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Development of Data Quality Improvement Method for Hydrodynamic Model of Urban Drainage System Using GIS Capabilities

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Çağrı Çimen

Education

- B.Sc. degree in Environmental Engineering, İstanbul University, Türkiye (1997).

Research Interest

- He has conducted research in several areas, SUDs (Sustainable Urban Drainage) that includes rain gardens, green roof, green infrastructure, rainwater harvesting. he has been in charge of infrastructure systems from feasibility phase/master plan to implementation designs for wastewater, storm water, creek rehabilitation, potable water and specific integration of these systems to different construction projects such as, road, rail, urban rail system and port.

Current Profession

- He works as a Deputy Manager in Water & Environment Department at Yüksel Proje Inc., Turkey, where he is working as a senior engineer on water-related projects, including conducting hydrological analysis and hydraulic modeling, as well as managing and developing GIS projects related to water and environmental studies.

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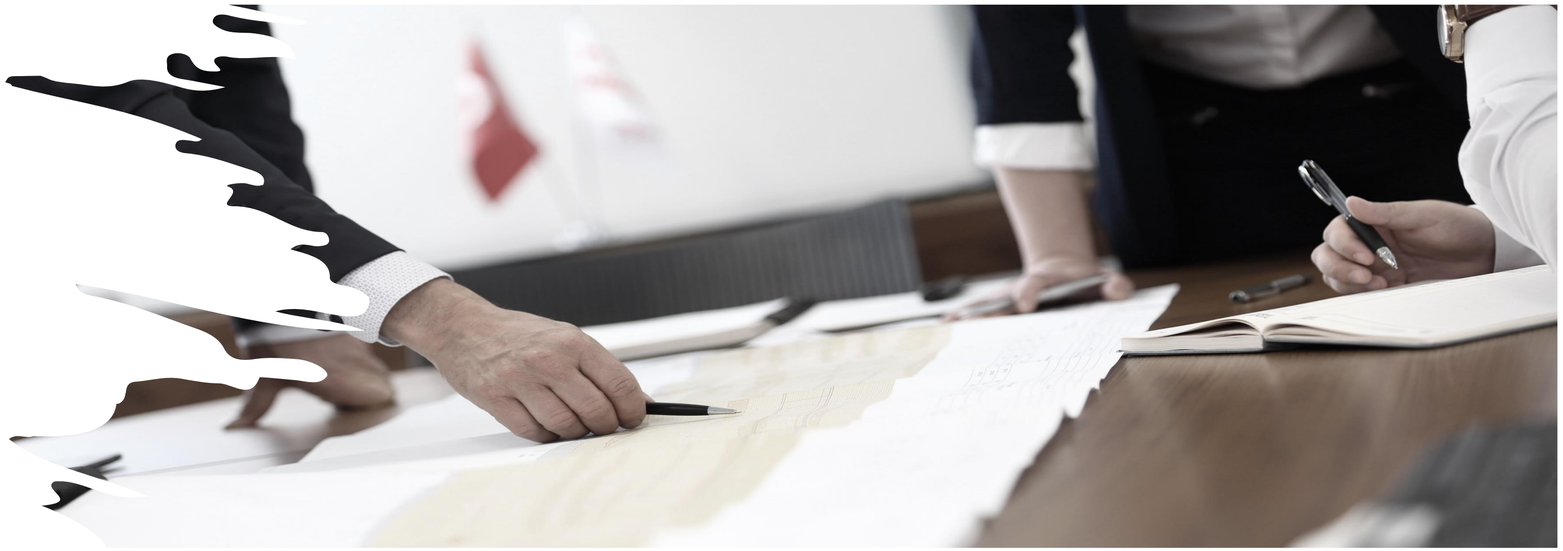
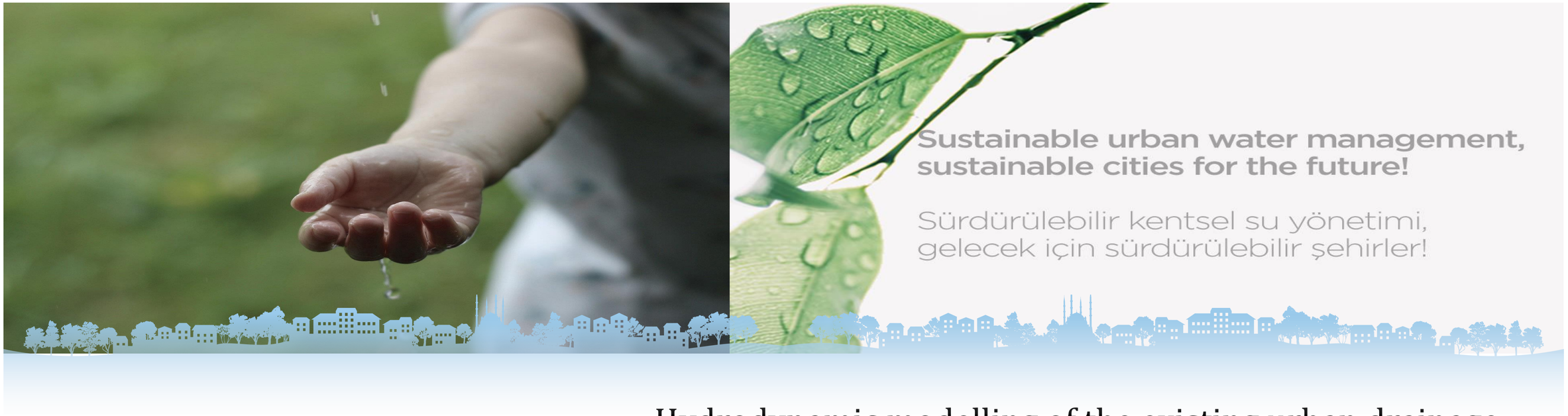
Purpose & Scope

- Paper aims to put forward a written **methodology on analyzing of drainage systems based on real-world conditions** which has already been implemented even limitedly.



- By following this methodology, it is planning to analyze drainage systems reflecting real-world conditions and identify **opportunities** for **improvement**, leading to more **effective** and **sustainable drainage systems.**

Introduction



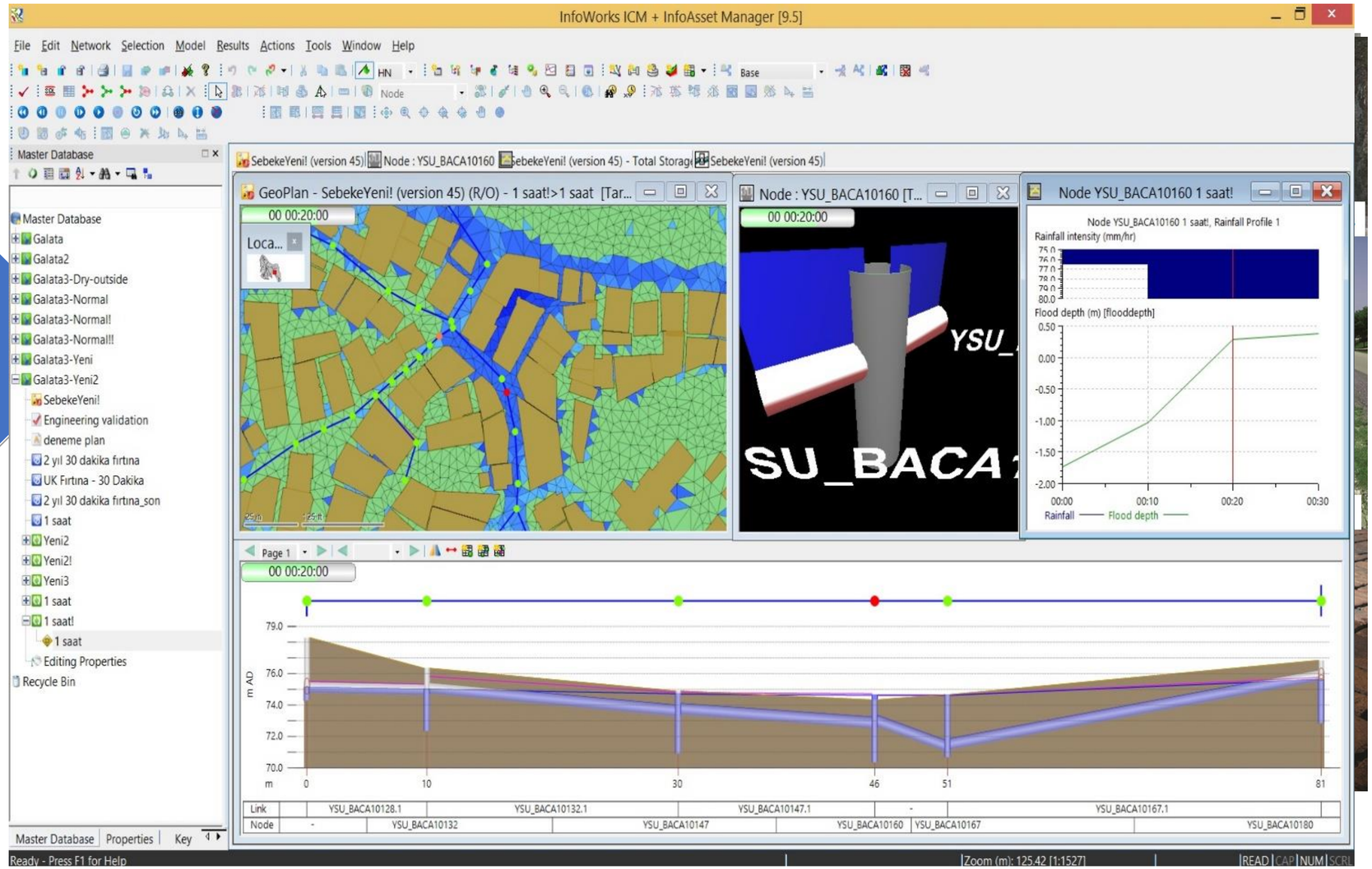
Introduction

Hydrodynamic modelling of the existing urban drainage system with **up-to-date** and **accurate data** is aimed for the **sustainable solution** of problems related to rapid urbanization and climate change in urban drainage systems.

BASIS OF JUSTIFICATION

YÜKSEL PROJE

Rapid Increase in
URBANIZATION



CONVENTIONAL MODEL SETUP

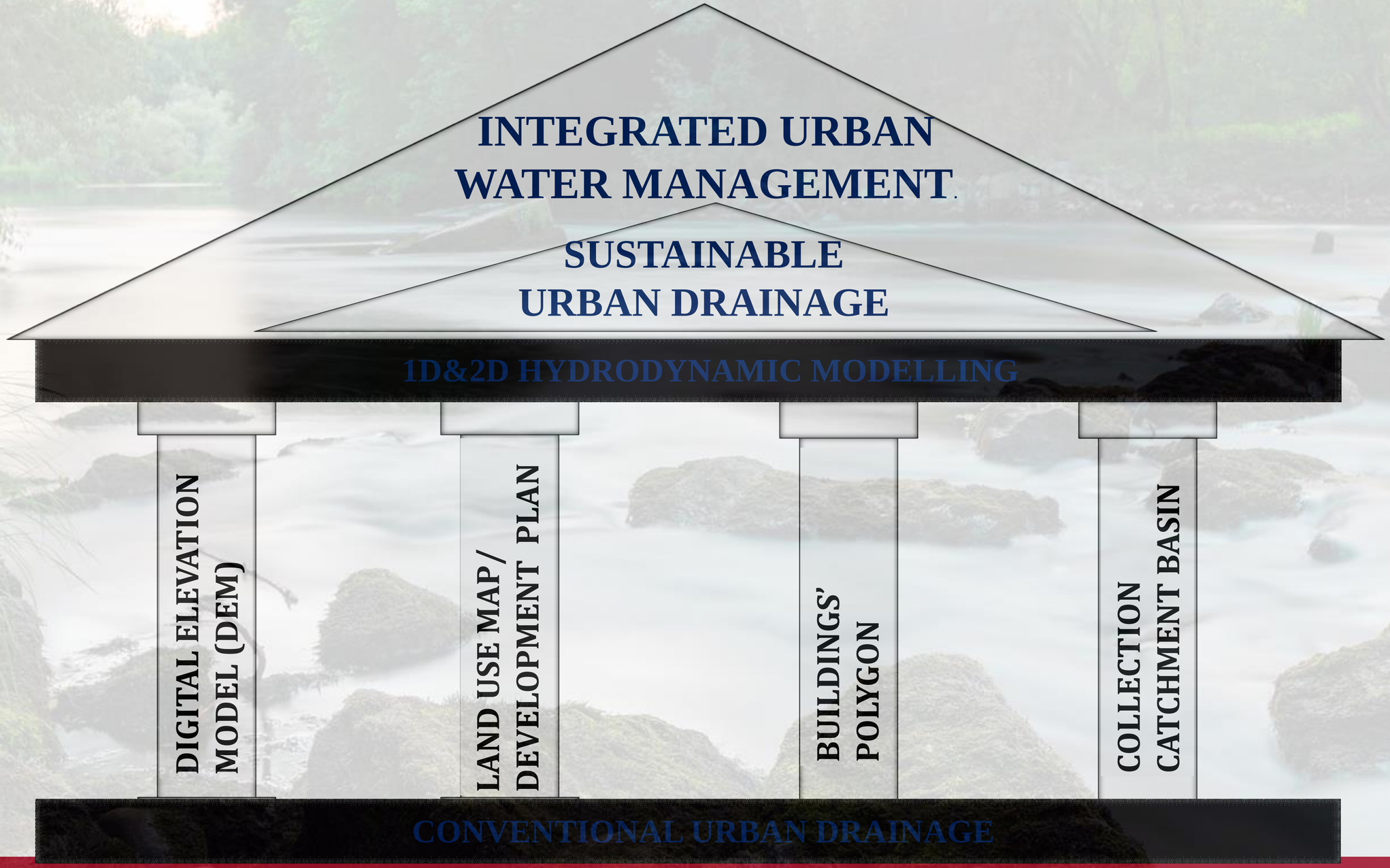
- Importing physical data of urban drainage systems
- Definition of initial conditions
- Describing the hydrologic criteria
- Describing the hydraulic criteria

ADVANCED MODEL SETUP

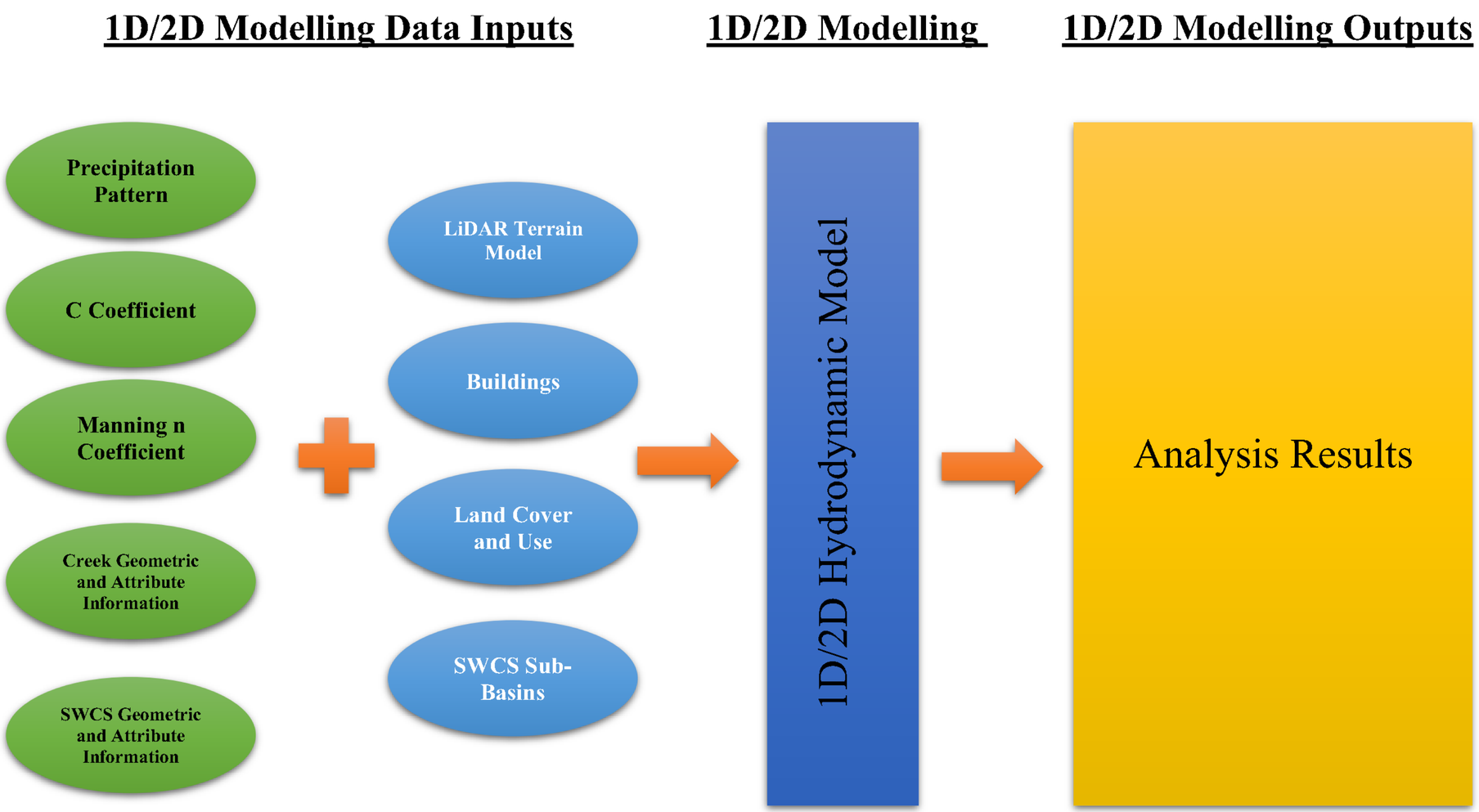
- Importing surface model
- Importing land use map
- Describing building polygons
- Identification sub-basins

YÜKSEL PROJE

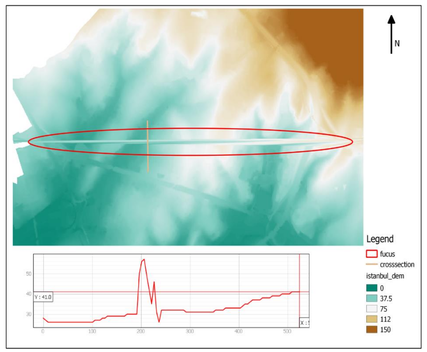
Final Aim


INTEGRATED URBAN WATER MANAGEMENT.
SUSTAINABLE URBAN DRAINAGE
1D&2D HYDRODYNAMIC MODELLING
DIGITAL ELEVATION MODEL (DEM)
LAND USE MAP / DEVELOPMENT PLAN
BUILDINGS' POLYGON
COLLECTION CATCHMENT BASIN
CONVENTIONAL URBAN DRAINAGE

Aim

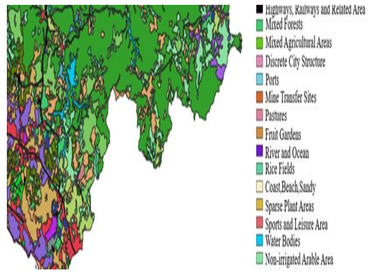

1D/2D Modelling Data Inputs
1D/2D Modelling
1D/2D Modelling Outputs
Precipitation Pattern
C Coefficient
Manning n Coefficient
Creek Geometric and Attribute Information
SWCS Geometric and Attribute Information
LiDAR Terrain Model
Buildings
Land Cover and Use
SWCS Sub-Basins
1D/2D Hydrodynamic Model
Analysis Results

Focus On



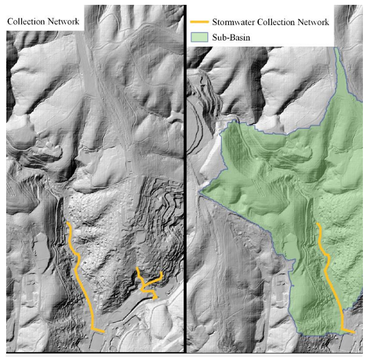
DEM

- Designating the flow obstructions
- Importing real dimensions/sections of bridges, overpasses and culverts
- Updating the critical creeks based on actual data
- Voiding the polygons (such as building, catchment, etc) on DEM



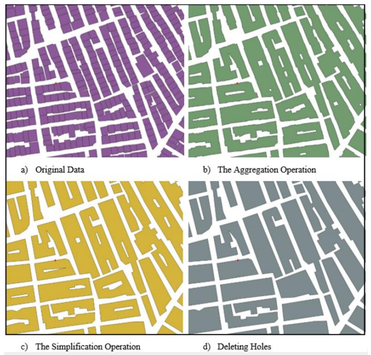
LAND USE

- Corine
- Development Plan
- Urban areas
- Restricted Areas
- Sensitive Areas



CATCHMENTS

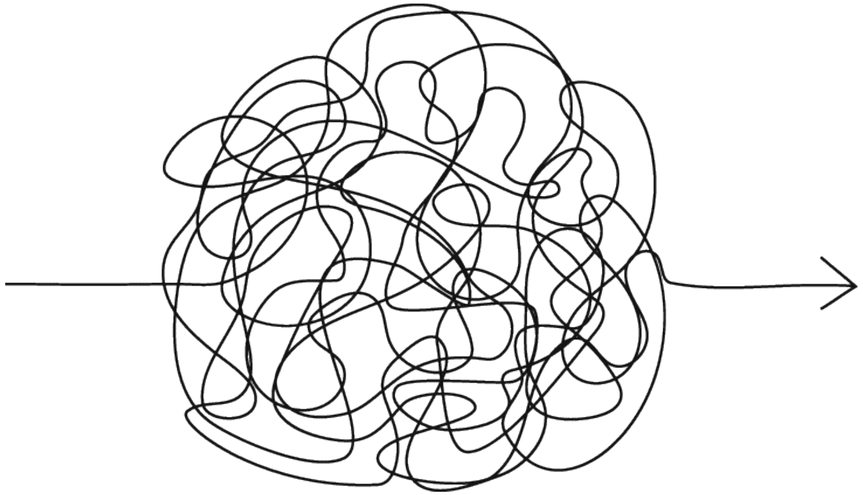
- Sub-catchments
- Voronoi polygons



BUILDING POLYGONS

- Meshing
- Model stability
- Void

Methodology



REAL-WORLD CONDITIONS

- Different complex
- Large-dimensional data
- Multivariable
- Need for reflecting real-environment conditions

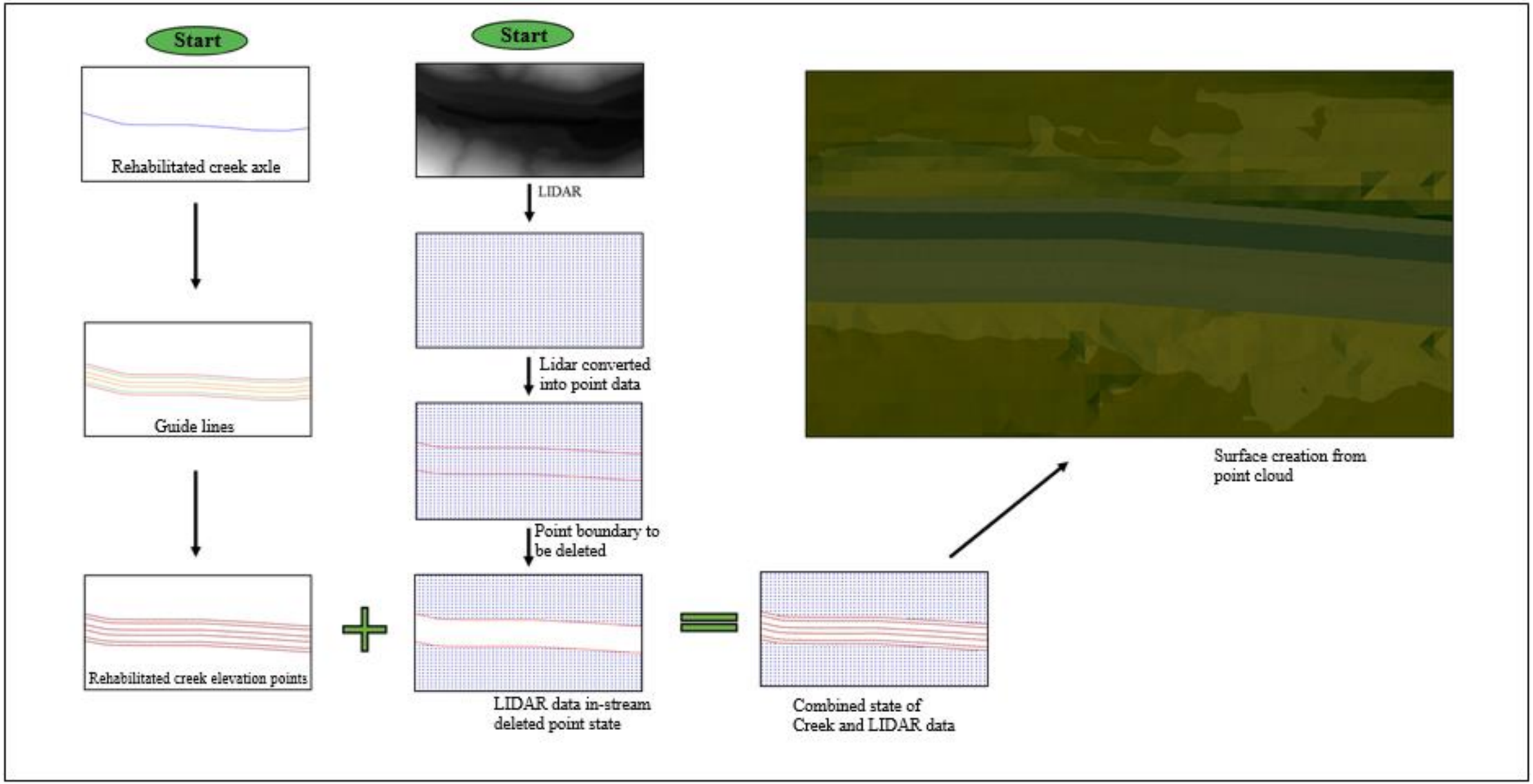
HOW?

- Requirement for incorporating all dynamics
- Research
- Considering hydrodynamic model needs

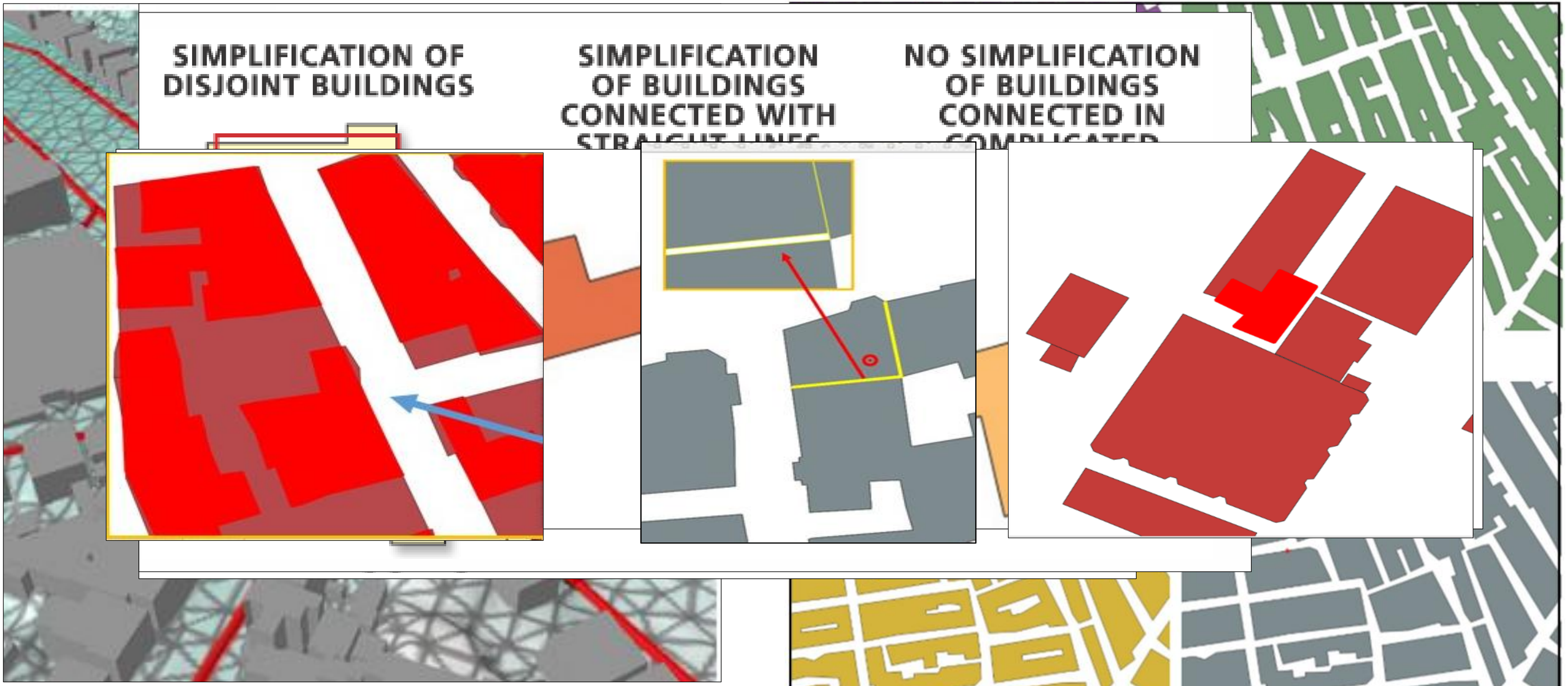
FORMING A METHODOLOGY

- Simplifying complex structures for realistic simulations as mathematically
- Using GIS capabilities
- Case studies
- Model calibrations
- Comparative evaluations

DEM


Start
Rehabilitated creek axle
Guide lines
Rehabilitated creek elevation points
Start
LIDAR
Lidar converted into point data
Point boundary to be deleted
LIDAR data in-stream deleted point state
Combined state of Creek and LIDAR data
Surface creation from point cloud

BUILDING POLYGON



c) The Simplification Operation

d) Deleting Holes

CATCHMENT BASIN

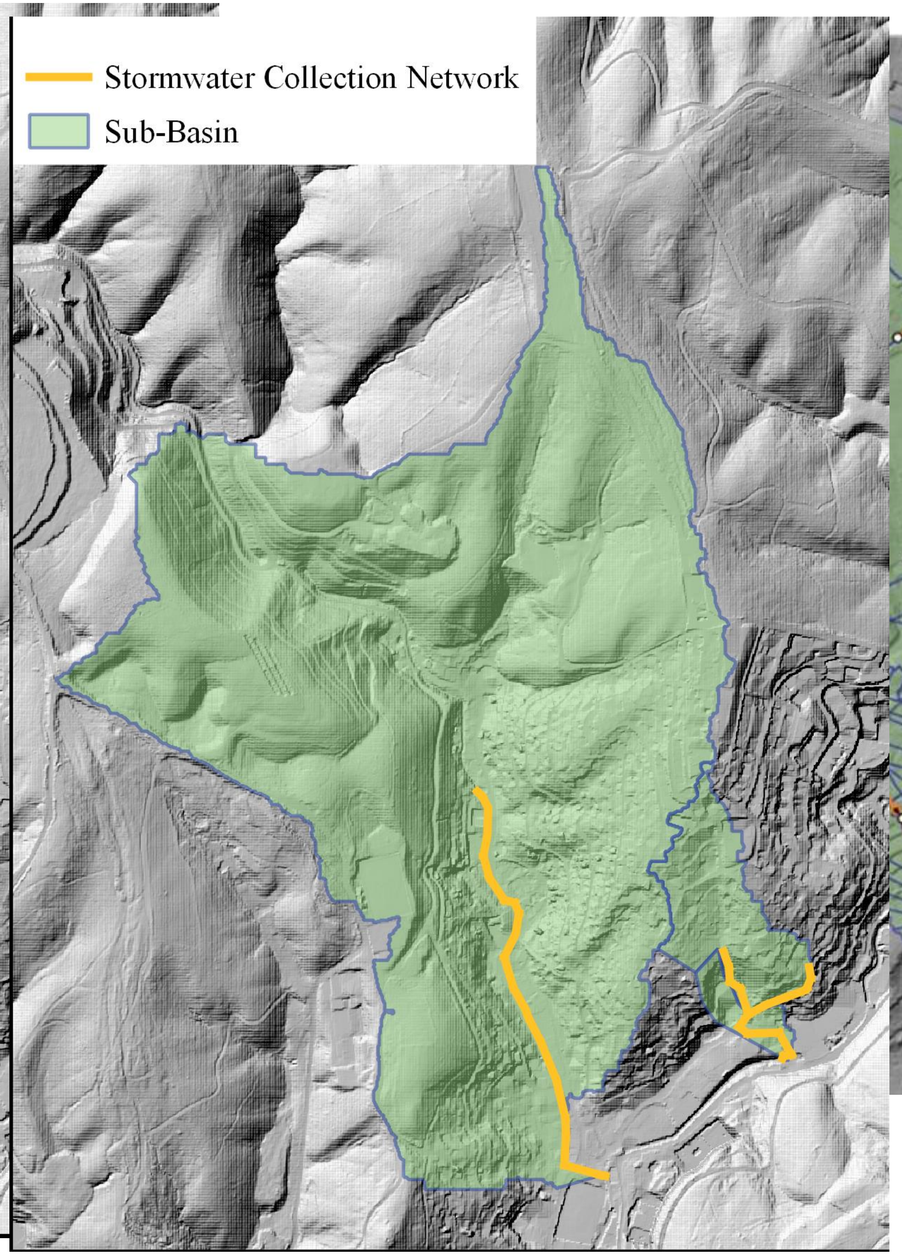
YÜKSEL PROJE

LIDAR

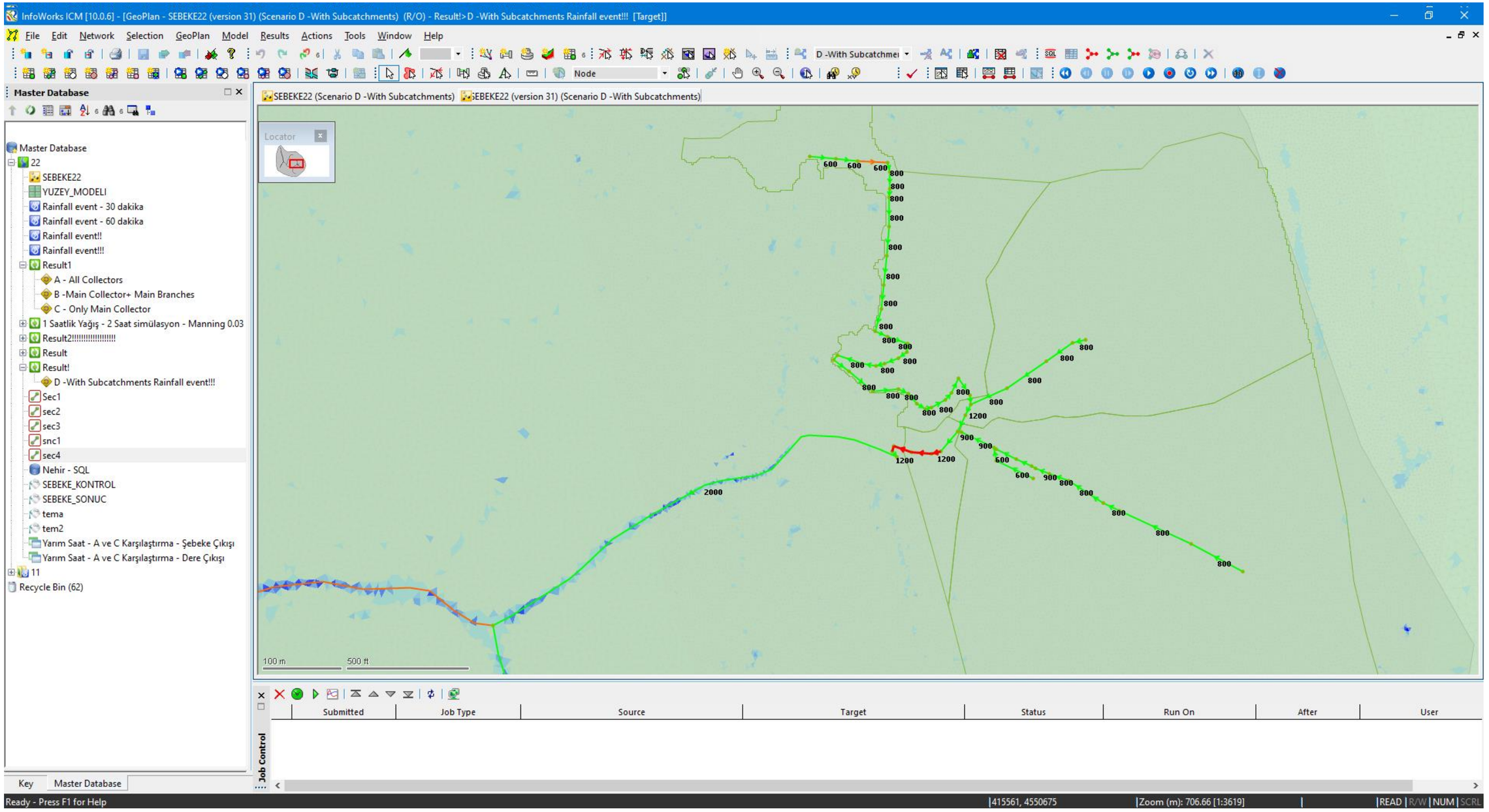
Drainage Network

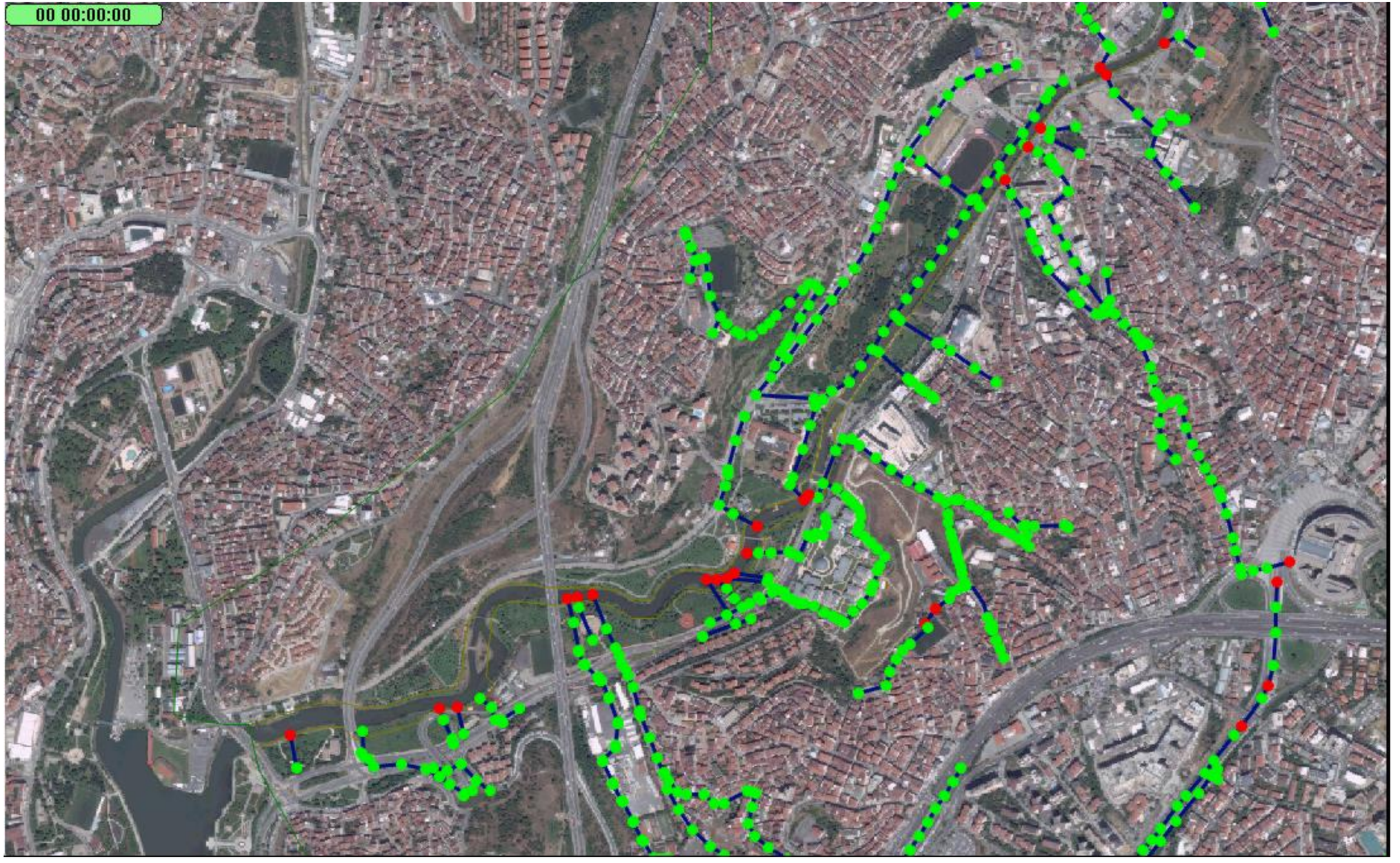
Discharge Points

SWAT+



Results and Findings

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Conclusion

- Accurate data-driven long-term planning and sustainable stormwater management are crucial for adapting to fast-growing urban conditions and ensuring efficient urban drainage services.

- Precise planning aligned with the smart city concept is essential for sustainable urban drainage management, considering engineering, administrative, and economic measures.

- GIS-based data preparation for hydrodynamic models offers high potential for ensuring efficient urban drainage services in rapidly growing cities, emphasizing the role of geospatial technologies in improving data quality and decision-making.

Future Works

- One or more plug-ins will be created from this methodologies . Thus, Easier and faster data conversion will be obtained that needed by Hydrodynamic modelling software.

- It’s planned to use contribution of Artificial Intelligence for processing building polygons at next phases. This will reduce possible production of incorrect polygons. Building polygons will be drawn with minimum distortion without damaging the main shape of the building. Therefore, Runtimes of hydrodynamic models will be shorten in 2d models.

References

[1] Z. B. Uygun, “Investigation of Stormwater Collection System Problems in ˙Istanbul,” ˙Istanbul Technical University, Graduate School of Science Engineering And Technology, November 2019.

[2] EPA, Environmental Protection Agency, ”Reducing Stormwater Costs through LID Strategies and Practices,” 841-F-07-006, 2007.

[3] G. Ferrier, D. Milan, C. Keat Yew, and R. J. Pope, “Potential of Retrofitting Sustainable Urban Drainage Systems Using an Integrated Geographical Information System-Remote Sensing Based Approach,” Department of Geography, Environment and Earth Sciences, University of Hull, Hull, HU6 7RX, UK, 2018.

[4] A. Casas, G. Benito, V. R. Thorndycraft, and M. Rico, “The topographic data source of digital terrain models as a key element in the accuracy of hydraulic flood modelling,” Earth Surface Processes and Landforms
Volume 31, Issue 4, 2006.

[5] G. Schumann, et al., “Comparison of remotely sensed water stages from LiDAR, topographic contours and SRTM,”, ISPRS Journal of Photogrammetry and Remote Sensing, 2008.

[6] M. E. Charlton, A. R. G. Large, and I. C. Fuller, “Application of airborne LiDAR in River environments: The River Coquet, Northumberland, UK,”, Earth Surface Processes and Landforms, 2003.

[7] CORINE Land Cover maps, European Environment Agency (EEA), Copenhagen, Denmark, 2018.

[8] Swiss Society of Cartography, “Cartographic Generalization—Topographic Maps,” Cartographic Publication Series, No 2, 1987.

[9] K. Bieger, et al., ”Introduction to SWAT+, a completely restructured version of the Soil and Water Assessment Tool.” JAWRA Journal of the American Water Resources Association, 53(1): pp. 115–130, 2017.


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