

**PRELIMINARY ASSESSMENT OF BIODIVERSITY / ECOSYSTEMS VULNERABILITY BY CLIMATE CHANGE AND SUGGESTION A SYSTEM OF MITIGATION MEASURES FOR THEM, CASE STUDY: HANOI CITY, VIETNAM**

**Doan Huong Mai<sup>1\*</sup>, Mai Dinh Yen<sup>2</sup>**

<sup>\*1, 2</sup> Faculty of Biology, Hanoi University of Sciences, VNU

**\*Corresponding Author:-**

**Abstract:-**

*In the paper, the authors applied the following items in order to assess the vulnerability of ecosystems / biodiversity of Hanoi city caused by climate change and to suggest a system of mitigation measures for them:*

- *The concepts on vulnerability, resilience, exposure, sensitivity, adaptation, mitigation according to guidelines of IPCC (2007).*
- *The impacts of climate change on ecosystems/biodiversity according to the results of researches of CBD experts (2009).*
- *Analysis the impacts of the factors of climate change on ecosystems/biodiversity according to the principles of ecological sciences.*
- *The characteristics of all 13 main ecosystems/biodiversity of Hanoi city are research results of the authors and our colleagues.*

*Preliminary assessment of ecosystems/biodiversity vulnerability by climate change of the 13 above main ecosystems/biodiversity of Hanoi city are:*

- *Group of ecosystems/biodiversity with high vulnerability: urban ecosystems, rural ecosystems, agricultural ecosystems, grassland ecosystems, land ecosystems yards outside the dyke.*
- *Group of ecosystems/biodiversity with middle vulnerability: nature lake ecosystems, dam ecosystems, wetland ecosystems, stream ecosystems, big river ecosystems.*
- *Group of ecosystems/biodiversity with low vulnerability: cave ecosystems, forest ecosystems.*

*A system of 7 mitigation measures must be applied, such as: to increase the sustainability of biodiversity/ecosystems, to reduce current pressure on biodiversity/ecosystems, to enhance community awareness, to actively implement REDD program.*

## OVERVIEW

Assessment of biodiversity/ecosystems vulnerability by climate change and suggestion a system of mitigation measures for them are urgent requirement for Vietnam.

Hanoi city is the capital of Vietnam, located in the Red River Delta region not far from the sea, with diverse terrain of 13 major ecosystems which are essential to assess the damage caused by climate change.

So far the assessment of biodiversity/ecosystems vulnerability by climate change and suggestion a system of mitigation and adaptation measures have not done much, common in countries around the world but in Vietnam, there is nothing to say, done only for some coastal ecosystems.

The authors of this report in the past have done more investigation/research on biodiversity/ecosystems in Hanoi, referred studies assessing the damage to biodiversity/ecosystems of foreign authors, make a preliminary assessment of the biodiversity/ecosystems in Hanoi due to climate change.

## METHODOLOGIES AND MATERIALS

1. Definitions: all concepts of vulnerability, exposure, sensibility, resilience, adaptive capacity are defined by IPCC, 2007.

The concepts of biodiversity, ecosystem, organism, population, community, ecological factors, ecological limits, biological productivity, ecological succession, ecological service, and ecological evolution... are from textbooks of Ecology and Biodiversity Conservation.

2. Climate change impacts on biodiversity/ecosystems through climate factors (called variables). The climate factors impact on biodiversity/ecosystems are considered as the ecological factors. The ecological factors affect individuals, populations, communities and ecosystems under the laws of ecology. The ecological impacts on biodiversity/ecosystems are divided into groups: abiotic, biotic, linear, non-linear, low limit, high limit, optimal point, independent of density, density dependent. Because of most of climate change impacts on biodiversity/ecosystems are harmful therefore they are often called vulnerability? The level of damage depends on the duration and intensity of suffering (exposure) of impact subject to the climate change variables. Biodiversity/ecosystem is characterized by adaptation, resilience, limited to changes in the ecological factors.

3. To get the oriented data results on the impacts of ecological factors on the organisms that need a lot of researches. So far most of data is on the qualitative level only and not at the full level.

4. All data of ecosystems/biodiversity of Hanoi is obtained from the survey/study of the authors and our colleagues which have done in the past. These materials are necessary to assess and update.

## CONTENTS

1. **Global climate change, climate change scenarios forecast by the Ministry of Natural Resources and Environment for Hanoi city:**

1.1. **Global climate change is confirmed by following factors:**

- Rise in temperature
- The increase of greenhouse gases (CO<sub>2</sub>, NO<sub>x</sub>, CH<sub>4</sub>, CFC...)
- Rise in sea levels, glaciers in the high mountains and polar melting
- Rainfall increases or decreases
- Sediment/erosion increases
- There are many extreme weather: floods, flooding, droughts, and storms, snow ... increase in frequency and intensity, unusually happened.
- Increase in interferences and other pressures: disease, forest fires, invasive species ...

1.2. **Climate change scenarios forecast by the Ministry of Natural Resources and Environment for Hanoi city**

Ministry of Natural Resources and Environment of Vietnam has made scenario of climate change for Vietnam including Hanoi on 3 factors: sea level, air temperature and precipitation, including low, medium and high levels of each decade until the end of 2100 (XXI century) are summarized in the average (B2) as follows:

- Rise in sea level: saltwater intrusion in the dry season up to the Hanoi's Red River.
- Temperature: rise in temperature (1,2-1,5)% in the period 2000-2019 and (9,6-10,8)% in the period 2080-2099. The variation of the air temperature is not evident differentiation by region, between the mountains and deltas.
- Precipitation: annual rainfall has increased – B2 scenario. Rainfall increased (from 0.77 to 0.87)% in the period 2000-2019 and (4.6 to 6.64)% in the period 2080-2099. The increase is different between regions: Ha Dong area at least, the most Ba Vi. Wet season rainfall (months from V-X) increased compared with the background. Rainfall dry season (months from XI-IV) reduced compared with the background.

2. **13 major ecosystems of Hanoi (related to climate change)**

There are 13 major ecosystems in Hanoi city related to climate change, they are: urban ecosystems; rural ecosystems; agricultural ecosystems; ecosystems of hills, savannas, midlands; land ecosystems yards outside the dyke; river

ecosystems; nature lake ecosystems; wetland ecosystems; grassland ecosystems; cave ecosystems; dam ecosystems; stream ecosystems; forest ecosystems.

Each ecosystem is identified by location. All of these ecosystems have characteristics of wildlife biodiversity as well as biodiversity species and urgent problems of ecological environment.

### **3. Preliminary analysis of the damage to biodiversity/ecosystems of Hanoi due to climate change**

#### **3.1. Climate change impacts on biodiversity/ecosystems as research results of the Secretariat of the Convention on Biological Diversity (CBD)**

- Climate change will increase the pressure on biodiversity/ecosystems if it is under different pressures (housing division, lost/change housing, overexploitation, invasive of alien species, pollution ...).
- In certain limits of climate change, a number of species and ecosystems have demonstrated the ability to adapt, but many species and natural ecosystems proved negative impacts.
- The habitats such as freshwater habitats, wetlands, mangroves, coral reefs, ecosystems in Polar Regions and highlands, the tropical cloud forests are all sensitive/fragile to climate change impacts. The species in high mountains, endemic species have been identified as very sensitive/fragile, have narrow tolerance limits (limit of tolerance) because their distribution regions are narrow, limited dispersal opportunities, sensitivity to the "pressure".
- IPCC suggested that about 10% of species will be extinction species at high risk level whenever the average temperature on the earth is increased every 1°C. This is only true if the increase in temperature below 5°C in year.
- If the current climate change continues, the impact will increase risk and reverse many ecosystems and their ecological services. However, it is still unclear about the level of change and speed of climate change and the adaptation of biodiversity/ecosystems.
- The risk of biodiversity/ecosystems caused by climate change is only a preliminary assessment of international scientists at present therefore it is necessary to be continued studying to have more accuracies.

#### **3.2. The variables of biodiversity/ecosystems are considered to be sensitive and adaptive to the climate change**

Ecological factors of the climate change have impacted on biodiversity/ecosystems under the laws of Ecology: ecological individual, ecological population, ecological community, and ecological ecosystems. For each individual, each population, community, ecosystem there is ecological limits/ limit of resilience which is given for each particular ecological factors. The vulnerability caused by climate change to biodiversity/ecosystems is a combination of all impacts of ecological factors. There may be displayed here the variables of biodiversity/ecosystems which are considered to be sensitive and adaptive to climate change, including:

1. Geographical location, topography, geomorphology
2. Components of biodiversity/landscapes/habitats.
3. The economic species, endangered species, endemic species.
4. Community characteristics: richness, diversity, the balance, biological productivity, food webs.
5. Area, volume, biomass, ecosystem morphology.
6. The pressures on biodiversity/ecosystems: fragmentation, overexploitation, pollution, invasive species, social - economic projects ...
7. Current ecological services.
8. Succession status, evolution stage, sustainable property, ecological balance.
9. Current status of biodiversity/ecosystems management and conservation.

#### **3.3. The results of preliminary analysis of biodiversity/ecosystems vulnerability of Hanoi by climate change**

Biodiversity/ecosystems vulnerability by the climate change through the climate change variables means the damage of climate change to variables of biodiversity/ecosystems and the adaptability of biodiversity/ecosystems to climate change. There can be interpreted basically as follows:

- *Vulnerability* will be higher if the location near the sea, flat topography, and uncomplicated geomorphology.
- *Vulnerability* will be higher if components of biodiversity/landscapes/habitats are not diverse, monotonic.
- *Vulnerability* will be higher if number of economic species, endangered species, and endemic species are high.
- *Vulnerability* will be higher if community has low level of diversity, richness, biological productivity, food web.
- *Vulnerability* will be higher if area, volume, biomass of ecosystem are small, ecosystem form has twisting perimeter.
- *Vulnerability* will be higher if there are additional pressures on biodiversity/ecosystems: fragmentation, overexploitation, environmental pollution, invasive species, socioeconomic projects, planning projects with negative impacts.
- *Vulnerability* will be higher if the current ecosystem services are declining.
- *Vulnerability* will be higher if biodiversity/ecosystems are on the stage near pioneer, far from climax, less evolved, less sustainable, ecological imbalance.
- *Vulnerability* will be higher if current status of biodiversity/ecosystems management and protection is weak.

The analysis of biodiversity/ecosystems vulnerability by climate change in Hanoi on the above principles will give us following results:

- Artificial ecosystems are more vulnerable than natural ecosystems.
- Terrestrial ecosystems are more vulnerable than aquatic ecosystems.

- Ecosystems under high pressure are more vulnerable than ecosystems under low pressure.
- Unsustainable ecosystems are more vulnerable than sustainable ecosystems.
- Ecosystems near climax are less vulnerability than ecosystems far climax.

More specifically, applied to 13 major ecosystems/biodiversity of Hanoi according the vulnerability order from highest to lowest:

1. Urban ecosystems
2. Rural ecosystems
3. Agricultural ecosystems
4. Grassland ecosystems
5. Land ecosystems yards outside the dyke
6. Hill / savana ecosystems
7. Nature lake ecosystems
8. Dam ecosystems
9. Wetland ecosystems
10. Stream ecosystems
11. Large river ecosystems
12. Cave ecosystems
13. Forest ecosystems

#### **4. Suggestion a system of mitigation and adaptation measures to climate change for Hanoi city**

Vulnerability of biodiversity/ecosystems of Hanoi is basically very large although Hanoi is not coastal city but locates in Red river Delta. Except two artificial ecosystems to be habitats such as urban ecosystems and rural ecosystems, all 11 ecosystems are vulnerable. As the above analysis, to mitigate and adapt to climate change we have to invest to increase resilience of biodiversity/ecosystems and increase conservation/protection of biodiversity/ecosystems. Which can be summarized as the following measures:

- 4.1. There are good strategic management and biodiversity/ecosystems conservation.
- 4.2. To increase adaptive capacity (AC) of species and ecosystems, such as:
  - To reduce the pressures which are not related to climate, such as: pollution, overexploitation, fragmentation and loss of habitat, exotic species.
  - To expand the network of protected areas and species / to improve and strengthen management quality.
  - To stimulate adaptive management through strengthening surveillance system and evaluate the effectiveness of management.
- 4.3. To supplement, continue planting, facilitate migration, reproduction, ex-situ conservation ... to conserve all species... support for in-situ conservation.
- 4.4. To have the REDD program (Reducing emissions from Deforestation and Forest Degradation) in order to reduce climate change and biodiversity conservation.
- 4.5. It is very necessary to carry out researches on the impacts of climate change to biodiversity/ecosystems and assessments of biodiversity/ecosystems services.
- 4.6. To create opportunities to develop forestry.
- 4.7. All plans and socio-economic developments should have Ecosystem Approach.

#### **CONCLUSIONS**

1. Global climate change is expressed by many climate factors including climate extremes in the weather. The predicted climate change scenarios of Vietnam has launched three major factors, they are: sea level rise, temperature and rainfall
2. The investigation/research on biodiversity/ecosystems shows that there are 13 major ecosystems of different groups in Hanoi: on land, in water, natural and artificial, manufacturing, residence and other functions.
3. Based on research results of relationship between climate change and biodiversity/ecosystems of world scientists and ecological regulations, we can appreciate that all ecosystems in Hanoi are more or less vulnerable. This vulnerability is more severe due to multiple harms because they are now under other "pressures".
4. In order to mitigate and adapt to climate change, maintain and maximize the ecosystem services, it is necessary right now to stop harmful "pressure" to biodiversity/ecosystems and invest resources to ensure the existence and sustainable development, to increase resistance to the effects of climate change.

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