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Article

Desertification and Its Mitigation Strategy in China

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Abstract: China is severely impacted by desertification. Of its territory, 34.6% — some 3.32 million km^2 — is classified as drylands[1)] (including arid, semi-arid and semi-humid arid areas). Of the drylands, 2.62 million km^2 meets the UNCCD definition of desertified land. These desertified lands spread across 18 provinces and account for 27.33% of the country's landmass. Over 400 million residents are affected, causing an annual direct economic loss exceed 64 billion CNY. China's desertification mitigation began in late 1950s. Through a number of high-profile programs – "Three-North Shelterbelt Development Program", "National Program on Combating Desertification", "Sandification Control Program for Beijing and Tianjin Vicinity", and "Croplands to Forests or Grasslands Program" launched between 1978 and 2000, the Government of China has poured on average 0.024% of the country's annual GDP into desertification mitigation and, as a result, some 20% of desertified lands have been brought under control. Approximately 50×10^4 km^2 of the existing desertified lands are considered restorable given current technology. When the potential desertification increments induced by global warming are taken into account, total desertified area within planning horizon is projected to range from 55×10^4 to 100×10^4 km^2. With the approximate restoration rate of 1.5×10^4–2.2×10^4 km^2 y^{-1}, China's anti-desertification battle is expected to last 45–70 years. The current strategic plans set restoration targets at 22×10^4 km^2 by 2015, with an additional 33×10^4 km^2 by 2030, and the final 45×10^4 km^2 of the 100×10^4 km^2 restored by 2050. Through examining state investment in mitigation and current rehabilitation strategies, the paper recommends: (i) boardening the previous sectoral perspective to a multi-stakeholder approach; (ii) setting priority zones within the restorable area, and establishing National Special Eco-Zones; (iii) steering state investment from government investment in tree plantations to acquisition of planted/greened areas; and (iv) introducing preferential policies in favor of sandy land restoration, including extending land tenures to 70 years and compensating for ecological services.

Key words: desertification; monitoring and assessment; national action plan; mitigation strategy

1 Desertification status in China

1.1 Climatic zones and area of potential desertification

Based on UNCCD's desertification definition (CCICCD 1997), China has a total of 3.32 million km^2 that are either arid (1.43 million km^2), semi-arid (1.14 million km^2) or sub-humid arid (0.75 million km^2), covering 34.6% of its territory. The desertification-prone areas in the vast northwestern China cross the east corner of the Qaidam Basin and extend westward to the southwestern edge of the Qinghai-Tibet Plateau. In total, the desertification-prone area encompasses a total of 498 counties (cities, banners) in 18 provinces (autonomous regions, municipalities). In addition, island-shaped hyper arid areas – with a humidity index less than 0.05 and colored in red (Fig. 1), are located in Gansu, Inner Mongolia and Xinjiang, representing a total of 25.3×10^4 km^2, which is equivalent to 2.6% of China's landmass.

1) Dryland refers to the areas of "arid, semi-arid and dry sub-humid areas", other than polar and sub-polar regions, in which the ratio (i.e., HI=humidity index) of annual precipitation to potential evapotranspiration falls within the range from 0.05 to 0.65; this range also lays out the enabling conditions and sets the boundary of the geographic region of potential desertification.

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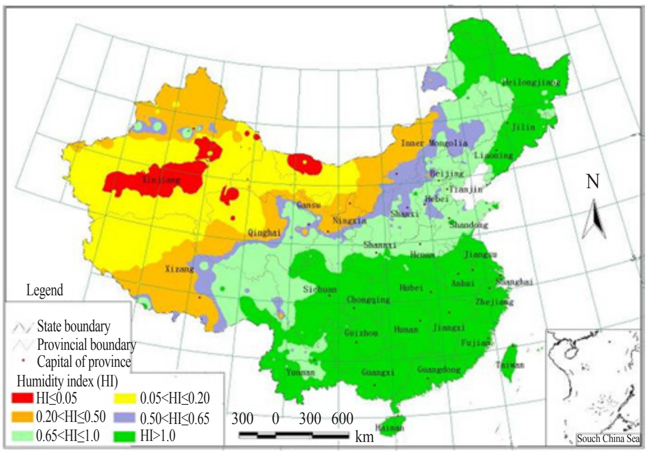

Fig. 1 Desertification climatic zone in China (Ci and Wu 1997).

Desertification causes ecological degradation, induces natural disasters (e.g., dust and sandstorms), and takes a heavy toll on human livelihoods by sharply reducing land availability, lowering soil fertility, and aggravating poverty in the affected areas. Especially, it brings about drastic losses to communication and transportation systems, water facilities and the mining industries. Direct annual economic losses are estimated to exceed 64 billion CNY (Lu and Wu 2002). Statistics shows that approximately 400 million people are affected, resulting in a considerable number of "environmental refugees" and "disaster migrants" in severely affected areas. Severe desertification and sandification[2)] have threatened the ecological security and sustainable economic development. This paper primarily focuses on examining the formation, evolution and control of wind-erosion-induced desertification[3)].

1.2 Mornitoring and evolution of desertification

Survey and observation data began to become available in mid-1950s. Data generated by initial surveys (Desert Control Group 1958) remained patchy and proved too fragmented for macro analyses, and the measurements had been changing as well. Nonetheless, desert expansion as a trend throughout 1950s was revealed. The diversity of sources and the incurred differences in survey scopes, objectives, timeframe, criteria, and emphases have led to a great deal of inconsistency and inherent contradictions in the data. However, of all the available data, a few sets have stood out for their breadth, depth, and influence: Survey on typical categories of deserts and desertification in northern China (late 1950s to early 1980s) conducted by the Lanzhou Institute of Deserts of the Chinese Academy of Sciences; Four times National Desertification Inventory were completed from 1999 to 2009. The major outcomes are listed in Table 1.

The statistics shown in Table 1 reveal data inconsistencies due to different inventory methods and survey scopes adopted at different times. These inconsistencies suggest limited utility of aggregated data, because they shield the dynamics of expansion and dwindling in different regions. Therefore, a time series comparison will not reveal an accurate evolution of the deserts. On the contrary, the changes over time of the major sandified lands may throw some light on the evolutionary history of the desertification process in affected areas.

Desertification mainly occurred in 5 provinces (autonomous regions) (Table 2), whose total desertified area accounts for 95.48% of China's total, while the other 13 provinces (autonomous regions, municipalities) account for the remaining 4.52%.

2 Combating desertification through national programs and projects

2. 1 National programs

Since late 1970s, China has launched a number of high-profile initiatives, including the *Three-North Shelterbelt Development Program* (1979–2050), *National Program on Combating Desertification* (1991–2000), and *Sandification Control Program for Areas in the Vicinity of Beijing and Tianjin* (2001–2010). The *Three-North Shelterbelt Development Program*, widely known as the Great Green Wall, has been recognized as "a great initiative to transform the nature" and "a world wonder of ecological engineering". Its formulation and implementation have been considered to usher in a new era of nationwide forestry development, and the program itself a milestone in forestry collaboration between the civil society and government agencies in China's history. It has also been regarded as a turning point in forestry undertaking using systematic and standardized engineering approaches.

In 2000, the Chinese government has launched a number of large, ecosystem-oriented desertification prevention and control initiatives, such as the *Croplands to Forests or Grasslands Program* (2000–2010) and *National Soil and Water Conservation Program* (2000–2010).

2) Sandy land refers to degraded land characterized by surface sandy materials. Sandy lands can be induced by single or multiple factors under different climatic conditions, thus its distribution is not limited geographically.

3) Four major processes of desertification are present in China: wind-erosion, water-erosion, salinization and freezing-thawing.

Table 1 Major nation-wide surveys on desertification/sandification and their findings.

Year	Survey	Major findings
1974	The first Desert Map of China (1:1 000 000)	China had 1.1 million km^2 of deserts, of which 458 000 km^2 were Gobi deserts
1980	Desert Map of the People's Republic of China (1:4 000 000)	Deserts and sandy lands occupy 712 900 km^2 and the Gobi 569 500 km^2 (Zhong 1980)
1994	First Nation-Wide Sandification and Desertifiaction Inventory & Monitoring	1.71 million km^2 of deserts, desertified and wind-eroded sandified areas, including 483 000 km^2 of deserts, 711 000 km^2 of the Gobi, 320 000 km^2 of wind-eroded croplands, 484 000 km^2 of desertified lands, and 54 000 km^2 of wind-eroded wild land (Zhu *et al*. 1999)
1999	Second Nation-Wide Sandification and Desertifiaction Inventory & Monitoring	1 743 100 km^2 of sandified lands, which include 427 200 km^2 of moving dunes, 201 800 km^2 of semi-fixed dunes, 260 800 km^2 of fixed dunes, 664 000 km^2 of the Gobi, 47 400 km^2 of wind-eroded croplands, 42 300 km^2 of sandified cultivated lands, 99 500 km^2 of bare sandy lands, and 66 km^2 of lands improved through physical engineering means
2004	Third Nation-Wide Sandification and Desertifiaction Inventory & Monitoring	1 739 700 km^2 of sandified land, which included 411 600 km^2 moving dunes, 178 800 km^2 semi-fixed dunes, 274 700 km^2 fixed dunes, 662 300 km^2 Gobi, 64 800 km^2 wind-eroded cropland, 46 300 km^2 sandified sown land, 101 100 km^2 naked bare sandy land, and 96 km^2 physically engineered mitigation land
2009	Fourth Nation-Wide Sandification and Desertifiaction Inventory & Monitoring	China had a total sandified land area of 1 731 100 km^2 (18.03% of the national territory), located in 902 counties (banners, cities) of the 30 provinces (autonomous regions, municipalities). Distribution of different sandification types – shifting sand dunes (lands): 406 100 km^2 (23.46% of the total sandified land); semi-fixed sand dunes (lands): 177 200 km^2 (10.24%); fixed sand dunes (lands): 277 900 km^2 (16.06%); sandy patch land: 99 700 km^2 (5.76%); sandified arable land: 44 600 km^2 (2.58%); wind eroded residual mounds: 8898 km^2 (0.51%); wind eroded inferior lands: 55 700 km^2 (3.22%); Gobi desert: 660 800 km^2 (38.17%); non-biological treated sandy lands: 66 km^2

Table 2 Sandified land in main provinces and autonomous regions (km^2).

Province/ autonomous regions	Zhong Decai (1980)		Zhong Decai (1998)	Zhu Junfeng *et al*. (1999)		Zhou Huanshui *et al*. (2002)		Zhu Lieken (2006)	SFA (2011)
	Desert/ sandy land	Gobi	Desert/ sandy land	Desert	Sandy land	Desert	Sandy land	Sandified land	Sandified land
Xinjiang	420 000	293 000	438 100	658 538.2	110 666.39	658 538.2	110 666.39	746 283	746 700
Inner Mongolia	213 000	188 000	227 900	159 167.56	91 342.71	159 167.56	91 342.71	415 936	414 700
Tibet	—	—	8860	187 133.49	26 261.81	187 133.49	26 261.81	216 843	216 200
Qinghai	38 000	37 000	19 390	84 615.83	31 656.46	84 615.83	31 656.46	125 583	125 000
Gansu	19 000	49 000	30 530	113 356.05	29 023.42	90 870.66	25 819.98	120 346	119 200

2.2 National action plan to combat desertification: nationwide blueprint

The *National Desertification Prevention and Control Plan* (2005–2010) approved by the State Council provides a vision and the guiding principles for combating desertification: through prioritizing prevention, active rehabilitation, and proper utilization, to bring under control the restorable desertified lands in 50 years. Overall, 13 million ha are targeted. The goal is to reverse the trend of deterioration in at least 60% of total restorable lands, particularly in the priority areas, by 2030. The entire rehabilitable lands will be brought under control by 2050. The Plan also specifies the following key strategies (Table 3).

(1) Prioritized regions: the Plan sets key regional demonstration programs in 5 major regions and 15 sub-regions to gather success stories and showcase best practices for other areas.

(2) Tiered management objectives in key programs: prevention (access ban, establishing nature reserves, ecological migration, etc.), comprehensive rehabilitation (integrated physical, chemical and biological approaches), and effective utilization (husbandry, plantation, product processing, etc.).

(3) Coordinated restoration and development in program implementation: (i) integrate poverty alleviation, sectoral development and regional economic development; (ii) incorporate proper water resource usage, agriculture and animal husbandry.

3 Desertification trends and rehabilitation projections

3.1 Projection of future desertification trends

Research findings by glacial scientists suggest that temperature rise and rainfall increase in North China and

Table 3 National roadmap and blueprint on combating sandification.

Rehabilazation arrangements		Priority/pilot rehabilazation programs/projects in typical areas
Eco-rehabilazation regions	15 sub-regions	
I-Desert margin and oasis in arid area	I-1 Taklimakan Desert	1 Phase II of the Sandification Control Program for Areas in the Vicinity of Beijing and Tianjin
	I-2 Gurban Tonggute Desert	2 Phase IV-V of the Three-North Shelterbelt Development Program.
	I-3 Hexi Corridor and Alex Plateau	3 Sandified Grassland Control Program (Phase II)
	I-4 Some humid sandyland	4 Soil and Water Conservation Program
II-Sandy-land in semi-arid area	II-1 The vicinity of Beijing and Tianjin	5 Conversion of Croplands to Forests Program
	II-2 Korqin Sandy Land	6 Conversion of Pasture to Grassland Program
	II-3 Mu Us Sandy Land	7 Afforestation Project for Areas in the Vicinity of Lhasa City, Tibet
	II-4 Hulun Baier Sandy Land	8 Ecological Restoration project in Hetian, Xinjiang
III-Sandified land in Qinghai-Tibet Plateau	III-1 Qaidam Basin Desert	9 National Pilot Areas of Integrated Anti-Sandification
	III-2 Gonghe Basin Desert	10 Pilot Areas of Integrated Anti-Sandification along the Old Beds of the Yellow River
	III-3 Sandylands of river valley in Tibet	11 Pilot Areas of Integrated Anti-Sandification in Southern China
IV-Sandy-land in semi-humid and dry semi-humid areas	IV-1 Sandified lands between Yellow and Huai Rivers	12 Integrated Rehabilitation Project in Shiyanghe/Minqin Basin, Gansu Province
	IV-2 Sandified lands between Yellow and Hai Rivers	13 Integrated Rehabilitation Project around Qinghai Lake, Qinghai Province
V-Humid sandy-land in Sourthern China	V-1 Coast Sandy-lands	14 Natural Conservation and Rehabilitation in the Headwater Areas of Yangtze River, Yellow River and Lancangjiang River
	V-2 Sandy-lands along middle/low Yangtze River	
	V-3 Sandylands in river valley of Southwestern China	

the Qinghai-Tibet Plateau are highly correlated. Relevant research results indicate that the average temperature increase from 1960s to 1980s in the Qinghai-Tibet Plateau, northwestern China, and northeastern China is 20% higher than that of the entire northern hemisphere. The same study predicts that by 2050 the Qinghai-Tibet Plateau and northern China will altogether experience a temperature rise of 3°C. Precipitation in those regions will rise too. However, given other conditions, the increase in evaporation will exceed the increase in precipitation; the climate will become drier. The rise in temperature will expedite the thawing of glaciers. It is estimated that China will lose 30%–76% of the surface areas and volume of its existing glaciers in 21st Century. This glacial retreat will bring about a visible increase in inland river runoff and contribute to the preservation or even expansion of the oases in the lower reaches or along river banks. However, such a positive influence is trivial for the vast desertified areas (Su *et al*. 2006).

(1) Lu Qi *et al*. (2004) amended the Qinghai-Tibet bioclimatic classification system and classified 37.3% of China's landmass as desertification-prone, a net increase of 2.7% (nearly 260 000 km^2) from the previous 34.6%.

(2) Ci *et al*. (2002) predicted the bioclimatic change under different climate scenarios using base data from 1914 meteorological stations across the country. The prediction provided quantitative evidence for the "responses" from desertification to climate change. The result shows that the total area of all desertification-prone bioclimatic zones (DBZ) tends to increase. Compared to 3 956 581 km^2 of DBZ in 1990, in the event of 1% annual GHGs increase with sulphate aerosol effect, DBZ area will increase by 11.33% by 2030 and 12.94% by 2056; whereas in the event of 0.5% annual GHGs increase with sulphate aerosol effect, the area is expected to increase by 3.75% by 2030 and 6.95% by 2056. If annual GHG increase is kept at 0.5% through abatement measures, the rate of DBZ increase will likely slow down, but the total amount in increase will still be significant.

3.2 Investment and outcome projections

Of the total desertified land in China, 500 000–550 000 km^2 is considered restorable or rehabilitable based on existing knowledge and prevailing technology. Plus the projected increments of up to 450 000 km^2 due to global climatic changes, a roadmap and strategy for combating desertification in China may follow this preliminary schedule of restoration: (i) 220 000 km^2 by 2015; (ii) an additional 330 000 km^2 by 2030; and (iii) the final 450 000 km^2 by 2050. To successfully follow this schedule – and on the rather optimistic assumption that desertification would not expand further in future – the breadth of control measures and the timeliness and scale of financial investment need to be adequate.

Even under this optimistic assumption, if restoration were to proceed with the pre-1990 speed – approximately 80 000 ha y^{-1}, it would take 3275 years to turn over the restorable lands, assuming sustained results; the number of years would come down to 244 if the restoration rate is maintained at the level attained during the 8th Five-Year Plan period (1991–1995), i.e., 1.07 million ha y^{-1}. In light of these scenarios, it will be unrealistic to expect a quick cure for desertified lands. Furthermore, current anti-desertification initiatives have been designed for the areas with relatively favorable conditions, and consequently much progress has been made in areas where natural conditions were less harsh.

Traditionally, the limited restoration funds were spread rather thinly across vast areas; consequently, the mitigation effectiveness was low. The "Three-North Shelterbelt Development Program", for example, targets at 551 counties but infuses merely 69.1 million CNY y^{-1}. On average, each county would receive 122 000 CNY, or 45–47 CNY ha^{-1}. The "National Combating Desertification Project" targets at 598 counties but had an allocation of 110 million CNY (data of the 8th Five-Year Plan period), which equals to an average annual funding of 40 000-50 000 CNY per county, or 34.5–42 CNY ha^{-1}.

In comparison, the cost of plantation or revegetation in desertified areas was 225 CNY ha^{-1} in 1980s, 750 CNY or as high as 1500–3000 CNY ha^{-1} (in relatively developed regions) in 1990s. The gap between allocated funding and actual needs has widened. In practice, the allocated funds cannot even cover the cost of site preparation. Investment inadequacy has undermined the incentive for public participation and threatened maintenance and post-plantation caring of the rehabilitated areas. Lasting effects are hard to achieve under such investment regime.

To obtain a realistic expectation of restoration effects by mid-21st Century, the following paragraphs examine the relationships between economic growth, fiscal spending on forestry and major anti-desertification programs, and attempt to project the cumulative effects of restoration till 2050.

It appears reasonable to assume that when an economy matures and when the total investment in forestry reaches a certain level, the percentage share of forestry investment in GDP will stabilize. Therefore, forestry investment levels may be projected in relation to China's estimated GDP in the coming years.

Nevertheless, projecting China's growth for the next half of century is by no means easy. Its sustained growth in the past one-third of a century has not yet been fully explained by development economics theories. This task has been further complicated by the recent financial turmoil. However, the major objective here is not to open yet another development economic debate, but to build scenarios illustrative of key aspects of the situations, rather than establishing precise models of them.

Across the diverse voices and schools of thoughts, projections of China's future converge on prospects of further significant growth. In the Goldman Sachs' 2003 *Dreaming with BRICs: the Path to 2050*, a projected gradually decreasing real GDP growth rate from 2000's 8.0% to 2050's 2.7% has been estimated. According to this projection, China's GDP (in 2003 USD) will increase from 1078 billion USD in 2000 to 44 453 billion USD

Table 4 Investment and Restoration Projection (from 2005 to 2050) – Scenario: Realistic Optimism.

Year	Projected real GDP growth	GDP (1978 price)	Forestry investment	Forestry investment rate (%)	Invested into programs	As % of forestry investment	Areas restored (ha)	Cost (CNY ha^{-1})	Total area restored (ha)	Targets (ha)	Gap from target (ha)
2015	5.2	2236.9	7.4	0.33	4.9	67	196 589	2516	**1 470 116**	**22 000 000**	**20 529 884**
2020	5	2852.2	10.8	0.38	7.5	69.5	258 276	2917	2 633 279	–	–
2025	4.2	3557.6	15.3	0.43	11	72	325 767	3381	4 130 226	–	–
2030	3.9	4340.8	20.8	0.48	15.5	74.5	396 036	3920	**5 969 089**	**55 000 000**	**49 030 911**
2035	3.9	5240.8	26.2	0.5	19.7	75	432 520	4544	8 088 201	–	–
2040	3.7	6327.3	31.6	0.5	23.7	75	450 446	5268	10 306 419	–	–
2045	3.3	7514.8	37.6	0.5	28.2	75	461 483	6107	12 595 615	–	–
2050	2.7	8652.7	43.3	0.5	32.4	75	458 353	7079	**14 897 209**	**100 000 000**	**85 102 791**

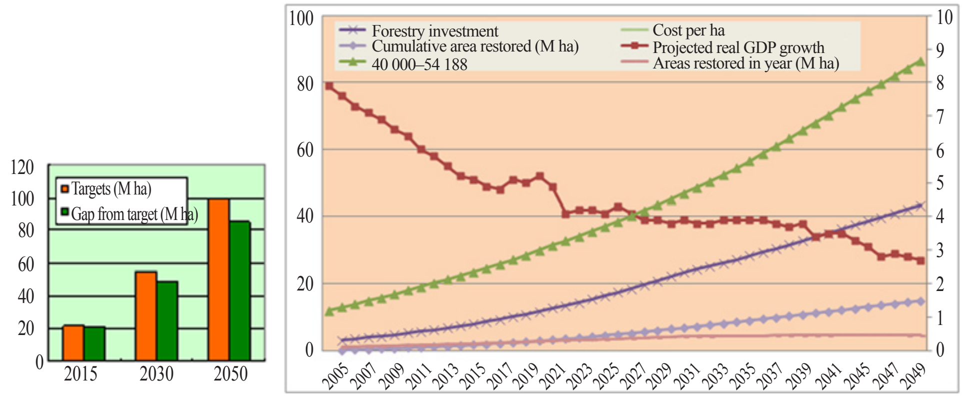

Fig. 2 Investment and Restoration Projection (2005 to 2050) – Scenario: Realistic Optimism.

and overtake the United States to become the largest economy in the world. Criticisms have emerged that this analysis has already underestimated the observed growth from 2000 to present, and the projection is understated – it predicts growth falling far below for example what Japan had experienced when catching up with the western GDP per capita. Nonetheless, the long-term trend line could remain largely valid. And there are many uncertainties and assumptions in the BRIC thesis, which could mean that any or all of the discussed countries – China included – will not live up to their promises. Combining these considerations, we will use Goldman Sach's projected growth rate together with the above analysis to first build a scenario of optimistic outlook for combating desertification and reversing land degradation.

Under this scenario, state investment in forestry will increase from the current 0.23% to 0.50% of total GDP on an annual basis and stabilize at the level of 0.50% in 2032. Assuming no launching of newer combating desertification programs, the total investment in the existing three programs will gradually increase from 62% of the total state forestry investment and stabilize at 75% by 2031. The cost of restoration per hectare will increase at an annual rate of 3%, considering the gradual increase in difficulty of restoration, as less severely desertified areas will likely be restored early on. The 2005 cost per hectare is the weighted average from the three major programs using their investment levels and area restored during the 10th Five-Year Plan period (2001–2005).

Given the total 2 636 200 km^2 of desertified areas in China (2004 data) and 1 million km^2 of land to restore, the results of projection are shown in Table 4 and Fig. 2.

Table 4 and Fig. 2 indicate that even under an optimistic outlook for national investment to combate desertification, the expected results will leave 850 000 km^2 of the 1 million km^2 of the restorable land untamed, falling far short of the planned restoration targets of 220 000 km^2 by 2015, an additional 330 000 km^2 by 2030, and the final 450 000 km^2 by 2050.

Then, if the 1 million km^2 restorable land were to be restored, what would be the necessary annual investment level, and how big a share of the projected GDP would it take? Table 5 and Fig. 3 show that holding the total investment of the three programs as a percentage of the total state forestry investment and the restoration cost per ha unchanged from the previous scenario and altering the annual level of state investment in forestry (and thus changing the percentage of forestry investment to GDP), to successfully restore the entire 1 million km^2 restorable land by 2050, it would require an annual input that is 6.7 times what has been considered in the "realist optimistic scenario" as exhibited above, and the share of state forestry investment to GDP would mount to 1.61% in 2006 (which is not what has been observed) and reach 3.36% by 2032 and stay at that level thereafter until 2050. However, even under this model with aggressive (and unrealistic) initial investment levels, the results fall short of the planned restoration targets for the year 2015 and 2030 as interims.

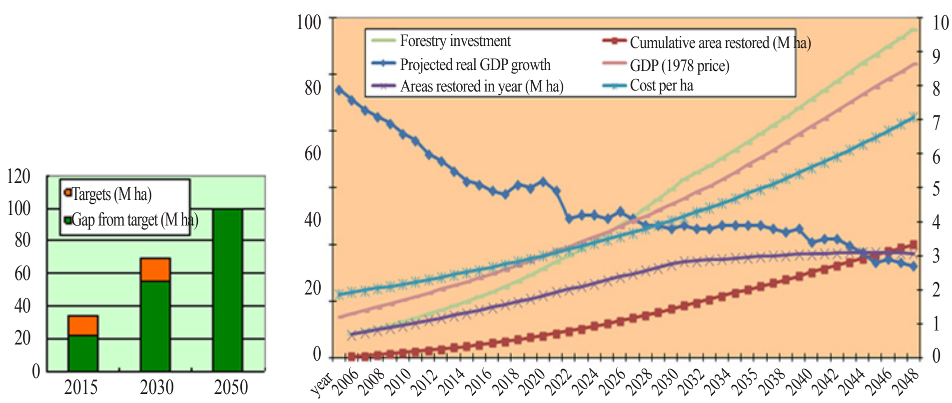

Fig. 3 Investment and Restoration Projection (2005 to 2050) – Scenario: Finding the "Internal Level of Investment".

Table 5 Investment and Restoration Projection (from 2005 to 2050) – Scenario: Finding the "Internal Level of Investment".

Year	Projected real GDP growth	GDP (1978 price)	Forestry investment	Forestry investment rate	Invested into programs	As % of forestry investment	Areas restored	Cost (CNY ha^{-1})	Targets (ha)	Gap from target (ha)
2015	5.2	2236.9	49.6	2.22%	33.2	67	1 319 635	2516	22 000 000	12 131 599
2020	5	2852.2	72.8	2.55%	50.6	69.5	1 733 720	2917	–	–
2025	4.2	3557.6	102.7	2.89%	73.9	72	2 186 769	3381	–	–
2030	3.9	4340.8	139.9	3.22%	104.2	74.5	2 658 460	3920	55 000 000	14 931 496
2035	3.9	5240.8	175.9	3.36%	131.9	75	2 903 360	4544	–	–
2040	3.7	6327.3	212.4	3.36%	159.3	75	3 023 692	5268	–	–
2045	3.3	7514.8	252.2	3.36%	189.2	75	3 097 778	6107	–	–
2050	2.7	8652.7	290.4	3.36%	217.8	75	3 076 769	7079	100 000 000	0

4 Mid- and long-term disaster reduction strategy: institutional arrangements and policy recommendations

4.1 Establishing special ecological zones and zero-access reserves

China's extended northwestern borderline has been an important sand shield belt. In western China, state-owned forest farms, nurseries and sand control stations, and experimental and demonstration stations in desertified areas constitute the main science and technology capacities in desertification prevention and mitigation initiatives. However, many research initiatives have been constrained by insufficient funding, and key technical issues remain unresolved, such as water-saving techniques, improved selective seed breeding, and pest control. Many seed production and seedling nurseries are at stake. In some cases, employee salaries have not been paid on time, let alone technical support for program implementation. Establishing special ecological zones and zero-access reserves are keys to the implementation of many initiatives.

4.2 Establishing specialized rehabilitation forest farm companies

The outbreak of yellow-spotted and Asian long-horned beetles in recent years have devastated massive protective forests and brought drastic losses to local agricultural production in northwestern China. In the Ningxia Plain, the pest outbreaks have forced the removal of many shelterbelts, resulting in the decline of crop yields by 20%–30%. Such outbreaks are illustrative of the presence of unsustainable interventions caused by croplands expansion due to pressures on forest farms to reduce seedling nurseries for cereal production on many anti-desertification sites. Specialized rehabilitation forest farm companies need to be established to overcome some of the operational and implementation difficulties mentioned above.

4.3 Legislation of preferential policies for combating desertification

A number of preferential anti-desertification and restoration policies, such as concessional loans with interest rate discount, fee waive for sandy land uses, and tax exemption for development projects on sandy lands, have been issued. However, many of these policies need renewal and updates to address the current needs:

(1) Provision of financial assistance. The desertified land rehabilitation poses high demand in financial assistance. The central government's budgetary allocations for various purposes – poverty alleviation, and agriculture, forestry, animal husbandry, water resources and energy sector development – should be combined and coordinated to enhance the intensity and enlarge the scale of the investment.

(2) Tailored concessional loans. Loan tenors should be designed to synchronize with the project cycle. For example, the loan tenors for fruit plantations should be extended to 8–15 years to reflect the longer investment period. The loan-granting conditions and procedures should be simplified and the existing mortgage requirements be relaxed.

(3) Reforming land tenure and property rights systems. Communities, civil society groups, private individuals and foreign enterprises should be encouraged to contract rehabilitation and development of desertified lands. A tenure system that allows the contributor to get the spoils should be formally institutionalized for stable land tenure (50–70 years) that allows for auctions, leasing, inherence, and transfer of the titles.

(4) Introducing tax breaks. Forestry has a longer production cycle compared to agriculture. The tax-free period for the "special agriculture-forest-products taxes" should be extended and the tax rates should be lowered.

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中国的荒漠化及其防治策略

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摘 要：中国作为世界上受荒漠化影响最为严重的国家之一，旱地面积约332万km^2（占国土面积的34.6%，包括干旱区、半干旱区和亚湿润干旱区），其中超过262万km^2 归属联合国防治荒漠化公约定义的“荒漠化土地”；主要分布在全国18个省、区、市。超过4亿人生活在荒漠化地区，每年因荒漠化造成的直接经济损失超过640亿元。中国治沙的实践可以追溯到20世纪50年代。特别是最近30年，先后通过“三北防护林”工程（1978年启动）、全国防沙治沙工程（1990年启动）、环京津风沙源治理工程和退耕还林还草工程（2000年启动）等一系列国家级生态治理工程的实施，以年均0.024% GDP的投入、治理和修复了大约20%的荒漠化土地。目前，以现有技术评估，可治理的沙化土地约有50×10^4 km^2。考虑到全球变暖的影响，预测未来50年需要治理的荒漠化土地面积大致在55×10^4–100×10^4 km^2 之间。若按照每年1.5×10^4–2.2×10^4 km^2 的治理速度，大约需要45–70年之久。规划安排到2015年治理完成22×10^4 km^2、到2030年治理面积新增33×10^4 km^2，到2050年治理完成45×10^4 km^2。基于国家生态修复投资战略的总体安排，未来防沙治沙决策应从以下四个方面着眼：一是强化多部门协作的综合治理；二是确立优先治理区，并在适当地方建立“生态特区”；三是改变投资模式，由目前政府直接投资植树改为投资买林、买绿；四是完善土地承包制度（70年权属不变）和实行生态补偿。

关键词：荒漠化；防治评估；治理规划；战略对策