



XVIII World Water Congress, Beijing, China. September 11-15, 2023



XVIII
World Water Congress
International Water Resources Association (IWRA)
Beijing, China | September 11-15, 2023

第十八届世界水资源大会，北京，中国 2023.09.11-15

Key Technology ←→ **Demonstration Projects**

关键技术 ←→ 示范应用

Key Technology for Combined Sewer Overflows (CSOs) Pollution Control based on Weather Forecast

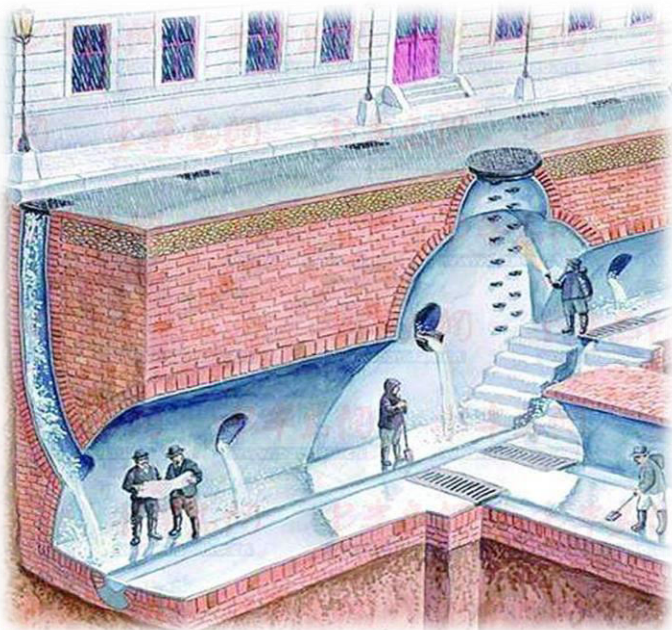
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2023.09.13

Municipal Sewer System



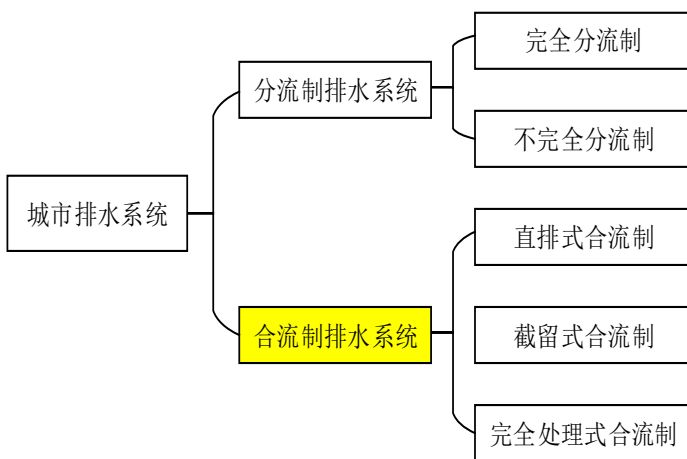
城市排水系统

是城市基础设施建设的重要组成部分，主要由排水管网和污水处理厂组成。

合流制排水系统

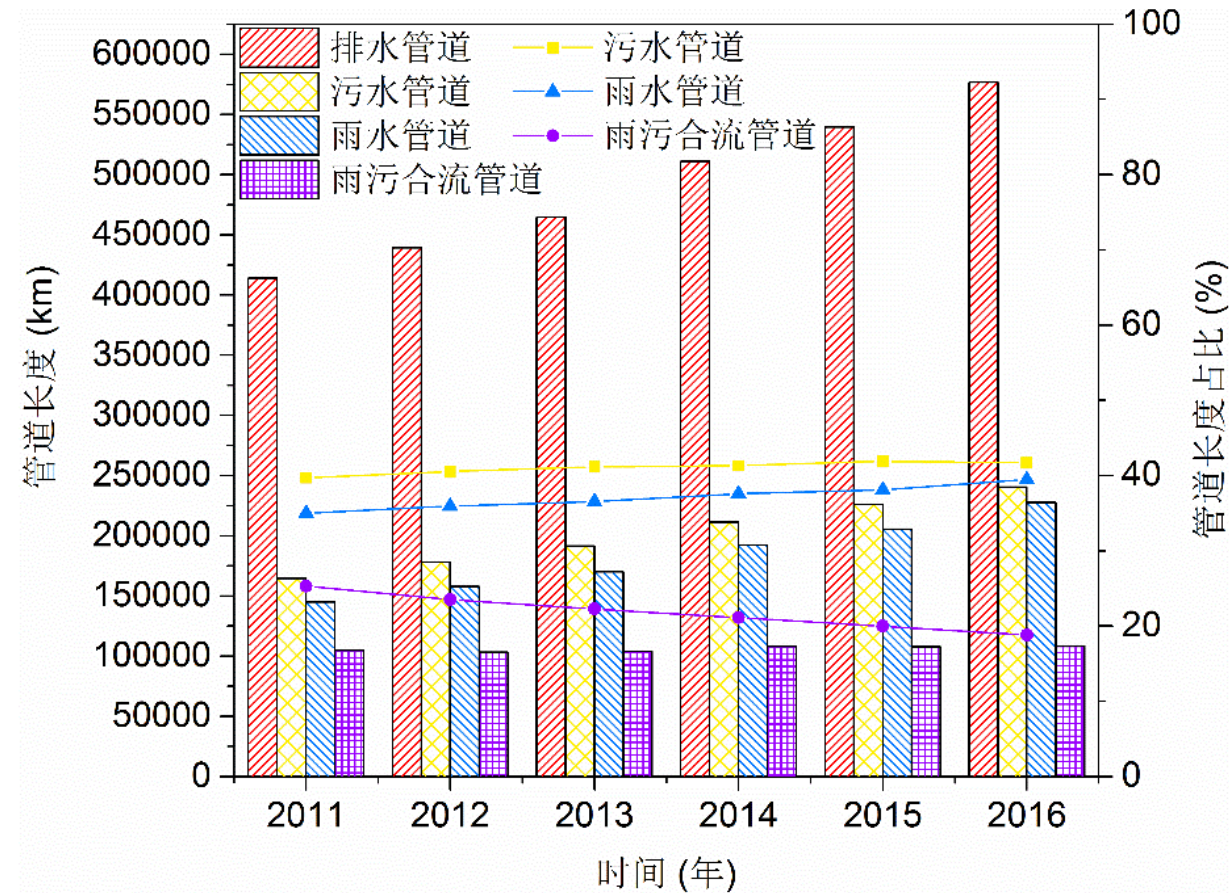
合流制排水系统(Combined Sewer System, CSS)是城市排水系统的重要组成部分，包括雨水、污水合流制管网收集系统和末端控制系统，用以收集、运输和处理雨水和污水，最终退水到接纳水体。

合流制排水系统采用单一的管道系统，将径流雨水、生活污水甚至工业废水混合在同一套管道中进行收集、运输和溢流排放。



城市排水管网统计

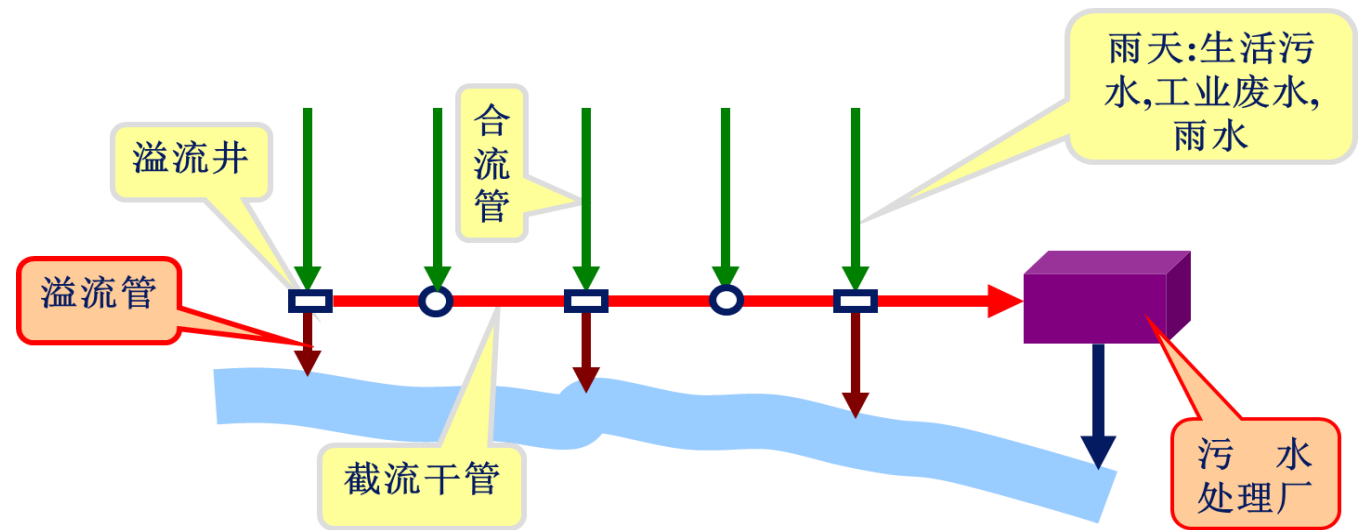
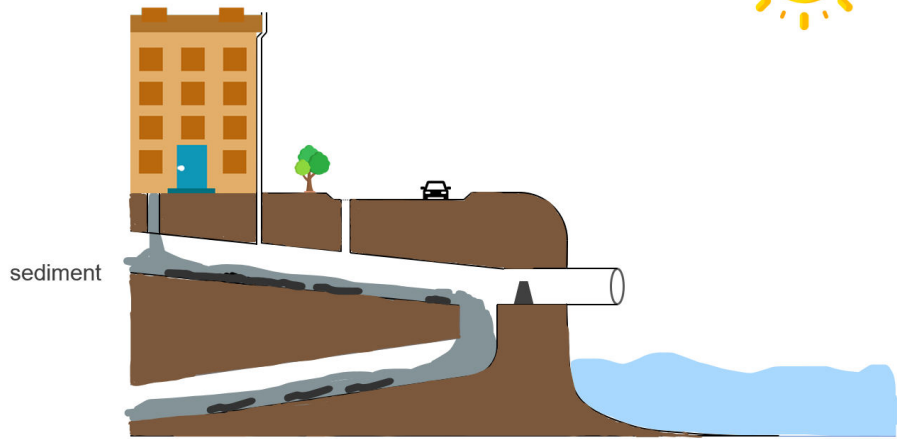
地区	城市	合流管道长度 /km	合流管道长度 /km	合流管道长度 /km	管道长度 /km	合流管道占比 /%	分流管道占比 /%
华北	北京	662	1606	1637	3905	17	83
	石家庄	78	981	750	1809	4	96
	唐山	23	1249	776	2048	1	99
	邯郸	57	559	608	1224	5	95
	保定	53	242	429	724	7	93
东北	齐齐哈尔	7	112	256	375	2	98
西北	西宁	450	170	187	807	56	44
	灵台	7	7	5	19	37	63
	宁夏	11	38	42	91	12	88
华东	上海	1228	3897	2817	7942	13	87
	合肥	45	1698	1134	2877	2	98
	苏州	1118	1192	913	3223	35	65
	张家港	82	255	358	695	12	88
华南	桂林	13	246	195	457	3	97
	泉州	15	102	102	219	7	93
	三明	69	8	18	96	72	28
	武夷山	15	43	5	63	24	76
西南	重庆	1035	3676	3776	8486	12	88
	昆明	220	96	142	458	48	52
	丽江	30	320	80	430	7	93



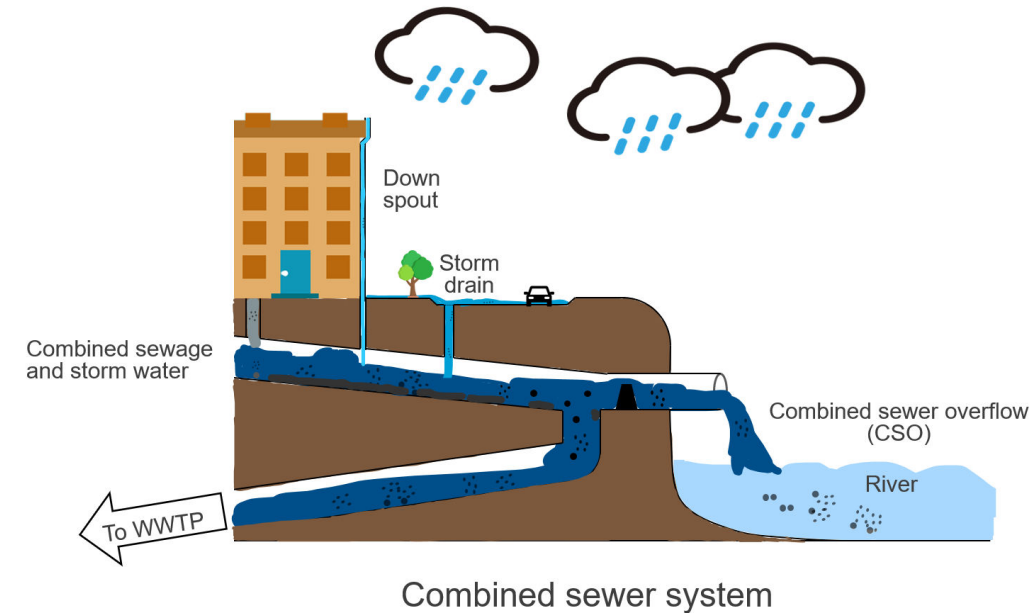
早期的城市污水管道以合流制为主，形成了目前城市核心区合流制管网占比较高的现状，囿于改造难度和成本，合流制管网仍将长期存在。

- 英国：2015年排水管道的总长为 3.23×10^5 km，雨污合流管道占比70%；
- 德国：2010年排水管道长达 5.40×10^5 km，其中雨污合流管道、污水管道和雨水管道分别为46%、33%和21%；
- 日本：雨污合流管道占排水管道长度的70%左右，其中东京的占比为83%，大阪的占比高达97%；
- 美国：采用合流制排水管道的州有32个，其中绝大多数分布在美国的东北部和五大湖；
- 中国：2016年我国城市排水管道长度达到 5.57×10^5 km，其中雨污合流管道东部、中部、西部、东北地区占比14.05%、25.88%、19.04%、38.93%。与发达国家相比，我国城市合流制管网占比明显较低，得益于我国城市建设的后发优势。

Combined Sewer Overflows (CSOs)



- Influence on urban aquatic ecosystems 影响城市水生生态系统
- Threatening the health of the population 威胁居民健康
- Impacts on the sustainable development of cities 制约城市可持续发展





Source, Characteristics and Impacts of CSOs Pollution



CSOs污染来源 Source of CSOs

合流制管网主要收集城镇废水，包括径流雨水、生活污水甚至工业废水等。CSOs污染的三个主要来源：①降雨径流；②生活污水；③管道沉积物，其中合流制管道沉积物是CSOs污染的重要来源，占比约30%以上

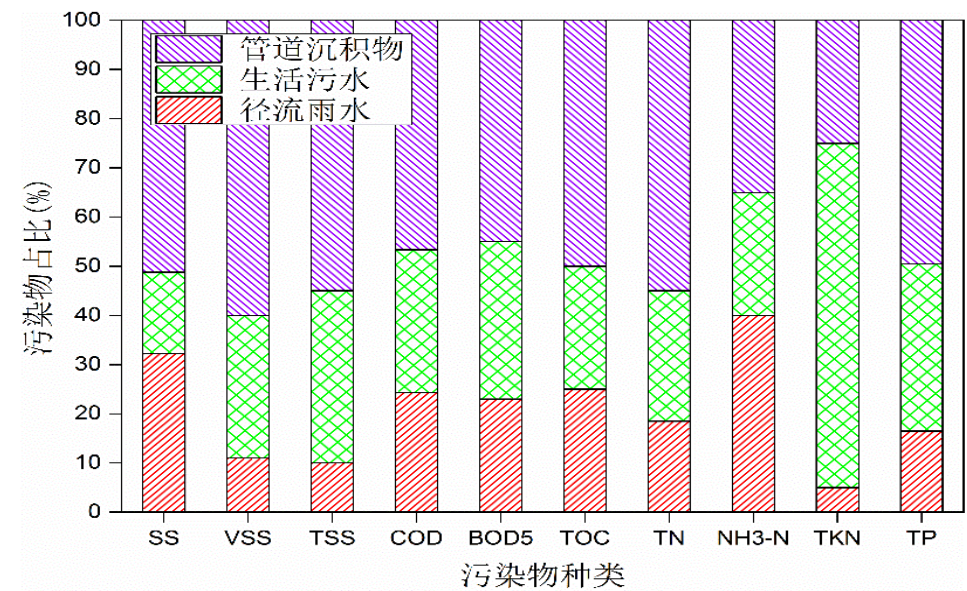
CSOs污染特性 Characteristics of CSOs

①水质特性：污染物浓度高。北京市CSOs的COD超标17倍，总磷超标6倍；②水量特性：瞬时性和间歇性；③水质与水量间的关系：初始冲刷效应（first flush），初始阶段污染物的负荷相对较高。

CSOs污染影响 Impacts of CSOs

1) 导致水体富营养化；2) 破坏水体生态结构；3) 影响受纳水体的观赏价值；4) 危害公共健康；5) 制约整个城市的可持续发展。

地点	累积降雨量 (mm)	流量 (m ³ /h)	污染物浓度值 (EC、FC: CFU/L; 其他: mg/L)										参考文献
			TSS	COD	BOD ₅	TP	TN	Pb	Zn	Cu	EC	FC	
纽约	-	-	252	80.4	26.6	0.6	3.3	0.0431	0.103	0.0268	13600	73000	[29]
巴黎	6.2	-	279	432	158	--	25	0.188	1.467	0.16	-	-	[30]
韩国大田	-	2731	373	395	129	13	16	0.213	-	-	-	-	[31]
西班牙	-	3313	282	329	123	2.2	22.8	0.005	69	-	-	-	[25]
斯洛伐克	-	-	430	445	175	2.6	16.8	<0.2	0.57	<0.5	-	130	[32]
上海	27.9	-	684	614	218	3.0	29.8	-	-	-	-	-	[33]
北京	26.6	-	579	675	--	2.4	26.5	-	-	-	-	-	[34]
昆明	26.9	-	449	208	--	3.0	25.9	-	-	-	-	-	[35]
V类标准	-	-	--	40	10	0.4	2.0	0.1	2.0	1.0	40000	-	[36]



Pollution Control for CSOs

常用控制措施

源头控制

主要是减少进入合流管道系统的径流量，从而改善CSOs的水质和水量。**海绵城市、低影响开发**
存在的问题：合流制溢流污染管理体制欠缺或落实不到位。

管道系统

是从管道设计的角度来改善CSOs的污染状况。
存在的问题：改建工作量大，耗时耗力，费用高。

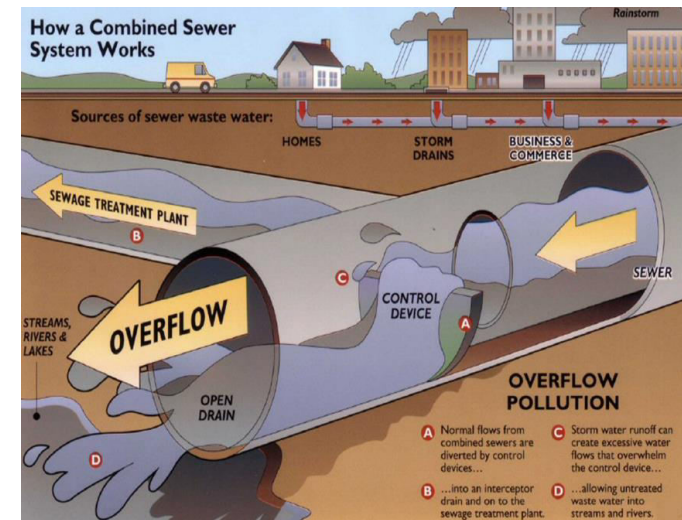
存储调蓄

设置中间调蓄设施能够有效的削减洪峰流量，降低下游合流制干管以及截流泵站的设计容量，相当于提高了系统的截流倍数，从而达到减轻CSOs污染的目的。
存在的问题：造价太高。

末端处理

CSOs污水净化处理技术用于减少排入水体的污染物负荷量，去除的物质包括可沉淀固体、漂浮物、细菌等。
存在的问题：控制技术有待丰富，控制效果有待提高。

无论是源头径流量削减还是提高管道截流倍数和增设调蓄池等措施，在**雨量较大**条件下都不能确保避免CSOs污染。





Environmental Governance Demands Driven by Industry Development and Policy Standards



- **Improve the ability to control the pollution of CSOs 提高溢流污染控制能力**
- **Improve capability for in-time warning, dispatching and responding to emergency 提高预警、调度和应急处置能力**

**Step 1:
Understand the system**

1 特征理解

System
understanding



Values
and Benefits



Ecosystem
Functions and
Services



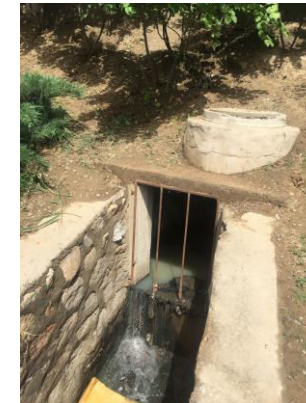
**Step 2:
Link values to your system**

2 指标构建

**Step 3:
Develop the solution**

3 技术开发

- Characteristics of CSOs ?
- How to identify CSOs ?
- How to control CSOs ?



Key Technology ← → Demonstration Projects

Clarify the mechanism of transport and transfer overflow pollutants in Shahe reservoir,

Develop key technologies (截冲掏·调蓄净一体化) to prevent and control combined sewer overflow based on weather forecast



Rainfall
降水



overflow
溢流

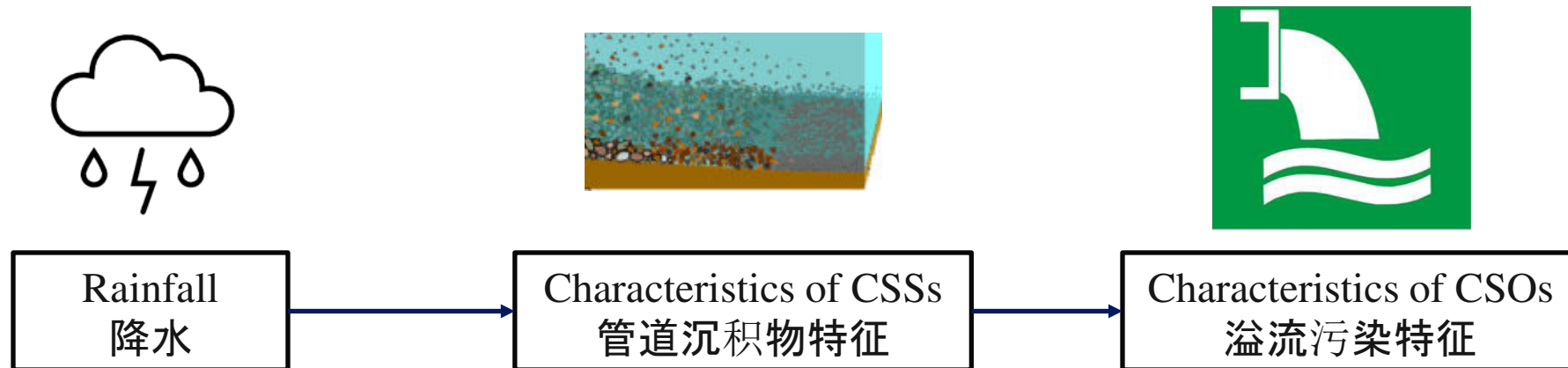


Control
防控

- Mechanism of pollutant transport and transfer
- Key technology for prevention and control
 - Development
 - Application

1. Mechanism of Transport and Transfer of Combined Overflow Pollutants

合流制溢流污染物运输和迁转规律

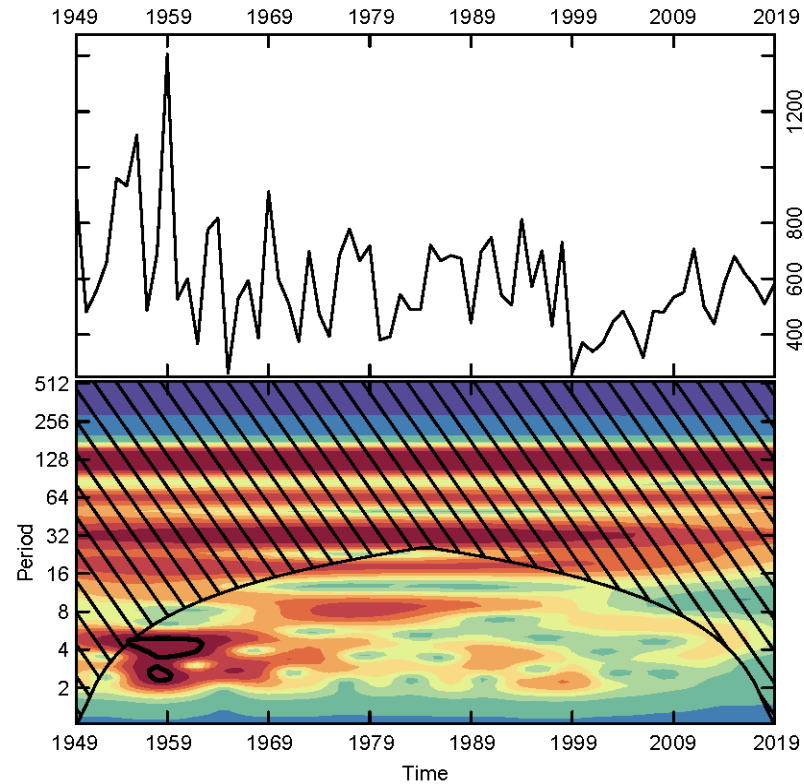


- Moderate and higher rainfall events: 19 times for 35 days, duration < 5 days, with frequent flush (频繁冲洗)
- 10 combined sewer overflow annually: 4 with heavy rainfall, < 1 with storm, strong flush, huge amount of overflow (强冲刷、大量溢流)

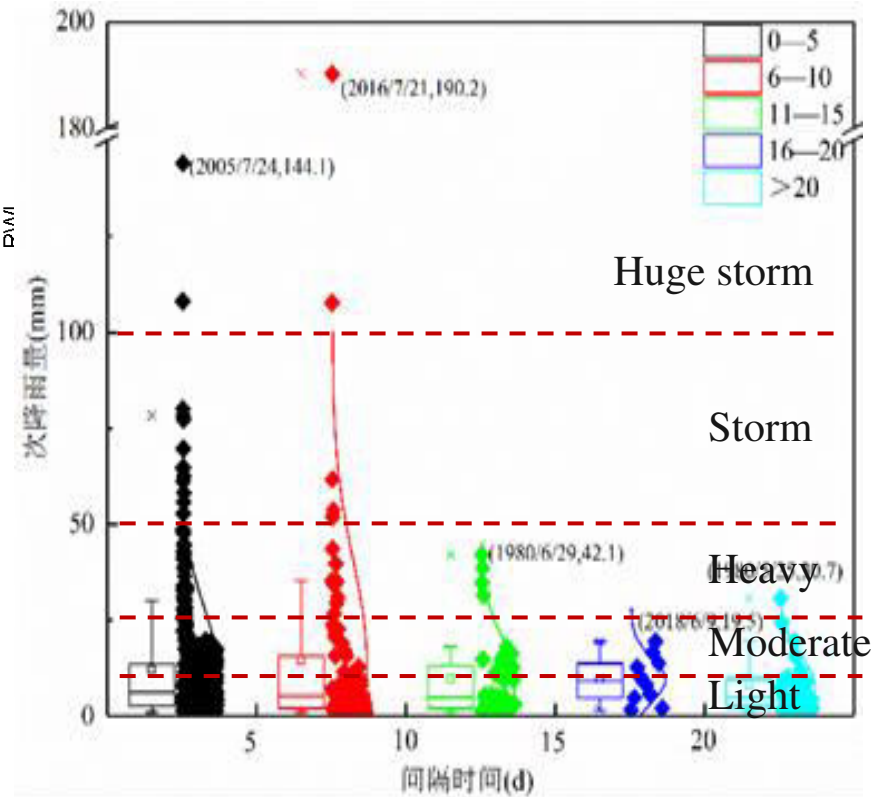
Table1. Rainfall characteristics in Shahe reservoir in recent 10 years(2010-2020)

Rainfall Intensity	Standard for Rainfall	Frequency	Annual Frequency	Intervals	Total Rainfall Volume
	(mm/12h, mm/24h)	times/year	days/year	days	mm/year
No rain	<0.1	--	263	2	
Light rain	≤4.9, <0.1~9.9	36(7)	55(11*)	4	189.5
Moderate rain	5.0~14.9, 10.0~24.9	15	35	7	138.6
Heavy rain	15~29.9, 25~49.9	4	11	21	247.6
Storm	30~69.9, 50~99.9	<1	<1	>783	——
Total	一年4-6次暴雨 ——	56(27)	101(57)	5 (flood season)	575.7

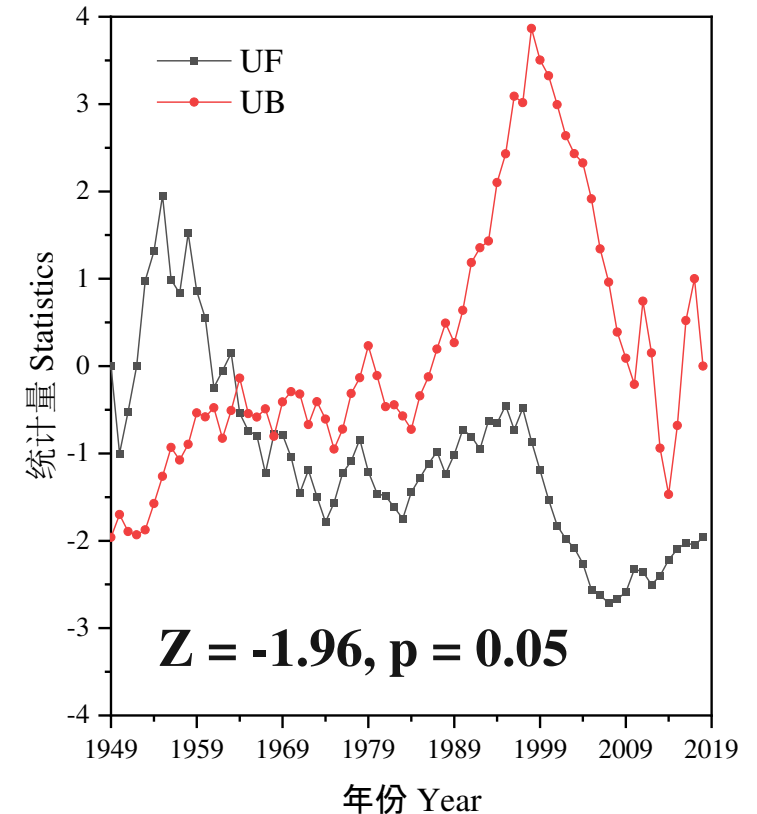
*note : 90~131days without rainfall continuously, an annual average of 133.2 days with sun, 129.1 days with cloud, 44 days being overcast, 5-10mm rainfall for 11days。



Wavelet transform of annual rainfall (mm/y)
年降雨量小波变换(mm/y)

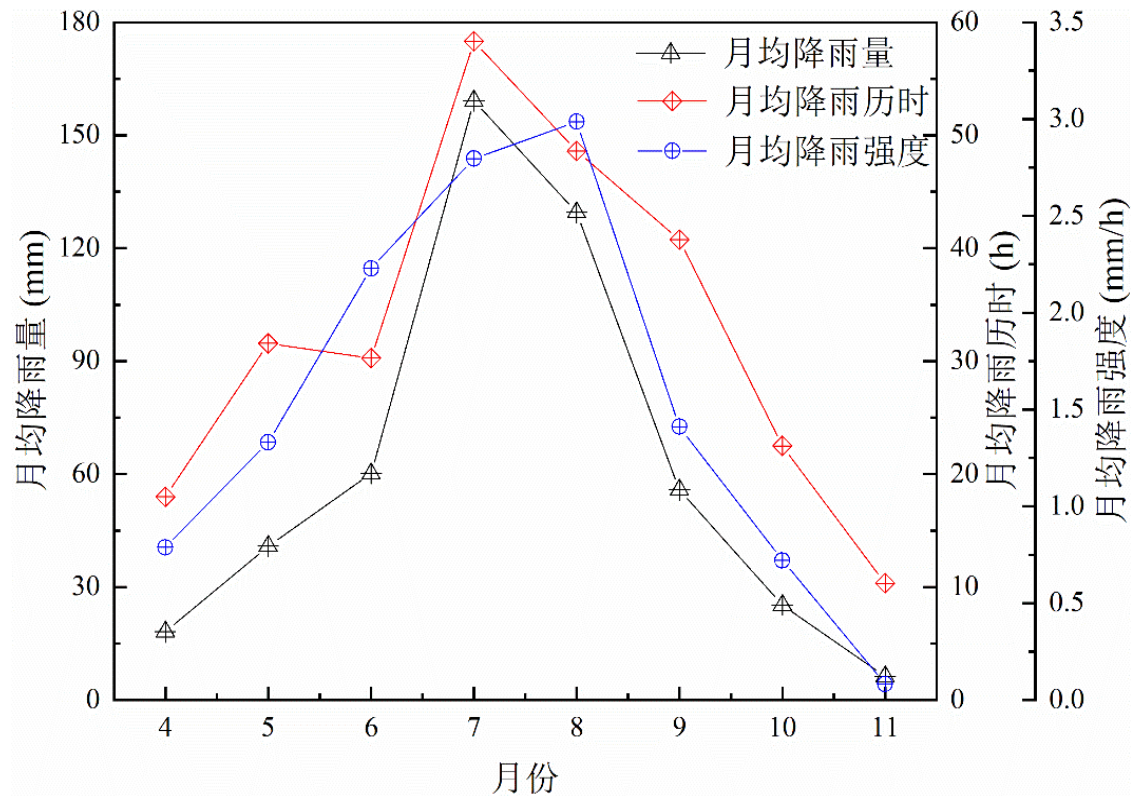


Characteristics of rainfall duration over years (mm/d)
多年降雨间隔特征(mm/d)

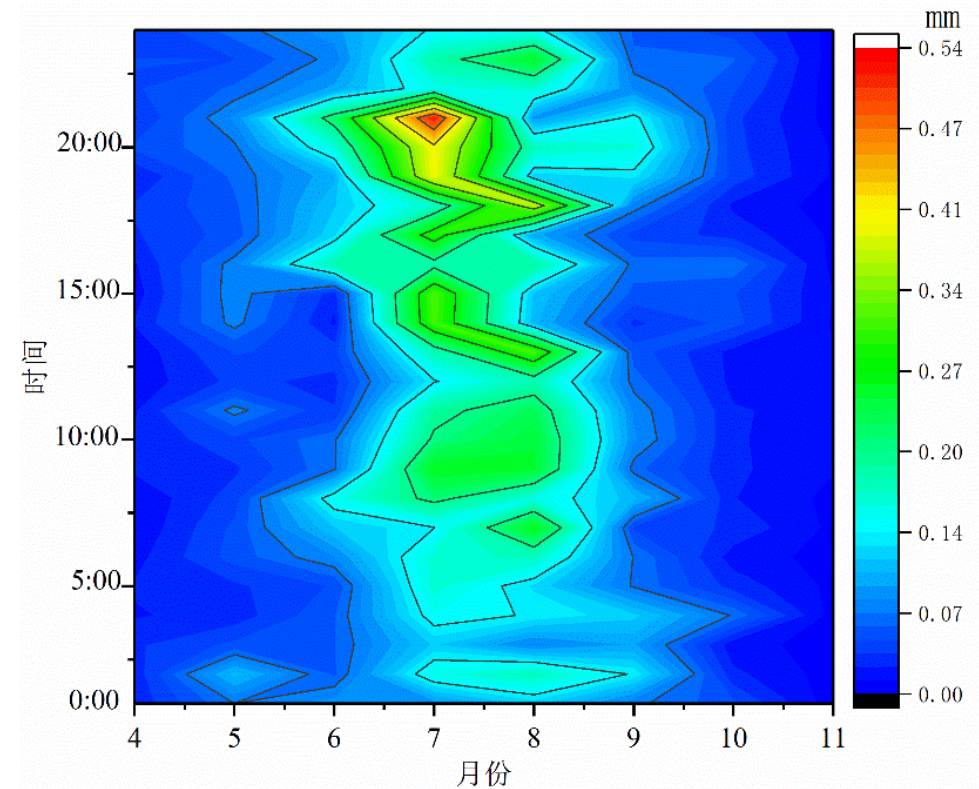


Interannual variation of rainfall intensity (M-K test)
降雨强度年际变化(M-K检验)

- Wavelet transform: annual cycle of rainfall change 4, 9 years
- M-K test: 1964-1969, precipitation changed suddenly and tended to decrease

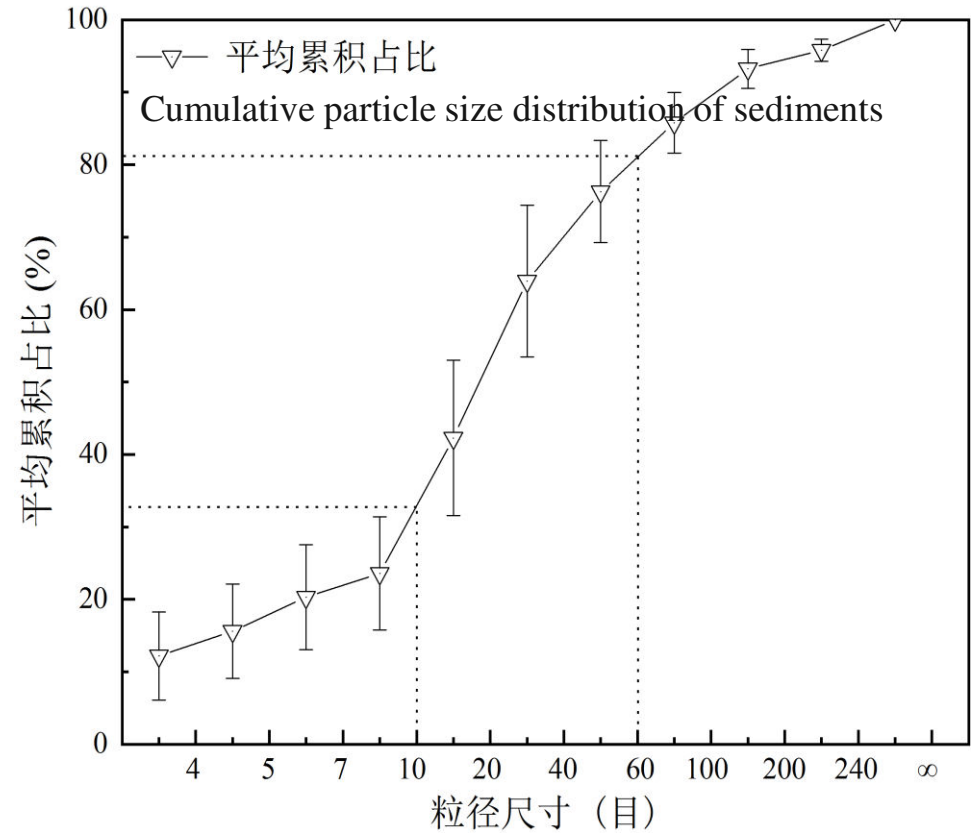
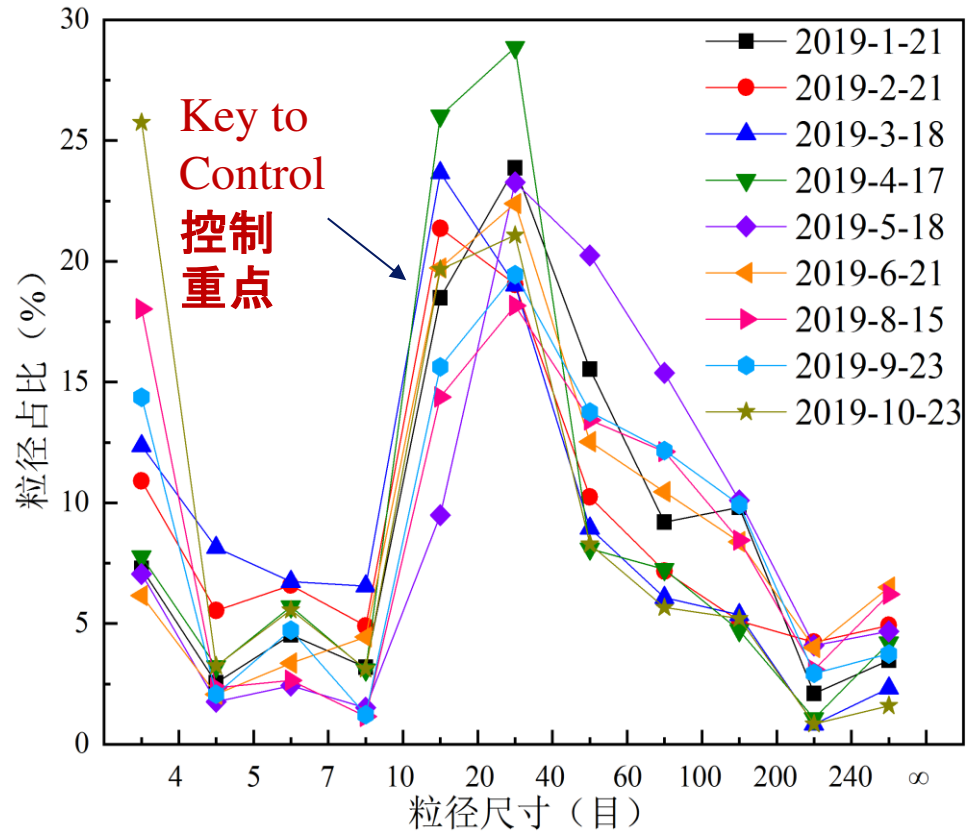


Monthly Rainfall, Rainfall Duration, Rainfall Intensity
月降雨量、降雨历时、降雨强度

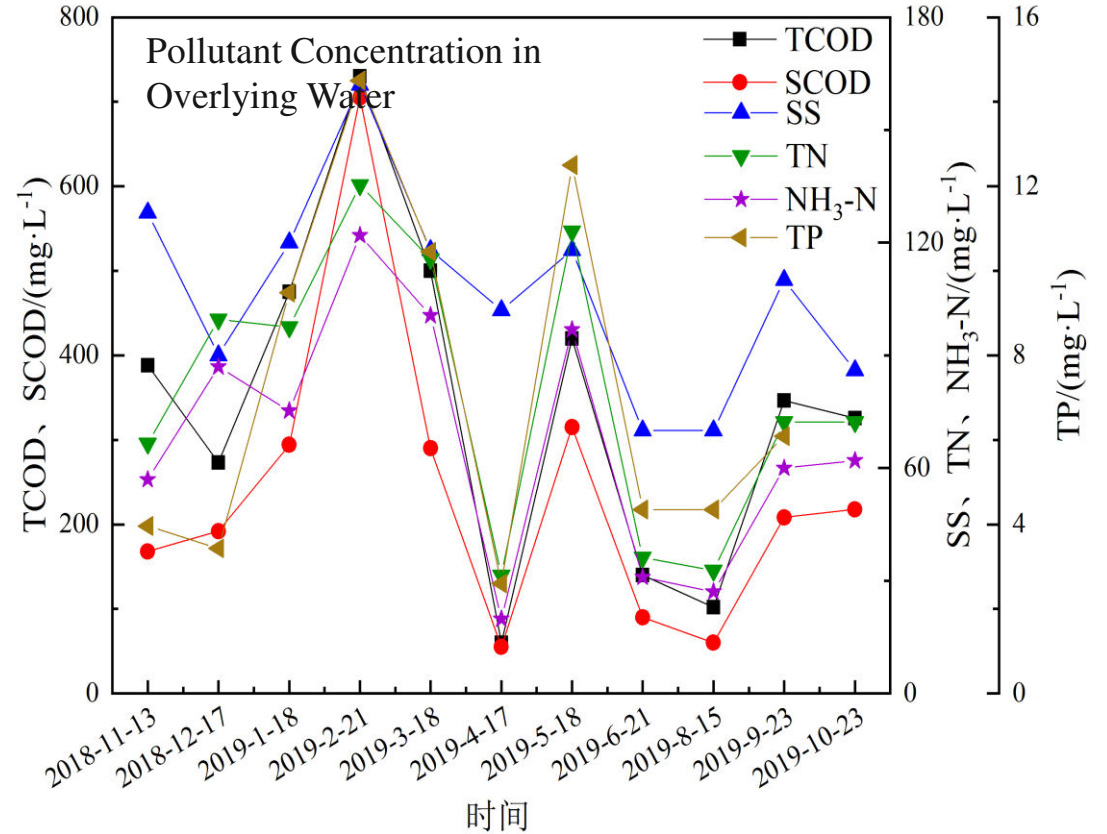
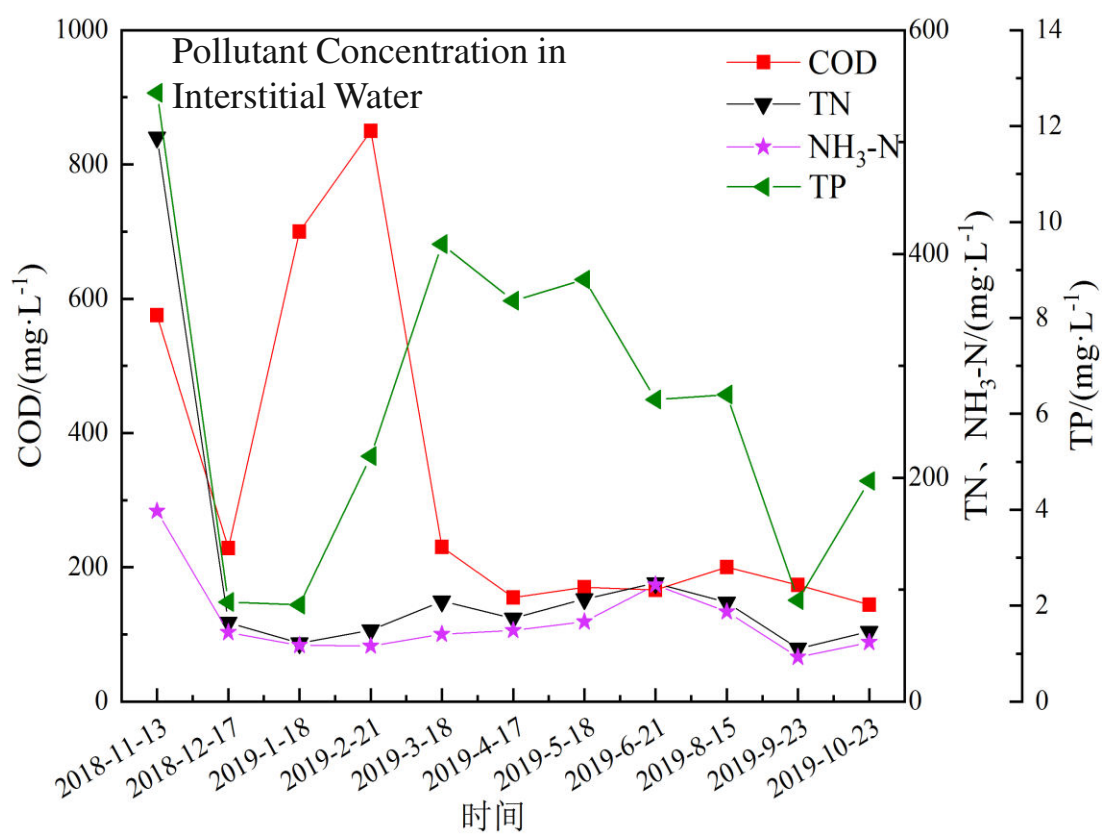


Rainfall Distribution
降雨分布

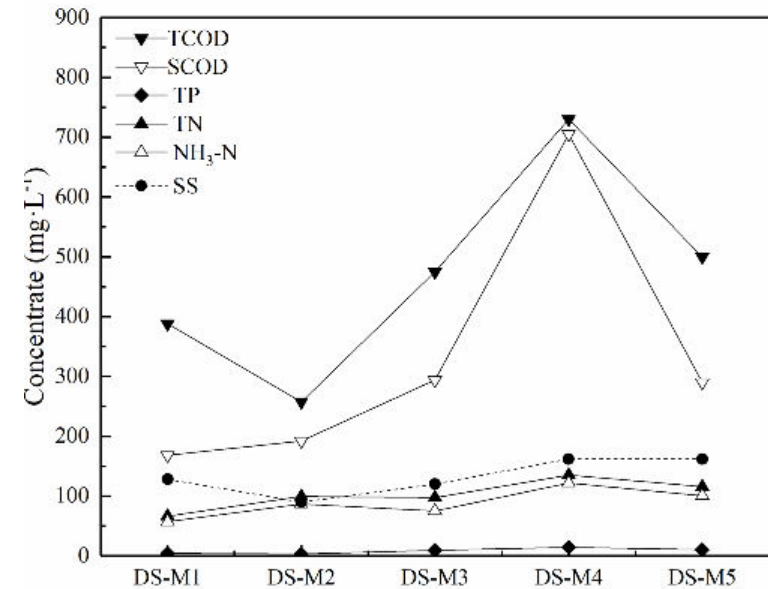
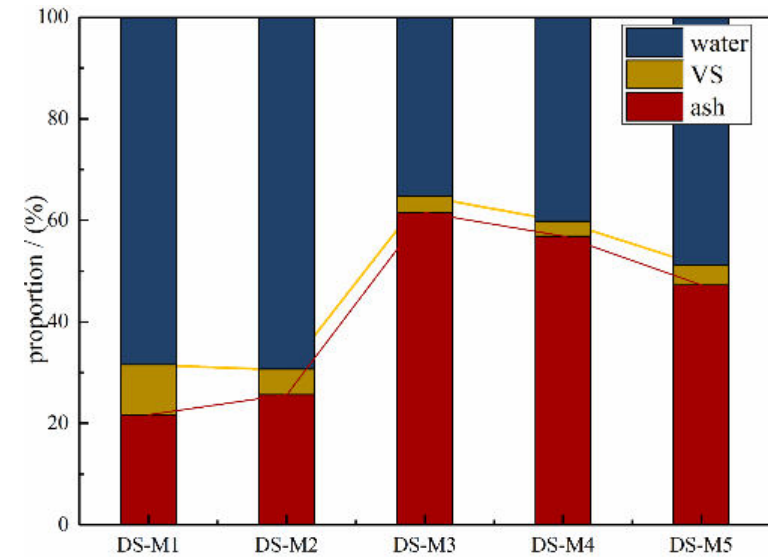
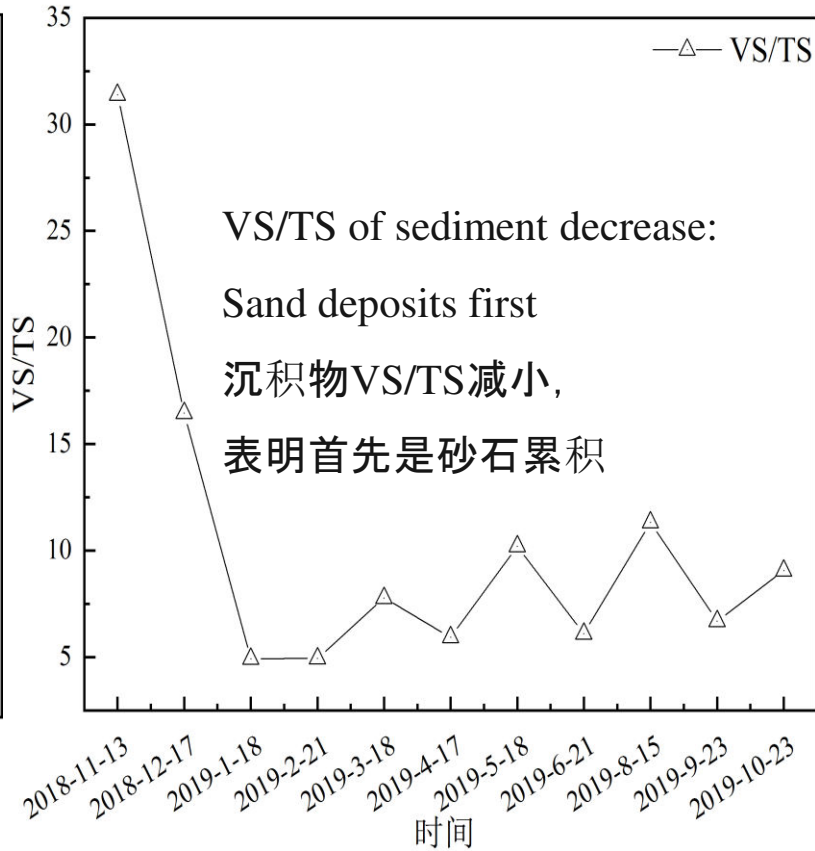
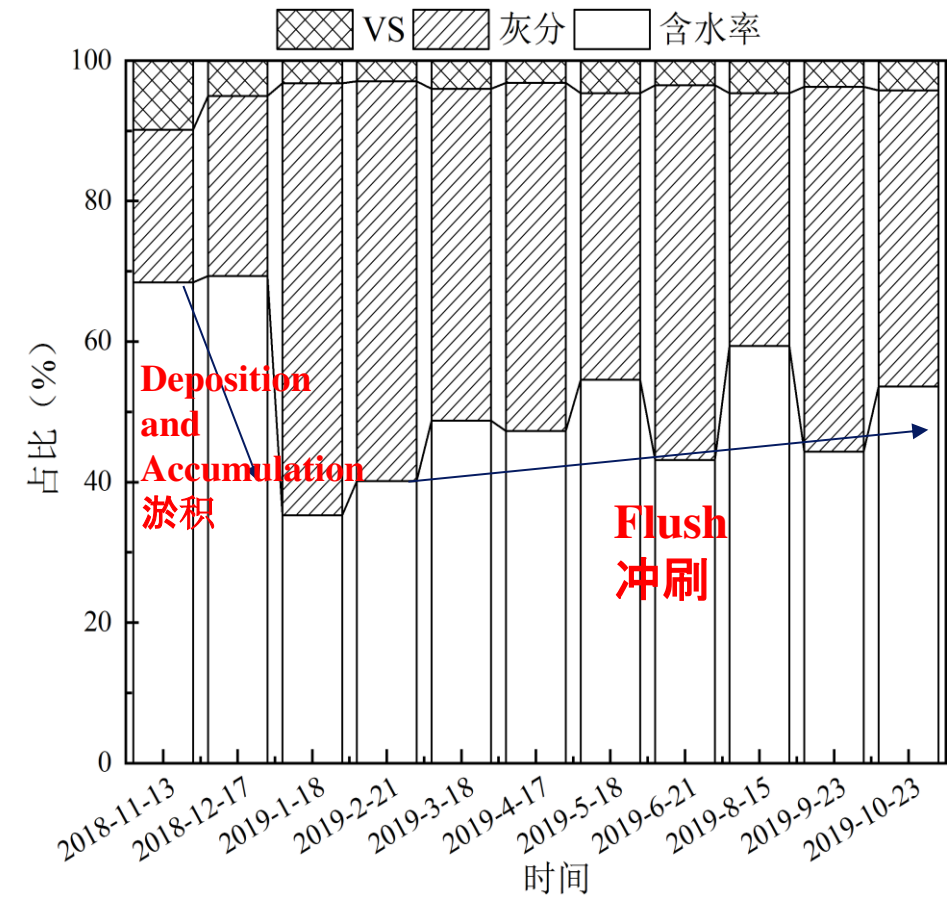
- Rainfall concentrate on **21:00 from Jun. to Sep.(404mm)**
- Flood seasons have long rainfall duration with average duration 49 h for Jul. and 58h for Aug.



- Mostly large particles 大颗粒沉积物 (10~60mesh, 0.42~2mm) >50%, fine particles <20%。
- Mostly sand (泥沙为主) : 21.7~61.5%, VS: 3.1~9.7%



- Pollutant concentration reached peaks in Jan. and Feb., with lower and relatively stable levels during the flood season (Jun. – Sep., especially in Jul. and Aug.)
- Pollutant concentration in overlying water (上覆水) exceeds that in Interstitial Water (间隙水) gradually : pollutants may accumulate in the sediment before being gradually released

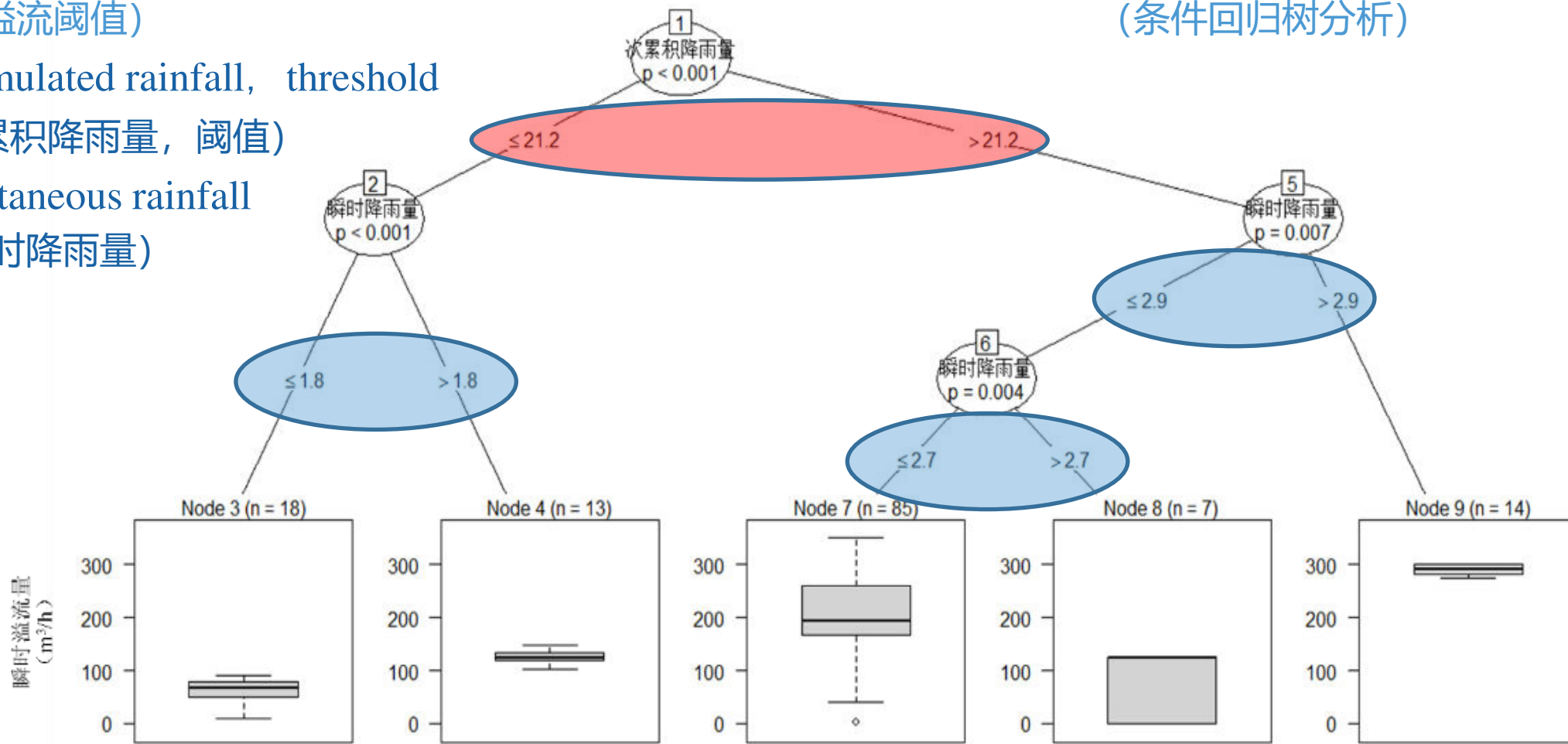


- Sediment and organic matter accumulate quickly (within 1-2 months), then gradually released (先快速累积, 再逐步释放)
- Pollutant concentrations reach peak in February

◆ Threshold of Overflow (溢流阈值)

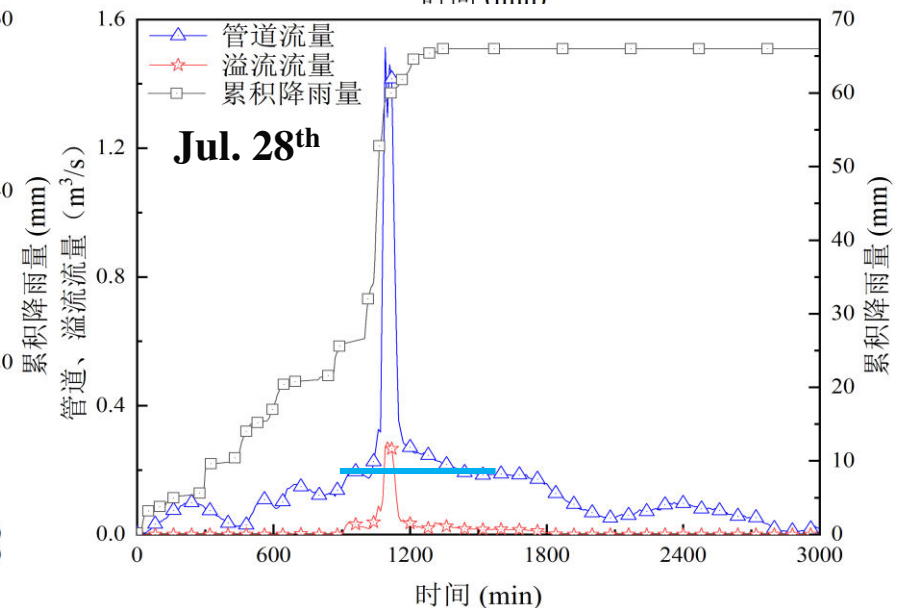
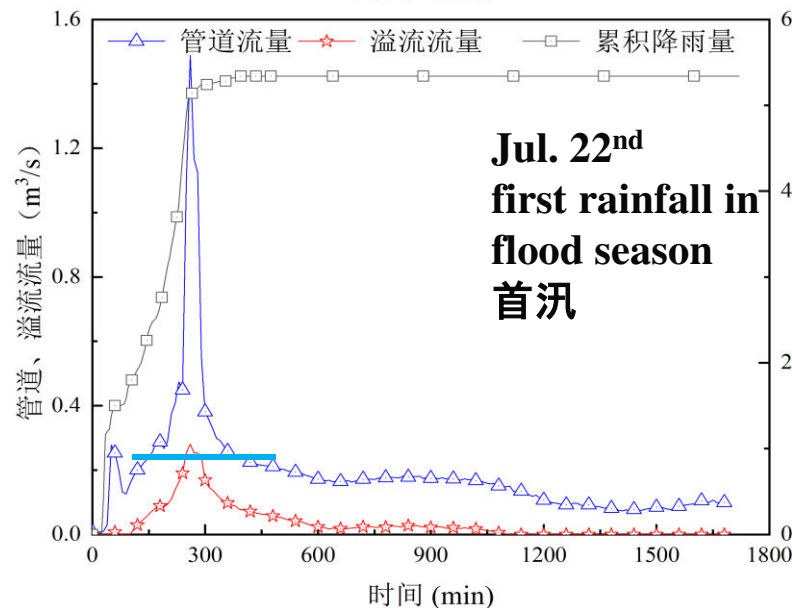
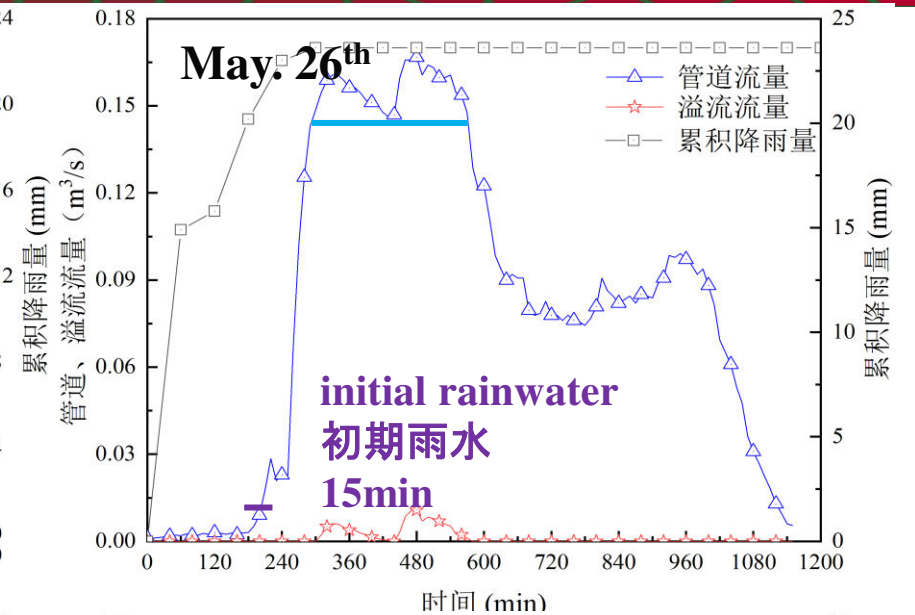
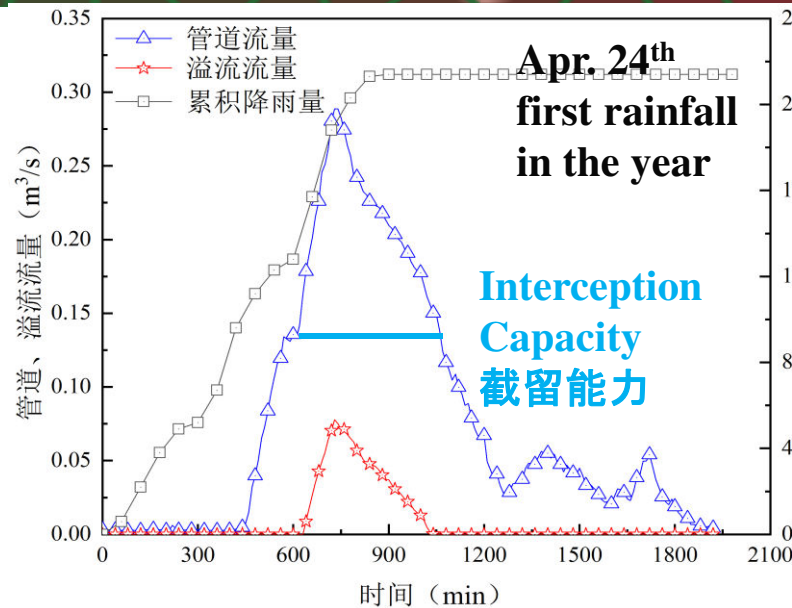
- Accumulated rainfall, threshold
(次累积降雨量, 阈值)
- Instantaneous rainfall
(瞬时降雨量)

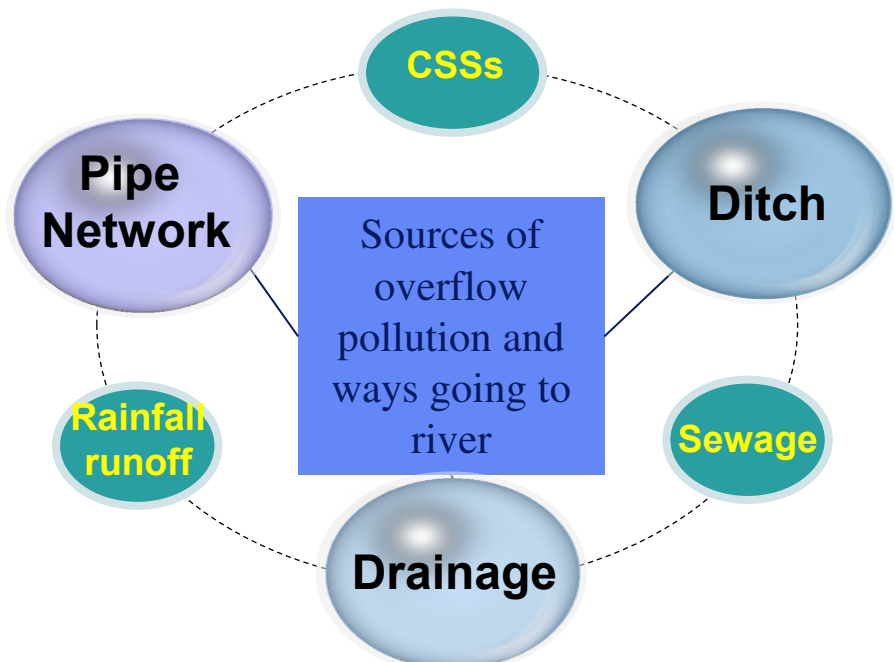
Conditional Regression Tree Analysis (n=137): 2 factors (条件回归树分析)



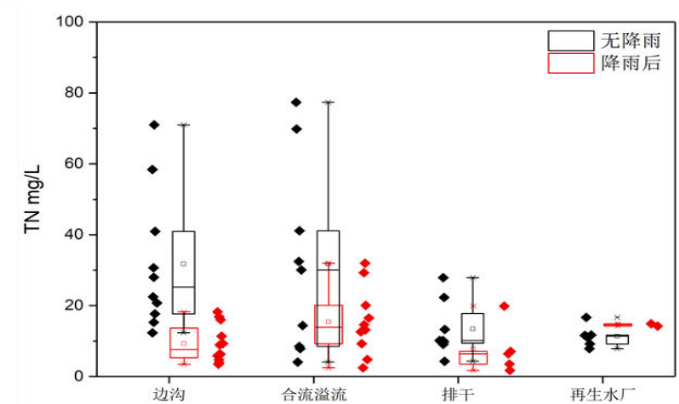
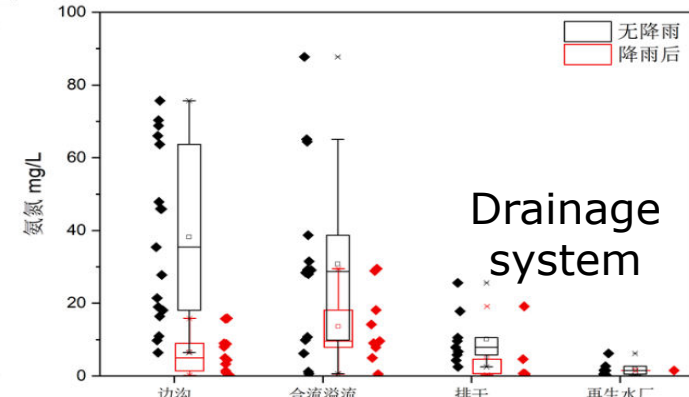
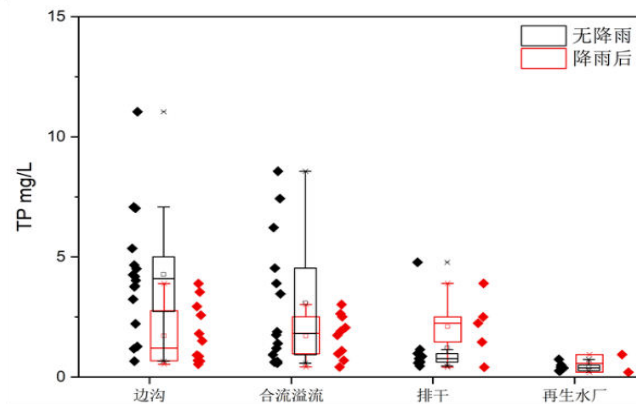
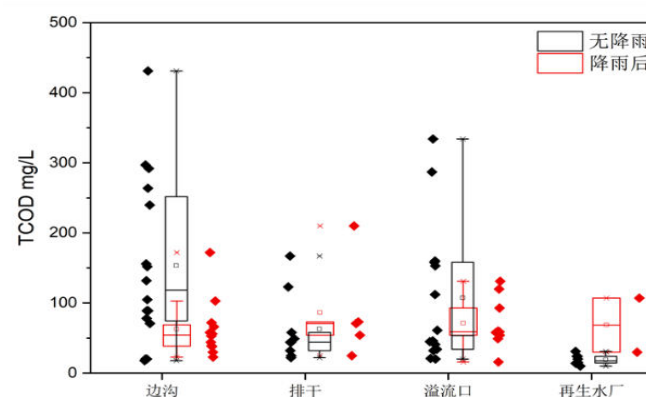
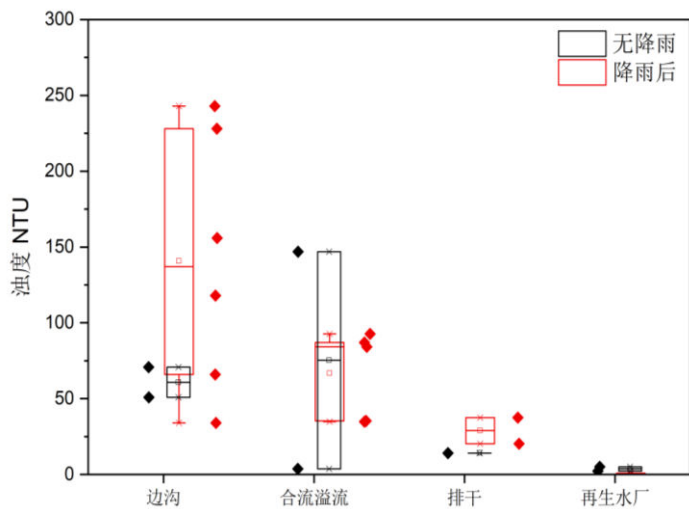
- The peak of overflow water volume occurs within 30 to 60 minutes, forming strong flush effect on the sediment in the pipe. (对管网的强冲刷效应)

- Single Overflow Volume: 720~5300 m³, accounting for 11~15 %





溢流污染来源与入库途径



➤ Pollutant source: CSSs > Rainfall runoff > municipal wastewater

污染物来源: 管道沉积物 > 降雨径流 > 生活污水

➤ Pollution degree of River Pollution Pathways: CSOs > Side Ditch

Rainwater > Drainage > WWTP

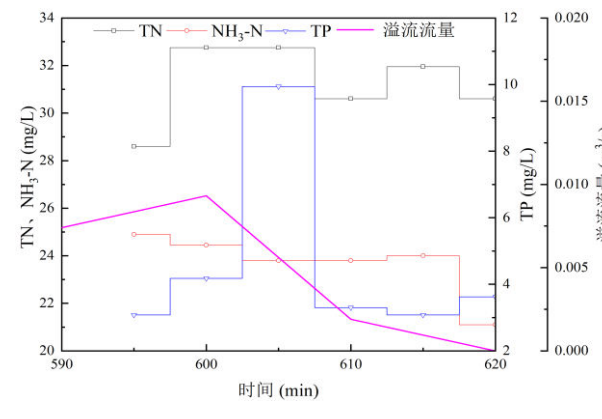
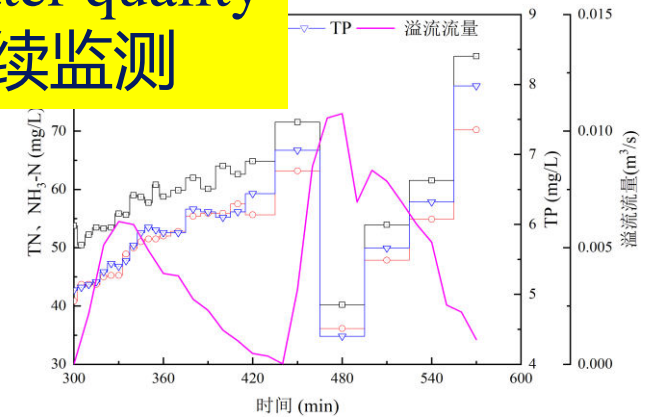
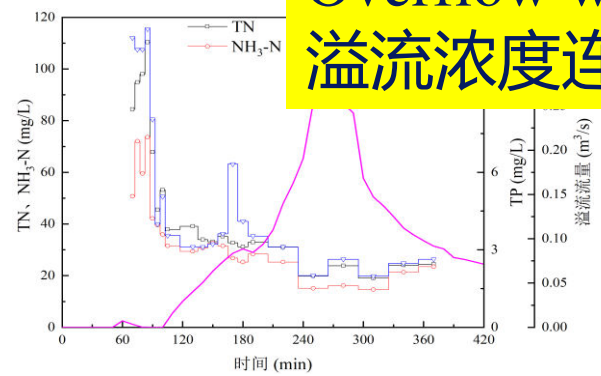
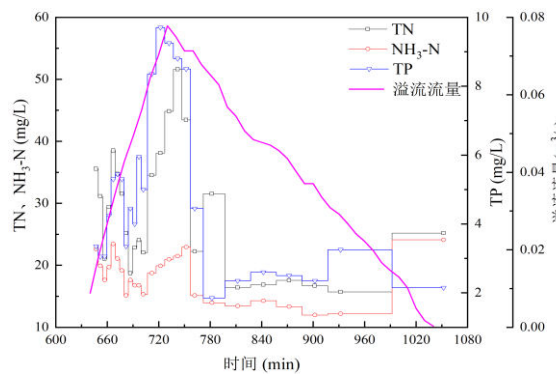
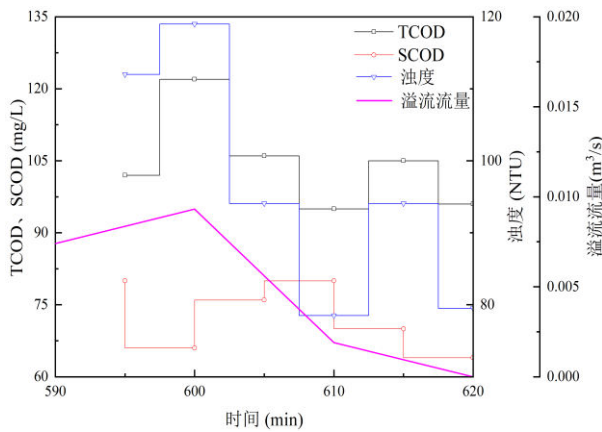
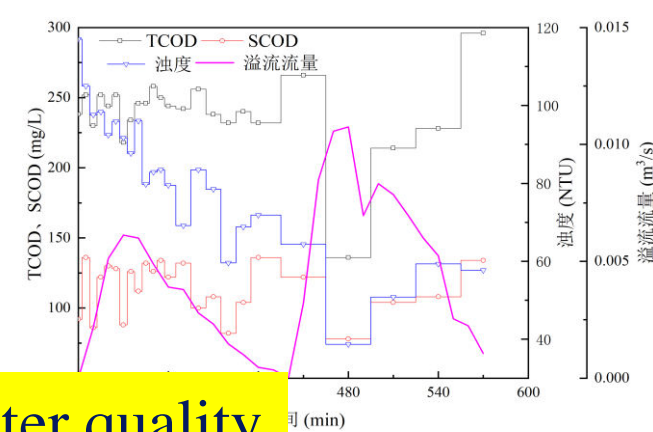
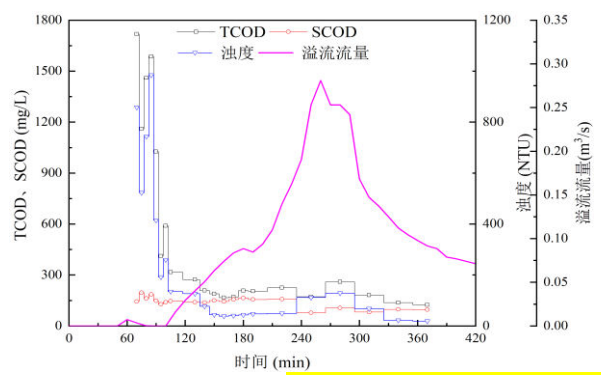
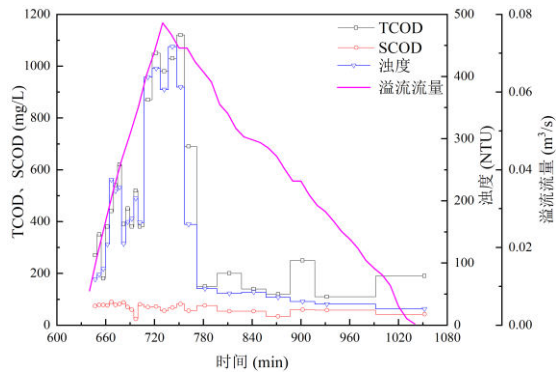
入河途径的污染程度: 合流溢流 > 边沟雨水 > 排干 > 再生水厂



Characteristics of Combined Sewer Overflow



Apr. 24th : first rainfall (21mm) Jul.22nd: first rainfall in flood season(53mm) May.26th : rainfall in dry season Jul.28th: rainfall in flood seasons

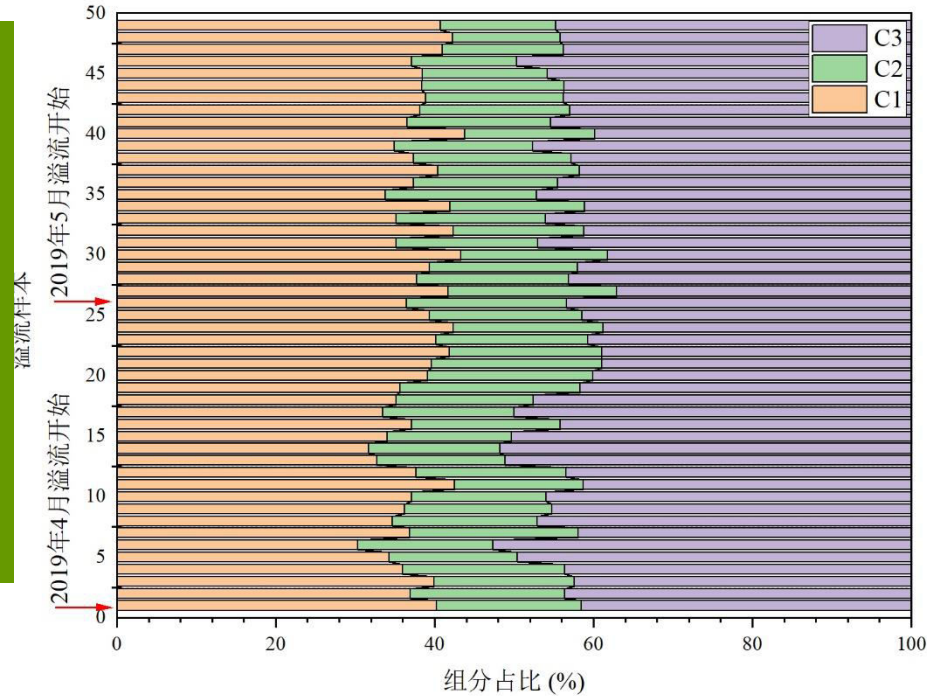


Overflow water quality
溢流浓度连续监测

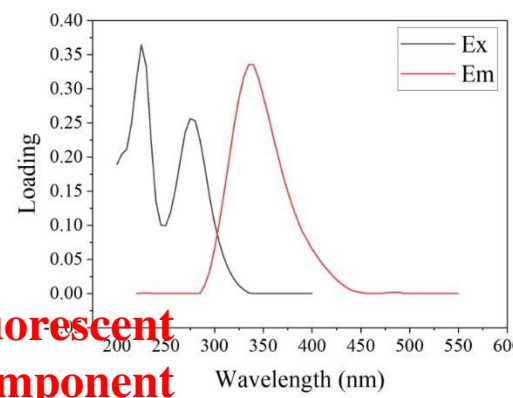
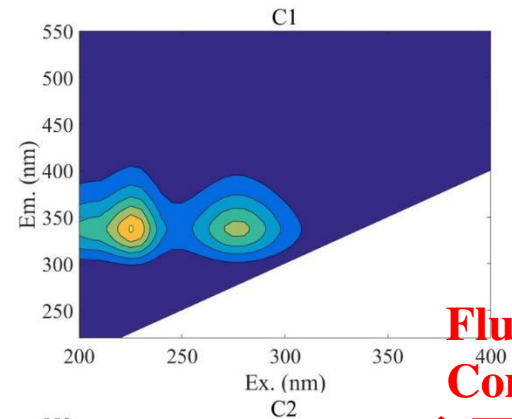
- Water quality of the first rainfall events in the year(年度首次), and first heavy rainfall events in flood season(汛期首次) are the poorest among the 4 major overflow events
- First overflow flush (初期溢流污染) carries sediment, in subsequent overflow rainfall run plays the role of dilution

Top priority in CSOs prevention and control
溢流污染防控的重中之重

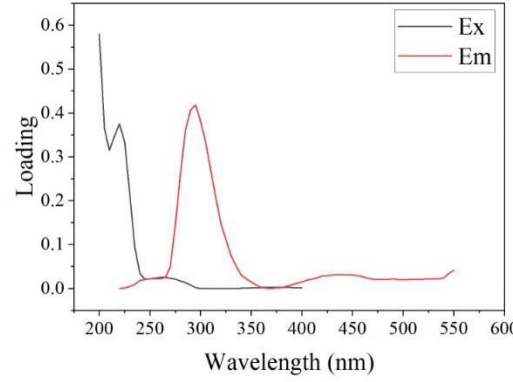
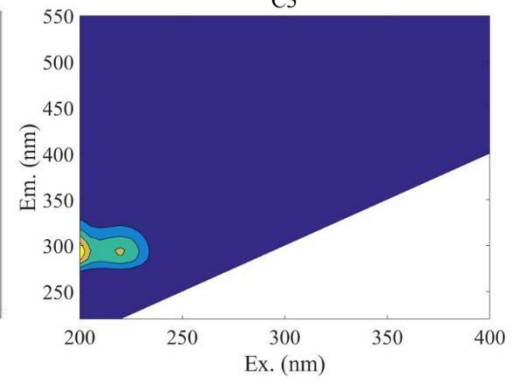
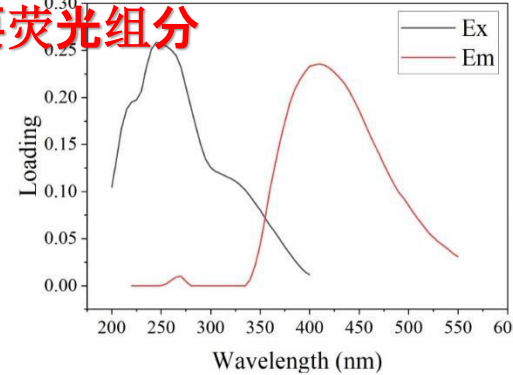
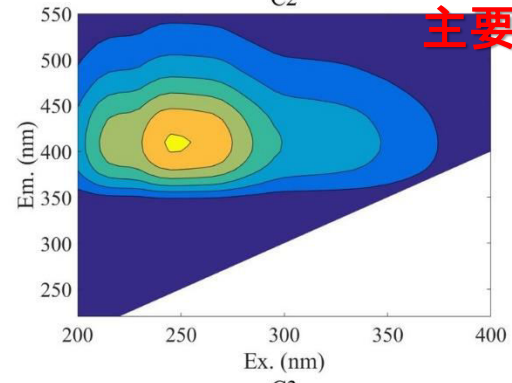
Fluorescence fingerprints (荧光指纹):
Organic matters mainly originate from CSSs flushed and secondary release



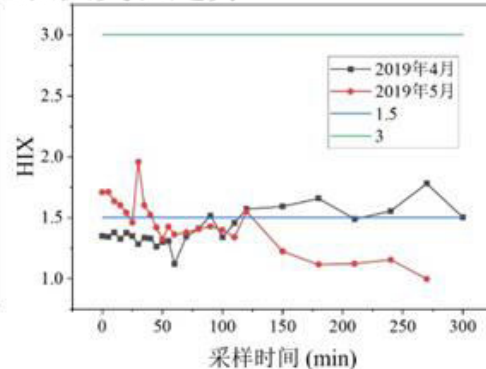
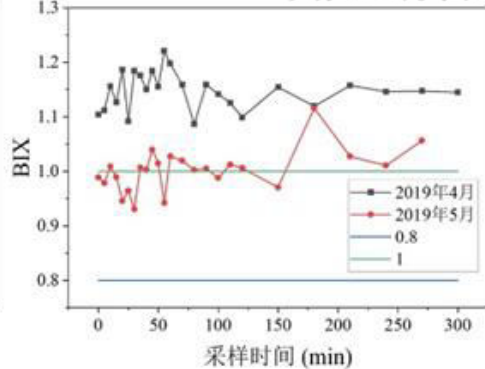
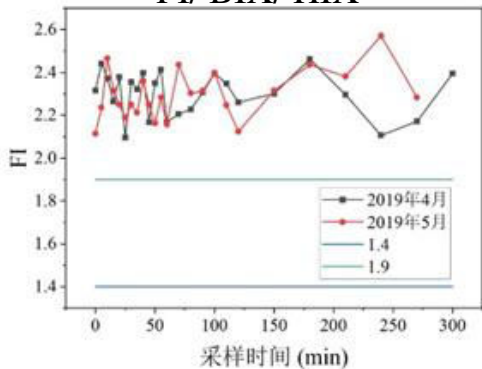
Proportion of Fluorescent Components and Changing Trend
荧光组分占比及其变化趋势



Fluorescent Component
主要荧光组分



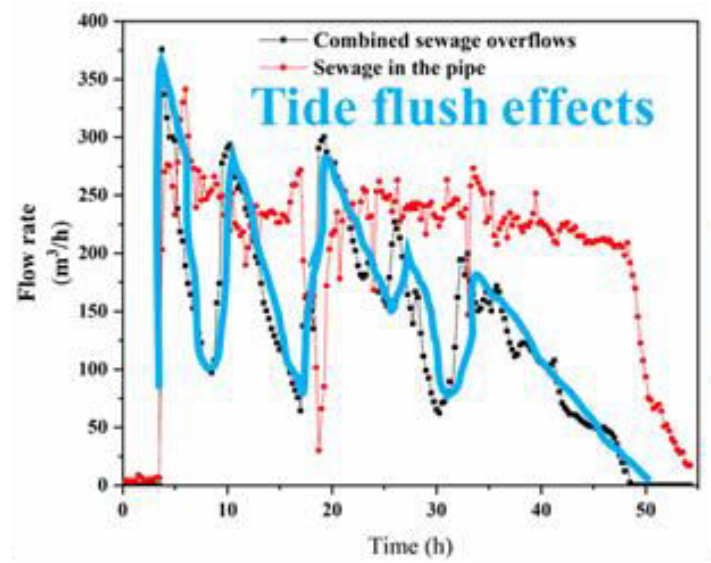
Fluorescence index
荧光指数
FI/ BIX/ HIX



Characteristics of CSOs: Resistance Tracing (抗性溯源)

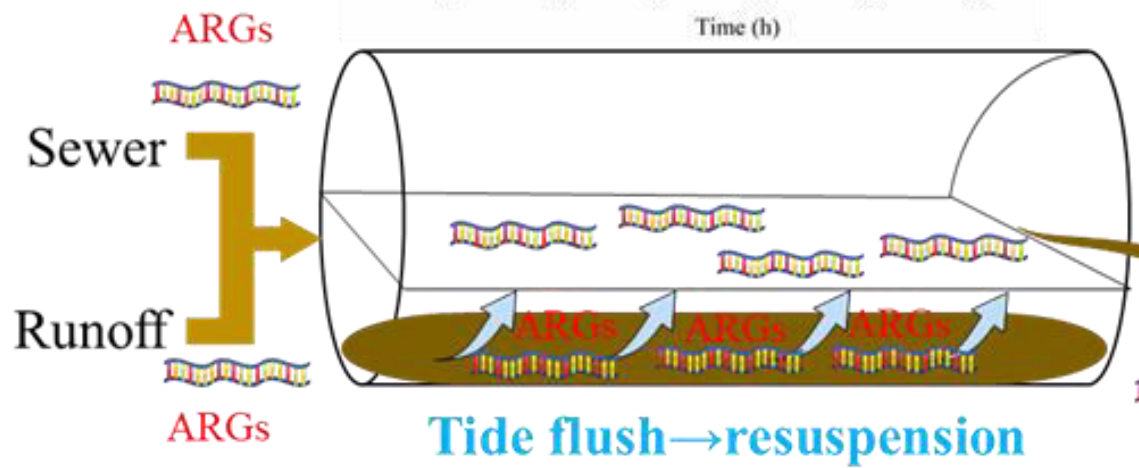
- Overflow pollution exhibits a higher abundance in antibiotic resistance, virulence factors, and transfer elements compared with treated wastewater from WWTP.
- Biological contamination mainly originates from CSSs

携带大量抗性和毒力因子的溢流



764 kinds of virulence factors,
153 kinds of pathogenic bacteria,
408 kinds of resistance genes,
over 90 kinds of resistance gene transfer elements.

Hosts of antibiotic resistome





✓ Combined sewer sediment processes driven by rainfall

降水驱动的管网沉积物污染迁转

- 10 CSOs events annually : heavy rain 4/storm 1
- Particle size of CSSs mostly range from 10 to 60 mesh before flood seasons
- Corresponding peak in pollutant concentrations carried with CSOs volume

2. Key Technology in Prevention and Control to CSOs Pollution

合流制管道溢流污染防控关键技术



Interception · Flush · Dredging
(截·冲·掏)



Regulation · Storing · Purification
(调·蓄·净)



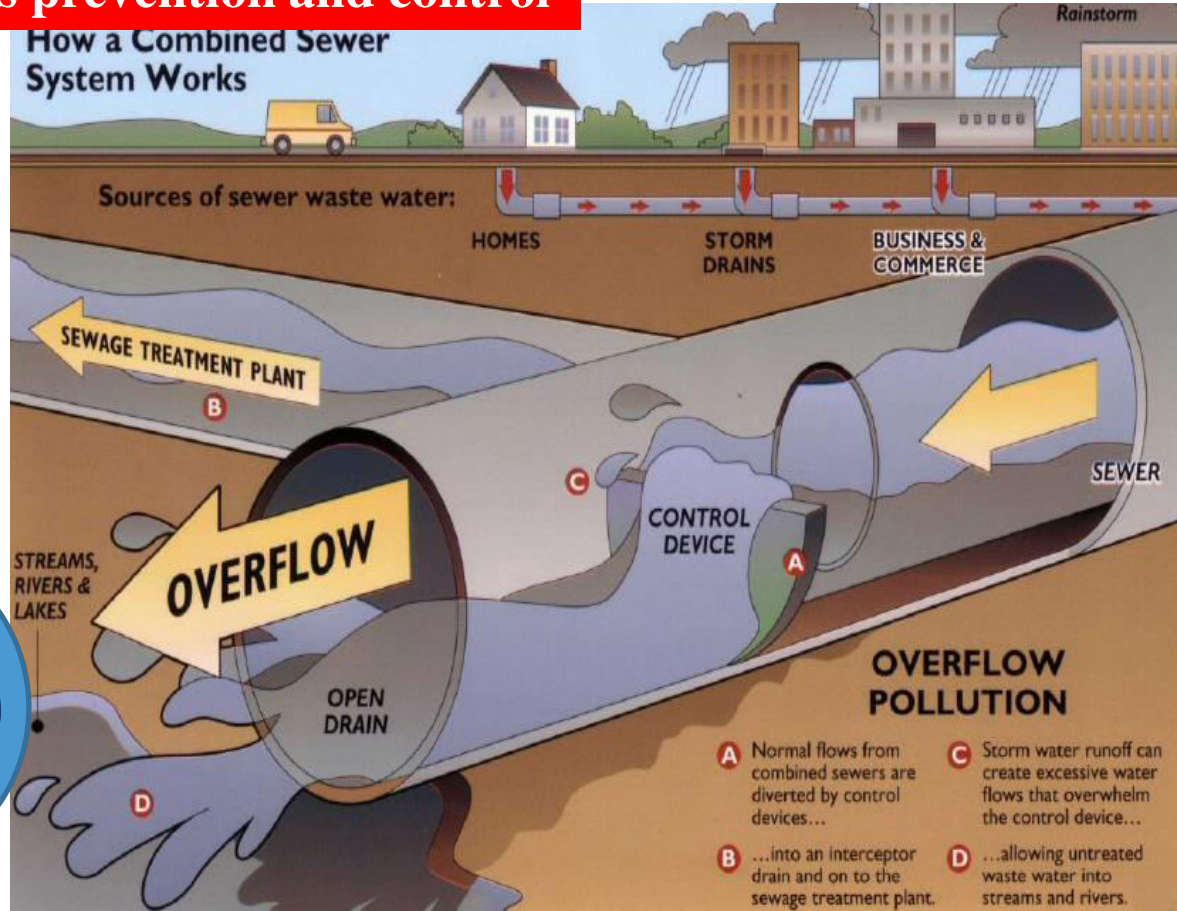
Approaches for Key Technology 关键技术研发思路

Key technology to CSOs prevention and control

Interception

Flush

Dredging



Regulation

Storing

Purification

Source

源头

Branch line

支管

Main line

干管

Well

井

Discharge

排口

River

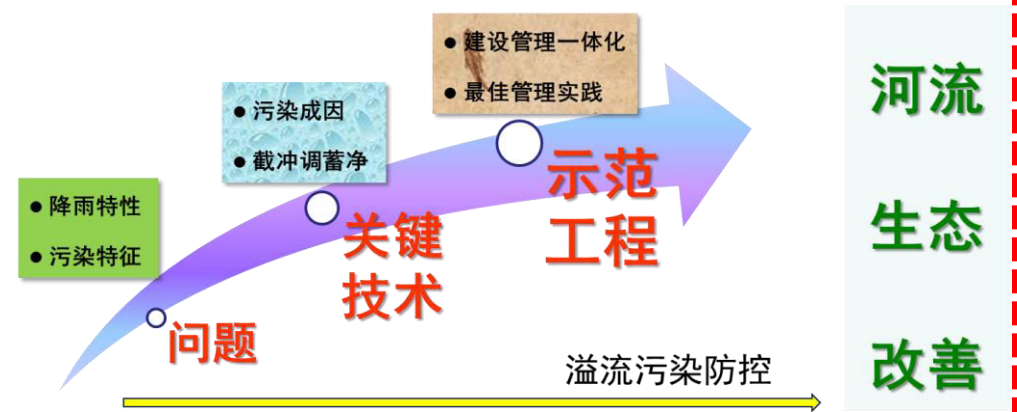
河道

➤ Technical principles or models:

- ✓ Best Management Practice focusing on prevention and control
- ✓ “Construction”: pollutants interception
- ✓ “Management”: flush, regulation, storing, purification

Specific measures -> quantitative management :

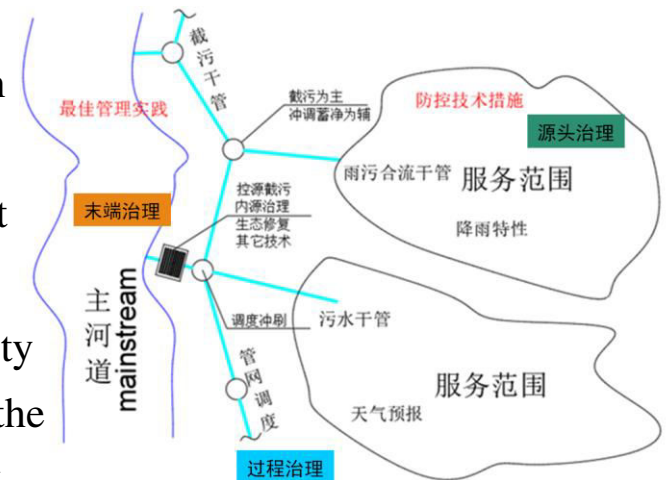
- ✓ **Origin (前端)** : reduce the pollutants quantity from the source (截)
- ✓ **Process (过程)** : “flush、dredging (冲、掏)” as key
- ✓ **End (末端)** : “regulation, storing, purification (调、蓄、净)” as breakthrough



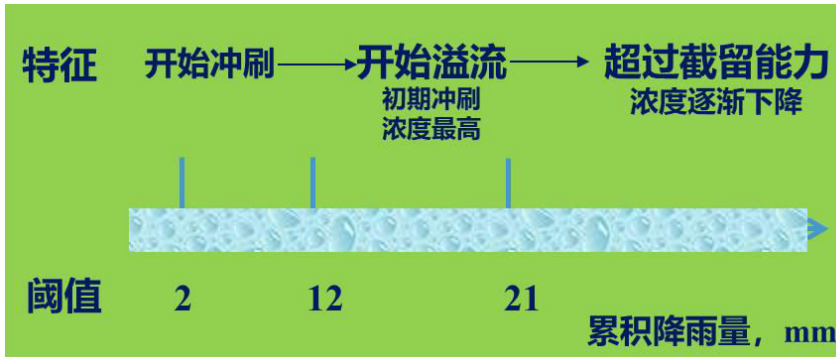
➤ **Innovation and increment**

Innovation point: Based on the characteristics of short duration and high intensity rainfall in the upstream of the North Canal, we put forward an innovative method for best management practice mainly focusing on pollutants interception and assisted by comprehensive management with “flush, regulation, storing, purification”.

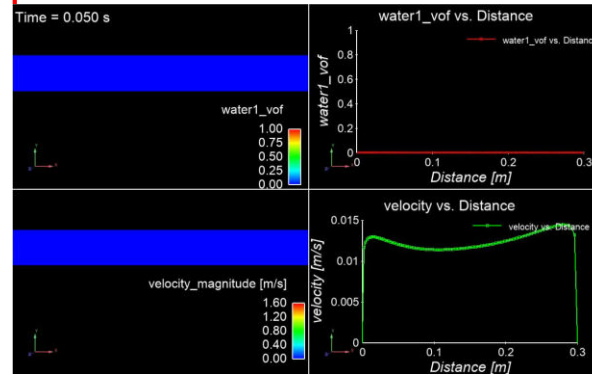
Technological increment: To mitigate CSSs flush driven by short-duration and high intensity rainfall, CSSs control prior to flood season can reduce peak and total pollution loads. Enhance the operation and maintenance capabilities of the network system, and improve system redundancy.



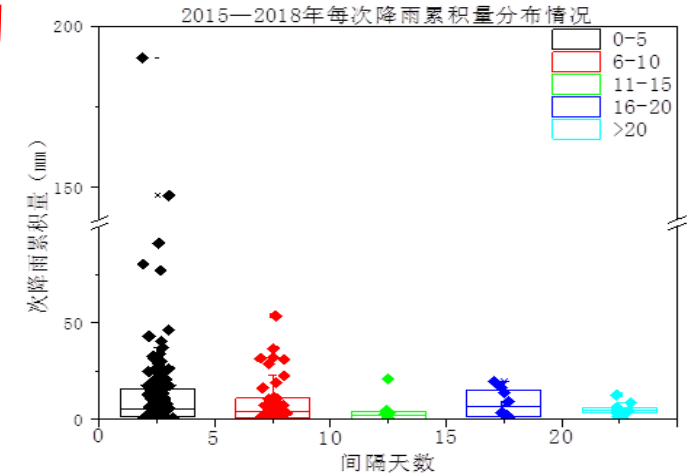
Interception 截 Identify the threshold: when accumulate rainfall reach 12-21mm, CSOs starts



Flush 冲 Flush speed : 0.3m/s



Dredging 掏 Dredging method based on weather forecast

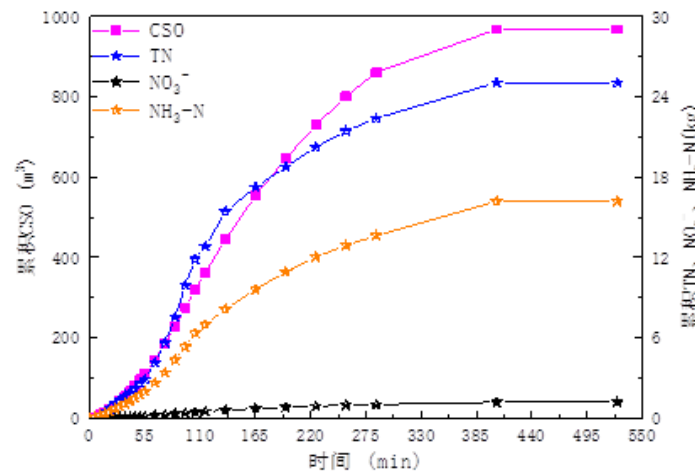


Regulation 调 Utilizing ecologically functional spaces operating at low water levels to form pebble energy dissipation, velocity reduced to <0.1m/s, SS, COD reduced by more than 30%

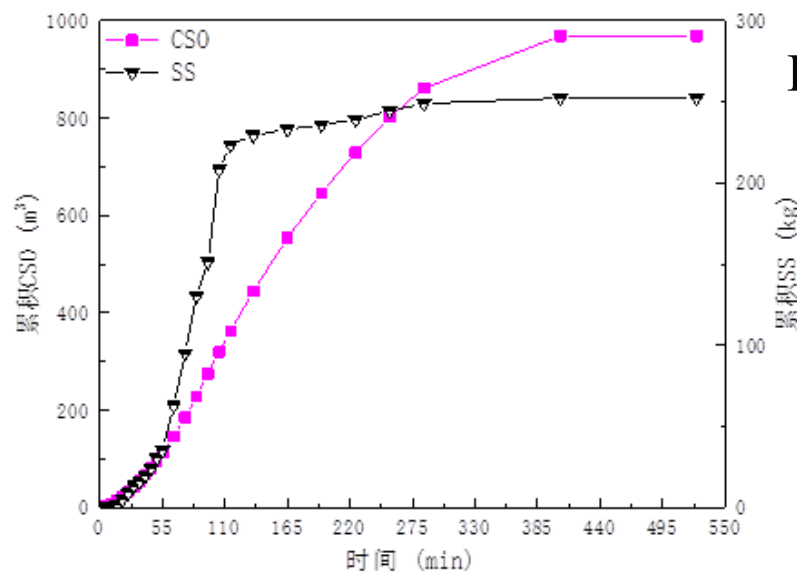
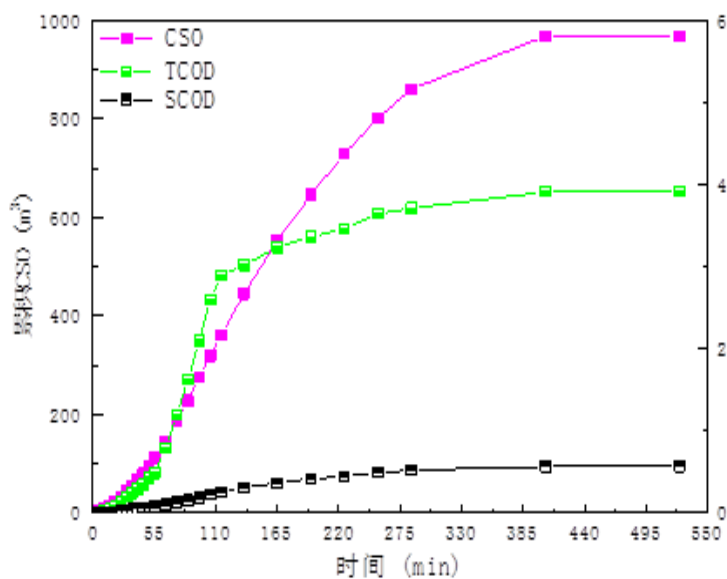


Storing 蓄 CSOs stored: 720~5300 m³, making up 11~15 % of the total

Purification 净 Nature based solution for outlet ecology restoration

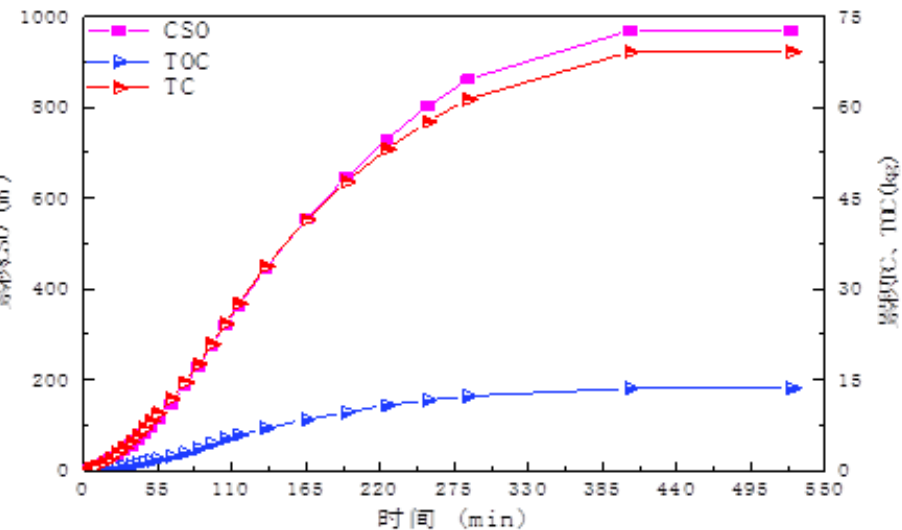
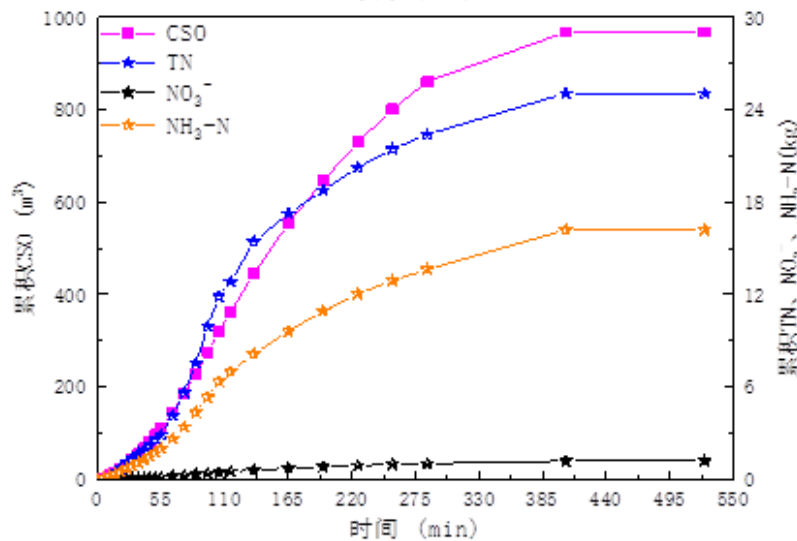
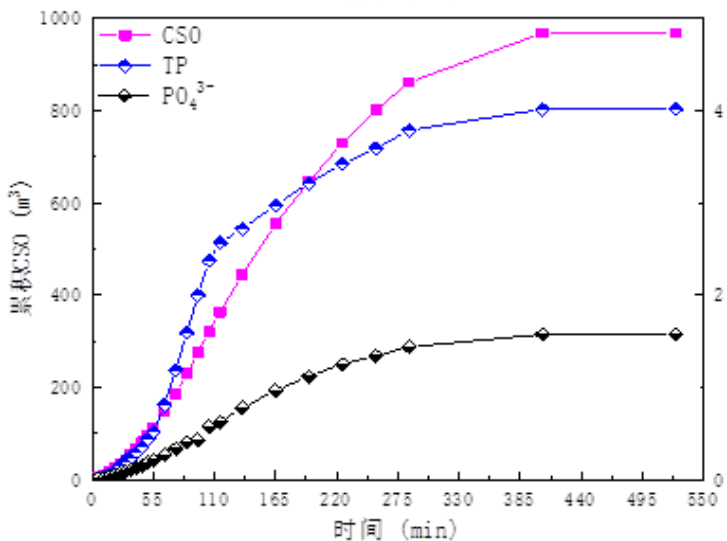


Key Technologies——Storing (蓄)



Integrated technology for storage, detention, and infiltration based on CSOs load
 基于溢流污染负荷的蓄滞渗技术集成

CSOs stored(溢流蓄滞量):
 720~5300 m³,
 making up 11~15 % of the total





Prevention and Control to CSOs: “Integrated Approach Of Interception, Flushing, Dredging, Regulation, Storage, And Purification” “截冲掏调蓄净一体化”

➤ Before

26 CSO outlet in Shahe reservoir, the South Shahe and the North Shahe listed as black and odorous water body
库区合流制管网溢流排口入库26处，南沙河、北沙河被列为黑臭水体



➤ After outlet (92.31%)

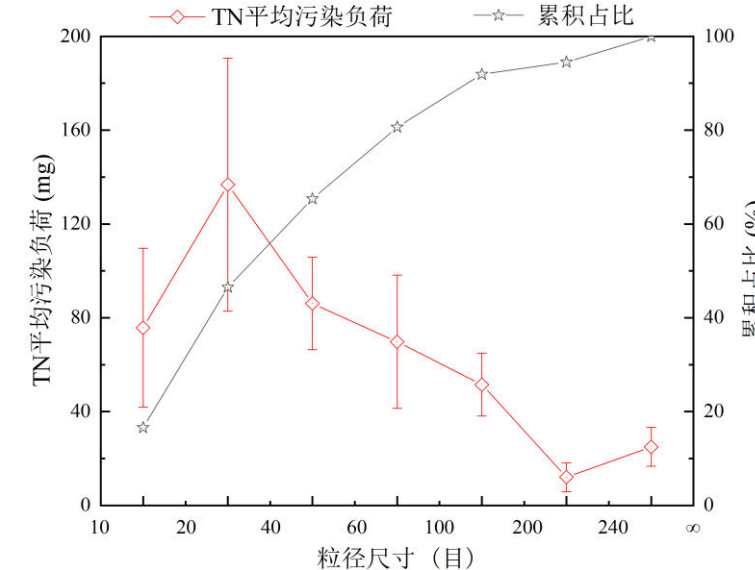
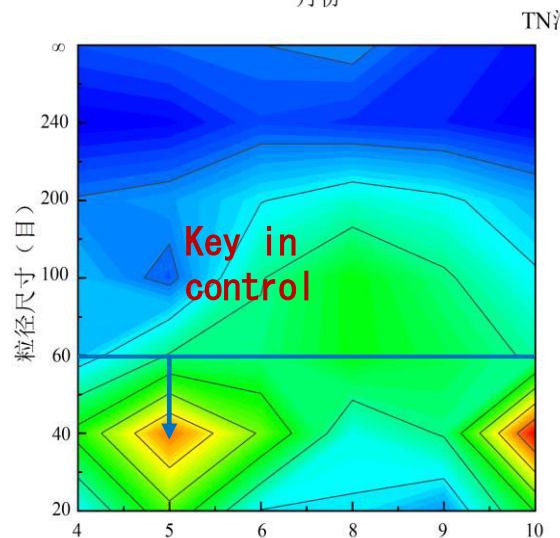
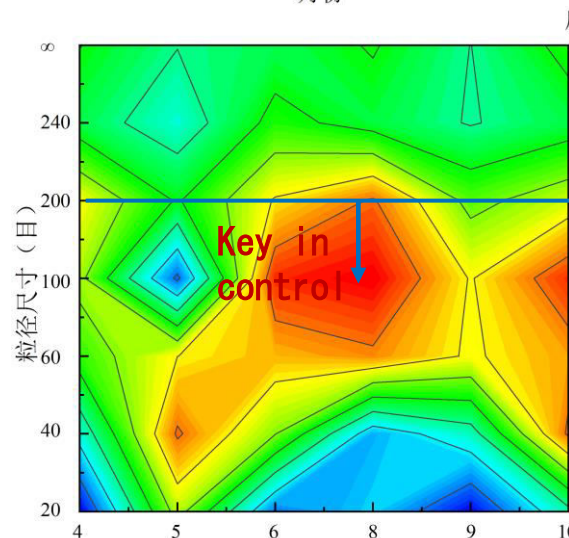
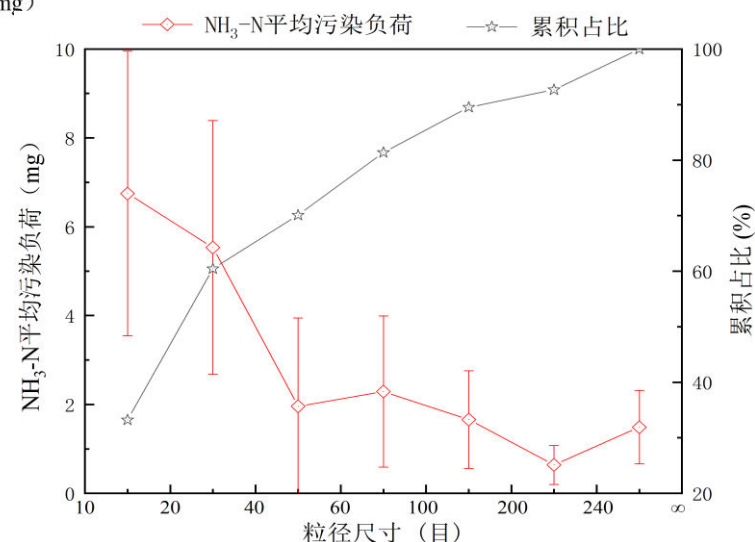
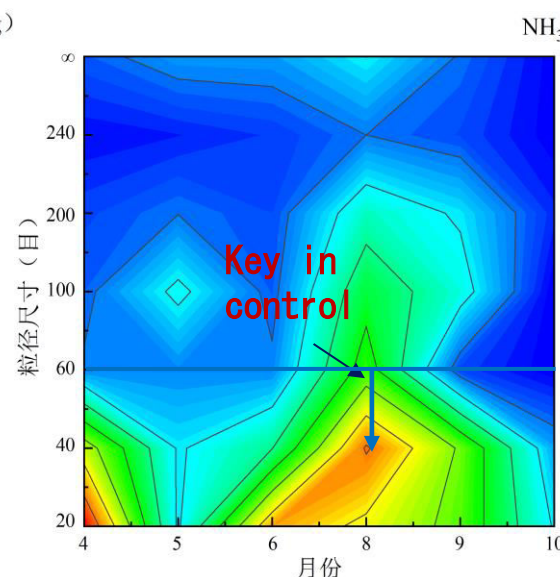
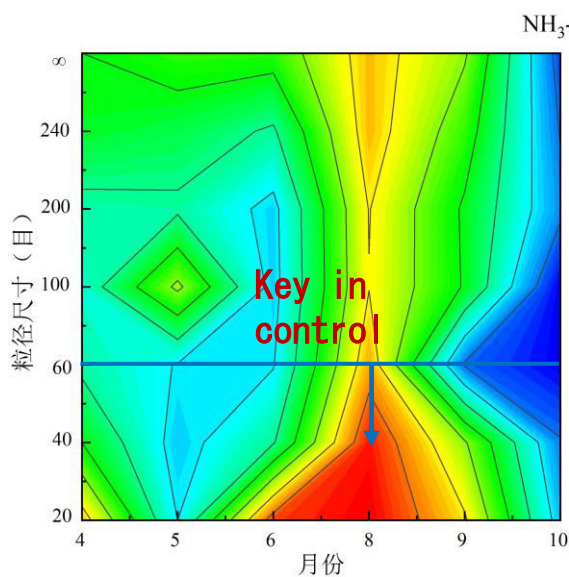
Set facilities to 24 of the



✓ Pollutant of CSSs transport and transfer driven by rainfall

降水驱动的管网沉积物污染迁转





➤ Particle size mostly around 60 mesh



3. Key Technologies \longleftrightarrow Demonstration Projects 示范应用

Pilot

Water Pollution
Control and
Treatment of
China(2017-2020)

Shahe Reservoir(2021)

Application

Low influent
concentration
(2021 to now)

Promotion

Site in Yangtze River
(2022 to now)

High-efficiency
sedimentation tank in
Beijing Enterprises
Water Group

(2022 to now)

Standard

Primary advanced
treatment
(2022 to now)

➤ Implementation effectiveness

- Integrated “Interception, Flush, Dredging, Regulation, Storing, Purification” in Shahe Reservoir effectively reduce the pollutants loading from the source, “flush、dredging” as key in processing, and “regulation, storing, purification” as breakthrough in the end. Based on weather forecast and BMP, strengthen prevention, ecological interception of suspended pollutants into storage, and improve the reduction effect of overflow pollution.
- Facilities have been set to 24 of the outlet (92.31%) in Shahe Reservoir.

➤ Promotion



北京市昌平区发展和改革委员会文件

京昌平发改〔审〕〔2017〕90号

**北京市昌平区发展和改革委员会
关于昌平区2017年黑臭水体治理工程
实施方案的批复**

北京燕龙水务集团有限公司：
你单位《关于报送昌平区2017年黑臭水体治理工程实施方案的请示》（燕龙水务报〔2017〕19号）及相关附件收悉。为改善黑臭水体河涌现状水环境和生态环境，落实市、区关于尽快消除黑臭水体的工作任务，根据北京市规划委员会昌平分局《关于昌平区2017年黑臭水体治理工程征求意见的答复意见》（规昌函〔2017〕153号）、北京市国土资源局昌平分局《关于昌平区2017年黑臭水体治理工程征求意见的复函》（京国土函〔2017〕

北京市发展和改革委员会文件

京发改〔审〕〔2016〕449号

**北京市发展和改革委员会
关于昌平区温榆河以南地区污水收集和再生水
利用管网工程项目建议书（代可行性
研究报告）的批复**

昌平区发展改革委：
你委《关于昌平区温榆河以南地区污水收集和再生水利用管网工程项目建议书（代可行性研究报告）的请示》（京昌平发改〔审〕〔2016〕41号）收悉。经2016年8月12日我委主任专题会议审议通过并报市政府批准，同意你区实施该项目。现就有关事项批复如下：

北京市昌平区发展和改革委员会文件

京昌发改〔2014〕86号

**北京市昌平区发展和改革委员会
关于沙河再生水厂二期工程初步设计概算
的批复**

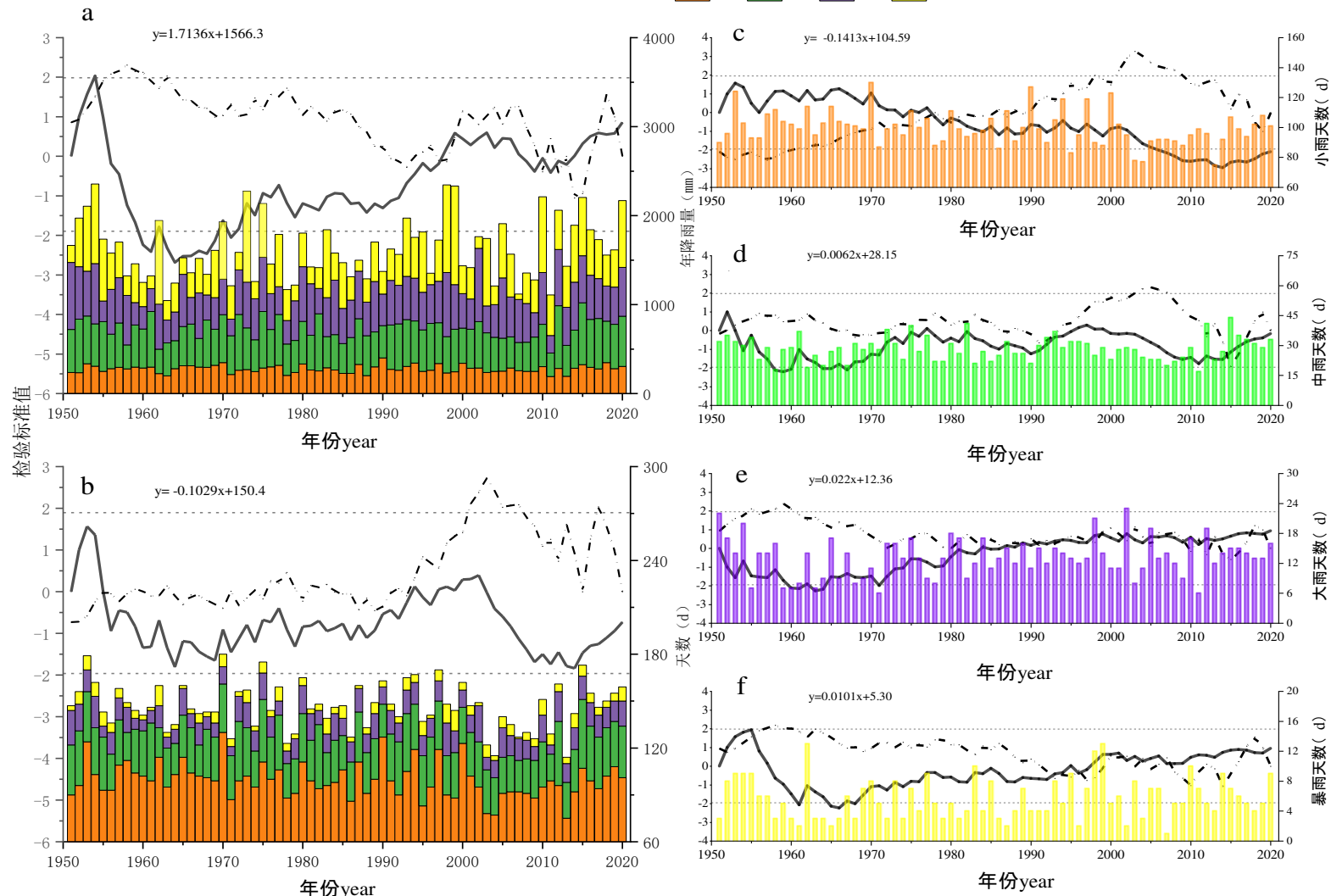
北京市昌平区水务局：
你单位《关于上报沙河再生水厂二期工程初步设计概算的请示》（昌平水务报〔2014〕394号）及相关材料收悉。根据我委《关于沙河再生水厂二期工程初步设计概算的请示》（京昌平发改〔审〕〔2014〕51号）等相关文件，现就项目初步设计概算有关事项批复如下：
一、建设单位：昌平区水务局。
二、建设地点：沙河再生水厂二期位于现状沙河污水处理厂南侧，距沙河高教园区规划建设用地300米，距离北沙河河北路中



3.2 Low concentration of inlet in a WWTP in Nanchang



— UF - - - UB 0.05显著水平 小雨 中雨 大雨 暴雨



南昌市西桃花河及桃花龙河水水质提升工程规划 附图4 初期雨水收集规划图



3.3 Optimization of High-Efficiency Sedimentation Tank

➤ Hydraulic loading:

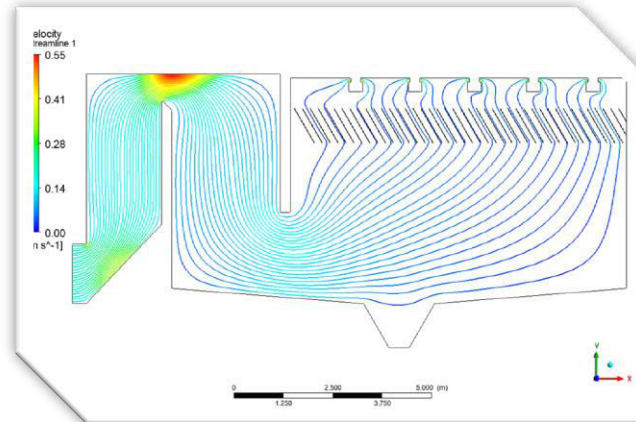
9 - 11 m/h

Chinese National Standard

2021~2022

12 m/h

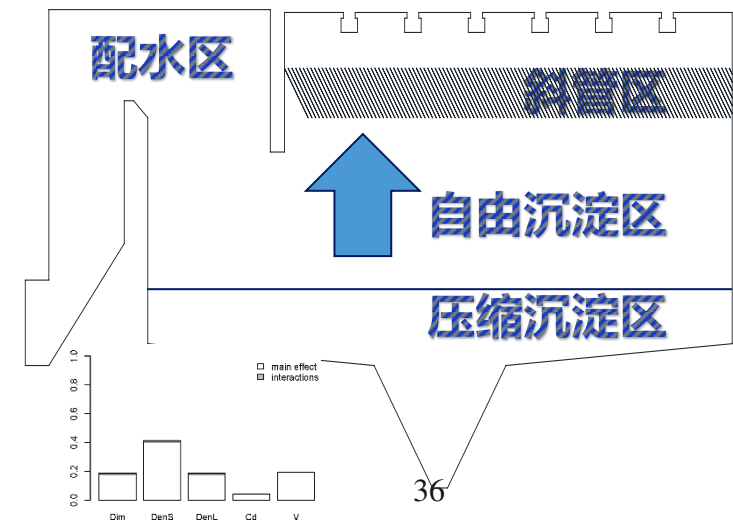
Standard design for tanks with 50k tons wastewater



2022~?

15 m/h

Top level in global





3.4 Study Site in Yangtze River: Writing Papers all over the Country

Ecological environment protection and restoration along Yangtze river: stationing study in Nanchang(Phase 2)

- ✓ Science support for “One cross-section, one strategy” (“一断面一策 ”) in Poyang Lake inside Nanchang: unconventional water supply support ecological restoration in river, technology for CSOs prevention and control.
- ✓ “One cross-section, one strategy” listed as 5 major administrative decisions in Nanchang, leaving it 52 first cities leading in “effectively assisting local management policies”。 (52个驻点城市中 “有效助理地方管理决策”)

进展与成效3: 有效助力地方管理施策

科技帮扶地方生态环境保护修复, 相关成果获得地方采纳和认可

南昌驻点组

把脉问诊, 提交《鄱阳湖南昌湖区“一断面一策”治理方案》被纳入2022年度南昌市人民政府重大行政决策目录为控制与削减鄱阳湖总磷污染提供决策支撑

昭通驻点组

跟踪帮扶昭鲁大河水质消劣, 提交《关于昭鲁大河得胜桥断面问题诊断与水质提升的建议》并进行宣贯建议得到昭通市政府领导的批示并被采纳, 受到昭通市各部门及鲁甸县人民政府认可, 相关技术帮扶工作被云南省厅报道

南昌市人民政府办公室

洪府办字〔2022〕464号

南昌市人民政府办公室
关于公布2022年度南昌市人民政府重大行政决策事项目录的通知

各县(区)人民政府, 开发区管委会, 市政府各部门:

根据《重大行政决策程序暂行条例》(国务院令 第713号)、《江西省县级以上人民政府重大行政决策程序规定》(省政府令 第247号)要求, 经市委、市政府同意, 现将《2022年度南昌市人民政府重大行政决策事项目录》印发给你们, 并就有关工作通知如下:

一、列入目录的重大行政决策事项必须严格履行相应的法定程序, 承办单位须严格落实公众参与、专家论证、风险评估、合法性审核、集体讨论等程序, 在提请市政府常务会议等集体讨论决定时, 应当说明履行重大行政决策程序情况。

二、请《2022年度南昌市人民政府重大行政决策事项目录》明确的承办单位认真组织实施, 落实责任分工, 把握时间节点, 确保按时完成。

三、各承办单位要重视重大行政决策的档案管理, 对决策立项和决策过程中形成的程序证明材料及时整理归档, 实现重大行政决策全过程记录。

四、对重大行政决策事项目录实行动态管理, 根据市政府年度重点工作任务的实际情况, 确需对列入《2022年度南昌市人民政府重大行政决策事项目录》的决策事项进行调整或新增事项的, 承办单位按照《江西省县级以上人民政府重大行政决策程序规定》确定的程序办理。

五、各县(区)人民政府、开发区管委会以及市政府各部门要制定本地本部门重大行政决策事项目录, 并向社会公布。该项工作同时纳入年度法治政府建设考核指标体系。

附件: 2022年度南昌市人民政府重大行政决策事项目录

(此件主动公开)

2022年7月18日

附件
2022年度南昌市人民政府重大行政决策事项目录

序号	决策事项名称	拟开展的重大决策程序	决策中是否需听证	决策承办单位
1	《2022年南昌市民生实事工程安排意见》	征求意见, 合法性审查、集体决策		市政府办公室
2	《2022年南昌市政府重大重点项目计划》	公开征求意见, 合法性审查、集体决策		市委办
3	《鄱阳湖南昌湖区“一断面一策”治理方案》	征求意见, 专家论证, 合法性审查、集体决策		市生态环境局
4	《南昌市矿产资源总体规划(2021-2025年)》	征求意见, 专家论证, 合法性审查、公示听证	是	市自然资源规划局
5	《南昌市高标准农田建设规划(2021-2030年)》	公开征求意见, 专家论证, 合法性审查、集体决策	否	市农业农村局



Acknowledgements

- Major Science and Technology Program for Water Pollution Control and Treatment of China: 2017ZX0710202-001
- National Water Project Office; Beijing Water Project Office.
- Beijing Municipal Water Bureau; Changping District Water Bureau; Beijing Water Science and Technology Research Institute
- Nanchang Municipal Ecology and Environment Bureau

Thank you

yswei@rcees.ac.cn



**XVIII
World Water Congress**
International Water Resources Association (IWRA)
Beijing, China | September 11-15, 2023

