BALTIC COMPASS

Baltic Sea Region Programme 2007–2013

Part-financed by the European Union (European Regional Development Fund and European Neighbourhood and Partnership Instrument)

Baltic Compass promotes sustainable agriculture in the Baltic Sea region

Baltic Compass is a pan-Baltic EU-financed project where the 22 partners from all the riparian countries share their practical and scientific knowledge concerning agriculture and the environment. Baltic Compass has a broad approach to addressing the agri-environmental challenges, covering agricultural best practices, investment support and technologies, water assessment and scenarios, and policy and governance issues.

The project supports positive development in

- stronger stakeholder involvement in transnational and cross-sector policy dialogues
- wider utilization of best practice and decision support tools
- strategic investments in best available technologies
- broader use of agricultural environmental impact assessment for spatial planning in high risk area management
- more cost-efficient agri-environment programs and measures taken to reduce eutrophication
- stronger integration between the Baltic Sea region countries
- transforming Baltic Sea region to a pilot area for innovations to combat eutrophication

Baltic Compass started its third and final year in January 2012. The project is working on outputs like:

- country report summaries for best agricultural practices
- training programs for choosing the methods
- sector study: an assessment of legal, technological and economic enablers and barriers of prioritized agro-environmental technologies in the BSR
- web-based Agri-technology Atlas
- pilot investments in agri-environmental technologies in Denmark, Germany and Belarus
- GIS database of high risk agricultural land in the region
- common approach to targeting high risk areas from the point of view of agricultural nutrient loading and biosecurity
- four decision support scenarios for management of nutrient reduction objectives
- synthesis report of eight thematic governance dialogues and policy recommendations
- thematic National Round Table discussions in each partner countries

More about the project, conference and results can be found in www.balticcompass.org. Here is a sample of available reports organized after project's Work Packages.

BEST PRACTICE UTILIZATION AND TRANSFER

- Measures for water protection and nutrient reduction
- Prioritized measures list and country reports from seven countries

INVESTMENT PREPARATION

- A study on energy potential in Schleswig-Holstein: Energy potential from biomass and its contribution to supply for the year 2020

COMPREHENSIVE ASSESSMENT AND SCENARIOS

- Guidelines for surface and drainage water quality monitoring in agriculture dominated areas
- Constructed wetlands in Finnish agricultural environments: Balancing between effective water protection and multi-functionality.
- Role of River Basin Management Plans in Finland, addressing diffuse pollution from agriculture to limit the eutrophication of the Baltic Sea - Aurajoki pilot area.
- model SWAT for estimating runoff pollution load from agricultural sources ,installed in the pilot area in Poland /catchment Reda river in the north part of Poland ,inflow of the Baltic Sea/
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GOVERNANCE AND POLICY ADAPTATION

- Implementability of agro-environmental targets country reports from six countries
- Policy Briefs on the implementability of agro-environmental targets
- Case study: Viability of biogas as an agro-environmental measure
- Case study Schleswig-Holstein: Improving bottom-up project communication and acceptance
- Case study: Constructed wetlands in Finnish agricultural environments
- Agriculture in a Changing context: Projected land use changes in the Baltic Sea Region 2020/2050
- Governance Innovations for Improved Phosphorus Management and Reuse: Voices from the Baltic Sea Region

The main tasks carried out by the Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB, Polish project partner in the Baltic Compass project, the WP5 group)

Model SWAT for estimating runoff pollution load from agricultural sources installed in the pilot area in Poland - Reda river catchment in the north part of Poland, inflow of the Baltic Sea.

1. A device for continuous, automatic measurement of pollutants in Reda river

Following the open tender there was bought a spectrometer type S - Can Nitro: lyser. The device was produced by Messetechnik Gmbh, Vienna, Austria. The device is directly immersed in the river, designed to perform automatic measurements of nitrates and nitrites concentrations, and turbidity (FTU) with the 1h frequency. There was also a dedicated software purchased to calibrate the measured parameters, and software for the transmission and processing of results and their presentation. A registration unit is built-in the memory of the apparatus. To ensure continuous operation there were also purchased portable batteries and cylinders with compressed air to clean the windows of the spectrometer. The spectrometer was installed in the Reda river cross-section in Wejherowo. The device was placed under water and attached permanently to the existing patches gage. There was placed a box with controls and registrant units, and scuba diving with compressed air on a bank of the river. In order to eliminate downtime caused by power failure, the device was equipped with a battery for constant power supply by the existing side telemetric hydrological-meteorological station. Due to the nature of the river, the facilities and turbines were secured against erosion.

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Photo. Installation of the spectrometer type S: Can Nitro: lyser in Reda river

Photo. On-line transmission of selected data and presentation on a web page from the spectrometer S: Can Nitro: lyser, submerged in the river.

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2. Starting of SWAT model in the Reda river catchment - the pilot area in Poland

SWAT (Soil Water Assessment Tool) is a hydrologic model with the following components: weather, surface runoff, return flow, percolation, evapotranspiration, transmission losses, pond and reservoir storage, crop growth and irrigation, groundwater flow, reach routing, nutrient and pesticide load, water transfer.

According to the schedule of the Baltic Compass project (Annex II of the Agreement, the operation of WP 5 Task1) one of the main tasks of the Lead partner (IMGW –PIB) is to develop optimal methods for estimating the load of agricultural pollution from the river catchment to into the sea. To accomplish this task in the Reda catchment there was installed a model for estimating runoff pollution load from agricultural sources.

The model selection, development and calibration of its structure was made by a team from the Warsaw University of Life Sciences /SGGW/, that is experienced in implementation of such models in Poland. As a result of working meetings there was decided to use a deployed SWAT model (Neitsch et al. 2005, SWAT version 2005 or 2009 along with Arc SWAT GIS interface) as the best tool. The calibrationg of the model required a preparation of the structure of the model which required expertise in the field of agriculture. This work was performed by a team from SGGW.

As part of a structure model to estimate the pollution load from agricultural sources there were made:

1.A division of Reda river sub-catchments on the basis of partial Digital Terrain Model – DTM, and a map of the river network.

2. Maps of land cover (land use) and a database update of land cover and plant growth (Corinne Land Cover).

3. Database and reclassification of soils with soil maps.

4. Sub-basin division into units of "Hydrologic Response Units", based on land cover maps, soil maps and maps of land slopes and structure of crop statistics.

5. Parameterization applied for agricultural practices for major crops in the Reda catchment.

In particular, the scope of the action plan of IMGW-PIB acquisition or purchase of:

- Digital Terrain Model - DTM,
- Localization of the hydrological and meteorological stations, sections of the river, measuring strings of river flows.
- Information from legal permits for intake and discharge of water, the protection zones of wells and hydraulic engineering constructions, collected in the water cadastre.
- Data quality monitoring, water quality measurement sequences.

- Map of land cover (Corinne Land Cover), parameters of plants, soil maps of IUNG and qualitative parameters of soil and groundwater carried out by the Chemical-Agricultural Station.

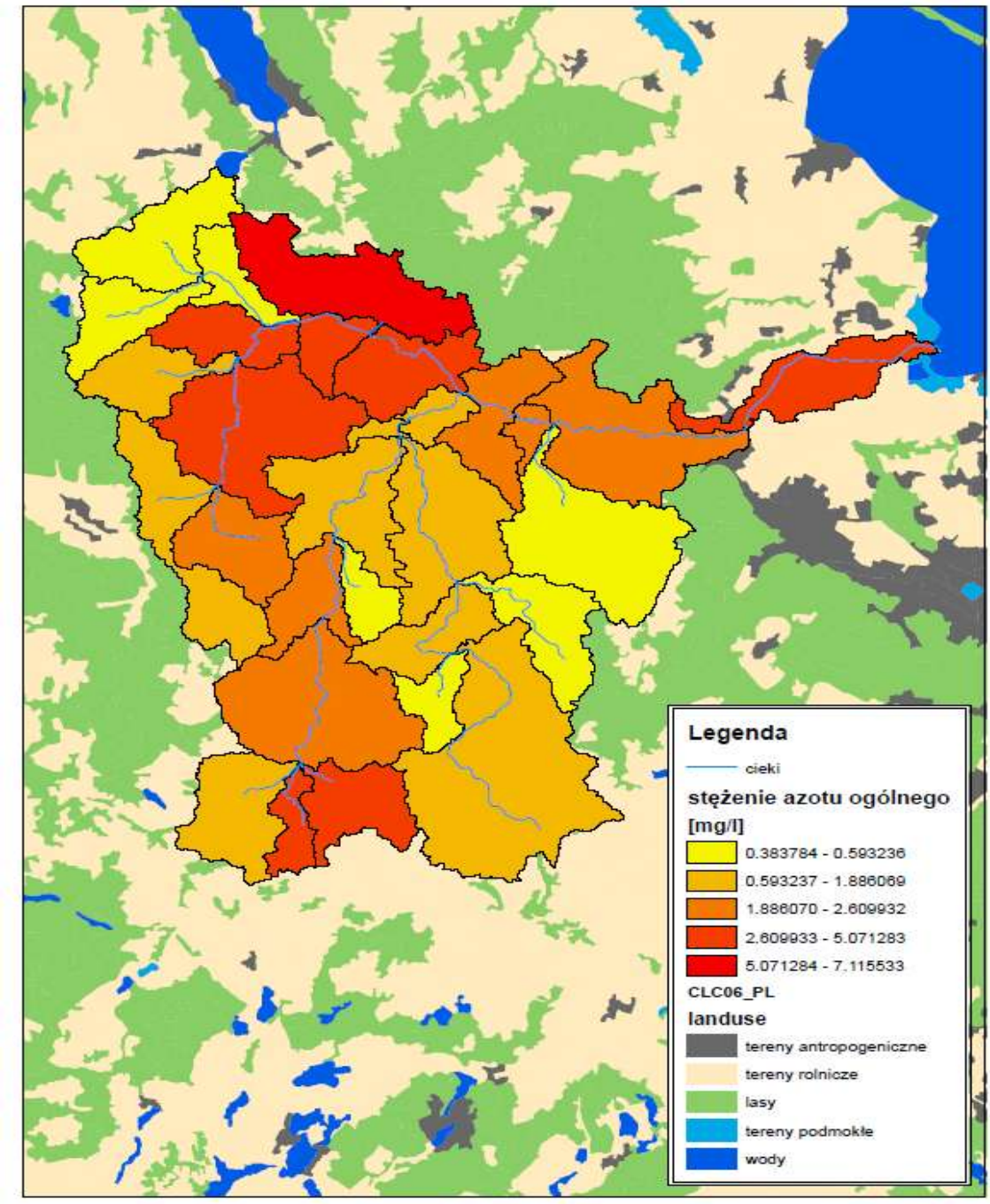
The SWAT model for the Reda river basin was created to estimate the load of agricultural pollution flowing into the Baltic Sea from the analyzed catchment.

The SWAT model for the Reda River basin developed by the SGGW team was calibrated quantitatively and qualitatively by the IMGW-PIB team. The calibration process was preceded by a thorough analysis of the model developed by the SGGW and the introduction of adequate corrections and additions. The calibration of the SWAT model was based on the verification of the simulation results obtained from the analysis for the years 1991-2010, with a daily timestep, and the analysis of the match of model results for flow monitoring measurements obtained from the measurement point in Wejherowo (Hydrological Station). The quantitative calibration of the model was performed both automatically and manually. The automatic calibration was performed using Calibration and Uncertainty Program (SWAT-CUP2). The SWAT-CUP2 is used for parameterization of the model, identification and calibration of the basin model and boundaries of its application, conditions of reference model or model uncertainty problems. Accuracy of the results was verified by using the determination coefficient R^2 according to hydrological and hydraulic models accuracy criteria and Sarm's classification. The value of the determination coefficient - R^2 for quantitative calibration was 0.73. Based on the above classification, according to the accuracy of the results of calibration and measurement data, the model is given as a very well fitting. During analyses additional statistical measures were used in order to verify the results of how the model matches the measurements, in example Nash-Sutcliffe coefficient (NS). It is used for predictive assessment of hydrological models. NS coefficient may range from - ∞ to 1. A value of 1 corresponds to optimally match the simulation results to the measurements. The closer to 1, the model is considered more accurate. For the Reda river basin the NS coefficient for flow reached a value of 0.57. The results are consistent with the values obtained from the correlation coefficient and show a good accuracy for the model results and the measurements. The value of determination coefficient - R^2 for quality calibration was 0.47 for total nitrogen, and 0.36 for total phosphorus, what qualifies model as quite good.

There was also used the PBIAS statistical measure in the analysis of results, which determines the tendency of underestimation or overestimation of the simulated to measured data. The value of this measure should aim to zero, but in hydrological modeling it is assumed that for the flow the PBIAS = ± 25% and for nitrogen and phosphorus ± 70%. For the Reda river the PBIAS values reached 22% for flow, 11% for total nitrogen and 44% for the total

phosphorus. This confirms the good accuracy of simulated to measured data and assess model as good.

Model installed in the Reda basin will be used to perform calculations and simulations of scenario analysis.



Map. The nitrogen concentration in Reda river sub-basins, set based on digital terrain model for estimating the model pollutants runoff into the Baltic Sea from the Reda river catchment.

3. Analysis of methods of reducing the outflow of nutrients from the Reda catchment

Scenario analysis was conducted for the purpose of research on the possibilities of achieving the objectives of the Baltic COMPASS Program. It aims to develop a comprehensive strategic action and investment in the sustainable development of agriculture in the Baltic Sea region. The strategic objective of the project is to contribute to reducing the eutrophication of the Baltic Sea, through, inter alia, the enrichment of nutrients. It has to be done by supporting the sustainable, bringing mutual benefits, approach to agriculture, municipal and environmental protection throughout the basin. For this reason, for the pilot catchment of the Reda river, was performed a model of nutrients outflow to the Baltic Sea by using ArcSWAT operating on the ArcGIS platform. Model, beyond the nutrient loads sizes simulation to the estuary at all days of the specified period, has the ability to perform situational scenarios. This allows to make the analysis of the impact of activities in the catchment on outflow of nitrogen and phosphorus to the sea.

Reda catchment and the entire Pomeranian province does not belong to areas particularly vulnerable to pollution from nitrogen compounds. According to information provided by the RZGW in the province, there are three such places, none of the areas of analyzed catchment. (Regulation No 1/2012 of the regional director of water management in Gdansk on 15 June 2012).

It was analyzed the factors associated with the activities in the catchment, which have the greatest impact on water pollution with nitrogen and phosphorus such as agriculture and urban waste water discharge. The effect of the process of fertilization, changes in doses of fertilizer, agricultural management and the reduction of nitrogen and phosphorus loads discharged from wastewater treatment plants assessed in accordance with the National Programme for Municipal Wastewater Treatment was evaluated.

The 'zero' scenario is a baseline simulation performed on the calibrated Reda river basin model. Therefore, simulations were performed by changing the individual elements which have an impact on nitrogen and phosphorus loads in the river which was the scenario analysis. The first two scenarios were related to the impact of fertilization and agronomic treatments on the charges. Scenarios presented sequentially were performed to determine hypothetical doses of fertilization, while maintaining the current agricultural technology, to 0 (TN_0) and by removal of all treatments related to agriculture in the basin, with no additional intervention (TN_II). These are typically hypothetical scenarios to examine the size of the impact of current agricultural activities on water quality. Another scenario was associated with reducing the discharge from waste water treatment plants (TN_III). In relation to the baseline scenario was changed only a discharge from the waste water treatment plants by referring to the guidelines of the National Programme for Municipal Wastewater Treatment (KPOŚK) according to which the discharge of nitrogen and phosphorus should be limited by 75%. Discharge limitations was assumed to 75% due to direct discharge of Reda river to the Baltic Sea in spite of the small size of the plant, where, according to KPOŚK, reduction applies to treatment of more than 15,000 pe.

The graph (Figure 1) shows the results of the simulation of average monthly total nitrogen loads (kg/day) for all scenarios carried out. As it is shown the differences in the charges are negligible. Both doses of nitrogen change and adaptation of agricultural practices, and release to the KPOŚK not affect the significant differences in the results.

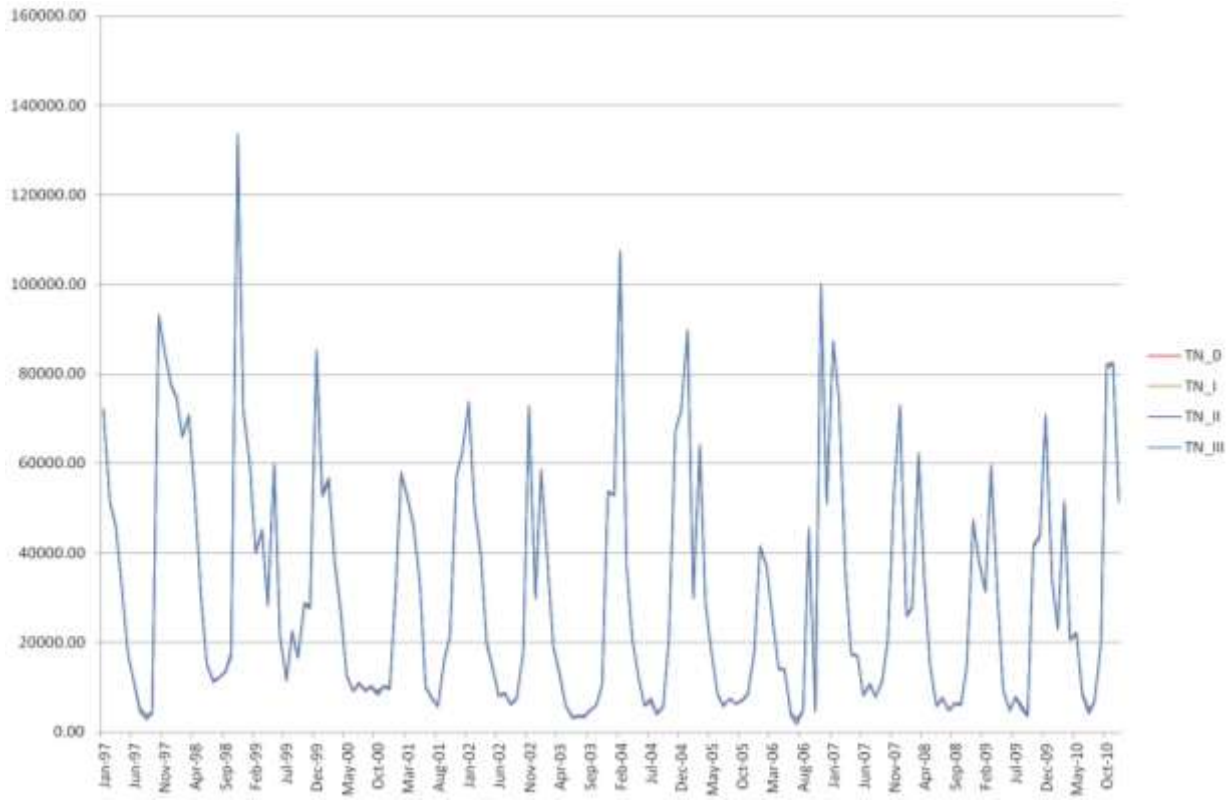


Figure 1. The results of simulation scenarios for total nitrogen

As presented in the graph (Figure 2) impact of doses of nitrogen fertilization on loads in the main profile of the estuary of the Reda river is small. For analyzed period of 14 years it was about 1% of the base value. The maximum decrease of the value was the 1 020 kg/day with the mean daily values of 30 000 kg/day.

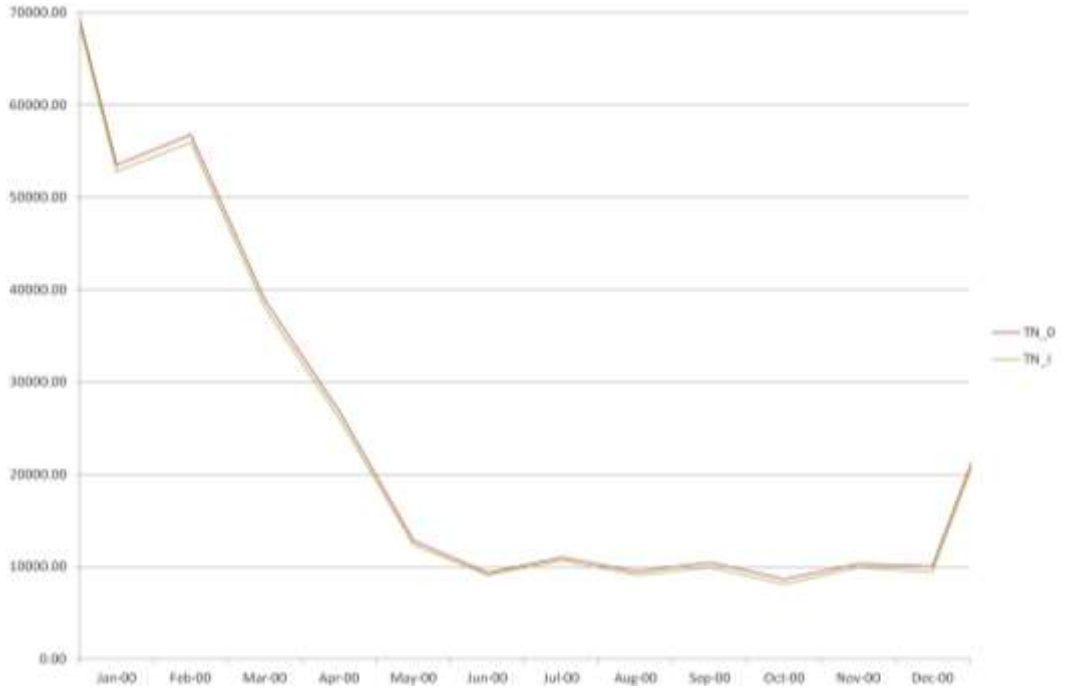


Figure 2. An example of the simulation results for the one year and for scenario I of total nitrogen

Due to the results of the previous scenario, the scenario in which all agronomic treatments on the catchment area were removed was performed. Similar results were obtained, what was shown in the Figure 3. There was a further decline of outflow according to the previous scenario, equal to a maximum of 1 315 kg/day, which was not even 1% of the average value of baseline scenario.

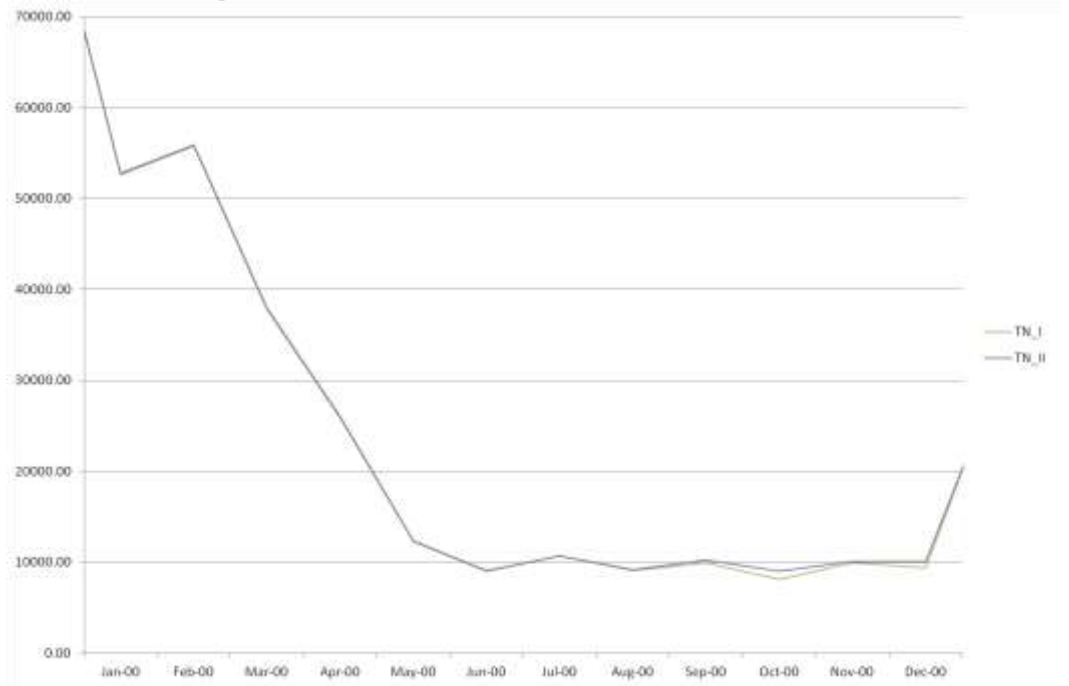


Figure 3. Example one-year simulation results for the scenario II for total nitrogen

Decline in the value of average daily loads with the introduction of assumptions derived from KPOŚK was also small and accounted for 1% of the baseline scenario. The maximum decrease in value amounted to 1 047 kg/day. Scenario results are as expected, however, as is usually observed, there is a smaller impact of wastewater discharges to the loads of total nitrogen than phosphorus. The results of analysis are shown in the graph (Figure 4).

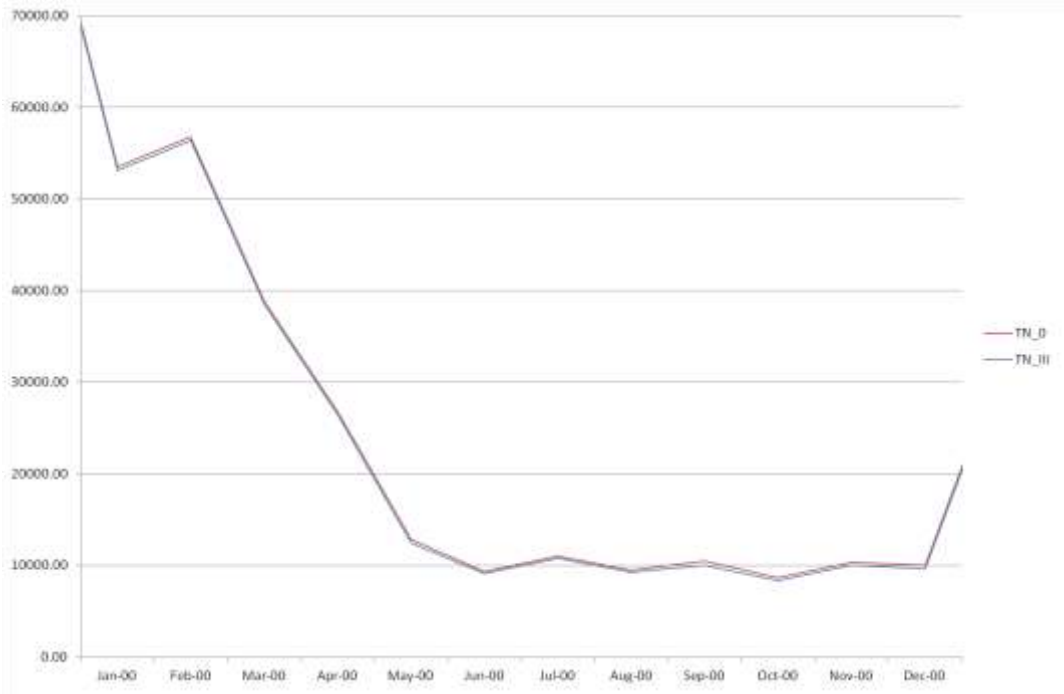


Figure 4. An example of the simulation results for the one year scenario III for total nitrogen

Differences of simulation results for each scenario for total phosphorus were more pronounced than for nitrogen. For scenarios related to agriculture they were small compared to the scenario relating to discharges from wastewater treatment plants, which gave a significant reduction in total phosphorus load for the estuary of the Reda river. The results of the simulation are shown in the graph (Figure 5).

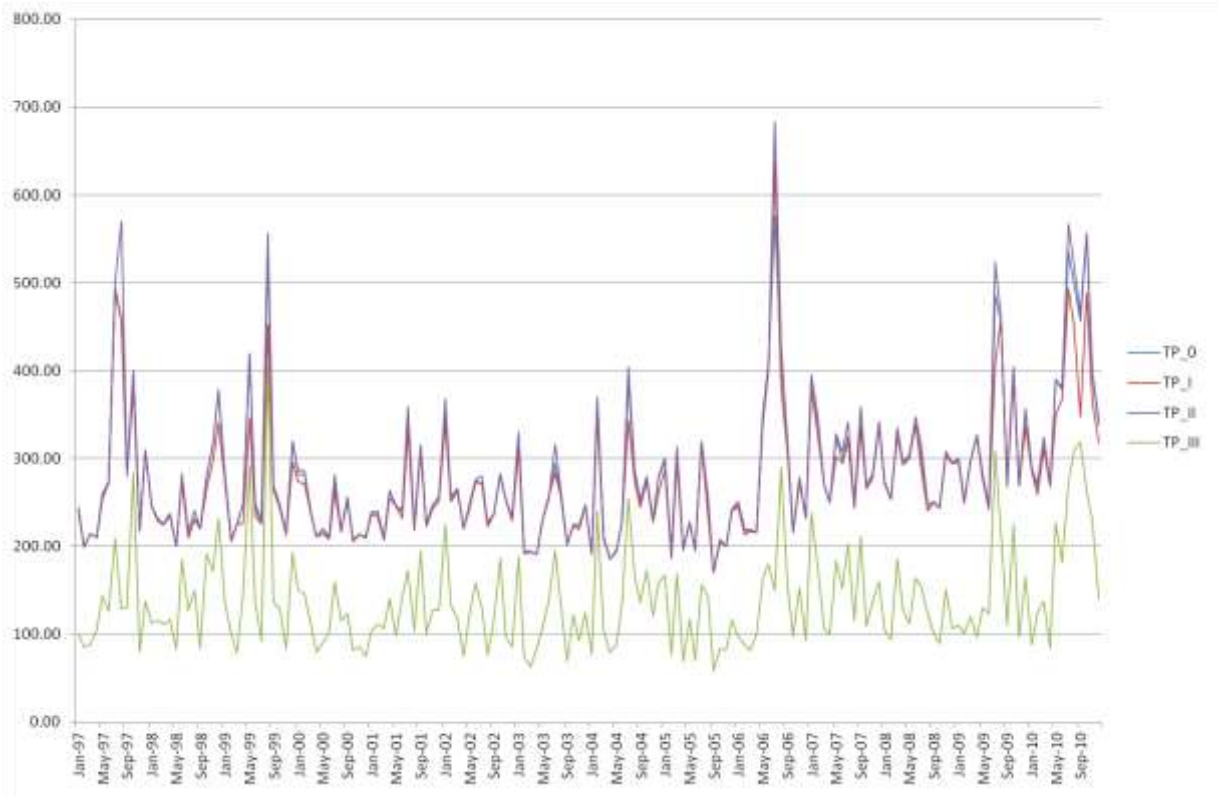


Figure 5. The results of simulation scenarios for total phosphorus

Results for 2010 are shown in the graph (Figure 6). The first scenario concerned fertilization dose reduction to 0 for both the elemental nitrogen and the elemental phosphorus. Such treatment caused a reduction in total phosphorus load to the estuary of 3% for the analyzed period of 14 years. Average decrease of daily value was 8 kg/day for average values of 280 kg/day. Cancelation of usage of any agronomic treatments resulted in a slight increase in total phosphorus load to the estuary. The increase of total values for period of 14 years was 1%. This result may be caused by a disturbed balance between nitrogen and phosphorus in the soil at the basin area at the decrease of supplied nitrogen. Significant impact on total phosphorus loads has the volume of discharges from wastewater treatment plants into the Reda river. Scenario III resulted the lower charges by as much as 51%. The mean difference of average monthly load is 142 kg/day and a maximum of 426 kg/day.

Figure 6. Example of one-year simulation results for scenarios I, II and III for total phosphorus

Reduction of fertilization on the catchment area of the Reda river does not result in a measurable decrease in the value of total nitrogen loads to the estuary of the river. In addition, abandonment of agricultural practices cause disorder relations of nitrogen and phosphorus and a slight increase in the concentration of total phosphorus at the estuary, though perhaps in this case reduced leaching of nutrients causes a slight decrease in total nitrogen loads. In addition, as shown in Figure 7, lower doses of fertilizers causes only a slight decrease in yield and failure of any agricultural activities cause a complete lack of crop. It follows that in the catchment area the contents of initial phosphorus and nitrogen in the soil is similar to the needs of the plants and the lack of fertilization only slightly affects both the yields and the loads in the water. However, the agronomic treatments will maintain appropriate relations of nitrogen and phosphorus, which allows the output of nutrients along with the yield. Discharges from wastewater treatment plants have a significant impact on the total phosphorus loads. However, in order to reduce nitrogen load, the search for other methods of influence on the nitrogen content in the water is needed.

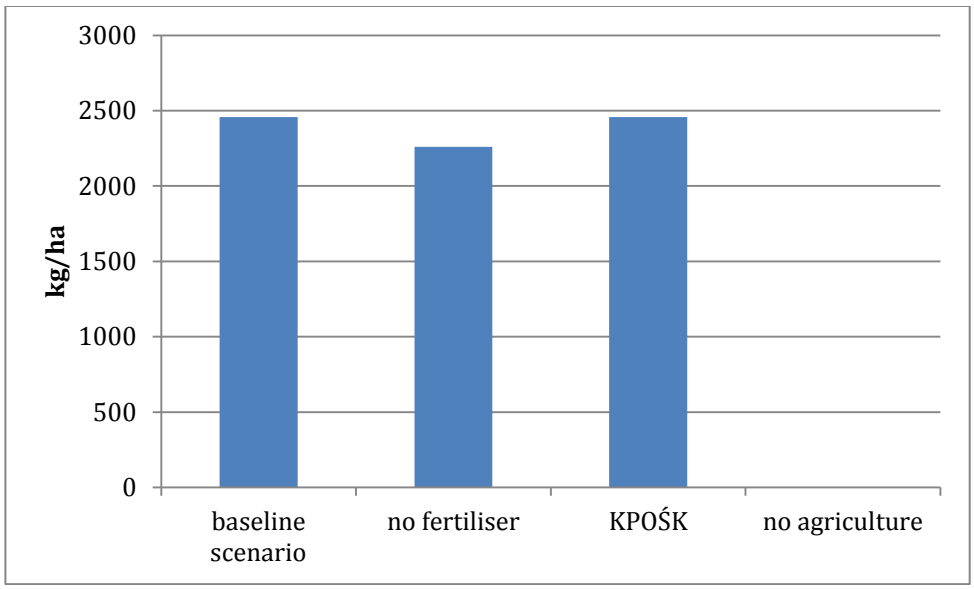


Figure 7. Yields for the various scenarios

The results indicate that in the catchment area the initial concentration of nitrogen in the soil is large enough to allow for optimum crop yield with only little additional fertilization. It therefore seems feasible scenario which reduced the current level of fertilization without reducing the current level of yields. It is a hypothesis that requires detailed analysis saying that the reduction of fertilizer to a certain level will not contribute to the decline in yields, and only exceeding this limit will cause a decrease in yields.

All of proposed and implemented scenarios for nitrogen significantly interfere with existing agricultural activities undertaken on the basin of the Reda river, yet received only slightly different results in loads of nitrogen and phosphorus in the outflow. It can therefore be assumed that the creation of the next, less intrusive in agriculture and thus more realistic scenarios will not bring significantly reduction of nutrient loads to the estuary of the river Reda to the Baltic Sea. This is probably caused by local conditions and initial values of these substances in the soil.

The outputs of the Baltic Compass project was presented in the "***A Greener Agriculture for a Bluer Baltic Sea***" conference in Copenhagen 24th -25th October, 2012.

4. The Internet portal presenting data from the project Baltic Compass /www.baltyk.pogodynka.pl/