

## **ECO-COMPENSATION MECHANISM FOR THE SAYU RIVER BASIN**

### **I. INTRODUCTION**

1. The Yudong Reservoir of the Sayu River is the only centralized drinking water source for Zhaotong City's 600,000 people, with this population estimated to grow to 1.0–1.5 million as based on the Zhaotong City Government's (ZCG) development plan. Rural domestic wastewater, solid waste, human and animal wastes, high sediment runoff caused by soil erosion, and agriculture-related nonpoint source (NPS) pollution pollute the water in the Sayu River Basin due to inadequate waste management. Proactive measures are thus needed to improve and ensure the Yudong Reservoir's long-term water quality and eco-compensation is envisioned to play an important role in facilitating such measures.

2. Ecological compensation, or eco-compensation, is an important policy concept in the People's Republic of China (PRC) which targets improvements in financial flows and incentives for conservation and restoration, especially regarding ecosystem services. It strengthens environmental monitoring; adopts performance-based compensation; develops more integrated cross-sector, and cross-regional management; identifies key stakeholders, and engages them in planning and decision making; and broadens and diversifies funding sources for conservation so as to better align incentives for services delivery.

3. There is a strong pre-existing eco-compensation mechanism in Zhaotong. The ZCG has a keen interest in utilizing the Asian Development Bank's (ADB) support to strengthen the eco-compensation mechanism by adopting international best practice, where feasible. There is a potential to scale up the eco-compensation mechanism to numerous other rivers in Zhaotong and other areas.

4. The Yunnan Sayu River Basin Rural Water Pollution Management and Eco-compensation Demonstration Project is in a strong position to help strengthen and refine the eco-compensation mechanism for the management of water quality in the Yudong Reservoir of the Sayu River, with potentially positive institutional spillover effects for management of other rivers in Zhaotong and other areas.

### **II. CURRENT CHALLENGES**

5. The Sayu River is a tertiary tributary of the Yangtze River, with length of 186 kilometers. The Sayu River Basin, at 3,558 square kilometers, is currently the only centralized drinking water source in Zhaotong for about 600,000 people. Urban drinking water is primarily provided from the Yudong Reservoir that was constructed in 1998. With a drainage area of 709 square kilometers and a total storage capacity of 364 million cubic meters (m<sup>3</sup>), the Yudong Reservoir is a large-scale Class-II reservoir for the provision of a comprehensive range of services, including urban water supply; agricultural irrigation; hydropower; aquaculture; flood control; disaster reduction (e.g., drought); and industrial water supply.

6. Rural domestic wastewater, solid waste, and human and animal wastes pollute the water in the Sayu River Basin due to inadequate waste management. Rural domestic wastewater and solid waste contribute to 27% of the chemical oxygen demand (COD), 9% of the total nitrogen (TN), 16% of the total phosphorus (TP), and 22% of the ammoniacal nitrogen (NH<sub>3</sub>-N); human and animal wastes contribute to 39% of the COD, 25% of the TN, 52% of the TP, and 48% of the NH<sub>3</sub>-N; high sediment runoff caused by soil erosion contributes 34% of the COD, 21% of the TN, 11% of the TP, and 18% of the NH<sub>3</sub>-N; and agriculture-related NPS pollution contributes 45% of

the TN, 21% of the TP, and 12% of the NH<sub>3</sub>-N; in the Sayu River.<sup>1</sup>

### III. PREEXISTING ECO-COMPENSATION MECHANISMS

#### A. Relevant Domestic Developments of Eco-compensation

7. An important background of the development of eco-compensation mechanisms in Zhaotong is that many other areas in the PRC are developing eco-compensation mechanisms for water source protection using a range of approaches and funding sources and based on the principle of “those who benefit should compensate.” Many of these use a portion of water fees to contribute to special funds for water source protection. Since downstream beneficiaries are clearly identifiable and relatively concentrated, eco-compensation mechanisms are relatively easy to establish and maintain. Numerous local governments across the PRC have developed eco-compensation mechanisms since 2002.

8. Provinces where eco-compensation mechanisms have been established include Fujian, Guangxi, Henan, Liaoning, Sichuan, and Zhejiang. One exceptional eco-compensation mechanism is an arrangement between the Anhui and Zhejiang provinces for protection of the Xin’an River Basin in Anhui Province. This arrangement was more challenging to develop since it involves a trans-provincial basin and required national government intervention.

#### B. Zhaotong District- and County-Level Horizontal Eco-Compensation Mechanism

9. On 27 December 2018, the ZCG established a district- and county-level horizontal (i.e., between same levels of local governments) eco-compensation mechanism. About 14 horizontal eco-compensation agreements, covering 17 river sections across Zhaotong’s one district, one county-level city, and nine counties, were signed by the district and county governments. Each agreement is for 1–3 rivers crossing the border either between the district and a county or between two counties. Compensation is paid based on water quality at the border. The evaluation leading group chaired by the Mayor of the ZCG makes decisions and coordinate for the 14 agreements. The Zhaotong City Environment and Ecology Bureau (EEB) in collaboration with the Zhaotong City Finance Bureau manages the 14 agreements, following the evaluation leading group’s decisions and instructions (the office of the evaluation leading group is in the Zhaotong City EEB).

10. One of the 14 agreements, which was signed by the Zhaoyang District Government (ZDG) and the Ludian County Government (LCG), is for the Longshu River in the Sayu River Basin and two other rivers (Nuilan and Zhaolu Rivers) outside the Sayu River Basin. The trial implementation period of the eco-compensation under the agreement is from 2018 until 2020, with 2017 as the base year; but will be extended.

11. Targets stipulated in the agreement are that water qualities of the Longshu, Nuilan, and Zhaolu Rivers meet Class III, II, and IV national water quality standard, respectively. Indicators to used are permanganate index, the TN, and the TP. Each of the ZDG and LCG provides Chinese yuan (CNY)2.0 million every year (CNY4.0 million in total every year); and CNY2.4 million and CNY1.6 million are allocated to the LCG and ZDG, respectively. At the border of the Zhaoyang District and the Ludian County, water qualities of the Longshu River and two other rivers are measured every month (36 monitoring data/year). Every year, CNY2.4 million multiplied by the ratio of monitoring data number which did not meet the standard agreed between the LCG and ZDG is deducted from the LCG and added to the ZDG.

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<sup>1</sup> China Urban Construction Research Institute Limited. 2018. *Application of ADB Loan: Yunnan Sayu River Eco-Compensation Demonstration Project–Project Proposal*. Beijing.

### **C. Fund for Ecological Restoration and Remediation**

12. Since 2015, CNY17 million/year has been collected for ecological restoration and remediation of the primary and secondary water source protection areas of the Yudong Reservoir (CNY8 million from the ZCG, CNY5 million from the ZDG, CNY2 million from the LCG, and CNY2 million of water resources utilization fees from downstream Baoho hydropower station).

13. The Yudong Reservoir Water Resources Protection Committee (YWPCO) comprise its chair, the Mayor of the ZCG; and its members: Directors General or Deputy Directors General of over 30 agencies of the ZCG, including Development and Reform Committee, Finance Bureau, Natural Resources Bureau, Water Resources Bureau, the EEB, Housing and Urban–Rural Development Bureau, Agriculture and Rural Bureau, and Forestry and Grassland Bureau. The YWPCO determines how to use CNY17 million every year; and with 15 permanent full-time staff, manages the fund, following the committee’s decisions.

## **IV. PROJECT INTERVENTIONS**

### **A. Implementation of the Zhaoyang–Ludian Horizontal Eco-Compensation Agreement**

14. The implementation of the Zhaoyang–Ludian horizontal eco-compensation agreement has not commenced yet. Detailed plans for the implementation of the agreement is still being formulated.

15. To support the implementation of the Zhaoyang–Ludian horizontal eco-compensation agreement, the project will construct one water quality monitoring station in the Longshu River at the border between the Zhaoyang District and the Ludian County. The project will also provide consulting services for the implementation of the agreement, including capacity development of staff of relevant government agencies for operation and maintenance (O&M) of the constructed station.

### **B. Establishment and implementation of Town- and Township-Level Horizontal Eco-Compensation Mechanisms**

16. Under the project, six new town- and township-level horizontal eco-compensation agreements will be concluded between the Leju and Sujia townships and the Sayu Town in the Zhaoyang District and the Longshu, Shuimo, and Xinjie towns in the Ludian County. In each of of the Zhaoyang District and the Ludian County, (i) the governor will chair a leading group on eco-compensation that makes decisions and coordinate the agreements; (ii) the office of the leading group will be established in the EEB; and (iii) the Finance Bureau in collaboration with the EEB will manage the agreements, following the leading group’s decision and instructions.

17. To support the implementation of two out of the six new town- and township-level agreements, the project will construct two water quality monitoring stations in the Longshu River at the borders between the Longshu and Xinjie towns in the Ludian County and between the Longshu and Shuimo towns in the Ludian County. For the implementation of the other four agreements, water quality monitoring will be conducted at existing monitoring stations or by field sampling. The project will also provide consulting services for the implementation of six new town- and township-level agreements, including capacity development of staff of relevant government agencies for the O&M of the constructed stations.

### **C. Establishment and Implementation of an Eco-Compensation Fund**

18. Horizontal eco-compensation mechanisms are agreements between governments, with weak involvement of ecosystem services providers and beneficiaries. More effective management of upper basin areas requires a clearer articulation and strengthening of the linkage and value flow between ecosystem service providers (e.g., upper basin governments, communities, and land users) and ecosystem beneficiaries (e.g., downstream urban and rural water users).

19. While the horizontal eco-compensation agreements are good starting-point to better incentivize good upper basin management and cost-sharing between upstream and downstream governments, compensation amounts to upstream governments are small and insufficient for needed interventions in the upstream areas. Under the Zhaoyang–Ludian horizontal eco-compensation agreement, the LCG receives only CNY0.4 million per year from the ZDG, if all 36 monitoring data in the year meet the standard; not only for the Longshu River in the Sayu River Basin, but also for the two other rivers outside the Sayu River Basin. A fund to strengthen available funding for interventions in the upper basin is needed.

20. Under the project, an eco-compensation fund will be established by improving the existing fund for ecological restoration and remediation of the primary and secondary water source protection areas of the Yudong Reservoir (paras. 12–13). The eco-compensation fund will complement the horizontal eco-compensation mechanisms by strengthening available funding for interventions needed to achieve targeted water quality and building beneficiary-pays mechanisms to sustainably support the interventions over the long term.

#### **1. Funding Sources**

21. The long-term goal of the eco-compensation fund is that it will be fully contributed by beneficiaries: downstream water, hydropower, and irrigation water users as well as business community at large. The eco-compensation fund will be initially supported by the funding from the governments, ADB, and a beneficiary, with the longer-term goal of diversifying the range of funding sources and tapping more funding from beneficiaries to improve sustainability and engender more direct linkages between upstream ecosystem service providers and downstream beneficiaries in line with the principle of “those who benefit should compensate.”<sup>2</sup> The eco-compensation fund would also ideally serve as means to leverage additional financial resources, such as from the domestic philanthropic and business community. Current and potential future funding sources of the eco-compensation fund are shown in Table 1.

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<sup>2</sup> Ministry of Environmental Protection (MEP). 2007. *Guiding Opinions on the Development of Eco-compensation Pilot Work*. MEP Issue [2007] no. 130. Beijing.

**Table 1: Eco-Compensation Fund–Current and Potential Future Funding Sources**

Funding Source	Amount (CNY million)								Remarks
	2023	2024	2025	2026	2027	2028	2029	2030	
<b>A. Governments</b>									
1. Zhaotong City	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	
2. Zhayang District	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	
3. Ludian County	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
4 Zhaoyang-Ludian horizontal eco-compensation agreement	0.00	0.00	0.00	0.00	tbd	tbd	tbd	tbd	Possible future funding source
<b>Subtotal (A)</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	<b>15.00</b>	
					<b>or more</b>	<b>or more</b>	<b>or more</b>	<b>or more</b>	
<b>B. Donors</b>									
1. ADB	10.00	10.00	10.00	5.00	0.00	0.00	0.00	0.00	
2. Domestic donors	0.00	0.00	0.00	0.00	tbd	tbd	tbd	tbd	Potentially important future funding source
<b>Subtotal (B)</b>	<b>10.00</b>	<b>10.00</b>	<b>10.00</b>	<b>5.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	
					<b>or more</b>	<b>or more</b>	<b>or more</b>	<b>or more</b>	
<b>C. Beneficiaries</b>									
1. Water users (by additional surcharge <sup>a</sup> )	4.30	4.30	4.30	4.30	4.30	4.30	4.30	4.30	
2. Hydropower users									
(i) Baoho hydropower station	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
(ii) By additional surcharge <sup>b</sup>	2.83	2.83	2.83	2.83	2.83	2.83	2.83	2.83	
3. Irrigation water users	0.00	0.00	0.00	0.00	0.00	0.00	tbd	tbd	Important future funding source
4. Business sector	0.00	0.00	0.00	0.00	0.00	0.00	tbd	tbd	Important future funding source
<b>Subtotal (C)</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	<b>9.13</b>	
<b>Total (A+B+C)</b>	<b>34.13</b>	<b>34.13</b>	<b>34.13</b>	<b>29.13</b>	<b>24.13</b>	<b>24.13</b>	<b>24.13</b>	<b>24.13</b>	
					<b>or more</b>	<b>or more</b>	<b>or more</b>	<b>or more</b>	

ADB = Asian Development Bank, CNY = Chinese yuan, kwh = kilowatt hour, m<sup>3</sup> = cubic meter, tbd = to be determined.

<sup>a</sup> Surcharge of CNY0.1/m<sup>3</sup> will be added to the raw water fee by 2023.

<sup>b</sup> Surcharge of CNY0.01/m<sup>3</sup> will be added to the hydropower fee by 2023.

### 1.1. Government Supports

22. Since 2015, CNY15 million/year has been collected for ecological restoration and remediation of the primary and secondary water source protection areas of the Yudong Reservoir (CNY8 million from the ZCG, CNY5 million from the ZDG, and CNY2 million from the LCG). The ZCG has confirmed that these funds will be used for the newly established eco-compensation fund from 2023.

### 1.2. Donor Supports

23. Under the project, ADB will provide about \$5 million loan to the eco-compensation fund. This, together with the government support, will cover initial investments before other funding sources of the fund become available.

24. In addition to ADB, the ZCG, including the YWPCO, will approach other domestic donors. To successfully leverage this approach, the initial investments should demonstrate improved management of the upper basin and improved water quality in the Yudong Reservoir by recording investment activities and outcomes. The ZCG, including the YWPCO, can then more effectively use the fund as a platform and communication vehicle to approach other domestic philanthropic donors for support. Internationally, similar mechanisms to improve basin management called “Water Funds” have also been able to successfully approach additional donors once improved management and outcomes have been demonstrated.

### 1.3. Beneficiaries

25. It is important to link beneficiaries and providers of ecosystem services via the principle of “those who benefit should compensate.” Though starting out with a relatively small contribution, beneficiaries of ecosystem services will become increasingly important contributors to the eco-compensation fund to ensure its financial sustainability and better align management incentives. Long-term financial planning for the fund should thus detail beneficiaries to provide contributions to the fund, amount of each contribution, and growth rate of each contribution.

26. **Water and hydropower users.** Since 2015, CNY2 million of water resources utilization fees has been collected from the downstream Baoho hydropower station, for ecological restoration and remediation of the primary and secondary water source protection areas of the Yudong Reservoir. The ZCG has confirmed that this fund will be used for the newly established eco-compensation fund from 2023.

27. Revenue ranging from CNY10 million to CNY30 million is generated every year from water fees, including raw water fee and water resource fee. All the revenue is provided to the Yudong Reservoir Management Bureau for its operation and management costs.<sup>3</sup>

28. Two components are estimated to become available to contribute to the eco-compensation fund by 2023. One is an additional surcharge of CNY0.1/m<sup>3</sup> to the raw water fee and another is additional surcharge of CNY0.01/ m<sup>3</sup> to the hydropower fee. CNY4.3 million per year from the raw water fee and CNY2.8 million per year from the hydropower fee would be added to the eco-compensation fund.

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<sup>3</sup> The Yudong Reservoir Management Bureau and the YWPCO share the same property (e.g., office building) and the same staff.

29. **Irrigation water users.** The Yudong Reservoir is providing irrigation water to downstream areas. Since irrigation water users in the downstream areas are relatively poor, irrigation water is sold at below-market rates and the users currently cannot afford to pay a surcharge to the irrigation water fee. Therefore, the irrigation water users are not envisioned as being a viable source of eco-compensation funding in the near term. However, as they comprise a significant share of total downstream water use, they will be a potentially key future source of funding to the eco-compensation fund.

30. **Business sector.** An additional potential beneficiary group is the business sector, especially the tourism sector, which will benefit from improved water quality and landscape, resulting from investments by the eco-compensation fund. These benefits would most clearly be seen in the appreciation of urban and peri-urban land values; but also in increased tourist numbers, and possibly in increased investments in Zhaotong. As such, the business sector is a potentially important future source of funding.

## 2. Fund Management

31. For the new eco-compensation fund, a new eco-compensation fund management committee (EFMC) will be established. The chair of the EFMC will be the vice mayor of the ZCG; and the members will be the Deputy Directors General of about 10 ZCG agencies, including the Development and Reform Committee, Finance Bureau, Water Resources Bureau, the EEB, Housing and Urban–Rural Development Bureau, Agriculture and Rural Bureau, Forestry and Grassland Bureau, etc. At least 3 months prior to the establishment of the eco-compensation fund, the ZCG should appoint the EFMC members.

32. Before the eco-compensation fund is established, the EFMC will (i) finalize a draft environmental and social management system (ESMS) in Appendix 4 of the project administration manual with ADB's prior approval; (ii) issue a formal directive to integrate the finalized the ESMS into the EFMC's operational procedures with ADB's prior approval; and (iii) establish the EFMC's operational procedures; and integrate the ESMS, including screening, selection, and approval procedures for activities; financial transfer mechanisms; and technical and financial reporting, with ADB's prior approval.

33. The EFMC will (i) comply with and implement its operational procedures, (ii) review and approve all activities qualified for funding from the eco-compensation fund in accordance with the its operational procedures, (iii) execute a grant payment agreement with each user of the eco-compensation fund which conducts the qualified activity, and (d) disburse grants to the users of the eco-compensation fund pursuant to appropriate disbursement arrangements agreed between ADB and the ZCG. The qualified activities will not involve any works; nor have any adverse impacts on environment, involuntary resettlement, or ethnic minorities. The EFMC will ensure that all users of the eco-compensation fund which conducts the qualified activities comply with its operational procedures.

34. The YWPCO will manage the eco-compensation fund following decisions of the EFMC. The YWPCO's 15 permanent full-time staff who manages the existing fund for ecological restoration and remediation (paras. 9–11) will manage the new eco-compensation fund.

35. An account under the Zhaotong City Finance Bureau will be used for the eco-compensation fund. The account will be managed by the Zhaotong City Finance Bureau, following decisions of the EFMC. Since the Deputy Director General of the Zhaotong City Finance Bureau will be a member of the EFMC, the Finance Bureau will just follow the EFMC's decisions without

any objections. The Zhaotong City Finance Bureau will disburse grants from the eco-compensation fund to recipients (e.g., government agencies and private companies operating facilities constructed under the project) through the Zhaoyang District Finance Bureau or the Ludian County Finance Bureau (and relevant town or township finance bureau, as necessary).

### 3. Investment Framework

#### 3.1. Area of Coverage

36. The eco-compensation fund will support interventions in the Yudong Reservoir Basin in the upper Sayu River Basin, including the Longshu, Shuimo, and Xinjie towns in Ludian County; and the Dazhaizi, Leju, and Sujia townships and the Dashanbao and Sayu towns in Zhaoyang District.

#### 3.2. Investment Goal and Principles

37. The goal of the eco-compensation fund is to improve water quality in the Yudong Reservoir so that the water quality meets Class III standard and the Yudong Reservoir remains eligible for being the only centralized drinking water source for Zhaotong. Investments from the eco-compensation fund should be clearly justified based on how they will improve the water quality in the Yudong Reservoir in short and long terms, clarifying logic behind them. How investments will protect the water quality in the Yudong Reservoir should be approached and rationalized to clarify the real costs and benefits of the investments. It will also be important to put in place mechanisms for monitoring and assessing ecological outcomes of investments on a continuous basis so that effective and efficient approaches can be identified. Principles to guide investment decision making are provided below.

38. **Achieve the goal.** The key first principle is to make explicit how investments will achieve the goal (improvement of water quality in the Yudong Reservoir). This should be assessed and the logic linkage between the investment and goal should be revised based on the assessment. This can be structured as the following questions: (i) what investments will be able to achieve the goal?; (ii) how will the investments achieve the goal?; (iii) have the investments achieved the goal?; and (iv) if not, how should the linkages between the investments and the goal be revised?

39. **Achieve cost-effectiveness.** In formulating investments, another important consideration is whether the goal will be achieved at the lowest cost. This is a critical consideration for long-term financial sustainability of the eco-compensation fund, which will depend not only on increasing and maintaining funding; but also on using pre-existing funds more effectively. Considering cost effectiveness is important to make initial investment decision and to also assess results.

40. **Make ecological outcomes sustainable.** The long-term sustainability of the goal should be ensured once it is achieved. Sufficient funding to retain achieved ecological outcomes should be ensured. For this, the ecological outcomes should be achieved at the lowest possible cost, so that funding can be stretched out as long as possible. For sustainability of the eco-compensation fund, the management framework of the fund should incorporate processes to continually search for additional funding sources and new approaches to lower costs.

41. **Work effectively with rural communities.** The NPS pollution has become a major source of water pollution in the PRC. What makes the rural NPS pollution control difficult is that agriculture is still dominated by small-scale households (the majority of crop output is produced by more than

250 million households, with average land size of 0.6 hectares).<sup>4</sup> In the project area in Zhaotong, average household land size is even smaller at around 0.24–0.36 hectares. One of the causes of water quality deterioration in the Yudong Reservoir is land-use activities conducted by numerous households scattered throughout the area. Selecting households and imposing land use control to them to improve water quality have been conducted in a top-down manner, with little or no inter-agency coordination. As a result, the households often find themselves passive recipients of various disconnected subsidies and/or compensations, with little inputs into the design and implementation of the program based on their needs and constraints. They have little sense of ownership of the program or motivation to achieve the outcomes of the program.

42. International experience highlights the value of developing adaptive co-management frameworks with rural land users to better achieve the ecological outcomes by collaborating and sharing responsibilities with rural communities.<sup>5</sup> The “adaptive” means that such frameworks are flexible and incorporate uncertainties into the decision-making and management framework. Uncertainties can be reduced by collecting as much as information required for decision making, and local communities are a critical source of such information.<sup>6</sup> Governments are increasingly moving away from regulatory models for managing natural resources towards more adaptive co-management processes, involving feedback learning and flexible partnerships with local communities.<sup>7</sup>

43. Given this context, a missing but necessary component for effective management of the Yudong Reservoir Basin is a formalized, consistent, continuous, and consultative framework for partnering with rural communities in these areas to mitigate impacts. It is thus recommended that pilot eco-villages under Output 1 of the project be used as a vehicle for developing an adaptive co-management framework with rural communities. The pilot eco-villages are envisioned as (i) becoming a core platform to consult with communities on their needs and constraints, and showcase and communicate to these communities the proposed project interventions; and (ii) facilitating the scaling up of the interventions to villages across the Yudong Reservoir Basin to achieve real impacts on downstream water quality.

44. The ultimate goals of the pilot eco-villages are to (i) develop effective protocols and approaches to engage with rural communities on mitigation of their impacts; (ii) find the most cost-effective approaches to mitigate rural communities’ impacts on the Yudong Reservoir Basin to scale them up to other rural communities in the basin; and (iii) create an effective platform that can facilitate business sector collaboration with the communities for green sector project development (e.g., low-emission agriculture); facilitate the transmission of innovation and best practice to the communities; and introduce a wider-range of incentive-based approaches, such as annual competitions to give awards to most ecological villages in the basin.

45. The pilot eco-villages are thus envisioned to include the following activities and elements: (i) direct consultation with the communities to address their needs and constraints (a form of compensation they want, measures to improve their willingness and enthusiasm to participate in

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<sup>4</sup> Huang, J., Wang, X., and Qiu, H. 2012. *Small-scale Farmers in China in the Face of Modernisation and Globalisation*. IIED/HIVOS, London/The Hague.

<sup>5</sup> Lemos and Agrawal. 2006. *Environmental governance Annual Review of Environment and Resources*. 31 (2006). pp. 297–325; Huitema, D., E. Mostert, W. Egas, S. Moellenkamp, C. Pahl-Wostl, and R. Yalcin. 2009. Adaptive Water Governance: Assessing the Institutional Prescriptions of Adaptive (Co-)Management from a Governance Perspective and Defining a Research Agenda. *Ecology and Society*. 14 (1): 26.

<sup>6</sup> Wilson, Douglas C. 2009. *The Paradox of Transparency: Science and the Ecosystem Approach to Fisheries Management in Europe*. Amsterdam: Amsterdam University Press – MARE Publications.

<sup>7</sup> Armitage, Derek, Fikret Berkes, and Nancy Doubleday, eds. 2007. *Adaptive Co-Management: Collaboration, Learning, and Multi-level Governance*. Vancouver: University of British Columbia Press.

activities to mitigate their impacts on the basin, etc.); (ii) joint decision making with the communities on interventions (community-level activities to mitigate impacts, community-level indicators to assess performance, structure of rewards and penalties based on compliance rates, etc.); (iii) improvement of investment outcomes with the communities by improving performance indicators, developing methods to monitor and assess outcomes, experimenting measures to lower the costs of interventions, and exploring measures to avoid long-term changes in behavior and land use; and (iv) training and educational workshops on rural land use and environmental awareness raising (environmental impacts and proper use of chemical inputs, fertilizer, and pesticides in agriculture, garbage classification and recycling, household and husbandry manure management, etc.).

46. Pilot eco-villages located along major roads in the basin where some key local markets are held have been selected to showcase the new approaches and environmental activities to communities in the Yudong Reservoir Basin.

#### **4. Proposed Program Interventions**

47. Activities supported by the eco-compensation fund should improve and proactively stabilize the water quality in the Yudong Reservoir. Since the rural NPS pollution is a major and growing concern for water quality in the Yudong Reservoir, activities targeting the rural areas of the upper Yudong Reservoir Basin will be a priority. To identify promising activities to be funded from the eco-compensation fund, a survey was conducted for 44 villages in the Yudong Reservoir Basin. Promising near-term activities to be funded from the eco-compensation fund are (i) wastewater management, solid waste management, activities for pilot eco-villages, the O&M of the constructed wetlands, compensation for farmland-to-forest conversion, and promotion of low-emission agriculture under Output 1 of the project; (ii) operation of the river protection model established under Output 2 of the project; (iii) implementation of the horizontal eco-compensation mechanisms under Output 3 of the project; and (iv) management of the eco-compensation fund.

48. A preliminary framework to develop necessary performance indicators and targets, including logic linkage between each activity and the goal (improvement of water quality in the Yudong Reservoir), for the promising near-term activities to be financed from the eco-compensation fund is in Table 2. Table 3 below details general annual cost estimates of these activities as well as service fees and profits to be used for the activities.

**Table 2: Preliminary Framework for Promising Near-Term Activities**

<b>Activities</b>	<b>Desired Outcome</b>	<b>Investment–Outcome Linkages</b>	<b>Performance Indicators (Preliminary)</b>	<b>Performance Targets</b>
Wastewater management	Increased treatment of wastewater, and improved water quality in the Yudong Reservoir.	Wastewater draining into the river systems will be reduced.	Volume of wastewater treated/day	1,347 m <sup>3</sup> /day
Solid waste management	Increased treatment of solid waste, and improved water quality in the Yudong Reservoir.	Solid waste dumped into the river systems, and pollution of the river systems by solid waste during rain events will be reduced.	Volume of solid waste treated/day	84 tons/day
Activities for pilot eco-villages	Improved hygiene and environment in the villages, scaling-up of the approaches taken in the villages to other villages in the Yudong Reservoir Basin, and improved water quality in the Yudong Reservoir.	Wastewater draining into the river systems from the villages, solid waste dumped into the river systems in the villages, and pollution of the river systems in the villages by solid waste during rain events will be reduced.	Improvement of hygiene and environment in the villages	To be determined
Operation and maintenance of constructed wetlands	Reduction of nonpoint source pollution, and improved water quality in the Yudong Reservoir.	Nonpoint source pollution in the river systems will be reduced.	Reduction of the TN and the TP by the wetlands	TN by 17% and TP by 11%
Compensation for the farmland-to-forest conversion	Reduction of soil erosion, and improved water quality in the Yudong Reservoir.	Soil erosion will be reduced which will reduce high sediment runoff into the river systems.	Reduced amount of soil which is eroded in upper area and flows into the river systems	18,800 tons/year
Promotion of low-emission agriculture	Reduction of agricultural emission, and improved water quality in the Yudong Reservoir.	Agricultural emission, not the river systems, will be reduced.	Reduction of chemical fertilizer, nitrogen, and phosphor losses through runoff and leach into deep soil in the low-emission agriculture pilot areas	By 30% (nitrogen to 3.920 kg/ha and phosphor to 0.077 kg/ha)
Operation of the river protection model	Improved water quality in the river systems and the Yudong Reservoir.	Ecological embankments will reduce nonpoint source pollution into the river systems. Monitoring of water quality in the river systems will be improved.	Water quality in the river systems	To be determined

**Table 2: Preliminary Framework for Promising Near-Term Activities**

<b>Activities</b>	<b>Desired Outcome</b>	<b>Investment–Outcome Linkages</b>	<b>Performance Indicators (Preliminary)</b>	<b>Performance Targets</b>
Implementation of the horizontal eco-compensation mechanisms	Improved water quality in the river systems and the Yudong Reservoir.	Upstream county, towns, and townships will reduce pollution into the river systems to improve water quality at the monitoring points.	Water quality in the river systems	To be determined
Management of the eco-compensation fund	Improvement of water quality in the Yudong Reservoir, including financing of activities.	Activities to improve water quality in the Yudong Reservoir will be conducted.	Annual average TN in the Yudong Reservoir	Class III

ha = hectare, kg = kilogram, m<sup>3</sup> = cubic meter, TN = total nitrogen, TP = total phosphorus.

Source: Asian Development Bank.

**Table 3: Preliminary Cost Estimates of Promising Near-Term Activities**  
(CNY million)

<b>Activities</b>	<b>2023</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>	<b>2029</b>	<b>2030</b>
A. Wastewater management								
1. Wastewater treatment plant operating costs	1.0558	1.0558	1.0558	1.0558	1.0558	1.0558	1.0558	1.0558
2. Wastewater treatment fees		-0.4678	-0.4678	-0.4678	-0.4678	-0.4678	-0.4678	-0.4678
3. Eco-brick manufacturing profits		-0.1187	-0.1187	-0.1187	-0.1187	-0.1187	-0.1187	-0.1187
<b>Subtotal (A)</b>	<b>1.0558</b>	<b>0.4694</b>						
B. Solid waste management								
1. Solid waste collection and treatment costs	7.7460	7.7460	7.7460	7.7460	7.7460	7.7460	7.7460	7.7460
2. Household solid waste collection fees		-2.6695	-2.6695	-2.6695	-2.6695	-2.6695	-2.6695	-2.6695
<b>Subtotal (B)</b>	<b>7.7460</b>	<b>5.0765</b>						
C. Activities for pilot eco-villages								
1. Supervision and cleaning	0.3120	0.3120	0.3120	0.3120	0.3120	0.3120	0.3120	0.3120
2. Educational subsidies				1.3736	1.3736	1.3736	1.3736	1.3736
3. Ecological education and capacity building	0.4800	0.7200	0.9600	0.9600	0.9600	0.9600	0.9600	0.9600
4. Water environmental protection education	0.7450	0.1118	0.1490	0.1490	0.1490	0.1490	0.1490	0.1490
5. Student training on garbage classification	0.3142	0.3142	0.3142	0.3142	0.3142	0.3142	0.3142	0.3142
6. Wetland protection education	0.0085	0.0128	0.0170	0.0170	0.0170	0.0170	0.0170	0.0170
7. Farmer training on improvement of cultivation practices		0.1350	0.2700	0.2700	0.2700	0.2700	0.2700	0.2700
<b>Subtotal (C)</b>	<b>1.8597</b>	<b>1.6057</b>	<b>2.0222</b>	<b>3.3958</b>	<b>3.3958</b>	<b>3.3958</b>	<b>3.3958</b>	<b>3.3958</b>
D. Operation and maintenance of constructed wetlands								
1. Operation and maintenance costs	0.2855	0.2855	0.4282	0.4282	0.4282	0.4282	0.4282	0.4282
E. Compensation for farmland-to-forest conversion								
1. For farmland-to-forest conversion	1.3045	1.3045	1.3045	1.3045	1.3045	1.3045	1.3045	1.3045
2. For perennial herb planting	0.6296	0.6296	0.4197	0.2099				
<b>Subtotal (E)</b>	<b>1.9341</b>	<b>1.9341</b>	<b>1.7243</b>	<b>1.5144</b>	<b>1.3045</b>	<b>1.3045</b>	<b>1.3045</b>	<b>1.3045</b>
F. Promotion of low emission agriculture								
1. Reduction of chemical fertilizer application		1.5179	1.5179	1.5179	1.5179	1.5179	1.5179	1.5179
2. Reduction of pesticides		1.9089	1.9089	1.9089	1.9089	1.9089	1.9089	1.9089
3. Demonstration zone and points management		0.6698	0.6698	0.6698	0.6698	0.6698	0.6698	0.6698
<b>Subtotal (F)</b>	<b>0.0000</b>	<b>4.0967</b>						
G. Operation of river protection model								
1. River-warden salaries			0.4716	0.4716	0.4716	0.4716	0.4716	0.4716
H. Implementation of the horizontal eco-compensation mechanisms								
1. Water quality monitoring	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500
2. Water quality-based awards	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000	3.6000
<b>Subtotal (H)</b>	<b>4.0500</b>							
I. Management of eco-compensation fund								
1. Eco-compensation fund management costs	0.4912	0.4912	0.4912	0.4912	0.4912	0.4912	0.4912	0.4912
<b>Total</b>	<b>17.4224</b>	<b>18.0091</b>	<b>18.8300</b>	<b>19.9938</b>	<b>19.7839</b>	<b>19.7839</b>	<b>19.7839</b>	<b>19.7839</b>

CNY = Chinese yuan

#### 4.1 Wastewater Management

49. **Operation of wastewater treatment plant.** Under Output 1 of the project to develop a centralized wastewater management system, wastewater collection pipes will be installed and three pump stations constructed to treat wastewater at an existing wastewater treatment plant (WWTP) in the Longshu Town of Ludian County. The operation of the WWTP will start in 2023. It is proposed that the operating costs of the WWTP (CNY1.06 million/year) will be covered by the eco-compensation fund in the near term.

**Table 4: Operation Costs of Wastewater Treatment Plant**

Item	Amount /Year	Unit	Price/Unit (CNY)	Total	Remarks
				(CNY million/year)	
A. Materials					The
1. Polyacrylamide+	0.365	ton	21,600	0.0079	operation will start in 2023.
2. Polyacrylamide-	0.730	ton	8,000	0.0058	
3. Polyaluminium chloride	14.600	ton	2,000	0.0292	
4. Sodium chlorate	3.500	ton	4,000	0.0140	
5. Hydrochloric acid	7.100	ton	800	0.0057	
<b>Subtotal (A)</b>				<b>0.0626</b>	
B. Electricity					
1. Wastewater treatment plant	444,300	kWh	0.72	0.3199	
2. Three wastewater pumping stations	101,600	kWh	0.72	0.0732	
3. Integrated wastewater treatment equipment	176,100	kWh	0.72	0.1268	
<b>Subtotal (B)</b>				<b>0.5198</b>	
C. Staff, maintenance, and other costs					
1. Facility staff (5 per plant)	10	Persons	22,500	0.2250	
2. Maintenance (0.5% of fixed assets)				0.0650	
3. Wastewater transportation and disposal, laboratory, and management fees				0.1834	
<b>Subtotal (C)</b>				<b>0.4734</b>	
<b>Total</b>				<b>1.0558</b>	

CNY = Chinese yuan, kWh = kilowatt-hour.

50. **Wastewater treatment fees.** Assuming that (i) out of 14,557 households covered by the centralized wastewater management system, 11,646 households will be actually connected to the system and pay wastewater treatment fee of CNY30/year; and (ii) all 1,184 commercial enterprises covered by the system will be actually connected to the system and pay wastewater treatment fee of CNY100/year, revenue from wastewater treatment fee will be CNY467,780/year.<sup>8</sup> The revenue will be produced from 2024.

51. **Eco-brick manufacturing profits.** Another source of finance to defray the operating costs of the WWTP will be income by selling burn-free ecological bricks made from slag from a water mill waste pyrolysis plant. With 2,186.71 tons/year of slag, 26,778.40 tons of burn-free ecological bricks will be produced. At a unit price of CNY201/ton, burn-free ecological bricks will generate an annual revenue of CNY5.3825 million, with a profit of CNY0.1187 million. The eco-brick production facility will be constructed in the WWTP and will produce bricks from 2024.

<sup>8</sup> Currently at the 14,557 households, wastewater is collected in the toilet. Each household needs to remodel the toilet (including installation of connecting pipes for wastewater) so that wastewater will be collected to the installed wastewater collection pipes. Actual numbers of households from which wastewater is collected will be smaller than the numbers covered by the centralized wastewater management system.

**Table 5: Profit from Burn-Free Ecological Bricks**

<b>Item</b>	<b>Amount /Year</b>	<b>Unit</b>	<b>Price/Unit (CNY)</b>	<b>Total (CNY million/year)</b>	<b>Remarks</b>
A. Costs					Bricks will
1. Cement	8,197.40	ton	410.00	3.3609	be
2. Stone	8,197.40	ton	108.00	0.8853	produced
3. Stone powder	8,197.40	ton	96.00	0.7870	from
4. Brick factor power consumption	95,200.00	kWh	0.72	0.0685	2024.
5. Water use	8,033.52	m <sup>3</sup>	3.50	0.0281	
6. Staff	2	Person	36,000.00	0.0720	
7. Depreciation (1% of asset value)				0.0080	
8. Quality control (1% of estimated sales				0.0539	
<b>Subtotal (A)</b>				<b>5.2638</b>	
B. Revenue					
Brick sales	26,778.40	ton	201.00	5.3825	
C. Profit				0.1187	

CNY = Chinese yuan, kWh = kilowatt-hour, m<sup>3</sup> = cubic meter.

## 4.2 Solid Waste Management

52. **Solid waste collection and treatment.** Under Output 1 of the project, two garbage pyrolysis facilities and four solid waste transfer stations will be constructed and equipment for collection and transfer of solid waste. Estimated cost of solid waste collection and treatment is CNY7.7460 million/year. This includes costs of materials, vehicle fuel, electricity, water, staff, and others. The solid waste collection and treatment will start in 2023.

**Table 6: Solid Waste Collection and Treatment Costs**

<b>Item</b>	<b>Amount /Year</b>	<b>Unit</b>	<b>Price/Unit (CNY)</b>	<b>Total (CNY million/year)</b>	<b>Remarks</b>
A. Material cost					Solid
1. Granular activated carbon φ4mm	9.600	ton	6,500	0.0624	waste
2. Caustic soda	8.322	ton	3,500	0.0291	collection
3. Cement	27.710	ton	410	0.0114	and
4. Chelating agent	3.690	ton	12,000	0.0443	treatment
<b>Subtotal (A)</b>				<b>0.1472</b>	will start in
B. Vehicle fuel cost					2023.
1. Diesel for compression trucks	44,019.0	Liter	7	0.3081	
2. Diesel for hook-arm garbage trucks	14,059.8	Liter	7	0.0984	
3. Diesel for detachable container garbage trucks	12,877.2	Liter	7	0.0901	
4. Electricity for electric tricycles	77,672.0	kWh	0.72	0.0559	
<b>Subtotal (B)</b>				<b>0.5526</b>	
C. Facility and station electricity cost					
1. Shuimo Town garbage pyrolysis facility	1,020,000	kWh	0.72	0.7344	
2. Sujia Township garbage pyrolysis facility	514,028	kWh	0.72	0.3701	
3. Xinjie Town solid waste transfer station	172,280	kWh	0.72	0.1240	
4. Longshu Town solid waste transfer station	172,280	kWh	0.72	0.1240	
5. Shuimo Town solid waste transfer station	172,280	kWh	0.72	0.1240	
6. Sujia Township solid waste transfer station	172,280	kWh	0.72	0.1240	
<b>Subtotal (C)</b>				<b>1.6007</b>	
D. Facility water cost					
1. For Shuimo Town garbage pyrolysis facility	2,720	m <sup>3</sup>	3.5	0.0095	
2. or Sujia Township garbage pyrolysis facility	4,930	m <sup>3</sup>	3.5	0.0173	
<b>Subtotal (D)</b>				<b>0.0268</b>	

Item	Amount /Year	Unit	Price/Unit (CNY)	Total (CNY million/year)	Remarks
<b>E. Staff</b>					
1. Operators (Shuimo Town garbage pyrolysis facility)	9	Persons	42,000	0.3780	
2. Operators (Sujia Township garbage pyrolysis facility)	6	Persons	42,000	0.2520	
3. Operators (Xinjie Town solid waste transfer station)	3	Persons	48,000	0.1440	
4. Operators (Longshu Town solid waste transfer station)	3	Persons	48,000	0.1440	
5. Operators (Shuimo Town solid waste transfer station)	3	Persons	48,000	0.1440	
6. Operators (Sujia Township solid waste transfer station)	3	Persons	48,000	0.1440	
7. Truck drivers (Xinjie Town solid waste transfer station)	7	Persons	42,000	0.2940	
8. Truk drivers (Longshu Town solid waste transfer station)	9	Persons	42,000	0.3780	
9. Truck drivers (Shuimo Town solid waste transfer station)	4	Persons	42,000	0.1680	
10. Truck drivers (Sujia Township solid waste transfer station)	5	Persons	42,000	0.2100	
11. lectric tricycle drivers (Xinjie Town solid waste transfer station)	58	Persons	12,000	0.6960	
12. Electric tricycle drivers (Longshu Town solid waste transfer	16	Persons	12,000	0.1920	
13. Electric tricycle drivers (Shuimo Town solid waste transfer	34	Persons	12,000	0.4080	
14. Electric tricycle drivers (Sujia Township solid waste transfer	60	Persons	12,000	0.7200	
<b>Subtotal (E)</b>				<b>4.2720</b>	
<b>F. Others</b>					
1. Maintenance (1% of the depreciation of fixed assets)				0.8250	
2. Insururance premiums (CNY10,000/vehicle/year)	25	Trucks	10,000	0.2500	
3. Transportation of slag from garbage pyrolysis facilities				0.0523	
4. Transportation of fly ash solidified bricks to landfill				0.0195	
<b>Subtotal (F)</b>				<b>1.1468</b>	
<b>Total</b>				<b>7.7460</b>	

CNY = Chinese yuan, kWh = kilowatt-hour, mm = millimeter, m<sup>3</sup> = cubic meter.

53. **Household solid waste collection fee.** Assuming that all 30,890 households and 1,184 enterprises covered by the four solid waste transfer stations will pay solid waste collection fees of CNY80/household/year and CNY167.5/enterprise/year, respectively, revenue from solid waste collection fees will be CNY2,669,520/year. Based on the rural survey results, rural households will indeed be willing to pay solid waste collection fees if quality of the service is sufficiently good. The revenue from solid waste collection fees will be produced from 2024.

#### 4.3 Activities for Pilot Eco-Villages

54. **Supervision and cleaning.** In each pilot eco-village, (i) four environmental supervision group members and six cleaning team members will be designated; and (ii) ecological rewards will be given to 10 households and 2 cleaners each quarter by the environmental supervision group in consultation with the village government. The supervision, cleaning, and ecological rewarding will start in 2023. The estimated cost of these is CNY312,000/year.

**Table 7: Costs of Supervision and Cleaning in Pilot Eco-Villages**

Item	Number in Each Village	Number of Villages	Cost (CNY)	Total (CNY million/year)	Remarks
<b>A. Supervision and Cleaning</b>					
1. Environmental supervision group	4	6	200 /person/month	0.0576	Activities will start in 2023.
2. Cleaning team	6	6	400 /person/month	0.1728	
<b>Subtotal (A)</b>					
<b>B. Ecological Rewards</b>					
1. Cleaning staff	2	6	200 /person/quarter	0.0096	
2. Households	10	6	300 /person/quarter	0.0720	
<b>Subtotal (B)</b>					
<b>Total</b>				<b>0.3120</b>	

CNY = Chinese yuan.

55. **Educational subsidies.** Educational subsidies are viewed as a near-term reward to engender villagers' enthusiasm to engage in activities to mitigate their impacts on environment and as an important long-term instrument to help facilitate environmental improvements in the villages. The subsidies are divided into two types. The first subsidy type is to help outstanding students from these villages (10% of the students) effectively continue their studies. The subsidy will be used to resolve livelihood concerns of the students; and thereby, help them concentrate on their studies. Subsidy packages will be set at CNY400, CNY600, CNY800, CNY800, and CNY1,000 per student per year for students going to elementary school, junior high school, high school (including vocational school), secondary school, and university, respectively. The second subsidy type is to provide rewards for outstanding 3% of middle school students to help them attend high-quality schools. Subsidies for these students will be CNY2,000 per student per year. The subsidies will be provided from 2026.

**Table 8: Educational Subsidies**

Item	Number of	Subsidy	Total	Remarks
	Students Receiving	(CNY/pers	(CNY	
	Subsidies	on/year)	million/year)	
A. Subsidies to Help Outstanding Students Concentrate on Study				Subsidies
1. Elementary school students	764	400	0.3056	will be
2. Junior high school students	491	600	0.2946	provided
3. High, vocational, and secondary school students	298	800	0.2384	from
4. University students	239	1,000	0.2390	2026.
<b>Subtotal (A)</b>			<b>1.0776</b>	
B. Subsidies to Help Outstanding Students Attend High Quality Schools	148	2000	0.2960	
<b>Total</b>			<b>1.3736</b>	

CNY = Chinese yuan.

56. **Training and education.** This will include ecological education and capacity building, water environmental protection education, student training on garbage classification, wetland protection education, and farmer training on improvement of cultivation practices. Estimated costs are in Table 3.

#### 4.4 Operation and Maintenance of Constructed Wetlands

57. Estimated cost for the O&M of constructed wetland is estimated at CNY71,373 per site. Operation and maintenance of wetlands will start at four sites from 2023 and at two sites from 2025.

**Table 9: Wetlands Operation and Maintenance Costs**

Item	Amount	Number	Total	Remarks
	/Site/Year		(CNY	
	(CNY)	of Sites	million/year)	
1. Sedimentation pond clearing and plant harvesting	30,000	6	0.1800	Operation and
2. Vehicle fuel	1,008	6	0.0060	maintenance of
3. Electricity for management room	365	6	0.0022	constructed wetlands
4. Labor	20,000	6	0.1200	will start at 4 sites
5. Analytical monitoring	20,000	6	0.1200	from 2023 and 2
<b>Total</b>	<b>71,373</b>		<b>0.4282</b>	sites from 2025.

CNY = Chinese yuan.

#### 4.5 Compensation for Farmland-to-Forest Conversion

58. For compensation for the farmland-to-ecological forest conversion (2,174.23 mu), compensation of CNY600/mu/year will be needed for 15 years.<sup>9</sup> For compensation for the farmland-to-perennial herb area conversion (2,098.61 mu), compensation of CNY300/mu/year will be needed for 3–5 years before the herb grows and makes a profit. Tree and perennial herb planting will be conducted in 2021. The eco-compensation fund will begin to finance the compensations from 2023.

59. These compensations will be paid from the eco-compensation fund to be established under the project.

#### 4.6 Promotion of Low-Emission Agriculture

60. **Reduction of chemical fertilizer application.** Based on survey results, most farmers in the project area primarily use chemical fertilizers due to (i) cost of environment-friendly fertilizers are high; (ii) there are no programs to financially help farmers to use environment-friendly fertilizers; (iii) farmers are generally unaware of adverse impacts of excessive chemical fertilizer application; and (iv) qualities of environment-friendly fertilizers are poor. To encourage farmers to reduce chemical fertilizer application and shift to higher-quality, organic, and slow-release fertilizers, special fertilizers will be demonstrated in 15,765.59-mu area; slow-release fertilizers will be demonstrated in 3,225.75-mu area; and soil sampling and testing will be conducted. Estimated cost of CNY1.5179 million/year for these activities will be financed from the eco-compensation fund from 2024.

61. **Reduction of pesticides.** A subsidy will be provided to farmers from 2024 to allow some portion of their fields to serve as experimental sites for disease-resistant crops, non-chemical physical pest control measures, new low-toxicity organic pesticides, and biological control measures. The subsidy standard is to be set at CNY100/mu/year, with targeted area of 19,089.34 mu for a total cost of CNY1.9089 million/year which will be financed from the eco-compensation fund from 2024.

62. **Shift to more environmentally sustainable cropping.** To promote improved cropping techniques, including adoption of better quality and value varieties; and improving resilience to pests and extreme weather, potato intercropping and corn-and-potato intercropping will be conducted in 2,605.81-mu and 4,092.55-mu experimental zones, respectively, from 2024, demonstrating a better use of climatic soil and light conditions to reduce fertilizer application and improve resilience of crops to pest outbreaks and extreme climate conditions. The eco-compensation fund will provide CNY100/mu/year, or CNY0.6698 million/year in total, to support the demonstration.

#### 4.7 Operation of River Protection Model

63. **River wardens.** River wardens will monitor tributaries of Sayu River, report violations in wastewater and solid waste management regulations, and assess impacts of various program to improve water quality. About CNY400 per kilometer per month from the eco-compensation fund will be paid to the river wardens as their salaries. The river wardens will begin their activities from 2025.

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<sup>9</sup> An *mu* is a Chinese unit of measurement (1 mu = 666.67 square meters).

**Table 11: River Wardens**

District or County	Town or Township	Village	River length	Number of River Wardens	River Wardens Salary	
			to be Monitored (km)		(CNY/km /month)	(CNY million /year)
Ludian	Shuimo	Huangnizhai, Tieguang, Xinpeng, Shuimo	16.09	10	400.0	0.08
	Longshui	Xinle, Zhaobi, Tangfang	27.63	11	400.0	0.13
	Xinjie	Jiufang, Shanqiao, Xinjie, Pingdiying	14.30	8	400.0	0.07
Zhaoyun	Sujia	Guihuayu, Guahai, Sujia, Buchu, Liyuan	20.02	7	400.0	0.10
	Sayu	Jule	3.94	2	400.0	0.02
	Leju	Xinhe	8.53	3	400.0	0.04
	Dazhaizi	Yuyu, Xinlin	7.74	1	400.0	0.04
<b>Total</b>		<b>20</b>	<b>98.25</b>			<b>0.47</b>

CNY = Chinese yuan, km = kilometer.

#### 4.8 Implementation of Horizontal Eco-Compensation Mechanisms

64. **Water quality monitoring.** For implementation of the existing horizontal eco-compensation agreement between the LCG and the ZDG, and the new town- and township-level horizontal eco-compensation mechanisms established under Output 3 of the project, water quality monitoring will be conducted to judge whether or not water quality targets set in the agreements were achieved, which will be the basis for compensation. The water quality monitoring is estimated to cost CNY0.45 million/year which will be financed from the eco-compensation fund from 2023.

65. **Water quality-based awards.** County, towns, and/or townships will be awarded based on water quality outcomes. Estimated CNY3.6 million/year will be financed from the eco-compensation fund for the awards.

### 5. Fund Sustainability and Scaling Up

66. A final important set of considerations for the fund is its sustainability; and within that, its ability to support scaling up of interventions and expanding the range of interventions. This section briefly examines these issues based on the fund's current design.

#### 5.1 Fund Sustainability

67. Table 11 based on conservative estimates of income of the eco-compensation fund (assuming that government annual contributions will remain the same) shows that, with contributions to the fund provided by the governments, ADB, water users, and hydropower users, the fund can finance all the promising near-term activities until 2030. Since more contributions are expected from domestic donors, irrigation water users, and business sector and the governments will likely increase their contributions year-by-year; sustainability of the fund is quite high and the fund can finance more qualified activities.

**Table 11: Financial Sustainability of Eco-Compensation Fund**  
(CNY million)

Year	Income (At Least)	Estimated Expenses	Surplus (At Least)	
			By Year	Cumulatively
2023	34.1300	17.4224	16.7076	16.7076
2024	34.1300	18.0091	16.1209	32.8286
2025	34.1300	18.8300	15.3000	48.1285
2026	29.1300	19.9938	9.1362	57.2647
2027	24.1300	19.7839	4.3461	61.6108
2028	24.1300	19.7839	4.3461	65.9569
2029	24.1300	19.7839	4.3461	70.3030
2030	24.1300	19.7839	4.3461	74.6490

CNY = Chinese yuan.

## 5.2 Achieving Cost Effectiveness to Facilitate Scaling-Up

68. How to scale up, the eco-compensation fund to the whole Yudong Reservoir Basin and costs which will entail should be considered. This will help better motivate the principle of finding low-cost but effective approaches, whenever possible. If an effective framework for working with rural communities in the basin is developed through the pilot eco-villages; and then, is scaled-up to other villages in the basin, this could significantly reduce the long-term transactions costs of scaling-up, as well as help catalyze business-sector interventions and innovations which will further reduce adverse impacts on water quality in the Yudong Reservoir.

69. One such business sector intervention could be engendering a regional organic agriculture base. It will require a stronger and more detailed government regulatory framework, but it could do much to cost-effectively achieve desired water quality outcomes, help catalyze green industry development, and achieve rural vitalization.

70. Such business-sector interventions need not be limited to eco-agriculture; but could take many forms and would be facilitated with a more effective rural engagement framework, covering the Yudong Reservoir Basin. Regarding this, future approaches that could be used by the eco-compensation fund could include credit support for the development of such green industry activities. Other incentive-based approaches that could also be used to change behavior and reduce impacts at scale include competitions, with awards, between various rural communities in the basin, regarding who is best able to achieve certain targeted results. Establishment of an effective rural engagement framework for working with upper basin communities will ultimately unlock numerous opportunities.