Host Country: People's Republic of China

Site Location: Momoge National Nature Reserve, Jilin Province, China

Project Duration: April 1, 2014 to December 31, 2016

Overall Aim: Sustainable water management for conserving Siberian Cranes and their world largest stopover site in China.

Final Report

Conserving Siberian Cranes in China through Sustainable Water Management (ID: F03196214)

Involved Institutions: Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences; Momoge National Nature Reserve of Jilin, China

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Project partners & Collaborators

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During the field works in 2014, 2015 and 2016. Mr. Sun Xiaowei, Qin Bo, Wang Bo, Wang Yong and Miss Shang Liyuan from the MNNR, Miss Zhang Yanan and Mr. Wang Xuan from National Bird Banding Center of China, and Mr. Hao Mingxu from our institute, participated in the Siberian crane monitoring and Marsh organ sampling. In particular, they also experienced the cold water in the late spring and high temperature in the early fall during the field work. It is an unforgettable time we spent together with endless happiness, even including the hard work in the water from sunrise to sunset. It would be unbelievable to accomplish the field work in the water without their help and support.

We would like to give our special thanks to the local Agriculture Bureau, Water Resources Bureau, Forestry Bureau, Reed Management Bureau, and Irrigation Area Management Bureau for their time and generous sharing of their knowledge and information during the periods of face to face interviews and stakeholders' workshop. We are grateful to the two primary schools for their support on public education activities. We were impressed so much by the students' dedicated spirit and rising enthusiasm.

We would also like to thank Prof. Jiang Hongxing of National Bird Banding Center of China and Professor Sammy Lee King of Louisiana State University for their valuable comments on our project proposal and concerns on the project progress. They also provided very useful comments and valuable visions on the draft of our sustainable water management plan.

Section 1

Summary

This project aims to increase the resilience of wetland biodiversity, especially Siberian cranes, through sustainable water management practices that respond to increased water variability. Through the field monitoring, the ecological relationship among water level, food plants and migratory Siberian Cranes was detected. The results showed the *Scirpus nipponicus* and *S. planiculmis* are the pioneering community, instead of the dominant community, in the shallow wetland of saline-sodic soils. Changes in water level would also affect the food availability of migratory Siberian Cranes and other waterbirds. With the development of irrigation areas in this region, the improved drainage systems have increased the water supply to the wetlands. The water management plan was developed with an emphasis of the wetland catchments as the highest priority. The management recommendations were proposed based on the ecological requirements of target species and potential capacity of wetland resilience. The local stakeholders actively participated in the planning process. They also incorporated some recommendations into their working practices, such as enlargement of water outlets, replacement of water structures and issuance of fishing and grazing bans in key wetlands. The wetland function, values and services were also widely recognized by the local students, farmers and stakeholders through the education campaigns.

Introduction

The Siberian Crane is the most aquatic crane with a general preference for wide shallow wetland, and ranked as critically endangered by IUCN. In recent years, approximately 80% of the world population of Siberian Cranes used the Momoge National Nature Reserve (hereafter "Momoge NNR") less than 5000 hectares for 1.5 months during each migration season. Momoge NNR is an alluvial area in the lower reaches of Nenjiang River, in the semi-arid area of western Songnen Plain, northeast China. The reserve has been recognized as an Important Bird Area by BirdLife International in 2004, and a Ramsar Wetland of International Importance in 2013. Momoge wetlands experienced huge loss and degradation due to long-term climate change and increasing human activities, such as agriculture development and water diversion projects. Predictions indicate that this region is sensitive to climate change, with conditions expected to become hotter and drier.

During the period of China's 11th five-year plan (2006-2010), Jilin Province implemented an agriculture development plan on the west of Momoge NNR. The improved drainage systems have increased the water supply to the wetlands, resulting in changes of natural succession of aquatic vegetation in an irregular cycle. Numerous hydrologic alterations have occurred in or around the

reserve that have affected water availability and/or the distribution of water across the reserve. Drainage of irrigation water off the rice fields also greatly affects the reserve and its wetlands.

Momoge NNR developed its site management plan in 2007 and established its water supply mechanism in 2010. However, due to the lack of effective wetland management planning in response to the increased water variability, the wetlands in the reserve are still experiencing threats of loss and degradation. The wetland function and services cannot ensure the needs of biodiversity conservation, especially for some threatened and endangered waterbirds during breeding and migratory periods. Historically, the Siberian Cranes were most common at wetlands within the core zone of the reserve, but due to drastic changes in the distribution and abundance of the different wetland communities, the birds are now using wetlands outside of the core zone. Etoupao wetland received high crane use for several years after enlargement of its water area provided ideal forage and water depths but was not used extensively prior to that time.

With lack of effective water management, the crane distribution and population size are unstable and changeable in this region. The reserve authority has developed a site management plan, which is hard to put into operation because of a lack of a practical and sustainable water management plan. This project aims to increase the resilience of wetland biodiversity, especially Siberian cranes through sustainable water management practices that respond to increased water variability. Our goals are to increase resilience of wetland biodiversity including Siberian Cranes, and benefit to local communities through sustainable water management practices in response to increased water variability and human developments.

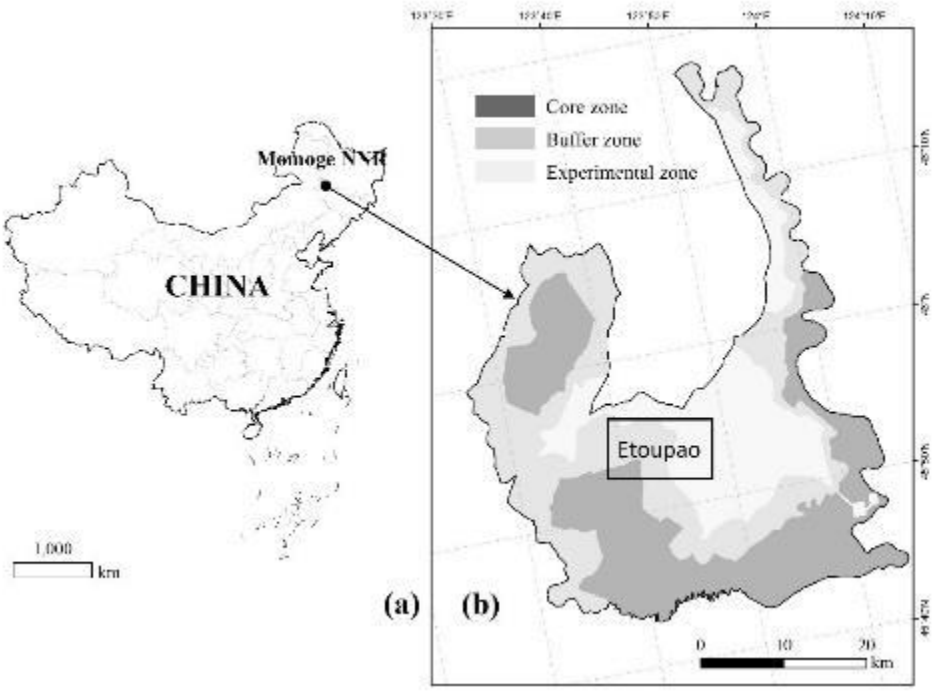


Figure 1 Momoge NNR location in China(a) and Etoupao wetland in Momoge NNR(b)

Project members

Dr. Liu Chunyue, 34 years old, the project team leader. She is skilled at the application of 3S techniques on the avian habitat study, and also familiar with the community work. She got a PhD degree in June 2011 and now is a researcher in the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences. During the project implementation, Dr. Liu is in charge of project design, field survey, data collection and analysis, information dissemination, community work, and the report development.

Mr. Zou Changlin, 36 years old, a team member. He got a Master's degree on wildlife management from the Northeast Forestry University. He worked at the Momoge National Nature Reserve since 2004. He is skilled at field survey and ecological monitoring, and familiar with the local communities and stakeholders. During the project implementation, Mr. Zou is responsible for the field survey, sample collection, information sharing, and communication with local communities and stakeholders.

Dr. Sun Yan, 34 year olds, a team member. She got a PhD degree in June 2012 from Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, and now is a lecturer in the Jilin Jianzhu University. She has plenty of experience in GIS planning and communication with the stakeholders and preliminary audiences. During the project implementation, she is responsible for the Data analysis, community work, sample collection and public education.

Ms. Zhang Lina, 29 years old, a team member. She got a Master's degree in the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences in June 2015. She is familiar with GIS planning, and communication with the communities and preliminary audiences. During the project implementation, she is in charge of community work and public education.

Dr. Cheng Shuai, 35 years old, a team member. He got a PhD degree in the Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences in June 2016. He has much experience on wetlands inventory survey, and is skilled in spatial data analysis by the technique of GIS. Now he acts as a teacher in the Zhengzhou University. During the project implementation, he is in charge of the field survey, sample collection and data analysis.

Section 2

Aim and Objectives

This project aims to increase the resilience of wetland biodiversity, especially Critically Endangered Siberian cranes and other threatened waterbirds at Momoge NNR through sustainable and participatory water management practices that respond to increased water variability under the influences of human pressures and climate change. To achieve the project goal, there are detailed objectives as follows:

1. Prepared sustainable water management plan to enhance resilience of wetland biodiversity, especially for Siberian cranes in response to increased water variability, and reflected in the existing site management plan.

2. Applied the results of field studies to support effective implementation of the sustainable water management plan.

3. Reduced external threats to key stopover sites of Siberian cranes.

4. Increased awareness of wetland biodiversity conservation and water variability adaptation among local stakeholders, and more broadly within the region.

Changes to original project plan

The original water management plan was drafted in late December 2015, and finalized in April 2015 after obtaining comments and suggestions from the local stakeholders and related experts. However, we were informed the drainage water income will be increased for the planned wetlands with the highest priority for the Siberian Cranes and other waterbirds when we visited the Momoge NNR in late July of 2016. The reserve authority hoped we could update the plan document to address the increased water income. We had two additional site visits and at least ten interviews with the related stakeholders after then. The major challenge is how to maintain the water in an acceptable level for the two prioritized wetland catchments under the current water conditions. Through consultation and workshop, the management measures of the two wetland catchments were updated in this water management plan. Meanwhile, the related stakeholders also expressed their support and concerns of the wetland management in the future working process. In particular, the Water Resources Bureau adjusted the engineering plan for the water bodies' connection project, with an emphasis on the wetland ecological water demands matching with the ecological requirements of target species.

Methodology

Surveying and data collection techniques:

Monitor the distribution and population size of Siberian Cranes along transect lines and fixed points at Momoge NNR in every two days in each migration season of 2014 and 2015. The location of each crane flock will be determined with assistance of triangulation method by ranging laser, compass and GPS. The records include site coordinates, habitat type, water depth, human disturbances and meteorological information. Water depth will be estimated relevant to the height of water on the crane's legs.

Set up “marsh organs” to collect the sampling data in every ten days during the growth seasons of 2014 and 2015, which were constructed using 6×6 PVC pipes to monitor the water levels, food plants, and salinity of water and/or soil. The records include water depth, plant tuber number, plant net primary production (NPP), salinity of water and soil. The water depth will be acquired by the water log, and salinity of water and soil will be measured by the portable equipment.

Purchase and digitize the topographic maps at the scale of 1: 50000 using ArcGIS 10.0 to develop the digital elevation map for Momoge NNR.

Procure and interpret the satellite images to acquire the wetland distribution maps in 2013, 2014 and 2015.

Monitoring:

Depend on the local hydrological stations to collect the water volume entering the wetlands, and water allocation data if water replenishment occurred.

Monitor the water depth of key managed wetlands using standard water level points in every ten days from March to November in 2014 and 2015.

Community work:

Organize three meetings/workshops with local communities and stakeholders to discuss the sustainable and participatory water management plan based on water supply requirements and management options, which will be determined by the results of the ecologically applied study. The meetings were held in the project initiation, end of first year and project completion.

Frequently collaborate with related stakeholders related to implementing a water management plan, and provide technical assistance to the planned engineering project connecting different water bodies.

Education:

Present at least 3 reports to local students and stakeholders by the team member concerning conservation of wetland biodiversity under increased water variability during the project implementation.

Data analysis:

Based on statistical analysis and modelling for the habitat-use data, the water requirements of habitats by Siberian cranes would be determined. GIS 3-D and hydrological analysis were employed to develop the sustainable water management plan, which should also combine the bottom-up and top-down approaches.

Outputs and results

Development of sustainable water management plan

The sustainable water management plan was updated after the submission of the preliminary final report of this project. The detailed design of this plan consists of improvement of hydrologic conditions, emulation of natural hydroperiods, and vegetation management. The major adjustment is how to maintain the water within an acceptable level for the two priorities of 21 wetland catchments: Erlongtao River catchment and Etoupao wetland catchment. As the water income tripled after the operation of the newly developed irrigation areas. The two catchments accommodate almost the entire migratory population of Siberian Cranes in Momoge. The management conflict is the abundant water incomes with high salinity and high nutrition. Enlargement of the current water outlets, installment of some water stoplogs, and relocation of some water structures were proposed. Ecological monitoring was given a higher priority to be initiated in the early stage. Furthermore, the reserve authority should actively coordinate with the local government to redirect the drainage water system in a more effective way.

Application of the results of applied researches

The analysis of the annual precipitation data (1956-2014) indicated a ten-year wet-dry cycle. That means a wetland would maintain 3-4 years each for wet, dry and flood periods, respectively. The monitoring detected that the *Scirpus nipponicus* and *S. planiculmis* are the pioneering community in shallow wetlands, which will be replaced by reed and cattail with high water levels, and by *Echinochloa oryzoides* and *Chloris virgata* with continuous drought. Field observations found that *Scirpus* would have a 3-4-year lifespan in the wild. The seeds remain viable for long periods and plants rapidly establish once germination conditions are met. The design of wetland management aims to increase the hydrological regulation capacity to effectively manage aquatic plants as required. This emulation would enhance the wetland resilience under diverse water conditions.

Reduction of external threats to key stopover sites

The project team members did not only deliver the knowledge of wetland function, values and services to the local stakeholders, but also respected their experiences and perspectives related to the wetland management. Local Water Resources Bureau modified the Engineering Design of Water Bodies Connection Project to ensure the water management was more effective. Local Animal Husbandry Bureau and Fishery Bureau issue the ban for grazing and fishing activities for the key staging areas in migration seasons. Local Agriculture Bureau inspired the local farmers to plant some environment-friendly products to reduce the use of ground water and some chemicals. Local Security Bureau also joined the conservation of Siberian Cranes during the migration seasons.

Increased conservation awareness and water variability adaptation

Three education campaigns were organized by the project team members. The local students demonstrated positive attitude and great enthusiasm for natural science and environmental conservation. Some farmers established the mutual-help group to plant the environment-friendly products. Some farmers changed the free-ranging sheep to the fence-raised lambs. Local Agriculture Bureau introduced the drip irrigation technology under the plastic film. Accordingly, the local government provided some technical and financial support for these activities.

Communication & application of results

The team members have attended three regional workshops to present and share the project outputs and outcomes. We took advantage of these opportunities to communicate with relevant representatives and experts, to enlarge project impacts and improve our knowledge. Determining water management options for wetland management units with high priority is a complicated and comprehensive process. With lack of enough knowledge concerning different wetland types in response to hydrology, water management is a learning process. In the northeast China, conservation-based water management is a relatively new concept. It is lucky that we had two times to work with the foreign experts during the period of project implementation. We were impressed by their broad knowledge and deep insights into wetland science and management. This plan emphasizes the natural dry-wet process in semi-arid regions, which is basic in the formation of a stable (at large scale) yet dynamic (at small scale) system bound with physical constraints. In addition, we also had many interviews with the representatives of local stakeholders. The information about the drainage systems and water incomes, and the experience on the water structures and infrastructures, helped us improve the management measures for the two prioritized wetland catchments.

Monitoring and Evaluation

One mid-term workshop was organized to solicit comments from the internal team members and external experts about the project's progress. A plant expert pointed out the main food plants consist of two *Scirpus* species. Accordingly, we modified the plant composition for the marsh organs to test the ecological requirements of the two *Scirpus* species. Two stakeholders' workshops were organized to present the preliminary water management options and collected the abroad information and comments for improvement. This also affected the late submission of the final report of this project. The additional site visit after the submission of the preliminary final report also provided a good chance to evaluate the feasibility and reasonability of the water management plan. In addition, the distribution of the draft water management plan brought many valuable comments and suggestions from the project supervisors and referees, wetland specialists, ornithologists and hydrologists. Without these steps, we cannot imagine the plan would attain agreement among the local stakeholders.

Achievements and impacts

Recognized the natural hydroperiod of 10-year' cycle

The climate change analysis indicates that Momoge wetlands experience a natural wet-dry process within a ten-year cycle. The water management plan has followed this cycle: 3-4 years each for wet, dry and flood periods, respectively.

Detected the ecological relationship among water level, food plants and migratory Siberian Cranes

Introduction of marsh organs is an effective approach to detect the ecological requirements of the two food plants. Combined with the data of water level change and population dynamics, the preferred foraging habitat was determined for the Siberian Crane. The results were applied in the detailed water management plan.

Updated the sustainable water management plan

The development process is critical to determine the feasibility and reasonability of the final management plan. In this project, the hydrologic ecology, ornithology, plant ecology, wetland science and geographic information system were employed to optimize the final plan document. The plan was widely recognized and has been referenced by the other reserves in Songnen Plain.

Improved the wetland resilience for migratory waterbirds

Considering the expansion of the staging areas of migratory Siberian Cranes after 2013, the water management plan was developed in the landscape and site scales. This design follows the natural hydrologic conditions, and chemical and biological conditions will respond accordingly. Such

variability among years – ranging from severe drought through deep flood -- may be essential to the health and productivity of this wetland. Therefore, the design should take into account the different scales.

Reduced the external threats for the key staging areas

The local government has incorporated the wetland conservation into the 13th five-year plan of the Zhenlai County Development Plan. This is also a significant component of the ecological civilization construction plan. Relevant stakeholders also recognized the importance of the wetlands, and gave more attention to the wetland management and biodiversity conservation.

Increased the awareness and water variability adaptation

Under our suggestion, the reserve authority has established one We-chat platform to share the information of natural conservation and knowledge of wetland management for a more abroad audience. The variant pattern from year to year is also an important characteristic, particularly for wetlands in arid landscapes. We also proposed the rolling approach in managing the wetland units. This strategy also increases the capacity of water variability adaptation for the local farmers and related stakeholders.

Capacity Development and Leadership Capabilities

The project leader, Dr Liu Chunyue gained the capacity for project management and the communication skills with the stakeholders, enhanced the knowledge of biodiversity conservation, and incorporated results of applied field studies into water management practices. After two CLP projects, she has already become a competent conservationist. CLP projects had an important impact on her, they are a critical reason she became a conservationist. She still works on the waterbirds and wetlands conservation in Northeast China. Zou Changlin is a Member of Scientific Research Division of Momoge NNR, he showed extensive skill at field work and ecological monitoring. During the project, he enhanced the ability of scientific data analysis, which will aid him in conducting scientific research by himself to benefit his career. Sunyan learned how to design a field sampling to address scientific issues, and apply the research results into wetland management and conservation. After field works and public education practice, Zhang Lina learned how to deliver the knowledge of wetland biodiversity conservation to the broad outreaches, and enhanced skills to work with the local communities. Especially after she came back from CLP international training course in June 2014, she became a confident early-career conservationist. Now she works for Environment Protection Bureau of Shenyang City, she will apply the skills from our project to start her new conservation journey.

Section 3:

Conclusion

The Momoge wetland is the largest staging area for the critically endangered Siberian cranes. The shallow water wetland dominated by the two *Scirpus* plants is its favored foraging habitat during each migration season. The population monitoring indicates the distribution pattern has changed, especially after 2013. However, almost the entire population used the Erlongtao River catchment and Etoupao wetland. This change posed the wetland management would consider the design in site and landscape scales.

The hydrologic conditions determine wetland function. In the semi-arid region, its variability among years is essential to the health and productivity of the wetlands. The wetland formation process also reflects the aquatic plant composition. The *Scirpus* plants are the pioneering community in the saline-sodic soils, which can be replaced by reed and cattail with a continuous high water level, and taken by *Echinochloa oryzoides* and *Chloris virgata* with continuous drought. In this project, we inferred that a wetland can maintain *Scirpus* as the dominant community for a 3-4-year period. That means we can ensure, with proper management, that a wetland has abundant *Scirpus* for 3-4 years in a ten-year wet-dry cycle in this region, providing that the soil is disturbed through imitating a natural cycle and the wetlands are dried to reset succession.

However, we still lack of the knowledge concerning different wetland types in response to hydrology. Therefore, managing wetlands is a learning process in this region and should be improved through careful monitoring and adaptation in the future.

Problems encountered and potential solutions

Generally, the overall performance was satisfactory and implementation addressed our expected objectives. We still have some issues for lessons learned and best practices:

(1) The sustainable water management plan described from a more general perspective. The water management plan will help the authority evaluate objectively the water issue they encountered for Siberian Cranes and other waterbirds conservation. With lack of sufficient and qualified data to support the management decisions, it is difficult for us to select highly specific management measures on the cycle of water level control and vegetation management during the practise. Wetland monitoring is a critical step in pursuing adaptive wetland management, especially when we do not understand the current wetland ecosystems well. So, we recommended some wetland monitoring measures in the long-term to get more detailed information about water level, vegetation and bird distribution, which can help to improve adaptive management practices in the future.

(2) The Etoupao wetland catchment is a relatively closed wetland/impoundment. Before a big flood occurred in 1998, this area was dominated by the reed community. In response to a continuous drought, while restoring Etoupao in the 2000s, management focused on securing sufficient water for the wetland. With an easing of the drought and subsequent large-scale rice paddy development, the challenge for conservation of Etoupao wetlands and its Siberian Cranes has become too much water. In order to ensure the security of farmland in the upper reaches of Qianhang drainage station, the local government had the plan to enlarge the outflow capacity from the current 9 to 27m^3/s. However, the outflow of Etoupao outlet sluice was designed to be 5 m^3/s. Now the reserve authority is coordinating with the local water resources bureau to newly construct the outlet sluice in the southeast. And it is necessary to enlarge the water outflow capacity of the new outlet sluice to ensure the water flow into the lower reaches.

(3) According to the research plan, our team put 4 group marsh organs for collecting field data on April 2015, which should be there a whole growing season. At the end of the migration season, there was a severe cold wave at our study area a couple days before we planned to dig them out, thus our marsh organs were frozen in the wetlands. We didn't want to break our marsh organs, since the freezing wouldn't affect the numbers of tubers inside, we decided to keep the marsh organs in the field the entire winter of 2015. In May 2016, we collected the tubers from marsh organs once the ice was melted naturally in the field of the study area.

The marsh organs in summer

The frozen marsh organs with tubers in winter

In this case, we cannot get the tubers for data analysis, and the preliminary report and financial report won't be done on time due to the delayed field work. The final report will be delayed as well. Considering all the activities related to the marsh organs were affected, we request to update our project end date to 31st Dec 2016. Thus, we finished all the field work by the end of September of 2016.

In the Future

(1) To monitor the migratory population dynamics of Siberian cranes at Momoge wetlands and conduct at least another 3 years marsh organs research to better understand the relationship between water depth, food plant succession and crane distributions. The project leader already applied the fund to continue research activities at the study area over the next 4 years. The results could help examine the efficiency of sustainable management plan practice and provide more information on the future work.

(2) The project leader has participated the ICF project “East migration Siberian Crane population conservation” as GIS expert, she will work with other researchers to develop wetland zonation and adaptive management plan for Momoge NNR, which would focus on management of wetland units with highest priority in Momoge NNR to maximize waterbird diversity, especially for threatened and endangered waterbird species, and to enhance wetland resilience under different water conditions.

(3) In the meantime, the project leader has been keeping regular communication with the related stakeholders, especially for the implementation of the sustainable management plan. In the future, the team members will speed up the publication of related monitoring and research results.

Financial report

Itemized expenses	Total CLP Requested (USD)*	Total CLP Spent (USD)	% Difference	Details & Justification	Proposed Spending
PHASE I - PROJECT PREPARATION					
Communications (telephone/internet/postage)	50.00	60.56	21%		
Field guide books, maps, journal articles and other printed materials	300.00	252.33	-16%		
Insurance	400.00	461.52	15%		
Visas and permits					
Team training	600.00	688.29	15%		
Reconnaissance	400.00	442.79	11%		
Other (Phase 1)	1,300.00	1465.13	13%		
EQUIPMENT					
Scientific/field equipment and supplies	3,450.00	3592.63	4%		
Photographic equipment	400.00	371.10	-7%		
Camping equipment	300.00	336.98	12%		
Boat/engine/truck (including car hire)	800.00	889.32	11%		
Other (Equipment)					
PHASE II - IMPLEMENTATION					
Accommodation for team members and local guides	3,440.00	3657.72	6%		
Food for team members and local guides	3,840.00	3671.87	-4%		
Travel and local transportation (including fuel)	5,120.00	4766.23	-7%		
Customs and/or port duties					
Workshops	1700.00	1635.38	-4%		
Outreach/Education activities and materials (brochures, posters, video, t-shirts, etc.)	1,800.00	2204.43	22%		
Other (Phase 2)	600.00	533.86	-11%		
PHASE III - POST-PROJECT EXPENSES					
Administration					
Report production and results dissemination	500.00	499.35	0%		
Other (Phase 3)					
Total	**25,000.00**	**25,529.48**			

Section 4

Appendix4.1 ： CLP M&E measures table

Output	Number	Additional Information
Number of CLP Partner Staff involved in mentoring the Project	0	
Number of species assessments contributed to (E.g. IUCN assessments)	1	The migration monitoring data of Siberian Cranes was shared with the chair of Crane Specialists Group under the IUCN Species Survival Commission.
Number of site assessments contributed to (E.g. IBA assessments)	1	The project provided basic monitoring data for completion of Ramsar site information sheet by the Momoge reserve staff.
Number of NGOs established	1	Momoge Wetland Conservation Association was established in 2015 under the management of Momoge National Nature Reserve.
Amount of extra funding leveraged ($)	42,000	$2,000 was funded by the Institute to support procurement of the high resolution satellite images. $40,000 was funded by the Jilin Forestry Department to support the germination experiment of *Scirpus*: main food plant of Siberian Cranes.
Number of species discovered/rediscovered	1	Eight and six Baer's Pochards *Aythya baeri* were discovered during the fall monitoring periods of 2014 and 2015, respectively, which is recognized as a critically endangered species by the IUCN RedList.
Number of sites designated as important for biodiversity (e.g. IBA/Ramsar designation)	1	The Momoge wetland was recognized as the Ramsar Site in October of 2013.
Number of species/sites legally protected for biodiversity	2	Two new staging areas in Momoge National Nature Reserve have been fenced to prevent the external disturbances such as fishing and grazing activities, and disturbances from the visitors and photographers.
Number of stakeholders actively engaged in species/site conservation management	10	The local Water Resources Bureau, Agriculture Bureau, Reed Management Bureau, Animal Husbandry Bureau, Irrigation Area Management Bureau, Forestry Bureau, and four

		townships were actively engaged in the wetland conservation.
Number of species/site management plans/strategies developed	1	Water management plan for Momoge National Nature Reserve was developed.
Number of stakeholders reached	16	The project team members interviewed representatives of 16 stakeholders two or three times during the life of project. We also invited them to attend one stakeholders' workshop to solicit the comments and suggestions on the draft of the water management plan.
Examples of stakeholder behaviour change brought about by the project.	6	The local Water Resources Bureau organized one workshop to solicit the comments on the design of Water Bodies Connection Engineering Project, which considered the design of water replenishment and control for the key staging areas of Siberian cranes. The local Animal Husbandry Bureau and Fishery Bureau issued the grazing ban and fishing ban in the key staging areas of Siberian Cranes in migration seasons.
Examples of policy change brought about by the project	1	Wetland conservation plan was incorporated into the Zhenlai County Development Plan, which is the first time to present the wetland conservation plan under the ecological civilization construction strategy by the local county government.
Number of jobs created	15	15 farmers and workers were temporarily employed during the construction of marsh organs and field monitoring.
Number of academic papers published	1	Jiang HX, Liu CY, Sun XW, Lu J, Zou CL, Hou YQ, Lu XG. 2015. Remote sensing reversion of water depths and water management for the stopover site of Siberian Cranes at Momoge, China. Wetlands, 35: 369-379.
Number of conferences where project results have been presented	3	1. International Conference on Resources, Enviroment and Regional Sustainable Development in Northesat Asia on June 12, 2014. Changchun, China; 2. Asian Wetland Symposium/Ramsar Pre-COP12 Asia Regional Meeting from November 3 to 7, 2014 at Siem Reap, Cambodia; 3. Seminar on Fostering Chinese Talents in Nature Conservation July 23 to 24,2016 in Beijing, China;

Appendix4.2：Raw field data

Water bird monitoring data

Table 1 Coordinates of 28 fixed points for observation of Siberian cranes in Momoge wetland

Code	wetland name	Name	Latitude (degree)	Longtitude (degree)
1	Yanbaotu	Northwest Yuanbaodu	45.968855	123.522555
2	Duluba	South Duluba	45.878033	123.601367
3	Duluba	East Duluba	45.886094	123.634874
4	Taolagao	Taolagao	45.925126	123.519354
5	Taolagao	Zhushan Brigde	45.909137	123.523107
6	Minggatun	Southeast Mingga	45.884877	123.586050
7	Minggatun	West Mingga	45.891516	123.556347
8	Minggatun	East Chatai	45.858149	123.528302
9	Mitai	West Mitai	45.864955	123.682634
10	Taipingshan	Taimingshan	45.932151	123.747831
11	Yueliangpao	Longkeng Station	45.794271	123.925477
12	Haernao	Ximao	45.858140	123.979903
13	Haernao	Laojiangbei	46.000252	123.951537
14	Haernao	Luweiju	45.964202	123.944419
15	Haernao	Haernao	45.943753	123.941211
16	Juzhidao	Crane house	45.931054	123.562006
17	Juzhidao	Flyway platform	45.938918	123.532321
18	Mengtaizhao	North Mentianzhao	46.057397	123.606361
19	Mengtaizhao	East Mengtianzhao	46.050544	123.625603
20	Halata	South Halata	46.028238	123.570775
21	Halata	West Halata	46.037332	123.564424
22	Halata	Nabutai	46.030433	123.605339
23	Halata	Nadai	46.014754	123.577473
24	Etoupao	Sukema	45.890846	123.638751
25	Etoupao	Jiankong	45.897959	123.671486
26	Etoupao	Etou	45.904231	123.699800
27	Etoupao	Daitou	45.882667	123.724098
28	Wulanzhao	West Duluba	45.886941	123.580966

Due to the large amounts of original data in Chinese, we just present the daily counting of chicks and adult Siberian cranes at Momoge NNR in 2014, 2015.

Figure 2. The population dynamices of Siberian Cranes in 2014 and 2015 at Momoge NNR

Water level data from water Logger

We set water loggers in the wetland and recorded the water level data every 6 hours during growing season in Etoupao wetland. The number of data is over 3000, so we only represent the water level records figure here.

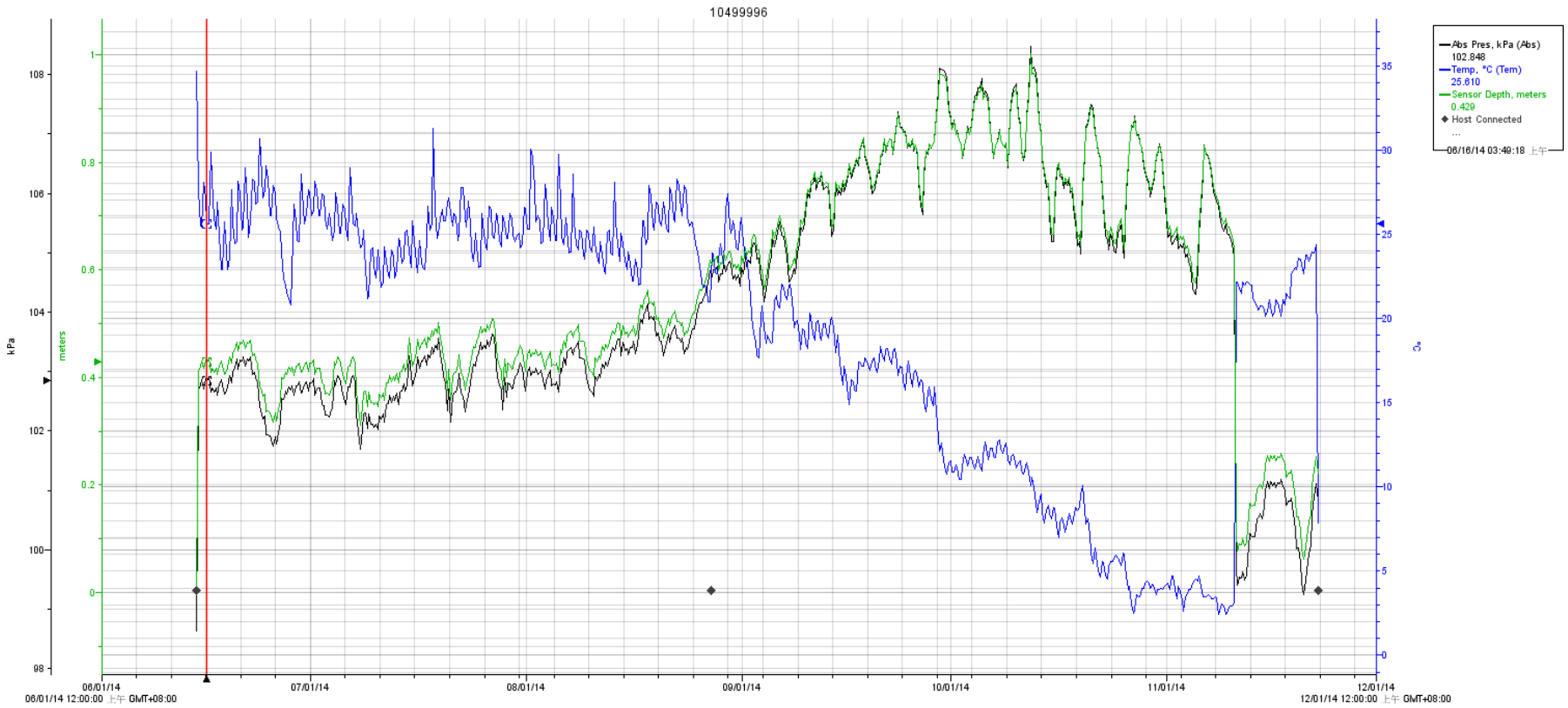


Figure 3 The records of water logger in Etoupao wetland from June 1 to Dec. 1 2014, The green line is water depth(m), the black line is Abs press(Kpa), the blue line is the water temperature(℃)

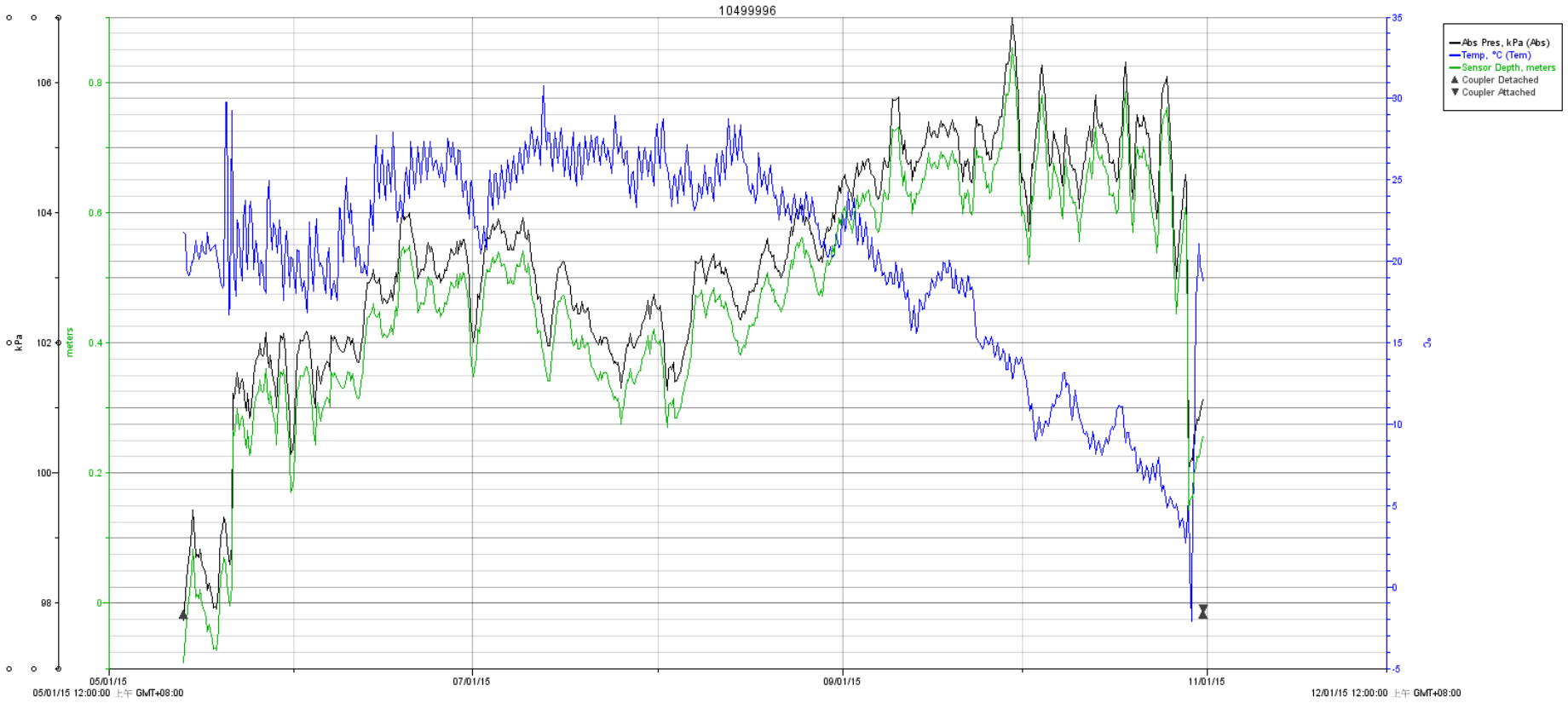


Figure 4 The records of water logger in Etoupao wetland from May 1 to Nov. 1 2014, The green line is water depth(m), the black line is Abs press(Kpa), the blue line is the water temperature(℃)

Marsh organs data

During the project implementation, four sets of marsh organ were manufactured and set up in the wetland in late April 2014 to test the response of the two food plant species (*Scirpus nipponicus* and *S. planiculmis).* to various water levels and soil types. Unfortunately, one set was submerged completely due to a big water wave in mid-May. The remaining three sets now operate well in the growing season in 2014 and 2015. The records include plant species, number, and height. Since we had 3 groups of marsh organs, which were monitored every 10 days during the grown season in 2 years, so we got 27 record tables in 2014 (9 times) and 24 record tables in 2015 (8 times), so we just present the Group A recode in 2014:

Table 2 The recodes of marsh Organs Group in 2014(SJ,5,54.8: SJ or LW is the plant species, SJ: *Scirpus nipponicus*, LW: Reed; the number between commas is the number of plants; the number after the second comma is the mean height of plants.

Date: 20140629								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,7,25.43						1
	60cm		SJ,1,12	SJ,1,34				2
	50cm							3
	40cm							4
	30cm		SJ,1,32					5
	20cm	SJ,4,66.8	SJ,4,55					6

Date: 20140709								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,8,27						1
	60cm							2

	50cm						SJ,2,7.5	3
	40cm							4
	30cm		SJ,1,32					5
	20cm	SJ,4,86	SJ,4,64.3					6

Date: 20140719								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,7,30.9						1
	60cm							2
	50cm						SJ,2,17.5	3
	40cm							4
	30cm		SJ,1,49					5
	20cm	SJ,4,91.3	SJ,5,63.6					6

Date: 20140729								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,8,28.75						1
	60cm							2
	50cm						SJ,2,23.5	3
	40cm							4
	30cm		SJ,1,67					5
	20cm	SJ,4,91.3	SJ,5,65.6					6

Date: 20140808								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,8,27.4						1
	60cm							2
	50cm					SJ,3,22.7	SJ,2,26.5	3
	40cm							4
	30cm		SJ,1,67					5
	20cm	SJ,4,92.8	SJ,6,63.6					6

Date: 20140818								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,7,28.7						1
	60cm	SJ,1,13						2
	50cm						SJ,2,28.5	3
	40cm	SJ,3,31	SJ,3,32				SJ,3,22.7	4
	30cm		SJ,1,71	LW,1,33			LW,3,42	5
	20cm	SJ,5,91.25	SJ,7,63.6					6

Date: 20140828								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water	70cm	SJ,8,27.2						1

depth	60cm	SJ,1,36						2
	50cm						SJ,1,28	3
	40cm	SJ,4,33.5	SJ,3,45			SJ,1,31	SJ,3,33	4
	30cm		SJ,1,67	LW,1,44			LW,4,47	5
	20cm	SJ,5,80.4	SJ,6,67.8					6

Date: 20140907								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm	SJ,5,30.6						1
	60cm				SJ,1,20			2
	50cm						SJ,3,28.3	3
	40cm	SJ,4,50	SJ,3,62.3				SJ,3,45.7	4
	30cm		SJ,1,69	LW,1,44			LW,4,56	5
	20cm	SJ,4,85.3	SJ,4,74.8					6

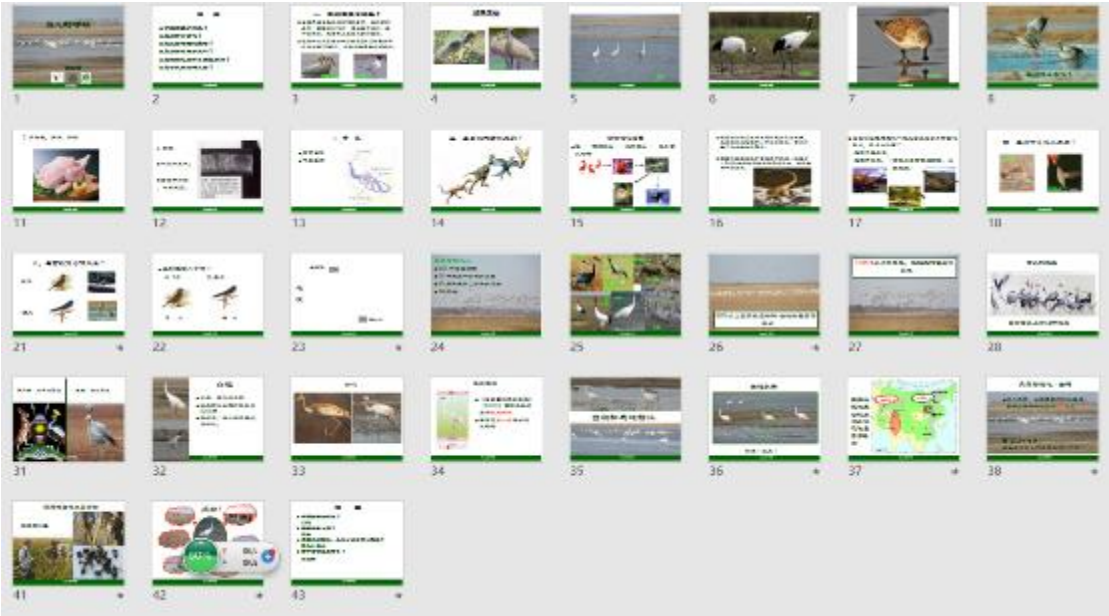
Date: 20140917								
Group A*Scirpus nipponicus* (SJ)seeds with Alkaline soil								
seeds	No.	6	6	4	4	2	2	
	Depth	10cm	5 cm	10 cm	5 cm	10 cm	5 cm	
		A6	A5	A4	A3	A2	A1	Code
Water depth	70cm							1
	60cm				SJ,1,20			2
	50cm						SJ,3,28.6	3
	40cm	SJ,5,54.8	SJ,4,61				SJ,4,44.5	4
	30cm		SJ,2,69 LW,2.57				LW,4,61.5	5
	20cm	LW,2.80.5	LW,3.65					6

Appendix4.3： Public education materials

The project logo T-shirt

The Logo of the project printed on the back of T- shirt is a Siberian Crane standing in the wetland. The blue color of T-shirt represents water which is our projects critical issue; the words under the logo means “humans and cranes drink Nenjiang water, we share one world”. The T-shirts have been distributed to some local stakeholders, farmers, students, and the reserve staff.

The PowerPoint of environmental education on local primary school



Appendix4.4：Published paper

Jiang HX, Liu CY, Sun XW, Lu J, Zou CL, Hou YQ, Lu XG. 2015. Remote sensing reversion of water depths and water management for the stopover site of Siberian Cranes at Momoge, China. Wetlands, 35: 369-379.

Wetlands (2015) 35:369–379
DOI 10.1007/s13157-015-0626-6

ORIGINAL RESEARCH

Remote Sensing Reversion of Water Depths and Water Management for the Stopover Site of Siberian Cranes at Momoge, China

Hongxing Jiang · Chunyue Liu · Xiaowei Sun · Jun Lu · Changlin Zou · Yunqiu Hou · Xianguo Lu

Received: 29 March 2014 / Accepted: 7 January 2015 / Published online: 23 January 2015

Abstract Traditional water depth survey of waterbird habitats takes huge amount of labor, time and money. The optical remote sensing image from passive multispectral scanner has been widely employed to estimate water depth. We developed a water depth model based on the characteristics of visible and near infrared spectra of Landsat ETM+ image at Etoupao shallow wetland. The wetland is the largest stopover habitat of the critically-endangered Siberian Crane, which mainly feed on the tubers of *Scirpus planiculmis* and *S. nipponicus*. Water control is critical for maintaining tubers production and food availability for the crane. Multi-band approach is employed in the model, which effectively simulates water depth for the shallow wetland. The parameters of NDVI and GREEN in the model indicated that the vegetation growth and coverage affecting reflectance from water column change were uneven. Combined with observed water level data in the same day of image acquisition, the digital elevation model (DEM) for underwater terrain was generated. The findings provide a good reference to manage water level and water demand, and create suitable foraging habitats for the crane. The methods can be adapted for underwater terrain simulation and water management in waterbirds habitats, especially in the shallow heterogeneous wetlands.

Key words Shallow wetland habitat · Remote sensing · Water depth reversion · Siberian crane · Waterbirds · Water management

Introduction

Waterbirds are birds that inhabit in or depend on water bodies or wetlands. They are found in a specific range of water depths (Boettcher et al. 1995; Ntiamoa-Baidu et al. 1998; Rajpar and Zakaria 2011; Baschuk et al. 2012). Many waterbird species can readily alter diets and feeding locations to the food resources available, but the accessibility of food is limited by the birds' morphological attributes such as the length of their necks, beaks and legs. For shorebird species, the size, shape and function of their body place a limit on the water depth to which they can access food (Velasquez and Navarro 1993; Collazo et al. 2002). In addition, water depth also determines

Acknowledgments This research was supported by the Basic Research Fund of Central Public-interest Scientific Institution of China (CAFRIFEEP201001), Conservation Leadership Programme (F03196214) and WetAdapt Project (cooperated with the International Crane Foundation). We thank Momoge National Nature Reserve for giving us permission to conduct this study. We also thank the anonymous reviewers for their comments on an earlier version of this manuscript.

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Hui SR, Li X, Zhang ZX, Ning Y (2009) Impact of soil salinity on the growth of *Scripus planiculmis*. J Liaoning For Sci Technol 1:25–28
Jiang HX (2010) The maximum daily count of Siberian cranes reached 3128 individuals in spring 2010 at Momoge national nature reserve. Newsl China Ornithol Soc 19(1):6
Jiang HX (2013) Migratory Siberian Cranes at Momoge National Nature Reserve, Northeast China, in 2012. Siberian Crane Flyway News

Appendix4.5： Minutes of stakeholder meetings in Momoge NNR

The First stakeholder meeting

Following completion of the draft of sustainable water management plan, the project team cooperated with the Momoge NNR to hold the first stakeholder meeting at the 3rd floor meeting room of Forestry Bureau building from Nov. 26 to 27, 2014. A total of 24 participants attended this meeting, which includes the representatives from the Fishery Bureau, Reed Bureau, Livestock Bureau, Agriculture Bureau, Forestry Bureau, Water Resources Bureau, Environmental Protection Bureau, Land Management Bureau, Zhenlai Irrigation Districts, Management office of land arrangement of western Jilin (Zhenlai), Wujiazi Pump station, Baishatan Pump Station and the reserve authority. The meeting was presided by this conservation project leader Dr. Liu Chunyue.

The meeting agenda is below:

In the first morning session, the project leader introduced the background, objectives and main findings of this Conservation Leadership Project, and the reserve staff introduced the current status of the waterbirds and habitat in the MNNR.

In the first afternoon session, one team member, Mr. Zhou Changlin introduced current hydrology conditions, including Natural water system and Irrigation area system and facilitated the discussions on it.

In the second day session, one team member, Ms. Zhang Lina presented the sustainable water management plan and led the discussion on it. Then the representatives from Water Resources Bureau, Zhenlai Irrigation Districts, Management office of land arrangement of western Jilin (Zhenlai) introduced their situation in Momoge wetland.

In the course of the meeting, all participants were actively involved in the discussion and communicated very well. All of them recognized the significance of this wetland to the critically endangered Siberian Cranes, and that it is every important to keep this wetland safe for protecting this species. They all agreed our sustainable water management plan was a good start to lead them to think what they can do for the wetland conservation, they all also provided comments to improve the draft plan, which will be included in the Final version of the plan to correct some factual inaccuracies. Finally, all representatives also hope for us to share the revised plan after this meeting, they all expect us to continue the project in this area.

Team members of the CLP ID F03196214

November 27, 2014

The Second stakeholder meeting

In order to share the project results, disseminate the project achievements, increase the audiences' awareness, and discuss the implementation of the sustainable water management plan, the project team cooperated with the International Crane Foundation and Momoge NNR to hold the second stakeholder meeting at the meeting room of Siberian Crane Hotel of Zhenlai from April 27 to 28, 2015. A total of 46 participants attended this meeting, which includes the representatives from the International Crane Foundation, NBBC, Jilin Forestry Department, Inner Mongolia University, Northeast Institute of Geography and Agroecology, CAS, Local Fishery Bureau, Reed Bureau, Livestock Bureau, Agriculture Bureau, Forestry Bureau, Water Resources Bureau, Environmental Protection Bureau, Management office of land arrangement of western Jilin (Zhenlai), Tumuji NNR and the reserve authority. The meeting was presided by Dr. Jiang Hongxing from NBBC.

The meeting agenda related to our project is below:

In the first morning session, the project leader Dr. Liu Chunyue introduced the background, objectives and main findings of this Conservation Leadership Project briefly and the sustainable water management plan from 10:00am to 11:00 am.

In the first afternoon session, one team member, Mr. Zhou Changlin facilitated the discussions on the analysis of strengths, weaknesses, opportunities, threats (SWOT) involved in the implementation of sustainable water management from 15:00am to 17:00 am.

In the second morning session, the representatives from Reed Bureau, Agriculture Bureau, Water Resources Bureau, Management office of land arrangement of western Jilin (Zhenlai) gave a brief presentation about their own water management policy, current and future water infrastructure condition related to the water resource availability at Momoge wetland.

In the second afternoon session, the opening discussion day, all the team members participated with the stakeholders on how to implement the optimal conservation strategies in the study area, then the meeting minutes were developed based on the former discussions.

In the course of the meeting, all participants were actively involved in the discussion and communication. The following were concluded from the meeting:

(1) According to the sustainable water management plan, the representative of the ICF will develop the wetland Zonation and Adaptive management plan for Momoge NNR from 2016, which focuses on management of wetland units with highest priority in Momoge NNR to maximize waterbird diversity, especially for threatened and endangered waterbird species, and to enhance wetland resilience under different water conditions.

(2) The wetland recovery research group from Northeast Institute of Geography and Agroecology, CAS, will work on the two *Scirpus* species succession research for Siberian Crane habitat recovery near Etpopao area.

(3) The vegetation management demonstration base will be established by Chinese Academy of Forestry and ICF within Erlongtao catchment for experimenting with control of cattail and reed in the deep-water wetlands.

(4) The reserve authority promised to help coordination with related stakeholders to push this recommendation into reality. Meanwhile, they also hope to get the technical support from this project concerning the timing and amount of water supply.

Team members of the CLP ID F03196214

April28, 2015

Appendix4.6：Copies of project news

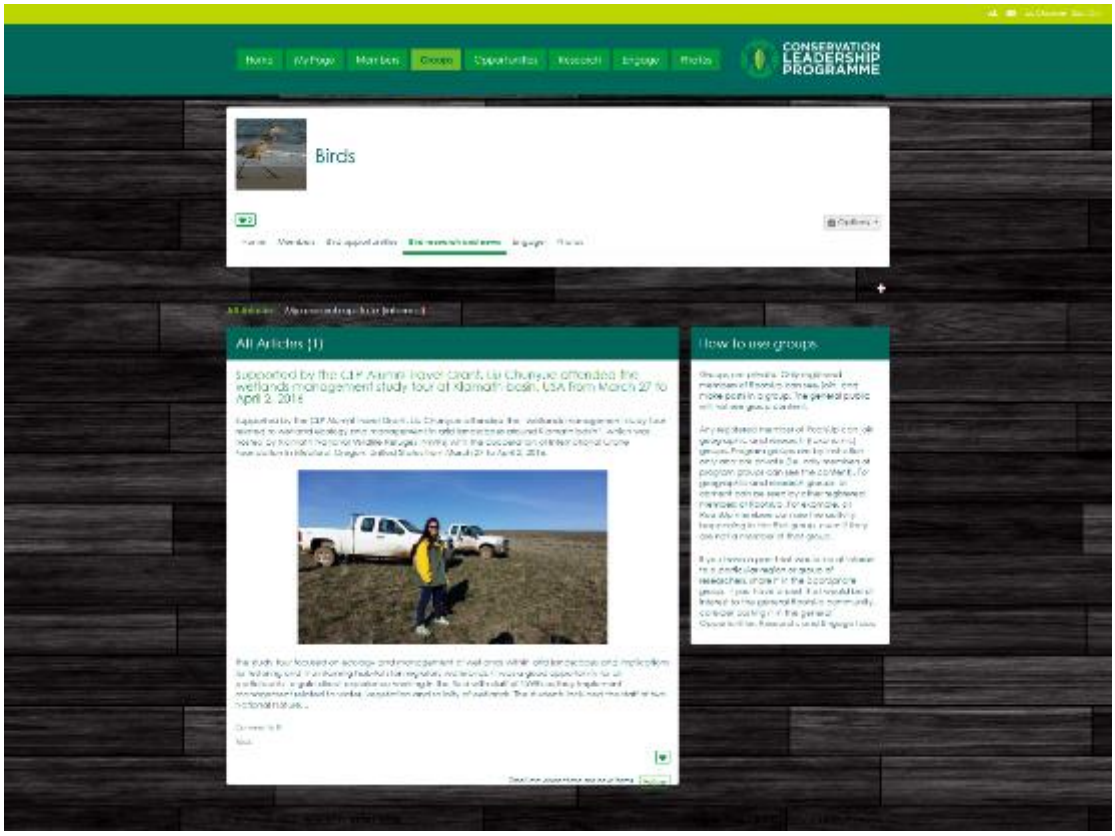
(1) The Project news in Weixin (In Chinese)

https://mp.weixin.qq.com/s?__biz=MzAxMjc5MDMzNg==&mid=2649130333&idx=2&sn=399d6f8b7158372763bf22d2ca3dcf65&mpshare=1&scene=1&srcid=0903zsKykKvmVW8lOrkLZ1xd#rd

(2) The Project poster in Asian Wetland Symposium/Ramsar Pre-COP12 Asia Regional Meeting from November 3 to 7, 2014 at Siem Reap, Cambodia

(3) The Project Leader Dr. Liu Chunyue presented the project's results in the International Conference on Resources, Enviroment and Regional Sustainable Development in Northesat Asia in her institute on June 12, 2014, if any one wants a copy of this report, please contact the project leader, Dr. Liu Chunyue.

(4) Supported by the CLP Alumni Travel Grant, Liu Chunyue attended the “wetlands management study tour related to wetland ecology and management in arid landscapes around Klamath basin”, which was hosted by Klamath National Wildlife Refuges (NWRs) with the cooperation of International Crane Foundation in Medford, Oregon, United States from March 27 to April 2, 2016.



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Communication outputs

Communicate with the Senior Vice-president Jim Harris of International Crane Foundation, who incorporated the bird monitoring and marsh organ data into the progress report of "Wetlands, Cranes, Communities and Climate Change – Strengthening Adaptive Management at Momoge and Tumuji National Nature Reserves"

Communicate with the reserve authority, they cooperated with International Crane Foundation to develop the wetland Zonation and Adaptive management plan for Momoge NNR in 2017 based on the sustainable water management plan, which focuses on management of wetland units with highest priority in Momoge NNR to maximize waterbird diversity, especially for threatened and endangered waterbird species, and to enhance wetland resilience under different water conditions.

Papers preparing to be published

1. Modeling Stopover Habitat Selection of Siberian Cranes *Leucogeranus leucogeranus* to Guide Site Management in Staging Areas along Eastern Flyway
2. Are food supply enough to support over 80% world population of Siberian cranes in each migration season in Etoupao wetland, Northeastern China?

Address list and weblinks

Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences.

The Institute is a comprehensive research institution in geography and agronomy in China. It aims at the international forward position of wetland science and national strategic demands on wetland ecology, resources and environment, considering the agroecological situation and the developmental trend of modern agriculture, NEIGAE takes wetland science as its superior subject, wetland eco-environment and regional agroecology as its important research fields, and remote sensing geo-information and regional development as related research fields.

Address: No. 3195, Weishan Road, Gaoxin District, Changchun, Jilin Province. PC: 130012. PR of China.

Administrative Bureau of Momoge National Nature Reserve

The reserve is located in the west Songnen Plain, which is the semi-drought area. It was established in 1981 as the provincial reserve, and upgraded as the national nature reserve in

1997. The total area of the reserve is 144 thousand hectares. Three rivers pass through the east, south and west of the reserve, which are Nenjiang River, Taoer River, and Erlongtao River, respectively. Since 1980s, no water from Erlongtao River can pass through the west of the reserve due to the reservoirs constructed in the upper reaches. With regard to the Taoer River, it is very hard for the water to overflow into the wetland south of the reserve due to the dam construction and poor water flow in normal water years. Now the natural water resources for the wetland mainly come from the Nenjiang River, releasing water from paddy fields and the rainfall. In recent years, about 50% of the wetlands are facing drought, desertification and salinization, which negatively affect the waterbirds for wintering, breeding and stopover.

Address: MomogeTown, ZhenLai County, Jilin Province. PR of CHINA. PC: 137316.

National Bird Banding Center of China

The National Bird Banding Center of China (NBBC) was established in 1982 and is located in the headquarters of Chinese Academy of Forestry (CAF). The NBBC is subject to the Research Institute of Forest Ecology, Environment and Protection (RIFEEP) of CAF, which has the responsibilities of implementing inter-governmental agreements on migratory birds, providing technical support and information management of national bird banding, coordinating national waterbirds monitoring, and conducting research and protection on endangered waterbirds in China. The NBBC is also the technically supportive organization for the Department of Wildlife Conservation and Nature Reserves Management, State Forestry Administration of China.

Address: No. 1, Dongxiaofu, Qinglongqiao, Haidian District, Beijing. PC: 100091. PR of CHINA

marsh.neigae.csdb.cn

China wetland scientific database is the integration of spatial information and computer techniques. The database was based on the wetland information obtained by the field survey, and spatial distribution information of wetland acquired by the remote sensing technique, covering the national wetlands from 1956 to 2006. The database was expanded to include some waterbirds database since 2003 with the initiation of the Siberian Crane Wetlands UNEP Project. The database has numerous applications such as wetland data mining, impact assessment of wetland changes on the waterbirds, wetland landscape pattern change, and so on. The site is heavy with advertising, including some technical support for the wetland management authorities, basic data for some scientific research, and public education.

Distribution list

The project report and related outputs have been distributed to the following agencies and persons:

Administrative Bureau of Momoge National Nature Reserve, Jilin Province, China.

Division of Wildlife Conservation, Jilin Forestry Department.

Songliao Water Resources Commission, Ministry of Water Resources of China.

Mr. Jim Harris, Senior Vice-President of International Crane Foundation.

Dr. Su Liying of International Crane Foundation. liying@savingcranes.org

Mr. Crawford Prentice of International Crane Foundation. Crawford@savingcranes.org

Dr. Jiang Hongxing of National Bird Banding of China. hxjiang@caf.ac.cn

Prof. Sammy King, Louisiana state University and Louisiana Cooperative Fish and Wildlife Research Unit and Adjunct Associate. sking@agcenter.lsu.edu