

WaterPUCK: A new approach for investigating the impact of pesticides and nutrient flux from agricultural holdings and land-use structures on the coastal waters of the Baltic Sea

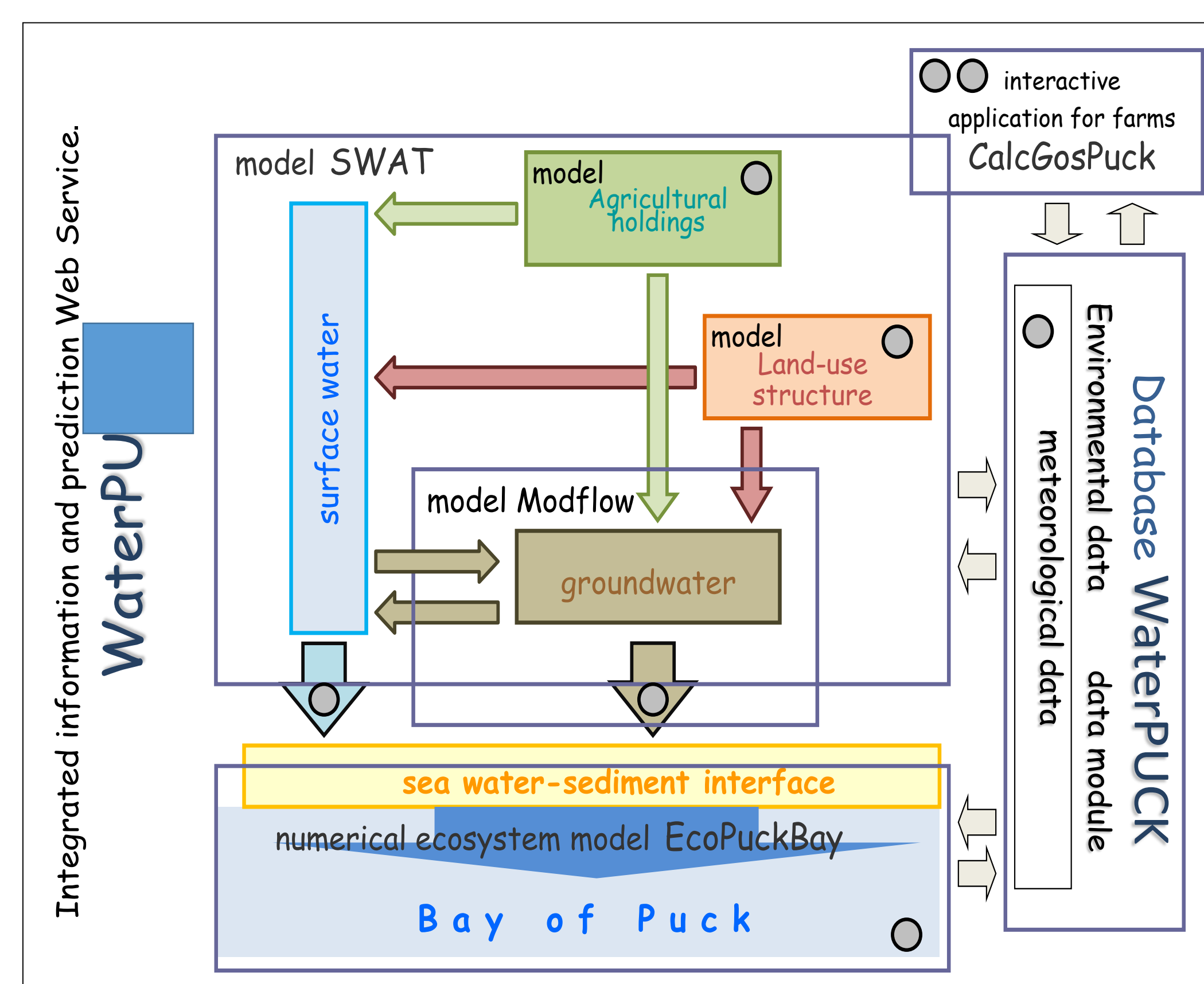
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ABSTRACT

General concept of a new method as 'Integrated information and prediction Web Service WaterPUCK' for investigation influence of agricultural holdings and land-use structures on coastal waters of the southern Baltic Sea is presented. WaterPUCK Service is focused on determination of the current and future environmental status of the surface water and groundwater located in the Puck District (Poland) and its impact on the Bay of Puck the southern Baltic Sea) environment. It will highly desired tool for land-use and environment management. WaterPUCK combines several different components and methods such as retrospective analyses of existing monitoring data sets, in situ measures and the application of various models to estimate main mechanisms and threats responsible for the pollution transport from the agricultural holdings and land-use structure to the surface and groundwater and potential predictability of environment change of the Puck District and the Bay of Puck ecosystem. WaterPUCK Service will integrate several models, such as a surface water model based on SWAT, a groundwater flow model based on MODFLOW, a 3D-ecohydrodynamic model of the Bay of Puck called EcoPuckBay and an agriculture calculator called CalcGosPuck. The WaterPUCK Service is constructed as part of the project with the same name 'WaterPUCK'.

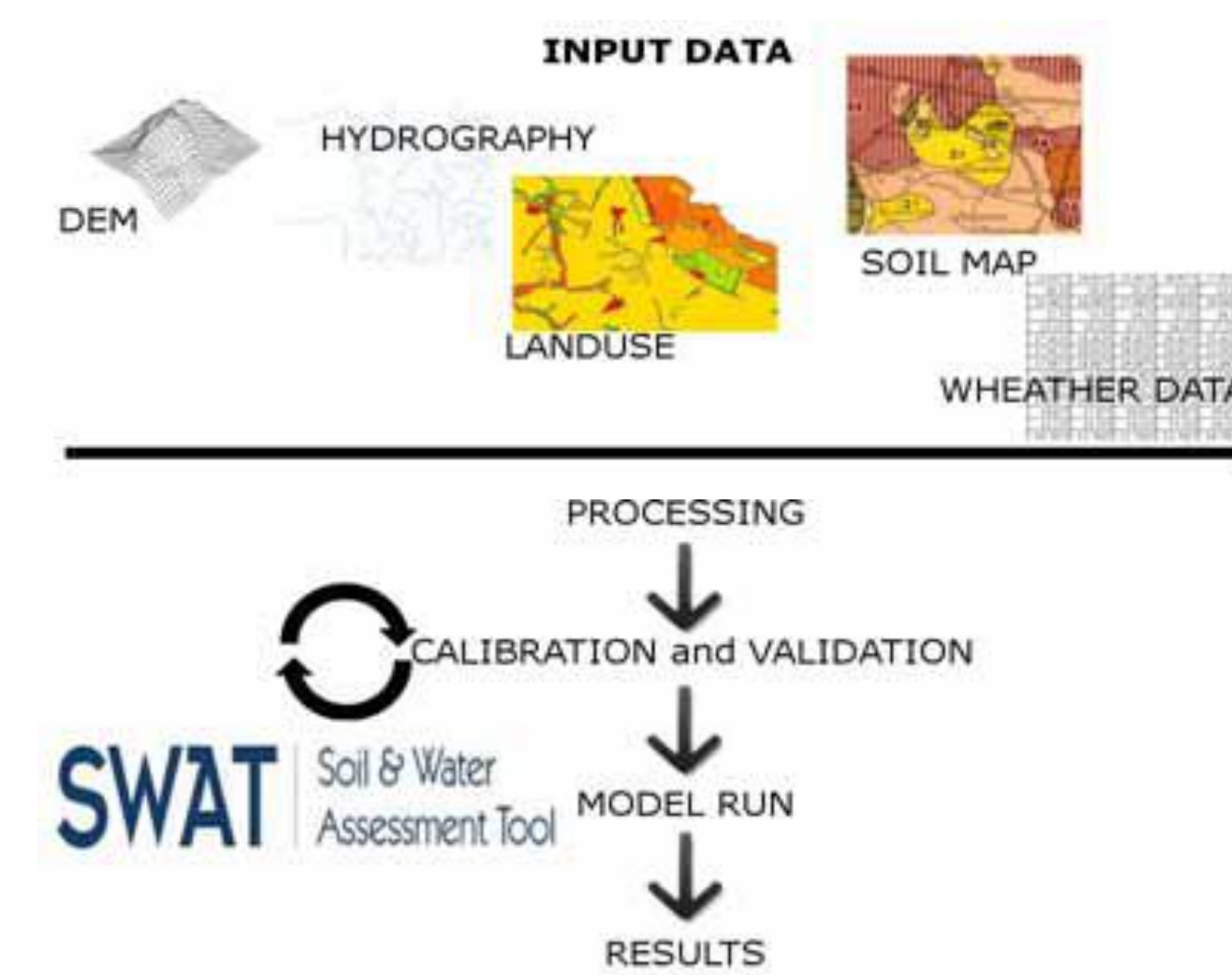
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- a surface water model based on SWAT,
- a groundwater flow model based on MODFLOW,
- a 3D-ecohydrodynamic model of the Bay of Puck called EcoPuckBay and
- an agriculture calculator called CalcGosPuck.



SWAT model

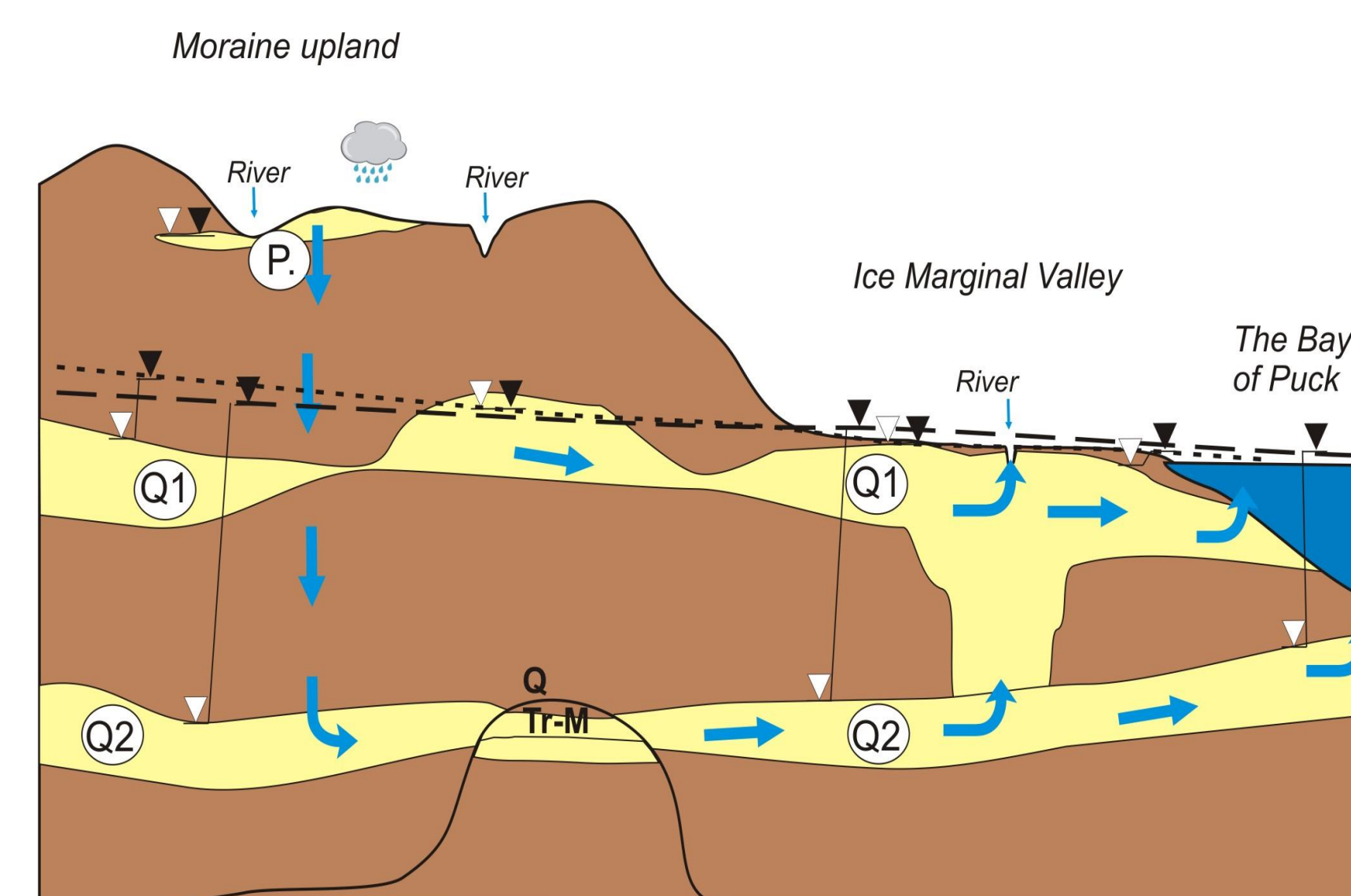
SWAT model (Soil and Water Assessment Tool) has a river basin structure and will be use to predict the influence of changes in the way of farming for: water balance, erosion degree, nitrogen and phosphorus compounds pollution, pesticides, bacteria and heavy metals. SWAT model is a physically based, time continuous simulation model that operates on a daily time step at catchment scale



SWAT model schema; source: own elaboration

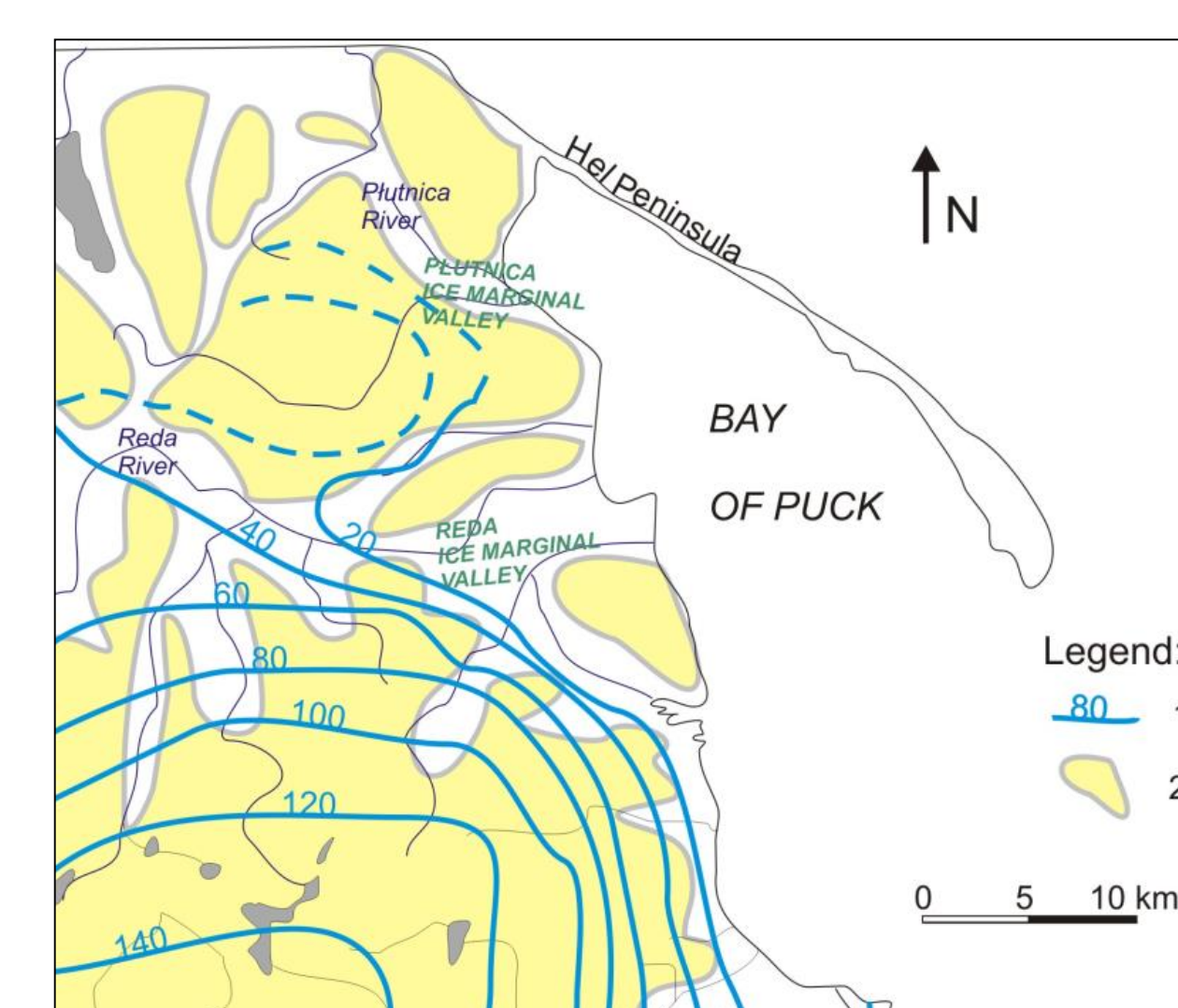
MODFLOW model

Based on the knowledge of the hydrogeological system, a steady-state mathematical model of the Puck multi-aquifer system is developed. The extent of the multi-aquifer system is limited by the rivers watersheds and the drainage area of the Puck Bay. The mathematical modelling is based on the finite difference solution of the MODFLOW program, which is the most commonly used code for simulating groundwater flow.

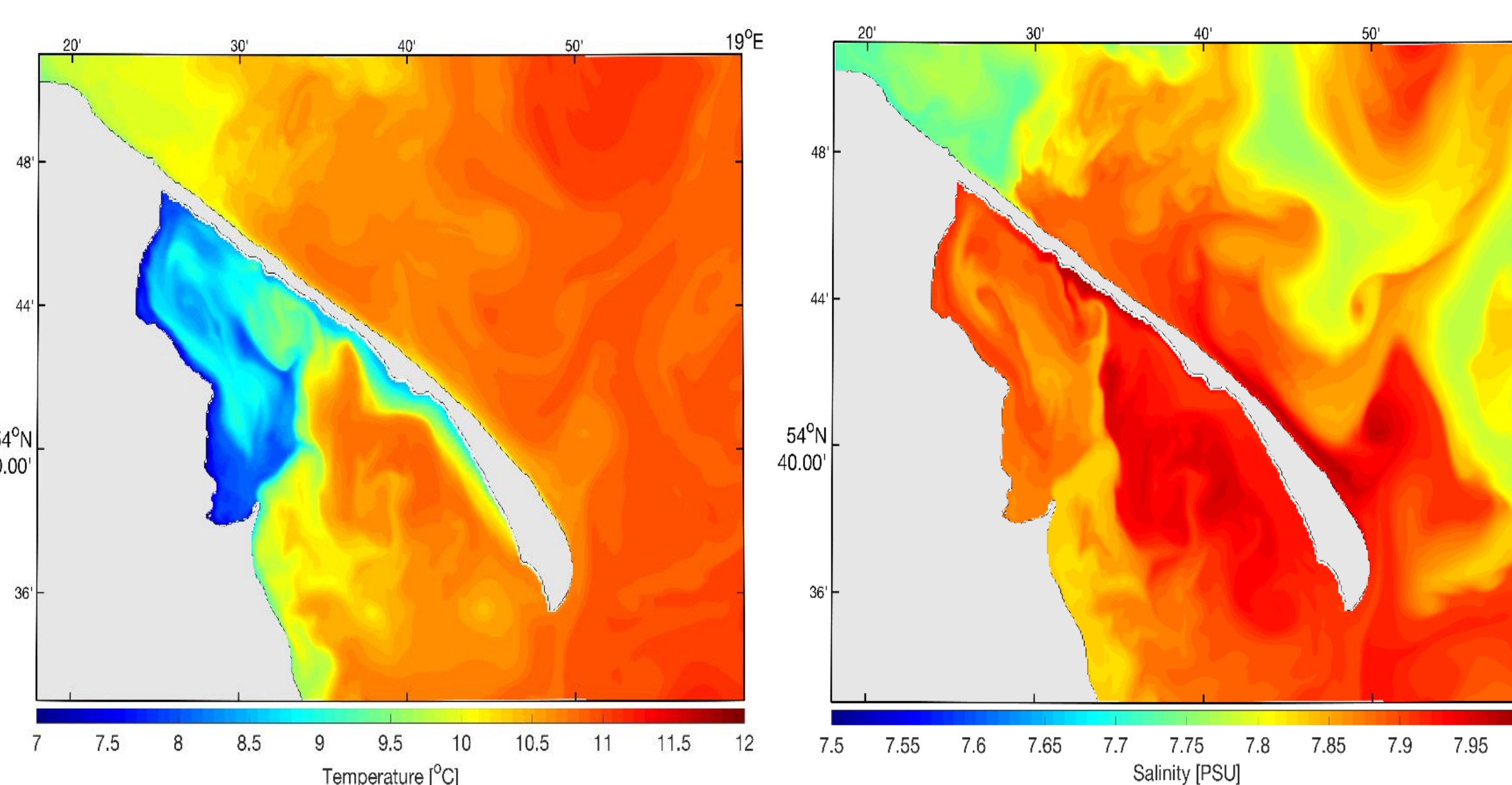


Simplified diagram of groundwater flow, Q1 and Q2 upper and lower Quaternary aquifers, P – local perched groundwater.

Examples of preliminary results



Hydraulic head distribution for the Quaternary (Q1) aquifer (m a.s.l.). 1 - head contour line, 2 – moraine upland

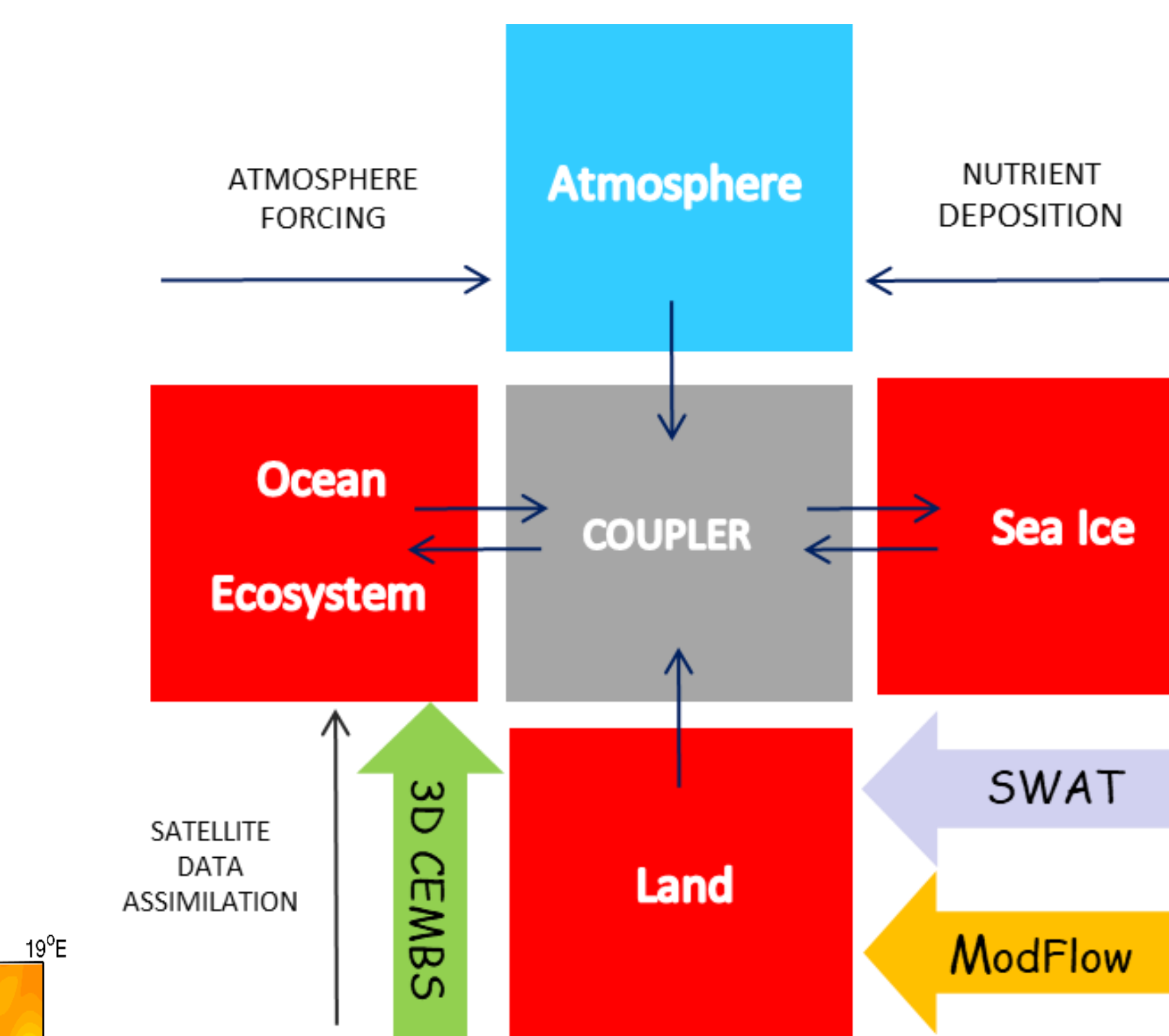


Temperature and Salinity distribution in the surface layer in Bay of Puck in November (3D EcoPuckBay).

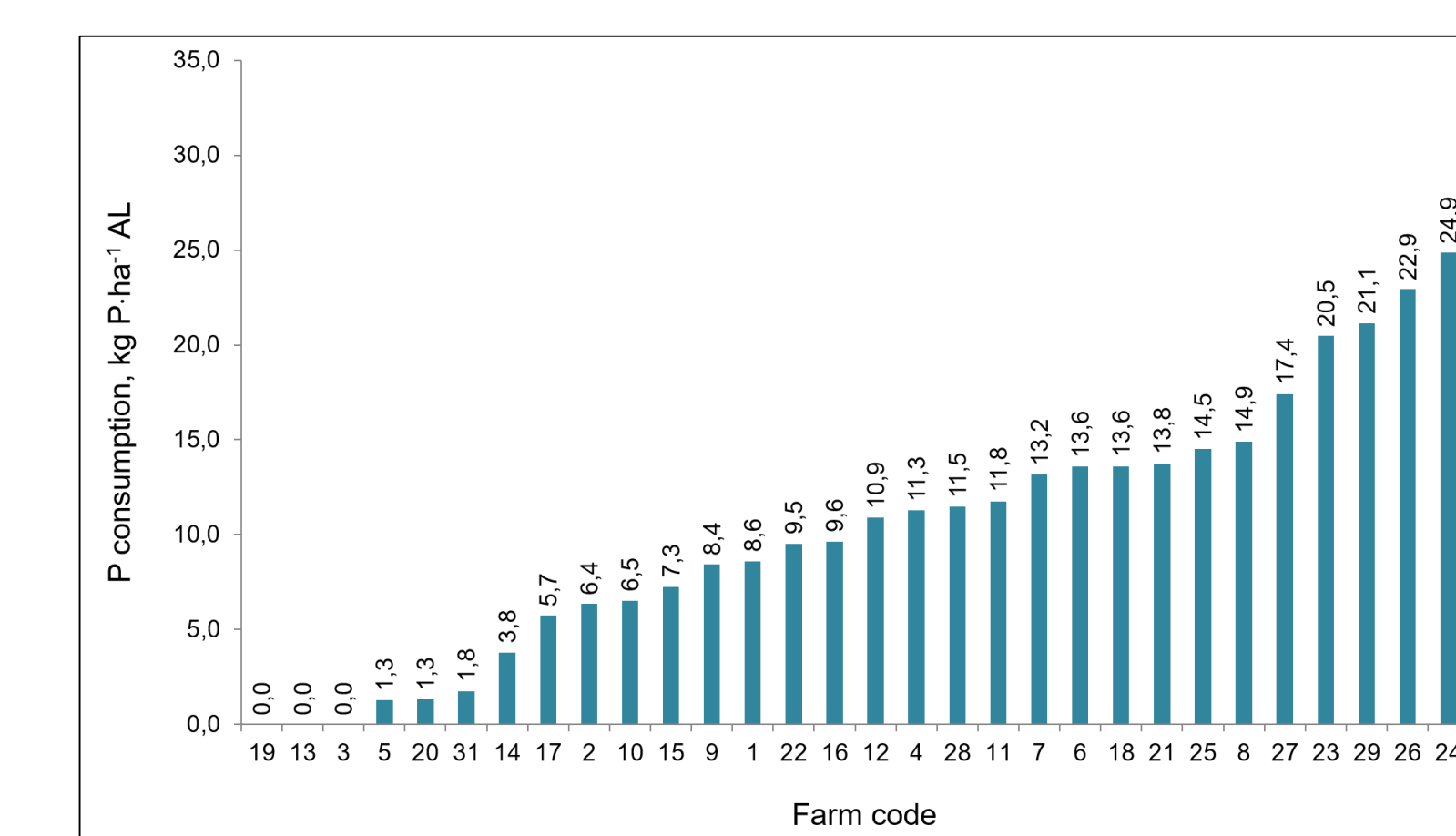
3D EcoPuckBay model

EcoPuckBay model consists of active ocean, ecosystem and ice modules, coupled together with active land module (SWAT plus ModFlow) which provide data, such as freshwater inflow and nutrient discharge from rivers and ground, and passive atmospheric module which provide data such as weather forecasts from external sources (UM ICM).

From the side of the open sea, boundary conditions will be fed from the three-dimensional model of the ecosystem for the Baltic Sea 3D CEMBS (www.cembs.pl). The model horizontal resolution is 1/960°, which corresponds to ca. 115 m grid. Vertically model is divided into 19 layers. The first of 5 layers is 0.4 metres thick.



Configuration of the 3D EcoPuckBay model



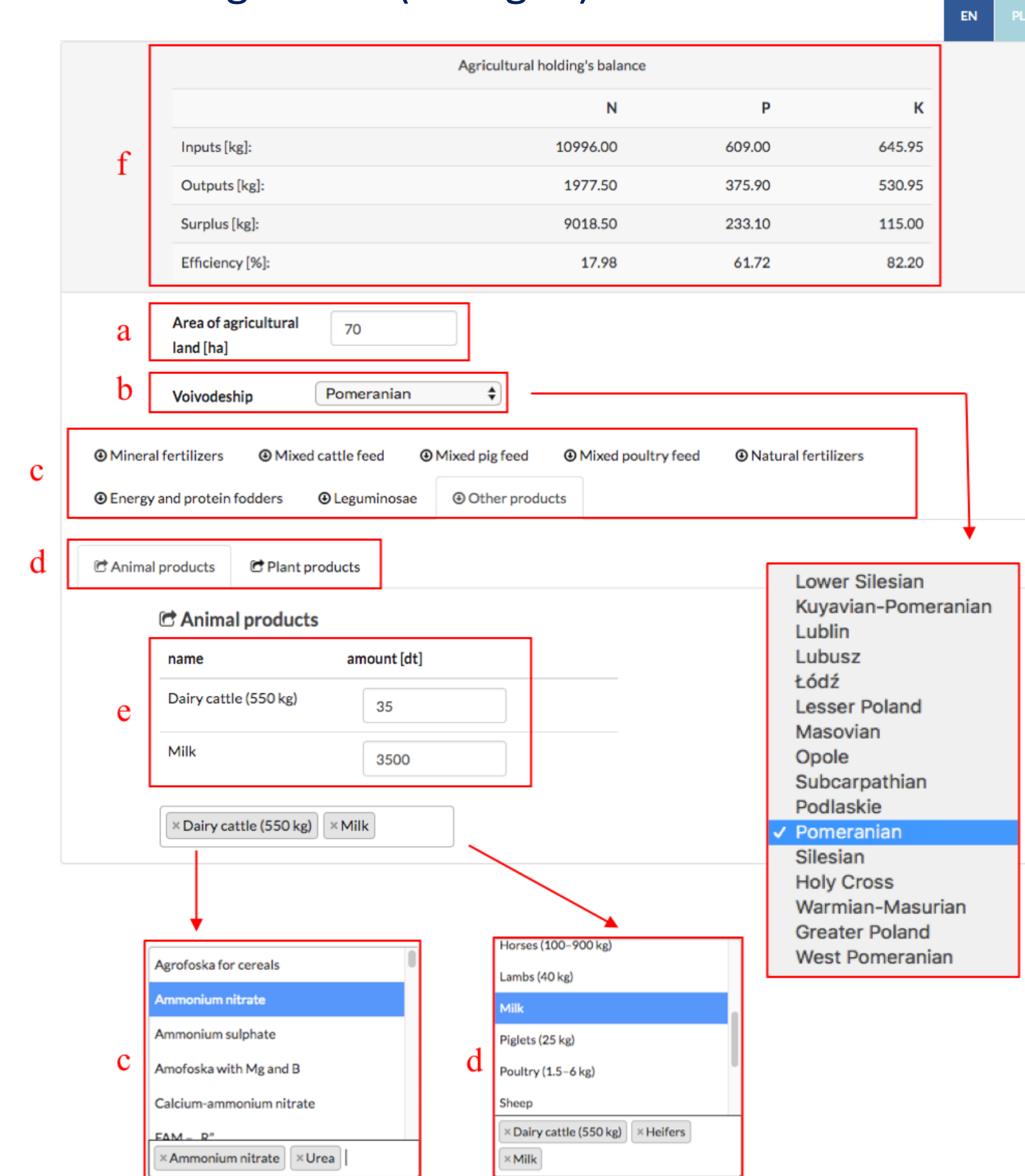
The consumption of phosphorus fertilizers in the individual farms in farms participating in the WaterPUCK project.

CalcGosPuck calculator

The CalcGosPuck calculator will be working as an independent application by which will can be to plan the fertiliser usage by farmers in order to obtain the best harvest policy. Preparation of the nutrient balance at farm level by the "at farm gate" method involves determination of input and output streams on the farm.

Inputs are the masses of nutrients brought onto the farm in the form of:

- 1) Purchased materials:
 - mineral fertilisers
 - commercial feedstuffs
 - breeding and replacement animals
 - other agricultural inputs, for example, manure, straw, seed
- 2) Biological fixation by plant material (legumes and nitrogen)
- 3) Atmospheric deposition
- 4) Biological fixation in soil by non-symbiotic microorganisms (nitrogen).



CalcGosPuck calculator

www.waterpuck.pl

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