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Halaman muka (cover): Traditional boats at anchor on the famous waterfront of Makassar (Losari beach) celebrating Indonesia's Independence Day (17 August) - these festivals are an important celebration of Indonesia's heritage (Photo: Dietriech G. Bengen, 2000)

KATA PENGANTAR
FOREWORD

Invitation to ICRS (International Coral Reef Symposium) Delegates

On the eve of the International Coral Reef Symposium largest ever marine conference to be held in Indonesia, it is worth reflecting on the status of marine science in Indonesia. Following a significant investment in a range of Indonesian marine sciences and fisheries institutions in the 1990s, marine science has developed rapidly. The establishment of a new National Marine Ministry in October 1999 is a further sign of the important role Indonesias coasts and oceans play in national development.

There is now a renewed sense of purpose in our approach to ocean resources utilization and governance. Projects like MREP, COREMAP, Proyek Pesisir, Komodo National Park (TNC) and the WWF Sulu - Sulawesi regional initiative are demonstrating how marine science and management are blending in ways compatible with Indonesian culture and capacity. However, the challenge ahead is enormous. The vast scale of Indonesia's coastal and marine habitats, the lack of knowledge about most ecosystems and their interactions and the ever rising pressures of development limit our management effectiveness. Clearly new development paradigms and partnerships are needed.

The Indonesian marine science community with benefit greatly from the knowledge and experience shared at ICRS. We hope that seminar event will not, however, be just another "one-off" activity, quickly forgotten when delegates return home. Rather, we hope ICRS will be a spring board to help us build capacity in the marine sciences.

As a practical measure to this end, we invite delegates to share their experience with our journal readers. If you have an article relevant to coastal (pesisir) and marine/ocean/sea (laut) management in Indonesia, please send it to us - our editorial team will then put the article into our local format.

I look forward to your contributions - if you have any queries, please see me at ICRS.

Editor-in-Chief

Dietriech G. Bengen

ANALISIS KEBIJAKAN PEMANFAATAN RUANG WILAYAH PESISIR DI KOTA - PASURUAN - JAWA TIMUR

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ABSTRAK

Penelitian ini dilakukan pada bulan April - Agustus 1999 di wilayah pesisir Pasuruan, Jawa Timur. Tujuan penelitian ini adalah untuk (1) mengevaluasi kesesuaian lahan dalam pemanfaatan ruang wilayah pesisr, (2) menganalisis faktor-faktor yang menyebabkan terjadinya konflik pemanfaatan ruang dalam pengelolaan sumberdaya pesisir, (3) mengetahui persepsi pemerintah, swasta dan masyarakat berkaitan dengan penentuan prioritas penggunaan lahan, (4) Menentukan prioritas penggunaan lahan dalam pemanfaatan ruang wilayah pesisir, (5) Menyelesaikan konflik pemanfaatan sumberdaya pesisir, dan (6) Memberikan rekomendasi sebagai dasar pertimbangan pengambilan keputusan dalam penentuan kebijakan. Dalam mengevaluasi kesesuaian lahan digunakan Sistem Informasi Geografis (SIG), dan untuk menyelesaikan konflik penggunaan lahan digunakan metode Proses Hierarki Analitik (Analytical Hierarchy Process - AHP). Hasil penelitian memperlihatkan bahwa penyelesaian optimal dalam pemanfaatan sumberdaya di Desa Gadingrejo direkomendasikan untuk kawasan industri, sementara desa Trajeng direkomendasikan untuk industri dan bantaran sungai.

Kata-kata kunci: Sistem Informasi Geografis, Proses Hierarki Analitik, Pasuruan, wilayah pesisir

ABSTRACT

This research was conducted in April – August 1999 in Pasuruan coastal zone Pasuruan. This research aimed to (1) Evaluate Land suitability in exploitation space of coastal zone (2) Analysis the causal factors of landuse conflict of Coastal Resources Management (3) Know the perception of government, private and communities in act of determining of landuse priority (4) Determine of optimalization the landuse priority in coastal area (5) Solve conflict of the resources exploitation of coastal zone (6) Recommend the decision –makers with respect to coastal land use policy. For evaluating the land suitability its used Geographic Information System (GIS) Method, and for resolving landuse conflict its used Analytical Hierarchy Process (AHP) Method. The result showed that the solution for resources exploitation in Gadingrejo village should be to industrial used, while in Trajeng village it is recommended that industrial and embankment areas be developed.

Keywords: Geographic Information System (GIS), Analytical Hierarchy Process (AHP), Pasuruan, coastal zone

PENDAHULUAN

Arah pembangunan yang dilaksanakan di daerah selama ini masih terkonsentrasi di daratan, sehingga tekanan kegiatan pembangunan di darat akan semakin tinggi oleh proses pembangunan. Kondisi demikian sangat dirasakan di Kota Pasuruan yang memiliki daya dukung lahan dan potensi sumberdaya daratan yang terbatas. Oleh karena itu pemanfaatan sumberdaya pesisir dan lautan di wilayah pesisir Kota Pasuruan seluas 1.244 Ha merupakan salah satu

alternatif yang tepat bagi pengembangan pembangunan daerah dan menjadi salah satu tumpuan harapan bagi pemenuhan kebutuhan masyarakat dimasa mendatang Anonymous, 1998).

Pemanfaatan sumberdaya pesisir di Kota Pasuruan berpotensi menimbulkan permasalahan dalam pemanfaatan ruang oleh berbagai pengguna lahan *(stakeholders)* yang mempunyai perbedaan kepentingan, sehingga dapat memicu terjadinya konflik dalam pemanfaatan ruang. Agar pengembangan pembangunan di wilayah pesisir Kotamadya Pasuruan dapat mengakomodir kebutuhan nyata masyarakat, maka diperlukan suatu analisis kebijakan yang dapat digunakan sebagai dasar / bahan pertimbangan bagi para pengambil keputusan dalam menentukan pemanfaatan ruang dan penetapan kawasan yang optimal dan proporsional untuk berbagai pengguna lahan (stakeholders) yang berkepentingan.

Perumusan Masalah

Kotamadya Daerah Tingkat II Pasuruan terdiri dari 3 (tiga) Kecamatan dikelilingi oleh hinterland kota yang berada di wilayah Kabupaten Pasuruan dan merupakan daerah yang potensial untuk kegiatan industri, pertanian, perikanan dan Konservasi

Berdasarkan arahan Rencana Induk Kota (RIK) dan Rencana Umum Tata Ruang (RUTR) Kotamadya Pasuruan, serta Hukum serta Peraturan perundang – undangan yang ada dikaitkan dengan kondisi faktual di lapangan, permasalahan utama yang terjadi dalam pemanfaatan ruang di wilayah studi adalah konflik penggunaan lahan / pemanfaatan lahan dan alih fungsi (konversi) lahan, penyimpangan pemanfaatan ruang dari rencana tata ruang, dan pemanfaatan ruang yang tidak sesuai dengan peruntukkannya.

Dengan demikian, maka perumusan masalahnya adalah sebagai berikut :

a) Apakah pemanfaatan ruang yang ada telah sesuai dengan kesesuaian lahannya ?
b) Faktor - faktor apa yang menyebabkan terjadinya konflik pemanfaatan ruang ?
c) Bagaimana persepsi pemerintah, swasta dan masyarakat terhadap konflik penggunaan lahan yang terjadi ?
d) Kebijakan apa yang sebaiknya dilakukan dalam menyelesaikan konflik pemanfaatan ruang yang terjadi?

Tujuan dan Manfaat

Penelitian ini bertujuan untuk :

a) Mengevaluasi kesesuaian lahan dalam pemanfaatan ruang wilayah pesisir.
b) Menganalisis faktor-faktor yang menyebabkan terjadinya konflik pemanfaatan ruang dalam pengelolaan sumberdaya wilayah pesisir.
c) Mengetahui persepsi pemerintah, swasta dan masyarakat berkaitan dengan penentuan prioritas penggunaan lahan.
d) Menentukan prioritas penggunaan lahan dalam pemanfaatan ruang wilayah Pesisir.
e) Memberikan rekomendasi sebagai dasar pertimbangan pengambilan keputusan dalam penentuan kebijakan.

Penelitian ini diharapkan dapat memberikan kontribusii bagi pembangunan daerah, melalui pengembangan proses hierarki analitik dan analisis SIG dalam pemanfaatan ruang dan penetapan kawasan, selain itu diharapkan dapat menjadi bahan pertimbangan bagi pengambilan keputusan dalam penentuan kebijakan penyusunan rencana tata ruang wilayah pesisir, dan sebagai acuan teknis dalam menetapkan suatu kawasan dan pemanfaatan ruang serta pengendaliannya.

Kerangka Pendekatan

Berdasarkan karakteristik dan dinamika dari kawasan pesisir dan lautan, potensi dan permasalahan pembangunan serta kebijakan pemerintah untuk sektor kelautan, maka dalam mencapai pembangunan kawasan pesisir dan lautan secara optimal dan berkelanjutan, tampaknya hanya dapat dilakukan melalui pengelolaan wilayah pesisir dan lautan secara terpadu. Hal ini cukup logis, karena bila dikaji secara impiris, terdapat keterkaitan ekologis atau hubungan fungsional antar ekosistem di dalam kawasan pesisir maupun antar kawasan pesisir dengan lahan atas dan laut lepas. Dengan demikian perubahan yang terjadi pada suatu ekosistem pesisir, cepat atau lambat akan mempengaruhi ekosistem lainnya. Pada prinsipnya pengelolaan wilayah pesisir berkenaan dengan faktor lingkungan ekologis, lingkungan ekonomi dan lingkungan sosial yang saling berkaitan dan diatur melalui hukum, aturan aturan lokal dan tradisi. Timbulnya masalah dalam pengelolaan tersebut antara lain karena ketiga faktor tersebut tidak berjalan secara harmonis..

Kebijakan pembangunan wilayah pesisir dan lautan berdasarkan kebijaksanaan pemerintah yang diatur dalam Undang Undang Nomor : 24 Tahun 1992, tentang Penataan Ruang, menetapkan Rencana Tata Ruang Kota Pasuruan sebagai pedoman dalam perumusan kebijakan

pokok pemanfaatan ruang guna mewujudkan keterpaduan, keterkaitan dan keseimbangan pembangunan di daratan, wilayah pesisir dan lautan. Essensi tata ruang menurut Undang - undang Nomor : 24 Tahun 1992 adalah Rencana Tata Ruang, Pedoman Pemanfaatan Ruang dan Cara Pengendalian Pemanfaatan Ruang yang diatur dalam pasal 13, 15 dan 17 UU No: 24 Tahun 1992. Perencanaan tata ruang pada dasarnya merupakan perumusan pemanfaatan / penggunaan ruang secara optimal dengan orientasi produksi dan konservasi bagi kelestarian lingkungan.

Peraturan dan perundang - undangan yang bersifat sektoral dan belum operasional tersebut merupakan salah satu penyebab terjadinya penyimpangan pemanfaatan ruang dari rencana tata ruang yang ada, karena masing masing stakeholders, baik pemerintah : dalam hal ini lembaga / instansi, maupun pihak swasta dan masyarakat berusaha memanfaatkan sumberdaya yang ada di wilayah pesisir se optimal mungkin sesuai dengan kepentingan masing - masing. Disamping itu kondisi alam yang meliputi : ketersediaan lahan, daya dukung lahan dan lingkungan serta dan kondisi sosial budaya masyarakat setempat yang meliputi : response masyarakat, tradisi dan kebiasaan yang sudah turun - temurun dan lain lain juga perlu dipertimbangkan dalam perumusan kebijakan pemanfaatan ruang wilayah pesisir dan lautan.

Penyimpangan pemanfaatan ruang dari Rencana Tata Ruang berpotensi menimbulkan konflik pemanfaatan ruang. Dengan mempelajari konflik pemanfaatan ruang melalui pendekatan analisis spasial dan analisis konflik., akan dapat ditentukan prioritas kegiatan pemanfaatan ruang yang optimal. hasil kedua analisis tersebut dapat memberikan rekomendasi bagi pengambilan keputusan dalam penentuan kebijakan (Gambar 1); sedangkan permasalahan kebijakan dalam pemanfaatan ruang diuraikan secara sistematik dalam gambar 2.

METODOLOGI

Lokasi Penelitian

Lokasi penelitian terletak di wilayah pesisir Kotamadya Pasuruan yang terdiri dari 9 Desa / Kelurahan, yaitu : Gadingrejo, Tamba'an, Trajeng, Tapa'an, Ngemplakrejo, Mandaranrejo, Panggungrejo, Kepel dan Blandongan (Gambar 3).

Pengumpulan Data

Data sekunder diperoleh dari Dinas, Instansi terkait dan data primer diperoleh dari survei, observasi dan wawancara secara langsung di lapangan. Sedangkan pengambilan sampel dilakukan secara *purposive sampling* terhadap sejumlah responden dengan pertimbangan responden adalah aktor / pengguna lahan *(stakeholders)* yang dianggap memiliki keahlian atau yang memiliki kemampuan dan mengerti permasalahan terkait serta yang mempengaruhi pengambilan kebijakan, baik secara langsung maupun tidak langsung.

Analisis Data

Sistem Informasi Geograpis (SIG)

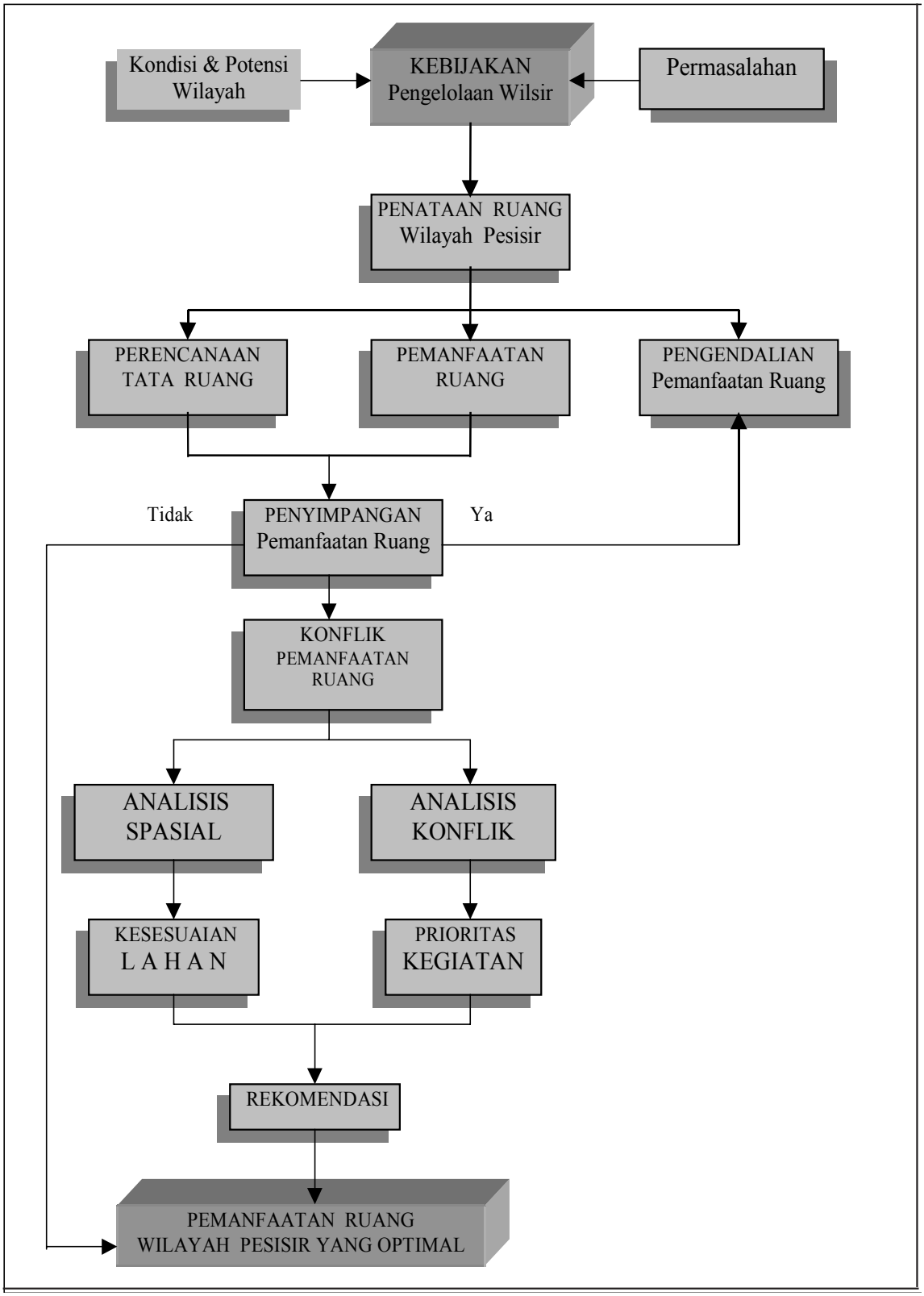
Untuk mengevaluasi kesesuaian lahan dilakukan Analisis spasial dengan pendekatan SIG yang menggunakan perangkat lunak *ArcInfo 3.5* dan *ArcView 3.1* dengan metode tumpang susun (*overlay)*, pembobotan *(weighting*), pengharkatan (*scoring*) dan kelas (*Class*).

Analisis spasial dilakukan terhadap 4 (empat) jenis kesesuaian lahan, yaitu : kesesuaian lahan untuk industri, tambak, sawah, permukiman dan konservasi. Setiap jenis penggunaan lahan dianalisis kesesuaiannya berdasarkan kriteria dan persyaratan penggunaan lahan, kemudian diidentifikasi secara terpisah dengan mempertimbangkan masing – masing faktor / parameter pembatas. Klasifikasi suatu faktor pembatas (parameter) bagi suatu peruntukan penggunaan lahan disusun dalam pembobotan, scoring dan kelas.

Pembobotan, scoring dan kelas yang telah dilakukan tersusun 4 (empat) kelas, yaitu : Sangat Sesuai (S1), Sesuai (S2), Tidak Sesuai Saat Ini (N1) dan Tidak Sesuai Permanen (N2). Pemberian bobot setiap parameter ditentukan terbesar 1,0 dan terkecil 0,8, sedangkan pemberian harkat/skor pada setiap parameter ditetapkan tertinggi 25 dan terendah 10, dan untuk pemberian kelas pada setiap faktor pembatas ditentukan berdasarkan pada besar skor yang diperoleh. Skor tertinggi akan mendapatkan kelas 1, berikutnya 2 dan seterusnya sampai pada skor terendah mendapatkan kelas 4 (tabel 1, 2, 3, 4, 5).

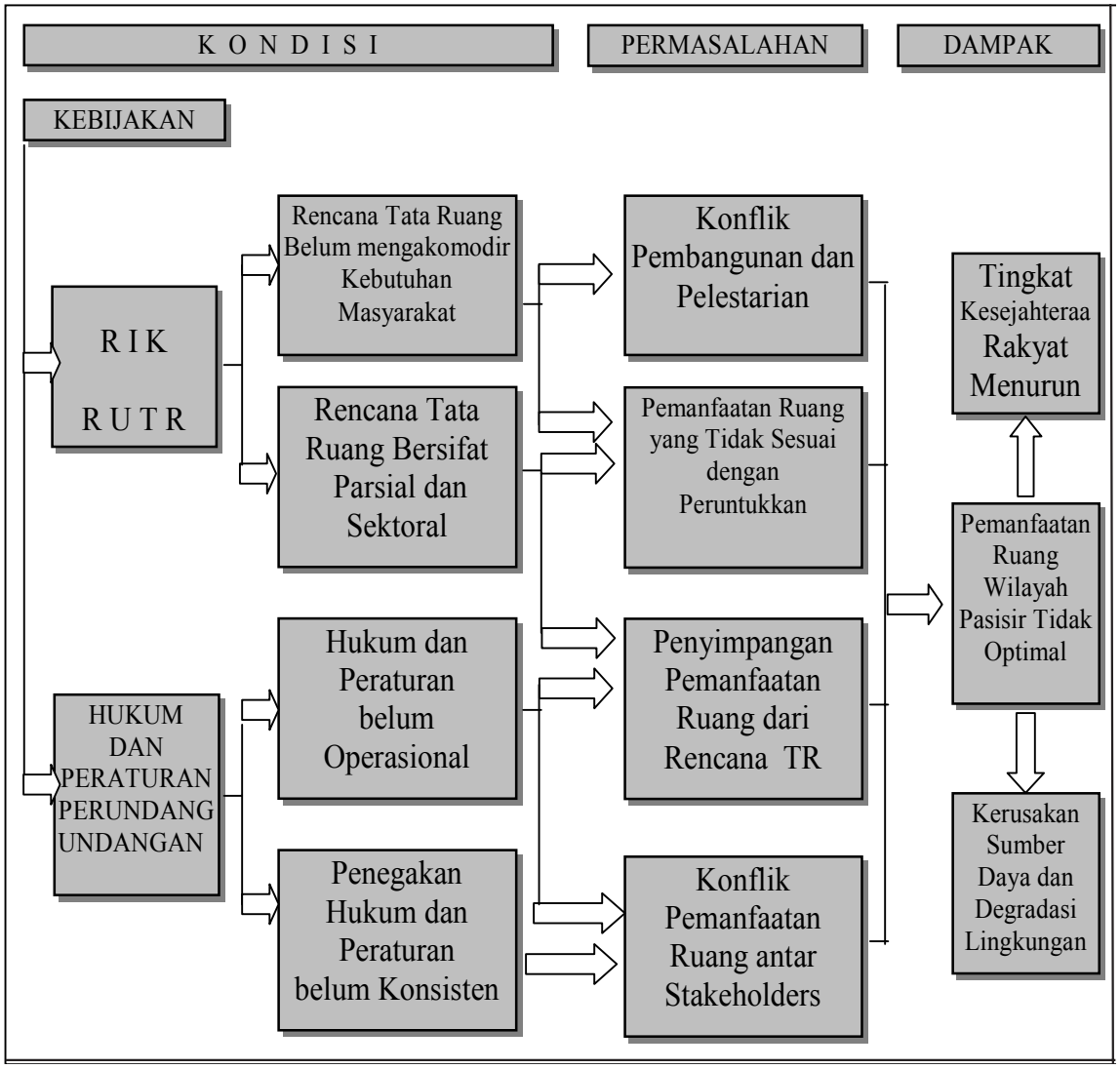
Metode Pendekatan Proses Hierarkhi Analitik (AHP).

Analisis kebijakan yang bertujuan untuk menyelesaikan konflik pemanfaatan ruang yang terjadi dengan cara memilih / menentukan prioritas kegiatan /



Gambar 1. Diagram kerangka pendekatan masalah

penggunaan lahan yang optimal digunakan metode pendekatan AHP dengan bantuan perngkat lunak '*Expert Choise'*. Untuk dapat memberikan solusi yang diinginkan, maka ada 4 (empat) aspek yang dipertimbangkan, yaitu : aspek ekonomi, lingkungan, sosial dan teknologi. Dari keempat aspek tersebut terdapat beberapa faktor yang sangat mempengaruhi keputusan pada pemilihan / penentuan prioritas penggunaan lahan dalam pemanfaatan ruang yang akan dikembangkan. Selanjutnya disusun struktur hirarki fungsionalnya.



Gambar 2. Diagram permasalahan kebijakan dalam pemanfaatan ruang

HASIL DAN PEMBAHASAN

1. Evaluasi Kesesuaian Lahan

Dari hasil analisis kesesuaian lahan untuk masing-masing penggunaan lahan, diperoleh luas areal penggunaanlahan seperti yang dirinci dalam Tabel 6.

a. T a m b a k

Lokasi yang *sangat sesuai* untuk kawasan tambak berada di sebagian Desa Blandongan, Desa Kepel, Desa Tapa'an, Desa Panggungrejo, Desa Ngemplakrejo dan Tamba'an seluas 600,425 Ha, dan lokasi yang *sesuai* berada di sebagian Desa Blandongan, Desa Kepel, Desa Tapa'an, Desa Tamba'an dan Desa Trajeng seluas 302,354 Ha, sedangkan lokasi *tidak sesuai saat ini* dan *tidak sesuai permanen*, masing – masing berada pada sebagian Kelurahan Gadingrejo, Desa Trajeng, Desa Tamba'an, Desa Ngemplakrejo dan Mandaranrejo seluas 152, 352 Ha dan sebagian Desa Blandongan, Kelurahan Gadingrejo dan Desa Kepel seluas 188,870 Ha (Gambar 4).

b. I n d u s t r i

Lokasi yang *sangat sesuai* untuk kawasan industri seluas 185,177 Ha berada di sebagian Desa Mandaranrejo, Desa Ngemplakrejo, Desa Trajeng, dan Kelurahan Gadingrejo, dan lokasi yang sesuai seluas 492,88 ha berada disebagian Kelurahan Gadingrejo, Desa Trajeng, Desa Kepel, Desa Tapa'an dan Desa Tamba'an; sedangkan lokasi tidak sesuai saat ini seluas 57,22 ha berada di Desa Tamba'an, Desa Ngemplakrejo dan Desa Trajeng, sementara yang tidak sesuai permanen seluas 508,72 ha berada di sebagian Desa panggungrejo, Desa Blandongan, Desa Kepel dan Desa Tapa'an (Gambar 5).

Tabel 1. Bobot, skor dan kelas penggunaan lahan untuk Kategori Kemiringan / Lereng (%) .

Kategori	Sawah			Tambak			Industri			Konservasi			Permukiman		
	B	S	K	B	S	K	B	S	K	B	S	K	B	S	K
0 - 2	0,8	17	2	1,0	25	1	0,9	16	3	1,0	25	1	0,9	17	3
3 - 8	0,8	20	1	1,0	14	3	0,9	22	1	1,0	10	4	0,9	22	1
9 - 15	0,8	15	3	1,0	10	4	0,9	19	2	1,0	10	4	0,9	20	2
> 16	0,8	12	4	1,0	10	4	0,9	10	4	1,0	10	4	09	15	4

Tabel 2. Bobot, skor dan kelas penggunaan lahan untuk Kategori Ketinggian (m)

Kategori	Sawah			Tambak			Industri			Konservasi			Permukiman		
	B	S	K	B	S	K	B	S	K	B	S	K	B	S	K
0 - 5	0,9	18	2	1,0	24	1	0,8	17	2	1,0	25	1	0,8	15	3
6 - 15	0,9	20	1	1,0	14	3	0,8	20	1	1,0	15	3	0,8	24	1
16 - 20	0,9	15	3	1,0	12	4	0,8	15	3	1,0	10	4	0,8	22	1
> 21	0,9	10	4	1,0	10	4	0,8	10	4	1,0	10	4	0,8	20	2

Tabel 3. Bobot, skor dan kelas penggunaan lahan untuk kategori kedalaman efektif tanah (Cm)

Kategori	Sawah			Tambak			Industri			Konservasi			Permukiman		
	B	S	K	B	S	K	B	S	K	B	S	K	B	S	K
< 30	1,0	18	2	0,9	21	1	0,9	18	3	0,8	20	1	1,0	16	3
31 - 60	1,0	22	1	0,9	15	3	0,9	22	1	0,8	10	4	1,0	22	1
61 - 90	1,0	15	3	0,9	10	4	0,9	20	2	0,8	10	4	1,0	20	2
> 91	1,0	10	4	0,9	10	4	0,9	10	4	0,8	10	4	1,0	12	4

Tabel 4. Bobot, skor dan kelas penggunaan lahan untuk Kategori Jenis Tanah

Kategori	Sawah			Tambak			Industri			Konservasi			Permukiman		
	B	S	K	B	S	K	B	S	K	B	S	K	B	S	K
Aluvial pantai	1,0	12	4	1,0	22	1	-	-	-	0,9	20	1	-	-	-
Al. Hidro. Kel	1,0	22	1	1,0	15	3	-	-	-	0,9	10	4	-	-	-
Gleihumus	1,0	20	2	1,0	10	4	-	-	-	0,9	10	4	-	-	-
Regosol	1,0	15	3	1,0	10	4	-	-	-	0,9	10	4	-	-	-

Tabel 5. Bobot, skor dan kelas penggunaan lahan untuk Kategori Drainase

Kategori	Sawah			Tambak			Industri			Konservasi			Permukiman		
	B	S	K	B	S	K	B	S	K	B	S	K	B	S	K
Tergenang Periodik	1,0	12	4	1,0	24	1	1,0	14	3	1,0	24	1	1,0	14	3
Tidak Tergenang	1,0	22	1	1,0	10	4	1,0	20	1	1,0	10	4	1,0	20	1

Keterangan :

B : Bobot
S : Skor
K : Kelas

Kelas 1 : Sangat Sesuai
Kelas 2 : Sesuai
Kelas 3 : Tidak Sesuai Saat Ini
Kelas 4 : Tidak Sesuai Permanen

c. Permukiman

Lokasi yang *sangat sesuai* untuk kawasan seluas 112,921 ha berada di sebagian Kelurahan Gadingrejo dan Desa Trajeng, dan lokasi yang sesuai seluas 227,522 ha ini barada di sebagian Desa Kepel, Desa Blandongan, Desa Ngemplakrejo dan Kelurahan Gadingrejo; sedangkan lokasi *yang tidak sesuai saat ini* dan *tidak sesuai permanen*, masing – masing seluas 283,132 ha berada di lokasi Desa Kepel, Desa Trajeng, Desa Blandongan, Desa Tapa'an Desa Mandaranrejo, Desa Ngemplakrejo, desa Tamba'an dan Kelurahan Gadingrejo, dan seluas 620,425 ha berada di sebagian Kelurahan Gadingrejo, Desa Blandongan, Desa Kepel, Desa Tapa'an, Desa Ngemplakrejo, Desa Mandaranrejo, Desa Panggungrejo dan Desa Trajeng (Gambar 6).

d. S a w a h

Lokasi yang *sangat sesuai* untuk kawasan pertanian sawah seluas 191,523 Ha, dan lokasi *sesuai* seluas 298,357 Ha, sedangkan lokasi *tidak sesuai saat ini* dan *tidak sesuai permanen*, masing – masing seluas 27.650 Ha dan seluas 726.466 Ha (Gambar 7).

e. K o n s e r v a s i

Lokasi yang *sangat sesuai* untuk kawasan konservasi seluas 220,245 Ha, dan lokasi *sesuai* seluas 16,544 Ha, sedangkan lokasi *tidak sesuai saat ini* dan *tidak sesuai permanen*, masing – masing seluas 399,795 Ha dan seluas 607,237 Ha (Gambar 8).

Berdasarkan hasil analisis spasial penggunaan lahan, dapat diidentifikasi konflik penggunaan lahan yang terjadi, yaitu: (1) konflik penggunaan lahan antara industri dan tambak di Kelurahan Gadingrejo, dan (2) konflik antara industri, pemukiman dan tambak di Desa Trajeng. Adapun faktor yang antara lain menyebabkan terjadinya konflik adalah pemanfaatan ruang yang tidak sesuai dengan Rencana Tata Ruang yang ada.

2. Konflik Pemanfaatan Ruang

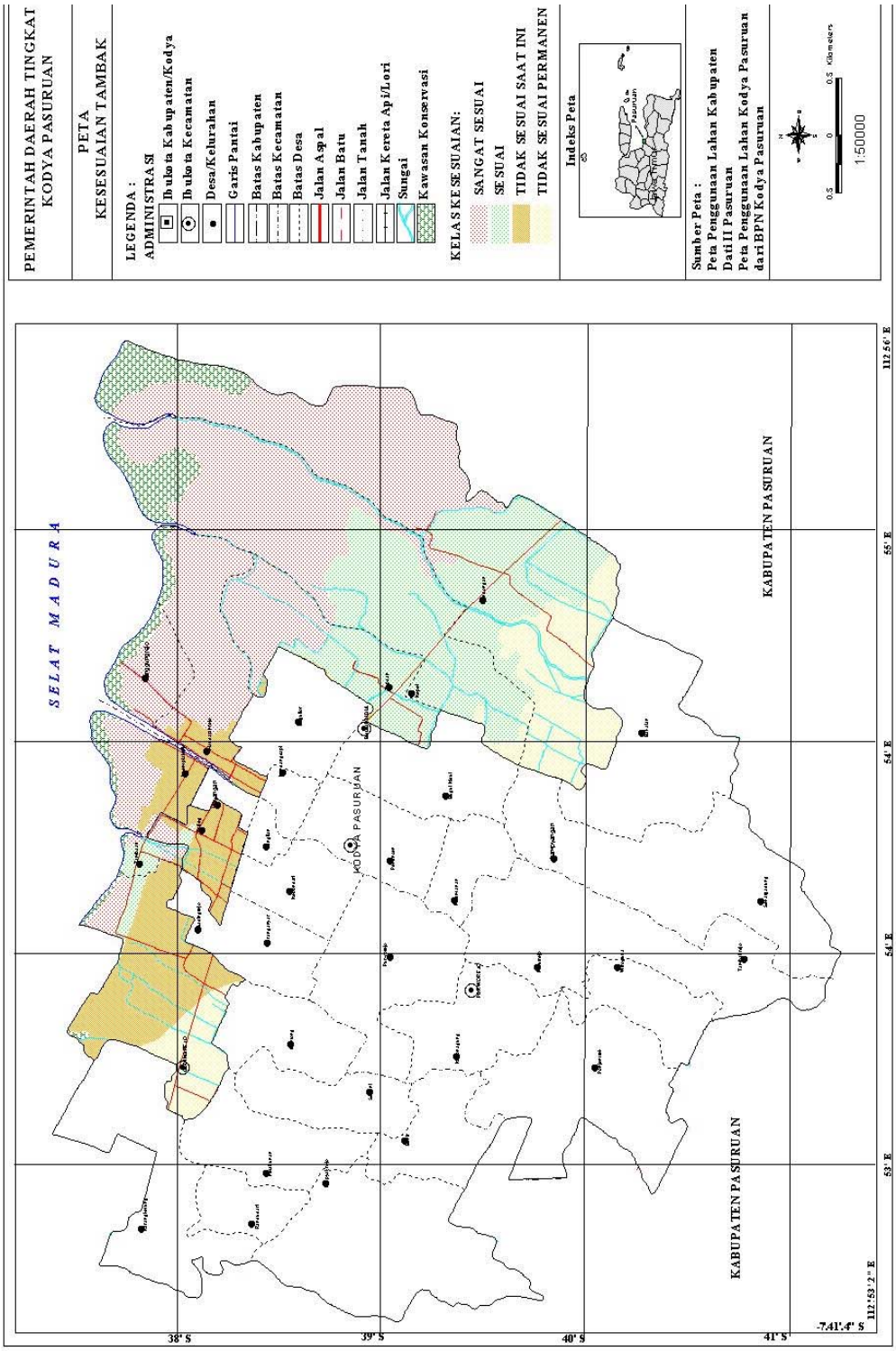
Dari hasil analisis AHP terhadap konflik yang terjadi, berdasarkan *judgment* para *stakeholders* yang meliputi : Pemerintah, Swasta dan Masyarakat, diperoleh nilai Consistency Ratio (CR) berkisar antara 0,03 s/d 0,11 atau masih berada dibawah nilai CR < 0,10. Dengan demikian para stakeholders *'konsisten'* dalam memberikan nilai pembobotan dengan tingkat penyimpangan yang kecil.

a) Konflik antara Industri dan Tambak

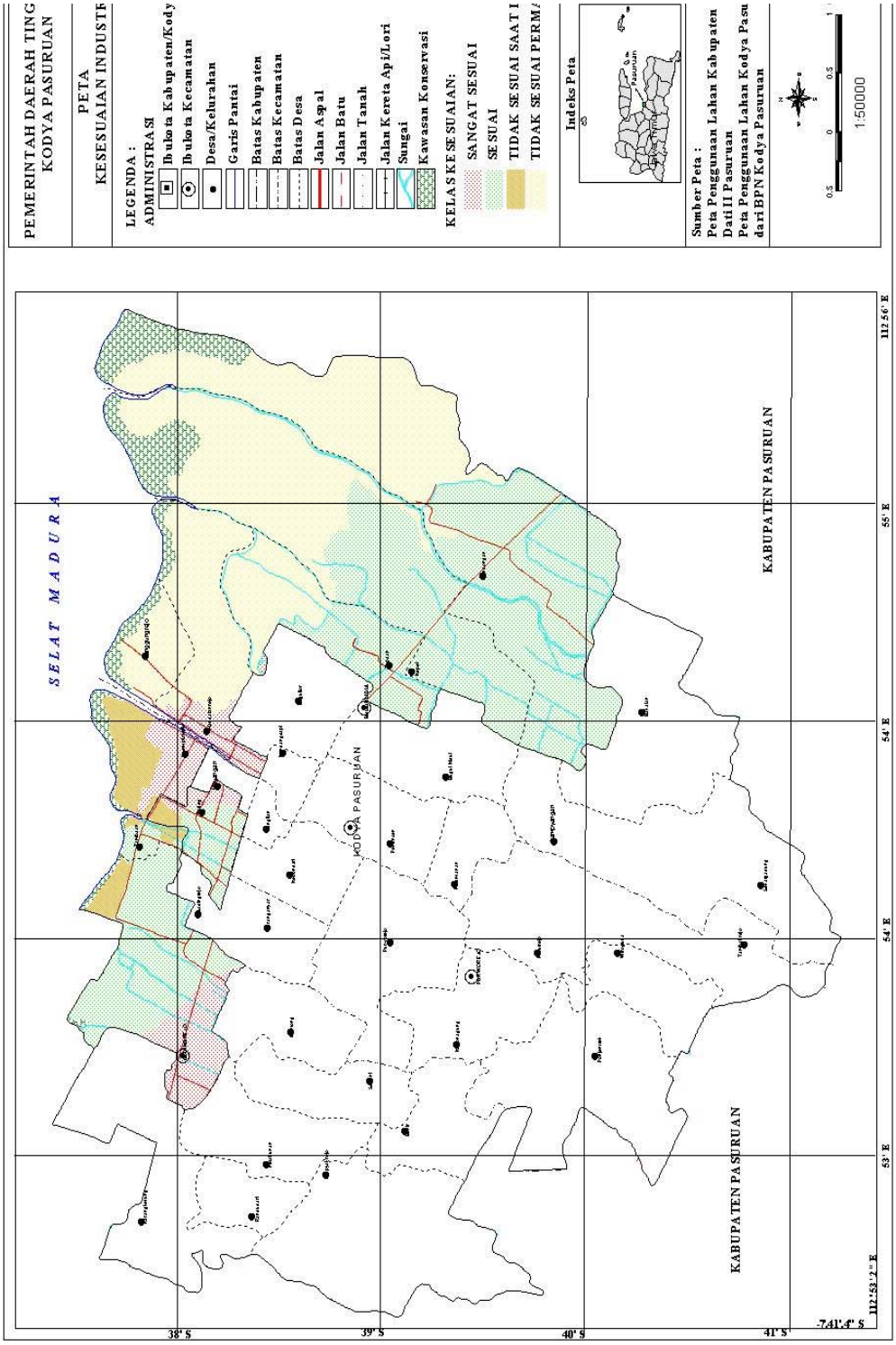
Berdasarkan hasil analisis pendapat kelompok dalam Penentuan Prioritas Penggunaan Lahan bagi masing - masing stakeholders yang berkepentingan terhadap konflik yang terjadi di Kelurahan Gadingrejo, diketahui bahwa : menurut persepsi pemerintah, prioritas pertama adalah Industri dengan nilai bobot 0,58 dan apabila dilihat dari hierarki diatasnya (level 3), maka bobot faktor tertinggii adalah Peningkatan pendapatan dengan nilai bobot 0,54 dan Penyerapan tenaga kerja dengan nilai bobot 0,107. Jadi persepsi pemerintah dalam menentukan prioritas pertama diperuntukkan industri dengan pertimbangan aspek ekonomi dan sosial. Dan menurut persepsi Swasta, prioritas pertama adalah industri dengan nilai bobot 0,72, dan apabila dilihat dari hirarki diatasnya (level 3), maka bobot faktor tertinggi adalah eksploitasi sumberdaya dengan nilai bobot 0,68 dan ketersediaan lahan dengan nilai bobot 0,12. Jadi persepsi swasta dalam menentukan prioritas pertama diperuntukkan industri dengan pertimbangan aspek ekonomi dan lingkungan. Sedangkan berdasarkan persepsi masyarakat, prioritas pertama adalah tambak

Tabel 6. Luas areal penggunaan lahan dari hasil analisis kesesuaian lahan (ha)

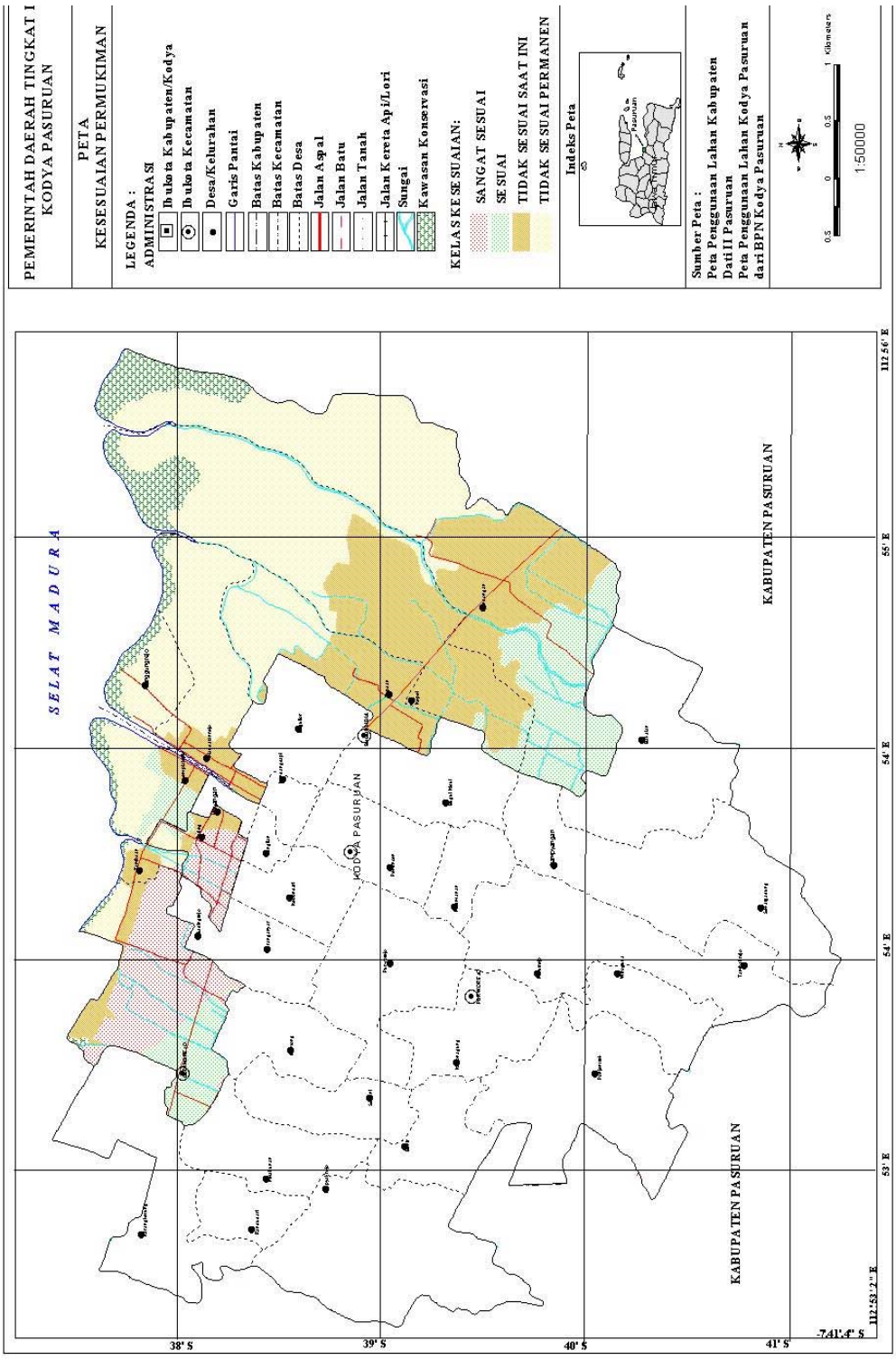
Kelas Kesesuaian	Tambak	Industri	Pemukiman	Sawah	Konservasi
Sangat sesuai	600,43	185,18	112,92	191,52	220,42
Sesuai	302,35	492,88	227,52	298,36	16,54
Tidak sesuai saat ini	152,35	57,22	283,13	27,65	399,80
Tidak sesuai permanen	188,87	508,72	620,42	726,47	607,24



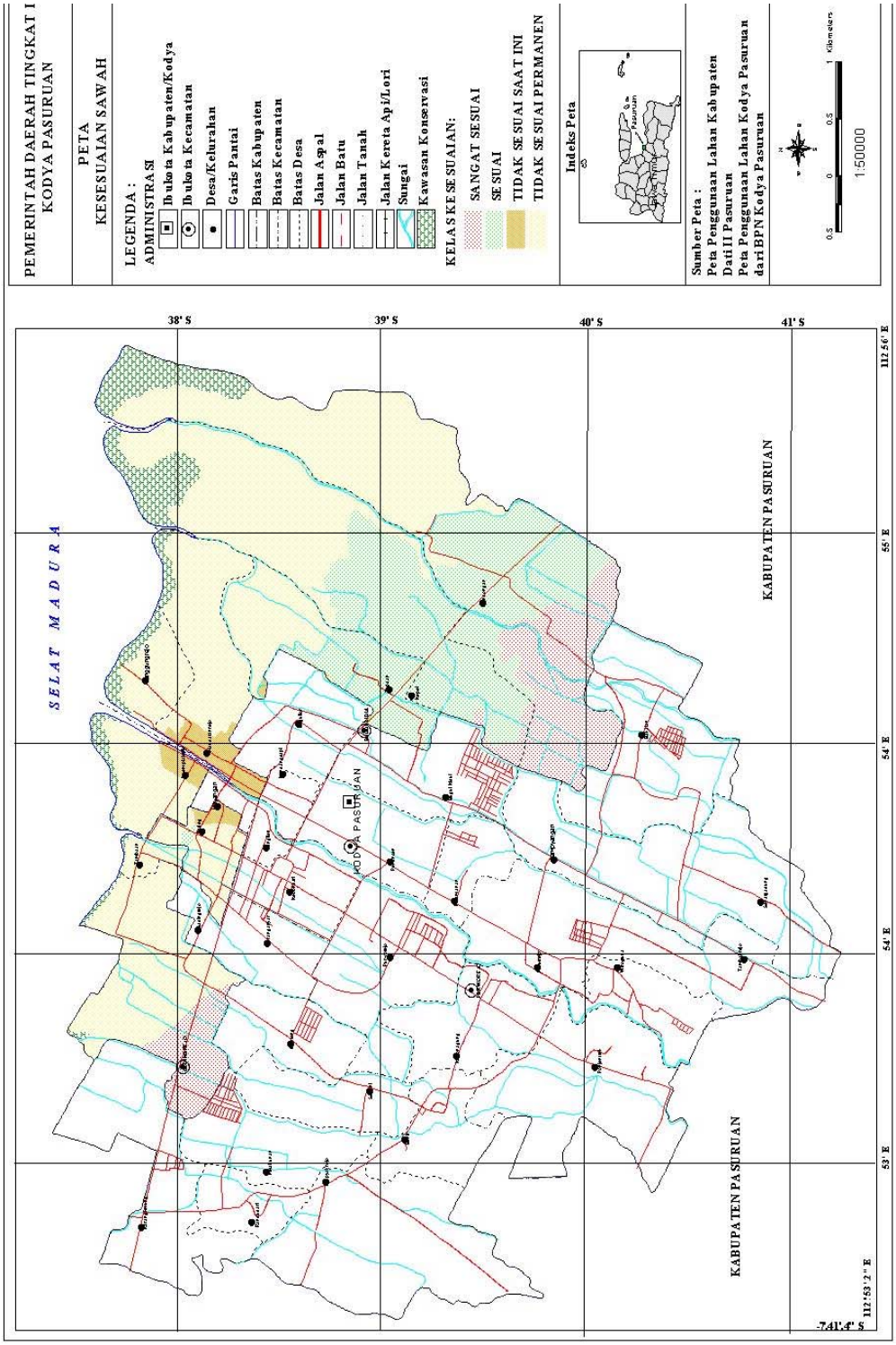
Gambar 4. Peta kesesuaian lahan untuk tambak



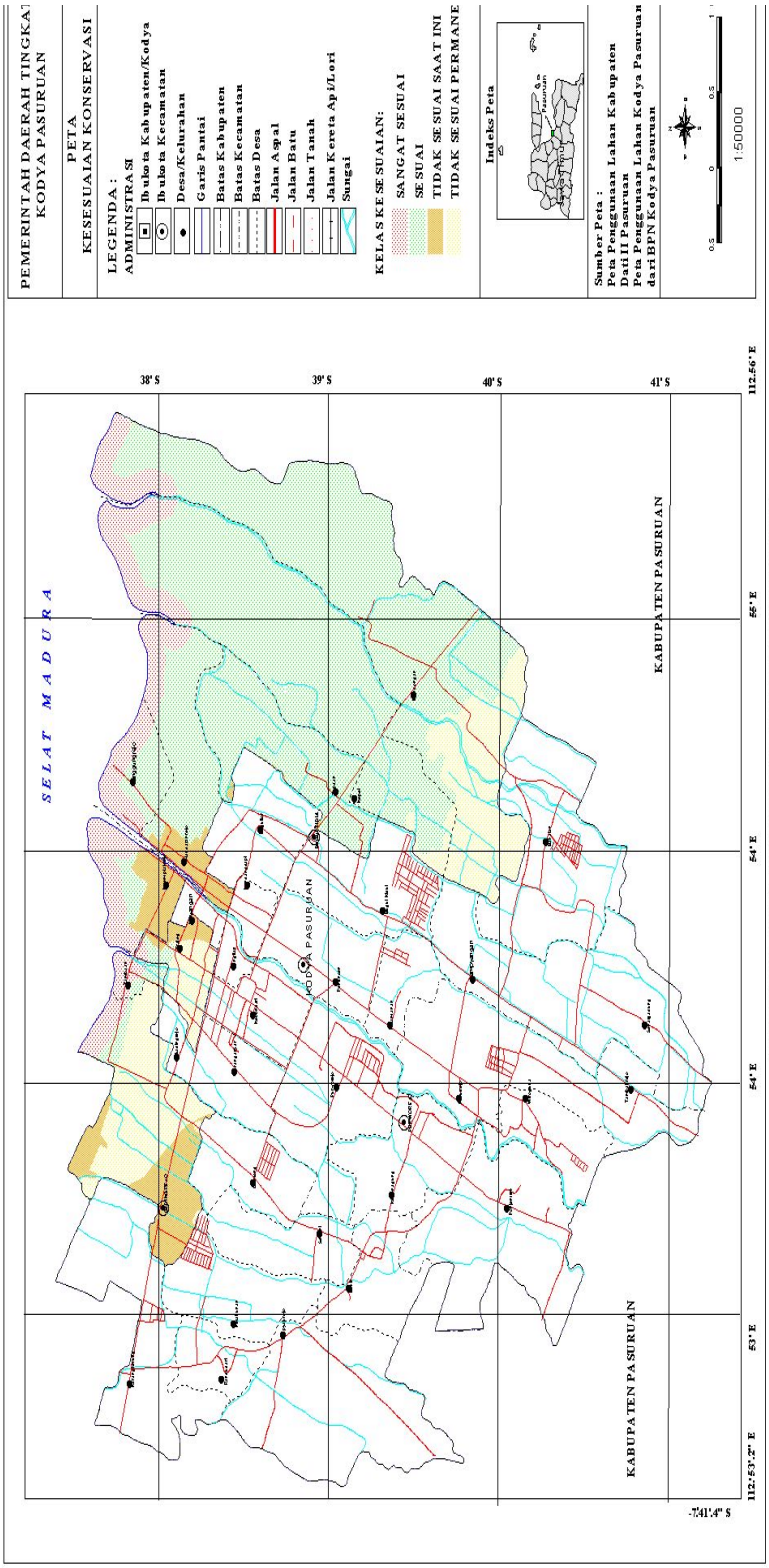
Gambar 5. Peta kesesuaian lahan untuk industri



Gambar 6. Peta kesesuian lahan untuk pemukiman



Gambar 7. Peta kesesuian lahan untuk sawah



Gambar 8. Peta kesesuaian lahan untuk konservasi

dengan nilai bobot 0,76 (tabel 7). Bila dilihat dari hierarki diatasnya (Tingkat 3), faktor tertinggi adalah tradisi dan kebiasaan yang turun - temurun dengan nilai bobot 0,61, dan meningkatkan pendapatan dengan nilai bobot 0,09.

Tabel 7. Hasil Analisis Pendapat Kelompok terhadap Penentuan Prioritas untuk masing-masing Stakeholders di kelurahan Gadingrejo

Penggunaan Lahan	Stakeholders					
	Pemerintah		Swasta		Masyarakat	
	Bobot	Prioritas	Bobot	Prioritas	Bobot	Prioritas
INDUSTRI	0,58	1	0,72	1	0,24	2
TAMBAK	0,42	2	0,22	2	0,76	1

Jadi persepsi masyarakat dalam menentukan prioritas pertama diperuntukkan industri dengan pertimbangan aspek sosial dan ekonomi.

Berdasarkan hasil analisis aspek dan faktor - faktor yang berpengaruh pada struktur hierarki pertama dan kedua terhadap penentuan prioritas penggunaan lahan, dapat dikatahui bahwa : penggunaan tanah untuk industri, pertimbangan aspek ekonomi yang paling berperan dengan bobot sebesar 0,511 dan faktor yang sangat mempengaruhi aspek tersebut dalam kaitan penggunaan lahan untuk industri secara berurutan adalah Peningkatan pendapatan merupakan prioritas pertama dengan bobot 0.303, hal ini dimungkinkan dengan adanya industri di wilayah tersebut dapat meningkatkan pendapatan asli daerah dan masyarakat setempat, dan eksploitasi sumberdaya alam merupakan prioritas kedua dengan bobot 0.228, sedangkan prioritas ketiga adalah tumbuhnya sektor informal dengan bobot sebesar 0.129, hal ini disebabkan perkembangan industri memicu tumbuhnya sektor informal sebagai sektor penunjang

Penggunaan lahan untuk tambak, menunjukkan bahwa pertimbangan aspek sosial merupakan prioritas pertama dengan bobot sebesar 0,507 dan faktor yang sangat mempengaruhi aspek tersebut adalah faktor tradisi dan kebiasaan yang turun – temurun dengan bobot sebesar 0.197, dan prioritas kedua adalah merupakan pendapatan masyarakat dengan bobot sebesar 0.178, sedangkan prioritas ketiga adalah penyerapan tenaga kerja dengan bobot sebesar 0.157 (Tabel 8 dan 9).

Berdasarkan hasil analisis pendapat gabungan pada penentuan prioritas penggunaan lahan menunjukkan bahwa penggunaan lahan di Kelurahan Gadingrejo lebih diutamakan untuk industri dengan nilai bobot sebesar 0,529 yang didasarkan pada pertimbangan aspek ekonomi (meningkatkan pendapatan asli daerah dan masyarakat setempat), dengan nilai bobot sebesar 0,279, dan pertimbangan aspek sosial (penyerapan tenaga kerja) dengan nilai bobot sebesar 0,223 (Tabel 10; Gambar 9). Aspek ketiga yang cukup berpengaruh adalah aspek lingkungan (pencemaran), dimana industri – industri yang berkembang di daerah ini yang berpotensi menimbulkan pencemaran, diharuskan mengelola limbahnya baik padat maupun cair sebelum dibuang ke sungai atau laut.

b) Konflik antara Industri, Tambak dan Permukiman

Dengan cara yang sama pada analisis konflik penggunaan lahan di Kelurahan Gadingrejo, maka pada analisis konflik penggunaan lahan antara industri, permukiman dan tambak di Desa Trajeng diperoleh hasil pada tabel 11 .

Berdasarkan hasil analisis hierarki, konflik penggunaan lahan untuk industri, permukiman dan tambak di Desa Trajeng diprioritaskan untuk industri dan tambak dengan nilai bobot sebesar 0.344 dan 0.343 (Tabel 11 ; Gambar 10). Kedua kegiatan penggunaan lahan dapat dilakukan berdampingan , berdasarkan pertimbangan aspek ekonomi (meningkatkan pendapatan asli daerah dan masyarakat setempat) nilai bobot sebesar 0.258, pertimbangan aspek lingkungan (pencemaran limbah industri) dengan nilai bobot sebesar 0,179 (Tabel 11 ; Gambar 10), Industri - industri yang berkembang di daerah penelitian yang berpotensi menimbulkan pencemaran, diharuskan mengelola limbahnya baik padat maupun cair sebelum dibuang ke sungai atau laut. Aspek ketiga yang juga berpengaruh

Tabel 8. Hasil analisis pendapat terhadap pertimbangan aspek penentuan prioritas penggunaan lahan wilayah pesisir di Kelurahan Gadingrejo

Penggunaan Lahan	ASPEK							
	Ekonomi		Lingkungan		sosial		Teknologi	
	Bobot	Prioritas	Bobot	Prioritas	Bobot	Prioritas	Bobot	Prioritas
INDUSTRI	0.511	1	0.102	4	0.209	2	0.177	3
TAMBAK	0.311	2	0.127	3	0.507	1	0.055	4

Tabel 9. Hasil analisis pendapat terhadap faktor-faktor yang berpengaruh dalam penentuan prioritas penggunaan lahan wilayah pesisir di Kelurahan Gadingrejo.

FAKTOR	PENGGUNAAN LAHAN			
	Industri		Tambak	
	Bobot	Prioritas	Bobot	Prioritas
Pendapatan	0.303	1	0.178	2
Eksploitasi sumberdaya	0.228	2	0.137	4
Sektor informal	0.129	3	0.057	7
Pencemaran	0.111	4	0.085	6
Ketersediaan lahan	0.072	6	0.136	5
Tenaga kerja	0.075	5	0.157	3
Tradisi dan kebiasaan turun temurun	0.040	8	0.197	1
Transfer teknologi	0.042	7	0.055	8

Tabel 10. Hasil analisis hirarki pendapat gabungan pada penentuan prioritas penggunaan lahan wilayah pesisir di Kelurahan Gadingrejo

Penggunaan Lahan	FAKTOR									
	E1 0.279	E2 0.063	E3 0.101	L1 0.191	L2 0.075	S1 0.224	S2 0.052	T1 0.016	Bobot	Prioritas
Industri	0.303	0.228	0.129	0.111	0.072	0.075	0.040	0.042	0.529	1
Tambak	0.178	0.136	0.057	0.136	0.055	0.157	0.197	0.085	0.471	2

Keterangan:
E1: Pendapatan
E2: Eksploitasi sumberdaya
E3: Sektor informal
L1: Pencemaran
L2: Ketersediaan lahan
S1: Tenaga kerja
S2: Tradis dan kebiasaan turun temurun
T: Transfer teknologi

Tabel 11 : Hasil analisis hierarki-2 pendapat gabungan pada penentuan prioritas penggunaan lahan wilayah pesisir di Desa Trajeng

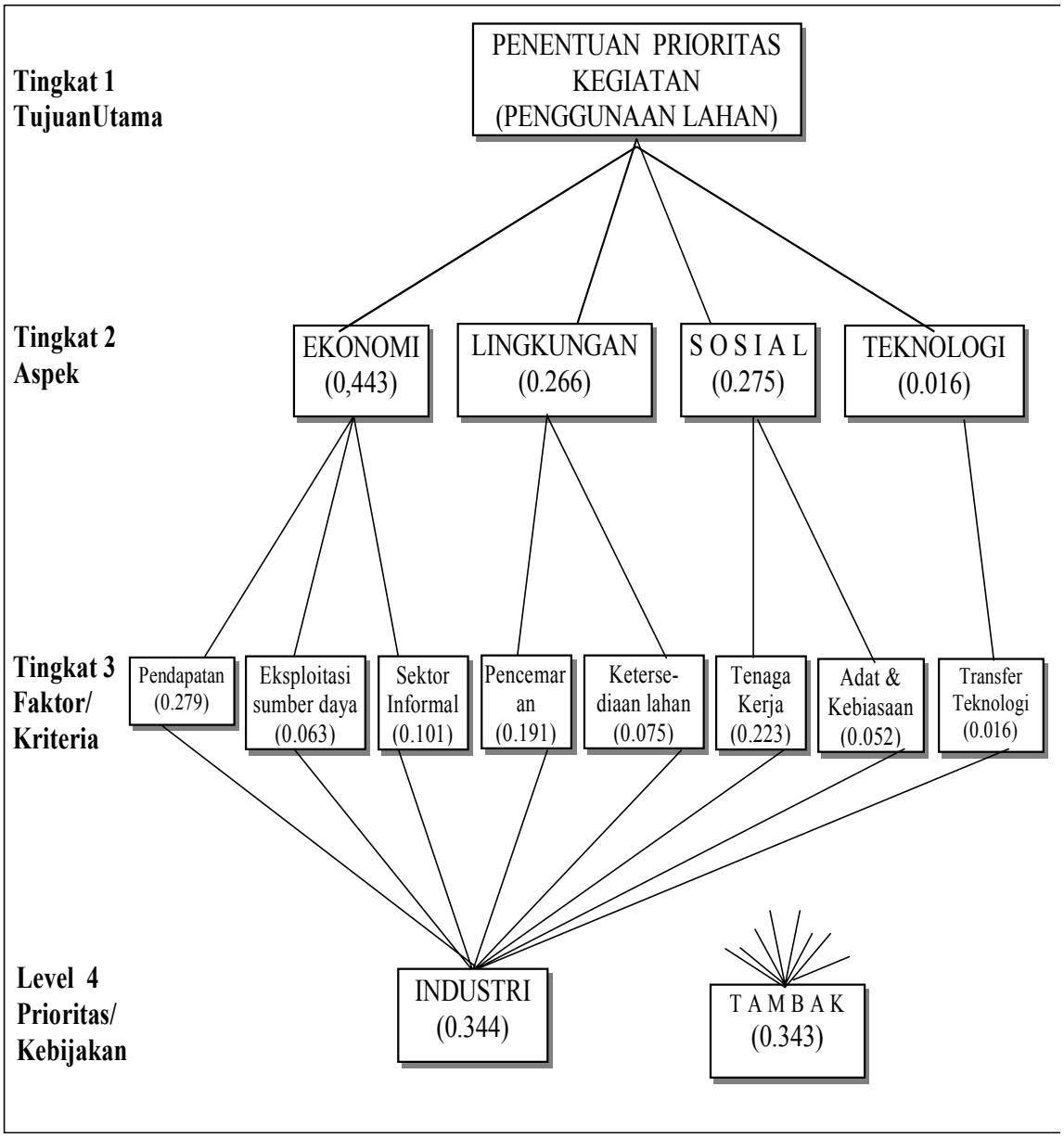
Penggunaan Lahan	FAKTOR									
	E1	E2	E3	L1	L2	S1	S2	T1	Bobot	Prioritas
	0.258	0.056	0.1122	0.179	0.084	0.1119	0.170	0.028		
Industri	0.279	0.240	0.134	0.118	0.076	0.069	0.045	0.039	0.344	1
Tambak	0.176	0.116	0.048	0.099	0.083	0.125	0.265	0.088	0.343	1
Permukiman	0.125	0.088	0.278	0.160	0.142	0.093	0.061	0.053	0.313	2

Keterangan:
E1: Pendapatan
E2: Eksploitasi sumberdaya
E3: Sektor informal
L1: Pencemaran
L2: Ketersediaan lahan
S1: Tenaga kerja
S2: Tradis dan kebiasaan turun temurun
T: Transfer teknologi

adalah aspek sosial (tradisi dan kebiasaan yang turun - temurun) dengan nilai bobot 0.170; Sedangkan prioritas kedua diperuntukkan bagi pemukim dengan nilai bobot 0,313. (Tabel 11; Gambar 10).

4. Analisis Kebijakan

Menurut E.S. Quade, Analisis Kebijakan adalah suatu bentuk analisis yang menghasilkan dan menyajikan informasi, sedemikian rupa, sehingga dapat memberikan landasan bagi para pembuat kebijakan dalam membuat keputusan. Analisis kebijakan menghasilkan informasi

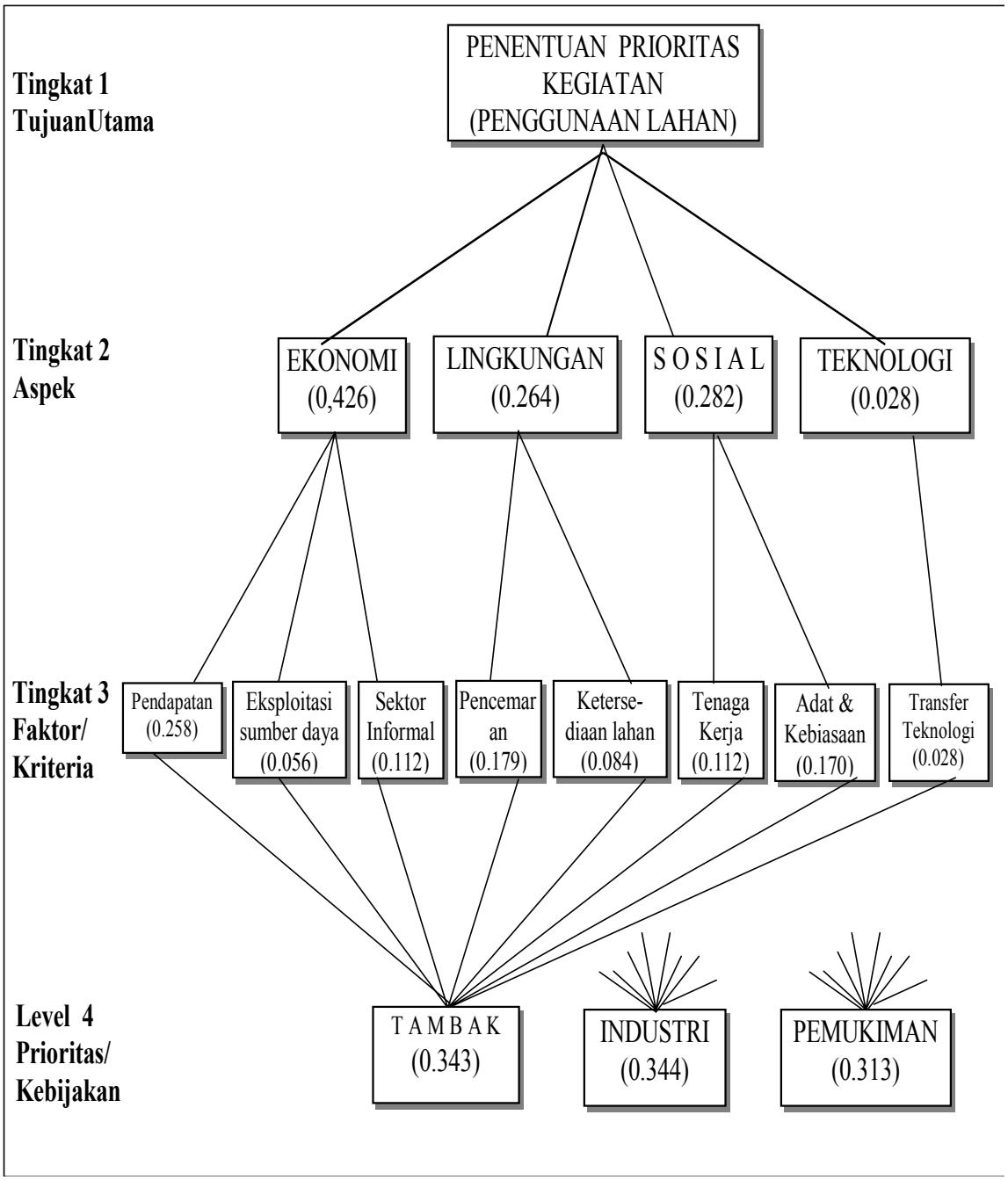


Gambar 9. Hasil analisis hierarki kegiatan industri dan tambak dalam penggunaan lahan wilayah pesisir di Kelurahan Gadingrejo, Pasuruan.

mengenai nilai – nilai dan serangkaian tindakan yang dipilih. Oleh karena itu analisis kebijakan dapat dilakukan dengan melalui evaluasi dan rekomendasi kebijakan.

Berdasarkan hasil analisis hierarki terhadap konflik penggunaan lahan dalam pemanfaatan ruang wilayah pesisir yang terjadi di Kelurahan Gadingrejo yang telah dibahas sebelumnya, maka dapat diketahui bahwa : konflik antara industri dan tambak berdasarkan hasil analisis hierarki, lokasi tersebut lebih diutamakan untuk kegiatan industri dan berdasarkan hasil evaluasi kesesuain lahan lokasi tersebut memang sesuai untuk kedua kegiatan tersebut, sedangkan faktor penyebab terjadinya konflik di lokasi tersebut karena penggunaan lahan yang tidak sesuai dengan arahan Rencana Tata Ruang yang diperuntukkan untuk kegiatan tambak. Dengan demikian penentuan penggunaan lahan untuk industri dapat direkomendasikan sebagai landasan pengambilan keputusan dalam menentukan kebijakan untuk menyelesaikan konflik yang terjadi di Kelurahan Gadingrejo.

Demikian pula halnya dengan penggunaan lahan di Desa Trajeng dimana lokasi tersebut dapat diprioritaskan untuk kegiatan industri dan tambak, karena kedua kegiatan memiliki tingkat kepentingan yang relatif



Gambar 10. Hasil analisis hierarki kegiatan tambak, industri, dan pemukiman dalam penggunaan lahan wilayah pesisir di Desa Trajeng, Pasuruan

sama baik bagi pemerintah, swasta maupun masyarakat. Prioritas berikutnya dapat direkomendasikan untuk pemukiman, meskipun berdasarkan hasil evaluasi kesesuaian lahan lokasi tersebut sangat sesuai untuk industri, tapi juga sesuai untuk tambak dan pemukiman. Faktor penybab terjadinya konflik di desa Trajeng karena penggunaan lahan untuk tambak di lokasi tersebut tidak sesuai dengan arahan Rencana Tata Ruang yang memprioritaskan untuk kegiatan industri dan pemukiman, dengan petimbangan arah pengembangan pembangunan wilayah. Berdasarkan hasil analisis hierarki dan evaluasi serta pertimbangan arahan dan Rencana Tata Ruang Tahun 1994, maka penentuan prioritas penggunaan lahan dapat direkomendasikan untuk kegiatan industri dan tambak dalam upaya menyelesaikan konflik yang terjadi di Desa Trajeng.

KESIMPULAN

Dari hasil dan pembahasan serta rekomendasi yang telah diuraikan sebelumnya, maka dapat disimpulkan bahwa :

- Berdasarkan evaluasi Kesesuaian lahan wilayah pesisir Kota Pasuruan direkomendasikan kawasan yang sangat sesuai untuk dikembangkan bagi peruntukan tambak berada di sebagian besar Desa Blandongan, Desa Kepel, Desa Panggungrejo, Desa Ngemplakrejo dan Desa Tamba'an seluas 600,43 ha. Industri dapat dikembangkan di sebagian Desa Mandaranrejo, Desa Ngemplakrejo, Desa Trajeng dan Kelurahan Gadingrejo seluas 185,18 ha. Kawasan pemukiman dapat dikembangkan di sebagian Desa Trajeng dan Kelurahan Gadingrejo seluas 112,92 ha. Kawasan Pertanian Sawah berada di sebagian Desa Blandongan, Desa Kepel dan Desa Tapaan seluas 91,52 ha. Kawasan Konservasi berada di sebagian Desa Blandongan, Desa Panggungrejo dan Desa Tamba'an seluas 220,42 ha.
- Faktor – faktor yang mempengaruhi terjadinya konflik pemanfaatan ruang dalam pengelolaan sumberdaya wilayah pesisir adalah terjadinya penyimpangan pemanfaatan ruang dari Rencana Tata Ruang dan berdasarkan evaluasi kesesuaian lahan, Rencana Tata Ruang yang ada dibuat Tahun 1994 sudah tidak sesuai lagi dengan kondisi dan perkembangan wilayah.
- Persepsi pemerintah dan swasta Terhadap pemanfaatan ruang wilayah pesisir di Kelurahan Gadingrejo, lebih diutamakan bagi kegiatan industri dengan pertimbangan aspek ekonomi. Sedangkan persepsi masyarakat lebih dominan untuk kegiatan tambak dengan pertimbangan aspek sosial, yaitu pengusahaan tambak merupakan tradisi dan kebiasaan yang turun temurun.
- Persepsi pemerintah dan swasta terhadap penentuan prioritas penggunaan lahan dalam pemanfaatan ruang wilayah pesisir di Desa Trajeng lebih diutamakan bagi kegiatan industri, kemudian tambak dan permukiman. Sedangkan persepsi masyarakat lebih mengutamakan kegiatan tambak dengan pertimbangan aspek sosial.
- Dengan mempertimbangan hasil evaluasi kesesuaian lahan, hasil analisis hierarki dan Rencana Tata Ruang yang ada, serta kondisi perkembangan wilayah, maka untuk menyelesaikan konflik yang terjadi di Kelurahan Gadingrejo direkomendasikan untuk kawasan industri, karena kawasan tambak yang ada disekitarnya kurang produktif, sehingga lahan yang ada dapat dikonversi, akan tetapi untuk kawasan tambak yang masih produktif tetap dipertimbangkan. Sedangkan di Desa Trajeng direkomendasikan untuk kawasan industri dan tambak, karena kedua kegiatan tersebut mempunyai tingkat kepentingan yang relatif sama baik bagi pemerintah, swasta maupun masyarakat. Dari kedua rekomendasi tersebut dapat digunakan sebagai dasar pengambilan keputusan dalam menentukan kebijakan.

SARAN

- Perlu dilakukannya revisi Rencana Tata Ruang, karena Rencana Tata Ruang yang ada sudah tidak sesuai lagi dengan kondisi dan perkembangan pembangunan wilayah.
- Perlu adanya sosialisasi Rencana Tata Ruang kepada masyarakat sebagai persiapan menghadapi perubahan dan perkembangan penggunaan lahan.

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KOMODO NATIONAL PARK CETACEAN SURVEYS:

A RAPID ECOLOGICAL ASSESSMENT OF CETACEAN DIVERSITY, ABUNDANCE AND DISTRIBUTION

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ABSTRACT

During May and October 1999 visual and acoustic cetacean surveys were conducted in Komodo National Park (KNP), Indonesia and adjacent waters. The surveys were conducted as a rapid ecological assessment of KNP with the aim to 1. identify which cetacean species occur in these waters; 2. monitor seasonal patterns and identify sensitive marine areas for cetaceans; 3. identify marine environmental impacts affecting cetaceans; 4. provide site-specific information on cetaceans for educational and environmental awareness programs; 5. initiate a volunteer cetacean monitoring program for environmental staff and dive operations.

In total, 14 cetacean species were identified during 207 active survey hours conducted over 26 field days. The surveys covered an estimated 1443 nautical mile (nm). The 14 species encountered were predominantly toothed whales and dolphins, and included the long-nosed spinner dolphin (*Stenella longirostris*), bottlenosed dolphin (*Tursiops truncatus*), pan-tropical spotted dolphin (*S. attenuata*), melon-headed whale (*Peponocephala electra*), sperm whale (*Physeter macrocephalus*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), pygmy killer whale (*Feresa attenuata*), false killer whale (*Pseudorca crassidens*), rough-toothed dolphin (*Steno bredanensis*), common dolphin (*Delphinus sp.*), pygmy or dwarf sperm whale (*Kogia sp.*), Cuvier's beaked whale (*Ziphius cavirostris*) and a rorqual whale species (*Balaenoptera sp.*) with unusual morphological characteristics.

An estimated total of 2423 individual cetaceans were sighted during the 1999 survey periods. The acoustic surveys included 93 hydrophone listening stations. These covered an estimated 5912 nm^2. Acoustic contact with cetaceans was recorded during 29% of the listening stations. The sightings within KNP borders were dominated by members of the Family Delphinidae, especially *T. truncatus* and *S.longirostris*. The off-shore waters adjacent to KNP have a far more diverse pattern and high diversity of cetaceans, some rare and endangered. Three species were seen regularly throughout the survey period: *S. longirostris, T. truncatus* and *S. attenuata*. For eight species a relative abundance index was calculated using multiple species-specific visual search times. Species were assigned a local abundance category (abundant, common, uncommon and rare) according to their sighting frequency and visual search time. On six occasions species associations were observed, including one school comprising of four different dolphin species.

The presence of new-born calves was observed for seven dolphin species as well as the sperm whale, indicating the KNP area could be an important cetacean calving (and breeding) ground. Several environmental impacts were identified of relevance to cetaceans, which are especially sensitive to acoustic disturbances, such as reef bombing, as well as chemical pollution.

Responsible cetacean watching potential in the area has increased due to the survey results. However, this may not be an appropriate activity without strict permit and operational conditions, educational programs and adequate enforcement realised from the start. The survey's outreach activities include a volunteer cetacean monitoring program. The Nature Conservancy field staff and several dive tourism operators interested in cetacean ecology and ocean conservation have advanced their identification skills through workshops and field training. This program is currently active with staff recording cetacean sightings on standardised datasheets. This community involvement will increase the information available on KNP cetacean diversity and abundance during times other than the priority survey periods.

Komodo National Park and World Heritage Area has been identified as one of the richest marine diversity sites in the Indo-Pacific. The rapid ecological assessment for cetaceans shows that the Komodo region is also an important habitat for whales and dolphins, and would benefit from additional cetacean survey efforts to assist resource

management plans, conservation measures and alternative livelihood options. Extensions of the Park and its buffer zones have been adopted by the management authorities in order to protect cetacean preferred habitats and migration routes and a 25 year management plan is currently being implemented.
Key words: cetacean, rapid ecological assesment, Komodo National Park

ABSTRAK

Pada bulan Mei dan Oktober tahun 1999 telah dilakukan penelitian visual dan akustik di Taman Nasional Komodo dan perairan sekitarnya. Penelitian tersebut dilakukan sebagai kajian ekologis secara cepat terhadap Taman Nasional Komodo dengan tujuan: 1. Mengidentifikasi spesies setasean yang terdapat di perairan tersebut, 2. Memantau pola-pola musim dan mengidentifikasi wilayah perairan yang sensetif bagi setasean tersebut, 3. Mengidentifikasi dampak lingkungan laut terhadap setasean, 4. Menyediakan informasi mengenai setasean yang spesifik untuk perairan tersebut bagi program-program pendidikan dan kesadaran lingkungan, dan 5. Menginisiasi satu program pemantauan setasean sukarela bagi staf pengelola lingkungan hidup dan penyelenggara kegiatan selam.

Secara total, survei yang dilakukan selama 207 jam kerja dalam 26 hari lapangan telah mengidentifikasi 14 spesies setasean. Daerah yang diteliti mencakup perairan seluas 1.443 mil laut. Jenis setasean yang teridentifikasi didominasi oleh jenis-jenis paus bergigi dan lumba-lumba, termasuk lumba-lumba paruh panjang (*Stenella longirostris*), lumba-lumbahidung botol (*Tursiops truncatus*), lumba-lumba totol (*S. attenuata*), paus kepala semangka (*Peponocephala electra*), Paus sperma (*Physeter macrocephalus*), lumba-lumba abu-abu (*Grampus griseus*), lumba-lumba Fraser (*Lagenodelphis hosei*), paus pembunuh kerdil (*Feresa attenuata*), paus pembunuh palsu (*Pseudorca crassidens*), lumba-lumba gigi kasar (*Steno bredanensis*), **common dolphin** (*Delphinus sp.*), paus sperma kerdil atau cebol (*Kogia sp.*), paus paruh Cuvier (*Ziphius cavirostris*) dan **a rorqual whale species** (*Balaenoptera sp.*) dengan karakteristik morfologi yang tidak biasanya.

Sejumlah 2.423 individu setasean terpantau selama periode penelitian di tahun 1999 tersebut. Survei akustik termasuk pemasangan 93 stasiun pendengar bawah air (hydrophone) yang meliputi area setasean terekam sebanyak 29% pada stasiun pendengar. Pantauan visual di sekitar Taman Nasional Komodo didominasi oleh jenis-jenis famili Delphinidae, terutama T. truncatus dan S. longirostris. Perairan laut lepas yang berdampingan dengan Taman Nasional Komodo memiliki pola yang jauh lebih beragam dan modernitas yang lebih tinggi, beberapa termasuk langka dan terancam punah. Tiga spesies terpantau secara reguler selama penelitian yaitu: S. longirostris, T. truncatus dan S. attenuata. Untuk spesies dilakukan perhitungan indeks kelimpahan relatif dengan menggunakan "multiple spesies-spesific visual search times". Tiap spesies diberi kategori kelimpahan lokal (melimpah, umum, tidak umum, jarang) sesuai dengan frekwensi penampakan dan periode pencarian visual ("usual search time"). Dalam 6 kesempatan telah diobservasi asosiasi spesies, termasuk satu kelompok yang terdiri dari 4 spesies lumba-lumba yang berbeda.

Kemunculan bayi-bayi dari 7 jenis lumba-lumba dan juga dari paus sperma menunjukkan bahwa Taman Nasional Komodo merupakan perairan dimana spesies-spesies tersebut melahirkan dan mengasuh anaknya. Beberapa dampak lingkungan yang relevan terhadap setasean seperti gangguan akustik telah didefinisikan, misalnya pengeboman dan juga polusi kimiawi.

Potensi pengamatan setasean di wilayah tersebut telah meningka sebagai hasil penelitian. Namun bagaimanapun kegiatan tersebut mungkin bukan kegiatan yang sesuai, bila tidak dilengkapi oleh kondisi perijinan dan operasional yang ketat, program-program pendidikan dan penegakan hukum yang memadai yang dirancang dari awal.

Staf lapangan *The Nature Conservancy* dan beberapa penyelenggara kegiatan selam yang memiliki minat terhadap ekologi setasean dan konservasi laut telah meningkatkan kemampuan mereka dalam melakukan identifikasi melalui lokakarya dan latihan di lapangan. Program ini sedang di aktifkan dengan staf *The Nature Conservancy* untuk merekam penampakan setasean yang telah distandarkan. Pelibatan masyarakat akan meningkatkan ketersediaan informasi mengenai keanekaragaman setasean di Taman Nasional Komodo dan kelimpahannya di waktu-waktu lain selain survei.

Taman Nasional Komodo dan "World Heritage Area" telah diidentifikasi sebagai salah satu lokasi keanekaragaman hayati laut yang terkaya di Indo-Pasifik. Pengkajian ekologis secara cepat untuk setasean menunjukkan bahwa wilayah Pulau Komodo merupakan habitat penting bagi paus dan lumba-lumba, dan akan mendapat keuntungan dari kegiatan penelitian tambahan mengenai setasean, untuk membantu perencanaan pengelola sumberdaya, tindakan-tindakan konservasi dan alternatif mata pencaharian. Perluasan taman dan wilayah penyangganya telah diadopsi oleh pengelola sebagai cara untuk melindungi habitat yang disukai oleh setasean dan jalur migrasinya dan rencana pengelolaan 25 tahun saat ini sedang diimplementasikan.
Kata-kata kunci: setasean, kajian ekologis cepat, Taman Nasional Komodo

INTRODUCTION

The significance of cetacean surveys at Komodo National Park, Indonesia.

The waters of Komodo National Park (KNP) and adjacent areas include numerous coastal and marine habitats, and are characterised by strong currents, localised upwellings and a complex oceanography. KNP has exceptional tropical marine bio-diversity and recent coral reef and fish surveys conducted by The Nature Conservancy (TNC) have identified at least 250 species of scleractinian corals, 70 species of sponges, over 900 species of fish and several species of marine turtles and mammals (TNC, 1997). Its World Heritage Area status reiterates the importance to "ensure the identification, protection, conservation, presentation and transmission of world heritage values to future generations" (UNESCO, 1972).

No detailed studies have been done in these waters on cetacean species diversity, abundance and distribution. A review of cetaceans sighted in Indonesian waters includes 29 species and regards the occurrence of three species as unconfirmed (Rudolph *et al.*, 1997). Data on cetacean species diversity, abundance and distribution is especially important when considering the region's complex oceanography. Indonesia is uniquely located as the only equatorial region worldwide where inter-oceanic exchange of marine flora and fauna occurs (e.g. Tomascik *et al*., 1997). Cetacean movements between the tropical Pacific and Indian Oceans can occur through the passages between the Lesser Sunda Islands which span over 900 km between the Sunda and Sahul shelves (Klinowska, 1991).

The ecological significance of these passages remains poorly understood, yet their importance as whale and dolphin migration corridors has been identified (PHPA, 1984). Migratory cetaceans which include these passages in their local or long-range movements are vulnerable to numerous regional and local environmental impacts such as habitat destruction, subsurface noise disturbances, net entanglement, marine pollution and over fishing of marine resources (Hofman, 1995). Most, if not all, of these impacts may occur in the waters of Komodo National Park. These impacts would affect residential populations as well as transient species that include these waters in their long-range movements.

Cetaceans are long-lived marine mammals dependent on the long-term health of marine resources. Their ecology, longevity, mobility and sensitivity to disturbances make cetaceans appropriate indicators for acute as well as chronic marine environmental impacts.

It is important to conduct periodic visual and acoustic cetacean surveys in Komodo National Park and adjacent waters in order to:

1. To provide data on cetacean diversity, distribution and abundance in all marine habitats of Komodo National Park (KNP). The survey's marine habitat foci include:
   i. Coastal habitats of KNP to monitor the presence of vulnerable coastal cetaceans.
   ii. Inter-island straits and deep channels of KNP to examine their significance as migration corridors for wide-ranging migratory cetaceans occurring in eastern Indonesian waters.
   iii. Oceanic areas to the north and south of KNP to monitor the presence of oceanic cetaceans.
2. To monitor seasonal patterns in KNP cetacean diversity, distribution and abundance.
3. To identify sensitive marine areas for cetaceans, including preferred feeding grounds, mating locations and migration corridors.
4. To identify regional marine environmental impacts affecting KNP cetaceans.
5. To provide site and species-specific information on KNP cetaceans for:
   i. Marine resource and park management purposes.
   ii. Environmental awareness and educational programs.
6. To establish community-based cetacean monitoring programs through the active participation of management agencies and stakeholders including:
   i. TNC-Komodo Field Office staff
   ii. Balai Taman Nasional Komodo rangers
   iii. Komodo National Park dive operators.

Previous cetacean sightings in Komodo National Park and adjacent waters.

The oldest recorded sightings of cetaceans in the Komodo region were made during the 19th Century by the Yankee whalers who sailed through these waters to the Sulu and Celebes Sea whaling grounds. These records show that sperm whales (*Physeter macrocephalus*) were sighted year round and caught occasionally in the Komodo region (Townsend, 1935).

Recent reports on Komodo cetaceans are scarce. A review of Indonesian cetaceans (which included both historical information and more recent sightings) listed a total of five species (Rudolph *et al.,* 1997) for this region. Another noteworthy report mentions that the endangered blue whale (*Balaenoptera musculus*) has been sighted year round in Komodo waters, with a peak abundance in April-May (IUCN/UNEP, 1988).

The initial cetacean survey in May 1999 was the first of this kind in the area. The surveys identified additional rare species (e.g. *Kogia, Pseudorca*) which were not previously reported in the area (Kahn, 1999). The group composition of several of species sighted, such as the bottlenosed dolphin (*Tursiops truncatus*) and melon-headed whale (*Peponocephala electra*), included newborn calves. This initial survey indicated that the KNP area warranted additional attention as a relatively diverse cetacean habitat. The survey efforts during the October intermonsoon period were scheduled

to provide comparable data to the previous survey, maximise the probability of mysticete (baleen whale) sightings and obtain data on the area's ecological significance for both resident and migratory cetaceans.

SURVEY METHODS AND RESEARCH ACTIVITIES

The methodologies involved in this program have been specifically designed to cause minimal disturbance to cetaceans while allowing for discrete and close observations. These procedures have been extensively trialed in Indonesian waters

Survey method I: TNC speedboats.

The majority of the visual and acoustic cetacean surveys were carried out from a 25-foot TNC Yamaha speedboat cruising at 16-18 knots. This survey focused on the coastal areas, bays and inter-island passages of KNP. While underway a minimum of two experienced observers conducted visual surveys of the surroundings waters. Once cetaceans were sighted, the vessel's course and speed were adjusted to allow for a discreet approach and close observation. Whenever possible a positive species identification (ID) was made. Unidentified cetacean encounters were also recorded. These were usually the result of unfavourable light conditions, sea state, lack of proximity or active avoidance behaviour.

Time, sea surface conditions, GPS location, group size and presence of newborn calves, minimum distance from vessel, direction of travel and eight selected behaviours were recorded on standardised, waterproof data sheets (Appendix I). After the ID and recordings, the vessel departed from the sighting area at reduced speed and resumed with the predetermined survey route.

During offshore routes the visual surveys were complimented by periodical acoustic listening stations using a directional Vemco custom VHLF hydrophone with audio amplifier. Acoustic surveys were only conducted if the vessel was located 4 or more nautical miles offshore to minimise any coastal interference. Listening stations were conducted every 30 minutes, or approximately 7-8 nautical miles apart depending on off-shore conditions. The survey would commence in the early morning departing from The Nature Conservancy (TNC) Komodo Field Office in Labuan Bajo, Flores, Nusa Tenggara Timor and returned before sunset each day. On one occasion an overnight stop was made at Wenci Ranger Station, KNP, to increase the speed boat survey effort for Selat Linta and Selat Sape, which are the major deep-water passages between Sumbawa and Flores.

Survey method II - Local live-aboard vessels.

Visual and acoustic cetacean surveys were also carried out from two local live-aboard vessels, in order to increase coverage to remote areas and allow the surveys to continue during less optimal weather conditions. The data collection procedures did not differ between survey methods. The vessel speed averaged 6-7 knots and visual range was increased by the regular use of binoculars and increased observer height. The majority of the acoustic surveys were conducted while on-board the live-aboard vessels. Listening stations were conducted more than 4 nautical miles (nm) off-shore to minimise disturbance and spaced approximately 6 nm apart. The live-aboard survey effort focused on the waters adjacent to KNP, such as the productive region north of Komodo, Banta and San Geang, as well as the Flores and Sumba Seas. Unseasonally strong southerly winds and high seas in May meant this last area was surveyed during the October period only.

RESULTS AND DISCUSSION

Because of the limited time scale of the cetacean rapid ecological assessment (REA) in Komodo waters and the challenging nature of studying living cetaceans, the results described in this report are largely descriptive. Comparative analyses will be conducted once the two intermonsoon KNP cetacean survey periods in 2000 have been completed and seasonal and annual variations in cetacean ecological parameters can be examined. Sensitive marine areas for cetaceans within KNP will also be evaluated upon completion of the 2000 surveys.

Visual survey effort.

The results of the visual and acoustic cetacean surveys conducted in KNP and adjacent waters can be found in Tables 1 and 2 respectively. Surveys were conducted from 16-26 May and 11-28 October 1999. In total, 14 cetacean species were identified (Table 2c). The survey effort comprised of 26 field days and totaled 207 active survey hours. The surveys covered an estimated 1443 nautical mile (nm). The 14 species positively identified during 92 encounters were predominantly toothed whales and dolphins (Suborder Odontoceti), although during the October period rorqual whales (*Balaenoptera sp.*, Suborder Mysticeti) were observed frequenting the Gili Mota area on three occasions. This was the only area where baleen whales were encountered in 1999. An estimated total of 2423 individual cetaceans were sighted at sea. A detailed summary of survey effort for both methods and field periods is provided (Table 2).

Acoustic survey effort.

The acoustic survey included 93 hydrophone listening stations. It is estimated that a single station without any land interference and clear 360^{o} reception realistically surveys 63 nm^2 - o^{2}x the estimated acoustic radius of 6.5 nm. The acoustic survey covered an

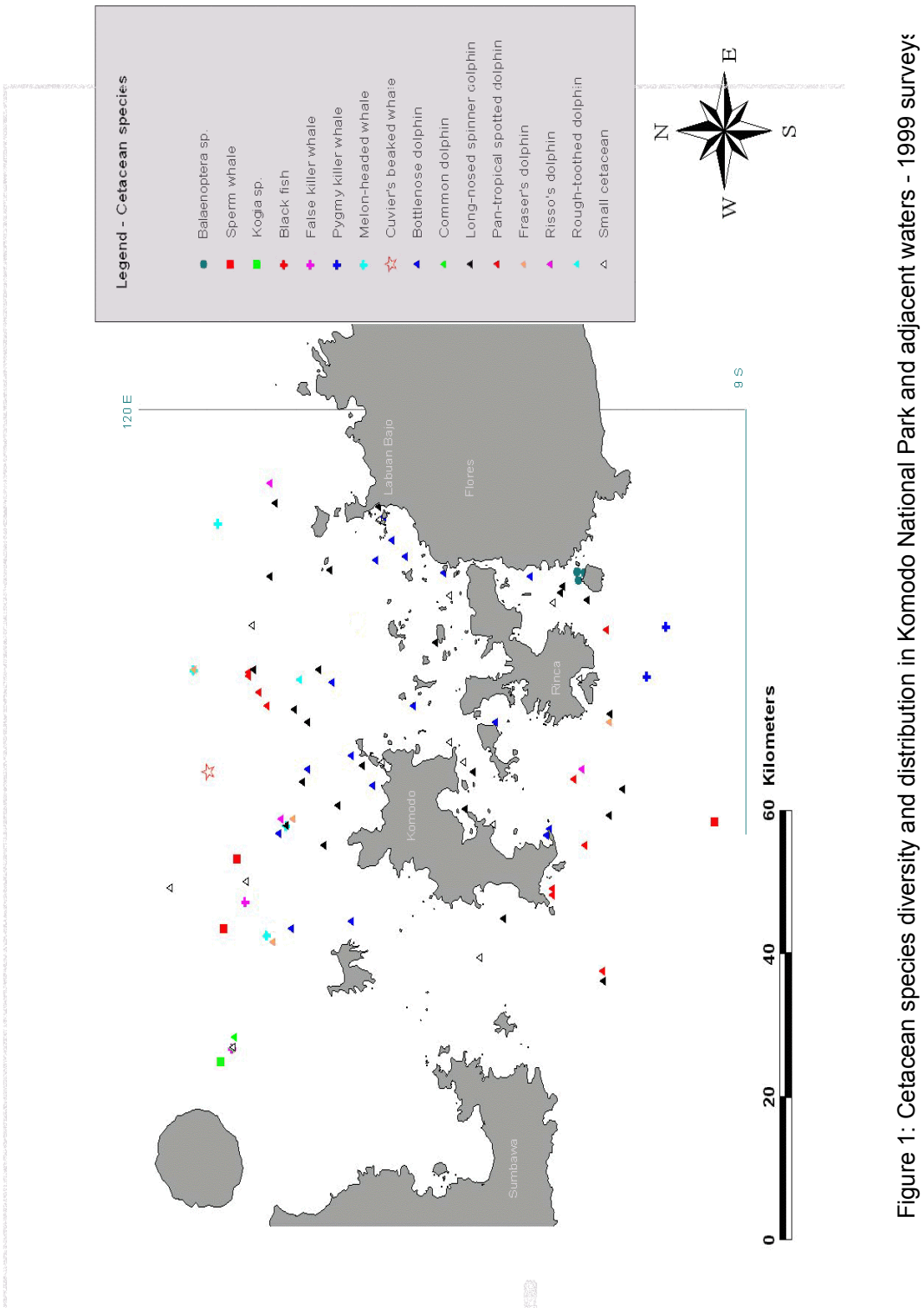

Figure 1: Cetacean species diversity and distribution in Komodo National Park and adjacent waters - 1999 surveys

Table 1: Certacean species positively identified in Komodo National Park (KNP) and adjacent waters of the Flores Sea and Sumba Strait, Indonesia.

Species		Status [1]	Indonesian name	Flores name [2]
1. Sperm whale	*Physeter macrocephalus*	V	Paus sperma	Kote kelema
2. Pygmy of dwarf sperm whale[3]	*Kogia sp.*	N	Paus sperma kerdil or cebol	Fefa kumu
3. False killer whale	*Pseudorca crassidens*	N	Paus pembunuh palsu	Temu blã
4. Pygmy killer whale	*Feresa attenuata*	D	Paus pembunuh kerdil	Temu kebung
5. Melon-headed whale	*Peponocephala electra*	N	Paus kepala semngka	Temu kebong
6. Spinner dolphin	*Stenella longirostris*	L	Lumba-lumba paruh panjang	Temu kirã
7. Pan-tropical spotted dolphin	*Stenella attenuata*	L	Lumba-lumba totol	Temu kirã
8. Rough-toothed dolphin	*Steno bredanensis*	D	Lumba-lumba gigi kasar	n/a
9. Risso's dolphin	*Grampus griseus*	D	Lumba-lumba abu-abu	Temu bura
10. Bottlenose dolphin	*Tursiops truncatus*	D	Lumba-lumba hidung botol	n/a
11. Common dolphin[3]	*Delphinus sp.*	N	n/a	n/a
12. Fraser's dolphin	*Lagenodelphis hosei*	D	Lumba-lumba Fraser	Temu notong
13. Cuvier's beaked whale	*Ziphius cavirostris*	D	Paus paruh Cuvier	Ika mea
14. Rorqual whale[3]	*Balaenoptera sp.*	D	n/a	n/a
15. Bryde's whale[4]	*Balaenoptera edeni*	D	Paus Bryde	n/a
16. Sei whale[4]	*Balaenoptera borealis*	E	Paus Sei	n/a
17. Blue whale[5]	*Balaenoptera musculus*	E	Paus biru	Lelanggaji

1. Status – IUCN status categories of threat. (Ex-Extinct; E-Endangered; V-Vulnerable; R-Rare: I-Intermediate; L-Lower Risk; Deficient; N-Not Evaluated; as defined in Anonymous, 1996)
2. Flores ID – As reported by Rudolph *et al* (1997).
3. Cetacean species sighted during the TNC cetacean surveys for which no positive identification could be made. The two *Kogia* two of the three *Delphinus* sp., have similar appearances, distribution and behaviours and are difficult to distinguish at sea un circumstances. These species are, however, very distinct from all other cetaceans are
   Therefore included in the cetacean species list.
4. Additional cetacean species positively identified by Rudolph *et al* (1997) in Komodo waters.
5. Additional cetacean species positively identified by Anonymous (1988) in Komodo waters.

Table 2a: KNP cetacean visual survey summary for the May 1999 period.

KNP Cetacean Visual Survey 16-26 May 1999	Survey method 1	Survey method 2	Survey May
Total no. of days surveyed	6	5	11
Survey effort (hrs)	42	48	90
Estimated area surveyed (nm)	450	225	675
Cetacean identification encounters	7	12	19
Estimated number of cetaceans	174	218	392
Cetacean species identified	2	6	7

Table 2b: KNP cetacean visual survey summary for the October 1999 period.

KNP Cetacean Visual Survey 11-28 October 1999	Survey method 1	Survey method 2	Survey October
Total no. of days surveyed	8	7	15
Survey effort (hrs)	57	60	117
Estimated area surveyed (nm)	518	250	768
Cetacean identification encounters	47	26	73
Estimated number of cetaceans surveyed	1563	468	2031
Cetacean species identified	10	9	12

Table 2c: KNP cetacean visual survey summary for the May - October 1999 periods combined.

KNP Cetacean Visual Survey May-October 1999 combined	May-99	Oct-99	Total 1999
Total no. of days surveyed	11	15	26
Survey effort (hrs)	90	117	207
Estimated area surveyed (nm)	675	768	1443
Cetacean identification encounters	19	73	92
Estimated number of cetaceans surveyed	392	2031	2423
Cetacean species identified	7	12	14

Survey method 1 - The Nature Conservancy speedboats
Survey method 2 - Local live-aboard vessels

Table 3: KNP Cetacean Acoustic Survey summary for the May - October 1999 periods combined.

KNP Cetacean Acoustic Survey	May-99	Oct-99	Total 1999
Listening stations	42	51	93
Cetacean acoustic contacts	9	18	27
Acoustic encounter rate (%)	21.5	35.3	29.0
Area covered (nm^2)	2670	3242	5912

Table 4: Sighting categories and allocated symbols.

Category	Symbol
1. Sub-order Mysticeti - baleen whales	
2. Families Physeteridea and Kogiidae - sperm whales	
3. Family Ziphiidae - beaked whales	
4. Blackfish - a historical name for six Globicephalid dolphin species.	
5. Other dolphins - Family Delphinidae	
6. Unidentified small cetacean ([6 metre)	
7. Unidentified large cetacean (> 6 metre)	

estimated 5912 nm^2 in all. Acoustic contact with cetaceans was recorded during 29% of the listening stations (Table 3). The acoustic radius has been estimated and calibrated numerous times by cross-checking audible underwater vessel noise and coastal interference with radar positions and GPS distances in various weather conditions.

The acoustic surveys confirm the relatively high abundance of cetaceans in these waters. Acoustic surveys are more effective than visual methods when detecting the presence of deep diving cetaceans with short surface intervals and often have an increased range when compared to visual surveys. The surveys have combined these methods where possible, resulting in a comprehensive search effort. Subsequent acoustic survey data will also be valuable for comparisons between different regions and seasons.

Cetacean species diversity and distribution.

The species diversity of the region appears to be relatively high. By conducting a relatively limited survey effort in the two intermonsoon periods, close to half of all cetacean species known to occur in Indonesian waters have been positively identified. The species identified during the rapid ecological assessment are listed in Table 1, as well as their IUCN conservation status, Indonesian and regional (Flores) names.

To analyse the positions of cetacean encounters and identify potential sensitive marine areas for cetaceans, all GPS cetacean encounter coordinates were transcribed to a global information system (GIS) format and assigned species-specific data points (Figure 1). The distribution of cetaceans shows the colour-coded distribution of 14 cetacean species. Sightings were categorised and allocated the following symbols (Table 4).

Members of the Family Delphinidae, especially the bottlenosed dolphin, *T.truncatus*, dominate the distribution of sightings within KNP borders. The offshore areas have a more diverse pattern. Numerous species of oceanic odontocetes are frequently encountered in this habitat, especially the long-nosed spinner dolphin, *S. longirostris* (Figure 1). The dominance in sighting frequencies and abundances of the two most common dolphins (*S.longirostris* and *T. truncatus*) shows that these species are able to adapt extremely well to a wide variety of marine environments, ranging from shallow turbid coastal waters to oceanic conditions. Other species may be more selective, or limited, in their preferred habitats and thus more vulnerable to disturbances and displacement.

During the extensive review of the high quality photographic slides and digital video images, field guides and literature, it became clear that the rorqual whales (*Balaenoptera sp.*) encountered off Gili Mota did not conform to any rorqual species' morphology published thus far. Rorqual whale morphologies (*Balaenoptera sp.*) in the Indo-Pacific, and especially South East Asia, are not well known. Several cetacean species from this region are described from skulls and occasional strandings and not in living detail. Other cetacean species in Australasia are being reviewed taxonomically and re-classified with additional (sub) species (e.g. Perrin *et al.*, 1996). Subsequent encounters within KNP borders during the April 2000 cetacean surveys have confirmed the unusual external features of this balaenopterid. High quality slide images and digital footage have been reviewed by several cetacean experts world wide, yet a positive identification remains difficult without genetic

Table 5. Species-specific data: Sighting frequencies, group sizes and visual search times (VST)

Species		Sightings (n)	Abundance category[1]	Estimated group size (SE)	VST (SE)
Long-nosed spinner dolphin	*S. longirostris*	27	A	3.50 (0.63)	28.4 (3.8)
Bottlenose dolphin	*T. truncatus*	18	C	5.57 (0.91)	8.4 (3.2)
Pan-tropical spotted dolphin	*S. attenuata*	11	C	8.29 (2.80)	100 (29.7)
Melon-headed whale	*P. electra*	4	U	7.13 (4.14)	57.5 (43.7)
Rorqual whale	*Balaenoptera sp.*	3	U	12.25 (4.26)	2 (–)
Sperm whale	*P. macrocephalus*	3	U	13.63 (8.52)	6.3 (2.7)
Risso's dolphin	*G. griseus*	3	U	14.54 (2.11)	8 (1.2)
Fraser's dolphin	*L. hosei*	3	U	18.93 (7.55)	19.3 (3.1)
Pygmy killer whale	*F. attenuata*	2	R	n/a	13.5 (2.1)
Pygmy/dwarf sperm whale	*Kogia sp.*	1	R	n/a	1 (–)
False killer whale	*P. crassidens*	2	R	n/a	2 (–)
Common dolphin	*D. delphis*	1	R	n/a	1 (–)
Rough-toothed dolphin	*S. bredanensis*	1	R	n/a	1 (–)
Cuvier's beaked whale	*Z. cavirostris*	1	R	n/a	2 (–)

1. Abundance category definitions: Abundant n µ20; Common 10[n >20; Uncommon 3[n >9; Rare n < 2

Table 6. Abundance categories and signting frequency

Abundance category		Sighting frequency (n)
Abundant	(A)	n > 20
Common	(C)	10 < n < 20
Uncommon	(U)	3 < n < 9
Rare	(R)	n < 2

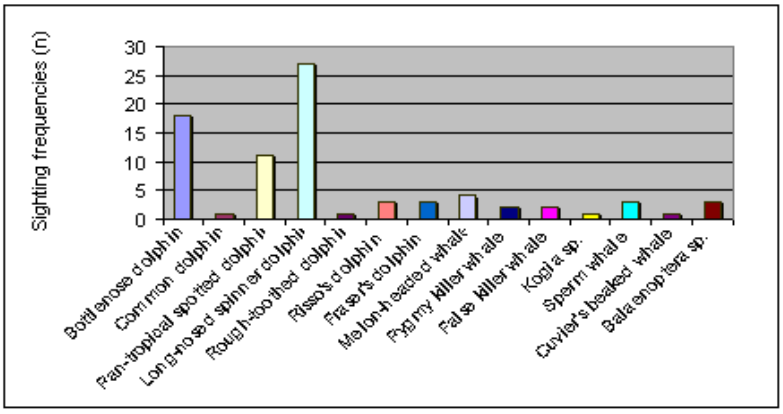

Figure 2. Species-specific sighting frequencies of cetaceans encountered in Komodo National Park and adjacent waters

samples and comparative DNA analysis (Kahn, 2000).

Species-specific data: Sighting frequencies, group sizes, calving rates and visual search times.

Sighting frequencies.

Of the estimated 2423 cetaceans seen and 14 species identified, only one dolphin species (*S.longirostris)* was classified as locally abundant (Table 4). Two species were considered common (*T. truncatus; S.attenuata,*), five uncommon (*P.electra; Balaenoptera sp.; P. macrocephalus; G.griseus; L.hosei*), and the remaining six species were considered rare (*Kogia sp.; P. crassidens; F. attenuata; D. delphis; S. bredanensis; Z. cavirostris* - Table 4). The abundance categories were defined by sighting frequency (Table 6).

These estimated local abundances were also confirmed by the visual search times as calculated for eight cetacean species (Table 4). All species-specific sighting frequencies of positively identified cetacean encounters are shown in Figure 2. The relatively high sighting frequency of *S.longirostris, S. attenuata, T. truncatus and P. electra* during both 1999 survey periods indicates KNP may inhabit residential populations of these species at least.

Group sizes and composition.

The mean group size (and standard errors) was calculated for all cetacean species encountered (Figure 3, Table 4). This data accurately reflects the known sociality of the species most frequently encountered. More detailed group compositions are hard to examine without more intrusive techniques such as biopsy darting. The most realistic source for group composition data in the KNP area would be from a (mass) stranding event in the area.

Although strandings are a rare occurrence in KNP, with the additional Balai Nasional Park Rangers and TNC-KFO Monitoring Staff involved in the cetacean sighting program, any stranding would have a good chance of being recorded and sampled. Data on species identification, health status, individual sizes and sex should be recorded together with photographic material illustrating the external characteristics of the animals.

Calving rates.

The presence or absence of calves was recorded for most encounters. Calves are defined as newborn depending on their size and behaviour. Newborn calves are estimated to be less than 6-12 months old. Calves were observed for seven dolphin species and the sperm whale, indicating the KNP region may be an important cetacean calving and breeding ground. No mating was observed, but for most species this takes place shortly after the birth of a single calf (e.g. Simmonds and Hutchinson, 1996). The estimated calving rates should be considered preliminary and interpreted with caution (Table 5).

Initial visual search times (IVST).

For each field day, the active visual survey time (hours) prior to the first cetacean encountered was recorded as the initial visual search time (IVST). IVST sightings did not need to result in positive identifications. Mean IVST of both survey methods and seasons were compared (Table 6). IVST did not differ significantly between season (t-test, p=0.08) or survey method (t-test, p=0.13).

Table 7: Estimated calving rates for eight Komodo National Park cetacean species.

	Species		Number of calves (C)	Total estimated abundance (A)	Calving rate[1]
1	Pan tropical spinner dolphin	*S. attenuata*	20	1100	0.019
2	Long-nosed spinner dolphin	*S.longirostris*	15	768	0.020
3	Bottlenosed dolphin	*T.truncatus*	4	151	0.027
4	Fraser's dolphin	*L.hosei*	3	58	0.055
5	Sperm whale	*P.macrocephalus*	3	19	0.188
6	Melon-headed whale	*P. electra*	3	230	0.013
7	Risso's dolphin	*G.griseus*	2	24	0.091
8	Pygmy killer whale	*F.attenuata*	1	27	0.038

1 - The estimated calving rate is calculated as C/(A-C).

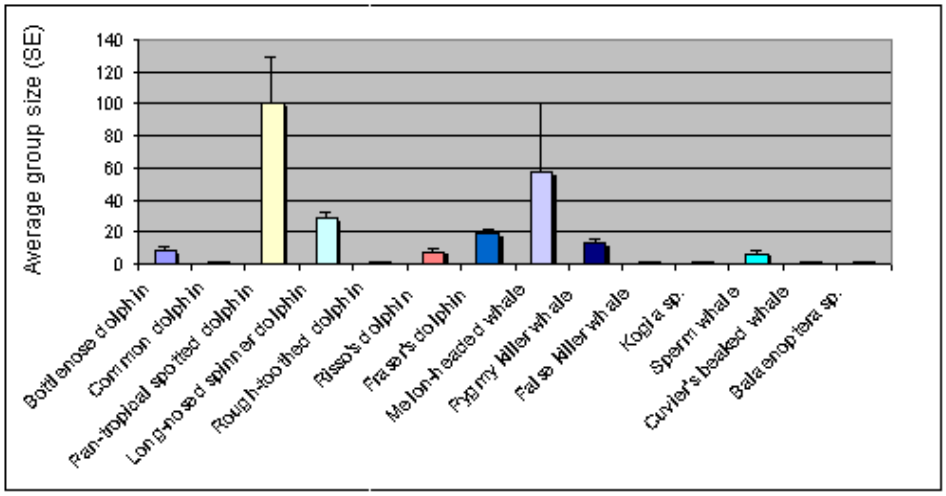

Figure 3. Average group sizes of cetacean species identified in Komodo National Park and adjacent waters

Table 8: t-Test results for seasonality and survey method (SM) in visual search times for the initial cetacean sighting made each survey day (IVST).

	May-99	Oct-99	SM1	SM2
IVST (hrs)	2.47	1.29	1.38	2.80
Observations (n)	11	15	14	12
Variance	5.68	2.17	2.11	5.7
p	0.08		0.13	
Significance (p<0.05)	No		No	

Species - specific visual search times (VST).

For those cetacean species encountered more than two times (nm3), a species-specific visual search time (VST) was calculated. VST could be calculated by recording the search effort in hours between sightings of the same species. VST is defined as the mean of all species-specific sighting intervals as corrected for active survey hours and survey method. The equation is

$$VST = \Sigma\{ (\Delta t_{1\text{-}2 \text{ species A}}) - \text{inactive survey time } \Delta t_{1\text{-}2 \text{ species A}} \} / n_{\text{species A}}$$

$\Delta t_{1\text{-}2 \text{ species A}}$ = the survey time (hrs) between two subsequent encounters with species A.

inactive survey time = the at sea spend (hrs) on other activities such as prolonged encounters with other species and operational pauses

$n_{\text{species A}}$ = the total number of encounters with species A over the survey period (VST could be calculated for species with n(3 only)

To calculate VST, the data from different survey methods was pooled in order to obtain the maximum comparable observations. This calibration was equated by comparing the visual search times of the two methods on the two most common species - *S.longirostris and T.truncatus*. The VST for both species proved highly consistent between survey methods (Table 7). The search time calibration from survey method two (local live-aboard) to method one (TNC speedboat) was calculated to be 0.40 (±0.03). Although the data allowed for only a limited number of calibration sets (n=4), the low variance between calibration sets indicated the data will remain robust once converted. In addition, the estimated speed ratio of the different survey methods very closely approximates this index (6/16= 0.38).

Table 9: Visual search time conversion factor for the two most common cetaceans sighted in KNP and adjacent waters.

Species	Survey Period	SM1	SM2	Conversion Factor SM2-1
T.truncatus	Oct 1999	6.78	13.88	0.488473
T.truncatus	May-Oct 1999	6.37	15.61	0.408072
S.longirostris	Oct 1999	3.39	10.05	0.338308
S.longirostris	May-Oct 1999	3.42	9.07	0.374862
			Mean SM2-1 (SE):	0.40 (0.03)

SM1 - Survey method 1 (The Nature Conservancy speedboats)
SM2 - Survey method 2 (Local live-aboard vessels)

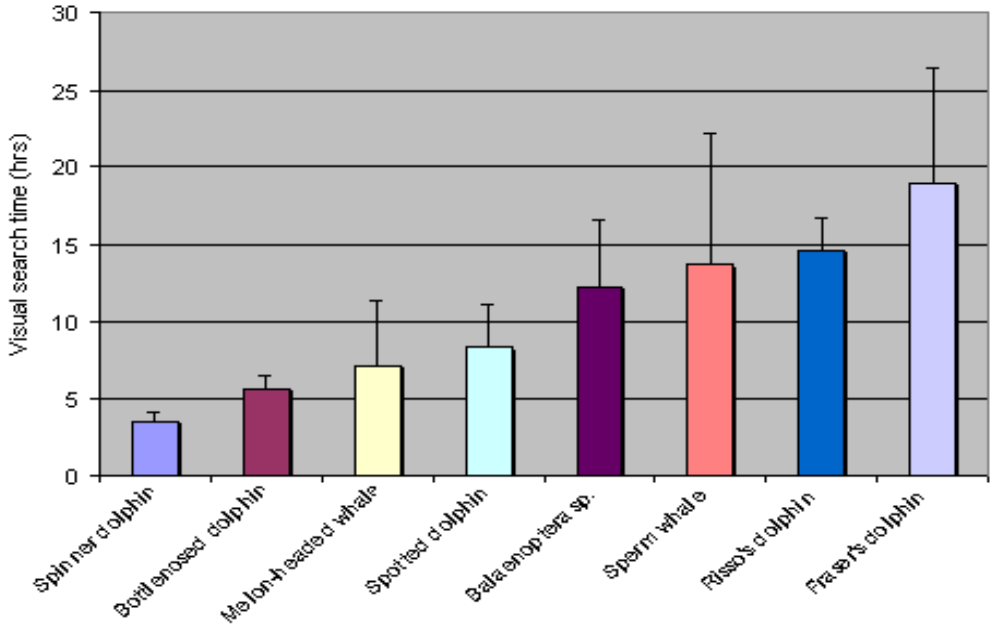

Figure 4. Species specific visual search times (SE) for Komodo National Park and adjacent waters - 1999 survey

Seasonality.

Information on the temporal and geographical variations in cetacean diversity and abundance are crucial to evaluating conservation measures, yet often require large data sets before any patterns can be identified (e.g Whitehead and Kahn, 1992). Seasonal fluctuations in KNP cetacean diversity distribution and abundance are especially difficult to quantify because of the absence of long-term observations. No detailed patterns were identified. Still, some general differences were evident for the two survey periods in 1999. Of the two periods, the October survey resulted in a marked increase in cetacean diversity, total encounters and overall estimated abundance (Table 2). This may be in part due to the increased survey effort, or the KNP area inhabited a more diverse cetacean community during this time. To what extend these results are confounded by search effort, or even short-term oceanographic fluctuations remains unclear. Additional survey efforts in 2000 will be necessary to further investigate these initial patterns in seasonality.

Species associations.

The survey results include numerous cetacean species associations. This is a fascinating aspect of cetacean ecology, yet the function of these associations remains poorly understood. A total of six odontocete cetacean associations have been recorded during the survey periods. The observations of these species association gives further indication that KNP is a valuable marine area for cetaceans.

Multi-species photo-identification of individual cetaceans.

One of the main long-term objectives of the rapid ecological assessment surveys is to investigate cetacean movements and habitat use within Komodo National

Park and its adjacent waters. This is necessary in order to develop ecologically-based conservation measures for management plans relevant to cetaceans and other large migratory marine life.

Information on cetacean movement patterns and habitat use is normally obtained by conducting multi-day visual and acoustic tracking surveys of particular pods of echolocating odontocetes, or by placing radio or satellite transmitter tags on individual animals of selected species. Non-invasive tagging of individual whales and dolphins can be best achieved by photographing the distinctive marks and colour patterns of numerous cetacean species. Reliable identification features for individual photo-identification studies have now been used for most baleen whales, sperm whales, pilot whales, several beaked whale species, as well as Risso's, spotted and bottlenose dolphins. Individual photo-identifications have been cataloged for the following KNP cetacean species: Bottlenose dolphin *T. truncatus,* Risso's dolphin *G. grampus,* rorqual whales *Balaenoptera sp.,* spotted dolphin *S. attenuata,* melon-headed whale *P. electra* and *s*perm whale *P. macrocephalus*.

These identifications are part of an Indonesian Cetacean Photographic Library, which includes cetaceans photographed in northern Sulawesi, the Sangihe-Talaud Archipelago, Bali, Lombok and Sumbawa. The long-term aim of the library is to confirm any re-sightings of previously photo-tagged individuals in the future. This will provide valuable resource management information on species' habitat preferences, local movement patterns and potential migration routes. In addition to the TNC Komodo Field Office staff and Balai Komodo National Park rangers, numerous dive operators have been approached to report cetacean sightings and assist with the photo-identification efforts of Indonesia's cetaceans. Interested individuals with possible identification photographs of Indonesian cetaceans are welcomed to contact the first author (BK).

Educational activities and the TNC Cetacean Monitoring Program.

Educational activities.

The survey's outreach activities include a Cetacean Monitoring Program for
The Nature Conservancy (TNC) field staff, Balai Taman Nasional Komodo rangers and dive tourism operators interested in cetacean ecology and ocean conservation.

This community involvement will ensure the program remains active between priority cetacean survey periods with continuous, real-time data recordings. This also facilitates information exchange between interested parties and fosters environmental awareness with TNC staff, KNP rangers, the nature-based tourism industry and local guides.

The education and environmental awareness activities conducted during the survey periods include:

i. Cetacean ecology and species identification slide seminars and videos for TNC staff, Komodo National Park rangers and interested parties.
ii. In-field cetacean identification training for TNC staff, Komodo National Park rangers and interested parties.
iii. Interviews with TNC staff and KNP Rangers to record details on previous cetacean sightings.
iv. Implementation of a voluntary cetacean sighting and monitoring program to TNC staff, as well as two interested live-aboard dive operations which frequent KNP and various remote marine areas of Nusa Tengara.
v. The distribution of information sheets, educational videos and illustrated reference books on the identification of cetaceans at sea.
vi. Additional training on data recording and use of standardised datasheets (Appendix I). These datasheets are also in use at other locations in Indonesia.

Cetacean sightings by TNC Komodo Field Office Staff and KNP Rangers.

Interviews with TNC personnel and KNP Rangers revealed that mysticetes (baleen whales) have been sighted within KNP, albeit infrequently. In some instances the same whales remained within KNP waters for several weeks, others were sighted only once. Most sightings occurred during the September-October inter monsoon period. No positive identifications were made by KNP Rangers. TNC staff also sighted numerous large cetaceans between 1995-1998, including rorqual whales (*Balaenoptera sp.*) in Selat Molo; sperm whales (*P. macrocephalus*) in Selat Sape; and a stranding of a large 15-20m unidentified mysticete at Rinca (J.Pet and A. Mulyadi pers.comm.).

The TNC Cetacean Monitoring Program is currently active. Sightings are to be reported to the cetacean monitoring coordinator of the Komodo Field Office in Labuan Bajo. The coordinator is to verify any positive identifications using the check lists, reference books and educational materials provided or by contacting the program's principal investigators. If there are *any* uncertainties on the positive species identification, then the encounter must recorded as 'unidentified cetacean'. Any guesswork, although done with the best of intentions, will greatly affect the accuracy of the data collected. This should be avoided at all costs. We hope that these monitoring activities will become incorporated into the daily routine of all marine monitoring personnel and boat crew interested. The enthusiasm shown thus far, and the growing experience of the staff involved, will surely result in valuable data on Indonesia's cetaceans throughout the year.

Tabel 10. KNP Cetacean Monitoring Program - Volunteer datasheet sample.

KNP Cetacean Monitoring Data Form		Vessel/Observer:					Sheet No:	
Date	**Time**	Lat (or Area)	Long (or Area)	**Species***	**Number***	**Distance* (m)**	**Record***	**Comments*- Calves; Behaviours**

Data Specifications:

Cetaceans are highly sensitive to visual and acoustic disturbances. All observations should be made discretely. Direct approaches and sudden changes in vessel speed and direction are to be avoided. An observation distance of 50m or more is recommended.

Species:	Please record the *species* identification (ID) of all cetaceans sighted. If ID is uncertain then refer to a generic name (e.g."dolphins").
Number:	The estimation of the total number of *individual* cetaceans in the pod, as seen on the surface.
Distance:	Note the estimated *distance* of cetaceans sighted (e.g. bowriding, 500m) and their travel *direction* (e.g.N, SE) when first sighted.
Record:	Whenever possible obtain ID photographs or video footage of cetaceans encountered. Please note the frame number/video counter.
Comments:	Include sightings of newborn calves, resting/active feeding/socialising/aerials, possible impacts and signs of disturbance.

Numerous dive operators have expressed interest in cetacean identification and are actively involved in a regional cetacean sighting program. The majority of operators have been briefed to identify those cetaceans frequently encountered at sea and to record this information on datasheets. Importantly, most contact persons responsible for data entry have experience with identifying cetaceans at sea. We are indeed fortunate that these motivated persons continue to monitor an extensive coastal area during their daily routes to and from dive sites. Once completed, the data sheets are faxed or e-mailed to the APEX Environmental office. Data are then verified, processed and become part of an Indonesian cetacean database. Numerous sightings have been reported covering an extensive marine area from Bali to Alor, northern Sulawesi, Papua Barat and Papua New Guinea. Operators or individuals with cetacean identification photographs or other relevant information are encouraged to contact the authors.

Increased marine education and environmental awareness, together with the conservation and enforcement measures currently implemented in KNP, are crucial for the future of Komodo's marine and terrestrial bio-diversity and the development of alternative, sustainable livelihoods alike.

Environmental threats to KNP cetaceans.

An overview of direct and indirect environmental threats to cetaceans can be found in numerous reviews (e.g. Hofman 1995) and include:

- Marine debris
- By-catch in commercial fisheries
- Noise pollution
- Food chain effects
- Diseases
- Oil and chemical spills

Of these the following are of particular relevance to cetaceans occurring in KNP and adjacent waters:

Marine debris and net entanglement.

On May 21, 1999 the survey identified a large marine area polluted with high concentrations of discarded plastics. The area affected was estimated to be 5-10 nm^2 and was located between 8^o13 S/119^o24 E and 8^o11 S/119^o31 E. Large quantities of plastic objects were seen, ranging from household wares to pellets, ropes, drums, large containers and bags. These items were distributed between the surface and approximately 20 metres deep.

Depending on the prevailing currents, this significant accumulation of plastic waste could have seriously affected KNP marine life and its remote beaches and coastal areas. At present, no effective waste disposal system for the KNP region including Labuan Bajo and Sape is available (Pet & Djohani, 1996), so it seems likely that at least part of the waste was locally produced.

On October 28, 1999, a 100m section of discarded long-line equipment was retrieved in open ocean south of Komodo Isl. (at approximately 8^o 53 S/ 119^o 25 E). Hooks and buoys were present and although this type of ghost net is relatively benign when compared to discarded gillnets, these nets continue to pose a serious threat to all large migratory marine life (e.g. Read, 1998). On all other survey routes the occurrence of marine debris was minimal.

Noise pollution related to destructive fishing practices.

On May 22, 1999 a total of seven bomb blasts were heard north of Labuan Bajo during two morning hydrophone listening stations of six minutes each (located at 8^o16S/119^o47E and 8^o16S/119^o53E respectively). No acoustic contact with cetaceans was recorded during these stations. The nearest point of land was eight nautical mile from these locations and no other vessels were sighted. Additional blasts, both within KNP borders, as along the southeast coast of Sumbawa, have been witnessed in 2000.

No direct studies on the effect of reef bombing on cetaceans have been published so far. However, research on effects of seismic and military tests indicate that the potential impact of bombing on these acoustically sensitive marine mammals could be extensive (Ketten, 1998).

Blasts or rapid onset sources are capable of inducing broad hearing losses in virtually all cetacean species. Blast injuries usually result from a single exposure with an explosive shock wave which has a sudden, massive pressure increase above ambient followed by a pressure decrease to well below ambient. Overpressures between 30 and 50 kPa are enough for a high incidence of severe blast injury. Acoustic traumas, at any one frequency, are highly species dependent and are a complex interaction of exposure time, signal characteristics, and intensity for a particular species at that frequency (Ketten, 1998). Generally, the smaller species are most sensitive to high frequency disturbances, whereas the larger whales are most disturbed by low frequency noise (Gordon and Moscrop, 1998).

Non-lethal reef blasting effects on cetaceans in the vicinity of the explosion site include:

- the permanent reduction of sensory capabilities
- the masking of important signals (including echolocation, intra-species communication, predator-prey interactions and other environmental cues)
- the disruption of important behaviours through startle and repellence
- the long-term abandonment of important habitats and
- the alteration of migration patterns.

These sub-lethal effects of reef blasting can have a profound impact on residential and migratory cetacean populations patterns (Ketten, 1998).

Apart from the negative effects on cetaceans, reef bombing is one of the major threats to reef ecosystems and sustainable reef fishing practices in Indonesia (e.g Djohani *et al.,* 1999). The acoustic detection of reef bombing activities may indicate that large scale monitoring of this illegal fishing activity in KNP can be done effectively by installing several hydrophone recorder units at strategic locations.

A constant acoustic monitoring presence in KNP could:

a) Quantify the practice of reef bombing in KNP and adjacent waters.
b) Effect a rapid enforcement response once a relay system to a shore-based monitoring station is operational.
c) Act as a deterrent by increasing the risk for fishermen to be caught while bombing KNP reefs.

Gill netting activities.

The apparent increase in the use of monofilament gill nets in the KNP area (J.Pet pers. comm.) could have a major impact on KNP cetaceans through entanglements in active and discarded fishing gear. This is likely to result in higher accidental cetacean deaths (Read, 1998). KNP cetaceans, as well as other large marine life in these waters, are especially vulnerable to net placements along the numerous inter-island passages and possible migration corridors. Such gill net placements could quickly result in high cetacean by-catch rates.

Potential long-term effects of destructive fishing activities near Nusa Tenggara migratory straits and passages.

The number of inter-island channels along the Nusa Tenggara island chain have been previously identified as important cetacean migration routes for numerous whale species, some rare and endangered (PHPA 1984). These passages are strictly limited in number. Displacement of migratory marine animals from a preferred passage would result in lengthy and unfamiliar alternative routes. For instance, if the KNP passages (Selat Sape, Selat Linta and Selat Molo) are avoided then the alternative migratory passages are several hundred kilometers away (i.e. the Sumbawa-Lombok Strait or the Flores-Alor passages). If these alternative passages are also subjected to similar levels of acoustic disturbance then the options for migratory cetaceans are even further diminished.

Ultimately, high levels of acoustic disturbance and inappropriate fishing methods (including gill and drift netting) in or near Indonesia's major passages could lead to the effective blockage of migratory routes, and the extirpation of vulnerable large migratory cetacean species. This would impact on the feeding ecology and mating systems of these long-lived marine mammals in eastern Indonesian seas. Such activities could even affect regional Indo-Pacific waters, as 'large scale biotic linkages mean that impacts can reverberate through geographically vast areas' (Agardy 1997) and is of special relevance to migratory cetaceans (e.g. Kahn *et al.,* 1993).

Increased protective management measures for KNP straits, and indeed all of Nusa Tenggara's major island passages, are crucial to the conservation of Indonesia's marine bio-diversity. Straits and passages should be considered as priority management units for species of special concern, such as those threatened or endangered, have important ecological roles, and those of cultural or commercial importance (Agardy, 1997).

Alternative livelihood options: Responsible cetacean watching potential in KNP.

To provide for sustainable alternative livelihoods is one of the main challenges to tropical marine conservation and an integral part of Indonesia's environmental issues. Environmentally sensitive marine tourism is widely viewed as a viable option to create economic and environmental sustainability as an alternative to resource depleting activities.

It appears likely that the current cetacean surveys and rapid ecological assessment will increase interest in commercial cetacean watching ventures in KNP. It is thus of interest that numerous international examples have illustrated that initial permit requests should be carefully considered; and if found appropriate for KNP, these activities should be strictly controlled with adequate management policies and enforcement measures in place from the start.

The basic prerequisites for responsible cetacean watching activities are:

1. Long-term consistency of cetacean sightings.
2. Controlled access to the targeted cetacean habitat.
3. High standards of environmental awareness of operators with a commitment to:

i. Minimal disturbance boat handling techniques.
ii. Periodic rest periods for target species.
iii. Specific training programs for staff.
iv. Educational commentaries and materials for clients.

4. Adequate management and enforcement of rules and regulations. Management issues to be addressed include but are not limited to:

i. Licensing and evaluation of permit requirements.
ii. The limit of the number of operators.
iii. The maximum number of vessels.
iv. The maximum number of clients per vessel.
v. Minimal approach distances and other strict operational guidelines and industry codes of conduct.
vi. Educational programs in cetacean ecology and

species identification for park managers, rangers and enforcement field staff.

vii. Environmental management charges or other initiatives to integrate marine conservation and tourism.

viii. Enforcement measures against the entry of illegal operators and regulatory breaches by permit holders.

ix. Logistics and economic costs of management requirements.

5. Marine environmental monitoring and cetacean research
   i. Monitoring of cetacean diversity, distribution and abundance, behaviours and responses to cetacean watching activities.
   ii. On-going surveys and ecological research on KNP cetaceans.

Relevance of regional cetacean surveys to coastal resource management and marine protected areas in Indonesia.

Cetaceans, as a guild of common species with a relatively high localised abundance, are increasingly recognised as a useful tool for marine conservation programs. Cetaceans have been identified as focal species for marine resource management and conservation (Lambert, 1997). In eastern Canada, for example, results from cetacean surveys have been instrumental in the establishment of a new marine protected area (Hooker *et al.,* 1999).

The on-going rapid ecological assessments of Komodo National Park cetaceans have identified a relative high cetacean diversity, abundance and extensive distribution within KNP borders and the adjacent waters of the Flores and Sumba Seas. The 1999 assessments indicate that the survey area supports a diverse community of whales and dolphins throughout the year. Sensitive marine areas for Indonesia's cetaceans are increasingly apparent as more data on resident and migratory species becomes available in 2000.

The cetacean survey program in Komodo National Park and adjacent waters has been implemented as an integral component of the current marine resources management strategy. Such a program is of direct relevance and broadens the protective management perspective for Komodo National Park and World Heritage Area.

The KNP protective measures for cetaceans as incorporated in the 25 year management plan include extensions of Park boundaries and cetacean migration buffer zones (Pet and Yeager, 2000). This is an important cetacean conservation strategy for Komodo National Park, but also when viewed from a regional perspective.

The Indo-Pacific, and the Eastern Indonesian region in particular, is considered the most bio-diverse ocean realm in the world. Indonesia's cetaceans, as highly effective and specialised predators, are an important component of this diversity and inhabit river, coastal and oceanic habitats. However, there is a considerable lack of scientific knowledge of relevance to marine resource management on the ecology of Indonesia's living cetaceans and this situation can only be improved by regional cetacean surveys.

Obtaining additional data on cetacean species diversity, distribution and abundance is especially important when considering Indonesia's location and complex regional oceanography. Indonesia is uniquely located as the only equatorial island nation where inter-oceanic exchange of marine flora and fauna occurs (e.g Tomascik *et al*., 1997). Cetacean movements between the tropical Pacific and Indian Oceans can occur through the Nusa Tenggara passages (PHPA, 1984; Klinowska, 1991; Kahn 2000). Because of this significant geographical location, there is an urgent need for additional protective measures for cetaceans in all seas under Indonesian jurisdiction.

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Jurnal PESISIR & LAUTAN

Indonesian Journal of Coastal and Marine Resources

Tujuan

- Meningkatkan kepedulian masyarakat luas terhadap manfaat dari pengelolaan sumberdaya pesisir dan lautan secara terpadu.
- Merangsang dialog di antara para praktisi dan pakar pengelolaan sumberdaya pesisir dan lautan.
- Membagi pengalaman dan pengetahuan di antara seluruh pemerhati masalah-masalah pengelolaan sumberdaya pesisir dan lautan.

Ruang Lingkup

Teknis, hukum, politik, sosial dan kebijakan yang berkaitan dengan pengelolaan sumberdaya pesisir dan lautan.

Sasaran Pembaca

Pejabat pemerintah dari seluruh tingkatan, kalangan akademik, para peneliti dan praktisi, serta berbagai kalangan pemerhati masalah-masalah pengelolaan sumberdaya pesisir dan lautan.

Format

- Makalah penelitian dan kajian kebijakan (tidak lebih dari 3.000 kata).
- Laporan singkat (menggunakan data yang lebih terbatas dan tidak lebih dari 1.500 kata).
- Artikel kajian (tidak lebih dari 8.000 kata).
- Komentar (opini tentang naskah yang telah diterbitkan dan berbagai macam isu lain yang sesuai dengan ruang lingkup jurnal, tidak lebih dari 1.000 kata).
- Resensi Buku.

Objectives

- Increase public's awareness of the benefits of integrated coastal and marine resources management.
- Stimulate dialogue between practitioners and scientific community.
- Share experience and learn lessons within the coastal and marine management community.

Scope

Technical, legal, political, social and policy that related to the management of coastal and marine resources.

Target Audience

Government officials at all levels, academics, researchers and practitioners involved in discipline of coastal and marine resources management.

Format

- Research and policy review papers (up to 3,000 words).
- Research notes (usually based upon more limited set of data and not exceeding 1,500 words).
- Topic review articles (not more than 8,000 words).
- Comments (opinions relating to previously published material and all issues relevant to the journal's objectives, not more than 1,000 words).
- Book review.

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