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## **Towards resilient cities: stormwater runoff mitigation strategies**

Vers des villes résilientes : stratégies d'atténuation du ruissellement des eaux pluviales

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### **RÉSUMÉ**

Les régions et villes méditerranéennes doivent faire face à des nombreuses questions liées à l'eau : gestion des eaux pluviales, qualité de l'eau, impact des sécheresses sur les milieux aquatiques. Pour répondre durablement à ces questions, il est évident que «l'eau» doit être intégrée dans le développement urbain et dans les politiques d'aménagement du territoire. Le projet de coopération TRIG eau (Transfrontalier, résilience, innovation et gouvernance pour la prévention des risques hydrogéologiques) vise à renforcer la résilience des territoires français et italiens méditerranéens exposés au risque hydrogéologique et hydraulique en favorisant la mise en œuvre de stratégies de gestion de l'eau dans l'aménagement du territoire tant au niveau régional que local. L'objectif de cette étude est d'évaluer l'impact des solutions de développement à faible impact (LID) afin d'atténuer les problèmes de gestion des eaux pluviales (aspects qualitatifs et quantitatifs) et de réduire ainsi la défaillance hydraulique des systèmes de drainage des eaux pluviales. Les trois études de cas italiennes sont examinées respectivement dans la municipalité de Solarussa (Sardaigne), dans la municipalité de Campo dlel'Elba (Isola d'Elba, Toscane) et dans la municipalité de Camogli (Liguria).

### **ABSTRACT**

Mediterranean regions and cities face important challenges related to water management, including storage, discharge, quality and periodic stress. To address these challenges, it is evident that water must become an integral part of urban planning policies and their implementation. The co-operation project TRIG eau (Trans-boundary, Resilience, Innovation and Governance for hydrogeological risk reduction) aims to strengthen the resilience of the French and Italian territories exposed to the hydrogeological and hydraulic risk by promoting the implementation of water management strategies in the territorial planning both at a regional and local scale. The objective of the present paper is to assess the impact of Low Impact Development (LID) solutions in order to mitigate the stormwater management problems (both quality and quantity aspects) and thus reducing the hydraulic failure of stormwater drainage systems. The three Italian case studies are examined located respectively in Municipality of Solarussa (Sardinia), in the Municipality of Campo dlel'Elba (Isola d'Elba, Tuscany) and in the Municipality of Camogli (Liguria).

### **KEYWORDS**

(green/blue spaces; hydraulic risk; stormwater runoff, urban planning, water management)

## 1 INTRODUCTION

European regions and cities face important challenges related to water management, including storage, discharge, quality and periodic stress. Furthermore, recent studies (e.g. Trambly and Somot, 2018) point out an increase in extreme rainfall in Northern basins of Mediterranean area, in particular the order of magnitude of the projected changes in extreme precipitation at the end of the twenty-first century may exceed + 20% in South France, North Italy and the Balkans. To address these challenges, it is evident that water must become an integral part of urban planning policies and their implementation. Considering these challenges, the project TRIG eau (Trans-boundary, Resilience, Innovation and Governance for hydrogeological risk reduction) aims to strengthen the resilience of the French and Italian territories exposed to the hydrogeological and hydraulic risk by promoting the implementation of water management strategies in the territorial planning both at a regional and local scale. The TRIG eau project is founded within the Interreg Italy-France Maritime Programme 2014-2020 co-financed by the European Regional Development Fund (ERDF) within the framework of the European Territorial Cooperation (ETC) and involves four Mediterranean regions: Liguria, Tuscany and Sardinia within the Italian territory and the Alpes-Côte-d'Azur-Region within the France territory. Relevant sub-objectives of the project concern the implementations of green/blue spaces within the urban landscape in order to limit and control the runoff generation and thus promoting the restoration of the natural water cycle.

The objective of the present paper is to assess the impact of Low Impact Development solutions (LIDs) on French and Italian urban catchments in order to mitigate the stormwater management problems (both quality and quantity aspects) and thus reducing the hydraulic failure of stormwater drainage systems.

## 2 METHODS

The potential impact of green/blue spaces is evaluated by means of a demonstration platform for the hydraulic risk evaluation implemented in the TRIG eau project. This platform has been developed to provide a support for technicians of the water management sector and in general for public servants in charge of the urban planning and integrate tools for hydrologic-hydraulic analysis and spatial database through which it is possible to have access from any geographic information system (GIS).

The specific objective is to provide a preliminary assessment of the impact of LIDs solutions on the hydrologic performance of the stormwater drainage network by means of a simplified hydrologic-hydraulic analysis tool thus promoting and supporting the implementation of green/blue spaces at the urban catchment scale. The tool allows to implement a project in the EPA SWMM (Rossman, 2010) environment through a limited selection of parameters and integrated all the available spatial database.

As for the hydrological component, the analysis of the precipitation regime is performed in order to point out the extreme rainfall event conditions for each investigated case study. Secondly, a simulation of the current scenario is carried out in order to localize the failures/hydraulic stress of the urban drainage network. Finally, a feasibility study is performed to design potential technical solutions for sustainable storm water management.

## 3 RESULTS

In order to test the proposed simplified hydraulic tool, four pilot case studies, one for each of the municipalities/territories involved in the project have been selected.

The first case study is an urban catchment located within the Municipality of Solarussa (Sardinia - Italy) as illustrated in Figure 1. In the last decades, the urban catchment has been densely urbanized thus significantly increasing the runoff generation on the other hand the stormwater network is fairly limited in terms of drainage density and often characterized by undersized hydraulic sections. Furthermore, the failure of the drainage system is worsened by the insufficient hydraulic section of the stream channel along with the outlet sections of the drainage network discharge the stormwater runoff. The installation of permeable pavements, infiltration trenches and green roofs is hypothesized to reduce the hydraulic risk (Palla et al., 2015).

The second case study is a residential neighborhood located in the Municipality of Campo dell'Elba (Elba Island, Tuscany – Italy). This area has been recently urbanized and does not reveal hydraulic failure of the drainage system however due to the significant fluctuation of inhabitants related to the touristic flow in the spring-summer periods, the implementation of stormwater management strategies to preserve the quality of receiving water bodies is crucial. Therefore, in this case the resilient scenario includes the installation of RainWater Harvesting (RWH) systems to limit the runoff discharge and reduce the potable water demand (Palla et al., 2018).

The third case study is an urban block located in the Municipality of Camogli (Liguria – Italy). The coastal area of Liguria Region is characterized by small and steep catchments densely urbanized mainly in the downstream area where the lower stretches of local streams were subjected to rectification and restriction of the natural hydraulic section. Any further urbanization of the peri-urban area has a extremely negative impact on the hydrologic response of the system. The implementation of LID green solutions as well as RWH systems allows to reduce the impact of urbanized area in terms of runoff volume and peaks (Palla and Gnecco, 2015).

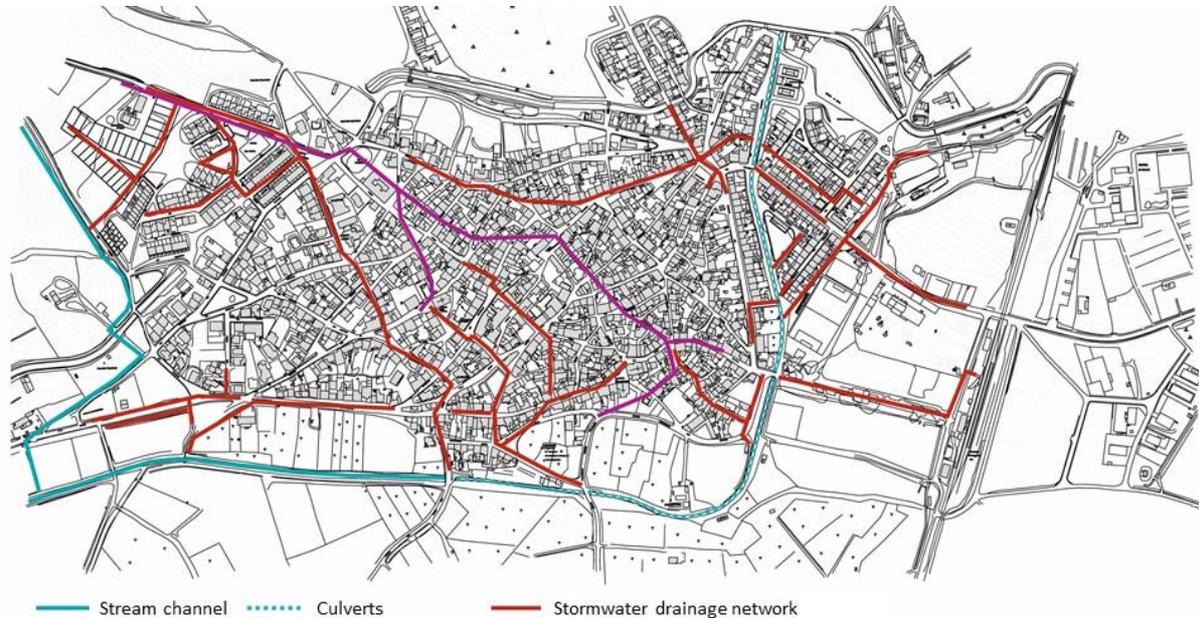


Figure 1. Map of the Solarussa Municipality (Sardinia, IT). The red lines refer to the main stormwater drainage networks and the blue lines refer to the receiving water body (stream channel).

#### 4 CONCLUSIONS

The demonstration platform plays an important role in the decision-making process related both to the stormwater management and the urban planning practices. In particular, the results of the different scenarios simulated for each case study facilitates the implementation of sustainable urban drainage solutions within urban planning policies thus enriching public discussion and adding transparency to the urban planning processes. Solely a multidisciplinary and participative approach allow to effectively move from the traditional urban drainage design to a more water-sensitive approach.

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