

# A Study on the Theory and Approach of Environmental Impact Assessment in General Land Use Planning

Qin Jianqiao<sup>\*</sup>, Jiang Xiaohong

School of Environmental and Chemical Engineering, Zhaoqing University, Zhaoqing 526061, China

**Abstract** In this paper, the theory and approach of environmental impact assessment in general land use planning are studied from different aspects. First, starting from the content and concept of general land use planning, the necessity of environmental impact assessment in general land use planning is illustrated. On the basis of its evaluation theories and methodologies, it attempts to establish index system of environmental impact assessment in general land use planning, and point out that current general land use planning requires public participation.

**Key words** General land use planning; Environmental impact assessment; Public participation

**DOI** 10.19547/j.issn2152-3940.2019.05.007

All human activities are inseparable from land, while the contradiction between land resources and human society has evolved into a global problem of the environment space for the survival and development of mankind as a whole. In terms of national conditions, there is a large population in China, and per capita land area is only 0.777 hm<sup>2</sup>. In some areas, land resources are scarce, and the contradiction between man and land is prominent. So, general land use planning is particularly important.

In current land use planning of China, there exist many environmental problems, such as land desertification and serious soil pollution. Taking land desertification as an example, the investigation of *The Fourth Bulletin on Desertification in China* displayed that total area of desertification land in China has reached 2 623 700 km<sup>2</sup> to the end 2009, accounting for 27.33% of total land area. Compared with 2004, net reduction value of desertification land in the five years reached 12 454 km<sup>2</sup>, and annual average reduction value was 2 491 km<sup>2</sup>[1]. For initial containment of land desertification in China, the *Planning Environmental Impact Assessment Regulations* approved by the 76<sup>th</sup> standing meeting of the state council on August 12, 2009 and implemented on October 1, 2009 played an important role. Article 2 of the regulation clearly stipulates that environmental impact assessment should be conducted on relevant plannings of land use, plannings for the construction, development and utilization of region, watershed and sea area, special plannings for industry, agriculture, animal husbandry, forestry, energy, water conservancy, transportation, urban construction, tourism and natural resources development organized and compiled by the relevant departments of the state council, the local people's governments at or above the municipal level and their relevant

departments. Its promulgation and implementation provide legal basis for general land use planning<sup>[2]</sup>. It is clear that environmental impact assessment is an indispensable link in the planning process of land use, and it has legal status in law.

In this paper, concept and content of environmental impact assessment in general land use planning are explored. On the basis of sustainable development, ecological carrying capacity and landscape ecology, theory of environmental impact assessment in general land use planning is studied. Moreover, the existing environmental problems in current general land use planning of China are pointed out. Comprehensive assessment method of environmental impact in general land use planning is explored, and it attempts to establish index system of environmental impact assessment in general land use planning. Finally, some suggestions on public participation in general land use planning are proposed.

## 1 Related concepts of environmental impact assessment in general land use planning

**1.1 General land use planning** Land use planning indicates making overall arrangement and long-term plan for land development, utilization, renovation and protection by combining local nature, society and economy according to the requirements of national socio-economic sustainable development, and land use is its overall target, and it is foundation of land use control by the state. General land use planning indicates overall arrangement, structural adjustment and rational distribution of land development, utilization, regulation and protection in a certain time span and space range according to the requirement of sustainable development and characteristics of land itself<sup>[3]</sup>, and is a strategic and controlling plan. The essence of general land use planning is for efficient allocation and sustainable utilization of land resources<sup>[4]</sup>, thereby maximizing fiscal revenue and benefit under two-way management of efficient allocation and sustainable utilization. Article 17 of the

Received: August 15, 2019 Accepted: September 17, 2019  
Supported by Zhaoqing Science and Technology Plan Project (2018N001); Special Innovative Project of Guangdong Education Department (Natural Science) (2018KTSCX251).

\* Corresponding author. E-mail: 173513821@qq.com

*Land Management Law of the People's Republic of China* stipulates that people's governments at all levels shall organize the compilation of general land use planning according to national economic and social development planning, requirements of territorial regulation and resource and environment protection, land supply capacity and demand of various construction projects for land<sup>[4]</sup>. General land use planning is the fundamental method to realize sustainable utilization of land resources.

**1.2 Environmental impact assessment** Environmental impact assessment indicates sufficiently identifying, predicting and evaluating possible environmental impacts of the activity before people take activity that has an impact on the environment and on the basis of sufficient survey. According to the principle of coordination between social and economic development and environmental protection, the countermeasures of eliminating or mitigating environmental pollution and destruction are prepared, and then contradictions between socio-economic development and environmental protection could be solved properly. Seen from the definition, environmental impact assessment work has two core contents. One is predicting environmental impact of the development action, and evaluating range, type, degree and process of possible environmental impact caused by the assessed development action. The other is proposing environmental countermeasures and suggestions. After predicting and evaluating environmental impacts, cost and benefit of possible environmental protection measures are analyzed, and then the benefit of development activity and gain and loss of environmental impact are weighed on this basis<sup>[5]</sup>.

**1.3 Environmental impact assessment in general land use planning** Environmental impact assessment in general land use planning indicates implementing environmental impact assessment in compilation process of general land use planning. For the given feasible planning scheme by environmental impact assessment, mitigation measures of environmental impact are proposed from strategic and policy dimensions. It belongs to the category of planning environmental impact assessment. Therefore, its assessment process is conducted on the basis of taking the work step of planning environmental impact assessment. Environmental impact assessment in general land use planning could be divided into four stages: planning outline compilation stage, planning research stage, planning compilation stage and planning approval stage. Specific work steps at each stage could refer to Fig. 1.

Planning environmental impact assessment is an important means of implementing comprehensive decision making and sustainable development, and its proposal has made the sustainable use of land resources enter a new milestone. The combination of environmental impact assessment in general land use planning with planning environmental impact assessment is complementary and inseparable, and their combination brings a new round of reform to the general land use planning.

## 2 Theoretical basis of environmental impact assessment in general land use planning

On the basis of referring to strategic environmental impact

assessment and project environmental impact assessment, theoretical basis of environmental impact assessment in general land use planning is summarized by combining the learned knowledge. Moreover, theoretical basis is mainly divided into three aspects; theory of sustainable development, theory of landscape ecology, and theory of ecological coordination.

**2.1 Theory of sustainable development** Sustainable development indicates comprehensive and sustained development of economy and society on the basis of sustainable utilization of natural resources and good eco-environment<sup>[2]</sup>. The essence of planning environmental impact assessment is realizing sustainable development. It is because that planning environmental impact assessment could measure sustainability of resources after planning is implemented from environmental perspective. Moreover, its proposed mitigation and remedial measures or alternative scheme, *etc.* correspond with requirements for sustainable development, thereby providing environmental basis for finally implementing land use planning and improving social acceptability of general land use planning. Therefore, theory of sustainable development is core content of planning environmental impact assessment.

**2.2 Theory of landscape ecology** Landscape ecology studies interaction among structure, function and dynamics of heterogeneous surface composed of ecosystem, and concerns landscape patterns of time and space, and the relationship between pattern and its process. It is interdisciplinary science of geography and ecology, and aims to study the interrelationship between landscape spatial pattern and ecological process by combining "horizontal" approach to study spatial relations of physical geography in geography with "longitudinal" approach to study the interior structure – function relations of ecosystem in ecology<sup>[2,6]</sup>. However, land use planning is dynamic, and change in land use manner decides transformation of land function. Therefore, it is not difficult to see that the principle of landscape ecology is an important theoretical basis for environmental impact assessment of general land use planning.

**2.3 Theory of ecological coordination** Any unreasonable exploitation and utilization of natural resources will lead to ecological destruction, and then there will be frequent occurrence of environmental problems. At present, environmental problems are especially represented by ecological destruction, with large influence degree and wide range. Ecological function of forest declines, and biodiversity reduces, and loss and destruction of cultivated land resources are very severe. Affected by land desertification, soil erosion and salinization, scale of land degradation continuously enlarges, and degradation velocity accelerates. Loss and destruction of cultivated land make that the contradiction between man and land is becoming more and more prominent<sup>[7]</sup>. These environmental problems are produced by that human activities exceed the tolerance capability of the environment, and destroy structure and function of natural ecosystem, causing disharmony with the living environment. Therefore, to obtain harmonious development between human beings and environment, and promote comprehensive, coordinated and sustainable development of economy and society, it

must better play the role of planning environmental impact assessment in compilation stage of general land use planning.

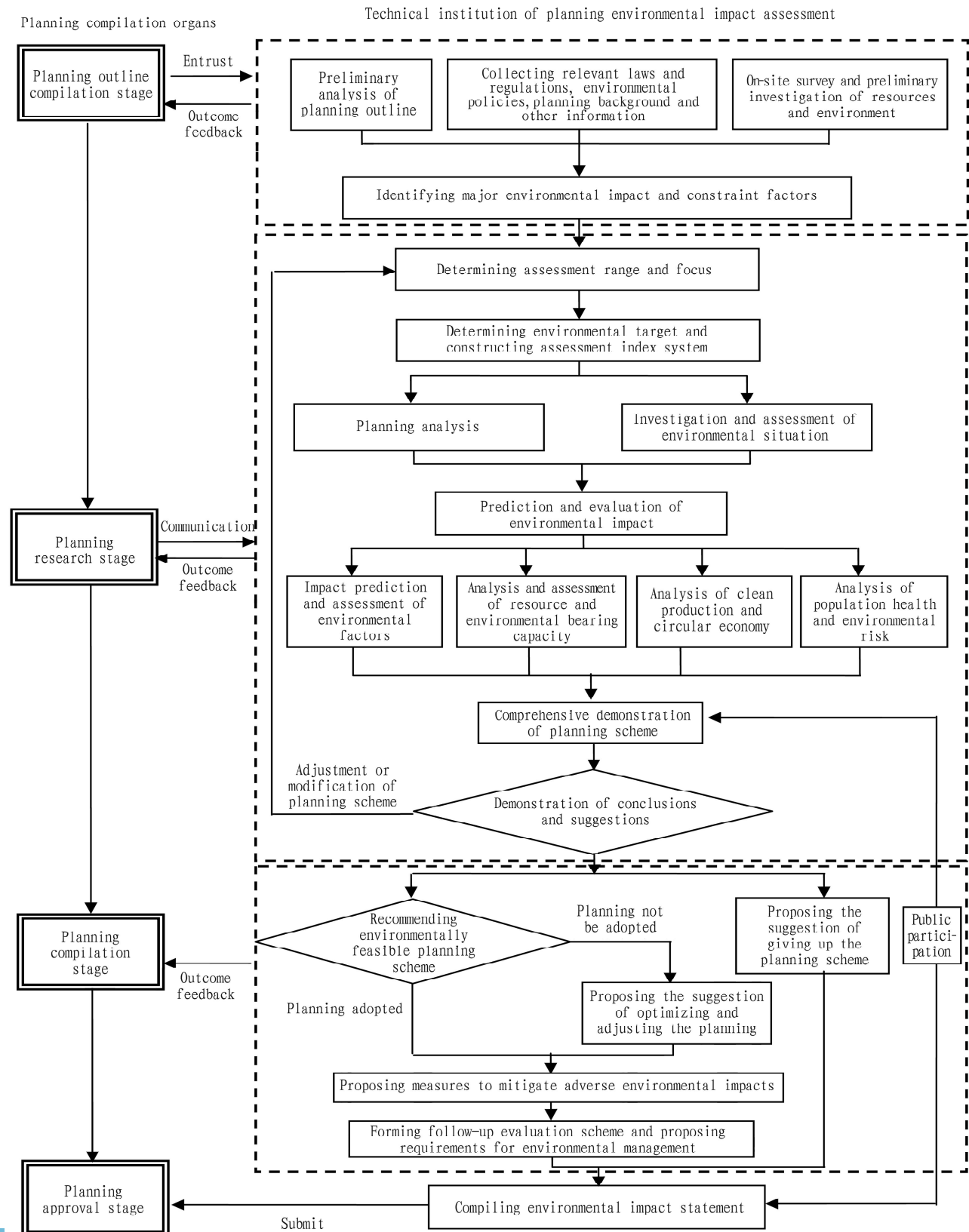


Fig.1 Steps of planning environmental impact assessment

### 3 Current environmental problems of general land use planning in China

Since blind expansion of cultivated land area, rapid expansion of non-agricultural land, rapid development of urbanization and industrialization, the contradiction between economic development and resources, environment is increasingly prominent, and the supply constraints of limited land resources and the ecological environment of land also show a deteriorating trend. At present, environmental problems are prominent, such as land desertification, soil and water loss, desertification and salinization, causing that the lack of land resources is getting deeper and deeper.

Seen from Table 1, soil loss area has exceeded 1/3 of total land area in China. Current environmental problems in general land use planning is very prominent in China, and environmental condition is also quite severe. Due to the influence of environmental problems, land resources of China are declining rapidly at a high speed. Additionally, some irrational land development makes that the contradiction between man and land is getting worse and worse. Therefore, reasonable and sustainable use of land is imminent, and general land use planning comes into being at the historic moment.

Of course, soil pollution situation is equally worrying in environmental problems of general land use planning. Abuse of pesticides and unreasonable fertilization cause farmland soil fertility decline, soil consolidation and nutrient imbalance. Due to the influence of "waste water, slag and gas" in industry and

acid rain, pollution of heavy metals and organic matters in agricultural land is seriously over the standard. According to incomplete investigation, there are at least 100 000 km<sup>2</sup> of contaminated arable land in China at present. Among them, there are 21 667 km<sup>2</sup> of cultivated land affected by sewage irrigation, while the area of field destruction by waste residue stockpiling also reaches 1 333 km<sup>2</sup>.

**Table 1 Status quo of environmental problems in general land use planning of China**

| Type                 | Area// × 10 <sup>4</sup> km <sup>2</sup> | Proportion to land area//% |
|----------------------|--|----------------------------|
| Soil erosion         | 356.92                                   | 37.20                      |
| Land desertification | 262.37                                   | 27.33                      |
| Desertification      | 173.11                                   | 18.03                      |
| Land salinization    | 99.13                                    | 10.30                      |

### 4 Comprehensive assessment method for environmental impact of general land use planning

Procedure of planning environmental impact assessment is generally divided into three stages: identification, prediction and assessment of environmental impact. By referring to the *Technical Guidelines of Environmental Impact Assessment on Land Use Plan* (draft for comments), comprehensive assessment method for environmental impact of general land use planning is shown as Table 2.

**Table 2 Technical methods for environmental impact assessment of general land use planning**

| Method  | Screening and identification | Current situation investigation | Prediction | Assessment stage | Mitigation measures and environmental management |
|---|------------------------------|---------------------------------|------------|------------------|--|
| Data collection method  | √√                           | √√                              |            |                  |  |
| On-site investigation method  |                              | √√                              |            |                  |  |
| Stacking method + GIS   | √√                           | √√                              | √          | √√               | √√   |
| Comparative analysis method   | √                            |                                 | √√         | √√               | √  |
| Check list method   | √                            |                                 | √          | √                |  |
| Matrix method   | √                            |                                 | √          | √                |  |
| Professional judgment method  | √                            | √                               | √          | √                | √  |
| Definition method   | √                            |                                 |            |                  |  |
| Network method  | √                            |                                 | √          |                  |  |
| Scene analysis method   |                              |                                 | √          | √√               | √  |
| Weighted comparison method  | √                            |                                 |            | √                |  |
| Mathematical model method   |                              |                                 | √          | √                |  |
| Input – output method   |                              |                                 |            | √                | √  |
| Cost – benefit analysis method  |                              |                                 | √          | √                | √  |
| Analysis method of bearing capacity   |                              |                                 | √          | √                |  |
| Evaluation method of sustainable development capability                             |                              |                                 |            | √                | √  |
| System dynamics   |                              |                                 | √          |                  |  |
| Ecological footprint method   |                              |                                 |            | √                |  |
| Life cycle analysis   | √                            |                                 |            |                  |  |
| Pressure – Status – Response (PSR)  |                              |                                 |            | √√               |  |
| Land ecological suitability analysis method   |                              |                                 |            | √                |  |
| Conference discussion (hearings, demonstration meetings, expert consultation, etc.) | √                            | √                               | √          | √                | √  |
| Questionnaire (field interviews and letters, etc.)                                  | √                            | √                               | √          |                  | √  |
| Media (newspapers, radio, television and internet, etc.)                            |                              | √                               |            | √                | √  |

Note: The number of "√" represents use frequency.

#### 4.1 Common technical methods for environmental impact assessment of general land use planning

**4.1.1** Expert consultation method. Expert consultation method is generally applied in screening and recognition stage. By consulting experts, environmental impact of general land use planning is recognized. Its advantages are simplicity, rapidity, strong universality and relatively high reliability. But it is easy to have inconsistent result, and result may be biased and unscientific.

**4.1.2** Data collection method. Data collection method is widely applied in the stages of screening, identification and current situation investigation. Various current relevant data are collected, and initial analysis and evaluation are conducted based on the collected data, to understand current environmental condition of general land use planning. Its advantages are wide application range, large effect, and saving manpower, material resources and time. But since the collected data by the method are second-hand information, and they are often incomplete, it could not completely correspond with standard.

**4.1.3** Scene analysis method. At prediction stage of environmental impact, scene analysis method is often used. Time series is taken as base point, and future development status of the system is described, and it is judged according to current situation. Via a series of description and analysis, future development of the special planning after implementation under different time and environmental conditions is pointed out. That is to say, environmental impact consequences of different planning schemes (containing general land use planning) under different situations and process of main change are reflected, convenient for analysis, comparison and decision making. But scene analysis method is to consider both analysis condition and information level, maybe it has certain deviation from actual process, and it often needs combining other assessment methods for application.

**4.1.4** Geographic information system (GIS) method. GIS integrates user, analysis of spatial data, attribute data, computer software, hardware and design capabilities together, which could effectively collect, process, store, modify, manage, analyze and display all relevant computer systems and geographic information. Moreover, automatic matching of management and transmission information could be realized via GIS. GIS technology is scientific, timely and reliable, and it could update timely land change situation in general land use planning.

In above methods, expert consultation method is the simplest and could be implemented quickly. But its reliability is not high, and it is applicable to impact and identification stages. GIS method is accurate, and it could accurately and timely reflect data and is applicable to each stage of environmental impact assessment of general land use planning. Data collection method is simple, with wide application, but its limitation is also large. It is generally applicable to the stages of screening, identification and current situation investigation. Scene analysis method often needs other technical methods for evaluation, which is used in the stages of prediction, evaluation, mitigation measures and environmental management<sup>[5,8]</sup>.

### 5 Index system of environmental impact assessment in general land use planning

#### 5.1 Common models of index system construction

**5.1.1** Basic index model. In domestic research, "ecology –

environment – social economy" is generally taken as basic index model. This form of index system is core of planning environmental impact assessment, which not only reflects the relationship between socio-economic coordinated development and environmental protection but also corresponds with the requirements of sustainable development, and interlinks with "society – economy – environment" index system model in assessment index of sustainable development. It is clear that basic index model provides a basic framework for the establishment of index system of planning environmental impact assessment.

**5.1.2** Index system model based on LCA. Life cycle assessment (LCA) is a kind of tool of evaluating environmental factors related to product or service and environmental impact throughout their life cycles. Index system based on LCA is established around the entire life cycle of a planning, and it could more completely reflect the environmental impact after the implementation of the policy or in the whole process of the planning compilation stage.

**5.1.3** Index system model based on DSR. DSR (drivers – status – responses) model is used to analyze environmental pressure in the sustainable development process by taking driving forcing, status and response as assessment indexes, and suggestions for adjustment are proposed. Driving force index could be used to assess the factors of developing unsustainable development activities and consumption model or economic system. Status index could be used to reflect status of each system in sustainable development process. Response index is used to show the countermeasures taken by human to promote sustainable development<sup>[8]</sup>.

**5.2 Establishment of index system** Based on the researches on basic index model, LCA index system model and DSR index system model, index system of environmental impact assessment in general land use planning is designed by combining technical method of environmental impact assessment in general land use planning (Fig.2).

The index system could be divided into five specific indexes, and next research could be carried out by selecting representative thematic areas. Each specific index is studied to reflect internal structure, external state, the development of relevant social and economic factors of realizing sustainable development in environment of planning region by general land use planning. Since planning has uncertainty, and planning environmental impact assessment index has various kinds and different nature, there is still no unified and standard index system at present.

### 6 Suggestions on organizational form of public participation in general land use planning

**6.1 Significance of public participation** At present, it is more necessary to improve the democratization and scientificization of government decision-making in order to better balance the interests of all parties. Public participation could integrate the voices of social interest groups and reflect them to the government, make government integrate information provided by

the public and balance all aspects of interest pursuit, thereby developing public policies that are more in line with public opinion and have the smallest impact on all stakeholders, to enhance authoritativeness of decision-making. Moreover, since the public participates in the formulation of policies, they could have a sense of identity with policy, making that the policy has

been widely recognized by the public in the process of implementation, and there is less resistance to policy implementation and lower supervision costs. In the final analysis, whether the implementation of land use planning program meets the requirements of the people, whether the needs of the people are taken into account, the public has the most powerful voice.

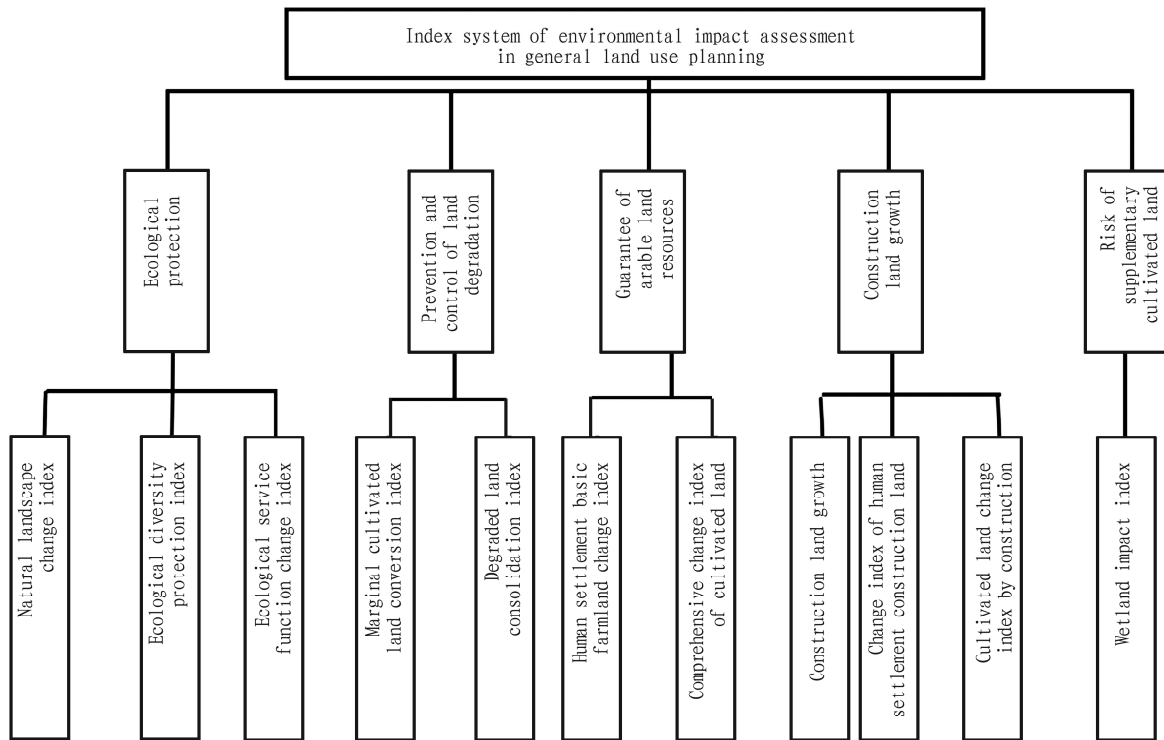


Fig.2 Index system of environmental impact assessment in general land use planning

A general land use planning with public participation in decision-making process could make that the past pattern of government monopoly is strongly impacted, and it is conducive to promoting government to establish a more dedicated and responsible attitude for organization of planning decision and land management. Meanwhile, people also need more democratic decision-making power, and require that government improves transparency in management and information disclosure, thereby making the public become an important social force of affecting planning decision-making and supervising urban construction, to decrease government covert operation and the resulting inequality and corruption. Overall, public participation in general land use planning process helps government to understand opinions and suggestions on major issues in the region. In the process of seeking solution scheme, suggestions are collected and organized to the public, which not only provides rich and comprehensive planning revision information and valuable opinions for general land use planning scheme, but also makes that the initiative and enthusiasm of the public in accepting the plan formulation have been greatly enhanced. Meanwhile, it also improves people's awareness of protecting land resources, and promotes the development of land management<sup>[9]</sup>.

## 6.2 Suggestions

**6.2.1** Establishing and improving laws and regulations on public participation. In China, there is no complete government regulation to regulate public participation in administrative legislation at present. Due to special social objective situation of China, laws and regulations on land management lack public participation for a long time in China, and public participation is not yet a statutory necessary link in general land use planning. In some local laws and regulations on land management, it is generally stipulated that the opinions of the public must be listened in compilation process of general land use planning. But it does not clearly stipulate public participation stage, participation content, participation body and supervision scope of participation in implementation process. This is not only not operable, but also not mandatory. It needs government breaking the mode of public participation in social public affairs dominated by the will of the government, making that the public could truly participate in decision-making process of general land use planning under guarantee of legal system.

**6.2.2** Standardizing the organizational form of public participation in general land use planning. Due to the existence of various social and cultural factors, civil society has not yet formed in China. The form of public participation in general land use planning is generally individual participation, and spontaneous

formation of interest groups is rare. Additionally, Chinese citizens enjoy constitutional rights of political association according to law, but freedom of association is often bound by government in real life. Therefore, it is difficult to establish a truly legitimate civil society. So, it is very important for the government to standardize and rationalize the organizational form of public participation in general land use planning.

**6.2.3** Establishing and perfecting the system of government information disclosure. In compilation, approval and implementation process of land planning in China, only after the plan has been approved will the government announce it, and the public have the opportunity to know the content of the plan. Additionally, network, media, newspapers and magazines often convey government information to the public according to the wishes of the government, with strong political color. It makes the public not get complement information. It should establish strong government information disclosure system, maintain openness of channel of social conditions and public opinions, effectively help government to decrease uniformity of data collection, and make the public more understand general land use planning scheme, further expressing their opinions.

**6.2.4** Enhancing public participation awareness. Since economic development level of China is not high, the culture level of public education in China is generally low. Therefore, there is no clear understanding of the general land use planning by the public at all. Additionally, people depend too much on the government in the process of policy decision-making in China, and lack awareness of active participation. Since this dependence mentality has been deeply rooted in the hearts of the people, public participation consciousness is naturally very weak. Therefore, government should work with the media to widely publicize the public's awareness of participating in general land use planning, and implement enlightening education for the public<sup>[10]</sup>.

## 7 Conclusions

The current general land use planning still needs to be improved in practice. Public attention is not high, causing weak participation consciousness. The research on index system of environmental impact assessment in general land use planning is not comprehensive, and relevant standard index system has not been established. The solution of these problems should be continuously explored in the practice.

## References

- [1] State Forestry Administration of China. The fourth bulletin on desertification in China[N]. China Green Times, 2011.
- [2] CHEN XB, ZHAO XM, WU CY. A primary study on the theory and approach for environment assessment in general land use plan[J]. Acta Agriculturae Universitatis Jiangxiensis, 2006, 28(1): 134–138.
- [3] SUN DF. Study on environmental impact assessment of general land use planning[D]. Jilin: Northeast Normal University, 2008.
- [4] LIANG K. Study on environmental impact assessment of general land use planning[D]. Jilin: Jilin University, 2007.
- [5] LIU Q, PAN WB. Environmental quality assessment[M]. Guangzhou: South China University of Technology Press, 2008.
- [6] WU KN, LI YC, CHEN WQ, *et al.* Thought on environmental impact assessment of general land use planning[J]. Resources & Industries, 2005, 2(1): 39–41, 88.
- [7] YANG JP, ZOU LJ. Desertification state of China and control countermeasures[J]. Journal of Arid Land Resources and Environment, 2000, 14(3): 15–23.
- [8] XU H. Study on technical method of planning environmental impact assessment[M]. Beijing: Science Press, 2012.
- [9] CHENG Q, HAO JM, ZHANG FG, *et al.* Study on public participation in general land use planning[J]. Rural Economy, 2005(7): 45–48.
- [10] ZHOU HM. Study on public participation in general land use planning[D]. Zhengzhou: Zhengzhou University, 2011.
- [11] LIU L. Promoting aviation meteorological service to a new stage[N]. China Civil Aviation Daily, 2016–03–31.
- [12] PANG YL. Research on measures to improve aviation meteorological service capability[J]. Technology and Economic Guide, 2018, 26(6): 168.
- [13] General Office of the State Council. Guidance on promoting the development of general aviation industry[R]. 2016.
- [14] The State Development and Reform Commission, China Civil Aviation Administration. Layout planning of national civil transport airport[R]. 2017.
- [15] ZHAO W. Statistical characteristic analysis of global aviation safety[N]. Civil Aviation Resource Network, 2015–06–12.
- [16] WU FB, XIAO HP, CHENG YQ. Supporting role of meteorological service in the whole process decision-making of civil aviation transportation industry[J]. Journal of Guangdong Meteorology, 2015, 37(1): 47–51.
- [17] SCHIERMEIER Q. Climate change brings stormier weather to the US[J]. Nature, doi:10.1038/nature.2013.12763.
- [18] WILLIAMS PD. Transatlantic flight times and climate change[J]. Environmental Research Letters, 2016, 11(2): 024008.
- [19] WILLIAMS PD, JOSHI MM. Intensification of winter transatlantic aviation turbulence in response to climate change[J]. Nature Climate Change, 2013, 3(7): 644–648.
- [20] IPCC AR5. Intergovernmental panel on climate change climate change fifth assessment report (AR5) [R]. London Cambridge University Press, Cambridge, UK, 2013.
- [21] LI HL. Research on competence model of pilots on high plateau route[D]. Guanghan: Civil Aviation Flight University of China, 2016.
- [22] WILLIAMS PD. Intensification of transatlantic aviation turbulence in response to anthropogenic climate change[J]. Nature Climate Change, 2013, 3(7): 644–648.
- [23] WILLIAMS PD. Transatlantic flight times and climate change[C]// EGU General Assembly Conference. EGU General Assembly Conference Abstracts, 2016.
- [24] WILLIAMS PD, JOSHI MM. Will climate change increase transatlantic aviation turbulence? [J]. EGU General Assembly, 2013.
- [25] WILLIAMS PD. Increased light, moderate, and severe clear-air turbulence in response to climate change[J]. Advances in Atmospheric Science, 2017, 34(5): 576–586.
- [26] ZONG M. Research on monitoring method for carbon emission of civil aviation in China[D]. Tianjin: Civil Aviation University of China, 2014.
- [27] YANG JH. Climate change threatening aviation safety[J]. Science News, 2013(5): 91.

(From page 30)

- [5] LIU L. Promoting aviation meteorological service to a new stage[N]. China Civil Aviation Daily, 2016–03–31.
- [6] PANG YL. Research on measures to improve aviation meteorological service capability[J]. Technology and Economic Guide, 2018, 26(6): 168.
- [7] General Office of the State Council. Guidance on promoting the development of general aviation industry[R]. 2016.
- [8] The State Development and Reform Commission, China Civil Aviation Administration. Layout planning of national civil transport airport[R]. 2017.
- [9] ZHAO W. Statistical characteristic analysis of global aviation safety[N]. Civil Aviation Resource Network, 2015–06–12.
- [10] WU FB, XIAO HP, CHENG YQ. Supporting role of meteorological service in the whole process decision-making of civil aviation transportation industry[J]. Journal of Guangdong Meteorology, 2015, 37(1): 47–51.
- [11] SCHIERMEIER Q. Climate change brings stormier weather to the US[J]. Nature, doi:10.1038/nature.2013.12763.
- [12] WILLIAMS PD. Transatlantic flight times and climate change[J]. Environmental Research Letters, 2016, 11(2): 024008.
- [13] WILLIAMS PD, JOSHI MM. Intensification of winter transatlantic aviation turbulence in response to climate change[J]. Nature

Reproduced with permission of copyright owner. Further reproduction prohibited without permission.