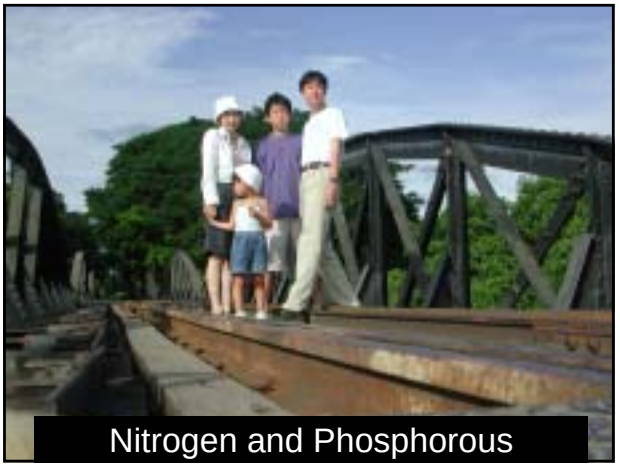
Urban Environmental Engineering 2

Taro Urase



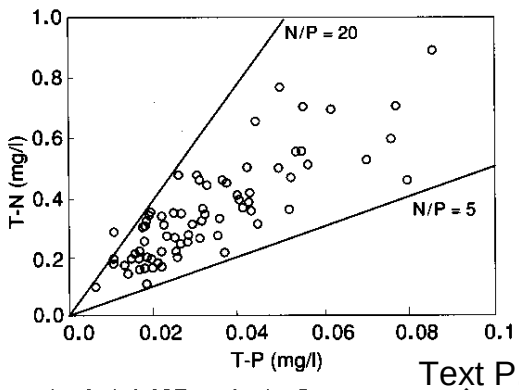
Total nitrogen and total phosphorous are the items for the protection of living environment and the standard values are dependent on the category of public waters.

b.

category	water use	Standards T-N	Standards T-P
I	Conservation of natural environment, and uses listed in II-V	0.1	0.005
Ii	Water supply classes-I, 2 and 3 (except for special types), fishery class 1, bathing ; and uses listed in III-V	0.2	0.01
III	Water supply class-3 (special types), and uses listed in IV-V	0.4	0.03
IV	Fishery class 2, and uses listed in V	0.6	0.05
V	Fishery class 3, industrial water ; agricultural water ; conservation of living environment	1.0	0.1

Why N and P are important

- Other nutrients than N and P, which are necessary for the growth of phytoplankton are relatively abundant in natural environment. In other words, N and P are the limiting elements for the growth of algae.
- It is dependent on water bodies which of P and N is the limiting element.
- So N/P ratio is important.

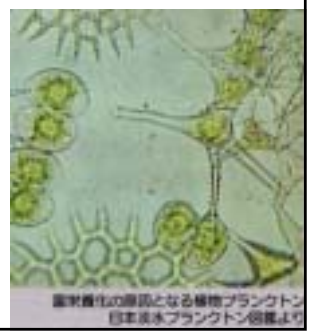


Text P.51

Fig. 3-5-6 N/P ratio in Japanese estuaries

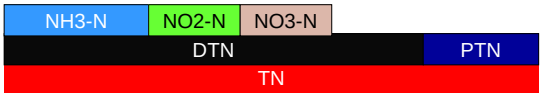
Question

- If we talk about three main components of fertilizers, K, N and P can be listed. Why K is not important in water environment ?
- What are the possible elements other than N and P which may affect on the growth of phytoplankton?

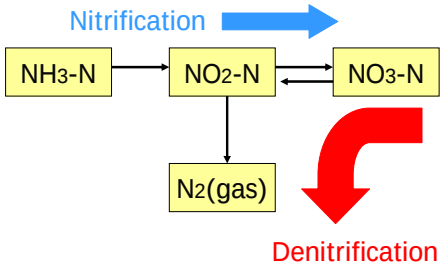


Nitrogen

- TN (total nitrogen)
- DTN (Dissolved TN) and PTN (Particulate TN)
- NH3-N (Ammonia Nitrogen), NO2-N (Nitrite), NO3-N(Nitrate)



Nitrification and Denitrification



Nitrification takes place in the case of sufficient DO condition.

Denitrification takes place in the case of anoxic condition.

Equation of change in Nitrification

First order reactions in series

$$\frac{d[NH3-N]}{dt} = -k_1[NH3-N]$$

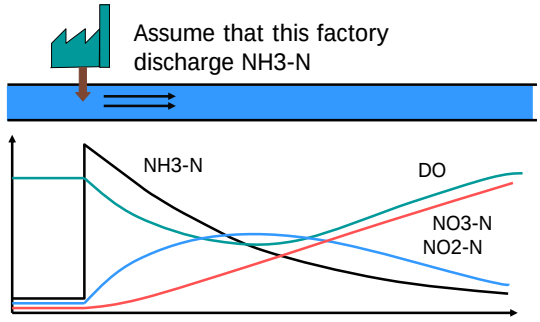
$$\frac{d[NO2-N]}{dt} = k_1[NH3-N] - k_2[NO2-N]$$

$$\frac{d[NO3-N]}{dt} = k_2[NO2-N]$$

All Units are (mgN/L) or (mol/L)

If we use mgNH3/L, mgNO2/L, and mgNO3/L, the inclusion of conversion factor is necessary.

Change in Nitrogen



If DO is sufficient, NH3-N is converted into NO3-N

Measurement of Nitrogen

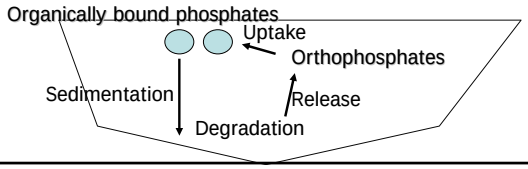
- TN (total nitrogen) : Persulfate digestion method.
- NH3-N (Ammonia Nitrogen) : Electrode method, Titrimetric method, Phenate method.
- NO2-N (Nitrite) : Colorimetric method, Ion chromatograph method.
- NO3-N (Nitrate) : Ultraviolet spectrophotometric method, Electrode method, Cadmium reduction method,

Other parameters for Nitrogen

- Organic nitrogen (N_{org}) by Kjeldahl method.
- Kjeldahl = Norg + NH3-N

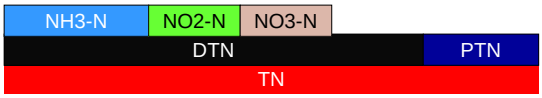
Phosphorus

- Phosphorus occurs in natural waters and in wastewaters almost solely as phosphates.
- Phosphates are classified as orthophosphates (pyro-, meta- and polyphosphates) and organically bound phosphates.



Phosphorous

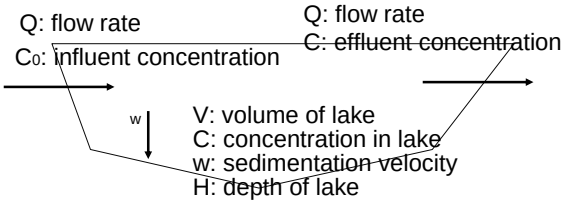
Phosphorous



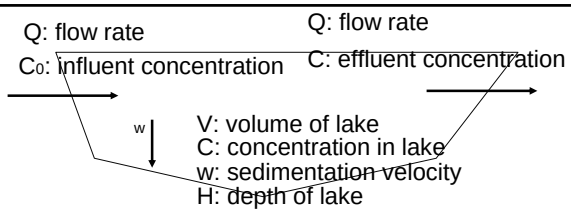
Various indicators for phosphorous and detection method

- TP : Digestion by acid or by persulfate and measurement of PO_4-P
- DTP (Dissolved TP)
- PO_4-P : Molybdenum blue – ascorbic acid method.

Vollenweider model for phosphorous in lakes



$Q(C_0-C)=wVC/H$ is obtained from mass balance.



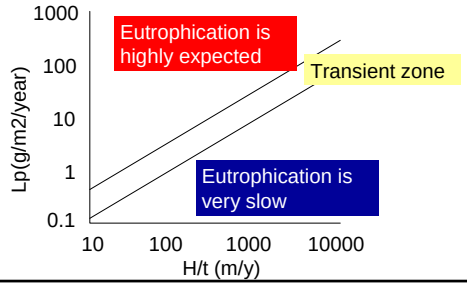
$Q(C_0-C)=wVC/H$ is obtained from mass balance. Here, we introduce Lp, pollution load for unit surface area. By this definition, $Lp = QC_0 / (V/H)$.

Substituting this equation to the original mass balance equation leads to $Lp = QC(H/V) + wC$.

By defining retention time t as V/Q, $Lp=C(w+(H/t))$

Vollenweider model for phosphorous in lakes

Lp=C(w+(H/t))



Lakes and Reservoirs

- The retention time of water is long in the case of closed or semi-closed waterbody.
- Eutrophication is caused by nitrogen and phosphorous.

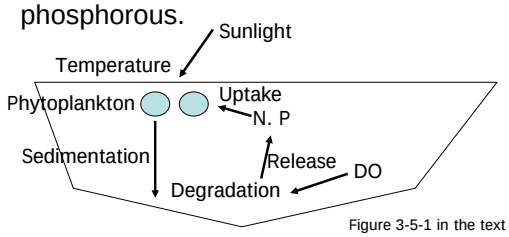
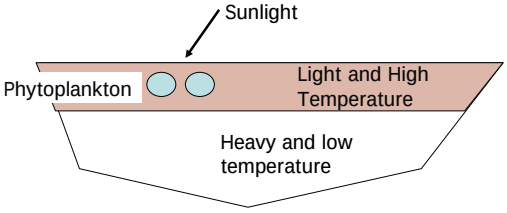


Figure 3-5-1 in the text book.

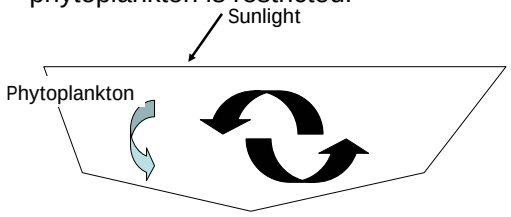
Stratification

- In summer, upper layer is heated. On the other hand, bottom layer is cold and relatively heavy



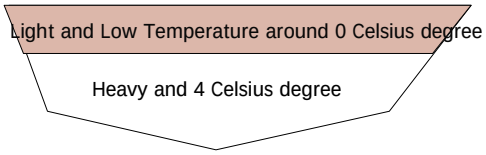
Breakdown of Layers

- In autumn and in spring, stratification disappears and mixing occurs. In this condition, the abnormal growth of phytoplankton is restricted.



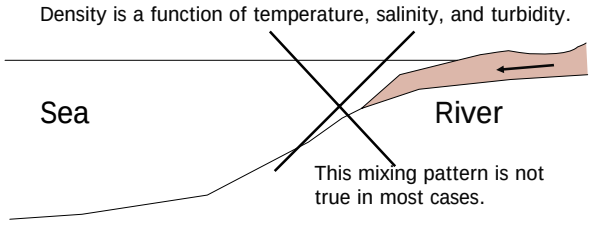
Stratification in winter

- In winter, lakes in the northern part of Japan saw stratification because the density of the water is maximum at 4 Celsius degree.
- However, abnormal algae growth may not occur because of low temperature.

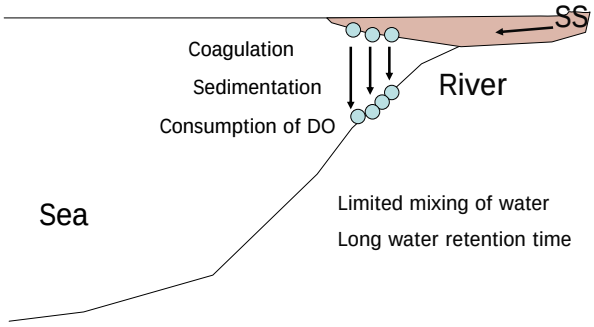


Estuary and Tidal River

- The place where seawater and freshwater mixes. Phenomena induced by difference in density may occur in this region.



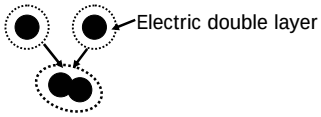
Low DO is often found where seawater and fresh water meets



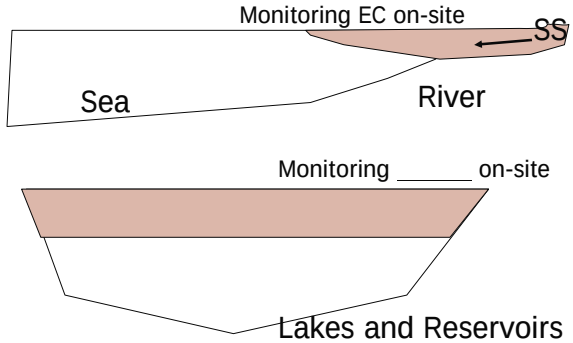
Seasonal Flow Change induces Coagulation

Coagulation

- Coagulation is a phenomenon that small particles aggregate with each other and form larger particles. When salt concentration is high, repulsion force between the particles become small and coagulation takes place easily.
- In drinking water treatment, coagulation – flocculation – sedimentation is a very common process.



We must take care the position of the sampling



Homework

- Why is eutrophication a problem?
- What is chlorophyll-a? It is usually monitored for the evaluation of eutrophication.
- What is the internal production of COD ? We often regard this matter as a problem of lakes with eitrophication.
- Explain change in pH when photosynthesis occurs.

Homework

- Underground environment is more or less anoxic. Why is the ground water pollution caused by nitrogenous compounds observed as the pollution of nitrate, not as that of ammonia ?
- Why is it difficult to improve the water quality in terms of TN and TP compared with the improvement in BOD and COD? Use a word of non point sources.

Homework

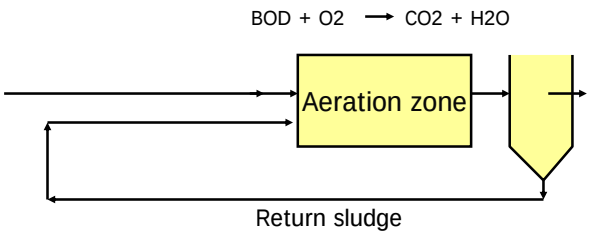
- Why is the contribution of forest, precipitation and agriculture relatively small in the case of TP compared with the case of TN and COD?

Nitrogen and phosphorous removal technologies.

- Strategies

1) Nitrogen can be converted to nitrogen gas by using nitrification and denitrification.
2) Phosphorous can be removed by letting it be uptaken by microorganism or by adsorbed by certain materials.

Conventional Activated Sludge Process



Nitrogen Removal Process using nitrification and denitrification