

The Study of Relationship between Population Dynamics and Climate Change in China - an Ongoing Research Project

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Abstract:

Adaptation and mitigation of climate change is receiving immense global attention. For China, the population's dynamics is both the factor and the impact receiver of the climate change. Based on the literature survey of previous studies on the global and China climate change, few effort and attention has been paid on the relationship between population dynamics and climate change. Some previous studies included the population factor, but with very primitive models only considering the total volume change of population, while overlooking the diversity within the population, e.g., quality, structure and dynamics, impact on carbon emission and climate change, and multiple effects of climate change on the population dynamic behaviors, such as how the haze could affect the birth, decease and migration of population. This study, utilizing the system dynamics, considers the climate change, population dynamics, regional sustainable development, carbon emission, capture and pricing mechanism in an integrated model, and analyzes how the climate change interact with the population volume, structure and quality. This research project is jointly funded by the P07 program of United Nations Population Fund and China's National Development and Reform Commission. This paper presents an overview of the research approach of this on-going project.

Keyword: system dynamics, population dynamics, climate change, mitigation & adaptation, carbon emission

This project is currently conducting guided by the following information and requirements: Suggested Outline for submissions to the CPAP of CP7 UNFPA GoC; 2011-2015 United Nations Development Assistance Framework (UNDAF); United Nations Population Fund country programme document draft (CPD-country programme document); Programme of Action of International Conference on Population and Development(PAICPD); Suggestion of the Central Committee of the Communist Party of China on establishing the 12th Five Year Plan of National Economy and Social Development and State of World Population 2009-facing a changing world: women, population and climate (UNFPA2009).

This project is oriented with the result, providing system dynamics model simulation tool and combined policy advice based on sustainable development for national population and industrial policy adjustment, and trying hard to bring into national policy system.

1. Background

Mitigation and adaptation to climate change have become the most concerned focal point all over the world. Copenhagen Conference in 2009 and recent major conferences on climate change had not obtained substantive achievement. It possibly also needs the multi-round negotiation in order to achieve performable agreement.

In new emission reduction agreement negotiation of climate change, the attitude and promise of China play a vital role. Even though China has made the promise that the GDP carbon dioxide emission in unit of China up to 2020 will drop 40% to 45% compared with that in 2005 [1], but China has not obtained the understanding of the international community. The developed countries hope China to further reduce carbon emission amount in order to mitigate probable and drastic global climate change. The causation that Chinese Government is difficult to make greater emission reduction promise is China's special national situation-population factor limit.

First is huge population size. China is the most populous country in the world. Even though the transition from high birth, high death and high growth to low birth, low death and low growth of population has realized, total population amount is still speeding up with approximate 7-8 million people per year. And the population quantity will gradually drop till 2033 more or less [2]. Second is lower population quality and poor environmental consideration. Third is that poverty-stricken population quantity is remaining high. Even though China has been the second economy in the world, the income level per capita of one hundred countries at least is higher than that of China. If balancing with worldwide standard by 1 dollar per day, China approximately has 100 million poor population, and the living of more than 10 million therein is on the breadline [3].

If not considering the population situation of China, the enforcement of industrial structure adjustment and energy conservation and emission reduction will cause severe social & economic consequence. First is the severe unemployment phenomenon and the social unrest; second is intensifying poverty condition, especially the living of disadvantaged groups such as women, elders, children and low technique crowd will be more difficult; third is incapable of realizing sustainable development of society and economy, and also incapable of realizing the global target of energy conservation and emission reduction and dealing with climate change at last.

In addition, China has not been provided with comprehensively systematic prediction and strategy study of population and climate change. Therefore, this research project is of significant importance to both China and the rest of the world in terms of how adopting systematic and scientific method, studying the relation of population with carbon emission and climate change from the aspects as population size, structure, quality, distribution, family planning policy adjustment, proposing population regulation target through combination adjustment of population, social & economic and environmental policy under the premise of not influencing persistent and stable China social & economic development according to sustainable development requirements, controlling energy consumption, reducing carbon emission, precipitating new global emission reduction agreement conclusion, and making due contribution for mitigating or preventing climate warming.

2. Current Situation of the Researches and Their Results

The current situation of the researches and their results will be summarized and analyzed with both national and international aspects in this part, and the study framework and approaches of the project will be illustrated and offered in the next part.

2.1 International Research and Progress

The international research outcomes are mainly published on following two websites.

<http://www.ipcc.ch/languages/chinese.htm#2>.

<http://unfccc.int/secretariat/items/1629.php>

The first one was established by Intergovernmental Panel on Climate Change (IPCC) to display the research findings by various special committees. The second one was established by United Nations Environment Programme to smooth the implement of “Climate Change Convention” and it is mainly about the implementation of the convention, meetings and news on climate change from various countries of the world.

Common practice of research approaches on climate change studies is first analyze the contributing factors to greenhouse gases and the emission trend; second evaluate the changing atmospheric concentration of greenhouse gases, which is subjected to the discharge amount of greenhouse gases, chemical reaction process of the greenhouse gases in the atmosphere and the capacity of ecological system in absorbing carbon; third analyze the change of temperature, rainfall and general circulation of atmosphere by using the statistical or simulation models describing the relationship between atmospheric CO₂ and climate change; finally, put forward socioeconomic policies on climate change to determine the development mode of human being in the future in Figure-1 [4].

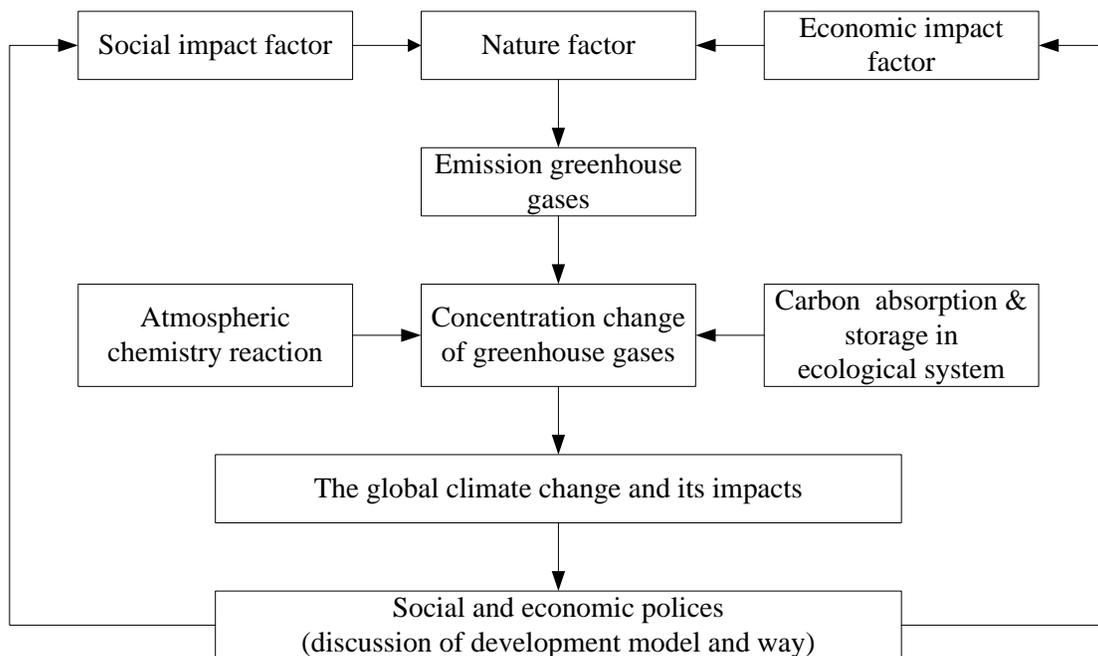


Figure - 1 General research model on global climate change

Considering the extensive phenomena concerning global climate change, it is extremely hard to systemize and model the all-embracing changing process of the climate. We need to leave out unimportant elements before analyzing and determining the relationship among the various elements. The relationship of main contributing factors to the climate change is shown in Figure-2 [5].

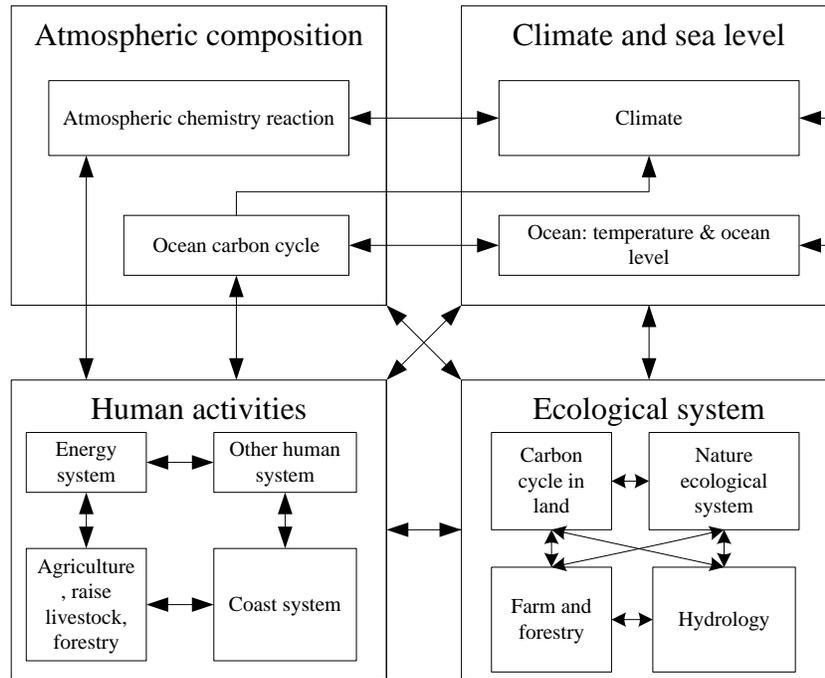


Figure-2 Integrated assessment model framework on climate change

As shown by Figure-2, researchers constructed their Integrated Assessment Model (IAM) [6] on climate change based on previous research results from different fields. The IAM is generally based on the cost-benefit analysis. It introduces the cost and penalty function of emission reduction in climate change model. By maximizing the post-discounting social benefit function value, the optimal emission reduction plan is achieved. Climate change IAM is essentially a group of models and so far there have been 30 IAM models available around the world [7].

Based on its approach, the climate change IAM can be generally categorized as Optimization Model, Computable General Equilibrium Model (CGE) and Simulation Model. Based on the its scale, the climate change IAM can be categorized as Global Model and Regional Model. The Global Model takes the entire world as a whole, while the Regional Model divides the world into several regional for consideration.

Based on its objective function, the Optimization Model can be categorized as Social Benefit Maximization Model and the Cost Minimization Model. The concept behind the Social Benefit Maximization Model is relatively simple. That is, production results in consumption and emission. The emission then brings climate change, which later leads to social cost and decrease

of consumption. The Social Benefit Maximization Model determines the emission reduction quote for each time period and then maximize the post-discounting social benefit for the entire time horizon. The Cost Minimization Model aims to find the best cost-benefit model on climate policy. Some Cost Minimization Models clearly include the module of climate, while others use the emission to represent the climate module.

CGE Model is based on the optimal behavior of Micro-economic subjects, and uses the interaction between Macroscopic and Microscopic variables as the link. It analyzes the economic system as a whole object and is capable to describe the interaction between multiple markets and their agents. It is also capable to estimate the direct and indirect impacts of policy change. These features make the CGE model popular and quickly develop in analyzing climate policy, gaining world wide application and recognition.

The Simulation Model is based on the forecast of future carbon emission and climate condition. Given external parameters, it determines the carbon emission quota that can be used in production for each time period in the future, which implies that the change in climate is not affected by the economics module. The Simulation Model cannot be used to answer which climate policy is with the maximum social benefit or the minimum social cost, while it can be used to evaluate the social cost under every possible scenario of carbon emission.

2.2 Domestic Researches of China

Since the United Nations Framework Convention on Climate Change in 1992, China has been actively taken part in international negotiation on climate change. The Chinese scientific community has made numerous studies on the climate change.

On December 26, 2006, the Ministry of Science and Technology, China Meteorological Administration and Chinese Academy of Sciences jointed their hands in holding a press conference on National Appraisal Report on Climate Change. This appraisal report was together composed by 12 ministries and commissions, including the Ministry of Science and Technology, China Meteorological Administration and Chinese Academy of Sciences, 17 departments and 88 experts, taking four years. This is the first report of this type ever composed in China. The National Appraisal Report on Climate Change was divided into three parts as “the history of climate change and its developing trend”, “the influence of the climate change and conformation” and “social & economic assessment on mitigating the climate change”.

On March 2, 2009, Chinese Academy of Sciences issued “Report on China's Sustainable Development Strategy in 2009” with its subject centering at “searching for a low-carbon road with Chinese features”. This report was focused on treatment of global climate change, has given us a scientific cognition of global warming, as well as it influence and developing trends, researched and analyzed the evolution of carbon emission and its main driving forces, summed up experiences from low carbon consumption countries, predicted the future trend of energy, climate and development in China, analyzed the opportunities and challenges facing China in its transformation into low carbon consumption country-analyzed bottle-neck problems concerning technology transfer and capital mechanism in climate change, made a study of experiences on

development of low-carbon economy and put forward development strategies, targets and road of low-carbon with Chinese features.

The two aforesaid reports summed up the fruits of research on the climate change in an all-round way. The broad contents may be divided into three parts: research on countermeasures; research on carbon emission and absorption; integrated study on the climate change.

2.2.1 Research on Countermeasures

In front of the global climate change, China has carried out wide researches in the aspects of social economy, energy efficiency and pollutant reduction, development of late-model energy and low-carbon economy. China's countermeasures have been detailed in the White paper-China's Policies and Actions on Climate Change, issued by the Chinese Government in 2008. Problems with the countermeasures are lack of data support and that the research mainly centers in the macro level.

2.2.2 Research on Greenhouse Gas Emission

At the request of the IPCC, the Climate Change Coordination Office under National Development Reform Commission has started the National Information Notification Construction on October 19, 2001. The checklist of energy activity greenhouse gases, greenhouse gases checklist of process engineering, checklists of greenhouse gases in agricultural activities, checklists of greenhouse gases of urban solid waste and checklists of greenhouse gases in land utilization and forestry are given. This explained that the largest-scale greenhouse gas estimation made by China classified the emission of greenhouse gases as energy activities, industrial production and process engineering, agricultural activities, city wastes, land utilization and forestry [8].

The principal causes of global climate warming are carbon dioxide, so the emission law of carbon dioxide should be the focus of research. The basic clues are much the same with international research technique. The carbon emission models relevant to energy consumption are mainly divided into three classes:

(1) ERM AIM/ Emission Model of China

The AIM/ Energy Emission Model consist of three models. The first is "energy service and calculation model". The second is "energy efficiency computation model" for calculating change of energy efficiency. The third is "various service and technology model" determining energy efficiency. It is an integrative research model.

(2) Logistic Model

We can observe the discharge amount of CO₂ generated by energy consumption year by year with nonlinear regression to get a statistics formula.

(3) MARKAL Model

MARKAL Model is a dynamic linear programming model, it is based on energy system and has given a detailed description of the exploitation, processing, conversion, and distribution of

energy taking into consideration not only the existing technology but also various advanced technologies in the future.

The above-said are three macro models. As to the specific emission quantity of certain energy consumption, there is seldom model analysis and are generally made actual measurement in analytical study.

2.2.3 Research on Climate Change

On this stage, prediction research on climate change is to simulate the future climate change with various emission scenarios based on the existing earth climate mode of different complexity [9]. The research will focus on the following aspects:

(1) Projections of future climate change with various emission scenarios

- i) Regional climate change under condition of multiply increasing or progressive increasing CO₂
- ii) Regional climate change projected according to scenarios of IPCC IS92 and SRES series;
- iii) Projections of future climate change in East Asia and China

(2) Impact of climate change on resources and social economy

- i) Impact on water resources
- ii) Probability of occurrence of drought and flood;
- iii) Impact on food production;
- iv) Impact on public health.

2.3 Conclusion of Problems on Climate Change Research

2.3.1 Lacking of Advanced Research on the Relationship between the Population and CO₂ Emission and Climate Change

There is no contents reflecting impact of factors, such as the complex and variable population structure, quality, fertility rate, mortality rate and family planning policy, on carbon emission; also no contents reflecting the great feedback action of related factors, such as flood/ drought disaster, cereal crop underproduction, fog & haze pollution and disease outbreak which caused by climate change, on population.

2.3.2 Research on Climate Change being not Laid in the Framework of Sustainable Development

Climate change essentially is a problem of regional sustainable development. However, research on carbon emission cannot reflect the general requirement of regional sustainable development because it has not been laid in the general framework of regional sustainable development. Therefore, the target of controlling CO₂ emission and alleviating climate warming through energy-saving and emission-reduction is difficult to come true.

2.3.3 Lacking of Normative Research Method

Research on climate change covers complex systems of many fields including politics, economy, society, environment and climate change laws. The overall complex system is possessed of properties that subsystem does not have, therefore, the properties of the overall system can't be incarnated by subsystem, and overall behavior of the overall system can't be explained even if analyzing the subsystem clearly. Consequently, the model only considering single aspect such as energy, economy, environment or technology has prodigious limitation and otherness. It is required to have a comprehensive consideration on the impact of population, industrial structure, energy utilization and CO₂ emission on climate change, and to establish a normative population-industrial structure-climate change integrated model.

2.3.4 Large Difference in Forecasting Results of Carbon Emission

Climate change depends on the carbon emission conditions, and carbon emission has complex interaction with factors including the population situation, socioeconomic development, agricultural production, and land use and energy consumption. Therefore, an integrative analytic model is required to analyze these factors' impact on carbon emission, and also to improve quantitative level of the research and scientific character of the research findings. It is required to provide forcible data to support the policy establishment and adjustment [10]. In fact, the research model of carbon emission is too simple: there is no detailed structural analysis and no sufficient systematicness; even effective policy control and forecasting also can't be carried out [11].

2.3.5 Unobvious Support Action on the National Climate Protection Policy

Because of lacking overall and delicate analytical study on the population-carbon emission-climate change system structure, as well as the fact that the IAM is only single group of models and it take sequential steps to calculate the result, which means it cannot reflect the complex interaction between climate change and other change variables, it is difficult to work out convincing results and also limited to support national climate policies.

Consequently, it is required to probe into new method for researching the relationship between carbon emission and climate change, so as to find operable route for China's low-carbon economic development and practical instrument for policy regulating and controlling.

3. Study framework and approaches of this project

3.1 Study Framework

The special topic on population and climate change in the Fourth Assessment Report (AR4) of Intergovernmental Panel on Climate Change (IPCC) is a calculable general equilibrium (CGE) model method; population is just listed into influencing factor as one total amount, incapable of reflecting all influence of population [12]; furthermore, the general equilibrium model method is a static and difficult to regulation for relevant factors optimal method.

China study is concentrated on population and carbon emission amount aspect, and the used method is stochastic model based on IPAT (Ehrlich, Paul R. and John P. Holdren, Equation, $I = P \times A \times T$), which is difficult for the regulation and policy analysis on the complex population and the climate change system.

Following the guidance of the theory of sustainable development, utilizing the system dynamics method, centering on the population change, based on the five sub-systems which influence the sustainable development, this study adds the climate change and its impacts as two sub-systems, studies the complexly mutual relationship among population dynamics, carbon emission and absorption, climate change and various influences. Under the condition of guaranteeing the comprehensive, coordinative and sustainable development of China's society & economy, it finally tables the operable adjustment suggestions on the population and industrial policy to maximally reduce the carbon emission, increase the carbon absorption, mitigates and adapts to the climate change through combinatorial regulation simulation of various policy system. Figure-3 is the study framework.

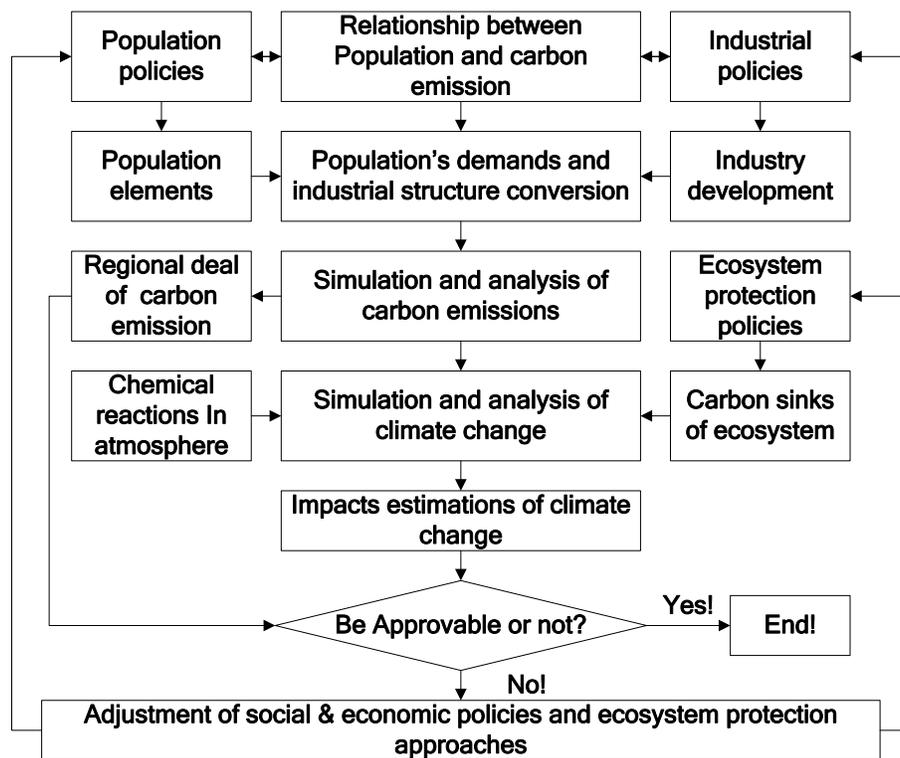


Figure-3 Study Framework of Population and Climate Change

3.2 Research Approaches of This Project

This research shall be carried out with system dynamics method so as to carry out model design and policy simulation analyses.

System dynamics (System Dynamics, SD) was initially established in America in 1956. As an integrated interdisciplinary subject, it shall be used to analyze and research problems of the

complicated motional feedback system with computer modeling technology. In terms of system methodology, system dynamics is the unity of structural method, functional method and historical methods. Based on the systematology, it integrates partial contents of the control theory and information theory, and becomes the system science method integrating several theories and methods including natural science, social science and technical science. It is extensively used in all areas of human production and life, and also praised as “strategy and policy laboratory”.

Dennis L. Meadows said in the prologue of “The Limits to Growth” which initiated new concept of sustainable development: “The established model is deficient, over-simplified and unfinished, like other models. We have fully realized its disadvantages, but we still believe it is the most useful model for dealing with problems in the space-time chart...”

In general, methods of system dynamics are possessed of the following basic characteristics:

(1) SD is a subject can be used to research and deal with problems of social, economic, ecological, and biological and the other highly nonlinear, high-level, multi-variable, multi-feedback, complex time-varying large system. It is able to carry out comprehensive research on the complex multi-level multi-sectoral large system both in macroscopic and microcosmic levels.

(2) SD primarily focus on the open system, which stresses the view of system, the view of interconnection, the view of development and the view of movement. As for SD theories, behavior model and feature of the system are based on the interior dynamic structure and feedback mechanism.

(3) In theories of SD, the problem-solving method is the combination of qualitative and quantitative method for systematic thinking, analyzing, integrating and reasoning. “Whitening” technology shall be adopted as far as possible, so as to relatively “optimize” the poor structures. The model simulation shall be the structure-function simulation, and also be the bridge of statistic model and gaming model.

(4) SD model is normative if seeing the integral. It is convenient for human clearly communicating ideas, carrying out analyses for existing problems and proposing assumption for policy test. It is convenient for dealing with complicated problems, reliably finding out the indicated mess and confusion from the complex system, rather than keeping ambiguous words, partial emotion or mistaken intuition.

(5) The SD modeling process is convenient for integrating modeling experts, decision maker and practice manager, and also convenient for using all kinds of data, documents, experiences and knowledge, as well as merging other systematic subjects and other scientific theory payoffs. As a result, system dynamics is the best method to research relationship between population and climate change and also to make optimal policy selection.

3.3 Technical Approach

Based on the structure diagram of this research project, technical approaches are proposed. Firstly, analyzing the relationship between population and CO₂ emission; secondly, determining the relationship between population demand and industrial structure according to the population situation and industry development conditions, and determining the model structure of carbon emission according to the general model of China's sustainable development; Thirdly, setting and simulating the carbon emission amount according to related policies, and calculating the quotient of China's carbon emission in the world's total emission amount; fourthly, simulating the climate change scenarios and determining the climate change according to carbon emission amount, the reaction relation between CO₂ in air and the other chemical substances, carbon absorption and storage capacity of the ecosystem. Fifthly, referencing to the determined climate change to analyze the impact of climate change on social economy, population and ecological environment; conducting contrast analysis on the conditions and quotient of future carbon emission in China, so as to determine the satisfaction degree; the research shall be finished if the results are satisfactory; If the results are unsatisfactory, the policies on social economy and ecological environment protection should be adjusted to newly carry out simulation until reaching the satisfactory results.

4. Major Research Contents and SD model Structure

4.1 Analyses on Population- Industrial Structure-CO₂ Emission-Climate Change Relationship

It is required to focus on determine future change of products demand, labor and employment demand of population through analyzing quantity, structure, quality, movement and urbanization of population, so as to determine the alteration trend of future industrial structure and to finally determine the primary source of carbon emission. The essential model structure of population and its interactive factors is shown in Figure-4.

4.2 Design of Carbon Emission & Carbon Absorption Model

Sources of carbon emission mainly comprise energy used for industrial production, agricultural production, social service and domestic life. Whereas, industrial production, agricultural production and social service are related to state of the population, policy of the socioeconomic development, storage amount of resources as well as state of ecological environment. System science method must be adopted as the only way to definite influencing factors in the integrated system of population, resource, environment and socioeconomic development. Therefore, this research shall be used to project the carbon emission state by adopting the model of China sustainable development system, and the model structure shall be arranged according to the systematic relations showed in figure-5. The carbon emission model should be composed of five subsystems: population subsystem, society subsystem, economy subsystem, environment subsystem and resource subsystem.

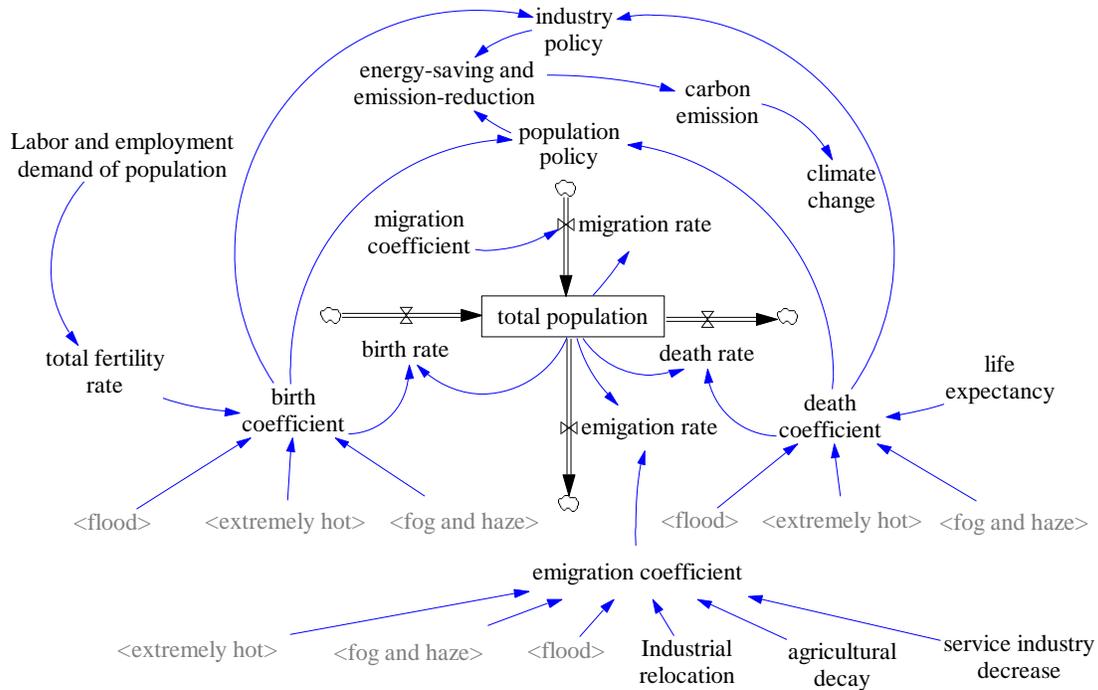


Figure-4 The essential model structure of population and its interactive factors

4.3 Model Design for Carbon Concentration in Atmosphere

Carbon concentration in atmosphere is involved with two subsystems including carbon emission and carbon absorption. Carbon concentration is the accumulative results of the difference between carbon emission and carbon absorption. Carbon emission shall be calculated with the carbon emission model; carbon absorption shall be calculated with the internationally matured carbon absorption model also.

4.4 Selection of Carbon Concentration and Climate Change Model

There are numerous research findings about the relationship between climate change and CO₂ concentration in atmosphere, in which the matured and authorized model will be selected for this research, so as to simulate the conditions of climate change caused by change of CO₂ concentration.

4.5 Impact of Climate Change

The research mainly focuses on the relationship between climate change and precipitation, drought, flood, monsoon change, fog & haze, epidemic disease, forest resources growth & decline, and food production. Internationally matured research model shall be selected as prediction model, for example, we can choose RegCM4.0 to simulate and predict monsoon change in eastern china in which fog and haze arises frequently from 2011.

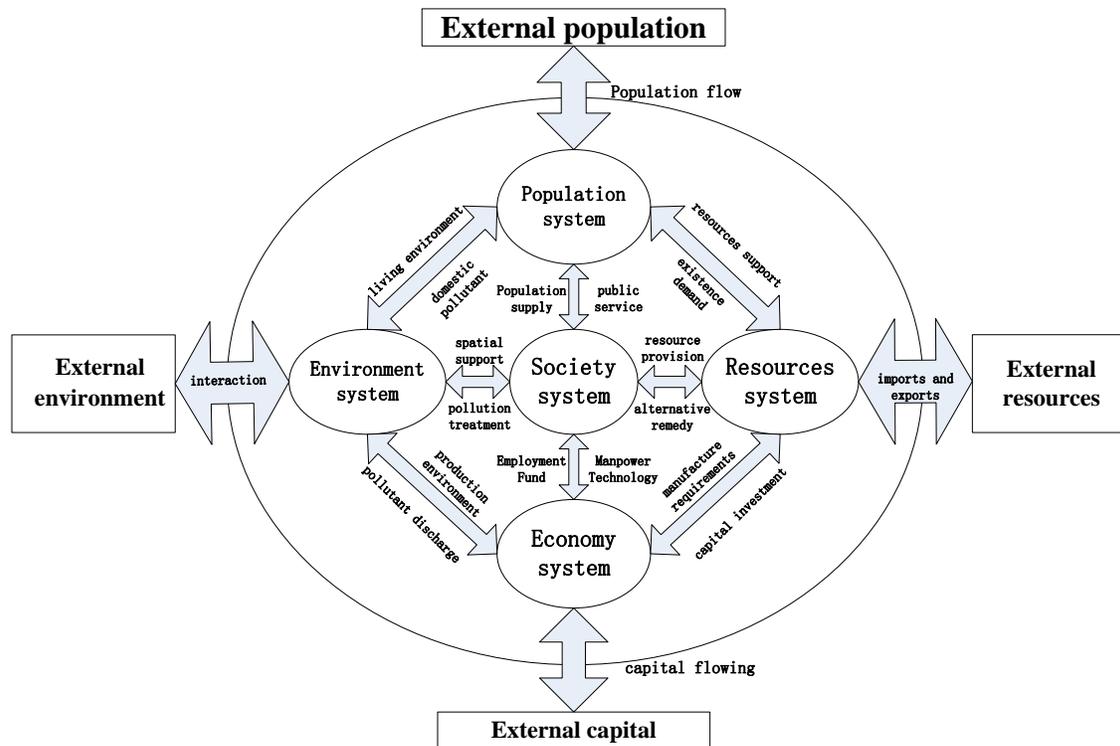


Figure-5 Basic Structural Relationship of the Population, Resource, Environment and Social Economy Coordinated Development

4.6 Specification of the General Model of Population and Climate Change

It is required to combine the population dynamics system, carbon emission system, carbon absorption system, carbon concentration system, climate change system, impact system of climate change, adaptation & mitigation system, system of energy-saving and emission-reduction and technique system of carbon capture and as a coordinated system. This combined system is eventually used for policy setting, scenarios model analyzing, population policy analyzing and selecting. Figure-6 is the mixed flow figure of system dynamics (SD) simulation model.

4.7 Policy Setting and Scenarios Simulation Analysis

All related policies including policies on population, reorganization of an industry, energy, agricultural & animal husbandry as well as forestry.

- (1) Population policies comprise the existing policy and two-child policy.
- (2) Reorganization policies of an industry comprise adjusting the first, second and third industrial structures.
- (3) Energy policies comprise policies on energy production, imports and exports as well as application.
- (4) Agricultural & animal husbandry policies comprise the planting structure and agricultural policies, including agricultural planting structure and return grazing to grass.

(5) Forestry policies comprise the forestry investment, returning land for farming to forestry and forest planting.

It is required to integrate, intersect and compile schemes according to aforesaid policy setting; to adopt models to simulate the climate change and primary effect of integrated policies in future 50 years; to recombine simulation program through analyzing the set problems, and then simulate again.

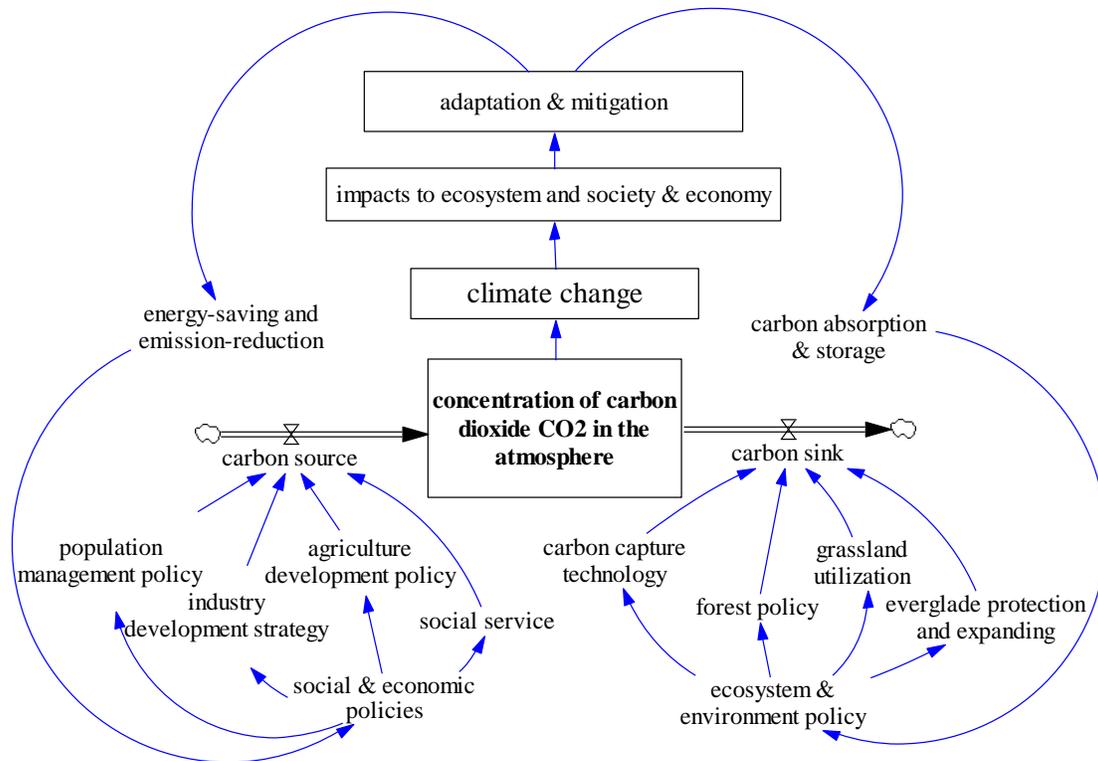


Figure-6 System Dynamics Mixed Flow Figure of Population Dynamics and Climate Change Study

5. Study Team

Office of Scientific Research Administration, Renmin University of China is responsible for the organization and coordination of this study. Researchers of relevant disciplines--population, environment, economy and climate change, etc. from Renmin University of China and the researchers from relevant domestic research institutes are called together by the Office of Scientific Research Administration, Renmin University of China to compose the multi-agency, multi-disciplinary study team and carry out the study work.

In addition, organizations with strong study capabilities and study achievements on the population and climate change field will be invited to join the study as the partners of Renmin University of China. These partners include:

- (1) Energy Research Institute of National Development and Reform Commission
- (2) National Climate Research Center of China
- (3) Population & Development Studies Center of the National Health and Family Planning Commission
- (4) China Research Academy of Environmental Science of Ministry of Environmental Protection
- (5) College of Environmental and Energy Engineering of Beijing University of Technology

The above organizations will constitute a core study team to carry out the study. The members and job distribution of the core team are specified in Table-1.

Table-1 Members and Job Distribution of Core Study Team

No.	Subtopic	Undertaker
1	General design and coordination of topic	Office of Scientific Research Administration, Renmin University of China
2	Study and design of system dynamics model	Center for Population & Development Studies, Renmin University of China
3	Study for population subsystem	China Population & Development Studies Center of the National Health and Family Planning Commission
4	Study for resource subsystem	Center for Energy Efficiency Studies of National Development and Reform Commission
5	Study for environment subsystem	School of Environmental and Energy Engineering of Beijing University of Technology
6	Study for society subsystem	Institute for Climate Change and Low Carbon Economy Studies of International School, Renmin University of China
7	Study for economic subsystem	Climate Change and Development Research Center of School of Economics, Renmin University of China
8	Climate change subsystem	National Climate Research Center of China
9	National policy on climate change of China	School of Environment & Natural Resources, Renmin University of China
10	Analysis for international policy on climate change	Center for International Energy Strategy Studies of School of International Studies, Renmin University of China
11	Environmental impacts of climate change and solutions	Research Center for Environmental Safety of China Research Academy of Environmental Science, Ministry of Environmental Protection

6. Schedule of the Project

Bounded by the year 2014, the research of 5 years is divided into two phases: in the first phase (2012-2014), the research will involve the work -- probing the interaction approach of the population factor and climate change, and identifying the regions and the population vulnerable to the impact of the climate change in China through establishing the dynamic model of population and climate change in China; in the second phase (2014-2016), based on the

established mold, the research team will cooperate with the related government departments, and stress on coping with the population-related practical problems in the climate change in China, so as to raise the proposal with more controllability to reflect the population factor in the national climate change solution. The specific research plan is detailed in Table-2.

7. Expected Output

The study on this project is expected to produce four levels of achievement.

7.1 System Dynamics SD Simulation Platform (Software) of the Research of Chinese Population and Climate Change

- (1) The establishment of the platform will borrow the international experiences of existing models today through integration and perfection.
- (2) The subsystem of the platform will be based on the international and domestic research findings accepted widely
- (3) This platform will reflect adequately the national conditions of China and the authoritative domestic historical data will be collected, sifted and used.

This study will establish the system dynamics SD simulation platform (software) of the research of Chinese population and climate change, and change the current situation that the study on the population, industrial structure and the mitigation and adaptation of climate change adopts mainly the logical deduction, regression statistics, static analysis and lacking in the simulation study of system, dynamic and feedback, making the policies and suggestions proposed more pertinence, reliability and workability.

7.2 Analysis of the Interactive Methods between Population and Climate Change

In the mitigation respect, the study will try to explain the logical relationship among the demographic factors (total amount, structure, disposition of the population and the size of the families, etc.), their dynamic and the climate change; in the adaptation respect, the study will endeavor to discuss the influence degree of the climate change on the different districts and crowd, and provide support for more suitably unveiling the decentralized efforts measure to help the most disadvantaged groups such as women, elders, children and the groups with low technical ability to cope with climate changes.

7.3 Policy Suggestion

Through the track searching on the interaction between the Chinese population and the climate changes, the adjustment strategy and the policy suggestions may be proposed in this study in several respects including in the population, industrial structure and the use of the energy to expect that the demographic factors will be brought into the national scheme of dealing with the climate changes of China. Specifically, this study is expected to put forward the relevant policy projects mainly in three respects:

(1) Demographic factors will be given more concerns in the national scheme for dealing with climate change of China. Through the simulation analysis of the feasibility of the industrial transfer of the employed people and the population migration, determine the influence degree of the climate changes on the different people and propose more suitably the subbase intervention measure to help the most disadvantage groups such as women, the aged, children and the crowd with low technical ability to cope with climate changes. The main targets for using this policy project in this part are such departments as the National Development and Reform Commission, Ministry of Human Resources and Social Security and so on.

(2) Provide the suggestions for the reorganization of national industry structure of China. The projects mainly include: the human resource layout of the three industries; the policies of production, imports/exports and use of the energy; agricultural planting structure and returning grazing land to grassland; forestry investment and returning land for farming to forestry, plantation, etc. Through the adjustment of the industrial structure, improve the service efficiency of the energy resources, reduce the consumption of the energy resources of fossil, reduce the amount of carbon emission, add the absorption of the carbon and mitigate climate changes. The major targets of the projects in this part are such departments as the Energy Resources Office, Climate Change Department, Social Development Department, etc. under the subject of National Development and Reform Commission.

(3) Provide the frame and schedule for the adjustment of the population policy This study will explain the logical relationship between the population dynamics and climate changes theoretically. According to the simulation results, answer quantitatively the influence ratio of the variation of the Chinese population on the Chinese and the global climate changes, the negative impact of climate change on variation of the Chinese population, and propose the schedule for the regulation and control of the population policy.

The major targets of the research findings of this part include the National Health and Family Planning Committee and so on.

7.4 The Influence beyond the Study and the Prolongation Application of the Research Findings

(1) Establish a research team for the Chinese population and climate change. The research team is based on the Renmin University of China and includes the researchers in several colleges and universities in China and the relevant research organizations. Through the tracing, learning and communicating of the most advanced research method internationally, a research team setting foot in China and having the global sight will be formed to continuously provide the consultation and projects for the government to formulate the policy design and construction including the climate change reply scheme of the demographic factors, the national transition of economic growth mode and the change of the life style of the citizens.

(2) Based on the research team and research findings, develop extensively the relevant activity to the population and the climate changes. These activities include:

- 1) Provide the research method, simulation model software and technical training of the policy analysis for the relevant national ministries and commissions and the local and international organizations.
- 2) Issue and publish regularly the relevant research reports of the population and the climate changes, monograph, etc.; convene the international and domestic conference and forum; reinforce the recognition and concerns of the society for the problems of population and climate changes.
- 3) Develop the South-South Cooperation and South-North-South Cooperation in the field of population and development.

8. Discussion

(1) For the increasingly severe fog and haze pollution in China, this research project focuses on how the population dynamics could affect the climate change, how the monsoon in China is affected by the climate change which worsens the haze pollution, and the impact of haze pollution on population birth, decease and migration.

(2) The simulation of carbon emission's impact on climate change and the consequence of the climate change on monsoon is a complicated computation process. The main difficulty in the project is to find a simple but sufficiently accurate simulation model that can be integrated into the SD simulation model.

(3) This paper provides an overview on the research plan to investigate the interaction between population and climate change. Project outcomes will be published in the future with the complete of the project.

Table-2 Specific Research Plan

Phase	Year	Actions
Phase I	2012	Annual objective: establishing the China population and climate change research model. Actions: 1. International communication (1) Inviting the international authorities to assist the research; (2) The chief research workers in the research team study and take out the communication abroad. 2. Model structure and research scheme design. 3. Expert evaluation. 4. Reach task allocation.
	2013	Annual objective: establishing and debugging the China population and climate change mold. Actions: 1. Key variants and interaction relation analysis. 2. Data collection and screening. 3. Mold simulation and result reading 4. Mold perfecting (1) Mold structural adjustment; (2) Checking and evaluation for the authenticity and validity of the model. 5. Expert evaluation.
	2014	Annual objective: taking out the analysis on the future scenarios of population and climate change in China. Actions: 1. The next-hundred-year scene simulation analysis on the base of no policy change. 2. The next-hundred-year scene simulation analysis on the population and industrial policy mix adjustment. 3. Expert evaluation on the simulated result. 4. Phase outcome report.
Phase II	2015	Annual objective: taking out the application research on the matters, related to the population, in the China climate change solutions. Actions: 1. Probing into the feasibility of the policy adjustment jointly with the National Development and Reform Committee (NDRC) and the National Health and Family Planning Commission (NHFPCC). 2. Conducting the researches jointly with NDRC and NHFPCC according to the actual demand. (1) Researches on the population-related relieving countermeasures; (2) Researches on the population-related adopting countermeasures. 3. Expert evaluation.
	2016	Annual objective: striving to promoting the population and industry policy adjustment proposal into the national climate change general solution. Actions: 1. Raising the population and industry policy adjustment proposal. 2. Determining the decision scheme on the base of the negotiation with the national decision-making bodies. 3. Publishing the final research findings.

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