Nature-based Solutions (NbS) to Climate Change Adaptation and Disaster Risk Reduction in Indonesia Urban Areas

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Disampaikan pada PBAK Biologi

THEATER ROOM FST

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Why NbS to Climate Change Adaptation and Disaster Risk Reduction in Indonesia Urban Areas?

Karena Tema Semnas Bio 6 ini adalah Climate Change dan Dampaknya bagi keanekeragaman hayati→ dibahas dari sisi konsep dan teknologi apa yang dapat digunakan untuk mereduksi dampak Climate Change tsb diantaranya dengan Konsep Nature Base Solutions (NbS)

Kenalan dulu yuk!

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List of Content

General Impact and Consequences of Climate Change for Urban Areas :

1. Effect on Urban Temperatures

The urban climate itself is suggested to increase the heat stress experienced by people during periods of high temperature, particularly during the night, when the UHI is largest (Pascal et al. 2005). Studies suggest that there is an adaptation factor in relation to heat and that early-season heat waves or heat waves in regions where hot weather is infrequent have more negative consequences (Anderson and Bell 2011). This suggests that for parts of Indonesia that previously have not experienced periods with dangerously high temperatures people are less adapted to deal with the increase in temperature

General Impact and Consequences of Climate Change for Urban Areas in

2. Effect on Urban Hydrology

With a changing climate, the frequency of flood peaks is predicted to increase. Estimations point towards an average doubling of severe flood peaks with a return period of 100 years within Europe by 2045 (Alfieri et al. 2015). In addition, this is matched by a rise in sea level that, together with a predicted increase in windstorm frequency, will lead to an increase in coastal flooding (Nicholls 2004). As most of the urban areas within Europe are situated either on floodplains or along the coast, these two types of flooding will have a major impact on European cities. Climate-driven increasing sea levels in certain areas of Europe will also translate into more frequent basement flooding (Arnbjerg-Nielsen et al. 2013).

General Impact and Consequences of Climate Change for Urban Areas in

3. Indirect Effects on Urban Habitats and Biodiversity

1,2,3

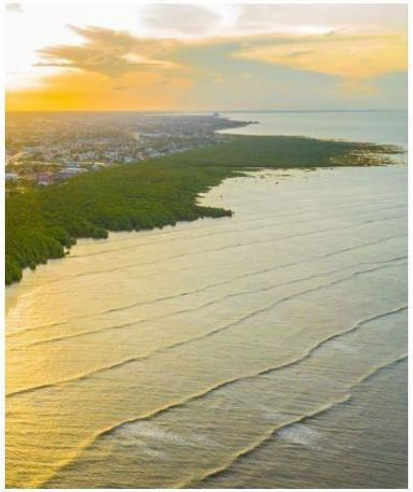
Climate Change Adaptation Possibilities Using Green Infrastructure and Nature-Based Solutions (NbS)

Climate change will influence several factors of importance to habitat quality and the development of urban biodiversity. The projected change in temperatures, rainfall, extreme events, and enhanced CO2 concentrations will influence a range of factors related to single species (e.g. physiology), population dynamics, species distribution patterns, species interactions, and ecosystem services, as a result of spatial or temporal reorganization (Bellard et al. 2012). Increasing urban temperatures and changed precipitation dynamics will influence species community development by limiting water availability during the growing season as well as changing the nutrient dynamics.

1.What are Nature-based Solutions (NbS)?

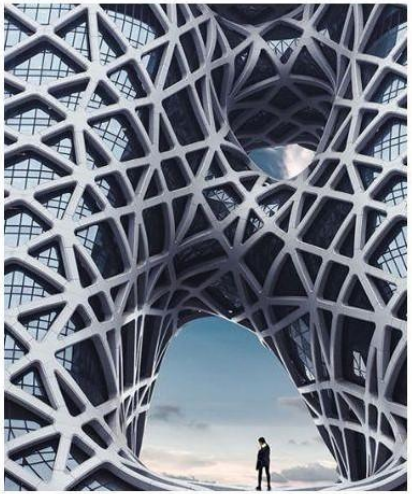
Nature-based Solutions are: *“actions to protect, sustainably manage and restore natural or modified ecosystems, that address societal challenges (e.g. climate change, food, and water security or natural disasters) effectively and adaptively, simultaneously providing human well-being and biodiversity benefits”*

- First used by the World Bank and IUCN in 2008/2009
- Above definition adopted by 1,400+ IUCN members at the IUCN Congress in Hawaii, USA in 2016 (Res. 69)
- Cited in 2000+ peer-reviewed articles in recent years
- Cited by IPCC and IPBES in 2021
- Incorporated in the UNEA resolution on NbS in 2022



Nature-based solutions

Nature-derived solutions



Nature-inspired solutions

> NbS are often described as 'no-regret' options, providing benefits to people in a range of scenarios

> Nature-based Solutions have a vitally important role to play in addressing both the causes and consequences of climate change

2.NbS for Climate Change Mitigation, Adaptation and Disaster Risk Reduction in Urban Areas

2.1 Introduction
2.1.1 Challenges of Climate Change in Cities
2.1.2 Risk and Vulnerability to People, Ecosystems and Infrastructures in Cities
2.1.3 The SETS Framework

2.2 Approaches to Reducing Risk and Overall Effects of Urban Climate Change
2.2.1 Grey Strategies
2.2.2 Green and Blue Infrastructures
2.2.3 Hybrid, Green-Grey Approaches,

2.3 Focusing on Key Urban Climate Challenges

2.3.1 Indonesia and Climate Change

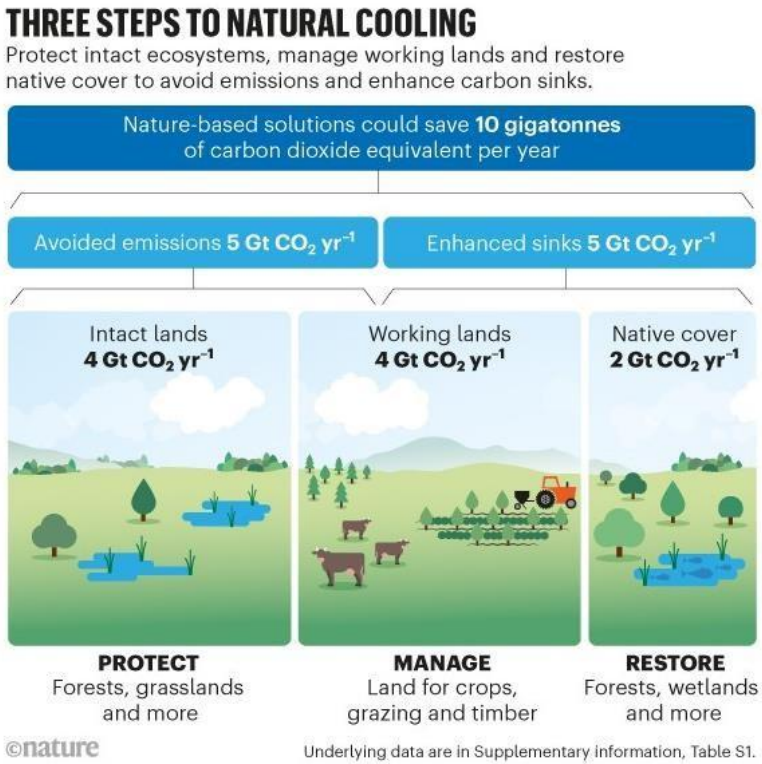
2.3.2 Surface and Coastal Flooding in Urban Area

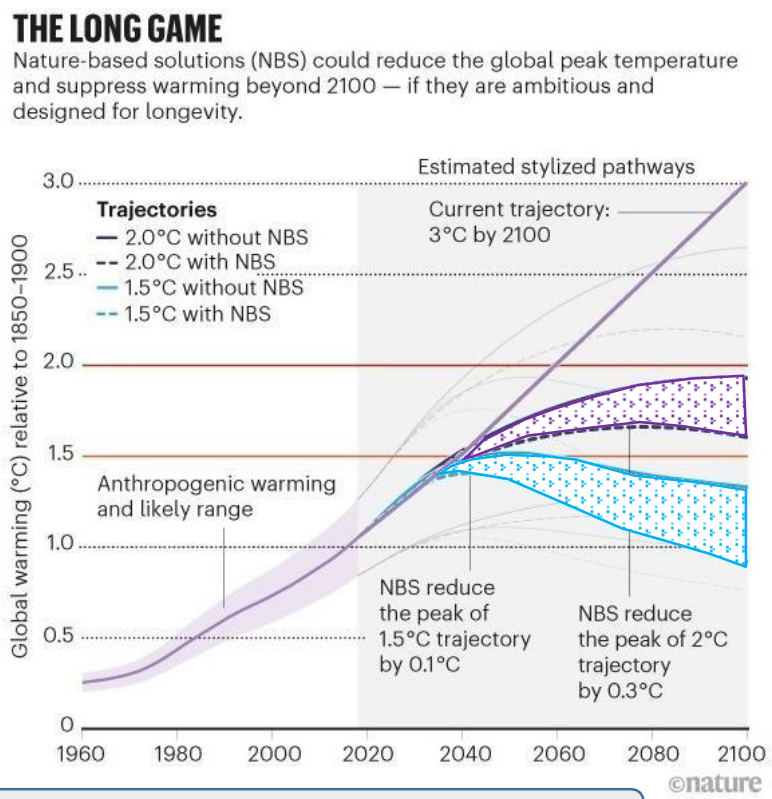
2.4 Discussion

2.4.1 Embrace Both Green and Grey Approaches

2.4.2 Urban SETS and the Importance of Bringing Together Engineering & Ecological Approaches

2. NbS for Climate Change Mitigation, Adaptation, and Disaster Risk Reduction





10 Gt CO_2 yr^{-1} is more than the emissions from the entire global transportation sector

Source: Cécile A. J. Girardin, Stuart Jenkins, Nathalie Seddon, Myles Allen, Simon L. Lewis, Charlotte E. Wheeler, Bronson W. Griscom & Yadvinder Malhi. 2021. 'Nature-based solutions can help cool the planet — if we act now', *Nature*, 12 May.

Nature-based Solutions are critical for achieving Net Zero

Net Zero by 2050

=

Ambitious Emissions Reductions (decarbonization of global economy)

+

Nature-based Solutions

(protect, manage & restore ecosystems)

- ***at least* 5 $GtCO_2e$/year at 2030** (max est: 11.7 $GtCO_2e$/year)
- ***at least* 10 $GtCO_2e$/year at 2050** (max est: 18 $GtCO_2e$/year)

- UNEP and IUCN (2021) Nature-based solutions for climate change mitigation

Mangroves → Coastal Resilience

- Mangroves provide over **$65 billion in flood protection**, and **safeguard 15 million people against flooding** per annum[1]
- Of all the world's ecosystems, mangroves are the **most effective per unit area at trapping and storing carbon**[2]

Green spaces → Urban Resilience

- Green spaces absorb **storm water run-off**, reduce **urban heat-island effect**, and lower **drought impacts** and **remove carbon**
- *Sponge City* – Xiamen, China
- *Green Cities, Clean Waters* – Philadelphia, USA

Wetlands helped to **avoid US$ 625 million** in direct flood damages during **Hurricane Sandy** in 2012[3]

3. What is the Urban Area? https://en.wikipedia.org/wiki/Urban_area#Definitions

Urban area

56 languages

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From Wikipedia, the free encyclopedia

"Built up area" redirects here. For the Highway Code, see Built-up area (Highway Code).
"Urban agglomeration" redirects here. For city clusters, see Megalopolis.

An **urban area**, **built-up area** or **urban agglomeration** is a human settlement with a high population density and an infrastructure of built environment. This is the core of a metropolitan statistical area in the United States, if it contains a population of more than 50,000.[1]

Greater Tokyo in Japan, the world's most populated urban area, with about 40 million inhabitants as of 2022

Urban areas originate through urbanization, and researchers categorize them as cities, towns, conurbations or suburbs. In urbanism, the term "urban area" contrasts to rural areas such as villages and hamlets; in urban sociology or urban anthropology it contrasts with natural environment.[*citation needed*]

The development of earlier predecessors of modern urban areas during the urban revolution of the 4th millennium BCE[2] led to the formation of human civilization

4. How is the implementation of NBS in Indonesia?

https://rimbamakmurutama.com/projects/katingan-mentaya-project/

Contoh Penerapan NBS di Indonesia

Salah satu penerapan NBS adalah Katingan Mentaya Project, sebuah proyek restorasi dan konservasi lahan gambut di Kalimantan Tengah, yang berlokasi di antara Sungai Katingan dan Sungai Mentaya. Proyek ini dikelola oleh PT Rimba Makmur Utama bersama Wetlands International, Yayasan Puter, dan Permian Global.

Inisiatif restorasi ekosistem RMU ini memandang hutan sebagai penghasil berbagai manfaat dengan menyelaraskan antara usaha kehutanan dan konservasi melalui pengelolaan bentang alam berbasis ekosistem. Pada prakteknya, KMP dibentuk sebagai usaha jasa lingkungan dengan memanfaatkan mekanisme perdagangan kredit karbon di pasar sukarela.

NBS: Melindungi Alam, Kesejahteraan dan Manusia

KMP dimulai 2007, dengan luas 157,875 ha mencakup hutan rawa gambut utuh terbesar di Asia Tenggara, KMP merupakan kegiatan konservasi terbesar di dunia ditinjau dari segi penurunan emisi karbonnya. Berdasarkan metode perhitungan karbon standar VCS dan CCB, kawasan ini menghasilkan rata-rata 7.5 juta per tahun atau penghindaran emisi ini setara dengan penghindaran emisi dari 2 juta mobil setiap tahun.

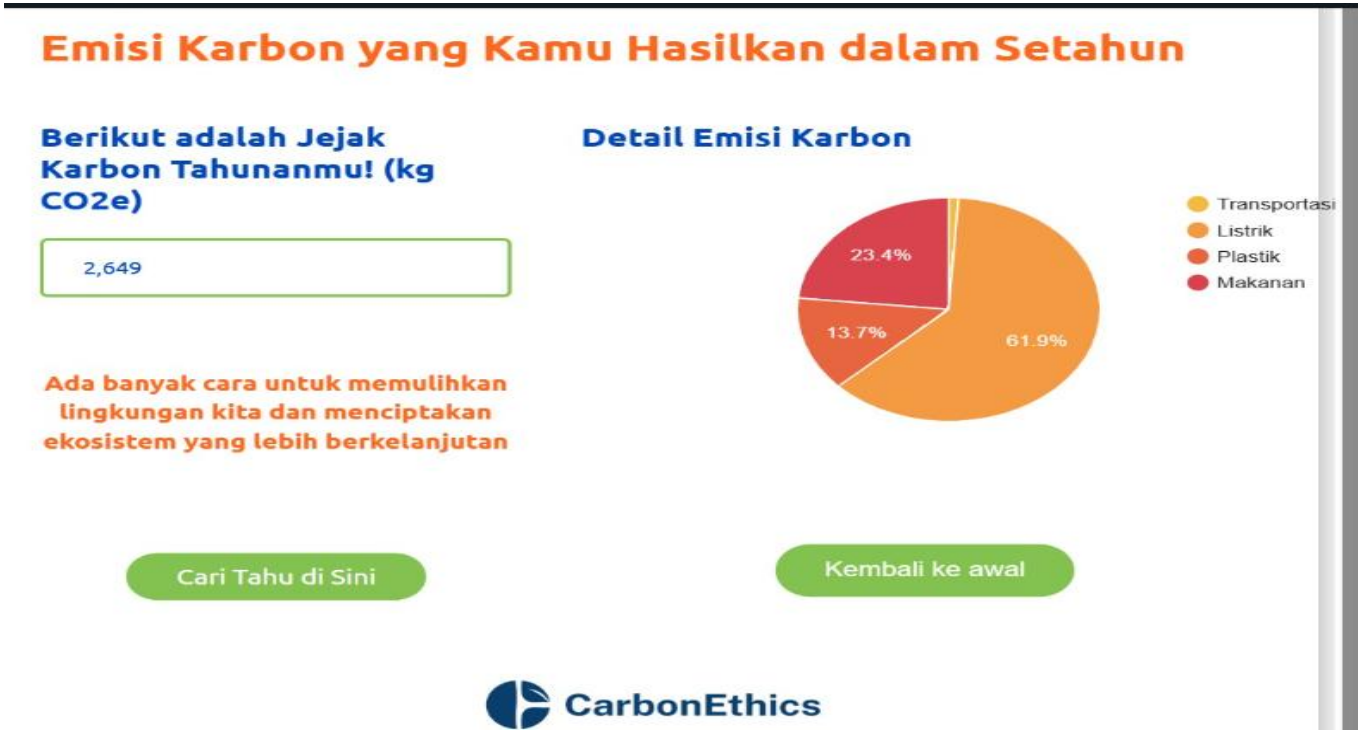
Dengan adanya pemasukan dari kredit karbon dalam KMP, maka RMU mampu membangun kemitraan dengan masyarakat, melakukan perlindungan terhadap ekosistem kawasan dan memenuhi biaya operasional perusahaan. Hal ini menjadi bukti bahwa **keseimbangan antara 3 dimensi pengelolaan yaitu: Ekologi, Sosial dan Ekonomi** mampu diimplementasikan dengan tetap sejalan dengan prinsip-prinsip Sustainable Development Goals (SDGs).

- Secara sosial, KMP aktif bermitra dengan masyarakat lokal untuk perubahan transformatif yakni seperti bermitra dengan 34 desa yang berbatasan langsung untuk mendorong peningkatan kapasitas masyarakat dan kemandirian.

- Secara ekologi, KMP telah melindungi ekosistem gambut yang penting, melindungi 5 spesies "*Critically Endangered*", 8 spesies "*Endangered*" dan 31 spesies "*Vulnerable*". Kawasan ini juga merupakan rumah bagi 10% dari populasi keseluruhan Bekantan, Orangutan dan Owa Kalimantan.

Kalkulator Karbon

Ikut Beraksi | Rimba Makmur Utama



Indonesia can lead the world in nature-based solutions for climate change

https://www.thejakartapost.com/opinion/2023/07/14/indonesia-can-lead-the-world-in-nature-based-solutions-for-climate-change.html

Jadi, apa Solusi Berbasis Alam lainnya yang bisa kita lakukan bersama?
Aksi nyata RMU dalam Katingan Mentaya Project adalah salah satu langkah penerapan NBS di Indonesia.

Menurut bapak ibu dan saudara sekalian, wilayah Indonesia bagian mana lagi yang perlu diterapkan Solusi Berbasis Alam ini?
Bagaimanapun, sebagai generasi penerus dunia, kita tidak boleh melihat alam sebagai ajang mencari keuntungan semata, melainkan, kita juga harus punya rasa tulus untuk menjaga alam.

5.Bentuk lain NbS terkait Climate Change dpat digunakan dalam Bidang Disaster yang sedang kami usulkan Bersama BRIN, ITB, UIN dan Japan.

HALAMAN PENGESAHAN
PROPOSAL KEGIATAN PENDANAAN
RISET DAN INOVASI UNTUK INDONESIA MAJU

Judul Proposal : PENGELOLAAN GARIS PANTAI AKIBAT GELOMBANG EKSTRIM (TROPICAL STORM DAN TSUNAMI) BERDASARKAN ATAS KONSEP NATURE BASED SULUTION (Studi kasus: PROVINSI LAMPUNG)

1. **Ketua Periset** :
   a. Nama Lengkap : Widodo Setyo Pranowo
   b. Jenis Kelamin : Pria
   c. NIP/NIK/KTP :
   d. Jabatan Struktural : -
   e. Jabatan Fungsional : Peneliti Utama Ahli
   f. Institusi Periset : Pusat Riset Iklim dan Atmosfer
   g. Alamat :
   h. HP/Telepon/Faks :
   i. Alamat Rumah :
   j. Telpon/Faks/Email :
2. **Mitra Riset** : ~~jurusan~~ Prodi **Teknik Kelautan, FTSL - ITB**
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3	Ir. Anthony Harli, M.Sc	-	PUPR
4	Dr. Erma Yulihastin		PRIMA BRIN
5	Dr. Albert Sulaiman	197004281998031003	PRIMA BRIN
6	Ir. Suaydhi, M.Sc		PRIMA BRIN

Solusi berbasis alam untuk pengelolaan pesisir meliputi:

- **meningkatkan struktur buatan manusia dengan fitur ekologis,**
- **meningkatkan habitat atau bentang pantai alamiah dan bukit pasir atau rawa rawa asin tempat tumbuhnya hutan mangrove dan burung bangau laut**.

Pengelolaan garis pantai berdasarkan NBS ini dapat memiliki manfaat:

- mengurangi risiko banjir rob,
- menciptakan habitat bagi satwa liar,
- melindungi simpanan karbon,
- menarik wisatawan untuk meningkatkan ekonomi lokal,
- dan menyediakan ruang rekreasi

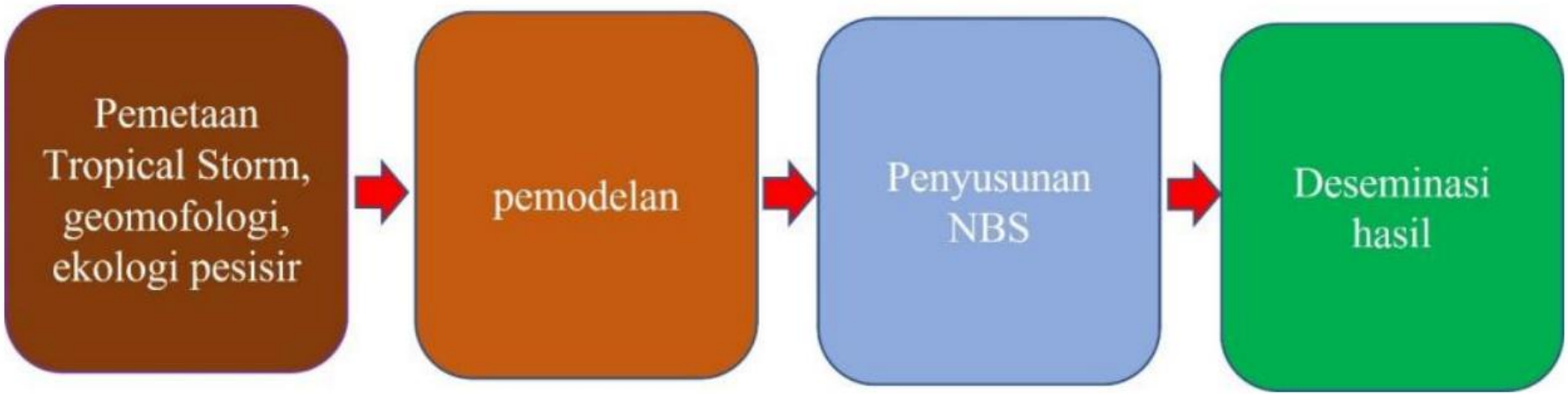
NbS menekankan rasa hormat prinsip kearifan lokal terhadap alam dan orang-orang yang bergantung pada sumber daya alam. NBS melakukan penilaian komprehensif terhadap teluk, bakau, pulau, dan lahan basah dari sistem laguna pesisir. Kondisi hidrologi, iklim gelombang, dan perubahan morfologi sepanjang garis pantai dipetakan untuk menjelaskan kerusakan lahan basah pesisir (Slinger et al 2021)

PENGELOLAAN GARIS PANTAI AKIBAT GELOMBANG EKSTRIM (TROPICAL STORM DAN TSUNAMI) BERDASARKAN ATAS KONSEP NATURE BASED SULUTION (Studi kasus: PROVINSI LAMPUNG)

PROPOSAL

RISET DAN INOVASI UNTUK INDONESIA MAJU

Road Map Nbs Perubahan Garis Pantai akibat Climate Change



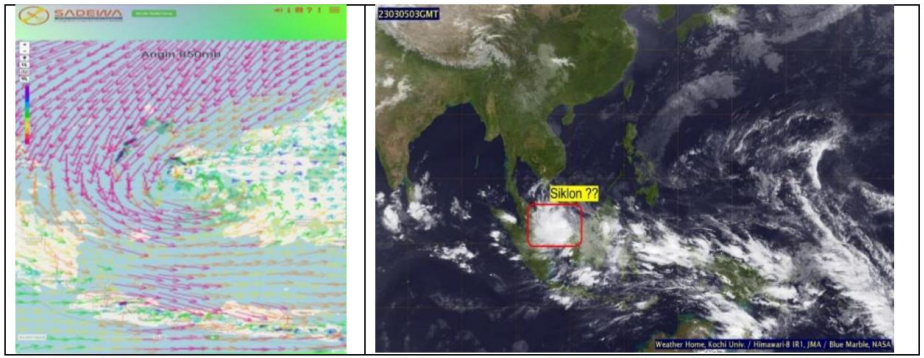
1. Model Pemetaan Badai Tropis di Perairan Indonesia

badai tetap terbentuk. Penelitian mekanisme garis badai akan dilakukan berdasarkan tiga persamaan simultan berikut (Rotuno et al 1988),

$$\frac{\partial \eta}{\partial t} + J(\psi, \eta) = -\frac{\partial b}{\partial x} + \nu\left(\frac{\partial^2 \eta}{\partial x^2} + \frac{\partial^2 \eta}{\partial z^2}\right) + F(x,z,t) \qquad (1)$$

$$\frac{\partial b}{\partial t} + J(\psi, b) = \kappa\left(\frac{\partial^2 b}{\partial x^2} + \frac{\partial^2 b}{\partial z^2}\right) + \Theta(x,z,t) \qquad (2)$$

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial z^2} = \eta \qquad (3)$$



Gambar-1. Tropical Storm yang terekam melalui system monitoring Sadewa dan citra satelit (weather-kochi.ac.jp.

dimana η adalah vortisitas, b adalah the buoyancy, ψ disebut the stream function yang zonal and vertical velocity sebagai $(u,w)=(\partial\psi/\partial z, -\partial\psi/\partial x)$, dan ν adalah viskositas kinematik, dan κ adalah konduktivtas termal atmosfer.

$$J(A,B) = \frac{\partial A}{\partial z}\frac{\partial B}{\partial x} - \frac{\partial A}{\partial x}\frac{\partial B}{\partial z} \qquad (4)$$

Ini adalah the Jacobian symbol. Gerombolan persamaan diatas akan dicari solusinya menggunakan transformasi Laplace untuk kasus linier dan *multiple scale expansion* untuk kasus nonlinier.

2. Pemodelan Gelombang Ekstrim Akibat Badai Tropis

penjalaran air multiarah. Pada kajian yang dilakukan tersebut, menggunakan modifikasi dari persamaan Kadomtsev-Petviashvili (KP). Perbaikan relasi dispersi pada persamaan KP standar menghasilkan persamaan *improved KP* (iKP) sebagai berikut,

$$\frac{\partial}{\partial x}\left(\frac{\partial \psi}{\partial t}+\frac{\partial}{\partial x}\left[\frac{\sqrt{\tanh(k)}}{k}\psi+\tfrac{3}{4}\psi^2\right]+\tfrac{1}{6}\frac{\partial^3\psi}{\partial x^3}\right)+\frac{1}{2}\frac{\partial^2\psi}{\partial y^2}=0 \qquad (5)$$

dengan ψ adalah fungsi gelombang. Persamaan linear iKP memiliki relasi dispersi

$$\omega=\Omega(k)=\sqrt{k\tanh(k)}+\tfrac{1}{2}\frac{l^2}{k^2}, \qquad l \square \ k \qquad \vec{k}=(k,l) \qquad (6)$$

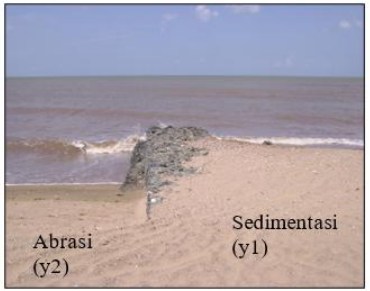
Beberapa persoalan yang akan kami selesaikan dalam kajian gelombang ekstrem multiarah adalah sebagai berikut:

- Formulasi selesaian paket gelombang untuk persamaan gelombang multi-arah, yaitu memperoleh formula ***persamaan NLS*** *(Non Linear Schrodinger)* ***2D***. Dengan perspektif ini, akan dikaji parameter-parameter gelombang ekstrem sebagai hasil interaksi paket gelombang soliton NLS.
- Analisis kestabilan gelombang multi-arah melalui formulasi Benjamin-Feir.
- Formulasi Soliton Finite Background dan menentukan parameter-parameter gelombang ekstrem multi-arah.

3. Pemodelan Interaksi Gelombang dengan Bangunan Pantai

a) Model perubahan garis pantai akibat abrasi

$$y_2 = \frac{(\alpha_H - \alpha_T)\varepsilon t}{B}\left[2i^2 erfc\left(\frac{x+B}{2\sqrt{\varepsilon t}}\right) + 2i^2 erfc\left(\frac{x-B}{2\sqrt{\varepsilon t}}\right)\right] - \tan(\alpha_T)\left[2\sqrt{\frac{\varepsilon t}{\pi}}e^{-\frac{x^2}{4\varepsilon t}} - x erfc\left(\frac{x}{2\sqrt{\varepsilon t}}\right)\right]$$



b) Model perubahan garis pantai akibat sedimentasi

$$y_1 = \frac{(\alpha_H - \alpha_T)\varepsilon t}{B}\left[2i^2 erfc\left(\frac{B-x}{2\sqrt{\varepsilon t}}\right) + 2i^2 erfc\left(\frac{B+x}{2\sqrt{\varepsilon t}}\right) - 1\right] - \tan(\alpha_T)\left[2\sqrt{\frac{\varepsilon t}{\pi}}e^{-\frac{x^2}{4\varepsilon t}} - x erfc\left(\frac{x}{2\sqrt{\varepsilon t}}\right)\right]$$

Gambar 3. Perubahan morfologi garis pantai akibat struktur.

Interaksi gelombang dengan struktur dalam kegiatan penelitian ini akan dilakukan berdasarkan teori potensial (ϕ) yang memenuhi persoalan harga batas sebagai berikut (Huspeth, 2006),

$$\frac{\partial^2\phi}{\partial t^2} + g\frac{\partial\phi}{\partial x} + \nabla_H\phi\cdot\nabla_H\left(\frac{\partial\phi}{\partial t}\right) + \frac{1}{2}\nabla_H\phi\cdot\nabla_H\left(\nabla_H\phi\cdot\nabla_H\phi\right) = 0 \qquad (7)$$

$$\eta = -\frac{1}{g}\frac{\partial\phi}{\partial t} + \frac{1}{2g}\left[\left(\nabla_H\phi\right)^2 + \left(\frac{\partial\phi}{\partial z}\right)^2\right] \qquad (8)$$

$$\frac{\partial\phi_I}{\partial n} + \frac{\partial\phi_S}{\partial n} + \frac{\partial\phi_R}{\partial n} = 0 \quad : on\, S_B, \quad \lim_{r\to\hbar}\left(\frac{\partial\phi_S}{\partial r} - ik\phi_S\right) = 0, \quad \phi = \phi_I + \phi_S + \phi_R \qquad (9)$$

Persamaan di atas akan diselesaikan secara analitik dan numerik dimana diseusikan dengan tingkat kerumitan dan hasil kondisi lapangan.

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Sekian, terima kasih
Wassalamu’alaikum Wr. Wb