

## **Modeling urban waters using TONIC model in large metropolitan areas: comparison between Lyon (France) and Ho Chi Minh City (Vietnam)**

Modélisation des eaux urbaines dans les grandes agglomérations avec l'outil TONIC : comparaison entre Lyon (France) et Ho Chi Minh Ville (Vietnam)

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### **RÉSUMÉ**

Dans un contexte de changement climatique et de densification des centres urbains, les grandes villes doivent faire face à de nouvelles questions sur la gestion de l'eau pour prévenir les risques d'inondation et de pollution. Les deux villes ciblées dans cette étude (Lyon et Ho Chi Minh Ville) ont une gestion de l'eau contrastée en termes d'infrastructures existantes et de planification urbaine. Ho Chi Minh-Ville prévoit de construire de nouveaux réseaux d'assainissement et des stations d'épuration d'ici 20 ans, en s'inspirant des modèles de gestion centralisée des pays industrialisés. La ville de Lyon a suivi ce modèle de centralisation de l'eau urbaine via la collecte dans le réseau d'assainissement puis le traitement. Mais aujourd'hui, Lyon s'investit dans le développement d'une gestion alternative de l'eau en favorisant l'infiltration et l'imperméabilisation des zones urbaines grâce à des Solutions Fondées sur la Nature. L'objectif de l'étude est de proposer une vision alternative à « l'assainissement centralisé » dans un contexte de forte urbanisation et dans deux sites urbains très différents. Ce projet est financé par le Pack Ambition International Région AURA (2020-2022). Cette communication vise à présenter le modèle TONIC (Tools fOr green resilient Cities) et les données nécessaires à son implémentation sur deux petits bassins versants urbains à Lyon et à Ho Chi Minh City. Des résultats préliminaires sur les scénarios d'implémentation de NBS sont présentés.

### **ABSTRACT**

In a context of climate change and densification of urban centers, large cities have to face new questions about water management to prevent flood risks and pollution. The two cities targeted in this study (Lyon and Ho Chi Minh City) have contrasted water management in terms of existing infrastructure and urban planning. Ho Chi Minh City plans to build new sanitation networks and water treatment plants within the next 20 years, drawing inspiration from the centralized water management models of industrialized countries. The city of Lyon has followed this model of centralizing urban water via the collection in the sewerage network and then treatment. But today, the city of Lyon is invested in the development of alternative urban water management by promoting the infiltration and waterproofing of urban areas through Nature-based Solutions. The study's purpose is to offer an alternative vision to "sewerage" in a context of strong urbanization and in two very different urban sites. This project is funded by the Pack Ambition International Region AURA (2020-2022). This communication aims to present the TONIC model (Tools fOr green resilient Cities) and the data necessary for its implementation on two small urban watersheds in Lyon and Ho Chi Minh City. Preliminary results on NBS implementation scenarios are presented.

### **KEYWORDS**

urban water management, nature-based solutions, modeling

## 1 INTRODUCTION

In a context of climate change and densification of urban centers, large cities have to face new questions about water management. European cities have followed the classic urban water management scheme of industrialized countries with centralized collection of wastewaters and rainwaters routed to sewage treatment plants. This legacy model poses many problems today (storm overflows, concentration of water flows, pollution of the environment). To make cities more resilient to global change, alternative management therefore seems inevitable to meet environmental and health (preservation of the resource, flood risk) and socio-economic (network maintenance) challenges (Masi et al 2018). The aim of the study is to develop modelling and analytical tools for alternative management of urban water in large cities and to test scenarios for decentralized management of urban waters.

## 2 STUDY SITES

The two cities targeted in this study (Lyon and Ho Chi Minh City) have different socio-economic trajectories. Water management is very contrasted in terms of existing infrastructure and urban planning. Ho Chi Minh City (HCMC, more than 9 million inhabitants) is the economic capital of Vietnam in full demographic and economic expansion. The flood risk is regular and the deterioration of water quality is extreme due to a lack of wastewater and rain collection and treatment (less than 20 %). Ho Chi Minh City plans to build ten new wastewater treatment plants within the next 20 years. Lyon City (1.4 million inhabitants) has followed the model of centralizing urban water via collection in the sewerage network and then treatment in 12 treatment plants (99% of collection). Today, the city of Lyon is invested in the development of alternative urban water management by promoting the infiltration and waterproofing of urban areas through Nature-based Solutions (existing 56 infiltrations basin of rain water). Two urban basins of these two large cities were selected to test the approach. The Ecully basin is in Lyon city and the Thu Duc basin is in HCMC (figure 1).

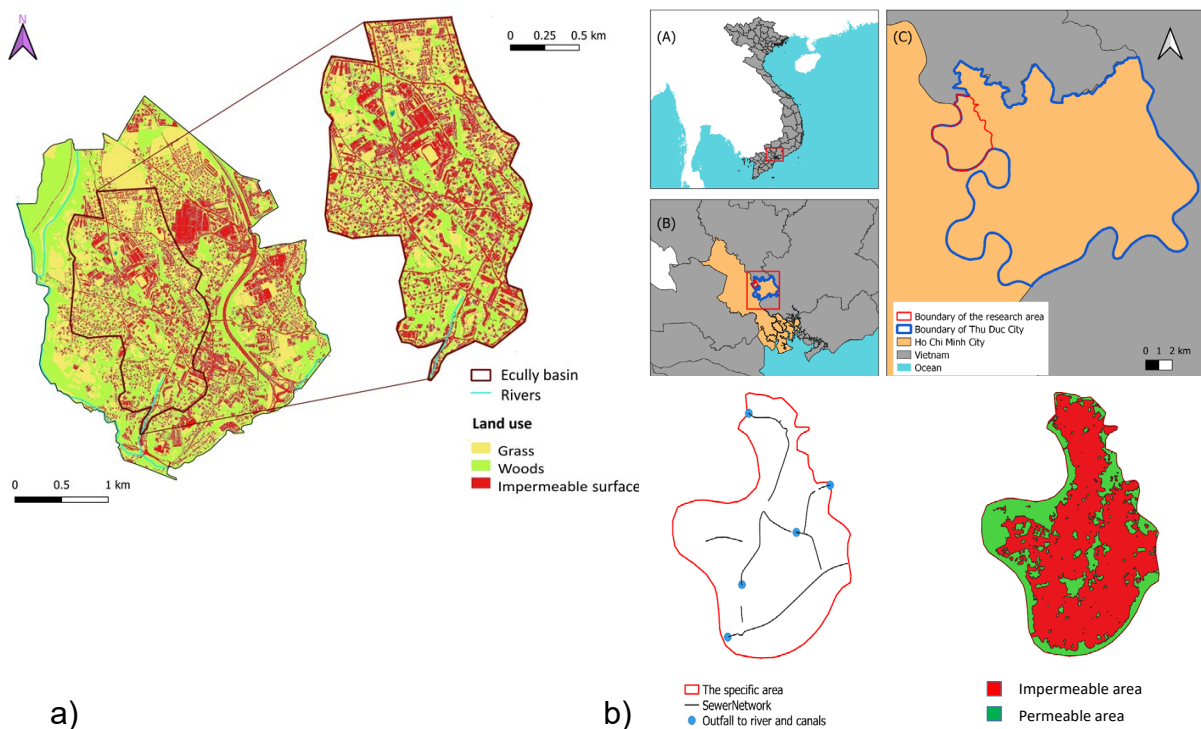


Figure 1 : Map of a) Ecully basin in Lyon City (area, 245 ha, 18 000 inhabitants, impermeable area : 55 %, combined sewage system, one overflow) and b) Thu Duc basin (area : 1469 ha, 74 137 inhabitants, impermeable area : 69 %, combined sewage system, five overflows)

### 3 MODELLING APPROACH

The TONIC model (Tools fOr greenN resilient Cities) is a simplified hydrology and hydraulic model being developed in the laboratory DEEP (INSA Lyon France) to provide to municipalities a decision support tool for selecting urban water management strategies based on the implementation of Nature-based Solutions for water treatment, storage, and reuse in urban areas. The below flow chart shows steps and input parameters used for running TONIC model (Figure 2). The implementation of the model requires description of the watershed (percentage of impermeable surface), geometry of the sewer system (diameter, length, slope, number, height and width of overflows, threshold law) and inputs data (population, water per capita, rain, infiltration). The TONIC model works in two phases i) the production phase that simulates the wastewater, rainwater discharges and the infiltration of parasite water to sewer pipes and ii) the transfer phase that routes the total discharge into the pipes. After a calibration step, the outputs model allows to get the total discharge within the sewer pipes and the total volume and number of spills.

The model is then used to assess the capacity of drainage of sewer system and to test efficiency of NBS implementation (rain garden, swales, green roof storage) in different scenarios.

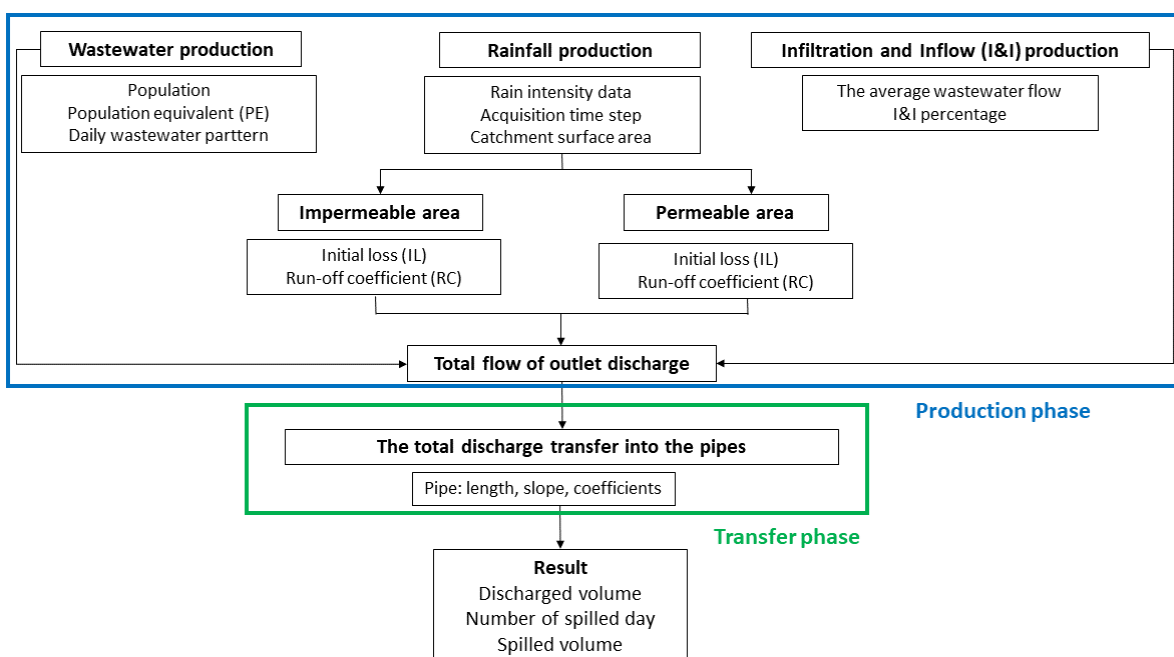


Figure 2 : Flowchart of the TONIC model

The TONIC model was consolidated in Ecully case study due to the large number of data available on the site (especially to take into account the variability of the rain and its runoff) (Michel 2021). On the contrary, the case study of Thu Duc lacks of data and some hypothesis have to be done to calibrate the model (especially on the rain distribution). Nevertheless, the TONIC model was able to give realistic outputs results and to show that the reduction of impermeable area in Thu Duc basin from 69% to 46 % using NBS will reduce by 20 % the total discharge volume in the sewer system.

### LIST OF REFERENCES

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