Kepekaan makroinvertebrata bentos terhadap tingkat pencemaran deterjen. Studi kasus di Kali Mas Surabaya = The sensitivity of benthic macroinvertebrate to detergent pollution level. A Case study in Surabaya Mas River

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Abstrak

ABSTRAK
Kali Mas adalah anak cabang bagian hilir Sungai Brantas yang secara khusus melewati deerah perkotaen Surabaya. Berhubung sejak di bagian hulu Sungai Brantas sampal dengan Kali Mas ini menerima limbah padat dan atau cair dari berbagai kegiaten pertanian, industri, dan pemukiman maka kualitas air Sungai Brantas maupun Kali Mas akan mengalami pencemeran yang depat berupa bahan organik, unsur hara, padatan tersuspensi, dari atau bahan toksik. Perum Jasa Tirta (1995) mencatat bahwa 87% pencemar di sepanjang Kali Mas berasal dari limbah domestik.

Surlaktan deterjen sintetik adalah salah satu limbah domestik yang bersifat toksik di perairan. Pengaruh beban masukan deterjen sintetik pads biota perairan dapat tercermin dari perubahan struktur komunitas makroinvertebrata bentos yang hidup menetap di substrat perairan. Beban masukan deterjen akan mengakibatkan pemusnahan jenis secara selektif sesuai dengan toleransinya terhadep deterjen.

Dalam rangka upaya pengendalian kualitas air Kali Mas, diperlukan suatu metode evaluasi yang bersifat obyektif. Dalam upaya pendugaan kualitas air, selain dilakukan dengan metode fisika-kimia yang cukup kompleks, juga diperlukan metode bioiogi khususnya untuk mengendalikan bahan pencemar yang bersifat toksik. Komunitas makroinvertebrata bentos dipertimbangkan tepat untuk dijadikan biota indikator perairan sungai oleh karena hidup menetap di dasar perairan dan mempunyai keenekaragaman yang tinggi. Dari perubahan struktur komunitas makroinvertebrata bentos yang aktual terjadi, depot dijadikan sebagai dasar informasi tentang tingkat kadar deterjen sintetik. Apabila hal ini dapat dipastikan maka obyek penilaian tingkat pencemaran deterjen sintetik dapat didasarkan pada perubahan struktur komunitas makroinvertebrata bentos.

Berdasarkan hal di atas, maka penelitian ini dilakukan untuk (1) memperoleh informasi tentang kualitas air di Kali Mas Surabaya khususnya berkenean dengan adanya masukan bahan deterjen sintetik, (2) mengetahui perubahan struktur komunitas makroinvertebrata bentos pada berbagai tingkat pencemaran di Kali Mas, dan (3) mengetahui tingkat kepekaan jenis makroinvertebrata bentos terhadap perubahan kandungan surfaktan deterjen sintetik (LAS dan PBS) untuk dijadikan dinar indikasi tingkat pencemaran deterjen.

Penelitian kepekean makrolnvertebrata bentos terhadap tingkat pencemaran deterjen di Kali Mas Surabaya menggunakan metode penelitian Ex Post Facto. Uji toksisitas surfaktan deterjen sintetik (LAS dan ABS) terhadap kelangsungan hidup Jenis makroinvertebrata bentos dilakukan dengan metode eksperimental.

Strategi pendekaten untuk telaah analisis kausatif hubungan antara habitat dan tingkat pencemaran deterjen terhadap struktur komunitas makroinvertebrata bentos di Kali Mas Surabaya adalah sebagai berikut :
1. Penentuan lokasi penelitian atas dasar kandungan deterjen.
2. Penentuan tingkat pencemaran Kali Mas dengan melakukan pemantauan kualitas air termasuk di dalamnya kandungan deterjen pada tiap lokasi.
3. Telaah struktur komunitas makroinvertebrata bentos pada tiap lokasi.
4. Telaah hubungen fungsional muftifaktor antara kualitas air (DO, TOM, TSS, fosfat, sutfat, dan deterjen) dengan kelimpahan jenis makroinvertebrata bentos yang ditemukan.
5. Analisis kepekaan dari masing-masing Jenis dan kelilmpahan makroinvertebrata bentos terhadap perubahan kadar deterjen.
6. Untuk mengetahui sifat toksik dari surfaktan deterjen, maka Jenis-Jenis yang bersifat peka terhadap perubahan kadar deterjen tersebut kemudian diuji lebih lanjut melalui uji toksisitas dengan metode bioassay lethal acute effect terhadap surfaktan deterjen LAS dan ABS.

Pengambilan sampel air, substrat, dan makroinvertebrata bentos untuk pemantauan kualitas air dilakukan pada 7 lokasi di suatu ruas Kali Mas mulai dari pintu air Wonokromo sampai daerah Ngemplak di Kotamadya Dati II Surabaya. Analisis kualitas kimia dan biologi serta uji toksisitas dilakukan di laboratorium Ekologi Jurusan Biologi F.M1PA Universitas Brawijaya. Studi pendahuluan untuk penentuan lokasi dilakukan tanggal 12 Meret 1996.

Pengambilan sampel dilakukan sebanyak enam kali (tanggal 11, 15, 19, 23, 27, den 31 Mei 1996). Uji toksisitas dilakukan pada bulan Aguslus sampai September 1996.

Pengambiian sempel air pada tiap stasiun dilakukan pada lapisan permukaan dan lapisan dasar (± 25 cm dari permukaan dan dasar). Pada masing-masing lapisan tersebut dilakukan pengembilan sampel secara komposit pada bagian tepi (kiri dan kanan) dan bagian tengah.

Faktor lingkungan yang diukur dalam penelitian adalah kecepatan arus, lebar sungai, kedalaman, debit, tekstur substrat, padatan tersuspensi total (TSS), suhu air dan udara, konduktivitas air, oksigen tertarut (DO), CO2 bebas terlarut, GODS, COD, TOM, deterjen, total fosfat terlarut, sulfat, ammonium, pH, alkalinitas, dan selinitas. Pengumpulan data kualitas air yang berupa NH3 -N, NO3, NO2, Fe, Hg, Mn, Zn, dan Crs+ diambil dari DPU Pengairan Dati I Jawa Timur.

Untuk penentuan tingkat pencemaran Kali Mas, data hasil pemantauan kualitas air dikompilasi dan dihitung nilai rata-rata serta kesalahan baku untuk masing-masing stasiun dan waktu pantau kemudian dibandingkan dengan nilai baku mutu air golongan B dan C berdasarkan SK Gubernur Kepala Dati lI Jawa Timur No. 413 Tahun 1987. Tingkat pencemaran Kali Mas secara umum ditentukan dengan mencari indeks Pencemaran lmplisit dari Pratis (Ott, 1978). Pengelompokan habitat dan tekstur substrat dinar ditentukan dengan mencari Indeks Kesamaan Bray-Curtis. Untuk mengetahui perbedaan kualitas air antar lapisan air, stasiun, dan antar waktu pantau maka dilakukan uji Anova yang dilanjutkan dengan uji beda nyata terkecll (BNT) pada niaai tiap-tiap parameter.

Data hasil identifikasi dan perhitungan kelimpahan Jenis makroinretertebrata bentos digunakan untuk menghitung indeks keanekaragaman Shanon-Wiener, indeks keseragaman (Equability), indeks dominansi, indeks kesamaan komunitas Bray-Curtis, dan Index of dispersion. Untuk mengetahui perbedaan kelimpahan antar stasiun dan waktu pantau dilakukan uji Anova yang dilanjutkan dengan uji BNT pada kelimpahan tiap-tiap Jenis makroinvertebrata bentos yang ditemukan.

Parameter kualitas air penentu kelimpahan makroinvertebrata bentos, ditentukan dengan telaah hubungan fungsional antara tiap-tiap parameter fisik - kimia air dengan kelimpahan jenis makroinvertebrata bentos dalam bentuk model regresi berganda. Kepekean makroinvertebrata bentos terhadap kadar deterjen dihitung dari rumus turunan pertama dan persamaan regresi berganda tersebut terhadap deterjen. Penghitungan uji Move, BNT, den regresi berganda dengen menggunaken SPSS for Windows Release 6.0.

Hasil penelitian menunjukkan bahwa kualitas air di Kali Mas sudah tidak memenuhi nilai baku mutu golongan B dan golongan C. Parameter kualitas air yang telah melampaui nilai baku mutu adalah BOD5 (6.33 - 19.08 mgA), DO (2.10 - 4.14 mgA), TSS (67.90 - 154.97 mg/I), COD (119.25 - 143.25 mg/I), deterjen (1.9i - 4.30 mgA), fosfat (0.31 --1.21 mgA), ammonia (0.15 - 0.62 mgA), nitrit (0.07 - 0.27 mgA), den besi (5.07 - 7.14 mg11). Tingkat pencemaran di Kali Mas berdeserkan Indeks pencemaran Implisit dari Prati's digolongkan dalam kategori tercemar ringan sampai tercemar (2.87 - 7.65).

Sehubungan dengan pencemaran tersebut, beberapa parameter habitat makroinvertebrata bentos mengalami perubahen secara spasial. Rataan deterjen (1.55 - 4.81 mgA), fosfat (0.32 - 1.20 mg/l), sulfa' (29.80 - 34.14 mgA), BOD5 (7.00 - 21.50 mgA), den DO (2.63 - 4.60 mg11) nyata lebih tinggi pada daerah ke arah hilir. Retain suhu, DHL, pH, TOM, TSS, COD, dan ammonium tidak berbeda nyata secara spasial. Selama penelitian, secara umum ditemui perubahan temporal dari semua parameter kuailtas air yang diamati. Habitat Kali Mas berdasarkan kondisi TOM dapat dibagi menjedi dua kelompok yaitu waktu pantau ke-1,2,3 dengan kadar TOM yang lebih tinggi (630.42 - 660.44 mg/I) den waktu pentau ke-4,5,6 dengan kadar TOM yang lebih rendah (337.33 - 533.25 mgA). Secara keseluruhan, perubahan kualitas air Kali Mas tersebut berdasarkan indeks kesamaan Bray-Curtis pada tingkat kesamaan 90% didapatkan kualitas habitat di stasiun 7 (waktu kadar TOM tinggl} dan stasiun 6 (waktu kadar TOM rendah) berbeda nyata dibandingkan dengan stasiun yang lain dengan natal Indeks kesamaan berturut-turut 88% den 89%.

Pada daerah penelitian ditemukan 24 jenis makroinvertebrata bentos yang dildentifikasi dan filum Annelida, Mollusca, dari Arthropoda. Adanya perubahan kualitas air di Kali Mas mengakibatkan perubahan komposisi, tipe penyebaran, dan perubahan kelimpahan dari beberapa jenis mekroinvertebrata bentos secara spasial. Secara khusus pada stasiun 1 ditemukan tingkat keanekaragaman (0.35 - 1.14) dan keseragaman (0.12 - 0.36) jenis yang mantap rendah maka dominansi jenis tinggi (0.49 - 0.91), den pada staslun 6 ditemukan tingkat keanekaragaman (2.19 - 2.65) dan keseragaman (0.60 - 0.74) jenis makroinvertebrata yang mantap tinggi maka dominansi jenis rendah (0.19 - 0.29). Sedangkan pada stasiun yang lain ditemukan struktur komunitas yang berubah-ubah yaitu keanekaragaman (0.48 - 1.85) dan keseragaman (0.24 - 0.54) jenis yang rendah sampai sedang maka dominansi jenis sedang sampal tinggi (0.32 - 0.85). Berdasarkan indeks kesamaan Bray-Curtis didapatkan pengelompokan struktur komunitas dan ekotipe dari makrolnvertebrata bentos yang serupa.

Stasiun 6 mempunyai struktur komunitas dan ekotipe yang paling berbeda dibandingkan dengan stasiun yang lain dengan nilai indeks kesamaan 6% dan 9% (pada waktu kadar TOM tinggi) serta 7% dan 996 (pada waktu kadar TOM rendah).

Pada waktu kadar TOM tinggi ditemukan tiga jenis makroinvedebrata bentos yang nyata dipengaruhi oleh deterjen yaitu Bellarnya javanica, Wattebledla insularian, dan Corbicula javanica. Pada waktu kadar TOM rendah ditemukan jenis Lymnaea rubiginosa yang nyata dipengaruhi oleh deterjen. Tingkat kepekaan dan keempat jenis tersebut pada tingkat signifikansi 5% adalah 0.4873 mgA, 1.009 x 10 mgA, 5.0359 x 1010 mgA, dan 3.3645 x 9012 mg/_ Perubahan kader TOM di ruas Kali Mas mengakibatkan perbedaan tingkat kepekaan dari jenis makroinvertebrata bentos terhadap kadar deterjen. Berdasarkan uji toksisitas ditemukan bahwa pada kadar TOM yang lebih rendah, jenis Lymnaea rubiginosa bersifat lebih peka terhadap peningkatan surfaktan LAS dan ABS (nilat LC50-96 jam 9.40 dan 13.59 mgA) dibandingkan dengan Wattebledla insularian (natal LC5rr96 jam 10.73 dan 15.89 mgA).
<hr><I><b>ABSTRACT</B>
The Sensitivity Of Benthic Macroinvertebrate To Detergent Pollution Level (A Casa Study In Surabaya Mas River)Mas River is a downstream tributary of Brantas River which pass through Surabaya municipality. Since from the upstream of Brantas River up to Mas River it received solid and liquid waste from various agriculture, industry and household activities, therefore, the water quality of both Brantas as well as Mas River are polluted by organic substances, nutrient, suspended solid, and or toxic substances. Perum Jasa Tirta (1995) noted that 87% polutants along Mas River came from domestic wastes.

Synthetic detergent's surfactant is one of the toxic domestic waste in the body of water. The influence of synthetic detergent discharges to the aquatic population are reflected by the changes of benthic macroinvertebrate community structure that live in the aquatic substrate. The load of detergent discharges selectively resulted in the elimination of species according to their selective degrees of tolerance towards the detergent.

In order to control Mas River water quality, the evaluation methods objectively are needed. The physic chemical examinations are complicated methods for assessing water quality and that is why it is needed biological method specially to control toxic substances pollutant. Benthic macroinvertebrate communities are considered as an appropriate bioindicator of rivers because they live In the bottom of the water and have high diversity. The actual change of benthic macroinvertebrate communities can be regarded as basic information on the level of synthetic detergent concentration. If this can be proofed, then, the pollution level of synthetic detergent assessment can be based on benthic macroinvertebrate community structure change.

Based on the above explanation, this research was carried out to obtain information on (1) water quality of Surabaya Mas River, especially those concerning the existing synthetic detergent content, (2) to know benthic macroinvertebrate communities structure changes at different pullution levels In Surabaya Mas River , and (3) to know the sensitivity level of benthic macroinvertebrate species towards the concentration of synthetic detergent surfactant as the basic indicator of detergent pollution level.

The ex post facto method was used to study the sensitivity of benthic macroinvertebrate to detergent pollution level in Surabaya Mas River. The experimental method was used to toxicity test of synthetic detergent's surfactant (LAS and ABS) towards the survival of benthic macroinvertebrate species.

The strategical approach of causative analysis review between habitat and detergent pollution level on benthic macroinvertebrate community structure in Mas River are as follows :
1. To determine the sampling site based on detergent concentration.
2. To determine Mas River pollution level by monitoring the water quality including the detergents'concentration at each sampling site.
3. To analyze benthic macroinvertebrate communities structure at each sampling site.
4. To analyze the multifactor functional Interaction between water quality (DO, TOM, TSS, phosphates, sulfates, and detergent) with species abundance of benthic macroinvertebrates found.
5. To analyze the sensitivity of each benthic macroinvertebrate species abundance towards detergent concentration change.
6. To know the toxicity of detergent surfactant, the sensitive species towards detergent concentration change mentioned above are then tested further by way of toxicity test with bioassay lethal acute effect method towards LAS and ABS detergent surfactant.

The collection of water, substrate, and benthic macroinvertebrate samples to monitor water quality were carried out at 7 locations of Mas River commencing at Wonokromo sluice up to Ngemplak Area in Surabaya municipality. Chemical and biological quality analyses as well as the toxicity test were done at the Ecology Laboratory, Biology Department, Faculty of Mathematics and Science, Brawijaya University, Malang. The preliminary study to determine the location was done on March 12, 1996. The sampling was done six times (11, 15, 19, 23, 27, and 31 May, 1996). Toxicity tests were done between August and September 1996.

The sampling of water at each station was carried out at the surface and bottom layer (± 25 cm from the surface and bottom). In each layer, the sampling is done in composit way at the edges (left and right) and the middle. Environmental factors measured in this research are current velocity, width, depth, discharge, substrate texture, total suspended solid, temperature of water and air, conductivity, dissolved oxygen, dissolved CC2, BOD5, COD, TOM, detergent, total dissolved phosphates, sulfates, ammonium, pH, alkalinity, and salinity. The data of NH3-N, N03, NOj, Fe, Hg, Mn, Zn, and Crs+ were taken from the Irrigation Public Works Department of East Java local government.

To determine the Mas River pollution level, the data of water quality monitoring result is compiled and the average value as well as its standard error for each station end sampling period are calculated then compared with water quality standard values of class B and C based on the Governor of East Java Province decree No. 413 (1987). The Mas River pollution level is, in general, determined by looking for Prati's Implicit Index of Pollution (Ott, 1978). The grouping of Mas River habitat and the substrate texture are determined by searching for the Bray-Curtis similarity Index. Anova test Is used to find out the water quality difference between water layer, station, and inter-sampling period. It is continued with Least Significance Difference (LSD) test at each parameter's value.

The results of identification and species abundance of benthic macroinvertebrate calculation was used to compute the Shanon-Wiener Diversity Index, Equitability Index, Dominance Index, Bray-Curtis Community Similarity Index and Index of Dispersion. To find out the difference of species abundance inter stationally and sampling period, the Anova test was carried out and followed by LSD test on abundance of each species of benthic macroinvertebrates found.

Water quality determinants of benthic macroinvertebrate abundance are determined by reviewing the functional Interactions between each physic chemical parameter of water and species abundance of benthic macroinvertebrate in the form of multi regression model. The sensitivity of benthic macroinvertebrate towards detergent concentration was calculated from the formula of first derivation of multi regression equation towards the detergent. The calculations of Anove, LSD test, and multi regression took place by using SPSS for Windows Programme release 6.0.

The result of this research showed that the water quality of Mas River is not eligible for raw water of drinking water (class B) as well as for fishery requirements (class C). Water quality parameters exceeded the quality standard values are BOD5 (6.33 - 19.08 ppm), DO (2.10 - 4.14 ppm), TSS (67.90 - 154.97 ppm), COD (119.25 - 143.25 ppm), detergent (1.91 - 4.30 ppm), phosphates (0.31 - 1.21 ppm), ammonia (0.15 - 0.62 ppm), nitrite (0.07 - 0.27 ppm), and iron (5.07 - 7.14 ppm). The Pollution level of Mas River, based on Prati's Implicit Index of Pollution Is classified in categories of slightly polluted to polluted water (2.87 - 7.65).

Some parameters of the benthic macroinvertebrate habitat has been changed because of the pollution level in Mas River. The average concentration of detergent (1.55 - 4.81 ppm), phosphates (0.32 - 1.20 ppm), sulfates (29.80 - 34.14 ppm), BOD5 (7.00 - 21.50 ppm), and DO (2.63 - 4.60 ppm) tend to increase in the down stream. The average of water temperature, pH, TOM, COD, and ammonium at the bottom layer do not show spatial change. All of the water quality parameters show temporal change. Based on TOM condition, Mas River habitat can be divided into two groups namely sampling period 1,2,3 with higher TOM content (630.42 - 660.44 ppm) and sampling period 4,5,6 with lower TOM content (337.33 - 533.25 ppm). Based on the Bray-Curtis similarity index it was found that there is significance difference of the habitat quality of station 7 (on the high TOM content periods) and station 6 (on the low TOM content periods) compared to the other station at 90% similarity level with the similarity index value are 88% and 89% respectively.

There are 24 species of benthic macroinvertebrates in the study area, classified as Annelida, Mollusca, and Arthropoda phyltum. The change of water quality in the Mas River has changed the composition, dispersion type, and spatial abundance of some benthic macroinvertebrate species. Station 1 and 6 have special structure of benthic macroinvertebrate community. Station 1 has low species diversity (0.35 - 1.14) and equitability (0.12 - 0.36) and that is why there is high species dominance (0.49 - 0.91). Station 6 has high species diversity (2.19 - 2.65) and equitability (0.60 - 0.74) and that is why there is low species dominance (0.19 - 0.29). The other stations have lower to intermediate species diversity (0.48 - 1.85) and equitability (0.24 - 0.54) so that the species dominance are intermediate to high (0.32 - 0.85). Based on the Bray-Curtis similarity index it was found that there is similar the grouping of community structure and ecotype of benthic macroinvertebrate. It was found that there is difference of community structure end ecotype of

benthic macroinvertebrate between station 6 compared to the other stations with the similarity index value are 6% and 9% (on the high TOM content periods) and 7% and 9% (on the low TOM content periods).

Bellarnya javanka, Wattebledia insular,,,, Corbicula javanica (on the high TOM content periods) and Lymnaea rubiginosa (on the low TOM content periods) were affected by detergent concentration. The sensitivity level of those species at the significance level of 5% are 0.4873 ppm, 1.009 x 10 ppm, 5.0359 x 1010 ppm, and 3.3645 x 1012 ppm respectively. The change of TOM content in the Mas River has changed the sensitivity level of benthic macroinvertebrate species to detergent concentration. Based on the toy icity test it was found that Lymnaea tublglnosa was more sensitive to LAS and ABS surfactant concentrations on the low TOM content periods (L.C50-96 hours are 9.40 and 13.59 ppm respectively) compared to Wattebledia insular (LC50-96 hours are 10.73 and 15.89 ppm respectively).</i>