丹华水利环境技术（上海）有限公司

面对洪水风险分析和洪水管理的几点看法

A Few Points on Facing the Flooding Risk Analysis and Flood Management

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2019/06/13

01

挑战与机遇

Challenge and Opportunity

02

面对洪水风险分析和洪水管理的几点看法

A Few Points on Facing Flood Management

过去30年中国治水的经历

WAEM in China during the last 30 years

中国

在过去近**30**年治水的经历：

Process of about 30 years in China on WAEM

PART 01

挑战与机遇

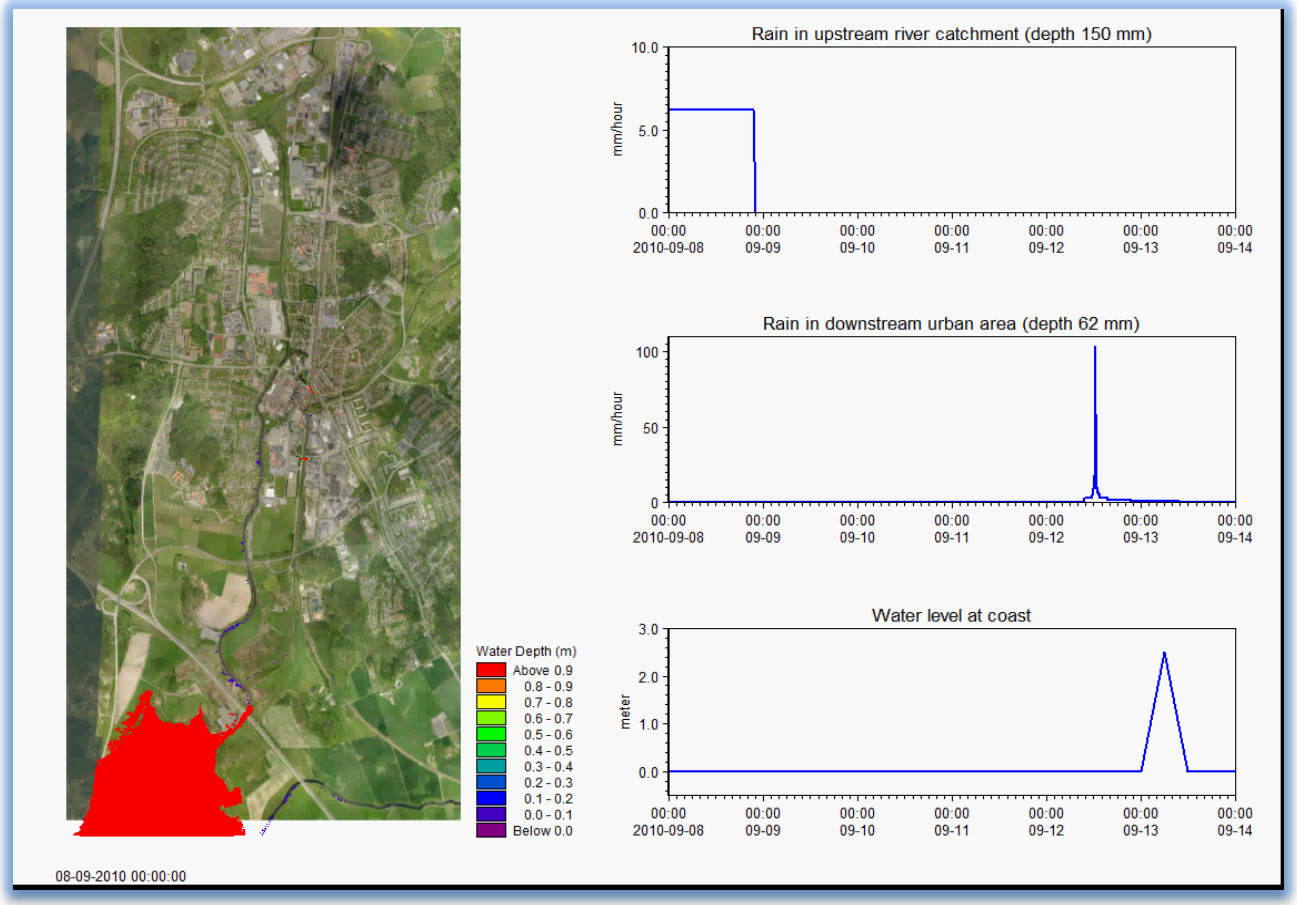
Challenge and Opportunity

洪涝过程和组成 —— Flooding process and constitute

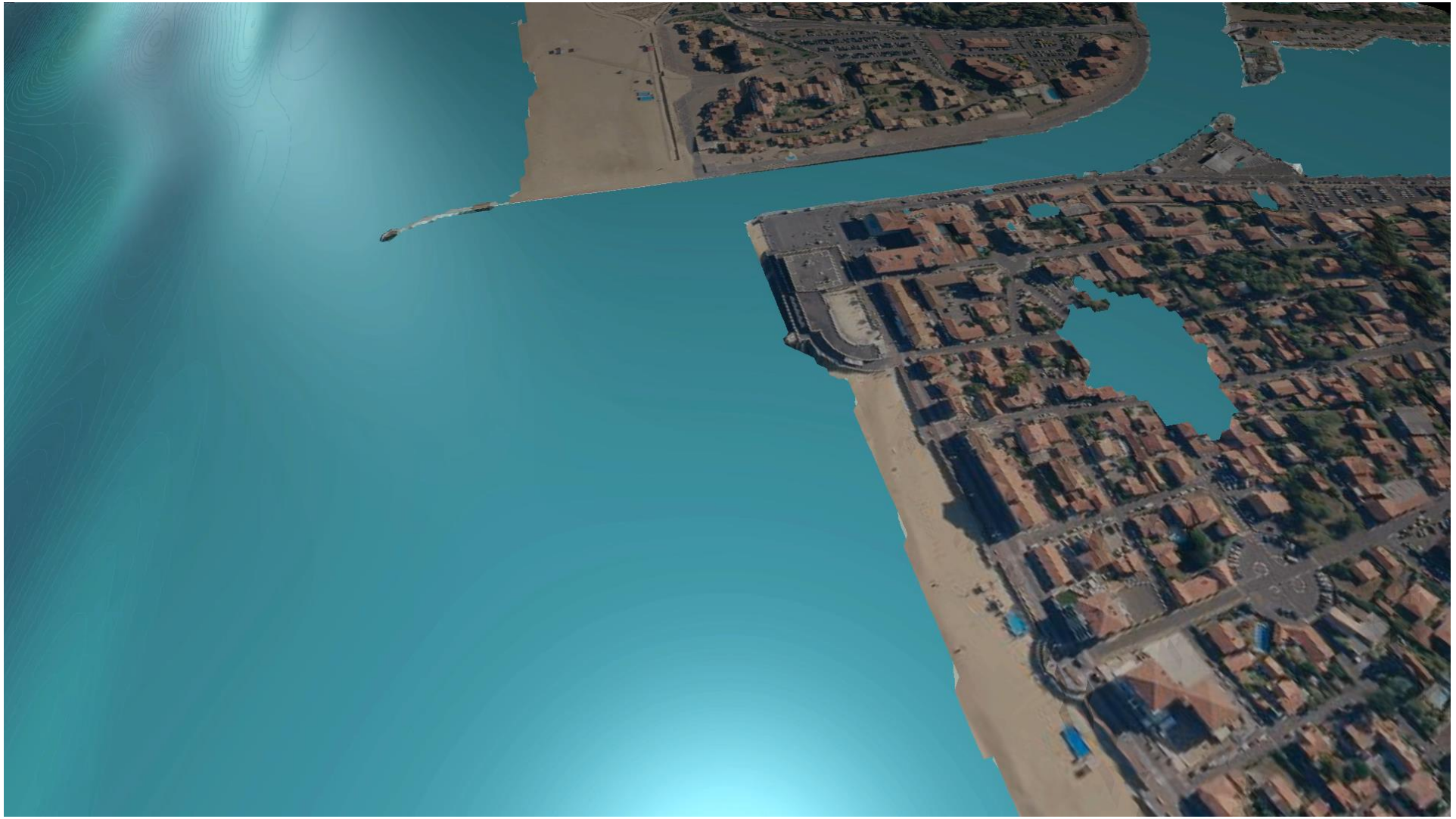
- **上游洪水的演**进 Upstream flooding peak processing
- **局部强降雨** Local rainstorm
- **河口**风**暴潮的**顶**托** Storm tide

最为棘手的是上述3项**同**时产生，**称之**为3**碰**头。
The most dangerous case is which are happened simultaneously (called three-meetings together).

越浪是海岸区域的另一种洪水现象。
Wave overtopping flow is another phenomenon of flooding.

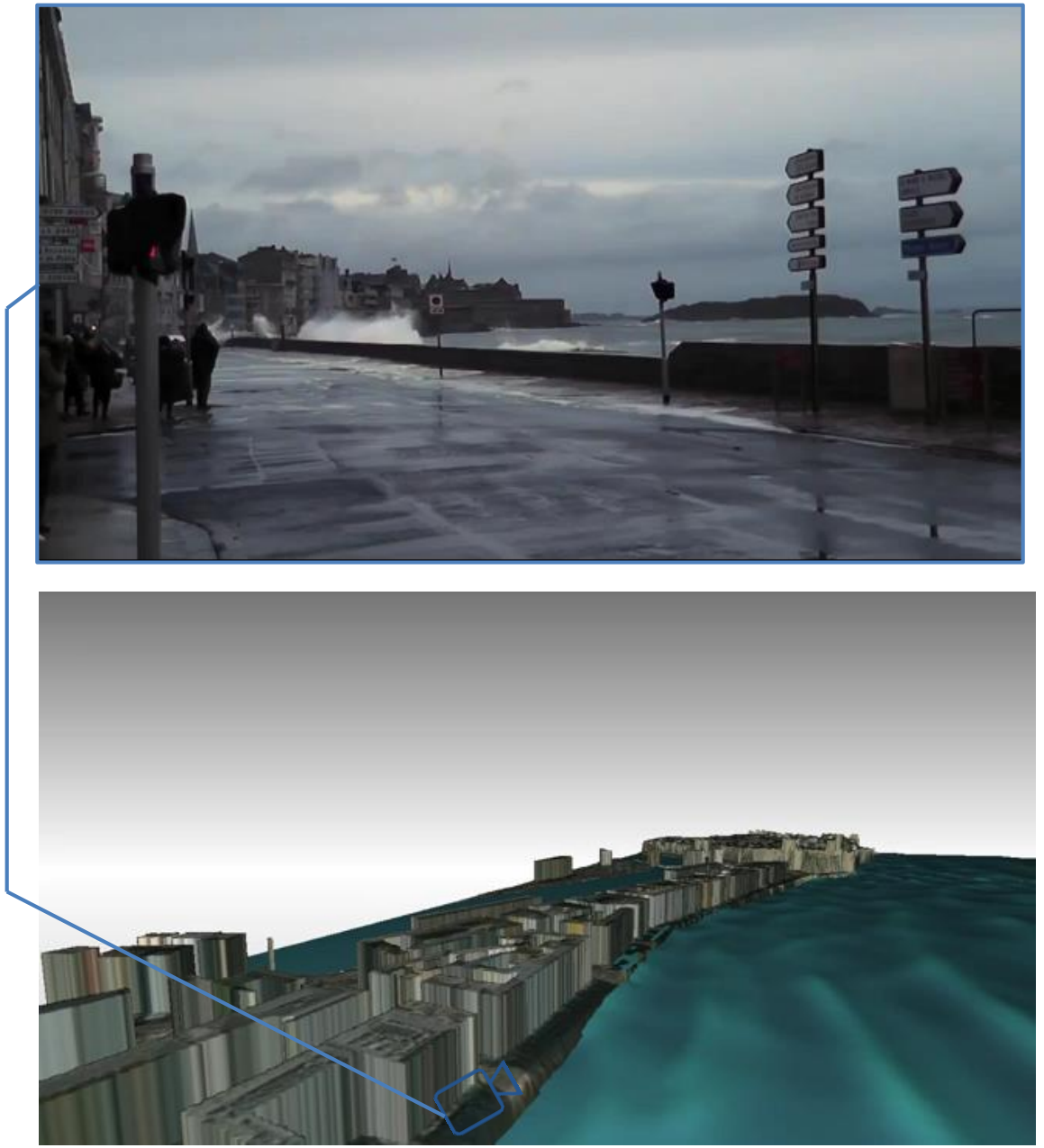


Coastal flooding in Capbreton
法国卡普布雷通海岸洪水



Validation

- The simulated sea state is based on a typical spring tide storm event
  - Irregular waves (JONSWAP)
  - Hs = 2.5 m
  - Tp = 10.6 s
  - MWD = 315 ° N
  - WL = 13.2 m LAT
- Flooded areas are consistent with visual observations of past similar events



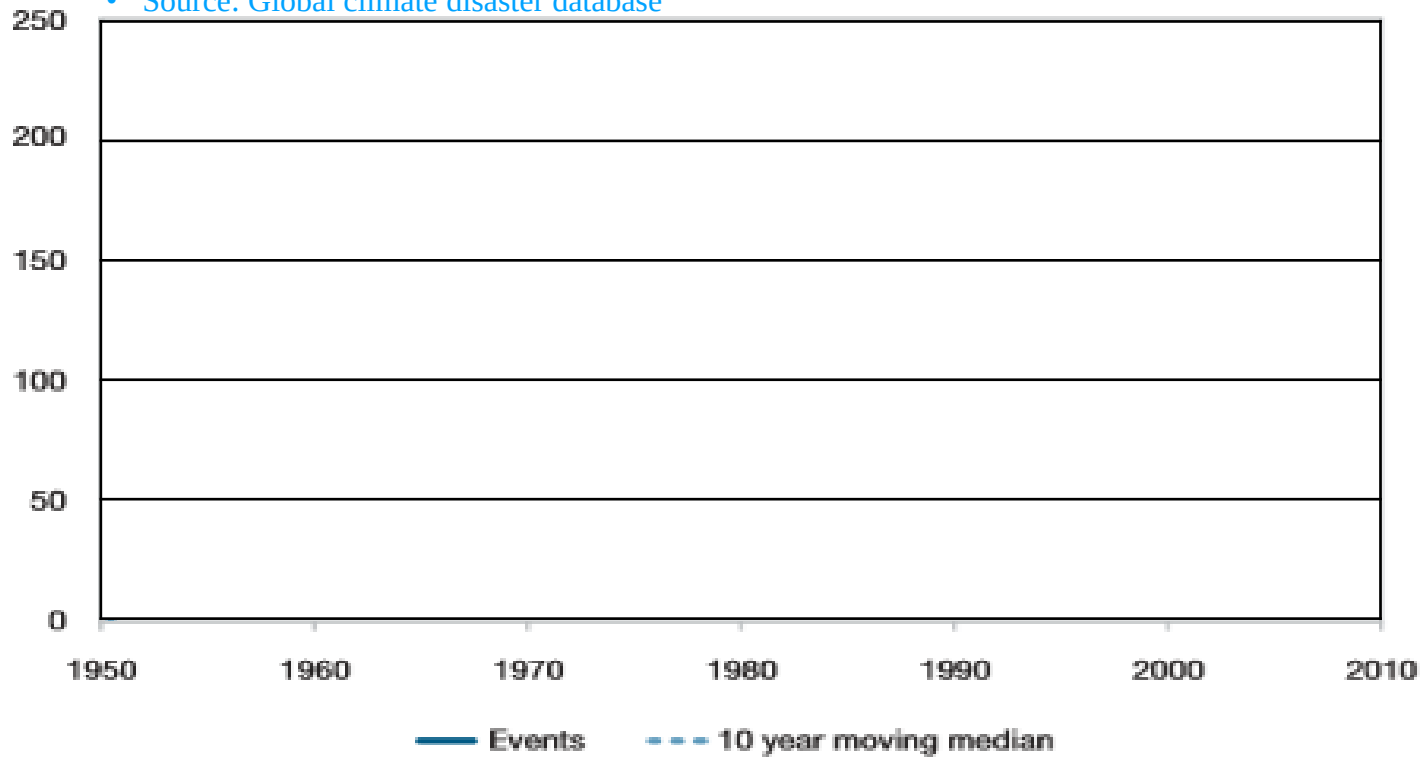
城市面临防洪排涝的挑战愈加严重

The growing challenge of urban flood control

随着全球气候的转变，**极端气候条件比例上升**，随之而来的城市内涝灾害趋势不断上升，严重影响了城市的正常生产和生活秩序，造成了严重的生命财产损失。全球平均每年由于城市内涝灾害带来的经济损失**高达3000亿人民币**以上。

As the global climate changes, **extreme climate appears more frequently**. The consequent urban flood has made heavy losses. The global annual loss caused by urban flooding is **up to 42.5 Billion US$**.

- 数据来源：全球气候灾害数据库
- Source: Global climate disaster database



城市面临防洪排涝的挑战愈加严重

The growing challenge of urban flood control

随着城市化进程的加速，城市抗风险能力的提升越发重要，社会对城市内涝防治的呼声也越来越高，国家也不断出台了相关的政策。

With the acceleration of urbanization, the improvement of city's risk resistance become more and more important. The call of preventing urban flooding from social is growing. In China, the government has also constantly published a series of policies.

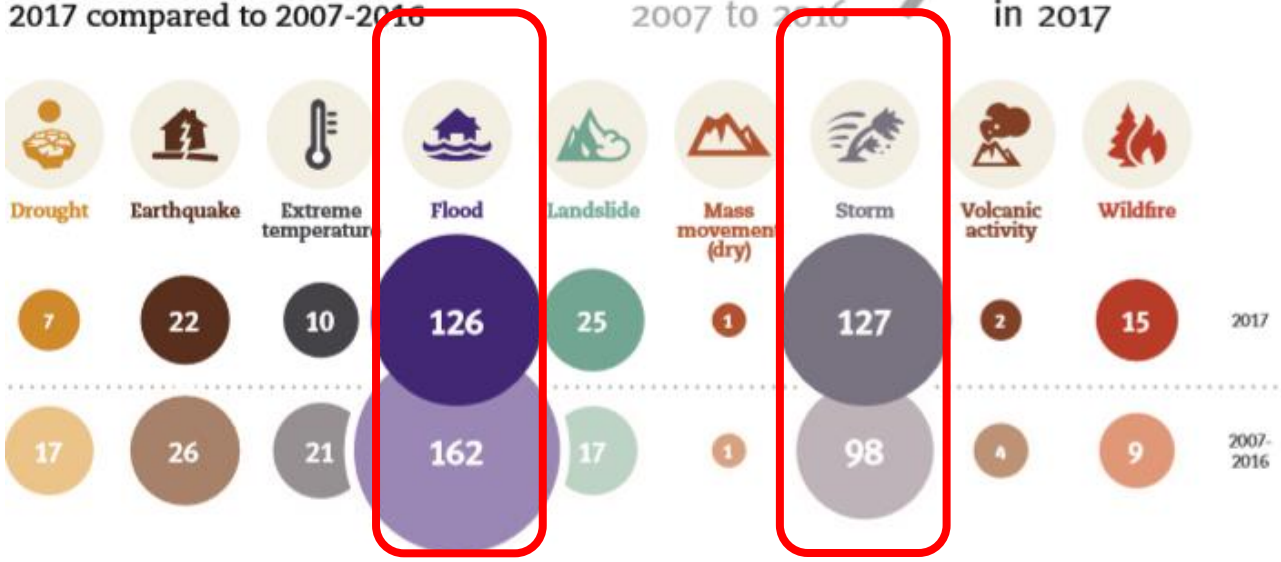
Figure 1

Number of disasters by continent and top 10 countries

Figure 2

Occurrence by disaster type: 2017 compared to 2007-2016

354 2007 to 2016 › 335 in 2017



深圳暴雨引发洪水已致7人遇害,解决城市内涝不能光喊口号!
搜狐网 2019年04月12日 17:44

强降水来袭 广东东莞现严重内涝
中国天气网 2019年04月20日 17:23

汉中突降暴雨 城区出现多处内涝点
网易 2019年04月20日 22:19

暴雨袭击!赣州多地遭遇内涝,山体塌方!这场雨要一直下到……
赣州热门话题 2019年04月19日 18:54

城市内涝是人类面对的几大自然灾害(地震、海啸、干旱、暴雨)中频率较高的重大灾害之一。人类目前还无法仅靠工程措施完全防止内涝灾害。

Urban flooding is one of the most frequent natural disasters (earthquakes, tsunamis, droughts and rainstorms). At present, human can not completely prevent waterlogging disasters by engineering measures only.

4月11日，深圳洪水，2人死亡，9人失联。
Flood at April 11th, Shenzhen, 2 dead,9 missing

2019年4月11日晚，深圳市突发瞬时强降水，造成数名河道施工人员被冲走，已致2人死亡9人失联。
At night of 2019-4-11, rainstorm suddenly hit Shenzhen. Several river constructors were washed away, with 2 people dead and 9 people missing.

「菲特」台风，经济损失124亿元。
Typhoon Fitow, caused economic losses 12.4 Billion RMB

2013年10月，”菲特”台风登陆，6日至7日，浙江出现全省性暴雨和大暴雨天气，局部特大暴雨。对浙江省造成超过124亿元损失，同时造成大量道路严重堵塞。
In October 2013, Typhoon Fitow landed and brought heavy rain in all region of Zhejiang Province, which caused around 12.4-Billion RMB loss.

7.21北京特大暴雨，79人死亡，经济损失116.4亿。
Heavy rainstorm at July 21st,Beijing,79 dead, 11.64 Billion RMB loss

2012年7月21日至22日8时左右，中国大部分地区遭遇暴雨，其中北京及其周边地区遭遇61年来最强暴雨及洪涝灾害，北京已有79人因此次暴雨死亡，经济损失116.4亿元。
On 2012-7-21, Beijing suffered the most severe rainstorm and flood disaster through recent 61 years , with 79 people dead and 11.64 Billion RMB loss.

从技术角度来看，所面临的挑战有

From technical point of view, there are the following challenges

1. **如何对流域洪水和城市内涝进行联合调控**
   How to achieve joint regulation and control on river basin and urban floodings

2. **洪水预报技术水平 (精度、时间、实测手段) 需进一步提升**
   It is required to improvement of flood forecast technical level (accuracy, time and measurement)

3. **如何将大数据、云计算、人工智能等新技术运用到洪水预报和管理中**
   How to apply the new technology (big data, cloud calculation, AI) in flooding management

4. **城市淹水的风险日益突出**
   The risk of urban flooding becomes much frequent

PART 02

面对洪水风险分析和洪水管理的几点看法

A Few Points on Facing Flood Management

1. 目前急需解决城市淹水的问题
   Solving the problem regarding urban flooding is currently urgent

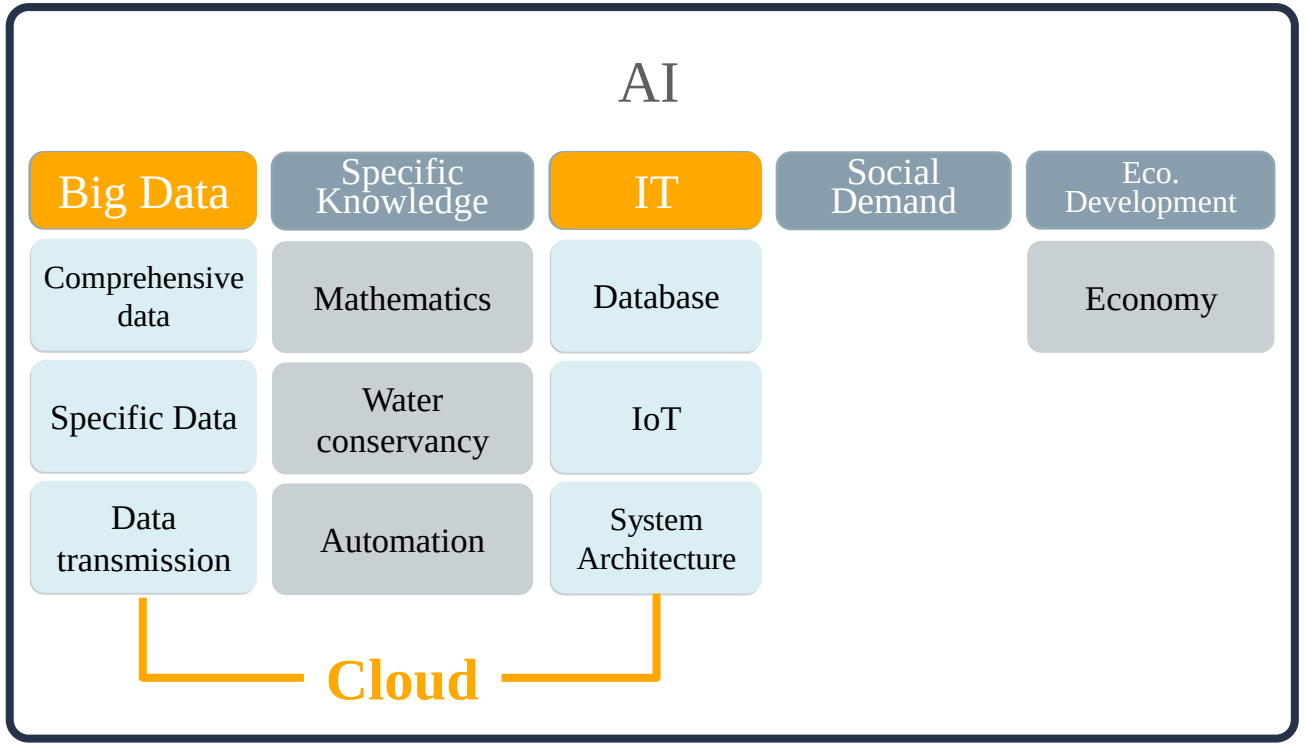
2. 建议建立城市内涝预警预报平台
   Suggest to build up a general urban flood forecast platform

3. 注重流域洪水与城市洪水的共同预报问题
   Focus on the joint forecast of river basin flood and urban flood

4. 洪水过程的实时分析与动态洪水风险图
   Real-time flood process analysis is the way to generate dynamic flood risk map

智慧水务 ——— 集人工智能于水务优化运行管理

Smart Water Management ---- Combined Artificial Intelligence (AI) into optimal operation management



The characteristics of urban flooding management:

- The scale is much smaller comparing with the basin situation, not only regarding the physical phenomenon，but it links to the limitation in the modelling approach.
- In general the real measure data is pure comparing with the basin situation, not only less data collected, but the underground data regarding the pilelines are more difficult.
- The urban flooding forecast has to including the urban hydrology modelling, river system modelling and dranage modelling (real coupling together), in order to get precisely results.

城市雨洪模拟 Urban Flooding Simulation北京 Beijing

城市内涝实时预警预报面临的挑战

The Challenges of real-time urban flood forecast

互联网 + 智能创造 = 解决方案

Internet + Intelligent creation = Solution

预报精度 Accuracy

降雨的位置不一定是成灾位置，灾害的产生基于地形，管网，下垫面，排水泵站，降雨持续时间等综合因素。因此只依靠天气预报无法有效预报城市内涝的详细情况。

The location of rain may not be the location of inundation. Flood forecasting cannot be accurate only rely on weather-forecast.

时效性 Timeliness

数值模型可以准确模拟城市内涝的完整过程，但是想要得到高精度的时空分辨率的结果，计算时效性是制约数值模型应用的瓶颈。

Numerical model can simulate the whole process of flooding precisely. However, timeliness is the obstacle to the widely application.

数据支持 Data Support

准确有效的实测数据，尤其是在线监测数据是预报系统的眼睛。但是城市排水系统监测设备维护成本高、安装受到很多限制。

Measured data is restricted by monitoring facilities.

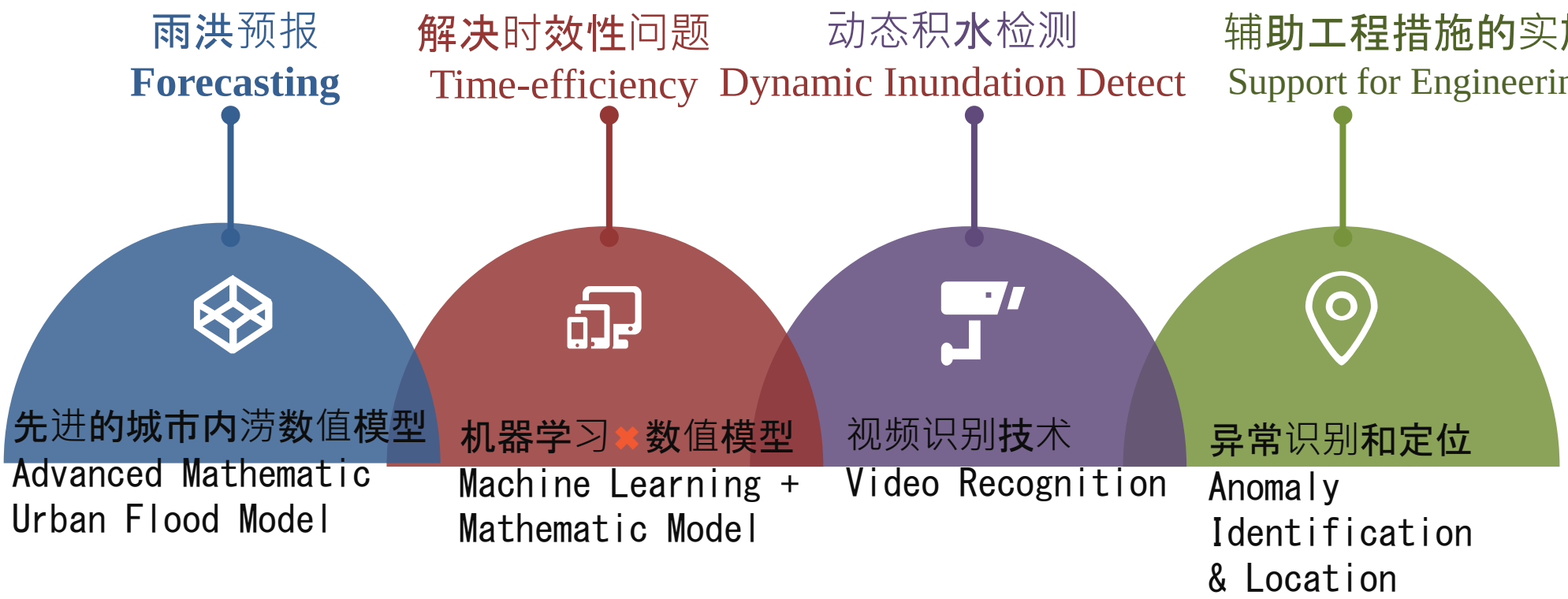
异常识别 Anomaly Identification

城市排水系统属于地下工程，具有隐秘性，当管网出现堵塞淤积等问题时，往往无法及时发现。

Blocking of underground pipe network may not be detected in time.

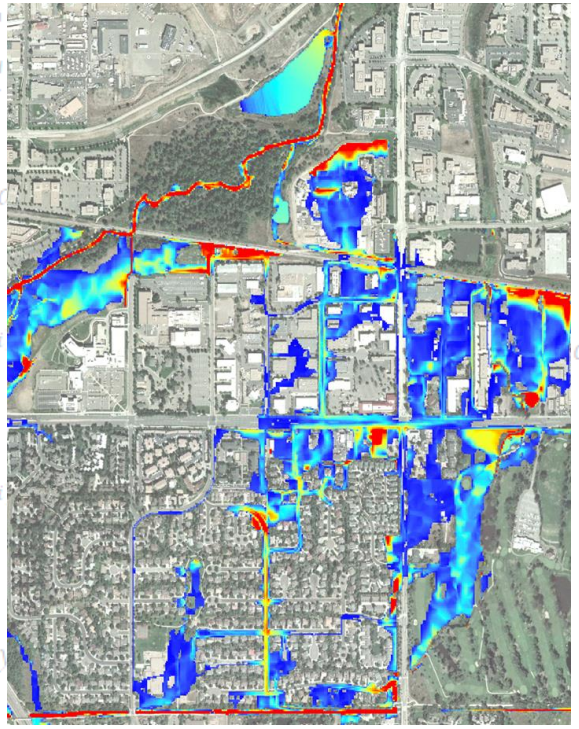
城市内涝预警预报平台
Urban Flood Forecasting Platform

核心技术
Core



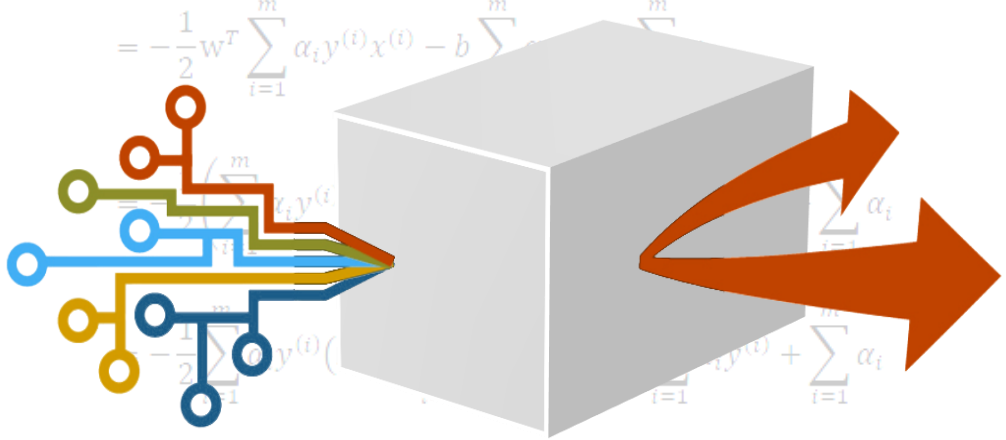
机器学习 ✖ 数值模型

Machine Learning Mathematic Model



使用 **MIKE FLOOD 与 SVM** 模型结合，解决计算效率的问题
(已成熟应用)
Combined MIKE Flood and Support-Vector Machine (SVM) model to improve calculation timeliness

- 将 **SVM** 与 **MIKE FLOOD** 进行结合训练，使用 MIKE FLOOD 为 SVM 模型提供训练数据并选择特征，在预测阶段直接使用 SVM 模型，可以提供高分辨率（米级别）和超高速（秒级别）的城市内涝实时预报。（已成熟应用）
- Using data from MIKE Flood to train SVM and then provide real-time forecast with high resolution (meter-level) and high speed (second-level)



基于视频识别技术的动态积水监测

Real-time inundating detect Based on Video Recognition Technology

- 利用深度学习技术，对交通影像进行视频识别，可以识别出影像中的积水区域。
- Using deep learning to identify waterlogging area by using existing the traffic camera system.

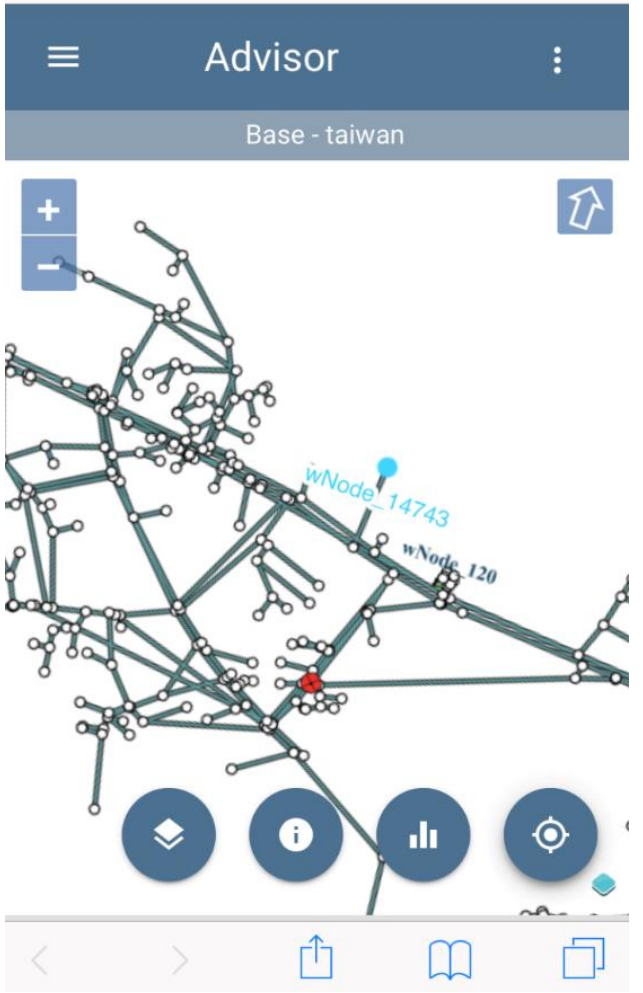
- 当前城市交通摄像头对城市主要道路都进行了大覆盖面的监控，利用已有的交通摄像头获取影像并对积水区域进行识别，结合高精度城市数字高程图，可以识别出积水点水深，同时结合城市内涝模型，可以重构出完整的城市二维积水过程，实现城市内涝监测。
- Since the traffic camera system has a large coverage in most cities, the inundated depth can be identified, with high resolution DEM. Meanwhile, the 2D inundating process can be re-present by combining urban flood model.

基于数学模型和在线监测的异常识别技术

Anomaly Identification and location Based on Mathematic Model

通过异常识别技术，可以及时发现管网中存在的问题，指导排水管网维护人员及时排查和抢修。（研发中）

通过结合精确定位和异常识别技术，通过分析排水管网模型模拟结果和在线监测数据，系统会指出可能存在问题的异常管道，指导维护人员及时排查和抢修，并且维护人员可以随时查看当前管道水位和流量情况以及未来几小时的积水预报。

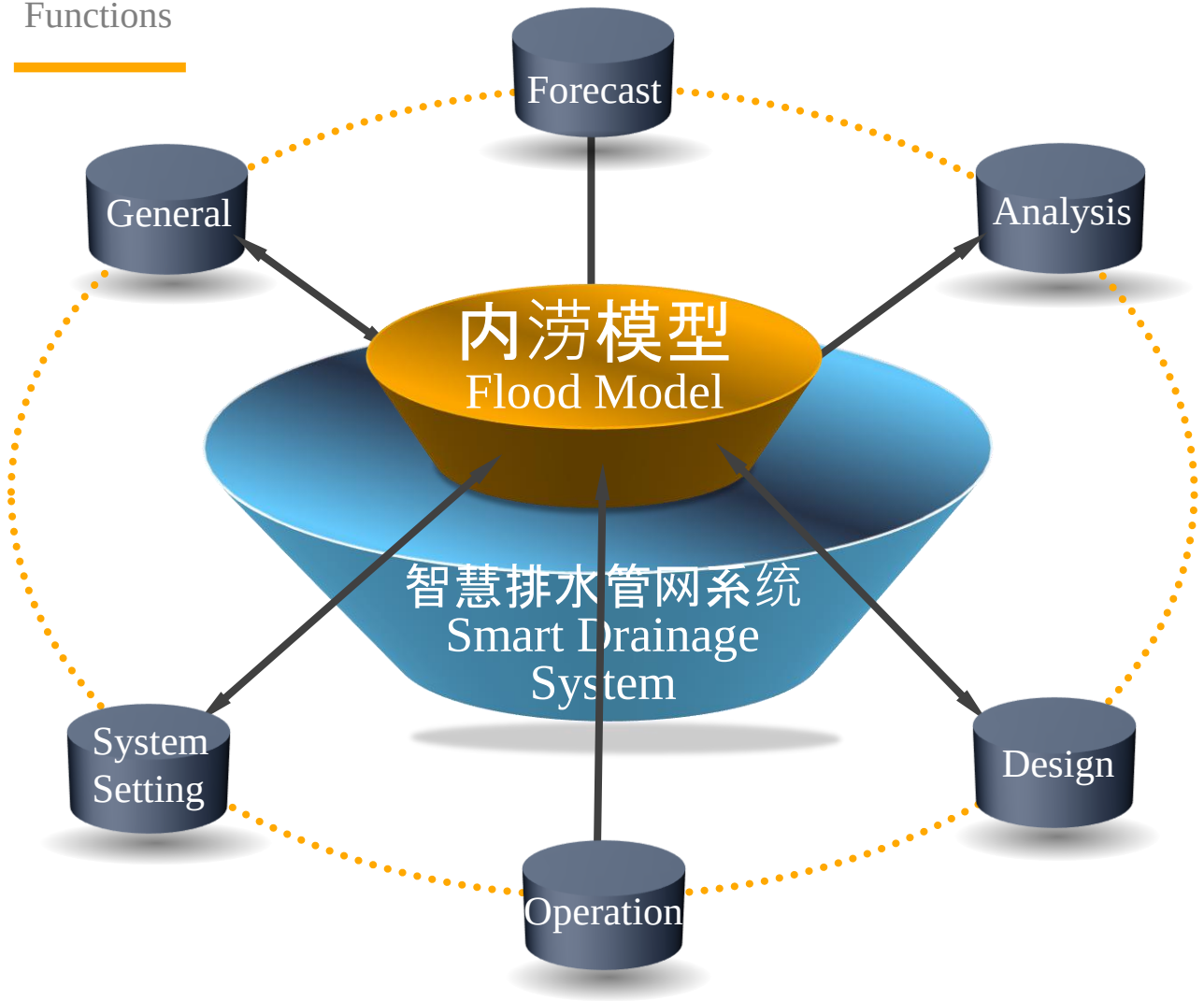


By combining “anomaly identification”, comparing simulation result from pipe network model and real-time monitoring data, the system can figure out the possible abnormal pipe with both real-time water level, discharge and forecast water level and discharge in several hours.

城市内涝预警预报平台
Urban flood forecast platform

功能
Functions

- 综合信息查询与展示
  Information check & display
- 在线内涝预报预警
  Real-time forecast
- 城市排水现状分析 Urban dranage system analysis
- 辅助管网规划设计
  Pipe network design assessment
- 城市雨水泵站调度
  Optimal pump operation



如何对流域洪水和城市内涝进行联合调控

How to Carry out Combined Dispatching on Basin and Urban Flood

城市洪水预报

Hazard

Frequency

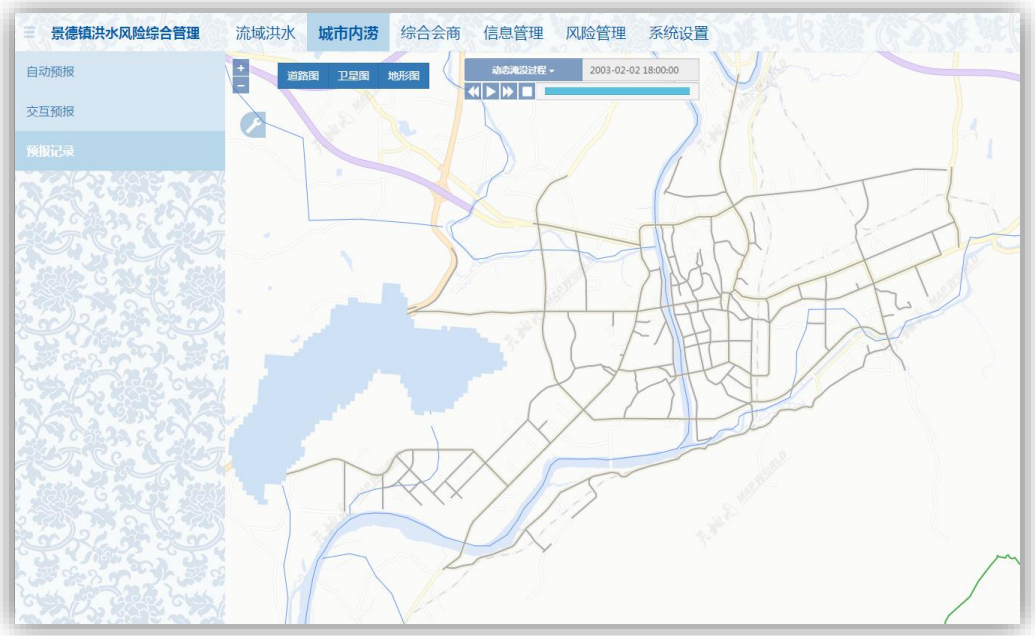
如何对流域洪水和城市内涝进行联合调控

How to Carry out Combined Dispatching on Basin and Urban Flood

➢ 城市洪水预报 - 景德镇洪水预报系统 Jingdezhen Flood Forecast System

流域洪水
River Basin Flood

- 采用多种模型方法，对水文、流量进行预报 Using multiple model methods for Hydrological and Hydraulic forecast
- 预报漫堤对城市淹没范围 Predicting inundated area when overtopping
- 水库优化调度Optimizing Reservoirs' Operation
- 实时校正模型 Real-time Correction



城市内涝
Urban Flood

- 根据预报降雨模拟城市积水深度、范围 Predicting depth and area of waterlogging by using forecasted precipitation.
- 河道水位采用洪水预报结果 Using simulation result as river water level
- 泵站调度规则灵活改变 Easily change can be done for pumps' operation.

系统用户 (Final user)：

专职机构-景德镇洪水管理中心 **(Jingdezhen flood managing centre)**

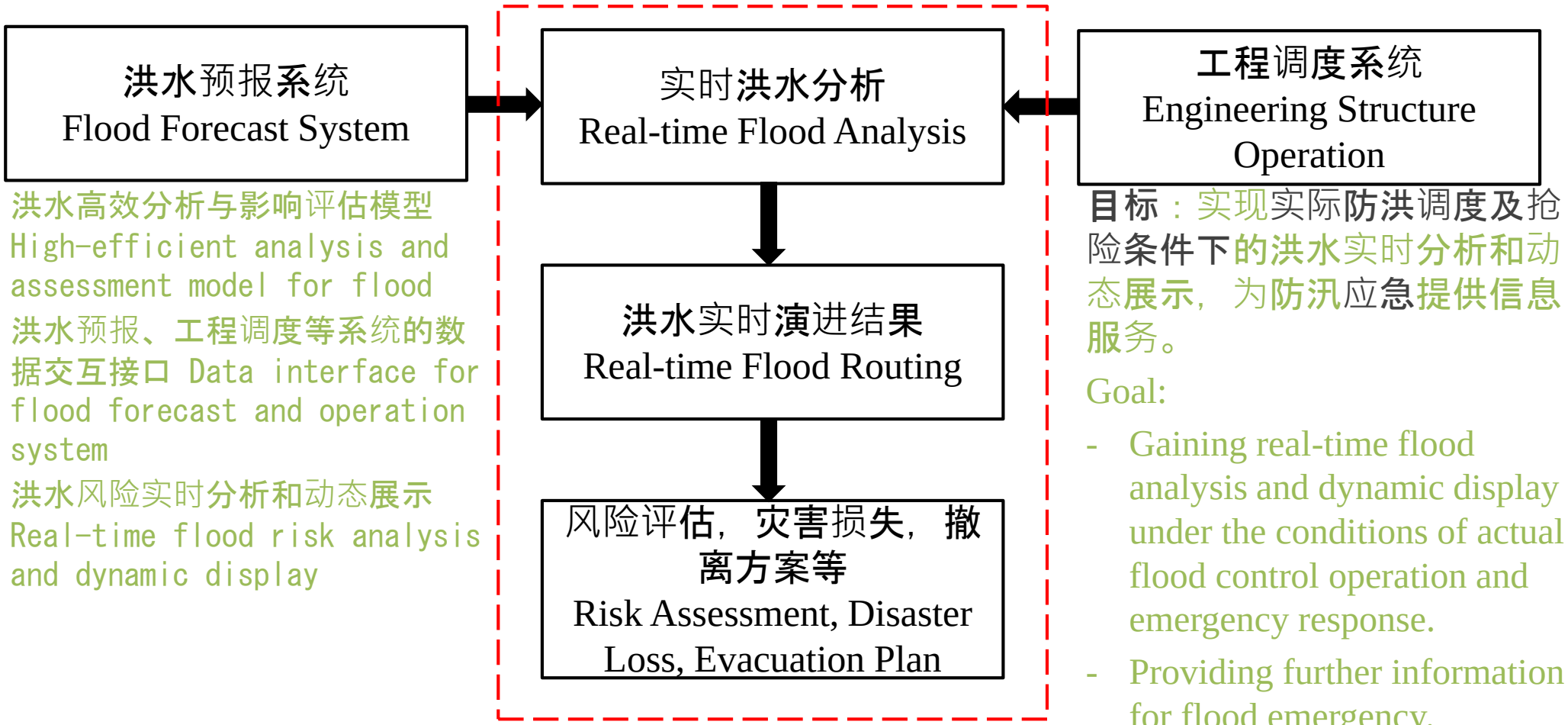
防训期间：水务、防办、建委协同办公

如何对流域洪水和城市内涝进行联合调控

How to Carry out Combined Dispatching on Basin and Urban Flood

内涝6小时
Waterlogging 6hrs

溃口6小时
Dambreak 6 hrs



- 洪水高效分析与影响评估模型 High-efficient analysis and assessment model for flood
- 洪水预报、工程调度等系统的数据交互接口 Data interface for flood forecast and operation system
- 洪水风险实时分析和动态展示 Real-time flood risk analysis and dynamic display

目标：实现实际防洪调度及抢险条件下的洪水实时分析和动态展示，为防汛应急提供信息服务。

Goal:

- Gaining real-time flood analysis and dynamic display under the conditions of actual flood control operation and emergency response.
- Providing further information for flood emergency.

洪水风险实时分析系统的优势
Advantages of Real-time Flood Risk Analysis System

- 分析结果更准确 High Accuracy

洪水实时分析系统基于洪水预报和工程调度信息来分析洪水风险，分析评估实际防洪调度及抢险条件下的洪水风险。 Based on flood forecast and operation information to analyze and assess the flood risk under actual flood control operation and emergency response conditions.

- 时效性 Time-efficiency

洪水风险实时分析系统可以快速分析当前洪水预报和工程调度条件下的洪水风险，为防汛调度决策和应急决策提供信息服务。 Quick assessment for flood risk under current forecast and operation conditions, provides information to operation and emergency decision.

洪水风险实时分析系统的优势
Advantages of Real-time Flood Risk Analysis System

- 动态展示 Dynamic display

动态展示可以让信息传达更流畅，降低认知成本，为决策者提供更明确的信息，符合洪水风险实时分析系统的使用场景。Makes information convey more smoothly, reduce cognitive cost, provide more clear information for decision maker.

- 扩展性 Expansibility

洪水风险实时分析系统可以充分利用已有预报系统和工程调度系统信息，并为今后的功能扩展预留接口。后台洪水分析功能可以与时俱进。Highly usage of existing forecasting system and operation information, and reserve interfaces for future functional expansion to keep pace with the times.

云平台·大数据综合管理
Cloud Platform and Big Data Integrated Management

城市雨洪管理
Urban Flooding Management

黑臭水体治理
Black Water Treatment

生态环境监控
Environmen Monitoring

智慧城市水务
Smart City Water

丹华水利环境技术（上海）有限公司

Thank You!

DHI is the first people you should call when you have a tough challenge to solve in a water environment – be it a river, a reservoir, an ocean, a coastline, within a city or a factory.