Quantitative Analysis of How China’s Six Major Scientific & Technological Program to Include Environment Protection based on Data 1982-2015

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Abstract. Environment protection has been a trans-disciplinary public policy issue on the global government agenda, including China. However, research on how PRC China’s six major S&T program to include environment protection remains a research vacuum. The core research question is how environment protection has been included in China’s major S&T programs in a quantitative way. The conclusion is: a) the impact of environment protection is growing bigger; b) the attention level to environment protection is getting higher and c) the fiscal allocation to environment protection by the 6 S&T programs is getting more. Further, this paper estimates the budget sum and ratio of “Three Major S&T Programs” to environment protection and its five-year ratio from 2001-2013 for the first time.

1. Theoretical Framework

1.1. Literature Review
Literature has pointed out PRC China’s national level S&T policies, long-mid term Scientific & Technological plannings and Scientific & Technological(S&T) Programs must include environment protection [1-16]. S&T Programs has been a very important governance tool in China’s S&T arena. Since the very first one Key Technologies R&D Program (NKTRD Program) set in 1982, China has established more than 100 S&T programs, 39 of which are national-level. However, few research has studied how environment protection has been included in China’s 6 major S&T program, which is exactly the core research question of this paper.

1.2. Research Object and its Representativeness
This paper is to select out the most-important and most-representative S&T program as research object. The four selection criteria are: long time-span, fat budget, irreplaceable S&T field representativeness and significant social impact. According, 6 major S&T programs have been selected, which are: Key
Technologies R&D Program (NKTRD Program) set in 1982, National High-tech R&D Program (863 Program) set in 1986, Basic Research Program of China (973 Program) set in 1997, National Nature Science Foundation (NNSF Program) set in 1986, Spark program set in 1986 and Torch Program set in 1988.

The research objects here chosen in this paper are of high representativeness, which can be seen in two ways. The first is in China S&T arena, NKTRD Program, 863 Program and 973 Program are usually seen as a whole, being called “Three Major S&T Programs” because they are seen logo of China’s national S&T strength and of high political attention (863 program especially) and of major resource allocation. The second is the 6 S&T Program chosen here in this paper has made up a full S&T value-chain, covering from basic research, R&D research and technical innovation in key industries, in hi-tech industries and in agriculture.

1.3. Research Methods
The usual main body of China’s S&T program is combined with four indicators, which are: a) strategic goals; b) key funding S&T fields; c) funding budget allocated to environment protection field by the program; d) funding projects allocated to environment protection field by the program. Accordingly, this paper is to explore the four indicators to measure how China’s 6 major S&T program to include environment protection from 1982-2015 in inductive logic and quantitative manner. The first two indicators are measured in the program texts and content analysis methodology is used. The third and fourth indicators have been tracked, calculated and verified by the author.

1.4. Research Boundary
All data of S&T program in this paper only refers to the “supply side”, excluding the implementation, assessment and actual effect of the program.

2. Research data

2.1. Data Source
As mentioned above, this paper uses four indicators: a) strategic goals; b) key funding S&T fields; c) funding budget allocated to environment protection field by the program; d) funding projects allocated to environment protection field by the program. The first two indicators have been collected from program text which is easily found from books and web. The third and fourth indicators from more books, statistics, research reports [17-20] and the author verified all data.

All research data utilised in this paper is collected or made by the first author herself. All figures and table in this paper are calculated or estimated by the first author herself.

2.2. Data Cleaning and Selection
Data cleaning and selection of the first and second indicators is obtained by content analysis method, which are: a) program text is checked one by one according to the criteria whether the strategic goals and key fields contains keywords or main content reflecting environment protection as data; b) the chosen data is then divided by “directly include” or “indirectly include”. Data cleaning and selection of the third and fourth indicators is collected and the author analyzed.

2.3. Data Representativeness
All data in this paper is of high representativeness, covering full-sample and all-time (1982-2015) and avoiding sampling bias.

The 12th five-year only refers to 2011-2013 because the official figures of 2014 and 2015 isn’t available until July 7th 2017 when the paper is finally revised and contributed.
3. Results

3.1. Slow increase period (1982-1995): China’s 6 major S&T program to include environment protection

From 1982-1995, 5 of the 6 S&T programs have been set, except the 973 program. Year 1982 is the starting year of China’s S&T program history. Year 1995 is chosen here mainly because major S&T programs follow China’s “five-year planning” rhythm and also because 1995-2015 will make a decade due to research data ends in 2015.

Research findings show 1982-1995 is the \textbf{SLOW Increase Period} of China’s 6 major S&T program to include environment protection with two characteristics. The first characteristic is the core keywords of S&T program directly include environment protection being around environment pollution and showing the track from simple pollution control to complicated pollution control of different environmental media, of which NKTRD Program and NNSF Program show most obviously. The second characteristic is the keywords of directly include environment protection showing the newly appearance of environment management, of which NKTRD Program shows most obviously.

Two reasons have been identified of 1982-1995 being labelled \textbf{“SLOW” Increase Period instead of “QUICK”}. The first is performance of four indicators is relatively poor, namely the strategic goals and key funding S&T fields of some programs to include environment protection, while others (863 program and Spark program) don’t. The second is relatively low ratio of environment protection projects approved of the program (NKTRD Program and NNSF Program).

(a) Quantitative analysis of NKTRD Program to include environment protection

NKTRD Program is the first S&T program aiming at solving big technological issues in key industries, with which show four characteristics to include environment protection from 1982-1995.

The first characteristic is unstable appearance of strategic goals to include environment protection. For example, the $6^{th}$ and $8^{th}$ five-year NKTRD (1982-1985 and 1991-1995) include environment protection while $7^{th}$ five-year NKTRD (1986-1990) doesn’t.

The second characteristic is low ratio of environment protection project approval. The $6^{th}$ five-year of NKTRD ratio is 2.6%, the $7^{th}$ five-year being 5.3% and the $8^{th}$ five-year being 6.1%.

The third characteristic is increasing different environment pollution control media. There is only one project approved in the $6^{th}$ five-year of NKTRD with its keyword “environment protection and pollution prevention& control technology”. In the $7^{th}$ five-year NKTRD, there are two projects approved with their keywords being “atmosphere pollution technology” and “water pollution technology”. In the $8^{th}$ five-year of NKTRD, there are more projects approved with their keywords being “hazardous waste and urban waste technology” and “solid-waste recycling technology”, apart from “acid precipitation control technology”.

The fourth characteristic is keyword of approved project during this period is more than merely environment S&T but environment management. For example, only 1 project with its keyword “environmental background value and environmental capacity” has been approved the $7^{th}$ five-year of NKTRD, which is the first environment management project in China. Further, 2 recycling projects(wastewater resource and solid waste recycling) and one complex-system project (coordinated development of population, resource and environment appropriate new technology) have been approved the $8^{th}$ five-year of NKTRD, the latter one is the first S&T project aiming at adapting relation between human and nature in China.

(b) Quantitative analysis of 863 Program to include environment protection

The 863 program was set in 1986 aiming at boosting hi-tech, choosing 7 key fields and 15 projects, none of which include environment protection from 1986-1995. So we can say 863 program doesn’t include environment protection from 1986-1995.

(c) Quantitative analysis of NNSF Program (Major Project) to include environment protection

NNSF Program was set in 1986 aiming at boosting basic research. NNSF Program was combined of three types: General Project, Key Project; and Major Project. Budget to each Major Project is
around RMB 1.5 Million and above, while budget to each General Project and Key Project budget is around RMB 30,000-45,000 each (these are budget figures of 1986). This paper selects Major Project to be research object because this type represents the State willingness most and has highest policy significance.

There are two characteristics of NNSF Program (Major Project) to include environment protection. The first is the ratio of project approved in the 7th five-year is 4.6% and the ratio in the 8th five-year is 10.5%. The second is NNSF Program (Major Project) keyword transformation from mere disaster prevention and mitigation to pollution prevention. For example, there is 4 projects approved in the 7th five-year NNSF Program (Major Project) with the keyword being “Southeast coast red tide”, “Yellow River environment and water and sediment rules”, “Climate and sea-level change” and “Yellow River and Yang-zi River drought and flood prevention”, which focus mainly on traditional natural disaster prevention and mitigation. There are 3 projects in the 8th five-year NNSF Program (Major Project) with keywords “typical chemical pollutants and their ecological effects”, “atmospheric ozone and its impact on climate” and “large-scale environment evolution in China’s arid and semi-arid areas”, which means focus on pollution caused by industrialization.

(d) **Quantitative analysis of Spark Program to include environment protection**

Spark program was set in 1986 aiming at boosting S&T at rural areas and agriculture, none of which include environment protection from 1982-1995.

(e) **Quantitative analysis of Torch Program to include environment protection**

Torch program was set in 1988 aiming at boosting hi-tech industrialization, with which show three characteristics to include environment protection from 1982-1995. The first is the stable appearance of environment protection in its strategic goals. The second is the stable appearance of environment protection in its 6 key fields with its field-name “new energy, saving-energy and environment protection”. The third is the increasing ratio of project approved 4.7% in 1988 and 14.5% in 1995.

3.2. **Quick increase period (1996-2015): China’s 6 major S&T program to include environment protection**

Research findings show 1996-2015 is the **QUICK Increase Period** of China’s 6 major S&T program to include environment protection with three characteristics.

Two reasons have been identified of 1996-2015 being labelled **QUICK** Increase Period. The first is performance of four indicators is stably increasing, namely the strategic goals and key funding S&T fields of each programs to include environment protection. The second is relatively increasing of budget and projects approved of each program (see Fig 1 and Fig2).
Note 1: In the NKTRD Program, the ratio for 2001-2005 is the expenditure ratio of the resource and environment sector divided by 2, and the expenditure ratio of the environmental sector is adopted for the other years; data of 2006 and 2010 are unavailable;

Note 2: The ratio of the 863 Program is the expenditure of the resource and environment sector divided by 2 for all years; data of 2001, 2002 and 2010 are unavailable for the 863 Program;

Note 3: The ratio of the 973 Program is the expenditure of the resource and environment sector divided by 2 for all years; data of 2007, 2008, 2009 and 2010 are unavailable for the 973 Program.

(a) **Quantitative analysis of NKTRD Program to include environment protection**

NKTRD Program shows four characteristics to include environment protection from 1996-2015. During 1996-2005, NKTRD program has set “resource and environment” field, so data of budget and project approved here used is the estimated figure divided by 2.

The first characteristic is strategic goal of NKTRD program directly include environment protection and keep strengthening. For example, in the 9th and 10th five-year of NKTRD (1996-2000 and 2001-2005) include environment protection while the 11th five-year of NKTRD (2006-2010) put environment protection into the first strategic goal. The second characteristic is environment protection as a key-field has been separated from resource key-field from the 11th five-year period on and environment protection field ranks 3rd in all key-fields, which is higher than ever before. The third characteristic is increasing budget to environment protection. The ratio during the 10th five-year NKTRD is 4.25% (during this period only set “resource and environment” field, of which 8.5% is its budget, so 4.25% is the estimated figure divided by 2), ratio during 11th five-year (2006 and 2010 not included) being 6.34% and ratio of 12th five-year being 10.88%, and ratio of 12th five-year is 7.34% (Fig 1).The fourth characteristic is increasing ratio of environment protection project approval. The ratio during the 9th five-year NKTRD is 4.4%, ratio during 10th five-year being 7.9% ratio of 11th five-year being 10.88%, and ratio of 12th five-year is 7.34% (Fig 2).
(b) **Quantitative analysis of 863 Program to include environment protection**

863 Program shows four characteristics to include environment protection from 1996-2015. During this period, 863 program has set “resource and environment” field, so data of budget and project approved here used is the estimated figure divided by 2.

The first characteristic is environment protection has been included as a key-field from 2001 on (it is “resource and environment field”, not as a separate key-field) and ranks 6th in all 6 key-fields. During the 11th five-year period, 863 program expands its key-fields from 6 to 10 and resource and environment field has climbed to rank 6th in all 10 key-fields. The second is project keyword transformation from environment monitoring to environment pollution control. For example, there is only 1 project in the 9th five-year 863 program with its keyword “marine environment integrated monitoring”, the keywords in the 10th five-year 863 program are about “environment pollution prevention” and “water pollution control” and the keywords in the 11th five-year 863 program are about “environment pollution prevention”, “major environment pollution emergence technology” and “global climate change”. The third characteristic is increasing budget to environment protection. The ratio during the 10th five-year increases from 3.2% to 5.1%, ratio during 11th five-year stays at 4.5% (except 2008 falls to 3%) and ratio of 12th five-year being 5.3% (Fig 1). The fourth characteristic is increasing ratio of environment protection project approval. The ratio during the 10th five-year is from 0 to 5%, ratio during 10th five-year being 6.2% and ratio of 11th five-year being 5.3%, and ratio of 12th five-year is 6.6% (Fig 2).

(c) **Quantitative analysis of 973 Program to include environment protection**

973 Program shows two characteristics to include environment protection from 1996-2015. During this period, 973 program has set “resource and environment” field, so data of budget and project approved here used is the estimated figure divided by 2.

The first characteristic is stable budget to environment protection. The ratio during the 10th five-year increases from 8.4% to 5.1%, ratio during 12th five-year stays at 5.6% (figures of 2006-2011 are unavailable) (Fig 1). The second characteristic is decreasing ratio of environment protection project approval. The ratio during the 10th five-year is 8.35% and ratio of 12th five-year is 6.6% (figures of 2006-2011 are unavailable) (Fig 2).

(d) **Quantitative analysis of NNSF Program to include environment protection**

There are two characteristics of NNSF Program (Major Project) to include environment protection.

The first is the ratio of project approved and the budget is sharply increasing. For example, in the 9th five-year is 20.6% and budget sum comes to RMB 5.2 Million each project, the ratio in the 10th five-year is 11.4% (which doesn’t mean decreasing but because 973 program was set during this period dividing certain projects ) and budget sum climbs to RMB 8 Million each project and the ratio in the 11th five-year is 16.7% and budget sum rises to RMB 10 Million each project. The second is NNSF Program (Major Project) keyword being more and more around environment pollution. For example, there is 31% projects approved in the 9th five-year NNSF Program (Major Project) being on industrialization-induced environment protection, the ratio rises to 75% in the 10th five-year NNSF Program (Major Project) and 60% in the 11th five-year NNSF Program (Major Project).

(e) **Quantitative analysis of Spark Program to include environment protection**

Spark Program shows two characteristics to include environment protection from 1996-2015. During this period, spark program has set “resource and environment” field, so data of budget and project approved here used is the estimated figure divided by 2.

The first characteristic is environment protection has been included into strategic goals and key-fields from 2001 on. The second characteristic is stable ratio of environment protection project approval. The ratio during the 9th to 12th five-year is around 4.1%.

(f) **Quantitative analysis of Torch Program to include environment protection**

Torch Program shows two characteristics to include environment protection from 1996-2015. During this period, torch program has set “resource and environment” field, so data of budget and project approved here used is the estimated figure divided by 2. The characteristic is stable increasing ratio of environment protection project approval. The ratio during the 9th to 12th five-year is above 5%. 
4. Conclusions

Based on the above data analysis and results, the conclusion of this paper has been reached that China’s Six Major Scientific & Technological Program (1982-2015) is: a) the impact of environment protection is growing bigger; b) the attention level to environment protection is getting higher and c) the fiscal allocation to environment protection by the 6 S&T programs is getting more.

Further, this paper estimates the budget sum and ratio of “Three Major S&T Programs” to environment protection and its five-year ratio from 2001-2013 as follows. The sum of NKTRD Program from 2001-2013 to environment protection is about RMB 3.07 Billion, the sum of 863 Program from 2001-2013 is about RMB 2.37 Billion and the sum of 973 Program from 2001-2013 is RMB 1.66 Billion. The budget trend of Three Major S&T Programs from 2001-2013 is annually increasing, the ratio of 10th five-year is about 7.7%, the ratio of 11th five-year is about 8.6% and the ratio of 12th five-year is about 10.3%.

Table 1 Budget sum, Budget to Environment Protection and its ratio of Three Major S&T Programs from 2001 to 2013 (Unit: RMB 100 Million)

| Program Name/ Budget Sum | 2001   | 2002   | 2003   | 2004   | 2005   | 2006   | 2007   | 2008   | 2009   | 2010   | 2011   | 2012   | 2013   |
|-------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| NKTRD Program / 30.704  | 0.582  | 0.582  | 0.582  | 0.582  | 0.582  | 1.902* | 2.72   | 3.29   | 3.75   | 3.243* | 4.73   | 3.92   | 4.23   |
| 863 Program / 23.73     | 1.085* | 1.526* | 1.9   | 3.43   | 4.07   | 3.65   | 4.14   | 3.36   | 4.81   | 4.6*   | 3.73   | 5.35   | 7.7    |
| 973 Program / 16.58     | 1.338  | 1.338  | 1.338  | 1.338  | 1.25   | 1.812* | 2.1*   | 2.873* | 4.42*  | 5.031* | 5.24   | 3.75   |
| Budget Sum of Three Major S&T Programs to Environment Protection | 3.01   | 2.45   | 3.82   | 5.35   | 5.99   | 6.80   | 8.67   | 8.75   | 11.43  | 12.26  | 13.49  | 14.51  | 15.68  |
| Budget Sum of Three Major S&T Programs | 23.8   | 43.85  | 51.19  | 62.83  | 66.1   | 76.6   | 111.6  | 121.6  | 120.1  | 128.3  | 137.1  | 146.2  | 141.6  |

* estimated figures

Source: Budget sum from China statistical yearbook on science and technology (1991-2006) and Annual report of the national science and technology; other figures from author

Note 1: In NKTRD Program, 2006 and 2010 are estimate figures due to unavailable official statistics; 2001-2005 are average figures due to only sum official statistics can be found; 2001-2005 are estimated figures of official “resource and environment” field statistics divided by 2;

Note 2: In 863 Program, all figures are estimated figures of official “resource and environment” field statistics divided by 2; 2001 and 2002 are estimated figures due to unavailable official statistics; 2010 is estimated figures due to unavailable official statistics;

Note 3: In 973 Program, all figures are estimated figures of official “resource and environment” field statistics divided by 2; 2001-2011 are estimated figures due to unavailable official statistics.

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