Response to reviewers

Response to Reviewer #1

Thank you very much for your elaborative review for our manuscript entitled “An optimisation approach for shallow lake restoration through macrophyte management”. We have carefully considered the comments and revised the manuscript accordingly. All the responses to the comments are summarized as shown below.

1. Comment: The overall conciseness of this manuscript should be improved. Certain sentences need to be rewritten because of their misleading meanings, e.g.: Line 25-26, Page 809, ‘*Phytoremediation can remove nutrients although the macrophyte community alsoleads to high evapotranspiration, which results in significant loss of water in lakes*’.

Response:

We have revised the English language again to improve the conciseness of the paper. Certain sentences, which may lead to misleading meanings, have been rewritten. Take the sentence in the comment as an example. This sentence has been replaced by “*Phytoremediation can remove nutrients, while the macrophyte community also leads to high evapotranspiration. The huge evapotranspiration results in significant loss of water in lakes.*”

2. Comment: Line 13-17, Page 810. The authors should explain more on the reason why optimization of plant density is not enough for lake restoration. Also, since both plant density and plant area are both key parameters for lake restoration, the authors should explain why only the plant area was discussed in this paragraph and the whole manuscript.

Response:

Macrophytes can remove nutrients from the lake to improve lake water quality, while huge loss of water caused by plant evapotranspiration is disadvantageous for water quality. Thus it is significant to regulate macrophyte populations considering these two opposite effects of macrophytes on water quality restoration. Macrophyte population is affected by two factors. One is plant density and another is plant area. Previous research has proposed the optimal plant density, but no research offered a method for determining the optimal plant area in lakes. Plant area also has a direct relationship with plant population, so only optimising plant density is not enough for water quality restoration.

Plant density and plant area are both key parameters for lake restoration, but only plant area was discussed in this study. The plant density of this study was set as the same as the current plant density in the lake. Plant density was not optimised because reed density is hard to be controlled in the real condition of the lake. If we want to control the plant density to a certain level, we need to harvest parts of them in the whole growing zone, which is more than 80 km^2. This is a really heavy task for lake managers. Besides this, reed rhizome system has high reproductive capacity (Lavergne and Molofsky, 2004). Although we could control reed density to the optimal level through harvesting, high reproductive capacity of reed rhizome would break the optimal level quickly. It is nearly impossible to control reed density at a certain level throughout its growing season. Thus plant density was not discussed in this manuscript. I have explained this problem in Line 7-10, Page 817.

After this explanation, people may wonder whether plant area is also hard to be controlled. Actually, plant area is much easier to be controlled than plant density. Various measures have been proposed to control growing area of reeds (*Schönerklee, M., Koch, F., Profilers, R., Haberl, R., & Labor, J. (1997). Tertiary treatment in a vertical flow reed bed system-a full scale pilot plant for 200–600 pe. Water Science and Technology, 35(5), 223-230*). For example, Geomembrane barrier is one kind of effective productions to control reed area, which can prevent rhizome penetrating and spreading out. Thus, we don’t need to worry about the feasibility of this management regime proposed in this manuscript.

In order to make the explanation clearer, one sentence has been added into the new manuscript. “*In actual conditions, plant density is very difficult to quantify and control. The reed rhizome system has high reproductive capacity (Lavergne and Molofsky, 2004), so it is almost impossible to artificially control reed density throughout the reed growing season.*”

3. Comment: Line 22, P810 to Line 6, P811. There is no need for the authors to discuss the effect of harvest on the water quality after Sep. For the time after Sep, the two systems are the same, since no evaporation or absorption will be occurred.

Response:

The highest nutrient storage of reed aboveground tissues occurred in September, so harvest of aboveground part should be finished no later than this month. If they are not harvested, reeds will release nutrients to the lake after September. Although evaporation and nutrient absorption are not occurred after September, it is still essential to discuss the effect of phytoremediation on water quality in the following months, because harvest time will determine the water quantity and nutrient amounts remaining in the lake and then affect the water quality of next months.

For example, the water quantity remaining in the lake affects the tolerance of nutrient inflows in following months. If water quantity of the lake is very small, the nutrient concentration will be very sensitive to nutrient increasing, even a small increment. Or if water quantity of the lake is really large, the nutrient concentration will be very tolerant to nutrient increasing. Thus, water quantity remaining in the lake deeply affects the water quality in the following months after September. We need to analyse the effect of harvest on water quality in both plant growing season and plant non-growing season, so we think that this content should be retained in the manuscript.

One sentence has been revised in the new manuscript. "*This harvest scheme may not be best for water quality in the following months, because in addition to nutrient removal reeds also undergo evapotranspiration. Water quantity and nutrient amounts remaining in the lake have a deep influence on water quality in next months*."

4. Comment: For the ease of understanding, it would be preferential for the authors to list all the equations relating to the optimization process, e.g.: the equations to calculate TN_{uptake}, $TN_{release}$, etc.

Response:

This manuscript offered a series of equations to help analyzing the mass balances in the water body, but we did not give these equations for calculating some parameters because we thought the calculation processes of these parameters were very clear. For example, $TN_{uptake,i}$ means the amount of TN absorbed by plants in month i, which can be calculated by multiplying plant growing acreage and the amount of TN absorbed by plants in unit area. The amount of TN absorbed by plants in unit area in each month is measured through experiments and these data are clearly showed in the manuscript.

According to your advice, we think that we should add some equations to help readers easily understand the calculation processes of these parameters about plant uptake and biological denitrification, such as $TN_{uptake,i}$, $TP_{uptake,i}$, $TN_{rhiz,deni,i}$ and $TN_{sedi,deni,i}$. These equations are added behind equation (5).

$$\mathbf{TN}_{\text{uptake},i} = (\mathbf{tn}_{\text{above,upt},i} + \mathbf{tn}_{\text{below,upt},i}) \times \mathbf{A}_{\text{plant,sub},i} \quad (6)$$

$$\mathbf{TP}_{\text{uptake},i} = (\mathbf{tp}_{\text{above,upt},i} + \mathbf{tp}_{\text{below,upt},i}) \times \mathbf{A}_{\text{plant,sub},i} \quad (7)$$

$$\mathbf{TN}_{\text{rhiz,deni},i} = \mathbf{tn}_{\text{rhiz,deni},i} \times \mathbf{A}_{\text{plant,sub},i} \quad (8)$$

$$\mathbf{TN}_{\text{sedi,deni},i} = \mathbf{tn}_{\text{sedi,deni},i} \times \mathbf{A}_{\text{submerged},i} \quad (9)$$

where $\mathbf{tn}_{\text{above,upt},i}$ and $\mathbf{tn}_{\text{below,upt},i}$ are the amounts of TN absorbed by aboveground parts and belowground parts of reeds in unit area; $\mathbf{tp}_{\text{above,upt},i}$ and $\mathbf{tp}_{\text{below,upt},i}$ are the amounts of TP absorbed by aboveground parts and belowground parts of reeds in unit area; $\mathbf{tn}_{\text{rhiz,deni},i}$ and $\mathbf{tn}_{\text{sedi,deni},i}$ are the amounts of TN removed through biological denitrification at plant rhizosphere and sediment in unit area; $\mathbf{A}_{\text{submerged},i}$ is the area of submerged zone in the lake; $\mathbf{A}_{\text{plant,sub},i}$ is the area of plants in submerged zone of the lake.

5. Comment: Several basic assumptions of this manuscript should be explicitly listed, e.g.: the reviewer assumes that one of the basic assumptions of this study is that there is no spatial difference of the water quality in Baiyangdian Lake.

Response:

This study is based on several assumptions. We have written parts of them in the manuscript, but maybe the description is not clear enough. According to your advice, we think that it is essential to make a list of assumptions, which is added in section 2.4 of the paper. The specific content is showed as below.

Before the model development, several basic assumptions should be listed as the base for the model.

1. Nutrients distribute uniformly in space. Spatial difference of the lake water quality is not considered.

2. The growth conditions are the same for reeds in different zones of the lake. The efficiency of nutrient removal by reeds has no spatial diversity.

3. The common reed is the dominant plant species in Baiyangdian Lake. The growing area of reeds is much larger than the total area of other plants. Thus common reed is the only plant species considered in this study.

6. Comment: Line 19-20, page 814. The authors should explain why '*This value is cited in this study, although the accuracy is suspect because this value differs for different sites*'.

Response:

"This value" in this sentence means a parameter reflecting the relationship between reed aboveground biomass and belowground biomass. In different zones of the world, the growth rhythms of plants have spatial differences. Even for two lakes in the same zone, the growth conditions of plants may also be different. In this study, we cited this parameter about plant growth according to the research in other lake, so the value may be not accurate to be used in our study site.

The best way to improve the accuracy is to directly measure this parameter in Baiyangdian Lake. However, the measurement of this parameter is very difficult. Reed belowground part is perennial. It is very complicated to measure the annual amounts of nutrients absorbed by the belowground part, because it is difficult to distinguish which tissues developed in the current growing season and the annual biomass increment of old tissues is also hard to measure. Thus, through short-term experiment and measurement, it is nearly impossible to determine this parameter in the lake.

The research by Valk and Bliss (1971) and Fiala (1976) did wonderful work to study the growth rhythm of reed belowground part. Plentiful experiments and observation were conducted in lakes. Through their work, they proposed values for some parameters about reed growth rhythm. We determined the parameter of this study according to their research. Although this value is not accurate to be used here, its influence on the results of our study is negligible. Our study focuses on method for water quality restoration, rather than reflecting plant growth mechanism. Thus, citation of the value in this study is acceptable. In the future, some botanists may give a more accurate value for this parameter, and then it is easy to change the value in this study.

7. Comment: Line 4-7, page 821. From the current understanding of the reviewer, there is no spatial difference considering the absorption efficient or transpiration of common reed in this study. Therefore, based on the assumption of this study, the water quality restoration ability of reeds plant near the lakeshore or far away from the lakeshore should be the same. The authors should find other reasons to explain why ‘*the effect of reed area variation on water quality is not obvious when the area is larger than 40 %*’.

Response:

In this study, there is no spatial difference considering the absorption efficient or transpiration of common reed, but the water quality restoration ability of reeds near the lakeshore or far away from the lakeshore has essential difference. Reeds normally absorb nutrients through their rhizome system (Haslam, 1972; Ailstock et al., 2001).This study divides reed growing area into two zones, one is submerged zone and another is terrestrial zone. Nutrients absorbed by reeds in submerged zone mostly come from water body, because most nutrients in the sediment is unavailable for biotic use and available nitrogen mainly occurs in soluble form in the lake water and interstitial sediment water (Wetzel, 2001). These reeds are considered effective for water quality restoration, while those growing in terrestrial zone mostly absorb nutrients from the soil and they are considered noneffective for improving water quality. Thus, water quality restoration ability of reeds plant near the lakeshore or far away from the lakeshore has obvious difference.

As monthly water level fluctuating, the area of reeds in submerged zone will vary accordingly, which is considered in this study. When reeds are planted in the lake in March, it is preferential to plant them in submerged zone. After filling the submerged zone, reeds will be planted in the terrestrial zone, which is insignificant for water quality restoration in this month. When water level rises in next months, they may be submerged and then they will be effective for water quality restoration. However, if reeds are planted far away from lakeshore, they may be not submerged during the whole growing season. These reeds are unmeaning for water quality restoration, so it can explain why '*the effect of reed area variation on water quality is not obvious when the area is larger than 40 %*'.

For ease of understanding, some sentences have been replaced by the followings in the new manuscript. "*Reeds absorb nutrients mainly through their rhizome system (Haslam, 1972; Ailstock et al., 2001). Only a small amount of nutrients is absorbed from the atmosphere by their leaves and can be ignored. This study divides reed growing area into two zones, one is submerged zone and another is terrestrial zone. Nutrients absorbed by reeds in submerged zone mostly come from water body, because most nutrients in the sediment is unavailable for biotic use and available nitrogen mainly occurs in soluble form in the lake water and interstitial sediment water (Wetzel, 2001). These reeds in submerged zone are considered effective for water quality restoration, while those growing in terrestrial zone mostly absorb nutrients from the soil and they are considered noneffective for improving water quality. As monthly water level fluctuating, the area of reeds in submerged zone will vary accordingly.*"

8. Comment: The lake level or available area for reed plantation of each month for each scenario should also be presented, since the available area for reed plantation may be less than the planned area at specific months of a specific scenario.

Response:

In section 2.3 of this study, we built the equation to calculate the water quantity balance in the lake. We used the average water level of statistical data as the initial water level and lake levels in next months should be calculated based on the water balance equation. So we can't offer the available area for reed plantation of each month before solving the model.

We set available area for reed plantation in March and reeds can be planted in the available zone. Then we need to run the model to analyze the water level variations in next months. During the optimisation process, the water volume and water level of the lake can be calculated every month, and then the solving program can recognize available zone for reed growing in each month. When the program finds that parts of reeds are planted in unavailable zone, it will acquiescently consider that these reeds should be harvested in this month, which means that the area of reeds harvested in this month should not be smaller than the area of reeds growing in unavailable zone. If they are not harvested, they may die and release nutrients to the lake. From these descriptions, we can find that the available condition for reed growing is considered during the whole growing season, although we didn't offer available area for reeds in each month.

9. Comment: The TN and TP concentration in both Fig 1 and 2 reached zero at July. The authors should explain whether the TN and TP values are calculated to be zero coincidently or corrected to be zero manually. The authors should also explain the setting of reed growth and transpiration if the TN and TP values are manually corrected to be zero.

Response:

In our optimisation program, we set that the TN and TP values should not be lower than zero. When these values are lower than zero, it means that the nutrients are not enough to maintain plant growth in last month. When this condition occurs in the calculation process, the program will calculate the acceptable area for reed growing in last month. The rest of reeds should be harvested at the end of last month, which means the reeds harvested in last month should not be smaller than the area of the redundant reeds. Their nutrient removal and transpiration will not be considered in current and following months.

In order to explain this problem, several sentences have been added into the new manuscript. "*From the figure, we can find that the nutrient concentrations in the optimal situation reach zero in July, which means that nutrients in the lake are not enough to maintain all reeds growing in June. When this condition occurs, the optimisation program can calculate the acceptable area for reed growing in this month and acquiescently consider that the redundant reeds should be harvested at the end of this month, which means that the area of reeds harvested in this month should not be smaller than the area of redundant reeds.*"

10. Comment: In the 'Discussion' part, the authors only presented the result of two different scenarios of planting area and two different schemes of harvest. Most parts of these contents could be moved to 'Results'.

Response:

This study focuses on proposing an optimal management regime for reeds, including an optimal planting area and monthly harvest scheme. This regime is obtained through the optimisation model. In the "Results" part, we mainly described the optimal result and proposed the optimal management regime for reeds. A planting area of 40% of the lake surface (123 km^2) and harvest of 99% at the end of June is best for the water quality of Baiyangdian Lake. In the results, we compared several scenarios of planting area. These scenarios are created in the method part based on manipuility of management.

In the "discussion" part, we also compared water qualities under different scenarios, but these scenarios are different from those in "Results" part. The scenarios in "Discussion" part are created in order to compare the optimal result with the current situation of the lake, or with what proposed by previous research. These comparisons can show the significance of reed management on water quality. We think this content is very important. These comparisons are not the direct results of this study, so we think that remaining them in the "Discussion" part is more rational.

One sentence has been added into the new manuscript. "*In order to show the significance of macrophyte management on water quality, the comparison between optimal results and current situation is conducted*."

11. Comment: The authors should cite more literatures in the 'Discussion' part.

Response:

This study proposed an optimal management regime for plants in lakes. Previous research poorly considered this issue, so the literatures cited in the 'Discussion' part is just a few. According to your advice, we have revised this manuscript. More contents are discussed in this part and more literatures are cited at the same time.

12. Comment: The authors should discuss on the potential effects of the simplification (e.g.: the lack of consideration on variations of precipitation and evaporation, etc.) process on the final result.

Response:

There are several simplification processes in this study, such as precipitation, evaporation and water release from upstream reservoirs. We used average values to set these parameters according to statistical data of past years. These simplifications affect the water balance in the lake system and then affect the water quality. According to your advice, we have added a part to analyze the influence of simplification on final result. The specific content is showed as below.

Water balance calculation is an important fundament for developing the optimisation method in this study. Lake water volume is mainly affected by several factors, such as evapotranspiration, precipitation, permeation and upstream reservoir operation. In this study, average values are used to set these parameters according to statistical data of past years. It is significant to consider the influence of parameter variations on final result (Bullock and Acreman, 1999). All these parameters are about water quantity balance, so considering variation for one of them is enough to reflect the influence. Among these parameters, water release from upstream reservoirs is the most uncertain. Thus, the influence of water release from upstream on final result is discussed.

Through adjusting the volume of water released from upstream reservoirs, no obvious varying tendency is found for reed management regime, while the lake water quality varies obviously. When the annual volume of water released reaches $1\times10^{8}m^{3}$*, the gap index of water quality in the year is about 0.16, which means the water quality is very close to the target. The water qualities of upstream reservoirs are relatively much better, so water release can dilute the nutrients and decrease their concentrations directly. Besides this, water volume of a lake has direct relations with its water surface area and water depth. The water surface area decides the zone where sediment denitrification occurs and the water depth affects available zone for reed growing in the lake (Ishida et al., 2006; Lawniczak et al., 2010). The influence mechanism of water release on the water quality restoration is complicated, so the influence of parameter variation on reed management regime has no obvious rule.*

Response to Reviewer #2

Thank you very much for your approval to our manuscript and we appreciate your valuable suggestions. Those comments have been helpful in revising and improving our paper. We have carefully considered the comments and have revised the manuscript accordingly. The comments and detailed responses can be summarized as follows:

1. Comment: Page 812, line 9 "The monthly average nutrient inputs for total nitrogen (TN) and total phosphorus (TP) are 21.83 t and 0.56 t, respectively (Zhao et al., 2010). The monthly average TN and TP concentrations in the lake were respectively 5.15 mg L^{-1} and 0.54 mg L^{-1} from 2000 to 2009…" There is no reference for the source of the averaged concentrations. It should be mentioned if any field measurement has been made or otherwise some discussion on how the averaged concentrations are calculated. The monthly input mass ratio between TN and TP is close to 40. The average concentration ratio between TN and TP is close to 10. Explanation would be needed for such differences / discrepancy.

Response:

Most of the statistic data used in this study was obtained from Anxin Environmental Protection Bureau. Our group has conducted much work to investigate the polluting condition in Baiyangdian Lake (Zhao et al., 2010; Yang et al., 2012; Zhao et al., 2013). According to the research by Zhao et al. (2012), the monthly average TN and TP concentrations in Baiyangdian Lake were respectively 2.6-5.6 mg/L and 0.1-0.6 mg/L from 2000 to 2009. "The average nutrient concentrations of water samples for planting reeds were 5.15 mg/L for TN and 0.54 mg/L for TP, respectively." However, an understanding error occurred at this place. The average value in this sentence means average in space, rather than in time. These two values were obtained through field sampling and the process of field sampling has been clearly described in another paper by our group (*Ying Zhao, Zhifeng Yang, Xinghui Xia, Fei Wang. A shallow lake remediation regime with Phragmites australis: Incorporating nutrient removal and water evapotranspiration. Water Research. 46 (2012) 5635-5644.*).

Thus, this sentence in this manuscript should be revised into "*The monthly average nutrient inputs for total nitrogen (TN) and total phosphorus (TP) are 21.83 t and 0.56 t, respectively (Zhao et al., 2010). The average TN and TP concentrations of water sample in the lake are respectively 5.15 mg L^{-1} and 0.54 mg L^{-1} (Zhao et al.,* *2012)…*”

The monthly input mass ratio between TN and TP is close to 40, while the average concentration ratio between TN and TP is close to 10. This phenomenon can be explained by several possible reasons, such as the land characteristics of the region or polluting history of the lake. For example, these two average values about nutrient inputs are due to statistic data from 2000-2009, but we don’t know the nutrient input condition in last century. The input mass ratio between TN and TP in last century may be lower than 10. This reason is rational to explain the current nutrient concentration ratio in the lake.

2. Comment: Page 815, line 8 / Table 1 The contribution of sediments removal of TN is close to 10 times to that of TP. “The efficiency of rhizosphere denitrification can be doubled.” From Table 1, the total nutrient absorbed (aboveground and underground) for TN is roughly 10 times as of that for TP. This cannot explain the total input difference seen for TP and TN. The experiment has been mentioned within the text so there could be some more systematical comparison in between the experiment result and the simulation results. Suggesting including overall mass balance tables for both TP and TN.

Response:

The total input difference seen for TP and TN has been explained in last response. In this study, in order to investigate the amounts of nutrients removed by reeds, field simulation experiment was conducted in Baiyangdian Lake during the growing season from April to November 2010. The reed rhizomes, water, and sediment for the simulation experiment were all sampled from the lake at the beginning of April. The field sampling site was located in the north part of Baiyangdian Lake. A series of buckets (radius=0.33 m, height=0.60 m) were filled with sediments of 27±2 cm and water of 25 cm, which were in consistent with that in the water submerged reed stands of Baiyangdian Lake. Then, reed rhizomes were planted in the buckets. After reeds germinating, parts of reeds were harvested to measure the amounts of nutrients absorbed by reeds in each month. Besides reed uptake, sediment contribution also led to nutrient variation in the water body. We measured nutrient amount variation in water body and compared to the amounts of nutrients absorbed by reeds. Then the amounts of nutrients removed by sediment contribution could be obtained. A simplification was conducted at this place. We used the monthly average value in this study and did not consider the difference of sediment contribution in different months.

All data about nutrient removal have been described in the new manuscript.

3. Comment: Page 816, line 18 / Table 2. The evapotranspiration for zone 2 in March, April, October and November is ignored. Explanation is expected.

Response:

Zone 2 is the zone with reeds growing. Reeds normally begin to germinate at the end of March or the beginning of April in Baiyangdian Lake(Zhao et al., 2012). It is easy to understand that we don't need to consider reed transpiration in March. In April, only reed burgeon occurs and reed leaves have not developed sufficiently, so the transpiration of reeds at this time is really weak and can be ignored.

The highest aboveground nutrient storage of reeds occurs in September, so reeds should be harvested at the end of this month to prevent them releasing nutrients to the lake. Although the transpiration of reeds in October and November may be still obvious, but all reeds have been harvested at the end of September. Thus the transpiration of reeds is not considered after September in this study.

Several sentences have been added into the new manuscript. "*Reed transpiration in March and April is negligible. In October and November it also does not need to be considered because all reeds are harvested before October.*"

4. Comment: Page 819, line 15, I noticed that only the monthly harvesting rates for the 5 growing months were selected as the input parameters for AGA, the initial reed planting area was not considered. I wonder if there is any motivation for the way the method has been used. The methodology appears good, while not all the details on Adaptive Genetic Algorithm (AGA) are clear to me. It is then suggested for more discussion on the application.

Response:

Initial reed planting area is also an important variable needing to be determined besides the monthly harvesting rates for the five growing months. The monthly harvesting rates of five months are directly obtained through AGA. We can also select reed planting area as a variable and obtain it through AGA. However, considering the actual practicality, we decided to create scenarios to determine the optimal area instead of setting it as an optimal variable.

The planting area can be optimised as a discretionary value below 197 km^2, and then managers can define the boundaries of the planting area according to the optimal results. However, defining boundaries in the actual lake environment is a complex process, which includes two main tasks. First, we need to define the boundaries on a topographic map. Then measurements need to be made to determine the actual boundaries in the lake. If the optimal area varies randomly below 197 km^2, managers need to define the boundaries accordingly every year. This work is time consuming. In this study, several scenarios for different planting areas are created. Managers can define the boundaries for each of these scenarios at once. In the following years, managers only need to choose the best scenario and do not need to redefine the boundaries. This method may reduce the accuracy of the optimal result, but it is much easier to implement in practice.

Genetic algorithm (GA) is a search heuristic that mimics the process of natural selection in the computer science field of artificial intelligence. This heuristic is routinely used to generate useful solutions to optimisation and search problems. It can generate solutions to optimisation problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. Genetic algorithms with adaptive parameters (adaptive genetic algorithm, AGA) is a significant and promising variant of genetic algorithms. The probabilities of crossover (pc) and mutation (pm) greatly determine the degree of solution accuracy and the convergence speed that genetic algorithms can obtain. Instead of using fixed values of pc and pm, AGA utilizes the population information in each generation and adaptively adjust the pc and pm in order to maintain the population diversity as well as to sustain the convergence capacity. AGA has been widely used in various fields, including environment science area (Kaini et al., 2012; Yin et al., 2012; 2014). In this study, the fitness of AGA is to make the total gap index of one year as small as possible. There are five optimisation variables, which are the reed harvest ratios from May to September. The planting area can be determined through comparing these scenarios. After modelling all scenarios, we can determine the best reed planting area and harvest scheme, under which the most satisfactory water quality will be attained in Baiyangdian Lake.

One sentence has been added to introduce AGA in the new manuscript. "*AGA is one kind of global optimisation algorithm, which is widely used in various scientific computing fields. It can generate solutions to optimisation problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover*."

5. Comment: Page 820, line 22 / Table 4 The gap index appears to be monthly averaged value throughout the year. Clarification is needed if this is the case.

Response:

The gap index at this place is truly the monthly average value throughout the year. We call it total gap index because it is the sum of monthly average values for TN and TP. In the method part, we have clearly defined the total gap index in the new manuscript. The specific sentence is showed as below.

The objective of the model is: $\min \bar{\delta} = \min(\bar{\delta}_{TN} + \bar{\delta}_{TP})$

where $\bar{\delta}$ *is the total gap index used to show the water quality for a year,* $\bar{\delta}_{TN}$ *and* $\bar{\delta}_{TP}$ *are the monthly average gap indexes for TN and TP, respectively.*

6. Comment: Fig.1 / Page 821, line 16 The curve for the "current area" appears to be field measurements. The starting point of the curve then should correspond to a specific TP or TN concentration measured in 2010. This presumably should be different from the 2002-2009 averaged values. It has been mentioned in the text some extrapolation has been done. Explanation / clarification would be expected.

Response:

As mentioned in the manuscript, the result of the figure is extrapolated based on the nutrient balance and water quantity balance investigated in this study. The curve for the "current area" is also extrapolated, rather than due to field measurements. During the calculating process of the curve for the "current area", the plant growing area is set as the current area in the lake, and then the water quality is calculated based on the nutrient balance and water balance equations. In order to better comparing the influence of reed area on water quality, the initial nutrient concentrations are the same as the concentrations used in the model. Thus, the starting points of these two curves are the same in the Figure 1.

In the new manuscript, one sentence has been replaced by new one. "*Both these two curves in the figure are extrapolated based on the nutrient balance and water quantity balance investigated in this study*."