Lecture 3: Counteracting floods, local flooding, the effects of rising sea levels with solutions based on nature. (1.5 h)

General issues related to floods in the city

Slide 2

In Poland, a flood is defined as: *"temporary coverage by water of an area that is not normally covered by water, in particular caused by water rises in natural streams, water reservoirs, canals and from the sea, excluding water coverage of the area caused by water rise in sewage systems".*[1]

NBS solutions for the protection of areas exposed to the effects of floods are designed for the next 100 years: the following indicators are used: frequency, duration and intensity of rainfall, peak flood points or flow velocity.[2]

More about the flood in Poland on the website: https://www.powodz.gov.pl/pl/

Slide 3

Flooding in the town of La Plata.

(see Citadine website for details)

Slide 4

Flooding in the town of Opole.

(see Citadine website for details)

Slide 5 – 13

One of the ways of protecting given urban spaces against river floods is the rehabilitation of regulated rivers. A good example of such an approach is the implementation of the Bishan-

[1] www.powodz.gov.pl https://www.powodz.gov.pl/pl/definicja_i_typy

[2] Kumar P., Debele S., Sahani J., Aragao L., Barisani F., Basu B., Bucchignani E., Charizopoulos N., Sabatino S., Domeneghetti A., Edo A., Finer L., Gallotti G., Juch S., Leo L., Loupis M., Mickovski S., Panga D., Pavlova I., Pilla F., Prats A., Renaud F., Rutzinger M., Basu A., Aminur M., Shah R., Doini K., Opoulou M., Toth E., Ukonmaanaho L., Vranic S., Zieher T., 2020, *Towards an operationalisation of nature-based solutions for natural hazards*, Science of The Total Environment, 731

Ang Mo Kio Park project in Singapore. More about the project on the website: https://www.asla.org/2016awards/169669.html

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Retention ponds - dry. (see Citadine website for details)

Slide 16 -21

Retention pond - wet. (see Citadine website for details)

Slide 22 – 24

Rain gardens. (see Citadine website for details)

Slide 25 – 28

Bioswales. (see Citadine website for details)

Slide 29-30

Drainage container / Stormwater planters. (see Citadine website for details)

Slide 31

Trees. (see Citadine website for details)

Slide 32-33

Swale. (see Citadine website for details)

Slide 34-36

Permeable surfaces. (see Citadine website for details)

Slide 37-47

An example of the comprehensive design of stormwater retention spaces in urban areas is the project for the Zidell Yards District in Portland. More about the project on the website https://www.asla.org/2014awards/332.html

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Rising sea and ocean levels.

In the years 1901-2010, the average level of seas and oceans increased by approx. 19 cm.[3] This is due to global warming (an increase in the average temperature of the earth's surface),[4] and hence:

- melting of ice on land and glaciers,

- increase in water volume - due to its higher temperature.

It is calculated that:

- in the optimistic variant, with the reduction of greenhouse gases by the end of the 21st century, the level of seas and oceans may even rise by 30-60 cm,

- in the pessimistic variant - by 60 - 110 cm. (A critical situation will occur when the glaciers in Antarctica and Greenland melt).[5]

It is estimated that by 2050, 570 cities in the world will be affected by rising sea levels[6] and 150 million people living on the shores.

[3]Kardaś A., Malinowski Sz., 2021, *Zmiany w pogodzie*, Bohdanowicz Z., [w:] Budziszewska M., Kardaś A., (red.) "Klimatyczne ABC. Interdyscyplinarne podstawy współczesnej wiedzy o zmianie klimatu", Wydawnictwa Uniwersytetu Warszawskiego

[4]Kardaś A., 2021, *Emisje gazów cieplarnianych a klimat*, [w:] Budziszewska M., Kardaś A., (red.) "Klimatyczne ABC. Interdyscyplinarne podstawy współczesnej wiedzy o zmianie klimatu", Wydawnictwa Uniwersytetu Warszawskiego

[5]Kardaś A., Malinowski Sz., 2021, *Zmiany w pogodzie*, Bohdanowicz Z., [w:] Budziszewska M., Kardaś A., (red.) "Klimatyczne ABC. Interdyscyplinarne podstawy współczesnej wiedzy o zmianie klimatu", Wydawnictwa Uniwersytetu Warszawskiego

[6]www.c40.org https://www.c40.org/other/the-future-we-don-t-want-staying-afloat-the-urban-response-to-sea-level-rise

These threats are perfectly presented on the website https://coastal.climatecentral.org/map/6/-58.3368/-31.4504/?theme=sea_level_rise&map_type=coastal_dem_comparison&basemap=roadmap&contiguous=true&elevation_model=coastal_dem&forecast_year=2050&pathway=rcp45&percentile=p50&refresh=true&return_level=return_level_1&slr_model=kopp_2014

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Gray infrastructure.

Currently, measures are being taken to protect the coast with the use of traditional components, the so-called gray infrastructure, as well as new technological solutions. This type of project is the system protecting Venice (the tool was called MOSE – after Moses). To protect the city and the world heritage it represents, a special kind of gate was built. They are in the form of crates 20 m wide and varying in length from 18.5 to 29 m. Ultimately, they are to form a 1.6 km long protective strip consisting of 78 metal crates. They are to protect the city from a flood of 3 meters high. The cost of the project is estimated at 6.5 billion[7]. During storms, the lagoon with historical buildings will be separated from the part of the Adriatic Sea, thus becoming something like a closed reservoir. This is to protect the city from its regular flooding almost 5 times a year.[8]

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A storm wave defined as: *"abnormal rise in sea water level during a storm (...) and is measured as the height of the water above the normal predicted astronomical tide*". Storm waves are caused by strong winds that push water towards the coastal zone, which can cause land erosion and flooding. To counteract these negative effects, various NBS tools are used, such as: building salt marshes, dunes or recreating sandy beaches, artificial reefs or living coastlines.[9]

[7]www.inzynieria.com https://inzynieria.com/geoinzynieria/artykuly/57072,wydano-5-5-mld-eur-a-wenecje-dalej-zalewa,dlaczego-mojzesz © inzynieria.com

[8]www.rp.pl https://www.rp.pl/artykul/1056850-Na-ratunek-Wenecji.html

[9]Kumar P., Debele S., Sahani J., Aragao L., Barisani F., Basu B., Bucchignani E., Charizopoulos N., Sabatino S., Domeneghetti A., Edo A., Finer L., Gallotti G., Juch S., Leo L., Loupis M., Mickovski S., Panga D., Pavlova I., Pilla F., Prats A., Renaud F., Rutzinger M., Basu A., Aminur M., Shah R., Doini K., Opoulou M., Toth E., Ukonmaanaho L., Vranic S., Zieher T., 2020, *Towards an operationalisation of nature-based solutions for natural hazards*, Science of The Total Environment, 731

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Formation of artificial dunes and sandy beaches. (see Citadine website for details)

Slide 53

Planting of mangrove forests. (see Citadine website for details)

Slide 54

Formation of artificial reefs. (see Citadine website for details)

Slide 55

Building live coastlines. (see Citadine website for details)

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www.inzynieria.com https://inzynieria.com/geoinzynieria/artykuly/57072,wydano-5-5-mld-eur-a-wenecje-dalej-zalewa,dlaczego-mojzesz © inzynieria.com

www.rp.pl https://www.rp.pl/artykul/1056850-Na-ratunek-Wenecji.html