

**STRATEGY RESEARCH OF CITY INFRASTRUCTURE VULNERABILITY  
APPRAISAL AND SLOW-DOWN ADAPTATION DUE TO CLIMATIC CHANGE**

**Lianhui Wang<sup>1</sup> and Xia cui<sup>2</sup>**

<sup>1</sup> *Professor, vice-president, Shanxi Institute of Public Administration, Taiyuan, China*

<sup>2</sup> *Vice-professor, Modern leadership training center, Xia Cui, Shanxi Institute of Public*

*Administration, Taiyuan, China*

*Email: cuixia602@163.com , 751187998@qq.com*

**ABSTRACT :**

Since 21st century, scholars from different fields and disciplines have discussed the conceptual framework of vulnerability to climate change and launched practical climate change vulnerability assessments on agriculture, forestry, water resources, ecological systems, human health and the socio economic system. As urban national economic and social development necessary service and security, improve the urban infrastructure disaster-carrying capability have important meaning for the city's normal operation and sustainable development. Strengthen security fortified of urban infrastructure, provide a solid foundation for the city health and safety operation of a country's social and economic development.

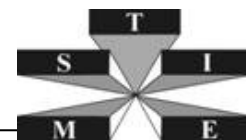
**KEYWORDS:**

city infrastructure, vulnerability, slow-down adaptation, climatic change

**PREWORD:**

Cities often are centers of a country or certain region politics, the economy and the cultural, are regions which the population and the capital gather highly. But the city infrastructure is the urban development precondition. The city infrastructure takes the carrier, its safety or not is the urban economy social product life order development foundation, is safeguards the city to be able the normal work support system, also is the important essential for the city sustainable development..

Along with technical development, urban economy society's unceasing reform and progress, the people in aspects and so on disaster defense as well as rescue have yielded many results. But the city modernization advancement speed is quicker, generally speaking, the city scale is bigger, the modernized level is higher, its latent disaster type are more, each kind of disaster



occurs the frequency is higher, the risk is also bigger. But the climatic change also is one of important challenges which the city must face. The short-term looked that, the climatic change biggest threat is the frequency which the extreme weather event occurs increases, the harm degree is more and more big. The perspective city present situation, the climatic change already posed the serious threat safely to the city infrastructure construction and the city, moreover the extreme climate event recent years had the frequency and the scope has the obvious ascension tendency, to the social economy influence which the disaster linkage and brought also day by day serious. Looked from the domestic and foreign city infrastructure resistance risk ability situation that, the urgent need takes the corresponding measure to enhance the city infrastructure plan and the construction potency, practically enhances the city infrastructure withstanding extreme climate change to bring the disaster ability, strengthens the city infrastructure safe fortification, has the vital significance regarding the city normal work and the sustainable development, is a country social economy healthy development and the city safe operation provides the solid foundation.

## 1. IMPACT OF CLIMATE CHANGE ON URBAN INFRASTRUCTURE<sup>1</sup>

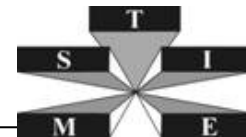
### 1.1 Impact of climate change

The climatic change influence is various, during various factors which affects is produced the chain interaction, its influence type may divide into the direct influence and the indirect influence approximately (really celebrates dragon, 2004), may divide into specifically the climatic change influence three levels, see Table .

Table 1 The level of climate change impacts

Influence level	Affect the subjects		Influence type
first - level influence	Natural ecological subsystem	Non biological factors change	direct influence
secondary effect		Biological factors change	direct influence
Three stage influence	Social economic subsystem	Production and life changes	indirect influence

As seen in Table 1, the climatic change level and two levels of influences may induce into the climatic change direct influence, main function in city natural ecosystem, including offshore sea ecosystem, farmland ecosystem, forest ecosystem, rivers lake ecosystem and shallow seas and tidelands wetland ecosystem and so on. Among them, the level influence is the climatic change to the nature Asia system Central Africa biotic factor influence; Two levels of influences are the climatic change to in the natural ecosystem biotic factor influence, mainly manifests in to the biological resources quantity, the structure, the distribution and in the behavior influence. The climatic change three levels of influences for asked meets the influence, the main function in the city social economy Asia system, including the economical industrial development, the energy expends, the human health, the city infrastructure as well



as the human occupies the environment and so on. This article angle of view mainly based on climatic change one of three level of influences - - to city infrastructure influence.

### ***1.2 The city infrastructure system and receives the disaster ability***

The city infrastructure is the city livelihood and the development foundation, is the city synthesis service function material carrier. The city infrastructure took city this complex huge large-scale system a sub-system, it includes the transportation system, the energy dynamic system, the correspondence information system, for the drainage system, the environmental protection system, the disaster prevention system six sub-systems, is provides the basic infrastructure for the city people which the production and the life must. They have the linkage organic whole. The city infrastructure movement is in certain situation, between each subsystem has the mutual synergism, when if the disaster approaches, in this system subsystem is mutually uncoordinated, has the problem, the overall system cannot the normal operation, be able to have partial or the whole paralysis. Thus after the city infrastructure disaster prevention, resists natural calamities the whole which, the disaster relief and the disaster restores to receive the disaster ability to affect the city movement situation directly, is the city sustainable development key.

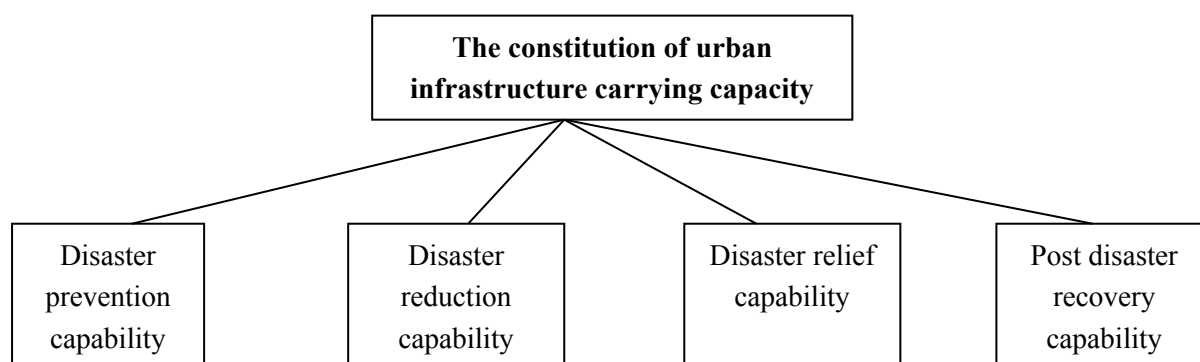
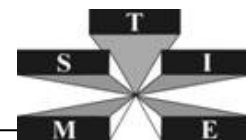


Fig.1 The city infrastructure receives the disaster ability the constitution

There are at least two reasons for the major disasters of urban infrastructure. On the one hand has not carried on the maintenance routine and the renewal to the infrastructure, like this can because cannot maintain and strengthens the city infrastructure function lack receives the disaster ability, cannot satisfy the urban development continually the request, cannot achieve in the city infrastructure function security resists the disaster the request. On the other hand is in city infrastructure plan and construction time standard excessively low, to environmental condition and disaster rank underestimate, thus cannot resist the burst characteristics disaster to safeguard the city system effectively the normal operation and promotes the city sustainable development ability.



### ***1.3 Receives the disaster ability based on the climatic change city infrastructure the quality synthetic evaluation***

#### ***1.3.1 Receives the disaster ability appraisal target system based on the climatic change city infrastructure the determination***

Receives the disaster ability based on the climatic change city infrastructure is refers, emergency is connected the sensitivity at the extreme climate event and the coordination which essential factors and so on government apparatus, manpower, resources display, makes every effort the personnel casualty, the economic loss and the environment destruction who creates in the short time achieve the smallest synthesis handling ability. Should to the climatic change be a dynamic process, after the disaster prevention, resists natural calamities, the disaster relief and the disaster restores four abilities, involves to aspects and so on physical features, social essential factor, human resources, emergency system, is a compound concept, is city integrated development ability manifests importantly.

Establishes the city infrastructure to receive the disaster ability appraisal target system, when selection appraisal target: ①The target system should conform to the systematic characteristic, both must synthesize, comprehensively, and must avoid the system too being tedious as far as possible, complex, as well as the target overlaps overlapping. ②The target system design should simultaneously satisfy the theory and the actual two aspect demand, the system establishment cannot too academic, does not favor the actual operation, simultaneously cannot too simple rough, should in the science, in the integrity foundation guarantee the target is objective, is real. ③The target system establishment should be feasible. The target system design should be advantageous for the user to accept, this includes the data easy to gain the degree as well as the model computation simple degree. ④The target system establishment will be supposed to focus on the future. Should while satisfy the present stage city infrastructure to receive the disaster ability appraisal request, will take a broad view as far as possible in the next city infrastructure development change and the development direction, will serve for the next city infrastructure construction and the improvement. ⑤The target system both must have the crosswise comparability, and must have the longitudinal comparability.

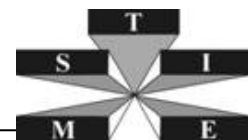
Establishes the city infrastructure to receive the disaster ability appraisal target system, in which weight coefficient is determines (Table with the analytic hierarchy process 1). Because each target unit is different, in order to calculate convenient, needs to carry on zero dimension processing to each target.

Regarding is most greatly most superior the target, the formula:

$$X'_{ij} = (X_{ij} - X_{\min}) / (X_{\max} - X_{\min}) \quad (1.1)$$

Regarding smallest most superior target, formula:

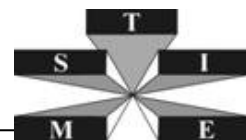
$$X'_{ij} = (X_{\max} - X_{ij}) / (X_{\max} - X_{\min}) \quad (1.2)$$



In the formula  $X_{ij}$  is the  $i$ th object  $j$ th target primitive value,  $X'_{ij}$  is the  $i$ th object  $j$ th target quantification value,  $X_{\min}$  and  $X_{\max}$ , respectively is this target maximum value and the minimum value. May see through the formula  $X'_{ij} \in [0, 1]$ .

Table 2 receives the disaster ability appraisal target system based on the climatic change city infrastructure

		Specific index X	Weight W
Disaster prevention capability (PI)	Disaster prevention measure investment ability	Risk index of pregnant disaster environment	
	Disaster analysis and monitor forecast ability	Risk index of disaster causing factors	
	Seeks asylum place emergency adaptability	Vulnerability index of the bearing body	
	Environmental protection	Content integrity of emergency plan; Emergency drill number (times / year)	
Disaster reduction capability (FI)	The transportation system resists natural calamities ability	Per capita highway traffic mileage; Roading density; Total length of subway project;	
	The communication system resists natural calamities ability	Total postal service; The average per household has telephone quantity;	
	The energy system resists natural calamities ability	Average per person life electricity consumption; Gas penetration rate;	
	Resists natural calamities ability for the drainage system	Water consumption per capita; Per capita total mileage of underground sewage; Water supply comprehensive production capacity;	
Disaster relief capability (EI)	Material reserve system	Emergency communication equipment	
	Ability of medical aid	Million people have bed number; Million people have a number of doctors	
	Government emergency management capability	Comprehensive capacity index;	
	Capital investment intensity		
Post disaster recovery capability (RI)	Post disaster reconstruction capability	Tents and sleeping bags	
	Ability to deal with the aftermath	Number of personnel	
	Social security compensation mechanism	Labor quantity; GDP ratio	
	Funds in place	Capital investment	



*1.3.2 Receives the disaster ability appraisal model based on the climatic change city infrastructure*

According to the disaster emergency management cycle theory, the risk management theory and the city infrastructure receive the disaster ability appraisal target system, the use weighting quality synthetic evaluation law and the analytic hierarchy process, establishes the following city infrastructure to receive the disaster ability appraisal model:

$$CIEI = PI \times W_{PI} + FI \times W_{FI} + EI \times W_{EI} + RI \times W_{RI} \quad (1.3)$$

$$PI = \sum_{i=1} A_{PI} W_{PI} \quad (1.4)$$

$$FI = \sum_{i=1} A_{FI} W_{FI} \quad (1.5)$$

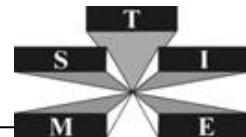
$$EI = \sum_{i=1} A_{EI} W_{EI} \quad (1.6)$$

$$RI = \sum_{i=1} A_{RI} W_{RI} \quad (1.7)$$

CIEI is the city infrastructure receives the disaster ability index, it expressed the city infrastructure the disaster bearing capacity which brings to the climatic change. PI, FI, EI, RI respectively be the disaster prevention ability index, resist natural calamities ability index, the disaster relief ability index and restore ability index, WPI, WFI, WEI, WRI expressed correspondingly disaster prevention ability, resists natural calamities ability, disaster relief ability, restores ability the weight, in the above equation, after  $A_i$  is the target i quantification value,  $W_i$  is the target i weight.

Based on the climatic change to the city infrastructure bearing capacity appraisal is an extremely complex work, involves many factors, must think the complete quota accurate carries on appraisal existence certain difficulty to it, in the appraisal target selection possibly can have is short of, can cause the appraisal result to receive slightly affects. Here is only an attempt, but also has some insufficiencies, from now on will also have to consummate in the target formulation aspect..

**2. THE MAIN STRATEGY TO STRENGTHEN THE CITY INFRASTRUCTURE CONSTRUCTION TO THE CLIMATIC CHANGE**



Appraises the city infrastructure based on the climatic change to receive the disaster ability, finally it should provide the policy-making basis and the science support for the formulation of the climatic change related strategy. In order to enhance the climatic change adaptability, avoid the adverse effects of climatic change on the urban economy, society and the ecological environment, the strategy should be formulated from two aspects: slow-down and climate change. The strategy should be comprehensive.

## ***2.1 Main principles of response to climate change***

### ***2.1.1 Integrates the climatic change factors to the city sustainable development plan and the implementation.***

The climatic change to the city nature, the economy and the society and so on various subsystems will bring each kind of adverse effect. Therefore, in formulating the city industrial structure adjustment, the energy developmental strategy, the ecology construction and the protection and so on involves the sustainable development in the plan and the implementation process, should consider fully the climatic change factor, simultaneously integrates the climatic change latent influence and the slow-down and the climate change positive role the correlation plan in the formulation and the implementation process, thus realizes truly under the sustainable development frame solves the climatic change problem.

### ***2.1.2 Strengthens the international cooperation, should together to the climatic change.***

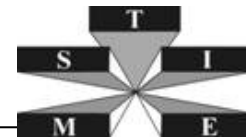
Use international climatic change domain fund, the technology and the mechanism, embark from the local actual situation, enhancement multilateral or bilateral international cooperation, attracts more funds, the technology for the local sustainable development. Discuss together through the experience share and the countermeasure, further advances the whole world to be supposed together to the climatic change.

### ***2.1.3 Adhere to the principle of mitigation and adaptation.***

The slow-down and the climate change is should to the climatic change challenge two organic constituent. The slow-down strategy is in order to slow down reduces the greenhouse gas which the whole world climatic change adopts to discharge as well as to increase each measure and the policy which the greenhouse gas collects. The measure to actual or the estimate climatic change influence vulnerability which the adaptation strategy for reduces the city compound ecosystem which proposes the proposal and adopts.

### ***2.1.4 Overall plan low-carbon urban development and other urban development prospect, enhancement climatic change related science and technology research and innovation.***

“The low-carbon city” is under the whole world climatic change background the city sustainable development effective pattern. Should practically grasp and be clear about “the low-carbon city” the concept and the connotation, plans under fully the sustainable development frame the city other development prospect. Should have to display the advance in technology and the technological innovation function fully to the climatic change, enlarges to the climatic change correlation science and technology work organization coordination and



investment dynamics, speeds up the slow-down and the climate change domain significant technology research and development, the demonstration and the promotion.

## ***2.2 The slow-down climatic change brings influence***

### *2.2.1 Optimization industrial structure, transformation economy growth pattern.*

The optimization industrial structure, speeds up the development tertiary industry, specially develops the modern service industry, reduces the national economy development the excessive dependence which grows to the industry; Supports the low-carbon industry and the green product development positively, the promotion industry competitive power enhancement, reduces the traditional industry the fixed effect; Advances the high-tech industry positively the development, suppresses consumes energy high, the high pollution profession; Enhances the market access standard, eliminates gradually falls the after-birth energy, reduces the unit GDP carbon emissions effectively the intensity, reduces the economical growth pattern to the energy demand dependence.

### *2.2.2 The improvement energy consumption pattern, enhances can the effect.*

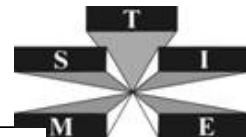
Presently, mostly was the city energy consumption pattern still by the fossil energy primarily, an energy structure still occupied the main status by the coal, the petroleum next best. Should enlarge the new energy and renewable energy development use support dynamics, develops and promotes the new energy and the renewable energy as circumstances permit; Through formulation and implementation policies and so on subsidy, preferential benefit tax revenue and price, low-interest loan, develops and promotes the nuclear electricity, the solar energy, the wind electricity and the small water and electricity massively and so on the renewable energy and the new energy technology; By energy sustainable development support economic society sustainable development.

### *2.2.3 'Low-carbon city' spatial plan strategy.*

The city space expansion took the urbanized coercion the composition factor, affects the urban climate change vulnerable important risk essential factor. Slows down the city carbon emissions through the optimized space pattern to include specifically: Avoids the city disorder spread growing, optimizes the urban setting reasonably, constructs the city space compact multistage network development pattern; Constructs the sustainable transportation system, reduces the journey demand and the journey distance, develops the mass transit vigorously; Encourages the different city function with the place mix use, avoids the simplification the function district, enhances the short distance journey proportion; The community space stratification plane, emphasized the mix use and the moderate high density develop the strategy; Develops the walk, the bicycle and the public transportation vigorously and so on the highly effective green transportation vehicle, satisfies the city peoples, the association and the social mobility request.

## ***2.3 To adapt to the impact of climate change***





*2.3.1 Raises entire society climate change consciousness.*

Using each method popularization climatic change aspect related knowledge, emphasized enhances the entire society to participate in the climate change vigorously consciousness and ability, enhances to the climate change importance and the pressing understanding, builds all the people climate change the good environment, urges the public positively to undertake the climate change social responsibility.

*2.3.2 To develop regulations to adapt to climate change*

Formulation compatible technology standard, and through establishment responsibility system impetus realization all levels of administrative department's compatible motion. Carries on the climate change the model district construction, the formulation seacoast protection and the development plan, and develops coastal and in the marine important project production construction plan at the coast region urban construction considers the climatic change factor. Advances the profession and the region adaptation plan gradually, the basis country adaptation goal determination profession and the region adaptation goal and first the item, the formulation adaptation course of action.

*2.3.3 Establishes the effective climate disaster emergency and the response mechanism.*

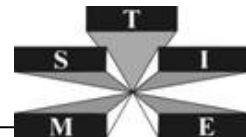
Along with the city fast expansion, the population and the economic output swift and violent growth, the loss which the same intensity catastrophe weather climate event (for example typhoon, rainstorm, storm unrest, snow disaster and so on) will create obviously is enlarged. The municipal government various departments should act according to the national natural disaster special emergency predetermined plan and the department responsibility, the formulation have the operational predetermined plan implementation means and the emergency operation regulations; Enhancement extreme weather and climate event monitor, early warning, forecast ability, promotion extreme climate event emergency capability: The enhancement climatic change emergency relief manoeuvre and enhances the resident to against disasters the skill knowledge.

*2.3.4 Carries out the city vulnerability appraisal and the key technologies research.*

The climate change belongs to “the public goods” purely, the vulnerability appraised in particular needs the massive foundational data, needs the country to aim at the city, in particular the super city development vulnerability appraisal key technologies research and the demonstration, determined reduces the climate risk the goal and the way. Should integrate the city plan, the land use management, the infrastructure investment, the service supply, the construction and in the plan design standard adaptation strategy practice motion the risk to the measure, establishment department information communication or policy-making platform, science reasonably overall assessment and government climate risk.

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