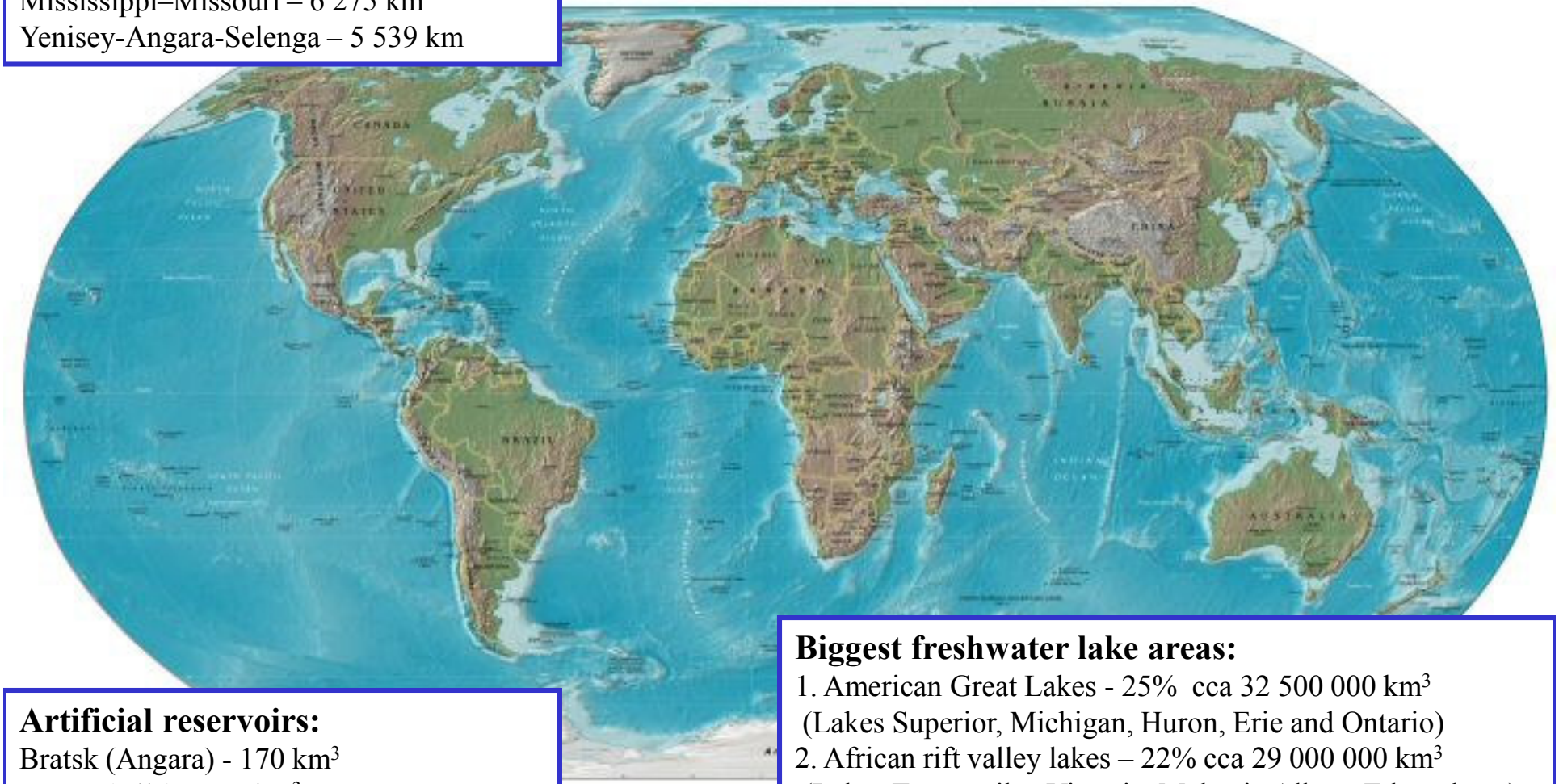
Components of hydrosphere	Volume [thousands of km^3]	% of total amount of water
Ocean	1 360 000	97,6784
Glaciers + permanent snow	24 000	1,7237
Atmosphere (to 11 km)	13	0,0009
Freshwater lakes	130	0,0093
Salt lakes	105	0,0075
Artificial reservoirs	6	0,0004
Wetlands	6	0,0004
Rivers	1,25	0,0001
Soil moisture	25	0,0018
Water in aeration zone	40	0,0029
Water in saturation zone	8000	0,5746
TOTAL WATER SUPPLY	1 392 325,25	100

- Freshwater – only 3% (glaciers 79%, underground 20%, surface 1%)

Water on the Earth

Longest rivers:
Amazon - 7 062 km
Nile – 6 695 km
Jang c'ťiang – 6 300 km
Mississippi–Missouri – 6 275 km
Yenisey-Angara-Selenga – 5 539 km

Biggest glaciers:
Antarctica + Greenland = 98%
Himalayas, Pamir, Cordillera and others only 2%



Artificial reservoirs:
Bratsk (Angara) - 170 km^3
Asuan (Nile) - 169 km^3
Kariba (Zambezi) - 160 km^3

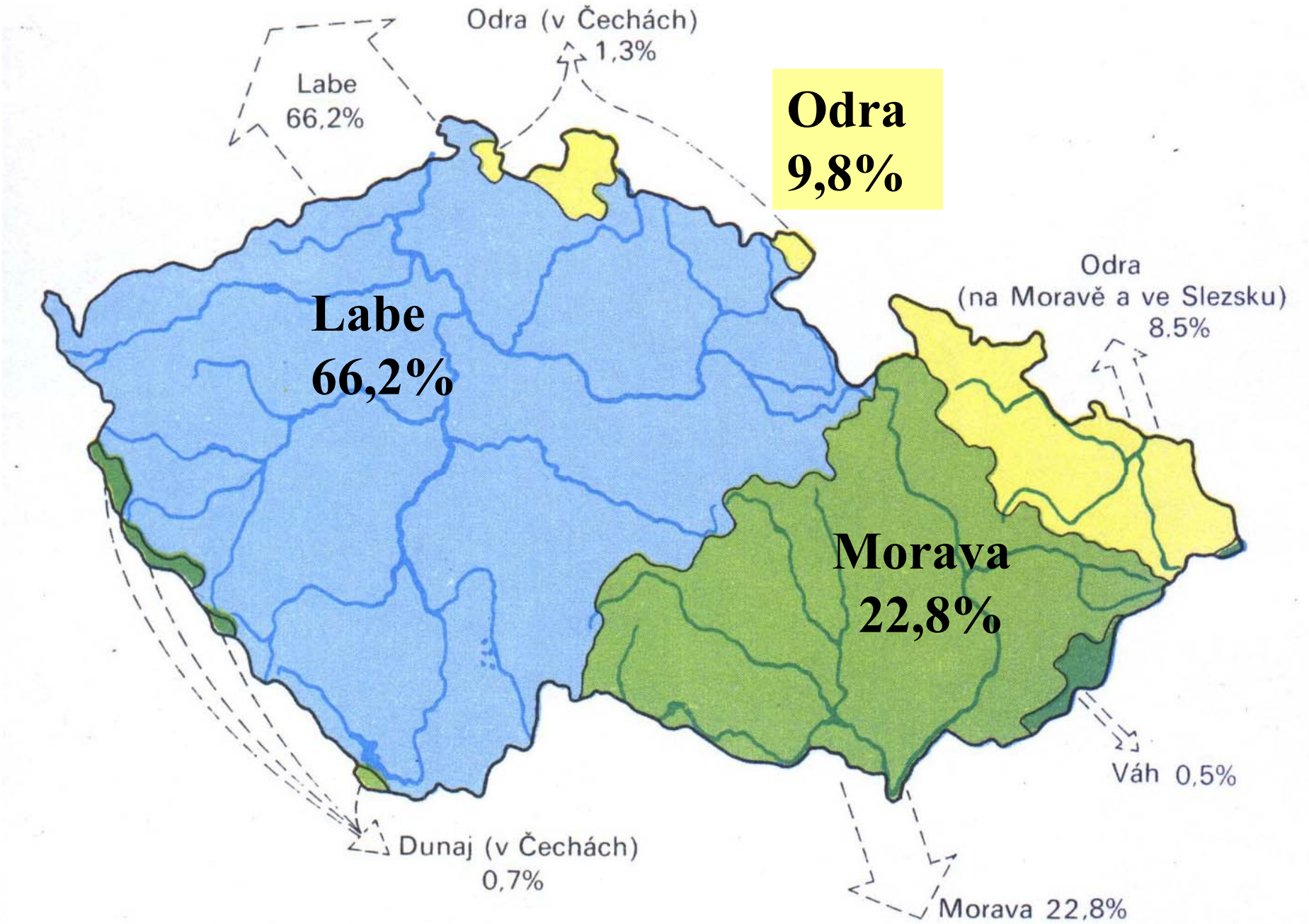
Biggest freshwater lake areas:
1. American Great Lakes - 25% cca 32 500 000 km^3
(Lakes Superior, Michigan, Huron, Erie and Ontario)
2. African rift valley lakes – 22% cca 29 000 000 km^3
(Lakes Tanganyika, Victoria, Malawi, Albert, Edward etc.)
3. Baikal Lake – 18% cca 21 500 000 km^3

Basic hydrographic characteristics of Czechia

- Czechia is situated in central Europe in the source area of European rivers (we are on the roof of Europe)
- Main European watershead contour come through Czechia

  – 3 separate sea-drainage areas:

North sea – catchement of Labe	**66,2%**
Black sea – catchement of Dunaj	**24,0%**
Baltic sea – catchement of Odra	**9,8%**


Odra (v Čechách)
1,3%
Labe
66,2%
Odra
9,8%
Odra
(na Moravě a ve Slezsku)
8.5%
Labe
66,2%
Morava
22,8%
Váh 0,5%
Dunaj (v Čechách)
0,7%
Morava 22,8%

Hydrographic and water management review

Total lenght of streams in Czechia	**76 000 km**
- basic net of streams (over 5 km²)	36 865 km
Streams important for water management	16 700 km
Small streams	59 300 km
Modified streams – 25% from total lenght	18 784 km
Lenght of artificial canals	578 km
Lenght of flood banks	586 km
Total volume of 114 big reservoirs (over 1000 m³)	**3,141 km³**
- water-supply reservoirs	0,934 km³
Total area of reservoirs (including small water bodies)	264 km²

Name	Area [ha]	Depth	Volume [km³]	Year	River
Orlík	2545,54	74	0,717	1960	Vltava
Lipno I	4909,76	22	0, 306	1957	Vltava
Nechranice	1307,77	46	0, 288	1968	Ohře
Slapy	1241,15	58	0, 269	1955	Vltava
Švihov	1337,55	55,7	0, 266	1968	Želivka

The biggest rivers of Czechia

River discharge ($m^3.s^{-1}$)

Labe (Elbe)	308
Vltava (Moldau)	150
Morava	115
Dyje (Thaya)	44,1
Odra (Oder)	43,3
Ohře (Eger)	**3**7,9
Berounka	36,0
Otava	26,0
Sázava	25,5
Lužnice	24,4
Jizera	24,0

Lenght of rivers (km)

Vltava	433
Labe	357
Morava	352
Dyje (Mor.)	304
Ohře	291
Berounka (Mže)	239

European largest river basins

(without Russian rivers)

Dunaj	817 000 km^2
Visla	194 000 km^2
Rýn	183 000 km^2
Labe	148 268 km^2

Division of the Labe River

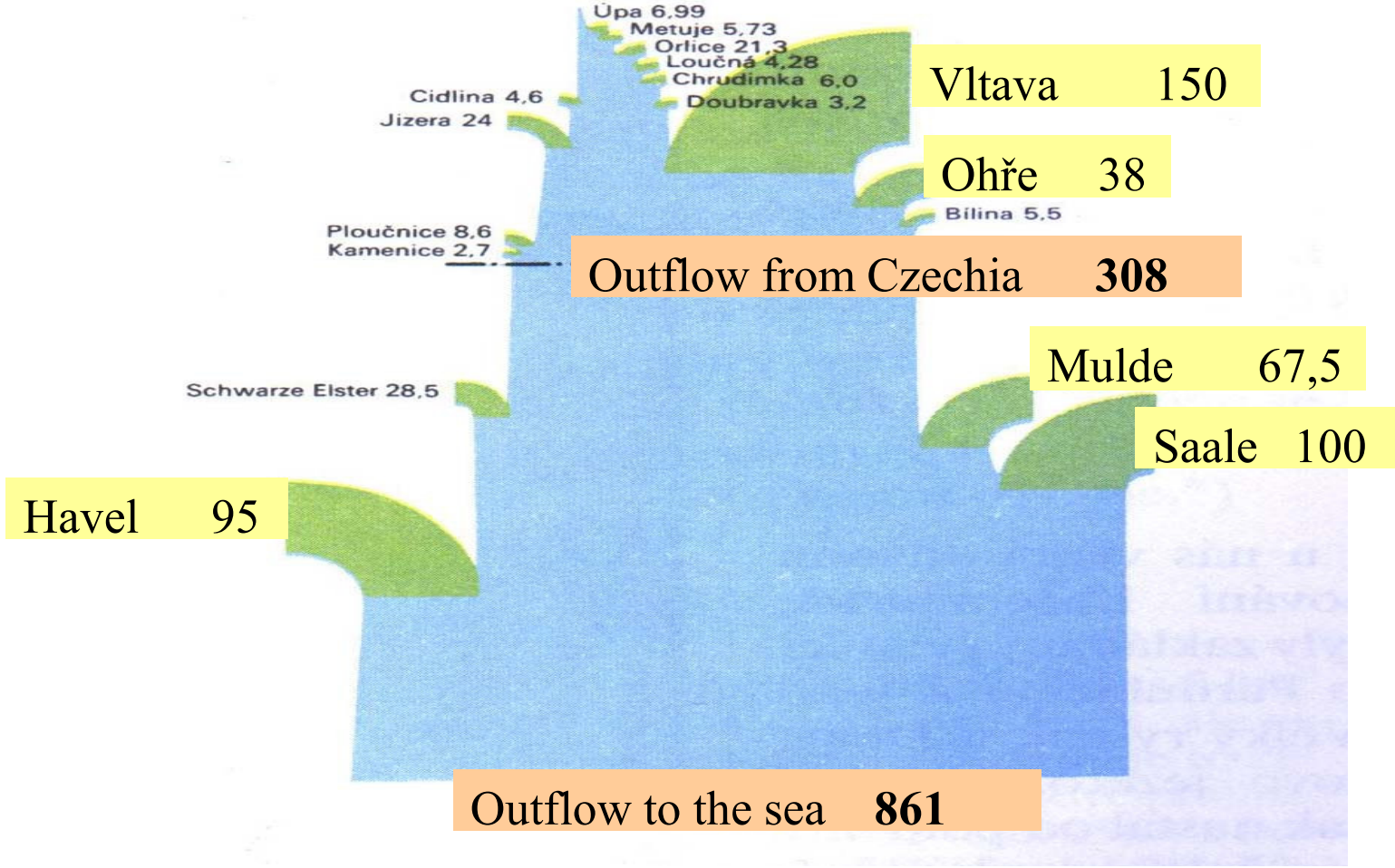
Upper Labe River (Hirschstein) - 463 km
Middle Labe River (Geesthacht) - 489 km
Lower Labe River (North Sea) - 142 km

Spring of the Elbe River

Krkonoše (Giant Mts.)
1 384 m a.s.l.
Labská louka (the Elbe meadow)
Water level obseravtions since 1851 – in Děčín

the Labe River – growth of discharge[$m^3.s^{-1}$]

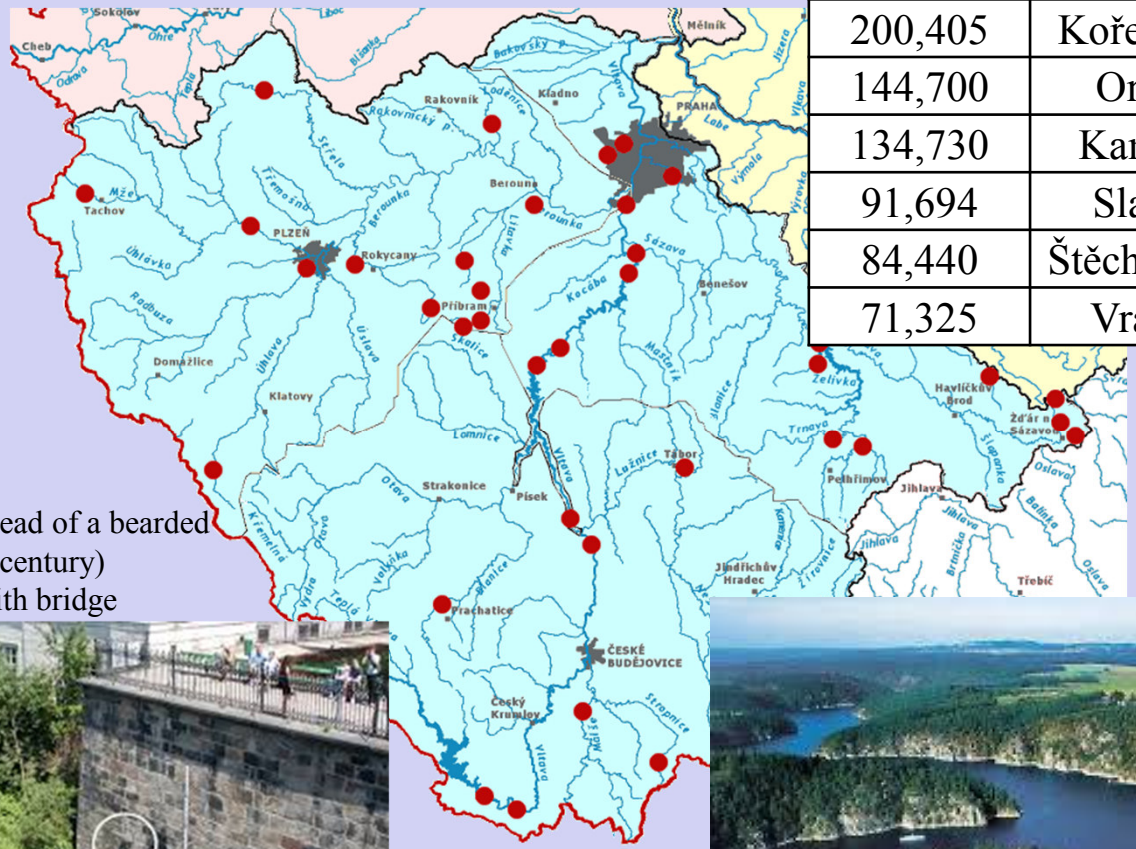
	Vltava - mouth	Labe – confluence with Vltava	Labe - state border	Labe - North Sea
Length [km]	433	235	357	1094
Discharge [$m^3.s^{-1}$]	150	100	308	861
Area [km^2]	28 090	13 714	51 394	148 268



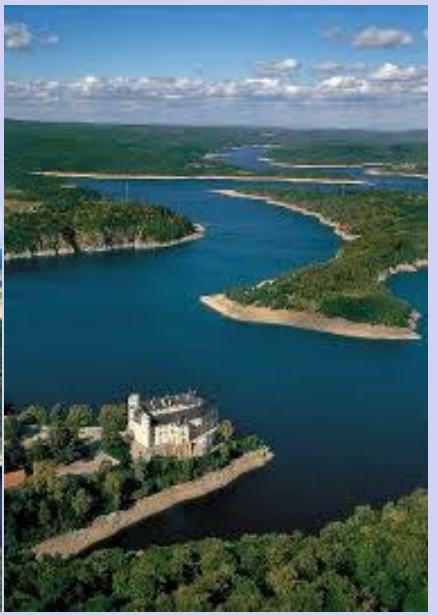
the Vltava River - dams

- Czech longest river - 433 km
- Spring - 1 172 m a.s.l. Šumava Mts.
- „Vltava Cascade“ 9 dams
- regular water level observation in Prague since 1825

River km	Name	Building	Volume tis. m³
329,540	Lipo I	1952–1959	306 000
319,120	Lipno II	1952-1959	1 685
210,390	Hněvkovice	1986–1992	21 100
200,405	Kořensko	1986–1991	2 800
144,700	Orlík	1954–1966	720 000
134,730	Kamýk	1956–1962	12 800
91,694	Slapy	1951–1954	270 000
84,440	Štěchovice	1937–1945	11 200
71,325	Vrané	1930–1936	11 100



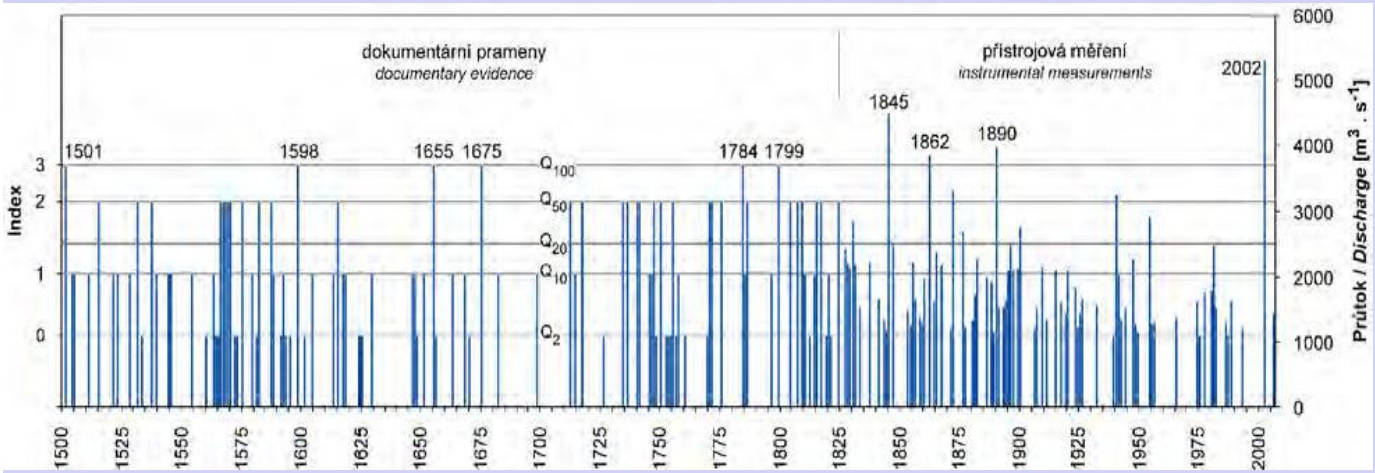
Bradáč – head of a bearded man (12th century) - from Judith bridge



the Vltava River - floods

Floods in Prague

- August 2002: max. discharge - 5 300 $m^3.s^{-1}$, max. water level – 785 cm
- July 2013: max. discharge – 3 210 $m^3.s^{-1}$, max. water level - 545 cm



http://www.geoportalpraha.cz/uploads/assets/video-povoden/povoden.html

Drought

Characteristics

- a random natural phenomenon caused mainly by rainfall deficit leading to a significant drop in water in various parts of the hydrological cycle (in the atmosphere, soil, watercourses, underground structures) and subsequently also in water resources
- water scarcity = water use requirements exceed available water resources

Types

- ***Meteorological*** - a prolonged time with less than average precipitation; precedes the other kinds of drought
- ***Hydrological*** - water reserves (aquifers, lakes, rivers and reservoirs) below a locally significant threshold (e.g. Discharge Q_{355} in 3 days); show up slowly; anthropogenic measures (landuse, wetland drainage etc.) can improve or worsen the situation

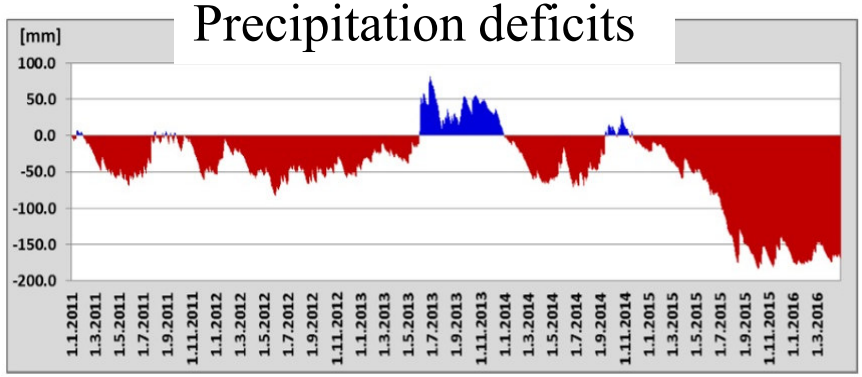
- ***Agricultura***l - soil drought, lack of moisture for crops; crop production affected; after meteorologicalvdrought; important role of agricultural management
- ***Socioeconomic*** – economic activities limited as a result of meteorological, agricultural or hydrological drought

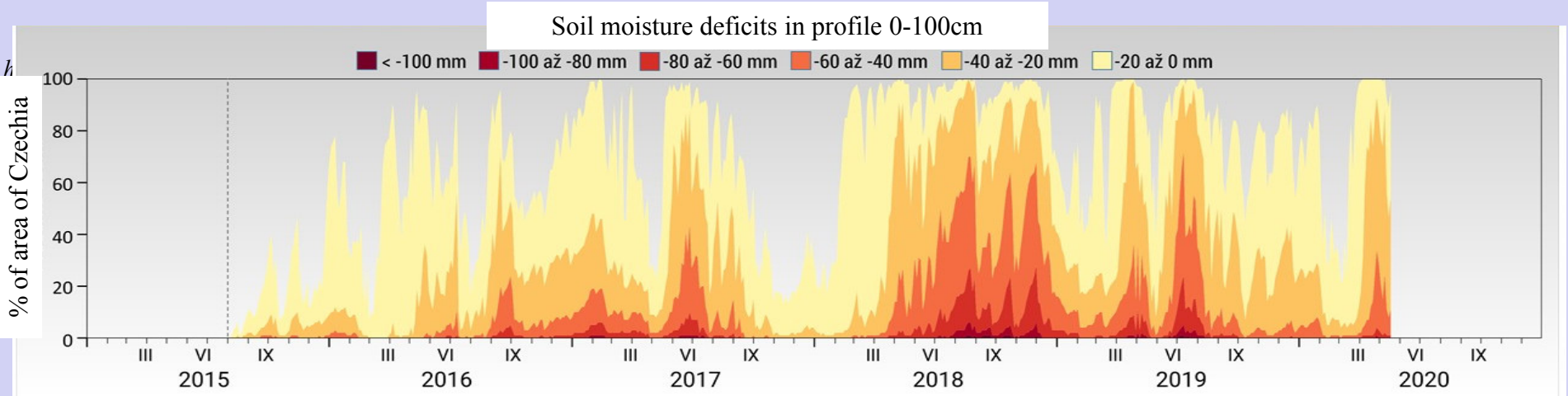
Prevention: landuse, water bodies, wetlands

Drought

The driest years in Czechia *(based on meteorological and hydrological observations, since the 20.century)*

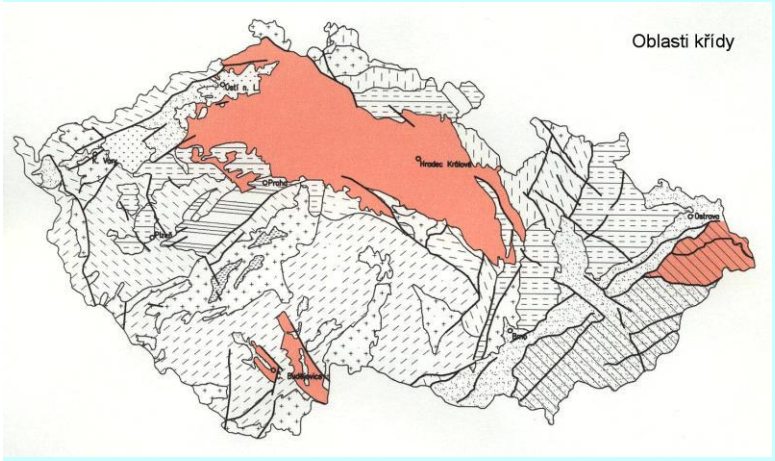
- *1904*
- *1911- summer lack of rainfall and higher temperatures*
- *1917*
- ***1947!! - lack of rainfall and higher temperatures from April to October***
- ***1953-1954!!! - March 53 and from August to March 54 – lack of precipitation, very cold winter***
- *1959 - lack of precipitation in autumn*
- *1992*
- *2000 - lack of precipitation in spring with higher temperatures for the whole year*
- *2003 - lack of precipitation from February to September with high temperatures – also in Europe*
- ***2015 - summer and autumn, lack of precipitation from the beginning of the year, high temperatures, lack of snow, consequences several years***
- ***2018! - from April to November 2018, in lowlands till autumn 2019, low precipitation, high temperatures, problems in agriculture, water supply – private wells, measures taken for the population e.g.: ban on filling the pools, garden watering…***

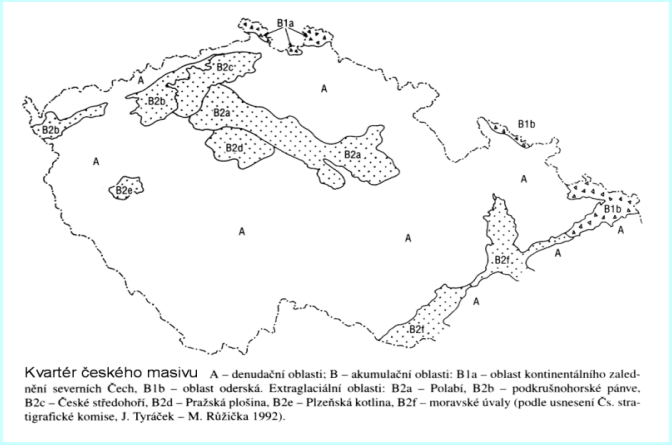




Outflow characteristics of Czechia

Average annual outflow from Czechia = O	**15,1 km³**
Hs = average annual sum of precipitation (1 mm = 1 litre on 1 m²)	679 mm
Ho = average anuual sum of surface outflow	189 mm
(Ho = O/P – P of Czechia = 78 000 km²)	
C = outflow coeficient (c = Ho/Hs*100)	27,8 %
Extreme dry years (1947)	436 mm





Kvartér českého masivu A – denudační oblasti; B – akumulační oblasti: B1a – oblast kontinentálního zaledněni severních Čech, B1b – oblast oderská. Extraglaciální oblasti: B2a – Polabí, B2b – podkrušnohorské pánve, B2c – České středohoří, B2d – Pražská plošina, B2e – Plzeňská kotlina, B2f – moravské úvaly (podle usnesení Čs. stratigrafické komise, J. Tyráček – M. Růžička 1992).

Annual capacity of underground resources	**1,44 km³**
Cretaceous sediments (Mesozoic era)	0,44 km³/year
Quaternary sediments	0,42 km³/year
Other (84% of area)	0,58 km³/year

Density of hydrological network

- most of the rivers in the Czechia **0,1–3 km·km^{-2}**
  (average **~ 1 km·km^{-2}**)
- **data for catchments of following rivers:**

Labe 1,2 km·km^{-2}

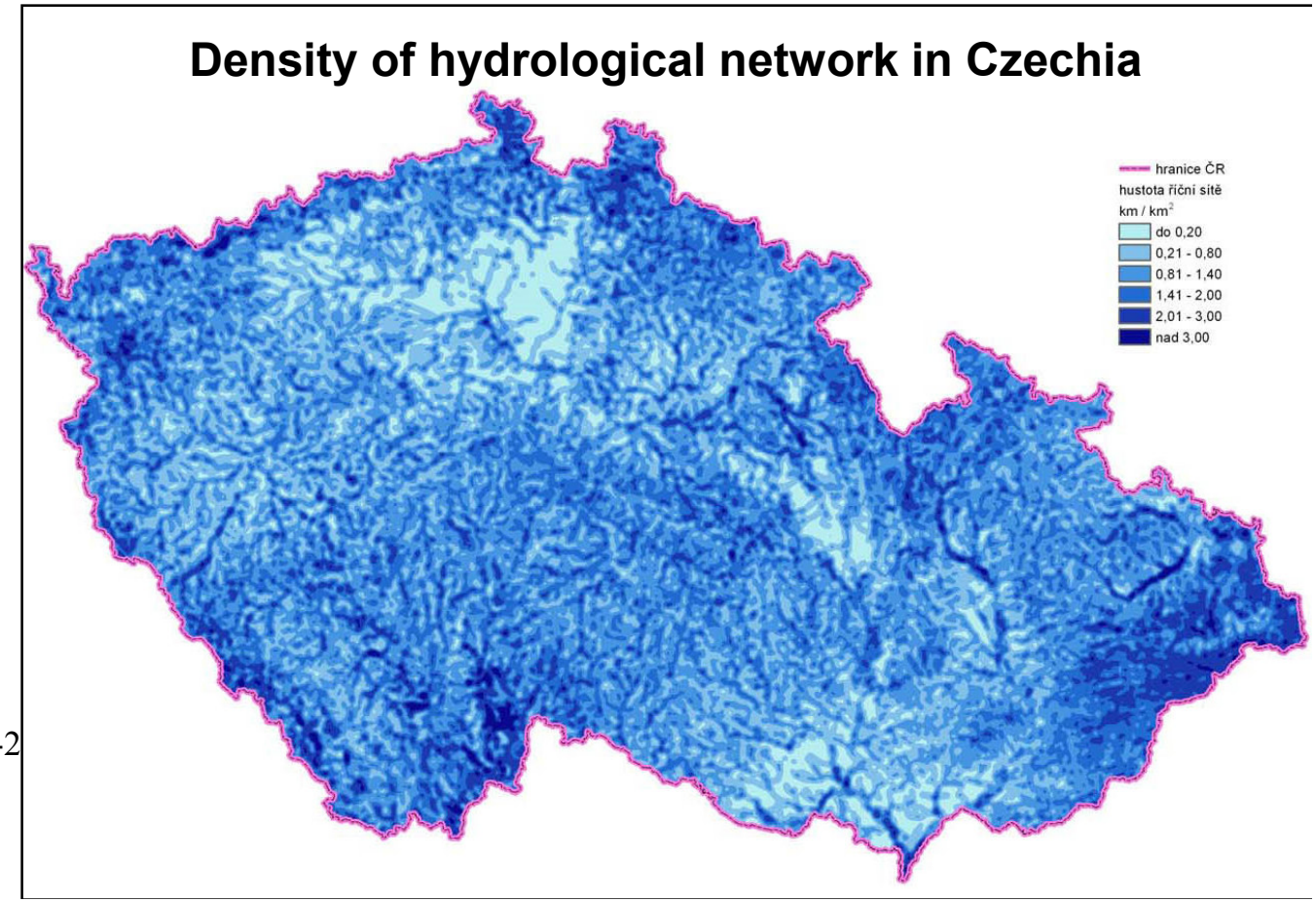
Morava 1,1 km·km^{-2}

Odra 1,5 km·km^{-2}

- mountain areas:
  1,5–3 km·km^{-2}
- lowland areas:

~ 0,1 km·km^{-2}

(lower Dyje < 0,2 km·km^{-2}
Pšovka < 0,1 km·km^{-2})

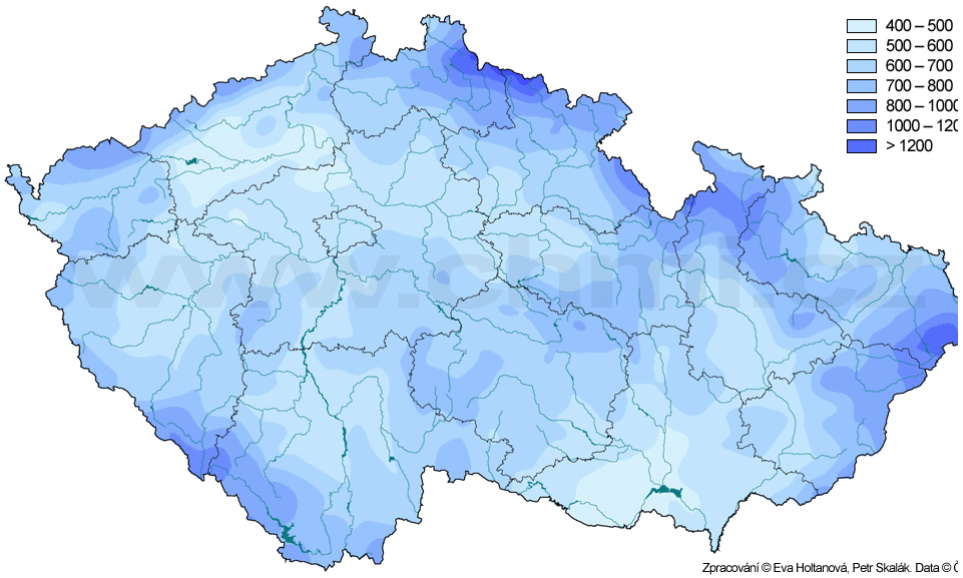


Outflow characteristics of Czech rivers

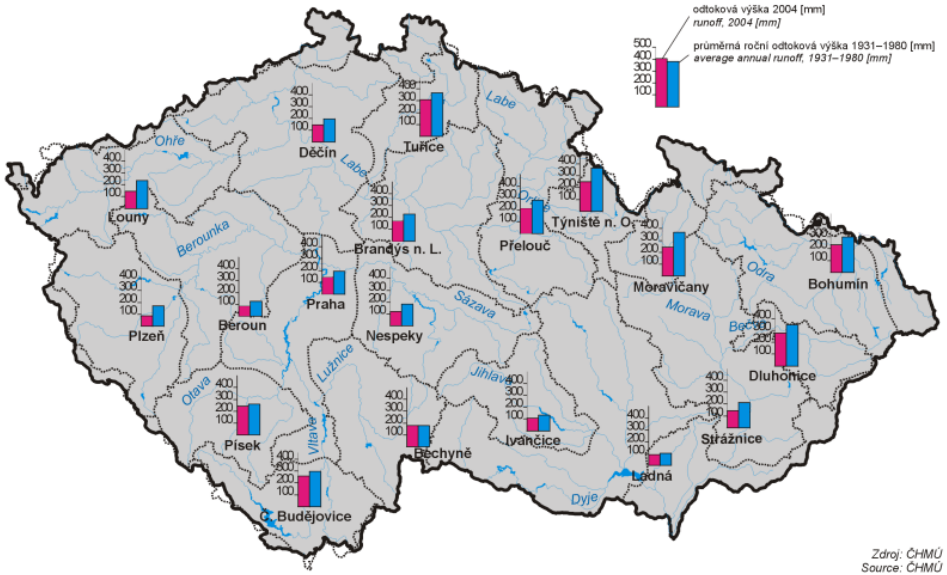
Outflow (runoff) coefficient [%] **c = Ho/Hs*100**

- varions catchments differ between **10 – 60 %**
- highest values in Moravsko-Slezké Beskydy Mts. (rivers Morávka, Ostravice),
- lowest values: tributaries of middle Labe (Pšovka), lower Vltava (Zákolanský p.) and lower Dyje (Kyjovka)

Hs = average annual sum of precipitation [mm]



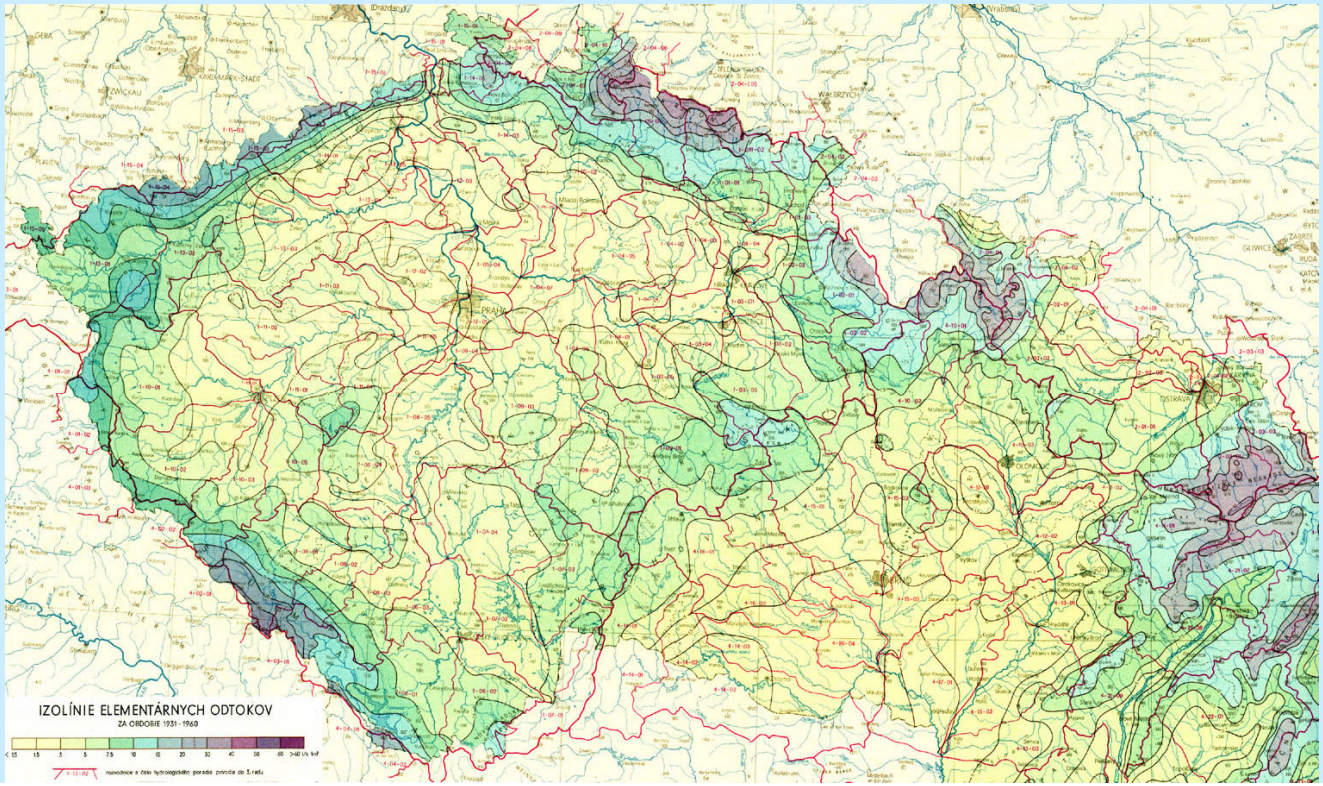
Ho = average annual sum of surface outflow [mm]



Outflow characteristics of Czech rivers

Runoff unit-yield [$l \cdot s^{-1} \cdot km^{-2}$] q = O/s*P

- in Czechia about **1–25 $l \cdot s^{-1} \cdot km^{-2}$** (average value **~ 6 $l \cdot s^{-1} \cdot km^{-2}$**)
- the Labe River catchment **6 $l \cdot s^{-1} \cdot km^{-2}$**
- the Morava River catchment **4,5 $l \cdot s^{-1} \cdot km^{-2}$**
- the Odra River catchment **10 $l \cdot s^{-1} \cdot km^{-2}$**
- headstream **areas 20–35 $l \cdot s^{-1} \cdot km^{-2}$** (Morávka, Olše, Ostravice, Morava, Labe)
- lowlands (central Polabí, lower Povltaví and Podyjí) **~ 1–3 $l \cdot s^{-1} \cdot km^{-2}$**, Dyje-Svratka revine **≤ 1 $l \cdot s^{-1} \cdot km^{-2}$**



Hydrological regime of Czech rivers

Main sources of water:

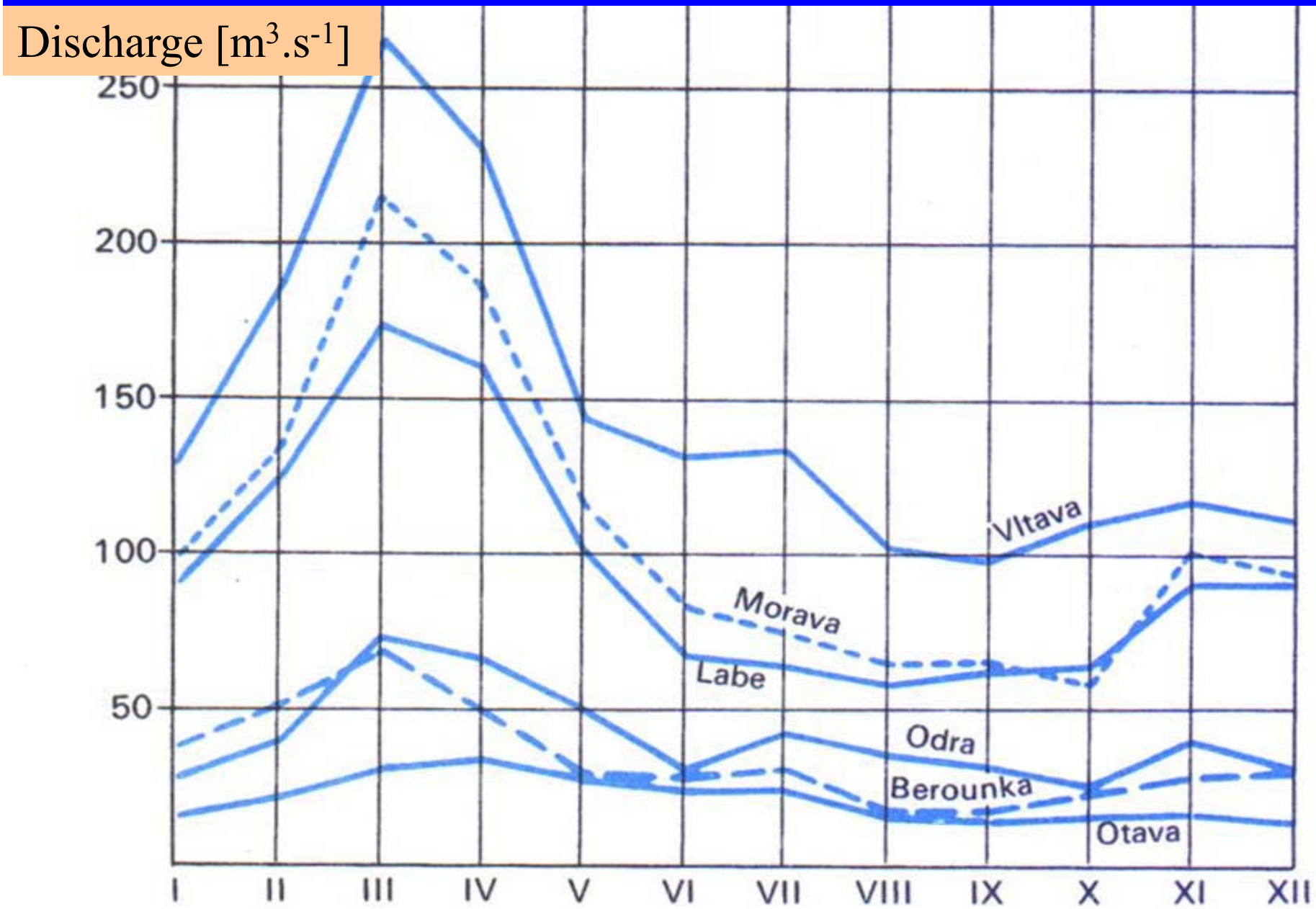
rain precipitations + snow melting

- complex outflow regime: ***pluvio-nival***
  (subtype continental Europe)
- over altitude 800 m a.s.l. ***nival-pluvial*** regime

Maximum discharge: spring – snow melting + autumn rains; frequent floods in summer – storm rainfalls

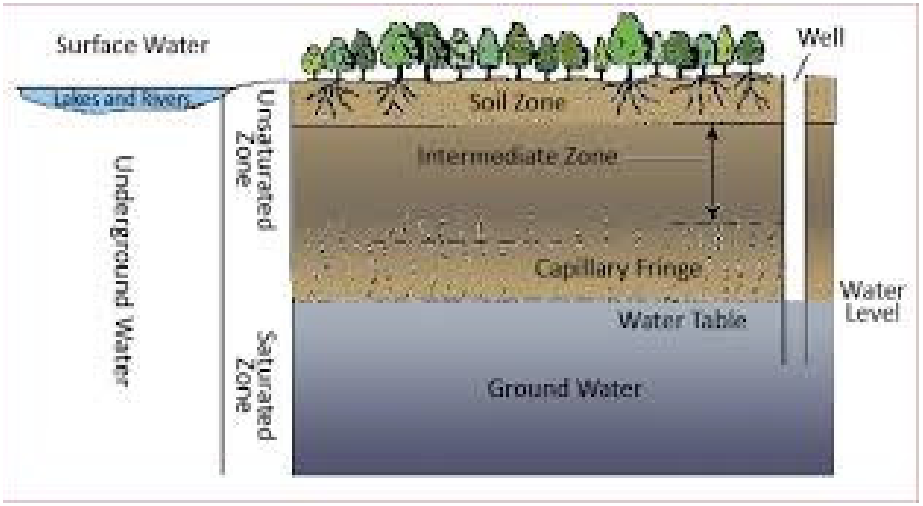
Minimum discharge: lowlands and uplands in autumm (September); mountain areas at the end of winter (February)

Typical hydrological regime of Czech rivers

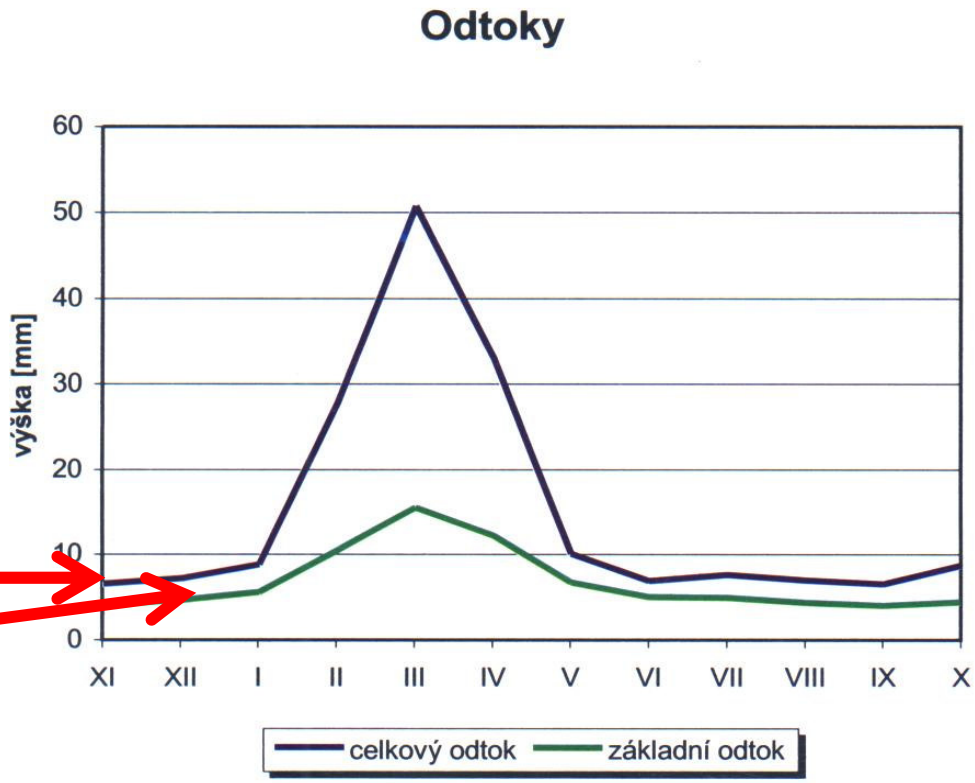


Total outflow

Total outflow = surface outflow + udergound outflow
Surface outflow – water level in rivers
Underground = Hypodermic outflow (Zone of Aeration) + Basal outflow (Zone of Saturatioin)
Basal outflow – water level in hydrogeological wells

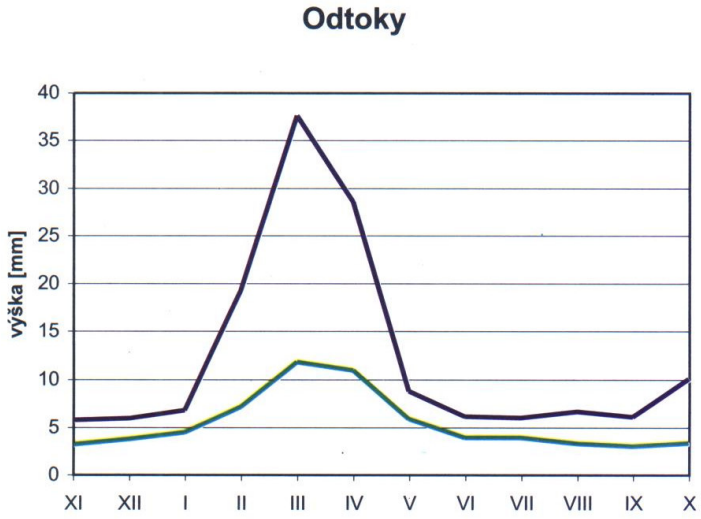


The Vltava River - Praha

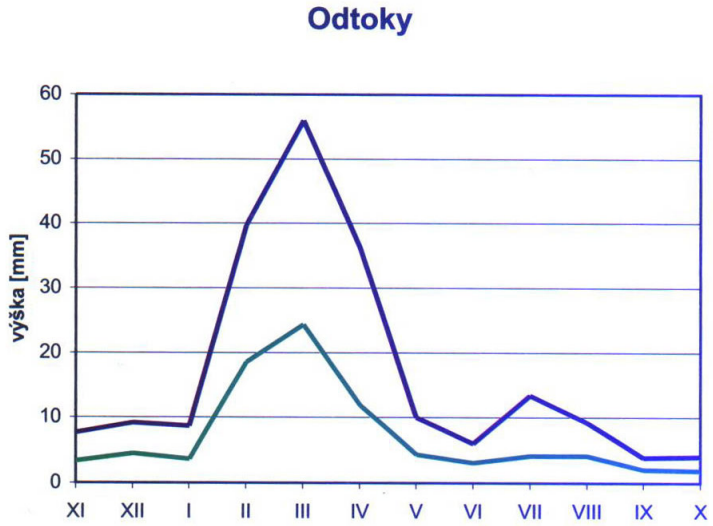


Total outflow [mm]
Basal outflow [mm]
(underground)

the Vltava River - Praha



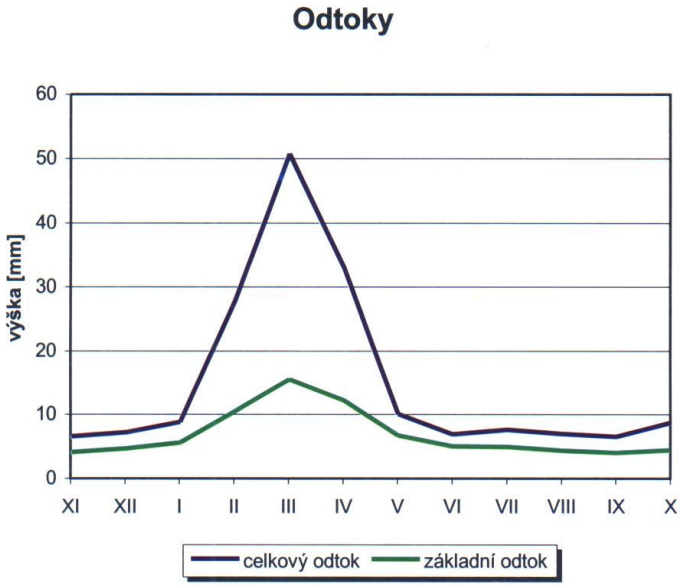
the Morava River - Strážnice



the Odra River - Bohumín

Total outflow [mm]

Basal outflow [mm]
(underground)



Consumption of water in Czechia 1965 - 1990

1965	5,5 km³
1970	7,7 km³
1975	10,9 km³
1980	15,5 km³
1990	21,0 km³

Water provided:

80% surface sources

20% underground sources

Usage of water – world 90s

5%	drinking water
75%	agriculture
20%	industry

Usage of water – the Czech Republic 90s

38 %	drinking water
4 %	agriculture
32 %	industry + services
26 %	energetics

- **developed countries:**

– diminution of water usage of about 25 % during last 20 years

Water use in Czechia

Since 1993 – decline of water usage per capita:

1993 – 343 l/capita/day 2000 – 245 l/capita/day

2016 – 132 l/capita/day 2019 – 91 l/capita/day

Decline of water consumption according to sectors during the years 1990 – 1999:

Agriculture – 88 %

Industry – 47 %

Energetics – 48 %,

Drinking supply – 34 %

Main reasons:

decrese of industrial and agricultural production,

environmental technologies,

price of water (2016 – water & sewage 37 Kč/m^3 & 32 Kč/m^3)

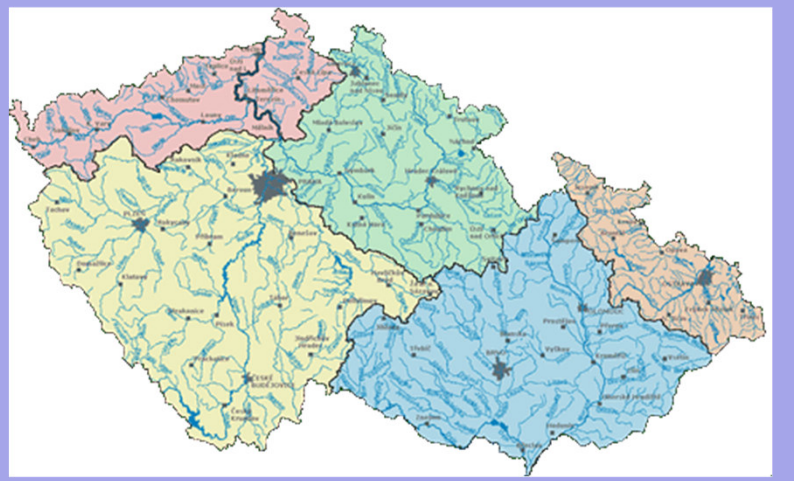
Hydrological management in Czechia

Main authorities for water law:

Ministry of Agriculture – National Plan, water management in the Czech Republic
Ministry of Environment - National Parks, protected areas
Ministry of Health – limits for drinking water, bathing norms
Ministry of Transport - navigation
Ministry of Defense – water as a strategic resource

Executive and monitioring role:

- the Labe River Authority – http://www.pla.cz (Hradec Králové)14 976 km^2
- the Morava River Authority – http://www.pmo.cz (Brno) 21 133 km^2
- the Vltava River Authority http://www.pvl.cz (Praha) 27 580 km^2
- the Ohře River Authority – http://www.poh.cz (Chomutov) 10 098 km^2
- the Odra River Authority – http:www-pod.cz (Ostrava) 7 246 km^2
- Forests of the Czech Republic- http://www.lesycr.cz (Hradec Králové)



- 94 % of streams
- 6 % municipalities, national parks, military areas

Hydrological monitoring in Czechia

Monitoring

Czech Hydrometeorological Institute & River Authorities

-stable profile network + special-purpose profiles

-water level measurement – gauging stations

-water quality sampling

-sediment & suspended matter sampling, biota sampling (benthos, fish)

-forecasts, assessment, measures

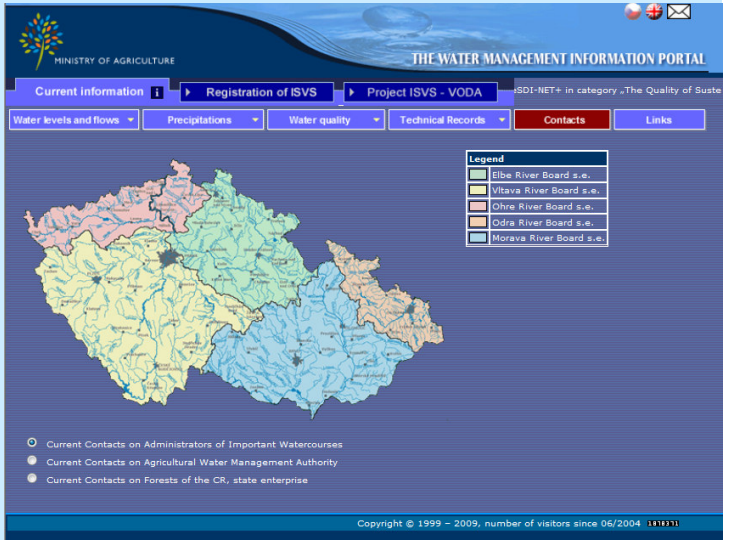
T.G.M Water Research Institute ASCI ČR, Research Instittute for Soil and Water Conservation ASCI ČR, Czech Geological Survey, universities, Environmental institutions, nongovernmental organisations etc...

DATA:

Information portals:

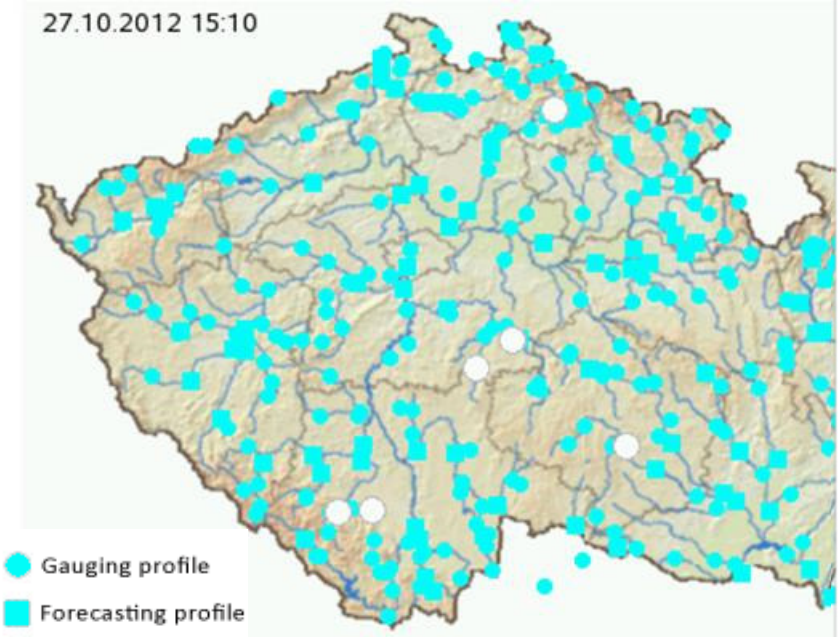
The water management information portal (Ministry of Agriculture)

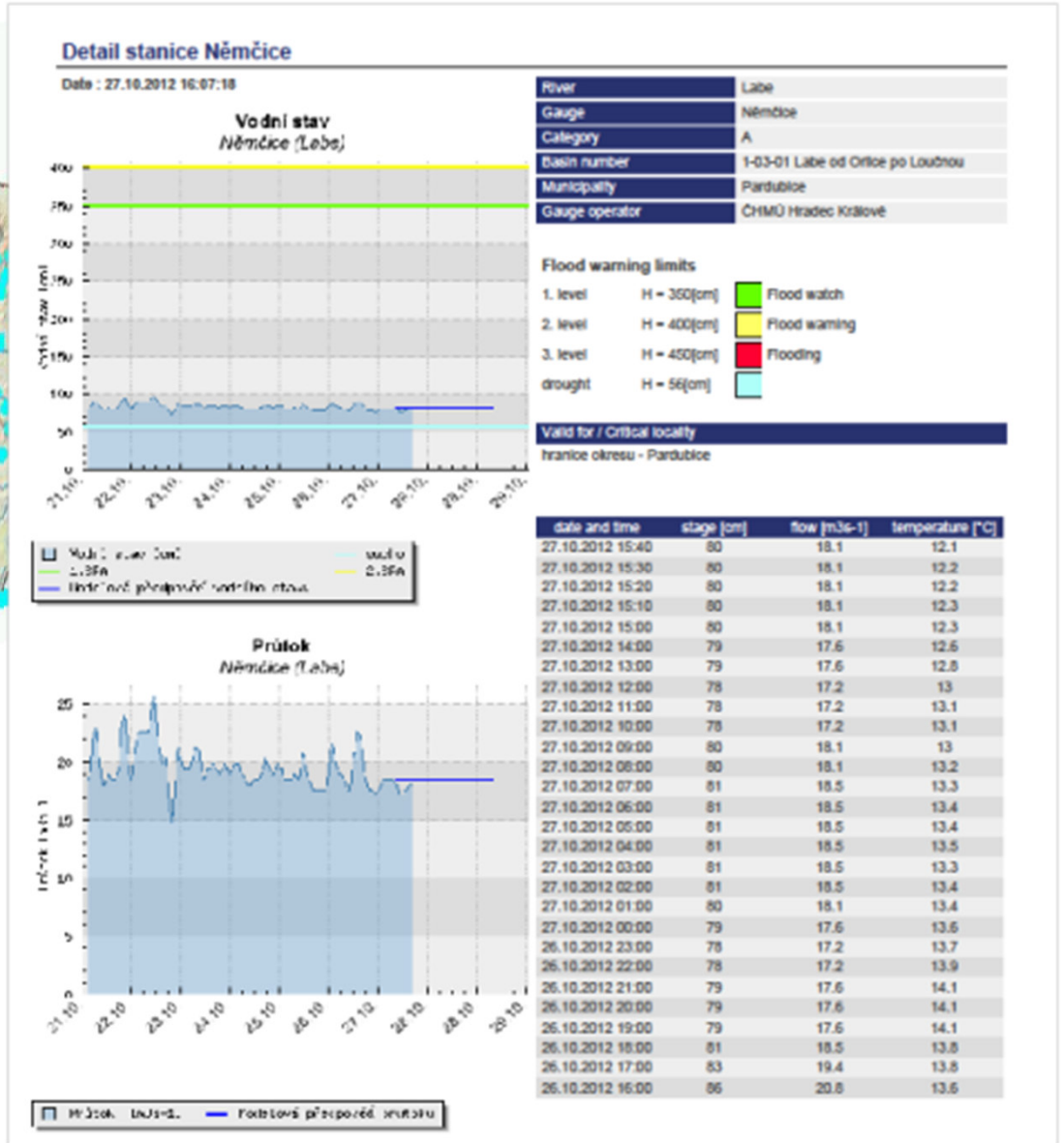
http://voda.gov.cz/portal/en/



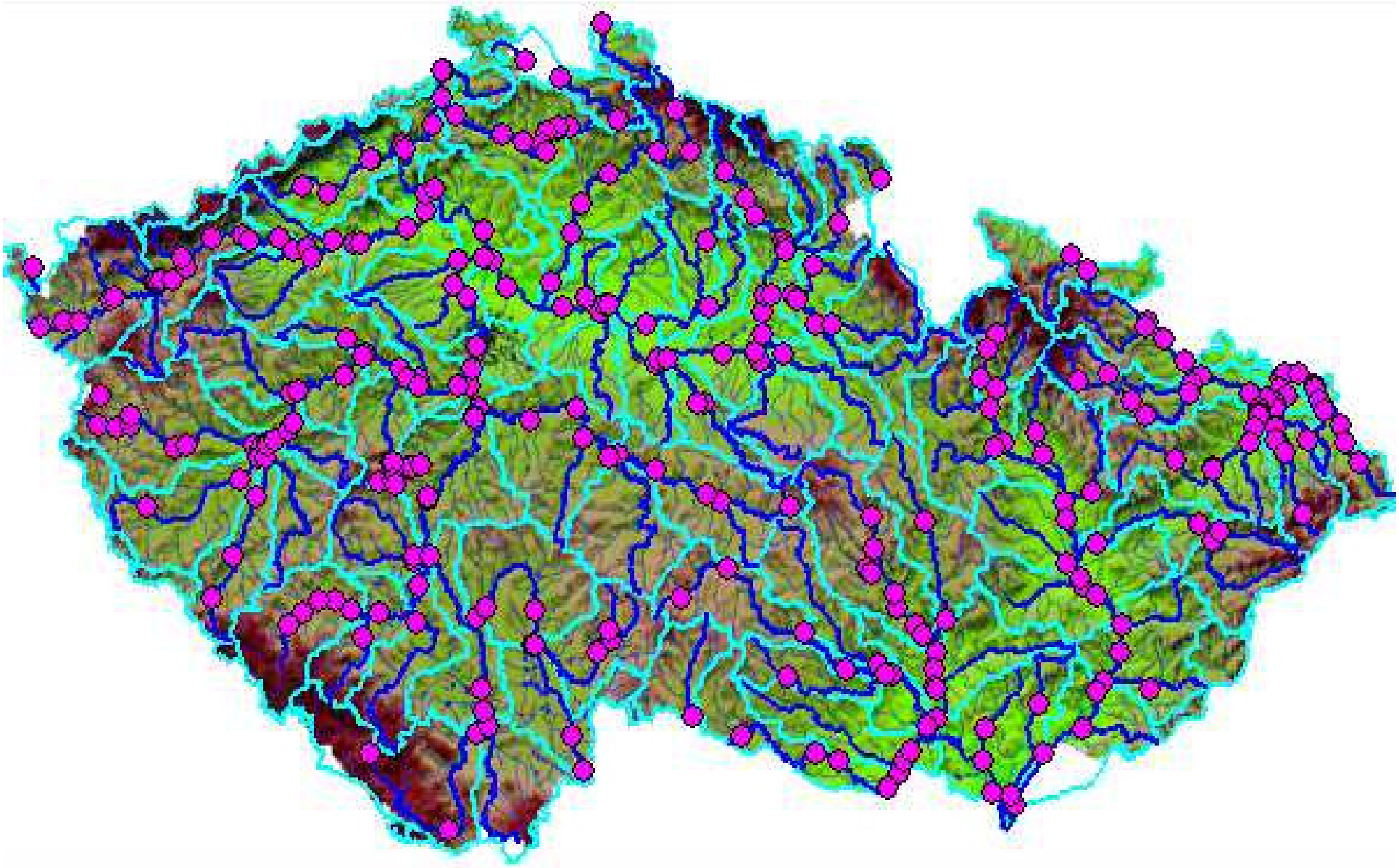
www.chmi.cz – **Czech Hydrometeorological Institute**

Flood forecasting service (CHMI) http://hydro.chmi.cz/hpps/index.php





Surface water quality profiles



Groundwater monitoring profiles