

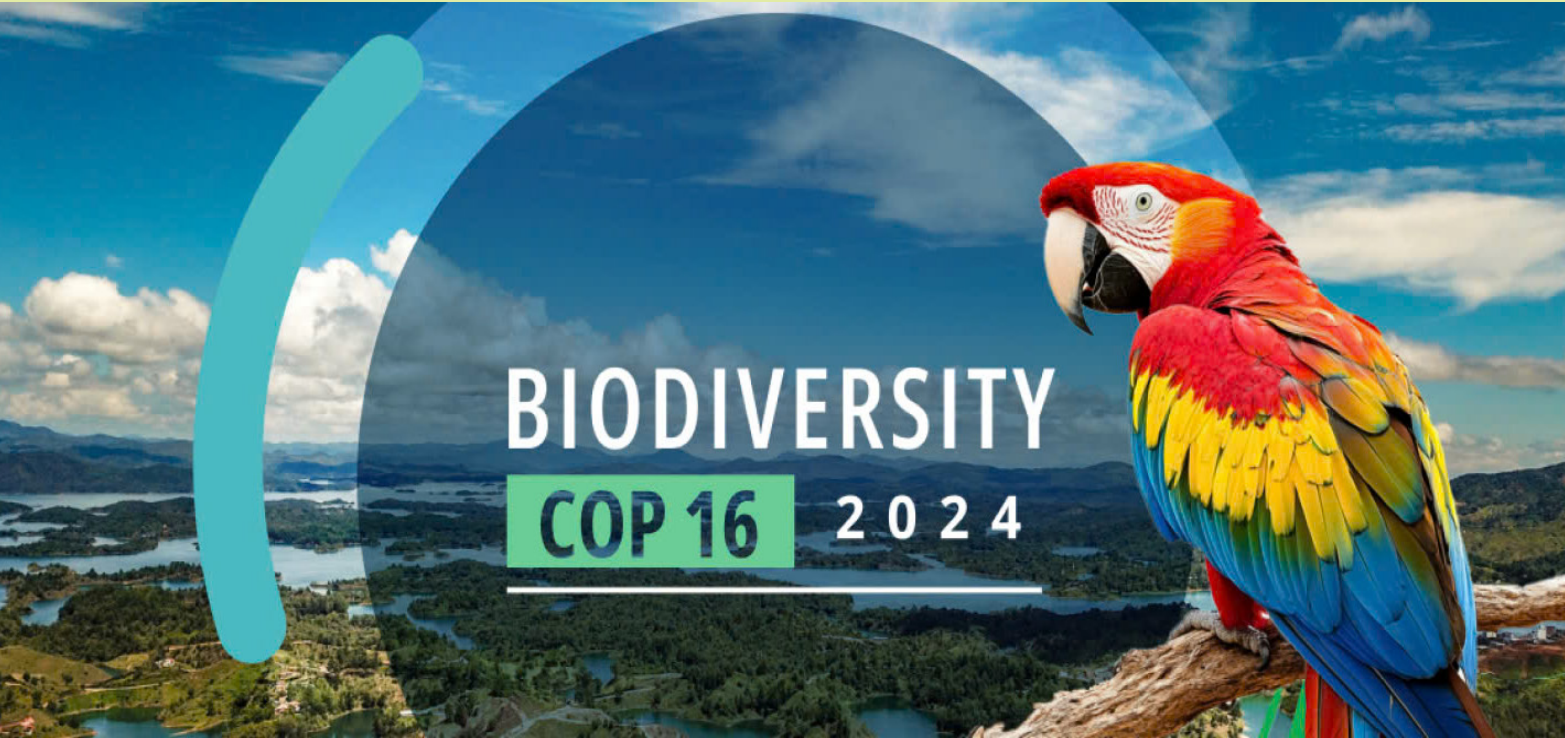


ISSN: 2615 - 9600
English Edition IV - 2024

MAGAZINE

Environment

INSTITUTE OF STRATEGY AND POLICY ON NATURAL RESOURCES AND ENVIRONMENT - MONRE



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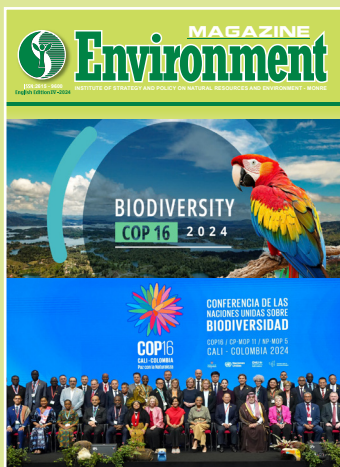


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PUBLICATION PERMIT

No 192/GP-BTTTT - Date: 31/05/2023

Photo on the cover page:

Biodiversity COP 16: Important agreements
reached towards making peace with nature

Photo by: UN Biodiversity

Design: Hoàng Đan

Processed & printed by:

Hanoi 1-member Military Printing
Company Limited

English edition IV/2024

Price: 30.000VND



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Investigation of major harmful crustacean species in the mangrove ecosystem of Ha Tinh province

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Abstract

In the mangrove ecosystem, the major pests can degrade forest quality, even cause forest death. In order to determine the major pests and the level of damage to the mangrove ecosystem, the study conducted an investigation on the “Composition of major pests in the mangrove ecosystem of Ha Tinh province”. The methods used in the study include: Investigation of the composition of major pests; identification of species names; identification of major pests; data processing and analysis. The initial results of the study recorded the composition of major pests, according to which there are 18 major pests belonging to 15 genera, 13 families in 7 orders, of which the Lepidoptera is the most diverse with 6 species (accounting for 33.3% of the total number of species), belonging to 6 genera and in 5 families (accounting for 38.5% of the total number of families). The study also identified 5 main harmful crustacean species belonging to 3 genera (*Balanus*; *Metopograpsus*; *Sphaeroma*), 3 families (*Balanidae*; *Grapsidae*; *Sphaeromatidae*) and 3 orders (*Cirripedia*, *Decapoda*, *Isopoda*). On that basis, it forms a scientific basis for preventing and controlling the decline in area and quality of mangrove forests.

Keywords: Major pest, Mangroves, *sphaeroma terebrans* Bate, 1886.

JEL Classifications: P48, Q56, Q57.

Received: 9th September 2024; **Revised:** 27th September 2024; **Accepted:** 18th October 2024.

1. INTRODUCTION

Ha Tinh province has a coastline of more than 137 kilometers from Cua Hoi to Deo Ngang. Along the coast there are 4 large river mouths: Cua Hoi (Hoi mouth area, Nghi Xuan district), Cua Sot (Sot mouth area, Thach Ha district, Loc Ha districts, Ha Tinh city), Cua Nhuong (Nhuong mouth area, Cam Xuyen district) and Cua Khau (Khau mouth area, Ky Anh town). According to the forest inventory data of the Ha Tinh Provincial Forest Protection Department in 2022, the total area of mangrove forests in the province is 687.9 hectares (ha), concentrated in 4 river mouths and mainly planted forests from 1996 - 2005. On August 18th, 2020, the Forest Protection Department of Region II coordinated with the Forest Plant Protection Center of Region IV, Vietnam Forestry Science Institute, Department of Agriculture and Rural Development of Ha Tinh province, Ha Tinh Department of Cultivation and Plant Protection, and the Management Board of the Mangrove Planting Project to conduct surveys, conduct field inspections, and collect samples of pests at various locations at the Mangrove Planting Project (specifically *Sonneratia caseolaris*) in the communes of Thach Mon, Thach Ha, and Ha Tinh City. Ha Tinh with an area of 25 hectares of sour mangroves, initially identified that the crop was attacked by the isopod crustacean *Sphaeroma terebrans* (family Sphaeromatidae, order Isopoda, class Malacostraca) causing the death of mangrove trees.

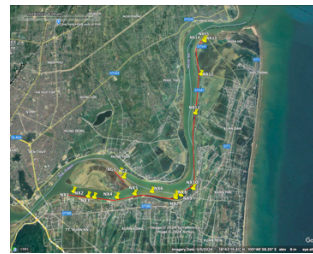
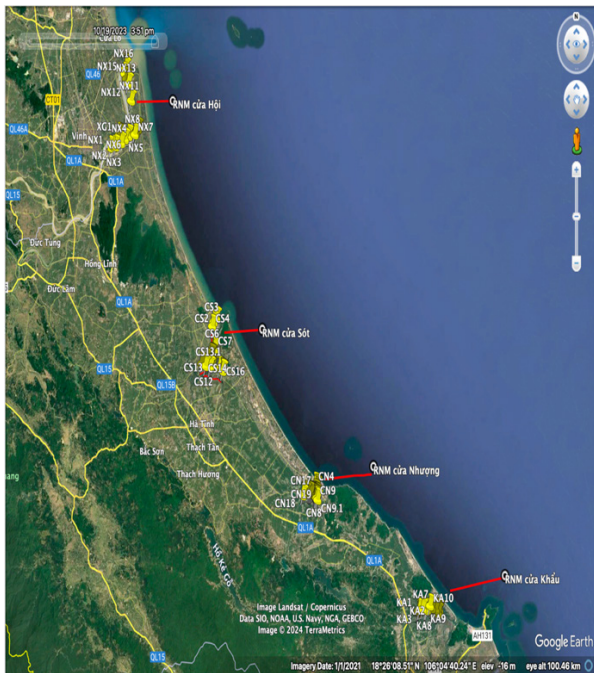
The ability to spread and the destructive power of harmful organisms is very large and causes serious consequences, this is a major challenge in the protection and development of mangrove forests in our country as well as in the world. In Ha Tinh province, there has not been any research project to determine the composition of harmful organisms on the mangrove ecosystem. Therefore, conducting: Investigation of the composition of the harmful crustacean species is an urgent task to determine the composition of the main harmful species, thereby providing scientific basis for effective prevention and control, stopping the decline in the area and quality of mangrove forests in Ha Tinh province.

2. MATERIALS AND METHODS

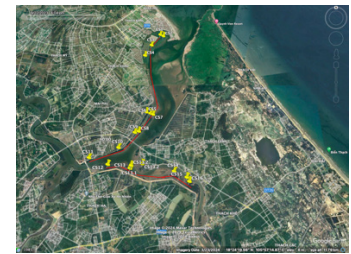
Research methods

* Time: Survey and sample collection from March to August 2024.

* Location: Collecting samples of pests according to habitats in 4 mangrove ecosystems: Cua Hoi (Hoi mouth mangrove area), Nghi Xuan district; Cua Sot (Sot mouth mangrove area), Loc Ha district, Thach Ha district and Ha Tinh city; Cua Nhuong (Nhuong mouth mangrove area), Cam Xuyen district; Cua Khau (Khau mouth mangrove area), Ky Anh town. The habitats in the mangrove ecosystem are divided into: Cua Hoi mangrove habitat (SCCH); Cua Sot mangrove habitat (SCCS); Cua Nhuong mangrove



Hoi mouth mangrove area - Nghi Xuan District



Loc Ha District, Thach Ha District, Ha Tinh City



Nhuong mouth mangrove area - Cam Xuyen District



Khau mouth mangrove area - Ky Anh town

▲ Figure 1: Study site, survey lines and location of standard plots (OTC)

habitat (SCCN); Cua Khau mangrove habitat (SCCK). Distribution states of mangrove species: Pure mangrove forest: (*Sonneratia caseolaris* (L.) Engl.): SCCH1; SCCS1; SCCK1; Pure *Sonneratia apetala* Buch-Ham forest: SCCH3; pure *Kandelia obovata* Sheue Liu & Yong forest: SCCS4; SCCN3; SCCK3; mixed forest: *Sonneratia caseolaris* – *K. Obovata* – *Aegiceras corniculatum* (L.) Blanco: SCCH2; (*S. caseolaris*) – *K. Obovata* – *Avicennia marina* (Forsk.) Veirh) – *Rhizophora stylosa* Griff. – *Ae. corniculatum*: SCCS2; SCCN1; *A. marina* – *K. obovata* – *Rh. Stylosa*: SCCN2; *K. obovata*– *A. marina* – *Rh. Stylosa* – *Ae. Corniculatum*: SCCK2; Mangrove distributes lagoon banks and sluice gates of aquaculture lagoons (SCBD-CC);

*** Method of investigating the composition of harmful organisms**

Collecting and investigating samples: Pest samples are collected according to the Handbook for monitoring and investigating biodiversity (World Wide Fund for Nature - WWF Indochina program, Hanoi, Vietnam, 2003): Method of studying benthic organisms: Use a 1 m² quantitative frame (1m x 1m) to collect samples in shallow intertidal areas and use a bottom rake to collect samples in subtidal flooded areas; Investigating and monitoring insects: Use a net (diameter 30 cm and a mesh bag made of synthetic fibers (dacron). Nylon net, the net bag is conical, the length of the mesh is 50 cm; the surf collects floating organisms 57 micrometer), flapping, sucking, trapping, filtering. Take 2 sets of samples in clean and good conditions, meaning complete appendages such as: Antennae, wings and legs. Use alcohol-resistant, leak-proof containers, such as plastic boxes, glass jars with lids, or plastic jars with screw caps to hold samples. Collecting samples at different stages in the life cycle can aid in the identification of the pest species.

Store samples in 70° alcohol solution, and label locations to bring them back to the laboratory for species composition analysis.

Specimen identification: Pest samples were collected and analyzed under a magnifying glass and Reife M3T 4K camera trinocular stereomicroscope. Invertebrate identification was based on: Dang Ngoc Thanh, Thai Tran Bai, Pham Van Mien (1980), Thai Tran Ba; Crab group (Brachyura): Dai Ai-Yun and Yang Si-Liang, 1994; Jocelyn Crane, 1975; Bivalvia group: Kent E. Carpenter and Volker H. Niem, 1998; Han Raven, Jap Jan Vermeulen, 2006; Insects: Tiplehorn. C. A., Johnson. N.F., (2005), Chujo M.,(1968), P. Bouchard. et all., (2011), Kurosawa. Y, Hisamatsu. H and Sasaji. H (Eds)., (1985).

*** Mangrove survey methods**

The selected habitats in the mangrove ecosystem represent the factors (tree age, site, afforestation method, forest type, species composition...). Arrange 63 standard plots (OTC-size: 10 m x 10 m) and 8 survey lines with 2 survey lines for each estuarine mangrove system in 4 areas: 16 OTCs on 2 survey lines in Hoi estuary mangrove forest (18°43'56.44"N; 105°45'0.48"E), Nghi Xuan district; 16 OTCs on 2 survey lines in Sot estuary mangrove forest (18°24'32.02"N; 105°54'23.01"E) Loc Ha, Thach Ha districts and Ha Tinh city; 16 OTCs on 2 survey lines in Nhuong estuary mangrove forest (18°14'57.40"N; 106° 5'41.57"E) Cam Xuyen district; 15 OTCs on 2 survey routes



in the RNM Cua Khau (18° 6'39.76"N; 106°18'30.62"E), Ky Anh town. In each mangrove area, surveys were conducted in OTCs according to habitat, each OTC carefully observed all 30 trees in a zigzag pattern to detect and collect harmful organisms and determine the location and level of damage to the mangrove trees. In case the OTC does not have enough 30 trees, continue to expand the OTC to ensure that the survey includes n = 30 trees.

*Method for determining the main harmful species

Based on TCVN 8928-2013 and TCVN 8927: 2013, to determine the main harmful species, it is necessary to rely on the abundance n' (%), disease incidence P (%), disease severity R (%), loss index, similarity (S), species diversity H' . These indicators are determined according to the following formula:

- Richness: $n'(\%) = ni/N \times 100$

In which:

ni : Number of individuals of species i in the study area;

N : number of individuals of all species in the study area

- Disease level: The average value calculated as a percentage of the total number of diseased plants at each disease level at each corresponding disease level compared to the total number of investigated plants and the number of damaged levels is calculated by the following

Formula:

$$R(\%) = \frac{\sum_{i=0}^4 ni.vi}{N.V} \times 100$$

In which:

R (%) is the disease level;

ni is the number of damaged plants at level i ;

vi is the value of damage level i , with a value from 0-4;

N is the total number of investigated plants;

V is the highest damage level value ($V = 4$)

Based on the R (%) value, the disease level is divided into the following levels:

No damage: healthy trees have an R (%) value less than 10%

Slight damage has an R (%) value from 10 to 25%

Moderate damage has an R (%) value from 25 to 50%

Severe damage has an R (%) value from 50 to 75%

Very severe damage has an R (%) value greater than 75%

- Disease infected area: The forest area calculated in hectares (ha) affected by the

disease, with a level of damage from mild damage or higher (R greater than 10%). The infected area is calculated directly by measuring the area on the disease distribution map or by using the following formula;

$$S(\text{ha}) = n/N \times A$$

In which:

S is the infected area; n is the number of infected standard plots;

N is the total number of OTCs;

A : Area of the survey area

- Damage rate: is the percentage of diseased samples over the total number of surveyed samples

$$P(\%) = n/N \times 100$$

In which:

P (%) is the damage rate; n is the number of damaged trees;

N is the total number of surveyed trees

- Disease index: Calculated by the product of the disease rate and the disease level

$$DI = P(\%) \times R(\%)$$

In which:

DI is the loss index; P (%) is the damage rate; R (damage level)

- Species similarity:

+ Use the Sorensen species similarity index (Krebs, 1999).

$$S = \frac{2C}{A+B} \times A \frac{2C}{A+B} \times A$$

In which:

A is the number of species in mangrove area A ,

B is the number of species in mangrove area B and C is the number of common species between the 2 compared mangroves;

S is the Sorensen species similarity index.

+ Using the biodiversity index or Shannon index (H'):

$$H' = -\sum_{i=1}^n (ni/N) \log_2(ni/N)$$

In which:

H' is the species diversity index or Shannon-Wiener index; ni is the number of individuals of the i -th species and N is the total number of individuals of all species at the study location.

* **Data processing and analysis:** Data are calculated using statistical software SPSS V.20 and Microsoft office Excell 2019.

3. RESULTS AND DISCUSSION

* Pest species composition structure

Pest species composition structure was collected at 4 ecosystems: Hoi mouth mangrove ecosystem, Sot mouth mangrove ecosystem, Nhuong mouth mangrove ecosystem and Khau mouth mangrove ecosystem. Accordingly, 18 species of pests belonging to 15 genera, 13 families in 7 orders were recorded (Table 1). Among the collected pests, the Lepidoptera order is the most diverse with 6 species

(accounting for 33.3% of the total species collected during the survey), belonging to 6 genera and 5 families (accounting for 38.5% of the total families). When arranged in decreasing order of the number of species, genera and families belonging to the orders, there is a change in the position of the Lepidoptera order, the Orthoptera order and the Hemiptera order. Specifically:

- The order in decreasing order of families is: Lepidoptera: 5 families (accounting for 38.5%), followed by Orthoptera and Hemiptera (both have 2 families, 15.4%), then the remaining 4 orders (1 family, 7.7%): Ostreida; Cirripedia; Decapoda; Isopoda.

- The order of arrangement of the orders in decreasing number of species: Lepidoptera with 6 species, accounting for 33.3%, followed by Orthoptera and Decapoda with 3 species, accounting for 18.8%, then Hemiptera and Ostreida with 2 species, accounting for 12.5%, finally Isopoda, Cirripedia, with 1 species, accounting for 6.3%.

Species composition of pests in mangrove ecosystems. Of the total 18 species collected in the study area, the Sot mouth mangrove ecosystem recorded 15 species of pests, accounting for 83.3% of the total species, followed by the Hoi mouth mangrove ecosystem with 13 species accounting for 72.2%; Nhuong mouth mangrove ecosystem and Khau mouth mangrove ecosystem recorded 11 species, accounting for 61.1%. According to O.K. Remadevi et al. (2019), 3 species of caterpillars including *Brachycyttarus* sp., *Pteroma plagiophleps*, *Metisa* sp. were found to be the main pests on *Rhizophora mucronata* trees along the West Indian coast and only focused on the group of pests in the insect group. According to Pham Quang Thu and colleagues (2006, 2008), there are 16 species of pests, 12 species of worms and 4 species of diseases on mangrove trees in the Can Gio mangrove ecosystem. Of these, 3 main harmful species are the white worm that causes stem and branch tumors, *Xyleutes* sp, the brown stem borer *Zeuzera conferta* and the hair clipper *Trirachys bilobulartus*, which specializes in borers, causing medium damage.

The research results did not show any difference in the composition of harmful organisms in the 4 mangrove ecosystems, the similarity index of harmful organisms was high in the mangrove ecosystems including: Hoi mouth mangrove ecosystem– Sot mouth mangrove ecosystem: $S = 0.80$; Sot mouth mangrove ecosystem – Nhuong mouth mangrove ecosystem: $S = 0.79$ and the lowest similarity index was Sot mouth mangrove ecosystem - Khau mouth mangrove ecosystem: $S = 0.71$ with lower similarity. The biodiversity index of harmful organisms in the studied mangrove ecosystems was low, the highest H' index was in Nhuong mouth mangrove ecosystem: $H' = 1.92$; Khau mouth mangrove ecosystem: $H' = 1.90$; Hoi mouth mangrove ecosystem: $H' = 1.41$; and the lowest was in Sot mouth mangrove ecosystem $H' = 1.3$; The SCBD-CC habitat has a high biodiversity index $H' = 2.51$, this is a habitat with an intersection and transition between the mangrove ecosystem and the agricultural ecosystem. Therefore, harmful species are found only in the SCBD-CC habitat (*Spodoptera litura* F, 1775; *Halyomorpha halys* Stal, 1855; *Actratomorpha lata* Motschulsky, 1886; *Pseudoxya diminuta* Walker, 1871) but not in other typical habitats of the mangrove ecosystem; 5/18 to 9/18 species have a wide distribution, the level of damage is more common. The number of species tends to increase in habitats with a more diverse structure of mangrove species. The SCBD-CC habitat has the highest number of species (16 species). SCCN1; SCCS4 has the least number of species (5 species). Analysis of differences in the number of harmful species according to ecosystems by Two-Way ANOVA showed that the number of species did not have a significant difference between ecosystems ($p = 0.575 > 0.05$) but there were differences according to habitats ($p < 0.05$).

Table 1: Structure of species composition of harmful organisms

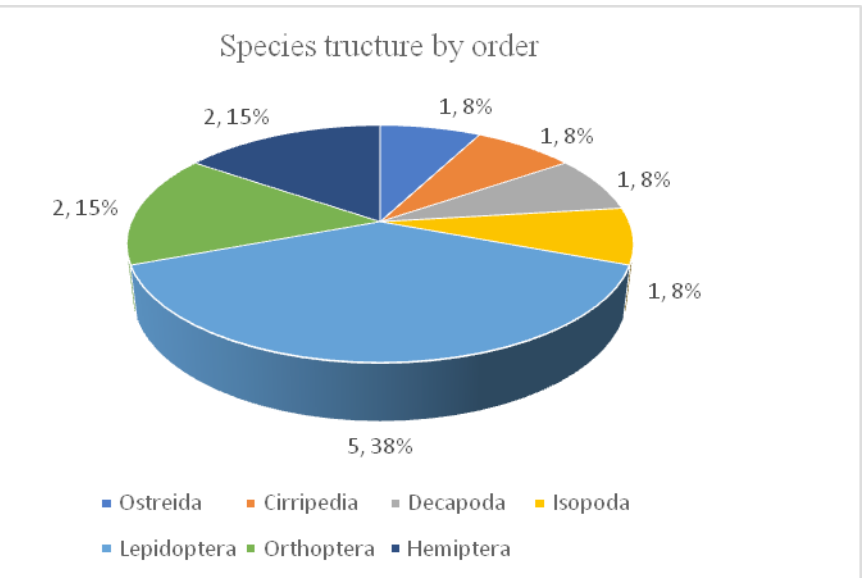
No	Scientific name	Vietnamese name	Family		Genus		Species	
			Quantity	Percentage (%)	Quantity	Percentage (%)	Quantity	Percentage (%)
1	Ostreida	Bộ hào	1	7,7	1	6,7	2	11,1
2	Cirripedia	Bộ giáp xác chân tơ	1	7,7	1	6,7	1	5,6
3	Decapoda	Bộ giáp xác mười chân	1	7,7	1	6,7	3	16,7
4	Isopoda	Bộ chân đều	1	7,7	1	6,7	1	5,6
5	Lepidoptera	Bộ cánh vẩy	5	38,5	6	40,0	6	33,3
6	Orthoptera	Bộ cánh thẳng	2	15,4	3	20,0	3	16,7
7	Hemiptera	Bộ cánh nửa	2	15,4	2	13,3	2	11,1
Total			13	100	15	100	18	100



*** Main species composition of harmful organisms**

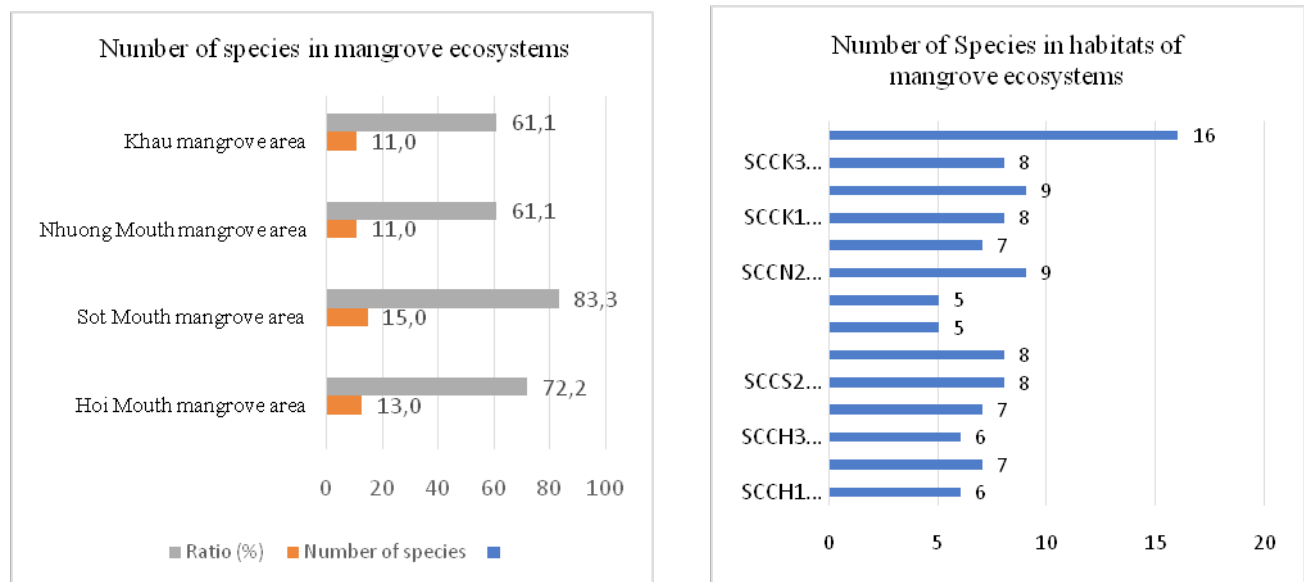
The research results show that the richness and ability to attack mangrove trees are concentrated in a number of species: There are 6 species of crustaceans that attack the stems and roots (accounting for 33.3%), using the stems and roots as food (*Metopograpsus latifrons* White, 1847. n' = 6.63%; *Metopograpsus quadridentatus* Stimpson, 1858. n' = 1.81%; *Metopograpsus thukuhar* Owen, 1839. n' = 1.34%, or the stems as a substrate (*Ostrea lurida* Carpenter, 1864. n' = 3.73%; *Ostrea edulis* L., 1758. n' = 9.72%; *Balanus amphitrite* Darwin, 1854. n' = 37.83%;) and habitat (*Sphaeroma terebrans* Bate, 1866. n' = 34.23%), 3 species attack the stem and leaves (accounting for 16.7%) using the stem and leaves as food, 11 species attack the leaves (accounting for 61.1%) accounting for more than half of the total species and mainly use the leaves as food, which also includes species in the pest stage of the order Lepidoptera. The group of leaf-eating pests will be able to change the structure and function of the mangrove forest, affecting the growth rate of the mangrove forest and the survival rate of the tree.

Elisha Mrabu Jenoh et al 2016, determined the level of insect infestation in 2 mangrove areas



(Gazi and Mida) along the entire Kenyan coast. Two wood-eating insect species were identified: a Metarbelid moth (Lepidoptera, Cossioidea) of an undescribed genus and the bark beetle *Bottegia rubra* (Cerambycidae, Lamiinae). *B. rubra* occurred at low densities in Gazi and high densities in Mida, Kilifi and Ngomeni, with densities decreasing towards the north. Insect infestation levels reached 18% in Gazi and 25% in Mida.

Assessing the ability to cause damage from light to death, the group of organisms that cause damage by boring into the trunk, base (*Sphaeroma terebrans*, wingless *Sphaeroma*, Amuridae, Rhizophora) and breathing roots (*Sphaeroma terebrans*, wingless *Sphaeroma*, Rhizophora) are the most dangerous, because they often kill the whole tree or all parts of the tree from the damaged location. The most dangerous representative of this group is the isopod crustacean *Sphaeroma terebrans* Bate, 1866. n' = 34.23%, high abundance, found in all mangrove habitats, boring into tree trunks to make nests and causing damage to all mangrove species at the position of the tree trunk near the ground, causing the tree to die slowly, but the most favorite are *Sphaeroma terebrans*, wingless *Sphaeroma* and Rhizophora. Some groups of the Lepidoptera also have a stem-boring stage, this group often causes damage at positions higher than the tidal range, at small breaks and is less dangerous. The group of plant species that cause damage to the outer bark



▲ Figure 3: Number of harmful species in mangrove ecosystems and mangrove habitats

Table 2: Pest species composition, abundance, damaged parts and damage hierarchy

No.	Scientific name	Hoi mouth area (n%)	Sot mouth area (n%)	Nhuong mouth area (n%)	Khau mouth area (n%)	Gate of aquaculture (n%)	Damaged parts	Damage
	MOLLUSCA							
	BIVALVIA							
	OSTREIDA							
	Ostreidae							
	Ostrea							
1	<i>Ostrea lurida</i> Carpenter, 1864	3,5	1,1	1,1	4,7	8,3	Stem	Mildly harmful
2	<i>Ostrea edulis</i> L., 1758	16,4	9,0	8,0	5,4	9,7	Stem, roots	Mildly harmful
	ARTHROPODA							
	THEOCOSTRACA							
	CIRRIPEDIA							
	Balanidae							
	Balanus							
3	<i>Balanus amphitrite</i> Darwin, 1854	30,4	27,9	43,5	51,6	35,7	Stem, roots, leaf	Heavily/ very heavily harmful
	MALACOSTRACA							
	DECAPODA							
	Grapsidae							
	Metopograpsus							
4	<i>Metopograpsus latifrons</i> White, 1847	5,7	6,6	8,1	7,8	5,0	Stem, roots	Mildly harmful
5	<i>Metopograpsus</i>	3,2	4,4	0,9	0,7		Stem, roots	Mildly harmful
6	<i>Metopograpsus thukuhar</i> Owen, 1839	3,8	0,2	1,2	1,4		Stem, roots	Mildly harmful
	ISOPODA							
	Sphaeromatidae							
	Sphaeroma							
7	<i>Sphaeroma terebrans</i> Bate, 1866	35,4	48,9	34,2	27,1	25,7	Stem, roots	Heavily/ very heavily harmful
	INSECTA							
	LEPIDOPTERA							
	Gracillariidae							
	Phyllocnistis							



No.	Scientific name	Hoi mouth area (n%)	Sot mouth area (n%)	Nhuong mouth area (n%)	Khau mouth area (n%)	Gate of aquaculture (n%)	Damaged parts	Damage
8	<i>Phyllocnistis citrella</i> Stainton, 1856					0,9	Leaf	Mildly harmful
	Noctuide							
	Agrotis							
9	<i>Agrotis ipsilon</i> Hufnagel, 1776	0,6		0,9		2,1	Leaf	Mildly harmful
	Spodoptera							
10	<i>Spodoptera litura</i> F. 1775					2,4	Leaf	Mildly harmful
	Hyblaeidae							
	Hyplaea							
11	<i>Hyplaea puera</i> Cramer, 1777		0,8		0,3	2,4	Leaf	Mildly harmful
	Cossidae							
	Zeuzare							
12	<i>Zeuzare conferta</i> Walker, 1856		0,8	1,1	0,7	0,9	Stem	Mildly harmful
	Lasiocampidae							
	Trabala							
13	<i>Trabala vishnou</i> Lefebvre, 1827	0,5	0,3	1,0	0,3	1,2	Leaf	Mildly harmful
	Orthoptera							
	Acrididae							
	Oxya							
14	<i>Oxya velox</i> F., 1787					0,9	Leaf	Mildly harmful
	Pseudoxya							
15	<i>Pseudoxya diminuta</i> Walker, 1871					1,8	Leaf	Mildly harmful
	Pyrgomorphidae							
	Actratomorpha							
16	<i>Actratomorpha lata</i> Motschulsky, 1886					1,5	Leaf	Mildly harmful
	Hemiptera							
	Pentatomidae							
	Halyomorpha							
17	<i>Halyomorpha halys</i> Stal, 1855					1,2	Stem, leaf	Mildly harmful
	Erthesina							
18	<i>Erthesina fullo</i> Thunberg, 1783					0,6	Stem, leaf	Mildly harmful
	Total	99,5	100,0	100,0	100,0	100,0		

Table 3: Analytical indicators to evaluate the rate, level and Disease index

Locality	Hectare (ha)	R (%)	P (%)	S (ha)	DI	Level of harm	Treatment
Hoi mouth area	53,9	32,8	13,4	33,7	4,4	Severity	Prevention-control
Sot mouth area	253,78	40,2	14,5		4,9	Severity	Prevention-control
Nhuong mouth area	59,54	17,1	9,6	29,8	1,6	Moderately	Disease prevention
Khau mouth area	320,75	12,7	7,7		1	Moderately	Disease prevention
Total	687,79			387			

greatly affects the growth of mature trees and causes death to seedlings and regenerated trees: representatives of this group are the barnacle (*Balanus amphitrite* Darwin, 1854.) with high average abundance: $n' = 37.83\%$; large bivalve oyster (*Ostrea lurida* Carpenter, 1864) and rock oyster (*Ostrea edulis* L., 1758); the clam (*Metopograpsus latifrons* White, 1847) with abundance $n' = 6.63\%$ causes damage to the basal stem position, however, they often cause damage to young trees, newly planted mangrove trees and when the environment is scarce in food, they will attack the trees.

Disease incidence P (%) (damaged): The rate of trees damaged by crustaceans is high in Sot mouth mangrove area (P = 14.5%), Hoi mouth mangrove area (P = 13.4%) and the rate of damaged trees is low in Nhuong mouth mangrove area (P = 9.6%), Khau mouth mangrove area (P = 7.7%).

Disease incidence R (%) (damaged): Indicates the number of levels of damage and the total number of damaged trees, Sot mouth mangrove area has the most severe damage: R = 40.2%; Hoi mouth mangrove area mangrove: R = 32.8% and the damage level is lighter than Nhuong mouth mangrove area: R = 7.1% and Khau mouth mangrove area: R = 2.7%

Disease infected area S (hactare) and Disease index (DI): The highest damaged area is Sot mouth mangrove area: $S = 142.8/253.78$ ha with severe damage level (DI = 4.9); Khau mouth mangrove area is damaged $S = 80.7/320.75$ hactares with moderate damage level (DI = 1); Hoi mouth mangrove area has damaged area $S = 33.7/53.9$ hactares with severe damage level (DI = 4.4); Nhuong mouth mangrove area has damaged area $S = 29.8/59.54$ hactares with moderate damage level (DI = 1.6).

Analysis of the indicators shows that 5 crustacean species are the main pests of mangroves with a wide ecological spectrum, high abundance and distribution in preferred habitats (Table 4).

From the above results, urgent measures need to be taken to apply to the mangrove systems of Hoi mouth mangrove area, Sotmouth mangrove area, Nhuong mouth mangrove area, Khau mouth mangrove area, which are to prevent and control harmful organisms, including:

Table 4: Major crustacean species causing damage to typical habitats of mangrove ecosystems

No.	Scientific name	Hoi	Sot Mouth area (n%)	Nhuong Mouth area (n%)	Khau Mouth area (n%)	Damaged part	Preferred habitas
1	<i>Ostrea lurida</i> Carpenter, 1864	3,5	1,1	1,1	4,7	Stem	SCCN2; SCCS2; SCCN1
2	<i>Ostrea edulis</i> L., 1758	16,4	9,0	8,0	5,4	Stem, roots	SCCN2; SCCS2; SCCN1
3	<i>Balanus amphitrite</i> Darwin, 1854	30,4	27,9	43,5	51,6	Stem, roots, leaf	SCCH3; SCCS4; SCCN3; SCCK3
4	<i>Metopograpsus latifrons</i> White, 1847	5,7	6,6	8,1	7,8	Stem, roots	SCCH1; SCCS1; SCCCK1; SCCS4; SCCN3; SCCK3
5	<i>Sphaeroma terebrans</i> Bate, 1866	35,4	48,9	34,2	27,1	Stem, roots	SCCH3; SCCS4; SCCN3; SCCK3



Testing silvicultural solutions: Selecting seedling species for new planting and restoration of mangrove, silvicultural techniques applied to mangrove trees, especially studies on biological and ecological characteristics of mangrove trees adapted to soil conditions, hydro-climate in the coastal area of Ha Tinh province.

Testing to evaluate the effectiveness of pest control (especially harmful crustaceans) by the following measures: Using bait poles (using poles for pests to cling to); physical barriers (layers of material wrapped around the body to protect the body); methods of trapping pests in the tidal environment of mangrove (using boxes, trap nets); Measures to repel and limit the attachment of harmful organisms by biological products, biological measures for mangrove areas being attacked by harmful organisms.

4. CONCLUSION

The main species composition of pests collected in the study area included 18 species of pests belonging to 15 genera, 13 families in 7 orders. Among the collected pests, the Lepidoptera was the most diverse with 6 species (accounting for 33.3% of the total species collected during the survey), belonging to 6 genera and 5 families (accounting for 38.5% of the total families). When arranged in descending order of species, genera and families in the orders, the results were Lepidoptera, Orthoptera and Hemiptera. The rate of trees damaged by pests is high in Sot mouth mangrove forest (P = 14.5%), Hoi mouth mangrove forest (P = 13.4%), the rate of damaged trees is low in Nhuong mouth mangrove area (P = 9.6%), Khau mouth mangrove area (P = 7.7%), the level of damage to Sot mouth mangrove area and Hoi mouth mangrove area is more and more serious than Nhuong mouth mangrove area and Khau mouth mangrove area. The area damaged by pests accounts for more than 50% of the mangrove area of Ha Tinh province, in which the level of damage is severe (DI = 4.9 Sot mouth mangrove area; DI = 4.4 Hoi mouth mangrove area and moderate damage in the two ecosystems of Nhuong mouth area and Khau mouth area. The study also identified 5 main species of harmful crustaceans belonging to 3 genera (Balanus; Metopograpsus; Sphaeroma), 3 families (Balanidae; Grapsidae; Sphaeromatidae) and 3 orders (Cirripedia, Decapoda, Isopoda). Therefore, urgent measures need to be applied to the Hoi and Sot mangrove ecosystems to prevent and control harmful organisms; Nhuong and Khau mangroves need to have measures to prevent harmful organisms from continuing to harm mangrove trees. Due to the short research time, this study has not yet studied the nutritional and reproductive habits of the 5 main species of crustaceans that are harmful to mangrove trees; it is necessary to continue to study these biological characteristics as a scientific basis for the prevention and control of the main species of harmful crustaceans ■

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Offshore wind power development policy in Vietnam: opportunities, challenges and solutions

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Abstract

With an extensive coastline and abundant wind resources, Vietnam can achieve an offshore wind technical potential of nearly 600 GW, significantly contributing to ensuring energy security and reducing carbon emissions. Experience from leading countries such as the UK, Denmark, Germany, and China shows the need for strong and synchronous support policies and close coordination among stakeholders. The study analyzes the potential, opportunities, challenges and barriers in developing offshore wind power in Vietnam. These challenges and barriers need to be removed, such as the lack of a synchronous legal framework, inappropriate bidding mechanisms and electricity prices, unready technical infrastructure and supply chains, and limited domestic capacity in technology and human resources. On that basis, the authors propose 8 groups of solutions: completing the legal framework, establishing a focal management agency, promulgating incentive policies, investing in research and development of human resources, spatial planning for marine space, strengthening international cooperation, leveraging green financial resources and raising community awareness and engagement.

Keywords: *Offshore wind power, renewable energy, marine spatial planning, supply chain, international cooperation*

JEL Classifications: *Q51, Q56, Q57*

Received: 31st July 2024; **Revised:** 10th August 2024; **Accepted:** 5th September 2024.

1. INTRODUCTION

Offshore wind power has become a significant source of renewable energy globally over the past three decades. By the end of 2023, the total global installed capacity of offshore wind power reached 75.2 GW, an increase of nearly 17% compared to 2022 [1]. The leading countries in offshore wind power development today include China, the United Kingdom, Germany, the Netherlands, and Denmark. According to forecasts by the World Energy Council (WEC), by 2050, offshore wind power could meet about 10% of the world's electricity demand, with a total installed capacity of up to 1,000 GW [2].

Vietnam is considered a country with enormous potential for offshore wind power development, with a coastline of more than 3,260 km and average wind speeds of 7 - 11 m/s [3]. According to a survey by the World Bank, the technical potential of offshore wind power in Vietnam is nearly 600 GW, which is many times greater than the total capacity of the current national power system [4]. Offshore wind power will contribute to ensuring national energy security, reducing reliance on imported fuels, and fulfilling the government's commitment to net-zero emissions by 2050. Notably, developing offshore wind power also holds significant importance in affirming Vietnam's sovereignty and sovereign rights at sea.

Despite having great potential and favorable conditions for offshore wind power development, Vietnam is facing significant challenges, with the main barrier being the lack of mechanisms and policies. In addition, the absence of a comprehensive legal framework and national maritime spatial planning also hinders the implementation of offshore wind power projects. With its considerable advantages and opportunities, Vietnam needs to take firm steps to timely harness its offshore wind power potential to become a leading country in the renewable energy sector in Southeast Asia. A systematic and comprehensive strategy for offshore wind power development will lay the foundation for sustainable growth, enhance the competitiveness of the economy, and contribute positively to global climate change mitigation goals.



2. OFFSHORE WIND POWER AND GLOBAL DEVELOPMENT POLICIES

The global trend to reduce greenhouse gas emissions to address climate change has created a demand for low-carbon renewable energy sources. According to the International Renewable Energy Agency (IRENA), renewable energy sources could generate 130,000 TWh of electricity annually, more than twice the current global electricity consumption [5]. By 2050, offshore wind power could account for nearly 40% of global renewable electricity generation (Figure 1).

Offshore wind power, along with onshore wind power, results in very low greenhouse gas emissions compared to current power sources, at around just over 10 g CO₂/kWh, which is 1/100th of coal power (Figure 2).

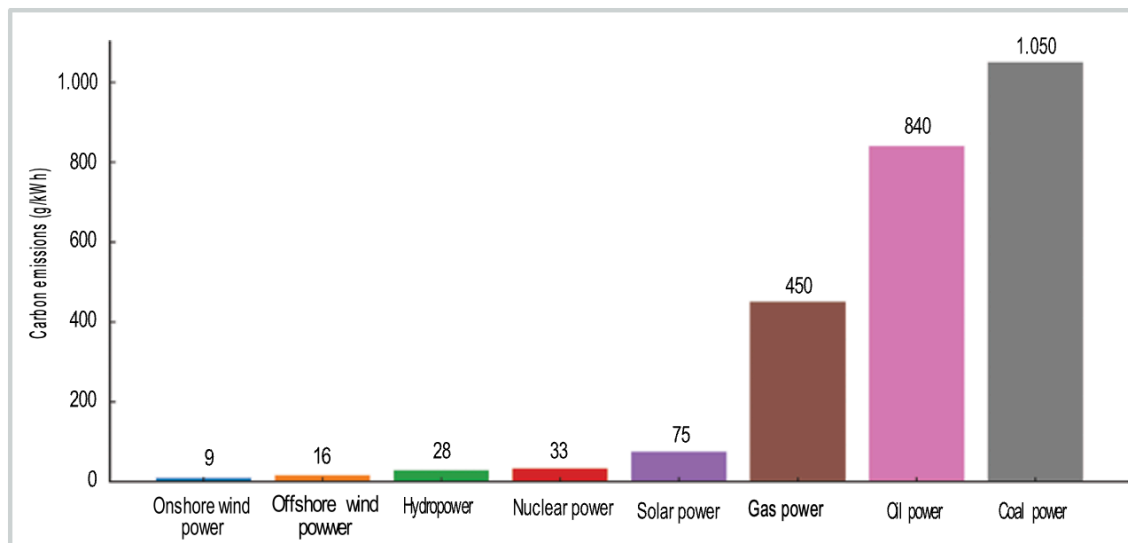
The technology for converting wind at sea into electricity uses large wind turbines with capacities up to 16-20 MW, designed for longer lifespans of up to 25-30 years, with rapidly decreasing costs and suitable for harsh marine conditions. Offshore wind power harnesses wind energy at sea, converting it into electrical energy and supplying it to the onshore transmission grid. The world's first offshore wind farm, Vinderby, with a capacity of 4.95 MW, located

off Lolland, Denmark, was commissioned in 1991 and was officially decommissioned and dismantled in 2017 after 26 years of operation [6].

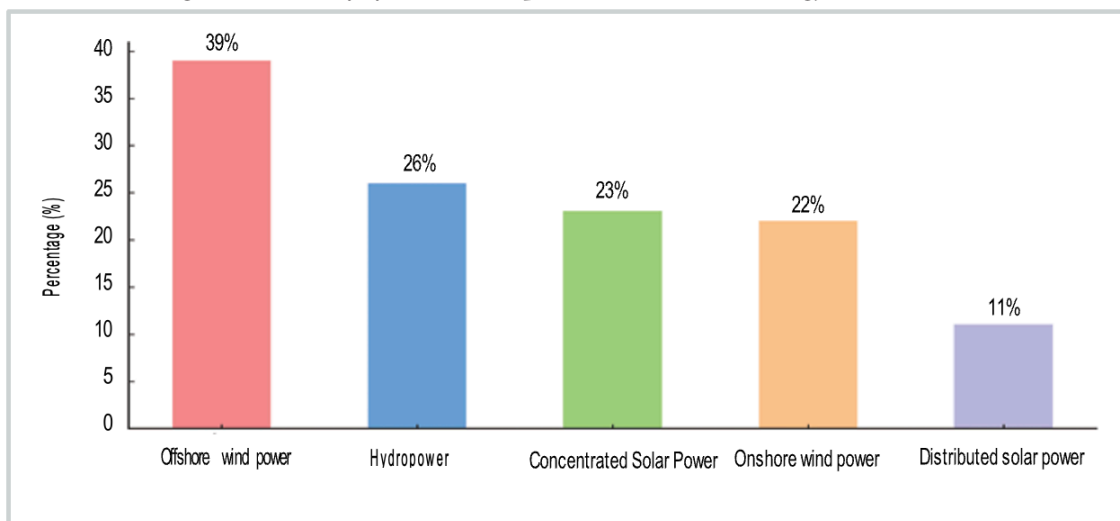
Offshore wind power has been deployed on a large scale in China, Denmark, Germany, the Netherlands, and the United Kingdom. For many countries, offshore wind power has established itself as a large-scale, clean, and reliable electricity generation option, with such advantages as:

- It is a breakthrough solution for ensuring national energy security, reducing dependence on imported fuel sources, and lowering emissions of pollutants and greenhouse gases.

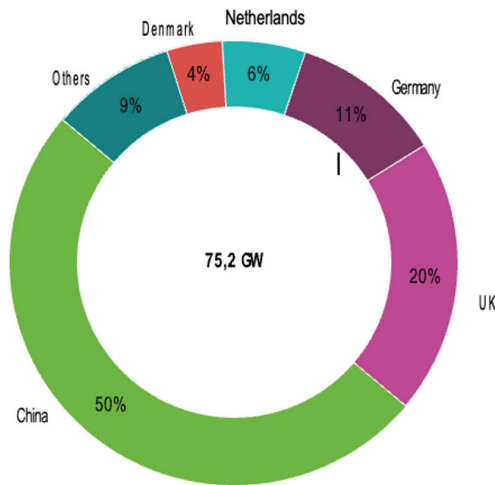
- It creates additional jobs, stimulates economic and social development in local areas, and improves the livelihoods of people. When offshore wind farms become operational, they create high-quality jobs from domestic human resources.



▲ Figure 1. Share of offshore wind power in renewable energy sources, 2050 [5]



▲ Figure 2. Carbon emissions per 1 kWh of electricity [5]



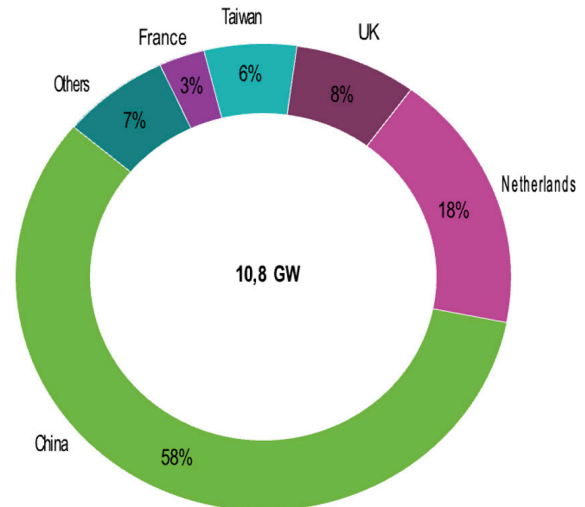
▲ Figure 3. Total installed offshore wind power capacity by country as of the end of 2023 [1]

- It gradually restores marine ecosystems to become natural reserves, as the underwater structures of offshore wind turbines can function as artificial coral reefs, attracting some mollusks and small fish, which directly impacts the food chain of larger marine organisms.

According to statistics from the Global Wind Energy Council (GWEC), by the end of 2023, the total installed offshore wind power capacity globally reached 75.2 GW. Leading the way are China (37.6 GW), accounting for 50%; the United Kingdom (13.6 GW), accounting for 20%; Germany (8 GW), accounting for 11%; the Netherlands (4.5 GW), accounting for 6%; and Denmark (3 GW), accounting for 4%. These five countries account for 91% of the total global offshore wind power capacity, while the remaining countries, including Vietnam, account for only 9% [1].

The total installed offshore wind power capacity is growing rapidly worldwide, reaching 15 GW in 2021, 10 GW in 2022, and nearly 11 GW in 2023. In 2023 alone, China accounted for 58% of the new global offshore wind power capacity, followed by the Netherlands at 18%, the United Kingdom at 8%, Taiwan at 6%, France at 3%, and other countries at 7% [1].

According to forecasts by the International Energy Agency (IEA), by 2040, \$1 trillion will be invested in offshore wind power, with Asia accounting for over 60%. China's offshore wind power capacity has increased from 4 GW in 2019 to more than 37.6 GW (exceeding Europe's total offshore wind power capacity) and is projected to reach 110 GW by 2040 and 350 GW by 2050.



▲ Figure 4. Total newly installed offshore wind power capacity in 2023 and its share by country [1]

The renewable energy policies and laws of several countries, including China, Denmark, the United Kingdom, and Germany, are considered quite advanced and comprehensive. These countries have had renewable energy laws and have been promoting renewable energy development in general and offshore wind power specifically since the 2000s, achieving significant milestones. In 2021, Australia also introduced specific legislation for offshore wind power.

Particularly, Denmark plans to consume 50% of its electricity from offshore wind energy by 2030, while the United Kingdom has successfully established the largest offshore wind project in the world. However, implementing offshore wind projects also faces difficulties and challenges such as land ownership disputes, marine resource conflicts, and environmental protection issues. Therefore, cooperation between countries and international organizations is necessary to develop a suitable legal and policy framework for offshore wind development, while ensuring stakeholder interests and environmental protection.

Recently, countries with specific policies for offshore wind energy include dedicated licensing agencies such as the U.S. Bureau of Ocean Energy Management (BOEM) and Australia's Department of Energy and Climate Change, along with various laws and strategies related to offshore wind development.

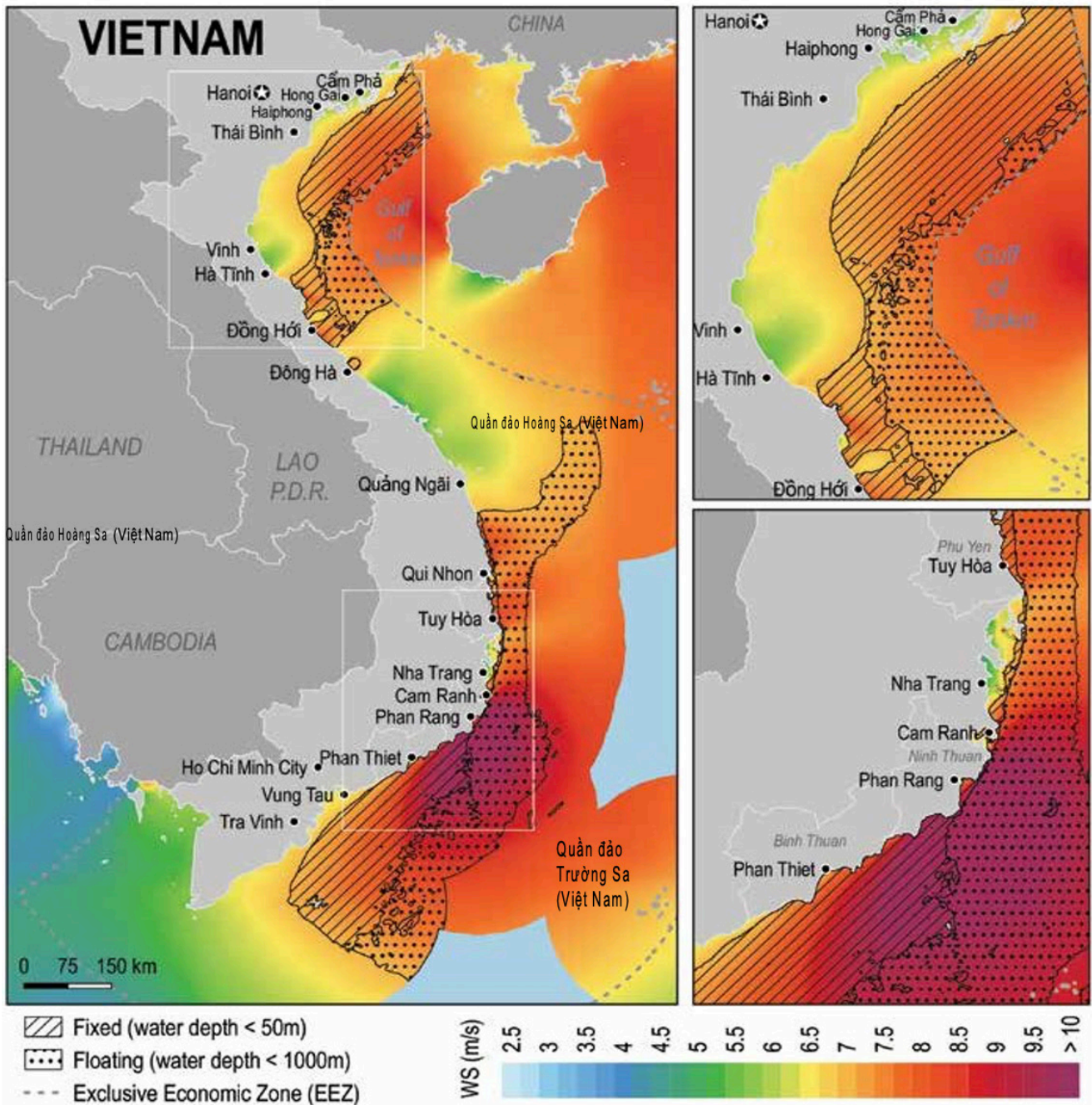
Leading countries in offshore wind development, such as Denmark, the United Kingdom, and Germany, have implemented effective support policies. Denmark, a pioneer, established the Offshore Wind Act in 1991, setting up a competitive bidding mechanism and financial support for projects [7]. The United Kingdom introduced the Energy Act in 2013 with specific targets for offshore wind and a price support mechanism (CfD) [8]. Germany enacted the Renewable Energy Act (EEG) with a feed-in tariff for offshore wind power starting in 2000 [9].



These countries have also facilitated maritime spatial planning, investment in grid infrastructure, supply chains, and logistics. Denmark has developed a wind atlas, planned potential areas, and infrastructure connectivity. The United Kingdom has established project zones and invested in upgrading transmission grids. Germany has created integrated planning for offshore wind farms [10].

In terms of technology, these countries focus on investing in research and developing advanced solutions such as large-capacity turbines (10-15 MW), floating foundations for deep waters, and energy storage systems [11]. State incentives and funding have encouraged the involvement of research institutes, universities, and collaboration with leading turbine manufacturers such as Vestas, Siemens Gamesa, and GE.

However, expanding offshore wind capacity also poses significant challenges. Issues such as high initial investment costs, complex licensing processes, and conflicts with stakeholders (e.g., fishermen, maritime transport) are major barriers [12]. Integrating a large amount of offshore wind power into the electricity system also requires substantial upgrades to grid infrastructure, increased reserve capacity, and flexibility of other power sources. Additionally, environmental impacts such as noise and changes in marine ecosystems need to be monitored and mitigated [13].



▲ Figure 5. Vietnam's offshore wind power potential [4].



To overcome these challenges, improving the legal framework, attracting private investment, and enhancing regional and international cooperation are considered key solutions. The experiences of leading countries will provide valuable lessons for Vietnam in its future offshore wind power development.

3. OPPORTUNITIES AND CHALLENGES IN DEVELOPING OFFSHORE WIND POWER IN VIETNAM

3.1. Opportunities

Vietnam is presented with numerous opportunities and favorable conditions for developing offshore wind power, with significant natural potential and supportive policy directions. Firstly, Vietnam's strong commitment at the 26th Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change to achieve net-zero emissions by 2050 demonstrates a high level of political will to transition to a green and clean energy economy. This aligns with the global trend of focusing on renewable energy sources, particularly wind and solar power. This policy creates an opportunity for the development of offshore wind power in Vietnam amidst rising energy demands.

Vietnam is naturally endowed with abundant offshore wind power potential. Figure 5 illustrates the distribution map of offshore wind speeds and potential areas for fixed-bottom and floating wind turbines [4]. Preliminary assessments suggest that the total technical potential could reach approximately 600 GW, several times the total capacity of the country's existing power sources. Of this, about 261 GW are fixed-bottom offshore wind projects in waters less than 50 meters deep, and 338 GW are floating wind projects in deeper waters [4]. Many coastal areas have average wind speeds exceeding 10 m/s, which are highly suitable for large-scale wind farms. This significant natural advantage allows Vietnam to develop offshore wind power on a large and long-term scale.

The Communist Party and the State of Vietnam have shown particular interest and consistent direction in boosting the exploitation of marine economic potential in general and offshore wind power in particular through a series of recent key resolutions and strategies. Notably, Resolution No.36-NQ/TW dated October 22, 2018, from the Politburo on the Strategy for Sustainable Development of Vietnam's Marine Economy to 2030, with a vision to 2045, identifies "renewable energy and new marine economic sectors" as a breakthrough pillar. Following that, Resolution No.55-NQ/TW dated February 11, 2020, on the orientation of the National Energy Development Strategy of Vietnam to 2030, with a vision to 2045, emphasizes "establishing support policies and breakthrough mechanisms for offshore wind power development linked to the implementation of the Vietnam Marine Strategy." This provides an important basis for ministries, sectors, and localities to develop and implement specific action programs. The government has issued Resolution No.26/NQ-CP dated March 5,

2020, on the Master Plan and the 5-Year Plan for implementing Resolution 36-NQ/TW dated October 22, 2018, from the 8th Central Executive Committee meeting of the 12th Party Congress on the Strategy for Sustainable Development of Vietnam's Marine Economy to 2030, with a vision to 2045; and Resolution No. 140/NQ-CP dated October 2, 2020, to issue the Government's Action Program to implement Resolution No.55-NQ/TW dated February 11, 2020, from the Politburo on the orientation of the National Energy Development Strategy of Vietnam to 2030, with a vision to 2045, creating a consistent and unified legal framework from central to local levels.

A series of recent decisions by the Prime Minister have established goals, tasks, and solutions for ministries and sectors to implement these strategic directions. The Green Growth Strategy for the period 2021-2030 (Decision 1658/QĐ-TTg) identifies priority green economic sectors, including renewable energy. Decision 841/QĐ-TTg of 2023 positions sustainable energy development and improving access to reliable, sustainable energy as a pillar in Vietnam's roadmap for achieving the Sustainable Development Goals (SDGs). Particularly, the National Power Development Plan for the period 2021-2030, with a vision to 2050 (Power Development Plan VIII), approved by the Government in Decision No. 500/QĐ-TTg on May 15, 2023, specifically sets targets for increasing the share of offshore wind power, aiming for 6 GW by 2030 and 70-91 GW by 2050. The Government has approved the implementation plan for Power Development Plan VIII, which outlines the roadmap for key projects. These decisions demonstrate a strong political commitment by the Government to offshore wind power development in the coming period.

The World Bank's analysis shows a positive outlook on the feasibility and investment efficiency of offshore wind power. Since 2012, investment costs have significantly decreased, from \$255/MWh to about \$80/MWh. With this trend, the cost of offshore wind power could drop to about \$58/MWh by 2030. This narrowing cost gap compared to traditional power sources indicates the increasing competitiveness and commercial potential of offshore wind power, which will be an important factor in attracting private and international investment. In the World Bank's high scenario, Vietnam's installed offshore wind capacity could reach 70 GW by 2050, making it the third-largest in Asia, after China and Japan.

**Table 1. List of Projects and Capacity by Province**

No	Province	Number of Proposed Projects	Capacity (MW)
1	Quang Ninh	2	6,000
2	Hai Phong	5	16,200
3	Thai Binh	2	3,700
4	Nam Dinh	1	12,000
5	Thanh Hoa	1	5,000
6	Ha Tinh	2	1,050
7	Quang Binh	5	4,109
8	Quang Tri	4	3,600
9	Binh Dinh	7	8,600
10	Phu Yen	8	3,350
11	Ninh Thuan	27	29,802
12	Binh Thuan	10	30,200
13	Ba Ria - Vung Tau	7	6,160
14	Tra Vinh	7	10,300
15	Soc Trang	4	4,900
16	Vinh Long	2	400
17	Ben Tre	9	7,460
18	Bac Lieu	10	5,255
19	Kien Giang	1	236
20	Ca Mau	6	8,500
Total		120	166,822

(Source: Vietnam's Power Development Plan VIII)

Vietnam has been developing a certain legal framework related to maritime activities and wind power projects, facilitating deeper implementation of offshore wind projects in the near future. The 2012 Law of the Sea of Vietnam and the 2015 Law on Natural Resources and Environment of Sea and Islands have laid the foundation for economic exploration and exploitation activities in Vietnam's maritime areas. Government Decree No.51/2014/NĐ-CP of May 21, 2014, on the allocation of specific sea areas to organizations and individuals for marine resource exploitation, has been replaced by Decree No.11/2021/NĐ-CP of February 10, 2021. Decision No.37/2011/QĐ-TTg, as amended by Decision 39/2018/QĐ-TTg, has also introduced important support mechanisms for wind power development, such as tax incentives, land use, and electricity purchase prices. The Ministry of Industry and Trade's Circular No.02/2019/TT-BCT provides specific guidance on the procedures for developing wind power projects. Recently, the Ministry of Natural Resources and Environment has completed a draft decree supplementing regulations on the documentation, appraisal, and licensing of activities related to marine resource observation and assessment. These legal documents will create an initial legal framework for participants in Vietnam's offshore wind power market.

Overall, offshore wind power in Vietnam has very favorable conditions to take off in the coming period. With abundant natural potential, consistent policies and directions from the Party and State, and strong political commitments to combating climate change and reducing carbon emissions, there is a great opportunity for offshore wind power development. Furthermore, if cost trends continue to decline and the legal framework continues to improve, the attractiveness of Vietnam's offshore wind power market will only increase. However, to effectively capitalize on this potential, it is necessary to address existing challenges and barriers through comprehensive measures, including institutional improvements and resource mobilization.

Table 1 provides information on the number of projects and capacity (MW) of wind power plants in 20 provinces registered for development under Power Development Plan VIII. The number of registered offshore wind power projects ranges from 1 to 27 projects per province. Ninh Thuan has the largest number of projects with 27, followed by Binh Thuan and Bac Lieu with 10 projects each. Kien Giang and Nam Dinh have the fewest projects, with only 1 each.

There is also a significant disparity in capacity between provinces, ranging from 236 MW in Kien Giang to 30,200 MW in Binh Thuan. In addition to Binh Thuan, provinces registering large offshore wind power capacities include Ninh Thuan (29,802 MW), Tra Vinh (10,300 MW), Ba Ria - Vung Tau (6,160 MW), and Binh Dinh (8,600 MW).

In total, the country has 120 registered offshore wind power plant projects with a total capacity of 166,822 MW. Table 1 highlights the potential for developing renewable energy from offshore wind in many coastal provinces of Vietnam, particularly in the South Central and Southern regions.

3.2. Challenges

Despite the significant potential and opportunities, the development of offshore wind power in Vietnam faces numerous barriers and challenges from various aspects.



3.2.1. Legal framework

The legal and policy framework specifically for offshore wind power is still lacking and inconsistent. Vietnam does not yet have specific legal documents regulating this sector, with the topic only briefly mentioned in the 2023 Power Development Plan VIII. While the 2012 Law of the Sea of Vietnam provides general regulations on allocating sea areas to organizations and individuals for resource exploitation, there are no specific guidelines for allocating sea areas for developing renewable energy projects such as wind power.

Similarly, the 2015 Law on Natural Resources and Environment of Sea and Islands only addresses scientific research activities on the sea by foreign entities and does not cover the survey and construction of marine economic projects in general, nor offshore wind power projects with private investment in particular. The 2020 Environmental Protection Law lacks specific regulations and guidelines for environmental impact assessments for marine renewable energy projects. The absence of a consistent and detailed legal framework has created gaps and bottlenecks, causing confusion among stakeholders in the licensing, construction, appraisal, and implementation of projects.

Due to the high initial investment costs, offshore wind power requires more special incentive policies and support compared to onshore renewable energy projects. However, Vietnam has not yet established a specific electricity pricing mechanism, tax incentives, fee reductions, land use benefits for sea areas, or long-term financial support for offshore wind projects. Additionally, administrative barriers and investment and construction procedures remain complex and time-consuming due to overlapping regulations and the involvement of multiple ministries and agencies.

Planning and potential assessment are not yet truly consistent and effective. The power development planning has not been integrated with other marine sectors and field plans. Data on wind measurement, geological, and topographical assessments, as well as other technical factors necessary for planning, are still incomplete, unsystematic, and inaccurate. Therefore, coordination among State agencies in evaluating and reaching consensus on suitable marine areas needs further improvement.

Technical infrastructure for grid connection, as well as supply chain and logistics services for offshore wind power, remain limited. The current power transmission grid has not been planned to meet the demand for integrating large and distant offshore wind sources in the future, necessitating investment in upgrades. Port infrastructure, roadways, and storage facilities in potential coastal areas do not meet the stringent technical requirements for the installation, operation, and maintenance of large-scale offshore wind farms. Experience with large-scale offshore wind projects is still new for maritime service providers, surveyors, and marine

construction companies. These factors pose difficulties and risks for implementing large-scale wind power projects and significantly increase investment costs.

Inter-agency coordination and shared responsibility among ministries and sectors in policy implementation also present challenges for offshore wind power development. The Ministry of Industry and Trade believes that investors must bear all risks during surveys due to the lack of specific planning, along with unclear issues such as survey licensing authority, investment policy approval, and the absence of regulations on conditions for foreign investors. The Ministry of National Defense requires adjustments to project scale if there is overlap with defense areas and emphasizes maritime safety. The Ministry of Public Security notes that current regulations do not allow foreign organizations to conduct surveys and lack clear provisions on the procedures for approving and managing marine survey activities. The Ministry of Foreign Affairs stresses the need to comply with regulations on port security and foreign activities in Vietnamese waters. The Ministry of Transport disagrees with granting survey permits in areas overlapping with national maritime routes. The Ministry of Agriculture and Rural Development also points out that surveys should not affect conservation areas and aquaculture zones. The differing viewpoints among ministries highlight the need to further enhance the coordinating role and problem-solving capacity of State management agencies regarding offshore wind power.

3.2.2. Technical obstacles

The development of offshore wind power in Vietnam faces several technical barriers that need to be addressed promptly. Vietnam currently lacks specific standards regarding the area of sea permitted for use in surveying and assessing project potential per unit of capacity (ha/MW). This requirement can vary significantly depending on the characteristics of each marine area, such as wind speed, depth, geological foundation quality, and the type of turbine used. Determining the optimal capacity for a project is also an unresolved issue due to the lack of appropriate guidelines and criteria. A project that is too small may not attract major investors, while one that is too large can create challenges for the transmission system.



Vietnam has yet to establish a long-term plan for the total offshore wind power capacity to be surveyed in each planning phase to ensure feasibility and alignment with established targets. The criteria for selecting project developers are also unclear, making it difficult to filter out entities with the necessary capabilities, experience, and commitment. Planning for prospective marine areas for wind power development requires more systematic investment to provide direction for investors and management agencies.

These technical barriers indicate the necessity of thoroughly researching and issuing specialized technical regulations and standards for offshore wind power.

3.2.3. Other obstacles

State management agencies still lack a unified understanding of whether to permit foreign organizations and individuals to conduct wind, geological, and topographical surveys in Vietnamese waters. This lack of clarity creates difficulties for international investors looking to enter the market, while also limiting the ability to learn from the experience and technology of more advanced countries.

Detailed regulations regarding the documentation, procedures, and timelines for approving activities related to marine resource investigation, survey, and assessment have yet to be clearly outlined, leading to prolonged licensing processes and project delays.

Current regulations lack clear guidelines on how to handle situations where multiple entities propose overlapping surveys in the same marine area. It is unclear whether the parties are allowed to conduct surveys together or if a single entity must be selected through a bidding process.

The maximum time for authorities to review and approve applications for wind, geological, topographical surveys, and environmental impact assessments is not clearly stipulated, leading to delays in approvals, increased costs, and risks for investors.

Additionally, the issuance of survey permits should specify a clear validity period to provide stability and confidence for investors to proceed with their projects. However, this is still lacking in the relevant legal documents.

Vietnam does not yet have a mandatory requirement for project developers to submit survey results to the approving agency, nor are there guidelines on the content and timing of such reports. Consequently, state agencies face difficulties in monitoring information, overseeing progress, and ensuring the quality of surveys.

4. SOME SOLUTIONS FOR OFFSHORE WIND DEVELOPMENT IN VIET NAM

Based on the analysis of opportunities and challenges in developing offshore wind power in Vietnam, the following key solutions are proposed:

Firstly, it is necessary to complete a comprehensive and specialized legal framework for offshore wind power development. In the short term, priority should be given to amending and supplementing overlapping and inadequate provisions in the Electricity Law, Renewable Energy Law, Law on Marine Resources and Environment, and related guiding documents. Specifically, a separate Decree on licensing for potential surveys, project development, and exploitation of offshore wind power should be issued promptly, clearly outlining the procedures, timelines, and responsibilities of all relevant parties. In the long term, consideration should be given to developing a National Assembly Resolution for piloting offshore wind power development and a specialized Law on offshore wind power to create a robust legal framework.

Secondly, there is a need to research and issue long-term incentive mechanisms and policies to encourage domestic and international private investment. These policies should include competitive bidding mechanisms and separate preferential electricity purchase prices, support in taxes, fees, seabed lease costs, credit guarantee mechanisms, and dedicated development funds for offshore wind power. Additionally, policies are needed to encourage technology transfer, local production of equipment, and the development of domestic supply chains for the offshore wind industry.

Thirdly, a centralized state management agency directly under the Government should be established to uniformly direct the formulation of strategies and master plans for national-level offshore wind power. This agency would also be responsible for licensing and supporting projects through a single-window mechanism, coordinating with relevant ministries, sectors, and localities to resolve obstacles and shorten project implementation timelines.

Fourthly, research, training, and technology transfer centers should be established, and cooperation with countries with advanced offshore wind industries should be strengthened. Comprehensive training programs on offshore wind power engineering and project management should be developed to proactively build a high-quality workforce for this sector.



Fifthly, offshore wind power development planning needs to be prioritized to provide a foundational orientation for investors. The National Marine Spatial Planning should be approved and implemented urgently, clearly identifying priority marine areas for renewable energy development. This planning must be integrated and harmonized with other sectoral plans, such as marine conservation, transportation, mining, tourism, and national security and defense. Databases on wind, geology, and the marine environment should also be digitized and made widely accessible to relevant stakeholders.

Sixthly, persistence and consistency are required in attracting and effectively utilizing international financial resources for offshore wind power development. Vietnam should proactively engage in and leverage programs and support funds from international organizations and developed countries for renewable energy transition. Actively seeking foreign investment, particularly from countries with experience and strong investment potential in offshore wind projects, and mobilizing green funds, green bonds, and clean technology support capital will also play a crucial role in achieving the set goals.

Seventhly, Vietnam should actively participate more in international cooperation networks for offshore wind power development, sharing information, learning management experiences, policy creation, and practical project implementation from leading countries such as the United Kingdom, Denmark, Germany, and China.

5. CONCLUSION

The article has synthesised and analysed the opportunities and challenges in policies and laws serving the development of renewable energy in Vietnam today to achieve the goals in the National Power Development Plan VIII. The article also pointed out the existing challenges in developing renewable energy and proposed regulations that need to be removed ■

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Assessment of heavy metal content and agricultural reuse potential of municipal solid waste incineration ash

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Abstract

Municipal solid waste incineration ash presents a significant environmental challenge globally. In Vietnam, the utilization of ash from waste incineration remains limited, posing potential risks to both the environment and public health. This study aims to analyze the heavy metal content and assess the potential reuse of ash from municipal solid waste incinerators in agriculture. Through sampling and analysis methods, the nutrient composition, including N, P, K, along with heavy metal residues (As, Hg, Pb, Cd), were determined to evaluate its reuse potential. The results indicate that both ash and slag contain high nutrient levels, and the heavy metal content falls within safe limits for agricultural applications. The study proposes solutions for the sustainable reuse of ash, reducing reliance on chemical fertilizers and contributing to the circular economy through effective waste management.

Keywords: ash; coal ash; heavy metals; municipal solid waste incinerator; slag; reuse.

JEL Classifications: Q51, Q52, Q53.

Received: 1st July 2024; **Revised:** 10th August 2024; **Accepted:** 23rd August 2024.

1. INTRODUCTION

Vietnam's population is rapidly increasing, positioning the country as the 14th most populous nation worldwide. This population growth exacerbates waste management challenges, as household waste generation rises significantly. Current landfill sites are overloaded, negatively impacting nearby communities. Waste-to-energy incineration plants are considered an advanced solution, widely implemented in countries like Japan, China, and several European nations (Tun et al., 2020). In Vietnam, facilities such as the Dan Phuong Waste Treatment Plant, the Soc Son Waste-to-Energy Plant, and the Can Tho Waste-to-Energy Plant have adopted this technology. However, the management of ash residue from incineration facilities remains a pressing concern.

Although composting technology for organic waste is known, it still faces challenges in Vietnam. For instance, compost from facilities like Vietstar and Tan Sinh Nghia struggles with high costs and low quality due to inadequate waste sorting, leading to compost backlogs. The use of incineration ash in agriculture is limited compared to its application in construction materials, partly due to concerns about potential hazards like toxins, radioactive substances, explosion risks, and corrosion or toxicity (Van, 2019). Ash can directly impact human health or interact with other elements to pose indirect risks (Ngo & Bui, 2015).

Research indicates that incineration ash can be utilized to improve agricultural soil, in building materials, and in environmental restoration of limestone quarries (Ngo & Bui, 2015). Ash holds substantial potential in agriculture due to its effectiveness in enhancing soil quality and crop yields. High levels of elements like potassium, sodium, zinc, calcium, magnesium, and iron in ash can increase the productivity of various crops (Hafeez et al., 2023). Its alkalinity and high mineral content make ash a viable option for use as fertilizer or soil amendment. Additionally, ash enhances soil structure, increasing porosity, water retention, and drainage capacity (Rashid et al., 2023). This has been shown to benefit the growth of leafy greens, roses, and water spinach, especially for urban households with limited space. Inexpensive and readily available, ash allows for the creation of mini vegetable or flower gardens with minimal effort and cost. Moreover, ash serves as an effective water filtration material, absorbing dissolved organic compounds and maintaining water clarity, which is advantageous for ornamental fish farming (Lavane et al., 2018).

Given the environmental challenges posed by waste incineration and the promising potential of ash reuse in agriculture, this study is crucial in evaluating its feasibility. The research aims to analyze the heavy metal content and assess the reuse potential of incineration ash from municipal solid waste incinerators in agriculture. By understanding the composition of bottom ash, the study seeks to determine its applicability in agricultural settings. The novelty of this study lies in its comprehensive assessment of incineration ash, focusing on its chemical composition and the potential risks and benefits of soil application. This research is significant for environmental sustainability, exploring innovative methods for waste management while enhancing agricultural productivity. Furthermore, the findings have broader implications for sustainable development and socio-economic growth, as using incineration ash in agriculture can reduce dependency on chemical fertilizers, lower agricultural costs, and mitigate the environmental impact of waste management practices. This aligns with promoting a circular economy, where waste materials are repurposed to create value-added products, contributing to environmental protection and economic development.

2. MATERIALS AND METHODS

2.1. Research materials

The ash and charcoal samples were collected from the incinerator 15 minutes after the combustion process began to ensure uniformity and represent the quality of ash at a stable temperature and chemical reaction phase. These samples were provided by Nam Long Xanh Joint Stock Company, a leading entity in solid waste incineration technology located in Binh Chanh district, Ho Chi Minh city, Vietnam. Sampling was conducted in August 2023 to ensure that the data accurately reflect the conditions and characteristics of the incineration process during the study period.

2.2. Sampling and analysis methods

For ash obtained from the incineration of homogeneous solid waste, three representative samples were randomly collected from various points within the waste mass to ensure representative distribution for comparison against hazardous waste thresholds.

The samples underwent leaching analysis following the ASTM D5233-92 standard (Nguyen et al., 2023), a standardized method for single-batch extraction for waste materials. Cadmium (Cd), Copper (Cu), Lead (Pb), and Nickel (Ni) concentrations were subsequently determined using EPA SW-846 Method 3050B and TCVN 647:2007. Atomic Absorption Spectroscopy (AAS) was applied to analyze Iron (Fe) according to ACIAR-AAS 008-2007, Magnesium (Mg) as per ACIAR-AAS 011-2007, Manganese (Mn) in line with ACIAR-AAS 012-2007, Zinc (Zn) according to ACIAR-AAS 019-2007, Mercury (Hg) following ACIAR-AAS 009-2007, and Arsenic (As) based on ACIAR-AAS 001-2007 (García & Báez, 2012).

To provide a comprehensive perspective and suggest effective solutions, the study also included an analysis of charcoal. This comparison aimed to evaluate the specific differences between these two by-products, thereby clarifying the application potential of each within different contexts. The inclusion of both ash and charcoal in the analysis not only broadens the research scope but also enables more detailed recommendations aligned with sustainable agricultural and waste management objectives. Data collection were statistically processed and analyzed using Microsoft Excel 2016 and SPSS 20..

2.3. Evaluation methods for reuse purposes

The evaluation methods and legal framework for the reuse of ash and charcoal are based on the following standards and regulations:

National Technical Regulation on Hazardous Waste Thresholds – Vietnam Standards (QCVN) 07:2009/BTNMT: This standard defines hazardous waste thresholds, covering both inorganic and organic hazardous components. It also specifies technical



▲ Figure 1. Ash (A) and coal (B) samples used in the experiment



requirements for sampling, analysis, identification, and classification of hazardous waste (QCVN 07:2009/BTNMT, 2009) (Huyen & Tram, 2019).

QCVN: 2018/BNNPTNT – National Technical Regulation on Fertilizer Quality: This regulation establishes quality standards, limiting factors, testing methods, and management requirements for fertilizers during production, import and distribution in Vietnam.

Government Decree No.108/2017/ND-CP on Fertilizer Management: This decree provides guidelines for state management of fertilizers, including recognition, testing, production, trade, export, import, quality management, labeling, advertising, workshops, and use of fertilizers in Vietnam.

Decision No.100/2008/QĐ-BNN on Production, Trading and Use of Fertilizers: This decision specifies allowable quantitative deviations and mandatory quantitative criteria for various types of fertilizers.

3. RESULTS AND DISCUSSION

3.1. Evaluation of nutritional components in ash and charcoal from municipal solid waste incineration

Table 1 provides information on the N, K, and P content in ash and charcoal derived from the incineration of municipal solid waste. The presented data highlight the primary chemical components that could impact plant growth when these materials are added to soil.

Both ash and charcoal exhibit relatively high alkalinity, with pH values of 9.8 and 9.4, respectively. This alkalinity can be advantageous for agricultural applications, as it may raise soil pH and neutralize acidic soils. Studies have shown that increasing the amount of fly ash can enhance soil pH (Kishor et al., 2010). However, an excessively high pH range, from 11 to 12, can severely inhibit bacterial respiration, impacting enzyme activity and disrupting the nitrogen cycle in soil.

Plants grow best under high humidity, above 90%, as increased respiration intensity promotes rapid germination. For sandy soils, the application of fly ash can alter soil structure, improve micronutrient availability, and enhance water retention (Page et al., 1979). Despite the relatively low moisture content of ash and charcoal, fly ash has a water-holding capacity of 49–66% by weight. Adding up to 46% fly ash can reduce soil bulk density. Increasing fly ash concentration in agricultural soils has been shown to improve soil porosity and water retention, benefiting plant growth (Khan & Wajid, 1996). High soil moisture, when supplemented with incineration ash, creates an ideal environment for seed germination.

The nitrogen content in ash and charcoal is 0.5% and 0.83%, respectively. Nitrogen is an essential nutrient for plant growth, supporting robust development. The phosphorus content (as P_2O_5) is 1.12% in ash and 0.32% in charcoal, playing a vital role in root and flower development, which are crucial for plant growth.

The potassium content (as K_2O) in ash is 3.07%, meeting the QCVN 01-189:2019/BNNPTNT standard, which requires a minimum of 3.0% K_2O in compound fertilizers. This indicates that ash can be an effective potassium source for crops. Although the potassium content in charcoal is 1.05%, lower than the QCVN requirement, it can still contribute potassium to the soil.

In conclusion, the levels of N, K, and P in ash and charcoal from municipal solid waste incineration indicate potential for soil quality enhancement (QCVN 01-189:2019/BNNPTNT, 2019). With their water retention capabilities and essential nutrients, ash and charcoal can support plant growth, reduce fertilizer costs, and promote sustainable agriculture. Utilizing ash and charcoal as viable fertilizer sources not only offers economic benefits but also contributes to environmental protection and sustainable agricultural practices.

3.2. Evaluation of heavy metal residues in ash and charcoal from incinerators

The four micronutrients - Nickel (Ni), Manganese (Mn), Titanium (Ti), and Copper (Cu) - listed in Table 2 may benefit soil and plants at low concentrations. However, excessive nickel can adversely affect plants by slowing germination, inhibiting shoot and root growth, reducing biomass, limiting nutrient uptake from roots, and suppressing photosynthesis and transpiration. At low concentrations, nickel plays an essential role in plants, bacteria, and fungi; thus, nickel deficiency can result in stunted growth, leaf and meristematic tissue infections, altered nitrogen metabolism, and reduced iron uptake (Ahmad & Ashraf, 2012). The nickel content in ash (16.4 ppm) is 2.8 times higher than in charcoal (5.78 ppm).

Table 1. N, K, P composition of ash after burning household waste

Parameter	Unit	Ash sample	Coal sample
pH		9.8	9.4
Moisture	%	8.2	10.6
Total N	%	0.5	0.83
Total P as P_2O_5	%	1.12	0.32
Total K as K_2O	%	3.07	1.05



Manganese is an important mineral nutrient for plants, playing a significant role in various physiological processes, particularly photosynthesis (Rashed et al., 2019). Manganese deficiency commonly occurs in soils with a pH above 6 and in highly weathered tropical soils. It is crucial in enhancing stress tolerance. The deficiency threshold for manganese is generally below 20 ppm in the dry weight of young leaves. The manganese content in ash (557 ppm) is 2.9 times higher than in charcoal (189 ppm).

Titanium is considered beneficial for plant growth. It is absorbed through roots and leaves and is known to improve crop yield by stimulating enzyme activity, increasing chlorophyll content and photosynthesis, enhancing nutrient uptake, strengthening stress tolerance, and improving crop yield and quality. Titanium is beneficial at low concentrations but can become harmful at high levels (Lyu et al., 2017).

Finally, copper is an essential nutrient for plants, yet excessive copper can negatively affect plant growth. The copper content in ash (32.4 ppm) is 2.4 times higher than in charcoal (13.4 ppm). Although copper is a necessary micronutrient for plants, an excess is toxic to most plant species (Shabbir et al., 2020).

According to the data, the metal content in ash and charcoal from municipal solid waste incineration remains below the absolute threshold limits set by QCVN 07:2009/BTNMT (National Technical Regulation on Hazardous Waste Thresholds). Therefore, the ash and charcoal samples can be considered non-hazardous to humans and the environment (QCVN 07:2009/BTNMT, 2009). After screening, the ratio of ash to charcoal was determined to be 12% ash and 88% charcoal. However, the concentration of heavy metals in ash is significantly higher than in charcoal. The results indicate that metal accumulation in ash is approximately 2.5 to 3 times greater than in charcoal.

3.3. Evaluation of toxic heavy metal content and their impact on plant growth

Metals such as arsenic (As), mercury (Hg), cadmium (Cd), cobalt (Co), antimony (Sb), and tin (Sn) are generally harmful to plants upon exposure. These metals adversely affect the physiological and biochemical functions of plants, leading to growth inhibition, chlorosis, necrosis, leaf curling, altered stomatal activity, membrane dysfunction, inhibition of photosynthesis and respiration, and disruptions in metabolism and the activity of essential enzymes (Ashfaque et al., 2016). The study by Farha Ashfaque and colleagues highlights the impact of heavy metals on plants, as detailed in Table 3.

However, results from Table 2 indicate that neither ash nor charcoal contains detectable levels of arsenic (As), mercury (Hg), cadmium (Cd), cobalt (Co), antimony (Sb), or tin (Sn). This absence is advantageous when considering the use of ash and charcoal in products to support plant growth. The lead content in ash and charcoal is 13.1 ppm and 3.95 ppm, respectively. Chromium levels are 29.9 ppm in ash and 11.6 ppm in charcoal. Although the concentrations of lead and chromium in both ash and charcoal are significantly lower than regulatory standards, these metals are harmful to both humans and organisms and should be carefully considered for agricultural applications (Pratush et al., 2018).

Table 2. Metal content from ash and coal

Metal	Unit	Ash sample	Coal sample	Hazardous waste threshold QCVN 07:2009/BTNMT
As	mg/kg	ND	ND	36.88
Hg	mg/kg	ND	ND	3.69
Pb	mg/kg	13.1	3.95	276.6
Cd	mg/kg	ND	ND	9.22
Ni	mg/kg	16.4	5.78	1291
Co	mg/kg	Lower 3.0	ND	1475
Sb	mg/kg	ND	ND	18.44
Cr	mg/kg	29.9	11.6	-
Sn	mg/kg	ND	ND	-
Mn	mg/kg	557	189	-
Ti	mg/kg	444	147	-
Cu	mg/kg	32.4	13.4	-

* Note: ND – Not Detected



Table 3. Evaluation of toxic heavy metal content and their impact on plant growth (Ashfaque et al., 2016)

Metal	Dosage	Physiological, metabolic and crop yield effects
Cd	200 mg CdCl ₂ /kg soil	Decreased net photosynthesis, RuBisCo activity, increased lipid peroxidation and H ₂ O ₂ content.
	25, 50, 100 and 150 mg CdCl ₂ /kg soil	Decreased dry weight, leaf area, net photosynthetic rate, chlorophyll content and grain yield
	25 and 50 µM/l CdCl ₂	Decreased photosynthesis, growth, chlorophyll fluorescence, leaf area, dry weight and increased antioxidant enzyme activities.
Pb	150 – 1500 µM of Pb(C ₂ H ₃ O ₂) ₂	Decreased growth, chlorophyll content, carotenoids and proline levels.
As	5 – 50 µM Na ₂ AsO ₄	Inhibited seed germination and stunted plant growth.
	25 µM Na ₃ AsO ₃	Reduced root and shoot development.
Cu	5 – 50 µM CuSO ₄ ·5H ₂ O	Reduced seed germination, inhibited plant growth and reduced root and shoot length.
Ni	200 µM NiSO ₄ /kg soil	Reduced photosynthesis, chlorophyll content, stomatal conductance, nitrogen content and activities of enzymes such as RuBisCo and nitrate reductase.

The analysis data show that lead levels in ash are approximately three times higher than in charcoal, suggesting a higher risk associated with ash compared to charcoal if added to soil in the same quantity. Similarly, the chromium content in ash is about 2.5 times greater than in charcoal. While chromium can have both beneficial and harmful effects, proper supplementation can promote plant growth.

3.4. Evaluation of the reuse potential of ash and charcoal from municipal solid waste incinerators for agricultural purposes

Beyond comparing with hazardous waste standards, considering the mandatory quantitative criteria for fertilizers - including organic, organic-mineral, microbial, and bio-organic fertilizers produced from municipal waste, industrial processing waste, food waste, livestock waste, and organic foliar fertilizers - as outlined in Decision No.100/2008/QD-BNN by the Ministry of Agriculture and Rural Development on “Regulations on Fertilizer Production, Trading, and Use,” the heavy metal content in both ash and charcoal does not exceed the mandatory quantitative limits. Therefore, they hold potential for agricultural use, provided they meet regulatory requirements for commercialization and undergo trial production testing.

Table 4. Mandatory quantitative criteria for fertilizers

Heavy metal	Limit threshold (100/2008/QD-BNN)
As	≤ 2.0 mg/kg or ppm
Cd	≤ 2.5 mg/kg or ppm
Pb	≤ 250.0 mg/kg or ppm

This assessment indicates that, although heavy metals are present in ash and charcoal, their concentrations remain within permissible limits. Therefore, ash and charcoal can be considered for agricultural applications, offering a sustainable approach to recycling waste materials into valuable soil amendments (Campos et al., 2020; Ukwattage et al., 2013).

Ash, rich in elements such as potassium (K), phosphorus (P), and nitrogen (N), is suitable for crops with high nutrient demands, such as rice, corn, soybeans, and fruit trees (e.g., banana, mango, orange), to improve yields. Meanwhile, charcoal, with its porous structure and good water retention, is ideal for crops grown in sandy or fast-draining soils, such as leafy vegetables (lettuce, mustard greens), flowers (roses, chrysanthemums), and ornamental plants.

Additionally, the alkalinity of ash aids in neutralizing acidic soils, which is particularly beneficial in areas with low pH. This makes ash useful in the cultivation of industrial crops such as coffee, tea, and rubber, helping to maintain stable pH levels while supplying essential nutrients. By enhancing soil structure and increasing water retention capacity, charcoal can support the growth of short-cycle crops and greenhouse vegetables, optimizing water and nutrient use.



To expand and widely implement these new technologies, various approaches need consideration. From a policy perspective, appropriate policies from government agencies or organizations and individuals interested in utilizing ash and charcoal are essential (Munawar et al., 2021). Policies should initially support businesses toward green development and environmental waste management. These policies should align with the national “Green Growth” agenda (Lorek & Spangenberg, 2014), leveraging the potential of individuals or groups interested in using this type of ash and charcoal waste.

To maximize the reusable amount of ash and charcoal, support from businesses or government is necessary. Additionally, policies promoting waste sorting at the source should be strengthened. The primary limitation of this process lies in properly collecting waste according to its composition to ensure a stable input source, avoiding harmful elements in the final product. Lessons should be drawn from previous policies and programs implemented in Vietnam to avoid pitfalls that led to unsatisfactory results, such as the “3R Project” (Mohammed et al., 2020).

4. CONCLUSION

Analysis of ash and charcoal from municipal solid waste incineration using gasification technology indicates that both materials contain high levels of N, P, and K, which are beneficial for enhancing soil fertility. However, ash exhibits a higher concentration of heavy metals compared to charcoal, with a sample composition ratio of 12% ash and 88% charcoal. Despite the presence of heavy metals, these concentrations remain within permissible limits under QCVN 07:2009/BTNMT, classifying ash and charcoal as non-hazardous waste with potential for agricultural reuse if managed appropriately. This application not only reduces reliance on chemical fertilizers and lowers production costs but also mitigates the negative impacts of waste management. The study highlights the potential for sustainable circular economy development by transforming waste into resources, which promises positive contributions to agriculture and environmental protection in the future.

While the study provides detailed data on nutrient and heavy metal content in ash and charcoal from municipal solid waste incineration, some limitations remain. First, the sample collection was restricted to a specific location and time, which may not fully represent variations over time and across different locations. Second, the study focuses on chemical composition analysis without in-depth evaluation of the long-term impacts of ash and charcoal on soil ecosystems and crop productivity over multiple growing seasons. Additionally, large-scale field trials to verify the effectiveness and safety of using ash and charcoal have yet to be conducted, limiting immediate

practical applications. Based on the study results, future directions could focus on long-term assessments of ash and charcoal impacts on various crops and soil environments over multiple seasons. Expanding the research to explore the combination of ash and charcoal with organic and microbial fertilizers could also optimize usage efficiency. Developing supplementary treatment processes for ash and charcoal to further minimize heavy metal residues is another essential area of focus. Further investigation into integrating ash and charcoal within closed-loop farming systems or high-tech agriculture holds promise for creating new value while contributing to sustainable circular economy models.

Acknowledgments: We would like to express our gratitude to the Ho Chi Minh City University of Technology, Vietnam National University, Ho Chi Minh City, for providing the time and facilities essential for this research. We also extend our thanks to Nguyen Tat Thanh University for supporting part of the venue and equipment needed for the experiments. The project team greatly appreciates the participation and support in the survey conducted by student Nguyen Binh Thao Nhi from the Faculty of Environment and Natural Resources at the Ho Chi Minh City University of Technology, Vietnam National University, Ho Chi Minh City ■

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Assessment of the amount of solid waste leaking into the environment in Phu Nhuan district, Ho Chi Minh city

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Abstract

Nowadays, most of the domestic solid waste (DSW) discharged by humans in urban areas has been collected, but some of it is still leaked and discharged into the environment. Therefore, assessing the amount and composition of waste leaked into the environment is necessary in the context of increasing environmental concerns. The study applied the survey and data analysis method to assess the amount and composition of waste leaked in Phu Nhuan district, Ho Chi Minh City. The research results recorded: On land with 35 survey locations with a total survey area of 2.600m², 1.849 pieces of garbage were collected, an average of 0,71 pieces/m². For garbage, fragments accounted for 54%, intact garbage accounted for 46%. Plastic waste is the most commonly found material, accounting for 49% of fragmented waste and 22% of intact waste. Of these, waste in size number 3 (from 2cm x 2cm, smaller than 4cm x 4cm) was found the most, accounting for 47%. The total number of garbage audited on the river was 2.161 pieces of garbage, of which 2.083 were fragmented and 78 were intact. 100% of intact garbage was plastic, while 95% of fragmented garbage was plastic. The most garbage found on the river was styrofoam food containers, accounting for 27%, followed by plastic bags, accounting for 26%, and food labels, accounting for 17%. The research results showed that plastic waste is currently the component with the highest proportion in surveys on land or garbage collected on the river. From there, the research team proposed a number of measures to limit garbage and plastic waste from leaking into the environment.

Keywords: Plastic waste, Solid waste, Waste leaked into the environment.

JEL Classifications: P18, Q53, Q56.

Received: 2nd August 2024; **Revised:** 22nd August 2024; **Accepted:** 16th September 2024.

1. INTRODUCTION

Most municipal solid waste (MSW) generated by urban residents is collected, but a portion remains uncollected, leaking and being emitted into the environment. This waste is discarded on land and streets and influenced by human activities and environmental factors, it eventually flows into canals, rivers, and streams, ultimately reaching the oceans. According to the 2016-2020 National Environmental Status Report, it is estimated that Vietnam is discharging around 60,000 tons of household waste into the environment every day, with an annual increase of 10%. It is estimated that about 15% of this waste is recycled or reused. The remainder is either buried in landfills, discharged into water sources, or burned in conventional waste disposal methods. The volume of plastic products used annually has increased from 3.8 kg per person in 1990 to 41,3 kg per person in 2018. The amount of plastic waste generated from MSW in Vietnam in 2021 was 8.021 tons per day, equivalent to approximately 2.93 million tons per year. The amount of plastic waste has been on the rise in recent years (approximately 2,7 million tons in 2018, 2,83 million tons in 2019, and around 2,93 million tons in 2021) [1].

Ho Chi Minh City is the largest urban area in Vietnam, with a population of about 9 million people. It is estimated that the city generates approximately 9.800 tons of MSW daily, with an annual growth rate of about 6-10% [5]. The average per capita waste generation rate is about 0,98 kg per person per day. With a collection rate of 91%, it is estimated that nearly 900 tons of waste remain uncollected every day. This uncollected waste is dispersed into the environment, flowing through canals, rivers, and eventually into the sea. Due to the tropical and subtropical climate, plastic waste is prone to degradation into small fragments and microplastics, which can easily escape into the environment.

Many studies have been conducted on the current status of solid waste management in Ho Chi Minh City. However, few have assessed the amount of solid waste that leaks or escapes into the environment. Phu Nhuan District, located 4,7 km northwest of the city center, is one of the central districts of Ho Chi Minh City. It serves as a gateway to



the northern part of the city. Phu Nhuan District covers an area of 4,88 km² with 13 wards and a population of approximately 195.743 people (as of June 2023). The Nhieu Loc – Thi Nghe canal flows through the district. With a waste generation rate of 0,98 kg per person per day, it is estimated that the district must collect approximately 191 tons of waste per day. Therefore, this study was conducted to assess the amount and composition of waste leaking into the environment in Phu Nhuan District. Choosing Phu Nhuan as a study area is considered representative of the inner-city districts of Ho Chi Minh City.

2. RESEARCH METHODOLOGY

2.1. Survey Time and Location

Survey period: From May 19th, 2024, to May 21st, 2024.

Location: The survey was conducted at 35 points within Phu Nhuan District and some neighboring areas of Phu Nhuan District, Ho Chi Minh City, Vietnam.

2.2. Research methodology

2.2.1. Survey method

Inland area survey method

The field data was collected according to the inland survey guidelines in the document “Manual on Ocean Waste Monitoring Methods, Part I and Part II” [3][4], developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) with the support of the Coordinating Body for the Seas of East Asia (COBSEA) and the United Nations Environment Programme

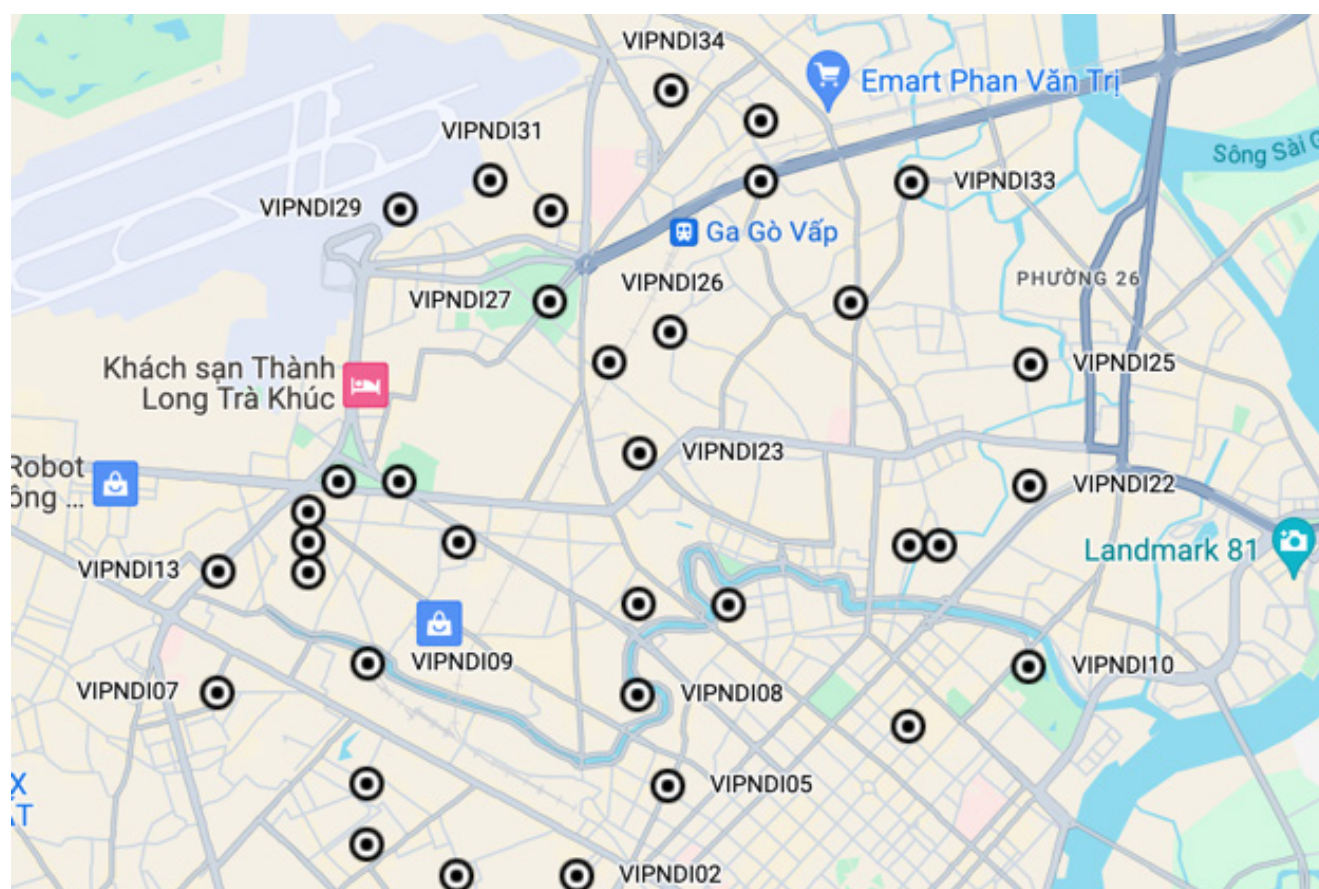
(UNEP) through the SEA Circular Project, funded by the Swedish Government. The following steps were undertaken:

Step 1: Site Selection: Survey sites were randomly selected on a map by placing a 500-meter grid over the study area and choosing the center of each 500m x 500m grid square. A total of 30 to 40 sites were selected. The survey area covered not only Phu Nhuan District but also nearby districts such as District 10, District 1, Binh Thanh District, Go Vap District, Tan Binh District, and District 3.

Step 2: Selection of Transects: A total of 3 to 6 transects were surveyed at each site. Transects on land were 25m² in area (12,5m x 2m or 25m x 1m) and were selected based on the main land uses in the survey area. The transects were spaced at least 30-50 meters apart. In this study, 104 transects were surveyed across 35 selected sites in Phu Nhuan District.

Step 3: Conducting the Survey:

1. Upon arriving at the designated GPS survey point, fill out the Inland Survey Area Information form, take photos, and record GPS coordinates.

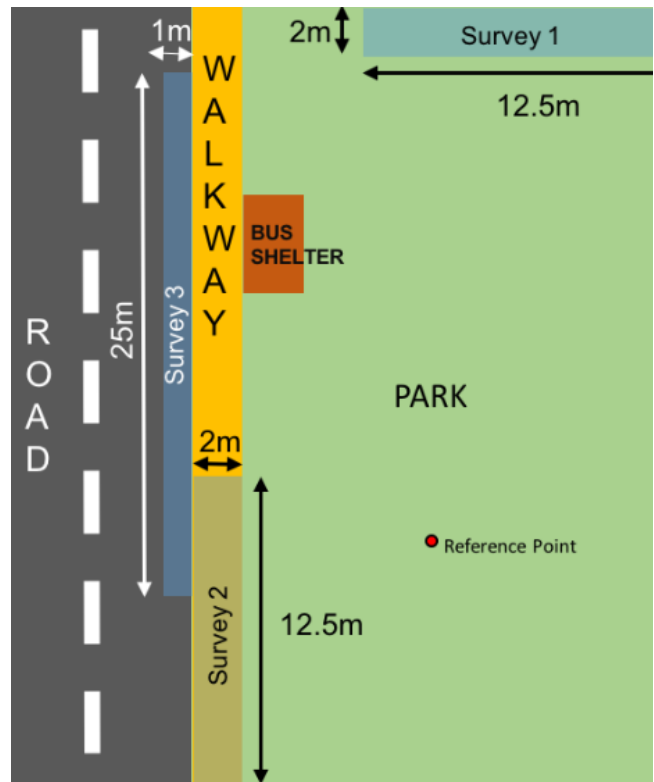


▲ *Survey points in Ho Chi Minh City*

The image below is an example of a survey site with four types of terrain/environment with different land use purposes: sidewalk, roadside, park, and bus stop.

The first transect is placed in the park, which has the largest area. The second transect is placed on the sidewalk, the second-largest area, and another transect is placed along the pathway.

If no waste is found in these areas, then additional transects numbered 4, 5, and 6 must be added. These should be placed in any types of terrain/environment that have not been surveyed yet, and then additional cross-sections should be added in proportion to the types of environments in the area. In the example above, a fourth transect can be added around the bus stop, the fifth transect in the park, and the sixth transect along the sidewalk.



2. Define the transect areas for the survey at the site:

- At each site, 3-6 transects were randomly selected for the survey. If no waste was found after completing the third transect, the survey continued until at least one piece of waste was found or all 6 transects were surveyed.

- If the site contained different types of land use, the transects were selected to represent the diversity of land uses (e.g., parks, roadsides, grassy areas, parking lots, etc.). Each transect had an area of 25m², and the dimensions could be 2m x 12,5m or 1m x 25m.

- The distance between transects should be at least 30m.

3. Mark the survey transect area with a measuring tape:

- Identify the starting point of the transect and use a random method to determine the direction of the transect.

- Use the measuring tape to mark the transect from the starting point to the end, dividing each side by 1 meter. When placing the tape, ensure it follows an arc to maintain the waste's current condition.

4. Complete the Transect Data Form and take a photo of the transect starting point.

5. Record the transect's length. Divide the transect into 10 equal sections and record the data for each section in the Object Catalog Form.

6. Move along the transect to identify, find, and count waste:

- Each transect is surveyed by a group of 3 people: 1 person recording data and 1-2 people conducting the survey. After marking the transect and setting the measuring tape, the surveyors will stand at the 0-meter point at each side of the tape.

- The length of the transect is divided into 10 sections. Each section is surveyed sequentially from 1-10. Each section is marked with a 1-meter-long string at the end of each section.

- Starting at each section, the surveyor will identify and report the first piece of waste seen, measure its size, and announce its position. The waste size is measured using a size chart, selecting the box that can fit the longest diagonal of the waste.

- Waste is categorized as either intact or fragmented.

Example: "Section 1, metal bottle cap, intact, at position 0,5m, size 2."

After the first piece, the surveyor will continue to identify and report the remaining waste, but without mentioning position or size for the subsequent pieces. Example: "Section 1, 2 metal bottle caps, intact."

Note: The surveyor only surveys each section once and does not go back to search for additional waste.

7. The recorder will log all data into the Object Catalog Form:

- The recorder will stand outside the survey area and record the data announced by the surveyor.

- At the beginning and end of the search, record the GPS coordinates and take panoramic photos of the transect from both ends.

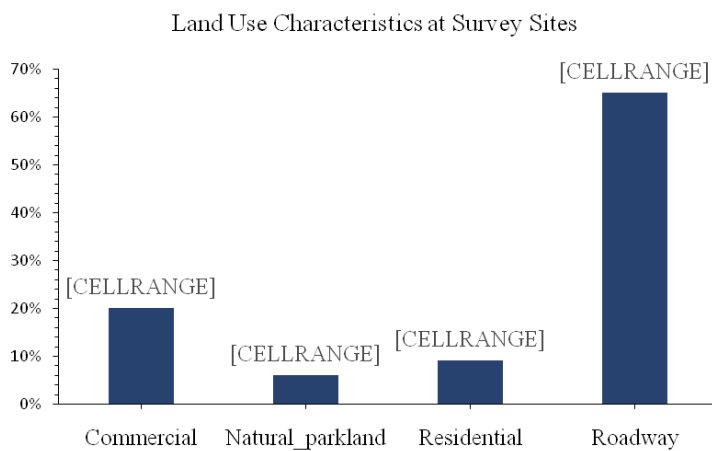


Research methodology for the river area

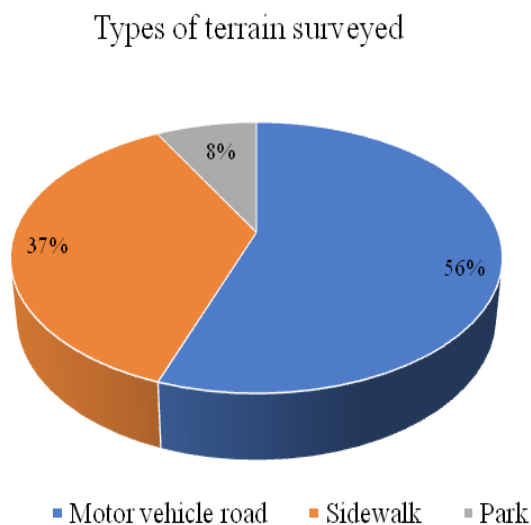
Due to the Nhieu Loc – Thi Nghe canal being lined with vertical embankments, perpendicular to the river's surface, the research team was unable to access the area for the survey following CSIRO's standard method. Therefore, the research team modified the methodology to better suit the current conditions of the area and available resources. The method applied for the study in this area is based on waste auditing techniques.

To assess the composition of waste, the research team used the ¼ method (as outlined in the "Solid Waste Management and Treatment Textbook," Nguyen Van Phuoc, 2008). The sample is taken after mixing and heaping the waste, and then sorting and counting each type of waste that makes up 10% of the total waste volume. The team took 10% of the waste recovered from the river (equivalent to 2 containers of 660L) to carry out the audit. The audit was conducted using the waste collection information categories provided by CSIRO.

Steps for execution: Start by emptying the trash from the container onto a large tarpaulin, and remove the organic waste. After the organic waste has been separated, the re-



▲ Figure 1: Land use characteristics at survey sites



▲ Figure 2: Proportion of Surveyed Terrain Types

maining waste is categorized into distinct types according to the list, with each type placed into separate styrofoam boxes. Then, count the number of waste pieces in each styrofoam box and record the results on a category sheet. Finally, compile and summarize the data.

2.2.2. Data analysis method

All survey data were recorded electronically using the ODK Collect data entry application. The data was then exported into an Excel file, containing the recorded information from the survey, such as the number of waste pieces, waste types, etc. The data was coded numerically and processed statistically based on waste size, waste type, and percentage distribution.

3. RESEARCH RESULTS

3.1. Results from Inland Area Survey

3.1.1. Overview of waste situation

The research team conducted surveys at 35 points spread across Phu Nhuan District and nearby districts [6]. Among the 35 survey points, the predominant land uses were: 66% roads and traffic areas; the second most common was 20% commercial and urban areas, while 9% were residential areas and 6% were parks (Figure 1).

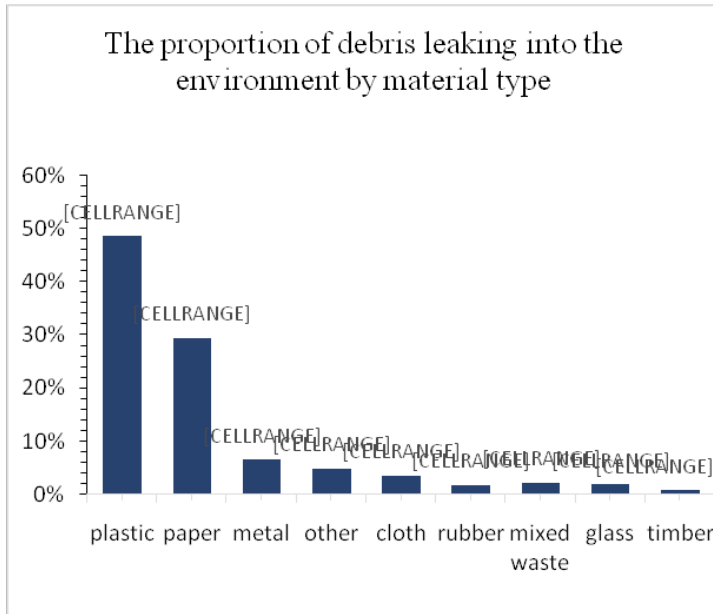
At each site, three transects were surveyed, making a total of 104 transects. Of these, 56% of the survey areas were roads used by motor vehicles (motorbikes, cars, etc.), 37% were pedestrian walkways (sidewalks), and 8% were park areas (grass fields, etc.) (Figure 2).

For the 35 survey points, the research team covered a total area of 2.600 m² across Phu Nhuan District and some neighboring districts. A total of 1.849 waste pieces were collected, including both fragmented and intact waste pieces of various sizes, with an average of 0,71 pieces/m².

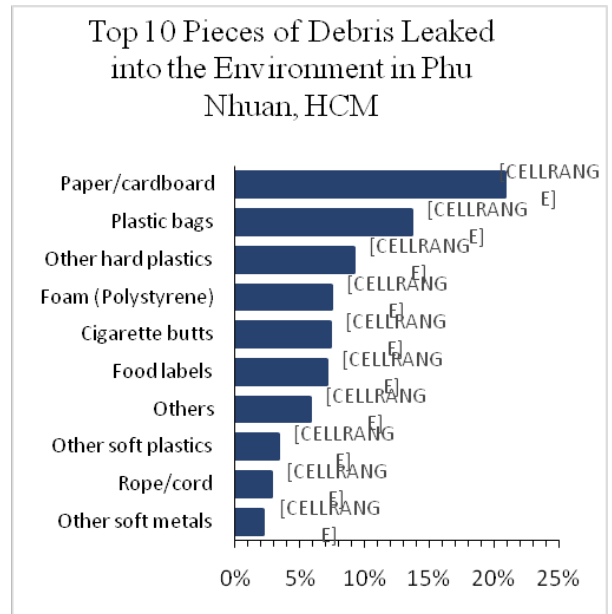
Regarding fragmented waste, 995 pieces (54%) were found, originating from 9 different material types, including plastic, paper, metal, fabric, mixed waste, glass, rubber, wood, and others. Among these, plastic was the most common material, with 484 pieces, accounting for 49% (Figure 3).

Among the 10 most commonly found fragmented waste items, paper/cardboard was the most frequently found type, with 150 pieces, representing 21% of the total fragmented waste. The second most common was plastic bags, with 98 pieces, accounting for 14%. The third most common was unidentified hard plastic items, with 66 pieces, making up 9%. In the top 10, plastic materials were also the most frequently found, accounting for 43% (Figure 4).

Regarding intact waste, 854 pieces (46%)



▲ Figure 3: The percentage of debris leaked into the environment by material type.



▲ Figure 4: Top 10 pieces of debris leaked into the environment in the Phu Nhuan area, HCM City.

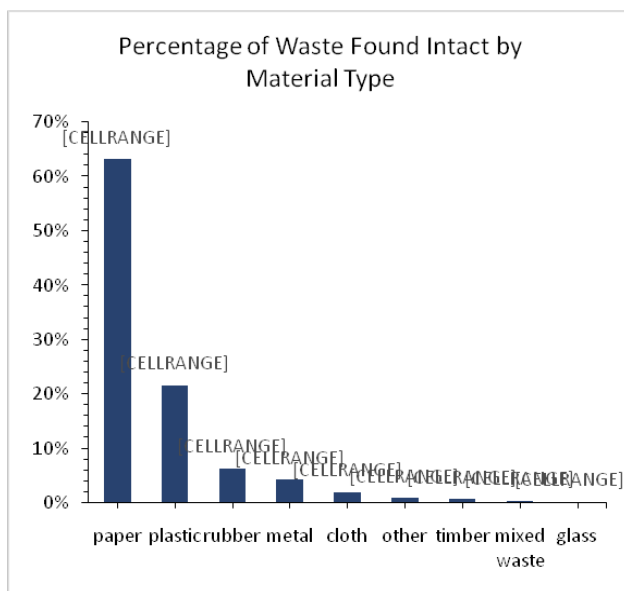
were found, distributed across 9 common material types. Unlike the fragmented waste, intact waste had paper as the most common material, with 540 pieces, accounting for 63%. The second most common material was plastic, with 185 pieces, making up 22%. The remaining materials were all found in quantities of 6% or less (Figure 5).

Among the 10 most frequently found intact waste items, cigarette butts (classified under paper) ranked first with 495 pieces, accounting for 58%. The second most common was paper/cardboard with 37 pieces (4%), followed by other rubber items (36 pieces), plastic bags (34 pieces), and food labels (30 pieces). The remaining items were found in quantities of less than 2% (Figure 6).

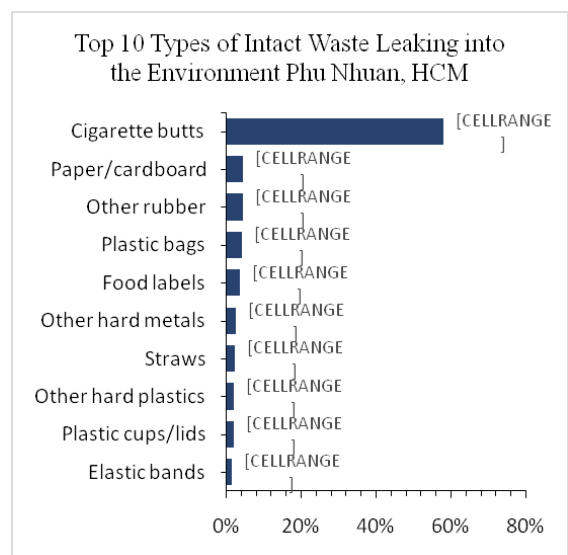
Of the 582 pieces of waste found during the survey, the waste sizes, including both fragmented and intact types,

ranged across seven sizes, from 1 cm² to 22 cm². Among these, size category 3 (ranging from 2 cm x 2 cm, smaller than 4 cm x 4 cm) was the most commonly found, accounting for 47%. Size category 4 (ranging from 4 cm x 4 cm and smaller than 8 cm x 8 cm) was the second most common, comprising 17%. The remaining sizes, category 5 and category 2, made up 12% and 11%, respectively, while the other sizes accounted for less than 7% (Figure 7).

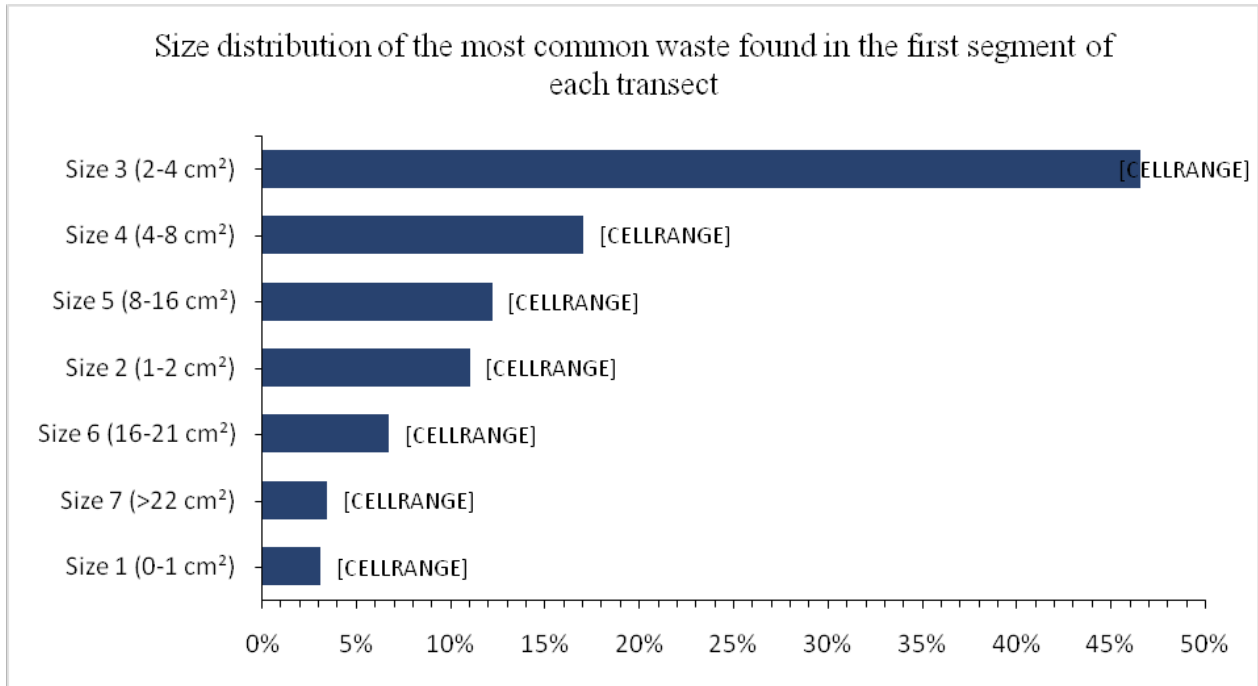
This statistical data aligns with the reality that large pieces of trash are collected for recycling scrap sales. Smaller pieces are often discarded because they have no economic value, or they are spilled during collection due to their small size, making sweeping with a broom ineffective



▲ Figure 5: The percentage of intact waste found by material type



▲ Figure 6: Top 10 types of intact waste leaked into the environment in the Phu Nhuan area, HCM City



▲ Figure 7: Proportion of common waste sizes found in the first segment of each transect

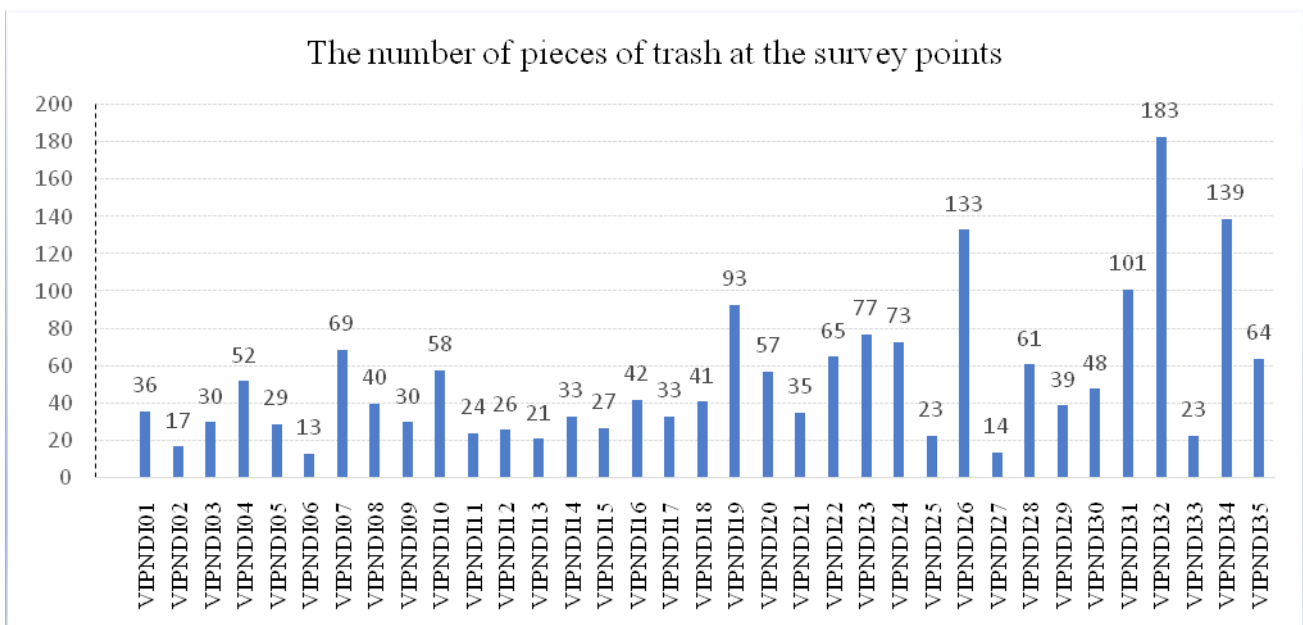
3.1.2. Correlation of waste across survey points

At the 35 different survey locations, the number of waste pieces counted varied, ranging from 13 to 183 pieces per point. Among the areas with higher waste counts (over 100 pieces), the following locations were noted: Location 32 had 183 pieces, Location 34 had 139 pieces, and Location 26 had 133 pieces. These locations are situated on major traffic routes with high pedestrian traffic, and the sidewalks are areas where daily commercial activities take place. For example, Location 32 is on Pham Van Dong Street, while Location 26 is along Nguyen Thuong Hien Street.

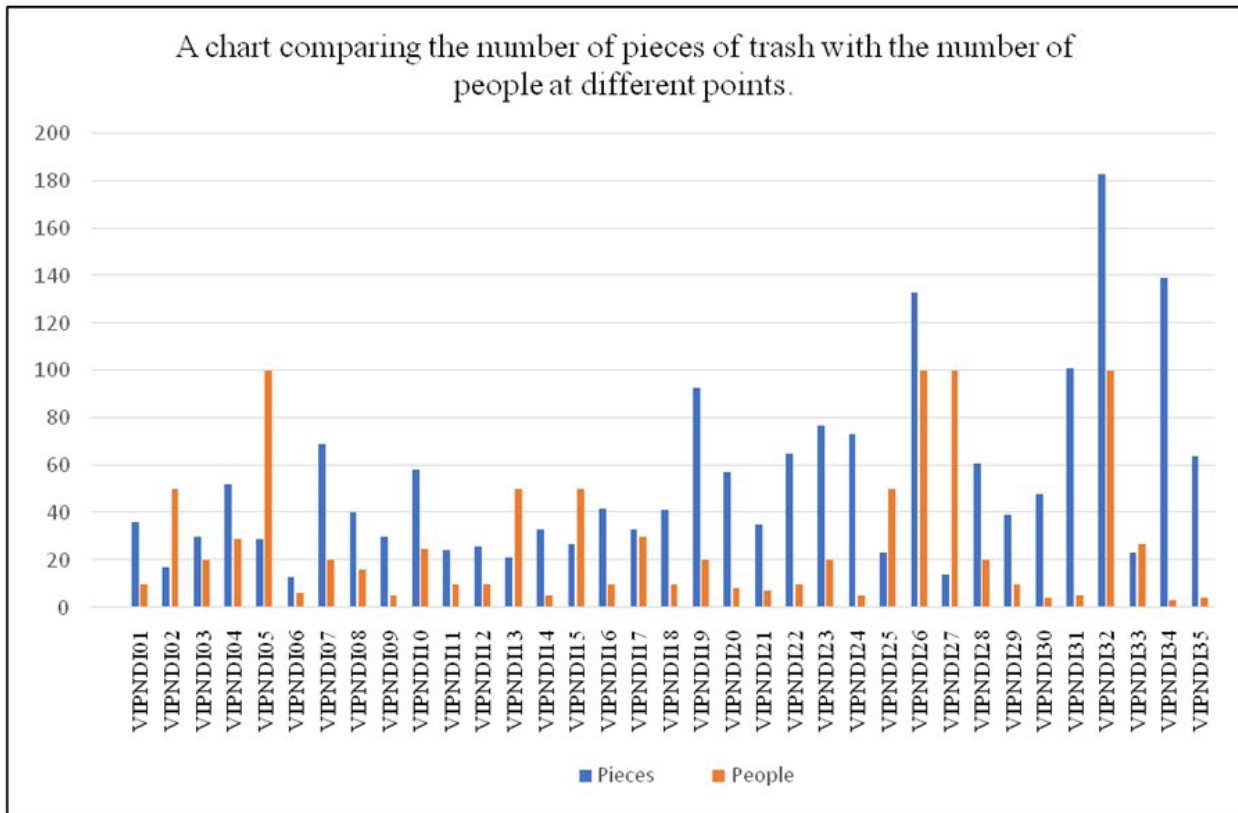
Conversely, areas with fewer waste pieces (under 20 pieces) include: Location 6 with 13 pieces, Location 27 with 14

pieces, and Location 2 with 17 pieces. These are locations that have daily cleaning activities, such as Location 27 in Gia Dinh Park and Location 2 near a foreign language center (Figure 8).

The number of people counted at the survey points can also be considered as a correlation, where areas with higher population densities tend to have a greater amount of waste leaking into the environment. For example, at the point VIPNDI32 (Pham Van Dong Street, Ward 1, Go Vap, Ho Chi Minh City), the highest amount of waste leakage found corresponds with the highest pedestrian traffic (100 people).



▲ Figure 8: Number of pieces of waste at survey locations



▲ Figure 9: Comparison of the Number of Waste Pieces with the Number of People at the Survey Points

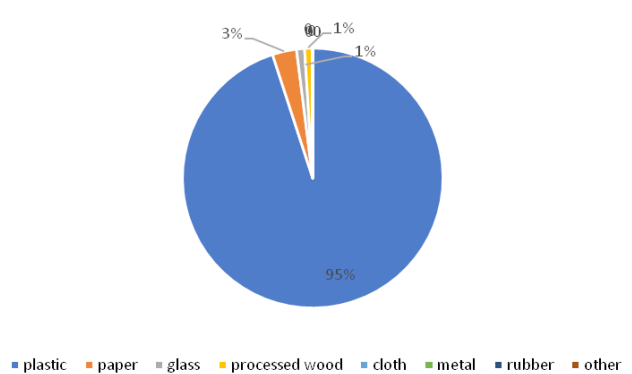
This location is a densely populated residential area with many businesses selling food, drinks, and various goods.

On the other hand, there are cases where this correlation does not hold. For example, at location VIPNDI05, where the count of people is 100, but only 13 pieces of waste were found (the lowest); or at VIPNDI34, where only 3 people were counted, but 139 pieces of waste were found (second highest). These variations could be due to factors such as the frequency of cleaning in the surveyed areas, the awareness and behavior of local residents, and other local conditions (Figure 9).

3.1.3. Comparison with findings from other studies

The results of the study survey indicate that the data collected by the research team is consistent with the data in the 2018 World Bank report (Table 1) [6]. According to the World Bank's data (excluding organic waste), plastic waste represents the largest proportion, followed by paper waste, and thirdly, metal waste. This suggests that the CSIRO survey method employed by the research team is highly suitable for assessing waste leakage into the environment in urban areas. This method can be used to evaluate other regions and serves as a reference for policymakers, local authorities, and the public in waste management and consumer recommendations.

The percentage of fragmented waste types found in the river area.



▲ Figure 10: The percentage of fragmented waste types found in the river area

3.2. Results of river area survey

The waste audit data for the river area shows a total of 2.161 waste items, including 2.083 fragmented waste items and 78 intact waste items. All of the intact waste was plastic, consisting of 62 bottle caps, 14 drinking water bottles, and 2 other bottles. Among the fragmented waste, 95% was plastic, 3% was paper, 1% was glass, and 1% was processed wood (Chart 10).

Among the plastic waste found, the most common item was food containers made from styrofoam, with 565 pieces (27% of the total fragmented waste). The second most common was plastic bags, with 542 pieces (26%). Third was food labels, with 352 pieces (17%),



Table 1: Percentage composition of waste in urban areas in Vietnam

Component	Other Urban Areas in Vietnam	Ha Noi	Hai Phong
Organic Waste	50,2% - 68,9%	51,9%	46% - 49,8%
Plastic and Nylon	3,4% - 10,6%	3,0%	12,2% - 14,2%
Paper and Cardboard	3,3% - 6,6%	2,7%	3,8% - 4,2%
Metals	1,4% - 4,9%	0,9%	0,1% - 0,2%
Glass	0,5% - 2,0%	0,5%	0,8% - 0,9%
Inert Waste	14,9% - 28,2%	38,0%	23,9% - 24,7%
Rubber and Leather	0% - 5,0%	1,3%	0,60%
Plant Waste	1,5% - 2,5%	-	-
Hazardous Waste	0% - 1,0%	-	-
Other Components	-	Textiles 1.6%	8,6% - 10,5%

Source: World Bank, 2018

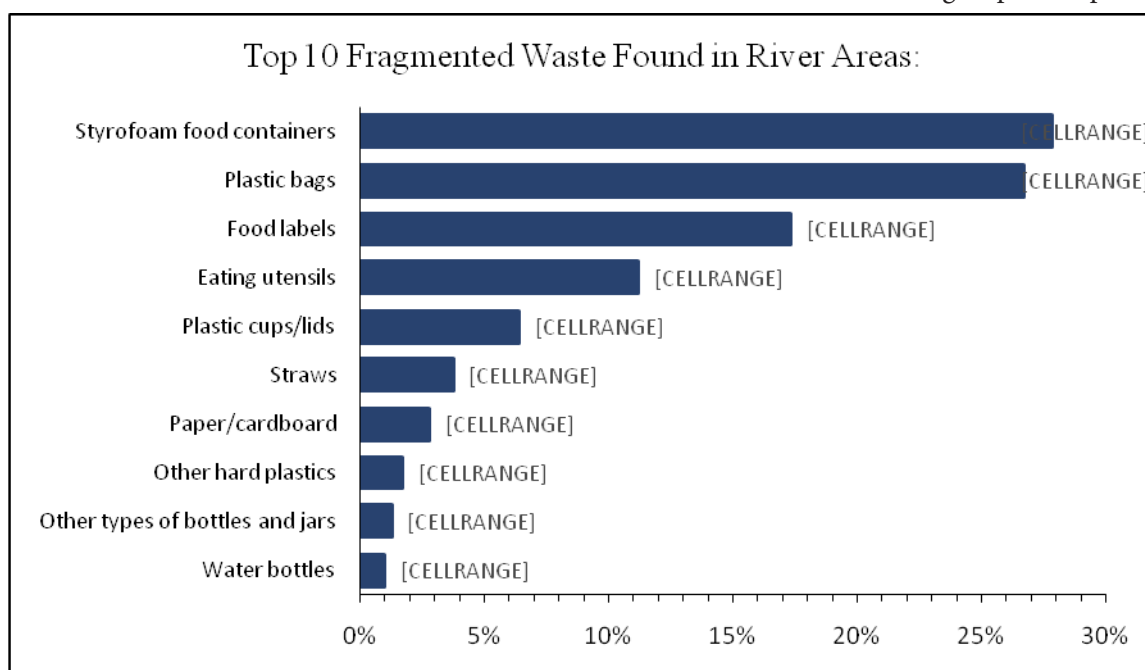
and fourth was plastic eating utensils, with 227 pieces (11%). Other items found in smaller quantities included plastic cups/lids, straws, paper/cardboard, other hard plastics, various bottles, and water bottles, each accounting for less than 10% of the total (Chart 11).

This shows that plastic waste in the river accounts for a very large proportion - over half of the drifting waste is plastic. Compared to the data collected from the land survey, the percentage of plastic waste in the river is much higher. During the survey, the research team observed that the majority of the plastic waste consisted of single-use plastic products, such as plastic bags, food packaging bags, water bottles, straws, plastic spoons, and various packaging materials like candy wrappers and milk cartons. Foam waste was primarily composed of foam food containers and packaging, with some pieces being broken remnants of foam boxes.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

With 35 survey sites covering a total area of 2.600 m², the research team collected a total of 1.849 pieces of waste, including fragmented and intact waste items of various sizes, with an average of 0,71 pieces per m². Of the fragmented waste, 995 pieces were found, accounting for 54%, with plastic being the most prevalent material, comprising 49%. For the intact waste group, 854 pieces were



▲ Figure 11. Top 10 fragmented waste items found in the river area



found, making up 46%. Unlike fragmented waste, the most common intact waste was paper, with 540 pieces (63%). In the river audit, a total of 2,161 pieces of waste were recorded, with 2,083 pieces being fragmented and 78 pieces being intact. The intact waste was 100% plastic, consisting of 62 bottle caps, 14 drinking water bottles, and 2 other bottles. Of the fragmented waste, 95% was plastic. The research team observed that the plastic waste primarily consisted of single-use plastic products that people commonly use daily, such as plastic bags, food packaging bags, water bottles, straws, plastic spoons, and various packaging materials such as candy wrappers, milk cartons, and foam containers used for meals or food. Additionally, some foam waste was broken fragments of foam containers.

4.2. Recommendations

Policy solutions:

Strengthen monitoring and enforcement of waste sorting activities to ensure proper waste disposal in designated areas. This will help to change people's behavior in the surveyed areas. It is essential to promote waste sorting programs and raise environmental awareness through campaigns in offices, schools, shopping malls, and supermarkets to encourage better waste management and establish good habits for waste collection and disposal.

Implement street cleaning and waste collection programs for public areas such as roads, sidewalks, and alleys to reduce littering in the environment. Additionally, the use of street sweeping and vacuum trucks could improve the efficiency of waste removal, ensuring that litter is more thoroughly collected and reducing the amount of waste discarded carelessly.

Increase recycling and reuse efforts for materials like plastic, paper, and organic waste. In parallel, reduce and gradually replace single-use plastic products with more eco-friendly alternatives, such as those made from sugarcane bagasse, coffee grounds, coconut husks, etc.

Implement quotas on the production of single-use plastics, increase taxes on plastic products, and impose taxes on other plastic goods. Expand the responsibility of producers regarding the disposal of their products, even after they become waste. Establish a roadmap for waste sorting at the source to facilitate collection, recycling, and reuse of waste. Proper source separation will pave the way for a circular economy regarding waste, which is the best approach to transform waste into valuable resources.

Public awareness solutions:

Increase public education on waste reduction, recycling, and the importance of not littering in order to cut down on the demand for single-use plastics. This will help minimize littering that contributes to waterway pollution and ocean contamination.

Promote campaigns such as “No littering in the streets or rivers, for a cleaner city and reduced flooding” to encourage people to keep the environment clean and build a community culture of environmental protection.

Raise awareness among the public, especially the younger generation, through comprehensive long-term efforts that maximize the reach of media channels and press coverage. In tandem with awareness-raising activities, provide the public with the necessary tools and knowledge to sort waste easily (such as proper bins and designated disposal areas).

The research only counted visible plastic waste, so further studies should be conducted to assess the full impact of plastic pollution. These should include studies on microplastic particles in soil and water environments and the concentrations of microplastics found in living organisms within these ecosystems. In the future, research should be expanded to assess the impact of waste on human health, especially plastic waste, and the accumulation of microplastics in food chains. In-depth studies are needed to understand the health implications of microplastic content on humans. This would help inform the ongoing efforts to reduce plastic waste and provide data for future research aimed at assessing trends in environmental pollution by solid waste.

Acknowledgments: This research was conducted with financial, technical support and coordination from the Centre for Supporting Green Development (GreenHub) within the Initiative “Pioneering company, community and consumer responsibility in plastic waste reduction in Vietnam (P3CR)”. This initiative is a part of the Reducing Pollution Project funded by the United States Agency for International Development (USAID), managed and implemented by Winrock International, with the Ministry of Natural Resources and Environment as the governing agency and the Pollution Control Department as the project owner ■

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COP29 concludes with climate finance deal

The UN Climate Change Conference (COP29), held from 11th-22nd November 2024 in Baku, Azerbaijan, with a new finance goal to help countries to protect their people and economies against climate disasters, and share in the vast benefits of the clean energy boom. With a central focus on climate finance, COP29 brought together nearly 200 countries in Baku, Azerbaijan and reached a breakthrough agreement that will: Triple finance to developing countries, from the previous goal of USD 100 billion annually, to USD 300 billion annually by 2035. Secure efforts of all actors to work together to scale up finance to developing countries, from public and private sources, to the amount of USD 1.3 trillion per year by 2035.

Known formally as the New Collective Quantified on Climate Finance (NCQG), it was agreed after two weeks of intensive negotiations and several years of preparatory work, in a process that requires all nations to unanimously agree on every word of the agreement. “This new finance goal is an insurance policy for humanity, amid worsening climate impacts hitting every country,” said Simon Stiell, Executive Secretary of UN Climate Change. “But like any insurance policy – it only works – if premiums are paid in full, and on time. Promises must be kept, to protect billions of lives.” “It will keep the clean energy boom growing, helping all countries to share in its huge benefits: more jobs, stronger growth, cheaper and cleaner energy for all.” The International Energy Agency expects global clean energy investment is set to exceed USD 2 trillion for the first time in 2024.

The new finance goal at COP29 builds on significant strides forward on global climate action at COP27, which agreed an historic Loss and Damage Fund, and COP28, which delivered a global agreement to transition away from all fossil fuels in energy systems swiftly and fairly, triple renewable energy and boost climate resilience.

COP29 also reached agreement on carbon markets – which several previous COPs had not been able to achieve. These agreements will help countries deliver their climate plans more quickly and cheaply, and make faster progress in halving global emissions this decade, as required by science. Important agreements were also reached on transparent climate reporting and adaptation as summarized below. Stiell also acknowledged that the agreement reached in Baku did not meet all Parties’ expectations, and substantially more work is still needed next year on several crucial issues.

The finance agreement at COP29 comes as stronger national climate plans (Nationally Determined Contributions, or NDCs) become due from all countries next year. These new climate plans must cover all greenhouse gases and all sectors, to keep the 1.5°C warming limit within reach. COP29 saw two G20 countries – the UK and Brazil – signal clearly that they



▲ UN Secretary-General António Guterres speaking to the press on the final days of COP29

plan to ramp up climate action in their NDCs 3.0, because they are entirely in the interests of their economies and people.

Speaking to the press on the final days of COP29, UN Secretary-General António Guterres urged negotiators to find a compromise and deliver an ambitious and balanced package on all pending issues, including a new ambitious climate finance goal. COP29 comes at the close of a brutal year – a year seared by record temperatures, and scarred by climate disaster, all as emissions continue to rise. Finance has been priority number one. Developing countries swamped by debt, pummeled by disasters, and left behind in the renewables revolution, are in desperate need of funds. An agreement at COP29 was absolutely essential to keep the 1.5 degree limit alive. And countries have delivered. Commitments must quickly become cash. All countries must come together to ensure the top-end of this new goal is met. COP29 also builds on progress made last year on emissions reductions and accelerating the energy transition. And it reaches agreement on carbon markets. This was a complex negotiation in an uncertain and divided geopolitical landscape. I commend everyone who worked hard to build consensus. You have shown that multilateralism – centred on the Paris Agreement – can find a path through the most difficult issues. I appeal to governments to see this agreement as a foundation – and build on it. First, countries must deliver new economy-wide national climate action plans – or NDCs – aligned with 1.5 degrees, well ahead of COP30 – as promised. The G20 countries, the biggest emitters, must lead. These new plans must cover all emissions and the whole economy, accelerate fossil fuel phase out, and contribute to the energy transition goals agreed at COP28 seizing the benefits of cheap, clean renewables. The end of the fossil fuel age is an economic inevitability. New



national plans must accelerate the shift, and help to ensure it comes with justice. Second, we need swift action to deliver on commitments made in the Pact for the Future. Particularly on effective action on debt; increasing concessional finance and improving access; and substantially increasing the lending capacity of the Multilateral Development Banks, with adequate recapitalization.

A brief summary of other key achievements at COP29 follows below:

Article 6 of the Paris Agreement: breakthrough on Global Carbon Markets

A notable achievement during the past two weeks was the progress made on carbon markets. After nearly a decade of work, countries have agreed on the final building blocks that set out how carbon markets will operate under the Paris Agreement, making country-to-country trading and a carbon crediting mechanism fully operational. On country-to-country trading (Article 6.2), the decision out of COP29 provides clarity on how countries will authorize the trade of carbon credits and how registries tracking this will operate. And there is now reassurance that environmental integrity will be ensured up front through technical reviews in a transparent process. On day one of COP29, countries agreed standards for a centralized carbon market under the UN (Article 6.4 mechanism). This is good news for developing countries, who will benefit from new flows of finance. And it is particularly good news for least developed countries, who will get the capacity-building support they need to get a foothold in the market.

This mechanism, known as the Paris Agreement Crediting Mechanism, is underpinned by mandatory checks for projects against strong environmental and human rights protections, including safeguards that ensure a project can't go ahead without explicit, informed agreement from Indigenous Peoples. It also allows anyone affected by a project to appeal a decision or file a complaint. Under the text agreed on Article 6.4, there is a clear mandate for the UN carbon market to align with science. It tasks the Body getting this market up and running to consider the best available science across all work going forward. The work on carbon markets doesn't stop in Baku. The Supervisory Body setting up the new carbon crediting mechanism has been handed a long 2025 to-do list by Parties and will continue to be accountable to them.

The COP29 Presidency identified the full operationalization of Article 6 as a key negotiating priority this year. Finalising Article 6 negotiations could reduce the cost of implementing national climate plans by \$250 billion per year by enabling cooperation across borders. This decision is an essential step in achieving that goal and establishes strong momentum for continued progress over the coming two weeks of negotiations. The COP29 President opened the summit by setting clear expectations for how global leaders must enhance ambition and enable action during the conference. COP29 is a critical moment for global leaders to come together and demonstrate their collective commitment to climate action.

To enhance ambition, the COP29 President called for countries to submit 1.5-aligned Nationally Determined Contributions to reduce emissions ahead of next year's deadline, submit National Adaptation Plans by 2025 to prepare for a warming world, and deliver their first Biennial Transparency Reports (BTR) this year.

Transparency

Transparent climate reporting made big strides forward in Baku, building a stronger evidence base to strengthen climate policies over time, and helping to identify financing needs and opportunities. To date, 13 Parties have now submitted their first Biennial Transparency Reports (BTR) – due from all Parties by the end of the year. In addition, all transparency negotiating items concluded successfully at COP29, with Parties expressing their appreciation for the timely completion of the Enhanced Transparency Framework (ETF) reporting tools, the technical trainings, and the support provided to developing countries for reporting under the ETF that took place in 2024.

A total of 42 events were organized under Together4Transparency, a UNFCCC collaborative initiative that promotes climate transparency with Parties and non-Party stakeholders. These events emphasized the vital role of transparency in preparing NDCs and net-zero pathways, as well as in recognizing climate action from non-Party stakeholders. Events included high-level sessions, mandated events and training sessions to prepare countries for their BTRs, as well as to equip technical experts for the upcoming review process.

The critical role of REDD+ was recognized through a £3 million pledge by the UK International Forest Unit to support UN Climate Change's work over four years. This funding will bolster REDD+ activities in many countries, enabling the secretariat to create dedicated spaces for REDD+ experts to engage in technical dialogue. These efforts are expected to enhance the transparency and implementation of REDD+, in line with the Global Stocktake objective to halt and reverse deforestation and forest degradation by 2030.

Adaptation

COP29 was an important moment for adaptation, with the delivery of several key outcomes. The COP decision on matters relating to the least developed countries (LDCs) contains a provision for the establishment of a support programme for the implementation of National Adaptation Plans (NAPs) for the



▲ *The finance agreement at COP29 comes as stronger national climate plans*

LDCs. Parties extensively discussed the second five-year assessment of progress to formulate and implement NAPs, and will continue that in June 2025.

A High-level Dialogue on National Adaptation Plans convened ministers from least developed countries and small island developing States, financial experts and international donors to address the growing urgency of climate adaptation. Their discussions focused on innovative financing, technical support, and accelerated action to meet the 2025 submission deadline for NAPs. The event concluded with a strong call to action to expedite NAPs and translate plans into tangible outcomes.

The outcome on the global goal on adaptation sets a clear path forward on the road to COP30 for the indicators work programme, providing a process for experts to continue their technical work before passing the baton to Parties. COP29 also launched the Baku Adaptation Road Map and Baku high-level dialogue on adaptation to enhance the implementation of the UAE Framework. Finally, the outcome raises ambition by agreeing to continue unpacking transformational adaptation moving forward.

COP29 took a decisive step forward to elevate the voices of Indigenous Peoples and local communities in climate action, adopting the Baku Workplan and renewing the mandate of the Facilitative Working Group (FWG) of the Local Communities and Indigenous Peoples Platform (LCIPP). The adopted decision acknowledges the progress made by the FWG in fostering collaboration among Parties, Indigenous Peoples and local communities, and underscores the leadership of Indigenous Peoples and local communities in addressing the climate crisis.

Gender and climate change

Countries agreed a decision on gender and climate change, extending the enhanced Lima Work Programme on Gender and Climate Change for another 10 years, reaffirming the importance of gender equality and advancing gender mainstreaming throughout the convention. They also agreed to develop a new gender action plan for adoption at COP30, which will set the direction for concrete implementation.

Civil society participation, children and youth

World leaders at COP29 were joined by civil society, subnationals, business, Indigenous Peoples, youth, philanthropy, and international organizations. More than 55,000 people attended COP29 to share ideas, solutions, and build partnerships and coalitions. The decisions taken at COP29 also reemphasize the critical importance of empowering all stakeholders to engage in climate action; in particular under Action for Climate Empowerment (ACE). Parties recalled the importance of integrating ACE elements into national climate change policies, plans, strategies and action, and noted the secretariat's compendium of good practices for integrating ACE elements into NDCs.

COP29 marked a significant milestone as dedicated spaces were created to ensure the meaningful participation of children within the Youth-led Climate Forum for the first time. Four children, including the youngest at just 10 years old, took on roles as moderators and speakers, engaging directly with Parties and observer organizations. Their participation highlighted the importance of inclusivity and intergenerational collaboration in driving climate action. In parallel with the formal negotiations, the Global Climate Action space at COP29 provided a platform for governments, businesses and civil society to collaborate and showcase their real-world climate solutions. The High-Level Champions, under the Marrakech Partnership for Global Climate Action, launched their 2024 Yearbook of Global Climate Action at COP29, showing that climate action by non-Party stakeholders, including businesses,



investors, sub-national actors and civil society, is driving progress towards the goals of the Paris Agreement, and that their engagement is more crucial than ever.

COP29 Declaration on green digital action

The COP29 Presidency today launched the global conference's inaugural Digitalisation Day with more than 90 governments and over 1,000 members of the digital tech community, including companies, civil society organisations, and international and regional organisations endorsing the COP29 Declaration on Green Digital Action. As part of the COP29 Action Agenda in September 2024, the COP29 Presidency has focused on building support amongst multisector partners for the Declaration, which urges to using digital tools to reduce greenhouse gas (GHG) emissions, strengthen climate resilience, and advance sustainable development. The Declaration calls for sector-wide collaboration to accelerate climate-positive digitalisation, improve energy efficiency, and promote inclusive digital access – especially in developing countries.

The introduction of the Digitalisation Day to the thematic programming for the conference reflects the critical role of technology in addressing climate change. It also reflects the COP29 Presidency's commitment to integrating digital solutions into global climate action, in collaboration with the International Telecommunication Union (ITU), the UNFCCC Technology Executive Committee (TEC), and other partners. It builds on efforts launched at COP28 by ITU and over 40 partners to underscore the challenges and opportunities in harnessing technology for climate action. Through this initiative, COP29 aims to place digitalisation at the heart of climate action, empowering nations and communities to adapt to and mitigate the effects of climate change.

Energy initiatives focus on green energy, hydrogen and global energy storage

While hosting a High-Level Roundtable on Green Energy, Hydrogen and Global Energy Storage and Grids, the COP29 Presidency officially launched three energy initiatives and called on Party and non-Party stakeholders for endorsement of each. These initiatives reflect the Presidency's efforts to take forward the outcomes of the first Global Stocktake on renewable energy and hydrogen. The initiatives include: COP29 Global Energy Storage and Grids Pledge – endorsers commit to a collective goal of deploying 1,500 GW of energy storage globally by 2030 - more than six times the capacity of 2022. It also includes a commitment

to add or refurbish 25 million kilometres of grids globally by 2030, recognising the need to add or refurbish an additional 65 million kilometres by 2040.

COP29 Green Energy Pledge: Green Energy Zones and Corridors – endorsers commit to promoting in green energy zones and corridors to connect sources of abundant green energy generation with the communities most in need by developing larger intraregional and interregional interconnected power grids. These grids will enable cost-effective and secure transmission of electricity over long distances.

COP29 Hydrogen Declaration – endorsers commit to scale up renewable, clean/zero-emission and low-carbon hydrogen production and accelerate the decarbonisation of existing hydrogen production from unabated fossil fuels. It aims to significantly increase green hydrogen production from one million tonnes annually today and reduce the 96 Mt of hydrogen currently produced from unabated fossil fuels.

Vietnam attends COP 29 Climate change conference

Vietnam's delegation at COP29 includes representatives from the Ministries of Natural Resources and Environment, Industry and Trade, Transport, Agriculture and Rural Development, Planning and Investment, Finance, Science and Technology, and Foreign Affairs. Also attending are members of Vietnam's climate negotiation task force and representatives from various agencies, localities, banks, and businesses implementing Viet Nam's COP26 commitments.

The first slogan calls for solidarity, urging countries to honor their commitments to greenhouse gas reductions and financial contributions to climate initiatives, working together for a common goal. The second slogan arises from the findings of the first global stocktake, showing that even if all current emission reduction commitments are met, global temperatures are still projected to rise by 2.4–2.7°C - far above the Paris Agreement targets of limiting warming to 2°C and striving for 1.5°C. Thus, nations must “raise ambition” to align with the Paris targets and “activate action” to turn commitments into reality.

At COP29, Viet Nam advocates for developed countries to ensure climate finance targets and maintain transparency in income sources and expenditures through annual reports. Viet Nam also calls for balanced spending on adaptation and mitigation efforts, as current discrepancies are significant.

With global temperatures hitting record highs, and extreme weather events affecting people around the globe, COP29 will bring together leaders from governments, business and civil society to advance concrete solutions to the defining issue of our time. A key focus of COP29 will be on finance, as trillions of dollars are required for countries to drastically reduce greenhouse gas emissions and protect lives and livelihoods from the worsening impacts of climate change. The conference will also be a key moment for countries to present their updated national climate action plans under the Paris agreement, which are due by early 2025. If done right, these plans would limit global warming to 1.5°C above pre-industrial levels and double as investment plans advancing the Sustainable Development Goals ■

NHÂM HIÊN



Biodiversity COP 16: Important agreements reached towards making peace with nature

The UN biodiversity summit known as COP16 officially opened in Colombia in October 2024, and negotiating countries can agree on a path forward to safeguarding the planet. Considered the world's most important event to conserve biodiversity, the summit is taking place in Cali, the third largest city of the South American nation, and will host some 15,000 attendees, including a dozen heads of State, 103 ministers and over 1,000 international journalists. The summit aimed to promote international cooperation, agree on investments to protect ecosystems and strengthen global environmental policies, COP16 takes as its roadmap the Kunming-Montreal Biodiversity Framework (GBF), a landmark plan to halt and reverse the loss of biodiversity for 2030, adopted at COP15 in Canada.

Global Biodiversity Framework (KMGBF) since its adoption at COP 15 in 2022. COP 16 acknowledged the progress made in the previous two years and highlighted the need to accelerate action. To date, 119 countries, representing the majority of the 196 Parties to the CBD, submitted national biodiversity targets reflecting alignment with the KMGBF. Additionally, 44 countries submitted National Biodiversity Strategy and Action Plans (NBSAPs) - the policy documents that support the implementation of national targets.

THE CALI FUND

Having agreed at COP 15 to establish a multilateral mechanism, including a global fund, to share the benefits from uses of digital sequence information on genetic resources (DSI) more fairly and equitably, delegates at COP 16 advanced its operationalization – a historic decision of global importance. This complex decision addresses how pharmaceutical, biotechnology, animal and plant breeding and other industries benefiting from DSI should share those benefits with developing countries and Indigenous Peoples and local communities. Under the agreed guidelines, large companies and other major entities benefiting commercially from DSI uses should contribute to “the Cali Fund,” based on a percentage of their profits or revenues. The model targets larger companies most reliant

on DSI and exempts academic, public research institutions and other entities using DSI but not directly benefiting. Developing world countries will benefit from a large part of this fund, with allocations to support implementation of the KMGBF, according to the priorities of those governments.

At least half of the funding is expected to support the self-identified needs of indigenous peoples and local communities, including women and youth within those communities, through government or by direct payments through institutions identified by indigenous peoples and local communities. Some funds may support capacity building and technology transfer. Strong monitoring and reporting will ensure industries see the impact of their contributions in a transparent and open way, and regular reviews will build the mechanism's efficiency and efficacy over time. This agreement marks a precedent for benefit-sharing in biodiversity conservation with a fund designed to return some of the proceeds from the use of biodiversity to protect and restore nature where help is needed most.

Strengthen the role of indigenous people and local communities

In a landmark decision at COP 16, Parties adopted a new Programme of Work on Article 8(j) and other provisions of the Convention related to indigenous peoples and local communities. This transformative programme sets out specific tasks to ensure the meaningful contribution of indigenous peoples and local communities towards the three objectives of the Convention (a) the conservation of biological diversity, b) the sustainable use of biological diversity, and c) the fair and equitable sharing of benefits), as well as the implementation of the KMGBF. Through this Programme, rights, contributions and traditional knowledge of indigenous peoples and local communities are further embedded in the global agenda.

Parties also agreed to establish a new permanent subsidiary body on article 8j and other Provisions, with its modus operandi to be developed over the next two years. The new Subsidiary Body is expected to elevate issues related to the implementation of Article 8j and enhance the engagement and participation of indigenous peoples and local communities in all convention processes. A further decision was taken to recognize the role of people of African descent, comprising collectives embodying traditional lifestyles, in implementing the Convention and in the conservation and sustainable use of biodiversity.

COP 16 adopted a landmark decision on Biodiversity and Climate Change with an important reference to the ocean-climate-biodiversity nexus. The text notably calls upon the Presidents of COP 16 of the CBD and COP 29 and COP 30 of the UNFCCC to strengthen multilateral coordination. The



decision also requests the Executive Secretary of the CBD to invite Parties, observers and other stakeholders to submit (by May 2025) their views on options for enhanced policy coherence, including a potential joint work programme of the three Rio conventions, namely CBD, UNFCCC and UNCCD. It is well established that biodiversity loss and climate change are correlated and mutually reinforcing. A thriving nature keeps carbon stored where it naturally belongs and not in our planet's atmosphere. Biodiversity enhances adaptation capacity and resilience, including in disaster-risk reduction. Climate change, on the other hand, is one of the major drivers of biodiversity loss.

PROGRESS IN ADDRESSING SYNTHETIC BIOLOGY CONSIDERATION

Synthetic biology was a prominent topic at COP 16, with an eye toward its potential benefits while considering the risks. To address inequity in the participation of developing countries in the synthetic biology field, the decision introduces a new thematic action plan to help address the capacity-building, technology transfer and knowledge-sharing needs of Parties, and Indigenous Peoples and Local Communities. By helping countries assess and apply synthetic biology technologies, COP 16 aims to foster innovation while safeguarding biodiversity. An expert group will guide identification of synthetic biology's potential benefits and review the potential impacts of recent technological developments – a unique opportunity to explore synthetic biology in relation to the CBD's three fundamental objectives and in implementing the KMGBF.

BIODIVERSITY AND CLIMATE CHANGE

COP 16 adopted a landmark decision on Biodiversity and Climate Change with an important reference to the ocean-climate-biodiversity nexus. The text notably calls upon the Presidents of COP 16 of the CBD and COP 29 and COP 30 of the UNFCCC to strengthen multilateral coordination. The decision also requests the Executive Secretary of the CBD to invite Parties, observers and other stakeholders to submit (by May 2025) their views on options for enhanced policy coherence, including a potential joint work programme of the three Rio conventions, namely CBD, UNFCCC and UNCCD. It is well established that biodiversity loss and climate change are correlated and mutually reinforcing. A thriving nature keeps carbon stored where it naturally belongs and not in our planet's atmosphere. Biodiversity enhances adaptation capacity and resilience, including in disaster-risk reduction. Climate change, on the other hand, is one of the major drivers of biodiversity loss.

CAPACITY-BUILDING, TECHNICAL AND SCIENTIFIC COOPERATION AND KNOWLEDGE MANAGEMENT

COP 16 adopted decisions to further guide action on capacity building and development, technical and scientific cooperation (TSC), knowledge management (KM) and the clearing-house mechanism (CHM) to support the implementation of the Kunming-Montreal Global Biodiversity Framework (KMGBF). With respect to capacity building and development, COP 16 invited Parties, indigenous peoples and local communities, and relevant stakeholders to share information about their capacity needs and their ongoing and planned capacity-building and development activities and requested the Secretariat to make this information available through the central portal of the clearing-house mechanism (CHM). The Secretariat was also requested to implement joint capacity-building activities with the Secretariats of the Rio conventions and the biodiversity-related conventions.



COP 16 welcomed the 18 subregional technical and scientific cooperation support centres (TSCCs) that were selected to support Parties to effectively utilize science, technology, and innovation in the implementation of the KMGBF. It also adopted modalities for operationalizing the global coordination entity and mandated the CBD Secretariat to host it. The entity will coordinate and facilitate the work of the TSCCs, including through providing them with access to relevant information, tools, advice, technical support and additional resources for their work and will be accountable to the COP.

The Parties also decided that the review of progress in the implementation of the long-term strategic framework for capacity building and development and the technical and scientific cooperation mechanism will be conducted in conjunction with the process for the global review of collective progress in the implementation of the KMGBF. The Parties also adopted a new programme of work for the CHM and a knowledge management strategy to support implementation of the Kunming-Montreal Global Biodiversity Framework.

ECOLOGICALLY OR BIOLOGICALLY SIGNIFICANT MARINE AREAS

COP 16 agreed on a new and evolved process to identify ecologically or biologically significant marine areas (EBSAs). Under the CBD, work on EBSAs, which identifies the most critical and vulnerable parts of the ocean, began in 2010 and became a central area of onean-related work. Continued development of the programme was stymied for more than 8 years due to legal and political concerns.

COP 16 gave new life to this process, agreeing on new mechanisms to identify new EBSAs and update existing ones, ensuring that the cataloging of information of these areas can support planning and management with the most advanced science and knowledge available. This comes at a time when EBSAs can play an important role for marine biodiversity protection, with major steps being taken to implement the 30x30 protected areas target and to prepare for the future implementation of the new agreement for marine biodiversity beyond national jurisdiction.

SUSTAINABLE WILDLIFE MANAGEMENT AND PLANT CONSERVATION

Among the most crucial areas of discussion was the protection of wild species. A decision on sustainable wildlife management underscores the necessity of monitoring, capacity-building, and the inclusive participation of indigenous peoples, local communities, and women. To this end, the decision calls for the cooperation of international bodies like CITES and FAO to implement. The framework encourages research on how wildlife use, biodiversity loss, and zoonotic diseases are interconnected, a vital area for a world increasingly aware of the public health implications of biodiversity loss.

Additionally, COP 16 saw a commitment to align plant conservation efforts with the KMGBF monitoring framework. This includes updating the Global Strategy for Plant Conservation with specific indicators and a standardized reporting template, ensuring that progress in plant protection is measurable and consistent with global biodiversity targets.

At COP 16, CBD Parties approved a Global Action Plan on Biodiversity and Health designed to help curb the emergence of zoonotic diseases, prevent non-communicable diseases, and promote sustainable ecosystems. The strategy embraces a holistic “One Health” approach that recognizes the health of ecosystems, animals, and humans as interconnected. Recognizing that biodiversity loss and poor health often share common drivers - such as deforestation, pollution, and climate change - the Plan emphasizes the urgency of tackling these threats to benefit both ecosystems and humans. The strategy underlines the need for education and promoting understanding of the connections between biodiversity and health, and the need to strengthen policies that promote sustainable ecosystems, support traditional medicine, and reduce habitat destruction. Special attention is accorded to vulnerable populations, including Indigenous peoples, who depend on local biodiversity for food, medicine, and cultural identity, as well as youth, seen as vital contributors to conservation and health initiatives.

At the heart of the plan is a collaborative framework that brings together health professionals, conservationists, and policymakers. The COP decision invites nations to designate national focal points for biodiversity and health, and to develop policies reflecting these interconnections, integrating biodiversity-health considerations in policies across the range of sectors from agriculture to urban planning. Parties further called for close cooperation with international organizations, including the World Health Organization, to develop monitoring tools and metrics for assessing the progress of biodiversity-health initiatives.

BIODIVERSITY AND HEALTH

At COP 16, CBD Parties approved a Global Action Plan on Biodiversity and Health designed to help curb the emergence of zoonotic diseases, prevent non-communicable diseases, and promote sustainable ecosystems. The strategy embraces a holistic “One Health” approach that recognizes the health of ecosystems, animals, and humans as interconnected.

Recognizing that biodiversity loss and poor health often share common drivers - such as de-



forestation, pollution, and climate change - the Plan emphasizes the urgency of tackling these threats to benefit both ecosystems and humans. The strategy underlines the need for education and promoting understanding of the connections between biodiversity and health, and the need to strengthen policies that promote sustainable ecosystems, support traditional medicine, and reduce habitat destruction. Special attention is accorded to vulnerable populations, including Indigenous peoples, who depend on local biodiversity for food, medicine, and cultural identity, as well as youth, seen as vital contributors to conservation and health initiatives.

At the heart of the plan is a collaborative framework that brings together health professionals, conservationists, and policymakers. The COP decision invites nations to designate national focal points for biodiversity and health, and to develop policies reflecting these interconnections, integrating biodiversity-health considerations in policies across the range of sectors from agriculture to urban planning. Parties further called for close cooperation with international organizations, including the World Health Organization, to develop monitoring tools and metrics for assessing the progress of biodiversity-health initiatives.

PARTICIPATION OF THE VIETNAMESE DELEGATION AT COP16

Participating in COP16, the Vietnamese Delegation including representatives of the Ministry of Natural Resources and Environment, Ministry of Agriculture and Rural Development, Ministry of Foreign Affairs... attended high-level meetings with the theme “Peace with Nature”, including Ministerial dialogues with topics on: Implementation of the Kunming-Montreal Global Biodiversity Framework (GBF); Biodiversity Finance; Biodiversity and Climate Change... During the COP16, members of the Delegation actively participated in meetings, commented on developments, and grasped the views of each country and groups of countries, exchanged ideas to contribute to the development of COP16 decisions.

In particular, the Vietnamese Delegation participated in and co-chaired the high-level dialogue event with the theme “Integrating biodiversity within and between sectors to prevent and reverse biodiversity loss by 2030”. At this dialogue, Vietnamese representatives shared



▲ *The Vietnamese Delegation at COP16*

about Vietnam’s experiences in integrating goals and contents of biodiversity protection in the fisheries sector. Many major guidelines and policies issued by the Central, Government, Ministries, and local levels have mentioned and integrated the task of protecting biodiversity into activities of the fisheries sector. Representatives of countries and organizations co-chairing the event also shared their experiences in integrating biodiversity protection goals into other sectors such as agriculture, tourism, forestry, etc. Through this event, Vietnamese representatives informed international friends about Vietnam’s responsibility and efforts in protecting marine biodiversity, protecting aquatic resources, and contributing to creating a “peace with nature” planet.

On the sidelines of the Conference, the Vietnamese Delegation also had bilateral meetings and working sessions with organizations and partners. The Delegation worked with the Asia Regional Coordinator of the Biodiversity Integrated Programs of the Global Environment Facility (GEF) to discuss GEF’s orientation for the next cycle; update the financial mobilization situation and calls for proposals of the Global Biodiversity Framework Fund (GBFF); assess Vietnam’s priorities for biodiversity conservation. The Delegation worked with the Secretary of the UNESCO’s Man and the Biosphere Programme (MAB) to discuss the implementation of the MAB Programme in Vietnam; the direction of the UNESCO’s MAB Programme for the assessment of damage after Typhoon Yagi to a number of biosphere reserves; update the plan to organize the Fifth World Congress of Biosphere Reserves in China and approve the MAB Strategy for 2025 - 2035. The Delegation worked and met bilaterally with representatives of the United States WWF to discuss progress in developing the Project Document “Enhancing biodiversity conservation and reducing climate vulnerability in Central Vietnam for sustainable development utilizing a landscape approach”. Through these events, the Vietnamese Delegation informed international friends about Vietnam’s responsibility and efforts in protecting biodiversity, contributing to creating a “peace with nature” planet ■

XUÂN THẮNG



National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050

NGUYỄN ĐỨC TOÀN
TRÌNH THANH TRUNG

Viet Nam Agency of Seas and Islands

On 28th June 2024, at the 7th Session, the National Assembly voted and passed the Resolution No.139/2024/QH15 on the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050. This is the first time Vietnam established the National Marine Spatial Master Plan, based on international experience but with adjustments suitable to its actual situation. The promulgated Master Plan will be an important tool to support state management of the sea according to a comprehensive approach; a framework, comprehensive, integrated, multi-sectoral, dynamic and open, leading Master Plan; concretizing the Party's policies and orientations and the State's legislations on the management, exploitation and use of marine space, especially Resolution No.36-NQ/TW dated 22 October 2018 of the 8th Session of the 12th Party Central Committee on the Strategy for sustainable development of Vietnam's marine economy to 2030, with a vision to 2045. The National Marine Spatial Master Plan allocates and arranges marine space reasonably for sectors and fields in the exploitation and use of marine space resources in a sustainable manner, harmoniously combining economic and social interests, environmental protection, national defence, security, foreign affairs and international cooperation in coastal areas, islands, archipelagos, sea and airspace under Vietnam's national sovereignty, sovereign rights and jurisdiction; minimizing conflicts in the exploitation and use of marine space.

MAKE VIETNAM A STRONG AND RICH COUNTRY BASED ON THE SEA

To achieve the goal of making Vietnam a strong and rich country based on the sea as set out in Resolution No.36-NQ/TW, the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050 provides development orientations for marine economic sectors, especially new marine economic sectors. The Master Plan sets out 5 focuses and 4 breakthroughs that are key, have great influence and create momentum for development. Specifically, 5 focuses are as follows:

The first focus is perfecting institutions and policies, developing criteria and regulations to handle problems arising in overlapping and conflicting areas in the exploitation and use of marine space. The Master Plan completes policies for the development of clean, renewable energy and new marine economy associated with the implementation of the Strategy for sustainable development of Vietnam's marine economy; promulgating guidelines and regulations on the implementation of local-level zoning of marine space.

The second focus is building marine infrastructure; focusing on key areas such as seaports and transport connecting seaports with the mainland, marine communications, digital economic infrastructure, etc.; synchronously developing roads, airways, railways, inland waterways between coastal and landlocked localities and with other countries; strongly developing marine economic sectors, especially fisheries economy associated with marine conservation and ensuring national defence, security, foreign affairs and international cooperation; maritime economy, maritime transport, construction of seaports and repair and building of new ships; marine tourism and services; strongly developing coastal and island urban systems to create strong economic logistics service centres and truly become the driving force for socio-economic development of each region; researching and assessing the overall potential and developing orientations for the exploitation and use of marine minerals and clean energy.

The third focus is building marine and island cultural institutions; organizing successfully marine cultural activities, improving the cultural and social life of coastal and island residents; organizing propaganda, raising awareness and responsibility for making a strong and rich country based on the sea according to the Strategy for sustainable development of Vietnam's marine economy, successfully and effectively organizing the Vietnam Sea and Islands Week.

The fourth focus is controlling and managing waste sources and resolving environmental pollution hotspots in the sea, coastal areas and islands; delimitating marine and coastal conservation and protection reserves, restoring degraded ecosystems to increase the area of marine conservation and protection.

The final focus is promoting baseline survey of marine and island resources and environment; establishing a digital database on the sea and islands, ensuring integration, sharing and updating; strengthening training of marine human resources, prioritizing the development of human



resources in the maritime, fisheries, renewable energy, tourism, marine science and technology sectors. Along with that, strengthen scientific research and application of marine technology to serve new and potential marine economic sectors such as marine medicinal herbs, marine medicine, marine chemistry, new materials; promote the attraction of resources from economic sectors, especially the private sector and foreign-invested sector.

The Master Plan also identifies 4 breakthroughs including: (1) Focusing on building a system of infrastructure and logistics services associated with the development of shipbuilding and maritime transport sectors, multi-purpose, dual-use, synchronous, modern coastal and island infrastructure, creating a driving force to attract resources, promote sustainable development of marine economic sectors, ensure national defence, security, foreign affairs and international cooperation, meet requirements of responding to natural disasters, climate change, sea level rise and marine environmental incidents; (2) Developing sustainable, responsible, and creative marine and island tourism associated with the development of green, smart island urban areas; (3) Promoting the development of the fisheries economy in the green, circular, low-carbon, and highly resilient direction, prioritizing the development of marine aquaculture and offshore fishing, associated with marine conservation and marine culture; (4) Rapidly and sustainably developing clean, green energy from the sea, prioritizing offshore wind power development, ensuring national energy security, defence, security, research and assessment of the comprehensive potential and development of sectors of oil and gas, solid minerals, and building materials on the seabed.

GROUPS OF KEY TASKS OF THE PLAN TO 2030

Key tasks of the Plan to 2030

To facilitate the implementation of the Master Plan, the Ministry of Natural Resources and Environment has drafted a Plan to implement the National Marine Spatial Master Plan and is sending it to ministries, sectors and local authorities for comments with groups of key tasks that need to be implemented, including:

Firstly, developing and perfecting institutions and policies: Review, amend the Law on Marine and Island Resources and Environment, and related legal documents to ensure consistency, improve the effectiveness and efficiency of management, exploitation and use of marine and island resources, and environmental protection; develop, implement inter-sectoral coordination mechanism on marine management and organize the implementation of the National Marine Spatial Master Plan; develop criteria and regulations for handling overlapping and conflicting areas in order of priority in the exploitation and use of marine space that have not been determined

in the National Marine Spatial Master Plan; review, adjust national sectoral master plans, regional master plans, provincial master plans, master plans of special administrative-economic units, urban master plans, rural master plans and related specialized technical master plans in accordance with the National Marine Spatial Master Plan...

Secondly, developing coastal, marine and island infrastructure for the development of marine economic sectors: Accelerate the implementation of programs, projects and tasks on developing coastal, marine and island infrastructure approved by the Government and the Prime Minister through regional master plans, national sectoral master plans and other related master plans, especially the seaport system, transport system connecting seaports with the mainland, the synchronous system of roads, airways, railways, inland waterways and logistics services associated with the development of shipbuilding and maritime transport sectors; develop a multi-purpose, synchronous, modern coastal and island infrastructure system that adapts to climate change and sea level rise; implement digital transformation, perfect the database system, monitor the exploitation and use of national marine and island resources and environment; in the immediate future, focus on developing and perfecting the technical system to support state management activities on the allocation and use of sea areas and monitoring dumping at sea in a synchronous and unified manner.

Thirdly, researching and developing new marine economic sectors, in the green, low-carbon, circular direction: Build and develop national sea and island tourism destinations and routes in the green, sustainable, responsible, creative direction associated with the development of green, smart coastal and island urban areas, improve the cultural and social life of coastal and island residents, conserve and protect natural, cultural, historical and national identity values on the basis of the Tourism System Master Plan for the 2021-2030 period, with a vision to 2045 approved by the Prime Minister in Decision No.509/QĐ-TTg dated 13 June 2024; maintain, conserve and develop marine cultural centres to preserve values, promote marine historical traditions and cultural identity in parallel with developing a sea-cohesive and friendly society; continue to focus on resources and accelerate the implementation of the Scheme on developing marine aquaculture approved by the Prime Minister in Decision No.1664/QĐ-TTg dated 4 October 2021 in the green, circular, low-



carbon, highly resilient direction, associated with marine conservation and marine culture, ensuring compliance with the orientation of the National Marine Spatial Master Plan...

Fourthly, conducting baseline survey of marine resources to serve the zoning of marine space use and socio-economic development: Focus on implementing the Key program on baseline survey of marine and island resources and environment to 2030 approved by the Prime Minister in Decision No.28/QĐ-TTg dated 7 January 2020 to ensure that baseline survey of marine resources and environment of 50% of Vietnam's sea area is conducted at a map scale of 1:500,000 and survey is conducted at a larger scale in some key areas; promote search and exploration to increase reserves and production of oil and gas, minerals in potential, deep water, offshore areas associated with the task of protecting national sovereignty at sea.

Fifthly, developing science, technology, human resources and international cooperation on sea and islands: Strengthen research, development of new and potential marine economic sectors (marine medicinal herbs, marine medicine, marine chemistry, new materials); build specialized and modern centres and laboratories to serve the survey, research and development of new and potential marine economic sectors (marine medicinal herbs, marine medicine, marine chemistry, new materials); research, develop the industry of recovering and storing greenhouse gases in sedimentary basins and offshore

geological structures; develop and implement training programs, update and improve knowledge and professional qualifications of staff in sectors and fields related to the sea; promote negotiation and signing activities on maritime boundary delimitation between Vietnam and relevant countries; establish regional and international cooperation framework on preventing, combating and reducing ocean plastic waste according to the Proposal on "Vietnam actively prepares for and participates in the formulation of a Global Agreement on Marine Plastic Pollution".

Sixthly, protecting environment and conserving biodiversity of the sea: Adjust and expand existing nature reserves; complete the establishment of marine reserves and protect identified resources; survey, identify and establish new conservation and protection reserves according to the Master Plan on protection and exploitation of aquatic resources for the 2021-2030 period, with a vision to 2050 approved by the Prime Minister under Decision No.389/QĐ-TTg dated 9 May 2024; delimitate marine, coastal and island conservation and protection reserves; restore coastal protection forests, mangrove forests, ecosystems, coral reefs, seagrass and other degraded ecosystems to increase the sea area for conservation and protection; promote the implementation of the National Action Plan for Management of Marine Plastic Litter by 2030 according to Decision No.1746/QĐ-TTg dated 4 December 2019 of the Prime Minister; control and manage waste sources and address environmental pollution hotspots at sea, coastal areas and islands.



▲ Making Vietnam a strong and rich country based on the sea



COORDINATE THE IMPLEMENTATION OF THE MASTER PLAN SYNCHRONOUSLY, EFFECTIVELY

Along with other solutions, the draft Plan clearly assigns tasks and ensures coordination among ministries, sectors, and coastal local authorities to synchronously and effectively implement the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050. In which:

Ministry of Natural Resources and Environment: Preside, coordinate with the Ministry of Foreign Affairs and other ministries, sectors, and Central agencies in organizing the public announcement of the National Marine Spatial Master Plan in accordance with legislations in forms appropriate to the actual situation and each target group; inform, propagate, disseminate, guide, and raise awareness of organizations and individuals about the National Marine Spatial Master Plan; preside, coordinate with ministries, sectors, and coastal local authorities to develop inter-sectoral coordination mechanism; organize guidance for ministries, sectors, and local authorities to effectively implement the National Marine Spatial Master Plan; preside, coordinate with ministries, sectors, central agencies, and People's Committees of coastal provinces and centrally run cities in organizing the implementation of the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050; propose adjustments to the National Marine Spatial Master Plan in accordance with legislations on planning...

Ministry of Planning and Investment: Preside in reviewing, synthesizing and submitting to competent authorities for consideration, arrangement and assignment of medium-term and annual public investment plans to implement programs, projects to implement the Master Plan in accordance with provisions of the Law on State Budget, Law on Public Investment; preside, coordinate with the MONRE and relevant agencies to study, submit to competent authorities for promulgation of appropriate mechanisms, policies to attract, mobilize capital sources other than public investment to effectively implement the National Marine Spatial Master Plan.

Ministry of Finance: Preside, based on the balancing capacity of the state budget, arrange regular funding to implement the Master Plan as regular expenditure from economic activities in the annual budget estimates of ministries and Central agencies, and submit to competent authorities for decision according to provisions of the Law on State Budget.

Ministry of Foreign Affairs: Preside, coordinate with line ministries, sectors to promote negotiation activities, promptly complete the signing of maritime boundary delimitation, international treaties and agreements on marine environmental protection, marine conservation, exploitation and use of common sea areas; preside, coordinate with line ministries and sectors in disseminating, informing and propagating to foreign countries, organizations and individuals about the National Marine Spatial Master Plan in accordance with

legislations in forms appropriate to the actual situation; prepare, implement solutions to international issues arising and changing during the implementation of the National Marine Spatial Master Plan.

Ministry of Home Affairs: Preside, coordinate with line ministries, sectors to promptly complete the delimitation of administrative management boundaries for localities with sea and islands; continue to advise on perfecting the system of state management agencies for the synthesis and unification of sea and islands at the central level and in coastal local authorities to effectively implement the National Marine Spatial Master Plan.

Line ministries and ministerial-level agencies: Preside, coordinate with the MONRE to establish, adjust national sectoral master plans, technical and specialized master plans, and other related master plans to ensure consistency, synchronization with the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050; coordinate with the MONRE in organizing the public announcement of the National Marine Spatial Master Plan in accordance with legislations in forms appropriate to the actual situation and each target group; provide information, propaganda, dissemination, training, and guidance to enhance the capacity, awareness of organizations, individuals about the National Marine Spatial Master Plan...

People's Committees of coastal provinces, centrally run cities: Preside, coordinate with the MONRE to establish, adjust provincial master plans, specialized master plans, urban master plans, rural master plans within their management scope, ensuring consistency and synchronization with the National Marine Spatial Master Plan for the 2021-2030 period, with a vision to 2050; preside, coordinate with ministries, sectors and local authorities in the region to develop, implement local socio-economic development master plans and plans; organize the implementation of post-master plan programs and projects according to state management decentralization; evaluate the implementation of the Master Plan within their management scope; coordinate with the MONRE to evaluate the implementation of the National Marine Spatial Master Plan every year and 5 years according to legislations on planning, report to the Prime Minister for consideration, timely adjustment of the Master Plan to suit the actual situation, conditions... ■



Master Plan for the Red river - Thai Binh river basin for the 2021-2030 period, with a vision to 2050

TRẦN THỊ THANH TÂM

Department of Water Resources Management

The Red river - Thai Binh river basin is the largest river basin in the North with an area of 169,000 km², of which its part in the territory of Vietnam is 88,680 km² accounting for 51.3% of the basin area, the rest belongs to territories of China and Laos. The water source of the Red river - Thai Binh river is the main water source for production, daily life and socio-economic activities of 16 Northern provinces, one of key economic regions of Vietnam. This is the largest river basin in the country, flowing through 25 provinces and centrally run cities with more than 30 million people living [1].

1. SOME CHALLENGES FOR WATER RESOURCES IN THE RED RIVER - THAI BINH RIVER BASIN

The Red river - Thai Binh river system is facing many difficulties and challenges due to the increasing demand for water for socio-economic development, making the water resource problem on the river basin increasingly complicated. The exploitation and use of water resources in the upstream part of the river basin will have a significant impact on the water source regime; together with the impact of climate change, it has caused challenges in developing plans for exploiting, using and regulating water sources. Water shortages during the dry season continuously occur in the downstream areas especially in recent years, the water level at some monitoring locations in the downstream has at times fallen to the lowest level in history. Along with competition in water use between sectors, especially between power generation and agricultural production, if water sources are not allocated reasonably, ensuring harmony of interests between water-using regions, sub-basins and sectors on the river basin, the exploitation and use of water source from the Red river - Thai Binh river will not ensure comprehensive economic, social and environmental effectiveness, the following are some challenges, specifically:

(i) Water resources are unevenly distributed in space and time, affected by upstream exploitation and effects of climate change. The Red river - Thai Binh river system is formed from large tributaries such as Da river, Lo river, Cau river, Thuong river and Luc Nam river. The total amount of surface water that can be exploited in the Red river - Thai Binh river basin is about 127 billion m³, the flood season accounts for about 75%, the dry season accounts for about 25% of the total annual flow, the underground water source that can be exploited stably on the river basin is about 7.1 billion m³. The average amount of water per capita in the dry season is about 1,600 m³/person. Because water resources are unevenly distributed in space and time, and are affected by upstream exploitation, the access to the water source is still difficult,

especially in high mountainous and remote areas leading to local water shortages in some areas during the dry season. In addition, the impact of climate change and the exploitation, use of water upstream beyond the border of the Red river - Thai Binh river basin caused water resource developments even more complicated.

(ii) There has been no general master plan for river basin, while it is the foundation for developing and implementing water exploitation and use master plans. In addition, a number of water exploitation and use master plans in localities have been and are being implemented, such as irrigation master plan, rural water supply master plan, urban water supply master plan, however these master plans had many shortcomings, were adjusted and expired when the provincial master plan was issued.

(iii) Pressure on socio - conomic development leads to an increasing demand for water exploitation and use, forecast to increase 1.2 times by 2050 compared to today. In addition, socio-economic development activities increase the discharge of waste water into water sources, polluting water sources, typically Cau river, Day river, Nhue river... some pollution parameters are exceeding allowable standards from 1.6 - 2.3 times (COD, BOD₅, NO₂-...). On the other hand, water exploitation and use without any master plan, without regulation on water source functions, and without regulation on minimum flow caused water sources to be increasingly degraded, seriously polluted, increasing the risk of losing water source security on the river basin.

(iv) Water scarcity in the dry season and lack of domestic water in high mountainous, remote areas are occurring in many places in the river basin. Access to water sources for people in high mountainous, remote areas is very difficult, water for daily life and production mainly depends on rainwater and underground water sources. This is a big challenge if there is no timely solution to manage, exploit and use water sources economically and rationally in the river basin in the future. Currently, the MONRE is coordinating with ministries and local authorities to survey, evaluate and find water sources to supply domestic water in 147

water-scarce areas and to build water supply works to serve essential needs of people in the planned area.

(v) Wasteful and ineffective exploitation and use of water resources is still happening on the river basin. Many water exploitation and use works have not been operated and exploited according to design, especially irrigation reservoirs, some reservoirs are only operating and exploiting at about 68% - 75% of construction design capacity.

From above challenges, on 6th February 2023, the Prime Minister issued Decision No. 50/QĐ-TTG approving the Master Plan for the Red river - Thai Binh river basin for the 2021-2030 period, with a vision to 2050. The Master Plan provides specific objectives, solutions, functions of water sources and management, regulation and allocation of water sources, contributing to ensuring water source security for exploitation and use purposes and socio-economic development goals in the planned area; develops solutions, stipulates specific responsibilities for each line ministry and local authority to organize the implementation the Master Plan effectively [1].

2. ENSURE WATER SOURCE SECURITY IN THE RIVER BASIN, STORE, REGULATE, AND ALLOCATE WATER RESOURCES FAIRLY AND REASONABLY

The Master Plan for the Red river - Thai Binh river basin for the 2021-2030 period, with a vision to 2050 was issued based on the viewpoint that water resources are managed in an integrated manner according to the river basin, with consistency in quantity, quality, between surface water and underground water, between upstream and downstream, between localities in the same basin; ensuring compliance with international treaties, bilateral cooperation that Vietnam has participated in. The Master Plan is developed on the basis of linking the current status, orientation of the use of water resources with land resources, land use structure and other natural resources, as a basis for formulating socio-economic development master plans and plans of localities, sectors

and fields that exploit and use water in the basin to ensure synchronization, consistency between master plans of sectors that exploit and use water on the river basin... Protect water resources on the basis of protecting water source functions to meet water quality for purposes of use, protect aquatic resources, consistent with socio-economic development conditions on the river basin. Prevent, control, remedy the consequences and harmful effects caused by water with the motto of proactive prevention as the key to minimize losses, stabilize social security, maintain national defence and security on the Red river - Thai Binh river basin.

The overall goal of the Master Plan is to ensure water source security on the river basin, store, regulate, allocate water resources in a fair and reasonable manner, exploit and use water economically and effectively associated with protection, sustainable development of water resources to meet water needs for people's living, socio-economic development, ensure national defence, security, and environmental protection. Protect water resources, prevent degradation, depletion, pollution of water sources and harmful effects caused by water, have a roadmap to restore degraded, depleted, and polluted water sources, meeting requirements of integrated management of water resources according to river basins and adaptation to climate change.

By 2030, store, regulate, allocate water sources to ensure harmony of benefits for localities and water users in the region, between the Northern midland and mountainous region and the Red river delta, exploit and use water

economically and effectively to improve the economic values of water, ensure water source security, adapt to climate change and in accordance with international treaties related to water resources that Vietnam has participated in... Strive to achieve basic targets of the Master Plan, including: 100% of locations that maintain minimum flow on rivers are monitored, with an appropriate automatic



▲ A section of the Red river flowing through Ha Noi City



and online monitoring roadmap; 100% of inter-provincial water sources with their capacity to receive wastewater and carrying capacity are announced; 100% of works exploiting, using water and works discharging wastewater into water sources are monitored for operation and system connection according to regulations; 100% of lakes, ponds with regulating functions, high biodiversity, historical and cultural values not filled are announced and strictly managed; 70% of water sources subject to the establishment of water source protection corridors are marked with protection corridors; 50% of the total amount of wastewater in urban areas of type II or higher and 20% of the total amount of wastewater in urban areas of type V or higher are collected, treated to meet standards, technical regulations before being discharged into the environment; 20% of important water sources degraded, depleted, polluted, especially river sections flowing through concentrated residential areas, important water sources for domestic water supply and socio-economic development activities are improved and restored.

Vision to 2050, maintain and develop water resources, regulate and allocate water sources to ensure water security, adapt to climate change and in accordance with international treaties and bilateral cooperation related to water resources that Vietnam has participated in. Strengthen the protection of water resources, ensure water quantity and quality to meet socio-economic development goals and minimize harmful effects caused by water. Management, exploitation, use and protection of water resources are carried out online on the basis of smart management. Restore degraded, depleted, and seriously polluted water sources and rivers in the river basin. Initially control the river bottom elevation in the delta, maintain water levels on the Red river, Duong river, and Cau river in the dry season, especially river sections flowing through urban areas such as Ha Noi, Bac Giang, Bac Ninh to create riverside landscapes...[2].

Main contents of the Master Plan include:

Water source functions: Inter-provincial and international water sources on the Red river - Thai Binh river basin have functions of being used for purposes of water supply for domestic use, industrial production, agricultural production, tourism, and service business, hydropower, water transportation. Groundwater sources on the Red river - Thai Binh river basin have functions of being used for the purposes of water supply for domestic use, industrial production, and service business...

Managing, regulating, allocating water sources to contribute to ensuring water source security for the purposes of exploitation, use, and socio-economic development goals on the river basin: Manage, regulate the amount of water that can be exploited, used throughout the basin corresponding to a frequency of 50% (about 133,930 million m³), corresponding to a frequency of 85% (about 102,210 million m³), of which the amount of water that can be exploited and used from outside the border flows in at a frequency of 50% (about 12,000 million m³), corresponding to a frequency of 85% (about 10,000 million m³) to meet the needs of water exploitation and use until 2030...

Managing exploitation and use of surface water to ensure minimum flow on rivers: Exploitation and use of surface water must ensure minimum flow value on rivers and streams specified in Appendix III attached to this Decision. In case of new construction of water exploitation and use works, based on actual conditions and water source characteristics, the MONRE and People's Committee of relevant provinces and centrally run cities shall consider deciding on the value of the minimum flow after construction works have been put into operation according to authority, ensuring minimum flow value on rivers according to regulations. Operate the system of works to create regular and continuous flow for the Bac Hung Hai, Nhue, Day and Ngu Huyen Khe rivers to ensure the environment, landscapes and socio-economic development purposes.

Protecting water resources: Water exploitation and use must be associated with protection of water resources, protection of aquatic resources, flow circulation, lakes and ponds that have regulating function and biodiversity value consistent with functions of water sources in the planned period. Strictly manage existing forest areas in provinces on the Red river - Thai Binh river basin. Maintain, protect and develop forest coverage rates to contribute to improving the capacity to adapt to climate change and promote mitigation of greenhouse gas emissions...

Preventing, controlling landslides in riverbeds, banks, beaches: Implement measures to protect, prevent, control landslides in riverbeds, banks, beaches; survey, evaluate, monitor flow developments, sedimentation, landslides in river beds, banks, beaches; research channel changes, natural laws affecting the stability of river beds, banks, beaches. Strictly manage sand, gravel mining activities in river beds according to regulations to ensure stability of river beds, banks, beaches and minimize water level decline on rivers. Sand, gravel mining areas in riverbeds in river sections with unstable terrain, geological conditions must be at a minimum safe distance from the edge of the bank consistent with the natural width of the riverbeds according to regulations [2].

3. SOLUTIONS TO IMPLEMENT THE MASTER PLAN

Firstly, improving institutions, policies, standards on exploitation, use, reuse of water resources: Review, amend, supplement regulations on management, protection of aquatic resources and protection, development of watershed forests; standards, technical regulations on water quality, water reuse. Amend, supplement financial mechanisms; mechanisms to attract, mobilize



financial resources in exploiting, using, protecting, preventing, controlling, remedying harmful consequences caused by water; supplement mechanisms for using cross-border water sources; adjust master plans related to exploitation, use of water resources, ensuring consistency, synchronization between master plans; encourage people to use water economically, improve water use efficiency, protect the water environment...

In addition, it is necessary to improve mechanisms, policies to encourage forest protection, forest regeneration, afforestation, forest services. Strengthen the implementation of policies to increase revenue from providing forest environment services in addition to electricity, water services that are being implemented to serve the management, protection and development of watershed protection forests.

At the same time, improve legal institutions, mechanisms, policies of the water sector, strengthen decentralization, transparency, reduce administrative procedures, create motivating conditions for organizations, individuals to participate in investment, management, operation of infrastructure of water sector, production and trading of clean water.

Secondly, regulating, allocating, developing, protecting water resources, using water economically and effectively, reusing water to contribute to ensuring water source security: Build, operate information systems, digital models, decision support tools to assess water sources in the basin under normal, water shortage conditions to support the regulation, allocation of water sources on the Red river - Thai Binh river basin. Build, complete the meteorological, hydrological and water resources monitoring system on the Red river - Thai Binh river basin. Control water exploitation, use, and wastewater discharge into water sources on the Red river - Thai Binh river basin through connecting, transmitting information, data to the water exploitation, use, and wastewater discharge monitoring system according to regulations.

Improve the water storage capacity of existing water reservoirs on the principle of ensuring safety; supplement, build new works to regulate, exploit, use and develop multi-purpose water resources, ensuring water supply for downstream as required by competent state management agencies in case of water shortages, in accordance with this Master Plan and other related specialized master plans...

Convert production, apply economical irrigation models, especially in areas where drought and water shortages often occur. Balance, adjust exploitation flow appropriately in accordance with actual conditions in water scarce areas, areas with low water levels on rivers and aquifers.

Thirdly, science, technology and international cooperation: Apply advanced, modern and smart science, technique, technology to use circulating water, save and reuse water, manage, protect water sources, develop and connect water sources.

Strengthen international cooperation in exchanging, providing information on cross-border water sources, research and transfer of science and technology to use circulating water, save and reuse water.

Regarding organization for implementation, the MONRE presides, coordinates with line ministries, ministerial-level agencies and related local authorities to organize the implementation of the Master Plan according to assigned state management functions; inspect, supervise implementation; periodically evaluate implementation, review, adjust the Master Plan according to regulations; build, complete information systems, digital models to connect information, data, monitor the exploitation, use of water resources and support decision-making to regulate, allocate water sources in the river basin according to regulations; manage activities of exploitation, use of water and discharge of wastewater into water sources according to authority, consistent with water source functions, water quality goals and minimum flow as prescribed in this Decision; inspect, examine the exploitation, use of water, discharge of wastewater into water sources to ensure water source functions, ensure minimum flow and other contents of the Master Plan; coordinate with line ministries, ministerial-level agencies and related local authorities to decide on plans to regulate, allocate water sources in inter-provincial river basins; carry out measurement, monitoring of flow, water quality; organize the sharing, regulating, allocating of water sources among water operators, users in the region, between the Northern midland and mountainous region and the Red river delta according to this Master Plan on the basis of annual forecast results of hydrometeorology, water sources, total amount of water stored at the end of the flood season and beginning of the dry season of important reservoirs, capable of regulation, and inter-reservoir operating procedures promulgated by the Prime Minister and related information, data on inter-provincial, inter-national, intra-provincial rivers to ensure coordination between ministries, ministerial-level agencies and local authorities in the basin...[2] ■

REFERENCES

1. *Submission document on approval of the General Master Plan for the Red river - Thai Binh river basin for the 2021-2030 period, with a vision to 2050.*
2. *Decision on approval of the General Master Plan for the Red river - Thai Binh river basin for the 2021-2030 period, with a vision to 2050.*



Technical regulations for establishing water source protection corridors

According to the Law on Water Resources 2023, investigation and survey activities serving the establishment of water source protection corridors are basic investigation activities (Article 9). Clause 4, Article 29 of the Decree No.53/2024/NĐ-CP dated May 16th, 2024 also stipulates that the marking of water source protection corridors is carried out according to the technical instructions of the Ministry of Natural Resources and Environment. However, at present, there are no technical regulations and economic-technical norms for establishing water source protection corridors issued by competent authorities, causing difficulties in the establishment, appraisal and implementation. Therefore, in order to comply with the Law on Water Resources 2023 and legal documents as well as practical requirements of water resource management in the current period, the development and promulgation of a Circular regulating the technical regulations for establishing water source protection corridors is crucial.

1. REGULATIONS ON ESTABLISHING WATER SOURCE PROTECTION CORRIDORS

The Decree No.53/2024/NĐ-CP stipulates that water sources that must have a protection corridor include water sources as prescribed in Clause 2, Article 23 of the Law on Water Resources, including: Lakes, ponds, lagoons, and estuaries in the List of lakes, ponds, lagoons, and estuaries that cannot be filled with a water surface area of 2 hectares or more. Based on the actual situation of the locality, the Provincial People's Committee shall decide to issue a List of water sources that must have a protection corridor for lakes, ponds, lagoons, and estuaries in the List of lakes, ponds, lagoons, and estuaries that cannot be filled with a water surface area of less than 2 hectares. Water sources that must have a protection corridor as prescribed in Point d, Clause 2, Article 23 of the Law on Water Resources, include: River sections, streams, canals, and ditches that are water sources for domestic and production water supply works; river sections, streams that are eroded or at risk of erosion; rivers, streams, canals, ditches, and inter-district and inter-provincial canals are drainage axes for urban areas, concentrated residential areas, industrial zones and clusters; river, stream, canal, and ditch sections that are degraded, polluted, or exhausted need to be renovated and restored; rivers, streams, canals, and ditches are closely linked to the livelihoods of communities living along the river.

The basis for determining the scope of the water source protection corridor is stipulated in Article 22 of the Decree No.53/2024/NĐ-CP, including: Functions of the water source protection corridor; characteristics of terrain, geology, hydrology, environment, ecology; changes in riverbeds, banks, streams, canals, ditches, and streams. Specific provisions on the scope of the water source protection corridor are in Articles 23, 24 and 25 of the Decree, specifically: In Article 24, for the protection corridor of rivers, streams, canals and ditches with the function of protecting the stability of the banks and preventing encroachment on land along water sources, the scope of the water source protection corridor is stipulated as follows: Not less than 10m from the edge of the bank for river, stream, canal and ditch sections flowing through urban areas, concentrated residential areas or planned for urban construction, concentrated residential areas; Not less than 5 m from the edge of the bank for river, stream, canal and ditch sections not flowing through urban areas, concentrated residential areas; In case the river, stream, canal and ditch section is eroded or at risk of erosion, the Provincial People's Committee shall base on the development of the channel and the erosion status to decide on the scope of the protection corridor to ensure the safety of people's lives and property, limit the causes of bank erosion, and protect the stability of the bank. For the protection corridors of rivers, streams, canals and ditches with the function of preventing and combating activities that



▲ *Guidelines for establishing and managing water source protection corridors in Vietnam*



pose a risk of polluting and degrading water resources, the scope of the water source protection corridor is stipulated as follows: not less than 20 m from the edge of the bank for river, stream, canal and ditch sections flowing through urban areas, concentrated residential areas or planned for urban construction, concentrated residential areas; not less than 15 m from the edge of the bank for river, stream, canal and ditch sections not flowing through urban areas, concentrated residential areas...

Article 25 the Decree No.53/2024/NĐ-CP also stipulates: For lakes, ponds, marshes, and lagoons identified in the List of lakes, ponds, marshes, and lagoons that cannot be filled, the corridor must not be less than 10 m from the edge of the shore, except for the cases specified in Clauses 2, 3, and 4 of this Article. For hydroelectric and irrigation lakes in the List of lakes, ponds, marshes, and lagoons that cannot be filled, the corridor must be implemented according to the provisions of Article 23 of the Decree No.53/2024/NĐ-CP. For natural lagoons, marshes, and water sources related to religious and belief activities, with high value in terms of biodiversity, cultural conservation, and protection and development of natural ecosystems, the corridor must not be less than 30 m from the edge of the shore. In case the water source is located in a nature conservation area or within the protection area of historical and cultural relics, it shall comply with the provisions of law on nature conservation and protection of historical and cultural relics...

2. DRAFT CIRCULAR ON TECHNICAL REGULATIONS FOR ESTABLISHING WATER SOURCE PROTECTION CORRIDORS

In order to ensure that the provisions of the Law on Water Resources and the Decree No.53/2024/NĐ-CP are implemented synchronously, consistently and effectively, the Ministry of Natural Resources and Environment has developed a Draft Circular regulating the technical regulations for establishing water source protection corridors. Accordingly, the contents of establishing water source protection corridors include the following contents: (i) Making a list of water sources that must establish water source protection corridors; (ii) Developing a plan to set up boundary markers for other water source protection corridors according to the provisions of Article 29 of the Decree No.53/2024/NĐ-CP; (iii) Implementing boundary markers for water source protection

corridors. The Draft Circular consists of 3 Chapters and 29 Articles, specifically: Chapter I. General provisions, including 4 Articles; Chapter II. Technical procedures for establishing water source protection corridors, including 23 Articles; Chapter III. Implementation provisions, including 2 Articles. In which, Chapter I. General provisions: This Chapter stipulates the contents on the scope of regulation; applicable objects; explanation of terms; contents of establishing water source protection corridors. Chapter II. Technical process for establishing water source protection corridors includes 3 sections. Section 1: Establishing a list of water sources that must establish a protection corridor, including 9 articles from Article 5 to Article 14: Technical process for establishing a water source protection corridor; collecting and reviewing relevant data and information; investigating and surveying to establish a list of water sources that must establish a water source protection corridor; synthesizing and correcting collected data and field investigations; analyzing and determining water sources that must establish a water source protection corridor, identifying river sections to determine the function of the protection corridor and the scope of the protection corridor of each water source; making a map of water sources that must establish a water source protection corridor; making a list of water sources that must establish a water source protection corridor and documents for collecting opinions, submitting for approval...

Section 2 of Chapter II stipulates: Developing a plan to set up boundary markers for water source protection corridors for other water sources as prescribed in Article 29 of the Decree No.53/2024/NĐ-CP, including 6 articles from Article 15 to Article 20: Technical process for developing a plan to set up boundary markers for water source protection corridors for other water sources as prescribed in Article 29 of the Decree No.53/2024/NĐ-CP; updating relevant documents, data and information; Conducting field surveys of proposed locations for setting up markers; synthesizing, processing collected information and analyzing the conditions and difficulty levels of setting up boundary markers for water source protection corridors; developing the content of the plan to set up boundary markers for water source protection corridors for other water sources as prescribed in Clause 3, Article 29 of the Decree No.53/2024/NĐ-CP; prepare documents for submission for approval of the plan to set up boundary markers for water source protection corridors. Section 3: Implementation of setting up boundary markers for water source protection corridors includes 7 Articles, from Article 21 to Article 27 including: Technical process for setting up boundary markers for water source protection corridors; preparation work; bringing the location of markers on the map to the field, marking for construction; preparing markers, recording the marker number; setting up markers, measuring the coordinates of markers; checking, accepting and handing over the product; updating the boundary markers for water source protection corridors into the National Water Resources Database System ■

VŨ NHUNG



Decree No.102/2024/NĐ-CP: Ensuring consistency, synchronization and uniformity between the Land Law and other related legal provisions

ĐOÀN THỊ THANH MỸ

Ministry of Natural Resources and Environment

In order to fully specify articles and clauses that the Law has assigned to the Government for regulation, ensuring compliance with the Land Law and effective simultaneously with the effective date of the Land Law; to ensure consistency, harmony, and unity between land law and other related legal regulations, on July 30th, 2024, the Ministry of Natural Resources and Environment issued Decree No. 102/2024/NĐ-CP detailing implementation of several articles of the Land Law.

1. THE NECESSITY OF ISSUING DECREE NO.102/2024/NĐ-CP

The 2013 Land Law was approved by the National Assembly and took effect on July 1st, 2014. To organize the implementation of the Land Law, the Ministries of Natural Resources and Environment, Justice, Finance and Agriculture and Rural Development have advised on establishment and submission of 25 Decrees (including 16 new Decrees, 7 amended and supplemented Decrees, and 2 replaced Decrees); ministries and sectors have issued 59 Circulars and inter-ministerial Circulars, of which the Ministry of Natural Resources and Environment has presided over the issuance of 46 Circulars. The timely, synchronized, and fairly complete issuance of detailed regulations for implementing the Land Law has created a coherent, tight, and feasible legal framework for managing and exploiting resources, using land reasonably, economically, and effectively, developing technical infrastructure, social infrastructure, and urban housing; facilitating land participation in the real estate market; significantly increasing revenue for the state budget, and positively contributing to the socio-economic development, national defense, and security of the country. During organizing of implementation of the 2013 Land Law, the Ministry of Natural Resources and Environment has always listened to feedback from localities, citizens, and businesses. Based on that, the Ministry has advised the Government to issue Decrees No.01/2017/NĐ-CP dated January 6th, 2017, Decree No.148/2020/NĐ-CP dated December 18th, 2020, Decree No.10/2023/NĐ-CP dated April 3rd, 2023 amending and supplementing several articles of the Decrees guiding the implementation of the Land Law, and Decree No.12/2024/NĐ-CP dated February 5th, 2024 amending and supplementing several articles of Decree No.44/2014/NĐ-CP dated May 15th, 2014 regulating land prices, and Decree No.10/2023/NĐ-CP dated April 3rd, 2023 amending and supplementing several articles of the Decrees guiding the implementation of the Land Law. The Decrees detailing the implementation of several articles of the 2013 Land Law mentioned above have contributed to resolving

difficulties and obstacles in organizing the implementation of the Law in the past period.

However, the process of summarizing the implementation of the 2013 Land Law shows that despite achieving certain results, administration and land use still face existing limitations, such as: land use planning has not ensured synchronization, comprehensiveness, and systematization; quality is not high and lacks long-term vision; land resources have not been fully and sustainably exploited; in some areas, land use is still wasteful and ineffective; access to land by organizations and individuals, especially ethnic minorities is still inadequate; land recovery, compensation, support, and resettlement in some areas have not ensured harmonious benefits between the State, land users, and investors; administrative reform in land management has not met practical requirements; land finance and land prices do not accurately reflect market realities; trends of land degradation, soil pollution, and saltwater intrusion are occurring in many places, with complex developments; land disputes, complaints, denunciations, and violations of land law are still numerous, but the handling is still limited... The causes are due to the historical and complex nature of land; the enforcement of land law in some places has not been strict; policies and laws still have inadequacies; some contents of related laws have not been consistent and synchronized with land law; detection, prevention, and handling have not been well implemented; some newly arising contents in practice have not been regulated by law.

Based on this situation, on January 18th, 2024, at the 5th Extraordinary Session, the 15th National Assembly passed the Land Law No.31/2024/QH15 with 16 Chapters and 260 Articles. On March 5th, 2024, the Prime Minister issued Decision No.222/QĐ-TTg assigning ministries and sectors to prepare detailed regulations for the implementation of the 2024 Land Law, under which the Ministry of Natural Resources and Environment was assigned to prepare 6 Decrees to detail the implementation of several articles of the Law, including Decree No.102/2024/NĐ-CP dated July 30th, 2024, detailing the implementation of



several articles of the Land Law. The Decree detailing the implementation of several articles of the Land Law is issued to specify 54 contents assigned in the Law, which is necessary to ensure effectiveness simultaneously with the effective date of the Land Law in accordance with the articles of the Law on the promulgation of legal documents.

2. SOME BASIC CONTENTS OF DECREE NO.102/2024/NĐ-CP

Decree No.102/2024/NĐ-CP detailing 54 Articles and Clauses assigned by the 2024 Land Law for the Government to specify. The Decree consists of 10 Chapters, 113 Articles, and 1 Appendix, specifically: General articles (Articles 1 to 12); Organization of public land services (Articles 13 and 14); Land use planning and plans (Articles 15 to 24); Land recovery and requisition (Articles 25 to 40); Development, management, and exploitation of land funds (Articles 41 to 43); Land allocation, land lease, and change of land use purpose (Articles 44 to 63); Land use regimes (Articles 64 to 100); Monitoring and evaluating land management and use; land inspection (Articles 101 to 104); Resolving land disputes and violations of land law in the performance of public duties in the land sector (Articles 105 to 109); Implementation clauses (Articles 110 to 113); and the Appendix includes 31 forms.

3. SOME MAIN CONTENTS OF THE DECREE

1. Regulations on scope of adjustment, applicable subjects; individuals directly engaged in agricultural production; land classification

One of the shortcomings in the implementation of the 2013 Land Law relates to defining what is meant by “stable income from agricultural production on that land” to identify households and individuals directly engaged in agricultural production. On the basis of inheritance specified in Clause 30, Article 3 of the 2013 Land Law, it has been clarified that individuals directly engaged in agricultural production must be those who have been allocated land by the State, leased land, or recognized for their rights to agricultural land; who have transferred rights to agricultural land and earn income from agricultural production on that land, and who are not recipients of salaries from the state budget, pensions, monthly social insurance benefits, or workers with indefinite labor contracts (Article 3).

Regarding land classification (Articles 4, 5 and 6), Decree No.102/2024/NĐ-CP details the types of land within the categories of agricultural land, non-agricultural land and unused land, specifically: (1) Agricultural Land: details 7 land types within the agricultural land category, including annual crop land, perennial crop land, forestry land, aquaculture land, concentrated livestock land, salt-making land, and other agricultural land; (2) Non-Agricultural Land: details 11 land types within the non-agricultural land category, including residential land, land for government offices, defense and security land, land for public works, non-agricultural production and business land, land for public purposes, religious land, worship land, cemeteries, funeral

homes, crematoria, columbarium land, specialized water surface land, and other non-agricultural land; (3) Unused Land: details 5 land types within the unused land category, including land recovered by the State that has not been allocated or leased and is managed by the local People’s Committee, unused flat land, unused hilly land, rocky land without forest, and unused water surface land. The detailed regulations on land classification fundamentally inherit the articles on land statistics, inventory, and mapping of current land use according to the 2013 Land Law, while also refining specific land categories to align with the classification articles in the 2024 Land Law, such as: supplementing the classification of concentrated livestock land into agricultural land category; supplementing columbarium land and merging river, stream, canal, brook, and specialized water surface land into specialized water surface land, and abolishing regulation on cemetery land within the non-agricultural land category.

Regarding land support for ethnic minorities (Article 8), this is a new policy in the 2024 Land Law. The law specifically outlines policies for supporting residential land and production land for individuals who are ethnic minorities classified as poor or near-poor households in ethnic minority and mountainous regions. It defines the responsibilities of state agencies in developing and implementing land policies for ethnic minorities, the resources required to carry out these policies, and ensures land availability to implement land policies for ethnic minorities. Additionally, it stipulates certain restrictions on the rights of land users regarding cases of land allocation, leasing, or changing land use purposes under the ethnic minority land policy. For detailed regulations, the Decree specifies support for individuals who are ethnic minorities and have been allocated land for the first time but no longer have residential land, allowing them to be allocated residential land or change the purpose of land use from other types to residential land. If they lack residential land, they may change the purpose of land use from other types to residential land and be exempt from land use fees for the area within the residential land allocation limit. In cases where they no longer have agricultural land or the agricultural land they are using is less than 50% of the local agricultural land allocation limit, they will be supported in being allocated agricultural land within the limit. Moreover, it assigns responsibilities to the commune-level and district-level People’s Committees in



supporting land for individuals who are ethnic minorities. It clearly defines the funding for compensation, support, and resettlement for land recovery; costs for surveying, preparing land registration documents, issuing land use rights certificates, and other expenses that will be allocated from local budgets and other legal funding sources as stipulated by law. If a locality cannot balance its budget, the provincial People's Committee must report to the Ministry of Finance for the Prime Minister's consideration and decision.

Regarding the regulations on economic organizations with foreign investment receiving capital transfers as the value of land use rights (Article 9), current land law regulates that the value of land use rights can be capitalized into the equity of the enterprise. However, the enterprise law and other related laws do not provide regulations on capitalizing the value of land use rights. To address this shortcoming, specific conditions have been established for foreign-invested economic organizations to receive capital transfers as the value of land use rights from organizations currently using land allocated by the State with land use fees or leased land paid in a lump sum for the entire lease period, where the value of land use rights has become part of the charter capital of the economic organization and has the rights and obligations specified in Clause 3, Article 41 of the Land Law. In cases where capital transfers are received as the value of land use rights in border communes, wards, and towns; coastal communes, wards, and towns; or other areas that affect national defense and security, the transfer of capital as the value of land use rights will be carried out in accordance with provisions of investment law and related laws.

Additionally, in order to reduce the requirements for reporting forms, the quantity and components of application files, shorten the appraisal time and provide flexibility in submission methods to facilitate individuals and businesses in carrying out land administrative procedures, Article 12 of the Decree clearly specifies the agencies responsible for receiving applications and returning results, submission methods, and the timeframes for resolving administrative procedures. According to this, the time for carrying out administrative procedures is calculated from the date of receipt of valid applications and does not include the time taken by financial and tax authorities, the time for land users to fulfill their financial obligations, the time for negotiating to implement land accumulation and concentration, the time for determining specific land prices, and the time for surveying the land parcel. At the same time, the provincial People's Committees are tasked with deciding on the agencies responsible for receiving and returning results for administrative procedures, the timelines for each step of the administrative procedures of relevant agencies and units, and ensuring inter-agency resolution under a one-stop-shop mechanism to comply with legal timeframes. They are also responsible for publicizing administrative procedures and the selection of application submission locations to ensure efficiency in time and costs for organizations, individuals, and competent authorities in resolving administrative procedures.

2. Organizing public land services

The Decree specifies the functions, tasks and organizational structure of the Land Registration Office and the Land Fund Development Center that detailed in Articles 13 and 14. Accordingly, the Land Registration Office is a public service unit under the provincial land management authority; it is responsible for registering and issuing land use rights certificates, ownership of property attached to land, surveying, adjusting, preparing cadastral maps, building, managing, operating, and exploiting the land information system, providing public land services, and supporting other state management tasks related to land at the provincial level. This regulation aims to ensure the institutional spirit of Resolution No.18-NQ/TW regarding decentralization, delegation of authority, clarity of roles and responsibilities, and transparency in resolving administrative procedures related to land, specifically detailing the contents of land registration and certificate issuance in the 2024 Land Law. Regarding the Land Development Center (Article 14), the Decree stipulates that the Land Development Center is a public service unit established by the provincial People's Committee and is directly under the provincial People's Committee. Based on the actual situation in the locality, the provincial People's Committee decides to establish the Land Development Center under the district People's Committee; specifies the tasks, organizational structure, financial sources, and expenditure related to the activities of the Land Development Center. The restructuring of the land development organization aims to address the shortcomings identified during the evaluation of the operational model of land development organizations, which include the dispersion of local land development organizations, a lack of concentration of resources, insufficient centralized and unified direction, difficulties in coordination with relevant agencies, inadequate support regarding environmental issues and operational mechanisms, and limitations on funding in terms of quantity and duration due to dependence on state budget allocations for the Land Development Fund or voluntary advance funding from project investors.

3. Land use planning and land use plans

The Decree assigns Ministry of Natural Resources and Environment (MONRE) the responsibility to establish technical regulations for the formulation and adjustment of the national land use plan, as well as provincial and district land use plans, as detailed in Articles 15, 18, 19, 20, and 21. It specifies the technical



requirements and steps related to the methods and content of land use target allocation for planning at various levels, including codes and symbols for land types, regulations on the forms and specifications of land use planning documents, steps in the process of formulating land use plans at all levels, and a system of codes and color symbols for different land types corresponding to the maps for each planning level. These regulations build upon existing articles, currently governed by Circular No.01/2021/TT-BTNMT dated April 12, 2021 which outlines technical regulations for formulating and adjusting land use plans with 52 articles and 185 pages, including annexes, forms, and map color symbols.

Regarding the principles and criteria for allocating land use targets (Article 22), this represents a new point of Decree compared to current regulations. The Decree details the principles and criteria for allocating land use targets, specifying five groups of principles for allocation to meet the requirements for each planning level. The criteria for allocating land use targets are categorized into two groups, separately defining the criteria for national land use targets (such as rice land, protective forest land, special-use forest land, natural production forest land, defense land and security land) for localities, and the criteria for allocating targets in provincial land use planning for district land use planning concerning 26 types of land in the agricultural and non-agricultural categories, consistent with land types defined in Article 9 of the Land Law. Clearly outlining the conditions, criteria, and responsibilities of consulting organizations and lead consulting experts, as well as the selection process for consultants in formulating land use plans at each level (Articles 23 and 24), ensuring that the participation of various stakeholders in land use planning is expanded while maintaining the quality of the selected consulting units.

4. Land recovery and land expropriation

The regulations regarding land recovery related to national defense and security (from Article 25 to Article 27) detail specific cases for (1) recovering land for national defense and security that is included in the national defense land use plan and security land use plan, which is to be transferred to localities for implementing socio-economic development projects for national and public benefit; (2) recovering land to perform national defense and security tasks that are not yet included in the national defense land use plan and security land use plan; and (3) recovering national defense and security land, along with assets attached to the land, to be transferred to localities for socio-economic development projects for national and public benefit, even when the area of land to be recovered has not been defined in the national defense land use plan and security land use plan. These are new regulations compared to current articles, aiming to detail Article

84 of the 2024 Land Law. The procedures for land recovery are clearly designed, outlining the steps, timelines, and responsibilities of agencies and land users involved in the recovery process.

The Decree also clarifies the cases of force majeure applicable to handling situations as stipulated in clauses 6, 7, and 8 of Article 81 of the Land Law, which include force majeure events and objective obstacles under civil law that directly impact land use. These include: natural disasters, environmental disasters; fires, epidemics; wars, national defense emergencies; other cases as regulated by emergency laws; situations where competent state agencies apply emergency measures, such as temporary seizure or freezing of land use rights and assets attached to the land, allowing land users to continue using the land afterward; administrative decisions and actions by competent state agencies that constitute objective obstacles, not due to the fault of the land user, directly affecting land use; other cases determined by the Prime Minister based on proposals from provincial People's Committees or relevant ministers; specifying the timing for extending the deadline to no more than 24 months for cases where land is not put to use or where there are delays in land use; time affected by force majeure is not counted toward the time for not putting land to use or delays in land use as stipulated in Clause 8 of Article 81 of Land Law. The Chairperson of the provincial People's Committee is responsible for determining the duration of the impact due to force majeure for projects within their jurisdiction based on legal regulations and the actual implementation of investment projects.

5. Development, administration, exploitation of land funds

The decree specifies the cases in which Land Development Organization develops, manages, and exploits land funds; the procedures for establishing, appraising, and approving land fund creation projects; regulations on managing and exploiting short-term land funds of no more than 5 years; stipulations that land lessees are not required to register land and will not be issued Land Use Rights Certificates or property ownership certificates attached to the land; the starting rental price is determined by the Chairman of the competent People's Committee granting the lease. Rental payments are included in revenue and accounted for according to regulations for public service units. Land users are prohibited from constructing permanent structures and must commit to voluntarily dismantling any constructions when the State recovers the land, and will not be compensated for land, assets, or investment costs related to the land and must pay a deposit for the responsibility of dismantling the structures.



6. Land allocation, land leasing, and change of land use purpose

In cases where the State leases land, if the land handover date is from January 1st, 2005, to before October 1st, 2009, the land price for calculating the land rent applies the land price table at the time of land handover. If the land handover date is from October 1st, 2009, to before July 1st, 2014, and falls under cases that require specific land price determination, the land price for calculating the land rent applies the land price table multiplied by the land price adjustment coefficient at the time of land handover. If the land handover date is from July 1st, 2014, to December 31st, 2014, for cases of leasing land with a one-time rent payment for the entire lease period, according to regulations at the time of land handover, which fall under the method of applying the land price adjustment coefficient when determining the specific land price, or cases of leasing land with annual rent payments, the land price for calculating the land rent applies the land price table multiplied by the land price adjustment coefficient at the time of land handover. If the land handover date is from January 1st, 2015, to before August 1st, 2024, for cases of leasing land with a one-time rent payment for the entire lease period, according to regulations at the time of land handover, which fall under the method of applying the land price adjustment coefficient when determining the specific land price, or cases of leasing land with annual rent payments, the land price applies the land price table at the time of land handover multiplied by the land price adjustment coefficient at the time of land handover. If the land handover date is from July 1st, 2014, to before August 1st, 2024, and according to regulations at the time of land handover requires specific land price determination and does not fall under the application of the land price adjustment coefficient method, then the methods specified in points a, b, c of clause 5 and points a, b, c of clause 6 of Article 158 of the Land Law, detailed in the Decree on land prices,

shall apply. The determination of the land price adjustment coefficient in the above regulations is carried out according to the Decree on land prices. In cases where land is allocated or leased by the State through forms permitted by the competent authority to change land use purposes and requires the payment of land use fees or land rents, the time for determining the land price for calculating land use fees and land rents is the time when the competent state authority issues the decision.

7. Land use regime

Based on the articles inherited from Decree No.42/2024/NĐ-CP of the Government, Section 3 of Chapter 7 has completed the content regarding land use planning and plans for marine areas designated for land reclamation; decisions on investment policy, approval of investment policy, and selection of investors for investment projects involving land reclamation; preparation, appraisal of feasibility study reports, and project approval; preparation, appraisal, and approval of construction designs; construction and acceptance of construction works for investment projects involving land reclamation or land reclamation components of investment projects. The regulations concerning land allocation, land leasing, and allocation of marine areas for land reclamation activities; acceptance of completed land reclamation activities; determination of land use fees and land rental fees; and issuance of land use rights certificates and ownership certificates for assets attached to land for land reclamation activities have been completed based on the regulations of the 2024 Land Law.



▲ *Ho Chi Minh City People's Committee will issue the adjusted land price list*



Besides, Articles 79 to 90 of the Decree provide general regulations on the land use for national defense and security; state administration of land for national defense and security; entities using national defense land in conjunction with production labour activities and economic construction; principles of using national defense and security land in conjunction with production labor activities and economic construction; the responsibilities of Minister of National Defense and Minister of Public Security in managing and using national defense and security land in conjunction with production labor activities and economic construction; rights and obligations of units and enterprises managed by Ministries of National Defense and Public Security regarding the use of national defense and security land in conjunction with production labor activities and economic construction; cases where the use of national defense and security land in conjunction with production labor activities and economic construction is exempt from annual land use fees; cases where annual land use fees must be paid for the use of national defense and security land in conjunction with production labor activities and economic construction; methods for calculating annual land use fees, the time frame for collecting annual land use fees, and the responsibilities of Minister of National Defense and Minister of Public Security in assigning functional agencies to guide the collection and payment of annual land use fees for state-owned units and enterprises managed by Ministries of National Defense and Public Security; procedures for preparing, appraising, and approving plans for using national defense and security land in conjunction with production labor activities and economic construction; revenues and expenditures from the use of national defense and security land in conjunction with production labor activities and economic construction; and management of the funds collected from the use of national defense and security land in conjunction with production labor activities and economic construction. The articles regarding the use of national defense and security land in conjunction with production labor activities are built on the basis of inheriting the contents specified in Decree No.26/2021/NĐ-CP dated March 25th, 2021, of the Government, which details some articles of Resolution No. 132/2020/QH14 dated November 17th, 2020, of the National Assembly, piloting some policies to resolve difficulties and outstanding issues in administration and use of national defense and security land in conjunction with production labor activities and economic construction, with improvements regarding the entities using national defense and security land in conjunction with production labor activities and economic construction to align with the articles of Clause 1, Article 201 of the 2024 Land Law.

8. Monitoring and evaluating land administration and use; specialized land inspection

The Decree stipulates the content of monitoring and evaluation for state administration agencies regarding land, monitoring and evaluating compliance with land law by land users; developing plans and organizing annual inspections of land management and use, specifying the subjects of monitoring and evaluation under the responsibility of Ministry of Natural Resources and Environment (MONRE) for large-scale areas that use extensive land; the declaration, registration, and reporting of the management and use of land by land users; regulations on providing and reflecting information on land management and use, including the timing, forms, and content of reports; providing and reflecting information on land management and use; bases, authority, responsibilities, content, and forms of specialized land inspections; and the procedures for conducting inspections. The content for monitoring and evaluating land management and use, as well as specialized land inspections, is fundamentally improved based on current regulations, with more specific articles regarding the monitoring and evaluation of land management and use by state management agencies and the compliance with land law by land users; regulations on the bases, authority, responsibilities, content, forms of inspections, and the procedures for conducting specialized land inspections.

In addition, the Decree also stipulates several contents related to the resolution of land disputes, violations of land law when performing duties in the field of land (from Article 105 to Article 109), and the enforcement provisions (from Article 110 to Article 113).

It can be said that with the decisive direction of the Government and the Prime Minister, to ensure the conditions for the implementation of the 2024 Land Law effective from August 1st, 2024 (five months earlier than planned), in a short period, Ministry of Natural Resources and Environment (MONRE) has actively and proactively coordinated with relevant ministries, agencies, and organizations to draft and submit to the Government four decrees detailing the implementation of the 2024 Land Law, which will take effect simultaneously with the Law. Among them is Decree No.102/2024/NĐ-CP dated July 30th, 2024, which details the implementation of certain articles of the 2024 Land Law. At the same time, the Ministry has also issued four circulars as authorized by the Law. These results have contributed to effective management and the release of land resources, meeting the requirements for socio-economic development, ensuring national defense and security, and sustainable development during the period of accelerating the country's industrialization and modernization. This also contributes to completing the socialist-oriented market economy institution in our country now and in the future ■



Implementing the management of solid waste on islands and coastal areas in Vietnam: A perspective from policy to practice

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The article addresses the issue of implementing solid waste management on islands and coastal areas in Vietnam, viewed from the perspective of policies to practice. It encompasses the Party's directives and orientations to legal regulations, notably the Law on Environmental Protection 2020 and other related policies such as planning. Specifically, the provisions of the Law on Environmental Protection 2020 are detailed through Decree No. 08/NĐ-CP issued on January 10, 2022, and the guiding circular No. 02/TT-BTNMT issued by the Ministry of Natural Resources and Environment on the same date. The article also highlights current difficulties and challenges in implementing policies related to solid waste management on islands and coastal areas. Based on these insights, it proposes solutions for effective solid waste management on islands and coastal areas in Vietnam that align with practical conditions and the implementation of the regulations set forth in the Law on Environmental Protection 2020.

1. OVERVIEW OF ISLANDS, COASTAL AREAS, AND THE NECESSITY OF SOLID WASTE MANAGEMENT

Vietnam's maritime space is three times larger than its land area, comprising over 3,000 islands and offshore archipelagos, including the Hoang Sa (Paracel) and Truong Sa (Spratly) Islands. The coastline stretches for 3,260 kilometers (excluding the shores of the islands) and spans 28 coastal provinces and cities. Situated in the tropical monsoon region of Southeast Asia, Vietnam's seas are characterized by high biodiversity, featuring typical ecosystems such as wetlands, mangroves, coral reefs, and seagrass beds. Marine pollution, particularly from solid waste originating from human activities, poses a significant threat to these ecosystems. If not properly managed and allowed to be freely discharged into the sea, solid waste pollution can lead to the degradation of marine ecosystems. The importance of addressing solid waste pollution lies in preserving these ecosystems, which are vital for environmental sustainability, economic activities, and the overall health of coastal and marine life. Figure 1 below outlines Vietnam's maritime space, key ecosystems and some of the islands and archipelagos within this area.

Previous studies have estimated that 80% of solid waste discharged into the sea originates from land-based activities. Vietnam's coastline features 114 river mouths, creating pathways for solid waste to flow into the sea and oceans. In 2018, the United Nations Environment Programme (UNEP) reported that Vietnam discharges between 0.28 and 0.73 million tons of plastic waste into the oceans annually, accounting for 6% of the global total, and ranking fourth

in the world. Marine waste pollution not only affects environmental quality and ecosystems but also has significant impacts on economic development and coastal communities, posing risks to food security and safety. Therefore, the management and treatment of solid waste, particularly in coastal areas and on islands, is of critical importance to mitigate these adverse effects and ensure sustainable development.

2. POLICIES AND LEGISLATION ON SOLID WASTE MANAGEMENT

The implementation of solid waste management in general, and on islands and coastal areas in particular, in relation to current policies and legislation, needs to be considered from the Party's directives and orientations to the State's policies and laws.

Party directives and orientations, the government's action plan.

Regarding the Party's directives and orientations related to solid waste management in general, and specifically for islands and coastal areas, there have been prior instructions, notably in Resolution No.24-NQ/TW dated June 3, 2013, and the resolution from the seventh session of the Central Executive Committee of the XIth Congress, which focuses on "*proactively responding to climate change, enhancing resource management, and protecting the environment.*" The specific target set for 2020 was to "*reuse or recycle over 65% of municipal solid waste.*" The specific tasks outlined aim to focus on solid waste management by 2020, with a vision extending to 2050, emphasizing the need to concentrate efforts on effectively managing solid waste.

Resolution No.36-NQ/TW and the resolution from the eighth session of the Central Executive Committee of the XIIth Congress, dated October 22, 2018, regarding the "Strategy for Sustainable Development of Vietnam's Marine Economy by 2030, Vision to 2045," addresses the management of solid waste by stating that "*In coastal provinces and cities, 100% of hazardous waste and municipal solid waste must be collected and treated in accordance with environmental standards.*" To implement Resolution 36/NQ-TW, the Government issued Resolution No.20/



NQ-CP on March 5, 2020, which outlines the “Overall Plan and 5-Year Plan for the Government’s implementation of Resolution No. 36-NQ/TW dated October 22, 2018, from the eighth session of the Central Executive Committee of the XIIth Congress regarding the Strategy for Sustainable Development of Vietnam’s Marine Economy by 2030, Vision to 2045.” In terms of environmental solutions related to solid waste management, Resolution 20/NQ-CP requires “*Investment in and strengthening of infrastructure and equipment for the collection and treatment system of municipal solid waste to meet environmental standards and to ensure the effective implementation of collection and treatment processes*”.

In the Socio-Economic Development Strategy for 2021-2030, under the section on “Directions, Tasks, and Solutions for Socio-Economic Development,” specifically item 7 regarding “Effective management and use of resources; enhancing environmental protection and responding to climate change; disaster prevention and mitigation,” it is stated that concerning the management of municipal solid waste, “the rate of reuse and recycling of municipal solid waste must reach over 65%.” Thus, the directives and orientations established by the Party indicate that by 2030, the entire country must achieve a result where more than 65% of municipal solid waste is recycled and reused.

Resolution No.48/NQ-CP issued by the Government on April 3, 2023, regarding the “Approval of the strategy for sustainable exploitation and use of marine and island resources, and environmental protection by 2030, with a vision to 2050,” establishes specific targets related to solid waste management by 2030. It states that “by 2030, in coastal urban areas, 100% of hazardous waste and municipal solid waste must be collected and treated in accordance with environmental standards.” In terms of strategic orientations and tasks for 2030, Resolution No.48/NQ-CP also emphasizes the issue of marine plastic waste, asserting the need to “prioritize resources from environmental protection funding to implement the National action plan on marine plastic waste management by 2030.” By that year, the resolution sets the goal that the rate of recovery and treatment of plastic waste at beaches, coastal tourism areas, and marine protected areas must reach 100%.

The Conclusion No.81-KL/TW issued by the Politburo on June 4, 2024, regarding the continued implementation of the Central Resolution 7 of the XIth Congress on proactively responding to climate change, enhancing resource management, and protecting the environment, addresses the management of municipal solid waste on islands and coastal areas. In this conclusion, it directs the “full and comprehensive implementation of the Environmental Protection Law 2020.”

Thus, regarding the directives, orientations, and strategies of the Party, as well as the implementation actions of the Government concerning municipal solid waste on islands and coastal areas by 2030, there is a nationwide requirement that the waste treatment rate must reach 100%, and the rates of reuse and recycling must achieve 65%. In particular, it is essential to fully and comprehensively implement the provisions of the Environmental Protection Law 2020 related to waste in general and municipal solid waste in particular.

State policies and laws.

Regarding the state’s legal policies, local authorities must first review and implement the provisions of the Environmental Protection Law 2020, which has been passed by the National Assembly, along with Decree No.08/NĐ-CP dated January 10, 2022, and Circular No.02/TT-BTNMT issued by the Ministry of Natural Resources and Environment on January 10, 2022. For the Environmental Protection Law 2020, the relevant provisions are found in Chapter VI, Section 2, “Management of Municipal Solid Waste,” specifically Articles 75 to 80. The key regulations under Decree No.08/NĐ-CP are located in Chapter V, Section 2, “Management of Municipal Solid Waste,” covering Articles 58 to 64. Circular No.02/TT-BTNMT details the management of municipal solid waste in Chapter IV, Section 2, Articles 26 to 32. Overall, the legal regulations concerning the management of municipal solid waste are quite comprehensive. Notably, compared to the Environmental Protection Law 2015, the 2020 version provides detailed stipulations that address waste management at the provincial, district, and community levels, specifically for household-generated waste. In relation to the management of solid waste on islands and coastal areas, local authorities in the 28 coastal provinces and cities, particularly in coastal districts and communes, need to fully understand these legal provisions to ensure effective implementation.

Regarding urban planning, Resolution No.139/2024/QH15 dated June 28, 2024, concerning the “National Marine Spatial Planning for the period 2021-2030, with a vision to 2050,” has been approved by the 15th National Assembly at its seventh session. The contents related to the management of municipal solid waste must be considered in this planning as a basis for implementation in islands and coastal areas. Notably, Resolution 139/2024/QH15 emphasizes the necessity to implement the guidelines and policies set forth by the Party, such as the Strategy for Socio-Economic Development for the 10-year period 2021-2030 and Resolution 36-NQ/TW. In terms of solid waste management, the specific objective for 2030 explicitly states the need to “prevent, minimize, and control marine environmental pollution, especially concerning marine plastic waste.” Currently, the 28 coastal provinces and cities have developed their provincial/city development plans for the 2021-2030 period, with a vision towards 2050, which include strategies for managing municipal solid waste in islands and coastal areas. The state’s management



role in these areas is crucial. Additionally, regions have begun implementing regional planning such as the Red River Delta, North Central Coast, Central Coastal Area, Southeast Region, and Mekong River Delta for the 2021-2030 period, with a vision to 2050. In particular, along with marine spatial planning, the coastal zone planning for the 2021-2030 period, with a vision towards 2050, provides critical frameworks for the implementation of municipal solid waste management in islands and coastal regions.

3. DIFFICULTIES AND CHALLENGES IN MANAGING MUNICIPAL SOLID WASTE ON ISLANDS AND COASTAL AREAS

In order to implement solid waste management in the islands and coastal areas of Vietnam, it is necessary to identify the difficulties and challenges to develop appropriate solutions. The following challenges need to be considered.

Firstly, the unique geographical characteristics of the islands, archipelagos, and coastal areas.

+ For the islands and archipelagos: The characteristic of islands and archipelagos is that they are not attached to the national territory; they are isolated in the maritime space and have a certain distance from the mainland. The islands and archipelagos that generate municipal solid waste requiring treatment are those with socio-economic activities and national security operations. Depending on geographical location, area size, natural advantages, and proximity to the mainland, the level of socio-economic development varies, which in turn affects the generation of municipal solid waste. In terms of management, the islands and archipelagos are assigned to be managed by a coastal province or city; therefore, the primary responsibility for managing solid waste on these islands and archipelagos lies with the coastal provinces and cities that contain them.

+ For the coastal areas: This refers to the interface between the sea and the mainland, with administrative boundaries typically aligned with the district-level administrative boundaries of coastal provinces and cities. This region has a high population density and vibrant socio-economic activities, resulting in a significant volume of municipal solid waste compared to other areas, with waste generated both on land and at sea. Additionally, a large amount of solid waste is contributed by river basins that discharge into coastal areas, originating from the mainland. With 114 river mouths along the coastline of Vietnam, a substantial quantity of municipal solid waste is released into coastal waters annually, necessitating effective management and treatment.

Secondly, regarding policy mechanisms

Although there are currently laws, decrees, and circulars in place for the management and treatment of municipal solid waste in general, as well as for islands, archipelagos, and coastal areas specifically, there are still certain challenges in implementing these policy mechanisms. These challenges include the compatibility and consistency of the relevant laws and policies. Additionally, some necessary circulars and guidelines, such as those pertaining to procedures, standards, and pricing for municipal solid waste treatment,

have yet to be issued. There is also a need for specific mechanisms tailored to the treatment of municipal solid waste on islands, archipelagos, and coastal areas. Other related policies, such as action plans for implementing a circular economy regarding municipal solid waste, must also be considered. Therefore, it is essential to promptly address the policy mechanisms for municipal solid waste treatment in general, and specifically for islands and coastal areas, in order to avoid creating barriers and delays that could result in significant losses for society.

Thirdly, the implementation process for the treatment of municipal solid waste in localities with islands, archipelagos, and coastal areas

Although there have been numerous policies and initiatives from the Party, along with clear targets set for the treatment of municipal solid waste, particularly with the enforcement of the Environmental Protection Law 2020, certain regulations are nearing their implementation deadline, such as the mandatory segregation of municipal solid waste at the source starting in January 2025. However, to date, the management of municipal solid waste on islands, archipelagos, and coastal areas has not met expectations, and the implementation remains inconsistent and insufficiently urgent to comply with the Party's guidelines and legal requirements. While there are some effective models for managing municipal solid waste in certain islands and coastal areas, they have not been widely adopted. Given the development plans of the 28 coastal provinces and cities, as well as the coastal region plans for the period 2021-2030 with a vision toward 2050, localities need to promptly implement detailed waste management plans for the islands, archipelagos, and coastal areas within the overall development framework of the provinces.

Fourthly, infrastructure for the management of municipal solid waste on islands and coastal areas

To effectively manage municipal solid waste on islands and coastal areas, a comprehensive technical infrastructure system is necessary, encompassing waste classification, collection, transportation, transfer, and final processing. Practical research indicates that many coastal localities currently fall short of meeting these requirements. Therefore, it is essential for local authorities to prioritize the development and immediate implementation of the necessary technical infrastructure for municipal solid waste management in these regions. This urgent need emphasizes the commitment of localities to enhance their waste management capabilities and ensure compliance with environmental standards.



Fifthly, the decisive involvement of the political system, businesses and the public

Although the issue of solid waste management is not new, it can be considered a specific challenge for islands and coastal areas, thus requiring the decisive involvement of the entire political system, businesses, and the public. In particular, it is essential to promote effective practices and initiatives that have proven successful at the local level, enabling their replication throughout the country.

4. KEY SOLUTIONS FOR SOLID WASTE MANAGEMENT IN ISLANDS AND COASTAL AREAS OF VIETNAM

Based on the identified difficulties and challenges, in order to overcome these obstacles and effectively implement the Party's guidelines, legal regulations, and other related policies, the following solutions need to be considered for the effective management of solid waste.

Firstly, regarding the policy mechanism

To create a policy mechanism for effectively managing solid waste on islands and coastal areas, it is essential to continue reviewing and refining existing policies. Specifically, this involves identifying shortcomings and inconsistencies in current policies, as well as addressing any misalignments with other relevant mechanisms, such as those related to finance, land, and energy. This approach aims to pinpoint bottlenecks that can serve as a basis for amending and supplementing existing regulations, thereby establishing a cohesive policy framework for managing solid waste in general, and specifically for islands and coastal areas.

Particularly, the legislative documents, decrees, and circulars related to the management of solid waste need to be urgently issued. This includes the decree for piloting the circular economy model, the government's action plan for implementing the circular economy, and the circular detailing procedures, standards, and pricing for solid waste management from the Ministry of Natural Resources and Environment, as well as other relevant documents to ensure effective implementation across ministries, agencies, and local authorities.

Secondly, implementation at the local level

To address this issue, based on the provisions of the Law on Environmental Protection 2020 regarding the management and treatment of solid waste, coastal localities and those with islands and archipelagos under their jurisdiction should assess the process of solid waste management in their areas over the recent period. They should compare this with the regulations of the Law on Environmental Protection 2020, as well as subordinate legal documents such as decrees and circulars, to continue implementing and proposing new methods suitable for the islands and coastal areas under their management.

Localities that have successfully implemented effective models for solid waste management on islands and coastal areas should summarize their experiences and replicate them. For example, the model for recovering plastic bags on Ly Son island in Quang Nam, the waste classification model at the source, collection, and treatment in Nghi Xuan district, Ha Tinh, and the current waste classification and organic fertilizer processing model in Hai Phong city, which applies a circular economy approach, should be documented and shared with other localities.

Thirdly, mechanisms for monitoring the implementation of the Law on environmental protection

Based on the provisions of the Law on Environmental Protection 2020 and the subordinate legal documents that have been issued, it is essential to establish mechanisms for monitoring the implementation of the law by coastal localities (28 provinces/cities) concerning the execution of solid waste management on islands, archipelagos, and coastal areas. This monitoring will facilitate the summarization and evaluation of the achievements and shortcomings, particularly focusing on identifying challenges and issues that need to be addressed at the local level to create favorable conditions for the effective implementation of solid waste management on islands, archipelagos, and coastal areas. The oversight of law enforcement should be led by the National Assembly in coordination with the Government, assigning the Ministry of Natural Resources and Environment to implement this process.

Fourthly, promoting the role of businesses, citizens, and social political organizations

To effectively manage solid waste nationwide, particularly in islands, archipelagos, and coastal areas, it is essential to harness the roles of businesses, citizens, and social political organizations. This approach will leverage a comprehensive effort where businesses act as the primary executors, supported by the consensus of the community and the assistance of social political organizations such as youth, women, and war veterans. This is especially critical in islands where issues of security and national defense are involved, highlighting the significant role of social political organizations.

Fifthly, specific mechanisms and appropriate models for managing solid waste in islands and coastal areas.

Due to the unique characteristics of islands, archipelagos, and coastal areas, specific mechanisms are required for solid waste management in these regions. For instance, the approach to solid waste management for islands should be based on factors such as the scale, generation rates, and volume of solid waste, as well as the transportation distances involved in waste disposal. In coastal areas, in addition to the solid waste generated on land, there are also floating debris in the sea and waste from river mouths discharging into the ocean; therefore, it is essential to establish suitable treatment methods according to a specific mechanism tailored to these conditions.

Additionally, there are various related solutions that depend on each island and coastal area within different localities. These include the necessary technical infrastructure for solid waste management, the implementation processes, technology used, and the awareness of the public, businesses, and local leaders. Solutions should be tailored to the specific characteristics of each area to ensure effectiveness and suitability ■



Main contents of the biosphere reserve management framework in Vietnam

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A biosphere reserve is an area that includes terrestrial, marine, and/or coastal ecosystems or a combination of these, and is internationally recognized under UNESCO's Man and the Biosphere Programme (MAB). It is designated as part of the World Network of Biosphere reserves. In 1976, the World Network of Biosphere reserves was established by UNESCO. As of June 2023, the Network has 748 Biosphere reserves in 134 countries. Vietnam became a member of the World Network of Biosphere reserve and joined MAB in 2000 since the first Biosphere reserve, Can Gio mangrove forest, Ho Chi Minh City, was recognized by UNESCO. After 22 years, Vietnam has 11 Biosphere reserves, accounting for about 14.69% of the country's natural area, becoming the country with the second largest number of Biosphere reserves in Southeast Asia. The nomination and management of biosphere reserves are conducted in accordance with UNESCO's guidelines, while adhering to the legal regulations of the host country. The article provides information on UNESCO's regulations and guidelines, the legal frameworks governing the organization and management of Biosphere reserves in Vietnam, and offers recommendations for improving and implementing the management framework for Biosphere reserves in Vietnam in the future.

1. UNESCO GUIDELINES FOR THE MANAGEMENT OF BIOSPHERE RESERVES

The UNESCO Biosphere reserves Management Framework is an international set of guidelines based on the voluntary participation of Member States, designed to support the management of biosphere reserves, including:

The Statutory framework of the World Network of Biosphere reserve (1995) defines the legal basis for the management and development of biosphere reserves under UNESCO's framework. It includes the following main provisions: Purpose and scope; Definitions; Principles; Nomination criteria; Evaluation and monitoring; Cooperation with intergovernmental organizations and partners; Evaluation and feedback; Effectiveness and implementation. The framework stipulates that the responsibility for the management and operation of biosphere reserves belongs to individual countries and must comply with their own legal systems. Essentially, UNESCO is not responsible for managing the biosphere reserves or for enacting or amending legislation to meet the requirements of the MAB Programme. This responsibility lies with the countries that have recognized biosphere reserves.

The Seville Strategy (1995) for World Network of Biosphere reserves, developed in 1995, sets specific goals for

UNESCO World Biosphere reserves and calls for the participation of all stakeholders.

Madrid Action Plan (2008-2015), MAB Strategy (2015-2025), The Lima Action Plan (2016-2025) sets out the orientation and key tasks in each period to strengthen and expand the World Network of Biosphere reserves in implementing sustainable development goals.

The legal framework of the World Network of Biosphere reserve defines the objectives of the recognition of Biosphere reserves, the functions of Biosphere reserves in terms of conservation (contributing to the conservation of landscapes, ecosystems, species and genetic resources), development (promoting economic, cultural and human development in a sustainable manner in terms of culture, society and ecology), support (supporting demonstration programmes, environmental education and training activities, research and monitoring related to conservation and sustainable development at local, national and global levels) and requires the zoning of Biosphere reserves into core zones, buffer zones and transition zones to carry out these functions. Biosphere reserves are required to periodically conduct a review report every ten years to ensure that all Biosphere reserves in the Network carry out the functions specified in the legal framework of the World Network of Biosphere reserve.

The strategies and plans of the MAB Programme are adopted to support member countries and other stakeholders in promoting biosphere reserves and ensuring their sustainable development. In particular, the MAB Strategy for 2015-2025 outlines four key objectives: (i) Conserve biodiversity, restore and enhance ecosystem services, and encourage the sustainable use of natural resources; (ii) Contribute to building a sustainable, healthy, and equitable society, economy, and human settlements; (iii) Foster sustainable scientific research and education to promote sustainable development; (iv) Support climate change mitigation and adaptation, as well as responses to other aspects of global environmental change. Based on these objectives, five priority areas of action have been identified: (i) The World



Network of Biosphere reserves implementing effective models for sustainable development; (ii) Comprehensive, dynamic, and results-based cooperation linking the MAB Programme and the World Network of Biosphere reserves; (iii) Building effective partnerships and securing adequate, sustainable funding for the MAB Programme and the World Network of Biosphere reserves; (iv) Ensuring comprehensive, open, and transparent sharing of information and data; (v) Effective governance of the World Network of Biosphere reserves.

UNESCO guidelines provide guidance and recommendations for countries to manage and operate Biosphere reserves within their own legal frameworks. Some countries have enacted laws and regulations to establish Biosphere reserves, while others have adapted existing laws to support this purpose.

2. VIETNAM'S LEGAL REGULATIONS ON THE MANAGEMENT OF BIOSPHERE RESERVES

The Law on Environmental Protection 2020 officially took effect on January 1st, 2022. Prior to its implementation, the nomination and management of biosphere reserves were guided by UNESCO, at the same time the management of natural resources, environmental protection, and biodiversity conservation within Biosphere reserves were governed by national laws. For instance, the core areas of Biosphere reserves, which often include nature reserves, were managed in accordance with forestry, fisheries, and biodiversity laws. However, Biosphere reserves were not yet given explicit legal status in national regulations, and there were no provisions regarding the organization of Biosphere reserve management to fulfill new requirements set by UNESCO.

The Law on Environmental Protection 2020, the Decree No.08/2022/NĐ-CP dated January 10th, 2022 of the Government detailing a number of articles of the Law on Environmental Protection (Decree No. 08/2022/ NĐ-CP), and the Circular No.02/2022/TT-BTNMT detailing the implementation of a number of articles of the Law on Environmental Protection (Circular No.02/2022/TT-BTNMT). These regulations establish that biosphere reserves are considered a type of natural heritage and are therefore subject to management and environmental protection regulations of natural heritage under Environmental protection Law. Specifically, the Law on Environmental Protection 2020 includes two articles directly related to biosphere reserves: Article 20 on natural heritage and Article 21 on the content of environmental protection of natural heritage.

The Decree No.08/2022/NĐ-CP further clarifies these two articles of the Law on Environmental Protection 2020 by addressing the following points: criteria, procedures, and authority for establishing and recognizing biosphere reserves (Clause 2, Article 19); procedures and authority for nominating natural heritage for recognition by international organizations (Article 20); and investigation, assessment, management, and environmental protection of natural heritage (Article 21). Additionally, Article 9 of the Circular No. 02/2022/TT-BTNMT outlines the development and approval processes for regulations and plans related to the management and protection of natural heritage.

3. MAIN CONTENTS OF THE BIOSPHERE RESERVES MANAGEMENT FRAMEWORK IN VIETNAM

Based on UNESCO guidelines, Vietnamese legal regulations and practical situations, it is possible to identify the main contents of the management framework for biosphere reserves in Vietnam.

3.1. *Nomination and withdrawal from the title of Biosphere reserves*

Management Board (or organization assigned to manage) of natural heritage sites (including nature reserves as prescribed by the Law on Biodiversity and other natural heritage sites) shall prepare nomination dossiers based on UNESCO's criteria for recognition of Biosphere reserves. The nomination process shall be implemented in accordance with the provisions of Article 20 of the Decree No.08/2022/NĐ-CP. On the other hand, countries may also request UNESCO to withdraw the title of Biosphere reserve when determining no longer meets UNESCO Biosphere reserve criteria.

3.2. *Organization of management of Biosphere reserves*

Agencies involved in the management of the World Biosphere reserve include the following main entities: the Biosphere reserve Management Board, the Ministry of Natural Resources and Environment, the Vietnam National Commission for UNESCO (with the Ministry of Foreign Affairs as the standing agency), the MAB Committee, and the People's Committees of the provinces and cities where the Biosphere reserve is located.

The National Park Management Board, Standing Office, and Advisory Board: To effectively manage the National Park, it is necessary to establish an Inter-sectoral Management Board for the Biosphere reserve. This Management Board plays a key role in inter-sectoral coordination, mobilizing, and enhancing the participation of relevant stakeholders to achieve the objectives of the Biosphere reserve. The decision-making authority for establishing the Inter-sectoral Management Board lies with the Provincial People's Committee for reserves located within one province, or with the Prime Minister for reserves that span multiple provinces, centrally-run cities, or sea areas where provincial administrative responsibility has not been clearly defined.



However, the Decree No.08/2022/NĐ-CP does not specifically address the structure and composition of the Inter-sectoral Management Board or the establishment of the Standing Office/Secretariat and Advisory Board. To ensure the effective implementation of inter-sectoral management tasks, the Head of the Management Board is typically a leader of the Provincial People's Committee (for example, in cases where the reserve is located entirely within one province, such as the Western Nghe An Biosphere reserve) or leadership rotates among the Provincial People's Committees (in cases where the core areas of the reserve are located in multiple provinces, such as the Red River Delta Coastal Wetland Biosphere reserve). In cases where the reserve is located within a district or city, the Head may be a city-level leader. Members of the Inter-sectoral Management Board include representatives from relevant sectors. According to UNESCO guidelines, depending on local conditions, Biosphere reserves may establish Permanent Offices/Secretariats and Advisory Boards. The permanent responsibility is often assigned to the agency managing natural resources and environment, forestry, fisheries, or the organization responsible for managing the particular heritage site. Depending on practical needs, the Provincial People's Committee may also consider establishing an Advisory Board for the Biosphere reserve Management Board to provide advice on management-related issues.

State management agency for biosphere reserve at the central level: The Ministry of Natural Resources and Environment is responsible for directing and guiding the preparation of dossiers for the nomination, recognition, and management of biosphere reserves. The Ministry assists the Government in implementing unified management and environmental protection, develops and submits legal documents for promulgation, organizes the implementation and inspection of compliance with the law, and provides technical guidance on the management and environmental protection of Biosphere reserves.

Vietnam National Commission for UNESCO (Standing agency: Ministry of Foreign Affairs): The Vietnam National Commission for UNESCO was established by the Prime Minister under Decision No.30/11/2011. It includes representatives from relevant ministries and agencies and is tasked with advising and assisting the Prime Minister in directing and coordinating activities related to UNESCO. This involves cooperation between ministries, government agencies, and provincial People's Committees, along with overseeing the organization and operation of UNESCO's specialized subcommittees.

National Committee on Man and the Biosphere (MAB): According to UNESCO guidelines, countries are required to establish a National Committee on Man and the Biosphere (MAB), which is responsible for providing advisory support for the management of biosphere reserves. In Vietnam, the National MAB Committee was initially established by Decision No.173-CT of the Chairman of the Council of Ministers on July 17th, 1986, and has undergone several reinforcements, the latest being under Decision No.02/BTK/19 of the Vietnam National Commission for UNESCO on August 14th, 2019. The MAB National Committee operates under the regulations issued by the UNESCO National Commission, with its term running until 2022. To align with current practices, the MAB National Committee will need to be restructured based on several principles. Its role is to advise the Ministry of Natural Resources and Environment, the UNESCO National Commission, Provincial People's Committees, and the Management Boards of biosphere reserves in fulfilling the nomination and management objectives of these reserves.

People's Committees of provinces and centrally run cities where biosphere reserves are located: These Committees are responsible for managing biosphere reserves according to the law, ensuring unified management and environmental protection within their jurisdiction. In Vietnam, the governance model for biosphere reserves does not involve private or community management. Therefore, current legal frameworks do not include specific provisions for the participation of the private sector or community in directly managing biosphere reserves.



▲ Cat Ba National Park was recognized by UNESCO as a Reserve World Biosphere in 2004.



3.3. Biosphere reserve's zoning

According to the Decree No.08/2022/NĐ-CP, a biosphere reserve is classified as a special national natural heritage site. It is divided into zones to perform the three key functions of a biosphere reserve: conservation, development, and logistic support. Each biosphere reserve requires functional zoning, which includes strictly protected areas (core zones), and areas designated for livelihood and development activities (buffer zones and transition zones).

- **Core Zone:** This zone consists of areas that are permanently protected to preserve landscapes, ecosystems, and genetic resources. According to Point a, Clause 5, Article 21 of the Decree No.08/2022/NĐ-CP, includes the core zone of nature reserves, protected zone Category I of scenic spots recognized as cultural heritage, and areas with core values that must remain intact to preserve the pristine natural features of the heritage site.

- **Buffer zone:** This zone includes areas with lower protection value than the core zone of natural heritage, protection zone category II of scenic spots recognized as cultural heritage and areas adjacent to the core zone's boundary that have the effect of preventing and mitigating the negative impacts of socio-economic development activities outside the natural heritage on the core zone of natural heritage. To ensure consistency in management regime, the buffer zone of the Biosphere reserve is also the buffer zone of the nature reserve (for areas with the core zone being a nature reserve according to the law on biodiversity), the buffer zone of the special-use forest (for areas with the core zone being a special-use forest according to the law on forestry), the buffer zone of the marine reserve (for areas with the core zone being a marine reserve according to the law on fisheries).

- **Transition zone:** This zone is where the community promotes sustainable economic and human activities in terms of culture, society and ecology. According to Point c, Clause 5, Article 21 of the Decree No.08/2022/NĐ-CP, the transition zone is the area located in connection with the buffer zone, where socio-economic development activities need to be controlled to be consistent and in harmony with the protection and conservation goals of establishing and recognizing natural heritage.

3.4. Issuance of plans and regulations for management and environmental protection of Biosphere reserves

The UNESCO Statutory Framework and Vietnamese law both require that Biosphere reserve need to be managed and protected according to plans and management regulations. The Decree No.08/2022/NĐ-CP stipulates that plans and regulations for management and environmental protection of Biosphere reserves shall be approved by competent authorities (Provincial People's Committees for Biosphere reserves located in a province or centrally-run city, Ministry of Natural Resources and Environment for Biosphere

reserves located in multiple provinces). The contents of environmental protection of natural heritage include regulations on controlling production and service activities in the core zone of natural heritage; restoring natural ecosystems, protecting core values of nature and biodiversity; investigating, evaluating, monitoring, supervising, inventorying, and reporting on specific indicators of geology, landscape, ecology, and biodiversity of natural heritage; implementation of other requirements on environmental protection, prevention and control of impacts on the environment, biodiversity and natural heritage according to the provisions of the Decree No.08/2022/NĐ-CP, relevant legal provisions and provisions of international treaties on environment and biodiversity that Vietnam has signed.

The development of management and environmental protection plans for Biosphere reserves should apply a participatory approach involving stakeholders and local communities. For most Biosphere reserves, management plans should focus on: conservation of biodiversity and ecosystem services; sustainable use of resources; improvement of livelihoods and benefits for communities; promotion of the green economy; tourism; ecosystem restoration; disaster mitigation and risk management; climate change, infrastructure development; research and education; communication, cooperation (including national and international cooperation).

3.5. Investigation and evaluation of the Biosphere reserve

The investigation and assessment of the Biosphere reserves shall be carried out as prescribed for natural heritage sites as stipulated in Clause 1, Article 21 of the Decree No. 08/2022/NĐ-CP, including periodic investigation and assessment every 5 years and other investigation and assessment activities as prescribed by relevant laws. Periodic investigation and assessment include the following contents: Environmental developments and natural values that need to be protected and preserved according to the criteria for establishing and recognizing Biosphere reserve; socio-economic development activities that have negative impacts on the environment of natural heritage; activities of exploiting and using the values of natural resources and ecosystem services of natural heritage; activities of restoring natural ecosystems, protecting and preserving the values of nature and biodiversity of natural heritage; implementing solutions for environmental protection of natural heritage according to the provisions of law. The management board or organization assigned to manage natural heritage shall conduct periodic investigation and assessment of natural heritage. The results of the investigation and assessment shall



be sent to the People's Committee of the province where the natural heritage is located and shall be updated in the national biodiversity database and specialized databases according to the provisions of relevant laws.

3.6. Conduct periodic assessment reports on biosphere reserves

Biosphere reserves are required to periodically conduct a ten-year assessment report according to the reporting format provided by UNESCO to ensure that all Biosphere reserves perform the functions specified in the Statutory Framework for the World Network of Biosphere reserve (UNESCO, 2015).

To carry out the responsibility of managing the Biosphere Reserve as committed in the nomination dossier, the Management Boards of the Biosphere Reserve will organize the preparation of reports, submit them to the Provincial People's Committees to send the reports to collect opinions from relevant sectors at both central and local levels (including natural resources and environment; agriculture and rural development; science and technology; culture, sports and tourism; education and training; planning and investment; finance; MAB Committee...); complete the report to send to the UNESCO Committee to submit to the Intergovernmental Council of UNESCO's MAB Program.

3.7. Financial resources for the operation of the Biosphere reserve

Activities of the Biosphere reserve are funded from state budget sources, investment sources, support from national organizations and individuals, foreign donors, organizations and individuals, and revenues from environmental services according to the provisions of law.

4. RECOMMENDATIONS TO STRENGTHEN THE MANAGEMENT OF BIOSPHERE RESERVE IN VIETNAM

Although the Law on Environmental Protection 2020 and its guiding documents have provided a crucial legal foundation for the management and protection of Biosphere Reserves, there are still several limitations in the implementation of Biosphere Reserve management objectives. The Biosphere Reserve management framework lacks sufficient guiding documents, and while some elements have been institutionalized, they remain incomplete. Additionally, the regulations for Biosphere Reserve management have not been uniformly implemented. The Biosphere Reserve Management Boards and the National Committee for Biosphere Reserve Management are not yet fully established, and there is a lack of resources to support management activities. Furthermore, there is no comprehensive master plan to guide and prioritize key tasks in the near future to strengthen management and expand the Biosphere Reserve network. To address these issues, several recommendations are proposed:

Develop strategies and action plans for the entire Vietnam Network of Biosphere reserves in line with UNESCO's orientation and national policies on sustainable development, environmental protection and biodiversity;

Issue technical guidance documents to manage Biosphere reserves in accordance with the provisions of the Law on Environmental Protection 2020 and the Decree No.08/2022/NĐ-CP;

Strengthening capacity and mobilizing resources for the Management Boards of Biosphere reserves; promoting communication and promotion activities of the Biosphere reserves, and strengthening the Network of Biosphere reserves in Vietnam;

Strengthen the role of the National Committee of MAB in advising the Ministry of Natural Resources and Environment in guiding the nomination and management of the biosphere reserves; consolidate and develop the national biosphere reserve network and connect with regional and international networks;

The People's Committees of provinces and cities where the Biosphere reserves are located and the Management Boards of the Biosphere reserves shall study and implement the requirements for the management of the Biosphere reserves according to the requirements of UNESCO and the laws of Vietnam, including perfecting the organization, developing, approving and implementing the Plan, regulations on management and environmental protection of the Biosphere reserves ■

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Principles of High Integrity Carbon Markets

High integrity carbon credit markets can play an important role in accelerating global decarbonization toward net-zero emissions. To achieve net-zero emissions by 2050 and keep a limit of 1.5°C temperature rise within reach, it is crucial to accelerate action by 2030, increase ambition and urgently implement current nationally determined contributions (NDCs) under the Paris Agreement and the collective long-term global aspirational goal adopted by the International Civil Aviation Organization (ICAO) Member States.

Enhance the integrity of voluntary carbon credit markets

These ambitious goals can be advanced by, among other actions, supporting greenhouse gas mitigation actions that generate high integrity carbon credits. In order to achieve this, they need to be consistent with a pathway toward overall net-zero emissions; in particular, both creation and use of credits need to be supplementary to immediate efforts to reduce emissions in line with science-aligned pathways, and should avoid lock-in of high emissions pathways and contribute to the implementation of host country targets such as by sharing mitigation benefits.

In addition to mobilizing climate finance from public and private sources, high integrity carbon credit markets can, where necessary safeguards are in place, provide sufficient demand to promote deployment of clean, safe and sustainable decarbonizing technologies and investment in nature-based solutions, unlocking social and environmental co-benefits.

There is a growing need to enhance the integrity of voluntary carbon credit markets and their alignment to the goals of the Paris Agreement, including their incorporation of best practices related to carbon crediting mechanisms. This set of “Principles of High Integrity Carbon Markets” can inform global efforts to enhance integrity of carbon credits to allow all stakeholders to take advantage of the full potential of carbon markets for both voluntary and compliance purposes.

These include relevant rules, guidance, and procedures developed multilaterally under Article 6 of the Paris Agreement and for ICAO’s Carbon Offsetting and Reduction Scheme for International Aviation (CORSA) and through independent multistakeholder initiatives. We will strive to promote these principles where appropriate in the development of carbon credit markets. We also emphasize that these principles are non exhaustive and require robust interpretation and implementation, and refinement as necessary, to ensure that they reinforce science and best practices for aligning carbon markets with ambitious global emissions pathways.

DEVELOPING HIGH QUALITY CARBON CREDITS



Core Carbon Principles: global benchmark for high-integrity carbon credits

REQUIREMENTS FOR CARBON-CREDITING PROGRAMS & CATEGORIES

Governance			Emissions Impact			Sustainable Development		
	Effective governance	P		Additionality	C		Sustainable development benefits and safeguards	P, C
	Tracking	P		Permanence (40 yrs)	C		Contribution toward net zero transition	C
	Transparency	P		Robust quantification	P, C			
	Third-party verification	P		No double counting	P, C			

Source: climateactionreserve.org



The principles for high integrity carbon credit markets

The following principles for high integrity carbon credit markets apply to strategies and standards guiding their supply, demand, and market infrastructure to improve credibility, transparency, and overall confidence in the markets.

Supply-side Integrity: A robust certification standard is applied to activity

design and measurement, reporting, and verification (MRV) of emission reductions or removals, with procedures that ensure the following aspects of the supported activities and resulting greenhouse gas mitigation: Crediting levels align with emissions pathways consistent with the Paris Agreement temperature goal and achievement of global net-zero emissions by 2050; Credits are issued for emission reductions or removals that clearly contribute to host country mitigation, and avoid lock-in of high emissions pathways, and where climate change mitigation strategies are in place that prioritize direct mitigation action; Alignment with relevant requirements for ensuring environment integrity and the CORSIA emissions units criteria and guidelines, including in reporting requirements under guidance on cooperative approaches and elements reflecting emerging best practices, in particular for ambitious baseline-setting, additionality assessment, avoidance of emissions lock in, emissions leakage accounting, permanence, and the avoidance of all forms of double-counting; Robust and transparent governance, with procedures in place to ensure transparency and, public accountability including with respect to decisions and decision-making processes, as well as the long-term administration of the standard issued credits and their ownership; Sustainable development objectives and resulting benefits are transparently reported. Environmental and social impacts are identified, publicly disclosed, and addressed through safeguards including monitoring. Human rights, gender equality and the rights of indigenous people are respected.

Demand-side Integrity: The use of credits, included by the private sector, align with keeping a limit of 1.5°C temperature rise within reach and achievement of global net-zero emissions by 2050, in relation to unavoidable emissions and where science-based climate change mitigation strategies and targets are in place that prioritize direct action to mitigate emissions. Emission reductions or removals underpinning carbon credits are claimed for use to achieve NDCs and other international



Source: climateactionreserve.org

mitigation purposes only when they are authorized according to the Guidance on cooperative approaches and eligible for such use. The use of carbon credits is disclosed through reporting processes that make such information transparent to and easily accessible by the public, to allow for public accountability and encourage investments in mitigation actions such as beyond the value chain. This includes information on the types, sources, and quantities of credits used.

Market Integrity Registries publicly track information necessary for compliance and voluntary carbon credit market integrity, including enabling users and the public to identify market eligibility, the status of authorization and corresponding adjustments, and the purpose of use. Emissions across all scopes and associated targets, and strategies and annual progress toward their implementation, are transparently disclosed and tracked, including any use of carbon credits as well as any targeted investments in beyond value-chain mitigation, to enhance integrity and appropriate signaling between supply and demand-side participants in the carbon credit markets. Global standard-setting bodies and initiatives cooperate to align standards, clarify their respective services or roles, and continually innovate certification products that will meet and exceed current practice and expectations of regulators and other stakeholders to reduce carbon credit market fragmentation and promote a uniform shift to high integrity ■

NHÂM HIỀN

Source: *The G7 Ministers' Meeting on Climate, Energy and Environment in Sapporo*

Navigating New Horizons: A global foresight report on planetary health and human wellbeing

This report from the United Nations Environment Programme (UNEP) and the International Science Council (ISC) shows why the world must get better at tracking and responding to a host of emerging challenges as environmental, technological and societal change join forces to disrupt human and planetary health. This report identifies eight critical global shifts that are accelerating the triple planetary crisis of climate change, nature and biodiversity loss, pollution and waste.

THE INSTITUTIONALIZED APPROACH TO STRATEGIC FORESIGHT AND HORIZON SCANNING

To help navigate current and future uncertainty and disruptive change, while effectively delivering on its mandate, UNEP has been implementing an institutionalized approach to strategic foresight and horizon scanning with the view to developing an anticipatory and future-oriented culture. This mirrors the growing interest and demand for foresight that is also reinforced by the United Nations reform agenda and the Secretary-General’s report on “Our Common Agenda”, which calls for all UN agencies, as well as all UN member states, to engage foresight practices more deeply and apply the derived insights to address global systemic risks.

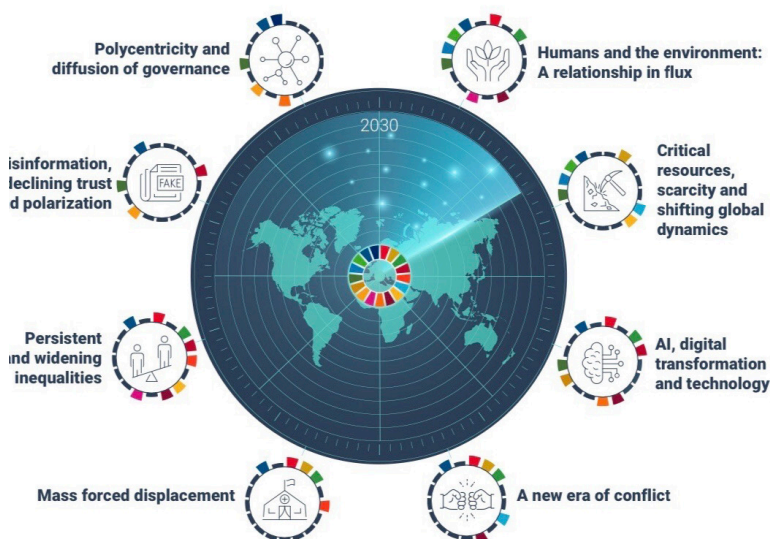
This process has culminated in the development of the present report “Navigating New Horizons – A global foresight report on planetary health and human wellbeing”, produced by UNEP in collaboration with the International Science Council. The report calls for the world to pay heed and respond to a range of emerging challenges that could disrupt planetary health and wellbeing. It presents insights on eight critical global shifts that are accelerating the triple planetary crisis of climate change, biodiversity and nature loss and pollution and waste.

Eighteen signals of change identified by hundreds of global experts and distilled through regional and stakeholder consultations that included youth offer a glimpse into potential disruptions, both positive and negative, which the world needs to keep a watching brief on (Figure 1). The report outlines how to create an enabling environment for better decision-making by creating a new social contract, embracing agile and adaptive governance, and increasing integrated accessible data and knowledge.

The report offers a stark reminder of the interconnectedness and fragility of our systems in the 21st century and warns that prioritizing short-term gains over anticipatory action and preparedness jeopardizes long-term prosperity and planetary health. However, it also points to the tremendous potential and human ingenuity that can be leveraged in the spirit of discovery and cooperation to deliver solutions across the triple crisis.

The outcomes of the report will be integrated into UNEP’s strategic planning, potentially influencing the next UNEP MTS, presenting an opportunity to consider expanding programmes in areas like artificial intelligence, new technology, and robotics in agriculture, prompting discussions on the level of engagement in these issues. This will ultimately serve UNEP in adopting a proactive posture and modernize tools for efficiency and cost savings.

Furthermore, the report will serve as UNEP’s contribution to the Summit of the Future. While it is not expected to substantively influence the Summit of the Future as such, it will serve to provide inputs into the preparatory discussions and events, including the High-level Political Forum, in the lead-up to the Summit of the Future as they relate to environmental dimensions.



▲ Figure 1: Eight critical global shifts or phenomena that emerged from the foresight process.

Source: Navigating New Horizons



CRITICAL SHIFTS AND SIGNALS OF CHANGE

Each of the eight critical shifts identified during the process are outlined below together with associated signals of change. They have a lower probability of occurrence and are possibly unintended but have significant potential to disrupt if they eventuated. The signals of change are not necessarily positive or negative, but simply early symptoms or indicators of a future development with potential to grow in scale and distribution (*Figure 2*).

A synopsis has also been provided of the most acute potential disruptions on the horizon for each signal of change, which could significantly influence planetary health and wellbeing. They need to be kept on the radar to observe their direction, character and strength before they develop into stronger trends. Monitoring signals on the horizon provides information to mute signals that have the potential to disrupt negatively, but also amplify those that will

accelerate positive change. (Each of the eight critical shifts identified during the process are outlined below together with associated signals of change). They have a lower probability of occurrence and are possibly unintended but have significant potential to disrupt if they eventuated. The signals of change are not necessarily positive or negative, but simply early symptoms or indicators of a future development with potential to grow in scale and distribution. Monitoring signals on the horizon provides information to mute signals that have the potential to disrupt negatively, but also amplify those that will accelerate positive change.

The shifts include humanity’s degradation of the natural world, the rapid development of technologies such as AI, competition for natural resources, widening inequalities and declining trust in institutions. These shifts are creating a polycrisis, in which global crises are amplifying, accelerating and synchronizing with huge implications for human and planetary wellbeing.

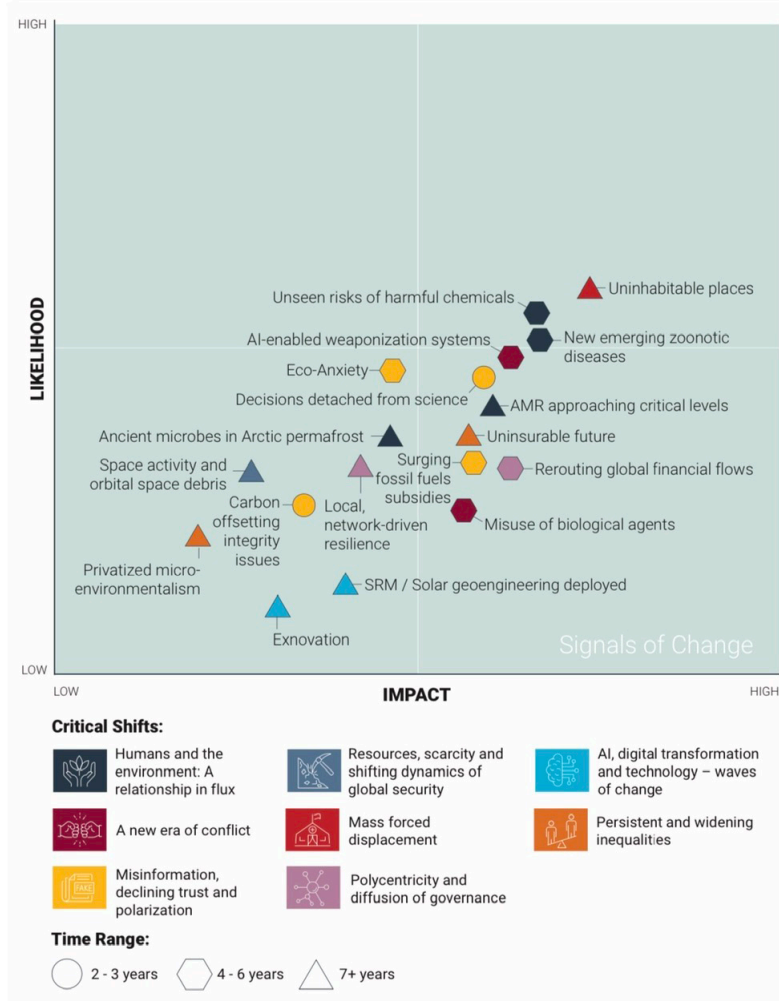
Eighteen accompanying signals of change identified by hundreds of global experts through regional and stakeholder consultations that included youth offer a deeper glimpse into potential disruptions, both positive and negative, that the world must prepare for.

“As the impacts of multiple crises intensify, now is the time to get ahead of the curve and protect ourselves from emerging challenges,” said UNEP Executive Director Inger Andersen. “The rapid rate of change, uncertainty and technological developments we’re seeing, against a backdrop of geopolitical turbulence, means any country can be thrown off course more easily and more often. By monitoring signals of change and using the foresight approach outlined in this report – including looking outside the traditional environmental space – the world can avoid repeating mistakes of the past and focus on solutions that can withstand future disruption.”

Key shifts and signals of change outlined in the report include:

The demand for critical rare earth elements, minerals and metals to fuel the transition to net-zero is expected to increase fourfold by 2040, increasing calls for deep sea mining and even space mining. This poses potential threats to nature and biodiversity, could increase pollution and waste, and spark more conflicts.

While AI and digital transformation can bring benefits, there are environmental implications – such as increased demand for critical minerals and rare earth elements and water resources to meet data centre demands.



▲ *Figure 2: Eighteen signals of change and potential disruptions depicted along three dimensions: likelihood, impact and time horizon.*

Source: *Navigating New Horizons*



The use of AI in weapons systems and military applications, and the development of synthetic biology, need careful review through an environmental lens.

Armed conflict and violence are rising and evolving. These conflicts result in ecosystem degradation and pollution, leading to repercussions for vulnerable populations.

Forced displacement is increasing human health and environmental impacts. One in every 69 people is now forcibly displaced – nearly double the figures from a decade ago. Conflict and climate change are key drivers.

Each of the signal of change images summarize the information gathered during the learning phase for each identified signal of change in the foresight process. They provide a concise description of the potential disruption and their perceived likelihood of occurrence and severity.

ADOPTING FORESIGHT

However, the report finds that using foresight tools can help the world to anticipate and prepare for the next emerging challenges and future disruptions. Peter Gluckman, President of the ISC, said, “Foresight provides a useful set of tools to step outside of short-termism to help identify future opportunities and risks provided that it is done in a truly pluralistic manner, transcending narrow institutional mandates, sectors and other artificial divides that constrain our framing of the problems and the solutions.”

The report recommends adopting a new social contract that engages a diverse range of stakeholders, including indigenous people; giving young people a stronger voice; and rethinking measures of progress to go beyond GDP.

Governments and societies can also introduce shorter term targets and indicators that allow them to be more agile in governance. Ushering in tools and actions to reconfigure

financial systems and reroute capital flows, a positive signal of change in the report could help to reduce inequalities, eradicate extreme poverty and address environmental crises.

Supporting agile and adaptive governance would require better monitoring and assessment of interventions. This includes integrating and improving monitoring on environmental change, and making data and knowledge more accessible.

Just as the impacts of multiple crises are amplifying harm to environmental and human health, the solutions are in sight and actions are underway that would address the global shifts and signals of change identified in the report. Foresight can help to accelerate these actions and spark many more.

MANAGING CHANGE AND BUILDING RESILIENCE

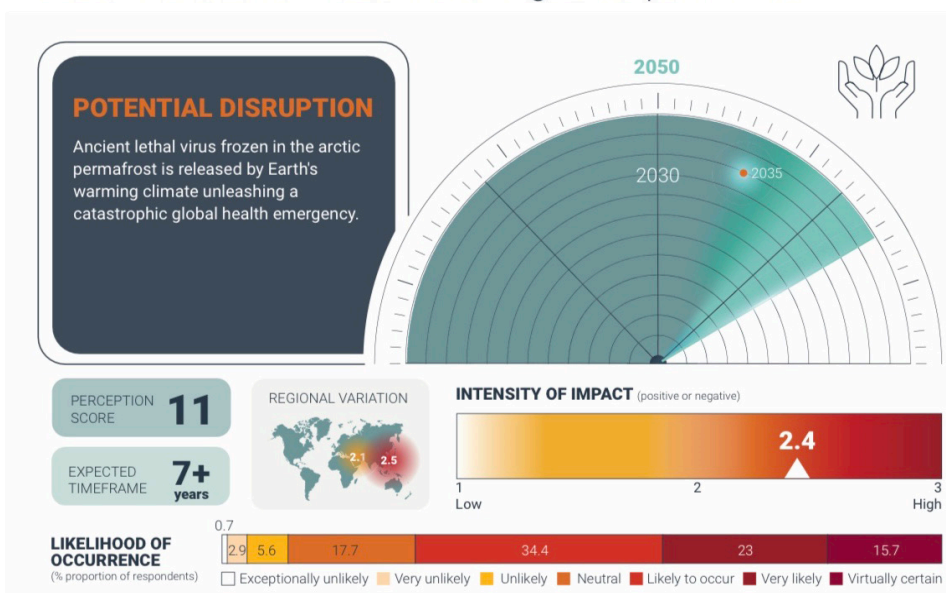
This report shows that humanity has a stark and urgent choice to make: continue to destabilise planetary health and risk losing humanity’s life support system, or build a future that embraces equity, addresses the underlying drivers of environmental degradation and achieves sustainable development. What humanity decides now will shape the world that future generations will inherit.

Since the start of industrialisation, successive and accelerating waves of technological innovation have transformed societies and economies globally, radically altering ways of living and working (Figure 4). Scientific and technological breakthroughs have created opportunities and boosted living standards in many regions, and further technological advances will be essential if humanity is to achieve sustainability in coming decades.

Embedding these principles and addressing the huge environmental and social challenges ahead will require the voices and knowledge of all society, nationally and globally. This will only be possible if the burdens and opportunities are shared fairly, and if youth and other marginalized

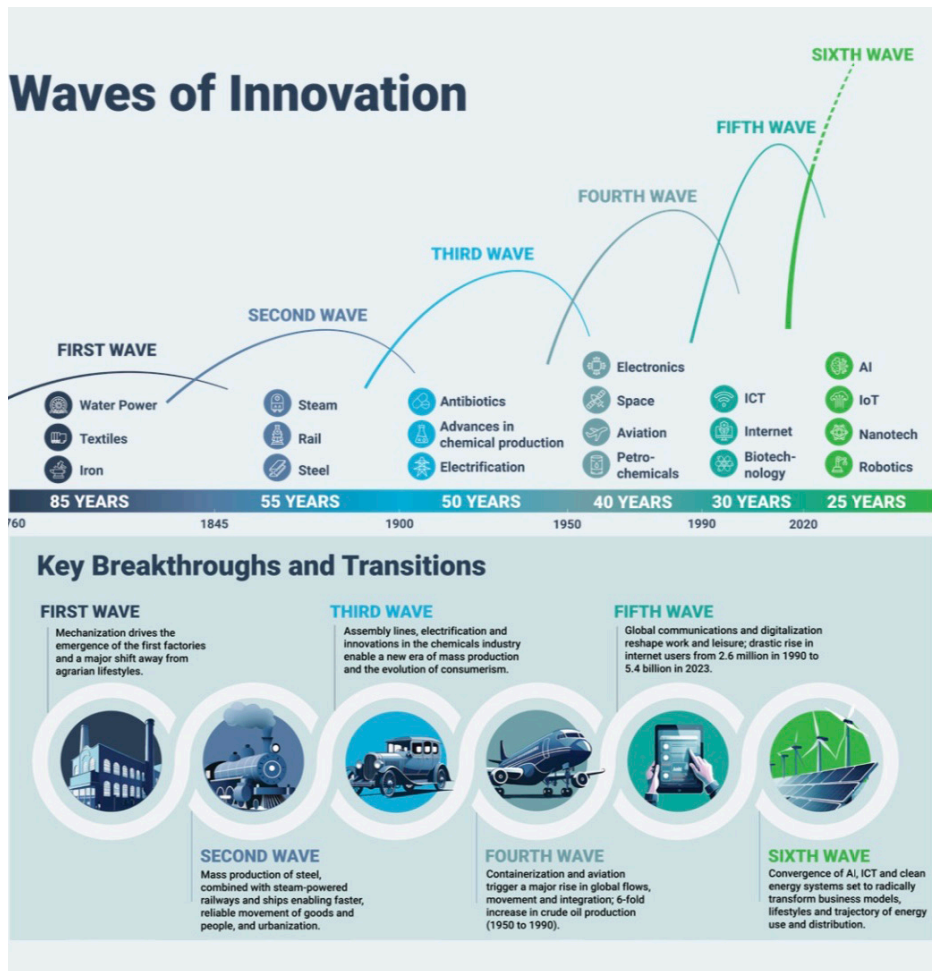
Signal of change 1

Ancient microbes hidden in thawing Arctic permafrost



▲ Figure 3: Ancient microbes hidden in thawing Arctic permafrost

Source: Navigating New Horizons



▲ Figure 4: Waves of technological innovation

Source: *Navigating New Horizons*

groups are given a voice. The world needs a new social contract.

From the foresight process, three areas stand out as important opportunities to renew the social contract and increase society's resilience: engaging and embracing a broader and diverse range of stakeholders including women, indigenous and local peoples; giving young people a stronger voice; and rethinking measures of progress.

Embracing the views of a more diverse group of stakeholders: The active participation of individuals and groups in the decision-making processes that affect their lives is central to social cohesion and trust in government.

Giving young people a stronger voice: Young people will bear the consequences of today's decisions for decades to come. In some developing regions that are particularly vulnerable to climate change, young people make up a large part of the population. In other regions, smaller youth cohorts face the

burden of financing the expanding population of pensioners in many parts of the world. In any event, young people face a difficult inheritance from earlier generations.

A new framework for prosperity: A new social contract would entail a fundamental reimagining of the role of businesses and markets. Current economic systems reward businesses for focusing narrowly on maximizing short-term financial returns for shareholders and externalizing environmental and social harms. Consequently, humanity's resources and ingenuity are largely invested in activities that cause widespread harm across globalized value chains.

Agile and adaptive governance for a sustainable future: Across many of the signals of change, accelerating change has emerged as

a core theme. Communities across the world face more frequent and severe disruptions as the effects of climate change intensify and the interdependence of globalized systems causes localized crises to spread. These changes create opportunities to meet material needs in more sustainable ways. But they also bring risks and uncertainties, potentially jeopardizing privacy and human agency, undermining democratic governance and contributing to conflict.

Guiding governance through data and knowledge: It will be difficult to navigate the challenges ahead without a transformation in the knowledge systems that support governance. Creating and implementing a new social contract requires the creation of open knowledge sharing platforms that empower citizens, as well as new metrics that go far beyond GDP to create a much richer representation of the health of societies and ecosystems. Supporting agile and adaptive governance depends on monitoring and assessing the impacts of innovation, experimentation and systems that enable information to be shared horizontally and vertically to guide investments and actions. But the needs and value of leveraging data and knowledge extend far beyond this ■

NHÂM HIỀN

(Source: *Navigating New Horizons 2024*)



Integrating technology in water resources management: “The door” to sustainable development in Vietnam

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Water is an essential resource for socio-economic activities and maintaining the life of the environmental ecosystem. In nature, water is an important component for the existence of humans and other organisms. In terms of consumption, water is used for most living and economic activities. Many countries in the world set goals for managing and using water resources safely and effectively in daily life and production. In which, water resource management based on technology is an important part of sustainable economic development. In the scope of this article, we will focus on studying popular environmental technology applications, evaluating the trend of approaching artificial intelligence (AI) and water production methods using renewable energy sources. Thereby, we make some recommendations in water resource management and wastewater treatment.

1. GLOBAL CONTEXT OF WATER RESOURCES MANAGEMENT

In recent years, environmental degradation has been partly reflected in the water resources on earth. In the report on Vietnam Environment and Climate Change Assessment by the Asian Development Bank (ADB), Asian countries in general and Vietnam in particular are facing rising sea levels, combined with the effects of climate change, increasing salinity intrusion and freshwater degradation. In addition, the development of irrigation and hydropower reservoirs across Vietnam, including some small basins with hundreds of dams, is causing freshwater biodiversity to decline without appropriate monitoring and improvement management programs.

Five years ago, UN figures from 2019 showed that untreated wastewater pollution was a problem in both developed and developing countries. Of these, about 297,000 children die each year from diseases caused by poor water quality and about 80% of wastewater is returned to the environment without being treated or reused. Recent statistics from the Centers for Disease Control and Prevention show that about 446,000 children under the age of 5 die from diarrhea related to inadequate access to safe water and sanitation. This represents 9% of the 5.8 million deaths among children under 5 years old.

The demand for clean and safe water is high, but the supply is severely lacking. The World Bank's annual report on water 2023 shows many difficulties in managing clean water resources. The report notes that 2.2 billion people lack safely managed drinking water, 3.5 billion people lack access to safely managed sanitation, and 2 billion people lack access to basic hand hygiene. According to forecasts, the demand for water continues to increase while water production in countries is very low, accounting for only about 12% of global standards. Also at the 28th United Nations Climate Change Conference in December 2023 held in the United Arab Emirates (UAE), the World Bank on Water forecast that by 2050, an estimated 4 billion people will live in water-stressed areas and 1.6 billion people will face flooding.

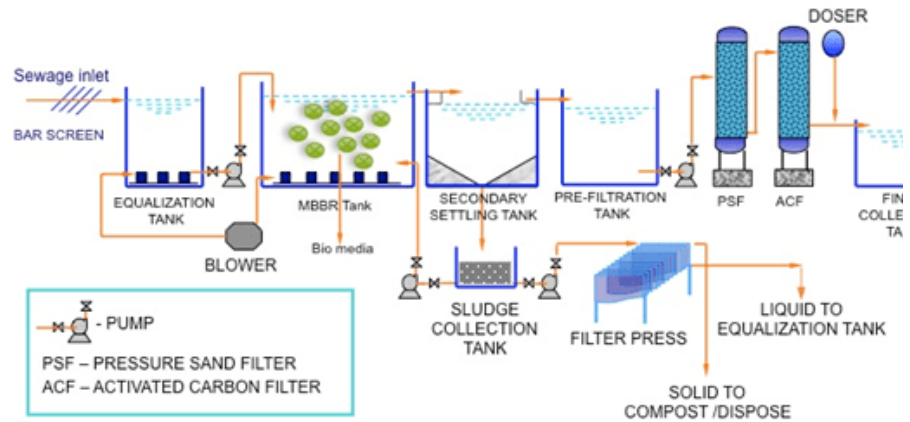
2. APPLICATION OF ENVIRONMENTAL TECHNOLOGY IN WASTEWATER TREATMENT

One of the leading causes of water pollution is ineffective wastewater treatment, leading to water being discharged into the environment without going through the decontamination process. In Vietnam, there are a number of large-capacity wastewater treatment plants, including: Yen Xa wastewater treatment plant (Hanoi) with a capacity of 270,000m³/day and night; Nhieu Loc - Thi Nghe wastewater treatment plant (HCMC) with a capacity of 480,000m³/day and night; Binh Hung wastewater treatment plant (HCMC) with a capacity of 328,000m³/day and night... According to Ministry of Natural Resources and Environment, currently the country has 291 industrial parks, but only 265 industrial parks have centralized wastewater treatment systems.

Wastewater treatment is an important process in environmental protection. Developing environmental technology in wastewater treatment plays an important part in the goal of achieving sustainable environmental economic development. Many environmental technologies help effectively remove pollutants, ensuring that wastewater meets standards before being discharged into the environment, bringing high efficiency with sustainable productivity (Syed et al., 2022). Environmental technology in wastewater treatment can be divided into two main groups: physicochemical technology and biological technology (wastewater treatment technology using microorganisms). Modern wastewater treatment technologies have many outstanding advantages over traditional technologies, such as high treatment efficiency, low cost, and environmental friendliness. Some popular wastewater



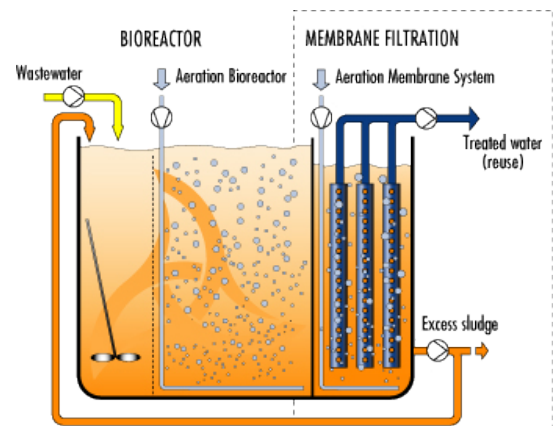
treatment technologies currently used in the world include: Industrial wastewater treatment technology combining traditional Aerotank and aerobic biological method - Moving Bed Biofilm Reactor (MBBR), Anaerobic Anoxic Aerobic organic wastewater treatment technology (AAO), Membrane bioreactors technology (MBR), Liquid waste treatment technology - Sequencing batch reactor (SBR),...



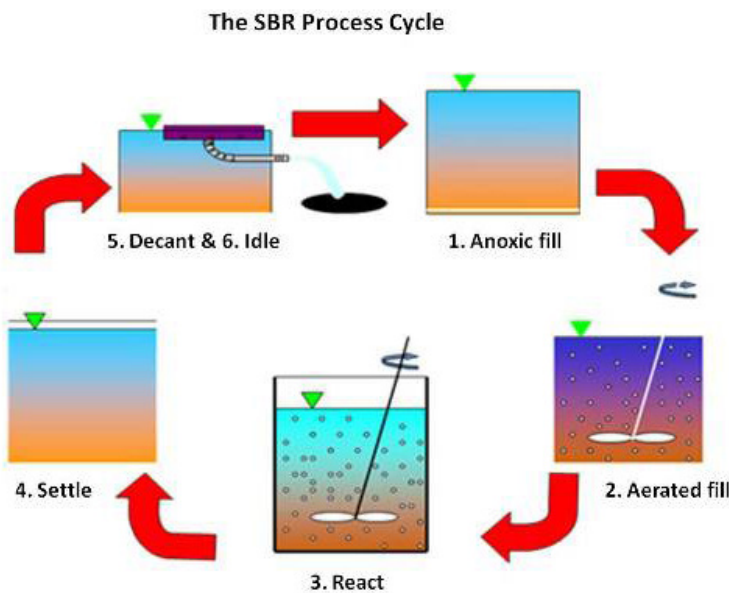
▲ Industrial wastewater treatment technology combines traditional Aerotank and aerobic biological method - Moving Bed Biofilm Reactor (MBBR)

3. TRENDS IN ARTIFICIAL INTELLIGENCE APPROACHES IN URBAN WATER RESOURCES MANAGEMENT

Artificial Intelligence (AI) is one of the breakthrough technologies of the 21st century and is becoming increasingly popular in many fields. For water resources management, AI technology plays a supporting role in many activities such as: monitoring and warning, operational management, forecasting and resource optimization.

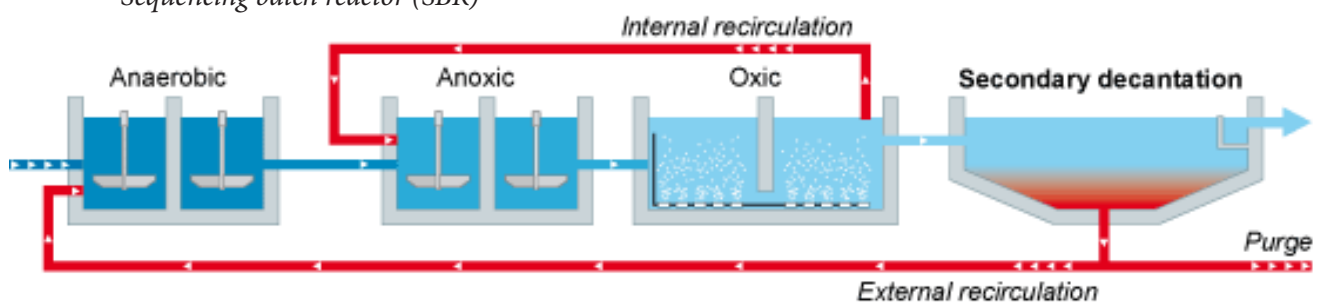


▲ Membrane bioreactors (MBR) technology



▲ Liquid waste treatment technology - Sequencing batch reactor (SBR)

With the goal of improving the efficiency of water resource management, ensuring water security and environmental protection, the application of AI models in urban water resource management is becoming increasingly popular. AI technology models improve water use efficiency by converting information into cleaner processes, improving data-based decision making. A typical example is the application of machine learning technology in prediction, control and optimization in wastewater treatment activities (Imen et al., 2023).



▲ Anaerobic Anoxic Aerobic (AAO) organic wastewater treatment technology



AI's Support in Water Resources Management

Operation	Support from AI
Monitoring and alerting	Check and monitor water quality, water flow, flood levels, etc. to detect problems early and give timely warnings.
Operations Management	Applying automation technology to water supply and drainage system operating processes helps improve operational efficiency.
Forecast	Provide forecasts on water demand, impacts of temperature, weather, natural disasters... to serve the planning of more effective water resource use.
Resource Optimization	Ensure compliance with water supply and drainage procedures, helping to save water and minimize environmental impacts during exploitation and production.

A recent proposal for intelligent automated water resource planning is called AIDWRP (Xiang et al., 2021). AIDWRP is a subset of AI developed for sustainable data management in urban areas. AIDWRP is used in water supply to increase the overall performance of water infrastructure operations such as asset inspection and repair, energy conservation, and carbon emission reduction, thereby improving the quality and optimizing the cost to citizens of water services provided at local levels.

4. TECHNOLOGY FOR WATER PRODUCTION USING RENEWABLE ENERGY SOURCES

During World Water Week 2023 held in Stockholm, Sweden, Csaba Korosi - President of the United Nations General Assembly emphasized the role of digital technology platforms in water resources management, especially considering the relationship between technology, renewable energy sources (solar energy, wind energy) and consumer energy products (electricity, water).

Many developed countries are deploying solar energy technology systems in clean water production (Li et al., 2021). Some technologies include: analyzing the energy transfer of evaporation and condensation caused by solar thermal conversion to improve the evaporation rate through the solar thermal interface desalination (STID) technology system, desalination technology of seawater or saltwater from 2 systems of solar thermal membrane desalination (STMD) and solar electrochemical desalination (SED), or solar thermal atmospheric water harvesting technology (ST-AWH), which is considered a solution to create clean water in the desert using solar panels. In general, the application of solar energy-related technology in water production has contributed positively to solving the needs of household drinking water, industrial water and personal hygiene in many countries.

Solar water production is the process of using solar energy to convert seawater or saltwater into fresh water. Nowadays, to produce water using solar energy, people often use the desalination method. This is a method that uses solar energy to evaporate seawater, then condenses the steam to obtain fresh water; this method does not produce carbon emissions because it relies on sunlight instead of pressure like other traditional desalination methods. However, because the cost of research and manufacturing, input costs, and operation and maintenance of products using the desalination method are relatively high, it has not been widely deployed in practice, especially in developing countries like Vietnam.

To address the above problem, over the years, the World Bank Group has been the largest investor in water production development projects globally. In 2024, the World Bank will continue its credit subsidy programs for projects aiming at sustainable production based on renewable energy sources by providing concessional loans and technical support for upgrading water infrastructure for governments, improving management methods and ensuring active community participation in protecting water security.

In developed countries like the United States, government funding for research into renewable energy water production has received much encouragement. In 2023, engineers and collaborators at the Massachusetts Institute of Technology (MIT) developed a solar-powered device to turn seawater into drinking water that is significantly cheaper and cheaper to operate than other clean water production devices on the market.



▲ *New solar desalination system based on desalination method, heating the system with natural sunlight*

Source: MIT News

5. SOME RECOMMENDATIONS

It can be seen that integrating technology into water resources management is an inevitable step to ensure sustainability and efficiency in exploiting, using and protecting water resources. However, to achieve high efficiency, there needs to be strong investment and close coordination between parties in a long-term strategy. Below are some recommendations that Vietnam can consider in the coming time.

Firstly, businesses and relevant agencies and sectors should promote the application of technology in water resources management and wastewater treatment. For example, wastewater treatment technologies such as MBBR, AAO, MBR, SBR or implementing AI models such as AIDWRP in urban water resources management. The great advances in science, modern technologies such as biological filters, advanced chemical treatment not only improve the efficiency of pollutant removal but also minimize the impact on the environment. Investing in smart wastewater treatment systems not only protects water resources but also contributes to building a sustainable future.

Secondly, products that operate on renewable energy are increasingly being widely applied. Vietnam needs to encourage the application of water production technology using renewable energy sources such as solar, wind, geothermal, etc. Utilizing clean energy not only helps reduce greenhouse gas emissions but also ensures a stable supply of clean water for the community.

In particular, these systems are often capable of operating automatically and saving energy, contributing to reducing production costs.

Thirdly, although technology is a way to make management activities more convenient and faster, people are still the key to opening the “door” to sustainable development. Therefore, the requirement to raise awareness is extremely essential, especially raising awareness of cybersecurity for officers and employees working in the field of water resources management ■

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International experience in water resource management and dam safety and lessons learnt for Viet Nam

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Vietnam is one of the vulnerable countries that are impacted by climate change and natural disasters, including floods, droughts, saltwater intrusion, and fluctuation of river flows. Specifically, with the distribution of a variety of dams and lakes from the North to the South, Vietnam has been facing challenges regarding dam safety, sustainable water management and coping with climate change. In the current context, the risk of water resource degradation, water conflicts, and dam collapses tends to increase because of the development of hydroelectric power projects by China and the countries within the Mekong River basin [1].

Two factors leading to several droughts during the dry season and catastrophic floods during the rainy season are the imbalance of two seasons and the upstream dam effect. With the agricultural economy of the country and the millions of citizens' lives involved in the rivers, ensuring dam safety, sustainable water source management, and solving climate change risks is dramatically necessary [2]. This article analysed water management and dam safety from the international experience and particular countries, thereby proposing solutions to develop sustainably, manage dam safety and restrict the adverse impacts of natural disasters in Vietnam.

1. INTERNATIONAL EXPERIENCE IN WATER RESOURCE MANAGEMENT AND DAM SAFETY

Japan and Norway: Both nations have global expertise in dam safety management, particularly in the harsh conditions and the risks of disasters. These experiences could provide valuable lessons for enhancing safety monitoring and management systems.

In Japan, to ensure the safety of the earth-fill dams, the Japanese government has conducted regular seepage, deformation, and surface leakage measurements. Besides checking the dam's administrator, experts have performed recurring inspections three times per year to investigate the dam's safety level and operational ability. Japan's standard systems are also strict in dam design, construction, and maintenance. Independent experts have performed periodic testing and maintenance systems cyclically. Japan's dams were designed against natural disasters with solid intensity and high risks of earthquakes and floods [3]. The real-time dam safety monitoring system, which uses sensors to detect risks such as cracks, vibrations, or abnormal water pressure, was also improved by Japan. This system provides continuous updates to management agencies, enabling timely interventions to prevent potential incidents.

In Norway, artificial intelligence (AI) was used to analyze data from the dam observing sensors and give early warning for potential failures. This system effectively reduces dam failure risks and optimizes maintenance and inspection activities [4]. In addition, Norway has an effective system for managing the risk of collapse, including emergency scenarios and well-trained rescue teams. Local communities near dams are also educated and equipped with knowledge and skills to respond to emergencies.

The United States is a pioneer country in establishing the early emergency system, especially for natural disasters such as floods, hurricanes, and dam failures. The system has been implemented on a large scale, leveraging advanced technologies with integrated real-time data and predictive models. A network of monitoring sensors that analyze real-time data from dams and reservoirs has been established. These sensors, strategically installed across the dam system, monitor critical parameters such as water levels, pressure, and structural conditions. When anomalies are detected, the system immediately alerts authorities and the public via text messages, mobile applications, and radio broadcasts [5]. The United States also employs meteorological forecasting models combined with hydrological data. This system is not only based on the data from the dams but is also tightly integrated with meteorological data from weather forecasting models. Therefore, the authorities can forecast the rainfall and flood conditions, allowing them to adjust reservoir discharge rates proactively to minimize flood risks.

Additionally, community involvement is a key factor in the success of early warning systems in the United States. The government frequently organizes flood response and dam failure evacuation drills for residents. Communities living near major reservoirs are equipped with knowledge about safety processes, evacuation skills, and emergency response measures.



The Netherlands: The Netherlands has almost land below sea level and has developed a highly advanced system for flood management and response. This includes the design of flood barriers, early warning and crisis management systems. Furthermore, a dikes and water control system network was constructed modally and extensively, including storm surge barriers and powerful pumping stations, to safeguard the nation against flooding risks. Additionally, “water retention areas” have been created where floodwaters can be stored and gradually released without causing severe flooding in residential areas [6]. The Netherlands has a highly advanced early warning and rapid response system that employs sensors to monitor water levels and pressure on dikes. When signs of a potential issue are detected, the system immediately triggers emergency response scenarios, ranging from adjusting water pumping stations to notifying residents in flood-prone areas. An integrated flood forecasting model has been developed in the Netherlands, utilizing meteorological and hydrological data to predict upcoming floods. This enables the government and management agencies to prepare proactively before floods occur, including planning for the evacuation of residents and implementing measures to protect dikes [7].

Israel: As one of the most efficient nations in managing and regenerating water resources, Israel has developed innovative solutions to address its limited freshwater supply. In particular, drip irrigation technology, which minimizes water waste in agriculture, delivers water directly to the root of plants, reducing evaporation and conserving water usage. Regarding wastewater reuse, over 85% of wastewater in Israel is recycled, primarily for agricultural use. This is the world’s highest rate of water reuse, highlighting Israel’s ability to optimize its water resources. Vietnam could learn from this model, particularly in building wastewater treatment systems for reuse in agricultural and industrial production. This approach helps mitigate freshwater scarcity and reduces water pollution caused by untreated wastewater [8]. Additionally, a key component of Israel’s water management strategy is desalination, providing water for domestic and industrial purposes. With its long coastline and abundant saline water resources, Vietnam has significant potential to develop desalination technology, especially in regions like Ninh Thuan, Binh Thuan, and the Mekong Delta, where freshwater is becoming increasingly scarce.

2. CURRENT STATUS OF WATER RESOURCE MANAGEMENT AND DAM SAFETY IN VIETNAM

Vietnam has over 7,000 operational irrigation and hydropower reservoirs, which play an important role in flood control, agricultural irrigation, and electricity production [1]. However, these facilities also present significant safety challenges, particularly in the context of climate change and inadequate management. Large reservoirs such as Hoa Binh, Son La, and Thac Ba in the northern region are crucial for regulating the Red River’s water flow and electricity supply but pose significant risks if not properly maintained, inspected, and strictly managed. Many dams and reservoirs in Vietnam were constructed decades ago and are now severely degraded. According to the Ministry of Agriculture & Rural Development, hundreds of reservoirs face a high risk of dam failure due to insufficient investment in regular maintenance and periodic inspections. Furthermore, the lack of effective incident management protocols and early warning systems exacerbates community risks near these facilities. Additionally, the impact of climate change on water resource management has led to significant changes in rainfall patterns and river flows across Vietnam. The rainy seasons are becoming increasingly extreme, with heavy downpours leading to heightened flood risks, while dry seasons are lengthening, resulting in dwindling freshwater supplies. This not only affects river ecosystems but also poses direct threats to food security, human health, and socio-economic development.

According to previous research, both average temperatures in Vietnam and sea levels are rising. The Mekong Delta, Vietnam’s largest rice-growing region, faces severe saltwater intrusion, impacting millions of hectares of agricultural land. Meanwhile, northern and central Vietnam are encountering heightened risks of flash floods and severe flooding due to intense rainfall concentrated over short periods. Most recently, Typhoon Yagi (Typhoon No. 3) was the strongest typhoon in the South China Sea in 30 years, making landfall in northern provinces with immense intensity. The storm’s circulation caused widespread rainfall across provinces from Thanh Hoa northward, with total precipitation ranging from 200–400 mm and 400–600 mm in mountainous regions, with some areas exceeding 700 mm. Many hydropower reservoirs in the Northern Midlands and Mountainous regions had to release water urgently to ensure structural safety. For example, Thac Ba Hydropower Reservoir (Yen Bai Province) experienced critically high upstream water levels, with inflows exceeding the reservoir’s designed discharge capacity. Additionally, downstream water levels in rivers of the Red - Thai Binh river system reached dangerous levels, with some locations surpassing Alert Level 3 or historical records, threatening the integrity of dike systems and causing flooding in residential areas, schools, hospitals, and essential infrastructure. Typhoon No.3 and its aftermath had a wide-reaching impact, affecting 26 provinces and cities across northern Vietnam and Thanh Hoa, which accounted for over 41% of the country’s GDP and 40% of its population. Combined with upstream dam



▲ *Song Cai Lake has been developed with detailed scenarios to respond to floods*

discharges, prolonged heavy rainfall led to significant flooding, flash floods, landslides and extensive damage in many areas. On September 15th, 2024, the Department of Dike Management and Disaster Prevention (MARD) reported the Typhoon No.3 damage, including 281 fatalities and 67 missing persons, over 231,851 houses damaged, more than 305 dike-related incidents and estimated economic losses exceeding 31,596 billion VND. To restrict the harmful about dam problems, it is essential to strengthen the management and operation of water reservoirs. This includes reviewing and amending deficiencies in the operational procedures for interconnected reservoirs within the Red River - Thai Binh river basin, particularly during the flood season, regulations on early water storage, and emergency response protocols. Measures should also reinforce and upgrade dam and reservoir safety, establish a flood discharge warning system for reservoirs, and ensure the efficient and safe operation of reservoirs and downstream areas. In compliance with regulations, particular attention should be given to key reservoirs, such as Son La, Hoa Binh, Thac Ba, and Tuyen Quang. Repairs and upgrades should prioritize critical structures, especially those damaged during recent floods. Coastal dikes should also be reinforced and upgraded to withstand powerful storms, such as Typhoon No.3. Additionally, inspecting and reviewing plans for addressing weak points in critical dike sections and other areas affected during the recent flooding is necessary.

3. LESSONS FOR VIETNAM

Vietnam has faced significant challenges in dam safety, water resource management, and climate change adaptation. The experiences of countries such as the Netherlands provide valuable lessons, particularly in addressing increasing risks of drought, saltwater intrusion, and flooding. For instance, Vietnam could construct infrastructure to prevent flash floods and landslides in critical areas, install automated flash flood warning stations in high-risk zones, and establish water retention zones to mitigate flooding... One of Vietnam's biggest challenges is managing major transboundary rivers, particularly the Mekong and Red Rivers. Upstream water control directly impacts Vietnam's water flow and resources, especially from China and other countries in the Mekong River Basin. To solve this problem, Vietnam could learn from the European Union's approach to transboundary river management [2]. For instance, a system for managing shared water resources has been successfully developed to establish rules for water discharge, monitoring water quality and managing flood risks by the International Commission for the Protection of the Danube River (ICPDR). Enhanced commitment and cooperation from all involved nations are essential for addressing water-sharing issues and impacting upstream hydropower projects. A key solution is promoting international agreements for data and information sharing on water flow, reservoir levels and climatic conditions from upstream hydropower dams. Based on international experience, the following are vital proposals to improve water resource management and dam safety in Vietnam:



International cooperation mechanisms for managing transboundary water resources should be continued, particularly in the Mekong and Red River Basins. Agreements on data and information sharing among basin countries are essential, alongside commitments from upstream nations such as China and Laos for sustainable water discharge practices. Furthermore, Vietnam needs to develop response scenarios for water shortages in the dry season and flood risks during the rainy season. Investment in flow and water quality monitoring technologies and the application of flow forecasting models will enhance forecasting capabilities and water management.

(2) *Enhance dam safety standards and maintenance*

Significant improvements in safety standards for constructing and operating hydropower dams in Vietnam are necessary. The Ministry of Agriculture and Rural Development and the Ministry of Industry and Trade should update technical standards and regulations related to dam safety, as learned from countries like Japan and Norway. Regular inspections, maintenance, and upgrades of ageing dams are mandatory to ensure nearby residents' safety. Using real-time monitoring systems and artificial intelligence to analyze data from monitoring sensors will enable early detection of risks and minimize potential threats.

(3) *Develop early warning systems and disaster response*

Vietnam needs to invest in building early warning systems for floods and dam failures, drawing on the experiences of the U.S. and the Netherlands. These systems should integrate weather forecasting models, flow data, and pressure monitoring at dams to provide accurate and timely information to authorities and the public. The government should also organize regular drills for flood and dam failure preparedness to raise awareness and equip communities near dams and dikes with essential skills. These measures will strengthen emergency response capabilities during critical situations.

(4) *Promote water-saving technologies and water reuse*

With climate change and increasing water scarcity, advanced water-saving technologies, such as drip irrigation systems and wastewater treatment, should be adopted for reuse. Israel's experience developing water-saving solutions for agriculture and industry can serve as a model, reducing pressure on natural freshwater resources.

(5) *Develop natural water storage areas and protect watershed forests*

Vietnam should establish natural water storage areas, similar to "water retention areas" in the Netherlands. These areas can be used to store floodwaters during the rainy season, reducing pressure on rivers and reservoirs while protecting residential areas from flood risks. Protecting and restoring watershed forests is also vital for safeguarding water resources. Watershed forests regulate water flow, prevent soil erosion, and mitigate flood risks. The government should strengthen policies on forest protection and encourage local communities to participate in managing and preserving natural resources.

4. CONCLUSION

With its complex system of dams and water resources, Vietnam has to learn from international experiences in dam safety management and water resource protection. The practices of countries such as the United States, the Netherlands, Israel, and others highlight the effectiveness of applying modern technological solutions to water resource management and dam safety. To safeguard water resources and ensure dam safety, many cutting-edge technologies should be invested in, such as monitoring technologies, early warning systems, water reuse practices, and protection of upstream ecosystems. These efforts will contribute to building a sustainable water resource management system for the future ■

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Designing digital systems for scale: Payments for Environmental Services

Payments for Environmental Services (PES), also known as Payments for Ecosystem Services, is a results-based financing mechanism to promote environmental conservation and restoration by the hands of local communities, farmers, and Indigenous communities, providing cash benefits for acting as custodians of nature. The publication explores the integration of digital technologies into Payments for Environmental Services (PES) schemes. The report underscores the potential of leveraging Digital Public Goods (DPG) and Digital Public Infrastructure (DPI) to enhance the scalability, efficiency, and effectiveness of PES programs. The research was conducted through interviews with UNDP practitioners, frontrunner countries with national PES schemes.

This guide is designed for PES practitioners, policymakers, financiers, and digital innovators. It begins with an introduction to PES, detailing its significance in promoting sustainable environmental services and providing financial incentives to local stakeholders. The document then delves into the opportunities and challenges associated with digitalizing PES schemes, highlighting lessons learned from previous implementations and the critical role of DPGs and DPIs in overcoming these challenges. The core of the report presents a practical framework for designing a digital PES system, including technical requirements, system architecture, and key software tools. It outlines a nine-step process for PES implementation, from application and legal assessment to field data collection, monitoring, and payment disbursement, and emphasizes the need for a modular, open-source approach that can be adapted to different national contexts and ecosystems. By showcasing the benefits of digital innovation in PES, UNDP aims to foster collaborative efforts among governments, NGOs, and the private sector to scale up nature and climate action globally. The report concludes with a call to action for increased investment in digital solutions that support sustainable development and climate resilience.

1. GENERAL STEPS TO ESTABLISH AND MANAGE A PES SCHEME

For countries that are developing an IT system for PES management, the report will inform the system architecture, readiness assessment, and technology roadmap. For countries and practitioners that are in the process of creating a new PES scheme, this report will show a future vision for digitally-enabled PES, which can help to design better processes and regulations. For donors and financiers, the report will serve as an invitation for digital cooperation and investment opportunities toward open-source, open data, and local nature and climate action.

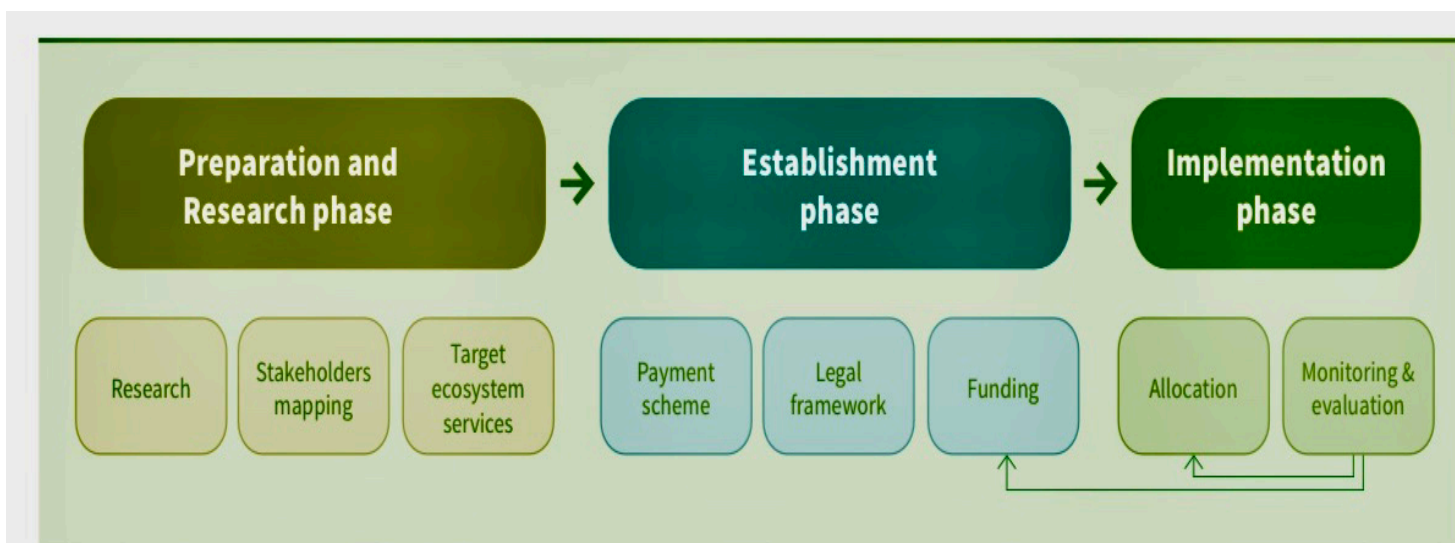
PES is a resultsbased, conditional financing mechanism that compensates farmers and local communities for the environmental services provided, due to specific actions and efforts undertaken by these stakeholders in their land. Under PES schemes, payments are conditional upon performance that is

to receive cash transfers, participants must achieve outcomes by doing (or refraining from doing) certain activities.

Across the world, various PES schemes, or PES-like schemes have emerged to incentivize farmers and local communities to maintain forests or watersheds on their land or avoid agricultural expansion into nearby forest areas. According to a recent study, there are more than 550 active programs around the globe and an estimated US\$36–42 billion in annual transactions. This includes a variety of arrangements through which users of environmental services, from watershed protection and forest conservation to carbon sequestration, reward communities or individuals whose lands provide these services with payments or monetary compensation, including cash transfer.

PES has been critical especially in forest landscapes, given the forests' essential role for over 1.6 billion people's livelihood, as well as serving as the 'lungs' of the Planet. If deforestation is stopped and degraded forests were stored, forests can provide a third of the carbon emission reductions and removals needed to avoid the most severe impacts of climate change. Paying for the benefits of natural ecosystems is a way to recognize their value and ensure that these services continue to be provided well into the future. In the current economy, the strongest financial incentive given to farmers and local communities encourages them to convert nearby forests and forest patches on their land into agriculture fields to increase production, and hence increase household income. This is the trend that PES is trying to counter.

In addition to preserving natural resources, PES has the potential to improve livelihoods as it can transfer needed cash resources directly to impoverished groups. In addition to being widely used to cushion the economic damage from sudden shocks, conditional direct cash transfers have long been recognized as an effective tool for poverty reduction worldwide, yielding benefits to health, education, employment, and overall well-being. UNDP has been working with countries to establish new



▲ Fig 1. PES life cycle

Source: undp.org

PES schemes, as well as to improve and enhance the implementation of existing PES schemes around the world. To further illustrate the benefits of PES, this section provides some examples of PES from countries.

PES schemes start from a preparation phase which includes an environment valuation study and feasibility study, stakeholder engagement and a process to define the target ecosystem services. Based on the research, a PES scheme is established. Specifically, this phase includes the designing of the programme and payment scheme, preparation of a legal framework and fund mobilization, which may be secured through international funding or national sources. Thereafter, implementation will start across years, which entails the conditional payments to individuals or communities, monitoring and evaluation of the programme, and funding replenishment. The diagram outlines the major steps required for establishing and implementing a PES scheme. Although not an exhaustive list, these steps serve as important benchmarks throughout the process and contribute to the overall success of the PES scheme. (Fig 1)

2. OPPORTUNITIES AND KEY CONCEPTS FOR DIGITALIZING PES SCHEMES

This section outlines how recent advancements in digital technologies and key concepts such as Digital Public Goods and Digital Public Infrastructure bring opportunities for PES and other similar innovative incentive mechanisms to be brought to scale.

Lessons learnt from earlier PES information management systems

Information management systems have been used for PES scheme implementation in earlier years. Interviews with managers of several front-runner national PES programmes surfaced three common challenges of earlier technology and approaches: Need for a holistic approach; Limited ability to update to new technology options; Lack of interoperability and open data policies.

Digital technology to support PES

Application Programming Interface (API) for interoperability: APIs are sets of protocols and tools that allow different software applications to communicate and share data and functionalities seamlessly. It is a direct way of solving the ‘interoperability’ issue. Most PES management systems pull data from different databases and overlay geospatial information.

High-resolution satellite imagery and remote sensing: Satellite imagery and remote sensing allow better data collection, particularly in remote locations or large-scale implementation. Where field data collection is challenging, remote sensing can provide a first rapid assessment of land use, while field data acts as primarily a verification exercise, saving inperson trips. In addition to local ground proofing needs, ecosystem qualities, such as biodiversity, cannot be determined from satellite imagery and require a combination of different technology and/or human research.

Mobile phones: Simple technology can significantly improve and reduce the cost of field data collection, encourage user enrolment, ease cash payment and add possibilities for new ways of verification by the beneficiaries themselves. Enumerators are able to efficiently collect georeferenced information on farmers, communities, their land, and forests cover on their land. Various open-source data collection apps exist to assist depending on the type of environmental service.

Artificial intelligence (AI): AI can support the automation of farm boundary detection, differentiation between arable and forest land, eligibility criteria verification, monitoring of the forest, and decision-making on whether

critical elements of the PES agreement were fulfilled.

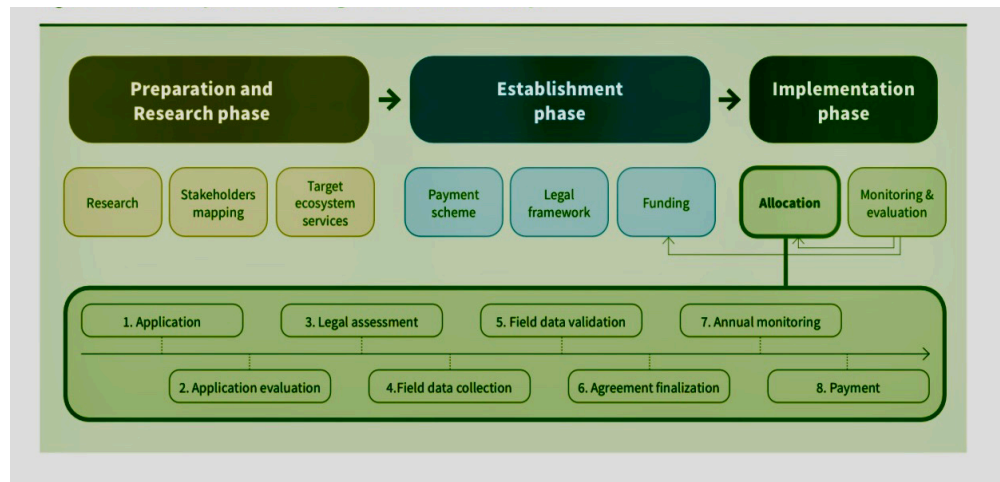
Distributed ledger technologies: Distributed ledgers are digital systems for recording the transaction of assets in which the transactions and their details are recorded in multiple places simultaneously. This technology is most famously exemplified by blockchain, which

underpins cryptocurrencies like Bitcoin but can be applied to a wide range of other transactions and record-keeping systems, making them decentralized, immutable, and transparent. Countries with existing foundational Digital Public Infrastructure (DPI), such as a national digital ID system, are at an advantage when scaling the beneficiary enrolment. Especially when data such as bank information or land ownership are already integrated, with robust privacy and security measures.

Digital payment systems: By enabling swift, secure, and transparent transactions, digital payment platforms significantly enhance the efficiency of PES initiatives. Existing DPI for Digital Payments makes it feasible to include a broader range of participants in PES schemes, as the ability to execute a payment transaction can often be a limiting factor in scaling the scheme. As PES is a growing climate action mechanism with commonalities across countries, regions, and types of ecosystems, it is well suited for a Digital Public Good (DPG) approach. DPG is open-source software, open data, open AI models, open standards and open content that adhere to privacy and other applicable best practices, do no harm and are of high relevance for attainment of the SDGs.

In recent times, Digital Public Infrastructure (DPI) has emerged as a critical enabler of digital transformation in multiple sectors in several countries. DPI is a set of shared digital systems that are secure and interoperable, built on open standards and specifications to deliver and provide equitable access to public and/or private services at a societal scale.

Designed and implemented well, DPI can boost the capacity of countries to achieve their national development priorities, accelerate the Sustainable Development Goals (SDGs) and also scale the green transition. DPIs are governed by rules and principles that drive and uphold sustainable development, inclusion, innovation, trust, human rights, and fundamental personal freedoms. There are three DPIs that are deemed 'foundational' to carrying out essential public functions and which should be accessible



▲ Fig 2. The PES life cycle with the eight allocation sub-steps

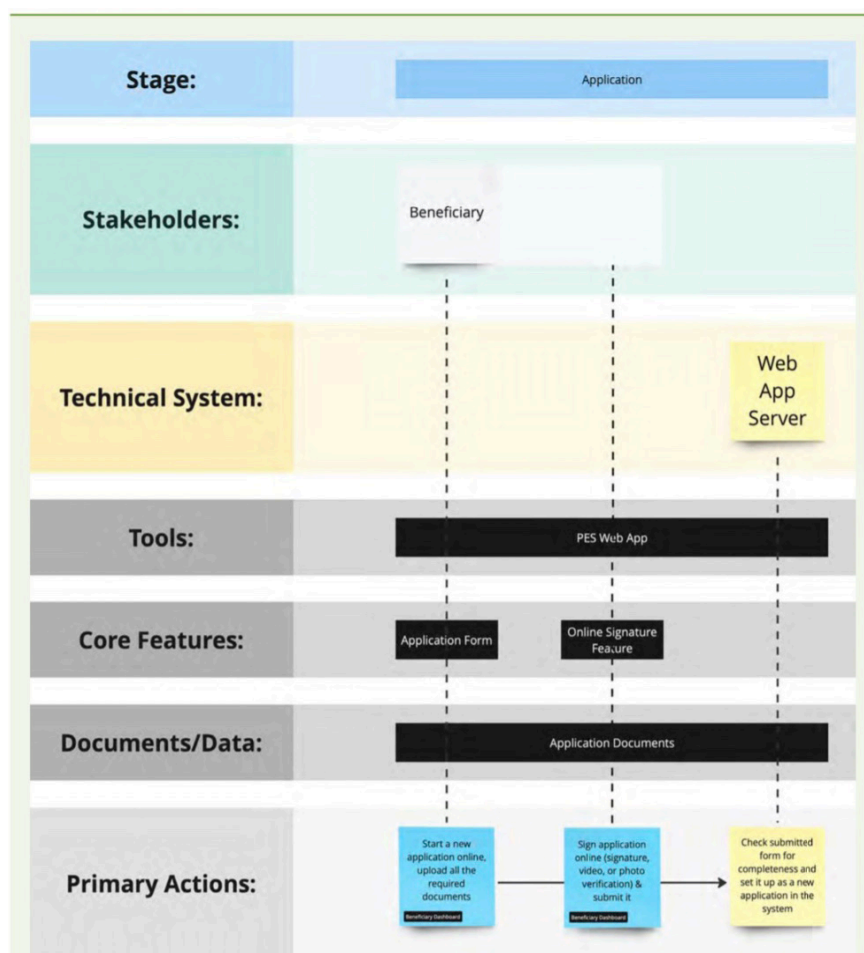
Source: undp.org

at a low cost to citizens or the end beneficiary. The following three foundational DPIs allow the technology stack to facilitate crosssectoral innovation and population-scale impact: Digital Identity; Digital Payments; and Consent-based Data Sharing.

3. DIGITALIZATION OF THE PES IMPLEMENTATION SYSTEM

This publication outlines how the PES implementation process works, and proposes a digital solution for each step of the process. The incentive allocation, which is the granting of funds, is one of the most important phases of the PES process as it comprises all the central PES allocation steps from the beneficiary application to the final compensation/payment. In total, this phase consists of eight sub-steps (Figure 2). A contract is made with each individual (or community). The land is monitored against ecosystem indicators (e.g., forest coverage, forest quality, biodiversity, water quality, etc.), results are validated, and payment is made. Some schemes have also included social safeguard requirements to complement environmental indicators.

Application: In the first stage of the fund-granting process, applicants send their application for their country's PES system via the PES web app. After filling in all the application data and attaching all the relevant documents (e.g., farm maps), the potential beneficiaries can directly sign their application online (either via written, photo, or video signature), from which it is automatically forwarded to the corresponding PES Team. From here, it will be analyzed in the next system stage. The application process can be streamlined if the country has a Digital ID system (Foundational DPI) which can be integrated with the PES application process.



▲ Fig 3. Application details

Source: undp.org

Application evaluation: Once submitted, every application goes through an evaluation process. After a preliminary manual completeness review, the PES Team creates an initial geodata file (e.g., shapefile) of the beneficiary's farm area and uploads it to the PES web app. From there, it is converted into Structured Query Language (SQL) - readable Geographic Information System (GIS) data and uploaded to the backend SQL database.

Legal assessment: The legal assessment occurs after the initial application evaluation to verify the potential beneficiary's land ownership. If there are any impending legal issues, the PES Team marks those as having to be resolved by the beneficiary via the PES web application.

Field data collection: For the field data collection, an independent (or, in some countries, internal) PES expert is assigned (or, in some countries, personally contracted by the beneficiary) to visit and geolocate the farm. The PES Expert has to map out the ultimate and exact perimeters of the farm. The future PES area within (e.g., forest for protection, reforestation, agroforestry, etc.) as well as, in some cases, evaluate the condition and ecological value of the forest (there are other methods this value can be determined by, such as through GIS models that have been established for the PES scheme).

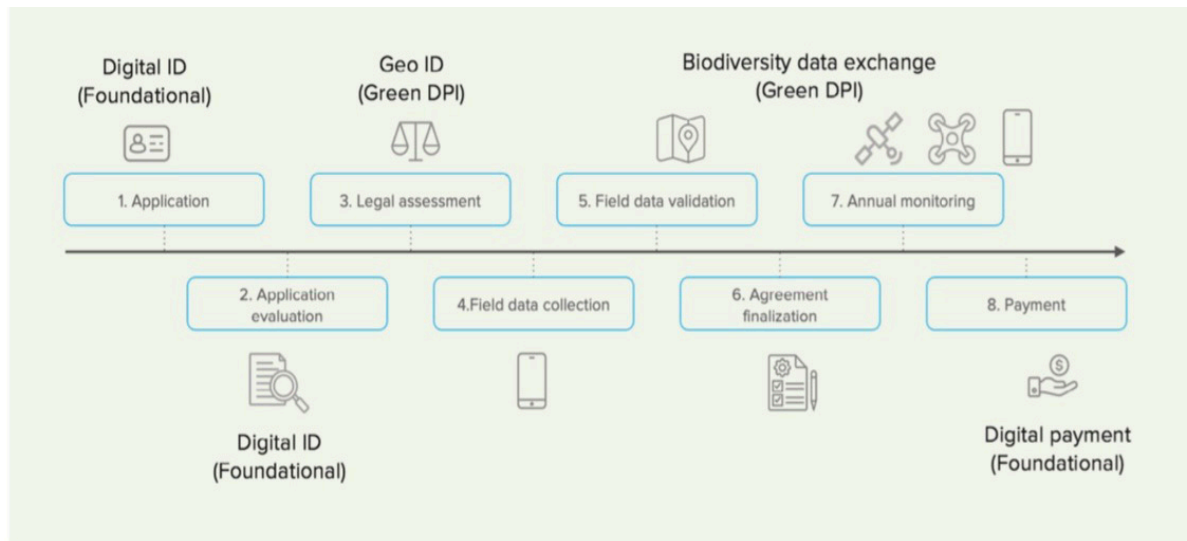
Field data validation: A fully automated validation process transforms the shapefiles from the previous step into SQL-readable geodata to verify that the field study documents comply with the approval requirements. On the SQL database, two separate checks are performed: first, to confirm the correctness of the uploaded geodata (e.g., identify topological errors), and second, to map out any overlaps with other areas (properties, government land, other PES areas, etc.).

Agreement finalization: An agreement is sent to the beneficiary via the PES web app to finalize the application process. Once signed, the agreement becomes official, and the SQL backend database takes the GIS location of the beneficiary's farm and merges the effective PES area with the geodata of all the other farm PES areas, thus creating a single file that complies in the entirety of the PES areas/sites.

This geodata layer is crucial for monitoring and controlling the development of the PES program, as it documents all the forest/ecosystem areas that are part of the system.

Annual monitoring: Every year, all the agreed-upon PES farm/community areas need to be monitored to verify their compliance with the initially drafted beneficiary agreements. This can be done either entirely remotely or with the help of a PES Expert who conducts a field visit to verify the beneficiary's farm area directly on the ground. Any potential changes to the agreed-upon PES area are tracked and uploaded to the PES web app.

Payment: After the annual monitoring results are finalized, the last step of the fund-granting process is the payment stage. Here, the backend PES system automatically relays the compensation payment to each beneficiary to reimburse them for their efforts. This can be done as a bank transfer, via check, or with the help of local NGOs, which might pay out any payment directly to the corresponding beneficiaries in cash (depending on the payment-related locally available). This is an apparent case where a foundational DPI Digital Payment system can be useful. After the payment,

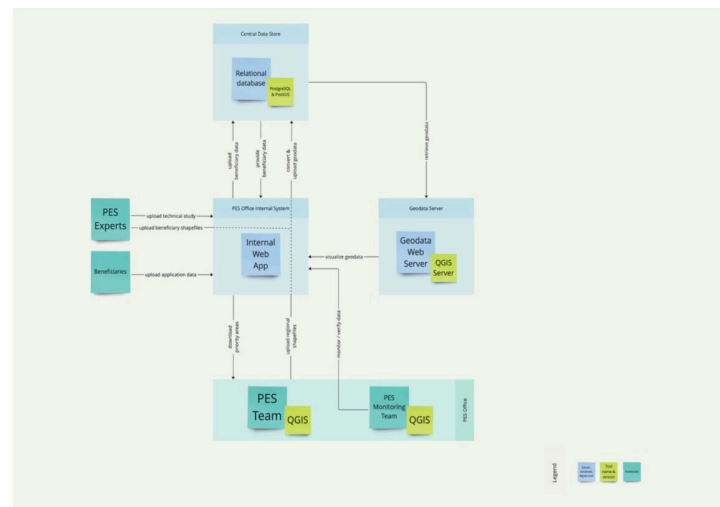


▲ Fig 4: DPI opportunities for each step of PES implementation

Source: undp.org

the PES fundgranting process repeats itself the following year, either at the annual monitoring step or at the application stage (if the agreement expires and needs to be renewed). Fig 4

DPI opportunities: As identified in each process section, a digital PES system will greatly benefit from leveraging on foundational DPIs if they already exist in a country. In addition, a ‘geospatial ID’ or land registry is a potential ‘Green DPI’ to help streamline the contracting and monitoring processes, along with a data exchange protocol for biodiversity and ecosystem data to incentivize data sharing from beneficiaries, private sector and citizens to revolutionize results verification.



▲ Fig 5. PES system data flow

Source: undp.org

4. TECHNICAL REQUIREMENTS AND ARCHITECTURE

The final section outlines the technical requirements, system architecture, information architecture, and core feature lists for a digital solution to support PES schemes implementation.

Technical requirements - data flow: The underlying structure of the universal PES process follows a heavily streamlined system approach with a high degree of automatization. The data flow on the right indicates how information is sent from one tool to another, thus creating an intricate system in which all data exchange paths are greatly optimized.

Technical requirements - Tools & software: RDBMS Server (PostgreSQL & PostGIS); QGIS Server; Web Backend Server; Internal PES Web App; GIS Software (QGIS).

System architecture: PES process. As part of its overarching system framework, the universal PES process features a variety of tools and software elements that all work together in the streamlined processing of geospatial data and beneficiary application documents. Hereby, all the tools that are part of the system fall into one of two overarching categories: frontend or backend. While the frontend tools are responsible for all the manual activities that must be executed as part of the PES process, the backend handles all the automated geodata analysis procedures and storing relevant beneficiary application data.

Information architecture - PES web application: A crucial component of the universal PES Process is the so-called PES web application (web app for short), which acts as the central interaction point between the front- and back-end of the system. The PES web app is the online portal through which all local geographic data generated by PES Experts and Teams is converted into SQL GIS data and then uploaded to the corresponding SQL database ■

NHÂM HIỀN
Source: undp.org



Extended Producer Responsibility and opportunities for formalization of informal waste collectors

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1. INTRODUCTION

The amended Law on Environmental Protection 2020 institutionalizes the principles of “polluters pay”, the circular economy, and Extended Producer Responsibility (EPR), marking a significant shift in Vietnam’s approach to waste management. Under this framework, the Ministry of Natural Resources and Environment (MONRE) has been designated as the primary authority overseeing waste management, introducing a new approach to solid waste management. This includes the mandatory sorting of waste at the source, as stipulated in Article 75, which requires individuals, households, and communities to classify waste before disposal. To support this, MONRE has issued guidelines for domestic waste classification, preparing for nationwide implementation of waste sorting at source by January 1st, 2025.

To operationalize the law, Decree 08/2022 was developed, which includes a chapter dedicated to the EPR system. This decree provides the legal framework for manufacturers and importers to fulfill their responsibilities for recycling and waste treatment. It is further supported by Circular No.02/2022/TT-BTNMT, which outlines specific requirements for recycling plans, reporting, and financial contributions to waste management activities. These legal instruments have laid the foundation for a collection and recycling industry aimed at gradually reducing landfill dependency.

An important milestone in this effort was the establishment of the National EPR Council and EPR Office in February 2023, as specified in Decision No.252/QĐ-BTNMT. These bodies assist MONRE in managing, supervising, and supporting the implementation of EPR by enterprises, overseeing recycling activities, and waste treatment responsibilities. Complementing this is the National EPR Portal, an online platform where producers and importers register, report, and declare recycling and waste management activities, replacing traditional paper-based submissions.

The financial backbone of the system is the Vietnam Environment Protection Fund (VEPF), which collects contributions from enterprises to support waste collection, transportation, treatment, and recycling activities. Additionally, professional recycling companies have been authorized under this mechanism, ensuring compliance with state standards for recycling operations. In February 2024, the Ministry announced a list of 24 authorized recycling units, further advancing the operationalization of EPR.

Private-sector initiatives also play a pivotal role in promoting the circular economy. The Vietnam Packaging Recycling Alliance (PRO), formed by companies in the

consumer and packaging sectors, has been instrumental in promoting sustainable collection and recycling practices, demonstrating how industry collaboration can complement government efforts.

While these developments represent significant progress, the implementation of EPR in Vietnam faces several challenges. The existing infrastructure for waste collection and treatment continues to operate in a traditional manner, relying heavily on landfilling. Enterprise awareness of EPR remains low, and detailed implementation guidelines are incomplete, creating obstacles to effective enforcement. Additionally, investments in the recycling industry and the market for recycled products are insufficient, highlighting the need for specific policies to support infrastructure development and market expansion. Despite these challenges, some pioneering enterprises have begun implementing EPR, showcasing its potential for driving sustainable waste management practices in Vietnam.

The formation of key components of a circular economy marks an important step forward in Vietnam’s waste management journey. However, continued efforts are required to address gaps in policy, infrastructure, and market development to fully realize the potential of EPR and the circular economy.

The shift in waste management thinking, guided by the Law on Environmental Protection 2020 and the Extended Producer Responsibility (EPR) system, provides promising opportunities to develop a comprehensive ecosystem for waste collection, recycling industries, and the recycling market. As outlined earlier, the law requires waste classification into three main categories, with URENCO companies responsible for waste collection under the EPR framework. Within this evolving ecosystem, the informal collection workforce serves as a critical link in the waste value chain, holding significant potential to connect with collection and recycling companies, self-recycling enterprises, and sorting systems managed by URENCO.



2. SEVERAL CHANNELS FOR FORMALIZING WORKFORCE

2.1. Connecting informal workers with URENCO

As the entity assigned by local People's Committees to oversee waste collection, transportation, and recycling, URENCO plays a pivotal role in local waste management. Under the Law on Environmental Protection 2020, URENCO is tasked with collecting and managing waste sorted into three categories as prescribed by the EPR. However, in practice, unsorted and poorly collected waste leaves a gap that URENCO can address by hiring informal workers under part-time or seasonal contracts. This approach provides informal workers with greater job opportunities, access to stable waste streams, and semi-formal employment benefits, improving their economic stability and working conditions.

2.2. Cooperating with collection and recycling companies

The EPR system encourages businesses to engage with waste collection workers through contracts for waste classification and collection services. Informal workers could secure stable incomes, receive skills training, and access safer working conditions through employment with large collection enterprises like VietCycle or major recycling plants such as Duy Tan. These workers could also participate in Return Deposit Systems (DRS) or B2B recycling models, contributing to the circular economy while reducing waste pollution. Enhanced training on occupational safety and social welfare ensures that informal workers' health and job security are prioritized.

Strengthening links with recycling companies

Recycling companies, including those evolving from small scrap procurement facilities, can act as intermediaries between households, informal workers, and larger recycling plants. Informal collectors, who are closely connected to local scrap procurement facilities, could benefit from EPR support through contracts, access to better labor equipment, and financial sponsorship. This connection would enable informal workers to transition into formal employment, benefiting from the operational structure and financial stability provided by established recycling companies.

Transforming informal scrap purchasing establishments

Informal scrap purchasing facilities, often located in residential areas, could register as official collection companies or cooperatives under the EPR framework. These facilities play a vital role in regulating scrap procurement by leveraging their knowledge of prices, market demand, and scrap types. The EPR system could support these establishments with financial assistance, training, and access to clean technologies, enabling them to professionalize their operations and improve their competitiveness. Formalizing these activities would allow scrap procurement facilities to access state support for capital, technology, and environmental protection training, thereby enhancing their capacity and sustainability.

2.3. Engaging with large manufacturing industries

Certain industries, such as those producing aluminum or milk cartons, are establishing recycling collection chains tailored to their products. These industries could outsource specific tasks to small and medium-sized recycling companies, providing opportunities for highly skilled informal workers to participate in specialized waste management and recycling efforts.

The EPR system thus presents significant opportunities to formalize the informal workforce in waste management, offering economic and social benefits to workers while contributing to a more effective and sustainable waste management system. However, while this study identifies substantial potential, the transition is fraught with challenges. The persistence of traditional waste management systems and other barriers complicates the formalization process, underscoring its complexity. To better understand the obstacles, the following section will examine the main opportunities and barriers affecting the formalization of informal collection forces, providing insights into how the EPR system can support this transition in its early stages.

Key legal and policy instruments supporting formalization: (i) The Law on Gender Equality (2006) emphasizes gender equality in all aspects of life, prohibiting gender discrimination and violence. (ii) The National Strategy for Gender Equality (2011 - 2020; 2021 - 2030) highlights Vietnam's commitment to closing gender gaps, including in development and environmental protection. (iii) The Law on Small and Medium Enterprises (2017) defines "women-owned enterprises" as a focus area for economic gender equality, providing tax incentives and financial support to SMEs employing many female workers. (iv) The Labor Law (2019) prioritizes gender equality, protecting female employees and vulnerable groups while promoting occupational safety and freedom from discrimination. (v) The Law on Cooperatives (2023) incentivizes cooperatives managed by women or employing a majority of female workers, aligning with circular economy goals and sustainable development. (vi) The Employment Law (2024) establishes financial and vocational training support for informal workers, including informal waste collectors, through the National Employment Fund. (vii) The Law on Environmental Protection (2020) emphasizes waste classification, environmental harmony, and gender equality, while Decree 08/2022 and Circular 02/2022 provide mechanisms for EPR implementation, supporting formalization efforts.



These policies collectively create an enabling environment for integrating informal workers into formal systems. The Extended Producer Responsibility (EPR) system acts as a financial tool to develop the waste collection and recycling industries. It offers informal collectors' opportunities to transition into formal employment within waste management companies, cooperatives, or self-recycling enterprises. Formalization provides access to social welfare benefits, insurance, and improved working conditions, empowering informal workers and contributing to the circular economy.

3. BARRIERS TO FORMALIZATION

While the opportunities are significant, the formalization process faces considerable challenges, including structural, organizational, technological, and workforce-specific barriers.

3.1. Structural and organizational barriers

The existing waste management system, dominated by entities like URENCOs and CITENCO, is large and complex. These systems rely heavily on traditional collection and landfilling, which must operate continuously without interruptions. Transitioning to a circular economy, which minimizes landfill use, requires substantial restructuring of these systems - a daunting task given their operational scale and reliance on daily waste collection. Coordination among relevant agencies remains weak, with gaps in understanding EPR policies and their implementation. Previous attempts to "socialize" waste management policies in Vietnam have encountered obstacles, further highlighting the challenges of systemic change. Similar difficulties in organizational capacity have been observed in other developing countries.

3.2. Technological challenges

In advanced economies, waste sorting and recycling are industrialized, supported by modern technologies that ensure efficiency and scalability. In Vietnam, however, recycling at procurement facilities and craft villages remains rudimentary, relying on manual labor and out-

dated methods. Scaling up recycling and waste management technology is critical but requires significant investment and capacity building.

3.3. Workforce-specific challenges

Informal waste collectors, particularly women, face significant internal barriers to formalization. These include limited education, low awareness of formal employment opportunities, and vulnerability to social stigma. Women in this workforce often lack access to training, financial resources, and social support systems, which further complicates their transition to formal employment. These challenges will be analyzed in greater detail in the next section.

The opportunities presented by Vietnam's legal framework and the EPR system are substantial, providing a pathway to integrate informal workers into formal waste management systems. However, addressing the barriers to formalization is essential for realizing these benefits. A deeper understanding of these challenges will guide the necessary support mechanisms and policy adjustments to ensure a successful transition.

3.4. Readiness informal collection workers

The willingness of informal collectors to transition to formalized systems is mixed. When asked about their readiness to work within formal organizations or businesses in the interview with group of 38 informal female collectors in Ha Noi, the results are: 71% expressed hesitation or reluctance, citing the desire for flexible working hours and the freedom to balance other responsibilities; 24% said they would be willing to participate if provided with support from the state or businesses; 5% were unsure.

Many of these women are migrant workers with limited experience in formal employment settings, contributing to their apprehension. However, the survey revealed that women who have participated in training programs related to waste management and environmental issues are more open to change. Among women who attended such programs between 2021 and 2023, 88% expressed a desire to continue participating in future training and pilot models.



▲ The mandatory sorting of waste at the source



In sum up, informal waste collectors are an essential yet marginalized group within Vietnam's waste management ecosystem. While they face numerous challenges, including economic insecurity, social stigma, and health risks, targeted interventions such as capacity-building programs, financial empowerment, and trust-building initiatives can help bridge the gap between informal and formal systems. Their willingness to engage with formalization efforts - when adequately supported - offers a pathway to creating a more inclusive, efficient, and sustainable waste management system.

4. OPPORTUNITIES, CHALLENGES, AND BARRIERS TO FORMALIZING INFORMAL WASTE COLLECTORS

The implementation of the Law on Environmental Protection 2020 and the application of Extended Producer Responsibility (EPR) policies represent a critical step toward building a circular economy in Vietnam. Developing the recycling industry requires a large and dedicated workforce, and the current informal labor force is a valuable resource to meet this demand. With official waste collection companies, such as the URENCO system, employing about 100,000 people nationwide, the informal sector offers an abundant and underutilized human resource that can significantly contribute to waste collection, recycling, and circular economy initiatives.

However, the formalization of this informal workforce is fraught with challenges. Policies and institutions, while relatively robust in acknowledging informal labor in general, do not specifically address the role of informal workers in the environmental and waste sectors. Policymakers often design regulations based on formal systems, overlooking the significant contributions of informal workers who have traditionally operated on the margins of the economy. Waste collection and recycling, often perceived as low-priority industries, have received minimal attention in economic planning, leaving the informal workforce largely unsupported.

Moreover, formalization is complicated by the involvement of numerous stakeholders, including government ministries, local authorities, the private sector, and civil society organizations. This complexity increases the risk of fragmented decision-making and potential conflicts during implementation. A clear policy environment, supported by specific enforcement measures, financial tools, and mechanisms to encourage collaboration, is essential. Additionally, a monitoring system to track progress and outcomes will be critical to ensuring transparency and accountability.

Challenges also arise from the internal characteristics of the informal workforce itself. These workers, particularly women, are highly dispersed and operate independently. Their awareness of labor rights, social protections, and the broader societal implications of their work is limited. Many are hesitant to join formal systems, valuing the flexibility of their current roles, which allow them to balance other responsibilities such as family and farming. Social stigma further compounds these issues, with waste collection often regarded as a low-status occupation, eroding the self-esteem and societal recognition of these workers.

Despite these barriers, formalizing the informal workforce holds immense potential. Integrating these workers into the formal economy is essential for the success of EPR policies and the broader goal of a circular economy. Beyond environmental benefits, formalization contributes to sustainable poverty reduction, providing workers with stable incomes, social protections, and access to better working conditions. For women, who make up the majority of this workforce, formalization represents a pathway to greater gender equality and economic empowerment. It also strengthens their role in achieving national climate goals, including Net Zero emissions, while ensuring that no one is left behind.

The journey toward formalization will undoubtedly be complex and require significant effort. While achieving full formalization may not be feasible, even partial integration of this workforce into formal systems can drive substantial progress. Overcoming current barriers will require coordinated actions, inclusive policies, and targeted support to build the capacity of informal workers and foster collaboration across all stakeholders. Ultimately, formalizing this workforce is not just a practical necessity for sustainable waste management but a moral imperative to empower a vital yet marginalized segment of society ■



The role and contribution of sustainable energy development in the implementation of ESG standards in Vietnamese enterprises

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1. INTRODUCTION

Currently, the world is facing increasingly greater challenges of climate change and the depletion of natural resources, so the transition to a sustainable development model is more urgent than ever. In particular, the energy sector - both an essential input for all socio-economic activities (SEA) and a major source of greenhouse gas (GHG) emissions plays a key role in this transition. According to data from the Ministry of Industry and Trade, industrial sectors consume more than 50% of the total national energy and emit about 70% of Vietnam's total greenhouse gas (GHG) emissions. Energy costs for many industries and industrial production sectors still account for more than 60% of product costs (Thanh Nguyen, 2021)... Therefore, in this period, the transition to a sustainable energy use model is urgent for the State, community and businesses.

With the trend of shifting to a sustainable development model, ESG (Environmental, Social, and Governance) is increasingly being focused on globally as a set of standards for evaluating businesses. ESG is not only a tool to assess the sustainability and social impact of businesses, but also a tool to manage risks and create long-term value. According to Bui Thi Thu Loan et al. (2024), enterprises with high ESG scores tend to better financial performance and greater resilience to market shocks. According to KPMG (2022), enterprises that actively apply ESG standards can reduce energy costs by 5-20% through energy saving and efficiency measures.

In Vietnam, although the ESG concept is still quite new, awareness and application and implementation of ESG standards by enterprises, especially foreign-invested enterprises, are increasing. In particular, activities aimed at sustainable energy development play a particularly important role in the ESG framework as they directly impact all three aspects of environment, society and governance. The transformation and development of clean and renewable energy models by enterprises help reduce GHG emissions and protect the environment. Socially, sustainable energy ensures energy security, improves quality of life and creates jobs. At the same time, building a sustainable energy strategy requires a good governance structure, transparency and accountability of enterprises.

However, investing and changing the energy development strategy of enterprises towards a more sustainable direction, thereby strongly promoting the implementation of ESG in Vietnamese enterprises still faces many challenges, limitations in financial resources, technical and technological

conditions to the vision and awareness of enterprises. The article aims to analyze the role and contribution of sustainable energy development in the implementation of ESG standards in Vietnamese enterprises. Through assessing the current situation, identifying favorable and difficult conditions, the article makes a number of recommendations to promote the implementation of sustainable energy development, contributing to the improvement of ESG of enterprises, towards a green and sustainable economy in Vietnam.

2. OVERVIEW OF ESG IN VIETNAM

ESG is a tool for assessing the sustainability and impact of enterprises on society, including three main aspects: (i) Environment (E), assessing the impact of enterprises on the natural environment, including issues such as climate change, resource use, pollution and biodiversity conservation; (ii) Society (S), focusing on the relationship of businesses with stakeholders, including employees, customers, local communities and society in general; (iii) Governance (G), referring to how businesses are run and managed, including governance structures, business ethics, and legal compliance. The concept was first introduced in 2004 in the United Nations "Who Cares Wins" report (UN, 2004) and has since become an important tool in global enterprises assessment.

In Vietnam, awareness and interest of enterprises in ESG are gradually increasing, especially after the Government committed to achieving net zero emissions by 2050 at COP 26. However, the level of application and publication of ESG reports is still quite modest and uneven among businesses; ESG application is mainly by large businesses, especially those with foreign investment or export activities. For small and medium-sized enterprises, accounting for 97% of the total number of enterprises in Vietnam, ESG application is still limited. The main reasons are lack of financial resources, limited awareness of enterprises and lack of specific guidance from management agencies.



Although ESG is increasingly gaining attention in Vietnam, its implementation still faces many challenges, especially for small and medium-sized enterprises. In this context, sustainable energy development becomes an important part of ESG and a driving force for Vietnamese enterprises to start the journey towards comprehensive sustainable development.

3. THE RELATIONSHIP BETWEEN SUSTAINABLE ENERGY DEVELOPMENT AND ESG

Sustainable energy development is one of the important goals of SDGs 2030, aiming to (i) Ensure universal access to modern energy services; (ii) Significantly increase the share of renewable energy in total energy supply; (iii) Doubling energy efficiency. The sustainable energy development of each country depends largely on the sustainable energy development of each enterprise in the economy. On the contrary, with the increasing demand for energy, sustainable energy production and use have a direct impact on the scale and development orientation of each enterprise. Therefore, sustainable energy development and a enterprises's ESG strategy are closely related, expressed through three aspects: Environment (E), Society (S) and Governance (G).

Environmental (E): Energy sustainable development plays a key role in reducing the environmental impact of businesses, especially reducing greenhouse gas emissions. The transition to clean and renewable energy directly contributes to the environmental goals in ESG by: (1) Reducing greenhouse gas emissions; (2) Conserving resources; (3) Reducing pollution.

Social (S): Energy sustainability has a positive impact on society through ensuring energy security, creating jobs and improving the quality of life. This is consistent with the social objectives in ESG of (1) Energy security; (2) Employment creation; (3) Public health; (4) Local development.

And on governance (G): Building and implementing an energy sustainable development strategy requires (1) Long-term strategic orientation; (2) Risk management; (3) Transparency and accountability; (4) Encouraging innovation and adaptation, in line with good governance principles in ESG.



In fact, in most ESG assessment indicators currently in use, energy occupies an important part, especially in the environmental aspect. For example, the Global Reporting Initiative (GRI) indicators have up to 5 energy-related indicators in GRI 302. A study of ESG assessment of ASEAN enterprises also showed that energy is the most disclosed topic in Sustainability Reports, with a disclosure rate of up to 65.4 % (NUS and ASEAN CSR Network, 2018).

Thus, it can be seen that the relationship between energy sustainability and a business's ESG development plan is comprehensive and multidimensional. Energy sustainability is the driving force that promotes and enhances the effectiveness of ESG implementation. It affects all aspects of ESG, from minimizing environmental impacts, improving social conditions, to strengthening corporate governance. Understanding this relationship helps businesses build a comprehensive and effective ESG implementation plan, creating sustainable value for all stakeholders.

4. CURRENT STATUS OF SUSTAINABLE ENERGY DEVELOPMENT IN ESG IMPLEMENTATION IN VIETNAM

Along with Strategies for Green Growth and Cleaner Production,... Vietnam has been implementing important policies and strategies to promote sustainable energy development. Resolution No.55-NQ/TW of the Politburo on the orientation of the National Energy Development Strategy to 2030, with a vision to 2045, has set a priority goal for encouraging investment in renewable energy with a series of policies, including incentives, to encourage businesses to manage and use energy in a sustainable manner. After committing to achieve net zero emissions by 2050 at COP 26, Vietnam has made stronger moves to encourage businesses to transform their energy production and consumption models towards sustainability.

Vietnamese enterprises, especially FDI enterprises, have begun to take positive actions to develop clean and renewable energy. In terms of the

▲ *Vietnamese enterprises implementing ESG will increase competitive advantage in the market and develop sustainable energy.*



environment, many enterprises have developed plans to reduce carbon emissions, in which switching to clean energy is considered the main solution. Currently, there are more than 10 cement factories using 35-40% of alternative fuels from waste to reduce emissions (Hai Yen, 2024). Vingroup also commits to achieving “zero” emissions by 2040 through the use of renewable energy and improving energy efficiency.

On the social side, with the potential and favorable exploitation conditions, the goal of developing clean energy for socio-economic development is also being strongly implemented. The country currently has nearly 90 solar power projects with a total capacity of more than 5,000 MW, typically: Solar power plant cluster in Ninh Thuan with a capacity of 330 MW; GT & Associates and Mashall&Street Ltd. plant in Quang Nam with a capacity of 150 MW.... At the same time, a recent study by WWF-Vietnam and The Vietnam Sustainable Energy Alliance (VSEA) shows the feasibility of supplying 100% of domestic electricity demand with renewable energy by 2050 with the support of a total of about 60 enterprises in many fields.

However, in terms of governance, the implementation and disclosure of energy-related ESG information in Vietnamese enterprises is still quite limited. According to the Vietnam ESG Readiness Report 2022 (PwC, 2022), only 35% of listed enterprises in Vietnam have set ESG commitments, while 58% plan to do so in the next 2-4 years. The main challenges in implementing ESG in Vietnam are the lack of clear ESG regulations and the lack of ESG leadership within the organization to promote the commitment. In terms of sustainability reporting practices, the majority of listed enterprises studied in Vietnam disclose short-term and medium-term ESG targets (84% and 70%, respectively). However, less than half (48%) disclose long-term targets (over 5 years) and only 8% disclose NetZero targets. Compared to the Asia Pacific region, Vietnamese businesses are facing a large gap in sustainability reporting practices related to senior management and their responsibilities towards ESG issues. Vietnam also has only one ESG investment fund of about 14 million USD, much lower than other countries in the region such as Thailand (61 funds worth 1.36 billion USD), Malaysia (27 funds, worth 393 million USD) (Thuy Nga, 2024).

In general, despite important policies and efforts from the State and large enterprises, integrating sustainable energy development into ESG implementation by the majority of Vietnamese enterprises, especially small and medium enterprises (accounting for 97% of all enterprises), there are still many limitations. Major barriers include: cognitive limitations, lack of financial and technological resources for implementation, as well as difficulties in measuring, reporting and disclosing standard ESG information. Therefore, to promote sustainable energy development within the ESG framework to become a widespread trend, it is necessary to have more specific support and guidance mechanisms from the State, as well as more efforts from businesses in raising awareness, investing resources and building a suitable transition roadmap.

5. ADVANTAGES AND DIFFICULTIES OF IMPLEMENTING SUSTAINABLE ENERGY DEVELOPMENT TARGETS IN ESG

Advantages: ESG and sustainable energy trends are becoming global standards, creating strong momentum for business transformation. Specifically, according to KPMG Big shifts, small steps (2023), currently 64% of investors are willing to pay more for Vietnamese businesses with good ESG performance, especially in the energy and environment sector. The government is also increasing support through incentives for green energy development. In addition, by investing in sustainable energy, businesses can open up opportunities to access new markets, especially export markets with high ESG standards and the potential to reduce energy costs in the long term (IFC, 2022).

Difficulties: the biggest barrier is the initial investment cost. According to *The Asian Development Bank* estimates that Vietnam needs about 16 billion USD in investment for clean energy in the period 2015 - 2030. In addition, there are limitations in infrastructure and technology as Vietnam still lacks long-term planning, strategies and specific roadmaps for renewable energy development (VCCI & Deloitte, 2022). Awareness and knowledge of sustainable energy in ESG of many businesses, especially small and medium enterprises, are still limited. Difficulties in measuring, compiling statistics and reporting indicators are also significant barriers, requiring businesses to invest in data collection systems and improve reporting capacity (PwC, 2022).

Thus, in addition to important driving forces from market trends, investor demands and government support, integrating sustainable energy into ESG still faces many difficulties from businesses themselves, with limitations in finance, technology, awareness and measurement and reporting capacity. These are complex and multi-dimensional issues that require efforts and cooperation from many parties to resolve. All need to be fully considered in the process of developing and implementing solutions to promote sustainable energy within the ESG framework, creating a favorable and consensual environment for businesses to actively participate and take the lead in this transformation process.



6. RECOMMENDATIONS FOR DEVELOPING CORPORATE SUSTAINABLE ENERGY TO IMPROVE ESG

To develop sustainable energy in ESG implementation in Vietnam, Vietnamese enterprises need to focus on solutions such as:

Firstly, build a long-term sustainable energy strategy, linked to the overall development orientation of the enterprise. This strategy needs to be based on a comprehensive assessment of the enterprise's potential, conditions and market trends, and at the same time set specific, ambitious but feasible goals and targets. Integrating the sustainable energy strategy into the enterprise's business strategies and processes is also very important to ensure consistency and effectiveness in implementation.

Secondly, prioritize resources for research and transfer of clean energy technologies, using energy efficiently in accordance with the characteristics of the enterprise. In addition to cooperation with domestic and foreign partners, enterprises also need to focus on internal innovation, encouraging employees to contribute ideas and initiatives to improve technology and energy management processes. Invest in the system. Advanced, automated energy management systems also help businesses better control energy usage and reduce waste.

Thirdly, regular training and communication to raise awareness and capacity on sustainable energy and ESG for managers and employees at all levels. The content should cover topics on policy, market, technology, good practices, as well as related planning, operation, monitoring and reporting skills. Building an energy-saving culture in enterprises is also essential to create diffusion and maintain the transformation process (VCCI, 2021).

Fourthly, continue to improve the quality of energy and ESG information disclosure, both to meet the increasing demands of the market and to help businesses see the overall picture to adjust their strategies accordingly. Referencing and gradually applying regional and international standards and good practices on ESG reporting will help information become more transparent, reliable and comparable. In addition to regular reporting, diverse communication channels should also be used to spread the message of sustainable development of businesses to the community.

Finally, work closely with stakeholders such as regulators, industry associations, NGOs and communities to jointly promote the sustainable energy transition. Through cooperation, businesses not only receive support in policy, finance, technology and market, but also have the opportunity to learn and share practical experiences to gradually improve their operations.

With the efforts and timely, synchronous actions from businesses themselves, along with the support and companionship of stakeholders, sustainable energy development activities and effective ESG implementation will gradually become a reality, to serve the practical needs of businesses as well as contribute essentially to the overall sustainable development process of the country ■

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Green environment – A key to sustainable tourism development in Quang Nam

With its rich and diverse natural resources, Vietnam has great potential for tourism development, particularly green tourism. The country considers protecting natural resources a way to ensure sustainable tourism development. The policy of developing green tourism, preserving the unique indigenous values of Quang Nam Province has seen an active response by authorities at all levels, businesses, and people, creating a number of new tourism products, attracting both domestic and foreign tourists.

RAISING AWARENESS OF ENVIRONMENTAL PROTECTION

Opening of the Visit Vietnam Year - Quang Nam 2022, Prime Minister Pham Minh Chinh requests to focus on key solutions to restore and develop sustainable tourism. Prime Minister Pham Minh Chinh said: “We need to create a green tourism environment where friendliness, public safety, and visitor safety are the commitment of all stakeholders, including the state, businesses, and the public, who exploit tourism without damaging natural resources or the environment. Administrations, the business community, and the public should join hands in practical, responsible actions to create a green environment for the sustainable development of the tourism sector. We need to maximize tourism potential and advantages, strengthen links between localities to create chains of destinations, and bring into play the creativity of each person in the region to create a combined strength for tourism and economic development. It’s important to build breakthrough mechanisms and strategies to make Vietnamese tourism more competitive regionally and globally. We also need to increase the competitiveness of cultural and natural heritages, festivals, craft villages, historical traditions, and the ecological and humanitarian values of each locality to make our tourism products more diverse and attractive.”

The Prime Minister asked travel companies and hotels to strengthen investment, reform technology, and accelerate digital transformation to boost tourism development, adding that these are current global trends toward promoting a smart tourism ecosystem connecting tourists, service suppliers, and state agencies. Tourism associations and businesses need to focus on developing tourism models which are economically, socially, and environmentally stable.

UNIQUE GREEN TOURISM RESOURCES

Located in a key tourist area of the country, Quang Nam is one of the localities with many potentials and advantages in terms of natural resources, indigenous culture, and history to develop tourism towards green growth.

Quang Nam has more advantages in terms of tourism resources than other localities in Vietnam and other countries in the region. Quang Nam is located in an important place on national and international tangible and intangible maps. The province has several heritages at national and international levels, such as Hoi An ancient town and My Son sanctuary (recognised as world cultural heritages by UNESCO in 1999) and Cu Lao Cham - Hoi An Biosphere Reserve, which was recognised by UNESCO in 2009. Bai Choi performance art, another UNESCO -recognised intangible cultural heritage, also plays an important role in local tourism development.

In addition, Quang Nam has a 125km long coastline with many famous beaches, nearly 70 festivals, hundreds of traditional craft villages, and nearly 500 historical-cultural relics and scenic spots. That is the advantage of Quang Nam to develop tourism, especially green tourism.

In the provincial tourism development plan, Quang Nam identifies three UNESCO world cultural heritages and one world biosphere reserve as the keys. These tourism products provide travellers and tourists with typical local natural and cultural experiences. At the same time, they are green tourism models at the international level. The local-specific tourism product is “one destination, three international-level experiences.” Besides, Quang Nam owns several beautiful beaches, river systems, natural and cultural landscapes, hundreds of traditional craft villages, characteristic festivals and local typical cuisine. Quang Nam people are friendly and hospitable. All of them become potential and advantages for Quang Nam tourism to develop.

Coming to Quang Nam, visitors have opportunities to get unforgettable experiences in different places from the mountainous area to the plain, such as Song Thanh Natural Reserve, Ngoc Linh ginseng area in Nam Tra My, Tra Que vegetable village in Hoi An, Dai Binh ecotourism village in Nong Son... So, Quang Nam becomes attractive to both domestic and foreign tourists.

A lot of green tourism products are now popular with visitors such as the tours of planting nipa palms and collecting trash in the Thu Bon and Hoai rivers. They are also honored by Forbes Travel, Travel and Leisure, ASEAN Travel Forum. Moreover, some models of green tourism have been approved by the locals and



visitors such as saving energy and water, saying no to plastic bags. Quang Nam will also connect green tourism products in the province to build tours that are attractive to visitors. At the same time, Quang Nam will make a linkage of green tourism with other provinces and cities in the country and abroad to help this model of sustainable tourism grow, introduce Quang Nam tourism brand name to the public.

The government of Quang Nam is constantly improving the quality of tourism products, catching up with new trends for green tourism when planning to build and develop from 10 to 20 green tourism products by 2025. Green tourism is considered the goal for sustainable tourism development in Quang Nam, a solution for the conservation and promotion of provincial natural, cultural and historical values. The province is ready to act, cooperating with other localities, businesses, communities, non-governmental and international organizations to jointly build and develop green tourism products, protect the environment and adapt to climate change.

GREEN TOURISM CRITERIA

The Quang Nam People's Committee issued Plan on green tourism development to 2025; at the same time promulgating the "Green Tourism Criteria". Quang Nam province will be the first local area in Viet Nam to promote green tourism criteria. Tourism businesses must employ waste recycling, waste reduction, energy-saving and plastic-free consumption.

The Quang Nam provincial Tourism Association has promoted green tourism in free plastic-zero waste-recycling and non-chemical communities. The chairman of the Quang Nam Tourism Association, Phan Xuan Thanh, said eco-tours aimed to promote awareness of fitness and hygiene in environmentally-friendly living spaces. It's a new choice among tourists during the coronavirus pandemic, so the association is boosting 'green' behaviour including cleaning, waste recycling, organic consumption and healthcare tourism products. Local tourism businesses offer healthy and safe service by boosting recycling waste, reducing plastic use and developing organic farm produce. This is the new trend in tourism in the province.

A group of local travel agencies and people have successfully established the Tan Thanh weekend open market as an artisanal and organic production rendezvous for local and expat vendors. Tan Thanh has been recognised as a one-commune, one product eco-tour brand - one of the first 'green' tourism brands employing

the 'circular economy' as a sustainable tourism strategy in Quang Nam. The community began waste classification at source and recycling by starting the first Material Recovery Facility in Hoi An for receiving recyclable and reusable waste for better treatment rather than dumping it at overloaded landfills.

PROMOTING GREEN AND SUSTAINABLE TOURISM DEVELOPMENT

In recent years, Quang Nam has invested in green tourism development and considers this an important task in the tourism development strategy. After successfully ending the National Tourism Year 2022 with the theme "Quang Nam - A green tourism destination", Quang Nam continues to mobilise investment resources for the development of ecotourism and green tourism, aiming to build a national green tourism centre.

Director of the Department of Culture, Sports and Tourism of Quang Nam Province Nguyen Thanh Hong said that after the COVID-19 pandemic, tourists' travel habits and needs have changed a lot. The selection of destinations and tourism products is the top focus of international tourists. That requires local authorities, tourism and service businesses to constantly invest and innovate products in the direction of improving quality, strengthening promotion and attraction, and ensuring the security and safety of tourists.

To develop tourism with high results, Quang Nam has proposed specific solutions



▲ Quang Nam is making every effort to become a classy green tourist attraction



▲ *Promoting green and sustainable tourism development*

and roadmaps. Quang Nam issued a resolution on supporting the development of mountainous tourism until 2025. Accordingly, the province will support a total budget of more than 121 billion VND for planning and planning; infrastructure investment in tourist zones and spots; product formulation and development; training, fostering, and developing human resources; and supporting tourism promotion and advertising. Up to now, mountainous districts have built eco-tourism sites associated with preserving traditional cultural values in the locality. Of these, the Dong Giang Heaven Gate Eco-tourism (Dong Giang district) is invested and built with the total investment of 2,600 billion VND.

In addition to this tourist area, there are currently many eco-tourism sites in mountainous areas that have been put into operation such as: the community tourism village of Bho Hoong, Dho Roong (Dong Giang district); the brocade weaving village of Zara (Nam Giang district); the heritage forest of Pomu; the community tourism village of Ta Lang (Tay Giang district); and the ancient village of Loc Yen (Tien Phuoc district).

Quang Nam has issued a plan to attract and welcome international tourists in the new period. Accordingly, the locality reviews, evaluates and develops appropriate tourism products; forming diversified and attractive products and organising activities to attract international tourists such as: sea festivals, food festivals, festivals, street activities. The province focuses on building new tourism product model on the basis of national cultural values and the unique and characteristic natural resources of each region and each locality.

In the immediate future, the province will attract social resources to embellish, perfect and upgrade facilities, tourism infrastructure, and stabilize human resources; promote the formation of alliances linking tourism development

between regions, localities, destinations inside and outside the province.

On the other hand, the province promotes the application of information technology, organises digital marketing campaigns on social networking platforms; develop websites to introduce destinations, local products and services, businesses with foreign language versions to market to target markets.

At the same time, the province strengthens the management of the tourism environment, ensures security and safety for tourists, creates a friendly, safe, and responsible tourism environment, towards the goal of building and promoting green and sustainable tourism development.

Quang Nam is making every effort to become a classy green tourist attraction. This is the provincial aspiration expressed in the Quang Nam Provincial Plan for the period 2021 - 2030, with a vision to 2050. One of the goals is to develop tourism into a key economic sector in Quang Nam by 2030. Quang Nam tourism resources are helpful for sustainable tourism development in Quang Nam. There will be more priority for tourism investment and development. These spaces will contribute to the load reduction in the heritage areas via eco-tourism products, community-based tourism, agricultural tourism, traditional handicrafts associated with tourism, leisure travel, and MICE. Quang Nam also has a lot of policies to support businesses and individuals who invest in the province ■

NGUYỄN XUÂN THẮNG

Center of Global Green Network

KEITI creates a clean and green world by disseminating eco-friendly technologies and establishing global cooperation networks so that every country can enjoy the benefits that the environment offers.

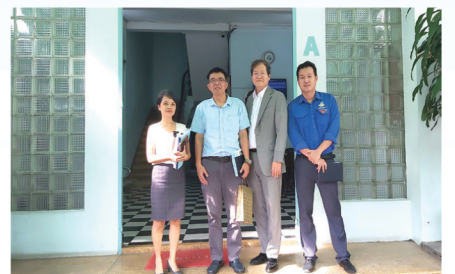
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