Sustainability Analysis of Cross-regional Drinking Water Project in North and South China-Take West Route of the South-to-North Water Diversion and the Tianhe Project

Sustainability Analysis of Cross-regional Drinking Water Project in North and South China-Take West Route of the South-to-North Water Diversion and the Tianhe Project

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Abstract. The difference of water resources distribution between north and south in China is very obvious, so the South-to-North Water Diversion Project and Tianhe Project emerge as the times require. Combining with the similarities and differences of the two projects, this paper analyzes the sustainability of the Tianhe Project and the western route of the South-to-North Water Diversion Project through a simple game model, and finds that the short-term applicability of the Tianhe Project are more significant, and the long-term applicability of the South-to-North Water Diversion Project are more significant. Therefore, the Tianhe Project and the western route of the South-to-North Water Diversion Project should be jointly constructed to achieve the maximum economic sustainblility. Both can bring great improvements to arid areas in environmental and social effect. Although it is conducive to realize the rational allocation of water resources, there are still many problems in the implementation of Tianhe Project, this paper puts forward relevant policy suggestions after analyzing the causes.

1. Introduction

The difference in the water resource distribution between the north and the south in China is very obvious; it has the characteristics of plenty of water in the south and lack of water in the north, which is not compatible with the productivity layout. Therefore, in order to improve the living standards of the Chinese people, it is necessary to rationally allocate water resources. Therefore, China implements the "South-to-North Water Diversion". This project is divided into three routes: east route, middle route and west route, the middle route project and the east route project (first-stage) have been completed and transfer water to the northern area. The west route project is still in the planning stage so far, and construction does not start.

In order to solve the problem of high cost and difficult construction of the west route of the South-to-North Water Diversion Project, China proposes to "get water from the sky" and builds the Tianhe Project, which is a cross-regional water transfer model based on atmospheric space. The "Tianhe Project" aims to scientifically analyze the distribution and transfer pattern in the atmosphere, and then adopts manual intervention ways to achieve redistribution of atmosphere and surface water resources in different regions.

In order to comprehensively measure the necessity and feasibility of various types of water conservancy projects, the academic circles have carried out many explorations on the measurement of

environmental impact on economic profit and loss, mainly use the cost-benefit analysis method [1, 2] to evaluate the environmental and resource value. The research results mainly focus on evaluating the impact of engineering on the regional environment from a qualitative perspective. [3, 4] and environmental economic profit and loss method [5]. There is less comprehensive evaluation of economic, environmental and social benefits.

Therefore, this paper tries to predict from the aspects of economic benefit, environmental benefit and social benefit, and explores how to build the Tianhe Project and the west route of the South-to-North Water Diversion Project to achieve the most remarkable results.

2. Comparison of Difference between the West Route of the South-to-North Water Diversion Project and the Tianhe Project

2.1. Economic benefits

2.1.1. Economic Benefits of the West Route of the South-to-North Water Diversion Project. At present, many scholars have studied the economic benefits of the South-to-North Water Diversion Project. Taking the west route of the South-to-North Water Diversion Project as an example, the project involves three rivers, Tongtian River, Yalong River and Dadu River, the main water transfer plans include three water transfer plans, 4.5 billion m^3, 5 billion m^3 and 14.5 billion m^3. Based on the research results of Tang Meiying et al. [6], the economic internal rate of return(EIRR), the economic net present value(ENPV) and the economic Benefit-Cost Ratio R_0 are used as indicators to conduct national economic evaluation, the following conclusions can be drawn:

Table.1 National economic evaluation of the west route of South-to-North Water Diversion Project

plan	4.5 billion m^3			5 billion m^3			14.5 m^3		
	EIRR	ENPV	R_0	EIRR	ENPV	R_0	EIRR	ENPV	R_0
basic plan	14.99	92.30	1.37	19.63	192.49	2.01	12.95	52.15	1.11
investment increases by 10%	14.12	69.88	1.26	18.63	176.75	1.85	12.16	9.37	1.02
benefit reduces by 10%	13.65	48.81	1.19	18.58	159.03	1.83	11.84	-8.18	0.98
delay 10 years to achieve design scale	13.20	37.64	1.15	17.98	150.44	1.79	11.96	-2.51	0.99
investment increases by 10% and benefit decrease by 10%	12.84	26.39	1.10	17.60	143.29	1.69	11.11	-50.95	0.90

When EIRR ≥ is (social discount rate), ENPV ≥ 0, PV ≥ 0, R_O ≥ 1.0, this plan is economically reasonable. The economic and internal rate of return of the middle route project of South-to-North Water Diversion is 21.6%, which is far greater than the 12% social discount rate; the economic net present value is 18.276 billion yuan, which is far greater than zero; the economic benefit cost ratio is 1.98, which is far greater than 1. The economic internal rate of return of the 4.5 billion m3, 5 billion m3 and 14.5 billion m3 basic plans for the west route project water transfer is 12.95% to 19.63%, the economic net present value is 52.15 to 19.249 billion yuan, and the economic benefit cost ratio is 1.11 to 2.01. Therefore, we can find that the economic benefits of the South-to-North Water Diversion Project are significant.

2.1.2. Input cost and water supply benefit forecast of Tianhe Project. The "Tianhe Project" is expected to achieve transfer 5 billion cubic meters water across the region every year, which is equivalent to the water storage of 500 West Lakes. The weight of 1 cubic meter of water is 1t, the Tianhe Project brings about 5 billion tons of new rainfall to the Yellow River Basin every year. If only the rocket artificial rainfall data of Hebei Province from 2000 to 2004 [7] (four years of total water increase by 4.414 billion

cubic meters, cost 48.515 million yuan) as the reference cost, the prescribed social discount rate of "Economic Evaluation Specification of Water Conservancy Construction Project(SL72-2013) is 6%, in May 2018, the living water price of residents in Xining City, Qinghai Province is 2.71 yuan/m^3 and as standard, and the annual cost of Tianhe Project is 124 million yuan, the revenue is 13.55 billion yuan. Considering that there is no South-to-North Water Diversion Project, the Yellow River Basin will face water shortages every year after 2010, it can be considered that the annual increased 5 billion cubic meters of rainfall all are utilized, and the input-output ratio is 1:109.3, as technology advances, the cost of artificial rainfall will decrease, so the current and future input-output ratios should be higher than this result.

2.1.3. Comparative game between Tianhe Project and the west route of South-to-North Water Diversion Project

1. Comparison of implementation plans

A. Tianhe Project: Artificial means is used to intervene atmospheric water vapor transfer, which requires using a large amount of artificial rainfall technology, and basically does not require the construction of surface or groundwater projects, therefore, the cost is mainly reflected in rockets, drones, and aircraft rainfall, but the implementation difficulty is greater and implementation plans have not been approved.

B. West Route Project: A large number of surface and groundwater projects need to be built, it is also possible to generate a large number of immigrants, the amount of investment is enormous, but there are already technical implementation possibilities., and the implementation plan has been basically determined.

2. Comparison of benefits:

Currently only consider the cost and benefit of domestic water:

A. Tianhe Project: The annual average cost is 124 million yuan, the annual income is 13.55 billion yuan, and the input-output ratio is 1:109.3. The net income is 13.426 billion yuan.

B. West Route Project: Planned year is 2030, but considering the fact that the first stage of this project, which should have started construction in 2010, has not yet begun, we extend the time to 2040, assuming construction time is 2020, totally 20 years. . The third stage of the project plans to invest (static) 744.8 billion yuan, the average annual investment (static) 14.9 billion yuan, but the annual net economic benefit is expected to reach 243.3 billion yuan, the input-output ratio is about 1:17.3.

3. Comparison of advantages and disadvantages:

A. Tianhe Project: The advantage is that if the technology is feasible, it will have a smaller cost and a larger input-output ratio, and does not require large-scale construction of water conservancy projects, which has less impact on the people's livelihood. The disadvantage is that the absolute amount of economic benefits is relatively small, and it is difficult to predict the impact on the environment, but compared with the South-to-North Water Diversion Project, this loss is negligible.

B. West Route Project: The advantage is that it is technically executable and has huge benefits, the time from loss to profit is short, and it can produce huge effects in a short time. The disadvantage is that the project volume is huge and the construction difficulty is high, and a large number of ecological immigrants may be generated, and the input cost is extremely high, according to the input comparison, the absolute value of this part of the loss is recorded as k. But 2433-k>134.26, If neither project is implemented, the absolute value of the loss recorded is m, m > k.

4. Analysis of results

Table 2. Comparison game between the Tianhe Project and the West Route of the South-to-North Water Diversion Project

	implement the west route	without implementing the west route
implement "Tianhe Project"	(134.26, 2433-k)	(134.26, 0)
without implementing "Tianhe Project"	(0,2433-k)	-m

Note: The left side of the bracket is the net benefit of the Tianhe Project, and the right side is the west route project; unit: 100 million yuan / year

a. (134.26, 2243-k): Both projects are constructed, and there will be a superposition of benefits, however, due to the order reasons of starting the project, they will not be generated at the same time, in the short term, the benefits of the west route project are the greatest, by contrast, the benefits of the "Tianhe Project" are relatively small.

b. (134.26,0): Only the Tianhe project is constructed, which will produce stable but small benefits; it can be used as a solution to solve the problem of local water shortage in a short time.

c. (0,2433-k): Only the west route project is constructed, there will be great benefits in the short term, and the long-term benefits are also considerable, but it is not guaranteed that it will always produce stable and huge benefits.

d. -m: If both projects are not built, there will cause losses.

On the whole, the benefits of the "Tianhe Project" are smaller, therefore, the Tianhe Project can be used as an auxiliary means for the South-to-North Water Diversion Project, it can solve the problem of local water shortage in a short time, but it is not suitable as a long-term solution to the shortage of water resources in north China, the South-North Water Diversion Project is still needed to play a major role. Therefore, the South-to-North Water Diversion Project is the main, supplemented by the Tianhe Project.

2.2. Analysis of environmental benefits

2.2.1. Environmental Benefits of the West Route of the South-to-North Water Transfer Project. For the water transfer area, the laying of the water transfer route will cause damage to the vegetation on both sides of the road; moreover, the water transfer area is located in the Kekexili-Jinsha River seismic belt in the southeast of the Qinghai-Tibet Plateau, the construction may cause geological disasters such as debris flow and landslide.

For the intake area, the severe water shortage of the Yellow River causes downstream to frequently dry up, the contradiction between supply and demand is intensified, and the ecological environment is deteriorating. In the middle and upper reaches of the Yellow River, natural precipitation is small; evaporation is large, drought and water shortage, in the past years, artificial planting of grass and trees has achieved little; its fundamental reason is the lack of necessary water resources. The west route project of South-to-North Water Diversion Project introduced water into Northwest China, which not only solved the problem of water shortage to a certain extent, but also increased vegetation, thus contributing to containing land desertification.

2.2.2. Environmental benefits of Tianhe project. If the Tianhe project is implemented, it can increase vegetation and improve the agro-ecological environment; control soil erosion and reduce the amount of yellow mud; and desertification can be effectively contained. In addition, after the implementation of the west route of the South-to-North Water Diversion Project, the water volume in all sections of the Yellow River has generally increased. With the implementation of the water transfer project, the development of groundwater is promoted, the self-purification of water quality is improved, the original area of over-exploited groundwater has been changed to use the Yellow River water, so that the area where the groundwater level is lowered year by year will be restored, and the environment will naturally

be improved. The implementation of the "Tianhe Project" further increases the possibility of achieving the above objectives.

2.3. Analysis of social benefits

On the whole, the implementation of the two major projects will bring huge social benefits to the west are. Two projects can increase agricultural and industrial water supply in the northwest area, promote economic development in the northwest area, and narrow the gap between the east and the west. Economic development will speed up the speed of urbanization, improve people's living standards, and increase employment opportunities, including meteorological monitoring stations, while facilitating the transfer of human resources to the west.

In summary, the Tianhe Project and the west route project of the South-to-North Water Diversion Project can bring enormous environmental and social benefits to the northwest area. In economic benefits, the short-term benefits of the Tianhe project are more outstanding, and the long-term benefits of the South-to-North Water Diversion Project are more significant, therefore, the South-to-North Water Diversion Project should be the mainstay and the Tianhe Project should be supplemented to achieve maximum economic benefits.

3. Policy Suggestions

3.1. Problems in the Tianhe Project

Although the Tianhe Project can bring greater economic, environmental and social benefits, the realizability of Tianhe Project still have question, and there are unresolved barriers both in terms of technology and cost. Because the project has not been completed, damage of the project to the destination of raw water vapor transfer is not yet clear, the realization degree of the rights and expected effects of local residents are unknown. In addition, people intervene in normal atmospheric water vapor transfer, and it may lead to imbalance of ecological structure, and problems related to sustainable development remain to be resolved.

3.2. Policy suggestions

In the implementation process of project, the government should consider how to balance the rational allocation of water resources in the north and south, how to alleviate the contradiction between the original water vapor transfer destination and the project intake area, how to ensure water resources security, how to rationally arrange the distribution of water resources in urban water supply, agricultural irrigation, industrial production and so on, how to promote the development of water-saving projects, water cycle projects.

Based on the above research, this paper proposes the following policy suggestions:

1. Balance the relation between supply and demand of water, consider the situation of the whole water vapor transfer channel of "Tianhe", and achieve water supply as much as possible within the reasonable water intake range.
2. Reasonably allocate water transfer to avoid disasters such as mudslide;
3. Ensure the safety of water supply and water use, and do a good job in prevention and control of atmosphere, landmark and groundwater pollution;
4. Implement supply-side reforms and rationally regulate water pricing level.

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