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OPPORTUNITIES TO REALIZE VIETNAM'S COMMITMENT TO NET ZERO EMISSIONS



**New contents about compensation for
environmental damages under
the Law on Environmental Protection 2020**



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Phạm Đình Tuyền
Tel: (024) 61281438

OFFICE

• **Ha Noi:**
Floor 7, lot E2, Duong Dinh Nghe Str.,
Cau Giay Dist. Ha Noi
Managing: (024) 66569135
Editorial: (024) 61281446
Fax: (024) 39412053
Email: tapchimoitruongtcm@vea.gov.vn
<http://www.tapchimoitruong.vn>
• **Ho Chi Minh City:**
A 209, 2th floor - MONRE's office complex,
No. 200 - Ly Chinh Thang Street,
9 ward, 3 District, Ho Chi Minh City
Tel: (028) 66814471; Fax: (028) 62676875
Email: tcmtpgianam@gmail.com

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PM. Phạm Minh Chính took a photo with world Leaders attending in the Declaration on Forest and Land Use at the event "Action on Forests and Land Use"

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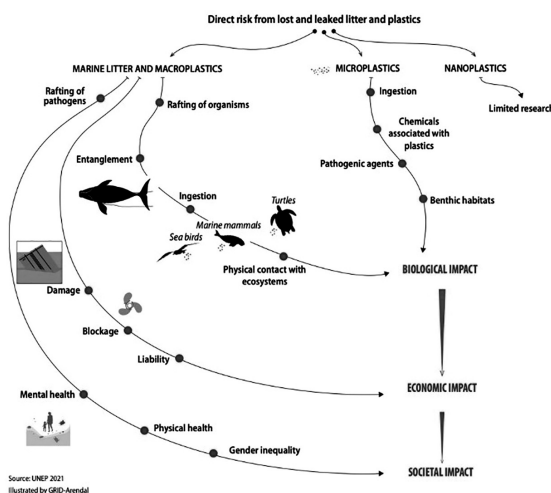
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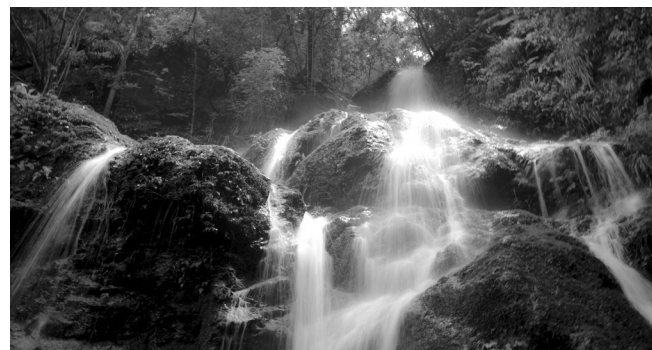
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Opportunities to realize Vietnam's commitment to net zero emissions

Dr. ĐỖ NAM THẮNG
Australian National University

In his speech at the COP26, Vietnam's Prime Minister Phạm Minh Chính announced that the country would aim at a net zero emission target by 2050. With this significant move, Việt Nam now joins the group of about 140 countries that have pledged to net zero emissions by the middle of the Century.

Strong determination is needed for Việt Nam to realize the net zero emissions commitment, as that would involve radical changes in the economy structure. Harmonizing domestic economic development and global environmental commitments is often not easy. This particularly applies for developing countries where demand for increasing emissions in a traditional development pattern is high and resources to switch to a new greener pathway typically are limited.

Việt Nam has opportunities to pursue the net zero emission target with domestic resources and international support. A concrete and actionable plan for net zero emissions would be vital to guide the process. Key elements of the plan include clear and ambitious targets, detailed responsibilities of stakeholders and close monitoring mechanisms.

The intention of replacing coal by imported liquefied natural gas for power generation would need careful reconsideration. Natural gas is not a zero-carbon energy. In addition, it will take years to establish the infrastructure needed for the new gas power plants. This poses high risks of stranded assets. By the time, the gas power projects finish, their electricity costs would have been too high compared to zero-carbon energy sources of solar and wind power. Solar and wind power are already cost competitive to gas power and technology costs of solar and wind are projected to continue declining quickly.

Increasing targets for solar and wind energy in the coming Power Development Plan 8 would boost their uptake. The country has the potential to achieve over 90 percent penetration of domestic solar and wind



▲ Prime Minister Phạm Minh Chính attended and spoke at the Climate Summit, held within the framework of the United Nations Climate Change Conference of the Parties (COP26)

power, coupled with off-river pumped hydro energy storage, in its electricity mix at a competitive cost. Impetus for ramping up renewable energy uptake could be built upon Vietnam's early success in solar and onshore wind power development that has positioned the country the top in Southeast Asia.





▲ Overview of a session of the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow, United Kingdom on 11/11/2021

Offshore wind power' (OWP) has sizable potential to contribute to GHG emission reduction significantly. Việt Nam has 475 GW of OWP technical potential within 200 km of the coast, equal to about 8 times Vietnam's total installed power capacity as of 2020. By replacing coal power with 25GW of OWP by 2035, as suggested by the World Bank, Việt Nam could avoid over 200 million tons of CO₂ emissions, nearly one third of the country's energy sector emissions under the business-as-usual scenario. OWP could be deployed at scale to meet domestic demand as well as export to other countries. This new maritime economy sector could be developed based on the country's existing offshore oil and gas industry.

Other strategies include enhancing energy efficiency, upgrading transmission, investing in energy storage systems and developing a competitive wholesale electricity market. Decarbonization in other sectors such as transport and industry would be vital. Potential policies include incentivizing electric vehicles, reforming subsidies for fossil fuels and speeding up the implementation of carbon pricing. These would need to be reflected in the coming National Energy Development Strategy, apart from the Power Development Plan 8.

Boosting efforts to reduce carbon emissions from deforestation and forest degradation would facilitate the net zero emissions while mobilizing international financing.

International cooperation is crucial for Việt Nam to unlock opportunities to pursue the net zero emissions targets. The COP 26 outcomes are expected to increase the developed countries' assistance to developing countries. The international assistance would facilitate renewable energy uptake, forest development and protection, new technology penetration and transition to green and sustainable growth.

Opportunities exist for Việt Nam to embark on the post pandemic green recovery and to enhance its contribution to global emission reductions■

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16th ASEAN Ministerial Meeting on the Environment and related meetings



▲ Deputy Minister of Natural Resources and Environment Võ Tuấn Nhân has the opening remarks at the AMME 16

The 16th ASEAN Ministerial Meeting on the Environment (AMME 16) is held every two years, this is an important event for ASEAN Member States (AMS) to review ASEAN cooperation activities in the field of environment, thereby jointly offering solutions and important orientations to make ASOEN's activities more practical and effective; contribute to the achievement of environmental sustainability goals within the framework of the ASEAN Socio-Cultural Community Master Plan and ASEAN Community vision 2025, at the same time achieve the United Nations' 2030 Sustainable Development Goals.

The AMME 16 were held on 21st October 2021 via online conference hosted by Indonesia. The Meeting was chaired by H.E. Siti Nurbaya Bakar, Minister of Environment and Forestry of Indonesia; Co-Chair of the Meeting is Dr. Saynakhone Inthavong, Deputy Minister of Natural Resources and Environment of Lao PDR. The Vietnamese Delegation attending the Meeting led by Deputy Minister of Natural Resources and Environment Võ Tuấn Nhân. Also in attendance were General Director of Vietnam Environment Administration (VEA), Chairman of ASOEN Việt Nam Nguyễn Văn Tài; together with representatives from: MONRE, Foreign Affairs, Labor, War Invalids and Social Affairs.

The Meeting noted the report of the Chairman of ASOEN (Myanmar) on the performance of 7 ASEAN cooperation areas on the environment in terms of nature conservation and biodiversity, coastal and marine environment, water resource management, climate change, chemicals and waste, environmentally sustainable cities, environmental education; report of the ASEAN Center for Biodiversity (ACB) on governance, institutional review, priorities and challenges as well as the post-2020 Global Biodiversity Framework.

Prior to the Meeting, the ASEAN Environment Ministers adopted the ASEAN Joint Statement on Chemicals and Waste at the Conference of the Parties to the Basel, Rotterdam and Stockholm Convention (BRS) in 2021; ASEAN Joint Statement on Biodiversity at the 15th Conference of the Parties to the Convention on Biological Diversity (CBD COP 15) and ASEAN Regional Action Plan on combating marine debris; ASEAN Status Climate Change Report (ASCCR).

The Meeting endorsed the nomination for the 5th ASEAN Environmentally Sustainable Cities Awards and 4th ASEAN Certificates of Recognition (the award presentation ceremony was then held in the afternoon of 21st October 2021 in Jakarta, Indonesia); agreed to have the ASEAN Joint Statement on Climate Change at the 26th Conference (COP26) of the Parties to the United Nations Framework Convention on Climate Change, then adopted by Ministers by ad-referendum; Draft ASEAN - China Joint Statement on Strengthening Cooperation for Green and Sustainable Development; The tentative agendas for the 17th ASEAN Plus Three Ministerial Meeting on Environment on October 22nd, 2021.



▲ H.E Siti Nurbaya Bakar - Minister of Environment and Forestry of Indonesia, Chairperson of the AMME 16

In addition, the Meeting also welcomed and supported Brunei Darussalam's initiatives in the ASEAN Chairmanship 2021 on the establishment of the ASEAN Center on Climate Change in Brunei and the ASEAN Youth Climate Action Seminar, (ASEANYouCAN). The initiatives are launched with the desire to promote research, development, co-ordination and co-operation on climate change between AMS and partners. The Meeting appreciated the recognition of youth as essential partners in the climate change adaptation and welcomed the Bandar Seri Begawan Statement on ASEAN Youth Action for Climate as a call by ASEANYouCAN youth delegates to strengthen climate action in the region.

At the opening remarks, Deputy Minister Võ Tuấn Nhân emphasized: "The Vietnamese Government always emphasizes the importance of environmental protection, especially issues related to nature conservation and biodiversity, water resources management, coastal and marine environment, climate change, chemicals and waste and marine debris".

To achieve the set goals, Deputy Minister affirmed: "*Firstly*, we need to make more efforts, uphold the spirit of solidarity, responsibility, mutual respect for the common interests of the whole region, continue to work together to solve urgent issues on water and air pollution, marine debris,

nature conservation and biodiversity; improve capacity to proactively adapt to climate change and at the same time, promote sustainable management and use of transboundary water resources, contributing to ensuring food security, water security and providing a safer living environment for generations of ASEAN people for now and in the future; *Secondly*, in the context that the impacts of climate change are increasing in scale and intensity, directly affecting sustainable development, environment, water resources, biodiversity, food security and life of people in each country; we need to have specific and strong commitments on efforts to reduce emissions, with appropriate measures and plans to achieve the target of zero emissions as soon as possible; *Thirdly*, in the context that countries in the region and the world are facing challenges caused by the COVID-19 pandemic, green economic recovery and circular economy need to be strongly deployed in each country, regionally and globally, on the basis of maintaining a relationship of cooperation and mutual trust and linking the participation, cooperation and support of partner countries, the international community, as well as the cooperation of all actors of society, especially citizens and the private sector".

As an active and responsible member of the ASEAN Community, Việt Nam will continue to work closely with AMS and partner countries to effectively implement the ASEAN Community vision 2025 Blueprint. Thereby, Việt Nam also expressed its desire to continue to receive close cooperation and support from the Community to realize the commitments of the Meeting■

CHÂU LOAN



32nd Meeting of the ASEAN Senior Officials on Environment: Việt Nam commits to continue co-operation with ASEAN Member States to jointly solve environmental issues

NGUYỄN MINH CƯỜNG

*Department of Science, Technology and International Cooperation
Việt Nam Environment Administration*

3^{2nd} Meeting of the ASEAN Senior Officials on Environment (ASOEN 32) and related meetings was held virtually from September 15th - 17th, 2021. ASOEN 32 Meeting is an occasion for ASEAN Member States (AMS) to jointly review ASOEN's action plan, as well as discuss to make recommendations, through which ASOEN's activities become more and more effective, contributing to achieving Draft ASEAN Strategic Plan for Environment (ASPEN) and environmental sustainability within the ASEAN Socio-Cultural Community Blueprint 2025, ASEAN Community Vision 2025.

There were other related Meetings were held back to back with ASOEN 32 Meeting, including: 15th ASEAN - Japan Dialogue on Environment (AJDEC); 1st ASEAN - ROK Dialogue on Environment and Climate Change; 3rd ASEAN - EU High - Level Dialogue on Environment and Climate Change (ASEAN - EU HLD); ASEAN-US Preparatory Dialogue for Engagement on Environment and Climate Change; 18th ASEAN 3+ Senior Officials Meeting on the Environment (APT SOME).

Progress of 7 ASOEN Working Groups in 8 areas of environmental co-operation

At ASOEN 32, the AMS and the ASEAN Secretariat (ASEC) jointly reviewed the results of the 7 ASOEN Working Groups on coastal and marine environment, climate change, chemicals and waste, nature and biodiversity conservation, environmental education, environmentally sustainable cities, water resource management. The meetings noted the progress of development and conclusion of the ASEAN Joint Statements: on Climate Change to 26th Session of the Conference of the Parties to the United Nations Framework on Climate Change (UNFCCC COP26); Joint Statements to the 15th Meeting of the Conference of Parties to the Convention on Biological Diversity (CBD COP15); Joint Statement on Chemicals and Waste to the 2021 Meetings of the Basel, Rotterdam and Stockholm Conventions; Draft ASEAN - China Joint Statement on Strengthening Co-operation for Green and Sustainable Development; Draft ASEAN Status of the Climate Change Report.

The Meetings endorsed the nominations of the selected cities in the AMS for the 5th ASEAN Environ-

mentally Sustainable Cities (ESC) Awards and 4th ASEAN Certificates of Recognition for Clean Air, Clean Water and Clean Land. In this year, 10 cities received the ESC Award and 13 cities received the ASEAN Certificates of Recognition. Việt Nam has Cần Thơ City received the ESC Award and Ninh Bình City received the ASEAN Certificates of Recognition for Clean Land. The Award presentation ceremony was held back to back with the 16th ASEAN Ministerial Meeting on Environment in Indonesia (October 2021). At the same time, the Meeting noted the process of nominating new ASEAN Heritage Parks, including: Nam Poui National Reserve (Laos PDR); Endau Rompin Johor National Park (National Park) (Malaysia); Pasosanca National Park (Philippines); Côn Đảo National Park (Việt Nam).

In addition, a number of project proposals were also considered by the Conference to be implemented in the near future, namely the ASEAN - Germany Project on Strengthening Domestic Waste Management in ASEAN Cities; Clean Air Project for Sustainable ASEAN: ASEAN - KOR Air Pollution Program; ASEAN - Germany Climate Action Plan and East Asia Program on Marine.

Other activities within the framework of ASOEN were also recognized by the Meeting such as progress of the ASEAN Status of the Environment Report (SOER 6). Accordingly, AMS have sent representatives to participate in the Technical Working Group to develop SOER 6. As planned, the SOER 6 will be completed and published in 2022; implementing the proposal to establish the ASEAN Green Economy Institute proposed by Myanmar; ASEAN Cooperation on Environmentally Friendly Technology; Building ASEAN Cooperation Framework on Sustainable Production and Consumption (SCP)...



▲ Dr. Nguyễn Văn Tài - ASOEN Chairman of Việt Nam, Director General of Vietnam Environment Administration, (fifth on the right) speaks at the ASOEN 32

Việt Nam is committed to actively promoting cooperation on the environment

The Vietnamese Delegation participating in ASOEN 32 and related meetings has actively involved in mutual discussions and deliberations on the important issues of the Meetings, well performing our role as the coordinating country for ASEAN-KOK cooperation from 2021; contributed many proposals for activities of cooperation fields such as nature conservation and biodiversity, coastal and marine environment, environmentally sustainable cities, chemicals and waste, environmental education...

At the Meeting, Việt Nam also announced the hosting of the Sustainable Ocean Economy and Climate Change Adaptation Meeting, scheduled for December 2021 and called on AMS to participate and actively support. In 2022, Việt Nam is hosting 22nd Meeting of ASEAN Working Group on Water Resources Management.

ASOEN 32 also discussed an important aspect of ASEAN co-operation on the environment in 2021, with the organization of 16th ASEAN Ministerial Meeting on the Environment (AMME) and other related Meetings. In addition, the 16th Meeting of ASEAN Committee under the ASEAN Agreement on Transboundary Haze (AATHP) and the 16th AATHP Meeting of the Parties (COP 16 AATHP) were also held back to back with 16th AMME Meeting. These meetings will be attended by the Ministry of Agriculture and Rural Development of Việt Nam.

2021 is a year of many challenges for the world in general and the ASEAN region in particular due to the COVID-19 pandemic. In the context of common difficulties, Việt Nam is committed to continue working closely with AMS to minimize the impacts of the pandemic, while still making determined efforts to join hands to solve the regional priority environmental issues of climate change, nature conservation

and biodiversity, marine debris, chemicals and waste and interdisciplinary and cross-sectoral issues.

ASEAN attaches importance and actively promotes cooperation with dialogue partners through the formulation of the ASEAN - China Joint Statement on Strengthening Cooperation for Green and Sustainable Development; ASEAN-Japan Climate Action Program 2.0; Organization of the ASEAN-EU High Level Dialogue on Environment and Climate Change (2021); ASEAN-ROK Dialogue on Environment and Climate Change (in the period of 2021-2024, Việt Nam is the co-ordinator of ASEAN-ROK cooperation); Support the idea of organizing the ASEAN-UK High Level Event on the sidelines of COP26 United Nations Framework Convention on Climate Change; Organize a preparatory Meeting for the ASEAN-US High Level Dialogue on Environment and Climate Change.

To respond to the requirements and responsibilities of our nation for ASEAN cooperation on the environment, Việt Nam will prioritize and allocate more human and financial resources in the upcoming time. At the same time, Việt Nam will continue to actively and proactively propose initiatives to further promote environmental cooperation activities among AMS and partner countries, especially on issues that receive great attention currently about climate change, marine debris, nature conservation and biodiversity, circular economy, sustainable production and consumption■

New contents about compensation for environmental damages under the Law on Environmental Protection 2020

Assoc. Prof. Dr. PHẠM VĂN LỢI

Director General Environmental Institute of Science

In the Constitution of the Socialist Republic of Việt Nam 2013, Article 63 stipulates that “Organizations and individuals that cause environmental pollution, natural resource exhaustion or biodiversity depletion shall be strictly punished and shall rectify and compensate for damages”. On the basis of the Constitution 2013, many other legal documents also stipulate the responsibility for remedy and compensation for damages caused by the acts which pollute the environment.

According to current legal provisions in Việt Nam, compensation for damages caused by violations against the Law on Environmental Protection (LEP) is in the field of compensation for non-contractual damages. Therefore, the legal basis for settling claims for compensation for damages caused by violations against the LEP is firstly implemented in accordance with the Civil Code 2015’s provisions on compensation for non-contractual damages. Specifically, in the Civil Code 2015, Article 172 stipulates: “When exercising ownership rights and/or other property-related rights, the owner or the holder must comply with the provisions of LEP; if he/she causes environmental pollution, the owner shall have to terminate the acts which cause the pollution, to take measures to remedy the consequences and to compensate for damages”. Article 602 stipulates: “Any entity polluting the environment, thereby causing damages, must compensate in accordance with the Law, including when the entity polluting the environment was not at fault”. Thus, the responsibility for compensation for environmental damages to individuals and organizations that pollute and degrade the environment has been stipulated by the Civil Code. According to these provisions, the entity that has the acts which pollute the environment while cause damages to others, must compensate for damages, including when the entity polluting the environment was not at fault.

The LEP 2014 continues to affirm the legal basis of prosecution for compensation for damages caused by acts which pollute and degrade the environment in Clause 8, Article 4: “Any

organization, family household or individual, who causes environmental pollution, incidents and degradation, is responsible for remedy, compensation for damages and assumes other responsibilities in accordance with legal provisions” and provides in details the compensation for damages in the field of environmental protection. The LEP 2014 stipulates damages caused by environmental pollution and degradation (Article 163); Principles of handling responsibilities of organizations, individuals polluting the environment (Article 164); Determination of damages caused by environmental pollution, degradation (Article 165); Determination of damages caused by deterioration in environmental function and productivity (Article 166); Liability insurance for compensation for environmental damages (Article 167).

In addition to the above provisions, the responsibility for compensation for damages caused by violations against the LEP is also stipulated by a number of other relevant laws: Law on Land, Law on Minerals...

After 6 years of implementation, besides the advantages, the provisions on compensation for damages have revealed a number of obstacles and shortcomings that need to be amended, supplemented and improved. The provisions on compensation for environmental damages in the LEP 2020 in item 2 from Article 130-135 include the following new points compared to the LEP 2014:

1. Principle for determining responsibility for compensation for environmental damages

The principle on responsibility for compensation for environmental damages is a newly added content compared to the LEP 2014. Organizations and individuals that cause damages to the environment are responsible for compensation for all damages caused by themselves and must at the same time pay all costs of damage determination and carry out the procedures for claiming compensation for the environmental damages according to legal provisions.



Organizations and individuals have the right to prove that they do not cause damages to the environment and when the results are proven to be correct, they are not required to pay compensation for environmental damages and do not have to bear the costs related to damage determination and implementation of procedures for claiming damages.

For cases where there are 2 or more organizations or individuals causing environmental damages, the responsibility for compensation is determined based on the proportion corresponding to the proportion of damages caused to the total environmental damages; If the concerned parties or the state management agencies in charge of the environment cannot determine the proportion of responsibility, the arbitration agency or the Court shall decide according to its competence.

2. Provisions on the subject responsible for claiming compensation and organizing the collection and verification of data and evidence to determine environmental damages due to pollution or degradation

The LEP 2020 stipulates the responsibility of claiming compensation for environmental damages to state management agencies including: Commune People's Committees, District People's Committees, Provincial People's Committees and the Ministry of Natural Resources and Environment. The addition of provisions clearly defines the subject responsible for claiming compensation and organizing the collection and verification of data and evidence to determine environmental damages due to pollution and degradation to facilitate the implementation of the subsequent processes of the compensation for damages. On the other hand, assigning the responsibility of organizing the collection and verification of data and evidence to determine environmental damages due to pollution and degradation to a competent state agency is appropriate because in fact the collection of data and evidence to prove the deterioration of the function and productivity of the environment is very complicated, expensive and beyond the ability of the people.

Such provisions are not only reasonable but also protect the legitimate rights of the parties involved and save litigation costs (such as the cost of verification which is very complicated and expensive). In recent environmental cases, polluting enterprises did not seem to have to do anything and even challenged people to sue to prove it (as per the general provisions of the Civil Code), leading to the Court having to solicit the verification of a third party and the suing party to advance costs, which is very complicated, lengthy and expensive.

3. Determination of damages caused by environmental pollution and degradation

The LEP 2020 additionally stipulates the determination of environmental damages and degradation based on information on: scope and area of environmental pollution or degradation; number of environmental components reduced, types of ecosystems, species damaged; damage levels of each environmental component, ecosystem and species.

The determination of damages due to deterioration of the function and productivity of the environment is carried out independently or in coordination between the damage-causing party and the damaged party. At the request of each party or parties, the specialized environmental protection agency shall participate in guiding the calculation and determination of damages or witness the determination of damages.

4. Provisions on settlement of compensation for environmental damages

According to the LEP 2020, compensation for environmental damages is settled through negotiation between the parties. In case of failure to negotiate, the parties can choose to settle through the following three forms: Conciliation; Settlement of disputes by arbitration; Settlement of disputes by Court.

New provisions on forms of settlement of compensation for environmental damages create advantages in actual settlement of disputes and claims for compensation for environmental damages between organizations and individuals.

5. Costs of compensation for environmental damages

As for the content of costs of compensation for environmental damages, the LEP 2020 stipulates more specifically and adds costs for determining damages and carrying out procedures for compensation for environmental damages compared to the provisions on this content in the LEP 2014. Along with other types of costs, including: Cost of immediate and long-term damages due to the deterioration of the function and productivity of the environment, cost for treatment, environmental improvement, cost for minimizing, eliminating sources of damages or organizing response to environmental incidents, this cost has become one of the four groups of costs used as a basis for compensation and settlement of compensation for environmental damages■



The Law on Environmental Protection 2020 facilitates promotion of international cooperation in environment, meeting the trend of international integration

HOÀNG XUÂN HUY - *Deputy Director General
Department of International Cooperation, MONRE*

Over the past years, Việt Nam international integration has made achievements in all aspects of politics, economy, society, culture, education, diplomacy and security - defense... In addition to the process of extensive international economic integration, international integration in natural resources and environment is also interested and promoted. International integration in general and international integration in natural resources and environment have contributed to enhancing the role, position and prestige of Việt Nam in the international community and brought benefits in many aspects for the country.

Today, international integration and cooperation in natural resources and environment continues to evolve according to the trend of extensive content, extent and broader scope and form. The trend of international integration and cooperation has been bringing many benefits, opportunities and potentials to countries, but also creates significant challenges for developing countries like Việt Nam. Some of the main trends in international integration and cooperation in natural resources and environment can be generalized as: Increased scope, scale, extent; increased obligations, extent of legal binding; diversified and rich in content and fields, continuing to form many international frameworks or “playgrounds” with many new “rules of the game” at various geographical, regional and global scales; requirements, demands of increased responsibility when participating, accompanied by increased investment and financial contribution; more connection with the economy, influencing and contributing a lot in the process of international economic integration and the economic development of the country; increasingly strict mechanism to evaluate and monitor the implementation of obligations, along with sanctions for non-compliance and implementation of committed obligations.

To meet the trend of international integration and current trends of international integration in natural resources and environment, Chapter XII of the Law on Environmental Protection (LEP) in 2020 has been developed, including provisions to create a legal framework for activities related to international integration and cooperation, specifically as follows:

1. Establishing principles for activities related to international integration and cooperation in natural resources and environment

Following the trend of integration and development, international integration and cooperation in natural resources and environment has taken place in an extensive direction, with a variety of extent, contents and forms, becoming more and more diverse, complex, sometimes sensitive and affecting the economy, politics and national security. Therefore, the LEP 2020 sets out several specific principles to regulate related activities, to clearly define the responsibilities of management agencies, organizations and individuals in participating in activities such as negotiating, signing, joining and implementing international treaties and agreements, international cooperation activities related to this field. These activities are carried out on the basis of giving priority to international treaties and agreements beneficial to national, regional and global environmental protection, in accordance with national interests and capacities.

With the trend of increasing extent of legal binding in international integration in environment, the fact has led to certain dangers and risks related to international disputes in this field. International disputes may arise in the compliance and implementation of environmental commitments and obligations in the new generation of Free Trade Agreements (FTAs) (which are legally binding and impose sanctions on them in case of failure to properly perform or not strictly perform the commitments). Therefore, the LEP 2020 adds provisions on dispute settlement, sets out the principles of dispute settlement using international practices, but still must ensure and be consistent with domestic laws, to avoid risks, disadvantages for Việt Nam when participating in environmental dispute settlement.



2. Clearly stipulating the responsibilities of the State, organizations and individuals in international integration and cooperation in environmental protection

For the State, the main role and responsibility is to orient and encourage international integration and cooperation activities in accordance with the guidelines, policies and strategies of the Party and State as for the fields of management and protection of environmental components, biodiversity conservation, green growth, sustainable development and response to climate change; be responsible for ensuring resources and fulfilling all obligations committed in international treaties and agreements related to the environment; establish mechanisms, create an environment and favorable conditions for international investment, cooperation and support activities for national environmental protection activities and also respond to, solve environmental incidents and other environmental problems at regional, global and transboundary scales.

For organizations and individuals, the LEP 2020 clearly stipulates the responsibilities of organizations and individuals for environmental protection in the integration process, aiming to improve the prestige of enterprises to expand international trade, suitable with the policy of international integration to contribute and support to international economic integration, also contribute to improving the prestige of Việt Nam in the world in efforts to protect the environment.

With established principles and clearly stipulated responsibilities of related objects, the LEP 2020 on the one hand has created a legal framework for activities related to international integration and cooperation in natural resources and environment, on the other hand, has created favorable conditions to promote these activities in the new period, meeting the current trends as well as the needs and requirements of extensive international integration in all fields today. Basically, with framework provisions that are oriented and principled, the LEP 2020 does not limit the scope and fields of participation in international integration and cooperation activities as long as those activities comply with the legal provisions. Accordingly, international integration and cooperation activities in a number of important and potential contents and activities related to the environment will have conditions and opportunities to be promoted, typically: Implementation of international treaties and agreements related to the environment. Việt Nam has participated in negotiations, signed and became a party to many international treaties and agreements related to the environment (also known as Multilateral Environmental Agreements - MEAs).



▲ *International integration in environmental protection contributes to enhancing the role, position and prestige of Việt Nam with the international community*



Up to now, Việt Nam has been an official member of about 28 international treaties and a number of international frameworks related to the environment, typically: The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (RAMSAR); The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); The Protocol on Substances that Deplete the Ozone Layer (MONTREAL); The United Nations Convention to Combat Desertification (UNCCD); The United Nations Framework Convention on Climate Change (UNFCCC); The Convention on Biological Diversity (CBD); The Convention for the Protection of the Ozone Layer (VIENNA); The Protocol on Biosafety (CARTAGENA); The Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (BASEL); The Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (ROTTERDAM); The Convention on Persistent Organic Pollutants (STOCKHOLM); The Convention on Mercury (MINAMATA); The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (NAGOYA); The International Convention for the Prevention of Pollution from Ships (MARPOL)... and implementation of obligations in the Nationally Determined Contributions (NDC) Report on responding to climate change.

Solve transboundary environmental problems such as water and air pollution, ocean plastic waste pollution, regional environmental incident response (on land and at sea).

Implement waste treatment, environmental pollution minimization through economic instruments and models and policy solutions such as green economy, circular economy, provisions on extended producer responsibility, best available techniques (BAT).

Develop a system of environmental regulations, environmental monitoring and information systems, environmental databases and audits.

Carry out environmental impact assessment, strategic environmental assessment, environmental planning and zoning.

Develop economic instruments such as environmental industry, circular economy, environmentally friendly products and services, green procurement, use and development of natural capital.

Promote human resource development, capacity building for environmental protection activities, communication and awareness raising...

As for the international cooperation methods, the LEP 2020 does not specify methods and forms to maximize the diversification and flexibility in cooperation methods and forms between the parties. International cooperation in environment can be through bilateral and multilateral cooperation methods with knowledge and experience exchange in policy formulation, scientific research and technology transfer and capacity building training, communication and awareness raising, development and implementation of projects, investment in joint ventures...

3. Orientation for some solutions

To promote the effectiveness of international integration and cooperation in environment in the coming time, the following directions and solutions should be implemented:

First, provide training to improve the quality of human resources participating in international integration activities in environment in the period of 2020 - 2025.

Second, improve the system of policies and laws on environmental protection in line with the trend and process of international integration in environment.

Third, strengthen the coordination mechanism in international integration activities in environment.

Fourth, increase financial resources for activities aimed at improving capacity to fulfill international commitments and obligations on the environment; mobilize the participation of enterprises in environmental protection in the integration process.

Fifth, promote and expand new bilateral and multilateral international cooperation relations to take advantage of and receive advanced knowledge, experience, technology and management models to deal with transboundary environmental problems.

Sixth, promote Việt Nam's initiative, pioneering, leading and mastering role in international integration and cooperation activities at the regional and global scale■



Provisions on environmental audit in the Law on Environmental Protection 2020

MSc. HÀN TRẦN VIỆT
Institute of Environmental Science

For the first time, the content of environmental audits has been specified in Article 74 of the Law on Environmental Protection (LEP) in 2020. The goal is to encourage the application of environmental audit tools at production, business and services establishments to meet the requirements of environmental protection and improve the efficiency of environmental protection at the establishment.

Regulations on environmental audits in the LEP 2020

The content of environmental audit has been recorded in Article 6, LEP 2014. However, because it has only been recorded without specific regulations and guidelines, so far the implementation of this content has not been implemented in practice.

The LEP 2020 has more specific provisions on the content of environmental audit than in the LEP 2014. Specific provisions include:

In terms of definition: Environmental audit is the systematic and comprehensive review and assessment of the effectiveness of environment management and pollution control of production, business and service establishments.

In terms of content: The main content of environmental audit for production, business and service establishments includes the use of energy, chemicals, raw materials and scrap imported from abroad as production materials and pollution control and waste management.

In addition to the above provisions, the content of environmental audit in the LEP 2020 also contains provisions suitable to the characteristics and development level of production, business and service establishments. The LEP 2020 stipulates to encourage production, business and service establishments to carry out environmental audits. The above regulation is appropriate as well as does not affect the development and create additional burden for production, business and service establishments. With self-awareness of the benefits that environmental audit brings,

production and service establishments will actively choose and apply environmental audit as an effective solution for environmental management.

With the desire that environmental audit regulations are implemented in practice, providing more knowledge and guidance for production and service establishments to conduct environmental audits themselves, the LEP stipulates that the Minister of Natural Resources and Environment provide technical guidance on environmental self-audit activities of production, business and service establishments. When issued, this is considered the first official document for production, business and service establishments to research and apply in the process of conducting environmental audits at their facilities.

Some regulations on environmental audit in some countries around the world

In the world, some countries have regulated the content of environmental audit in the LEP such as in Australia, Uganda, Malaysia, Myanmar or there is a Law on Environmental Audit such as in Turkmenistan.

Australia

Environment Protect Act 2019 stipulates the content of environmental audit in Articles 142 to 156. The provisions include the purpose of environmental audit, regulations on environmental audit reports, regulations on auditors.

According to this Act, an environmental audit is a documented assessment of an action and its environmental impact (including: an assessment of management practices, systems and factory) for any one of the following purposes: (1) to provide information to managers on compliance with legal requirements and policies related to environmental protection; (2) assessment of the nature, type, intensity and extent of environmental impacts; (3) evaluate whether measures to minimize or remediate environmental impacts or to restore the environment have been taken or have been effective.

According to the provisions of this Law, the implementation of environmental audit is carried out in enterprises and the head of the enterprise, the Chief Executive Officer (CEO) is the person who directly directs the implementation of the environmental audit at the enterprise. The CEO can designate organizations and individuals who are qualified to carry out environmental audits.

Turkmenistan

Law No. 122-VI on Environmental Audit (Law of Turkmenistan of March 2nd, 2019 No.122-VI) defines the legal basis for conducting environmental audit in order to achieve the environmental and ecological objectives of the country which applies to the subjects of economic activities and the objects prescribed by Law. According to this Law, environmental audit is the assessment of documents on compliance with the requirements of the laws of Turkmenistan, standards and regulatory documents in the field of ecological environmental protection according to international standards; conclusions and recommendations on improving environmental management.

The Law stipulates that the environmental audit at production, business and service establishments is mandatory or voluntary, depending on the regulations of the management agency. Management agencies encourage organizations/individuals to implement this tool. Environmental audits are performed by organizations and individuals with experience and knowledge in the relevant fields. The Law also stipulates a number of contents on technical methods for carrying out environmental audits and data for carrying out environmental audits.

Uganda

In Uganda, the National Environment Act 2019 defines environmental audit as the process of assessing a project, the management system of an organization, factory and equipments on environmental protection efficiency, in accordance with the provisions of this Act and other regulations.

Within the scope of the environmental audit regulation, carrying out an environmental compliance audit is required for some projects. The implementation of environmental compliance audit aims to protect the environment and prevent health impacts.

In addition, the Act also stipulates that the National Environment Fund provides financial support for the implementation of environmental audits.

Malaysia

The Environmental Quality Act of Malaysia, amended in 2006 in Article 33A, regulates environmental audit. Environmental audit is a systematic, independent assessment process with the goal of assessing compliance with regulations on environmental protection, assessment of environmental protection system and environmental risk assessment of organizations, production facilities and building.

The Minister of Environment shall prescribe a list of owners of vehicles, ships, production facilities and buildings that must carry out environmental audits and send environmental audit reports to the management agency. The environmental audit must be performed by fully functional organizations and individuals who licensed to operate by state agencies.

Myanmar

Environmental Conversation Law 2012 stipulates the content of environmental audit. Accordingly, environmental audit is a periodical, systematic and objective assessment to determine the level of compliance with legal regulations on environmental protection, environmental management system and environmental risks of a building or a project.

According to this definition, an environmental audit would include: (1) Auditing of the environmental management system; (2) Auditing compliance with legal regulations on environmental protection; (3) Auditing and assessing environmental risks.

Indonesia

Indonesia's Environmental Protection and Management Act No. 32/2009 stipulates that the Government encourages individuals and organizations to conduct environmental audits to improve the effectiveness of environmental protection.

The Minister of Environment shall stipulate the implementation of environmental audit for organizations, production and business establishments with high risk of causing environmental pollution; organizations and individuals that do not comply with regulations on environmental protection; activities with a high risk of causing environmental pollution will be carried out regularly. To carry out environmental audits, the Minister has the authorization to appoint an independent third party to perform environmental audits.

Benefits of performing environmental audit

The results of environmental audits in many countries show that the implementation of environmental audits has brought about combined environmental and economic benefits.

Performing environmental audits not only helps businesses comply with regulations, but also helps businesses better implement regulations on environmental protection. The implementation of environmental audit helps organizations, production facilities, business services accurately identify problems and risks related to environmental management at all stages of production and business. Thematic audits will identify specific issues, helping businesses operate better and better.

Organizations and enterprises often have to pay expenses for environmental protection activities such as costs of treatment and re-



A comparison table of some provisions on environmental audit in the LEP 2020 and legal documents of some countries around the world

No	Legal documents of countries	Subjects of application	Features	
			Mandatory	Voluntary
1	Vietnam's LEP 2020	Production, business and service establishments		X
2	Australia, Environment Protection Act 2019	Manufacturing enterprises	X	
3	Law of Turkmenistan 2019	Production, business and service establishments	X	X
4	Uganda, The National Environment Act 2019	Organizations, production, business and service establishments	X	
5	Malaysia, Environmental Quality Act	Production facilities, buildings	X	
6	Myanmar, Environmental Conversation Law 2019	Project, building	Not specified	
7	Indonesia, Environmental Protection and Management Act, 2009	Organizations, production, business and service establishments		X

mediation of pollution, costs of compensation for damage caused by environmental pollution, costs of environmental insurance. According to the assessment, these costs account for a large proportion of the total operating costs of the enterprise. In many cases, the environmental costs are higher than the profits achieved by the business. Therefore, performing an environmental audit will help businesses reduce these costs.

In business activities, many businesses realize benefits from environmental protection activities such as contributing to improving the image of the company, helping to increase competitiveness in the market. Besides other tools, environmental audit is a tool for the company to be proactive in implementing environmental protection.

Comparison of regulations on environmental audit in the LEP 2020 and legal documents of some countries

From the synthesis of regulations on environmental audit in the legal documents of some countries, it can be seen that the regulations are basically consistent with the theoretical and scientific contents of environmental audit.

Depending on the country, the object of environmental audit will be regulated in accordance with the objectives of environmental management. In some countries, the object of environmental audit is only industrial produc-

tion facilities. However, in some other countries, the implementation of environmental audit applies to projects, management systems of organizations, establishments or other entities according to regulations.

Environmental audit content focuses on auditing compliance with environmental protection policies, auditing of environmental management systems, thematic audits (energy, raw materials, materials and waste, biodiversity...). The main purpose when performing an environmental audit is to evaluate the effectiveness of the environmental management system, assess the compliance with the legal regulations on environmental protection, and create favorable conditions for control and prevention of environmental pollution in production, business and service establishments■

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Green growth towards carbon neutrality and post-COVID-19 economic recovery

Dr. LÊ VIỆT ANH - *Director General*
Msc. TRẦN MINH HUẾ

*Department of Science, Education, Natural Resources
and Environment, Ministry of Planning and Investment*

The COVID-19 pandemic is fundamentally changing the world in many fields, especially drastic changes in digital economic transformation, prompting countries to re-evaluate their economic development models, to improve public awareness of the growing threats of environmental and health problems. However, the COVID-19 pandemic also brings new and clearer insights into development opportunities, accelerating strategic transformation, towards a more sustainable future.

Green growth is an inevitable choice

In the world, the need to promote sustainable, long-term economic prosperity, in the face of growing concerns about maintaining and protecting natural capital and promoting robust, inclusive social development is being considered by countries. Accordingly, green growth (GG) has gradually become a mainstream trend, which is most evident in the change in energy structure, in which renewable energy is gradually accounting for a significant proportion compared to other energy sources, electric motors have gradually replaced gasoline engines in popular means of transport. Many countries have also committed to implementing the contents of the Paris Agreement on climate change: from the commitment “Limit global temperature rise” to “carbon neutrality target”.

The Sustainable Development Goals (SDGs) are gradually being nationalized according to specific goals appropriate to specific circumstances. Science and technology, innovation and increasing connectivity among countries in the world are making great progress. Investment trends for smart production activities thanks to the 4.0 revolution, e-Government, smart cities, smart industry and agriculture... are becoming popular.

The conventional economic growth model is being recognized as potentially weakening the resource base and social progress and thus promoting socio-economic development under the GG model is an inevitable choice to ensure economic prosperity, increase social welfare and improve people's quality of life in the long run.

GG in Việt Nam, the way has passed

Implemented since 2012, GG is considered as an effective tool to implement sustainable development towards a low-carbon economy, enriching natural capital, in which reducing greenhouse gas (GHG) emissions, greening production and lifestyle, promoting sustainable consumption are strategic goals that make an important contribution to repelling the negative impacts of climate change.

After 8 years of implementation, the Việt Nam's GG Strategy was on the right track, quite comprehensively implemented. The implementation of the Strategy has made many outstanding achievements, reflected in the content of institutional development and awareness raising. Some strategic goals have been achieved, green investment has gradually accounted for a significant proportion in the structure of both public and private development investment.

Besides the achievements, Việt Nam is increasingly facing many difficulties and challenges in the process of developing a GG economy.

From the existence of climate change

Việt Nam is not only one of the most vulnerable countries to climate change issues, but in recent time, the country has also faced an increase in extreme weather events, which have serious impacts on people and the economy. The year 2020 recorded many unusual and extreme natural disasters, occurring in many regions of the country, culminating in a historic heavy rain and flood, causing great damages in the Central region, especially in the provinces from Hà Tĩnh to Thừa Thiên - Huế and the worst drought in the Mekong Delta.

To external shocks

In the period of 2016 - 2020, the process of economic restructuring and transformation of Việt Nam's growth model took place very strongly with many positive changes. Việt Nam is considered as the most open economy in the world in terms of import and export value to gross domestic product (GDP). However, the greater the openness of the economy, the more vulnerable it is to adverse external influences. This can



be clearly felt through the COVID-19 pandemic when there is a break in both the “supply” side and the “demand” side of the world economy. Việt Nam’s economic prospects depend greatly on the world’s ability to fight the epidemic and the situation of disease control in the country as well as the ability to overcome the intrinsic weaknesses and risks of the economy at the moment.

To the implementation of new international commitments

The GG Strategy was approved in September 2012 in Decision No. 1393/QĐ-TTg dated 25th September 2012, demonstrating the determination of the Party and State in developing a green economy associated with sustainable development and contributing to realizing Việt Nam’s commitments at the United Nations Conference on Sustainable Development in June 2012 in Rio de Janeiro, Brazil (Rio +20).

In September 2015, the 2030 Agenda for Sustainable Development with 17 SDGs was officially adopted at the United Nations Conference in New York, replacing the Millennium Development Goals (MDGs) that have failed to take into account the holistic nature of development and are expected to change the nature from being targeted for poor countries to achieve with financial support from rich countries to the fact that all countries will join hands to achieve the SDGs.

Việt Nam has fulfilled its commitments through the approval of the National Action Plan in May 2017 for Việt Nam’s Sustainable Development to 2030, which includes 115 specific goals, corresponding to the global SDGs adopted at the 2015 United Nations Conference. The Action Plan demonstrates the Government’s efforts and commitments in implementing Việt Nam’s SDGs.

Also in 2015, the United Nations Climate Change Conference adopted the Paris Agreement—an “ambitious and balanced” plan to achieve the largest emissions reduction as soon as possible and lower emissions

by the second half of this Century, as well as keep the global temperature from rising less than 2 degrees Celsius with an effort to limit the increase to 1.5 degrees Celsius. This is considered a “historic turning point” in the goal of reducing global warming.

In the Việt Nam’s Nationally Determined Contributions (NDC) towards the implementation of the Paris Agreement to respond to climate change with a roadmap to reduce GHG emissions in the period 2021 - 2030, by 2030 Việt Nam will reduce its total GHG emissions by 9% compared to the BAU and can increase its contributions by up to 27% when receiving international support through bilateral, multilateral cooperation and implementing new mechanisms under the Paris Agreement on climate change.

The way forward

The Paris Agreement and the SDGs set common expectations for future global sustainability with effective changes in areas such as infrastructure, transport, energy systems, production and processing... In this context, developing countries like Việt Nam have changed from a “voluntary” to a “compulsory” form of implementing international commitments.

GG in the new period must therefore become the main driving force for sustainable development and an effective tool to help the Government balance domestic resources and effectively mobilize international resources, providing an inter-sectoral support solution in the implementa-

tion of GHG emission reduction targets at all levels which are closely linked with the goals set out in the 10-year Socio - economic Development Strategy (2021 - 2030) and the Socio - economic Development Plan (2021 - 2025).

Therefore, the development and implementation of the National GG Strategy for the period of 2021-2030, with a vision to 2050 plays a very important role.



▲ After 8 years of implementation, the Vietnam GG Strategy was in the right track, quite comprehensively implemented

GG Strategy from the point of view, formulation approach to action implementation

The National GG Strategy was developed on the basis of extensive consultation with stakeholders in the context of the complicated COVID-19 pandemic over the past time. The process of developing the Strategy has received active support, coordination and comments from line Ministries/sectors, local authorities, industry associations, embassies and international organizations, development partners. In the spirit of listening and fully receiving the opinions of stakeholders, the Ministry of Planning and Investment has completed the Strategy and submitted it to the Prime Minister for promulgation in Decision No. 1658/QĐ-TTg dated 1st October 2021.

The GG Strategy sets four important goals, including: Reducing GHG emissions, greening economic sectors, greening lifestyles and promoting sustainable consumption and greening the transition. In particular, the first goal of the GG Strategy is to reduce the intensity of GHG emissions per GDP, continuing to inherit the Strategy of the previous period in order to assess the ability to mitigate comparable GHG emissions per unit of economic output, helping determine the level of friendliness of the economy with the environment when the size of the economy is increasing, contributing to the realization of the dual goal of protecting the environment and closely associating with “fast and sustainable” development. Accordingly, the GG Strategy sets a milestone that by 2030, the intensity of GHG emissions per GDP will decrease by at least 15% compared to 2014. Further, in 2050, the intensity of GHG emissions per GDP will decrease by at least 30% compared to that of 2014.

Ministries/sectors, local authorities, embassies, international organizations, development cooperation agencies, businesses and academia highly appreciated the issuance of the GG Strategy for the new approach in the determination and feasibility of the goals, also expressed high agreement on the plan and roadmap for the implementation of the GG Strategy and believed that the GG Strategy would realize the goals set by Việt Nam for the timelines in 2030, 2045 and 2050. The relevant Ministries/sectors, local authorities, agencies and organizations agreed to immediately start working together to develop the National GG Action Plan,

the sectoral and local plans. Development partners and international organizations are committed to accompanying and supporting Việt Nam in the implementation of the GG Strategy in the near future.

The way to prosperity, post - COVID-19 economic recovery is GG

In the current international context with many fluctuations, especially the impact of the COVID-19 pandemic bringing with the nation's desire for prosperity, 2021 is the year that Việt Nam hits the threshold of a new development stage. In addition to numerical efforts to assess growth, it is time for productivity and efficiency issues to be focused more deeply on quality and value, because behind the numbers are many issues that need attention.

2021 is also the starting year of the 10-year Strategy for 2021-2030 with the view of fast and sustainable development based mainly on science - technology, innovation and digital transformation; harmonious development between economy and culture - society, environmental protection and adaptation to climate change...

Therefore, the implementation of the GG Strategy closely follows the viewpoints and orientations of the Resolution of the 13th National Party Congress, the 10-year Socio - economic Development Strategy for 2021 -2030 and the 5-year Socio-economic Development Plan for 2021-2025, especially coordination and implementation is of particular importance with the close support and coordination of Ministries/sectors, agencies, national and international organizations, and the business community, experts. In the coming time, in order to effectively implement the tasks and solutions assigned by the Prime Minister in the Strategy, there must be high consensus on actions to be implemented, especially the establishment of a National Steering Committee on GG, organization for the development of the National GG Action Plan.

At the Conference for launching the National GG Strategy for 2021-2030, with a vision to 2050 on 29th October 2021, Minister of Planning and Investment Nguyễn Chí Dũng emphasized: “The National GG Strategy for 2021 - 2030, vision to 2050” plays a very important role in promoting economic restructuring associated with growth model innovation, is an important way to realize sustainable development, and contributes to post - COVID-19 economic recovery, towards green economic development, as well as a premise to concretize long-term carbon-neutral, low-carbon emission targets and contribute to limiting global temperature rise. The Prime Minister's approval of the GG Strategy ahead of the 26th Conference of the Parties to the United Nations Framework Convention on climate change (COP26) in Glasgow, UK has demonstrated Việt Nam's strong commitment to reducing GHG emissions through practical and concrete actions”■



Cần Thơ strives to achieve environmental sustainability criteria



▲ Ms. Cao Thị Minh Thảo
Deputy Director of the DONRE of Cần Thơ

VEM: To achieve the AWGESC Award, what criteria must Cần Thơ meet? In your opinion, how does this Award have a positive impact on the City authority and people?

Ms. Cao Thị Minh Thảo: In 2017, Cần Thơ City achieved the Certificate for ASEAN potential environmentally sustainable cities on clean air, which is the foundation for the City to strive to achieve environmental sustainability criteria.

To meet the criteria of an environmentally sustainable city, Cần Thơ has closely followed the national sustainable development criteria, as well as gradually approached the environmental sustainability criteria of ASEAN. This is clearly shown through the promulgation and implementation of a number of fundamental policies and solutions to solve environmental problems. Specifically, the City has integrated environmentally sustainable development goals into its socio-economic development strategies, programs and plans, in which environmental protection policies have always been grasped and implemented thoroughly and extensively by City's authority leadership. Solutions always closely followed the vision, goals and guiding viewpoints in the City's socio-economic development master plans and strategies, promoting local strengths on the basis of respecting natural laws and prioritizing en-

Recently, at the 32nd Meeting of ASEAN Senior Officials on Environment (ASOEN) and related meetings taking place online from 15 - 17th September 2021, Cần Thơ was honored to receive the 5th ASEAN Environmentally Sustainable City Award (AWGESC). Cần Thơ is the first city in the Mekong Delta region, the 5th city of Việt Nam to receive this award since 2008.

On this occasion, *Environment Magazine* had an interview with the Deputy Director of the Department of Natural Resources and Environment (DONRE) of Cần Thơ Cao Thị Minh Thảo about the local efforts in environmental management in the past time and the sustainable development orientation of the City in the coming time.

vironmental protection, responding to climate change and using resources effectively, conserving biodiversity in order to develop the City into a regional, ecological, civilized, modern center, imbued with the river identity of the Mekong Delta.

In addition, the City's authority organizes the implementation of policies and solutions in a consistent, drastic and effective manner in all sectors and fields; is interested in investing in and perfecting technical infrastructure on environmental protection for sustainable development such as building centralized wastewater treatment systems in industrial parks (IPs), domestic solid waste treatment plants, domestic wastewater treatment plants; improves rural clean water supply systems; expands the coverage capacity of the wastewater collection systems. The City also strengthens the capacity of environmental monitoring and warning; implements projects to improve environmental quality; encourages and raises awareness of the community about environmental protection; implements environmental criteria in the National Target Program on New Rural Development, the movement "All people unite to build cultural and civilized urban lifestyle"...

Additionally, the City actively cooperates, integrates, participates in and implements international treaties, exchanges information and experiences, and has policy dialogues with other countries on climate change response and natural resource management, environmental protection.

Thanks to the above efforts, the City's environmental indicators have reached an increasingly high rate, meeting the environmental sustainability criteria of

ASEAN cities. Accordingly, the monitoring parameters show that the quality of environmental components of soil, water and air is controlled. Although, there are a few parameters that exceed the allowed standards at some times and the water quality in some locations tend to be polluted, but it has been controlled with timely remedial measures. The ability to meet hygienic drinking water for people in the City reaches 100%; operating IPs with centralized wastewater treatment systems meet the requirements of 83.3%, for IPs without centralized treatment systems, production and business establishments must invest in a satisfactory wastewater treatment system by themselves before discharging into the receiving sources. Continuous automatic surface water monitoring stations to control water quality at locations at risk of pollution help monitor water quality in a timely manner. The domestic wastewater treatment plant with a capacity of 30,000 m³/day has been operated, new urban areas all have local wastewater treatment systems before discharging into the sewer.

Currently, the domestic solid waste treatment plant with a treatment capacity of 400 tons/day, generating 7.5 MW of electricity, basically meets the City's domestic waste treatment needs. The rate of domestic solid waste collection in urban areas is over 98%, the collection rate in rural areas is about 71%; industrial solid waste and hazardous waste have been collected and treated by waste generating establishments. To collect waste floating on the river, the City has implemented a pilot project with an automatic garbage collection system on the river, now the system has been launched and is preparing to operate. In particular, the City attaches great importance to the propagation and education of environmental protection, especially education in schools. The issues of environmental protection, natural resources and biodiversity conservation are integrated into subjects and developed into topics in the local educational program of the City, helping raise people's awareness and responsibility in environmental protection.

With great efforts in the past time, Cần Thơ is gradually achieving its environmental sustainability targets and the 5th AWGESC is a remarkable result that the City has been honored to receive. The Award has affirmed its position, central role and driving force for the development of the Mekong Delta region. Moreover, it is also the pride of the people of Cần Thơ, contributing to creating confidence and motivation in the process of making the City's people with "Intelligence - Dynamism - Kindness - Chivalry - Elegance" expressed through a culture of environmentally friendly behavior.

VEM: *It is known that Cần Thơ is also the first city in Việt Nam to join the BreatheLife Cities Network of the World Health Organization (WHO). To achieve the above results, what activities has the City implemented to strengthen environmental management, gradually improve air quality, increase resilience to climate change?*

Ms. Cao Thị Minh Thảo: The BreatheLife campaign, founded by WHO, the United Nations Environment Program (UNEP) and the Climate and Clean Air Coalition, is an initiative to raise awareness of the global community about impact of air pollution on health and climate and at the same time, it calls on managers, organizations and individuals to increase activities to reduce air pollution.

To achieve the above results, the City has implemented many models to reduce emissions generated in the fields of industry, agriculture, transport and tourism such as the ecological IP model; ecotourism; deploying a system of electric vehicles for tourism; energy saving program in production facilities... thereby, actively contributing to the goal of reducing greenhouse gas emissions of Việt Nam.

In addition, the City also successfully developed the "Clean Air Action Plan of Cần Thơ City to 2025", thereby creating favorable conditions for the City to register to participate in this network. This is an opportunity for the City to learn and share with other cities in the world about solutions to improve air quality and contribute to finding investment resources through the support of media on the website of the BreatheLife. On the contrary, it is also an opportunity for international organizations to provide technical assistance and facilitate connections with stakeholders and communities in order to contribute to the implementation of measures to reduce air pollution in particular and air environmental protection in general.

VEM: *In the coming time, Cần Thơ needs to focus on what solutions to maintain the above titles and at the same time constructs and develops the City in the direction of civilization and modernity, worthy of being the gateway of the lower Mekong region?*

Ms. Cao Thị Minh Thảo: The AWGESC is an important award to honor and promote the image of typical cities in terms



▲ Cần Thơ City received the 5th AWGESG

of environmental quality (clean air, soil, water) of countries in the region, raising awareness of the community and leaders at all levels of countries about the importance of environmental protection. This Award will be the driving force, creating momentum for the City to continue to strive, build and develop in the direction of civilization and modernity, worthy of being the gateway City of the lower Mekong region.

Realizing clearly the responsibility in maintaining the title, despite many difficulties and limited resources, Cần Thơ also clearly identifies this as one of the important tasks, demonstrating the determination of the Party Committee, authorities, levels and sectors for construction and development of the City. Especially, continue to effectively implement Resolution No. 59-NQ/TW dated 5th August 2020 of the Politburo on construction and development of Cần Thơ City to 2030, with a vision to 2045 and Resolution No. 120/NQ-CP dated 17th November 2017 of the Government on climate resilient and sustainable development of the Mekong River Delta, specifically through a number of basic solutions as follows:

Firstly, carry out the work of thoroughly propagating and implementing the policies and guidelines of the Party and State on the sustainable development of Cần Thơ City;

Secondly, well implement planning and planning management, especially urban planning, based on maximizing potentials and advantages, not only of the City, but also of the Mekong Delta region;

Thirdly, develop socio-economic infrastructure, especially synchronous and modern transport infrastructure, connecting within and between regions. This is the basis for the City to promote its leading role and driving force for regional development; it is an important hub for regional and international transportation.

Fourthly, attract and effectively use investment capitals from all economic sectors for socio-economic development, especially for infrastructure development and economic sectors with potentials and advantages.

Fifthly, develop high-quality human resources, science and technology services, health care services for the socio-economic development of the City and the Mekong Delta region, affirming its position as a specialized center of education, training, science - technology and health care in the region.

Sixthly, associate economic development with cultural development and realize social progress and justice, affirming its position as the cultural, tourist and sports center of the Mekong Delta.

Seventhly, well perform the management, effective exploitation and use of natural resources, ecological environmental protection, aiming to be the center of climate change response of the Mekong Delta.

Eighthly, strengthen links and cooperation with provinces in the region, Hồ Chí Minh City and other localities in the country; promote cooperation between universities, research institutes and enterprises; promote the central role, become the linking nucleus of the region; improve the efficiency of foreign affairs and international integration, contributing to promoting the image of a dynamic, creative city, rich in cooperation potential, with a favorable environment to attract investment.

Ninthly, implement programs and projects for urban development/upgrading, to improve urban adaptability and to perfect the transport infrastructure system, dike and embankment, as well as technical infrastructure for the environment, improve the City's resilience in the context of climate change; actively coordinate with provinces/cities in the region, effectively implement the Cần Thơ City's sustainable development goals in particular and the Mekong Delta in general.

In addition, the City will strengthen the conservation and promotion of local core values, focusing on eco-tourism and river tourism services. With the above solutions, it is hoped that Cần Thơ will develop increasingly, becoming a city with a comprehensive, balanced and sustainable development space, in harmony with the natural landscape, increasingly promoting the identity of a river region.

VEM: Thank you!

PHƯƠNG LINH

Air pollution is the greatest environmental threat to public health globally. The World Health Organization (WHO) recently issued stricter recommendations on safe air pollution levels, in a bid to curb the millions of premature deaths and loss of millions more healthy years of life caused by air pollution. A United Nations Environment Programme (UNEP) report showcases many countries' progress in tackling air pollution through legislation, measured against a robust air quality governance model developed as part of the research.

According to Mr. Patricia Kameri-Mbote, the lead environmental law and governance expert at UNEP, the report of UNEP concludes that despite the increase in laws and regulations to address air pollution, air quality continues to deteriorate. So, while there is clearly an effort from some countries to deal with air pollution, more focus must be put on efforts at a global scale. However, significant challenges remain if we are to protect human health and well-being and address the triple planetary crisis.

Earlier this year, a court refused to extradite a man over concerns about air quality. This decision by the Administrative Court of appeals in Bordeaux, France, is indeed significant because it is the first time that pollution has been considered in a decision. The Court decided that given the extreme levels of air pollution in the man's home country, returning him there would endanger his already frail health. The Court in this case makes a direct link between human life and the environment and in so doing, reinforces the broader agenda on the right to a healthy environment. While many countries have set ambient air quality standards, they fall short of providing for every person's right to be protected from environmental harm including air pollution. The case can therefore be a good basis for encouraging countries with less developed environment and health legislation to speed up enactments relating to the right to a healthy environment.

Besides, a UNEP study revealed that 1 in 3 countries do not have legally mandated air quality standards. He emphasized that most countries surveyed in the report have air quality standards



▲ *In many countries, especially in the developing countries, air pollution is getting worse*



Why is legislation needed to curb air pollution?

within a legislative instrument. While this indicates a global trend in legislating for air quality standards, still many national air quality regimes don't have the measures needed to achieve public health or ecosystem health objectives. Legislation establishing air quality standards is important to reduce the impacts of air pollution on the public and the environment. Legislation can enable citizens to hold Government institutions responsible for air quality. It can also establish processes for monitoring, enforcement and public participation in air quality control which could have significant impacts on improving air quality. As the WHO's guidelines admit (2005), one of them is lack of prioritization of public health in Air Quality Law.

According to Mr. Patricia Kameri-Mbote, it is a challenging task for public authorities to embed air quality standards in legislation. They must make social and economic choices to meet air quality standard levels, beyond assessment and information requirements. Also, without an international regime on air quality standards, having many different national laws might also be a barrier to adopting contemporary approaches. Many countries need further guidance. Air quality laws should follow a robust air quality governance system informed by science. In other words, they should set requirements for institutional responsibility, monitoring, accountability, planning and sanctions, as well as public participation and human rights.

The report found that even in countries with air quality laws in the books, most of those don't meet standards outlined by WHO. Why are the laws in so many countries relatively toothless? These guideline values set by the WHO are not meant to be binding upon States. They were designed to protect human health from the harmful effects of air pollution. The report finds that indoor and outdoor air pollution are "among the leading avoidable causes of diseases and death globally and the world's largest single environmental health risk". They are "a cause of global health inequities, affecting in particular women, children and old persons, as well as low-income populations". So, following the WHO guidelines is a matter of public health. The WHO guidelines reflect a high degree of scientific consensus, giving them global authority. Countries can use them as a benchmark to inform legislation and policy. In some cases, air quality standards in national laws do not comply with the WHO air quality guide-

lines. This may reflect a process of transitioning to more stringent standards over time, subject to political and economic circumstances.

The UNEP report shows that we need cooperation between countries to effectively control air pollution across borders. Some global treaties on air pollution include the Vienna Convention, the Montreal Protocol, the Climate Change Convention, the Kyoto Protocol, the Paris Agreement, the Stockholm Convention, and the Minamata Convention on Mercury. At the regional level, there is also a Pan-European Air Pollution treaty, which has been particularly successful in encouraging European countries to pass laws on cross-border air pollution. The report finds that without an international regime on air quality standards, having many different national laws might also be a barrier to adopting contemporary approaches. Currently, no international treaty requires or encourages countries to adopt air quality standards. The report finds that there is a case for a complementary global treaty.

In many countries, especially in the developing world, air pollution is getting worse. To tackle air pollution, we need to act fast and together. Strengthening air quality laws and regulations is one key policy action to significantly improve air quality. The report points out that ambient air is not yet legally protected everywhere. If we support countries so that all have robust air quality laws, we can improve air quality globally. We can achieve this together, leaving no one behind.

UNEP and other stakeholders have been advocating for the shift from a carbon-based to a green economy. In a green economy, growth in employment and income are driven by public and private investment that allows reduced carbon emissions and pollution, enhanced energy and resource efficiency and prevention of biodiversity loss. Tightening air quality laws would contribute to this shift and to achieving the sustainable development goals, including SDG 8 on decent work and economic growth■

MAI HU'ONG



Over 100 global leaders pledge to end deforestation by 2030

More than 100 global leaders have pledged to halt and reverse deforestation and land degradation by the end of the decade, underpinned by US\$ 19 billion in public and private funds to invest in protecting and restoring forests. The promise, made in a joint statement issued at the COP26 climate talks in Glasgow, was backed by the leaders of countries including Brazil, Indonesia and the Democratic Republic of Congo, which collectively account for 85% of the world's forests.

According to a statement released by the UK Prime Minister's Office, the Glasgow Leaders' Declaration on Forest and Land Use will cover forests totaling more than 13 million square miles. "We will have a chance to end humanity's long history as nature's conqueror, and instead become its custodian", said British Leader Boris Johnson.

U.S. President Joe Biden said a new U.S. plan would "help the world deliver on our shared goal of halting natural forest loss" and restoring at least an additional 200 million hectares of forest and other ecosystems by 2030. "We're going to work to ensure markets recognize the true economic value of natural carbon sinks and motivate Governments, landowners and stakeholders to prioritize conservation", Mr. Joe Biden said.

Besides, several additional Governments and private initiatives were launched to help reach that goal, including billions in pledges for indigenous guardians of the forest and sustainable agriculture.

CLIMATE BUFFER

Forests absorb roughly 30% of carbon dioxide emissions, according to the nonprofit World Resources Institute (WRI). The forests take the emissions out of the atmosphere and prevent them from warming the climate. Yet this natural climate buffer is rapidly disappearing. According to WRI's deforestation tracking initiative Global Forest Watch, the world lost 258,000 sq km (99,600 sq miles) of forest in 2020. That is an area larger than the United Kingdom. Monday's agreement vastly expands a similar commitment made by 40 countries as part of the 2014 New York Declaration of Forests and goes further than ever before in laying out the resources to reach that goal.

Non-Government organization Global Witness said it was unclear how Governments would be held accountable for meeting the new pledge. National laws banning companies and financial institutions from activities that fuel deforestation are needed, it said in a statement. Veteran ecologist

Dan Nepstad with the Earth Innovation Institute praised the deal for refreshing past commitments with more money and wider support. But whether it is effective depends how quickly and efficiently the funds are doled out, he said.

Under the agreement, 12 countries including Britain have pledged to provide 8.75 billion pounds (US\$12 billion) of public funding between 2021 and 2025 to help developing countries, including in efforts to restore degraded land and tackle wildfires. At least a further 5.3 billion Pounds would be provided by private sector investors. Brazil signed on to the agreement despite soaring deforestation of the Amazon rainforest under right-wing President Jair Bolsonaro.

Scientists fear destruction of the Amazon, the world's largest rainforest, may push it beyond a point of no return, when it can no longer sustain itself and dries out into savanna. That would release massive amounts of greenhouse gas and be catastrophic for the global climate.

COMMUNITY GUARDIANS

Brazil separately announced a more aggressive target to end illegal deforestation by 2028. Mr. Carlos Nobre, one of the leading climatologists studying the Amazon, said Brazil has yet to show it is effective at enforcing the laws prohibiting most deforestation, despite the pledge. Although there are signs that Amazon deforestation has come down marginally in 2021, destruction remains at a level not seen since 2008. Gabon, also signed onto the agreement, despite plans to continue logging while using practices to reduce its greenhouse gas emissions.

Five countries, including the Britain and United States and a group of global charities on Tuesday also pledged to provide US\$ 1.7 billion in financing to support indigenous people's conservation of forests and to strengthen their land rights. Environmentalists say that



indigenous communities are the best protectors of the forest, often against violent encroachment of loggers and land grabbers. “There is no way to talk about emissions reductions without the participation of indigenous people”, said Mrs. Telma Taurepang, a member of the Taurepang indigenous tribe and coordinator of the Union of Indigenous Women of the Brazilian Amazon. She said she did not believe the money would bring real benefit to indigenous people as global leaders still fail to sufficiently consult them, particularly in countries like Brazil where Governments strongly support mining and industrial agriculture.

More than 30 financial institutions with more than US\$ 8.7 trillion in assets under management also said they would make “best efforts” to eliminate deforestation related to cattle, palm oil, soy and pulp production by 2025. COP26 aims to keep alive a target of capping global warming at 1.5 degrees Celsius (2.7 Fahrenheit) above pre-industrial levels. Scientists say forests and so-called nature-based solutions will be vital to reaching that goal.

Woodlands have removed about 760 million tons of carbon every year since 2011, offsetting about 8% of carbon dioxide emissions from fossil fuels and cement, according to the Biomass Carbon Monitor Project backed by Data Analytics Firm Kayrros and French research institutions. Our biosphere is really helping bail us out for the time being, but there is no guarantee those processes will continue■

TRẦN TÂN

NEW WHO'S GLOBAL AIR QUALITY GUIDELINES AIM TO SAVE MILLIONS OF LIVES FROM AIR POLLUTION

New World Health Organization (WHO) Global Air Quality Guidelines (AQGs) provided clear evidence of the damage air pollution inflicts on human health, at even lower concentrations than previously understood. The guidelines recommend new air quality (NAQ) levels to protect the health of populations, by reducing levels of key air pollutants, some of which also contribute to climate change.

Since WHO's last 2005 global update, there has been a marked increase of evidence that shows how air pollution affects different aspects of health. For that reason and after a systematic review of the accumulated evidence, WHO has adjusted almost all the AQGs levels downwards, warning that exceeding the NAQ Guideline levels is associated with significant risks to health.

WHO's new guidelines recommend air quality levels for 6 pollutants, where evidence has advanced the most on health effects from exposure. When action is taken on these so-called classical pollutants: PM, O₃, NO₂, SO₂ and CO, it also has an impact on other damaging pollutants. The health risks associated with particulate matter equal or smaller than 10 and 2.5 microns (µm) in diameter (PM₁₀ and PM_{2.5}, respectively) are of particular public health relevance.

The guidelines also highlight good practices for the management of certain types of particulate matter (black carbon/elemental carbon, ultrafine particles, particles originating from sand and dust storms) for which there is currently insufficient quantitative evidence to set air quality guideline levels. They are applicable to both outdoor and indoor environments globally and cover all settings.

WHO Director General Tedros Adhanom Ghebreyesus said: “WHO's NAQ Guidelines are an evidence-based and practical tool for improving the quality of the air on which all life depends. I urge all countries and all those fighting to protect our environment to put them to use to reduce suffering and save lives”.

Disparities in air pollution exposure are increasing worldwide, particularly as low- and middle-income countries are experiencing growing levels of air pollution because of large-scale urbanization and economic development that has largely relied on the burning of fossil fuels. Global assessments of ambient air pollution alone suggest hundreds of millions of healthy life years of life lost, with the greatest attributable disease burden seen in low and middle-income countries.

The more exposed to air pollution they are, the greater the health impact, particularly on individuals with chronic conditions (such as asthma, chronic obstructive pulmonary disease and heart disease), as well as older people, children and pregnant women.

The goal of the guideline is for all countries to achieve recommended air quality levels. Conscious that this will be a difficult task for many countries and regions struggling with high air pollution levels, WHO has proposed interim targets to facilitate stepwise improvement in air quality and thus gradual, but meaningful, health benefits for the population.

Almost 80% of deaths related to PM_{2.5} could be avoided in the world if the current air pollution levels were reduced to those proposed in the updated guideline, according to a rapid scenario analysis performed by WHO■

AN VI



Philippines' waste and the Ban of incineration

The Philippines is facing a garbage crisis” that requires immediate concerted action from the Government and civil society. Will the country overcome the crisis?

Following official data from the Philippines' Economic Planning Office, the country's waste generation reached about 40,000 tons per day in 2016. The World Bank in 2012 estimated that solid waste produced by Philippine cities would go up to 77,776 tons per day by 2025. Nationwide, about 40 to 85 percent of the solid wastes generated are collected. The poorer areas of cities, municipalities and rural barangays stay typically unserved or under-served. Uncollected waste ends up mostly in rivers, esteros and other water bodies.

One half biodegradable

Figures of the National Solid Waste Management Commission (NSWMC) indicate that the solid waste in 2013 consisted of 57 percent residential, 27 percent commercial, 12 percent institutional and four percent industrial waste. Accordingly, 52 percent of the waste was biodegradable, 28 percent recyclables, 18 percent residual and two percent special/hazardous. A newer source speaks of recyclable waste comprising plastic packaging materials of 38 percent, followed by paper and cardboard waste, which contributes about 31 percent. The remaining 31 percent are made up of metals, glass, textile, leather and rubber. According to Ms. Ana Baligod Cabatbat - a specialist at the Environmental Management Bureau (the Philippines' Department of Environment and Natural Resources - DENR) subclassifies the waste in compostable (50 percent), residual (15 percent), factory returnable (30 percent) and special waste (5 percent).

The National Republic Act No. 9003, otherwise known as the “Ecological SWM Act of 2000”, enacted in 2001, requires local administrations to close their existing open dumpsites by 2006. But ten years later, there were still 403 open dumpsites and 108 controlled dumpsites in operation. Although the number of sanitary landfills increased from 48 in 2010 to 118 in 2016, Local Government Units (LGUs) with access to controlled landfills stayed below 15 percent. In December 2018, about 353 LGUs had access to 165. Open dumping remains the general practice of waste disposal in the Philippines.

Different composting techniques

The Republic Act No. 9003 requires that at least 25 percent of all solid wastes from waste-disposal facilities is diverted or recovered through reuse, recycling, composting and other resource-recovery activities. LGUs are also mandated to put up or establish several waste facilities such as materials-recovery facilities (MRFs) for processing recyclable and biodegradable waste. Until 2016,

about 9,900 MRFs were in operation in the Philippines, serving a third of the country's 42,000 barangays (lowest Government structure, comparable to a district). A look at the National Solid Waste Management (SWM) Status Report published by the Environmental Management Bureau offers pictures underlining the different qualities of these facilities, ranging from bicycles with a trailer over simple wooden roof-covered sheds to smaller “centralized gravity-driven” buildings. There are several types of unpretentious composting techniques used by LGUs, national Government agencies, private farms and co-operatives in the Philippines. Several vermicomposting facilities separate the biological solids, which are further worm composted. According to Ms. Ana Baligod Cabatbat, 25 percent of the compostable wastes is recovered and recycled to organic fertilizer.

Energy from biodegradables

Biodegradable waste is also broadly treated by facilities for energy recovery. The Department of Energy delivers a table listing projects and capacity for generating energy in the Philippines as of March 31st, 2021. The list informs about sixty-five commercial biomass projects with a potential capacity of 182 MW and an installed capacity of 619 MW; 22 facilities in own use are responsible for a further 170 MW. Another earlier table with awarded biomass projects as of June 30th, 2020, offers forty-one ventures: Most of the biomass power plants mentioned have an installed capacity of up to 32 MW, biomass treatment facilities for landfill methane recovery, refuse-derived fuel processing, gasification, Waste-to-energy (W-t-E), multi-feedstock, rice-husk, bagasse as well as pineapple fruit waste fired are also mentioned.

Mismanagement of solid waste

The condition of solid waste treatment was different. A 2017 report from the Senate Economic Planning Office described the situation: “Majority of LGUs have yet to comply with the provisions of Republic Act No. 9003, particularly on the establishment of local SWM Boards, submission of SWM plans, establishment of MRF and closure of all open and controlled dumpsites”.



Some shopping malls promote eco-shopping bag programs, monthly waste markets, other malls, supermarkets, fast food chains and commercial shops organize their own SWM programs. Projects of Unilever Philippines, Nestlé Philippines or Coca-Cola reduced trash by 50 percent, enabled the composting of coffee grounds or launched a “Give a Can, Give a Hope” Program. But if households, communities and businesses are not practicing segregation at source and separate storage, most solid wastes end up as “mixed garbage”. While only 30 percent of barangays segregate their collected waste properly, seventy-seven million Filipinos imply a “mismanagement” of solid waste through their daily lives, the DENR gave account.

Recyclables delivered to junk shops

Concerning recyclables, in many cases, either the semi-formal or informal waste collectors or even the generators themselves bring the sellable materials to junkshops. The accumulated recyclables from MRFs are delivered to junk shops, too. Especially paper, scrap metals and plastics with high commercial value are typically sold to junk dealers, consolidators and recyclers. Disposal site scavengers catch most recyclables like paper, plastic, metals, glass and aluminum. After leaving local junk shops, the material usually passes through a business chain of middlemen and wholesalers for use by the industry sector, mainly outside the Philippines, the Status Report suggests. “There is a very limited number of mate-

rials recovery facilities equipped with technologies to reduce wastes like recycling and composting”, the Finnish supplier of waste solution products WOIMA Corporation judged in May 2020 and added: “Improper wastes disposal, inefficient waste collection and lack of disposal facilities are among the dominant concerns in the country’s SWM”.

PCB destruction and waste import ban

But things are getting in motion. In 2015, DENR and the Environmental Management Bureau (EMB) got ownership of the Non-Combustion Destruction Facility for persistent organic pollutants, worth US\$ 3 million. Before, the Facility had a design capacity to destroy 750 tons per year of PCB oil. In 2018, the Facility treated only 100 tons of PCB oil. After the Facility upgrades with the support of the United Nations Industrial Development Organization, it is now expected to destroy 600 tons of PCB oil and PCB annually. Due to using state-of-the-art non-combustion technology, it is now the only EMB-accredited facility in the country to treat PCB oil and PCB-containing equipment with concentrations below 10,000 ppm. The Facility will enable the country to treat its own PCBs instead of having these exported for incineration.

In May 2019, the DENR was tired of misdeclared shipment carrying garbage entering the country’s ports. Therefore, they began to develop



▲ Garbages extend all the way around the shore of the Navotas neighborhood in Manila (Philippines)



a policy, which would ban all waste imports. Not to affect the industry relying on recyclable products, the EMB was directed “to make an inventory on the industries relying on these recyclable materials”, the Environment Undersecretary for Policy, Planning and International Affairs Jonas Leones was quoted.

The International Trade Administration published a list of goods prohibited from being imported to the Philippines including, inter alia Polychlorinated biphenyls (PCBs), hazardous waste, used clothing and rags, used motorcycle parts as well as right-hand drive vehicles

Participation of informal workers

In February 2020, the Philippines banned single-use of plastic products like plastic bags, straws, spoons and forks in national Government agencies, local Government units and all other Government-controlled offices. In the same year, the United Nations Industrial Development Organization and the Philippines’ DENMs, with funding from the Global Environmental Facility (GEF), started to support safe and informal recycling of electronic devices in two low-income districts in the Manila metropolitan area. The project included the plan of a new facility and safety training in practical workshops for recyclers providing them with the necessary skills and teach them how to disassemble parts, all according to international safety and security standards. Another GEF-supported program aims at improving the conditions for artisanal miners. Moreover, the program wants to reduce harmful mercury emissions by eliminating mercury usage in artisanal and small-scale mining.

With the help from ADB and USAID

Support came from abroad. The Asian Development Bank (ADB) published comprehensive practical guides on “Integrated SWM for Local Governments” and on “Public-Private Partnerships (PPPs) by Local Governments”. The first presents “a comprehensive yet accessible approach to improve waste operation... by breaking down sector silos, providing relevant and technical knowledge and even showing how to maximize private sector participation”. The latter informs about “the next phase of PPP reforms in the country supported through ADB’s technical assistance on strengthening PPPs in the Philippines (second phase) and the Expanding Private Participation in Infrastructure Program”.

The United States Agency for International Development (USAID) awarded nearly US\$ 1.5 million in grants and provided technical assistance to ten local Philippines organizations for using novel approaches to improve SWM and increase recycling. In 2020, the Clean Cities, Blue Ocean (CCBO) Program on ocean plastic pollution was provided to start working with partners in Manila Bay, Batangas and Iloilo to identify, test and scale locally driven solutions to promote the 3Rs (reduce, reuse, recycle) and enhance SWM systems.

Worrying about 15,000 mangroves

The industry did not stay inactive. In March 2017, some Chinese enterprises signed letters of intent for investing US\$ 10.4 billion into the Philippines ship and ship recycling branch. According to Germany Trade and Invest, especially the Japanese shipbuilder Tsunishi Heavy Industries wanted to invest more than US\$ 100 million for a 150-hectare ship recycling project in the municipality of Hinoba-an (Local environmental groups opposed the project-worrying about the future of 15,000 mangroves and the nearby coral reefs - and the authorities refused the approval. Now the plan is on hold indefinitely).

New facilities planned

But Coca-Cola Beverages Philippines—for example—in partnership with Thailand-headquartered chemicals supplier Indorama Ventures, began to set up a joint venture for the country’s largest bottle-to-bottle recycling facility in 2020. An annual capacity of 30,000 tons or almost two billion plastic bottles and an output of 16,000 tons of recycled PET resin were projected. In August 2020, Nestlé Philippines reached plastic neutrality, the Company gave account: Nestlé collected and co-processed the equivalent amount of plastic as contained in the products sold. MetPower Venture Partners Holdings Inc. (a subsidiary of Metro Pacific Investments Corporation) was planning to invest in a CO₂ recovery facility that is expected to become Mindanao’s first indigenous source of food-grade CO₂. The Plant should be co-located at the Polomolok site, nearby the W-t-E Biogas Plant for Dole Philippines, Metro Pacific Investment informed in November 2020.

To produce eco-bricks

In January 2021, building solutions provider Holcim Philippines Inc. planned to invest PHP 121.5 million until 2022 to raise the efficiency of shredding operations at its Geocycle unit. That will convert qualified waste materials to alternative fuels and raw materials in cement production at its Bulacan Plant: In 2020, Holcim Philippines co-processed close to 130,000 tons of qualified wastes. In March 2021, Snack Food Company Mondelez Philippines teamed up with social enterprise The Plastic Flamingo to collect and recycle forty metric tons of post-consumer plastic packaging to produce “eco-bricks” as a sustainable wood alternative to be applied in the construction sector. Quezon City longs for a waste treatment facility to convert up to 3,000 metric tons a day of municipal waste into 36 MW of electricity.



Discussion about W-t-E

W-t-E is a broadly and controversially discussed issue in the Philippines. On principle, the Republic Act 9003-the “Ecological SWM Act” - bans the burning of waste for 20 years. From the perspective of the environment protection group No Burn Pilipinas with good reasons: Waste combustion uses fire grates, causes toxic and hazardous pollutants and thus provides a clear violation of the Philippine Clean Air Act of 1999. In addition, a university professor argued that external companies try to sell incinerators by not calling them by name but using different names, like W-t-E. In opposition, Philippine officials like the DENR are convinced that W-t-E facilities are more environmentally-friendly than sanitary landfills and would benefit in terms of a more secure energy system. Cautionary voices warned that the fee for tipping or processing wastes paid by LGUs would be too low. According to the Asian Development Bank (ADB) blog, three obstacles - the NIMBY attitude (not in my backyard), weak LGU capacities and lack of alternatives to landfilling - have aggravated the situation. That results in keeping the private sector from investing in solutions.

The first W-t-E Facility

However, in 2017, the Asian Development Bank discussed preparing “a pre-feasibility study of a W-t-E facility with a modular waste capacity of 1,000 tons per day using a stoker-type incinerator”. Moreover, they estimated the cost of establishing a W-t-E facility under public-private partnership at 13.1 billion Philippine Pesos (PHP) and required a tipping fee of PHP 1,600/tons (in addition to the subsidy of PHP 600/ton), resulting in a Return on Equity of 17 percent and a minimum debt service coverage ratio of 1.2x.

In April 2018, the Austworks Corporation, together with the City Government of Puerto Princesa, signed a joint-venture agreement about PHP 2.1 billion for the Puerto Princesa City W-t-E Project - the country’s first W-t-E facility. According to the Philippines’ Private Public Partnership Center, the facility should include a plasma-gasification process processing all current city waste and generate up to 4.2 MW of base-load electricity, twenty-four-seven.

Trials of private companies

In 2019, the EMB approved a project titled “Capacity development on improving SWM through advanced/innovative technologies”. With three years duration, the project aims to improve Philippine SWM through adopting W-t-E and other technologies. Moreover, the project will aim at targeting LGU’s capacity for improving SWM utilizing W-t-E and enhancing

other SWM technologies. In June 2019, an article in the online Magazine Eco-Business stated that private companies were trying to construct waste incinerators and asked if W-t-E plants were bad investments for Governments. The summary report 2019 of Metro Pacific Investments shows the intent: “We are also awaiting Notice of Award to build the Quezon City SWM Facility that could convert up to 3,000 metric tons a day of municipal waste into electricity”. In July 2020, environment protection groups denounced and thus made current moves in Congress public to legalize garbage incineration declared as W-t-E plants banned under the Clean Air Act.

Gasification over incineration?

The proceedings of the W-t-E process do not implement W-t-E being the best technology. In July 2020, the Manila Times engaged with the best thermal waste treatment method and stated: “But instead of incineration, gasification is a better, economical and cleaner alternative”. The article pointed to its high-revenue potential, the reduced need for landfills and fossil fuels, and the dire need for this “environmentally-friendly waste management technology”. A scientific article on the “Economic analysis of W-t-E investment in the Philippines”, published in 2020, declares: “While incineration is most widely used among W-t-E technologies, many cities are now recognizing the benefits of gasification over incineration as the syngas produced by this technology can be used for energy storage and electricity generation”.

However, in contrast, Ms. Sonia Mendoza, Chairperson of Mother Earth Foundation, mentions: “Instead of burning away billions of pesos in public funds to support W-t-E facilities, we urge the Government to invest in efforts by our communities and local Governments to implement zero waste programs as already provided for in the Ecological SWM Act. Cities and barangays doing/having zero waste have managed to divert municipal waste by as much as 80 percent and saved millions of pesos while creating jobs”. Be it as it may. The ADB has at least one proposal: “One solution is to provide more incentives to private companies to invest in SWM by extending contracts to a term of 7 - 10 years or more... However, this would require changes to the country’s procurement laws■

PHƯƠNG TÂM



Unsound management of chemicals and wastes underpins runaway climate change

With the eyes of the world on COP26 on climate change, policymakers are urged to act in addressing “the elephant in the room” - pollution arising from emissions from combustion, chemical production and non-circular waste management.

According to Mr. Rolph Payet - Executive Secretary of the Basel, Rotterdam and Stockholm (BRS) Conventions, the twin threats of climate change and biodiversity loss through increasing pollution from chemicals and wastes show no signs of slowing. COP26 needs to address pollution reduction, including the life-cycle approach to the management of chemicals and waste, including plastic waste, to simultaneously slow the increase in greenhouse gases and lead to improvements in environmental quality and the recovery of nature.

“Making peace with nature” is about stimulating and supporting the transition to a more sustainable global economy built upon circularity and a life-cycle approach to resource use. Since the sound management of chemicals and waste underpins all of the globally agreed Sustainable Development Goals (SDGs), it needs to also be addressed through strategies and policies addressing climate change as well”.

A recent BRS Secretariat technical report, produced jointly with the Secretariat of the Minamata Convention on mercury, explores the profound interlinkages between climate change, chemicals and waste. Four main linkages are particularly pertinent to deliberations in Glasgow:

First, petrochemical and chemical industries, with strong links to the fossil fuels sector, continue to be significant contributors to global greenhouse gas (GHG) emissions. Releases of GHG and hazardous chemicals happen at all stages in the life cycles of chemicals, including the production of input materials, primary and secondary production processes, chemical use and disposal. Hazardous chemicals and GHGs are released during everyday use of products including in agriculture through the application of pesticides, domestic refrigeration and air-conditioning and specialist use in fire-fighting foams and explosion protection, to name just a few.

Second, as we tackle issues of land degradation and food production as a result of climate change, adaptation responses often lead to increasing use of chemical fertilizer, pesticides and plastics, to combat higher incidences of pest and disease

outbreaks, as well as the need to create more micro-environments for agricultural production. Reports indicate increased distribution, growth and reproduction of pests at higher temperatures and in wetter conditions, which in turn leads to a reduction in the efficacy of pesticides. Pesticide usage as a result of both increased temperature and precipitation could rise by 1.1 - 2.5% by 2040 and by 2.4 - 9.1% by 2070 in China alone, despite current efforts to reduce pesticide usage. Robust strategies are thus required for pest and disease mitigation to avoid excessive growth in pesticide use.

Third, climate change can lead to increased releases of hazardous chemicals into the environment. One example is that the melting of polar and alpine glaciers, permafrost and ocean ice induced by climate change results in releases of trapped hazardous chemicals, including persistent organic pollutants (POPs) and mercury. Projections suggest that under a high GHG emissions scenario, mercury emissions from permafrost could reach a peak of 1.9 ± 1.1 Gg Hg per year in 2200, the equivalent of current global atmospheric emissions. Furthermore, flooding and other hydrological impacts caused by the melting of sea ice and permafrost, sometimes compounded by increased precipitation, can lead to local contamination due to physical disruption and damage of pipelines and storage facilities, leading to oil and chemical spills.

Fourth, increased mobilization and volatilization of chemicals from materials storage and stockpiles occurs as temperatures rise. An estimated that 240,000 tons of obsolete pesticides are stockpiled in Eastern Europe alone and between 4 and 7 million tons of HCH isomers, generated as a by-product of the manufacture of the POP Lindane, have been stockpiled globally since the 1950s.



Abandoned stockpiles of compounds containing heavy metals, which may include mercury, are also found in many parts of the world. Such stockpiles represent “ticking time-bombs” of chemical pollution in a world with rising temperatures.

Regionally, such impacts are already beginning to be felt. In the Arctic, for example, trends of POPs have generally been decreasing due to measures introduced to reduce emissions and releases, both before and since the establishment of the Stockholm Convention. Now, however, some are levelling off, and even showing upward trends in air and biota in recent years, climate change being part of the reason. Some POPs, such as polychlorinated biphenyls (PCBs), are no longer declining in the Arctic to the extent that would be expected, given known decreases in their primary source emissions, possibly due to climate change. This would support model-based studies which suggest climate change will affect contaminant transport pathways to the Arctic■

NAM HƯNG

FAST-TRACKING ACTION IN SUPPORT OF POST-2020 GLOBAL BIODIVERSITY FRAMEWORK

The Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) have issued a joint statement of support to commit to fast-track support to Governments to prepare for the rapid implementation of the post-2020 Global Biodiversity Framework (GBF).

To that end, the GEF, in partnership with UNDP and UNEP, will provide immediate financial and technical support to developing country's Governments drawing from GEF-7 enabling activity resources in the biodiversity focal area. The Framework, scheduled for adoption in May 2022 at part two of the UN Biodiversity Conference, will need urgent action to jumpstart its implementation at the scale that the current loss of biodiversity requires.

Activities envisioned in the fast-track support include a review and identification of opportunities around policy coherence and biodiversity mainstreaming across national policy, assessments of national monitoring systems and analyses of biodiversity finance, including possible innovative mechanisms that could help bridge the financial gap. The ongoing negotiations for the 8th Replenishment of the GEF have included a promising discussion on the need for a significant increase in biodiversity financing for the next funding cycle (2022 - 2026) to help countries respond to the ambition of the post-2020 GBF. The GEF-8 Programming Directions strategy has outlined an ambitious plan to help countries meet the new biodiversity targets.

In recognition of the urgency of this moment, and to prepare for that investment, GEF's support is designed to help accelerate implementation of the new Framework once it is formally agreed next year at COP15.

Through this initiative, GEF will support countries to conduct a rapid review of the alignment of existing

national biodiversity strategies and action plans with the new Framework in order to identify key areas that will need to be updated and refined in light of the new Global Framework and targets, including support to engage key stakeholders in the review process to ensure a whole of society approach and to reduce obstacles in implementation. This review process will aim to ensure continuous implementation of biodiversity goals and targets during and after the review. Activities envisioned in the fast-track support include a review and identification of opportunities around policy coherence and biodiversity mainstreaming across national policy, assessments of national monitoring systems and analyses of biodiversity finance, including possible innovative mechanisms that could help bridge the financial gap. The support for early action is expected to facilitate rapid implementation of the post-2020 GBF and allow countries to make effective use of the resources provided through the GEF-8 Programming Directions to implement key transformative actions to halt biodiversity loss and restore nature. This work highlights GEF's responsiveness to a once-in-a-generation opportunity to make biodiversity a high priority for the global community setting it on a path to place it on a par with climate change as the two key global environmental priorities■

VŨ NHUNG



From pollution to solution: A global assessment of marine litter and plastic pollution

The landmark report “From pollution to solution: A global assessment of marine litter and plastic pollution” released by the UN Environment Program (UNEP), reveals the impact of marine litter and plastic pollution in the environment and their effects on the health of ecosystems, wildlife and humans.

Plastics are the largest, most harmful and most persistent fraction of marine litter. Marine litter and plastic pollution are accumulating in the world’s oceans at an unprecedented rate. The volume of plastics currently in the oceans has been estimated at between 75 million and 199 million tons. Plastic pollution is becoming part of the Earth’s fossil record and has even created a new habitat known as the “plastisphere”. Plastics are now found in all the world’s marine ecosystems and all forms of marine life, not just birds, seals and turtles. Marine litter and plastics get into the oceans via uncontrolled waste streams on land, treated and untreated wastewater outflows, wear and tear on plastic products including textiles and vehicle tyres, run-off from land, leakages from plastics used in agriculture, as well as directly from maritime industries.

Plastics, especially microplastics, cause lethal and sub-lethal effects on marine life through entanglement, smothering, ingestion and exposure to associated chemicals. They also are of potential risk to human health, through seafood consumption, where they mix with microplastics taken up via inhalation and absorption through the skin and accumulate in organs. Some of the chemicals associated with plastics are also known to have serious health impacts, especially in women.

The main content of the report

The report reveals the impact of marine litter and plastic pollution in the environment and their effects on the health of ecosystems, wildlife and humans. It shows that there is a growing threat in all ecosystems from source to sea and while we have the know-how, we need the political will and urgent action by Government to tackle the crisis. The report calls for the immediate reduction of plastics and encourages a transformation across the whole plastic value chain. It looks at critical market failures, such as the low price of virgin fossil fuel feedstocks compared to recycled

materials, disjointed efforts in informal and formal plastic waste management, and the lack of consensus on global solutions. The report will inform discussions at the UN Environment Assembly in 2022, where countries will come together to decide a way forward for global cooperation.

It has been incredible to observe the acceleration in research and information that is now emerging about the sources, sinks and the pervasive impacts of plastics on all forms of marine life and our own health. It is especially worrying to see increasing levels of plastic production, as part of a global trade valued at a trillion dollars trade, when we know that the associated greenhouse gas emissions and the loss of value of the marine ecosystem go largely unchecked and unaccounted for. Fortunately, the last six months have seen Government, citizens and business coming together to find real solutions and even opportunities to “turn off the tap” of plastics.

Key findings

Since the publication of the 2016 UNEP report “Marine plastic debris and microplastics - global lessons and research to inspire action and guide policy change”, substantial new research has shown the extensive damage that marine litter, especially plastics and their breakdown products, causes to marine life and ecosystem functioning as well as potential risks to human health.

The amount of marine litter and plastic pollution has been growing rapidly: Emissions of plastic waste into aquatic ecosystems are projected to nearly triple by 2040 without meaningful action.

Marine litter and plastics present a serious threat to all marine life, while also influencing the climate: Plastics are the largest, most harmful and most persistent fraction of marine litter, accounting for at least 85 percent of total marine waste. Plastics can alter global carbon cycling through their effect on plankton and primary production in marine, freshwater and terrestrial systems.

Human health and well-being are at risk: Risks to human health and well-being arise from the open burning of plastic waste, ingestion of seafood contaminated with plastics, exposure to pathogenic bacteria transported on plastics and leaching out of substances of concern to coastal waters.

There are hidden costs for the global economy: Marine litter and plastic pollution present serious threats to the livelihoods of coastal communities as well as to shipping and port operations. The economic costs of marine plastic pollution with respect to its impacts on tourism, fisheries and aquaculture, together with other costs such as those of cleanups, are estimated to have been at least US\$ 6 - 19 billion globally in 2018. It is projected that by 2040 plastic leakage into the oceans could represent a US\$ 100 billion annual financial risk for businesses if Governments require them to cover waste management costs at expected volumes and recyclability.



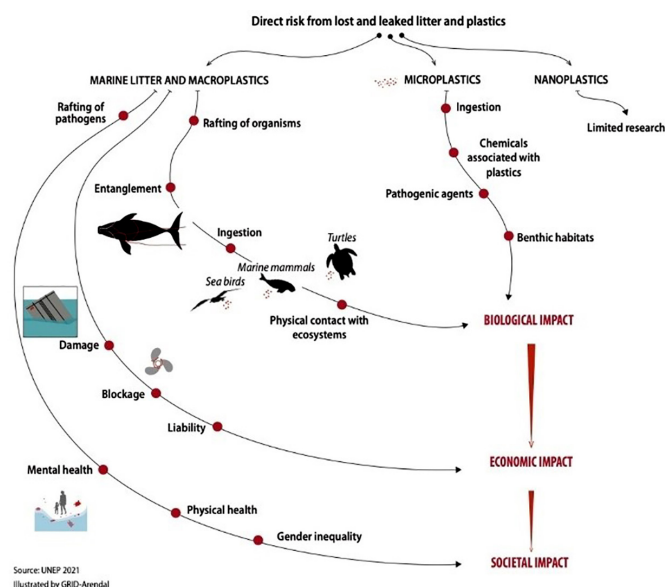
Marine litter and plastics are threat multipliers: Marine litter and plastics can act together with other stressors, such as climate change and overexploitation of marine resources, to cause far greater damage than if they occurred in isolation.

The main sources of marine litter and plastic pollution are land-based: Approximately 7,000 million of the estimated 9,200 million tons of cumulative plastic production between 1950 and 2017 became plastic waste, three-quarters of which was discarded and placed in landfills, became part of uncontrolled and mismanaged waste streams, or was dumped or abandoned in the environment, including at sea. With global cumulative plastic production between 1950 and 2050 predicted to reach 34,000 million tons, it is urgent to reduce global plastic production and flows of plastic waste into the environment.

The movement and accumulation of marine litter and plastics occur over decades: The movement of marine litter and plastics on- and offshore is controlled by ocean tides, currents, waves and winds, with floating plastics accumulating in the ocean gyres and sinking items concentrating in the deep sea, river deltas mud belts and mangroves. There can be significant time intervals between losses on land and accumulation in offshore waters and deepsea sediments. More than half the plastics found floating in some gyres were produced in the 1990s and earlier.

Technological advances and the growth of citizen science activities are improving detection of marine litter and plastic pollution, but consistency of measurements remains a challenge: There are currently 15 major operational monitoring programs linked to marine litter action co-ordination, data collection frameworks and large-scale data repository and portal initiatives, but the data and information from them are largely unconnected.

Plastic recycling rates are less than 10 per cent and plastics-related greenhouse gas emissions are significant, but some solutions are emerging: During the past four decades global plastic production has more than quadrupled, with the global plastic market valued at around US\$ 580 billion in 2020. At the same time, the estimated global cost of municipal solid waste management is set to increase from US\$ 38 billion in 2019 to 61 billion in 2040 under a business-as-usual scenario. The level of greenhouse gas emissions associated with the production, use and disposal of conventional fossil fuel-based plastics is forecast to grow to



approximately 2.1 gigatons of carbon dioxide equivalent gCO_{2e} by 2040, or 19 per cent of the global carbon budget. A major problem is the low recycling rate of plastics, which is currently less than 10 percent.

Progress is being made at all levels, with a potential global instrument in sight: However, none of the international policies agreed since 2000 includes a global, binding, specific and measurable target limiting plastic pollution. This has led many Governments, as well as business and civil society, to call for a global instrument on marine litter and plastic pollution.

Effectively tackling the problems of marine litter and plastic pollution requires a wide range of actions directed at the generation, disposal, management and leakage of waste from land- and sea-based sources, as well as measures related to plastics' overall production volumes and chemical make-up. Finding solutions requires greater engagement by civil society, businesses, industries and Governments to bring about necessary changes in policies, attitudes and practices. Citizens continue to have a key role to play, including by taking action and changing their own behaviours in order to substantially reduce marine litter and plastic pollution. The businesses and industries in which changes will be needed include oil and gas extractors and plastic resin producers, extruders and product manufacturers, automotive manufacturers and textile manufacturers, consumer product companies, packaging companies, retailers, waste hauliers and landfills, materials recovery operators, waste brokers and recyclers.

Policymakers have the opportunity to create the right mix of legislative and fiscal instruments to incentivize greater disclosure, support data sharing and transparency, provide financing, establish a transparent and effective regulatory environment and support research and development to address the challenge of marine litter and plastic pollution ■

NAM VIỆT



The effect of rice straw combined with selenium on the inhibition of copper phytotoxicity to pak choi

TRẦN LÊ UYÊN, NGUYỄN THỊ NGỌC HUỖN
HOÀNG LÊ LÂM, PHAN MINH VŨ, TRẦN THỊ ANH THƯ
Faculty of Management Science, Thủ Dầu Một University

This study aimed to explore the effects of rice straw (RS) combined with selenium (Se) on alleviating copper (Cu) toxicity through the change of Cu bioavailability in soil. The growth parameters, the concentrations of total Cu in pak choi and the distribution changes of Cu fractions in soil before planting and after harvest were determined. Results showed that RS combined with Se application may detoxify Cu at excessive concentrations (200 mg/kg) by transforming mobile Cu fractions into semi-mobile and non-mobile Cu fractions (FEM - Cu, OM - Cu and RES - Cu). The Cu concentrations in pak choi roots and shoots decreased and pak choi growth increased. This inhibition may significantly occur only when RS was at appropriate levels (20 g/kg). RS combined with Se also increased the Cu concentration in plant and promoted pak choi growth at low Cu concentration (50 mg/kg). Good correlation between the proportions of mobile Cu fractions (exchangeable EXC - Cu and bound to carbonates CAB - Cu) with Cu concentration in plants and plants growth were observed. This study suggested that RS combined with Se play important role in prevent Cu uptake by plant tissue at excessive concentrations through transformations into immobile Cu fractions.

1. INTRODUCTION

Cu is an essential micronutrient for most biological organisms and serves as cofactor for a large array of proteins involved in diverse physiological processes in plants, such as photosynthesis, the electron-transport chain, respiration, cell-wall metabolism and hormone signaling at low concentrations (Andre et al., 2010). However, excess Cu is cytotoxic due to its role in the catalysis of reactions that generate reactive oxygen species, leading to increased oxidative stress in plants (Andre et al., 2010). Cu enters agricultural soils through anthropogenic activities, such as metalliferous mining, pesticide, fertilizer and sewage irrigation (Belon et al., 2012; Ni and Ma, 2018; Grüter et al., 2019). Cu ions are taken up by plant roots and transported to edible plant parts, inducing detrimental effects on plant growth and productivity and posing a potential threat to human health (Ren et al. 2014). Therefore, feasible countermeasures for the remediation of Cu-contaminated farmlands are urgently needed to reduce toxic Cu concentrations, promote agro-environmental sustainability and food safety, and reduce the public health risk posed by Cu-contaminated soils.

Over the past several decades, techniques such as soil washing (Makino et al., 2008), low-temperature thermal desorption (Qiu et al., 2014) and phytoremediation (Belimov et al., 2005) have been applied to the treatment of heavy-metal-polluted soils. Although soil

washing can remove soluble and exchangeable heavy metals from heavily polluted soils, it can also remove essential soil elements (Wang et al., 2020). The high costs and soil disturbance associated with soil washing also needs to be considered. The costs of thermal treatment and its effects on soil properties require careful balance. Therefore, other approaches that can maintain a plant species while reducing Cu accumulation in plants need to be identified.

The mobility and bioavailability of Cu in soil are primarily influenced by soil pH and the binding properties and concentrations of organic matter (OM) (Sauve et al., 2000; Michaud et al., 2008; Bravin et al., 2012). Rice straw (RS) is the main OM that is available for most rice farmers and serves as an important source of K. Given that solid/(soil) OM can bind with Cu in soil, its mobility and bioavailability can be changed (Temminghoff et al. 1997). Selenium (Se) is an essential micronutrient for humans and animals predominantly obtained by the consumption of cereals, vegetables, meat and fish (Rayman, 2000). Recently, the application of Se fertilizers to reduce heavy metal has been confirmed as a cost-effective



tive strategy for mitigating heavy-metal accumulation and the deleterious effects of heavy metals on plants (Feng et al., 2013; Wang et al., 2016).

Total soil metal contents do not accurately indicate the possible metal transfer from soil to plants (Shahid et al., 2011). Indeed, the uptake and accumulation of heavy metals by plants highly depend on their bioavailability in soil (Michaud et al., 2007; Nguyen et al., 2017). The sequential-extraction technique provides basic information on heavy-metal fractionation and the actual and potential transport among different chemical forms (Huang et al., 2014; Monterroso et al., 2014; Zhang et al., 2014). These fractions possess different abilities to either retain or release Cu, thereby influencing the mobility and bioavailability of Cu in soil (Guan et al., 2011). Therefore, studying the transformation of fractions in soils is necessary to evaluate the bioavailability of Cu in soils.

The present study aimed to investigate the effects of the application of RS combined with Se on the inhibition of Cu bioavailability in plant based on the determination of total Cu concentrations in plant and the distribution of Cu fractions in soil. Cu fraction transformation in soils is good indicator to assess the limitation of the absorption and bioaccumulation of Cu in plants. The objectives were as follows: Clarify the role of exogenous RS combined with Se application on Cu uptake and translocation in plant; Explore the inhibition mechanism of Cu phytotoxicity from the changes in Cu fractions in soils; Determine the appropriate level of RS that significantly prevented the uptake of Cu by plant.

2. MATERIALS AND METHODS

2.1. Experimental materials

Agricultural soil was collected at a depth of 0 - 20 cm at the Chòm Sao area, Hưng Định Commune (Thuận An Town, Bình Dương Province), according to Environmental Quality Standard of Việt Nam (TCVN No. 5297:1995). Soil samples were completely air dried at room temperature, homogenized and passed through a 5 mm sieve. The experimental soil is clay loam soil whose basic physicochemical properties were as follows: proportion, 3.09 g/cm³; density, 1.15 g/cm³; humidity, 21.1%; pH_{KCl}, 3.8; pH_{H₂O}, 3.7; total N, 0.132%; total P₂O₅, 0.032%; total organic carbon, 4.07%; total Se, 0.31 mg/kg and total Cu, 5.1 mg/kg. These soil properties were determined according to the procedures described by Bao (2000).

2.2. Pot experiments

The dosages of metal exposure and RS to soil samples in this study were set as 0, 50, and 200 mg/kg soil for Cu (added as CuSO₄·5H₂O) (Hu et al., 2014); 0, 10 and 20 g/kg soil for RS; 0 and 2.5 mg/kg soil for Se (added as Na₂SeO₃). One treatment without RS, Cu and Se was prepared and set as the control. This experiment had a completely randomized design with three

replicates, including a total of 54 pots for 18 treatments (Table 1).

Different concentrations of RS, Se or Cu-spiked solutions were aspirated on dry soil by using a plastic nebulizer. After the soil was homogenized and equilibrated for 30 days, basal fertilizer comprising 0.15 g/kg N (urea, AR) and 0.033 g/kg P (monopotassium phosphate, AR) were thoroughly mixed in a plastic pot (diameter: 18 cm; height: 15 cm) containing 2.5 kg of the equilibrated soil. Soil moisture content was kept at approximately 70% water-holding capacity within the equilibrating period. Pak choi seeds were sowed in each pot, and the seedlings were thinned to five in each pot after 10 days of germination. The plants were grown in pots in a greenhouse and watered periodically to keep soil moisture at 70% of the field capacity. The plants were harvested after 38 days.

2.3. Sample preparation

Soil samples were collected from each pot before planting and after harvest. Then, the soil samples were placed in sealed polyethylene bags to prevent cross-pollution, completely air dried at room temperature, homogenized, and passed through a 100-mesh sieve (0.15 mm) for chemical analyses of total Cu concentrations and fractions. Pak choi samples were washed with deionized water and their shoots and roots were separated. The samples were oven dried at 90°C for 30 min and kept at constant weight at 50°C. The dried samples were ground into fine powder and then stored in a dark room at room temperature.

2.4. Chemical analysis

2.4.1. Determination of Cu concentration in plant and soil

Plant samples were digested using 4:1 (v/v) HNO₃ - HClO₄, whereas soil samples for determining Cu concentrations were digested with an oxidative acid mixture of 3:1 (v/v) HNO₃ - HClO₄ at 160°C. In a typical procedure, 0.5 g of each sample was precisely weighed in a 100 mL glass tube. HNO₃ and HClO₄ with a combined volume of 10 mL was added and kept overnight at room temperature. Acid digestion was conducted in an automatic temperature-controlled furnace until the digestion solution became clear. After acid digestion, the sample solutions were cooled and diluted with deionized water in a glass tube. Cu concentration in the digestion solution were determined with an atomic absorp-



tion spectroscopy (AAS) system according to the Standard Method TCVN 6496:2009 developed by the Ministry of Natural Resources and Environment (MONRE).

2.4.2. Determination of Cu fractions in soil

Cu fraction analysis applied the five-step sequential extraction method described by (Hu et al. 2014). According to the method, Cu was divided into exchangeable, bound to carbonates, bound to Fe - Mn oxides, bound to OM and residual fractions.

a. Exchangeable (EXC-Cu):

0.1 mol L⁻¹ NH₄HAC 25 °C, shaken for 2 h, liquid/soil = 10:1.

b. Bound to carbonates (CAB - Cu):

1 mol L⁻¹ NaAc 25°C, shaken for 2 h, liquid/soil = 10:1.

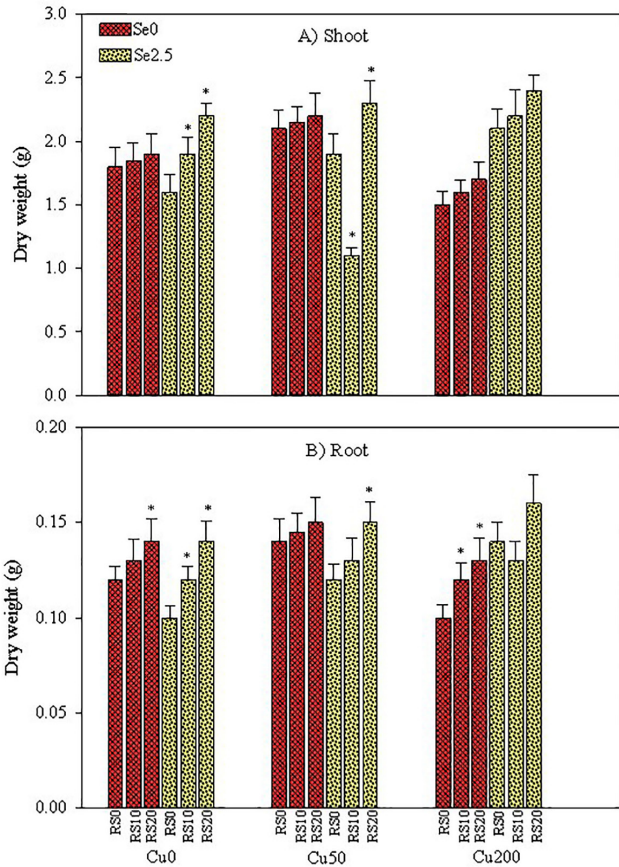
c. Bound to Fe - Mn oxides (FEM-Cu): 0.1 mol L⁻¹ NH₄OH + 0.01 mol L⁻¹ HCl 25°C, shaken for 0.5 h, liquid/soil = 10:1.

d. Bound to OM (OM - Cu): 0.01 mol L⁻¹ HNO₃, 30% H₂O₂, heated for 2 h in 85°C, shaken intermittently, liquid/soil = 10:1.

e. Residual (RES-Cu): 15 mL of HNO₃, 5 mL of HF, 5 mL of HClO₄, heated to 300°C for 2 h, until the solutions became clear. The extracted supernatant was analyzed by AAS.

2.5. Quality control

Different quality-assurance and quality-control measures were included in the



▲ **Figure 1.** The dry weight of pak choi tissues: shoot (A), root (B). Data are presented as means ± SD (n=3). Stars indicate significant difference from no rice straw treatments (One-way ANOVA, followed by Dunnett's test, *P < 0.05).

Table 1: Copper, selenium and rice straw concentrations in single and combined treatments

Treatment	Concentrations			Treatment	Concentrations			Treatment	Concentrations		
	Cu	Se	RS		Cu	Se	RS		Cu	Se	RS
Cu0Se0RS0	0	0	0	Cu50Se0RS0	50	0	0	Cu200Se0RS0	200	0	0
Cu0Se0RS10	0	0	10	Cu50Se0RS10	50	0	10	Cu200Se0RS10	200	0	10
Cu0Se0RS20	0	0	20	Cu50Se0RS20	50	0	20	Cu200Se0RS20	200	0	20
Cu0Se2.5RS0	0	2.5	0	Cu50Se2.5RS0	50	2.5	0	Cu200Se2.5RS0	200	2.5	0
Cu0Se2.5RS10	0	2.5	10	Cu50Se2.5RS10	50	2.5	10	Cu200Se2.5RS10	200	2.5	10
Cu0Se2.5RS20	0	2.5	20	Cu50Se2.5RS20	50	2.5	20	Cu200Se2.5RS20	200	2.5	20

* Cu (mg/kg); Se (mg/kg); RS (g/kg).

sample preparation and chemical analyses, including the use of certified reference materials for instrumental calibration, determination of the method detection limit and analyses of reagent blanks, sample duplicates and spiked samples. The certified reference materials analyzed along with each batch of samples in this study was QCVN No. 03-MT:2015/BTNMT (agricultural

land) from the National Standard Reference Material. The measured Cu concentration for QCVN No. 03-MT:2015/BTNMT was 100 mg/kg.

2.6. Statistical data analysis

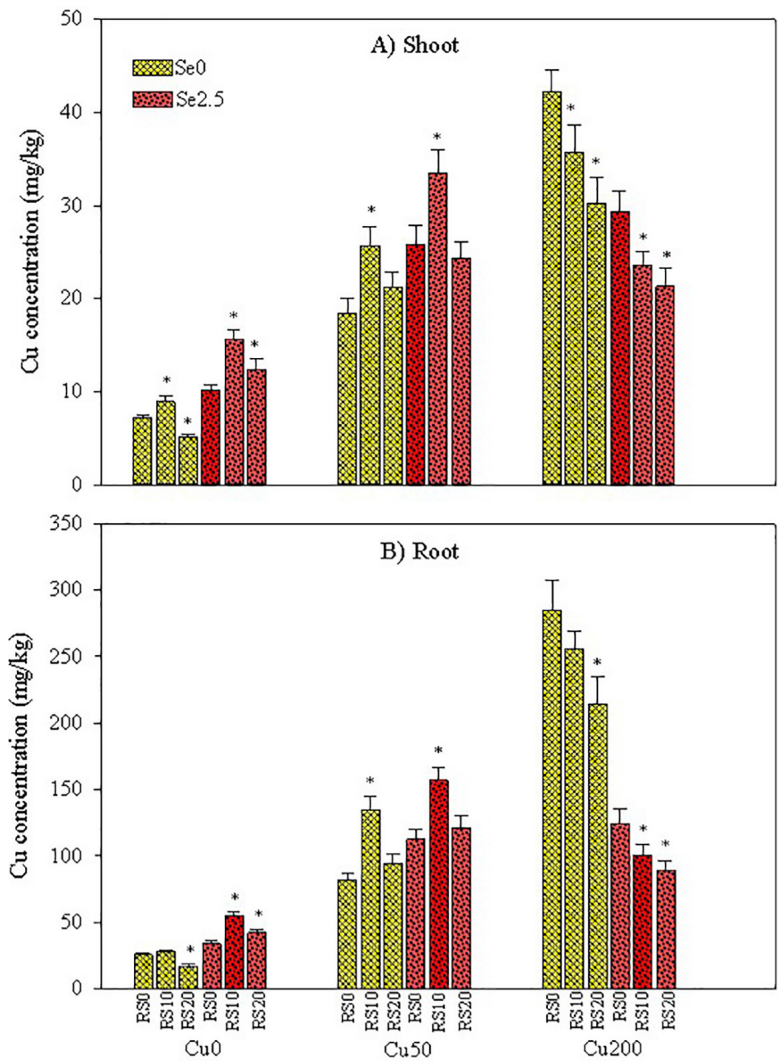
Data were subjected to statistical analysis using SPSS 20.0 software. All results are presented as the mean ± standard deviation of three replicates. This study used Dunnett's multiple comparison test of one-way ANOVA. For all tests, P < 0.05 was considered as significant difference.

3. RESULTS

3.1. Effect of RS combined with Se application on pak choi growth under Cu stress

The effects of single Cu treatment and applied RS and Se treatments on pak choi growth are shown in Fig. 1. The shoot dry weight and root dry weight of pak choi for single Cu treatments at 50 mg/kg slightly increased by 16.8% and 16.7%, respectively, compared with the control treatment. Conversely, they decreased by 28.6% and 27.1% for single Cu treatments at 200 mg/kg, respectively, compared with single Cu treatments at 50 mg/kg. These results suggested that high Cu concentrations (exceeding the standard) inhibited the growth of pak choi.

For Cu and RS co-exposure treatments, the shoot dry weight of pak choi not significantly increased by 2.4 - 6.7% and 4.8 - 13.3% for applied RS treatments with 10 and 20 g/kg, respectively, compared with single Cu treatments ($P > 0.05$). However, the root dry weight significantly increased to 16.7 - 30.0% for applied RS treatments with high content (20 g/kg) ($P < 0.05$), compared with non-amended RS. Similarly, a dramatic increase (21.1 - 25.0%, $P < 0.05$) for Cu - RS and Se co-exposure treatments at 50 mg/kg Cu and 2.5 mg/kg Se was observed, especially applied RS treatments with high content (20 g/kg), compared with co-exposed Cu - Se treatments. However, no significant increase ($P > 0.05$) was found for shoot dry weight and root dry weight of pak choi at high Cu concentrations (200 mg/kg) for Cu - Se and RS co-exposure treatments, compared with co-exposed Cu - Se treat-



▲ **Figure.2** The concentrations of Cu in pak choi tissues: in shoot (A), in root (B). Data are presented as means \pm SD ($n = 3$). Stars indicate significant difference from no rice straw treatments (One-way ANOVA, followed by Dunnett's test, * $P < 0.05$).

Table 2: Copper, selenium and rice straw concentrations in single and combined treatments

Treatment	Concentrations			Treatment	Concentrations			Treatment	Concentrations		
	Cu	Se	RS		Cu	Se	RS		Cu	Se	RS
Cu0Se0RS0	0	0	0	Cu50Se0RS0	50	0	0	Cu200Se0RS0	200	0	0
Cu0Se0RS10	0	0	10	Cu50Se0RS10	50	0	10	Cu200Se0RS10	200	0	10
Cu0Se0RS20	0	0	20	Cu50Se0RS20	50	0	20	Cu200Se0RS20	200	0	20
Cu0Se2.5RS0	0	2.5	0	Cu50Se2.5RS0	50	2.5	0	Cu200Se2.5RS0	200	2.5	0
Cu0Se2.5RS10	0	2.5	10	Cu50Se2.5RS10	50	2.5	10	Cu200Se2.5RS10	200	2.5	10
Cu0Se2.5RS20	0	2.5	20	Cu50Se2.5RS20	50	2.5	20	Cu200Se2.5RS20	200	2.5	20

* Cu (mg/kg); Se (mg/kg); RS (g/kg).

ments. These results indicated that the supplementation of Se in Cu-RS co-exposure treatments enhanced pak choi growth.

3.2. Effects of exogenous RS combined with Se on Cu bioavailability in soil

Cu concentrations in various parts of pak choi for different treatments are shown in Figure. 2. Cu concentrations in shoots and roots were 7.2 and 25.6 mg/kg in the control treatment, respectively, and reached up to 42.2 and 284.3 mg/kg, respectively, in single Cu treatment at 200 mg/kg (i.e., 5.9 and 11.1 - fold of control treatment, respectively).

For Cu and RS co-exposure treatments, the Cu concentrations in the shoot and root of pak choi dramatically increased ($P < 0.05$) by 39.7% and 64.3%, respectively, with low RS contents at 10 g/kg and low Cu treatments at 50 mg/kg, compared with single Cu treatments. However, the Cu concentrations in the shoot and root of pak choi not significantly decreased ($P > 0.05$) by 29.2% and 32.8%, respectively, compared with non-amended RS, with high RS contents at 20 g/kg and

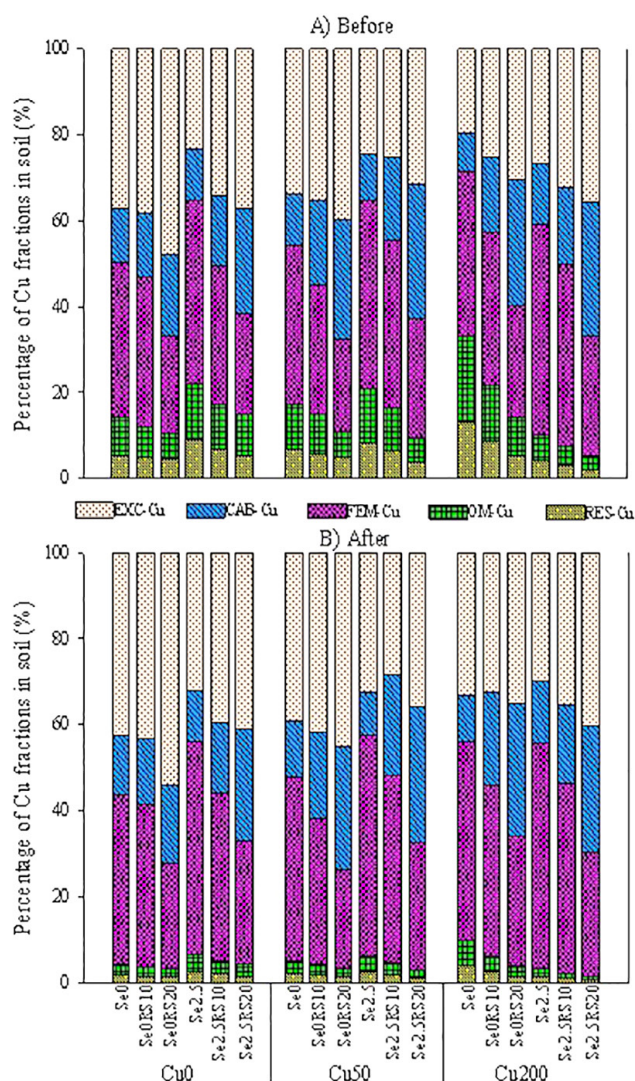
low Cu treatments at 50 mg/kg. The significant decrease ($P < 0.05$) in Cu concentrations in the shoot and root of pak choi was found among different Cu and RS co-exposure treatments at high Cu levels (200 mg/kg); indicating that added RS decreased the bioavailable Cu for plants. Similarly, with Cu-RS and Se co-exposure, at low Cu concentration (50 mg/kg), the Cu concentrations in the shoot and root of pak choi significantly increased ($P < 0.05$) by 21.7 - 29.8% and 39.9 - 43.1%, respectively, with low RS contents at 10 g/kg; conversely, the Cu concentrations in the shoot and root of pak choi no significantly decreased ($P > 0.05$) with high RS contents at 20 g/kg, compared with co-exposed Cu-Se treatments. In particular, in Cu-treated soils at 200 mg/kg, the Cu concentrations in the shoot and root of pak choi dramatically decreased ($P < 0.05$) from 12.5 - 27.6% and 19.4 - 35.3%, respectively, compared with co-exposed Cu-Se treatments and the significantly high value was observed at RS 20 g/kg. This finding suggested that RS and Se co-exposure can significantly inhibit Cu bioavailability in soils.

3.3. Changes in Cu fractions for different RS combined with Se applications

The distributions of Cu fractions in soils with different dosages of RS, Cu and Se are presented in Fig. 3. Cu fractions were arranged following the sequential mobile levels, namely, EXC - Cu, CAB - Cu, FEM - Cu, OM - Cu and RES - Cu.

Before planting, Cu primarily existed in FEM - Cu (36.1%) and RES - Cu (37.1%) fractions in native soil (control). The other stable fraction (OM-Cu) also accounted for 12.7% of the total soil Cu, whereas the mobile fractions were low (5.3% for EXC - Cu and 8.8% for CAB - Cu). When exogenous Cu was amended, the proportions of EXC - Cu and CAB - Cu fractions increased by 32.1% and 17.0% at low Cu concentration (50 mg/kg), respectively; whereas significantly increased from 2.5 - fold to 2.3 - fold at high Cu concentration (200 mg/kg), compared with the control experiment. Conversely, a significant decrease in RES - Cu fraction (19.6%) was observed; meanwhile, the proportions of FEM - Cu fraction still accounted for dominance in soil (38.3%) at high Cu levels (200 mg/kg).

When soils were simultaneously exposed to Cu and RS, the proportion of



▲ **Figure 3.** The Cu fractions proportions in soils before planting (A) and after harvest (B).



OM - Cu and RES - Cu fractions increased to 16.5 - 97.7% and 3.5-28.6%, respectively, compared with non-amended RS at low RS contents (10 g/kg). The proportion of OM - Cu and RES - Cu fractions markedly increased to 50.4 - 233.0% and 17.5-55.6%, respectively, compared with non-amended RS at high RS contents (20 g/kg). By contrast, the proportion of EXC-Cu, CAB-Cu and FEM - Cu decreased to 5.7 - 57.7%, 12.6 - 56.7% and 3.6 - 42.2%, respectively, compared with Cu - alone treatments.

These results suggested that RS can enhance Cu binding in soils as well. For co-exposed Cu-RS and Se treatments, the distributions of Cu fractions also change following a similar trend. The proportions of OM - Cu and RES - Cu markedly increased to 24.5 - 187.0% and 4.5 - 59.0%, respectively, those of EXC - Cu, CAB - Cu, and FEM - Cu decreased to 20.0 - 55.3%, 18.5 - 52.8% and 3.9 - 50.0%, respectively, compared with co-exposed Cu - Se treatments. These results further indicated that exogenous Cu - RS and Se co-exposure can inhibit Cu accumulation.

After harvest, Cu tended to transfer into FEM - Cu, OM - Cu and RES - Cu fractions for all treatments. Compared with those in soils before planting, the proportion of FEM - Cu, OM - Cu and RES - Cu increased by 4.3 - 20.7%, 1.2 - 23.2% and 9.9 - 29.0%, respectively; whereas the proportions of EXC-Cu and CAB-Cu considerably decreased to 68.9 - 71.7% and 68.6 - 73.3%, respectively, in co-exposed Cu - RS and Se treatments, corresponding with those in soils before planting; suggesting that Cu became less mobile with time and its bioavailability in soils significantly decreased.

3.4. Correlation between different Cu fractions in soil with uptake of Cu and pak choi growth

^{*}*P* < 0.05, ^{**}*P* < 0.01, *n* = 18. Cu (shoot): Cu concentration in shoot; Cu (root): Cu concentration in root; DW (shoot): shoot dry weight; DW (root): root dry weight.

To consider the effect of changes in Cu fractions on Cu bioavailability in soils and pak choi growth, we analyzed the correlations between them (Table 2). Results showed that the uptake of Cu by roots was significantly positively correlated with EXC - Cu and CAB - Cu fractions (*R*² > 0.45, *P* < 0.05), whereas significantly negatively correlated with RES - Cu fraction (*R*² > 0.65, *P* < 0.01) and no correlated with OM - Cu and FEM -

Cu fractions (*P* > 0.05) for before planting treatments. A similar trend was observed for after harvest treatments, however, these correlations decreased less (*R*²_{after harvest} < *R*²_{before planting}). This analysis only occurs the correlation for the mobile fractions, such as EXC - Cu and CAB - Cu fractions, because their high availability and easy absorption by plants. Whereas the semi-mobile fractions had lower availability, such as FEM - Cu and OM - Cu fractions, showed that no correlation, because they almost only exist in soils. Moreover, the change of the the proportions of FEM - Cu and OM - Cu fractions also is affected by the OM content, pH, clay minerals in soil. For pak choi growth, results showed that shoot dry weight and root dry weight of pak choi was significantly positively correlated with OM - Cu and RES - Cu fractions (*R*² > 0.5, *P* < 0.05; except OM - Cu with dry weight shoot), whereas significantly negatively correlated with EXC - Cu, CAB-Cu, and FEM-Cu fractions (*R*² > 0.5, *P* < 0.05; except FEM-Cu with dry weight shoot) for before planting treatments. However, after harvest, this correlation decreased less. The result of the correlation analysis suggested that the Cu fractions between before planting and after harvest can predict uptake Cu capability by pak choi and pak choi growth.

4. DISCUSSION

The bioavailability and mobility of Cu is affected by the OM content, pH, clay minerals, metal oxides, and other factors (Zhao et al., 2014; Adrees et al., 2015; Printz et al., 2016).

4.1. Effect of exogenous Cu alone on Cu bioavailability in soil

In the present study, the experimental soil was clay loam soil comprising phyllosilicate minerals rich in silicon and aluminum oxides and hydroxides (materials and methods). Cu does not exist as ion in soil,

Table 3. Correlation between copper fractions in soil with the uptake of copper by pak choi and pak choi growth

Correlation coefficient	Before planting					After harvest				
	EXC -Cu	CAB -Cu	FEM -Cu	OM -Cu	RES -Cu	EXC -Cu	CAB -Cu	FEM -Cu	OM -Cu	RES -Cu
Cu (root)	0.494 [*]	0.514 [*]	0.148	0.018	-0.658 ^{**}	0.473 [*]	0.494 [*]	0.186	0.132	-0.572 [*]
Cu (shoot)	0.394	0.407	0.279	0.023	-0.716 ^{**}	0.375	0.382	0.300	0.122	-0.690 ^{**}
DW (root)	-0.809 ^{**}	-0.802 ^{**}	-0.528 [*]	0.731 ^{**}	0.606 ^{**}	-0.822 ^{**}	-0.810 ^{**}	-0.631 ^{**}	0.663 ^{**}	0.409
DW (shoot)	-0.639 ^{**}	-0.628 ^{**}	-0.333	0.452	0.507 [*]	-0.636 ^{**}	-0.637 ^{**}	-0.398	0.307	0.423

and most Cu is adsorbed by iron and aluminum oxides in Cu^{2+} - O - Fe^{3+} or Cu - O - Al forms (Banuelos and Lin, 2005), thereby decreasing its mobility. Moreover, according to the principle of hard and soft acids and bases, the “classic” trace metals (Cu, Co, Ni, Al, Cd and Zn) have strong binding abilities with hard ligands (O - containing functional groups). Therefore, the fractions of Cu in native soil are primarily FEM - Cu (36.1%) and RES - Cu (37.1%) fractions. However, in Cu exposure, Cu tends to increase in mobile fractions. At low added Cu concentrations (50 mg/kg), the proportions of EXC - Cu and CAB - Cu fractions increased by 32.1% and 17.0%, respectively, compared with the control experiment (Figure. 3). Thus, pak choi may actively uptake Cu as nutrients to support growth, which increased by 16.8% and 16.7% in the shoot and root dry weight of pak choi, respectively, compared with the control treatment (Figure. 1). This conclusion was completely consistent with that of Feng et al. (2018), who studied a hydroponic solution at low concentrations (50 - 100 μM). At high added Cu concentrations (200 mg/kg), the proportions of EXC - Cu and CAB - Cu fractions significantly increased from 2.5 - fold to 2.3 - fold compared with the control experiment (Figure. 3). Meanwhile, the RES - Cu fraction significantly decreased (19.6%) (Figure. 3). Cu concentrations in shoots and root increased reached up to 5.9 - and 11.1 - fold in the treatment of 200 mg/kg Cu compared with the control treatment, respectively (Figure. 2). This phenomenon caused the shoot dry weight and root dry weight of pak choi to decrease by 28.6% and 27.1%, respectively, compared with single Cu treatments at 50 mg/kg (Figure. 1). However, the proportions of FEM - Cu fraction still accounted for dominance in soil (38.3%) at high Cu levels (200 mg/kg) (Figure. 3). Similar results have been obtained in other studies. For example, Luo et al. (2003) found that Fe-Mn oxidate Cu was the dominant fraction in Cu-polluted soil, whereas residual Cu was dominant in unpolluted soil.

4.2. Effect of Cu - RS and Se co-exposure on Cu bioavailability in soil

Soil OM content plays a very important role in the mobility and availability of Cu in soil by strong affinity with Cu (Bravin et al., 2009; Li et al., 2013; Laurent et al., 2020). On one hand, OM can enhance the

complexation, sorption and precipitation of trace metals in soil and thus reduce their mobility (Warne et al., 2008). On the other hand, it can enrich soil solution with organic chemicals that may act as chelates and enhance the bioavailability of trace metals (Zhao et al., 2015). Meanwhile, for Cu and RS co-exposure treatments, Cu concentrations in pak choi tissue dramatically increased ($P < 0.05$) with low RS contents at 10 g/kg and single Cu treatments at 50 mg/kg (Figure. 2). The addition of RS often modulates Cu (as nutrients) uptake by secreting root exudate, which increases small organic ligands in the rhizosphere (Tao et al., 2003; Qin et al., 2004; Krumins et al., 2015), thereby facilitating trace-Cu mobilization from OM-Cu fraction. Indeed, the proportion of OM-Cu fractions increased to 16.5 - 97.7%, compared with non-amended RS at low RS contents (10 g/kg) (Figure. 3). Given that RS was decomposed by microbes into some micro-organic materials through gut digestion, these micro-organic materials could chelate soil Cu ion and thus increase the quantity of soil available Cu (Christensen et al., 1996).

However, Cu mobility and bioavailability decreased in the presence of high OM content (Beesley et al., 2010). This finding was due to the high affinity of OM for Cu in soil (Vlček and Pohanka, 2018), which forms very strong complexes with Cu (Araújo et al., 2019; Conde - Cid et al., 2019). Accordingly, the OM - Cu complex was generally the most predominant form, and the proportions of OM - Cu fractions markedly increased to 50.4 - 233.0%, compared with non-amended RS at high RS contents (20 g/kg) (Figure. 3). Some studies have reported that about > 90% of the total soil Cu was found as OM - Cu form depending on Cu concentration in Cu-contaminated soil solutions (Rutkowska et al., 2013). Accordingly, Cu concentrations in the shoots and roots of pak choi were decreased by 29.2% and 32.8%, respectively, at low Cu concentration (50 mg/kg) and they significantly decreased ($P < 0.05$) at high Cu concentration (200 mg/kg) (Fig. 2). Thus, the shoot dry weight and root dry weight of pak choi increased by 4.8 - 13.3% and 16.7 - 30.0% for applied RS treatments with high content (20 g/kg), respectively (Figure. 1). For the Cu - RS and Se co-exposure treatments, Cu-Se compounds may combine more with the dissolved OM in the rhizosphere and then form much larger Cu-Se complexes to further reduce Cu bioavailability (Chissasson-Gould et al., 2014), leading to the proportions of OM - Cu and RES - Cu markedly increased to 24.5 - 187.0% and 4.5 - 59.0%, respectively, compared with co-exposed Cu-Se treatments (Figure. 3). Cu concentrations in the shoot and root of pak choi dramatically decreased ($P < 0.05$) from 12.5 - 27.6% and 19.4 - 35.3%, respectively, in Cu-treated soils at 200 mg/kg at RS 20 g/kg (Figure. 2).



4.3. Effect of time on Cu bioavailability in soil with Cu-RS and Se co-exposure

After harvest, the distributions of Cu fractions changed according to the influence of RS and Se similar to the case before planting. However, Cu tended to transfer more into FEM - Cu, OM - Cu and RES-Cu fractions with increased proportions of FEM - Cu, OM - Cu and RES - Cu to 4.3 - 20.7%, 1.2 - 23.2% and 9.9 - 69.4%, respectively, compared with those in soils before planting, in Cu - RS and Se co-exposure treatments (Figure. 3). This finding agreed with a previous conclusion asserting that Cu can transform from exchangeable to stable fractions within the amendment time (Lu et al., 2009). Specifically, the exogenous heavy metals that adsorbed onto the surface of solid soil as the exchangeable form rapidly entered the soil environment and then slowly transformed into other stable forms with time (Jalali & Khanlari, 2008). Soil pH was very low, reaching only 3.7 (materials and methods); thus, the mobile and semi-mobile fractions can be dissolved with time, releasing Cu^{2+} ions and increasing free Cu^{2+} ions (Chopin & Alloway, 2007). These free ions tend to combine with stable fractions by strong binding affinity with S^{2-} , resulting in increased RES - Cu fractions (Figure. 3). The presence of RS also increased the OM content of rhizospheric soil by the time, which can form Cu complexes and inhibit Cu mobility and bioavailability, leading to increased proportion of OM - Cu (Bloom and Preus, 2003; Reis et al., 2010; Reis et al., 2016) (Figure. 3). Moreover, with low-pH soil, plants developed various strategies such as secreting organic extrudes by the time (Chaignon et al., 2009; Cui et al., 2017). With the addition of RS in soil, Fe plaque on the epidermis was sequestered, the proportion of FEM - Cu increased (Feng et al., 2018) (Figure. 3), and a biomineralization rim was generated on root epidermis (Medas et al., 2015) to reduce Cu mobility. Therefore, Cu mobility in soil decreased after harvest and its uptake was restricted in plants.

5. CONCLUSION

This study aimed to investigate the effects of the application of RS combined with Se on the Cu bioavailability in pak choi. RS combined with Se may play an important role in prevent Cu uptake by pak choi tissue at excessive concentrations (200 mg/kg) through transformations into immobile Cu fractions. Notably, this inhibition may significantly occur only when RS were at appropriate levels (20 g/kg). Conversely, RS combined with Se increased the Cu concentration in plant and promoted pak choi growth at low Cu concentrations (50 mg/kg)■

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Conservation of wild birds through ecotourism activities



▲ Mr. Nguyễn Hoài Bảo - Director of Wildtour Company

With a love for nature in general and wild birds in particular, since 2005, Mr. Nguyễn Hoài Bảo has decided to establish Wildtour Research and Tourism Company Limited (Wildtour Company) to introduce the beauty of Vietnam's birds to the world. In addition, the Company specializes in carrying out research activities on ecology, conservation and environmental protection projects.

To learn about the Company's activities in environmental protection and biodiversity conservation, Vietnam Environment Administration Magazine (VEM) had an interesting conversation with Mr. Nguyễn Hoài Bảo - Director of Wildtour Company, who is also a lecturer at the University of Sciences - Việt Nam National University Hồ Chí Minh City.

VEM: *It is known that Wildtour is the first company in Việt Nam to provide bird watching tours. So please tell me, from what idea did you decide to establish Wildtour Company?*

Mr. Nguyễn Hoài Bảo: Việt Nam has more than 900 bird species, of which many rare species are listed in the IUCN Red list. I started studying birds in 1999 when I was a 3rd year university student. After a few years of research, I know that the beauty and diversity of birds in Việt Nam has attracted the attention of many nature lovers around the world. Therefore, in 2005, I decided to establish a company specializing in providing bird watching tours, in order to introduce the beauty of Vietnam's birds to the world community. At that time, bird watching was a very popular outdoor activity in developed countries such as Western Europe and North America, but it was still a very strange thing in Việt Nam. Therefore, some relatives and friends tried to dissuade, they did not believe that anyone would accept to spend money just to see birds. However, I myself have been asked by some international friends for a guide to endemic bird areas in Việt Nam, from which I believe that Việt Nam is a potential destination for bird "believers" around the world.

Birdwatching tour is an activity of observing and learning about birds in the wild, and can record and name observed species. Bird watching can be done with your eyes or through a number of supporting devices: binoculars, telephoto lenses, recorders... This is not a scientific study but just a "sport" - entertainment that comes from each person's passion. Bird watching tourism has appeared for a long time in the world but has not been widely popular because it is quite difficult and expensive for participants.

Europeans are very fond of traveling and learning about birds, especially English, Swedish, Danish and Dutch. Since the early 90s, when Việt Nam opened, tourists have been interested in bird tours. They come to see and take pictures of Vietnamese birds, especially the beautiful and endemic birds that occur only in Việt Nam. Recently, when digital photography has grown strongly, Asians participating in bird photography tours have also increased, so many visitors from Singapore, Thailand, Japan and Taiwan are emerging markets.

Most of Wildtour's clients are foreigners, some are experts in ecology, some have nothing to do with the profession, but all have the same passion for learning and studying birds. Bird watching in Việt Nam is quite difficult because most of the bird areas are far away and not easy to access. To see some endemic species, visitors have to go into deep forest, climb high mountains, to places where very few people set foot. The price of bird watching tour is also very expensive, from a few million VND for a trip of 1 - 2 days/person to tens of millions, even up to hundreds of millions of VND if it lasts a whole month for visitors who want to see the whole endemic bird area. Each year, the company only organizes about 20 bird watching tours due to the rainy months. Bird watching today has become a tourism trend that



brings great revenue to countries if they know how to properly exploit it. In addition to financial income, bird watching tourism also brings many other values such as arousing love of nature, thereby increasing the awareness of environmental protection for both visitors and local people.

VEM: *Can you share international experiences in building a model of wildlife conservation through ecotourism?*

Mr. Nguyễn Hoài Bảo: There are many bird conservation models in the world that have achieved great success. The most typical example can be mentioned as the conservation of birds of Paradisaeidae in New Guinea through ecotourism activities. Birds of Paradisaeidae are a family of 39 most beautiful, intelligent and rare birds in the world. Indigenous tribes often use their feathers to decorate hats, costumes, weapons, houses..., they are exchanged as jewelry and have a high price in the market, so these species have been mercilessly hunted. Recently, with the development of this type of bird photography tourism, the indigenous tribes gradually gave up the habit of hunting them to sell for money, on the contrary, they protect them and earn extra income. From serving local tourists to visiting and photographing birds of Paradisaeidae...

In Cambodia, a country nearby, there is a conservation program for the giant ibis and white-shouldered ibis in combination with ecotourism in the village of Tmatbouy, Prea Vihear Province. Specifically, the great ibis (*Pseudibis gigantea*) and the white-shouldered ibis (*Pseudibis davisoni*) are two species of birds listed as critically endangered due to hunting and loss of dipterocarp forest habitat. Both species are also recorded in Yok Đôn National Park of Việt Nam, but in very small numbers. To protect these two species, the Cambodian Government together with WCS and the local community have established an ecotourism program in Tmatbouy village in Kulen Promptep Reserve. The program has attracted many international bird-watchers to visit. This activity not only helps restore the populations of two species that are almost globally extinct, but also helps create the livelihoods of many local communities thanks to tourism-related activities such as guesthouses, restaurant and tour guide for international visitors to bird watching.

In Việt Nam, every year more than 1,000 international visitors come to take pictures of the striped-bellied penguins in Cát Tiên National Park. If we calculate the cost of 250 USD/person/day and stay at least 3 days in Việt Nam, the revenue from this bird so far, we have calculated no less than 1 million USD. But this cost cannot compare with the way in Hokkaido, Japan attracts a few thousand people a year to take pictures of cranes and has to register in advance because of the large number of people. Or when I went to take pictures of an Australian penguin, the lowest ticket price was 25 USD, the highest was 75 USD, but the number

of people taking pictures was full of the whole stadium.

Previously, sarus cranes were abundant in Đồng Tháp, now they have to go to Cambodia to take pictures for 15 USD/time excluding other travel expenses. Thailand now spends millions of dollars a year to restore the sarus cranes. Nowadays, the world is exploiting nature in a long and sustainable way, while in our country, the nature is left open for hunting and extermination of birds. We often exhort people to protect the environment and conserve biodiversity, but we don't prove that there is benefit from conservation activities. Moreover, the tourists' love of nature and environmental protection habits can also wake up the local people. Therefore, local people will pay more attention to environmental protection of birds and other species' habitat.

VEM: *Besides ecotourism activities, can you introduce some other activities of the Company?*

Mr. Nguyễn Hoài Bảo: During the 2 years of the epidemic, wildlife tourism activities were temporarily shelved. The company's main activities in recent years have focused on environmental impact assessment of projects, propaganda, education and advocacy for environmental protection and biodiversity. Some typical conservation projects can be mentioned as the Project of Conservation of Coastal Wetlands in the Mekong Delta with 2 phases. Phase 1 was carried out from 2019 - 2020 with the goal of studying the current status and identifying coastal wetlands which play important role for biodiversity in general and coastal migratory birds in particular. The results of this period show that the tidal flats in Cần Giỏi (Hố Chí Minh City), Gò Công (Tiền Giang), Ba Tri and Bình Đại (Bến Tre) are habitats that play a very important role for the survival of migratory birds. Phase 2 of the project will start from August 2021 to the end of 2023 with the main goals including: dissemination of the research results in phase 1 to stakeholders such as local people, Government agencies and scientists; development of the conservation measures needed to protect key wetlands for migratory birds with the participation of communities and local authorities; Development of plans and recommendations to propose to the government to establish new wetland protected areas.



▲ Mr. Nguyễn Hoài Bảo is training people near Bicloud National Park in bird - watching techniques

Furthermore, we also participated in the research project on using symbiotic fungi to restore forests in Lâm Đồng. This project has been implemented for 4 years with the cooperation of many units including Institute of Mushrooms and Biotechnology, Central Highlands Scientific Research Institute, Đa Nhim Protection Forest, University of Sciences - VNU Hồ Chí Minh City and The Mushroom Initiative (Hong-kong). With this project, we carried out study to inoculate symbiotic mycelium into some forest tree species to help the tree grow better and at the same time the mushroom can be to improve livelihood of local people and reduce pressure on the exploitation of forest resources. Keeping forests also increases the value of biodiversity, especially attracts birds to live to develop bird watching tourism for local communities, creating more jobs and income for them.

In addition, the Company also advises many wind electricity projects to minimize the project's impact on biodiversity such as in Quảng Trị, Ninh Thuận, Bình Thuận, Tiền Giang, Bến Tre, Trà Vinh and Bạc Liêu. Currently, the development of renewable energy, including wind electricity, is a hot issue in Việt Nam, but massive development without a specific assessment of its effects on the environment will lead to loss of biodiversity, especially birds and bats. Our studies as well as research around the world have shown direct and indirect effects on birds and bats, namely changes in habitat and collision on turbine blades kills a large number of birds and bats and can reduce biodiversity and unbalance the ecosystem. Therefore, all international financial institutions such as ADB, WB, IFC, KFW... require an environmental safeguard policy, in which the impact to biodiversity is minimized (IFC PS6) is a prerequisite when providing capital to wind electricity investors. With extensive experience and expertise in this area, based on baseline studies, we advise both

lenders and investors to develop a Biodiversity Management Plan (BMP) before constructing the project as well as biodiversity monitoring during operation.

VEM: From your Company's activities, what do you think about the status in Việt Nam and suggest solutions to conserve birds in particular and wildlife in general Việt Nam?

Mr. Nguyễn Hoài Bảo: Wildlife protection is a problem not only in Việt Nam but also in the whole world. From a backward agricultural country in combine with culture of hunting and gathering of forest products from the forest, we are gradually transitioning to an industrial economy. The habit of hunter-gatherer inherent in the community many years ago, today, when the economic structure changes, the people can't change their habit timely. A small part of the people living near the forest still maintain the habit of hunting and gathering because they have not been able to adapt to the new way of life. The most worrying issue today is that economic development activities that do not pay attention to the environment will lead to a lot of biodiversity loss that we can never recover, in which include habitat loss of wild species due to unsustainable urbanization and agricultural development.

The culinary culture of the Vietnamese has been deeply ingrained in our minds, most people think that wild bird meat is clean and nutritious and eating wild bird meat is stylish and aristocratic, so consumer demand is higher as more people



become rich. It is the great demand from people who have a lot of money and are willing to pay large amounts to buy those animals that have prompted many people to hunt more. Moreover, at present, our country's Law only punishes those who hunt and trade but do not handle consumers, so consumers are almost innocent, but they themselves are the cause of harm to the survival of wildlife.

Therefore, wildlife conservation in general and birds in particular needs the participation of the whole society while the state and relevant management levels need to take the lead as well as create a participation mechanism from many sectors. Businesses also need to have conservation activities to "pay back" for the impacts which caused by businesses activities. Under the current mechanism, only by establishing as many protected areas as possible can we hope to protect ecosystems and wildlife. We hope that the State will soon establish more wetland protection zones for coastal and alluvial lands near estuaries in Hải Phòng, Thái Bình and Hồ Chí Minh City, Tiền Giang and Bến Tre. In addition, there should be strict guidelines and regulations on environmental impact assessment of economic projects and strengthen Law enforcement in wildlife protection, especially with strict sanctions for wildlife traders and users.

In more civilized countries, people realize that wild birds play a very important role in human life, so they have no need to eat wild birds and so that birds can live freely next to people. There is one more thing that sounds paradoxical, but in fact wild bird meat is not "clean" as one might think, scientists have studied a lot about toxins that accumulate in the body of wild birds. Agrochemicals are transferred from small organisms to crabs, fish... and eventually accumulate in the highest organisms on the food chain such as birds so that toxic substances such as Dichlorodiphenyldichloroethylene (DDE) which are difficult to decompose in wild birds are several thousand times higher than in poultry. We need to promote propaganda to raise people's awareness about biodiversity protection in general and wildlife protection in particular ■

NGUYỄN HẰNG

ONLINE SEMINAR DISCUSSES SOLUTIONS TO ECOSYSTEM RESTORATION IN VIỆT NAM

Việt Nam needs to encourage and improve capacity and responsibility for the environment and nature and implement preventive actions in management agencies and businesses to minimize nature degradation.

At an online seminar on December of 2021, Dr. Nguyễn Đình Đáp from the Vietnam Academy of Social Sciences (VASS)'s Institute of Human Geography suggested, which focused on solutions to contribute to developing specific programs to promote rapid and sustainable development in Việt Nam. He said that assessing environmental degradation, global ecosystems and the United Nations Decade on Ecosystem Restoration, countries are working together to build a global strategic framework on biodiversity with the goal that by 2050 people will live in harmony with nature, biodiversity is valued, conserved, restored and wisely used.

While proposing solutions to restore Việt Nam's ecosystem and biodiversity in the context of the fourth industrial revolution, Prof. Dr. Đặng Huy Huỳnh - Vice President of the Vietnam Association for Conservation of Nature and Environment said to effectively implement restoration of ecosystems and biodiversity, it is necessary to promote nature-based socio-economic development in the principle of being in harmony with nature. Attention should be paid to living in harmony with nature in the process of developing national, regional and provincial plans; establishing more nature reserves, green corridors and biodiversity corridors; increasing investment of resources in finance, policy, science and technology, including attracting the participation of indigenous communities on the principle of happiness and peace for people, he said.

According to Prof. Dr. Đặng Huy Huỳnh, Việt Nam is currently facing the loss and rapid degradation of biodiversity. In the future, Việt Nam needs to train scientists, managers and technicians with specialized skills in restoring poor terrestrial and marine ecosystems, this is a crucial solution in restoring and enriching the ecosystem. In addition to natural causes, human activities have had a great impact on the destruction of nature. In the process of socio-economic development, a series of forests and natural covers have been invaded, causing the environment to be damaged and lose its protection function against natural disasters and extreme weather ■

NHẬT MINH



China publishes five-year tackling plastics pollution plan

China published a five-year plan outlining the Nation's Strategy for Tackling Plastics Pollution. The plan will see China's recycling capacity expanded, alongside the promotion of "green" plastic products. The plan also presents commitments to combat the overuse of plastics within the agriculture and packaging sectors.

As a nation that produces over 60 million tons of plastic annually, yet holds a recycling rate of just 30 percent, The National Development and Reform Commission (NDRC) stated in a notice that China was obligated to improve the entire chain of plastic pollution control. Attempts are already being made by the Chinese Government to tackle the issue of plastic waste. Major cities are being encouraged to introduce initiatives such as refuse sorting policies; the construction of industrial-scale recycling plants and the banning of single-use products, such as plastic straws and shopping bags, from being distributed by restaurants and e-commerce platforms. A solid waste law also came into effect last year, which saw fines for those illegally importing solid waste being raised tenfold, as well as the construction of modern recycling infrastructure being mandated. An NDRC spokesperson commented: "The essence of plastic pollution is that plastic waste leaks into natural environments like soil and water and is hard to degrade, causing visual pollution, soil damage, microplastics and other environmental hazards".

The action plan, jointly issued by the NDRC and the Ministry of Ecology and Environment, details measures to cut the production and use of plastics, develop alternatives for plastics and substantially reduce the amount of plastic waste in landfills and environmental leakage during the 14th five-year plan period (2021 - 2025).

According to the plan, by 2025, key sectors such as retail, e-commerce and express delivery, are expected to drastically cut the unreasonable use of disposable

plastics. The country will promote the use of alternatives to plastic, such as bamboo, wood, paper and degradable plastics. It will also ramp up research on degradable-plastic technologies and encourage the orderly development of related industries. The recycling and disposal of plastic waste will also be improved across the country, while plastic waste in key water areas, scenic spots and rural areas will be cleaned up.

In terms of combatting the overuse of plastics, the proposed plans will see a nationwide ban being imposed on the production of ultra-thin plastic bags, as well as on personal care products that contain plastic microbeads - these are currently already banned in the United States and much of Europe. The plans will also attempt to advance the recycling rates of agricultural plastic mulch to 85 percent, as the residues of the film material, which is typically used to conserve moisture and heat throughout China's Northern regions, have the potential to contaminate crops and reduce soil fertility. In tandem with reducing the usage of these plastics, the plan proposes that the Chinese Government commits to advocating the use of alternative products such as bamboo, wood, paper and biodegradable plastics.

As for the proposed increase in incineration capacity, urban incineration targets are to be set at 800,000 tons per day by 2025, according to the agenda - this would be an increase from 580,000 tons last year. Whilst the intention is that incinerators will divert plastic waste from polluting the environment, in particular aquatic and marine biomes, some would state that an increased incineration capacity also equates to an increased emissions capacity. Critics of incineration would also point out that many incinerators require plastic waste to be separated from the input material, in fact, in order to reduce the release of toxic gasses. So, in spite of the proposed expansion of China's combustion competency having the power to reduce the amount of plastic waste that ends up as litter, there is the contentious issue of an enlarged greenhouse gas (GHG) output■

HỒNG NHUNG



Asia Pacific Environment Ministers commit to bolstering actions for nature to realize the Sustainable Development Goals

Environment Ministers and senior officials from 32 countries in the Asia Pacific region have agreed to step up actions and place nature at the core of solutions to stem the tide of pollution, protect seas and biodiversity and transition to a carbon-neutral sustainable development path. The Ministers reaffirmed this commitment at the 4th Forum of Ministers and Environment Authorities of Asia Pacific held in Suwon, Republic of Korea on 6 - 7th October 2021. The Forum serves as a platform for the Member States and other stakeholders to contribute regional perspectives to the resumed 5th session of the United Nations Environment Assembly (UNEA - 5.2) and to the special session of the (UNEA to mark the 50th anniversary of UNEP, both taking place in 2022.

Ecosystem degradation and biodiversity loss are at critical thresholds in the region. Over 40 percent of coral reefs, and 60 per cent of mangrove forests have been lost in the past years. The region contributes to half of the world's greenhouse gas emissions and could generate about 1.4 billion tonnes of municipal solid waste by 2030. At the same time, the region is also more vulnerable to extreme weather events and future pandemics.

Speaking at the Ministerial Segment of the Forum, Minister of Environment of the Republic of Korea Han Jeoung-ae highlighted the urgent need to protect and restore nature to effectively address the triple planetary crisis of pollution, biodiversity loss and climate change. "The answer to overcoming the triple planetary crisis lies in nature. We can obtain sustainable energy from nature, use nature as carbon storage, restore nature to its original state and protect it. These are the actions we must start now for future generations", she said. The Republic of Korea has pledged to achieve carbon neutrality by 2050.

Ministers noted that while the COVID-19 pandemic had hampered the capacity of Asian countries to respond to the planetary crisis, it also offers an unprecedented opportunity to build back better. Government policies in response to COVID-19 can reinforce the linkages between human well-being, creation of green jobs and the health of ecosystems. They further underlined, developing countries require support to transition to greener, more sustainable development pathways post-COVID.

Speaking at the event, the UNEP's Deputy Executive Director Joyce Msuya emphasized the importance of the Forum: We know that nature-based solutions work and countries recovering from the COVID-19 pandemic now have a once in a lifetime opportunity to unlock their transformative power in a way that drives a sus-

tainable, green recovery. She challenged Governments to transform their relationship with nature and "work in the knowledge that if we look after nature, then nature will look after us".

While managing and recovering from COVID-19, Governments must not lose sight of addressing environmental challenges. Prime Minister of Samoa Fiamē Naomi Mataāfa said the pandemic was a wake-up call to protect nature and called for prioritization of the health of oceans and a coordinated and global response to halt biodiversity loss, marine litter and plastics pollution: "Much of the decline that our environment faces is reversible, but this requires bold and courageous decisions. The cost of inaction is too high a price to pay especially for future generations".

In the outcome document of the Forum, Ministers supported a common regional position for the upcoming session of the second session of the UNEA - 5.2 underscoring the need for stronger regional and global cooperation to combat transboundary challenges. A new resolution for an intergovernmental negotiating committee on marine pollution was proposed by Japan, while Indonesia and Sri Lanka proposed a resolution on sustainable lake management and nitrogen management, respectively.

To tackle the increasing unsustainable production and consumption rates in the region resulting in massive pollution, Indonesia and Singapore proposed to extend the 10-year framework of Programme on Sustainable Consumption and Production until 2030. Ahead of the Ministerial Forum, a Regional Youth Environment Forum, Major Groups and Stakeholders Meeting and a Science-Policy Business Forum took place. Speaking on behalf of the Children and Youth Major Group, Zuhair Ahmed Kowshik of Bangladesh called for an overall ecosystem restoration framework, stronger clean air partnership and for countries to include young people on negotiating teams ■

HOÀNG ĐÀN

World Biosphere Reserve: A model of sustainable socio-economic development



Prof. Dr. Nguyễn Hoàng Trí - National President of Vietnam MAB, Vietnam National Committee for (MAB)

On September 15th, 2021, within the framework of the 33rd session of the International Coordinating Council for the UNESCO Human and Biosphere Program held in Nigeria, two biosphere reserves Núi Chúa (Ninh Thuận Province) and Kon Hà Nừng Plateau (Gia Lai Province) of Việt Nam have been recognized in the World Network of Biosphere Reserve (BR). On this occasion, Vietnam Environment Administration Magazine (VEM) had an interview with Prof. Dr. Nguyễn Hoàng Trí - National President of Vietnam Program on Man and Biosphere (MAB), Vietnam National Committee for MAB about sustainable management of the BRs and orientations for the development of the BR network in the coming time.

VEM: Professor, in order to be recognized in World Network of BRs, what criteria should two BRs of Núi Chúa and Kon Hà Nừng Plateau of Việt Nam meet?

Prof. Dr. Nguyễn Hoàng Trí: Two BRs of Việt Nam as well as 714 BRs of 129 countries currently recognized that must satisfy 7 criteria to become a BR (according to Article 4, The Statutory Framework of the World Network of BR, adopted at the UNESCO General Assembly in 1995) is: (1) It should encompass a mosaic of ecological systems representative of major biogeographic regions, including a gradation of human interventions; (2) It should be of significance for biological diversity conservation; (3) It should provide an opportunity to explore and demonstrate approaches to sustainable development on a regional scale; (4) It should have an appropriate size to serve the three functions of BRs; (5) It should include these functions, through appropriate zonation (recognizing: a legally constituted core area or areas devoted to long-term protection, according to the conservation objectives of the BR, and of sufficient size to meet these objectives; a buffer zone or zones clearly identified and surrounding or contiguous to the core area or areas, where only activities compatible with the conservation objectives can take place; an outer transition area where sustainable resource

management practices are promoted and developed); (6) Organizational arrangements should be provided for the involvement and participation of a suitable range of inter alia public authorities, local communities and private interests in the design and carrying out the functions of a BR; (7) Implementation mechanism for management and conservation accepted by UNESCO (includes: Mechanisms to manage human use and activities in the buffer zone or zones; a management policy or plan for the area as a BR; a designated authority or mechanism to implement this policy or plan; programs for research, monitoring, education and training).

Being recognized as a BR has created many opportunities for us to access, apply initiatives and share experiences on natural resource management and sustainable socio-economic development.

BRs in Việt Nam are not only a title recognized by UNESCO but are gradually becoming a model of sustainable socio-economic development of the locality. This is a place of connection between humans and nature, where



knowledge accumulated during research can be applied to the conservation and development of present and future societies.

VEM: *It can be said that, over the past 20 years, Việt Nam has been recognized by UNESCO with a total of 11 BRs, becoming the country with the second largest number of BRs in Southeast Asia. So, what is your assessment after more than 20 years when Việt Nam joins the World Network of UNESCO BRs?*

Prof. Dr. Nguyễn Hoàng Trí: More than 20 years ago, Việt Nam had the first BR, Cần Giờ Mangrove Forest. Up to now, Việt Nam has a total of 11 recognized BRs, with a total area of more than 4.1 million hectares, accounting for about 12.1% of the country's total area. This is home to more than 2.3 million people and is also an area with extremely rich natural resources and biodiversity values.

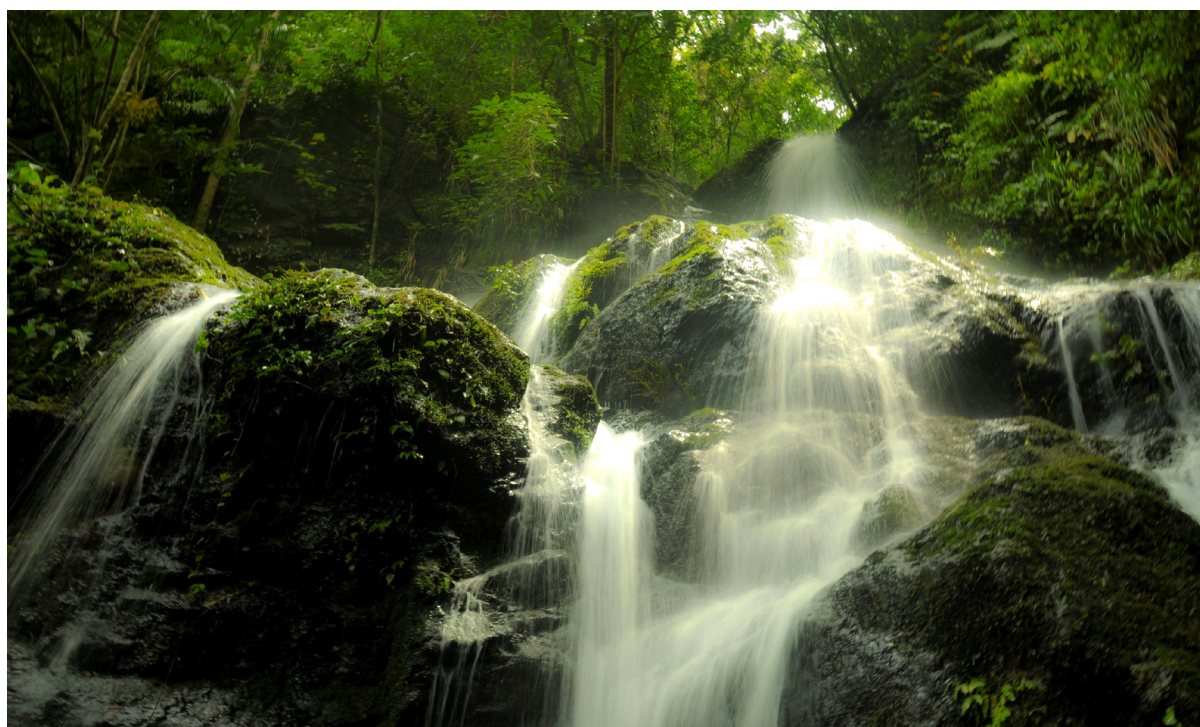
Looking back at the process of forming and developing the World Network of BRs in Việt Nam over the past 20 years, the BRs have an important meaning, demonstrating the implementation of the directives and guidelines of the Party and State about nature and biodiversity conservation, response to climate change. The development of the network of BRs is also in line with the trend of promoting cooperation between Việt Nam and UNESCO in the fields of heritage, global geopark and BR, towards sustainable development.

Over the past time, there have been many efforts of the BRs to implement the Lima Strategy

and Action Plan of the Human and Biosphere Program to improve livelihoods, biodiversity conservation, environmental protection and sustainable management of natural resources on the basis of respecting and maintaining traditional cultural values and identities. These efforts have made important contributions to the realization of the objectives of the National Strategy on Sustainable Development, Environmental Protection and Biodiversity as well as international commitments on environment to which Việt Nam is a member.

The results from the development and management of BRs in Việt Nam have been clearly demonstrated. Up to now, BR is not only a title recognized by UNESCO but is gradually becoming a model of sustainable socio-economic development of the locality. BRs are not only intended to conserve nature and biodiversity, but also serve as a connection between humans and nature, where knowledge accumulated during research can be applied to the conservation and development of present and future societies.

Việt Nam has taken advantage of UNESCO's knowledge, experience and resources to develop BRs in areas such as strengthening the legal corridor, strengthening management capacity, strengthening institutions and apparatus and improving



▲ Kon Hà Nừng Plateau Waterfall, Gia Lai Province



▲ *Black-shanked douc in Núi Chúa (Ninh Thuận Province)*

awareness and encouragement of community participation; Building and expanding the network of activities of Vietnam's BRs with other BRs in the region and the world, as well as a network of experts in the field of BRs...

At the same time, Việt Nam also actively participates and contributes to initiatives, operating models... of the World Network of BRs. Currently, Việt Nam is a member of the international MAB - ICC (term of 2017-2021). Some initiatives such as labeling the biosphere (Cát Bà BR, Đồng Nai, Kiên Giang, Tây Nghệ An), applying a green and low-carbon economic model (Cù Lao Chàm BR), reducing waste and do not use disposable plastic products... highly appreciated by UNESCO.

VEM: In your opinion, what does Việt Nam need to do to develop the BR in the coming time?

Prof. Dr. Nguyễn Hoàng Trí: Most of the protected areas and BRs are located in areas with high poverty rates, so achieving the goal of both conservation and economic development encounters many difficulties.

In addition, other barriers such as lacking of a common framework to implement integrated solutions in sustainable development; the organization and coordination of the participation of stakeholders in the BR are still not effective; the capacity for planning on the basis of landscape approach is not effective.

Therefore, the work of biodiversity conservation and the development of the world network of BRs needs to mobilize the participation of many Ministries/sectors, especially localities that own the BR, national and international conservation organizations; thereby contributing to the conservation of natural ecosystems, endangered and rare wild species, and protection of the biodiversity in Việt Nam and the world.

At the same time, countries need to properly implement the MAB Strategy 2015 - 2025 and the Lima

Action Plan 2016 - 2025 to achieve both conservation and economic development's objectives.

VEM: Currently, the Ministry of Natural Resources and Environment is collecting opinions to develop the Draft National Strategy on Biodiversity to 2030, with a vision to 2050, on this occasion, what suggestions do you have on this content?

Prof. Dr. Nguyễn Hoàng Trí: The MONRE is organizing consultations to develop the Draft National Strategy on Biodiversity to 2030, with a vision to 2025. Therefore, I would like to suggest to well implement the motto "conservation for development and development for the sake of conservation" in all recognized and unrecognized BRs. Because we cannot stop development for conservation, nor can we stop conservation for development, so it is necessary to develop an economy based on conservation. Where reputation and efficiency are preserved, that is the brand for economic development. Images of Cát Bà langur, Đồng Nai bison, Cù Lao Chàm snails... enter the minds of tourists - conservation messages on product labels add value to the commodity chain in the process of sustainable development of the country.

VEM: Thank you Professor!

NAM HÙNG



Ninh Thuận promotes sustainable development in Núi Chúa National Park marine protected area

Ninh Thuận Province have strengthened measures to conserve endangered and rare species of marine fauna and flora and sustainably restore and develop the ecosystem of the Núi Chúa National Park Marine Protected Area (NPMPA). The Provincial People's Committee issued a plan on the management of the Núi Chúa NPMPA in the 2021 - 2025 period with a budget of over VNĐ 3.3 billion (nearly US\$ 145,000), which will focus on activities to preserve the value of natural resources and cultural - historical relics, rationally exploit and promote the value of

the Marine Protected Area. The management of the Marine Protected Area will be carried out on an area of 7,352 ha.

The Provincial People's Committee requested the Núi Chúa National Park Management Board to strengthen the management and protection of the marine protected area in accordance with regulations on the management of marine protected areas in Việt Nam; coordinate with relevant departments and sectors to conduct scientific research, restoration and reproduction of aquatic species of fauna and flora and the natural marine ecosystem.

Ecotourism activities in the reserve must not adversely affect the environment of the marine protected area and ensure security and order in the maritime border area. Resources to be protected and managed include coral reef ecosystems and seaweed and sea-grass ecosystems. Priority will be given to endangered, precious and rare species of flora and fauna listed in the International Union for Conservation of Nature (IUCN) Red List and the Vietnam Red Data Book of Việt Nam.

The Núi Chúa National Park was recognized by UNESCO as a global biosphere reserve at the 33rd session of its International



▲ *Núi Chúa Biosphere Reserve, Ninh Thuận Province*

al Coordinating Council of the Man and the Biosphere Program (MAB-ICC). The 106,646-ha Núi Chúa Biosphere Reserve (BR) encompasses the terrestrial and marine areas of Ninh Thuận and is located at the end of the Trường Sơn Mountain Range. It is endowed with 1,511 species of flora, of which 54 are recorded in the Vietnam Red Data Book and the IUCN Red List. It is also home to 765 animal species including mammals, birds and amphibians, 304 species of corals, 188 types of seaweed, 147 species of fish, 115 species of molluscs and 80 species of crustaceans.

According to Director of the Management Board of the BR Trần Văn Tiếp, the unit has cooperated with domestic and foreign scientific research organizations to investigate and evaluate the potential and build data on marine resources and environment within the reserve as a basis for implementing projects on environmental protection and marine ecosystem restoration. The Management Board is implementing plans and solutions to effectively and sustainably protect sea turtle populations, their habitats and other endangered and rare aquatic species■

NGUYỄN HẰNG



Picturesque destinations in Gia Lai

The Legendary Province of Gia Lai in the North of the Central Highlands is still left largely untouched, combining riverine terrains with hilly slopes, waterfalls, rapids and primordial forests that prove so great for outdoor enthusiasts who crave for revenge travelling post-pandemic.

A land of volcanoes

Gia Lai has roughly 30 relics of inactive volcanoes. Their vestiges over hundreds of millions of years contribute to captivating natural gems ranked top among best scenes of Việt Nam and the world, including the Sea Lake, Chư Đăng Ya Volcano, Hàm Rồng Mountain or Ốp Hamlet Valley...

The Sea Lake is just 7km from Pleiku City and a natural freshwater Lake rising 800m from the sea level. This vast lake was formed out of three interconnected and inactive volcanic craters. Vestiges of larva and erupting coal ashes in prehistoric times contributed to the fecund basalt soil and extremely rich biodiversity all over meandering trails of hilly dunes, mist drenched lush green pine forests mirrored on the lake.

Chư Đăng Ya is another Paleolithic Volcano that towers over vast fields in Chu Pawh District, over 30km Northeast of Pleiku. From a bird's eye, the crater strongly resembles a huge tunnel surrounded by a concave being coffee farms and fields of maize, sweet potatoes, pumpkins... that adorn the lovely and picturesque surroundings. In particular, by the end of the year as Mexican sunflowers do abound from across the mountains up to dirt trails, making the volcano a huge swath of gleaming gold.

The heartland of towering waterfalls

The finest waterfalls toss up silver bubbles against the dark green backdrop of fleeting and grave old primordial forests. Some of these are Phú Cường Waterfall, Dream Waterfall, Nine Layered Waterfall, Three Layered Waterfall, Xung Khoeng Waterfall and a dozen of other waterfalls as part of the national parks of Kon Chư Răng and Kon Ka Kinh.

Phú Cường Waterfall is one of the finest ones of Gia Lai in Dun Commune, Chư Sê District. The waterfall glosses over vestiges of a volcanic crater, creating giant torrents falling up from the height of 45m. The spot is a must-visit for any journey to Gia Lai. Another wild, but equally imposing



▲ Chư Đăng Ya Volcano is one of the most interesting destinations of Gia Lai Province



▲ Đắk Đoa (Gia Lai)



▲ Kon Ka King plays important role in the protection of the upstream of the Ba River and the Đắk Pnê River

waterfall is the Dream Waterfall as a tributary of Pô Kô River that hosts the reservoir of Sê San 3A Hydroelectric Plant. It's a unique waterfall spilling over from up high onto layers of rocks below, creating colossal water stairs that further accentuate its distinct charm.

Unique pine forests and pink reed hills

Đắk Đoa (Gia Lai) boasts vast hills of pink reeds spanning up to hundreds of hectares that loom humbly in shady pine forests. The hills are collectively known as "Glar Valley of Pink Reeds" in Glar Commune, Đắk Đoa District, less than 20km from Pleiku City. In early wintertime under the leafy glade of pines, weeds come into radiant bloom of pink, draping hills in whole. These pink reed hills have recently emerged to be great camping and check-in sites on weekends ■

**QUỲNH HOA,
NHÂM HIỀN**



Thung Nham Bird Garden - the land of birds

Thung Nham Bird Garden (BG) ecotourist area is roughly 12km East of Ninh Bình City and fully nested within the core of Tràng An Natural Compound near the iconic Tam Cốc - Bích Động area. Thung Nham is also respectably known as the realm of birds and thus an appealing ecotourist area.

Spanning a total area of 334,2 ha, Thung Nham BG was restored and modeled in ecotourist architecture, including a fishing area, orchard tourist area, mangrove tours, primordial forests, caves, wild BGs and hiking services. The most notable spot is Thung Nham Bird Reserve. The Garden is a habitat for a number of species, including stork, crane, common starling, magpies, Eurasian teals and phoenix or Flamingo, all of which are classified in Red List.

Should time not matter, visitors may drop in other spots of Thung Nham BG, including Vải Giời Grotto, Buddha Cave, Mermaid Grotto, orchards, water palace grotto, the moving banyan,

the millennium old toothbrush tree or valley of love...

Vải Giời Grotto is perched atop mountains, spanning around 5,000 sqm and hosting numerous mystic stalactites. The Grotto is layered into three realms of the Mundane World, Heaven and Hell. Visitors to Thung Nham BG duly visit this Grotto to pray for a smooth journey.

The moving banyan is a perennial banyan tree spanning a thousand years. This banyan tree has moved three times around an ancient pagoda and was said to have taken over 300 years to complete the move by researchers and archeologists.

The orchards span over 80,000 sqm for a variety of fruits, including apples, guavas, star fruits, mangoes, persimmons, litchis or sugar apples... Here



▲ Thung Nham Bird Garden in Ninh Binh Province



▲ *This is a wild, beautiful landscape that is not available everywhere*



▲ *Visitor will feel free to get closer to nature*

visitors should feel free to get closer to nature, relish fine fruits and get engaged in farming like genuine farmers.

Buddha Cave is a natural cave stretching 500 m in Thung Nham BG. The Cave hosts an ossified stalactite of the Buddha sitting by a subterranean river. The Cave is dark without lighting system. Visitors are required to bring torches to facilitate the visit.

Thung Nham BG ecotourist area also is fully equipped with accommodation and catering services, including communal stilt houses, private stilt houses, a dining hall, meeting hall, karaoke room, swimming pool, huts around the lake to rest and drink... that prove well suited for visitors and guests.

The foods at Thung Nham BG are also big plus as they are rustic and well preserved, notably delicacies of the former citadel such as scorched rice, goat meat, grilled fish, steamed fish, chicken and organic vegetables and fruits. More specifically, all foods are subsistent at the complex, so visitors should be comfortable with their hygiene and sanitation and overall quality■

MINH THU, XUÂN THẮNG



Protects the parts of Hạ Long Bay

Covering an area of more than 1,500 square kilometers and with around 2,000 islets, this popular travel destination in Quảng Ninh Province was named a UNESCO World Heritage Site in 1994 and was recognized for its outstanding geological and geomorphological value by the World Heritage Committee in the year 2000. But over the years, the large amount of boats carrying both tourists and fishermen has taken its toll on the coral reefs below the surface. Climate change concerns have led to the authorities taking steps to preserve the reefs, which over the years have declined at a rapid rate.

Besides, Hạ Long Bay suffers from strong human impacts such as water transportation, tourism, fishing, mineral exploitation, wastewater... The coral ecosystem is very sensitive to the quality of the water environment. Coral reefs on Hạ Long Bay have undergone a long period of decline due to water pollution, fishing, raft farming and tourism. In 2006, a type of snail was discovered in the area that eats away at coral. In addition, climate change and the mutant development of *Drupella* snail, a species of coral eating snail discovered since 2006, also affects the degradation of coral reefs in Hạ Long Bay.

According to Deputy Head of Hạ Long Bay Management Board Phạm Đình Huỳnh, many measures have been put in place to protect the reefs, including banning fishing in Hạ Long Bay two years ago. He added, “we regularly observe and monitor the conservation of coral reef ecosystems to promptly detect threats and deploy protection and restoration solutions. We zone the areas of coral reefs with high coverage, from 30 percent or more, for strict protection. We also determine the location, coverage and species to build the database and map the coral area, thereby placing warning signs to prevent boats”.



▲ Coral are affected by water pollution, fishing, raft farming and tourism in Hạ Long Bay

Banning fishing in 2019 was a key regulation to protect the area. Unlike the more modern tourist vessels, many fishing boats do not have environmental protection equipment that prevents water pollution. Oil leakage and turbidity are one of the main causes of coral death. The Ban on fishing in the area also means preventing activities such as trawling, which will create a layer of sediment that kills coral reefs.

Mr. Phạm Đình Huỳnh said: “We also organize activities to protect the water environment of Hạ Long Bay such as informing and guiding boats not to anchor on coral reefs; preventing fishing activities in prohibited areas and strictly sanctioning acts of illegal fishing, especially when they using destructive tools. We organize teams to collect floating waste, especially garbage at the foot of the island or sandbank, where coral reefs are often distributed”.

Department of Business and Research, Ha Long Bay Management Board Phạm Lê Minh regularly dives the reefs to monitor their progress and clean up where necessary. He said: “From 2020, we started to organize dives to assess coral cover, with one or two trips a month. We want to participate in more in-depth monitoring and research training, to better meet the needs of my work. We hope our equipment such as underwater cameras will be upgraded and have foreign research organizations and agencies support research and conservation of corals”■

CHÍ VIỄN



▲ Divers prepare to dive to observe the coral reef in Hạ Long Bay



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