



# Sponge Cities: A Response to Climate Change -Experiences from Poland

Jacek Zalewski, 9<sup>th</sup> June 2026



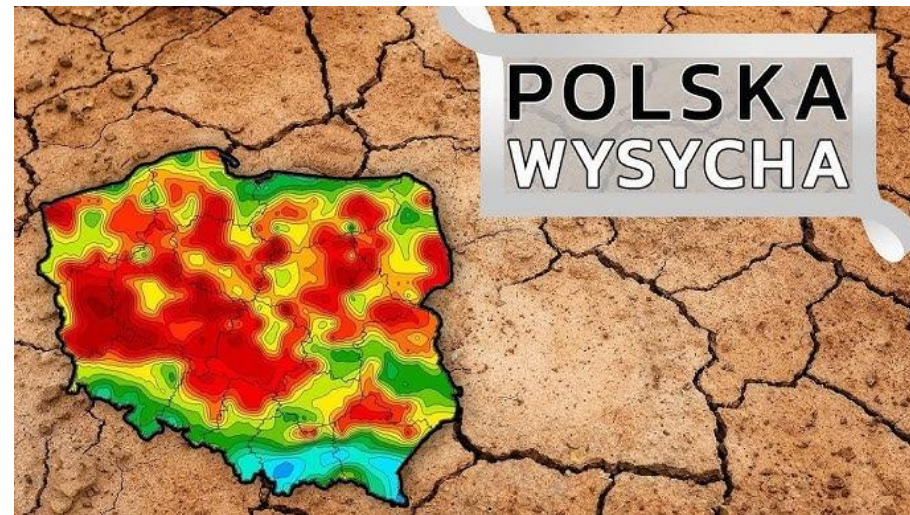
Over 20 years in water management, including 17 years in an international consultancy Ove Arup & Partners; currently Vice President of RetencjaPL, areas of expertise:

- stormwater management,
- rivers,
- sustainability,
- climate change adaptation in cities,
- green & blue infrastructure,
- design,
- digitalisation.

## JACEK ZALEWSKI



# Floods and droughts in Poland



# Paradigm shift – transition period



# Key drivers

- 1. Unsatisfactory condition of stormwater networks**
- 2. EU Financing for climate adaptation**
- 3. Citizens, who desire safe, green and friendly towns**



Source: <https://ikc.pl/krupnicza-stala-sie-zielona-ulica-z-priorytetem-dla-piesznych/>

# Key gaps

1. Know-how / education of all stakeholders
2. Old standards
3. Legal, however starting from 2018 rainwater is no longer defined as sewage



Source: <https://ikc.pl/krupnicza-stala-sie-zielona-ulica-z-priorytetem-dla-piesznych/>



# Our approach to projects in cities

# The three levels of stormwater design

## 1 LEVEL 1 FREQUENT SMALL RAINFALL EVENTS



### GOAL:

- Infiltration
- source control
- SuDS / NbS
- drought mitigation
- local retention



### EXAMPLES:



RAIN GARDENS



PERMEABLE SURFACES



INFILTRATION TRENCHES



GREEN ROOFS



“SMALL RAINFALL EVENTS SHOULD STAY WHERE THEY FALL.”

## 2 LEVEL 2 STANDARD DESIGN CONDITIONS



ACCORDING TO:  
PN-EN 752:2017



### INCLUDING:

- design storms
- control storms
- sewer network sizing
- hydrodynamic modelling
- technical drainage infrastructure

### OPTIONAL FORMULA:

$$Q = q \cdot \psi \cdot F$$

Q – peak flow [m<sup>3</sup>/s]  
q – rainfall intensity [l/(s·ha)]  
ψ – runoff coefficient [-]  
F – area [ha]



THIS IS THE TRADITIONAL BOUNDARY OF ENGINEERING DESIGN.

## 3 LEVEL 3 CATASTROPHIC RAINFALL EVENTS



### CLOUDBURST / EXTREME RAINFALL:



Where will the water flow?



Which streets become rivers?



What happens during a 1-in-100-year event?



“THE QUESTION IS NO LONGER IF URBAN FLOODING WILL HAPPEN – BUT WHERE.”

# The three levels of stormwater design

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**EXAMPLES:**



**RAIN GARDENS**    **PERMEABLE SURFACES**    **INFILTRATION TRENCHES**    **GREEN ROOFS**

**“SMALL RAINFALL EVENTS SHOULD STAY WHERE THEY FALL.”**

# Dispersed rainwater mgmt - SUDs



# Blue Green Infra in practice



# Nie uszczelniaj, powoli odprowadzaj, gromadź i wykorzystaj!

Przeanalizujemy zestawie inżynierskie podejście do tworzenia i fantastycznie różnorodnych projektów zielono-niebieskiej infrastruktury. A wy? Lubicie zaprawy deszczowe, muldy ochronne, rzeki i rowy, stawy i oczka wodne w parkach? Mnogość form i kształtów wymaga elastyczności i doświadczenia w artystycznym eksperymentowaniu, wypróbowaniu. Zapraszamy przez naszych indywidualnych katalożystów od lat inspirować do działania w Bydgoszczy, Sopocie, na Śląsku, w Kaliszu... Używajcie, bo może naszych kalkulatorów zielono-niebieskiej infrastruktury?



Padają deszcz, zbieraj wodę!

## Gromadź i wykorzystaj!

W ostatnich latach mierzymy się w miastach z zagrożeniem podtopieniami, ale także z dłuższymi okresami bez opadów. Warto umożliwić wsakanie wody deszczowej, a jej nadwyżkę z dachów, placów i chodników zgromadzić w zbiornikach i wykorzystać do podlewania, mycia ulic czy spłukiwania toalet. Użycie deszczówki niesie za sobą konkretne oszczędności. Dzięki zsumowanemu efektowi wielu mniejszych zbiorników, retencja rozproszona przetoży się na wymiarze korzyści dla wszystkich. Ponowne użycie wody będzie sprzyjać łagodzeniu efektu suszy i poprawi mikroklimat.\*

**Zbiornik podziemny**  
Zbiornik 2-3 m<sup>3</sup> pozwala zapobiec podtopieniom przy pomocy przemyślanej instalacji. Zbiorniki w domu i intensywnego podlewania trawnika.

**Zbiornik retencyjny**  
Zorganizowany w zbiornikach, nieinwazyjny sposób deszczówką z dachów można także spłukiwać podłogi i ulice.

**Mycie ulic i chodników**  
Zorganizowana w zbiornikach deszczówką z dachów można także spłukiwać podłogi i ulice.

**Podlewanie ogrodu**  
Woda deszczowa z dachu to cenny, stycy nawadniająca. W ogrodzie, chodnikach i placach świetnie nadaje się do podlewania.

**Beczki na deszczówkę**  
Nawet rankowy deszcz zapewni wodę z dachu 200 litrową beczkę. Ustawione przy każdej rynnie, zapewnią wodę do przyszybowania po ogrodzie lub mycia nawet na kłuzawce dla.

\* Średnie zużycie wody w miastach oscyła się na 150 litrów na mieszkańca. Z tego prawie 1/4 zużywana jest do spłukiwania toalet. Pełna wanna to niemal 200 litrów wody, a 3 minutowy prysznic to zużycie około 45 litrów wody. Tymczasem wypijamy tylko 2,5 - 3 litrów wody. Małe czas już zastanów się, jak nie marnować wody, która za darmo spada z nieba?



# The three levels of stormwater design

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### EXAMPLES:



RAIN  
GARDENS



PERMEABLE  
SURFACES



INFILTRATION  
TRENCHES



GREEN  
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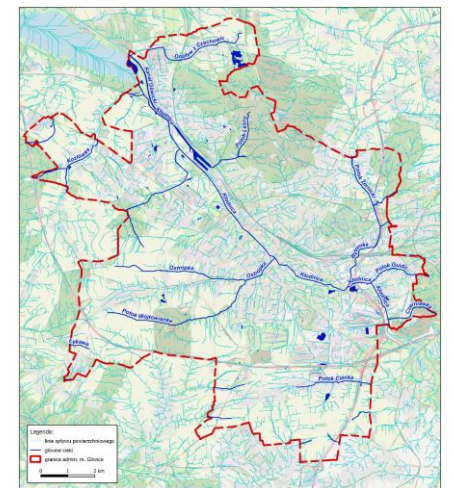
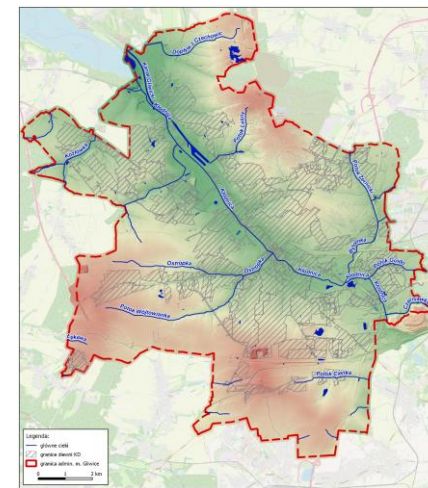
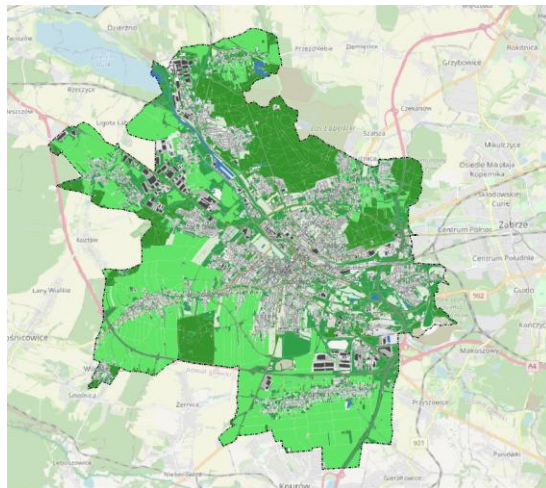
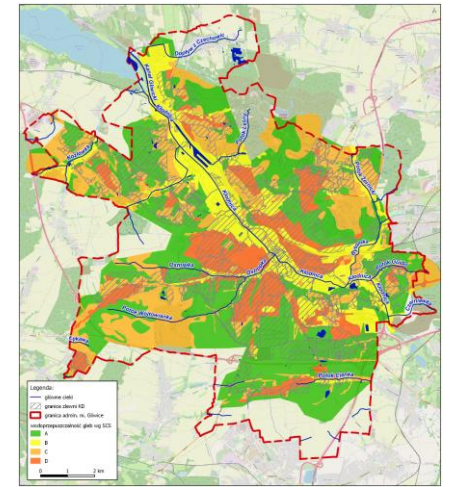
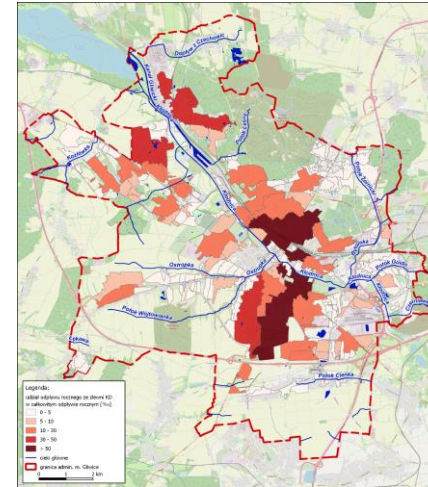
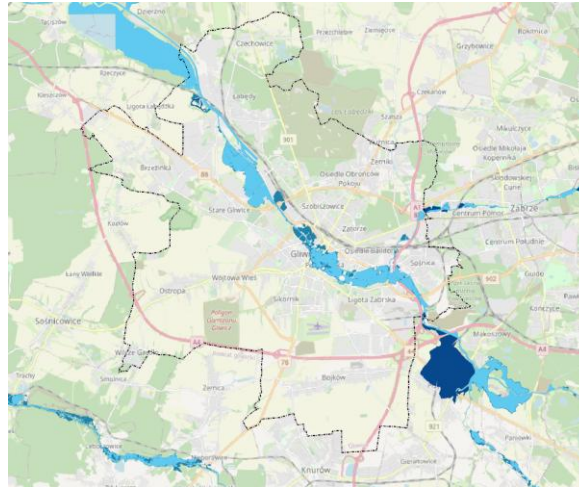
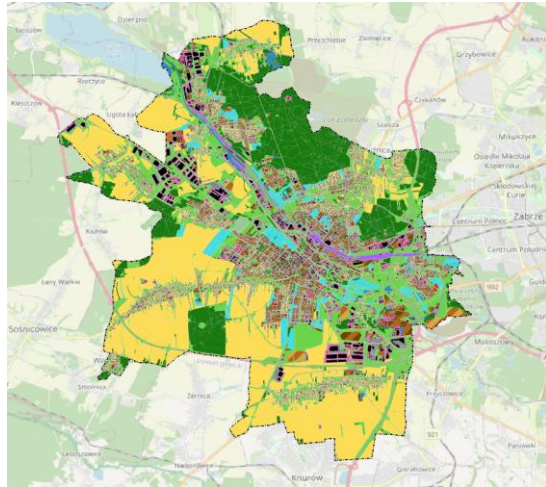
THIS IS THE TRADITIONAL  
BOUNDARY OF  
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# Gliwice: complex rainwater management strategy

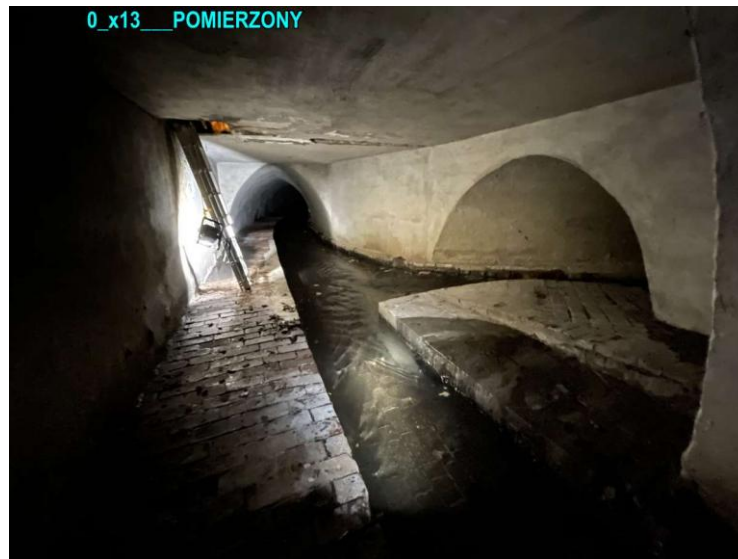


- 505 km of stormwater sewer network above DN300 mm
- 82 km of ditches
- catchment area: 6200 ha
- 17,500 partial catchments in the hydrodynamic model

# Desk study - GIS maps

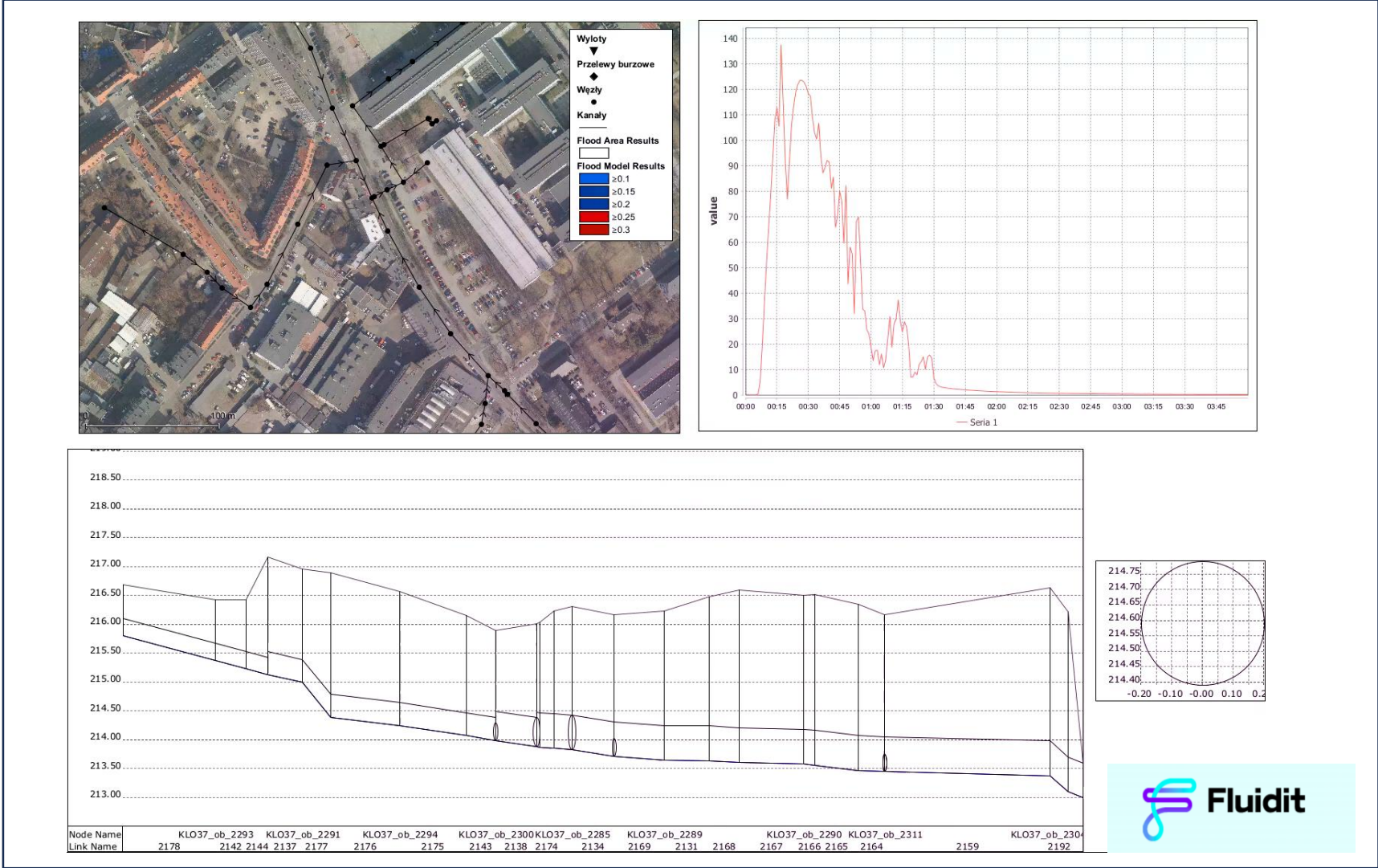


# Surveys



# Hydraulic modeling:

how the system works?



# Warsaw – Łuk Siekierkowski



Stormwater mgmt concept

1,640 hectares  
of land for development







# Mrągowo



# Mrągowo



# Some other examples

Smaller case studies

# Auschwitz Visitor Site

Legenda:

studnie KD	wysokość wylewu [m] w kolejności malejącej:
● wylewające	Z5.W12 0,20
● zagrożone wylaniem (napętnienie do 15cm poniżej rzędnej terenu)	Z5.W13 0,12
● niezagrożone wylewami	Z1.W3 0,06
	Z4.W3 0,04
	Z4.W1 0,04
	Z4.S9 0,04
sieć KD	Z1.W4 0,02
— brak przeciążenia	Z4.W17 0,01
— przeciążone	Z5.W1 <0,01
— granica opracowania	Z1.W2 <0,01
	Z4.S19 <0,01
wysokość i zasięg wylewu [m]	Z2.W12 <0,01
0,31	Z4.W9 <0,01
0	

oznaczenia studzienek:  
Z1 - zlewnia w której znajduje się studzienka patrz raport strona 8  
S1 - studnia z kolejnym numerem  
W1 - wpust z kolejnym numerem



Numer rysunku: R0392-KP-S-R001-2

# Auschwitz Visitor Site

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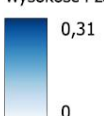
studnie KD

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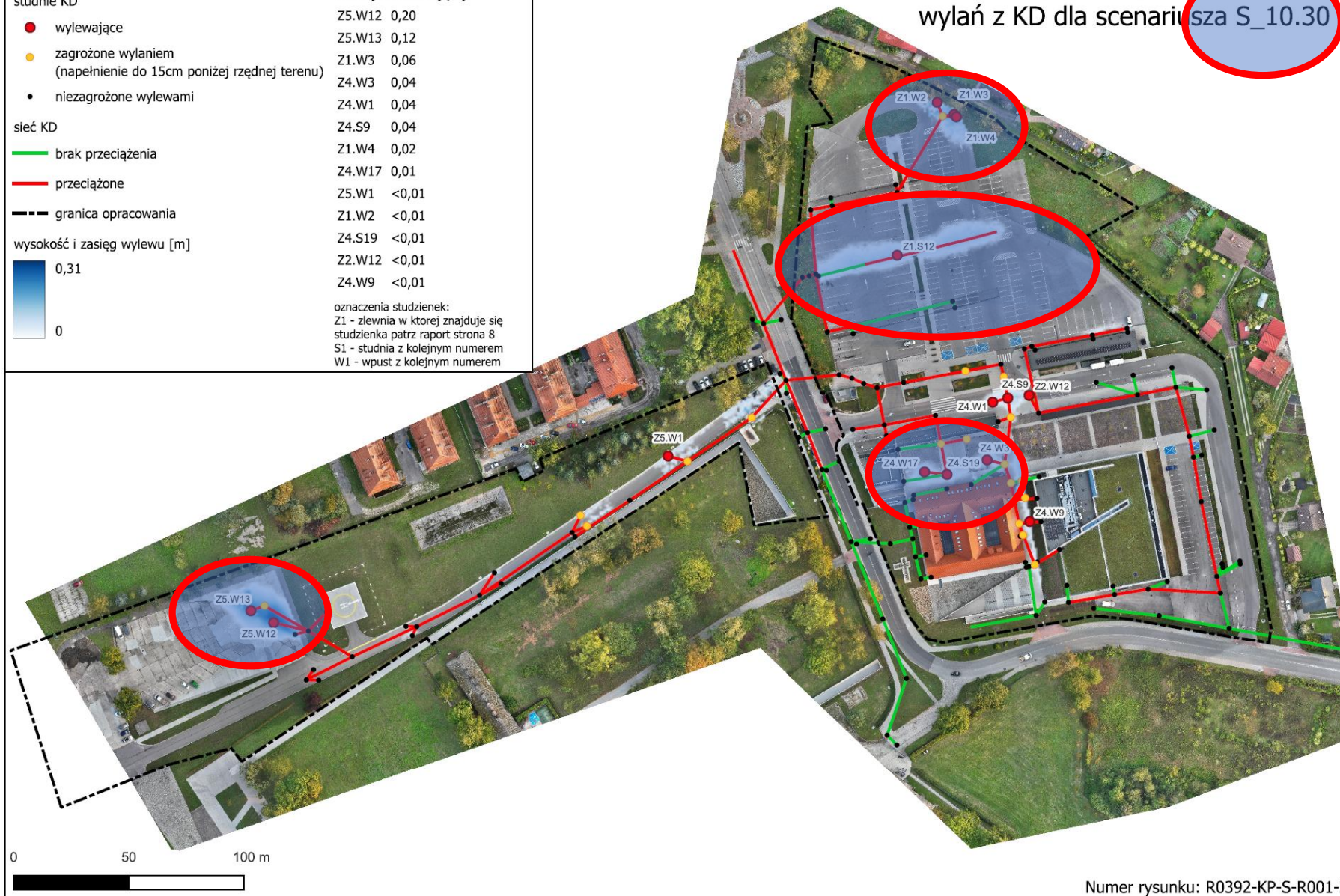
0,31  
0

wysokość wylewu [m] w kolejności malejącej:

Z5.W12	0,20
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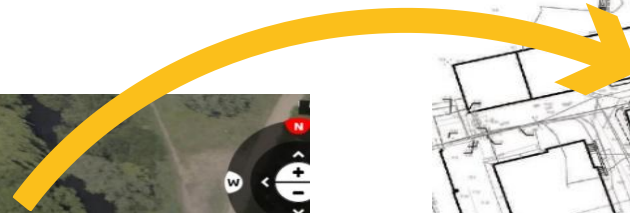
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Analiza rozplywów po terenie  
wylań z KD dla scenariusza S\_10.30



Numer rysunku: R0392-KP-S-R001-2

# Słupsk utility company headquarters







# Płock utility company headquarters




# The three levels of stormwater design

**3** **LEVEL 3**  
**CATASTROPHIC RAINFALL EVENTS**

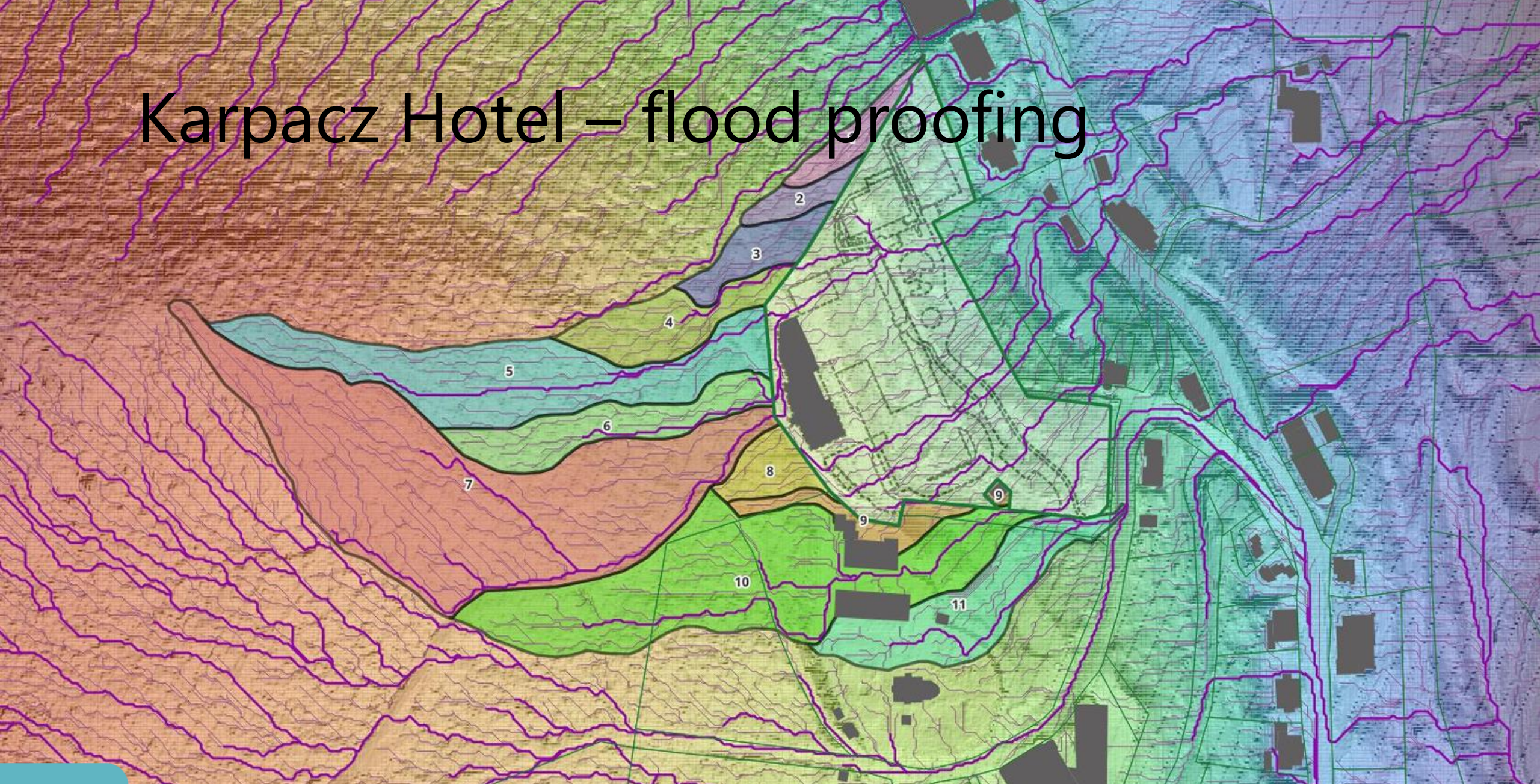
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# Karpacz Hotel – flood proofing



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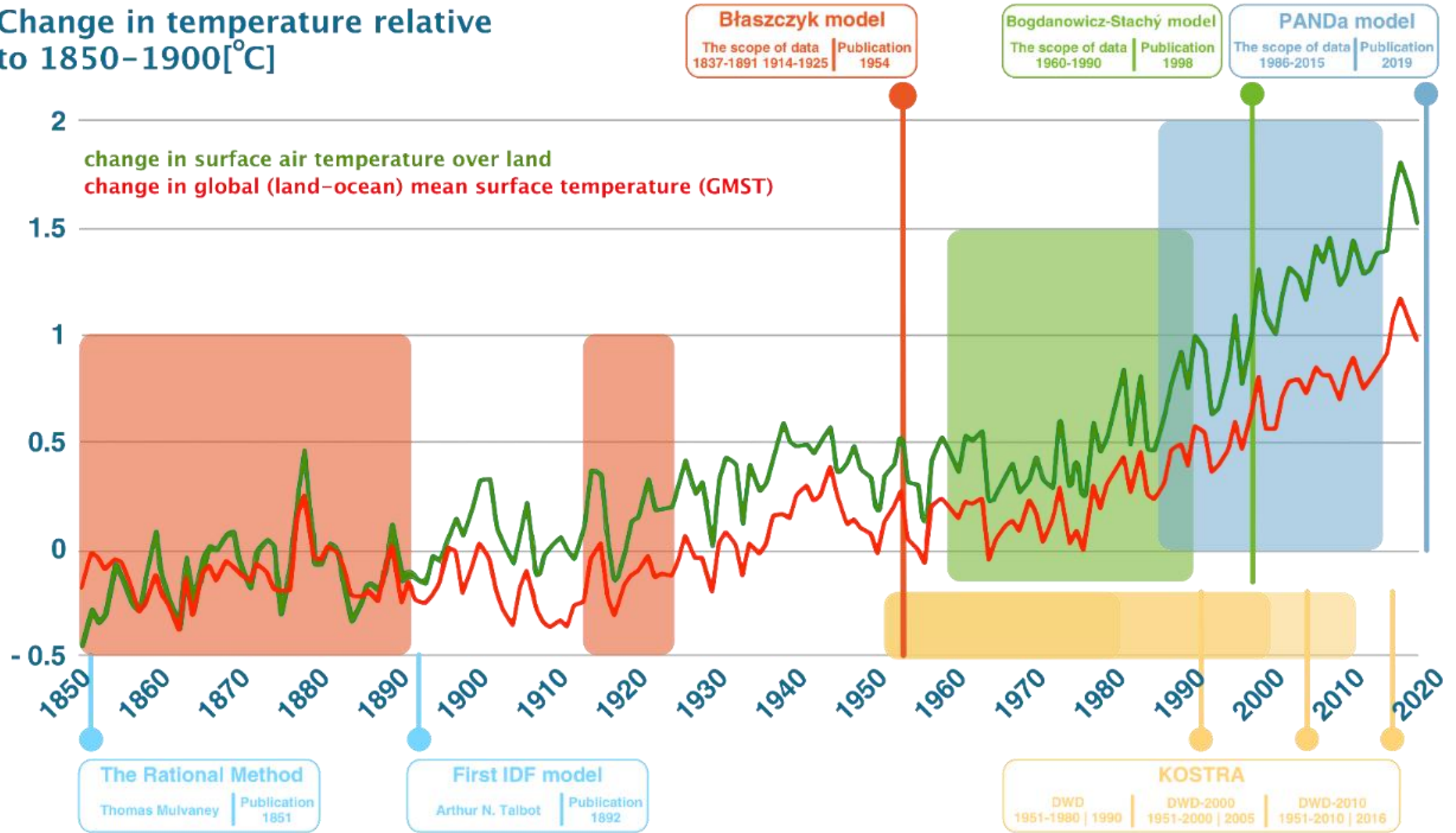


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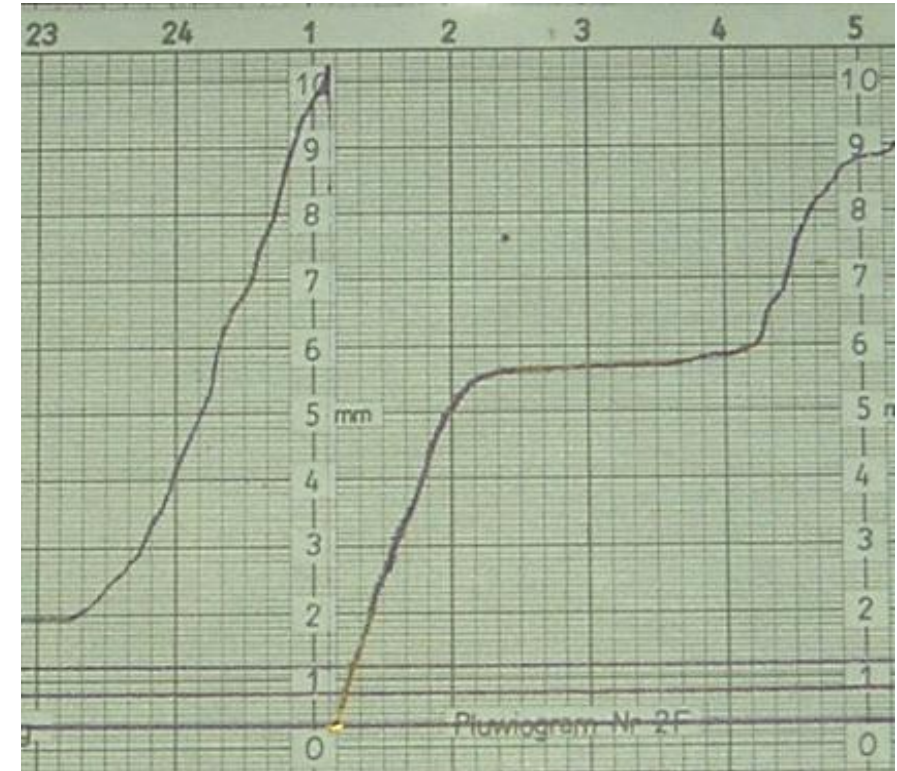
Going digital in stormwater  
management  
Polish Atlas of Rains Intensities  
(PANDa/PARIs)

# Change in temperature relative to 1850-1900[°C]



Data from 'Climate Change and Land' report made by Intergovernmental Panel on Climate Change

# Historic data from the 100 raingauges



Pluviograph

# Extremes – maximum depths and rainfall intensities

26 czerwca 1988 20:11 UTC

1138.58667 66

315.88260 25

313.54443 22

297.11666 21

296.66666 19

60. maksymalnych średnich natężeń I, l/s/ha dla okresu (w min):

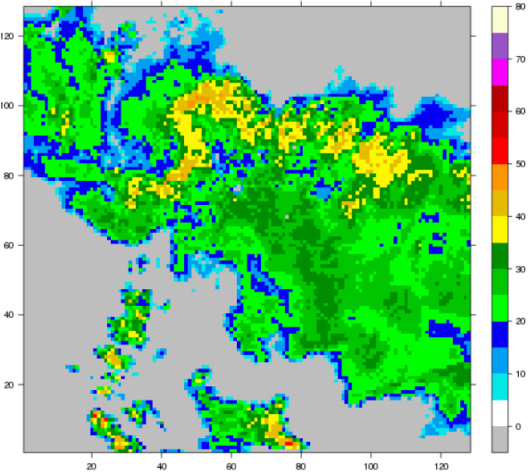
	15	30	45	60	90	120	180	360	720	1080	1440	2160	2880	4320		
7	280.00000	196.66667	144.44444	100.55556	75.41428	58.96970	47.81608	37.66211	28.42593	15.46296	8.07870	5.46296	4.31713	3.49700	2.64749	1.90771
8	267.35527	188.76470	141.33533	97.77778	69.62963	58.37370	45.37263	37.44056	26.57407	14.92519	7.73148	5.40123	4.25127	3.42684	2.57245	1.89043
9	266.66667	188.33333	148.15452	90.72777	67.83803	55.83333	43.52467	36.44177	26.52827	14.72391	7.51842	5.33788	4.23611	3.21270	2.40953	1.85059
10	263.00883	184.68713	146.66667	89.44444	67.40741	54.16667	41.11111	35.83144	26.45331	14.58333	7.50000	5.15432	4.16971	3.09115	2.32639	1.84534
11	258.91683	178.90732	146.66667	88.33333	65.74626	53.70603	39.97937	34.58333	26.02508	14.42858	7.48262	4.99433	4.13290	3.04327	2.28296	1.72941
12	249.50907	177.03235	145.68718	86.30810	64.89285	53.44930	39.83198	34.39080	25.80620	13.53161	7.37299	4.94765	4.05093	3.02165	2.26624	1.71296
13	246.66667	175.45258	145.66872	86.18534	61.85185	52.25586	38.91982	33.25587	25.08207	13.42593	7.29678	4.93870	3.91204	2.96462	2.25113	1.60645
14	240.00000	173.61222	131.77646	84.14216	61.17591	51.76271	38.19681	31.60082	24.96357	13.06050	7.13445	4.92269	3.89521	2.96126	2.24926	1.60214
15	239.12033	171.66667	131.34774	83.88889	60.37037	51.11111	37.77778	29.19288	23.91094	13.00926	7.05254	4.90973	3.86574	2.90895	2.22095	1.58433
16	231.81207															1.55093
17	230.00000															1.54707
18	220.66653															1.52963
19	220.41387															1.52531
20	213.89200															1.52392
21	210.00000															1.52197
22	210.00000															1.51572
23	206.66667															1.50076
24	203.33333	148.33333	117.55423	76.19233	55.40645	44.19598	32.77778	26.38889	18.98148	10.41667	6.46402	4.51054	3.62269	2.65432	2.06019	1.47948
25	201.97167	146.04348	117.38598	76.15031	55.37494	43.54666	31.81938	25.97222	18.81123	10.12275	6.43519	4.47679	3.62143	2.57716	2.02546	1.45833
26	201.80233	141.66667	114.44444	71.69184	55.20281	42.50000	30.98238	25.56821	18.24074	10.11863	6.40699	4.47531	3.61111	2.56903	2.01736	1.45361
27	197.63667	141.66667	113.33333	69.21354	55.18519	42.19388	30.74074	25.30796	18.16021	10.04164	6.38889	4.45988	3.56648	2.50043	2.01389	1.44775
28	196.66667	138.90081	112.28709	69.21109	53.51678	41.66667	30.37037	24.68541	18.14815	9.95370	6.37076	4.43460	3.54852	2.46405	1.99074	1.43133

Maximum rainfall intensities (years 1986-2015) for time durations:  
5, 10, 15, 30, 45, 60, 90, 120, 180, 360, 720, 1080, 1440, 2160, 2880, 4320 minutes

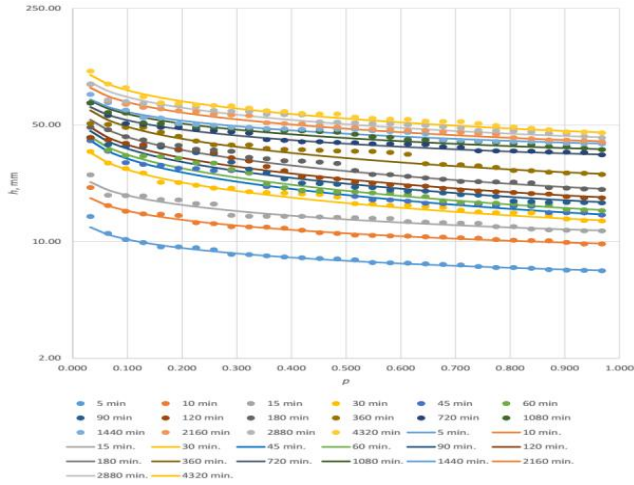
Dates are important for verification...

# Geostatistical analysis and data proofing

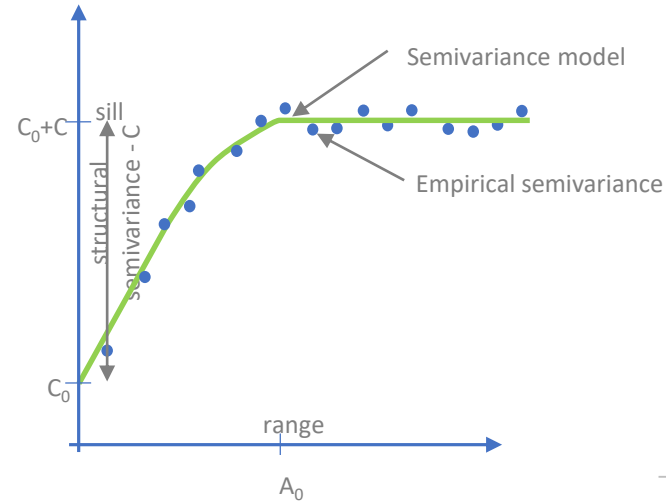
Radar precipitation, 06 Aug 2010 18:45



Radar: data proofing

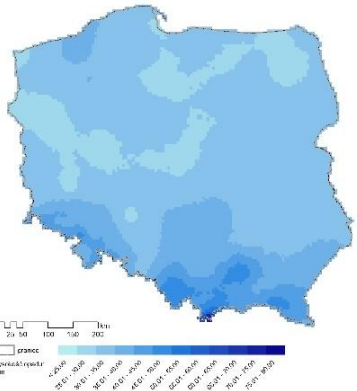


Fitting distributions

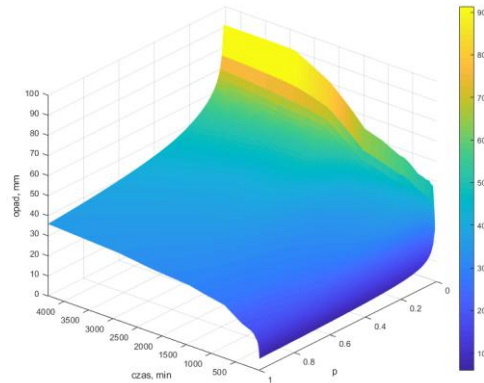


Spatial interpolation of extremes

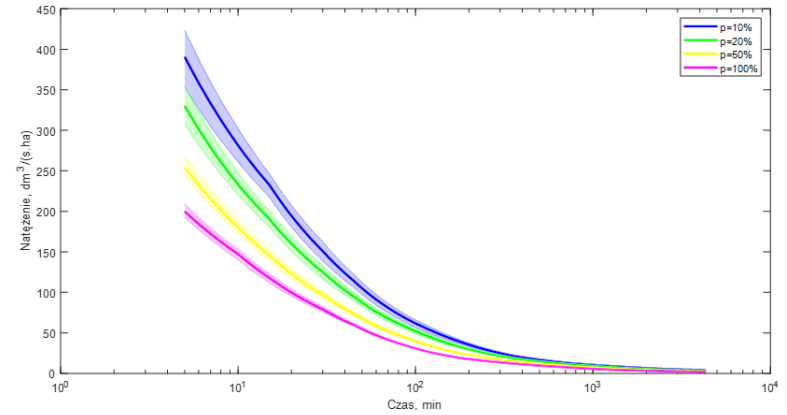
Spatial autocorrelation



Uncertainty allowance



DDF and IDF



IDF curves confidence

# <https://portal.atlaspanda.pl/login>

POLSKI ATLAS  
NATEŻEN DESZCZÓW  
**PANDA**

Obejrzyj film

Dowiedz się czym jest PANDa  
i jaki problem rozwiązuje!

Logowanie

Adres e-mail

Hasło

Zapomniałeś hasła?

**ZALOGUJ**

Nie masz jeszcze konta? Zarejestruj się



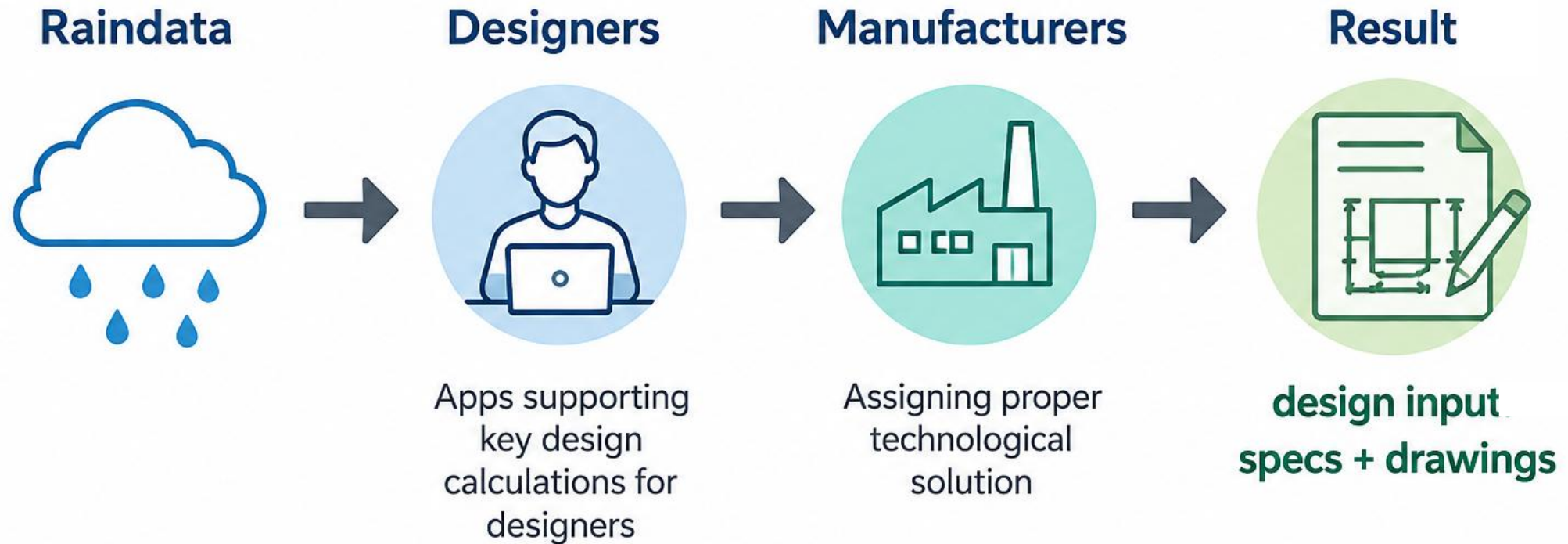


# WaterFolder.com

a digital design platform  
of drainage systems



# One platform, all you need



# WaterFolder

An example: infiltration system  
AquaCell by Wavin



## An innovative platform for water professionals.

**Efficiently design stormwater, water and sewage systems tailored to your project needs.**

WaterFolder combines the knowledge and expertise of our specialists with digital tools, offering advanced applications to help design the most optimal technical solutions. With WaterFolder, you gain quick access to proven equipment, saving both time and effort. Our platform has been successfully implemented across Poland and other European countries, continuously growing the number of users.

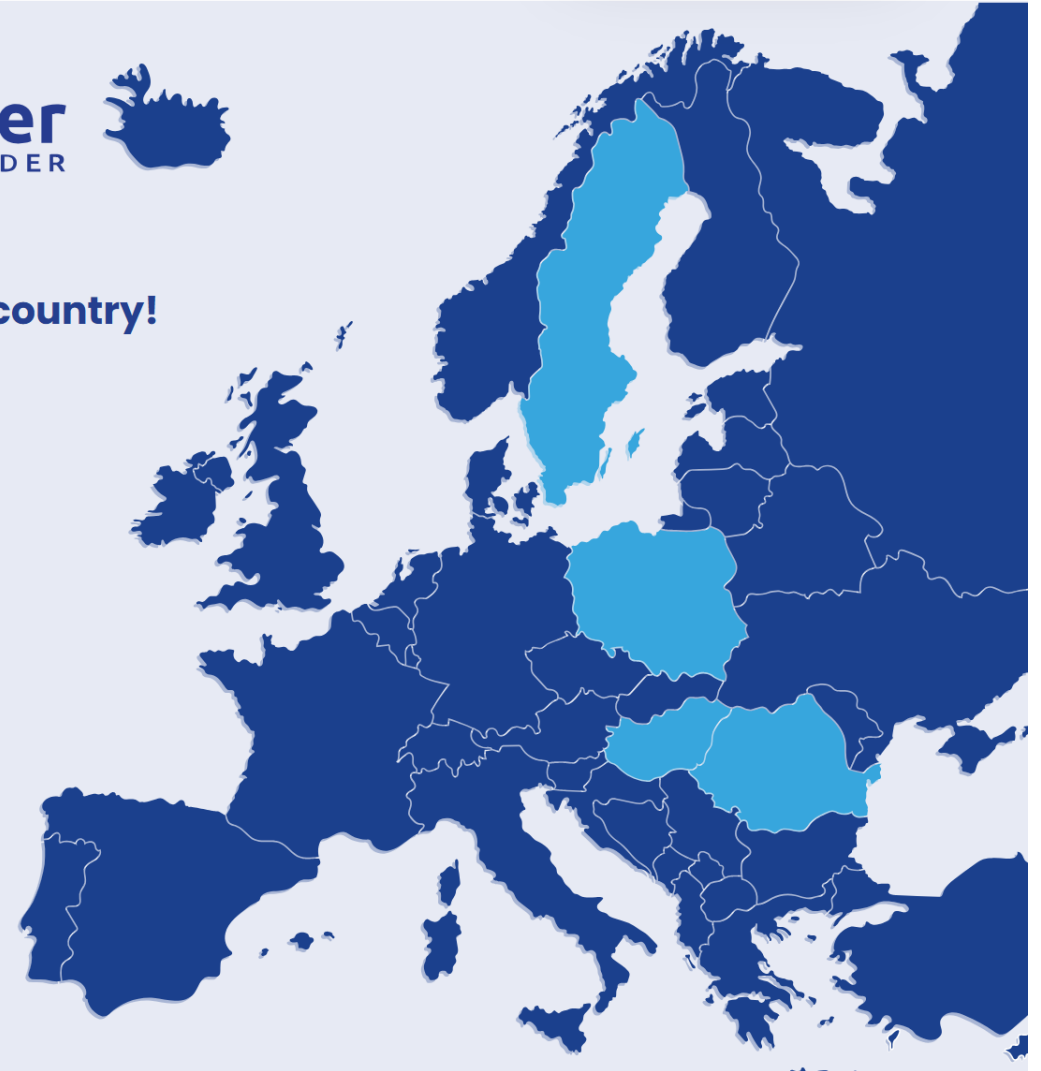
**Designing has never been this easy!**



[Create a free account →](#)



Select your country!

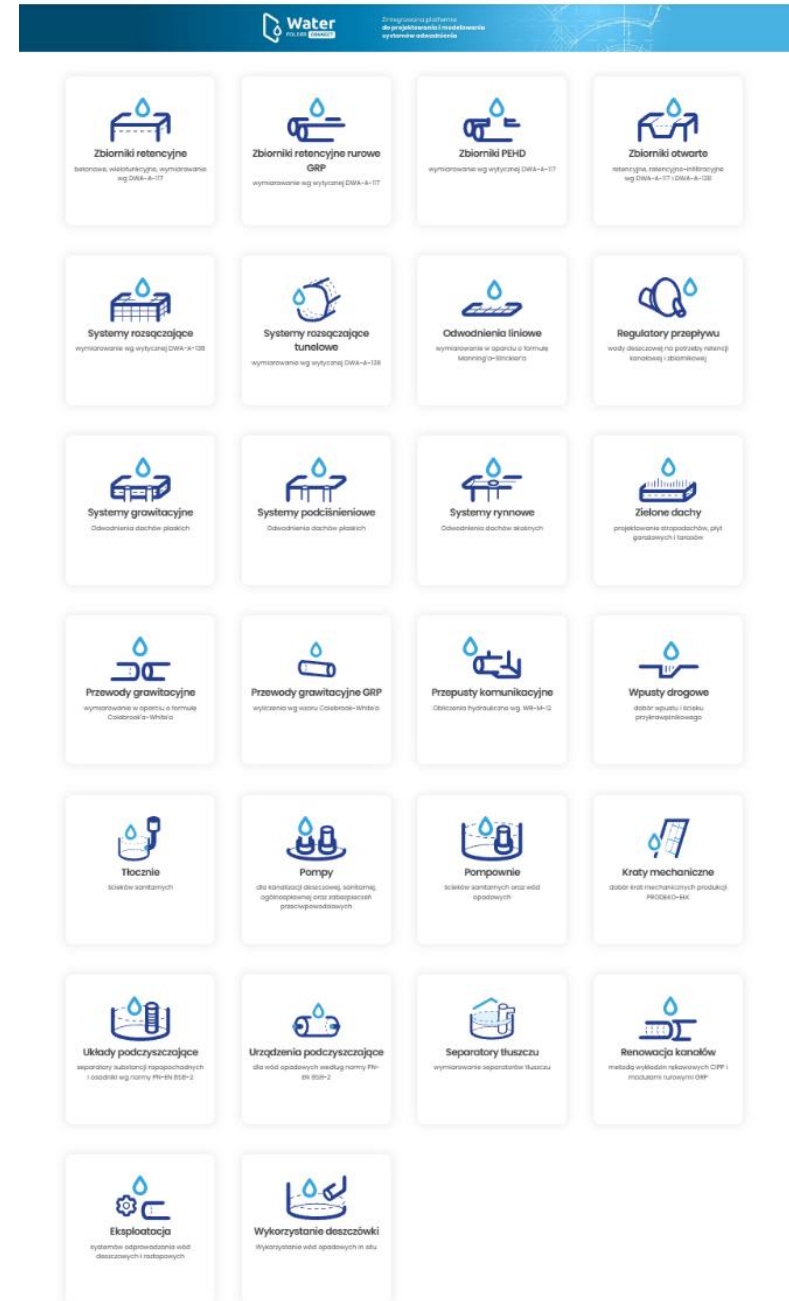


# WaterFolder

## In numbers

### ➤ 30 Applications:

retention tanks and reservoirs,  
infiltration, green roofs, pumps and  
pumping stations, flow regulators,  
pre-treatment, pipes, street's inlets,  
linear drainage and SUDs solutions.

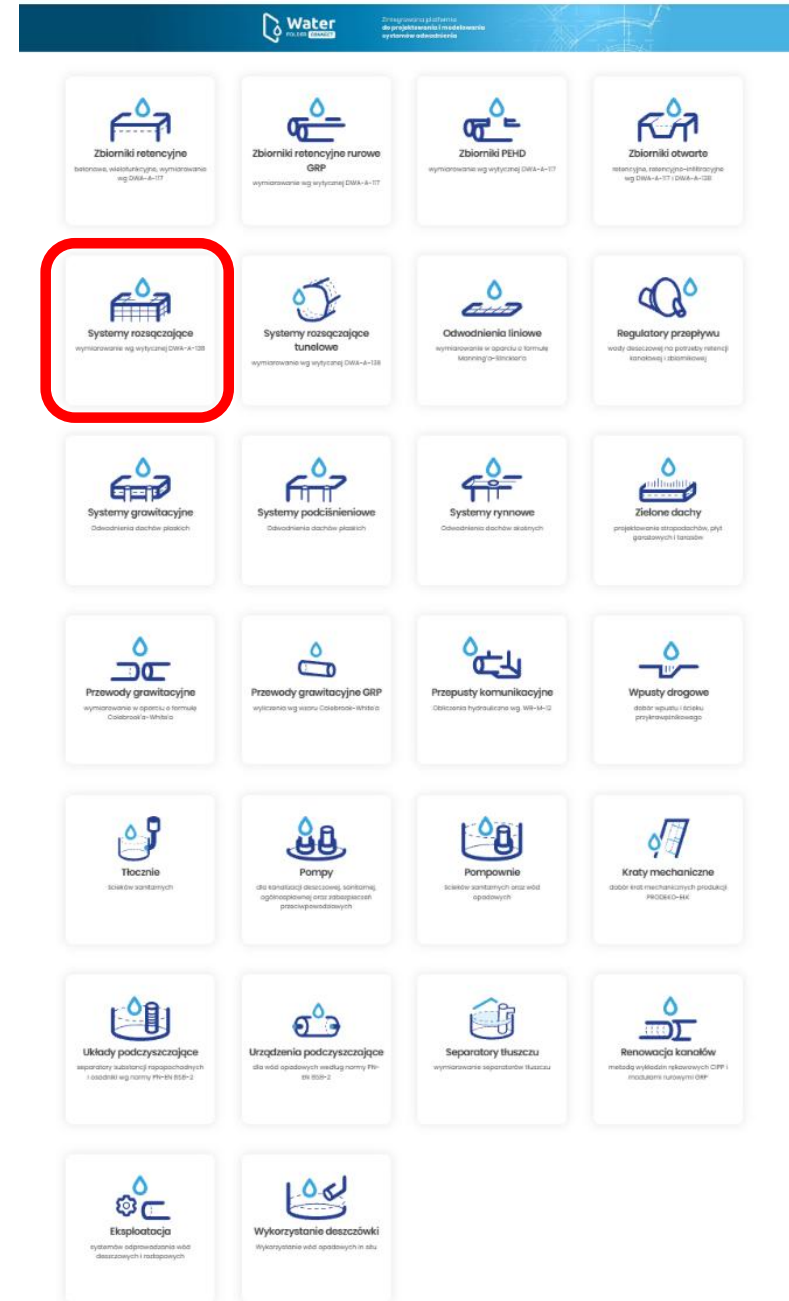


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# Step 1 – location

waterfolder.com/en/app/zbiorniki-rozsaczajace/dane-inwestycji

Select the country you are interested in and the language for your location

Polska English Select

Water FOLDER

pawel.licznar@retencja.pl Sign out

## Selecting infiltrating systems

Dimensioning in accordance with DWA-A-138 for a catchment area with sewage system  $\leq 200$ ha or systems with flow time  $\leq 15$ min

### Investment details

The details we ask for will help you to keep a list of generated calculations in our application. The details will also be featured in the PDF file generated in the last step. The generated file may form an appendix to project documentation.

Name of the investment\*  
IKEA Wrocław

Investment location  
Czekoladowa 5, Bielany Wrocławskie, Polska

Geographic coordinates\*  
51.047827, 16.954965

Street and No\*  
Czekoladowa 5

Postal Code

City\*  
Bielany Wrocławskie

Stage of the investment\*  
Concept

Detailed description

Additional information about the investment e.g. full name of the investment, the investor, planned construction year, etc.

Investment details 1/3

Next

niedziela, 28 sierpnia 2022

# Step 2 – rainfall and catchment data

waterfolder.com/en/app/zbiorniki-rozsaczajace/wybor-parametrow

Select the country you are interested in and the language for your location Polska English Select

Water FOLDER pawel.licznar@retencja.pl Sign out

## Selecting infiltrating systems

Dimensioning in accordance with DWA-A-138 for a catchment area with sewage system  $\leq 200$ ha or systems with flow time  $\leq 15$ min

### Choosing parameters

Investment type \*  
Industrial facilities

Development length [m] \*  
100

Development width [m] \*  
50

Terrain type \*  
Traffic load area LKW 30

Infiltration coefficient [m/s]  
0.00012

Reduced (impervious) area  $F_z$  [ha]  
0.598

Groundwater level BGL [m] \*  
4

Ground cover  $H_p$  [m] \*  
1.5

Precipitation model \*  
PANDa

Probability \*  
10

The rainfall return period  
10

Back Choosing parameters 2 / 3 Calculate

### Reduced areas

Type of area / development	Runoff coefficient $\psi$	Area [ha]	Area [m <sup>2</sup> ]	Reduced area $F_z$ [ha]	
Roofs	1	0.25	2500	0.25	×
Ordinary pavements	0.6	0.1	1000	0.06	×
Watertight pavements	0.72	0.4	4000	0.288	×
Enter	Enter	Enter	Enter	0	
Clear					
<b>Total</b>	<b>0.8</b>	<b>0.75</b>	<b>7500</b>	<b>0.598</b>	

# Step 3 – results

The screenshot displays the 'Selecting infiltrating systems' interface. The top navigation bar includes the Water Folder logo, a user profile for 'pawel.licznar@retencja.pl', and a 'Sign out' button. Below the navigation, there are language selection options for 'Polska' and 'English', and a 'Select' button. The main content area is divided into two sections: 'Calculation results' and 'Solutions proposed according to the calculations'.

**Calculation results**

Dimensioning in accordance with DWA-A-138 for a catchment area with sewage system  $\leq 200$ ha or systems with flow time  $\leq 15$ min

The minimum retention basin volume based on precipitation model PANDa	123.7 m <sup>3</sup>	Graph
Total inflow into the retention basin	180.3 m <sup>3</sup>	Graph
Total outflow from the retention basin	56.6 m <sup>3</sup>	Graph
Retention tank emptying time	1h 38min	

**Solutions proposed according to the calculations**

**Infiltration system Wavin AquaCell**

432 Number of boxes

Sizes

Length	86.4 m
Width	3.6 m
Height	0.425 m

System AquaCell Chosen

☆ Add to favourites! Send e-mail Send a question

Partner of the solution

**WAVIN**

Back Choosing product 3 / 3 New calculation



## Infiltration and attenuation system Wavin AquaCell

For the investment  
IKEA Wrocław

Document creation date  
28.08.2022



www.waterfolder.com

### Selected solution

Infiltration and attenuation system Wavin AquaCell

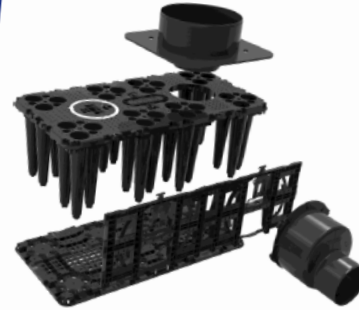
**432**  
Number of boxes

Dimensions

Length	86.4 m
Width	3.6 m
Height	0.425 m

**124.4 m<sup>3</sup>**  
Tank volume

**1h 38min**  
Emptying time



### Description

The **single-layer** infiltration tank has been designed measuring **86.4 m x 3.6 m x 0.425 m** and water capacity minimum **124.4 m<sup>3</sup>** consisting of 1,2 x 0,6 x 0,425 m dimension boxes. In the lowest layer of the tank there are bottomplates. Appropriate profiling of the bottom plate makes it easier to guide the control camera and the nozzle of the cleaning device, preventing it from getting stuck. Subsequent layers of boxes are built in without using the boards directly on the bottom layer.

The box has 8 columns. Each column is a group of 3 supports. The structure of the tank is open. Side walls are used only outside the tank, so that each layer of the tank is an open surface supported on columns.

Inside the tank, there are cross channels: two parallel 200 mm wide and perpendicular 185 mm wide. The inlet connector can be done anywhere, without changing the tank configuration. The assembly is carried out with the help by blocking holders and connectors - no extra connecting elements are used. Clips and handles are hidden in the box structure so as not to damage the geotextile.

The AquaCell box module is prepared for operation from the ground surface using Wavin DN/ID425 or 315 inspection chambers installed directly on the tank, inspection is possible in two directions. Operation via chambers installed in front of the tank is also possible. The chamber size should be agreed with the operator.

The basic unit consists of three channels: two with a width of 200 and a height of 365 mm and one with a width of 185 mm and a height of 365 mm, in each layer of the tank, which optimizes the access points to the tank.



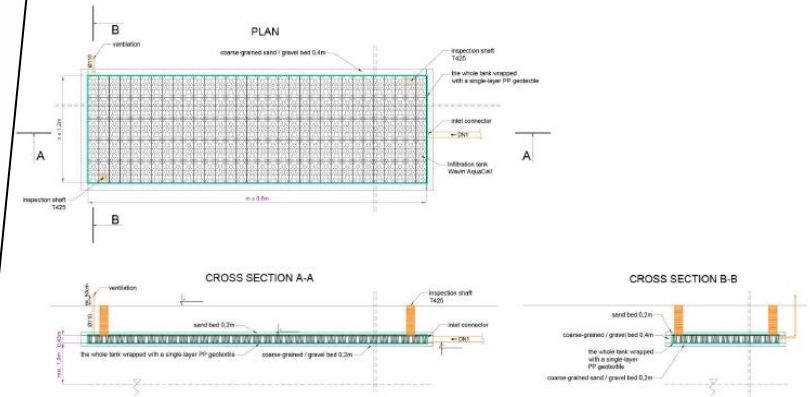
Infiltrating system calculation  
www.waterfolder.com

3

# A complete set of documents, drawings and specs in pdf format

### Draw diagram

#### General schematic diagram of the attenuation and infiltration tank Wavin AquaCell in a single-layer construction



- NOTES
1. Before off-take system is constructed to use of inspection and/or sand tank.
  2. Connecting possible dimensions: 315, 365 and 425.
  3. n - the number of rows, m - the number of units in a row (see reported).
  4. The surface of water depends on the size of the filter.
  5. Dimensions of a single unit: AquaCell 1.2m x 0.6m x 0.425 m.
  6. The height of the bottom plate (C/C) should be selected to the height of a single unit.



# WaterFolder

In numbers

➤ **4 countries:**  
**Poland, Hungary,**  
**Romania, Germany.**



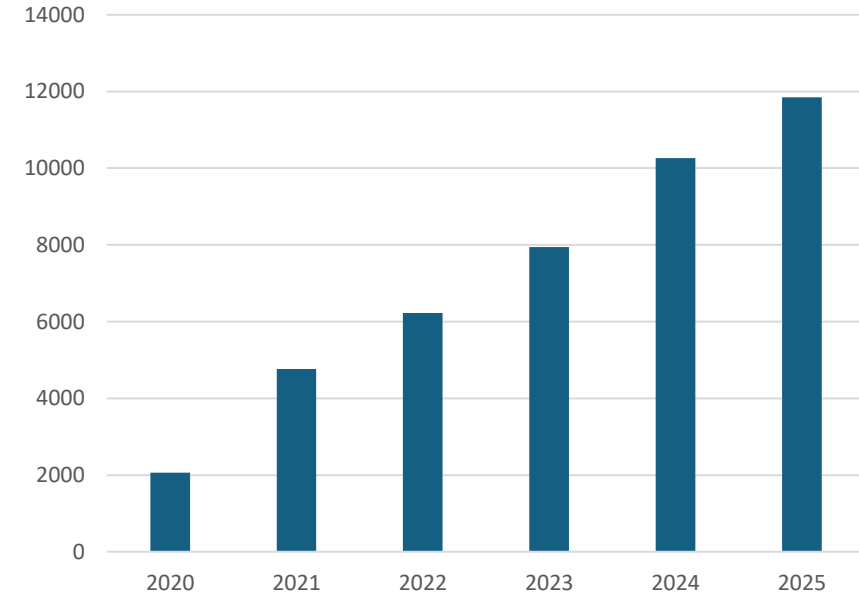
We build **value**,  
by creating local rainfall  
models – rain  
intensities atlases  
or digitalisation  
of existing IDF/DDF  
curves.



# WaterFolder

In numbers

➤ **11 000+ users**  
**(+200/annum)**



# WaterFolder

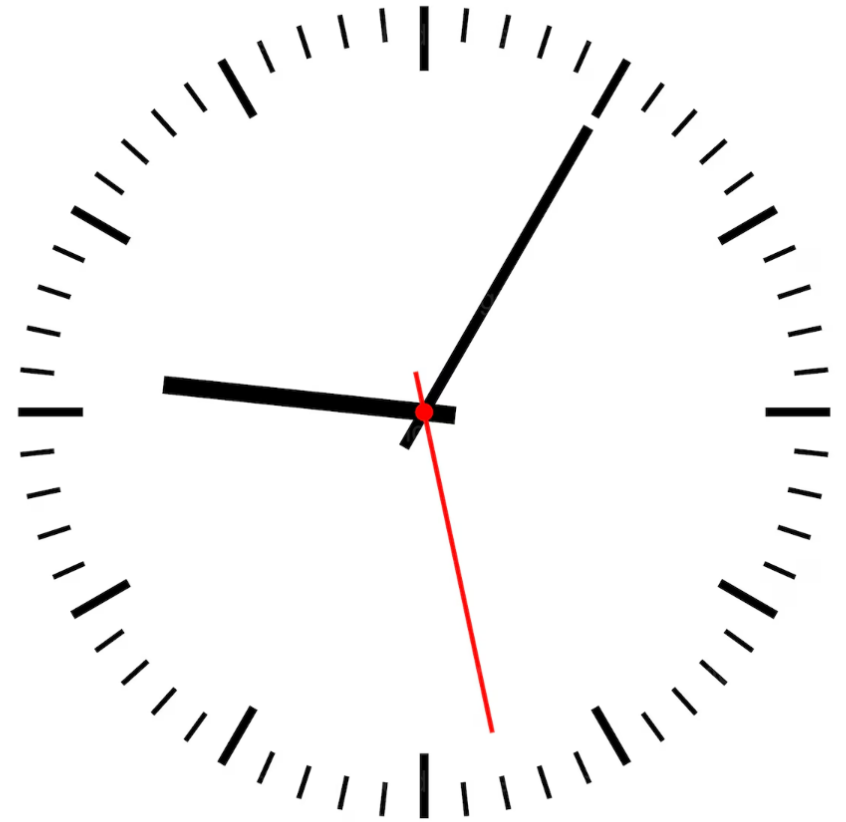
In numbers

➤ **18 000+**  
calculations per  
year



**Average calculation  
time:**

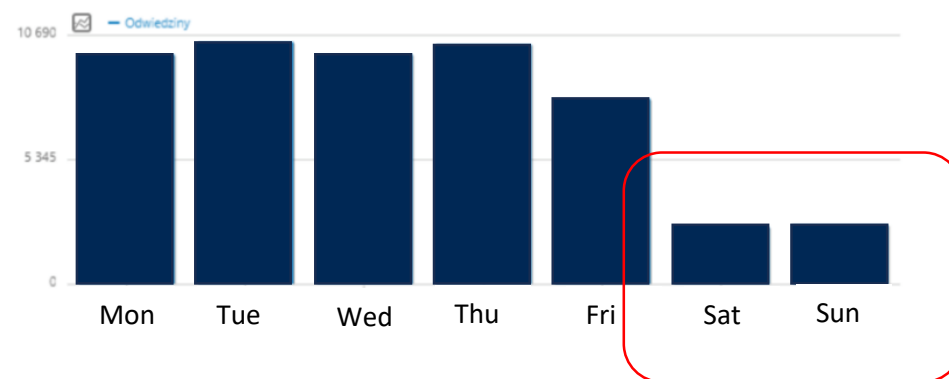
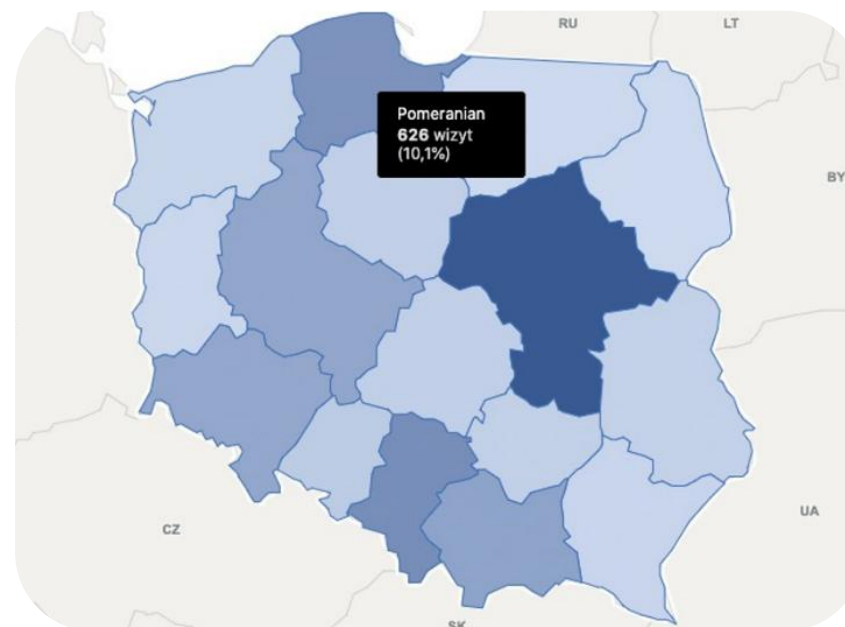
**2 min. 20 sec.**



Important  
commercial knowledge

30%

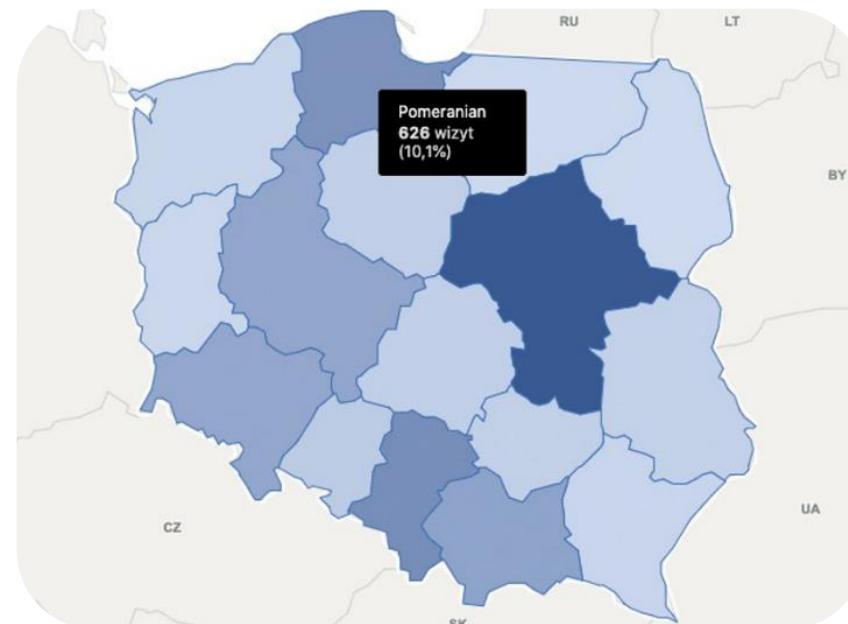
of all calculations are made  
on weekends  
& during evenings



Important  
commercial knowledge

12%

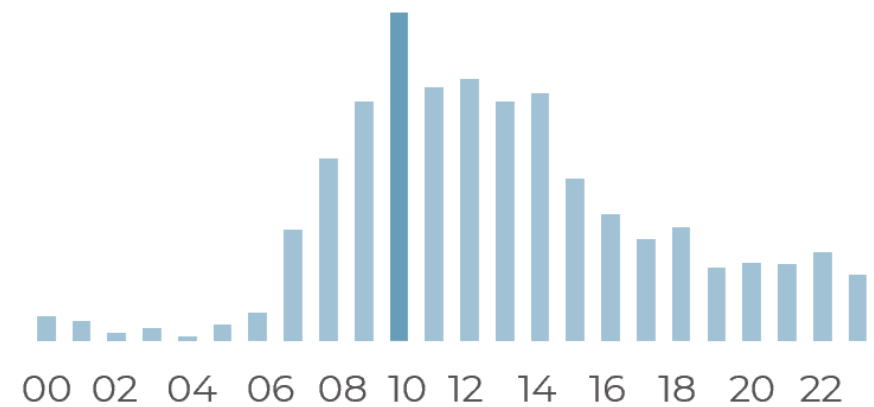
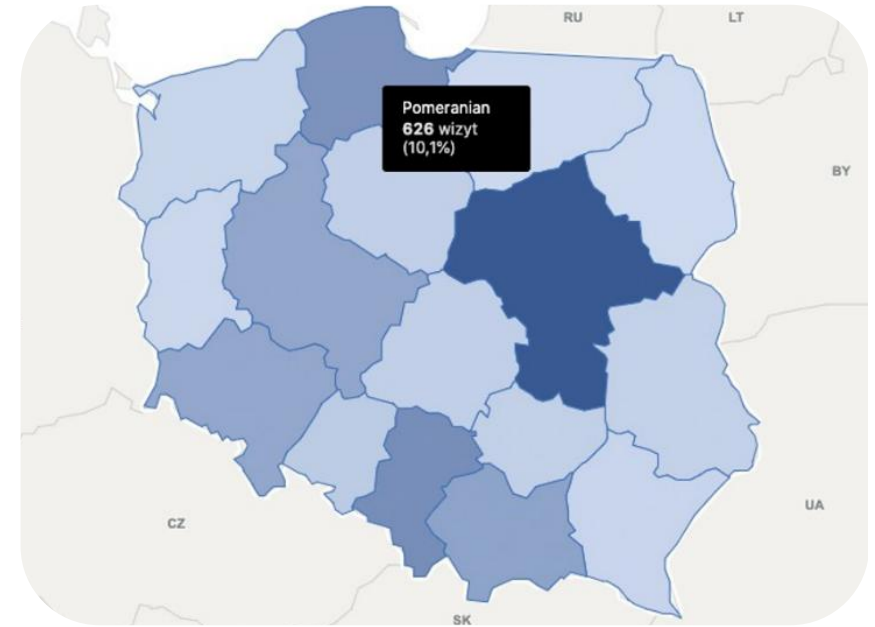
of whole calculations are  
made on mobiles



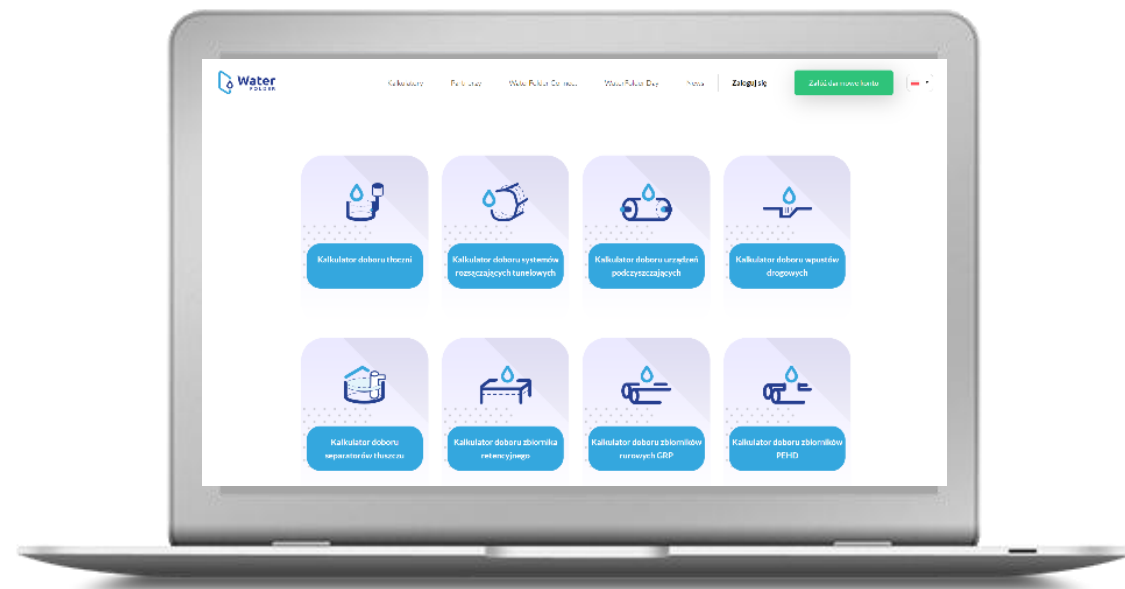
Important  
commercial  
knowledge

Most popular regions

Most popular  
calculation time



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# Conferences for platform users



Synergy effect

thanks to

**cooperation**

of many partners

# Upscaling with WaterFolder.com

- **Countries:** improved answer to floods and draughts
- **Manufacturers:** growth in sales opportunities
- **Designers:** quick, reliable design



# retencja.pl

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