LAPORAN AKHIR
PENELITIAN UNGGULAN PERGURUAN TINGGI

PENGEMBANGAN MODEL PENGELOLAAN KUALITAS FISIKO-KIMIA AIR DAN BIODIVERSITAS DI SEKITAR MATA AIR DAS BRANTAS HULU UNTUK MENDUKUNG AGROFORESTRY BERKELANJUTAN

Tahun ke 1 dari rencana 2 tahun

Dr. Catur Retnaningdyah, M.Si NIDN. 0003016802
Dr. Endang Arisoesilaningsih NIDN. 0008095905

Dibiayai oleh :
Direktorat Jenderal Pendidikan Tinggi,
Kementerian Pendidikan dan Kebudayaan, Melalui DIPA Universitas Brawijaya
Nomor : DIPA-023.04.2.414989/2013, Tanggal 5 Desember 2012, dan berdasarkan
SK Rektor Universitas Brawijaya Nomor : 295/SK/2013 tanggal 12 Juni 2013

UNIVERSITAS BRAWIJAYA
Nopember, 2013

HALAMAN PENGESAHAN

Judul	: Pengembangan Model Pengelolaan Kualitas Fisiko-Kimia Air dan Biodiversitas di Sekitar Mata Air DAS Brantas Hulu untuk Mendukung Agroforestry Berkelanjutan
Peneliti/Pelaksana	
Nama Lengkap	: Dr. Catur Retnaningdyah, M.Si
NIDN	: 0003016802
Jabatan Fungsional	: Lektor Kepala
Program Studi	: Biologi
Nomor HP	: 081615876594
Surel (e-mail)	: catur@ub.ac.id
Anggota Peneliti (1)	
Nama Lengkap	: Dr. Endang Arisoesilaningsih
NIDN	: 0008095905
Perguruan Tinggi	: UNIVERSITAS BRAWIJAYA
Institusi Mitra (jika ada)	
Nama Institusi Mitra	: -
Alamat	: -
Penanggung Jawab	: -
Tahun Pelaksanaan	: Tahun ke 1 dari rencana 2 tahun
Biaya Tahun Berjalan	: Rp. 100.000.000,-
Biaya Keseluruhan	: Rp. 200.000.000,-

Mengetahui,
Dekan Fakultas MIPA

(Prof. Dr. Marjono, M.Phil.)
NIP. 19621116 198803 1 004

Malang, 29-11-2013,
Ketua,

(Dr. Catur Retnaningdyah, M.Si)
NIP. 19680103 199103 2 002

Menyetujui,
Plt. Ketua LPPM UB

(Prof. Dr. Ir. Siti Chuzaemi, MS)
NIP. 19530514 198002 2 001

Pengembangan Model Pengelolaan Kualitas Fisiko-kimia Air dan Biodiversitas di Sekitar Mata Air DAS Brantas Hulu untuk Mendukung Agroforestry Berkelanjutan

Catur Retnaningdyah dan Endang Arisoesilaningsih

ABSTRAK

Penelitian tahun pertama ini bertujuan untuk melakukan evaluasi kualitas ekosistem mata air pada wilayah terkonservasi (radius 200 m di sekitar mata air) yang tercermin dari kualitas fisiko-kimia air (pH, DO, konduktivitas, bikarbonat, TDS, TSS, kekeruhan, nitrat, ortofosfat, ammonium, total fosfat, TKN, COD, BOD) dan kualitas biodiversitas di mata air meliputi makroinvertebrata bentos sebagai bioindikator kualitas air (struktur komunitas, diversitas, beberapa indeks biotik) dan vegetasi pohon riparian (jenis, kerapatan, diameter batang, tinggi pohon, stratifikasi, indeks *naturalness*, indeks *hemeroby*). Selain itu juga dilakukan pengamatan faktor lingkungan meliputi kondisi pemanfaatan lahan di wilayah konservasi mata air dengan menggunakan indeks jasa lingkungan dan kondisi geografi (ketinggian, *latitude, longitude*, dan kemiringan). Monitoring dilakukan pada 15 mata air yang ditemukan di DAS Brantas Hulu wilayah Malang raya dan Kota Batu (Sumber Jenon, Sumber Pitu, Sumber Awan, Sumber Mlaten, Sumber Brantas, Sumber Petung Ngamplok,
Sumber Riwuk, Sumber Umbul, Sumber Guno, Sumber jodo, Sumber Umbulan, Sumber Maron, Sumber Nongkojajar, Sumber Darmi, dan Sumber Tlogosari). Pengambilan sampel air dan biologi dilakukan pada mata air dan saluran air 200 m dari mata air. Data hasil monitoring digunakan untuk melakukan analisis profil kualitas air, profil biodiversitas, profil geografi dan pemanfaatan lahan menggunakan analisis *cluster* dan biplot. Hasil penelitian menunjukkan bahwa kualitas fisiko-kimia perairan 15 mata air yang dipantau berdasarkan parameter pH, DO, BOD dan fosfat total sudah melampaui nilai baku mutu air Kelas I yang telah ditetapkan untuk bahan baku air minum berdasarkan PP RI No. 82 tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air sehingga dengan demikian perairan tersebut sudah tidak layak dipakai sebagai bahan baku air minum. Berdasarkan perhitungan nilai indeks biotik dari makroinvertebrata bentos (HBI, FBI dan ASPT) mata air Sumber Pitu dan salurannya (200 m dari mata air), Sumber Jodo dan salurannya, Sumber Darmi dan salurannya serta mata air Sumber Petung Ngamplok mempunyai kualitas air yang lebih baik dan termasuk dalam kategori *Very Good* sampai dengan *Excellent* yaitu sangat sedikit tercemar bahan organik sampai tidak tercemar bahan organik dibandingkan dengan kualitas mata air dan salurannya pada wilayah penelitian yang lain yang termasuk dalam kategori *Fairly Poor* sampai *Good* yaitu tercemar bahan organik secara signifikan sampai sedikit tercemar bahan organik. Kualitas air di saluran dengan jarak 200 m dari mata air dapat terjadi penurunan atau peningkatan tergantung dari aktivitas di sekitar mata air.

Kata kunci: DAS Brantas Hulu, Kualitas air, Mata air, Makroinvertebrata bentos.

Model Management Development of Physico-Chemical Water Quality and Biodiversity Around the Wellspring Found in Upper Brantas Watershed to Support Sustainable Agroforestry

Catur Retnaningdyah and Endang Arisoesilaningsih

ABSTRACT

The purpose of this first year research is to evaluate the quality of the springs ecosystem on conserved regions (radius of 200 m around the spring). The water quality are reflected in water physico – chemical quality (pH, DO, conductivity, bicarbonate, TDS, TSS, turbidity, nitrate, orthophosphate, ammonium, total phosphorus, TKN, COD, BOD) and quality of springs biodiversity include benthic macroinvertebrates as bio-indicators of water quality (community structure, diversity, some of biotic indices) and riparian trees vegetation (taxa richness, density, stem diameter, tree height, stratification, naturalness and hemeroby index) . They were also be observed environmental factors include land used conditions in the area of conservation by using environmental services index and geographic conditions (altitude, latitude, longitude, and slope). Monitoring was done on the 15 springs that were found in the Upper Brantas river basin at Malang and Batu region (Sumber Jenon, Sumber Pitu, Sumber Awan, Sumber Mlaten, Sumber Brantas, Sumber Petung Ngamplok, Sumber Riwuk, Sumber Umbul, Sumber Guno, Sumber jodo, Sumber Umbulan, Sumber Maron, Sumber Nongkojajar, Sumber Darmi, dan Sumber Tlogosari). Water and biological sampling conducted in spring and drains 200 m from the spring. The data monitoring results were used to analyze the profiles of water quality, biodiversity, geography and land use both by cluster analysis and biplot. The results showed that the value of pH , DO , BOD and total phosphate of the 15 springs waters have already exceeded the water quality standards value for raw material drinking water based on Indonesia government regulation No. 82 year 2001 about Management of Water Quality and Water Pollution Control. So that is why these waters are not suitable to be used as raw material for drinking water. Based on the calculation of the macroinvertebrate benthic biotic indices (HBI, FBI and ASPT), Sumber Pitu spring and its channel (200 m from the spring), Sumber Jodo spring and its channel, Sumber Darmi spring and its channel as well as Sumber Petung Ngamplok spring have better water quality. They were included in the category of very Good (possible slight organic pollution) to Excellent (no apparent organic pollution) compared to the quality of the other springs and its channel which were included in the category Fairly Poor (significant organic pollution) to Good (some organic pollution). The quality of water in the channel at a distance of 200 m from the spring can be decrease or increase depending on the activity around the springs.

Keywords : Benthic macroinvertebrates, Upper Brantas river basin, Water quality, Wellspring.

Pengembangan Model Pengelolaan Kualitas Fisiko-kimia Air dan Biodiversitas di Sekitar Mata Air DAS Brantas Hulu untuk Mendukung Agroforestry Berkelanjutan

Catur Retnaningdyah dan Endang Arisoesilaningsih

RINGKASAN

Mata air sering digunakan oleh masyarakat di sekitarnya sebagai sumber air bersih. Kualitas air dan biodiversitas di ekosistem mata air yang berada di DAS Brantas hulu diduga sudah menurun akibat aktivitas masyarakat seperti penebangan liar vegetasi pohon serta pemanfaatan lahan yang tidak sesuai dengan kondisi geografis. Dalam rangka menjamin ketersediaan dan kualitas air yang baik di saluran mata air (sebagai hilir mata air yang biasanya digunakan untuk aktivitas agroforestry) serta untuk mendukung pertanian sehat maka diperlukan evaluasi kualitas ekosistem mata air yang tercermin dari kualitas fisikokimia air dan kualitas biodiversitas di mata air meliputi makroinvertebrata bentos sebagai bioindikator kualitas air dan vegetasi pohon riparian. Data

tersebut selanjutnya dapat digunakan sebagai dasar untuk membuat model keterkaitan antara kualitas biodiversitas, kondisi geografi dan pemanfaatan lahan dengan kualitas air yang selanjutnya digunakan sebagai dasar penyusunan strategi pengelolaan terhadap ekosistem mata air yang sudah mengalami degradasi kualitas air. Model pengelolaan dapat dilakukan secara insitu di saluran mata air sebagai hilir dari mata air yang telah mengalami degradasi kualitas air.

Tujuan akhir penelitian selama dua tahun ini adalah untuk pengembangan model paket teknologi pengelolaan yang sederhana, murah serta efektif mampu meningkatkan kualitas air di wilayah konservasi dari ekosistem mata air DAS Brantas Hulu yang terdegradasi melalui pemanfaatan biodiversitas lokal (makroinvertebrata bentos sebagai bioindikator dan vegetasi riparian sebagai fitoremediator) dalam rangka menjamin penyediaan air sesuai peruntukan agroforestry. Penelitian yang dilakukan sekarang ini merupakan penelitian tahun pertama dengan tujuan khusus: (1) melakukan evaluasi terhadap kualitas ekosistem mata air yang ada di DAS Brantas Hulu meliputi kualitas fisikokimia air dan biodiversitas di wilayah konservasi mata air (radius 200 m di sekitar mata air) meliputi makroinvertebrata bentos sebagai bioindikator kualitas air dan vegetasi pohon riparian; dan (2) melakukan monitoring faktor lingkungan di wilayah konservasi mata air DAS Brantas Hulu yaitu kondisi geografi dan pemanfaatan lahan.

Monitoring dilakukan pada 15 mata air yang ditemukan di DAS Brantas Hulu wilayah Malang raya dan Kota Batu (Sumber Jenon, Sumber Pitu, Sumber Awan, Sumber Mlaten, Sumber Brantas, Sumber Petung Ngamplok, Sumber Riwuk, Sumber Umbul, Sumber Guno, Sumber jodo, Sumber Umbulan, Sumber Maron, Sumber Nongkojajar, Sumber Darmi, dan
Sumber Tlogosari) yang terletak di sub-sub DAS Sumber Brantas, Bango, Amprong, Metro, Lahor, Lemon, Lesti dan Genteng. Pengambilan sampel air dan biologi dilakukan pada mata air (dua plot) dan saluran air 200 m dari mata air (dua plot). Pada tiap lokasi penelitian dilakukan pengukuran kualitas fisiko-kimia air (pH, DO, konduktivitas, bikarbonat, TDS, TSS, kekeruhan, nitrat, ortofosfat, ammonium, total fosfat, TKN, COD, BOD) dan kualitas biodiversitas di mata air meliputi makroinvertebrata bentos sebagai bioindikator kualitas air (struktur komunitas, diversitas, beberapa indeks biotik) dan vegetasi pohon riparian (jenis, kerapatan, diameter batang, tinggi pohon, stratifikasi, indeks *naturalness*, indeks *hemeroby*). Selain itu juga dilakukan pengamatan faktor lingkungan meliputi kondisi pemanfaatan lahan di wilayah konservasi mata air dengan menggunakan indeks jasa lingkungan dan kondisi geografi (ketinggian, *latitude, longitude*, dan kemiringan). Data hasil monitoring digunakan untuk melakukan analisis profil kualitas air, profil biodiversitas, profil geografi dan pemanfaatan lahan menggunakan analisis *cluster* dan biplot.

Hasil penelitian menunjukkan bahwa pada 15 ekosistem perairan mata air di DAS Brantas hulu yang dipantau sudah terjadi masukan bahan organik yang berasal dari aktivitas manusia di sekitarnya. Hal ini tercermin dari nilai beberapa parameter fisikokimia air seperti pH (5,63-7,19), DO (4,24-7,07 mg/L), BOD (1,53-3,05 mg/L) dan fosfat total (0,06-1,37mg/L) sudah melampaui nilai baku mutu air Kelas I (pH 6-9, DO>6, BOD<2, dan TP<0,2) yang telah ditetapkan untuk bahan baku air minum berdasarkan PP RI No. 82 tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air sehingga dengan demikian perairan tersebut sudah tidak layak dipakai sebagai bahan baku air minum. Nilai parameter fisikokimia yang lain berkisar antara 30,4-274,5 µS/cm (konduktivitas); 16,7-25,5^{o}C (suhu); 0,21-2,35 NTU (turbiditas); 0,3-12,5 mg/L (TSS); 74-377 mg/L (TDS); 45-311 mg/L
(bikarbonat); 0,63-6,09 mg/L (nitrat); 0-0,155 mg/L (ammonium); 0,02-0,13 mg/L (TKN); 387575 mg/L(TOM) dan 2,8-8,7 mg/L (COD). Berdasarkan analisis *cluster* dan PCA, pada tingkat kesamaan 80% wilayah penelitian dibagi menjadi dua kelompok. Kualitas air di Sumber Pitu 1 (mata air) dan 2 (200 m dari mata air) membentuk satu kelompok oleh karena mempunyai nilai yang relatif tinggi

untuk parameter DO, kecepatan arus, konduktivitas, TDS, bikarbonat, TOM, BOD, COD dibandingkan dengan yang lain. Sedangkan untuk wilayah yang lain menjadi satu kelompok dengan nilai beberapa parameter kualitas air tersebut yang relatif lebih rendah dibandingkan dengan Sumber Pitu. Kualitas fisikokimia air di saluran dengan jarak 200 m dari mata air dapat terjadi penurunan atau peningkatan tergantung dari aktivitas di sekitar mata air.

Berdasarkan perhitungan nilai indeks biotik dari makroinvertebrata bentos (HBI, FBI dan ASPT) yang dilanjutkan dengan analisis cluster dan PCA dapat disimpulkan bahwa mata air Sumber Pitu dan salurannya (200 m dari mata air), Sumber Jodo dan salurannya, Sumber Darmi dan salurannya serta mata air Sumber Petung Ngamplok mempunyai kualitas air yang lebih baik dan termasuk dalam kategori *Very Good* (*Possible slight organic pollution*/kemungkinan sedikit tercemar bahan organik) sampai dengan *Excellent (No apparent organic pollution*/tidak tercemar bahan organik) dibandingkan dengan kualitas mata air dan salurannya pada wilayah penelitian yang lain yang termasuk dalam kategori *Fairly Poor* (*Fairly significant-significant organic pollution*/tercemar bahan organik secara wajar sampai signifikan) sampai *Good* (*Some organic pollution* atau sedikit tercemar bahan organik). Mata air Sumber Awan, Sumber Jenon, Sumber Guno dan Sumber Maron mempunyai kualitas yang sudah tercemar bahan organik secara signifikan (*fairly poor*). Perairan yang terletak 200 m dari mata air akan mempunyai kualitas lebih rendah dibandingkan dengan mata air jika di sekitar mata air terdapat aktivitas manusia seperti penggunaan air untuk wisata yang melibatkan aktivitas mandi, cuci, kakus (MCK), aktivitas pertanian, serta pembangunan sarana prasarana untuk pemanfaatan mata air sebagai bahan baku air minum baik yang dilakukan oleh masyarakat maupun PDAM. Sebaliknya jika di sekitar mata air dan salurannya ditemukan banyak vegetasi riparian yang ada dapat berupa semak, vegetasi *submerged*, pohon (termasuk bambu) dan hutan, maka kualitas perairan pada wilayah konservasi akan terjadi peningkatan atau paling tidak sama dengan kualitas air di mata air tersebut.

Lima belas mata air yang diamati umumnya terletak di dataran rendah (87%) dan hanya dua mata air di dataran tinggi (altitude > 1200 m di atas permukaan laut), yaitu Sumber Brantas dan Sumber Petung Ngamplok. Sebagian besar hutan riparian mata air telah terdegradasi, kecuali riparian mata air yang ada di hutan Perhutani atau arboretum Perum Jasa Tirta. Vegetasi riparian yang paling terkonservasi di lereng tebing Sumber Darmi dan Sumber Petung Ngamplok, sehingga riparian ditumbuhi pohon hutan. Sebaliknya jika mata air atau 200m salurannya terdegradasi, maka vegetasi umumnya berupa semak belukar dengan indeks *naturalness* rendah, indeks Hemeroby tinggi, *environmental service index* rendah dan kerapatan diversitas tumbuhan asli di vegetasi hutan riparian rendah.

Hasil penelitian tahun pertama ini akan dijadikan dasar dalam penyusunan strategi pengelolaan terhadap ekosistem mata air yang sudah mengalami degradasi kualitas air. Mengingat kelemahan dari pengukuran kualitas air menggunakan parameter fisikokimia yang hanya mencerminkan kualitas sesaat saja, maka penentuan lokasi mata air yang akan dilakukan pengelolaan pada tahun kedua penelitian akan didasarkan dari hasil verifikasi melalui pengulangan pemantauan kualitas fisikokimia air pada beberapa lokasi mata air yang bersifat strategis dilakukan pengelolaan tersebut untuk mengetahui konsistensi hasil penelitian. Hasil penelitian tahun pertama dan hasil verifikasi tentang konsistensi kualitas air tersebut selanjutnya disosialisasikan kepada masyarakat setempat dan atau PDAM. Sosialisasi ini juga digunakan untuk menjajagi kemungkinan persetujuan dan dukungan dari masyarakat setempat dalam hal dilakukannya pengelolaan terhadap ekosistem mata air yang sudah mengalami degradasi kualitas air tersebut. Usulan strategi pengelolaan terhadap ekosistem mata air yang sudah mengalami degradasi kualitas air ini akan dilakukan secara eksperimen semu secara insitu di saluran mata air dengan penanaman vegetasi riparian di tepi kiri dan kanan saluran sepanjang 300 m dari mata air. Efektivitas pengelolaan tersebut dapat diketahui dengan cara

melakukan pemantauan kualitas air di inlet, tengah dan outlet yang tercermin dari kualitas fisiko-kimia air dan biodiversitas makroinvertebrata bentos sebagai bioindikator kualitas air.

Model Management Development of Physico-Chemical Water Quality and Biodiversity Around the Wellspring Found in Upper Brantas Watershed to Support Sustainable Agroforestry

Catur Retnaningdyah and Endang Arisoesilaningsih

SUMMARY

Springs are often used by the surrounding community as a source of clean water. Water quality and biodiversity in the ecosystem springs were located in the upper Brantas River Basin was thought to be declining due to community activities such as illegal logging of trees vegetation and land use that is not in accordance with the geographical conditions. In order to ensure the availability and quality of good water in the spring channels (as a downstream of springs which normally used for agroforestry activities) as well as to support a healthy agricultural ecosystems it is necessary to evaluate the quality of the spring water ecosystem which is reflected by physico-chemical water quality and quality of biodiversity in the springs included benthic macroinvertebrates as bio-indicators of water quality and riparian tree vegetation. The data can then be used as a basis for modeling the linkages between biodiversity quality, geography and land use with water quality that is used as a basis for develop strategic management of the springs ecosystem that have degraded water quality. Management model can be performed in situ in the channel downstream of the springs that have degraded water quality.

The final goal of this two-year study is to develop a simple model management technology package that is cheap and effective to improve the quality of water in the area of conservation of the degraded springs ecosystem located in Brantas Hulu watershed through the use of local biodiversity (benthic macroinvertebrates as bio-indicators and riparian vegetation as fitoremediator) in order to ensure the water supplying that appropriate for agroforestry. The research conducted today is the first year of study with specific objectives : (1) to evaluate the quality of the springs ecosystem located in the Upper Brantas watershed include physico-chemical water quality and biodiversity in the conservation region of springs (200 m radius around springs) include benthic macroinvertebrates as bio-indicators of water quality and riparian tree vegetation , and (2) monitoring of environmental factors in the conservation area of springs located in the Upper Brantas River Basin that is the geography and land use.

Monitoring was done on the 15 springs that are found in the Upper Brantas river basin located in Malang region and Batu city (Sumber Jenon, Sumber Pitu, Sumber Awan, Sumber Mlaten, Sumber Brantas, Sumber Petung Ngamplok, Sumber Riwuk, Sumber Umbul, Sumber Guno, Sumber jodo, Sumber Umbulan, Sumber Maron, Sumber Nongkojajar, Sumber Darmi, dan Sumber Tlogosari) located in the sub- watershed of Brantas, Bango, Amprong, Metro, Lahor, Lemon, Lesti and Genteng. Water and biological sampling conducted in the spring (two plots) and the water channel 200 m from the spring (two plots). At each study site measured physico - chemical water quality (pH, DO, conductivity, bicarbonate, TDS, TSS, turbidity, nitrate, orthophosphate, ammonium, total phosphorus, TKN, COD, BOD) and quality of biodiversity in the spring included benthic macroinvertebrates as bio-indicators of water quality (community structure, diversity, biotic indices) and riparian trees vegetation (taxa richness, density, stem diameter, tree height, stratification, naturalness index, index hemeroby). It also made observations of environmental factors include the land use conditions in the area of conservation by using the environmental services index and geographic conditions (altitude, latitude, longitude, and slope). Data monitoring results were used to analyze the profile of water quality, biodiversity profiles, profiles of geography and land use by cluster analysis and biplot.

The results showed that the 15 of spring ecosystems in the upstream of Brantas river basin have been polluted by organic materials derived from human activities in the vicinity. This is reflected in the value of some physicochemical parameters of water such as pH (5.63 to 7.19), DO (4.24 to 7.07 mg/L), BOD (1.53 to 3.05 mg/L) and phosphate total (0.06 to 1.37 mg/L) exceeds the value of the water quality standard Class I (pH 6-9, DO > 6, BOD < 2, and TP < 0.2) which has been set for raw materials of drinking water based on Indonesian Government Regulation No. 82/2001 about the Management of Water Quality and Water Pollution Control. Thereby these waters are not suitable to be used as raw material for drinking water. Other physicochemical parameters values ranged from 30.4 to 274.5 µS/cm (conductivity) ; 16.7 to 25.5 °C (temperature); 0.21 to 2.35 NTU (turbidity) ; 0.3 to 12.5 mg/L (TSS); 74-377 mg/L (TDS); 45-311 mg/L (bicarbonate); 0.63 to 6.09 mg/L (nitrate); 0 to 0.155 mg/L (ammonium) ; 0.02 to 0.13 mg/L (TKN), 387-575 mg/L (TOM) and 2.8 to 8.7 mg/L (COD). Based on cluster analysis and PCA in the level similarity of 80 %, the study sites were divided into two groups. The first group was Sumber Pitu spring and the channel (200 m from the spring) which it has a relatively high value for the parameter DO, current velocity, conductivity, TDS, bicarbonate, TOM, BOD, COD compared with the other. The second group was the other regions with a value of some of the water quality parameters are relatively lower compared with Sumber Pitu spring. Physicochemical quality of water in the channel at a distance of 200 m from the spring may decrease or increase depending on the activity around the springs.

Based on the calculation of the macroinvertebrate benthic biotic indices value (HBI, FBI and ASPT), followed by cluster analysis and PCA can be concluded that the Sumber Pitu spring and its channel (200 m from the spring), Sumber Jodo spring and its channel, Sumber Darmi spring and its channel and Petung Ngamplok spring have better water quality and are included in the category of Very good (Possible slight organic pollution) to excellent (No apparent organic pollution) compared to the other research areas of springs and its channel which were included in the category of fairly Poor (significant organic pollution) to Good (Some organic pollution). The water quality of Sumber Awan, Sumber Jenon, Sumber Guno and Sumber Maron springs has been significantly contaminated with organic material (fairly poor). Water channels are located 200 m from the spring will have a lower quality than spring water if there are human activities in the surrounding such as tourism activity involves bathing, washing, and toilet, agricultural activities, as well as the development of infrastructure for use spring water as a raw material of drinking water by society taps. Conversely, if the around of the springs and its channel found in many existing riparian vegetation can be a bush, submerged vegetation, trees (including bamboo) and the forest, so the water quality of the conservation area will be increased or at least equal to the quality of water in these springs.

Fifteen springs observed generally located in the lowlands (87%) and only two springs (Sumber Brantas and Sumber Petung Ngamplok) in the highlands (altitude> 1200 m above sea level). Most of the riparian forest of the springs has been degraded, except riparian of springs in the government forest (Perhutani) or government arboretum of Perum Jasa Tirta. The most conserved riparian vegetation on the slopes of the cliff of Sumber Darmi and Sumber Petung Ngamplok spring, so riparian was growth by forest trees. Conversely, if the springs or its channel has been degraded, so the vegetation form genearlly scrub vegetation which the value of naturalness index is low, Hemeroby index is high, environmental service index is low and density of native plant diversity in riparian forest vegetation is low.

Results of the first year of this study will be used as a basis for developing management strategies to the spring ecosystem that have degraded water quality. Because of the weakness of the measurement of water quality using physicochemical parameters that only reflect the quality of a moment, then the determination of the location of the spring that will be managing in the second year of the study will be based on the results of verification through repetition

physicochemical water quality monitoring at several locations of springs to find out the consistency of the results of research. Results of the first year of research and verification of the consistency of the results of water quality were further disseminated to the local community and or government which responsible to supply drinking water. Socialization is also used to explore the possibility of approval and support of the local community in terms of its management of spring ecosystem that has degraded the water quality. Proposed management strategies to the spring ecosystem would be a insitu quasi-experiment through the planting of riparian vegetation on the left and right edges of channels along 300 m from the spring. The management effectiveness can be determined by monitoring the quality of water in the inlet, middle and outlet are reflected from physico-chemical water quality and biodiversity of benthic macroinvertebrates as bio-indicators of water quality.

DAFTAR PUSTAKA

Asdak, C. 2004. Hidrologi dan Pengelolaan Daerah Aliran Sungai. Gadjah Mada University Press. Yogyakarta.

Ayers R.S., Westcot D.W. 1994. Water Quality for Agriculture. FAO Irrigation And Drainage Paper. 29 Rev. 1. Rome.

Bagatini, Y.M., R.L. Delariva & J. Higuti. 2012. Benthic macroinvertebrate community structure in a stream of the north-west region of Paraná State, Brazil. *Biota Neotropica.* 12(1):307-317.

Boyd, C.E. 1988. Water quality in warmwater fish. Fourth Printing Auburn Univ. Agricultural Experiment Station. Alabama.

Brown, J., A. Wyers, A. Aldous and L. Bach, 2007. Groundwater and Biodiversity Conservation: A methods guide for intergrating groundwater needs of ecosystems and species into conservation plant in the Pacific Northwest. The Nature Conservantion

Brower J.E,. Zar J.H, Von Ende C.N. 1990. Field and Laboratory Methods for General Ecology. Third Edition. Wm.C. Brown Publishers, Dubuque

Bruijnzeel, L.A. 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? Agriculture, Ecosytems and Environment. 104: 185-228

Chaudhry Q, Schroder P, Werck-Reichhart D, Grajek W, Marecik R.2002. Prospects and Limitations of Phytoremediation for the Removal of Persistent Pesticides in the Environment. Environ Sci & Pollut Res 9: 4- 17.

Clesceri L.S,. Greenberg A.E,. Eaton A.D. 1998. Standard Methods for the Examination of Water and Waste Water. 20th Ed., Washington.

Custovic, H. and Z. Haki, 2003. Water Regime of Some Soils in Herzegovina. Faculty of Agriculture Sarajevo University.

Clesceri L.S,. Greenberg A.E,. Eaton A.D. 1998. Standard Methods for the Examination of Water and Waste Water. 20th Ed., Washington.

Daam M.A, Brink P.J.V. 2010. Implications of differences between temperate and tropical freshwater ecosystems for the ecological risk assessment of pesticides Ecotoxicology 19:24–37.

Dama´sio J, Navarro-Ortega A, Tauler R, Lacorte S, Barcelo D, Soares A.M.V.M, Lo'pez M.A, Riva M.C, Barata C. 2010. Identifying major pesticides affecting bivalve species exposed to agricultural pollution using multi-biomarker and multivariate methods. Ecotoxicology 19:1084–1094

Departemen Kesehatan RI. 1980. Buku Pedoman Pemeriksaan Ekologi Air (Plankton, Peryphyton, Makrophyton, Makroinvertebrata benthos, dan Ikan). Team Penyusun Metode Pemeriksaan Mikrobiologi dan Biologi Departemen Kesehatan RI. Departemen Kesehatan RI, Jakarta.

Edmondson W.T. 1959. Freshwater Biology. Second Ed. John Wiley and Sons Inc., New York.

Faturrohman, D. 2010. Masalah Pengelolaan Daerah Aliran Sungai (DAS) Brantas Di Jawa Timur: Solusi dan Model Kolaborasi. Agritek Vol 16 No 5. Hal 678-952

Fiqa, A.P., L. Astari, E. Arisoesilaningsih, Soejono, S. Isniningsih. 2005. Architecture of local flora to conserve water source and stabilize natural slope of Brantas River watershed. Paper presented on National Seminar and Biological Congress XIII, Faculty of Biology, Gadjah Mada University, Yogyakarta, 16-17 Sep 2005.

Hairiah, K., D. Suprayogo, Widianto, Berlian, E. Suhara, A. Mardiastuning, R. Widodo, C. Prayogo dan R. Subekti, 2004. Alih Guna Lahan Hutan Menjadi Lahan Agroforestri Berbasis Kopi: Ketebalan Seresah, Populasi Cacing Tanah dan Makroporositas Tanah. Agrivita 26(1): 68-80.

Hawkes, H.A. 1979. Invertebrates as Indicators of River Water Quality. Dalam: Biological Indicator of Water Quality. James, A and L. Evison (Eds.) Academic Press. New York.

Heath, R.C. , 1994. Ground-Water Recharge in North Carolina. Prepared for the Groundwater Section Division of Environmental Management North Carolina. Department of environment Health and Natural Resources.

Hodkinson I.D., Jackson J.K. 2005. Terrestrial and Aquatic Invertebrates as Bioindicators

Jutting W.S.S. Van Benthem. 1953. Critical Revision of the Freshwater Bivalves of Java. Treubia 22:19-73

Jutting W.S.S. Van Benthem. 1956. Critical Revision of the Javanese Freshwater Gastropods. Treubia 23:259-47

Kalyoncu H, Zeybek M. 2011. An application of different biotic and diversity indices for assessing water quality: A case study in the Rivers Çukurca and Isparta (Turkey). Afri J of Agric Res 6:19-27.

Kementerian Lingkungan Hidup. 2003. Laporan Status Lingkungan Hidup Tahun 2002. Jakarta.

Keller A.E. 1993. Acute Toxicity of Several Pesticides, Organic Compounds, and a Wastewater Effluent to the Freshwater Mussel, *Anodontai mbecilis Ceriodaphnia dubia,* and *Pimephalesp romelas* Environ. Contain. Toxicol. 51:696-702.

Kim, Y., S. Zerbe & I. Kowarik. 2002. Human impact on flora and habitats in Korean Rural settements. *Preslia*. 74: 409-419.

Kirda C. 1997. Assessment of irrigation water quality. Paper on Mediterranean Seminar Proceeding A 31:367-377.

Korycinska M., Królak E. 2006. The Use of Various Biotic Indices for Evaluation of Water Quality in the Lowland Rivers of Poland (Exemplified by the Liwiec River). Polish J. of Environ. Stud. 15(3):419-428.

Krebs C.J. 1989. Ecological Methodology, Harper and Row Publ., New York.

Kusriningrum R.S. 2008. Perancangan Percobaan. Airlangga University Press, Surabaya

Landon, J.R. 1984. Booker Tropical Soil Manual. Antony Rowe Ltd. Chippenham Wiltshire.

Lee. C.D., S.B. Wang & C.L. Kuo. 1978. Benthic Macroinvertebrates and Fish as Biological Indicator of Water Quality, with Reference on Water Pollution Control in Developing Countries. Bull. C.Sci, Bangkok.

Linsley, R.K., M.A. Kohler, and J.L.H. Paulus, 1996. Hidrologi Untuk Insiyur. Penerbit Erlangga. Jakarta.

Lubis, R.F. 2006. I Bagaimana Menentukan Daerah Resapan Air Tanah ? INOVASI Vol.6/XVIII/Maret

Machado, A. 2004. An index of naturalness. Journal of Nature Conservation. 12: 95-110.

Mandaville S.M. 2002. Benthic Macroinvertebrates in Freshwaters- Taxa Tolerance Values, Metrics, and Protocols, Soil & Water Conservation Society of Metro Halifax.

Marganof. 2007. Model Pengendalian Pencemaran Perairan di Danau Maninjau Sumatera Barat. *Disertasi*. Pasca Sarjana. Institut Pertanian Bogor, Bogor.

Meireles A.C.M, de Andrade E.M, Chaves L.C.G, Frischkorn H, Crisostomo L.A. 2010. A new proposal of the classification of irrigation water. Revista Ciencia Agronomica. 41:349-357.

Misstear, B.D.R. 2000. Groundwater Recharge Assessment: A Key Component of River Basin Manajement. National Hydrology Seminar. Trinity Collage Dublin.

Muthanna M.N. 2011. Quality Assessment of Tigris River by using Water Quality Index for Irrigation Purpose. European Journal of Scientific Research 57:15-28

National Action Plan Addressing Climate Change (NAP). 2007. State Ministry of Environment. Jakarta.

Noordwijk.M.V., F. Agus, D. Suprayogo, K. Hairiah, G. Pasya dan Farida. 2004. Peranan Agroforestri dalam Mempertahankan Fungsi Hidrologi DAS. Agrivita 26(1) : 1-8.

Odum E.P. 1971. Fundamentals of Ecology. Third Ed. W.B. Saunders Company, London.

Ott, W.R. 1978. Environmental Indices. Theory and Practice. Ann Arbor Scin. Publ. Inc., Ann Arbor. Mich.

Pagiola, S., P. Agostini, J. Gobbi, C. de Haan, M. Ibrahim, E. Murgueitio, E. Ramírez, M. Rosales,J. P. Ruíz. 2004. Paying for Biodiversity Conservation Services in Agricultural Landscapes. The International Bank for Reconstruction and Development. United States of America.

Panagopoulos I, Mimikou M, Kapetanaki M. 2007. Estimation of nitrogen and phosphorus losses to surface water and groundwater through the implementation of the SWAT model for Norwegian soils. J Soils Sediments 7:223–231.

Pelczar, M.J., E.C.S. Chan & R.K. Noel. 1986. *Microbiology*. Fifth Edition. Mc. Graw Hill Book Company, New York

Perum Jasa Tirta I. 2005. Tinjauan Hidrologi dan Sedimentasi DAS Kali Brantas Hulu. Makalah disampaikan pada Diskusi Terbatas 'Masalah dan Model Penanganan Daerah Kritis di Jawa Timur' tanggal 15 Nopember 2005 di Balitbang Propinsi Jawa Timur
Peters, N. & Michel Meybeck. 2000. Water quality degradation effects on freshwater availability: Impacts of human activities. *Water Int*. 25 (2): 185-193.

Pescod, B.M. 2004. Wastewater Treatment and Use in Agriculture-FAO Irrigation and Drainage Paper 47. Food and Agriculture Organisation of The United Nations.

Pittwell, L.R. 1976. Biological Monitoring of Rivers in The Community. Dalam: Amavis, R. &

J. Smeets (ed.). *Principles and Methods for Determining Ecological Criteria on Hydrobiocenoses*. Pergamon Press, New York:225-261

Plafkin J.L., Barbour M.T., Porter K.D., Gross S.K., Hughes R.M.. 1989. Rapid Bioassessment Protocols for use in Streams and Rivers: Benthic Macroinvertebrates and Fish. U.S. Environmental Protection Agency. EPA 440/4-89/001. 8 chapters, Appendices A-D.

Prahardika, B.A., C. Retnaningdyah, Suharjono. 2013. The Control of Microcystisspp. Bloom by Combining Indigenous Denitrifying Bacteria From Sutami Reservoir with Fimbristylisglobulosaand Vetiveria zizanoides. Journal of Tropical Life Science. 3 (1): 52-57

Prastowo. 2001. Kerusakan Ekosistem Mata Air. Makalah Workshop. Bapedal, Jakarta

Prayogo, C. 2007. Laporan Akhir Kajian Kelestarian Sumber Air di Kota Batu. Fakultas Pertanian. Universitas Brawijaya. Malang. (tidak dipublikasikan)

Quigley M. 1977. Invertebrates of Streams and Rivers. A Key to Identification. Edward Arnold Publ. Ltd., London.

Retnaningdyah C, Prayitno, Samino S, 2005 Using River Benthic Macroinvertebrates from Indonesia as Bioindicator of Detergent Pollution. ORAL presentation in Third International Conference on Plants and Environmental Pollution (ICPEP-3) during 28 November – 2 December, 2005 at NBRI Lucknow India.

Retnaningyah C., Suharjono, Budiman, Purnomo. 2012. Control of *Microcystis* growth by *Azolla* sp. in combination with aerobic denitrifying bacteria indigenous from Indonesia reservoir. Oral Presentation on Malaysia International Biological Symposium 2012 (*i*SIMBIOMAS 2012), Kuala Lumpur July 11th -12th, 2012

Retnaningdyah C. Dan E. Arisoesilaningsih, 2012. Analisis Kesesuaian Indeks Ekologis Untuk Studi Kelayakan Kualitas Air Irigasi di Daerah Malang raya, Laporan Research Grant IMHERE. JBUB, Malang

Retnaningdyah C. Dan E. Arisoesilaningsih, 2013. Ecological Significance of Irrigation Channel Riparian to Improve Benthic Macroinvertebrate Diversity. Oral presentation on International Conference on Global Resource Conservation (ICGRC). February 7th-8th. Malang, Indonesia

Rosenberg D, Resh V. 1993. Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman and Hall. New York.

Sada, D.W and K.F. Pohlmann. 2006. Draft U.S. National Park Service Mojave Inventory and Monitoring Network Spring Survey Protocols: Level I and Level II. February I, 2006.

Semiun, C.G., E. Arisoesilaningsih, C. Retnaningdyah. 2013. Degradation of Riparian Tree Diversity on Spring Fed Drains and Its Impacts to Water Quality, East Java. J. Tropical Life Sciences 3(2):120-126

Singonyela, V. 2006. Towards understanding the Groundwater Dependent Ecosystems within the Table Mountain Group Aquifer: A conceptual approach. Tesis. Faculty of Natural Sciences. University of the Western Cape. Bellville.

Soejono, 2011. Jenis Pohon di Sekitar Mata Air. UPT Balai Konservasi Tumbuhan Kebun Raya Purwodadi-LIPI. Purwodadi.

Soejono, S. Budiharta, E. Arisoesilaningsih. 2013. Proposing local trees diversity for rehabilitation of degraded lowland areas surrounding springs. Biodiversitas. 14 (1): 3742.

Solano, R. 2003. Riparian zone land use in indigenous and colonist communities of the Palcazu basin, Peruvian Amazon. Department of Environmental Studies. Florida International University.

Sophocleous M.A. and J.A. McAllister, 1987. Basinwide water-balance modelling with emphasis on spatial distribution of groundwater recharge. Water Resources Bulletin 23, 997 – 1010

Sullivan, P. 2002. Drought Resistant Soil NCAT Agriculture Specialist/ ATTRA Publication.

Sundari, A.S., C. Retnaningdyah, Suharjono. 2013. The Effectiveness of Scirpus grossusand Limnocharis flavaas Fitoremediation Agents of Nitrate-Phosphate to Prevent MicrocystisBlooming in Fresh Water Ecosystem. Journal of Tropical Life Science. 3 (1):28-33

Supriyo, H. 2004. Perkembangan Fisik dan Vegetasi Wanagama I. Dalam S. Atmosoedarjo, R.I.S. Pramoedibyo, S. Ranoeprawiro (Ed.). Dari Bukit-Bukit Gundul Sampai ke Wanagama I. Yayasan Sarana Wana Jaya. Yogyakarta. Hal 41-85.

Suwondo, E., Febrita & F. Sumanti. 2005. Struktur Komunitas Gastropoda Pada Hutan Mangrove Di Pulau Sipora Kabupaten Kepulauan Mentawai Sumatera Barat. *Jurnal Biogenesis.* 2:25-29.

Testi A, Bisceglia S, Guidotti S, Fanelli G. 2009. Detecting river environmental quality through plant and macroinvertebrate bioindicators in the Aniene River (Central Italy). Aquat Ecol 43:477–486

Tiwari K.K, Dwivedi S, Mishra S, Srivastava S, Tripathi R.D, Singh N.K, Chakraborty S. 2008. Phytoremediation efficiency of *Portulaca tuberosa* rox and *Portulaca oleracea* L. naturally growing in an industrial effluent irrigated area in Vadodra, Gujrat, India. Environ Monit Assess 147:15–22

Vidayanti, V., C, Retnaningdyah, Suharjono. 2012. The Capability of Equisetum ramosissiumand Typha angustifoliaas Phytoremediation Agents to Reduce NitratePhosphate Pollutants and Prevent MicrocystisBlooming in Fresh Water Ecosystem. Journal of Tropical Life Science. 2 (3):126 – 131

Maitre D.C.L, D. F. Scott and C. Colvin. 1999. A Review of Information on Interactions between Vegetation and Groundwater. Water SA Vol. 25 No. 2 April 1999. 137 -152 Widianto, Didik S., Sudarto dan Iva D. L. 2010. Implementasi Kaji Cepat Hidrologi (RHA) di Hulu DAS Brantas, Jawa Timur. Working paper nr.121. World Agroforestry Centre ICRAF Southeast Asia Regional Office. Bogor, Indonesia

Yang J, He Z, Yang Y, Stoffella P, Yang X, Banks D, Mishra S. 2007. Use of amendments to reduce leaching loss of phosphorus and other nutrients from a sandy soil in Florida. Environ Sci Pollut Res 14:266–269

Yin F, Fu B.J, Mao R.Z. 2007. Effects of nitrogen fertilizer application rates on nitrate nitrogen distribution in saline soil in the Hai River Basin, China. J Soils Sediments 7:136–142