Task Force Report on Economic Growth and Environment

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Part I Background

China faces increasingly severe environmental, resource and social problems following rapid economic growth in many years. In all groups of society there is widespread awareness of resource and environmental problems. Blindly pursuing rapid economic growth will lead to environmental deterioration and resource depletion, and will impede the social and economic development at national and regional levels, as well as the progress of modernization.

The *China Green National Economic Accounting Study Report 2004*[1] shows that, if all the pollutants released into the environment in 2004 were treated with currently available technologies, the total direct investment would be 1080 billion RMB (in addition to investment already incurred), or 6.8% of the year's GDP. The "economic loss caused by environmental pollution" is estimated to be at least 3.05% of the GDP in the year. Here, the loss caused by pollution does not include the extra cleaning expenses due to air pollution and the losses caused by groundwater pollution, soil pollution and ecological destruction. Obviously, the environmental price that China has to pay for its economic growth is heavy.

In response to the problems of natural resource depletion and environmental degradation, the CCICED established a Task Force on Economic Growth and Environment. Its objectives are to

- monitor and assess harmonious and sustainable development in China,
- advise Chinese high-rank decision makers on setting the levels of economic incentives and disincentives
- promote the harmony between economic growth and the environment, and
- establish an operational mechanism of economic and environmental forecast and early warning for macro decision-making and regulation.

At the first phase of this project (in 2005), the Task Force considered the interaction between economy and environment, discussed the use and usefulness of integrated environmental and economic accounting, and suggested to establish an indicator framework to measure the performances of local governments. At the second phase (2006), the Task Force developed a 3E (Economy-Energy-Environment) model to forecast the trends of economic growth, energy consumption and environmental pollution during the 11th Five Year Development Plan. At a later stage, the Task Force intends to combine performance measurement, the green accounting system and the 3E model. It will also develop and publish a regular *Report on Evaluation of China's Economic, Environmental and Social Development*.

Our contribution includes, therefore, a long-term view of developing the information basis for performance and policy evaluation by:

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[1] SEPA and NBS, *China Green National Economic Accounting Study Report 2004*

- establishing an indicator system for monitoring the trends and policies of sustainable development, in addition to evaluating government performance;
- establishing an early warning and forecasting platform based on the 3E model; and
- providing policy recommendations on managing and monitoring the harmonious coexistence of economic growth and the environment

Part II

Evaluation and Early Warning of China's Economic Growth and Environment – Green Accounting, Indicators and Modelling

2.1 Changing approaches of economic growth and early warning of environmental risks

High-speed growth and heavy pollution are two major features of China's current economic development. China's government has set out, therefore, to change the approach to economic growth with a view to keeping the balance between economic growth and the environment. The Third Plenary Conference of the 16th National Congress of the CPC announced the scientific view of development. Later, it set up the goal of establishing a socialist harmonious society. The *11th Five-Year Outline Plan of Economic and Social Development* details quantitative targets for economic growth, energy efficiency and quantity control of total environmental pollution. However, the actual implementation in 2006 shows that these targets are hard to achieve, and it will be a difficult mission to balance economic growth and environmental protection. To achieve these goals, more effective policy instruments are essential. To this end, it is necessary to assess the trends of both economic growth and the environment and to provide early warning for decision-making based on reliable information.

The loss of natural resources and pollution are external effects of economic activities, which impair the public good of the environment. To deal with the resulting policy and market failures governmental intervention is required, as experienced by industrialized countries. This is particularly true for China in which economic development is strongly dominated by the government, and local governments at all levels are an important driving force of the economic growth. For many years, the idea of "development as the top priority" has been interpreted as "GDP on the top", leading to the imbalance between economic development and environmental protection. To solve the problem, governmental roles in environmental management and regulation need to be strengthened. Research carried out by our Task Force reveals that currently the priorities should be:

- implementing a new indicator system of governmental performance measurement to enhance governmental functions of environmental protection
- exploring the use and usefulness of integrated environmental and economic accounting, and
- establishing a mechanism of environmental forecast and early warning at both national and local levels to provide accurate information for more informed and scientific decision-making.

2.2 Evaluation and early warning of environment and economic growth: green accounting

2.2.1 Green accounting, evaluation of governmental performance

Green accounting is a new national accounting system which incorporates natural resource use and environment degradation into national economic accounting. Calls for a green GDP reflect the need for an overall assessment of the trade-offs between economic growth and environmental protection. Perhaps more importantly, the underlying production

and consumption patterns of households and enterprises need to be assessed as to their respective environmental impacts. To this end, Agenda 21 of the Rio Earth Summit recommended the implementation of a *System for integrated Environmental and Economic Accounting (SEEA)* by all member States.[1] The SEEA is based on the worldwide-adopted System of National Accounts (SNA). The SNA ensures not only consistency in the concepts, definitions and classifications of its indicators but facilitates international comparability and reporting in a globalizing world.

A green accounting system and its key indicator, Green GDP, may facilitate evaluating the performance of local governments, taking account not only of traditional economic growth but also of environmental problems. A joint international workshop of CCICED, the National Bureau of Statistics (NBS), Statistics Canada and international green accounting experts (Beijing, November 2004) explored options for "greening" China's GDP and national accounts. Green accounting and its environmentally adjusted indicators cater to the concept of scientific development that assesses the environmental sustainability of economic performance and growth (Box 1). The meeting concluded that green accounting in China is feasible but faces institutional and practical challenges. The implementation of environmental-economic accounts and indicators and their use in forward-looking analyses in China will require the close collaboration of data users and producers. This is a challenging task for a country on the way to more transparent and frank information exchange and discussion. Further work should determine environmental priorities and clear objectives for greening the national accounts.

Box 1

As described in a contribution to the 2004 CCICED Workshop the SEEA[2], can assess the environmental sustainability of economic performance and growth in terms of "economic" and "ecological sustainability":

- greened national accounts measure economic sustainability as the *maintenance of* the value of produced and natural *capital*, facilitated by reinvesting the cost of capital consumption; and
- physical material flow accounts measure ecological sustainability as the *dematerialization* of the economy in terms of material inputs, reduced by a specified sustainability factor.

2.2.2 Monetary indicators of green accounting

Monetary indicators such as the Environmentally-adjusted net Domestic Product (EDP), Capital Formation (ECF), and Value Added (EVA) measure sustainable economic activity and growth by deducting produced and non-produced natural capital consumption as cost from the conventional indicators. A controversial issue in compiling these indicators is the pricing of environmental impacts, notably of environmental quality degradation. An important application of monetary indicators of green accounting is the measurement of environmental (depletion and degradation) cost caused by economic agents. The well-known

[1] United Nations (1994). *Earth Summit, Agenda 21*, New York: United Nations, para. 8.42. The SEEA has now been revised and is available on the website of the United Nations Statistics Division: http://unstats.un.org/unsd/envAccounting/seea.htm.

[2] P. Bartelmus, "Green National Accounting: Measuring sustainable economic growth". For a historical and methodological overview see Bartelmus and Seifert (eds), *Green Accounting*, Aldershot, UK and Burlington, USA.

polluter/user pays principles hold the responsible agents accountable for their environmental impacts. Economists deem 'market instruments' of cost internalization (such as eco-taxes, deposit-refund schemes or tradable pollution permits) more efficient in bringing about sustainable production and consumption patterns – than top-down environmental regulation. In the absence of environmental accounts, a consistent assessment of environmental externalities and their allocation to causing agents is hardly possible. Political exigencies rather than rational cost estimates appear thus to have determined in most cases the setting of market instruments. The monitoring of the success or failure of environmental protection and natural resource management by means of more conventional accounting for actual environmental expenditures is a further possible use of the SEEA. The results of the above-mentioned green accounting project indicate that such expenditures amounted to 1.8% of GDP in 2004. The monitoring of the success or failure of environmental protection and natural resource management by means of more conventional accounting for actual environmental expenditures is a further possible use of the SEEA. The results of the above-mentioned green accounting project indicate that such expenditures amounted to 1.8% in 2004.

2.2.3 Material flow indicators of green accounting

The physical part of the accounting system presents material flows and stocks, notably natural resource inputs (e.g. the total material requirement, TMR, indicator) and pollution 'outputs'. Contrary to the monetary green accounting indicators, material flows cannot be interpreted as indicators of both, environmental and economic, performance. They measure environmental pressure and refer, therefore, to environmental performance only. They can be linked, however, to economic performance indicators, notably GDP, as ratios of material intensity or resource productivity. Time series of material flow indicators of can give early warning about the success or failure of "decoupling" environmental impacts from economic growth.

2.3 Towards a common indicator framework for assessing and early warning of economic growth and environment

2.3.1 Indicators and indices

Indicators and indicator frameworks *for* the environment and sustainable development have proliferated. The reasons are different policy agendas driving indicator development, and the necessarily judgemental selection of indicators for formulating and monitoring the agendas. Most indicator frameworks are derived from the popular Pressure-State-Response (PSR) Framework advanced by the OECD, which in turn was based on the United Nations Framework for the Development of Environment Statistics (FDES). For instance, the European Environment Agency uses a Driving Forces-Pressure-State-Impact-Response (DPSIR) Framework, and the same was adopted by UNEP's Global Environment Outlook (GEO). At the global level, the United Nations, through the Division for Economic and Social Affairs, proposed indicators for sustainable development and Millennium Development Goals for politically negotiated "themes".

The desire of policy makers to obtain overall 'nutshell' assessments of the state of the environment and sustainable development generated various indicators (or indices) *of* the sustainability of economic performance and development. However, compound indices usually resort to equal weighting of unequal phenomena when averaging 'representative' indicators. Ad-hoc compilations of these indices also lack consistency with established

statistical concepts and methods. Statistical offices do not therefore compile such indices in

Figure 1 Accounting framework for economic and environmental indicators

OPENING STOCKS			Economic assets (**CAP_f**)	Environmental assets (**CAP_n**)	
			+		
	DOMESTIC PRODUCTION (industries)	FINAL CON-SUMPTION (households, government)	CAPITAL FORMATION	CAPITAL ACCUMULA-TION	REST OF THE WORLD
SUPPLY OF RODUCTS	Output (**O_i**)				Imports (**M**)
	Thereof: environmental protection (**EPE**)				Thereof: (**EPE**)
USE OF PRODUCTS	Intermediate consumption (**IC_i**)	Final consumption (**C**)	Gross capital formation (**GCF**)		Exports(**X**)
	Thereof: **EPE**	Thereof: **EPE**	Thereof: **EPE**		Thereof: **EPE**
USE OF FIXED CAPITAL	Fixed capital consumption (**CC_i**)		Fixed capital consumption (**-CC**)		
VALUE ADDED, NDP	**VA_i**, **NDP**				
USE OF NATURAL ASSETS (depletion and degradation)	Environmental cost (**EC_i**) *Material inputs (**MI**), Land use (**L**), Emissions (**E**)*	Environmental cost(**EC_h**) ***MI, L, E***	Natural capital consumption (**-EC**) *Depletion of natural resources (**ΔCAP_n**), net additions to stocks (**NAS**), change in environmental quality (**ΔEQ**)*		*Export/imp. of materials, wastes and residuals (**$X_{MI,E}$**, **$M_{Mi,E}$**)*
ENVIRONMENTALLY ADJUSTED INDICATORS	**EVA_i** = VA_i - EC_i **EDP** = ΣEVA_i - ΣEC_h ***TMR, DMI, TDO, DO***	*Output of residuals by households (**DO, TDO**)*	**ECF** = CF - CC – EC *Net additions to stocks (**NAS**)*		
			+		
			Other changes of economic assets (**OVC_f**)	Other changes of environmental assets (**OVC_n**)	
			=		
		CLOSING STOCKS	Economic assets (**CAP_f**)	Environmental assets (**CAP_n**)	

Source: Bartelmus (in prep.).

Abbreviations: VA = Value Added
NDP = Net Domestic Product
EVA = Environmentally-adjusted net Value Added
EDP = Environmentally-adjusted net Domestic Product,
EC = Environmental Cost
ECF = Environmentally-adjusted Capital Formation
TMR = Total Material Requirement
DMI = Direct Material Input
TDO = Total Domestic Output

DO = Direct (domestic) Output
EPE = Environmental Protection Expenditure
CAP_f = Fixed Capital
CAP_n = Natural Capital

most countries.

2.3.2 Accounting framework for economic and environmental indicators

A common framework for all indicators and indices would increase the transparency of indicator selection, definition and compilation. It would also minimize the risk of data manipulation. A recent UN expert group, charged with revising the – largely ignored – indicators for sustainable development of the UN Commission for Sustainable Development, recommended, therefore, the development of a common indicator framework. The experts also identified a capital (accounting) framework as the most appropriate means of combining environmental and economic indicators.[1] Based on these views we recommend using a *hybrid accounting framework*. Such a framework would not only combine indicators for local and national performance evaluation but would make indicator selection more informed, compatible and transparent（Figure 1）

Figure 1 is in fact the centerpiece of the revised SEEA. It contains most of the economic and environmental indicators. However, it excludes social indicators because of the conceptual and measurement problems of "social" and "human capital". The shaded areas present environmental and environmentally adjusted indicators. Land uses and material inputs are also shaded as they represent pressures on environmental carrying capacities.

Physical indicators, notably from material flow accounts (MFA) are shown italics. To some extent they underlie the monetary indicators of the SEEA. The table thus displays the connections between the physical data base and monetary valuation. Material 'outputs' of the MFA are the emissions (E), which are costed in the SEEA. Their accumulation as ambient concentrations in environmental media of land, air and water affects environmental quality (EQ) and generates the environmental damage borne by humans and ecosystems. Among others, damage information enters human welfare indices such as the GPI (not shown in the figure). Physical resource stocks are the counterparts of monetary wealth indicators (CAP); monitoring the use of these stocks in different units of measurement facilitates their management and conservation but is less useful for overall environmental and economic policies.

The accounting framework of Figure 1 should be helpful in combining and harmonizing the various indicator listings, index compilations and accounting approaches, including material flow accounts, energy balances, input-output tables, and greened national (satellite) accounts, currently developed in China.

2.3.3 Micro-macro link

A further advantage of an integrated accounting framework for data development is its possible link to corporate accounting. More and more, corporations, motivated by 'corporate social responsibility', have taken up environmental accounting. Corporate accounting faces similar challenges and opportunities as national environmental accounting. Developing the so-called 'micro-macro link' between the two accounting efforts would facilitate, in particular,

[1] http://www.un.org/esa/sustdev/natlinfo/indicators/egmIndicators/egm.htm.

- full-cost pricing, i.e. the internalization of environmental (social) cost
- improve the data quality in both micro- and macro-accounts, and
- generate consistent micro- and macro-economic strategies and policies for making current production and consumption patterns more sustainable.

At the international level, the International Organizations for Standardization (ISO series 14000) and the European Union (EMAS: Environmental Management and Audit Scheme) have developed corporate environmental management guidelines and indicator systems.

2.4 Green accounting and modeling

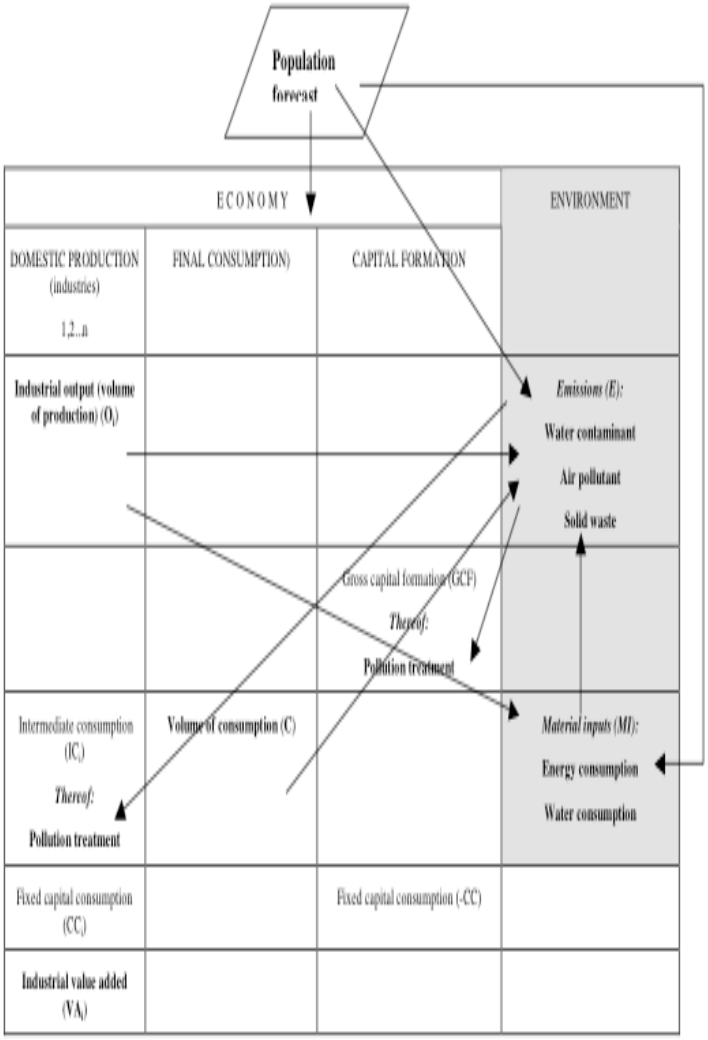
The time series features of indicators and green national accounting can be used for early warning on risks related to economic growth and environment and the anlysis of the driving forces of environmental impacts. However, green accounting and indicators alone are more suitable for retrospective or *ex-post* evaluation and analysis, while in and of themselves they are insufficient for forecasting or scenario analysis. Therefore, our task force developed the 3E model (see part IV), which aims to forecast economic and environmental trends and simulates different policy scenarios.

The 3E model is based on input--output table. It forecasts economic growth, change in the sectoral structure, energy consumption, emissions, and pollution disposal. According to the comparison of forecast results with proposed goals, .economic and environmental policies guaranteeing sustainable development are recommended.

Figure 2 describes in a simplified manner the direct connections between the 3E model and our accounting framework. The figure shows the different model components (in bold) as data modules of the framework. The arrows correspond to the different functional relationships of the 3E model.

Accounting and modelling are different, as the accounts are a descriptive data system, while model converts statistical variables into model parameters for forecasting or scenario analysis. Technical (input-output and pollution emission) coefficients indicate data relationship currently observed, whereas as modelling parameters they are usually held constant (or otherwise modelled) over future time periods. Despite these differences in accounting and modeling, the framework indicates the advantages of using an input-output accounting system for modeling. Contrary to other more abstract models such as system-analytic simulations or CGE models, the close link between input-output accounting and analysis ensures a high degree of validity and verifiability in the model functions and their parameters.

Figure 2 Accounting framework and 3E model



Part III

Indicators, Indices and an Early Warning System for Evaluating Sustainable Development and Progress towards a Harmonious *xiao kang* Society in China

In order to evaluate sustainable development in China and progress towards a harmonious *xiao kang* society, the Task Force developed indicators and an early warning system by which the performance of local government in the construction of a harmonious *xiao kang* society can be evaluated.

3.1 Indicators and early warning system for a harmonious *xiao kang* society

A harmonious *xiao kang* society does not simply mean achieving a certain level of GDP per capita. Rather it calls for a fair distribution of human well-being across China, alleviating the current disparities between rural and urban households and between coastal and inland households. Harmonious *xiao kang* society does not only denote material comforts but harmonious development in all aspects, which includes issues of urbanization, promotion of education and reshaping the social strata. As a key condition, harmonious *xiao kang* society also requires that human and economic development does not undermine China's natural resource base and ecosystems without which the sustainability of human well-being itself would deteriorate.

In other words, a *xiao kang* society is focused on the improved and sustained economic, social and environmental well-being of all citizens and the country as a whole. Balance between these three domains and human well-being that balances material and immaterial aspects with moderation together characterize the harmonious *xiao kang* society.

As part of China's long-range plan from 2006 to 2020, the goals of a harmonious *xiao kang* society and sustainable development are overlapping. Therefore, the target and indicators of harmonious society can be used to evaluate the performance of local governments, to provide early warning signals in cases where development is out of balance, as well as to evaluate progress towards sustainable development. Figure 3 shows a conceptual model of how *xiao kang* society and local sustainable development indicators at the local governance level are aligned and potentially integrated.

The selection of indicators used in performance evaluation and early warning, whether at the national or local government (or even corporate) level, is critically important. Indicators not only help provide a diagnosis of problems or identify solutions, they also motivate people. If indicators are poorly chosen or used the wrong way, they do not motivate people to do the right thing.

In order to harness the potential of indicators in motivating and measuring progress towards high-level goals and provide early warning in case we are getting off track, they should describe key features of harmonious *xiao kang* development in the local context. They also need to be supported by data derived from verifiable and dependable sources. Ideally, these data are derived from and synchronized with a green accounting system implemented at the local and national level as described in Part II of the report.

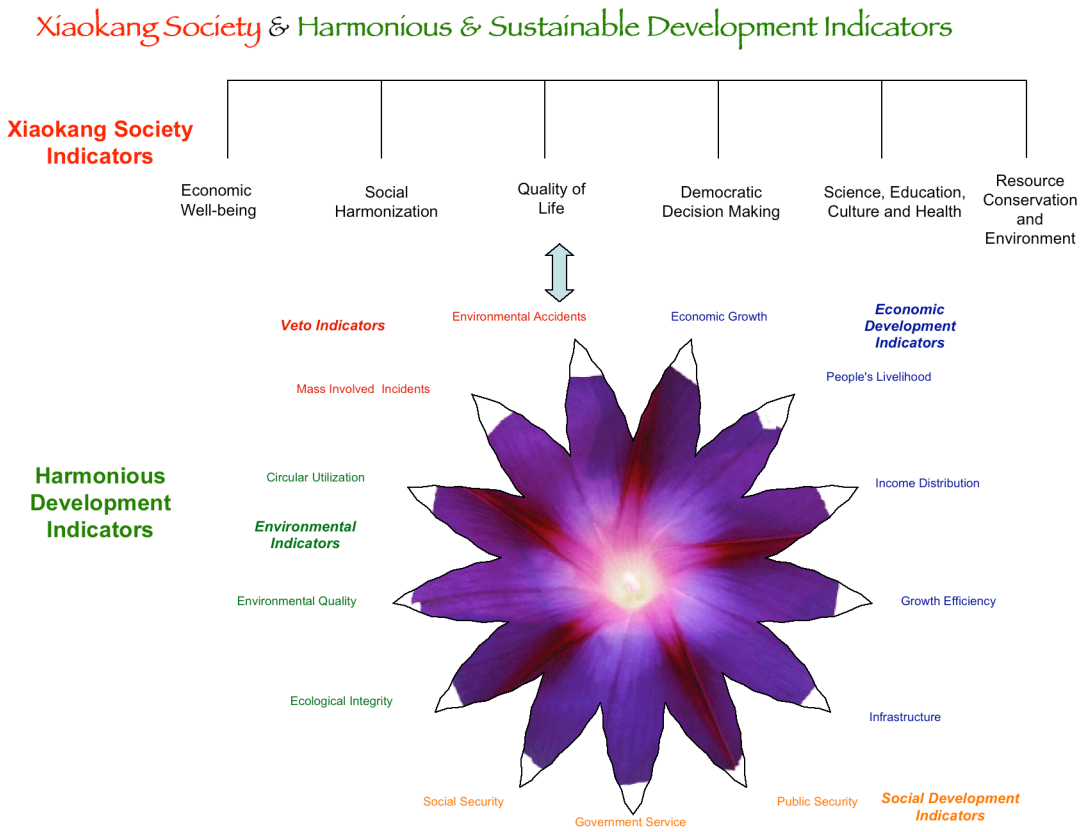


Figure 3 Conceptual diagram to illustrate a possible alignment of *xiao kang* and local sustainable development indicators

Some of the key methodological issues that need to be kept in mind when considering the development of a system of indicators and indices along these lines are the following:

- choice of a conceptual framework that reflects the local and overall priorities for a harmonious *xiao kang* society and defines the main categories for indicators
- process involving key local stakeholders and key experts in identifying component indicators
- choice of policy targets related to each indicator that also reflects critical thresholds, particularly in the socio-economic and ecological domains and thus are essential for early warning
- for an overall index of progress towards the goals of harmonious and *xiao kang* society (beyond indicator selection) the following has to be considered: (1) establishing a normalized (dimensionless) performance score for every indicator that is expressed as a 'distance to policy target' measure and (2) a weighting scheme and mathematical formula to calculate an overall composite index based on individual indicators
- Visual presentation of the score of indicators and index, such as the Dashboard of Sustainability, jointly developed by the Consultative Group on Sustainable

Development Indicators (CGSDI), IISD and the Joint Research Centre of the European Union[1].

3.2 From theory to practice: guidance for the establishment of an indicator system in support of performance measurement and early warning

Based on our review of international experience, the success and acceptance of new indicators depends not only on what the new measures are but *how*, through what process, they are introduced into public policy. This is definitely the case the more the new measures are to be used in determining performance of institutions and key individuals.

We propose the following steps in the development of an indicator and reporting system which can track, analyze and forecast the course of harmonious *xiao kang* society development.

- Establish a *sustainability evaluation and reporting system* or framework, which consists of a set of high priority and policy relevant sustainability performance indicators. The framework and indicators would be constructed, prudently and *incrementally*, over time at the national, regional/provincial and local government levels. Incremental development means that instead of introducing immediately an entire new complex indicator, a new system can be phased in piece by piece, based on thorough methodological work and coordination among key national, provincial and local government agencies, including statistical bureaus, treasury departments, development and reform commissions and others. The new system should be incremental also in the sense that it would need to build on existing statistical data collection and reporting mechanisms, even if it does require capacity building to ensure better quality and more strategically collected data.
- Establish a clear set of harmonious development *goals, principles,* and if possible specific, time-bound *targets* taking sustainability criteria (e.g. critical ecological thresholds, international policy commitments) into account. The goal statements and criteria should be linked to high-level national policy priorities that are commonly accepted throughout China, but reflect unique local economic, social and environmental conditions.
- Consider establishing *sustainability standards*, which are directly related to the sustainability values, goals, principles and targets, and the total natural, human, social and built capital (or genuine wealth) conditions at the provincial,regional or local scale. Healthy competition amongst provinces and the sharing and benchmarking of best-practices, using indexed indicators, could be encouraged. Benchmarking sustainability performance, using aggregate sustainability indices across communities and provinces is possible and desirable for evaluating local government performance, comparing best-practices amongst local governments, and providing early warning of unsustainable progress.
- The indicator system not only has an evaluation function, but also serves to *guide the decision-making of local government*.To this end, one should establish policy evaluation and feedback mechanisms. For example, when a local government's performance of sustainable development, according to the harmonious "xiao kang" society indicators, is far away from the benchmark or performance targets, there is

[1] http://esl.jrc.it/dc/

need to send out explicit early warning reports to that government. It might be equally important to introduce, over time, new evaluation criteria for senior local government officials in order to provide incentives for fundamentally strengthened consideration of *xiao kang* and sustainability priorities.

- The indicators can help diagnose past and current problems, but they are also essential as *analytic and communication tools* in identifying future problems and opportunities. The indicators should therefore be closely linked to the early warning system and modelling. Instead of simple (and usually inaccurate) forecasting of a single trajectory, the modelling can explore multiple policy trajectories and their socio-economic and ecological impacts.

3.3 Indicator system for the evaluation and early warning of China's sustainable development and the course of harmonious *xiao kang* society.

Measuring progress toward desired targets of sustainable development and harmonious society in different regions helps set policy priorities for local governments, and improve the monitoring system for the central or national government. The Task Force undertook the development and pilot testing of an indicator set shown in Box 2 that reflects some of the key priorities.

Moving from the current performance measurement system, dominated by a focus on economic growth towards a broader scope of sustainability criteria and objectives, will entail a multi-year, multi-level effort. China, like many other countries, is not new to these efforts. At various levels governmental institutions have been experimenting with sustainability indicators for several years.[1] The task force chose six example cities to carry out a pilot application of the indicator system shown in Box 2. The development of data sets have been completed in four cities. The results of the evaluation are shown in Table 1.

Data points for the cities were calculated on the basis of three-year averages. Of course, this average changes as time goes by and ensures that the base number in each year changes based on the yearly shifts. By using this method we reduce the risk of abnormal effects – common in China – which have a disproportionate impact on the overall value of an indicator. Indicators are aggregated using weighted averages, but taking all indicators into account with an equal weight. In fact, the resulting index can be considered a sustainable development focused "Annual Progress Index" (API).

Table 1: the sustainability API of four example cities

Year		2001	2002	2003	2004	Point of API Change per year
City B	Total score	109.50	114.69	90.30		**-9.71**
City A	Total score	**189.38**	**187.38**	**147.93**	**155.82**	**-8.39**
City D	Total score	**98.60**	**98.61**	**97.63**		-0.33
City C	Total score	94.99	96.25	106.18	107.77	+5.52
Total		492.47	496.93	442.04		-17

[1] Pintér, L. *Performance Measurement and Sustainable Development Reporting in the Urban Environment.* Presented at the Seminar on Environmental and Economic Policies Towards Sustainable Cities in APEC, Beijing, China, 18-20 September, 1997.

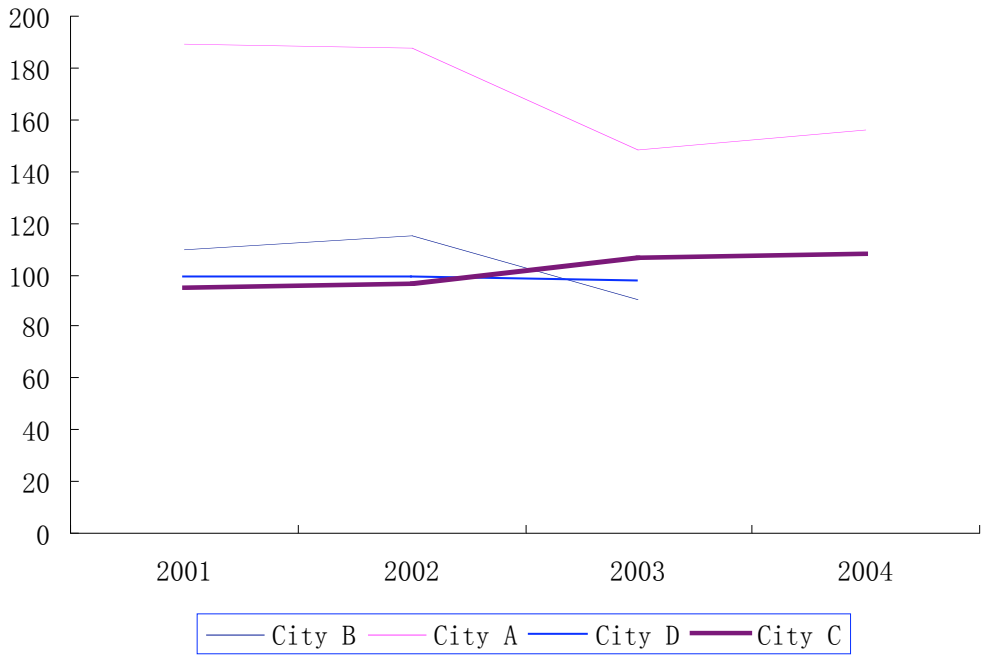


Figure 3 The API of sustainable development in four example cities

Changes in the API over time reflect overall sustainable development trends of the evaluated cities. Time series may also be used in early warning about risks to the sustainability of cities. The API could also be used as a tool for comparative analysis of the performance differences among cities, including the detailed exploration of the *causes* of these differences. Tools such as the Dashboard can serve as simple yet effective communication portals. The change and the comparative analysis of the API among different cities can also provide useful basic information for the performance of these cities to central government.

Table 1 shows that the API of three cities decreased, while one city saw a slight increase. Overall, and as possible early warning signal, during 2001-2003 the grand total of the API for the four cities dropped from 492.47 to 442.04 or 17 points annually and on average. The overall sustainability of the four cities may thus be decreasing. If similar results are available for a representative number of cities across China, changes in the sustainability of the entire country could be calculated.

The API of city A is the highest followed by City B and C. D is the the worst performer. What matters from the early warning point of view is that the sustainability of city A and B is dropping on a large scale. In particular the API of city B was highest among the 4 cities in the base year but its decline was the biggest. The API of city D is decreasing owing to lower-level performance. Only the API of city C went up steadily, although starting from a lower base (see Figure 3)

The method above has been based on the evaluation of sustainable development. By adding more indicators or adjusting the weight of the indicators reasonably one could carry out the evaluation and implement early warning about progress towards the harmonious *xiao kang* society.

Before the end of this part, it is pointed out that our future work should:

---ensure the development of a clear set of common sustainable and harmonious

development principles, criteria that are aligned with the three sustainability categories and eleven objectives;

---*compare, and* where necessary *adjust*, the proposed *indicators* with regard to these principles and criteria, and assess their statistical validity; where possible, identify specific quantitative, time-bound targets;

---continue with more detailed *pilot projects in cities*: involve participation through local roundtables and complement (uniform) core indicators with local-priority indicators;

Box 2:

Recommended Indicator System for Local Government Sustainability Performance Evaluation And Early Warning

Economic development indicators (10)	Economic growth	GDP growth rate
		fiscal revenue growth rate
	People's livelihood	growth rate of weighted residents income
		per capita urban housing area
		per capita rural housing area
	Income distribution	ratio of per capita income between urban and rural areas
		urban survey unemployment rate
		percentage of rural poor
	Growth efficiency	energy productivity
		water resource productivity
Social development indicators (12)	Infrastructure and public security	natural gas popularity rate in urban area
		Hygienic acceptance rate of drinking water in village and township
		popularity rate of nine-year compulsory education
		hospital beds/1000 people
		per capita highway length per square kilometer
		per capita paved road area in urban area
		safe production indicators
		rate of exposed criminal cases
		rate of solved criminal cases
	Government public services	degree of public satisfaction
	Social security	coverage rate of urban social security system
		coverage rate of rural health insurance
Ecological and environmental indicators (7)	Ecology	percentage of vegetation
		change in rate of soil degradation (area)
	Environment	change in rate of final discharge of industrial solid wastes
		change in rate of surface water quality within territory
		share of environmental protection investment in GDP
		annual up-to-standard rate of urban air quality
	Circular economy	rate of resource recycling
Veto-indicators (2)	Group accidents	
	Environmental accidents	

---test various methods for *benchmarking performance* of selected or pilot cities, including experimentation with different approaches to aggregation into sustainability indices;

---provide recommendations for strengthening the *institutional context* of performance measurement, both at the national and local government levels by assigning responsibilities for monitoring, reporting and using indicators, and ensuring that adequate resources and capacities are available for these tasks; and

---explore options for *improving communication*, reporting and use of indicators by a wider audience.

Part IV

3E Modelling: Forecasting and Early Warning

4.1 Structure and mechanism of the 3E model[1]

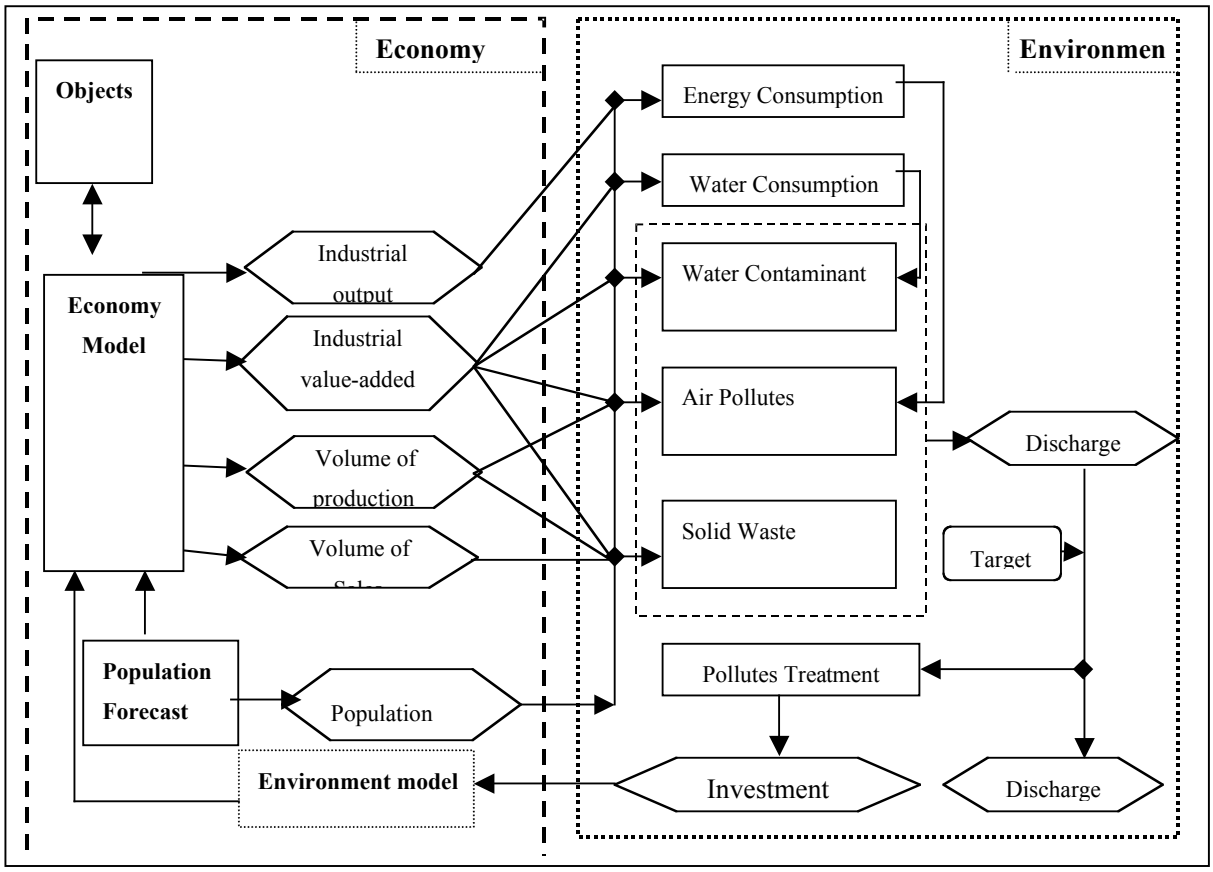
The Task Force developed a 3E (Economy-Energy-Environment) model that could forecast and provide early warning for China's economic growth, energy consumption and environmental pollution. It is a quantitative analysis platform, which combines econometric technique, input-output analysis and extended linear expenditure system.

The 3E model consists of three sub-models: economy, energy and environment.

The economy sub-model consists of the following modules: income, consumption, investment, import and export, employment, final demand formation and total output, which mainly forecasts industrial outputs, value-added by sectors, product sales volume, population, urbanization level and so on.

Based on the forecast results from the economy sub-model and the estimated energy consumption coefficient, the energy sub-model mainly forecasts volume and structure of energy consumption in each sector. In addition, volume and structural change of resident energy consumption are forecasted.

Figure 3 Structure of 3E Model



[1] See Appendix 1 for model function and forecast theories.

Also based on the results from the economy sub-model, the environment sub-model mainly forecasts generated volumes of wastewater, water pollutant, air pollution and solid waste. Volumes of reduction and discharge of these wastes are also forecasted. In order to control these wastes, investment should bring into operation which is just the feedback variable into the economy part. Based on this sub-model, we can also simulate the impacts of pollution control investment on economic development. The structure of the 3E mode is as following (see figure 3).[1]

4.2 Qualitative analysis of macro-economic trend during the 11th Five Year Plan

4.2.1 Long-run economic trend in China

Since the reform and opening up, China has experienced rapid economic growth. GDP in 2005 increased to nearly 12 times that of 1978, and per capita GDP increased nearly 9 times, reaching USD 1750 according to the current exchange rate. Following the development goals set up in the 16th Representatives Meeting of CPC, GDP in 2020 will be double compared with the GDP in2000, in other words, the annual growth rate of GDP should reach 7.2% on average. Based on our judgement, the average annual growth rate of GDP will exceed 9% during the 11th Five Year. The reasons are:

- *During the 11th Five Year, China's economic growth will remain at high level of the business cycle.* From 1978 to 2000, China is one of the fast-growth countries in the world, and the average annual growth rate of GDP was over 9%. Since 2000, China's economy has entered into another round of rapid growth, and major macro-economic indicators have maintained sound performance. This provides a favourable foundation for further rapid and stable economic growth during the 11th Five Year Plan in China.
- *Accelerated investment to upgrade the heavy and chemical industrial structure is the main feature of economic growth in China.* Since the late 1990s, China has entered into a new stage, which is the speeding up phase of industrialization and urbanization. Following the experiences of industrialization in the rest of the world, heavy and chemical industry usually upgrades rapidly at this stage. Therefore, China's investment will keep increasing at relative high speed, and investment ratio will remain at the level of 35-40% in the next five years.
- *Upgrading of consumption structure becomes an important driving force***.** With the gradual increase of resident income, China has entered into the age of mass consumption, and demand structure will be substantially changed accordingly. After Chinese citizens reach the overall *xiao kang* standard of living, targets of consumption will be turned from products worth of thousands RMB to those worth of ten thousand or more expensive. Updated household appliance, family cars and housing will become the new consumption hotspots for urban residents.
- *Rapid urbanization promotes the stable and rapid increase of domestic demand.* International experiences suggest that the progress of urbanization may be divided into three phases: start-up, speed-up and maturity. China's urbanization ratio was promoted from 29% in 1995 to 43% in 2005, which is in the speed-up stage and will

[1] Data used for prediction by the 3E model is partly offered by NBS publication, and partly from corporate survey. See appendix 2 for detailed description of the surveys and analysis.

go on in the following years. Development of housing and infrastructure will still stimulate investment, and will further encourage the growth of the entire economy. The *11th Five-Year Plan* proposes the strategy of constructing a new socialist countryside, providing another investment hotspot.

Box 3

National GDP growth rate during 2006-2010 calculated based on GDP planned of provinces/cities and weights of the GDP in national economy in 2005

Province/city	Planned GDP growth rates between 2006 and 2010 (%)	Weight in national GDP in 2005 (%)	Contribution share to GDP	Province/ City	Planned GDP growth rates between 2006 and 2010 (%)	Weight in national GDP in 2005(%)	Contribution share to GDP
Beijing	**9%**	3.47%	0.31	**Guangdong**	**9%**	11.04%	0.99
Tianjin	**12%**	1.86%	0.22	**Guangxi**	**10%**	2.07%	0.21
Hebei	**11%**	5.15%	0.57	**Hainan**	**9%**	0.45%	0.04
Shanxi	**10%**	2.10%	0.21	**Chongqing**	**10%**	1.56%	0.16
Inner Mongolia	**13%**	1.94%	0.25	**Sichuan**	**9%**	3.76%	0.34
Liaoning	**11%**	4.07%	0.45	**Guizhou**	**10%**	0.99%	0.10
Jilin	**9%**	1.84%	0.17	**Yunnan**	**9%**	1.77%	0.16
Heilongjiang	**10%**	2.80%	0.28	**Tibet**	**12%**	0.13%	0.02
Shanghai	**9%**	4.65%	0.42	**Shannxi**	**11%**	1.87%	0.21
Jiangsu	**10%**	9.30%	0.93	**Gansu**	**10%**	0.98%	0.1
Zhejiang	**9%**	6.80%	0.61	**Qinghai**	**10%**	0.28%	0.03
Anhui	**10%**	2.73%	0.27	**Ningxia**	**10%**	0.30%	0.03
Fujian	**10.90%**	3.34%	0.36	**Xinjiang**	**9%**	1.34%	0.12
Jiangxi	**11%**	2.06%	0.23	**Hubei**	**10%**	3.30%	0.33
Shandong	**10%**	9.40%	0.94	**Hunan**	**10%**	3.29%	0.33
Henan	**11%**	5.36%	0.59				
National GDP growth rate during 2006-2010 calculated based on GDP planned of provinces/cities and weights of the GDPs in national economy in 2005				9.96%			

- *Stable international situation is favourable to China's economy, and foreign trade will remain one of the driving forces of domestic economic growth.* In the next 5-15 years, peace, development and cooperation will continue to be the main theme of the world, and this will offer a great opportunity for world economic development. Further economic globalization, faster international industrial transfer and better functioning of science and technologies will be the irreversible trend of future global economy. Under this circumstance, China's cheap labour is still an important competitive factor, and foreign trade will play an important role in stimulating China's economy.

- *Local governments will face heavier pressures of economic development.* Various social conflicts will put greater pressure on local governments to develop their economies. As defined in each province's/city's *11th Five-Year Plan*, the proposed GDP growth rates of each province/city is much higher than the national one, which is also an important driving factor for overall economic growth (see box 3).

4.3 Environmental and economic pressures faced in the 11th Five-Year Plan based on 3E model simulations

4.3.1 Simulation and forecast

During the 11th Five-Year Plan, China's economy will continue to grow at high speed, with the average annual growth rate at 9% or higher. Based on the 3E model, we simulated three different scenarios of economic growth: higher speed, medium speed and lower speed.

In the higher-speed scenario: It is assumed that, during the 11th Five-Year Plan, China will follow the scientific view of development, and fully implement the national strategy of creating an innovative country, independent innovation will have important breakthroughs, urbanization will progress smoothly, approaches of economic growth will have major improvements, international trade will continue to grow at high speed, and many problems in current economic development will be successfully solved. Based on these assumptions, total factor productivity will continue to increase stably and rapidly, and reach 3%, much higher than the average level in past 20 years (2.6%).

In the medium-speed scenario: It is assumed that, although China has entered into a new rapid growth period, accumulated problems will become prominent. Institutional reform will continue but will face more difficulties; more time will be needed to fully implement the national strategy of creating an innovative country; independent innovation will need accumulated capacity; urbanization progress will be hampered by social security and other issues, and growth of international trade will probably slow down. Based on these assumptions, total factor productivity will maintain the same average level in past 20 and more years (2.6%).

In the lower-speed scenario: It is assumed that, China will face many risks in economic development. For example, institutional reform will continue but will face more difficulties; independent innovation will not make great progresses during the 11th Five-Year Plan; progress of urbanization will be disturbed by social security and other issues; the economic growth approach will be hard to change; appreciation of RMB will constrain export and will slow down the inflow of foreign investment; and prices of basic resources and energy sources will keep rising. Based on these assumptions, total factor productivity will drop down from 2.6% to 2.2%.

The forecast results of main indicators in the three scenarios is shown in Table 2.

Table 2 Forecasts of economic indicators in three different scenarios (growth rate, %)

Indicator	Higher-speed scenario	Medium-speed scenario	Lower-speed scenario
GDP	10.1	9.62	9.1
Consumption	8.33	8.24	7.6
Capital formation	13.7	12.8	12.6
Export	16.2	14.8	12.7
Import	14.2	13.5	10.6
Urbanization ratio	47.4	46.9	46.5

Table 3 Growth speed forecast of total output in different sectors during 2006-2010[1]

	Sectors	Lower-speed scenario	Medium-speed scenario	Higher-speed scenario
1	Cropping	4.79	6.09	6.23
2	Animal farming	4.46	5.71	5.69
3	Other agricultural activities	7.40	8.38	8.87
4	Coal mining and dressing	8.58	9.49	10.13
5	Oil and natural gas mining	9.08	10.15	11.18
6	Ferrous metal mining and dressing	9.88	10.53	11.49
7	Non-ferrous mining and dressing	9.68	10.45	11.42
8	Non-metal mining and dressing	9.06	9.87	10.93
9	Food, cigarette and soft drink	6.52	7.63	7.62
10	Textile	5.97	7.30	7.43
11	Garment, leather, feather and fibre manufacturing	4.13	5.51	5.41
12	Wood processing and furniture manufacturing	8.68	9.62	10.46
13	Paper manufacturing and products	9.43	10.29	10.79
14	Printing, record media reproduction, other manufacturing for education and culture	9.64	10.53	10.93
15	Oil processing and coking	9.07	9.97	10.79
16	Raw chemical material, chemical product manufacturing, other chemical products	8.57	9.58	10.30
17	Pharmaceuticals	9.57	10.41	10.59
18	Chemical fibre manufacturing	7.47	8.55	9.04
19	Rubber manufacturing	9.04	9.98	10.75
20	Plastic manufacturing	9.02	9.93	10.70
21	Cement manufacturing	8.99	9.73	10.71
22	Other non-metal minerals manufacturing	9.12	9.90	10.90
23	Ferrous metal melting and rolling	9.60	10.31	11.31
24	Non-ferrous metal melting and rolling	9.87	10.60	11.56
25	Metal products	9.05	9.90	10.83
26	Environmental protection equipments manufacturing	9.43	10.27	11.30
27	Other mechanical, electrical and electronic equipments manufacturing	9.89	10.64	11.59
28	Mechanical equipments repair	0.00	0.00	0.00
29	Other industries	9.89	10.65	11.39
30	Electricity, steam and hot water generation and supply	8.48	9.38	9.96
31	Coal gas production and supply	6.81	7.87	8.13
32	Tap water production and supply	7.66	8.61	8.96
33	Construction	9.34	10.03	11.29
34	Cargo transportation and storage	8.84	9.72	10.36
35	Passenger transportation	8.85	9.73	10.35
36	Commercial food service	9.89	10.64	11.17
37	Public environmental service	13.05	13.61	13.77
38	Other services	11.14	11.84	12.13

[1] Different from traditional sectoral breakdown, our classification makes slight changes to standard classification of sectors with the emphasis on high-pollution enterprises.

4.3.2 Forecast of industrial structural change

Each scenario predicts that, during the 11th Five-Year Plan, China's industrial structure will continue to shift towards heavy and chemical industry (see prediction results in table 3). Growth rates in industries such as ferrous melting, non-ferrous melting, oil processing, coal and charcoal, cement and other construction materials, heavy chemistry machinery, and auto manufacturing etc., will be slightly higher than the overall economic growth rate. Weight of heavy chemistry industry will grow to some extent. This will exert substantial pressures on China's environment and resources.

4.4 Energy demand forecast during the 11th Five-Year Plan in China

Economic growth has been steadily increasing in recent years. At the same time, consumption of resource and energy has been growing dramatically, even surpassing the speed of economic growth. Between 2001 and 2005，China's GDP increased by 9.54% per year, while energy consumption grew by 10.50% per year. The energy elasticity coefficient reached 1.1，meaning that this period had witnessed the highest elasticity coefficient of energy since the opening and reformation of China. Energy consumption per unit output is much higher than in the developed countries and the average of the world. In future, energy demand in China will be affected by many factors, and there will be many uncertainties. According to the forecast in the medium-speed scenario，energy demand will reach 2.9 billion tons of standard coal in 2010, increasing by 5.4% per year from 2006 to 2010.

Future energy demand will be a great challenge to the ability of energy supply in China.[1] With regard to total coal demand, it will reach 2.68 billion tons in 2010, and although coal's percentage in primary energy sources will be reduced to 66% in 2010 compared with 70% in 2002, coal's dominant status in energy consumption will keep for a long time (see Table 5 for forecast of future energy demand). With regard to sectors in demand of coal, electricity, ferrous metal melting, oil processing, cement production will still be the main industries of coal consumption. By 2010, total coal demand in these four industries will reach 2.06 billion tons, occupying about 77% of total coal demand. In particular, coal demand by electricity industry will reach 1.49 billion tons in 2010, occupying about 55.7% of total coal demand. In mid and long term, the coal-dominant structure of energy consumption will bring more difficulties to air pollution control in China.

Table 4 Energy consumption forecast in medium-speed scenario during the 11th Five-Year Plan

Type of energy source	2005	2010
Total energy consumption (10,000 tons of standard coal)	223319	290444
Coal consumption (10,000 tons of coal)	216558	268365
Raw oil consumption (10,000 tons)	32535	44640
Electricity consumption (100 MW.H)	24940	41655

[1] Zhou Dadi clearly stated that current rapid growth of energy consumption is unlikely to sustain. He predicted that, if the tendency of energy consumption elasticity continues during the 11th Five Year, the energy consumption in 2010 will reach 3 billion tons of standard coal, and the whole situation will be intensive.

4.5 Forecast of environmental pressures in China in the 11th Five-year Plan"

At present, the pressure of environmental protection is bigger than pressure of energy supply in China. Emissions of the air pollutants in China have all surpassed the carrying capacity of the environment at a large scale. Volume of pollutant emission has been rising in 2006. Emissions of COD and SO_2 have risen by 3.7% and 4.2% respectively in the first half year of 2006. The goal set up in the 11th Five-Year Plan to reduce the total volume of main pollutants by 10% is hard to achieve, especially at the economic growth rate of 9% annually. We used the 3E model to forecast the volumes of different pollutants separately. The forecast is based on the present level of technologies and policies and at current intensities of sectoral pollution discharge.

4.5.1 Wastewater produced will be increasing yearly, and wastewater treatment will be under heavy pressure

The wastewater forecast was based on the volumes of production and domestic wastewater, as well as the volume of aquatic pollutants (see Table 5 for the results).

For cropping sector with rapid increase of irrigated farmland, wastewater and pollutants generated will show rising tendency.

For animal farming industry sector with increasing output and higher proportion of large scale farming, wastewater and pollutants produced will rise annually.

Table 5[1] Forecast of volumes of wastewater and pollutants generated

Year		Volume of wastewater generated(100 million tons)	Volumes of pollutants generated (10,000 tons)	
			COD	NH_3-N
Cropping	2003	1178.19	333.98	66.80
	2010	1308.08	402.28	80.46
Animal farming	2004	31.9	1417.8	141.98
	2010	50.1	2509.7	249.90
Industry	2003	278.6	1558.38	72.39
	2010	750.1	3737	182
Urban domestic	2003	247	1111	104
	2010	409	1764	165
Rural domestic	2003	41	5827	208
	2010	62	5990	194
In total	2010	2579.28	14402.98	871.36

In industrial sectors, the volume of wastewater produced is mainly related to value added and the coefficient of wastewater generation. In the medium-speed scenario, the model forecasts that the volume of industrial wastewater will reach 75 billion tons by 2010, or 2.69 times the figure in 2003 (2.786 million tons). The volume of COD in wastewater generated will reach 37.37 million tons, or 2.4 times the quantity in 2003 (15.58 million tons). The volume of NH_3-N generated will reach 1.82 million tons, or 2.5 times the quantity in 2003 (724,000 tons).

[1]Waste generated in the service sector is separately allocated into industrial and domestic wastes. Therefore, waste forecast by sectors does not cover the service sector.

With regard to industrial structure, chemistry, paper production, electricity, and iron and steel will be the top four sectors with most wastewater generated, accounting for 32.8% of the total volume of industrial wastewater in 2010.

The top four sectors generating most volumes of COD will be paper making, food processing, chemical industry, and textile industry, accounting for 48.1% of the total volume of the whole industry.

Along with the increase of water consumption in urban and rural areas, urban and rural wastewater generated will increase correspondingly. Rapid growth of urban population and slight increase of the pollutant generation coefficient will cause a fast increase in the volume of pollution. Without effective treatment, damage caused by urban wastewater pollution will be excessively high.

4.5.2 Rapid increase of atmospheric air pollutants generated and heavier treatment task in the future

Economic trend, energy consumption forecast and analysis of fuel quality suggest that by 2010, the volume of SO_2 generated will amount to 45.85 million tons (see Table 6), among which the volume of industrial SO_2 generation will reach 43.65 million tons. Research shows that for compliance with standards of urban environmental quality and realization of targets of acid rain control, the volume of SO_2 emission must be limited to 16 million tons. During 11th Fve-Year Plan, SO_2 emission needs to be reduced by 10% compared to the year 2005 to 22.95 million tons. Consequently, the volume of SO_2 reduction should reach 20.70 million tons, a difficult task indeed.

Table 6 Forecast of SO_2 generated in the year of 2010 (10,000 tons)

		2010
Industrial	Energy combustion	3398
	Production process	967
	Subtotal	4365
Domestic and other	Other sectors	121
	domestic	99
	Subtotal	220
Total		4585

Soot generation is consistent with the trend of coal consumption growth. By 2010, total volume of soot produced will reach 247.04 million tons, mainly from the power industry. By 2010, the volume of soot produced by the power industry will be 215.67 million tons, accounting for 87.3% of the total. Therefore, soot control in power industry is very important. Similarly, volume of dust produced will show an upward trend. By 2010, volume of dust generated will reach 108.41 million tons, mostly by the cement industry and ferrous and non-ferrous metal melting.

4.5.3 Continuous increase of solid waste generated and higher pressure on treatment and disposal of solid waste

The 3E model reveals that China's fixed capital investment will grow at high speed during the 11th Five-Year Plan. Resource-intensive industries will also grow quickly. Therefore, production of solid waste will be remain at peak levels to reach 1169.96 million

tons in 2010, increasing by 30.1% compared to the year 2003. See Table 7 for forecast results.

Along with accelerated urbanization, improved living standard and wide consumption of household appliance, urban and rural domestic waste will also accelerate.

The volume of urban domestic waste equals the number of people times per capita urban domestic waste generated. It is forecasted that per capita domestic waste generated by urban citizens on average will reach 1.06 kg/day by 2010, and the total volume will reach 220.29 million tons. Significant factors considered in the forecast of electric and electronic waste are mainly sales and the average life span of electric equipment. It is forecasted that there will be 55.36 million sets of used electric and electronic appliances in five major categories in 2010, generating 2.102 million tons of electric and electronic wastes. Therefore, recycling and safe disposal of industrial solid waste, household waste, and used household appliances etc., will be an important issue in the next five to ten years and beyond.

Table 7: Forecast of industrial solid waste generated in China

Category	2004	2010
Total volume of coal gangue (ten thousand ton)	12921	19800
Total volume of coal dust generated (ten thousand ton)	17481	22967
Total volume of slag(ten thousand ton)	10509	11634
Total volume of slag from melting(ten thousand ton)	12298	15113
Total volume of tailing (ten thousand ton)	25583	32753
Total volume of dangerous waste (ten thousand ton)	1171	1274
Total volume of industrial solid waste(ten thousand ton)	89932	116996
Total volume of general solid waste in industry(ten thousand ton)	88731	115722
Total volume of dangerous solid waste (ten thousand ton)	1171	1274

4.6 Comprehensive analysis of economic growth and environment, early warning during the 11th Five-Year Plan

As described above, China's economy in the 11th Five-Year-Plan period will still grow with a high speed, and the growth will hold endogenous momentum and pressure. Though the central government will take measures to control the fast speed of economic growth, the average annual growth rate will still exceed 9%, which will put large pressure on resource supply and environmental protection.

- *Growth rate of GDP will reach 9.6 percent, 2 percent higher than proposed.*

During the 11th Five-Year Plan, the persistent and fast growth of China's economy has endogenous momentum and pressure. Since 2004, the Central government has launched a series of strong economic and administrative measures to slow down growth, but the results are not satisfactory. China's economy may not be overheated, but some structural conflicts

have aggravated, for instance, inefficiencies in the financial system, distorted income distribution, overheating of the real estate industry, etc. Notably, persistent economic growth has gone beyond the limit of environment's carrying capacity.

- *Energy consumption will increase on a large scale; as a result, reducing energy consumption per unit of GDP by 20% will be difficult to achieve.*

According to the medium-speed scenario, the energy consumption in the 11th Five-Year Plan will increase by 5.4% each year. The elasticity coefficient of energy consumption will be 0.56, nearly halved in comparison with 1.1 in the 11th Five-Year Plan. Despite this reduction, the energy consumption per unit of GDP will be reduced by merely 17.35%. In the first half of 2006, this figure did not decrease; rather, it increased by 0.8%. As a consequence, the energy consumption per unit in 2006 will be slightly higher than in 2005，meaning that the target to reduce the energy consumption per unit of GDP by 20% in the 11th Five-Year Plan must be realized in four years. In each year 5.4% of energy consumption needs to be reduced. According to the forecast of the 3E model, even if the policy of energy saving could be implemented effectively, the target to reduce 20% of the energy consumption of GDP per unit is extremely difficult to reach.

- *Environmental pressure is increasing, and there are few chances to realize the target of reducing the total volume of major pollutants by 10%.*

Table 8 Environmental and economic pressures facing China in 2010

Main pollutants	Volume in 2010 (million tons)	Proposed control goals in"11th five years plan "	Volume of emission in 2010 (million tons)	The volume should be treated in 2010 (million tons)	Investment of treatment(investment and running cost) /billion RMB
Waste(COD)	37.37	Volume of emission reduces 10% comparing to the end of 2005	12.73	24.64	554.2
Waste air (SO_2)	45.85	The volume of emission reduces 10% comparing to the end of 2005	22.94	22.91	640.9
Industrial solid waste	1169.96	Integrative recycling rate of solid waste is over 60%	---	----	196.5

Table 8 shows that China will face enormous environmental pressure. According to the 11th Five-Year Plan, the volume of discharge of themain environmental pollutants (COD and SO_2) should be reduced by10% compared to the year 2005. In 2010, COD generated in China will reach 37.37 million tons. The discharge volume should be lower than 12.73 million tons, and the reduction volume should reach 24.64 million tons. This needs an investment of 554.2 billion RMB. SO2 generated will reach 45.85 million tons; the discharge volume should be lower than 22.94 million tons, and the reduction volume must reach 22.91 million tons. An

investment of 640.9 billion RMB will be necessary. Industrial solid waste generated will reach 1.17 billion tons. To recycle and reuse 60% of the waste will need an investment of 196.5 billion RMB. Treatment of the three pollutants needs an investment of 1391.6 billion RMB，accounting for around 1.8% of GDP. Disposing other waste and realizing the environmental targets in 2010 will cost 2% of the GDP. This is difficult to achieve. Obviously, with the current approach of "end-of-pipe" control, environmental targets cannot be realized. This means that the circular economy, clean production and waste control from sources is the key to the realization of environmental protection. However, the development of a circular economy faces institutional and conceptual obstacles. For instance, the state has promoted a policy that gives priority to grid connection for power generation with waste and surplus heat. However, there is still strong resistance to grid connection for this type of electricity, even in the capital.

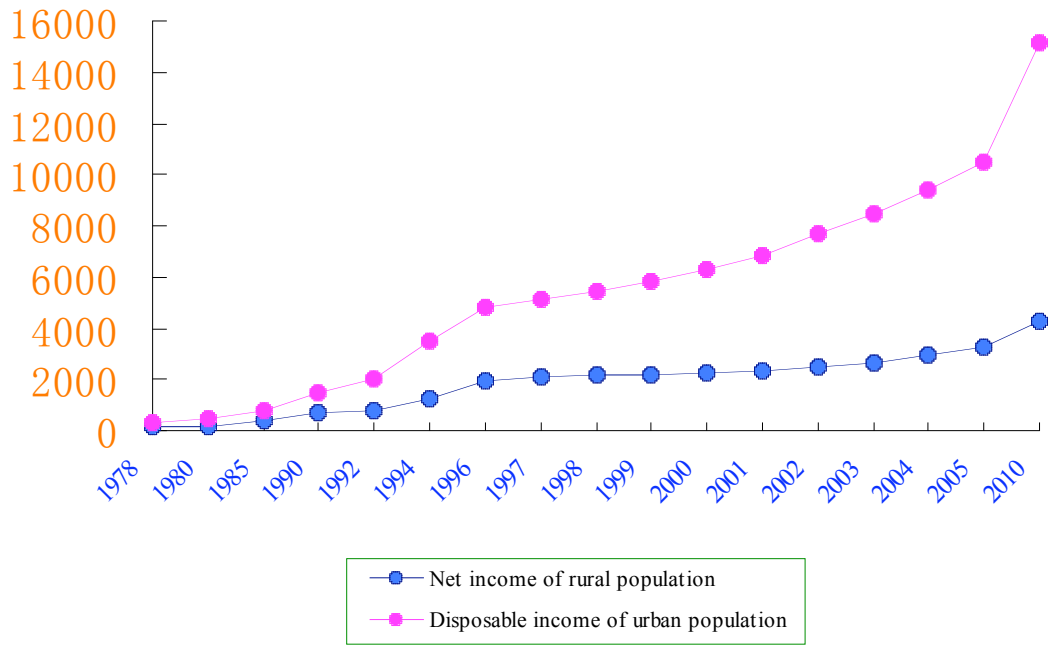
- *Downward trend of Annual Progress Index of Urban Sustainability.*

Analysis about the Annual Progress Index of Urban Sustainability in pilot cities shows that, although the economic growth rates in cities have been high, the value of the index has been falling. Between 2001 and 2003, the index values in four pilot cities have dropped from 492.47 to 442.04, i.e. by 17 points annually. This indicates that the overall sustainability of these four cities is in a downward trend. Even at a low decreasing speed, this trend is still alarming.

Box 4：

Early warning of urban- rural gap

Since 1996, the gap between rural and urban areas has been expanding. Between 1995 and 2005, the average annual income of urban population per capita increased by 7.67% annually on average, while the net income of rural population increased by only 4.99%. The ratio between urban income and rural net income increased from 2.71 in 1995 to 3.22 in 2005. This trend will continue in the future. During the 11th Five-Year-Plan period, it is assumed that the annual growth rate of urban income will remain the same (7.67% annually), while the growth rate of rural income will increase from 4.99% to 5.5%. By 2010, the ratio between urban income and rural net income will increase to 3.6. The expanded income gap will cause the further widening of the gap between urban and rural living standards. The model forecasts that the gap between urban and rural consumption will widen by 15.8%.



Box 5.

The fast speed of economic growth in China exhibits strong internal power and pressure

First: After the opening and reformation for 20 years in China, capital accumulation of the economy has been high is increasing. Low-cost capital supply provides the stable foundation of investment.

Second: the progress of industrialization and urbanization and the increase of income per capita leads to mass demand of investment and consumption, providing plentiful investment opportunities for the enterprises. Private investment and investment by self-raised fund have become the dominant forces of fixed capital investment in China. This is one of the essential reasons of the fast speed of the economic growth.

Third, the implementation of the scientific concept of development and the development of a harmonious society is putting more pressure on expenditure of local governments, which pushes the local governments to promote economic growth. The scientific concept and the goal of a harmonious society have strengthened the responsibility of the local governments, and the pressure on governmental expenditure is heating up. For example, establishing the scientific concept and a harmonious and "people-centered" society, promoting "Five Comprehensive Considerations", cancelling the agriculture tax, reinforcing the construction of infrastructure, enhancing the investment in social security and medical and sanitation services for the rural inhabitants, improving educational condition in rural areas, improving the ecological environment and so on needs to increase the expenditures of local governments. Without fast economic growth, there would be no source for governmental expenditure. The construction of a harmonious society needs a capital infusion. Harmonious social development must be supported by a certain speed of economic growth.

Fourth, narrowing the over-expanding gap between city and countryside requires an income increase of the rural inhabitants and people in poor undeveloped areas, but the income of urban residence cannot be reduced. China has not developed to such level as to eliminate the "Matthew Effect" in the market economy. China needs to reach a balance between fairness and efficiency. The rural-urban gap expands unceasingly, but the society keeps general stability, the main reason being the fast economic growth. Although the growth rate of farmer's income is lower than the rate of city people, income is, after all, growing. If the speed of economic growth decreases to a degree that job hunting for farmers becomes difficult and wages are low, the degree of disharmony will be higher.

Five, regional differences are also expanding continuously. The GDP per capita of Shanghai is over 10 times that of Guizhou Province. In the same country, in the identical market, at similar price level, the existence of such big income gap between regions is a special characteristic of China's economy. Regional "Matthew Effects" will continue to enlarge the regional differences. If not accelerating the economic growth in undeveloped areas, the establishment of a harmonious society will remain on paper.

Six, the increase of employment is also an important driving power of economic growth. In China, the social security system is not satisfying today. For the ordinary countryside inhabitants, employment means income. Without income, farmers' livelihood will have no safeguard. Millions of graduates from universities and over several ten millions of farmers are not covered by the social security system. China has eight million new workers every year. Only at an 8% of the rate of economic growth, can this problem be solved. At alower rate, employment pressure will become obviously higher.

Seven, With the gradual increase of resident income, China has entered into the age of mass consumption. General consumption of household appliance, family cars, and increased per capita housing have become driving forces of fast economic growth.

Above factors determine that China's economic growth must be kept at a high speed.

Box 6

A comparison of the GDP growth rates between east and west regions during 2001-2005

	Province	Real average growth rate of GDP during 2001-2005	GDP of each province in 2005	The weight of GDP in the region	The share of contribution in region's growth rate of GDP（%）
Ten province /cities of the east region	Beijing	11.90%	6814	5.87%	0.67
	Tianjin	12%	3663	3.16%	0.38
	Hebei	11%	10116	8.71%	0.96
	Liaoning	11%	8005	6.89%	0.76
	Shanghai	11.50%	9144	7.88%	0.91
	Jiangsu	13.1%	18272	15.74%	2.06
	Zhejiang	9%	13365	11.51%	1.04
	Fujian	10.60%	6560	5.65%	0.60
	Shandong	10%	18468	15.91%	1.59
	Guangdong	13%	21701	18.69%	2.43
	Sum for east		**116110.8**	**100%**	**11.40%**
Twelve provinces of the west region	Inner Mongolia	**16%**	3822	11.45%	1.83
	Guangxi	**11%**	4063	12.16%	1.29
	Chongqing	**9%**	3069	9.19%	0.86
	Sichuan	**11%**	7385	22.12%	2.48
	Guizhou	**10%**	1942	5.82%	1.06
	Yunnan	**9%**	3472	10.39%	0.92
	Tibet	**12%**	250	0.75%	0.09
	Shanxi	**12%**	3674	11.01%	1.27
	Gansu	**10%**	1928	5.77%	0.59
	Qinghai	**10%**	543	1.63%	0.16
	Ningxia	**9%**	599	1.81%	0.16
	Xinjiang	**10%**	2639	7.91%	0.80
	Sum for west		**33390.3**	**100.01%**	**11.49%**

Note：Above data is from the "11th –five-year-outline" of different provinces. Locally proposed GDPs are all higher than the data from National Statistics Bureau (NBS). This table uses the proportion of local province data in local GDP to represent the total proportion of 2001-2005, and uses the proportion as the weight to weigh the growth rates of east and west in 2001-2005 on average, and then obtain the total local growth rate in east and west separately.

Box 7

A comparison of the planned growth rates of GDP between east and west regions during the "11th-five-year-plan"

		Planned average growth rate of GDP during 2006-2010	Share of each province GDP in the east region in 2005	The share of contribution to the region's GDP growth rate
Ten province /cities of the east region	Beijing	9%	5.87%	0.53
	Tianjin	12%	3.16%	0.38
	Hebei	11%	8.71%	0.96
	Liaoning	11%	6.89%	0.76
	Shanghai	9%	7.88%	0.71
	Jiangsu	10%	15.74%	1.57
	Zhejiang	9%	11.51%	1.04
	Fujian	10.90%	5.65%	0.62
	Shandong	10%	15.91%	1.59
	Guangdong	9%	18.69%	1.68
	Planned economic average growth rate of GDP in the east region during 2006-2010		9.84%	
Twelve provinces of the west region		Planned average growth rate of GDP during 2006-2010	Share of each province GDP in the west region in 2005	The share of contribution to the region's GDP growth
	Inner Mongolia	13%	11.45%	1.49
	Guangxi	10%	12.16%	1.22
	Chongqing	10%	9.19%	0.92
	Sichuan	9%	22.12%	1.99
	Guizhou	10%	5.82%	0.58
	Yunnan	9%	10.39%	0.94
	Tibet	12%	0.75%	0.09
	Shanxi	11%	11.01%	1.21
	Gansu	10%	5.77%	0.58
	Qinghai	10%	1.63%	0.16
	Ningxia	10%	1.81%	0.18
	Planned average growth rate of GDP in the west region during 2006-2010		10.17%	

Part V

Policy Recommendations on Balancing Economy and Environment

All the study results, including those of the case studies about the measurement of governmental performance / sustainable development using indicator systems, and the early warning / forecasting about macro-economic growth and the environment by the proposed 3E model, reveal that the sustainability of China's economic development is facing great challenges. During the 11th Five-Year-Plan period, the economy will keep growing at a high speed far above the proposed goal, while goals of energy efficiency and environmental protection will be very hard to achieve. Without effective measures, these goals may not be reached. Therefore, the Task Force suggests that, during this period, the Chinese government shall take effective measures in five areas in order to realise the goals. These areas include (1) investment; (2) environmental monitoring and information disclosure; (3) more intensive development of the circular economy; (4) reform of institutional arrangements and the administrative system; and (5) improvements in the pricing / taxation system.

5.1. During the 11th Five-Year-Plan period, the economic growth rate in China will exceed 9%. If the total quantity of major pollutants is to be reduced by 10%, the government should take effective measures to encourage local governments and corporations to increase investment in environmental protection and pollution control. Environmental investment should account for up to 2.0% of GDP by 2010.

We advise that:

Firstly, regard environmental investment as one of the major goals of macro-economic policy, and define annual objectives. An economic and environmental forecasting and early warning platform should be set up as it can serve as a basis for establishing annual environmental protection and regulation targets.

Secondly, Further clarify environmental responsibilities of governments at different levels. Increase the weight of the environment in evaluating local government performance and implement strictly the evaluation to encourage local governments to increase investment in environmental protection and to take other effective measures.

Thirdly, in conjunction with the policy of total quantity control, accelerate the implementation of emission trade policy so that the maintenance of environmental absorption capacity becomes an important source of environmental protection investment.

Fourthly, through regulation establish an environmental guarantee deposit scheme. Environmental guarantee deposits should be collected from all new construction projects in line with sectoral pollution discharge standards. The deposit shall be returned after the project, once implemented, is verifiably in compliance with discharge and other relevant standards.

5.2. Establish an enhanced mechanism for collecting valid environmental information. To ensure that high quality information is readily available for accurate environmental accounting, environmental management and policy making, and objective and fair measurement of local governmental performance, the Central Government should establish an independent environmental data management and distribution system.

We advise that

Firstly, based on existing environmental monitoring systems, the Central Government should

establish an improved national water pollution, air quality, soil quality and solid waste monitoring system**.** It should also improve the tracking of land use and land cover change.

Box 8

About Environmental statistics and data collection

Environmental data gaps and varying quality of economic, social and environmental statistics require a comprehensive review of the statistical data base for indicator development and integrated environmental-economic accounting. In particular, there is a need to

---assess the capacity of China's existing *monitoring and data collection infrastructure*, on multiple levels, to provide a stream of high-quality data for the suggested core indicators

---review the status of current *data quality assurance* systems and suggest options for improvement, including the possibility of independent third-party data verification and audit.

Secondly, ensure legal enforcement and supervision capacity for environmental protection is in place by establishing an environmental supervision system. In all medium and large cities, strengthen environmental protection and resource management, and expand the relevant functions and responsibilities of governmental departments in charge of environmental protection and resource management. Building on the experience of Germany, establish a public servant regime for environmental supervision. In large state-owned or highly polluting enterprises environmental supervisors should be appointed by and be under the direct administrative control of state environmental protection authorities. Further, a well-trained and competent public servant should be appointed to every 50 enterprises or public institutions for supervising their environmental activities, resource efficiency and information accuracy. Overall benefits of this system for environmental protection and resource conservation will far exceed the cost, as well as contribute to increased employment.

Box 9

Detailed recommendations about Green GDP

China's transition to an increasingly market-based economy and the environmental trade-offs of rapid economic growth call for the development and use of environmental satellite accounts, parallel to, but compatible with, the conventional national accounts. Such a programme should:

---take the increasing *information needs of decision making* (by economic agents) *and policy making* – beyond the evaluation of government officials – into account;

---place all indicator work in a common *integrated environmental-economic accounting framework* so as to ensure compatibility and comparability of environmental, social, institutional and economic indicators across the nation;

---establish regular *collaboration of the official statistical services with data users* in environmental, social and economic departments and institutions;

---gain experience with green accounting by means of *pilot projects* at national and sub-national (provincial) levels;

---establish cooperative links with other ongoing green accounting and indicator projects in the country, in particular of *Statistics Canada*, *the World Bank, Norway and OECD*; and

---explore the data requirements and data availability for *modeling* trends and options of sustainable economic growth and development.

Thirdly, while continuing the pilot projects on green GDP accounting, establish a material flow

accounting and statistical system to provide scientific and accurate information for improved nationwide environmental and resource management and policymaking.

Fourthly, establish and improve the mechanism of environmental and resource information disclosure. Regularly publish quarterly environmental and resource newsletters.

5.3. Shift the emphasis of the circular economy approach from resource saving to environmental protection, and accelerate its development.

Firstly, accelerate the introduction of basic and special laws on the circular economy, promote recycling, reuse and reduction of resource use and waste, thus minimize the pressures on end-of-pipe waste control.

Secondly, strengthen the enforcement of the *Energy Saving Law* and *Renewable Energy La*w. Accelerate the development and utilization of biomass energy sources, especially the generation of biogas, petroleum, and the use of organic and other wastes for fuel production.

5.4. Improve the environmental management system and clarify the authority and responsibilities of both central and local governments.

We advise that

Firstly, based on the present inter-ministerial regime of the National Environmental Protection Joint Meeting, establish a State Environment and Resource Committee (SERC) to coordinate the activities of SEPA, MLR, MWR, SFA, and energy authorities.

Secondly, establish an environmental management hierarchy, and clarify authorities and responsibilities of both central and local governments for environmental protection. Macro environmental management should be the responsibility of the central government, while local environmental affairs should be the responsibility of the local governments. This institutional arrangement will allow the central government to effectively supervise local governments, to expand local governments' environmental responsibilities and will ultimately increase the efficiency and effectiveness of policy measures.

Thirdly, change the title "State Environmental Protection Administration" to "Ministry of Environment" (MoE) so that the authority of national environmental protection is enhanced. As an integrated department in charge of environmental protection affiliated to the central government, the MoE's authorities include: formulating national policies of environmental management; controlling and managing environment and natural resources at the aggregated level; environmental management across catchments and regions; collection, processing and disclosure of the state's environmental information; assessment, monitoring and early warning of local environmental management; and supervision of environmental management in large state-owned enterprises.

At the same time, the local governments should follow the central government's regulation on aggregated quantity control, be in charge of environmental management, and hold responsibility for environmental quality and environmental accidents in their administrative areas.

5.5 Reform the pricing mechanism for full (social) cost pricing of the use of environment and natural resources in order to support activities and policies aligned with the circular economy approach.

We advise that

Firstly, set pollution discharge fees at higher rates for wastes such as sulphur dioxide, sewage, industrial and other soot, and solid waste. Rate increase should benefit waste recycling and reusing enterprises and support the objectives of a competitive circular economy.

Secondly, increase primary resource price in two ways: raise natural resource tax rates so as to fully capture resource rents, and improve payment of and working conditions for workers in rural areas. With the leverage function of the pricing system, encourage enterprises to efficiently use resources and recycle

wastes. Prediction results from the 3E model advise an increase of resource tax rate to 20% of output of resources, such as coal, oil and natural gas. Tax rates for other resources shall be increased according to scientific assessments notably from environmental accounting

Thirdly, distribute an "environmental bonus" (subsidy) reasonably. While corporate social responsibilities and environmental taxes are increased, the environmental bonus should also be shared. This helps people balance economic growth and environmental protection. It is advised to adopt tax compensation policies, which is to rebate one percent of tax to those enterprises in compliance with environmental standards.