Solutions for Structural Planning of the Urban Green Corridor for Hanoi City

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Abstract. Hanoi is the capital of the Socialist Republic of Viet Nam. It is also the political, economic and cultural center of the Red River Delta area and Viet Nam. Hanoi City is the first large urban center in Vietnam to adopt the Green Corridor model as part of the master plan approved in 2011, which is somewhat similar to the green belt model widely adopted in urban areas in the world. The green corridor for Hanoi includes “rural areas, systems of rivers, lakes, hills, natural forests, farming areas ... strictly protected to provide logistics support for urban development, landscape protection and healthy urban environment”. The green corridor for Hanoi includes the entire suburban areas, which play a role in controlling the sprawling development of the central urban hub and occupy nearly 70% of the city's land area. This solution also causes a lot of controversy on how the concept should be interpreted as the structural planning does not reflect natural conditions and there remain difficulties in the management of such a plan in practice. Using field surveys, graphic presentation and literature review, the article identified existing problems in development of a Green Corridor plan for Hanoi. Based on these problems, the article presented the concept, planning structural model and some solutions for management of the urban green corridor for Hanoi.

1. Introduction

Scientifically, the formation of the green belt in urban planning structure has been successfully adopted in many large urban areas in the world such as London (England), Seoul (South Korea), Tokyo (Japan), etc. (Marco Amati 2016). The Structural Planning of Urban Green Belt has many different types of structures associated with specific natural and socio-economic conditions of each urban area. The Green Corridor forms large natural landscapes to strike a balance with the urban environment, while establishing a linkage between urban with peri-urban and agricultural suburban areas. At the same time, the concept of Green Belt also triggers development of policies that require more rigorous management to control the sprawling and unplanned expansion of central urban hubs and prevent any harms to natural environments in the vicinity. However, the concept of Green Corridor and the Structural Planning of Urban Green Belts in Viet Nam is not fully understood, the scientific grounds for such a concept are missing, and the proposed structural solutions are not suitable to the specific urban conditions in Vietnam.

In reality, unlike most developing countries which applied successfully the model, the Structural Planning of Urban Green Belts as part of the development master plan for Hanoi city presents limitations and risks of failure to realize the proposed planning structure. In the area where the Green Corridor for Hanoi, or Green Belt as called elsewhere in the world, is expected to be established, there...
are a dense of real estate projects, high population density and many other forms of development. Due to urbanization, natural green areas tend to be scaled down, urban environment is polluted, natural ecosystems are seriously degraded and urban areas tend to develop along transport axes, which is difficult to control. This is a specific feature of Hanoi City, currently shared by other large cities in Vietnam, which requires that systematic studies are to be conducted to test the model of Structural Planning of Urban Green Corridor for Hanoi.

2. Concept of Green Corridor

2.1. Globally accepted definitions of Green Space, Green Corridor and Green Belt

Green space: Green space is an open space. Green space in cities exists mainly as natural or semi-natural areas and play an important role to sustainable development and improved quality of urban living environment. During urban construction and development, green space is established in different models with different goals such as green belts, green corridors, green wedges or specialized areas such as parks, nature conservation areas, etc.

Green corridor: Green corridors are linear open spaces, including green parks, farmland or natural or semi-natural areas interwoven inside or outside urban areas for environmental and landscape protection. (Pham Hung Cuong, 2012)

Green belt: The concept of green belt was popular in the 1950s. Its definition has evolved through the stages of urban formation and development in the world. Currently, the concept of green belt is defined as follows: A green belt is an open space comprising natural areas, farmland, forestland and low density functional areas such as a recreation parks, eco-tourism areas, and cultural heritage protection areas, etc. A green belt’s key function is to prevent the uncontrolled expansion of large cities, contributing to sustainable urban development (Huifeng Peng, 2005, Marco Amati, 2016)

In addition, other concepts linked with the establishment of various green space structures are also used globally such as green wedges, green roads, green networks, green hearts, green infrastructure, etc. However, green space is established with a clear planning structure and the most common elements in the urban development planning structure are green belts and green corridors.

A green belt and green corridor are both open spaces with natural elements and low construction density to create and protect the environment and urban landscapes. Thus, in some cases, a green corridor is established as a natural landscape route around the central urban hub, functioning as a green belt.

2.2. Concepts of green space, green corridor and green belt as in the development master plan for Hanoi capital approved in 2011

According to Decision No. 1259/QD-TTg dated July 26, 2011 by the Prime Minister, the green space, green corridor and green belt for Hanoi city are defined as follows:

- Hanoi's green space includes "the green corridor and green belt along Nhue River, green wedges and urban parks".
- The green corridor for Hanoi includes "rural areas, systems of rivers, lakes, hills, natural forests, farming areas ... strictly protected to provide logistics support for urban development, landscape protection and healthy urban environment". The green corridor for Hanoi includes the entire suburban areas, which play a role in controlling the sprawling development of the central urban hub and occupy nearly 70% of the city's land area.
- Hanoi's green belt "along the Nhue River is a buffer zone between the expanded inner city center and the urban area expanded to the south of the Red River". (Prime Minister, 2011)

Such citations show that green corridor defined in the development master plan for Hanoi does not have linear structures, as in the globally accepted definition of green corridor, but is structured like a green belt, with large suburban areas (similar to the green belt model in the 1929 Greater London Regional Plan and the 1958 Tokyo Regional Plan). This has led to different explanations and interpretations by scientists and urban planning managers of the term "green corridor for Hanoi City".
3. Research methodology

The article utilized two main research methods:

- Literature review of documents, books, Internet sources, and collection of inputs in scientific seminars on relevant issues. Regarding the issues related to the research topic, the author analyzed the data and perspectives collected from research articles to validate the overall evaluations provided in the article.

- Observation and field surveys: Due to the large scope of study and similarities between different areas, the author surveyed highly representative areas. The survey results were then summarized by the author to produce comparative analysis and the research findings were presented in highly generalized charts and tables. The author focused on point- and route-based surveys. Basis of mapping the survey sites:
  - The survey sites must be linked with the location of green corridor and green belt of Nhue River and green wedges identified in the development master plan for Hanoi approved in 2011 (Prime Minister, 2011). In this document, the planned area for green corridor establishment covers all suburban areas in Hanoi city. The survey was focused on the planned areas for green corridor and green belt establishment in Hanoi.
  - The survey sites must reflect the pervasive urban development.
  - The survey sites should highlight the natural areas (including mountains, forests, rivers and lakes) and the development potentials of green space in Hanoi.
  - The survey sites must represent 03 typical development zones of Hanoi city: Central urban hub, areas bordered with the central urban hub and suburbs.
  - Based on this, the article selected 03 block survey points in 03 zones. The specific survey locations were as follows:
    - Point-based survey: The article selected 3 points with typical characteristics for analysis according to three criteria: Areas in the central urban hub, areas bordered with the central urban hub and suburbs.
    - Route-based survey: In order to have a representative picture of Hanoi city, survey routes were selected based on the structure of Hanoi city: Routes that linked the city center to suburban areas along national roads;

![Figure 1. Map of survey points.](image1)

![Figure 2. Map of survey routes.](image2)
4. Green corridor in the development master plan for Hanoi city from 2011 ÷ 2030, vision to 2050

Development goals: “Introduce clear and customized development thresholds of the central urban hub and its satellite urban areas; Establish boundaries and manage the uncontrolled development of the city; Maintain productive farmland; Introduce preventive measures for flood prone areas; Preserve culture and heritage; Encourage green and eco-friendly activities; Allow to maintain the current status and/or upgrade existing traditional handicraft villages and promote eco-tourism activities; Facilitate public transport services between satellite urban areas and central urban hub”. (Vietnam Institute For Urban And Rural Planning, 2010)

Location and scope: “Green corridor running along Day river, Tich river, Ba Vi and Huong Tich mountains, and the belt road No. 4, crossing the Red river and connecting the green areas around Soc Temple, which accounts for nearly 70% of the city”. (Vietnam Institute For Urban And Rural Planning, 2010)

Form of green corridor structure: green corridor is structured as a "belt that encircles the expanded urban area, including the entire suburbs" (Vietnam Institute For Urban And Rural Planning, 2010). Functional components: Nature conservation areas, agricultural development areas, rural residential areas and cultural heritages.

In general, the idea of Structural Planning of Urban Green Corridor is necessary and the project has been built on the planning ideas developed for the previous period. However, the proposed Structural Planning of Urban Green Corridor in the 2011 master plan still has the following shortcomings:

- Consensus is missing and there is confusion on the concepts of green space, green corridor and green belt as named by the plan development consultant;

Figure 3. Green corridor functions in the development master plan for Hanoi.

Figure 4. Green corridor structures in the development master plan for Hanoi.
The location of the green corridor was not selected to reflect natural conditions as well as green land availability in the city; The areas for setting up the green corridor was too large, up to nearly 70% of the city’s land area, the feasibility of planning options was low;

The form of green belt structures was not appropriate, based on subjective judgments, not scientific grounds.

In the planned areas for green corridor establishment, there were numerous "gray" functions such as: urban development projects, industrial production projects, handicraft production, urbanized villages, trade villages, etc.

Green technical infrastructure was quite poor, making it difficult to integrate green functions into a green system.

Function-based zoning is not linked with development goals, and it is difficult to manage areas with too many functions as envisioned for the green corridor.

5. Functionality of the green corridor for Hanoi from 2011 to 2030

Natural areas: In the green corridor, there are many natural areas such as forests, mountains, rivers, lakes, lagoons, canals forming a natural landscape that is intertwined with and encircles urban areas. The survey of the Day River corridor shows various natural terrains, including mountains, hills, plains and rivers (see Appendix 10). The current situation is that these areas are being overexploited, leading to resource depletion and environmental degradation. Among others, the most dangerous consequences is the serious pollution of the river system. Nhue River survey (survey route #1) indicates seriously polluted water surface; for the Day river route (survey route #3), there are as many as 14 blocked sections and the water surface at its section in Dong Mai ward (survey point #2) is seriously polluted and cannot be used as irrigation water for agricultural production.

Cultural heritage sites: In the green corridor plan, there is a system of dense historical relics. The key ones are nationally and provincially recognized relics, and other valuable relics. The historical sites have been restored, renovated and upgraded. However, the green spaces for ponds, trees and gardens are reduced. Tourism activities to leverage heritage resources are limited to contribute any services to the local economy. The survey of historical sites indicated high density of relics, mostly in rural residential areas (Dong Mai village) and river corridors (Day and Nhue rivers). For the Day River corridor, there are 21 temples and 12 churches for which official recognition has been granted.

Service areas: Travel services: In the green corridor area, there are many key tourist sites (Huong Son, Ba Vi, Soc Temple, etc.) and other small and medium-sized tourist sites. The survey of Day river route (route #3) showed that there was 01 large-scale tourist cluster, 14 tourist resorts and 03 tourist sites which were being developed. Tourism and service activities are generally low-performing. Key tourist sites have not produced unique tourism products to match their expected role in the city’s tourism industry. Regarding tourism activities at the Quan Son Lake tourist site (survey route #3), the government investment of thousands of billion dong has failed to deliver an attractive destination for travel companies. One of the reasons for this is the absence of site-specific tourism products. Services linked with educational and training activities: The green corridor area is home to many institutes (research centers), clusters of universities and colleges. The surveys of Co Nhue, Thuy Phuong and Tay Tuu wards, Bac Tu Liem district (survey point #1) showed that many universities, research institutes, incubators and projects for green biological urban areas.

Rural residential areas: A key component in the green corridor for Hanoi. At present, rural residential areas are in the vicinity of the central urban areas; the corridors on both sides of national roads and provincial roads are expanding quickly; the option to live by main roads is more widely selected, increasing building density. Rural population is densely distributed. Rural residential areas quickly develop along National Road 32 as part of the survey route #1. Management of these areas remain a difficult task for local authorities.

Agricultural production area, trade villages: Agricultural land occupies the largest share of land in the green corridor. The value gap between agricultural production and urban services is increasing. The land plots are small and scattered. On average, each farmland plot per person is 200 ÷ 500m2 in
size. Peri-urban agricultural land is heavily abandoned. The survey of Dong Mai ward (survey site # 2) indicated that nearly 60% of agricultural land was abandoned as it was planned for urban development projects. In fact, some of the handicraft villages are stably maintained to generate relatively high income. The survey of Cu Da vermicelli village (survey route # 02) showed that the average monthly income is VND 15 ÷ 30 million/household.

Land for urban development projects: In the green corridor, there have been many new projects for urban, social infrastructure and technical infrastructure development. The biggest issue is project for new urban areas on large land blocks, designed to accommodate high density of residents. Licenses were quickly granted to a series of urban development projects after the Hanoi expansion plan, resulting in overlaps with important corridors such as the Day River/Nhue River corridors, and two-crop agricultural land areas. As many as six projects have been implemented on the 700ha scale as surveyed in Dong Mai commune, Ha Dong district (survey point #2). Among the projects, the Dong Mai urban area project has been licensed before the city expansion was official. Upon approval, the project was converted into Dong Mai ecological housing area; the total land size is about 214.08 hectares and the planned size of residents is about 10,094 people.

Industrial parks and clusters: Industrial parks, industrial clusters and industrial production companies were established before the development master plan was approved. These functions do not match the goal of green corridor development under the master plan. The survey of Nam Thang Long industrial park (survey point # 1), Thanh Oai industrial cluster (survey point # 2) and handicraft factories along the Day River corridor (survey route #3) indicated the negative impacts of industrial operations on adjacent space. The survey of the Day River route indicated that there exist many industrial projects such as industrial parks and craft clusters. Therefore, a balance is hard to be struck to control expansion of industrial activities, ensure employment and address environmental pollution all at the same time.

General assessment: The functions in the green corridor are diverse and complex. The green corridor for Hanoi maintains the natural landscape and the functions that are potential to develop green space include rural residential areas, service areas and farmland. However, the natural green space is increasingly smaller, environment pollution is getting worse, farmland is abandoned, and the average income gap between rural and urban areas is increasing. Economic efficiency of agricultural activities is low.

Figure 5. Status of functions at the survey point # 1.
6. Proposed Structural Planning of Urban Green Corridor for Hanoi City

6.1. Development Goals

6.1.1. Environmental and landscape protection goals
Create a good natural environment to respond to climate change. Given the rapid urbanization process in Hanoi, the urban ecological environment is seriously degraded. Also, the negative impacts of climate change on Hanoi urban areas are abnormal and extreme. The green corridor for Hanoi is a green infrastructure, linked with the natural landscape required for a city to create a good natural environment in response to climate change. This goal is specifically demonstrated in the following aspects:

- Protect the natural landscape and create an ecological environment for the urban area: The green corridor is strictly protected in terms of natural water body, groundwater, mountains, forests. The green corridor as a large natural corridor would link the natural landscape with the green functions to create an ecological spatial structure for the urban area.

- Support urban technical infrastructure systems: The green corridor is the urban drainage corridor (rivers, lakes, flooded areas) and groundwater storage for the city.

- Contribute to adaptation to negative impacts of climate change. It was forecast that the impacts of climate change on Hanoi city would be increasing, typically including floods, hot weather, drought, etc. The green corridor has a role in minimizing the impacts on urban areas due to abnormal climatic events such as urban heat islands, floods, etc.

- Create a green space with beautiful scenery, contributing to the urban identity: In the context of globalisation and international integration, keeping the landscape and space that are typical of Hanoi's urban identity is a very important task. The green corridor for Hanoi City is formed by a set of natural elements, and its green land reflects diverse landscape features. In particular, the landscape of the green corridor reflects the vitality of Hanoi's urban life, in the past, at present and in the future. Therefore, the green corridor for Hanoi city must be a space that creates distinctive features of the urban landscape. The typical landscape of the green corridor is the combination of natural landscapes (forests, mountains, rivers, lakes) with cultural heritages, tourism and entertainment landscapes, rice fields, rural residential areas, contributing to the urban identity of the city.

- Contribute to the management of the sprawling, fragmented and uncontrolled development of the city: In urban areas globally, the green corridor, in the form of forest belt encircling urban areas, plays a role of controlling the development of urban areas. As analyzed in chapter 2, Hanoi is developing rapidly, which is out of control to some extents. Thus, green corridor must create green areas of different functions that are manageable, and have low and stable building density to control the sprawling and fragmented development of urban areas using strict rules.

6.1.2. Social and cultural goals
Preservation and promotion of traditional cultural values. Within the green corridor, there is a large traditional cultural environment with rich tangible and intangible cultural heritages along the river and lake corridors. Therefore, the green corridor must also play a role in preserving and promoting the value of cultural heritages.

- Create sustainable rural residential communities: The process of developing rural residential communities in Hanoi City is always double-sided; for sustainable development, the green corridor should support rural residential communities minimizing negative aspects of the development processes such as unemployment, economic equality between the rich and the poor, urban migration, social evils. The green corridor for Hanoi city, seen from its expected role to create sustainable rural residential communities, should deliver the following: Creation of new jobs, stable organization of the villages; Promotion of a healthy cultural environment with different social activities towards a sustainable living environment.
6.1.3. Economic goals
Create new spaces for green services and economic activities associated with urban functions. The process of urbanization in Hanoi has reduced both size and quality of its green spaces. In addition, the urbanization drives the demand for education, entertainment, tourism and sports. The green corridor with a variety of spaces for green economic and service activities will not only provide extra land bank for tree planting but also create a space to address the needs for education, entertainment and tourism and sports of urban residents.

Increase economic efficiency in farmland uses. The green corridor, in addition to natural areas, also includes spaces for agricultural economy, traditional crafts, tourism associated with agriculture, etc. The proximity to a large urban area requires these economic activities to have their own features, especially with regard to agricultural production. Leverage the advantages of agricultural production and traditional crafts, etc. Agricultural economic activities in the green corridor for Hanoi must bring expected economic efficiency to strike a balance with the industrial and services activities inside the central urban hub and the agricultural production in neighboring urban areas. As analyzed in chapter 2, in the green corridor structure for Hanoi, the farmland area takes up a large share. Therefore, the goal of promoting effective and sustainable farmland uses to contribute to social stability and career transformation in the Hanoi green corridor is critical.

6.2. Principles for Structural Planning of Urban Green Corridor for Hanoi City
The green corridor for Hanoi is a vast area with various urban economic development functions, and there are risks of disrupting the structural planning process. Therefore, the Structural planning of urban green corridor for Ha Noi includes 06 principles:

1. Structural planning of urban green corridor is based on the development master plan for Hanoi City.
2. Structural planning of urban green corridor is a process in which four main actions are performed simultaneously, specifically:
   - Action 01: Protection of the natural ecosystems. Restoration of natural flows, linked with ponds and flood-drainage areas, to establish the key spatial axes of the green corridor.
   - Action 02: Protection of existing green space.
     - Protection of existing green space linked with cultural heritages and based on preservation of the value of cultural heritages: Undertake proper zoning and protection of cultural and historical relics and large green areas (forests, national parks, etc.) in order to create cultural corridors.
     - Protection of existing green space linked with rural residential communities: Develop a system of public works, residential buildings and technical infrastructure systems in an eco-friendly fashion, on the basis of protection of cultural and natural heritage resources, in order to create a sustainable rural communities.
     - Protection of existing green space linked with services: Leverage and develop an advanced education system linked with promotion of international integration, service economy based on ecological resources and cultural heritage landscapes and resources, hi-tech farming to build a sustainable economic corridor.
   - Action 03: Provision of extra green space. Convert low-efficiency or unused land for tree planting. Establish a system of new green tree corridors for the city.
   - Action 04: Ensuring proper control of development interventions. Control other functions such as high-density rural population, urban development projects, infrastructure projects with low building density; maintain the proper size and proportion of land occupation in the green corridor as planned, avoiding unplanned sprawling development that would disrupt the continuity of the green spaces.
3. Structural planning of urban green corridor is a process of establishing links between the natural landscape and the possible green space expansion functions (cultural heritages, services, rural residential areas and agricultural production) to establish a complete and continuous system in which its components support one another in the development process.
4. Structural planning of urban green corridor is a process that integrate 04 main actions, standards, regulations and legal documents on the greenfields corridor along the rivers in order to create a green corridor that is featured by: Environmental- Cultural - Economic sustainability to maximize the development goals of the green corridor in urban development.

5. Structural planning of urban green corridor must be invested and maintained using different resources;

6. Structural planning of urban green corridor must be closely protected and managed by state management agencies and local communities.

6.3. Functional zones in the green corridor
The green corridor includes 04 main functional zones as follows:

1. Forest areas (natural forests, planted forests, protection forests), natural water body (rivers, lakes, canals, ditches), etc. The zone is characterized by plantations of perennial trees, high forest cover, and large and stable water body. This zone is defined as a Natural Green Zone.

2. Preservation and promotion of the values of cultural heritages. According to the Law on Cultural Heritage and its updates, cultural heritages include “tangible and intangible” ones. This zone is defined as a Cultural Green Zone.

3. Education development, eco-tourism, theme parks, and areas for outdoor sports. For these areas, the building density is controlled to be less than 15%, creating favorable conditions for the development of large greenery areas. The location and scale of greening efforts should be effectively planned. Establishment of greenery areas can be based on natural and cultural factors. This zone is defined as Service Green Zone.

4. Land for agricultural production, aquaculture and urban garden and farm models. This zone is defined as Agricultural Green Zone.

5. Green spaces of shared uses, traditional landscapes (village ponds and bamboo hedges). Trees are planted in mansions and housing models with low building density (under 50%) and many orchards. The percentage of greenery areas in residential villages shows a difference between handicraft villages, purely farming villages and peri-urban villages, etc. This zone is defined as a Rural Residential Green Zone.

However, in the green corridor, there have been many functions in conflict with the green corridor development goals, such as industrial parks, urban development projects, urban technical infrastructure projects. These functions are visible in most of these areas closely bordered with Hanoi. It can be partly or entirely located in the green areas of the green corridor, so their impacts on the green corridor should always be examined. This functional zone requires immediate control and relocation measures for the purity of the green corridor. The available land bank after relocation will be reused to develop green functions.

6.4. Structural model of green corridor for Hanoi City
Hanoi is an urban area, including the central urban hub and its surrounding areas. At its heart is the central urban hub (inner city center) and the surrounding areas include those bordered the central hub and suburban areas. Its surrounding areas can include small and medium-sized urban areas such as towns, townships and district centers.

Based on these, the structural model of green corridor in Hanoi is designed as follows: The green corridor structure is a linear structure, having the streamflows as the main axises and establishing the green technical infrastructure system to integrate functions such as natural areas, cultural heritages, service development areas, agricultural land, and low-density rural residential areas.

Adjustment to the green corridor structures in the development master plan for Hanoi at 3 levels:

Entire Hanoi city: The green corridor is a buffer between the central urban hub and satellite urban areas. The green corridor controls the sprawling development of central and satellite urban areas to suburban areas along major radial roads such as National Road 1, National Road 6, Thang Long Highway, National Road 32, National Road 3 and National Road 5.
Areas adjacent to the central urban hub: The green corridor provides the space that limits the development of historical and expanded urban center.

Areas in the central urban hub: To the South of the Red River: Create green spaces inside and outside the urban areas along the Nhue river system. To the North of the Red River: Create green spaces inside and outside the urban areas along the Ngu Huyen Khe river system and Van Tri lagoon.

Figure 6. Green corridor structures of Hanoi city.

6.5. Adjusted structural planning of urban green corridor for Ha Noi according to Decision No. 1259/QD-TTg by the Prime Minister

From now to 2030, It is proposed to adopt scenario b (medium scenario) as the most feasible solution for structural planning of urban green corridor for Ha Noi. This scenario is suitable to the socio-economic development of urban areas in particular and the country in general.

To ensure consistent and connectedness of green spaces in the central urban hub, establish the green corridor structural framework for the areas adjacent to the central urban hub and suburban areas, it is suggested to revise the overall green corridor structural framework in the development master plan for Hanoi as shown in Figure 7:
i) In the central urban hub: Establish connections between the green corridor structural framework and the green spaces of the central urban hub (based on the study on Hanoi’s Urban Green Space by Hanoi Urban Planning Institute). The connections are established by having river corridors, parks and street greenery taken into account. The connections between the green corridor structural framework and the green spaces of the central urban hub are as follows:

- Southern region of the Red River: Establish connections in the form of green routes (green wedges) based on a network of riverine greenery and street greenery on radial roads. The solutions to establish green routes based on the river corridors are as follows: The green routes along the key river corridors (Red river); the green routes established on the basis of river corridors (To Lich river, Kim Nguu river, Set river, Lu river). Undertake renovation, ensure normal water flows and perform water purification of urban rivers (removal of pollutant sources, planting of suitable aquatic species plus regular dredging, etc.); change from hard (concrete) embankments to soft (steel mesh, soil) embankment; and plant additional shade trees on both river banks. (Hanoi Urban Planning Institute, 2012)

- Northern region of the Red river: Establish connections along the Ngu Huyen Yen Khe river corridor, and connections with Van Tri lagoon, Co Loa citadel relics and the system of parks - street greenery (based on the study of Hanoi Urban Planning Institute). Similar to the southern region of the Red River, green routes are also established to link green spaces in the central urban hub and suburban areas, as well as establish connections with the Co Loa citadel relics and the green space network which includes the parks and street greenery.
ii) Areas adjacent to the central urban hub: Establish the green corridor in the form of green routes along the river corridors that encircle the city. This area has the following key types of green corridor:

- Southern region of the Red River: Establish the green corridor by restoring water flows, ecosystems and landscapes of Nhue river. Bridge connections between Nhue river and Red river. This green corridor will control the development of the central urban hub to the South. Establish the green corridor by restoring water flows of To Lich river; separate sewage from rainwater drainage system. Develop peri-urban services and forms of entertainment. This green corridor covers a large size of land in the suburban areas to the south of Hanoi city.
- Northern region of the Red river:
  - To the North of Duong river (north of the city): Establish the green corridor based on Ca Lo river and Cau river corridors and urban railway station No. 4. This green corridor will control the development of the central urban hub to the North. Besides, for the urban railway station

**Figure 8.** Map of connections between the suburban green corridor with the green space in the central urban hub of Hanoi city.
No. 4, its nearby green space will form a park and can be used for food & beverage and shopping services in a healthy and attractive ecological environment.

- To the South of Duong river (east of the city): Establish the green corridor in the form of a green belt based on the system of Thien Duc, Kien Thanh and Bac Hung Hai rivers. Create new green areas interspersed between river corridors as science parks, eco-parks, etc.

iii) Suburban areas: Establish the green corridor in the form of a green network in suburban areas. This area has the following key types of green corridor:

- Southern region of the Red River: Establish a green network on the basis of Day river, Tich river, Bui river corridors and Ba Vi and Huong Son mountains. This green corridor will control the development of the central urban hub and satellite urban areas to the South. Creating ecological and landscape connectivity is the key. Establish the network by restoring aquatic ecosystems and planting trees and plants atop the riverbanks. This green corridor is divided into several segments with typical structures such as: the Day River green corridor connects the Red River with the Bui River; Tich River green corridor connects the Red River with the Bui River; the Day River green corridor connects Bui River with Huong Son relic site; the Lien river green corridor connects Quan Son, Tuy Lai and Dong Quan lakes.

- Northern region of the Red river: The structure of green routes is established on the basis of the Cong river corridor, Soc Son temple and surrounding mountains. This green corridor plays a role in controlling Hanoi urban development to the North and that of satellite urban areas of Thai Nguyen and Bac Ninh provinces. Creating ecological and landscape connectivity is the key. The solution is to maintain the existing green space and establish additional green spaces to create a seamless ecological connection.

7. Conclusion
By fulfilling the necessary steps for a scientific study, the author has a solid ground to provide the following assumptions:

i) In the urbanization process, Vietnamese urban areas, including Hanoi, are expected to have multi-faceted changes: urban area expansion, rapidly growing population, upgrade of technical infrastructure and further construction investment, etc. towards a modern and civilized urban areas. However, in the process of urbanization, Hanoi has been under a lot of urban development pressures such as widespread development, serious pollution of rivers and lakes, deforestation and degradation of natural forests. In the planned area for establishment of the green space, there is a dense and equally distributed system of villages while a lot of agricultural land is abandoned. These are the challenges in structural planning of an urban green corridor. Therefore, the idea of "structural planning of an urban green corridor" is a critical solution to ensure sustainable urban development.

ii) Literature review and field surveys indicated that: Urban planning for sustainable development is an emerging trend. There have been a lot of, both theoretical and empirical, studies, on structural planning of an urban green corridor, which provide valuable inputs to establish green corridors for Vietnamese urban areas. Hanoi retains its system of terrain-based resources linked with the distribution of rivers, lakes and flood-drainage areas, and has a diverse system of historical relics along the river corridors. In addition, the city has a large land bank potential for developing green spaces such as services areas, rural residential areas and farmland. These are the scientific grounds for structural planning of green corridors for Vietnam urban areas, including Hanoi city.

iii) Based on the above assumptions, the article presented the objectives, principles, scales and solutions to adjust the structural planning of green corridors approved by the Prime Minister at Decision No. 1259/QD-TTg dated July 26, 2011. These proposals are for the local authority to adjust its overall planning as well as spatial management of the green corridor in Hanoi in practice.

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