Bahan Pengajaran

4. Pencemaran Perairan

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Program Studi Magister Ilmu Perikanan

ANALISIS DAN PENGELOLAAN PENCEMARAN LINGKUNGAN (SKS: 3)

Link presensi tersedia pada ruang zoom chat

Recap:

Faktor yang mempengaruhi degradasi bahan pencemar

1. Photolysis (Fotolisis)

Degradasi bahan kimia akibat radiasi energi cahaya baik secara langsung atau tidak langsung

Environ. Sci. Technol. **2000**, *34*, 1240−1245

Photolytic Transformation of Organic Pollutants on Soil Surfaces—An Experimental Approach

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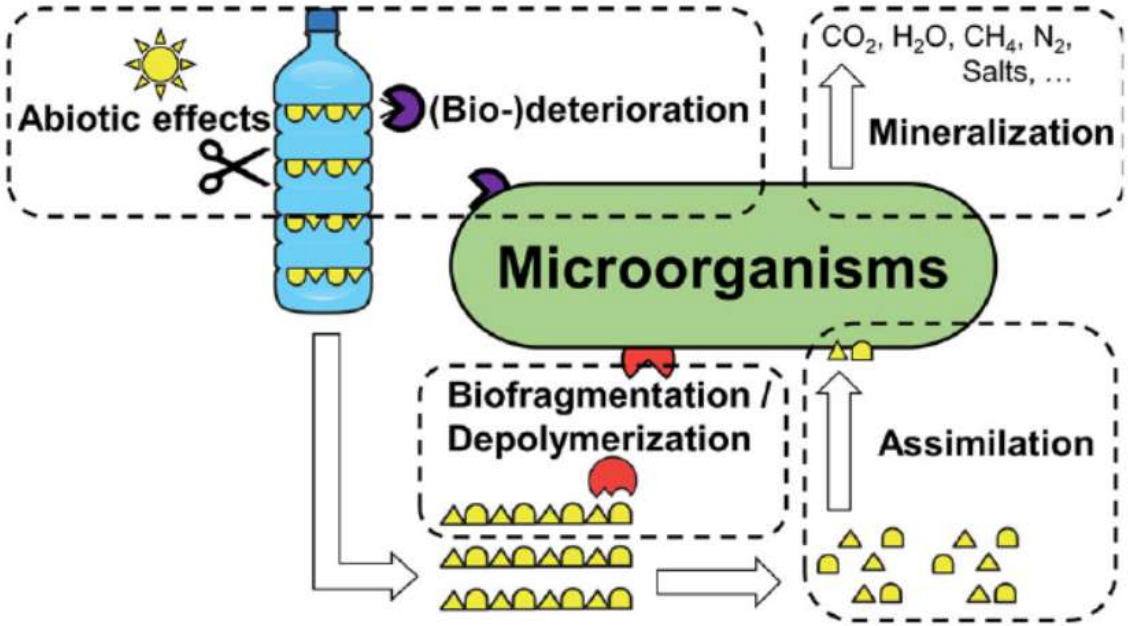
Photolysis on soil surfaces is an important degradation pathway for many agrochemicals. Although the investigation of photochemical pesticide transformation on soil surfaces is required by registration authorities, knowledge of the relevant processes is limited. The quantification of photolysis on soil surfaces is of higher complexity than it is in

then determined by measuring the total loss of compound from the soil layers as a function of time. However, these reported rates are of rather limited value, because they always depend on the layer thickness of the soil and in most cases also on transport kinetics which should in fact be treated separately. Because light penetration into soils is very limited (i.e. 0.1 to maximal 0.5 mm as reported by refs *6* and *14*) and wavelength-dependent, the fraction of total compound actually exposed to light depends on the type of soil, on the thickness of the soil layer, and on the light absorption spectrum of the compound. Thus, the rate of transport (i.e., retarded diffusion) of the compound from dark to irradiated zones within the soil layer will heavily influence the observed overall elimination rate. Since transport depends on the gas/solid partitioning behavior of the compound, and since sorption is strongly influenced by temperature and humidity (*15*, *16*), these parameters also need to be controlled in experiments. For future studies, experimental approaches are needed that allow to determine the actual photolysis rate constants, that are independent of layer thickness and transport velocity of a compound.

2. Biodegradasi

Adalah proses penguraian bahan pencemar oleh organisme hidup (seperti bakteri dan jamur)



Schematic illustration of plastic biodegradation (Lucas *et al.*, 2008).

Wei, R., & Zimmermann, W. (2017). Microbial enzymes for the recycling of recalcitrant petroleum-based plastics: how far are we?. *Microbial biotechnology*, *10*(6), 1308-1322.

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Standard Review

Biodegradation alternative in the cleanup of petroleum hydrocarbon pollutants

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Accepted 29 May, 2006

Extensive petroleum hydrocarbon exploration activities often result in the pollution of the environment, which could lead to disastrous consequences for the biotic and abiotic components of the ecosystem if not restored. Remediation of petroleum-contaminated system could be achieved by either physicochemical or biological methods. However, the attendant negative consequences of the physicochemical approach are currently directing greater attention to the exploitation of the biological alternatives. This paper provides a review of the menace of petroleum hydrocarbon pollution and its biodegradation in the environment with the view of understanding the biodegradation processes for better exploitation in bioremediation challenges.

Key words: Petroleum hydrocarbon, pollution, environment and biodegradation.

3. Fitoremediasi (*Phytoremediation*)

Fitoremediasi adalah upaya penggunaan tanaman dan bagian-bagiannya untuk dekontaminasi limbah

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FITOREMEDIASI LAHAN TERCEMAR DI KAWASAN INDUSTRI MEDAN DENGAN TANAMAN HIAS

Phytoremediation of Contaminated Land at Medan Industrial Area by Ornamental Plants

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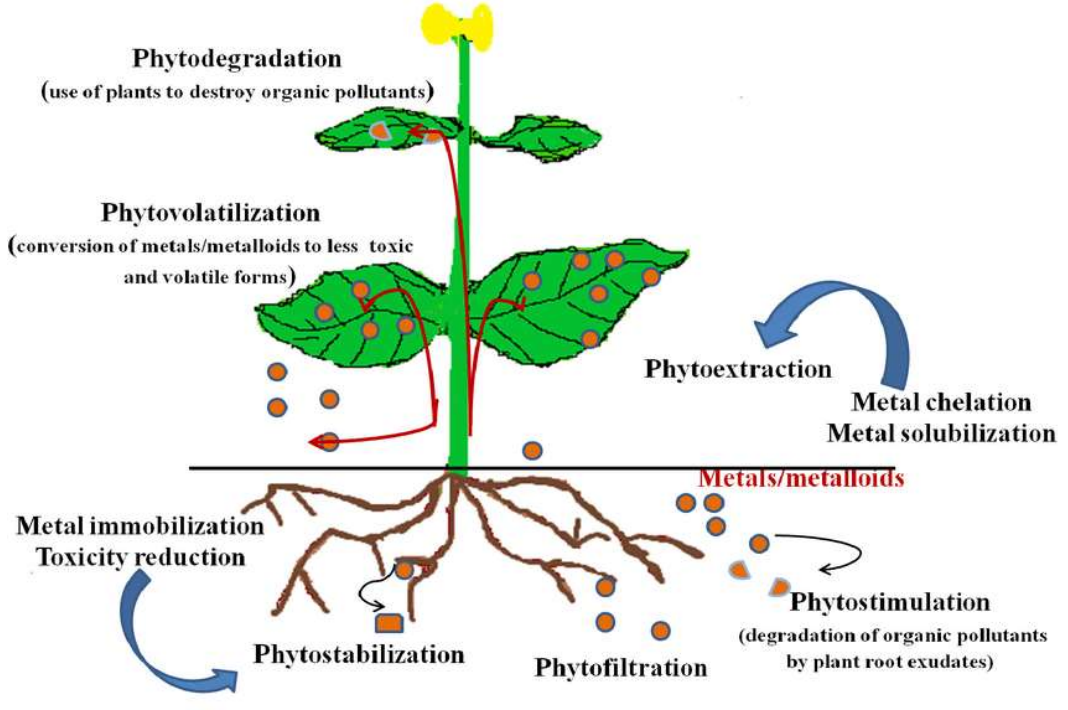
ABSTRACT

The development of industrial area in Medan City, North Sumatera impact for the increasing soil polluted by heavy metal at the area. Phytoremediation is an emerging technology for cleaning up contaminated sites, which is inovatif, cost effective, safety and has aesthetic advantages and long term applicability. The important aspect to be noted was the plant should not be used for consumption crops. The goal of our research was to develop the phytoremediation technology by testing different ornamental plant planting under different

TABLE I: PHYTOREMEDIATION PROCESSES FOR REMEDIATION OF CONTAMINATED SOILS

Phytoremediation processes	Description
Phytoextraction	Plants absorb contaminants and store in above-ground shoots and the harvestable parts of roots.
Phytostabilization	Roots and their exudates immobilize contaminants through adsorption, accumulation, precipitation within the root zone, and thus prevent the spreading of contaminants.
Phytodegradation	Plant enzymatic breakdown of organic contaminants, both internally and through secreted enzymes.
Rhizodegradation (phytostimulation)	Plant roots stimulate soil microbial communities in plant root zones to break down contaminants.
Phytovolatilization	Contaminants taken up by the roots through the plants to the leaves and are volatized through stomata where gas exchange occurs.



HAYATI Journal of Biosciences
Volume 12, Issue 1, March 2005, Pages 35-40

Fitoremediasi dan Potensi Tumbuhan Hiperakumulator

Phytoremediation and Potency of Hyperaccumulator Plants

NURIL HIDAYATI

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https://doi.org/10.1016/S1978-3019(16)30321-7

Phytoremediation is defined as cleaning up of pollutants mediated primarily by plants. It is an emerging technology for environmental remediation that offers a low-cost technique suitable for use against different types of contaminants in a variety of media. Phytoremediation is potentially applicable to a diversity of

Tabel 2. Jenis tumbuhan berpotensi sebagai hiperakumulator

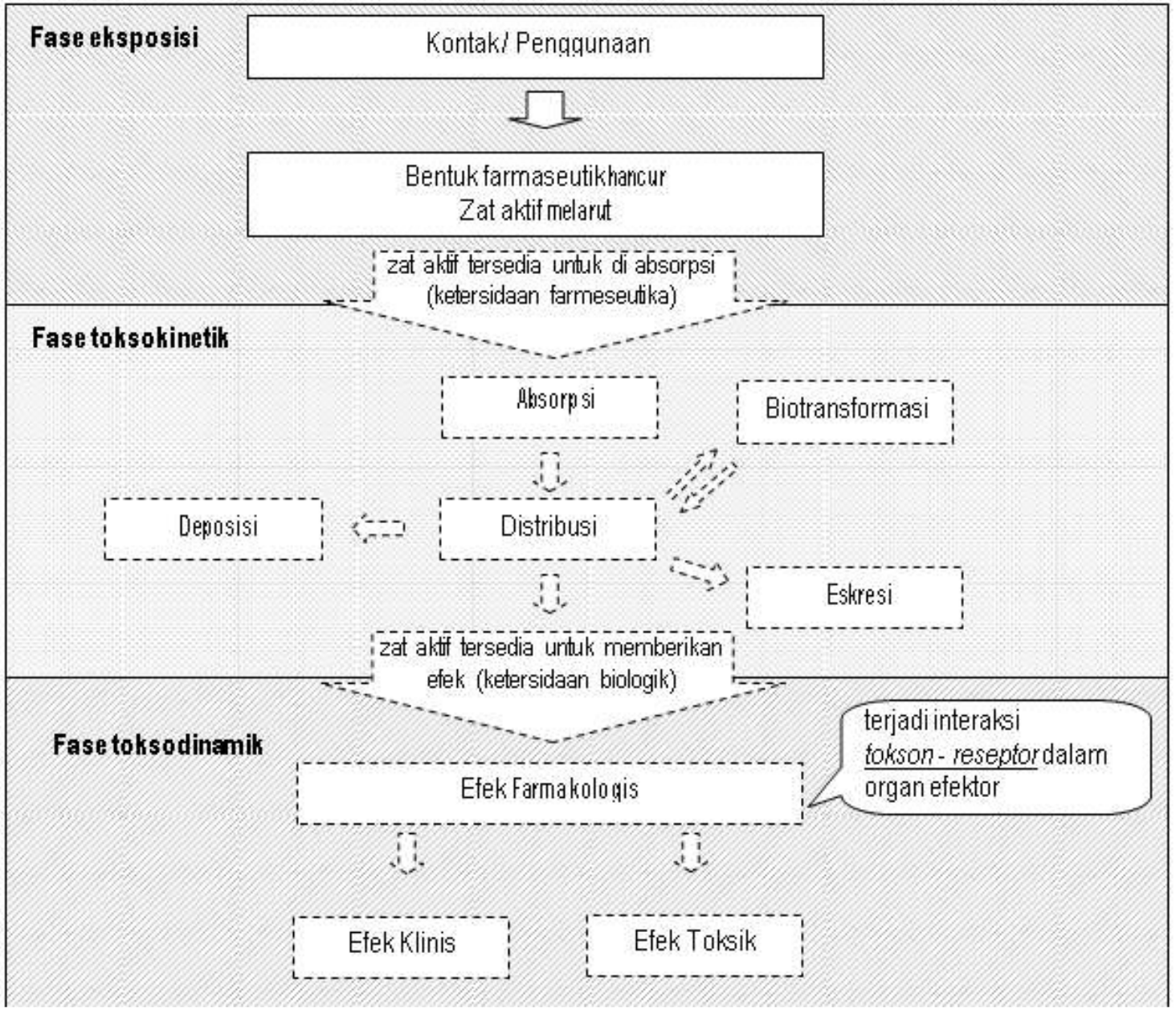
Jenis kontaminan	Tumbuhan
Zn (zink)	*Thlaspi caerulescens, T. calaminare, Sambucus, Rumex*
Cd (kadmium)	*Thlaspi caerulescens, Sambucus, Rumex, Mimulus guttatus, Lolium miscanthus*
Pb (plumbum)	*Lolium miscanthus, Thlaspi rotundifolium*
Co (kobalt)	*Agrostis gigantea, Haumaniastrum robertii, Mimulus guttatus*
Cu (kuprum)	*Aeolanthus biformifolius, Lolium miscanthus*
Mn (mangan)	*Alyxia rubricaulis*
Ni (nikel)	*Alyssum bertolonii, A. lesbiacum, Berkheya coddii, Hybanthus floribundus, Thlaspi goesingense, T. montanum, Senesio coronatus, Lolium miscanthus, Phyllanthus serpentinus*
Cs (sesium)	*Amaranthus retroflexus*
As (arsenik)	*Reynoutria sachalinensis, Chlamidomonas* sp.
Se (selenium)	*Astragalus racemosus*
Fe (ferum)	*Poaceae*
Hg (merkurium)	*Arabidopsis thaliana*
Salinitas	*Attriplex* spp., *Halosarcia* spp., *Enneapogon* spp.
Minyak bumi	*Euphorbia, Cetraria, Amaranthus retroflexus*

Efek dari toksik pada manusia dapat diklasifikasikan sebagai **efek akut** dan **efek kronis**.

- **Efek akut** → efek **cepat**: Racun akut akan mengganggu proses fisiologis, yang menyebabkan berbagai gejala gangguan, dan bahkan menyebabkan kematian jika gangguan tersebut cukup parah.
- **Efek kronis** → efek **lambat**: Racun kronis akan mengganggu proses fisiologis setelah terakumulasi sekian lama.

Rantai kerja xenobiotika/toksik:

- **Fase eksposisi** merupakan **kontak suatu organisme dengan xenobiotika/toksik.**
- **Fase toksokinetik** adalah yaitu fase dimana **xenobiotika/toksik diserap dan disebarkan** oleh darah, pada saat bersamaan sebagian molekul xenobiotika akan terekskresi ke sistem ekskresi.
- **Fase toksodinamik** adalah **interaksi antara xenobiotika/toksik dengan reseptor** (tempat kerja bahan toksik) dan juga proses-proses yang terkait dimana pada akhirnya muncul efek toksik/farmakologis



Now … **Pencemaran Perairan**

Question

Sekitar 70% dari permukaan bumi ditutupi oleh lautan.

Berapa proporsi air tawar yang ada di planet bumi?

A: 0.5%

B: 2.5%

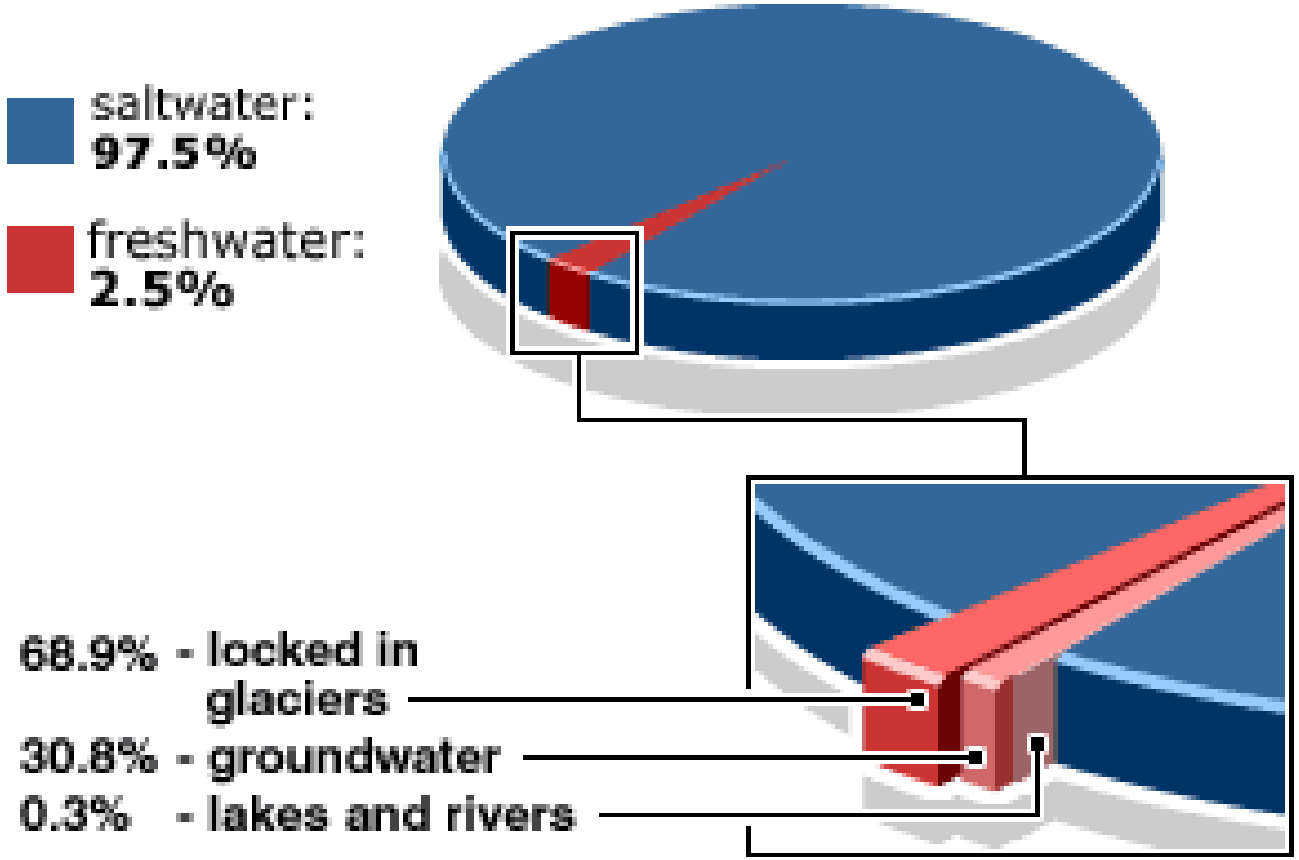
C: 5.0%

D: 15.0%

Jawabannya adalah B

Dari semua air yang ada di bumi, air tawar hanya 2.5%.

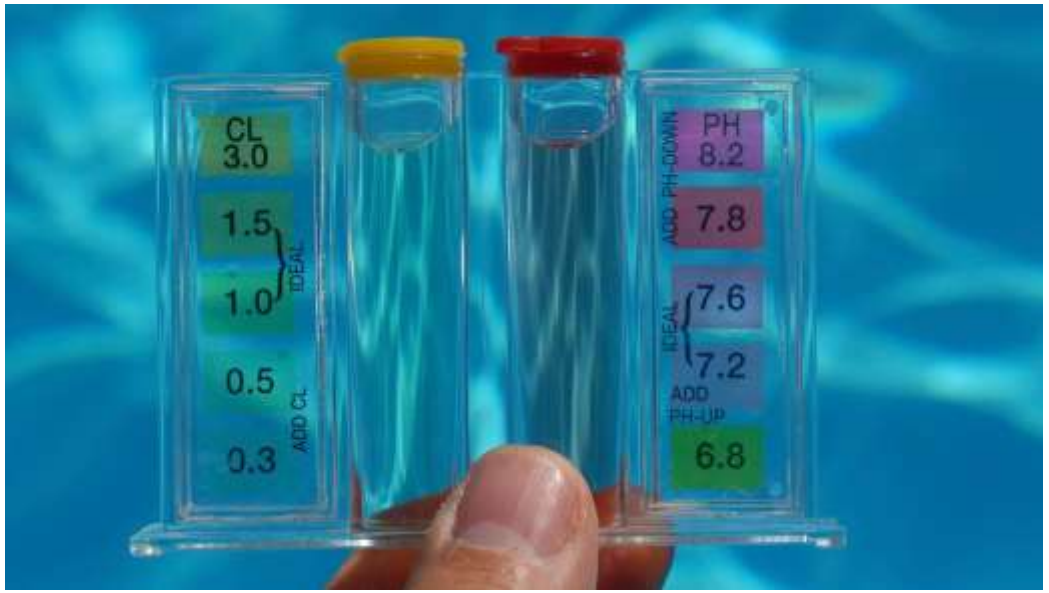
Distribusi air di bumi



What does WATER QUALITY mean?

Kualitas air

- Kualitas air didefinisikan sebagai kondisi air, biasanya berhubungan dengan kesesuaian untuk penggunaan tertentu, misal: air minum, kolam renang/wisata, perikanan, irigasi, pembangkit listrik dll.
- Coba pikirkan, penggunaan air yang tidak melibatkan dimensi kualitas air? …..



Pencemaran Perairan

Pencemaran air adalah masuknya atau dimasukkannya makhluk hidup, zat, energi dan atau komponen lain ke dalam air oleh kegiatan manusia, sehingga kualitas air turun sampai ke tingkat tertentu yang menyebabkan air tidak dapat berfungsi sesuai dengan peruntukannya.

PERATURAN PEMERINTAH REPUBLIK INDONESIA NOMOR 82 TAHUN 2001 TENTANG PENGELOLAAN KUALITAS AIR DAN PENGENDALIAN PENCEMARAN AIR

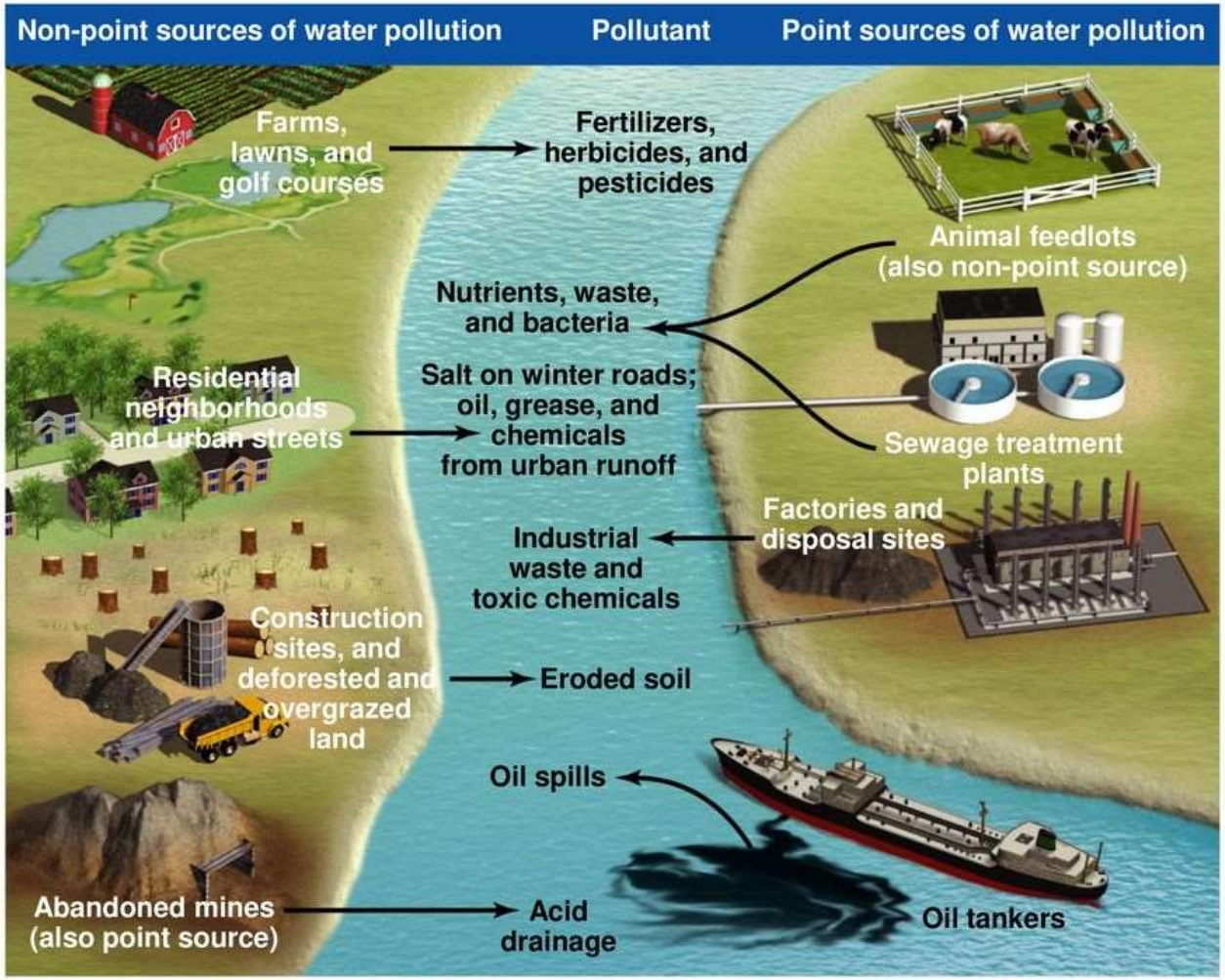
Yang menjadi perhatian adalah sehubungan dengan **kegiatan manusia** yang mencemari badan perairan (sungai, laut, danau, waduk, air tanah dll.)

Sumber Pencemaran Perairan

- Point Source Pollution (sumber titik)
- Non-point Source Pollution (sumber non titik)

SE 15-18 Point-source and non-point source water pollution

Slide 1



Dampak pencemaran air pada umumnya dibagi atas 4 kelompok, yaitu

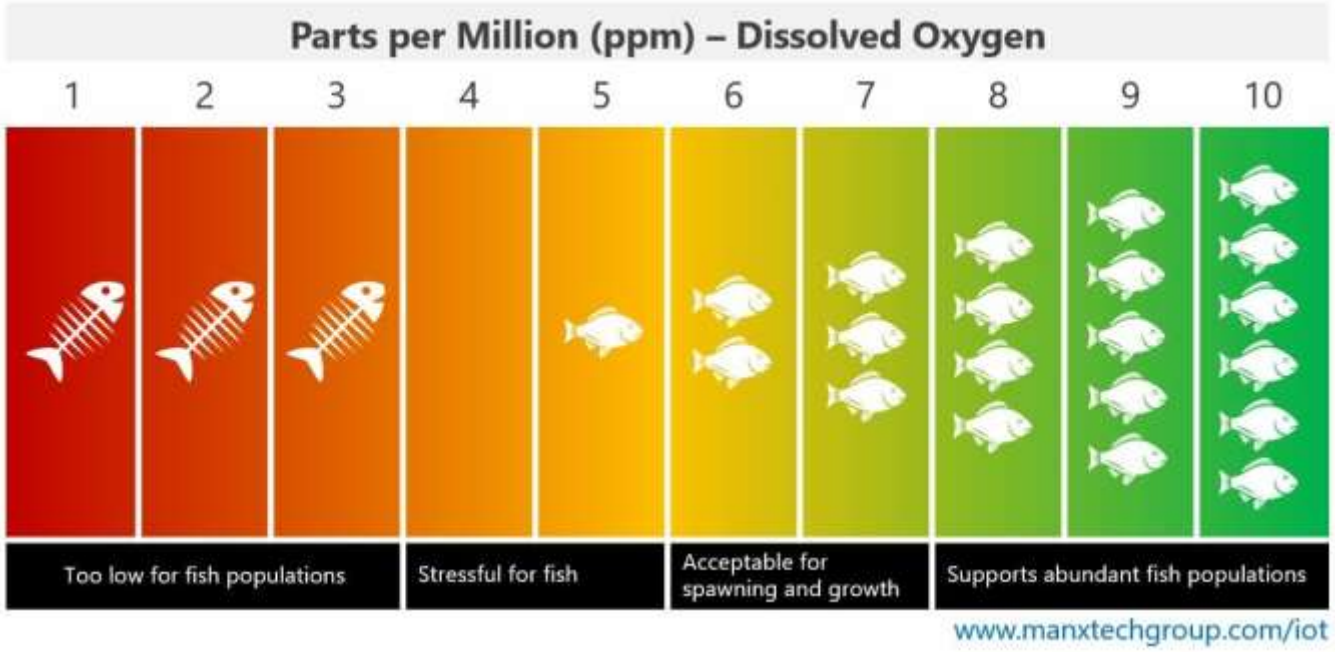
1. Dampak terhadap kehidupan biota air
2. Dampak terhadap kualitas air tanah
3. Dampak terhadap kesehatan manusia
4. Dampak terhadap estetika lingkungan

Beberapa parameter Kualitas Air penting

- Oksigen terlarut
- Suhu
- pH
- Turbiditas
- Unsur hara

Oksigen terlarut

- Indikator terbaik untuk kemampuan mendukung kehidupan akuatik
- Mempengaruhi hampir semua proses kimia dan biologi di perairan
- Indikator tingkat pencemaran air sehubungan dengan kehadiran bahan organik (Tes BOD)

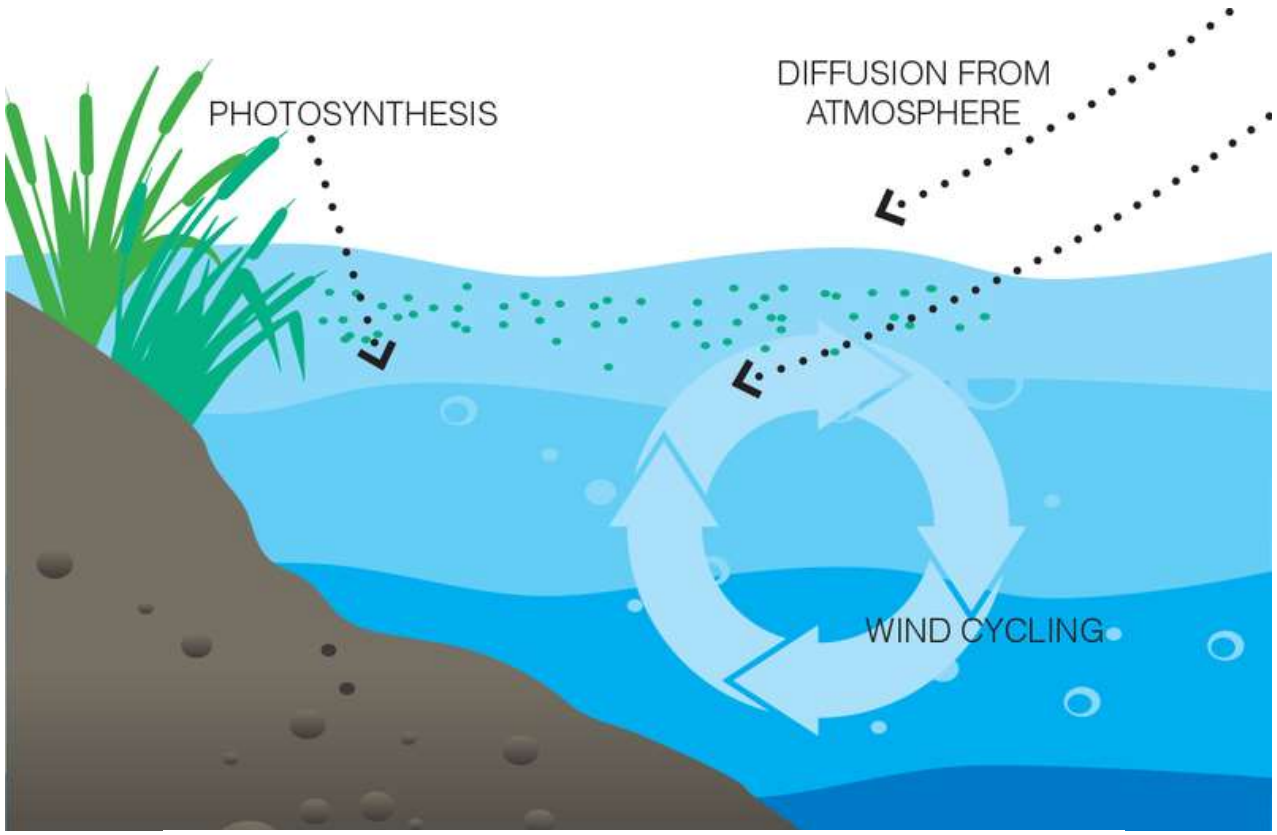


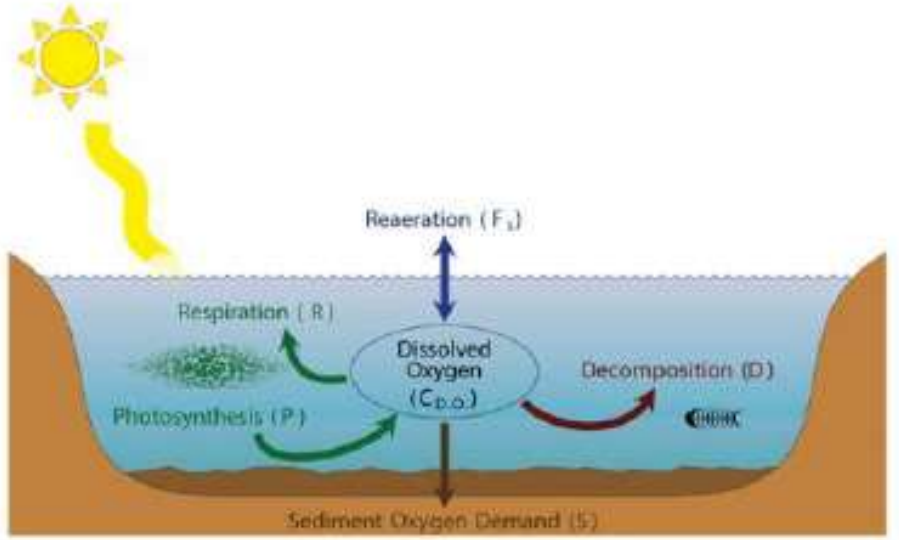
Sources of Oxygen in Natural Waters (processes that provide DO)

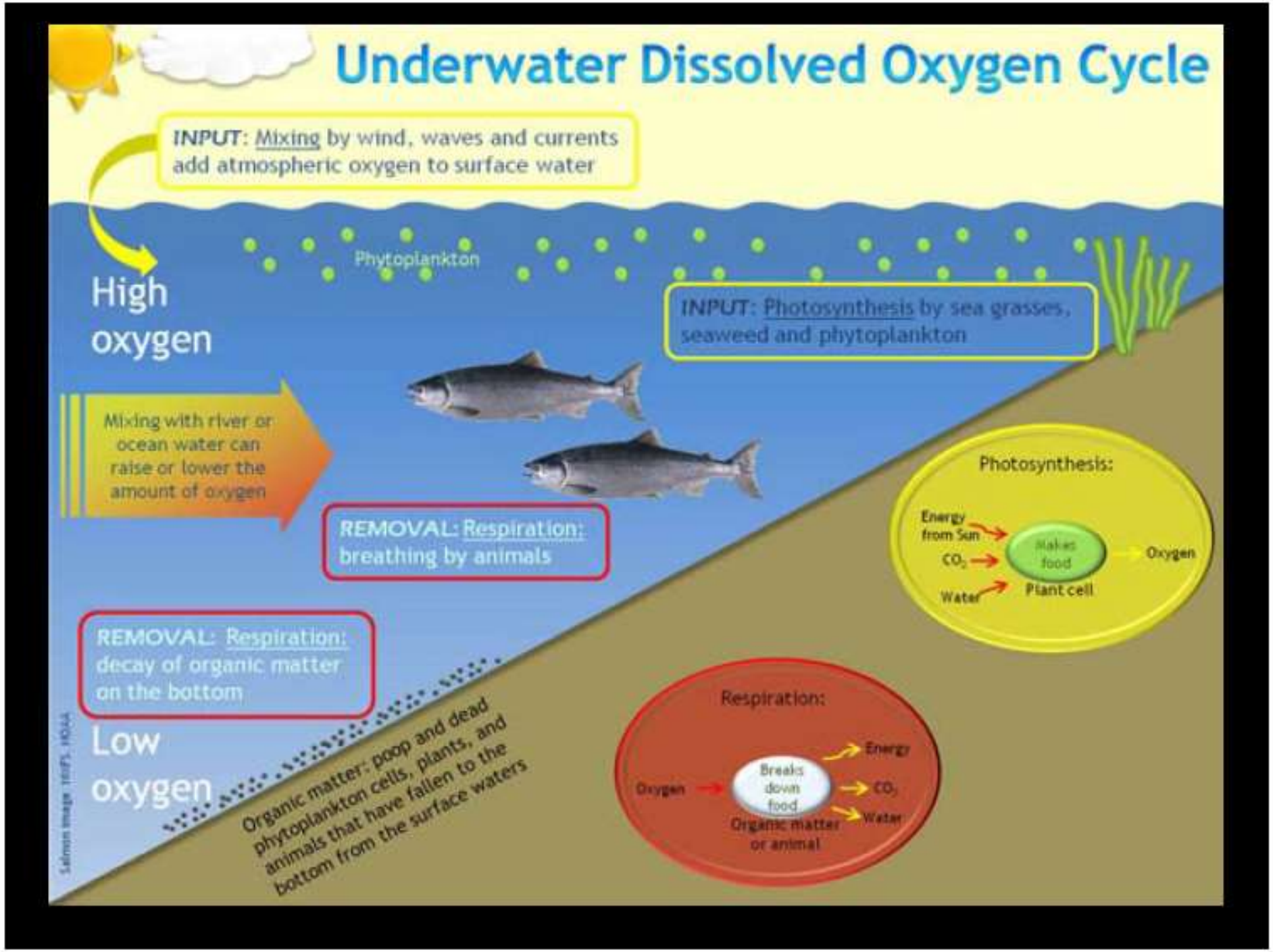
1. Re-aeration across the water surface by wind/wave action
2. Photosynthesis by plants (diurnal effect)

Sinks for Oxygen in Natural Waters (processes that remove DO)

1. Decomposition (respiration) of organic matter by bacteria, mainly in the benthic (bottom) layer
2. Respiration by plants (at night) and by animals (all the time)
3. Oxidation of nitrogenous compounds: organic nitrogen, ammonia, & nitrite (NO_2)

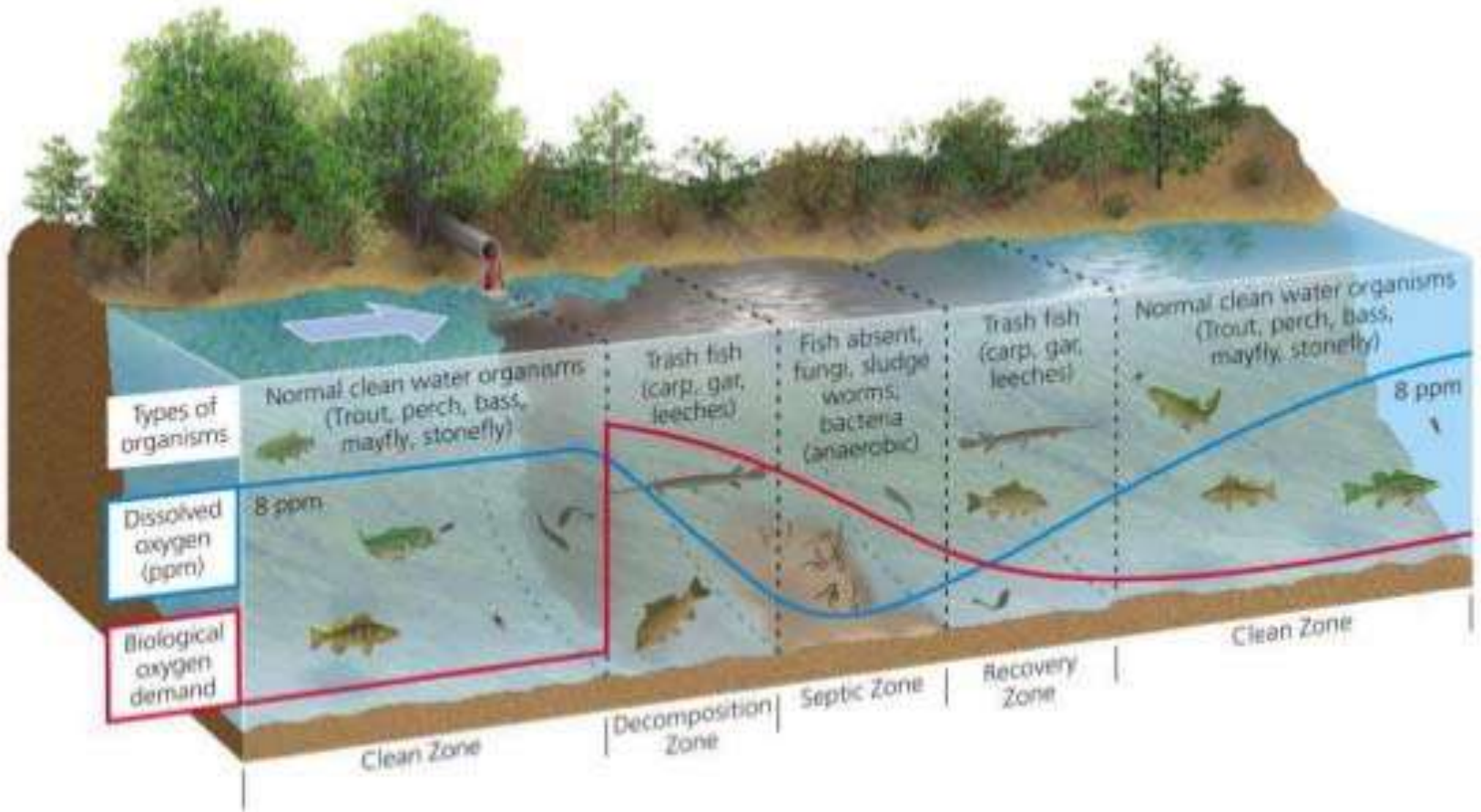





Underwater Dissolved Oxygen Cycle
INPUT: Mixing by wind, waves and currents add atmospheric oxygen to surface water
Phytoplankton
High oxygen
INPUT: Photosynthesis by sea grasses, seaweed and phytoplankton
Mixing with river or ocean water can raise or lower the amount of oxygen
REMOVAL: Respiration: breathing by animals
Photosynthesis:
Energy from Sun
CO_2
Water
Makes food
Oxygen
Plant cell
REMOVAL: Respiration: decay of organic matter on the bottom
Low oxygen
Organic matter: poop and dead phytoplankton cells, plants, and animals that have fallen to the bottom from the surface waters
Respiration:
Oxygen
Breaks down food
Energy
CO_2
Water
Organic matter or animal

In a river impacted by point source pollution:

Dissolved Oxygen, Aquatic organisms and BOD

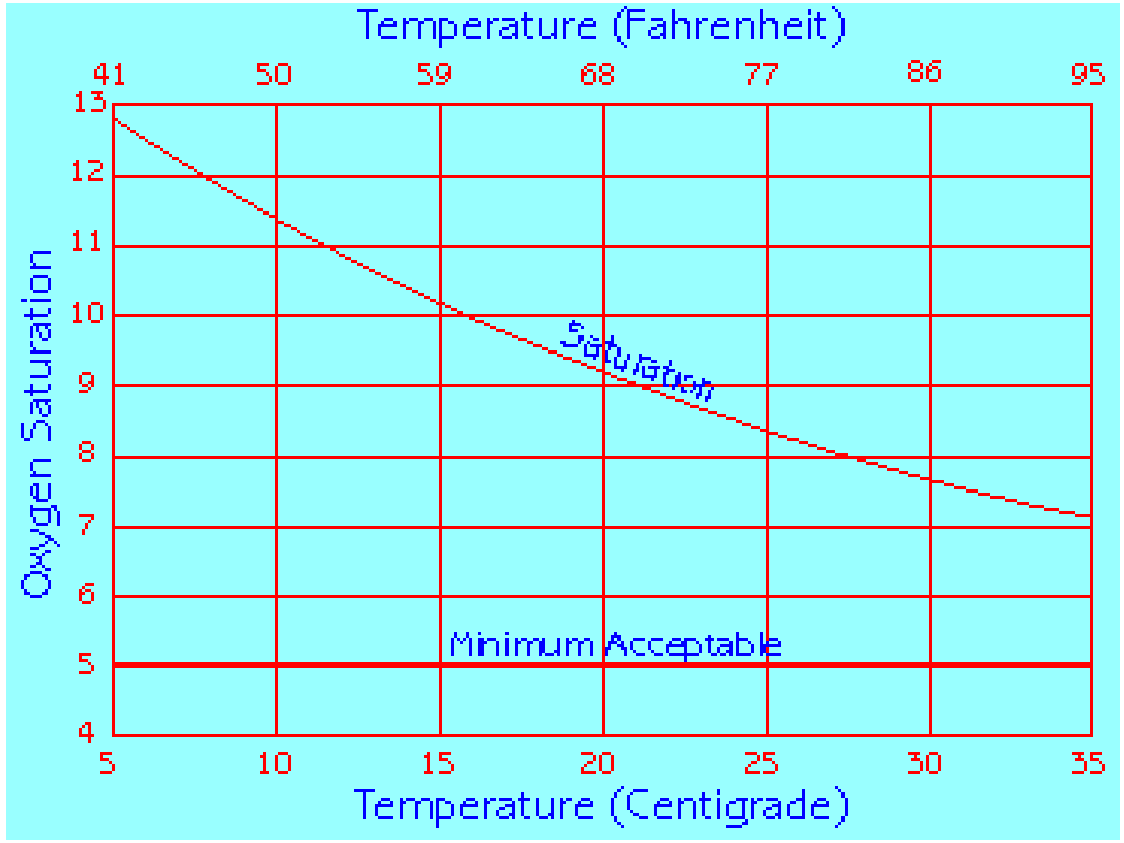


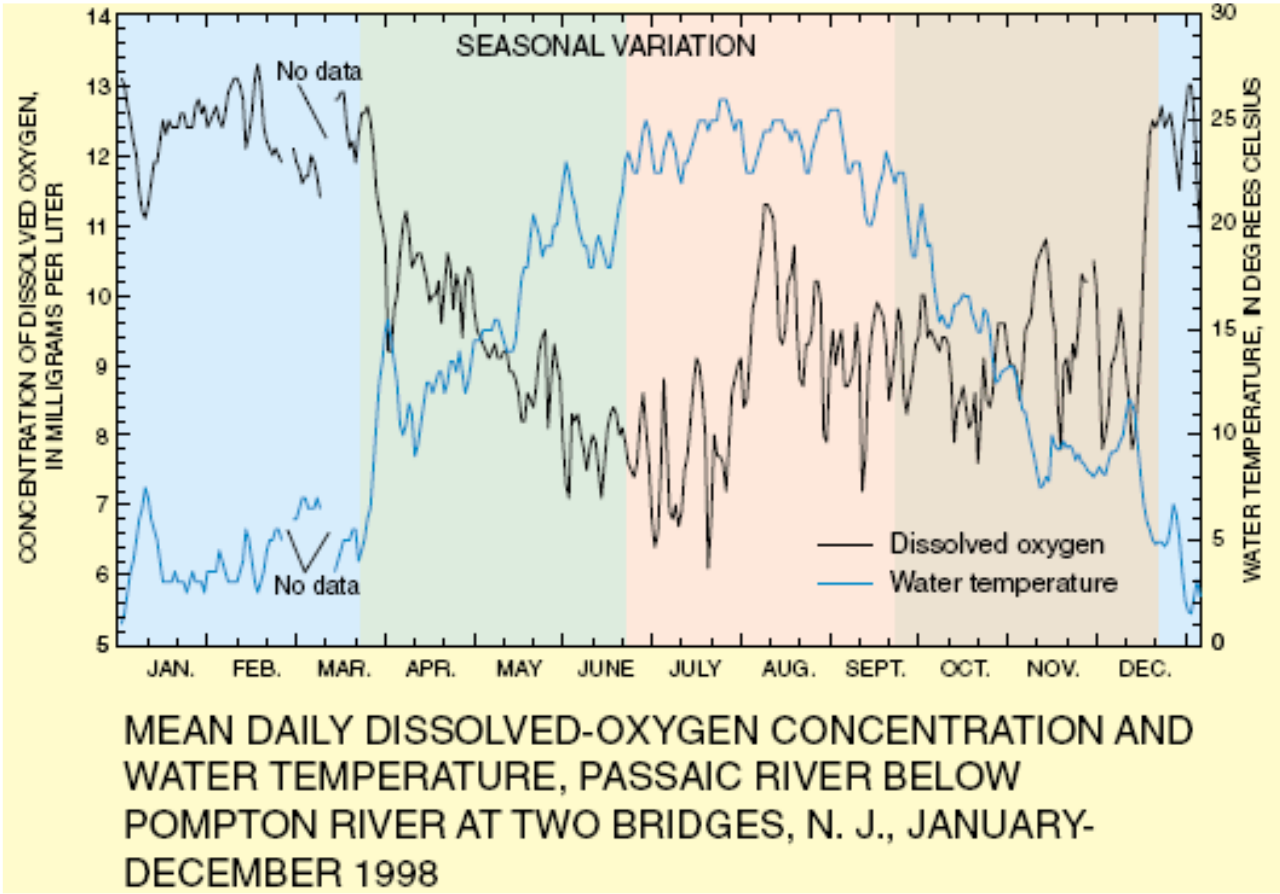
1. Clean Zone
2. Decomposition Zone
3. Septic Zone
4. Recovery Zone

Temperatur air

- Suhu secara langsung atau tidak langsung sangat dipengaruhi oleh sinar matahari.
- Suhu air bervariasi secara perlahan-lahan antara siang dan malam serta dari musim ke musim.
- Selain itu, air mempunyai sifat dimana berat jenis (densitas) maksimum terjadi pada suhu 4ºC dan bukan pada titik beku.

- Peningkatan suhu air mengakibatkan peningkatan viskositas, reaksi kimia, evaporasi dan volatisasi serta penurunan kelarutan gas dalam air seperti O_2 dan CO_2, sebagainya.
- Kisaran suhu air yang sangat diperlukan agar pertumbuhan ikan-ikan pada perairan tropis dapat berlangsung berkisar antara 25-32°C.

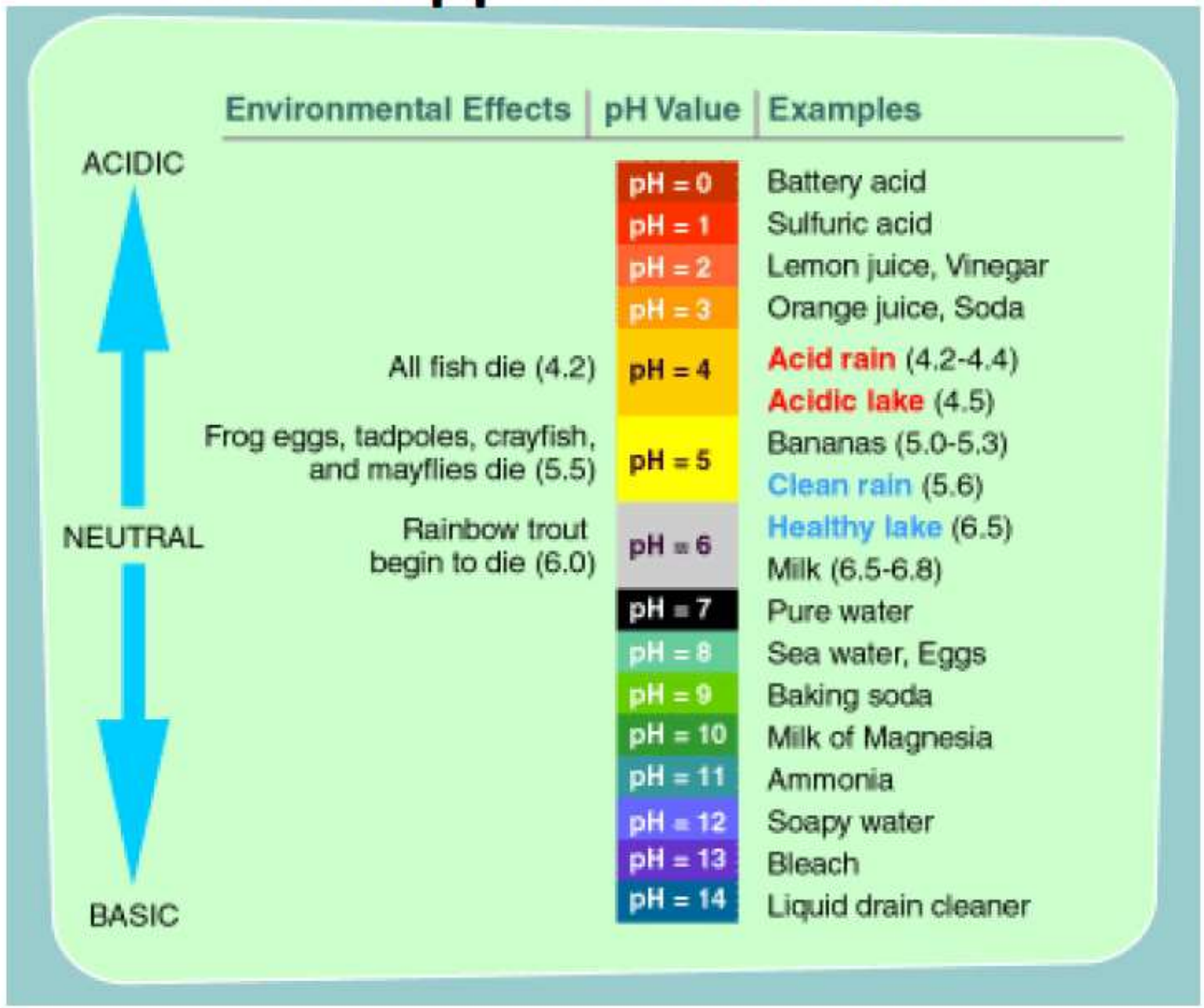




MEAN DAILY DISSOLVED-OXYGEN CONCENTRATION AND WATER TEMPERATURE, PASSAIC RIVER BELOW POMPTON RIVER AT TWO BRIDGES, N. J., JANUARY-DECEMBER 1998

pH scale

What happens at the limits?



Mengapa pH penting untuk diketahui?

- pH air menentukan **kelarutan** kelarutan bahan2 kimia, misalnya logam berat (timbal, tembaga, cadmium dll.) dan juga unsur hara (fosfor dan nitrogen)
- pH air menentukan **ketersedian biologi** bahan2 kimia, misalnya logam berat (timbal, tembaga, cadmium dll.) dan juga unsur hara (fosfor dan nitrogen)

Controls/mobilizes heavy metals

- As pH decreases, heavy metals become more soluble, and hence, more toxic to aquatic life
- Acid rain: can mobilize heavy metals
- Acid mine drainage: mobilizes heavy metals (Pb, Cd, Cu, Ni, …)
- Fe, Si, Al are very dominant in earth's crust, yet we see very little of them in most waters (they are only soluble at low pH)

Kekeruhan (turbidity)

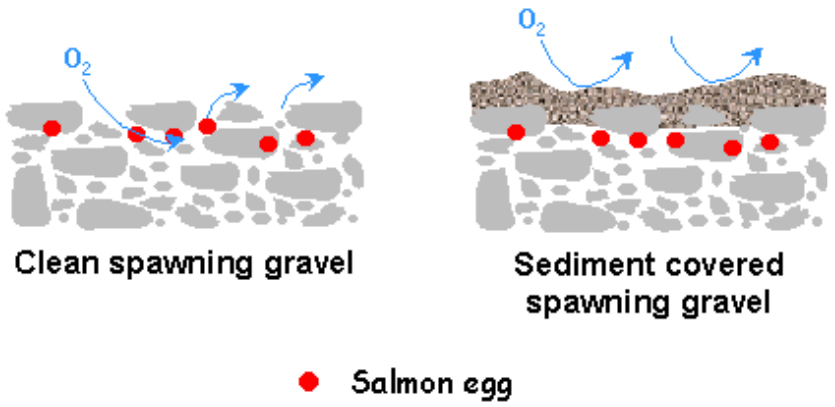
Kekeruhan: materi tersuspensi (kadang tidak terlihat mata) tetapi mengganggu kejernihan air

- Ada 4 hal yang berkontribusi:

1. Partikulat organik (fitoplankton, zooplankton dan mikroba lain)
2. Partikulat inorganic: clay dan silt
3. Kolloid
4. Bahan organik berwarna terlarut

Konsekuensi kekeruhan tinggi

- Bahan tersuspensi akan mempengaruhi pantulan cahaya, mengurangi penetrasi cahaya sehingga mengganggu fotosintesis → low DO
- Bahan tersuspensi akan menyerap panas → low DO (sensitive spesies)
- Bahan tersuspensi dapat merusak struktur insang
- Bahan tersuspensi dapat terdeposisi, menutupi habitat dasar perairan



Unsur hara di perairan

Masuknya unsur hara (mis: fosfat, nitrat, dan ammonia) berlebihan akan mengganggu kesehatan badan perairan

- Memicu terjadinya eutrofikasi (mis: fosfat, nitrat)
- Secara langsung dapat mempengaruhi spesies yang sensitive (kematian ikan pada ammonia >0.5 ml/L)

Pemerintah dalam rangka pengendalian pencemaran air pada sumber air berwenang:

a. menetapkan daya tampung beban pencemaran;
b. melakukan inventarisasi dan identifikasi, menetapkan daya tampung beban pencemarani sumber pencemar;
c. menetapkan persyaratan air limbah untuk aplikasi pada tanah;
d. menetapkan persyaratan pembuangan air limbah ke air atau sumber air;
e. memantau kualitas air pada sumber air; dan
f. memantau faktor lain yang menyebabkan perubahan mutu air.

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Geofisika FMIPA UNMUL

STUDI PENENTUAN DAYA TAMPUNG BEBAN PENCEMAR KUALITAS AIR SUNGAI MAHAKAM DENGAN MENGGUNAKAN METODE *QUAL2KW*

[1*]Yana Jumiati, [1]Dr. Mislan, M.Si, [1]Kadek Subagiada, M.Si
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ABSTRAK

Penelitian ini mengambil sungai Mahakam sebagai objek. Kasus memburuknya air sungai Mahakam diduga dipengaruhi oleh kegiatan bukaaan permukaan alam di sekitar DAS yang tidak terkendali dan sangat massif oleh kegiatan tambang, perkebunan dan kehutanan. Penelitian ini menggunakan bantuan program *QUAL2Kw* versi 5.1 untuk menghitung beban

LAMPIRAN

PERATURAN PEMERINTAH

NOMOR 82 TAHUN 2001

TANGGAL 14 DESEMBER 2001

TENTANG

PENGELOLAAN KUALITAS AIR DAN PENGENDALIAN PENCEMARAN AIR

Kriteria Mutu Air Berdasarkan Kelas.

PARAMETER	SATUAN	KELAS				KETERANGAN
		I	II	III	IV	
FISIKA						
Tempelatur	^{o}C	deviasi 3	deviasi 3	deviasi 3	deviasi 5	Deviasi temperatur dari keadaan almiahnya
Residu Terlarut	mg/ L	1000	1000	1000	2000	
Residu Tersuspensi	mg/L	50	50	400	400	Bagi pengolahan air minum secara konvesional, residu tersuspensi £ 5000 mg/ L
KIMIA ANORGANIK						
pH		6-9	6-9	6-9	5-9	Apabila secara alamiah di luar rentang tersebut, maka ditentukan berdasarkan

LAMPIRAN V : PERATURAN DAERAH PROVINSI KALIMANTAN TIMUR NOMOR 02 TAHUN 2011 TENTANG PENGELOLAAN KUALITAS AIR DAN PENGENDALIAN PENCEMARAN AIR

BAKU MUTU AIR PADA SUMBER AIR BERDASRKAN KELAS

Parameter	Satuan	Kelas				Keterangan
		I	II	III	IV	
a. FISIKA						
Temperatur	^{0}C	deviasi 3	deviasi 3	deviasi 3	deviasi 5	Deviasi temperatur dari keadaan alamiahnya
Residu Terlarut	mg/L	1000	1000	1000	2000	
Residu Tersuspensi	mg/L	50	50	400	400	Bagi pengolahan air minum secara konvensional, residu tersuspensi ≤ 5000 mg/L
Warna	PtCo	100	180	200	250	
KIMIA ANORGANIK						
pH		6-9	6-9	6-9	5-9	Apabila secara alamiah di luar rentang tersebut, maka ditentukan berdasarkan kondisi alamiah
BOD	mg/L	2	3	6	12	
COD	mg/L	10	25	50	100	
DO	mg/L	6	4	3	0	Angka batas minimum
Total Fosfat sebagai P	mg/L	0,2	0,2	1	5	
NO_3 sebagai N	mg/L	10	10	20	20	
NH_3-N	mg/L	0,5	(-)	(-)	(-)	Bagi perikanan, kandungan ammonia bebas untuk ikan yang peka ≤ 0,02 mg/L