# Atmospheric P load to the Baltic Sea – first measurements at the Utö Atmospheric and Marine Research station

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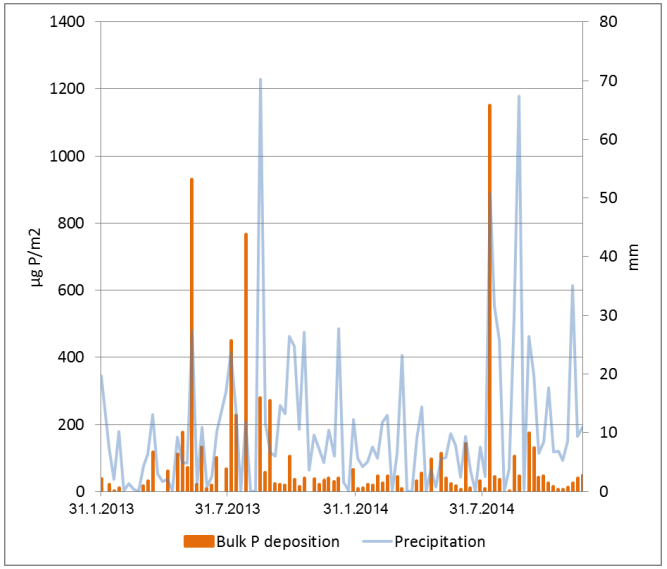
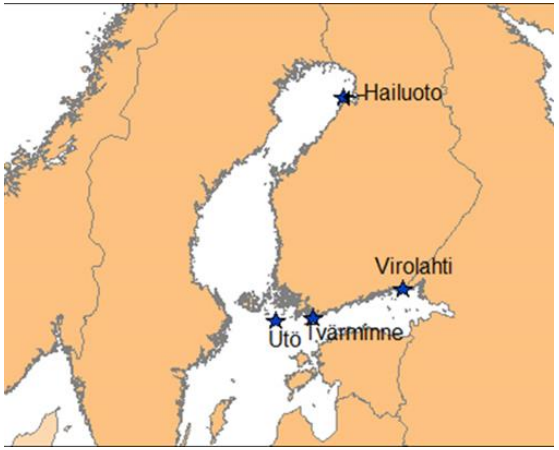
In the HELCOM Baltic Sea Action Plan, maximum allowable nutrient inputs to the Baltic Sea and country wise allocated reduction targets for the HELCOM contracting parties are given. Both waterborne and airborne loads should be taken into account in the implementation and revision of the country allocation of nutrient reductions, but the information of the atmospheric phosphorus (P) deposition to the Baltic Sea is insufficient. In the HELCOM cooperation, a preliminary estimate of 5 mg P/m$^2$ has been used for the atmospheric load in calculation of the reduction targets.

Weekly bulk deposition measurement of P on a remote island Utö was started in January 2013 in order to estimate the atmospheric P load in the open sea. The sampling of particles (PM10) started in 2014. The analytical method used is the molybdenum blue method.




Weekly bulk deposition of total P and precipitation amount at Utö.




Finnish stations for the measurement of the atmospheric deposition to the Baltic Sea

The estimate for mean annual bulk deposition in Utö is about 4 mg/m$^2$ based on measurements in 2013-14. The bulk deposition at Utö is similar to the recent estimates at remote Baltic Proper islands (see table). In agricultural areas the annual bulk deposition is larger, up to 10 mg/m$^2$.

The first estimate for the total P concentration in PM10 particles in Utö is 5-10 ng/m$^3$. This is slightly higher than the modelled value for the Baltic Sea and the open sea measurements in the North Atlantic Ocean (table).

Further work include continuation of the measurements and estimation of dry deposition fluxes.

Table. Estimates of atmospheric P deposition and P concentration in particles.

| Station/Country | Period | Matrix | P mg/m$^2$ year | Area description | Source |
|---|---|---|---|---|---|
| Utö/Finland, this study | 2013-2014 | bulk | 3.6 | rocky island | Finnish Meteorological Institute; Finnish Environment Institute |
| Tvärminne/Finland | 2010-2012 | bulk | 9.3-10.5 | agricultural area | Finnish Environment Institute |
| Lammi/Southern Finland | 2010-2013 | bulk | 4-6 | forested background area | Finnish Environment Institute |
| Baltic Sea, Baltic Proper/Sweden | 2006-2007 | bulk | 2.8-15.8, isolated islands: 2.8 and 3.3 | 3 island stations | Rolff et al., 2008. Biogeosciences 5. |
| Denmark | 2011 | wet | 2±1 | 7 stations | Ellermann et al. 2012. Aarhus Universitet. Nationalt Center for Miljø og Energi, Rap. nr. 30. |
| **Station/Country** | **Period** | **Matrix** | **P ng/m$^3$** | **Area description** | **Source** |
| Utö/Finland, this study | 2014 | $PM_{10}$ | 5-10 | rocky island | Finnish Meteorological Institute |
| Baltic Sea | | modelled PM | 1-5 | | Mahowald et al. 2008, Global Biogeochem. Cycles 22. |
| North Atlantic | 2005-2010 | PM <1µm + >1µm | 0.4-1.6 | on cruises | Baker et al., 2010. Global Biogeochem. Cycles 24. |

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