XVIII World Water Congress
International Water Resources Association (IWRA)

城镇化进程中水电站建设对河流连通性的影响研究与实践

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XVIII WORLD WATER CONGRESS Water for All Harmony between Humans and Nature
第18届世界水资源大会 水与万物：人与自然和谐共生

Research and practice on the influence of hydropower station construction on river connectivity during urbanization

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1.背景介绍-Foreword

大藤峡水利枢纽工程
Datengxia Water Control Hub Project

广西西江老口航运枢纽工程
Guangxi Xijiang Laokou Navigation Hub Project

百色水利枢纽
Baise hydro-junction

西津水电站
Xijin Hydropower Station

2.流域概况-Overview of the Basin

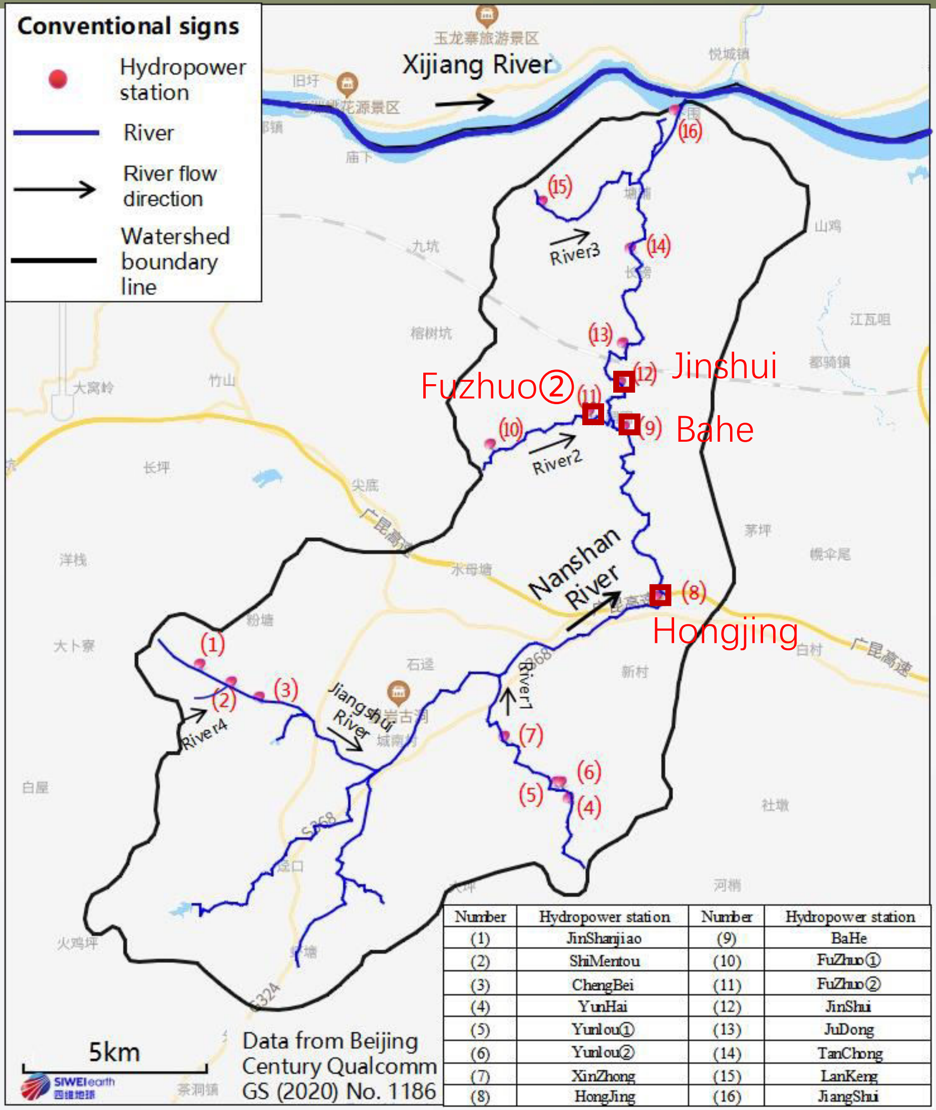
南山河流域-Nanshan River Basin:

➢ 位于中国广东省云浮市，集水面积255km²，属于典型的中型流域。

It is located in Yunfu City, Guangdong Province, China, with a catchment area of 255 square kilometers, which is a typical medium-sized basin.

➢ 南山河为珠江流域西江水系西江段的支流，河长46公里，多年平均流量5.74m³/s，年径流量1.81亿m³。

Nanshan River, a key river in the basin, is a tributary of the Xijiang River system in the the Pearl River basin. The river is 46 kilometers long, with an average annual flow of 5.74 cubic meters per second and an annual runoff of 181 million cubic meters.



Number	Hydropower station	Number	Hydropower station
(1)	JinShanjiao	(9)	BaHe
(2)	ShiMentou	(10)	FuZhuo①
(3)	ChengBei	(11)	FuZhuo②
(4)	YunHai	(12)	JinShui
(5)	Yunlou①	(13)	JuDong
(6)	Yunlou②	(14)	TanChong
(7)	XinZhong	(15)	LanKeng
(8)	HongJing	(16)	JiangShui

图1 南山河流域水电站分布现状

Figure 1. Distribution Status of Hydropower Stations in the Nanshan River Basin

2.流域概况-Overview of the Basin

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- 1970年以来，流域内先后建成16座中小型水电站（图1、表1），电站拦河闸坝坝高为1.5~50米，各电站均未建设过鱼设施。受电站拦河闸坝的阻隔影响，流域的纵向连通性为劣。

Since 1970, 16 small and medium-sized hydropower stations have been built in the basin (Figure 1 and Table 1). The dam height of the power station's river blocking gate is 1.5-50 meters, and no fish facilities in each station. Due to the barrier effect of the station's river blocking gate dam, the longitudinal connectivity of the basin is inferior.

- 至2022年，八和等4座水电站已报废拆除。

By 2022, four hydropower stations including Bahe have been scrapped and demolished.

表1 南山河流域水电站建设情况

序号	水电站	建设年份	序号	水电站	建设年份
(1)	金山脚	1993	(9)	八和	1994
(2)	石门头	1992	(10)	扶卓①	1992
(3)	城北	1992	(11)	扶卓②	1995
(4)	云海	1997	(12)	金水	1999
(5)	云楼①	1971	(13)	菊洞	1999
(6)	云楼②	1971	(14)	滩冲	1972
(7)	新中	1989	(15)	蓝坑	2008
(8)	鸿景	1997	(16)	降水	1982

Table 1 Construction of Hydropower Stations in the Nanshan River Basin

Number	Hydropower station	Year	Number	Hydropower station	Year
(1)	JinShanjiao	1993	(9)	BaHe	1994
(2)	ShiMentou	1992	(10)	FuZhuo①	1992
(3)	ChengBei	1992	(11)	FuZhuo②	1995
(4)	YunHai	1997	(12)	JinShui	1999
(5)	Yunlou①	1971	(13)	JuDong	1999
(6)	Yunlou②	1971	(14)	TanChong	1972
(7)	XinZhong	1989	(15)	LanKeng	2008
(8)	HongJing	1997	(16)	JiangShui	1982

3.研究方法-Research method

阻隔系数法 + 改进阻隔系数法 + 树状水系连通性指数法(DCI法)

the barrier coefficient method

the improved barrier coefficient method

the tree shaped water system connectivity index method (DCI)

河流纵向连通性评估

Assessment of River Longitudinal Connectivity

Using ArcGIS soft ware to digitize

Actual situation of the watershed

Preliminary research results

ArcGIS数字化处理 + 流域实际情况 + 前期研究成果

从1970年的3座水电站发展到2010年的16座，至2022年减至12座-
From 3 hydropower stations in 1970 to 16 in 2010, and reduced to 12 by 2022

夏继红，侯佳明，孙鹏，Cote D
Jihong Xia，Jiaming Hou,Peng Sun,Cote D

图2. 水库、大坝对鱼类的阻隔影响
Figure 2. Impact of Reservoir and Dam on Fish Barrier

1.河流水系连通性机制及计算方法综述-
Review of the connectivity mechanism and calculation methods of river systems
2.基于改进阻隔系数法的河流纵向连通性评价-
Evaluation of River Longitudinal Connectivity Based on Improved Barrier Coefficient Method
3.闸坝对河流栖息地连通性的影响研究-
Study on the Impact of Sluice Dams on River Habitat Connectivity
4. 一种新型的河网纵向连通性计算方法-
A new measure of longitudinal connectivity for stream networks

4.纵向连通性评估-Longitudinal Connectivity Impact Assessment

1. 河流纵向连通性

□ Longitudinal connectivity of rivers

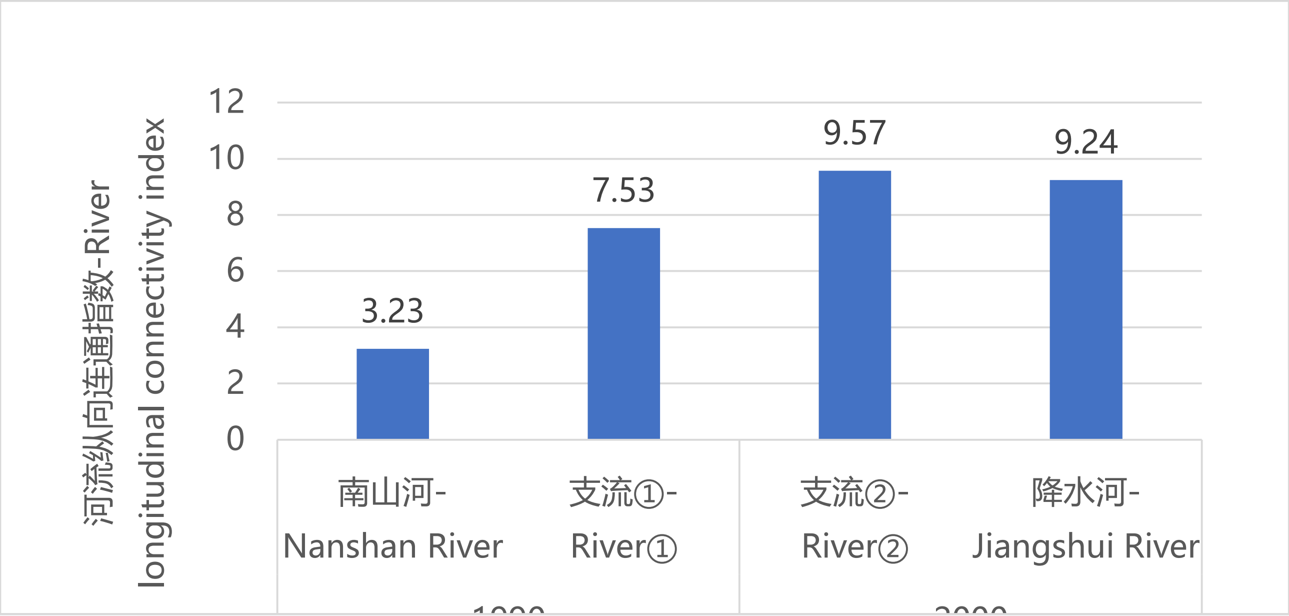

图4　南山河、支流①和支流②、降水河的河流纵向连通性指数对比
Figure 4 Comparison of River Longitudinal Connectivity Index of Nanshan River, RIver① and River ②, and Jiangshui River

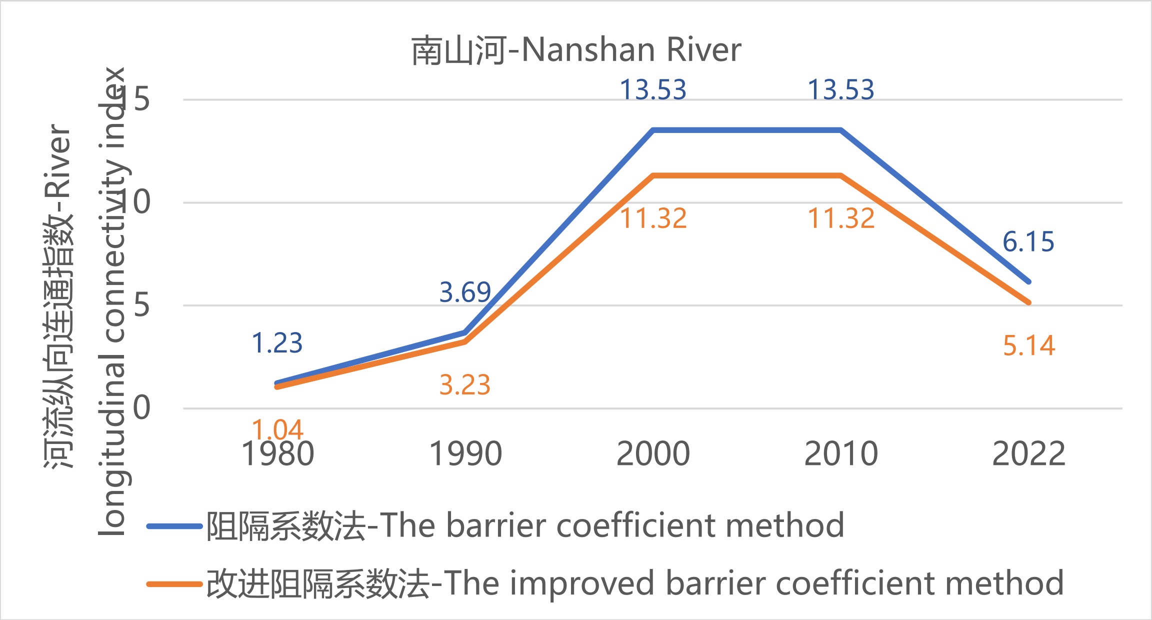

图3　南山河1980-2022年河流纵向连通性指数变化
Figure3 Changes in Longitudinal Connectivity Index of Nanshan River from 1980 to 2022

4.纵向连通性评估-Longitudinal Connectivity Impact Assessment

2. 水系纵向连通性

□ Longitudinal connectivity of water system

表2 南山河流域历年DCI值变化对比

Table 2 Comparison of DCI value changes over the years in the Nanshan River Basin

年份-Year	水电站个数-Number of hydropower stations	DCI值-DCI value	差值-The difference	变幅-Amplitude (%)
1980	3	86.32	/	/
1990	4	82.10	-4.22	-4.9
2000	15	28.11	-58.21	-67.4
2010	16	28.02	-58.30	-67.5
2022	12	46.86	-39.46	-45.7

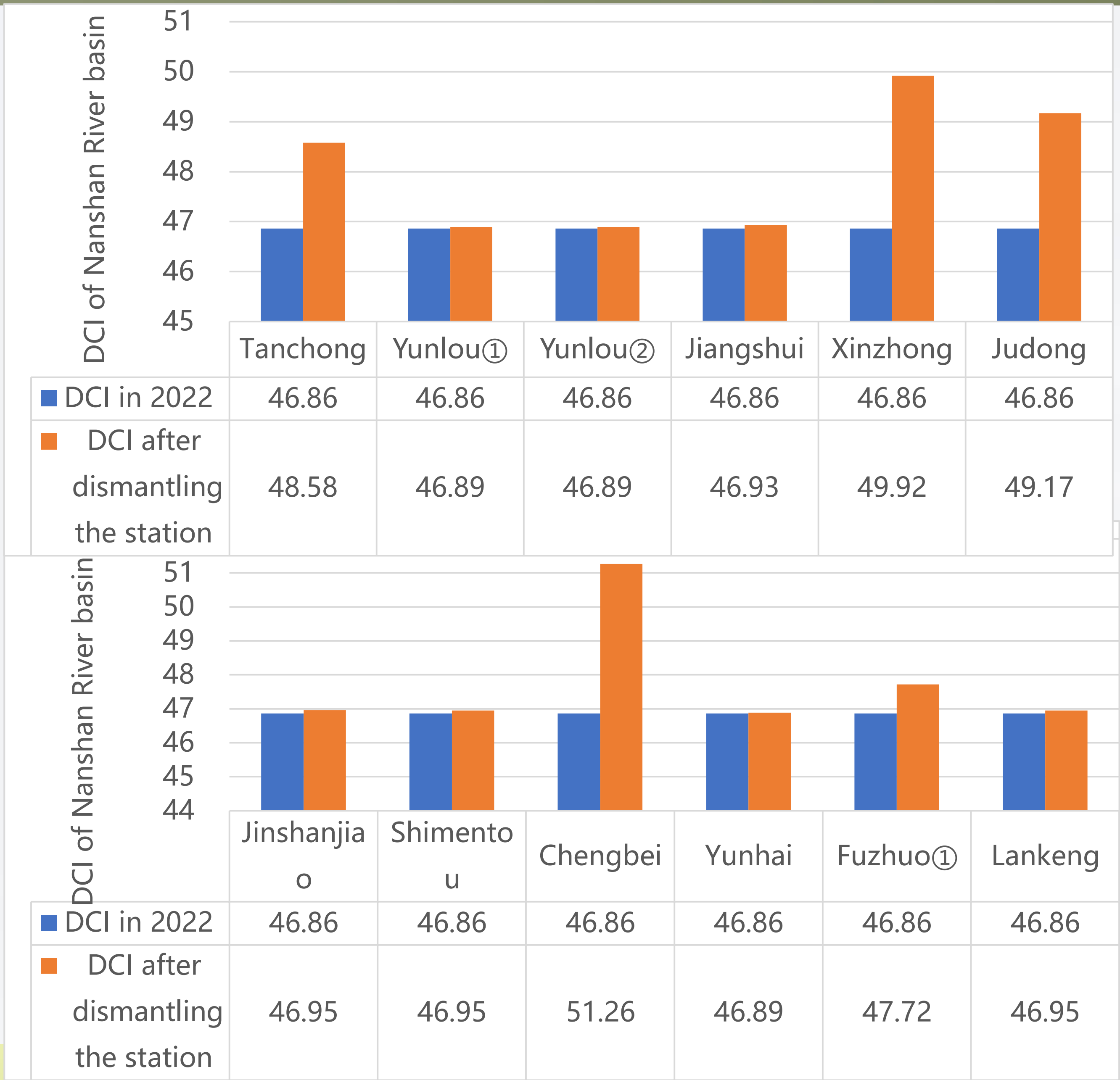

图5. 南山河流域水电站拆除前后DCI变化对比
Figure 5. Comparison of DCI changes in the Nanshan River Basin before and after the demolition of the hydropower station

5.结论-Conclusion

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可依据DCI的变化值大小提出流域纵向连通性恢复方案。建议优先退出城北、新中、菊洞、滩冲等电站（或新增过鱼设施），以提升南山河流域纵向连通性。

改进阻隔系数法可充分考虑水电站数量、类型和所在地理位置对河流带来的阻隔影响，该方法较阻隔系数法更加合理。

相较大型河流和大型流域，中小型河流、流域的纵向连通性受水电站的阻隔影响更为显著，应更深入研究中小型河流和流域的纵向连通性恢复问题，为推动流域生态文明建设提供技术支撑。

以南山河流域为例，采用阻隔系数法、改进阻隔系数法、DCI法进行评估

- Taking the Nanshan River Basin as an example, the barrier coefficient method, improved barrier coefficient method, and DCI method were used for evaluation

- A restoration plan for longitudinal connectivity of the watershed can be proposed based on the magnitude of changes in DCI. It is recommended to give priority to exiting power stations such as Chengbei, Xinzhong, Judong, and Tanchong (or adding fish passing facilities) to enhance the longitudinal connectivity of the Nanshan River basin.
- The improved barrier coefficient method can fully consider the impact of the number, type, and geographical location of hydropower stations on the barrier of rivers. Using this method to evaluate the longitudinal connectivity of rivers is more reasonable than traditional barrier coefficient methods.
- Compared to large rivers and basins, the longitudinal connectivity of small and medium-sized rivers and basins is more significantly affected by the obstruction of hydropower stations. Therefore, more in-depth research should be conducted to provide technical support for promoting the construction of ecological civilization.

Thank you

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