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Natural Hazards and Earth System Sciences
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Discussions

Interactive comment on "Impacts of the emergency operation of the South-to-North Water Diversion Project's eastern route on flooding and drainage in the water-receiving area: An empirical case from China" *by* Kun Wang et al.

Kun Wang et al.

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Responses to Referee #2' comments

Referee #2: The authors present an interesting study on the effects of a giant water diversion system, installed in China to transfer water from Yangtze River to provinces/regions further in the north, e.g., water scarce Shandong Peninsula. Due to the continuous water shortage in the receiving areas, the channel is operating continuously, though there are considerable amounts of rainfall along the way. The study ex-

plains, how local weather phenomenon interacts with an almost transcontinental water diversion scheme. Since it is not my primary field of research, it is difficult to evaluate whether the presented. study reveals some new concepts, tools or methods. However, the scientific methodology and input data are valid, the scenario selection is relevant and fits the requirements of the study. And finally, the authors reach substantial conclusions and clearly show the hazard of a water transfer project like the SNWDP. However, the manuscript is generally and particularly in the introduction part weak in English. Not only, but seriously influenced by that comes the second, much larger weakness. The presentation of the general setting and conditions of the study, the problem and why certain technical/hydraulic activities are done to manage/control water flow to, within and out of the Nansi Basin are not clearly described. The introduction is immature and also the presentation of the scenarios must be seriously improved. Particularly the wording is difficult, but also the description of figures lacks sufficient details. A lot of (at least to me) unknown technical phrases are used instead of international terminology. The figures have to be improved to meet journal requirements (e.g. include numbering of each figure, descriptions must be improved to allow understanding of each figure by itself). Finally, I strongly suggest to involve a native speaker. Doing so, the manuscript will surely meet the journal's requirements to be published in NHESS.

In addition to my general comments some specific in the following: Page 1 L15: What is a waterlogging simulation and wouldn't be flood simulation the better term? Which interactions are meant?

Answer: The sentence has been is revised as follow. "First, a flood simulation model was constructed to simulate the complex movement of the transferred water, waterlogging water in the lakeside area around Nansi Lake (NL) and the water in NL and its tributaries.

L28: a map showing the most important geographical places, including contour lines and information about elevations would be required. Furthermore, some climatic characterisations (annual rainfall as colourcode) would help understanding the general con-

ditions.

Answer: Fig.1 has been divided to Fig.1 (in section1) and Fig.2 (in section 2).The contour lines of annual rainfall has been added in Fig.1 b, and Surface elevation information of Nansi Lake basin has bend added in Fig.2.

L29: development of what? L30: which lake and what does the lakeside area mean? It is somehow indicated in Fig. 1, but what are the borders, how are they defined, etc.

Answer: The economic development in lake basins along the ER-SNWDP. The lakeside area refers to the area with ground elevation below 36.79 m around Nansi Lake (Fig.2). We explained it in the manuscript, and Fig.2 is modified. Tanks a lot.

L31: what does "blocking of the rising lake level" means and what are subsequent "waterlogging disasters"? The entire process chain is not clear to me.

Answer: The lake level raised by the ER-SNWDP will decrease the drainage efficiency of pump stations and hinder flood discharge of rivers in the lakeside area and then influence the flood control and waterlogging drainage of the NLB.

L34: There is no reason to distrust the publication of Webber et al., however, aren't there better information about intended water volumes from official authorities/reports, etc.?

Answer: We added the information from official authorities/reports (Bureau of South to North Water Transfer of Planning, Designing and Management, Ministry of Water Resources, 2003). Thanks a lot.

L34: what is the "water diversion period"? L35: does the project stops and runs in intervals? And why is it obvious, that water tables rise? If water is consumed the same amounts as brought into the basins, nothing happens. The operational scheme does not become clear.

Answer: The water diversion period is from October to next May. Because Nansi Lake

is the storage pond, the water level of NL will be raised during the operation of the project (Bureau of South to North Water Transfer of Planning, Designing and Management, Ministry of Water Resources, 2003). We explain those in the manuscript as follow: According to the comprehensive plan of the SNWDP, (1) the first phase planning (before 2030) of the eastern route is designed to transfer 8.9 billion m3 water annually, and approximately 7 billion m3 is expected to be consumed in the above five lake basins and the route; and (2) the water diversion period covers the non-flood season (October to next May), and the water diversion will be stopped during the rest of the time (Bureau of South to North Water Transfer of Planning, Designing and Management, Ministry of Water Resources, 2003). As the water-receiving areas and the transmitting channels of the ER-SNWDP, the five lakes are used to store and regulate water resources, and the water level of the five lakes are significantly raised when the project is operating.

L37: what is "emergency water diversion"? I can imagine the possible meaning, but it has to be clarified. Why did water supply occurred sung flood period?

Answer: We revised the introduction and explained why did water supply occurred during flood period and what is "emergency water diversion" as follow: Otherwise, the Shandong Peninsula has suffered from severe drought and the water supply cannot meet the water demand even in the flood season for four consecutive years since the eastern route operated in 2013. Emergency water diversion, that is, the water transfer through the water diversion project in flood seasons to alleviate water shortages in the water-receiving areas, has been performed many times to supply water for Shandong Peninsula. Furthermore, considering the rigid demand for water resources caused by rapid economic and social development, frequent water transfers are expected in the flood season to alleviate water shortages in the water-receiving areas, which extends beyond the planned design of the ER-SNWDP (Guo et al., 2018).

L38: The sentence: "Furthermore, considering the rigid demand for water resources caused by rapid economic and social development, extreme hydrological events

caused by environment changes have increased along the ER-SNWDP.“ is unclear. And social development, extreme hydrological events caused by environment changes have increased along the ER-SNWDP.“ is unclear.

Answer: Those sentence have been revised as follow: Furthermore, considering the rigid demand for water resources caused by the rapid socioeconomic development, more frequent water transfers are expected to alleviate water shortages in the water-receiving areas in flood seasons (Guo et al., 2018). Meanwhile, extreme hydrological rainfall events caused by climate changes have increased in eastern China (Liu et al., 2015). Thus, the probability of rainstorm during the water diversion in these lake basins will increase.

Page 2 L3-6: Please rephrase the sentence the way you split it at least into 2-3. In the current version and with the amounts of questions, which rose at the passage before, the reason to do these simulations is still not clear.

Answer: the sentence is revised as follow: Therefore, simulate the flood and waterlogging process in the water-receiving lake basin under the condition of emergency water diversion by the ER-SNWDP. And then, based on the simulation results to quantify the interbain water transfer on the flood control and waterlogging drainage in the water-receiving lake basin has great significance for the scientific management of the ER-SNWDP and the flood control and waterlogging drainage in lake basins along the route.

L6: which situation? L7-8: if there are studies, why is there a gap in the literature? L12: again, which gap?

Answer: We reorganized this part of the language in the introduction.

L14: why is it an important storage node?

Answer: We explained in the introduction as follow: The reason why we choose the NLB is that the NL basin is an important storage node of the ER-SNWDP. Because the

NL is the largest freshwater lake in northern China and has the largest water storage capacity among the lakes along the ER-SNWDP (Zhang, 2009).

This is important to state. L15: again, the authors base on preliminary knowledge: it is not introduced, that the lake is separated into 2 halves by a dam. How can one know about the upper and the lower lake since the lake is just mentioned as the Nansi Lake.

Answer: We explained perfected Fig.2 and cited it in introduction. Thanks a lot.

L17: what is the phenomenon, where explained, etc.

Answer: We added the explanation of “drought-flood abrupt alternation” phenomenon as follow: DFAA refers to a rainstorm after a long period of drought and can result in severe flood damage.

L17-L19: I have difficulties to follow the argumentation, too many things are written in a row without making it clear. L20: as far as I understood, NLB is a flow-through basin, where water tables are fluctuating due to natural floods and droughts and additionally due to water pumped into the basin, which will be pumped out as it comes in. Why is it a water receiving area?

Answer: Because Nansi Lake is a storage pond of the east route of the south to north water diversion project, and the flow of water transferred into Nansi Lake is 200 m3/s and the outflow is 100 m3/s. A large quantity of water assumed in the Nansi Lake Basin, so it a water receiving area.

L21: what are “structures under water diversion”?

Answer: The sentence has been deleted.

L34: what is “the world’s annual water intake”? The world’s water budget is closed.

Answer: This should be “the world’s annual water withdrawals”, and has been corrected. Thanks a lot.

Page 3 L24-26: please explain that corresponding effects by using the correct hydrological terminology.

Answer: We has revised the sentence as follow: Sun et al. (2008) took the Anyang River Basin which is crossed by the middle route of the SNWTP as an example to study the influence of the water diversion project on flooding in the river basin that the project passes through.

L30: what is the “disaster risk”, which exact disaster(s) is/are meant?

Answer: It is the flood and waterlogging disaster. We have revised it in the manuscript.

Page 4: L5: why “land”?

Answer: It should be flood movement on the land in the lakeside area. We have corrected it. L15: the elevation is in respect to what: main sea level? L16: please explain slope in degrees. Answer: It is the height above sea level. Tanks a lot. We changed the content as follow: The lakeside area, refers to the area with a ground elevation (above sea level) below 36.79 m around the lake, and has the ground gradients in this area slope is between 0.0029° and 0.0057° (Tian et al., 2013; Wang et al., 2010).

L20: please explain what you mean by:” waterlogging in lakeside areas can no longer directly drain into rivers and lakes “and how does it work: "The waterlogging water is primarily carried into rivers and NL by pumping stations in the lakeside area.”

Answer: We explained this part as follow: Flood control embankments have been built on both sides of the main inflow channels and around NL to prevent flooding from entering the lakeside area. Due to the low-lying terrain and the construction of flood control embankments, waterlogging in lakeside areas cannot directly drain itself into rivers and NL. The waterlogging water in the lakeside area is mainly pumped into rivers and NL through pumping stations.

L22: What does it mean the rainfall is concentrated? How high is the rate?

Answer: We want to express that the drainage capacity in the Nansi Lake Basin is low, and waterlogging caused by rainfall storm frequently occurs. The sentence has modified as follow: The existing pumping stations in this region cannot resist the rainstorm waterlogging occurred every five years, some pumping stations even cannot resist rainstorm waterlogging occurred every three years. Encountering heavy rainstorm, the water cannot be discharged in time, the NLB belongs to the historical frequent flooding area.

Page 5 Fig. 1: Please add (a), (b) and (c) to the single figures, as it is usual. In the upper right map: why is China’s SE not continuously bordered? What does the inset map express and why is the international border southwards dashed? In the upper left map: please name the rivers. In the lower map: please indicate the location of the dam, Description of Fig. 5: delete “The logo of Copernicus publications” L4: what is Yangzhou? L5-8: please indicate the location of sluices and dams in Fig.1, otherwise it is impossible to follow.

Answer: Those figures have been modified as these suggestions. We made a map of China according to the convention of Chinese map. Thank you for your suggestions.

L8: what is the 1st phase, how is it defined, when does it end, etc.

Answer: “1st phase” refers to the first phase planning (before 2030) of the east route of the south to north water diversion project. We revised the sentence as follow: According to the first phase planing of the ER- SNWDP, the discharge that enters the lower lake occurs at 200 m3/s, and 5/8 of this amount will be pumped into the upper lake. Furthermore, this has been explained in introduction. Tanks a lot.

L8: what is the Liangji River mouth, 24.6 km up- or downstream? L9: “project operation”: during which phase? Water table in respect to mean sea level?

Answer: This part has been revised as follow: The Changgou pumping station is built at 24m south of Liangji River Estuary in the upper lake, to transfer water to the Shandong

Peninsula. Water table has been explained in manuscript.

Page 6: L1-3: “project operation”: during which phase? Water table in respect to mean sea level?

Answer: Here we want to express when the water diversion project is running, the water level of NL will be raised. This section has been modified as follow: When the water diversion project is running, the water level (in respect to mean sea level) of the lower lake will reach 32.8 m, which is 0.70 m higher than the mean annual water level.

L9: river channel bathymetry of which river? L11: please indicate the location of rainfall stations in map of Fig. 1. L13: please indicate the location of water level recording stations in Fig. 1

Answer: The channel bathymetry of all rivers simulated in the 1-D model. The location of rainfall stations have been added in Fig.2. Thanks a lot.

L17: what are “hydraulic engineering data”?

Answer: We explained as follow: (4) The hydraulic engineering data including the technique parameters of sluices, pumping stations and levees in the NLB were supplied by the Planning and Design Institute of the Huaihe Basin Hydraulic Management Bureau in Shandong Province, China.

Page7 Fig. 2: where is MIKE FLOOD integrated into the workflow? L8-9: Equations are usually cited in the text.

Answer: The corresponding modification of Fig. 3 is made. And we revised the reference.

Page 8 L5: again, elevation reference is missing

Answer: The elevation reference has been added in the manuscript.

L6 1000 pump stations are situated in the lakeside area, are they taking water out of

the lake or from the rivers?

Answer: They taking flood water out of lakeside area to rivers and Nansi Lake. We explained this as follow: A total of 1000 draining pump stations are used to drainage waterlogging water from the lakeside area to rivers and NL.

L18-19: Equations should be cited in the text.

Answer: We revised it in the manuscript. Thanks a lot.

L32: where is the model area and how was it chosen? L32: If I understand it right, lakeside area is outlined by the 36.79 m contour line. How was that contour line derived? Does the DEM resolve elevation in 1cm steps?

Answer: The model area includes NL and the lakeside area around the lake (Fig.2). This area was chosen according the advice of the Planning and Design Institute of the Huaihe Basin Hydraulic Management Bureau in Shandong Province, China. We explained it in section 3.2 Data sources.

Above, it is given; the area given by that contour line has an area of 3969 km2, now it is 4750 km2 large, which is almost 1 4 larger.

Answer: The model area includes the lake surface (1266 km2) and the lakeside area (3969 km2) and deducts the area of the rivers that simulated by 1-D model. The results (4750) was calculated by Arc GIS. We explained it in the manuscript.

L35-36: why only 5 out of the 7 stations?

Answer: We checked the manuscript and modified the stations. Tanks a lot.

Page9 L1-6: The entire passage is not clear, particularly due to the use of unusual terms like “into-lake river”.

Answer: We want to express that the model uses the lateral link method to link the lakeside area and tributaries of NL to simulate the flood exchange between the lakeside

area and tributaries. We revised it as follow: A lateral link is applied to connect the lakeside area and tributaries of NL to simulate the flood exchange between the lakeside area and tributaries.

L16: I do not understand, why the Lake receives a roughness

Answer: Limited by data and technical means, it is a pity that we cannot obtain the roughness data of NL. Considering that we concerned more about the inundation process in the lakeside area. We only set a roughness for the lake in the model and the verified results show that the model error is acceptable. At home and abroad, the spatial distribution of roughness is one of the unsolved problems in large watershed flood simulation based on hydrodynamic model. In future research we will try to solve this problem. Tanks a lot.

Page 10 L10: loss of what?

Answer: It refers economic loss. We revised it as follow: The statistical data show that the waterlogged area of the NLB is 2360 km2, and waterlogging disasters resulted in a great economic loss in the lakeside area.

L10: The information concerning the locations of the stations is missing to follow argumentation

Answer: The locations of the stations have been added to Fig.2. Tanks a lot.

L18: not the paper, but the study, please change.

Answer: We checked carefully and modified the manuscript. Thanks a lot.

L19: please explain “ecological water” and what is the “emergency transfer” L22: I assume the “emergency transfer” follows some kind of a pre-set protocoll, which means, it must be possible to request its starting and ending time from the SNWDP operating authorities.

Answer: We explained these as follow: The ecological water refers to the transferred

water to maintain the normal development and relative stability of all kinds of ecological systems in the NLB during drought period, and to prevent the recurrence of dry lake situation that occurred in 2003. Emergency water diversion, that is, transfer water through water diversion project in flood season to alleviate water shortages in the water-receiving areas. It has been explained in introduction.

L22: rainfall where and why does the diversion now only affects NL? L25: in line 22 it is stated emergency diversion ended, here you state it continues... L26: what is the flood season, is it somehow restricted? Page 11: L1-2: what is “the situation”? L4: what is “this condition”? Unfortunately, the entire paragraph is not very clear. To me it stays unclear, when wis which scenario calculated and why (due to which conditions). It is a general difficulty in the entire paper. Due to unclear terminology, even headlines like 5.2 are not clear and it is impossible to follow the argumentation

Answer: This paragraph in section 5.1 scenario design was amended as follow: (1) An ER-SNWDP emergency requires a supply of ecological water for NL. Take the waterlogging occurred in the NLB after August 22, 2003 as example, the impact of water diversion on the waterlogging process in the NLB was studied. Considering flood control safety of the NLB, we assume that the emergency water transfer stopped at the beginning of rain on August 22, 2003 (Fig.5). Because the water diversion project is no longer operational during the rainfall, the effect of water diversion on the flood process of NL is mainly to lift the water level of NL. Therefore, two scenarios of waterlogging of the NLB in August 2003 were simulated: The waterlogging process of the NLB under the influence of the emergency water transfer in August 2003 is recorded as scenario âŚą , and the waterlogging process without water diversion is recorded as scenario âŚă , see table 2 for scenario settings. The difference between scenario âŚă and scenario âŚą is the initial water level of NL. In scenario âŚă , the water level of the upper lake and lower lake are measured on August 22, 2003. In scenario âŚą , the water level of the upper lake and lower lake have been raised to 34 m and 32.3 m by the emergency water diversion. The rainfall process of the two scenarios was measured

from August 22, 2003 to September 2, 2003. The headlines has been revised as follow: Impacts of the emergency water diversion by the ER-SNWDP on the waterlogging of the NLB. Tanks a lot.

Page 12 L1-2 I don't understand the difference between scenarios 1 and 2, different initial water tables? If yes, what was the water table of Scenario 1? Table 2 is not clear, please re-organize it and give exact numbers.

Answer: The difference between scenarios 1 and 2 has been explained in answer Page 10 L22: - Page 11: L1-2. And the Table 2 has been revised. Thanks a lot.

L4-7: Here, for the first time, the reason for the study is clearly described and one can follow the intention of the authors. This should be integrated into the introduction, of course in a different way, but that's the reason for the study, I guess.

Answer: We have revised the introduction according to your suggestion.

L4-7: indicate the scenario number behind each pre-condition and refer to table 2 directly, not at the next paragraph. L8: prevent one sentence paragraphs.

Answer: We have revised this paragraph as follow: In this condition, the influence of water diversion on waterlogging disasters in the lakeside area of NL under different rainstorm intensities is analyzed. The processes of a 3-day designed rainfall with return periods of 5 years, 10 years and 20 years at six precipitation stations were calculated. Affected by the emergency water diversion, the initial water level of the upper lake and lower lake are 34.00 m and 32.30 m in scenario âŚě, âŚę and âŚğ. Because the water was transferred to alleviate the water shortage of Shandong Peninsula, China, the ER-SNWDP continued to operate during the rainfall. As a contrast, the initial water level of the upper lake and lower lake are 33.01 m and 32.20 m, which measured on August 22, 2003, in scenario âŚć, âŚč and âŚď. In summary, a total of 8 simulation scenarios were set up as shown in Table 2.

L10: why are areas of 0.1 and 0.5 considered?

Answer: We explained as follow: Rice, cotton, corn and soybean are the main crops in NLB, and the waterlogging tolerance depths of them are 0.5m, 0.1m, 01m and 0.1m, respectively (Lin et al.,2007).

L20: 0.99% of what?

Answer: 0.99% of relative increase in submerged area.

L25: EASTERN portion of the lake is mountainous... L26: the interaction is either given or not. There is no option to interact larger or less. Please describe what you want to say differently: e.g. The influence of...results in increased...

Answer: We revised this sentence as follow: Comparing with the eastern part of NLB, the terrain of the western NLB is lower and flat, and the western NLB has a greater impediment to drainage water into NL when the water level of NL is high.

L36: compared to what, scenario 1? Please describe sharply and refer to fig. 6

Answer: We revised this part as follow: Affected by the higher initial water level raised by the water diversion, the flood discharge start time of the Erji dam junction in scenario âŚą is 4 days earlier than that in scenario âŚă. Furthermore, the total amount of flood discharge in scenario âŚą increased by approximately 249 million m3 compared to scenario âŚă (Fig.7). Under Figure 7, we added a detailed description. Thanks a lot.

Page 13 L6-7: please check, which one is correct: Figure 7 a and b or the reference in the text, in the moment it is switched. Fig. 7: Please explain a and b in Figure description.

Answer: We checked Fig.8, and modified it in manuscript. A detailed description has been added. Thanks a lot.

L9-11: again, please be very clear in describing the effects of with/without active diversion.

Answer: We revised the effects of water diversion as follow: When the NLB encoun-

tered a design rainfall with 5-year return periods, the water of level upper lake did not reach the flood discharge condition without the influence of water diversion (Fig.9 a). Affected by water diversion, the sluices of the Erji dam began to drain the flood 30 hours after the start of the rain, and the total discharge volume is 85 million m3 (Fig. 9a). When the NLB encountered a rainstorm with 10-year return periods under the affection of water diversion, the sluices began to drain the flood 28 hours after rainfall. Compared with the situation without water diversion, the flood discharge time of the sluices was 36 hours earlier (at the 66th hour). The total flood volume discharged by the Erji dam project was 104 million m3 higher than that without the affected of water diversion (Fig. 9b). When the NLB encountered a storm with a 20-year return periods under the condition of water diversion, the time that the sluices began to discharge the flood was 26 hours after the start of the rain, which was 32 hours ahead of the situation with no water diversion (at the 58th hour). Affected by water diversion, the total discharge volume of flood has increased 129 million m3 (Fig. 9c).

L18: in Fig. 8a it do not look like 36 hours, more like 31 hours. Wrong figure? L20-25: please use some different descriptions for time: 30th hour is very uncommon and “e36 hours” is unclear to me. L25 reference is wrong, it is fig. 8c

Answer: We checked carefully and revised it in text and figure. Thanks a lot.

Page 14: Fig. 8: please explain a, b, c in the figure description.

Answer: We and descriptions under Fig. 9. The flood discharge under rainfalls for different return periods: 5 year (a), 10 year (b), 20 year (c). The bar chart with different colors show the three-day rainfall process at each rainfall station. Black lines show the flood discharge process of the Erji dam with and without the effect of water diversion.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-216/nhess-2018-216-AC2-supplement.pdf

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-216, 2018.

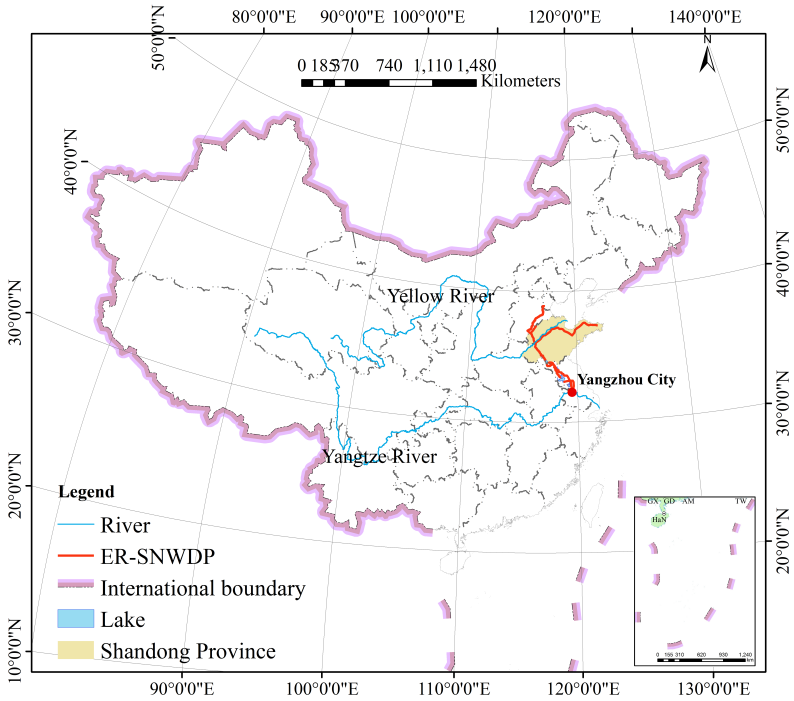
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Fig. 1.

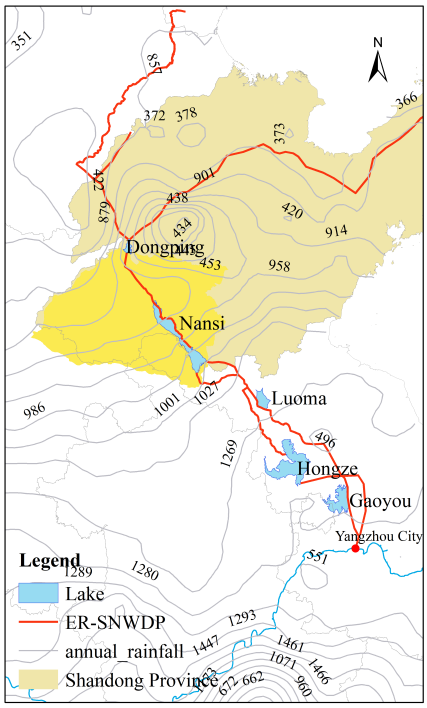
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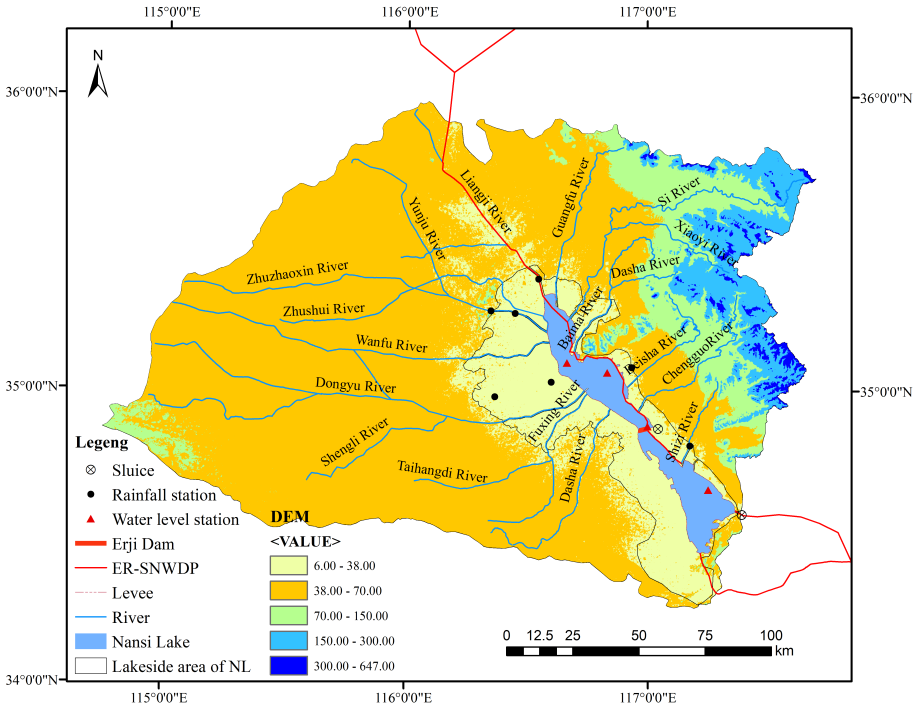
Fig. 2.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Dongyu River
Shengli River
Taihangdi River
Baisha River
Fuxing River
Dasha River
Chengguo River
Shizi River
Legeng
Sluice
Rainfall station
Water level station
Erji Dam
ER-SNWDP
Levee
River
Nansi Lake
Lakeside area of NL
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Fig. 3.

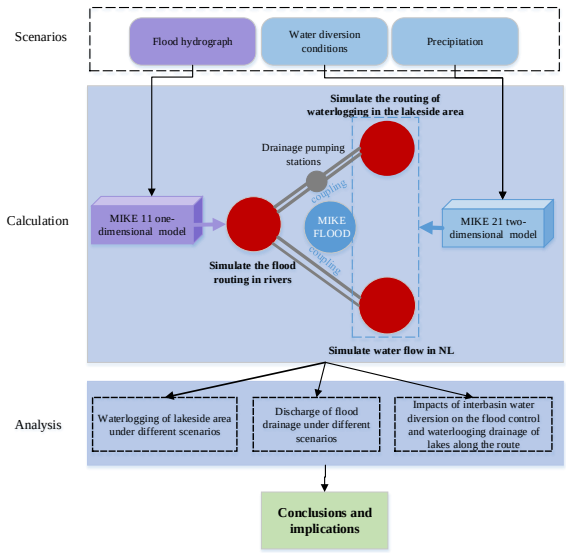
Scenarios
Flood hydrograph
Water diversion conditions
Precipitation
Calculation
Simulate the routing of waterlogging in the lakeside area
Drainage pumping stations
coupling
MIKE 11 one-dimensional model
MIKE FLOOD
MIKE 21 two-dimensional model
Simulate the flood routing in rivers
coupling
Simulate water flow in NL
Analysis
Waterlogging of lakeside area under different scenarios
Discharge of flood drainage under different scenarios
Impacts of interbasin water diversion on the flood control and waterlooging drainage of lakes along the route
Conclusions and implications

Fig. 4.

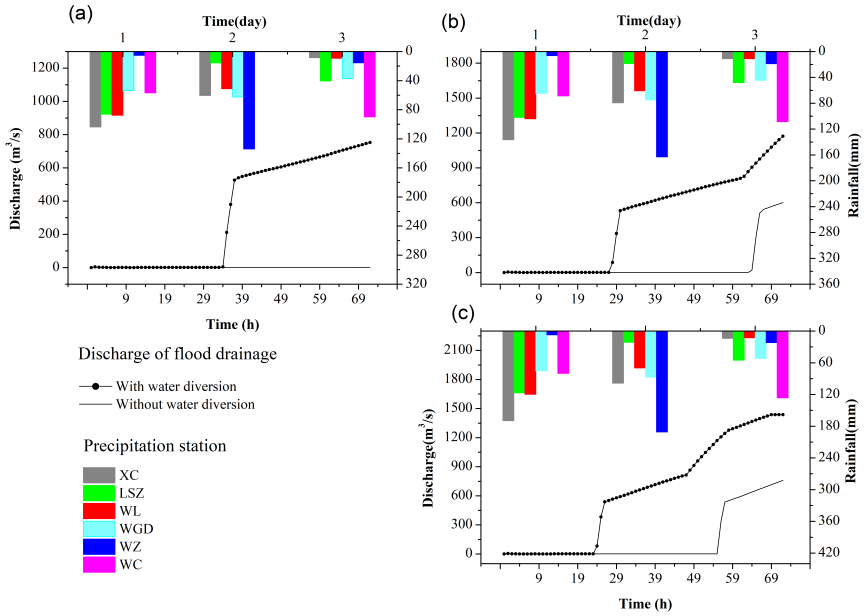
(a)
Time(day)
Discharge (m3/s)
Time (h)
(b)
Rainfall(mm)
(c)
Discharge of flood drainage
With water diversion
Without water diversion
Precipitation station
XC
LSZ
WL
WGD
WZ
WC

Fig. 5.