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Management of Urban Environment in Ho Chi Minh City Facing Views of Climate Change

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Abstract— *By 2100, Ho Chi Minh City has become a real city. The city's pleasant living environment throughout the century has attracted countless multinational companies, talents and investments. This is a great achievement when there is great competition among cities in the region. Creating a safe and pleasant environment has been shown to be of great importance in the 21st century, as the natural hazards of climate change have increasingly affected the delta cities. Not the most powerful cities of the 20th century will be the most successful in the 21st century, but they are the cities that are best able to adapt to changing circumstances and has become most livable with a vibrant economy. This is just a possibility in the future and fewer positive alternatives. Adapting a city to the challenges of climate change requires ongoing strategic action based on dedicated community and institutional support. The Government of Vietnam recognizes this and has solicited international expertise to shape a Climate Adaptation Strategy. Urban environmental management in Ho Chi Minh City focus on three main issues: air quality management, water resource management, including water supply and sewerage and solid waste management and recommendations of relative measures including adaptation (such as land use planning, infrastructure planning, public awareness raising, ….) as well as prevention (mitigation of greenhouse gas emissions and risks). Author hopes that these initial recommendations will stimulate discussion among researchers and policy makers in Vietnam and elsewhere on this important topic for Ho Chi Minh City's sustainable development.*

Keywords— *Climate change, sea level rise, environmental management, urban environment, Ho Chi Minh City.*

I. INTRODUCTION

Vietnam is suffering from climate change (climate change), natural disasters, floods, storms and droughts. This is obvious and undeniable. Under these circumstances, sectors, branches and localities should carry out research activities, evaluate the situation, developments and impacts of climate change on natural resources, the environment and socio-economic development (Socio-economic), propose and initially implement coping solutions, and in the long term integrate climate change response goals into their regular activities[1].

Vietnam has developed a National Target Program to For cities, effective urban environment management aims to reduce the impacts of climate change[2]. The purpose of this report is to study climate change-oriented policy solutions related to urban environmental management in Ho Chi Minh City [3]. In particular, three key issues will be focused on: Air quality management, water management (water supply and drainage) and solid waste management. Respond to climate change2 (Decision 158/2008 dated 2 December 2008). On October 13, 2009, the Ministry of Natural Resources and Environment (MONRE) also announced the Framework for developing action plans to respond to climate change of ministries, sectors and localities.

Ho Chi Minh City (HCMC) is a vibrant city. Rapid economic growth, population growth and the presence of many socio-cultural organizations are characteristics of the city that have been expanding rapidly over the past decades[4]. Most industries and ports in southern Vietnam are concentrated in Ho Chi Minh City or neighboring provinces. The city is like an international trading center with seaports located at the intersection of strategic international maritime routes [5].

Ho Chi Minh City is expanding quickly and the urban density is increasing. The increase in pressure on space has a downside: the plots of land reserved for urban green spaces decrease and the adjacent construction areas can encroach on the natural water system[6]. As natural vegetation and water systems are being compromised through urban development, the result is more frequent flooding due to high rainfall and river flows[7]. In addition to these rapid economic-driven developments, two slower and more difficult-to-recognize processes are becoming increasingly important to the city's future. The first is climate change that leads to rising sea levels, changing rain patterns and increasing average temperatures. Secondly, subsidence occurs in many parts of the city, making these areas vulnerable to flooding. Especially since the mid-1990s, the intensity, frequency and duration of floods is increasing [8].

According to the 2007 - 2008 Human Development Report of UNDP 1, with the rising sea level scenario, by 2100, the average temperature increase of 3-4 degrees C will have about 22 million Vietnamese people affected. In particular, the Mekong Delta region will be completely flooded, causing agricultural productivity to decrease by 20%[9]. Floods, floods also increased. Diseases, especially dengue fever and malaria, have flourished, affecting people's health.

With the development of road transport, the development of inland waterway transport is now a key task of the transport sector. Recently, Vietnamese Inland Waterway Administration has completed the detailed outline of the inland waterway system in the North to 2020 with orientation to 2030. In the future, the system of waterway ports will become the center connects to other modes of transport[10], contributing significantly to socio-economic development in the localities.

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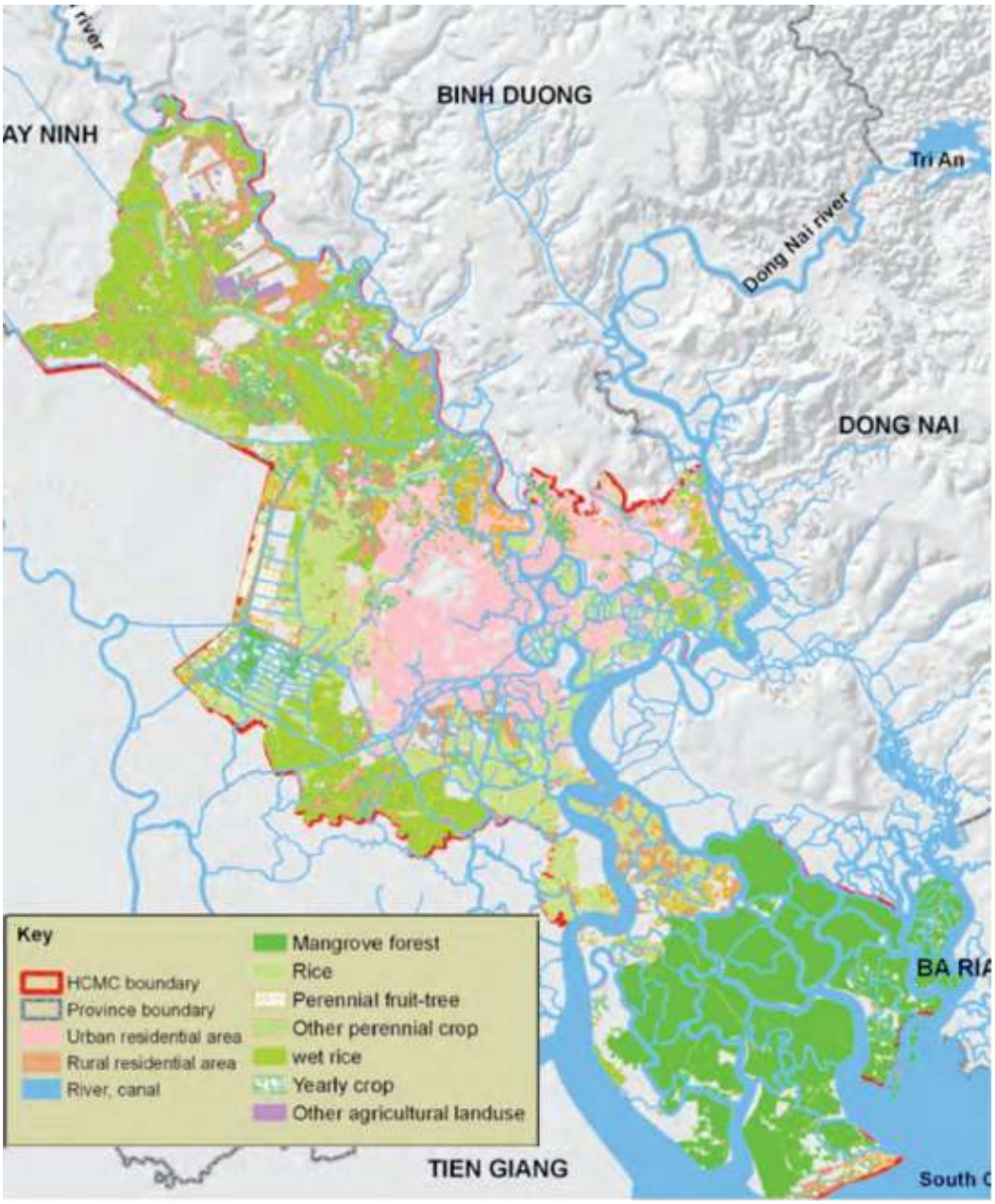

Fig. 1. Land use map of Ho Chi Minh City in 2005. *(Source: Ho Chi Minh City Climate Change Adaptation Research Report)*

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II. Management of Air Quality in Response to Climate Change in Ho Chi Minh City

a. Climate Change Impacts

Rising temperatures

According to the climate change scenario of the Ministry of Natural Resources and Environment by 2050 and 2100, the temperature in Ho Chi Minh City will increase compared to the 1980s and 1999, respectively 1 and 2^{o}C (Table 1).

Meanwhile, based on measurement data of the Southern Hydrometeorology Station shows that Ho Chi Minh City is getting warmer and hotter. The number of days with temperatures above 35°C is increasing sharply[12].

Prolonged drought will reduce the amount of water in hydroelectric reservoirs, the amount of hydroelectricity reduced so it is necessary to increase the power from fossil energy sources (coal, oil, ...), which will increase the emissions load more than Calculation (Table 2).

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TABLE 1. Annual average temperature change (°C) in Vietnam, compared to 1980-1999, average scenario (B2)

Climate region	2020	2030	2040	2050	2060	2070	2080	2090	2100
Northwest	0.5	0.7	1.0	1.3	1.6	1.9	2.1	2.4	2.6
Northeast	0.5	0.7	1.0	1.2	1.6	1.8	2.1	2.3	2.5
Northern Delta	0.5	0.7	0.9	1.2	1.5	1.8	2.0	2.2	2.4
North Central	0.5	0.8	1.1	1.5	1.8	2.1	2.4	2.6	2.8
South Central	0.4	0.5	0.7	0.9	1.2	1.4	1.6	1.8	1.9
Highlands	0.3	0.5	0.6	0.8	1.0	1.2	1.4	1.5	1.6
Southern	0.4	0.6	0.8	**1.0**	1.3	1.6	1.8	1.9	**2.0**

TABLE 2. Estimating greenhouse gas emissions for electricity generation and energy use

Branch	2000	2005	2010	2020	2030
Electricity generation	10,459	27,936	27,984	100,134	293,648
Use energy	37,233	61,821	81,167	139,813	232,235
Industry	14,049	23,890	31,340	52,992	76,544
Traffic	11,601	21,760	28,123	48,352	85,525
Agriculture	1,127	1,782	2,066	2,444	2,901
Appliances	7,193	10,145	13,994	25,313	49,373
Trade in Services	3,263	4,154	5,644	10,712	17,893

Consequence

The temperature in the city from 1960-2005 increased by about 0.02°C, in which from 1991-2005 it increased by 0.033°C (the speed increased gradually). With climate change, it is expected that the temperature will increase even more. Studies of the Urban Heat Island (UHI) effect show that the air temperature in urban areas is significantly higher (up to 10°C) than ambient temperatures in places. Forest trees and rural areas. The reason for the difference in temperature is due to the dense concentration of infrastructure, buildings, urban houses, poor air convection, high energy consumption for transportation, industry and living, and the absence of green areas, surface water.

While UHI and extreme weather conditions (storms, storms and droughts) will promote greater energy consumption (due to the cooling needs of residents), the reduction in the performance and longevity of buildings, equipment and facilities will be improved. were, means, reducing labor productivity and entertainment activities of the people of the city, ... they also adversely affect the health of the elderly, children, the sick and the poor. In fact, the heatwave5 in Europe in 2003 affected 20,000 people, mostly poor and lonely elderly. In Pradesh, India, heatwave has killed more than 1,000 people, mostly outdoor workers in urban settlements.

In addition, higher temperatures are expected to spread to hosts carrying human diseases such as dengue and malaria. Rising temperatures and changes in rainfall and drought can spread pests, pests and crop diseases, as well as adversely affecting ecosystems and growing seasons.

In addition, UHI will increase the harmful effects of air pollution on human health and property. Many urban areas will face more problems with air pollution because the concentration of air pollutants can change correspondingly to climate change because their formation depends partly on temperature. This is especially important in Asian and Latin American cities because most of these cities have the highest levels of air pollution.

b. Management Solution

Greenhouse gas inventory (a form of emission source statistics) is one of the important factors in the response to climate change. Full greenhouse gas emissions database is considered an effective tool in developing climate change adaptation strategies and plans.

Minimize CO2 emissions from vehicles on the basis of applying stricter emission standards (For example, raising the current standard of EURO 2 to EURO 4). Improve the transportation system with measures such as: Developing the public transport system[10], using standards for testing vehicle quality, fuel tax, having incentives for vehicles using renewable fuels.

Planning and building satellite cities, reducing the load of the current downtown areas; Investing in developing new energy technologies and using energy efficiently. Types of renewable energy have potential in the city. HCM is solar, biogas and wind energy. Enhancing green areas to minimize the "urban heat island effect".

Increasing public awareness (policy makers, businesses, people, especially those who are most affected by climate change). Propagate and educate about opportunities and benefits when implementing measures to prevent climate change and adaptive methods, improving coping capacity for community.

III. Orientation on Water Resources Management to Cope with Climate Change in Ho Chi Minh City

a. Impacts of Climate Change

Global climate change has been strongly affecting water sources and has had some impacts as follows:

- Change the rain time and rain area.
- Severe storms and droughts occur frequently.
- Decreasing quality of water resources.

In HCMC, the phenomenon of climate change related to water resources can be seen through the following factors:

Sea level

Sea level rise of 3 cm /year and higher is being recorded at the monitoring stations in the world and Hon Dau station of our country9. In Vietnam, according to the climate change scenario of MONRE10, the results for all three low, medium and high scenarios indicate that by 2050 and 2100 sea levels will increase by 28-33 cm and 65-100 cm, respectively.

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Salinization

Sea level rise leading to saline intrusion and pushing the salinity boundary higher upstream is one of the most visible impacts of climate change. In the dry season of 2010, on the Saigon River, saline intrusion deeper than the mainland compared to previous years, causing Dau Tieng Lake (Tay Ninh) to discharge saline water to protect fresh water for Tan Hiep water plant. (Cu Chi).

Amount of rain

Rainfall in the dry season is expected to decrease due to the prolonged dry season while rainfall in the dry season will increase (see Tables 4 & 5). According to the measurement data of the Southern Meteorological and Hydrological Radio Station, starting from 2007 up to now, the rainfall in Ho Chi Minh City has increased by about 20% compared to the previous years, with record rains up to 140mm.

TABLE 3. Forecast of rainfall decrease in dry season by percentage

Moth	2050	2010
Dec-Feb	-7,4	-19,6
Mar-May	-7,2	-18,2

TABLE 4. Forecast of rainfall increase in the rainy season by percentage

Moth	2050	2010
Jun-Aug	0,8	2,1
Sep-Nov	6,5	16,5

Research shows that in Ho Chi Minh City, about 26% of the population is affected by heavy rainfall, this figure can exceed 60% by 2050 (ADB, 2010).

Tides

According to the Southern Hydrometeorology Station, from 2006 onwards, the tide level measured at Hoa An station in Nha Be district "is always higher than the previous year". Before 1999, the highest tidal peak on the Saigon River was 1.36m, in 2007 it was 1.49m, by 2008 the tidal peak reached 1.54m and by 2010 the tidal peak in Ho Chi Minh City had reached a record level 1, 58m.

Consequences for water supply activities

WWF (2009) argues that saline intrusion will cause salinity of surface and groundwater, damaging the water supply system and millions of people in Ho Chi Minh City13. Clearly, saline intrusion and severe drought in the dry season will put the city's water supply in a difficult position for both quality and quantity of water: Where is the water needed to discharge it and push it in? summer? If the sea level rises by 0.65 - 1m as predicted, the Saigon River will be seriously salted, deeper inland - then the role of pushing saltwater of Dau Tieng and Phuoc Hoa lakes is almost invalid. How to manage water resources when the flow and quality of water resources decrease due to the exhaustion of upstream flows and pollution caused by nature and people, along with the increasing demand of water due to urbanization and industrialization?

Consequences for drainage, flood control

Recently, when the heavy rains combined with high tides, flooding in Ho Chi Minh City is complicated, increasing both in water level and duration of flooding.

Currently, Ho Chi Minh City has created many new flooding points in suburban districts. In addition to natural causes, many scientists believe that it may be because many canals or channels were encroached or deposited without water storage and the wetland has been leveled too much. And make the tidal peak in Ho Chi Minh City continuously increase in recent years. The recorded data is that the water level of rivers and canals in the city has increased by 1.5-2 cm / year while the sea level has only increased by 4-5mm / year. In addition, the urban drainage system is old, patchy and overloaded because it was built more than 50 years ago. While the new drainage projects are outdated in terms of input design data compared to the latest developments in the weather of Ho Chi Minh City and in these projects almost no mention of climate change impacts.

In the future, due to climate change, the rainy season will be more severe, the time, intensity and frequency of rain will increase, making the existing drainage system more overloaded, breaking the protection system, dike and increase flooding if we do not have effective preventive measures.

b. Management Solution

In the face of climate change impacts on water resources, living with the water is inevitable, requiring both 'adaption' and prevention approaches. through appropriate and complete solutions.

Restore and build water storage areas (lowlands or along rivers, canals, ponds and lakes), which regulate water and store water during floods and storms. The solution of ‘Space for rivers’ –Room for the rivers’16 is being applied by the Dutch and encourages Vietnam to apply. Instead of the concept of 'mastership' now translates to 'making friends with nature' (partnership): Instead of improving dams, the Netherlands renovates and drills coastal areas for rivers. natural rising water during floods (also known as 'Natural Climate Buffer'), reducing the pressure on the dam; Reconstructing flood-bearing areas; In addition, they also introduced a solution called "Nature Driven Design" that follows the laws of wind, waves and currents; ensure principles of safety, solidity, flexibility and little maintenance. Ho Chi Minh City needs to well protect its Can Gio biosphere reserve as a 'natural climate buffer'[7].

Increasing green areas (streets, parks, public areas, even 'green roofs') to increase water permeability to the ground, replenish underground water sources and at the same time reduce the amount of water instant flooding due to rain. Similarly, the solution to build underground rainwater tanks in urban areas (experience in Osaka, Japan), when heavy rains will be stored here and then water will be pumped into the drainage system (to regulate, reduce flooding), or pump it to underground water (to compensate for water withdrawals), or pump it to water treatment plants (such as water supplies)[8]. Note the above groundwater recharge solutions in industrial zones, which consume large amounts of water.

Urban planning also needs attention. Attention should be paid to the impact of climate change (water level rise) on land use planning in the following steps:

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(1) Select the most appropriate sea level rise scenario (WB, ADB, MONRE, etc.). In choosing a scenario, avoid underestimation as well as exaggerating the problem. Point out flooded areas and localities according to each scenario (through GIS models and maps);
(2) Review current land use planning and compare with flooded areas / localities over time (based on scenario overlapping of flooded maps and land use maps);
(3) Proposing and adjusting the planning to suit each locality, which is highly oriented and practical;
(4) The above adjustment of land use planning should be carried out within a certain period of time based on updated results of future sea level rise calculations. However, ADB, JICA & WB (2010) said that it is difficult to identify the infrastructure and prospect of future urbanization in Ho Chi Minh City due to the city planning problem set up by three different agencies in different areas. different times (urban planning by the Department of Planning and Architecture, land use planning by the Department of Natural Resources and Environment, socio-economic development planning by the Department of Planning and Investment). Experts suggest that it should be built in a number of places suitable for the high level of compaction to reserve land for public spaces and water storage.

Currently Ho Chi Minh City's dike system is being upgraded, but to ensure that by 2050 flooding this area causes less damage that requires local authorities more efforts. For some areas particularly affected by climate change, in that case migration is the only solution[4]. According to climate change policy advisor of the United Nations Development Program in Viet Nam, Koos Neefjes, the expansion of the city to the lowlands must be stopped immediately and the population will be relocated and industrial plants out of town. Meanwhile, experts from the Netherlands (Rotterdam) proposed that the City develop towards the sea (Nha Be, Can Gio). Therefore, more research is needed on these proposals.

UNDP19 also proposed: "For example, embankment strengthening is needed to protect villages, communes, and cities including Ho Chi Minh City from typhoons. These phenomena will evolve in the direction of deterioration in the face of climate change. Storm waves can be mitigated by expanding and protecting mangrove forests along the coast, and even dykes need to be built and reinforced to ensure increased safety. Fences may be required to prevent flooding to protect large ports. Roads, bridges, and industrial areas need to be "shielded from the effects of climate", which means that designs must be adjusted to remain relevant when sea levels (average as well as peaks) rising, ensure drainage requirements, pay attention to water supply issues. The metro system in urban areas, the drainage and sewerage systems need to be adapted to the extreme cases of extreme rainfall and wastewater discharge. Public and private buildings must be solidified to avoid hazards from typhoons. This can be partly achieved by adjusting the standards and construction practices of buildings."

In order to ensure sufficient water supply in the dry season, prevention of saline water intrusion in the City, it is recommended to: Research modern technologies for brackish water treatment together with site study of water treatment plants and distribution networks. New water distribution. Research renewable technologies and encourage water reuse. ARUP (2010) proposed to build raw water reservoirs that help discharge saline water in the dry season (similar to Dau Tieng lake), can also be a source of quality raw water for the water supply system, providing flood control benefits and supplement groundwater sources if any to enhance Ho Chi Minh City's response to climate change.

Demand management, not only meets demand" to reduce future water consumption. The demand reduction needs to be implemented in 03 subjects: Irrigation, industry and daily life. Sustainable water resource management must include demand management (through price & fee tools, quantity norms, awareness education, information provision) and supply management (including searching for new water sources and reduce the rate of losses through the pipe network)[30].

IV. Orientation on Solid Waste Management to Cope with Climate Change in Ho Chi Minh City

a. Climate Change Impacts

Solid waste (CTR) treatment in urban areas in Vietnam as well as in HCMC is mostly open-dumping site or sanitary land fill (see Table 5). Environmental pollution, especially the smell and pollution of groundwater, surface water from leachate from landfills are always a matter of concern from regulators, while the construction of urban solid waste incinerators in Vietnam is probably expected after 2020.

UNDP forecasts: "The risk of flooding and storm surge will be to release pollutants from the chemical manufacturing and use industries, or from unprotected waste gathering areas". More specifically, ADB (2010), calculated based on A2 scenario, considers that 60% of wastewater treatment plants and 90% of the city's waste landfills are at risk of being flooded. The environmental consequence of flooding is the release of pollutants from the landfill into the surrounding environment. Also due to the increase in climate change, storms, and floods affecting the operation of solid waste management systems (including collection, transportation and treatment), reduce the efficiency and service life of works, equipment and means of operation.

TABLE 5. Current situation of urban waste treatment in HCMC

Waste landfill	Place	Area (ha)
Da Phuoc	Binh Chanh	73
Phuoc Hiep	Cu Chi	45
Thu Thua(in preparation)	Long An	1796
Dong Thach(closed)	Hoc Mon	43
Go Cat(closed)	Binh Tan	25

b. Management Solution

Municipal solid waste management in the future should be based on the content of the National Strategy on solid waste management up to 2025, with a vision to 2050 of the Prime Minister. In addition, urban planning in which planning of

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waste treatment sites must take into account the impact of flooding due to climate change (as proposed in 4.2).

V. Conclusion

Climate change is no longer the 'dumb-ness' that scares people, but its manifestations and effects are more visible, more intense and more harmful. Awareness of it, accepting and adapting, and taking proactive measures to minimize harm and risk prevention is probably the most appropriate policy in the management of urban environment in our country and especially in the future. Even if climate change is not as expected, the proposed solutions will help to manage urban environment more sustainably, meet the needs of urbanization, population growth and socio-economic development.

Ho Chi Minh City's ambition is to develop into a modern city by 2030 with a way of managing rapid and sustainable economic development. In order to realize sustainable development, it is necessary to integrate action plans to adapt to climate change.

However, climate change adaptation should not be realized as a single goal. The results will be much more interesting if Ho Chi Minh City itself is committed to the goal of improving the quality of the already vibrant city. In each climate change adaptation project, and during the implementation of each proposed measure, both these goals can be combined.

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