The impact of agriculture holdings on the concentration of mineral compounds of nitrogen and phosphorus in drainage waters

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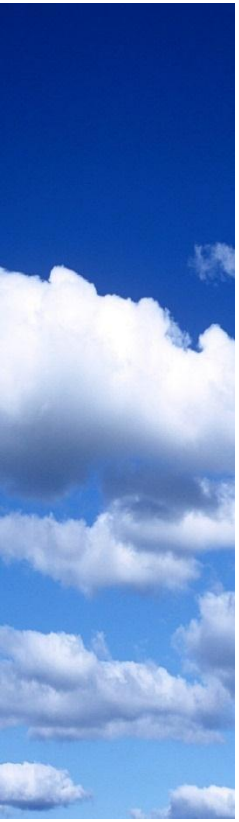

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The project

„Modelling of the impact of farms and the use structure of the catchment area on the example of the Puck commune on the quality of land and sea waters located in the coastal zone of the Baltic Sea - the Integrated Information and Prediction Service WaterPUCK"

The main objective

Assessment of the impact of agricultural holdings and the land use structure in the Puck commune on pollution with **nitrogen, phosphorus** and pesticides in the catchment of **surface water**, groundwater and, as a result, **marine water** in the Puck Bay region using computer models.

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Study area

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The Baltic Sea and the Puck Bay

Surface area – 377,000 km^2
Catchment area – 1,641,650 km^2
Max depth – 459 m
Average depth – 55 m
Water volume - 21,700 km^3
Residence time – 25 years
Average salinity – 7 PSU

Surface area – 364 km^2
Max depth – 55 m

The Puck Bay

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Sampling

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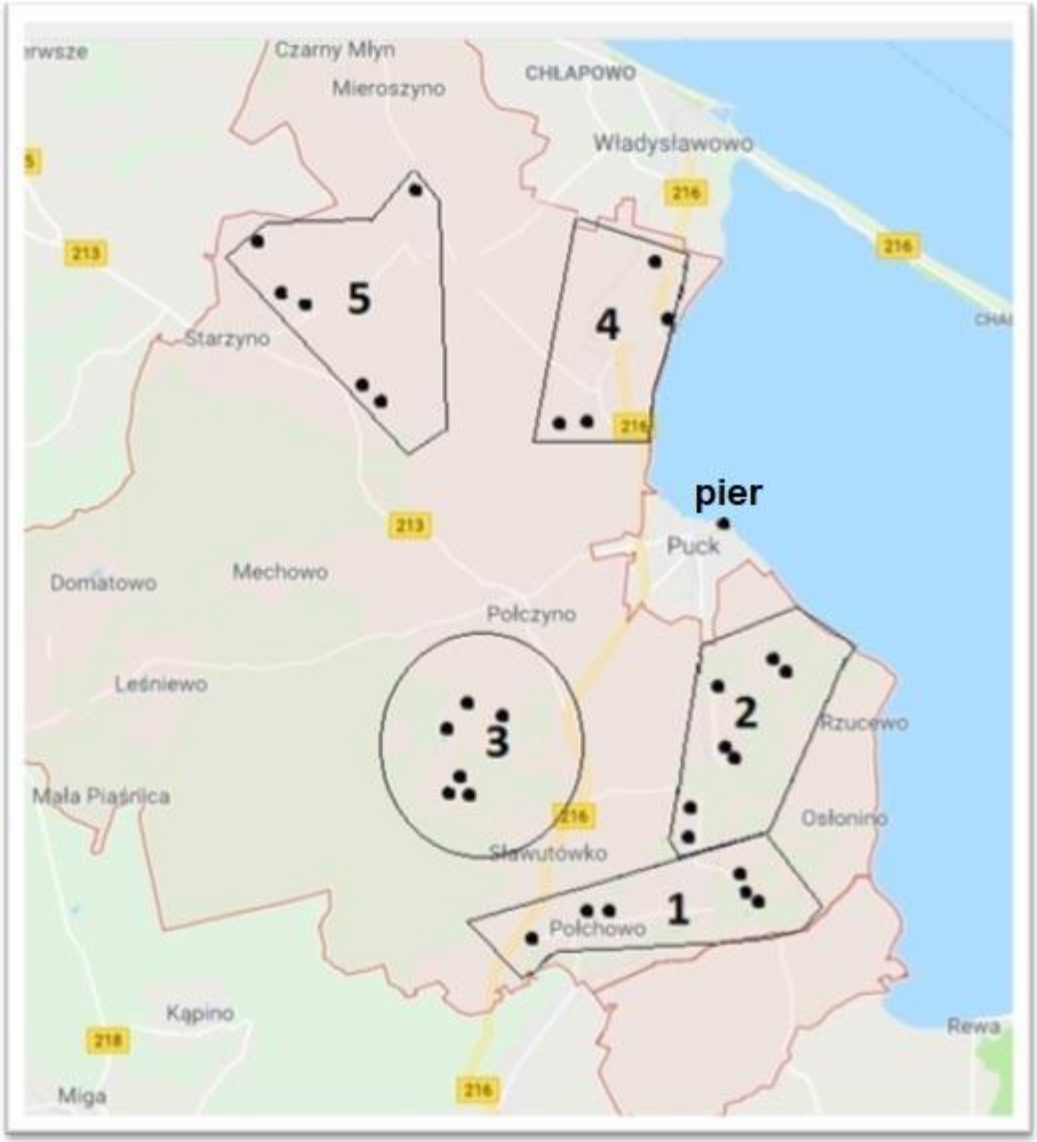


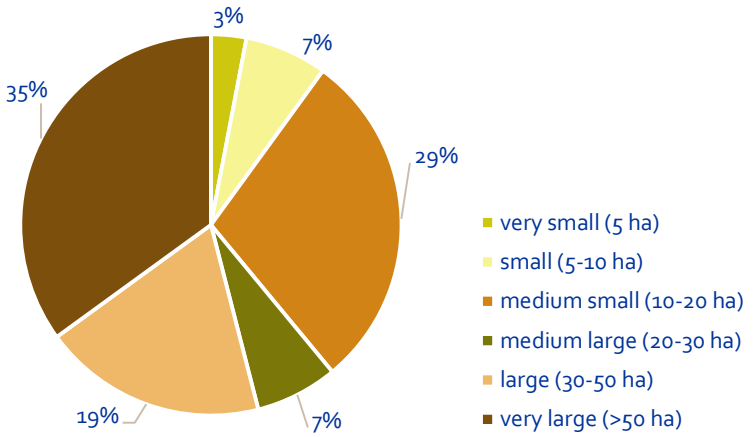
31 farms – 3,6% of all farms in Puck commune

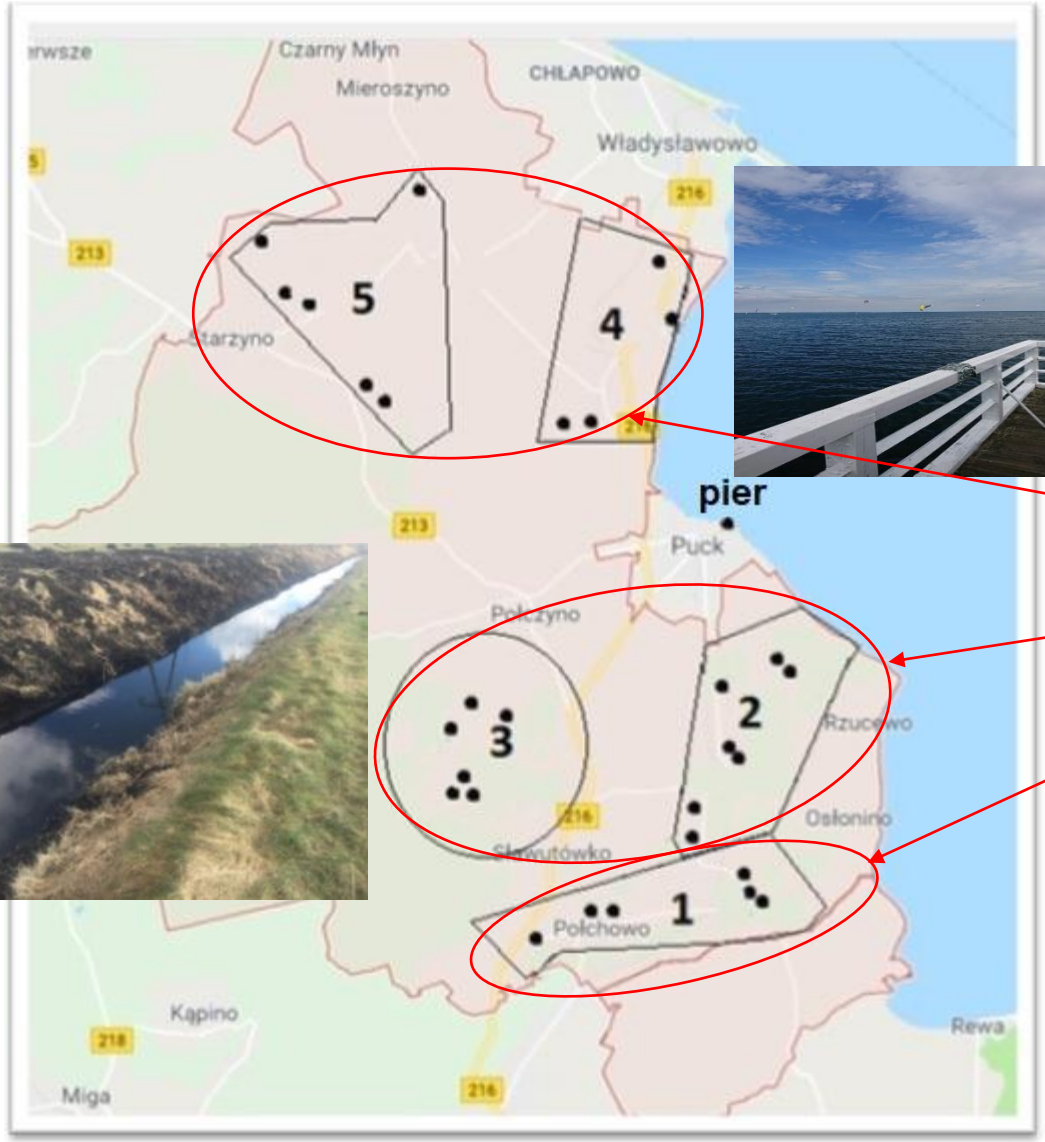
Farm area – 5-130 ha (average 37,9 ha)

Farmlands – average 50,79%

Grasslands – average 12,77%

The size-structure of surveyed farms





- Surface water samples were taken from drainage ditches (neighbouring of 31 farms), 3 main rivers of Puck catchment and from the Puck Bay

Bladzikowski Stream catchment - BS

Gizdebka river catchment - G

Mrzezino Canal catchment MC

- Water sampling period: January - September 2018
- Frequency: every 2 months

Analysis

Measuring equipment and applied methods of analysis

Spectrophotometric technique:

- Total nitrogen (PN-EN ISO 11905-1; PB-27)
- Total phosphorus (PB-20; PB-31)
- Phosphate phosphorus (PB-07; PB-32)
- Nitrate nitrogen (PB-28)

Ion chromatography:

- Nitrate nitrogen (PN-EN ISO 10304-1:2009/AC:2012)

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Results

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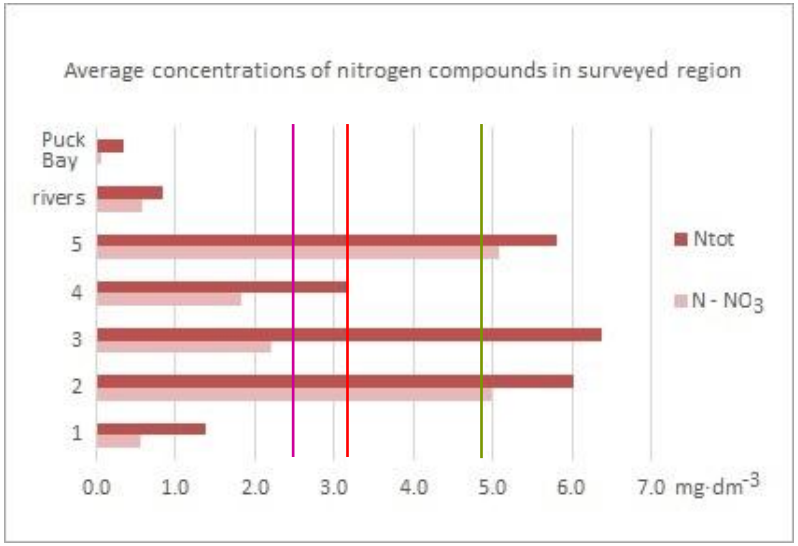
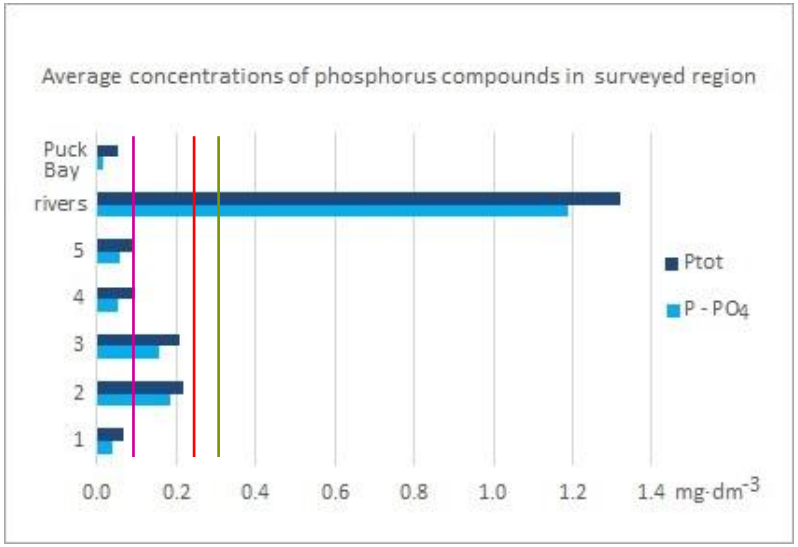
Average concentrations of nutrients in drainage diches, rivers and water from the Puck Bay





Limit values according

Polish law regulation*:

1st class of water quality

Ntot <**3.2** mg·dm^{-3} Ptot <**0.25** mg·dm^{-3}

2nd class of water quality

Ntot <**4.9** mg·dm^{-3} Ptot <**0.30** mg·dm^{-3}

* Regulation of the Minister of the Environment of July 21, 2016 on the method of classification of the state of surface water bodies and environmental quality standards for priority substances (Journal of Laws of 2016, item 1187)

Recommendation of HELCOM-CART (Country-Allocated Reduction Targets, 2013):

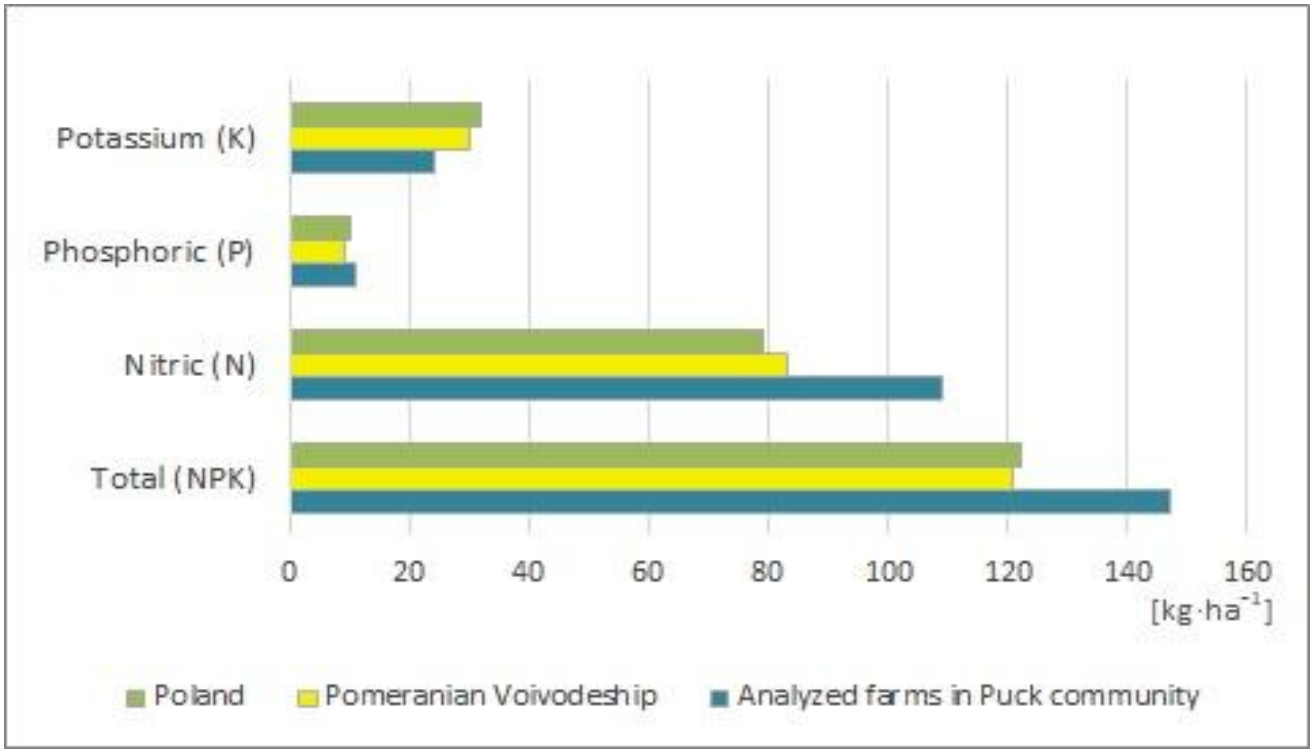
Ntot **2.5** mg·dm^{-3} Ptot **0.07** mg·dm^{-3}

Background value

0.067 mg P dm^{-3} in Vistula River

0.083 mg P dm^{-3} in Odra River

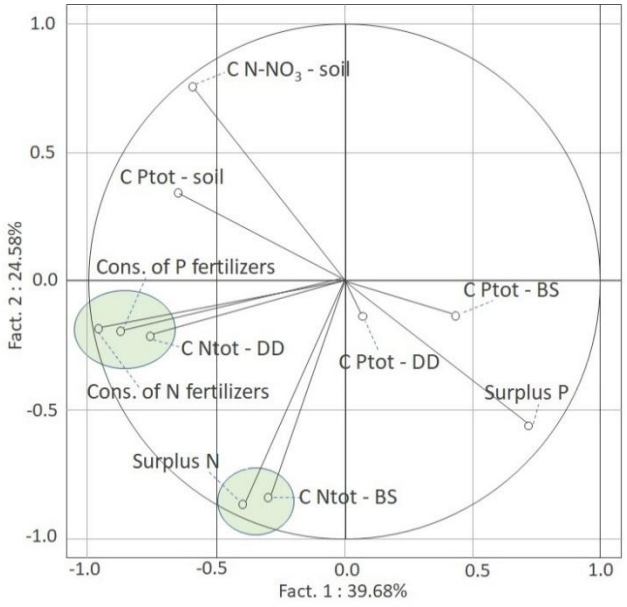
Consumption of mineral fertilisers



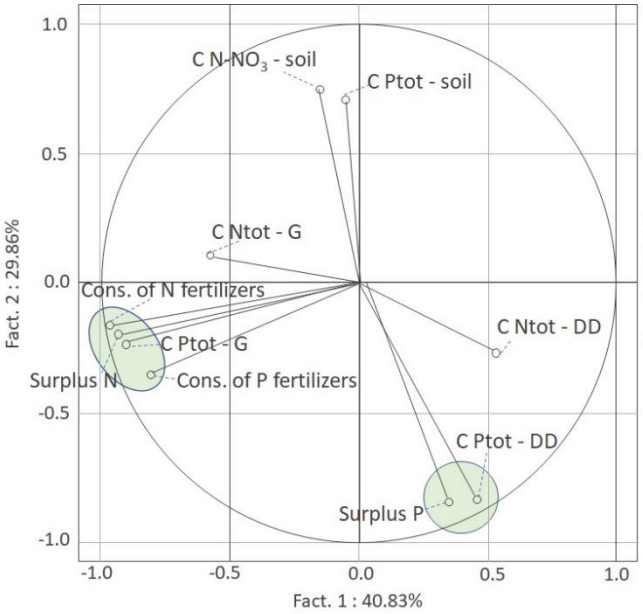
Consumption of mineral fertilisers (calculated as a pure component) per 1 ha of agricultural land in the 2016/2017 marketing year.

Source: https://stat.gov.pl/obszary-tematyczne/rolnictwo-lesnictwo/rolnictwo/srodki-produkcji-w-rolnictwie-w-roku-gospodarczym-20162017,6,14.html (Polish version) (access: 16.05.2019)

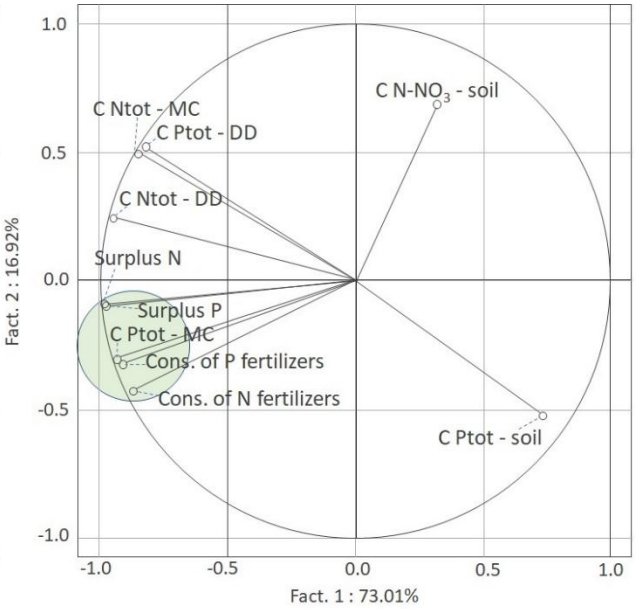
Correlations between concentrations of nutrients in stream (C Ptot – BS, C Ntot – BS), drainage diches (C Ptot – DD, C Ntot – DD), soil (C Ptot – soil, C N-NO3 – soil), fertilizer consumption and surplus nutrients



Bladzikowski Stream catchment



Gizdebka catchment



Mrzezino Canal catchment

WaterPUCK Web Service and Calculator CalcGosPuck

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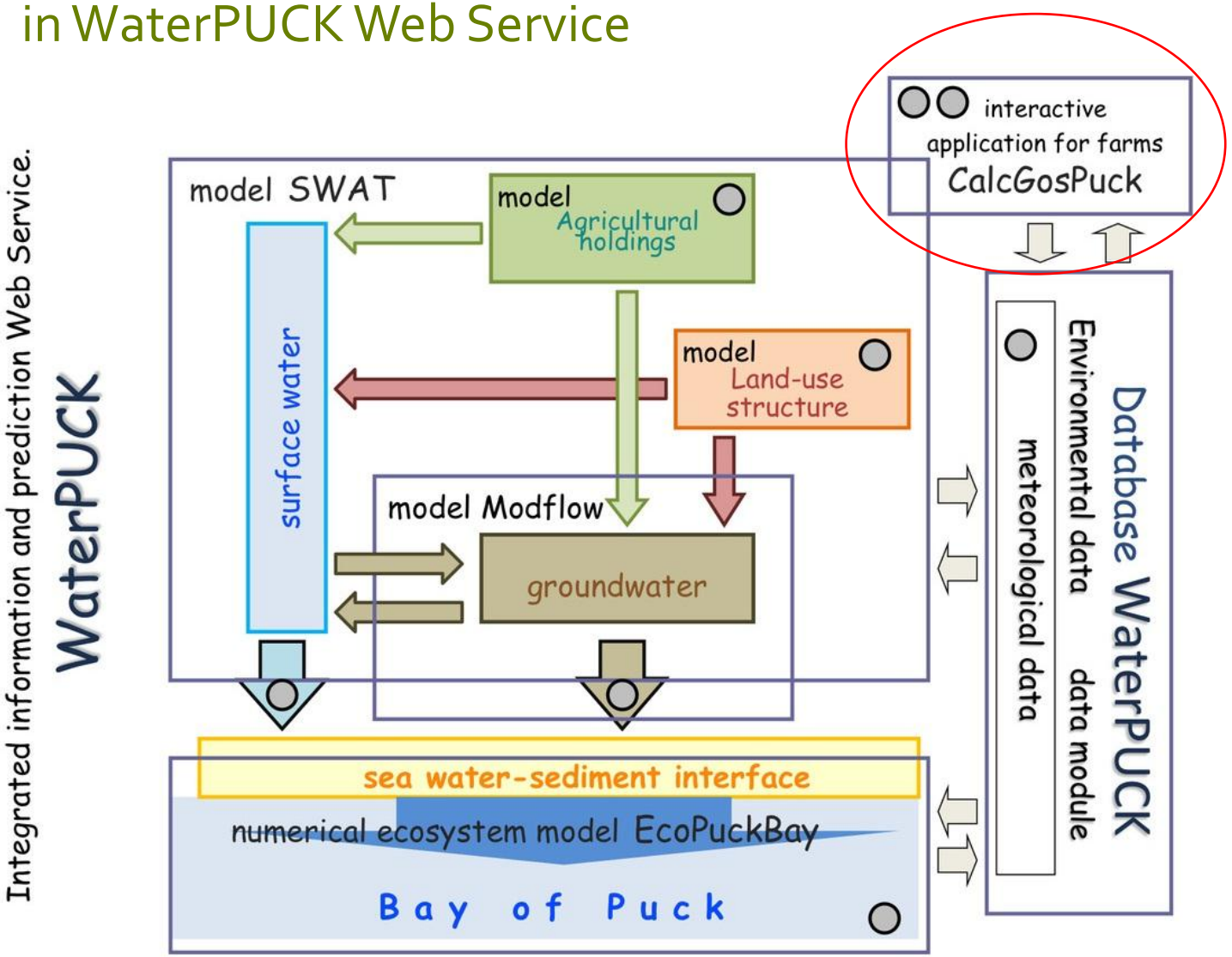
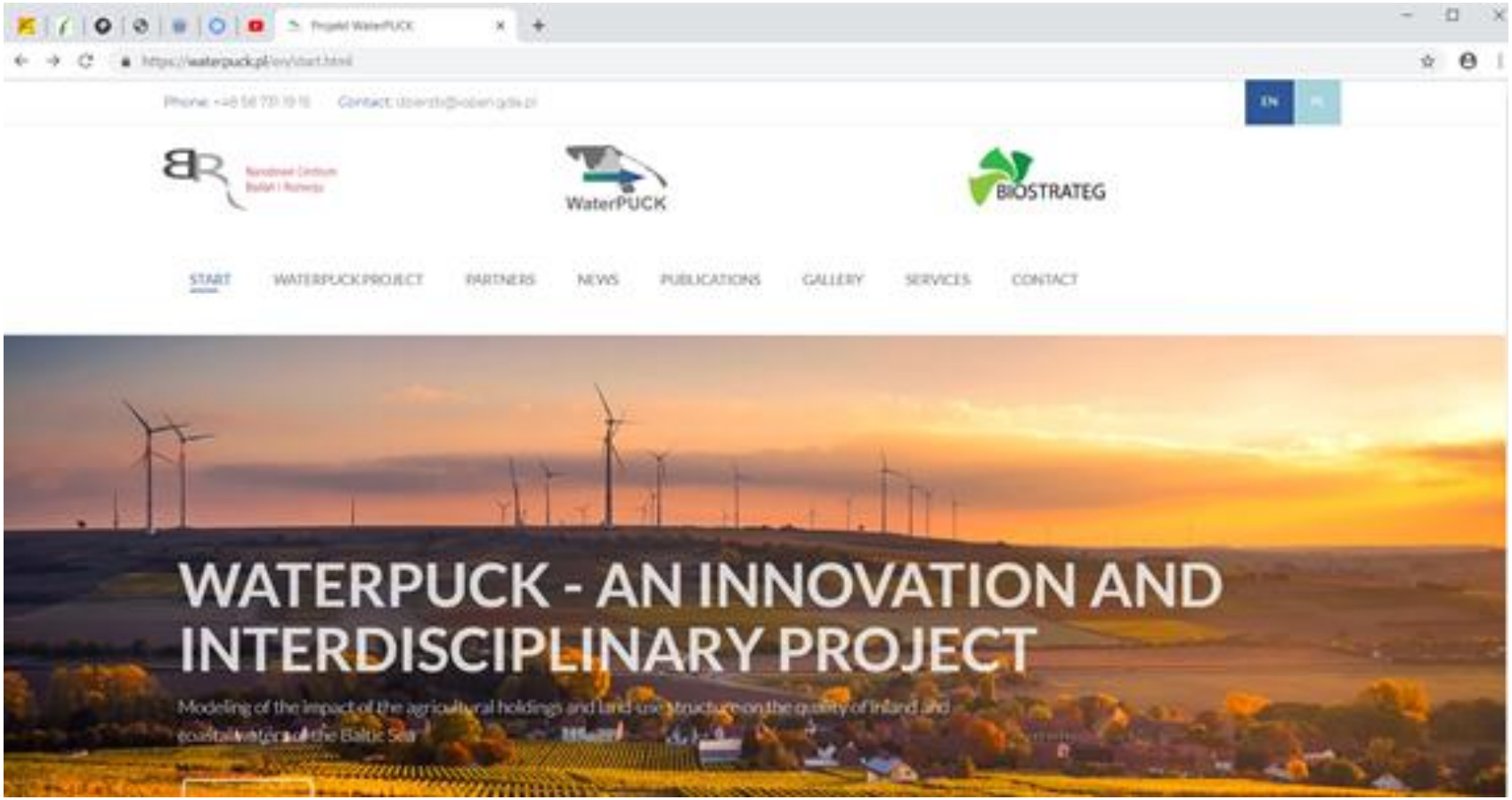
The shame of water and contaminant fluxes covered in WaterPUCK Web Service



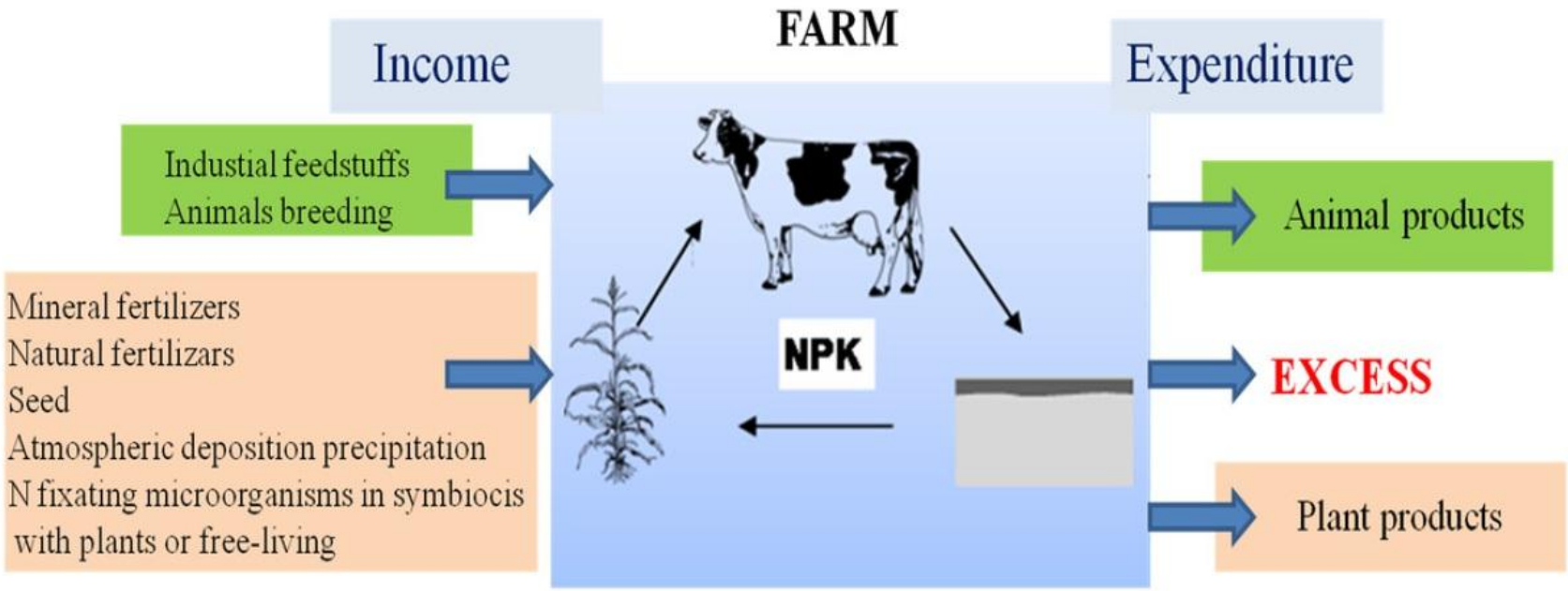
Calculator CalcGosPuck

https://waterpuck.pl/en/start.html



Calculator CalcGosPuck

Balance of nutrients at farm level based on input and output streams on the farm.



The difference between the mass of **Income** and **Expenditure** is defined as the balance (surplus or deficit).

Conclusions

Conclusions

- Enrichment of agricultural areas with fertilizers containing nitrogen compounds (mainly ammonium forms: urea, nitrogen saltpetre, ammonium sulphate) and phosphorus compounds (potassium salts and ammonium phosphate) causes an increase in concentration of nutrients in surface waters.
- In more than half of water samples taken from drainage ditches, limit values for at least one eutrophication indicator were exceeded.
- The content of phosphorus compounds in surface water of studied rivers exceeded all limit values. However the natural background of phosphorus is high in Polish rivers.

Conclusions

- It was found that nitrates are easily washed out from soils, which means that the eutrophication index is more often exceeded.
- Phosphates are leached to a small extent from agricultural land and more often they form stable sorption complexes.
- Based on the study performed, it was found that the maximum concentrations of both parameters occurred in regions 2 and 3 of the Puck commune (Gizdebka catchment).
- The CalGosPuck calculator, which is one of the final products of the WaterPuck project, really helps farmers in the rational planning of using fertilizers in accordance with the sustainable development policy.

Long-term effects of the project WaterPUCK

identifying sources of biogenic substances and pesticides and limiting the amount of fertilizers used

modeling of processes and mechanisms affecting the persistence of nutrients in the environment (e.g.. denitrification)

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modeling of pollutant loads discharged to surface and underground waters and their distribution in the Puck Bay

predicting changes in charges of chemical substances following changes in land development

Easing the development of eutrophic processes

Improving the quality of the natural environment of the Puck Bay

Increasing of biodiversity and abundance of organisms

Increasing the attractiveness of the entire region

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Thank you for attention

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