ID 1354 | FLOOD RISK MITIGATION: FROM ENGINEERING TO ECOSYSTEM-BASED MEASURES. THE BENEVENTO CASE STUDY

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1 THE INCREASE OF FLOOD RISK IN EUROPE

In the last two decades Europe has faced a strong increase of flooding events. Out of 325 flood events recorded from 1980 to 2012, indeed, more than 200 occurred in the 2000s (EEA, 2012). Among all natural hazards, more than 64% of the damages are due to hydro-meteorological events, namely to floods and landslides, with costs higher than 13 billion euros since 2000 (EEA, 2013a). If on the one hand the increase of heavy downpours can be ascribed to climate change, on the other hand the amount of damage has to be imputed to the significant, and sometimes uncontrolled, urbanization processes (EEA, 2017). Therefore, both of these matters have to be addressed in order to prevent future flood disasters.

Climate change, intended as "a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period", is caused by "internal processes" or by "persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC, 2001). The subversion of natural patterns has led not only to the increase of the sea level and of the mean temperatures but also to "changes in the frequency and magnitude of heavy precipitations" (EEA, 2017) that are expected to become even more frequent over the 21st century. Meanwhile, the population's strong migration toward cities has enhanced the growth of urban areas with the consequent processes of land take and soil sealing (EC, 2012). In Europe, since the 1950s, the amount of impervious surfaces has registered an increase equal to 78%, with an increase of only 33% of the population (EC, 2012).

Furthermore, numerous European cities are located close to rivers or along the coast, and are continuing to spread into areas potentially prone to river floods (EEA, 2017), with a consequent increase in the number of inhabitants and assets exposed to fluvial flood risk. The latter, that occurs when the "river run-off volume exceeds local flow capacities" (EEA, 2012b), is only one of the risks connected to heavy downpours.

Extreme rainfalls may put at risk, indeed, also areas located far from water bodies. The increasing levels of land take and soil sealing consequent to the sprawling of urban land uses, often combined with the widespread inadequacy of existing sewage systems, are leading to a significant increase in pluvial flood phenomena that are only optionally considered by the Flood Directive. These phenomena are related to the "excessive superficial run-off and ponding" (EEA, 2016a) that occurs when the rainwater's load exceeds the city's sewer system capacity. Furthermore, it is worth noting that pluvial and fluvial flooding risks are strictly connected. As a matter of fact, sewage systems discharge water into the closest water bodies: therefore, their overload due to an excessive amount of impervious surfaces (pluvial flood), may cause the raise of water levels above normal ranges that can culminate with the river's overflow (fluvial flood).

2 COPING WITH FLOODS: EUROPEAN STRATEGIES

In the face of the significant increase of flooding events throughout Europe, numerous tools and initiatives have been put in place in the last decade. First of all, in 2007, the European Flood Directive has been issued. This document clearly highlights the importance to develop effective flood management plans, outlining both protection and prevention strategies able to "prevent and reduce damage to human health, the environment, cultural heritage and economic activity" (Directive 2007/60/EC). Prevention and protection, as later on explained by the European Commission's Note "Towards Better Environmental Options for Flood Risk Management" issued in 2011, can also be achieved by implementing environmentally friendly solutions, such as "natural, ecosystem-based water retention measures" (EC, 2011). These solutions, besides requiring less expenses and maintenance compared to the traditional engineering measures, allow to produce numerous indirect benefits, such as promoting tourism, creating

new job opportunities and providing new recreational areas (EC, 2011). Moreover, the increasing awareness that changes in climate conditions are likely to further increase flood risk in Europe and that cities represent not only the major contributors to climate change but also the most vulnerable targets to its impacts, in the April 2014, the European Union launched the Mayors' Adapt Initiative, addressed to support Local Authorities in carrying out comprehensive local adaptation strategies or integrating adaptation issues into relevant existing plans, in order to increase city's resilience in the face of climate impacts.

In order to drive cities towards the development and implementation of effective adaptation strategies in the face of climate impacts, the European Union provided guidelines and platforms aimed at guiding adaptation processes and favouring the sharing of information and best practices. In detail, provided guidelines distinguish adaptation actions into three main categories: grey infrastructure, including physical interventions aimed at improving the capacity of the built environment to withstand extreme events; green infrastructure aimed at using "functions and services provided by the ecosystems to achieve a more cost effective and sometimes more feasible adaptation solution than grey infrastructure" (EEA, 2012b); and soft measures, which include land use planning and control, monitoring and warning systems as well as information campaigns and devoted programs to raise citizens' awareness, to promote adaptive behaviours and to favour stakeholders' engagement. Furthermore, the EEA also underlines how the integration of the two approaches, "soft" and "green", helps achieving better performances. Indeed, the involvement of stakeholders and the growth of awareness among the population strengthen the "inter-connections between natural and social systems" by building up acceptance and accelerating the adaptation process (EEA, 2013b).

In respect to floods, numerous studies (Foster et al. 2011, EEA, 2016a) have recently emphasized how the so far most widespread grey infrastructure, that include retentions or protection structures (e.g. dams, dikes, embankments), show high construction and maintenance costs, create a false sense of safety, pushes further urban developments, and provide a limited flexibility in the face of the uncertainty of long-term climate conditions. Based on these assumptions, current European approach to flood adaptation is progressively shifting from an "engineering-based" perspective, largely based on grey measures, toward an environmental-based perspective, mostly relying on green and soft measures, characterized by lower costs, higher flexibility and multiple benefits. The latter would enable cities to turn climate threat into an opportunity to create a safer urban environment and a better quality of life for citizens. Such a shift is clearly remarked by the French National Strategy for Flood Management, issued in 2014, which consider the creation of new grey infrastructure as the last option, to be put into play only when all other possibilities are insufficient (EEA, 2016a).

Hence, in the last years numerous cities are developing and experiencing "green" adaptation strategies, involving the increase and the enhancement of urban green areas, the integration of Sustainable Drainage Systems (SUDSs) in areas characterized by a predominance of impervious surfaces and the restoration of natural environments such as floodplains. Moreover, an increasing number of cities are promoting community based adaptation processes, in order to improve local awareness as well as to prepare local communities (decision makers and citizens) to make informed decisions about adaptation in a constantly changing scenario (Keys et al., 2016).

Summing up, starting from the second half of the 2000s, European Union has undertaken a path toward the reduction of different typologies of fluvial and pluvial floods that is fully in line with the hints provided, on a global scale, by the Sendai Framework for Disaster Risk Reduction 2015-2030, issued in 2015, that represents a milestone towards more effective risk reduction strategies. The Framework has indeed clearly stressed the linkages among risks, climate change and sustainability, emphasizing the need for strengthening "the sustainable use and management of ecosystems" and implementing "integrated environmental and natural resource management approaches that incorporate disaster risk reduction". Furthermore, the Document has put large emphasis both on the need for "mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning" and for promoting "a culture of disaster prevention, resilience and responsible citizenship" by encouraging an active engagement of public and private stakeholders (UN, 2015).

3 CITIES DEALING WITH FLOOD RISK: EUROPEAN BEST PRACTICES

Cities represent the economic, cultural and political core of today's society. In Europe almost 73% of the population lives in cities and this percentage is expected to grow up to 80% before 2050 (EEA, 2015). This high concentration of inhabitants increases on the one hand the exposure to natural disasters and, on the other, the opportunity to spread new prevention strategies.

For this instance, cities represent the best place to encourage the promotion of ecosystem-based strategies. Many have already developed pioneer projects in this line, by adhering to global and/or European initiatives, so that today they can be looked at as best practices. Likewise, cities also offer the opportunity to introduce and successfully employ "soft measures". The latter are conceived to raise awareness and increase citizens' involvement in outlining prevention strategies. This approach, if accurately applied, would not only promote the acceptance of new policies but also positively influence their final outcomes.

Hereunder two European best practices are briefly described: the first one refers to the city of Sheffield that introduced green infrastructures to reduce flood risk; the second one refers to the city of Ghent that successfully promoted citizens' engagement in the implementation of green measures.

The city of Sheffield, located in South Yorkshire (England), rises along two main rivers, the Don and the Sheaf. This city has suffered a devastating flood in 2007 and almost repeated this experience 2012. Thus, in 2015 the "Flood and Water Management Capital Investment Programme" was issued to develop projects able to prevent these events from happening again. Sheffield's flood protection scheme is based on three main goals: "slowing the flow", "containing the flow" and "building resilience" (Sheffield City Council, 2017).

Sheffield aims at achieving the first goal, slowing the flow, by implementing green measures, capable to intercept rainwater preventing it from increasing river's flow. As a matter of fact, the realization of both storage areas and SUDSs would allow capturing rainfall and soaking it before it reaches the river. More precisely, this goal is expected to be achieved by: managing rural land, resorting to "tree planting, moorland restoration and creation of landscape features" to collect rainwater; managing existing reservoirs, that have to be transformed in order to better contribute to flood prevention; creating new storage areas, designed and conceived for storing rainwater; and urban water management, introducing the SUDSs to reduce the superficial run-off. In respect to the second goal, containing the flood, the city aims at improving existing flood defence measures. For instance, by raising the level of existing embankments and reducing possible obstacles along the river. Finally, the third goal, "building resilience", the city aims not only at improving warning systems and emergency policies but also at ensuring a better maintenance of the rivers and at increasing the capability of urban environment to recover after the flood.

In brief, Sheffield integrates green measures into two of its three main flood prevention goals, in "slowing the flow" and in the "building resilience". For both of these purposes green infrastructures are conceived as long-term solutions with multiple benefits, since they would be useful not only for prevention issues, but also to create new recreational areas and improve the overall quality of the urban environment.

The city of Ghent, located in Belgium, rises at the confluence of the Lys and upper Scheldt rivers and therefore has to deal with both pluvial and fluvial floods. However, considering that during heavy downpours fluvial flooding "is more likely to take place in areas intended for flooding or where flooding causes less damage" (Gent Klimaatstad, 2016), the main concern of Local Authorities is to protect inhabitants from pluvial flooding. For this matter, Ghent's strategy addresses the following goals:

- Prevention of more sealed soil due to hardening of surfaces, that involves both the integration of new green areas and the improvement of existing ones;
- 'Greening' the city, to be achieved through a Green Structural Plan, designed both for water retention and for cooling (addressing the heat island effect as well as the flood risk);
- Maximum focus on the green-blue network that calls for major safeguard of the watercourses, by preserving the enclosed areas and greening the banks;
- Creation of space for water, by realizing new floodable areas;
- Maximization of the city's sponge effect that will decrease the water load toward the rivers through "local catchment, retention, reusage, infiltration or buffering and delay" (Gent Klimaatstad, 2016) of rainwater thank to the introduction of SUDSs;

- Provision of cooling infrastructure, finalized to decrease the heat island effect, by introducing such as trees, water elements and light buildings' coverings.

In brief Ghent, analogously to Sheffield, entrusted green infrastructures to ensure flood protection. Furthermore, this city's prevention strategy deserves credit not only for promoting "green" measures, but also for successfully combining them with "soft" measures. Indeed, in 2015, Ghent launched a crowd-funding platform to ensure the economic feasibility of adaptation actions that are proposed and financed by citizens (EEA, 2016c). This platform, by favouring bottom-up adaptation initiatives, guarantees a large public engagement in improving city's wellbeing. So far, two adaptation projects have been successfully promoted through this platform (EEA, 2016c) and will be soon implemented.

4 RECOVERING FROM AND ADAPTING TO FLOODS: THE BENEVENTO CASE STUDY

Italy, alongside with most of the European countries, is battling with hydro-meteorological events. Floods and landslides caused 1.989 deaths and injured 2.561 inhabitants in the time span 1964-2013 (ISPRA, 2015), becoming a key priority for local and national institutions. One of the most recent flooding events has affected the city of Benevento, located in Southern Italy and characterized by high flood risk levels due to its geographical location. As a matter of fact, this city rises along the banks of the Calore River and more specifically at the confluence of this river with its two main tributaries, Tammaro and Sabato (Figure 1). The confluence with the tributaries, most importantly with the Tammaro River, represents a weak spot due to abrupt shift of the hydrological regime caused by the overload of gravel and sand (Soreca, 2013). This condition has already caused flooding disasters in the past; the most disruptive one dates back to 1949, when the river's overflow wrecked many residences, agricultural and industrial activities leaving hundreds of inhabitant homeless and jobless (Calò, 2015). In response to this event, massive concrete protection walls were erected along the river in correspondence to the most inhabited area (Comune di Benevento, 2015).

The latest floods occurred the nights between the 14th and 15th and the 19th and 20th October 2015, causing damages to public and private buildings, to flood defence measures, to infrastructures, to the primary services network, to the productive activities. Furthermore, the events caused strong inconveniences to the population, leading to the death of two persons (Provincia di Benevento, 2015). Overall, 33 cities of the Province of Benevento were affected by the hazardous events with costs equal to 120 million Euros for the reinstatement of public buildings and infrastructures[1] and further 24 million Euros for the compensation of damages and production losses of the agricultural activities (Giunta Regionale della Campania, 2015).

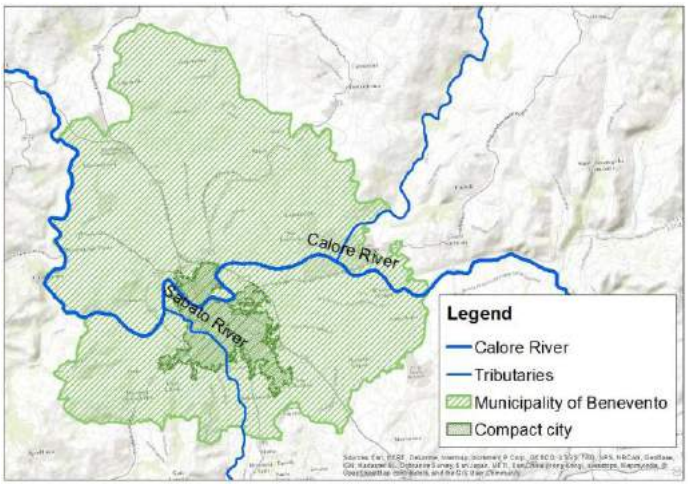

Figure 1: City of Benevento and main Rivers. Source: own elaboration.

[1] Data source: Nota della Regione Capania prot. 0698789 of the 18/10/2015. Available at: http://provincia.benevento.it/

Therefore, these events proved not only the inadequacy of the defence system conceived after the 1949 flood, but also the deficiencies of the "Extract Plan for Flood Defence: the Volturno Basin" published in 1999 and still in force in the October 2015. As a matter of fact, the concrete barriers built along the course of the Calore River present many discontinuities, especially in low population density areas (Comune di Benevento, 2015). This condition, combined with the lack of maintenance interventions and the consistent increase of population and of impervious surfaces over the past 60 years, made these barriers obsolete and inadequate to protect the urban area. Furthermore, the flooded areas exceeded the hazardous areas identified by the "Extract Plan for Flood Defence: the Volturno Basin", highlighting the necessity to review current Plan.

In brief, the event of 2015 highlighted the need for reconsidering and strengthening current strategies against floods in order to guarantee the population's safety and avoid the likely future flooding events from being disruptive.

4.1 BENEVENTO: ONE YEAR AFTER THE FLOOD

A year after, Benevento is still struggling to recover from the impacts of the 2015 floods. So far, despite most of the implemented measures have been addressed to repair the damage caused by the hazardous events, not all the damages have been repaired; moreover effective risk reduction strategies, aimed at preventing future disasters, are still at a very early stage.

An in depth analysis of the event, its consequences and the measures adopted starting from the immediate aftermath, allows to identify which actions have been implemented and what is still missing. More specifically, the considered actions refer to: the emergency management, the recovery phase, the prevention phase, which is crucial to turn the disaster into an opportunity for enhancing city's capacities to deal with likely future events.

The flooding events of October 2015 inundated numerous roads and buildings causing many families to be evacuated and many others to be confined on highest floors[1]. The management of the emergency phase was entrusted to the "Civil Protection Plan" (Comune di Benevento, 2015). The Municipality adopted the Plan in 2006 and its most recent update, before the 2015 events, dated back to 2010 (Città di Benevento, 2016). The Plan was sized according to the risk scenarios outlined by the "Extract Plan for Flood Defence" issued in 1999 by the Basin Authority of the Liri-Garigliano and Volturno Rivers[2]. Unfortunately, the 2015 events were significantly beyond the expected; hence, in 2016, the new "Civil Protection Plan: Hydrological Risk and Intervention Model" (Comune di Benevento, 2015) has been issued. The Plan includes new detailed cartographic support concerning the most exposed areas of the city, a reviewed list of both the facilities adequate to offer shelter and support in case of emergency and of the human and technological resources to employ in order to manage likely future crises (Città di Benevento, 2016). Furthermore, the plan comes with cartographic attachments representing, the critical points, the fastest escape routes and the areas inundated in the 2015 event.

However, further improvements of the Plan are expected: current risk scenarios should be updated, indeed, according to the on-going revision of the "Extract Plan for Flood Defence: the Volturno Basin", following the directions provided in December 2015 by the Hydrographic District of the Southern Apennines[3] regarding the delimitation and classification of the hazardous and risk areas (Città di Benevento, 2016).

In respect to the recovery phase, it has to be noticed that the Report published in October 2016 and titled "Flood events from the 15th to the 20th October 2016: Interventions implemented by the Province of Benevento" summarizes the actions so far undertaken or still underway to repair physical damages suffered by public facilities and infrastructures (Provincia di Benevento, 2016). The comparison of these data with those listed in the damage reports, released after the event and analysed in-depth by the

[1] http://www.comune.benevento.it/
[2] A detailed description of this Plan is provided in the paragraph 4.1
[3] The "Extract Plan for Flood Defence: the Volturno Basin" published by the Basin Authority of the Liri-Garigliano and Volturno Rivers is subordinated to the Hydrographic District of the Southern Apennines. The latter, responsible for all Basin Authorities that fall within its jurisdiction area, provides key criteria and instructions to improve and update the Basin Authorities' Plans.

Authors in a previous research work (Galderisi and Treccozzi, 2017), highlights that many damages involving schools, streets, bridges and flood defence measures for the Tammaro River, haven't been repaired yet. Furthermore, damages involving bike lanes and flood defence measures for the Sabato River haven't been mentioned in any intervention report so far (Figure 2).

Figure 2: Physical Damage to public facilities in the city of Benevento after the October 2015 event (left) and their recovery status in October 2016 (right). Source: own elaboration.

Although the comparison proves that many damages have been repaired, it is important to outline that these interventions were mainly intended to recover the pre-event, and largely inadequate, state (Provincia di Benevento, 2016). Furthermore, even though the biggest challenge is still related to the recovery of the hit industrial and agricultural activities, the provided comparison refers only to physical damages to public buildings, facilities and infrastructures (schools, administrative buildings, bank defence measures, road network, etc.), since no official data and reports regarding the recovery of private buildings and economic activities have been made accessible to the public, impeding to evaluate the progress.

As for the prevention phase, it has to be outlined that the Plan in charge for flood prevention when the 2015 flood occurred was the "Extract Plan for Flood Defence: Volturno Basin", issued in 1999 by the Basin Authority of the Liri-Garigliano and Volturno Rivers and still in force. Nevertheless, as mentioned above, the surface actually flooded in 2015, revealed itself to be way more extensive than the one portrayed in the Plan. Figure 3 gives a closer look to the difference between the areas actually flooded and the ones expected to be flooded in the confluence area of the Calore with its two main tributaries, in other words in the city's most exposed area. Therefore, on December 2015 the "Management Plan for Flood Risk" was published from the Hydrographic District of the Southern Apennines, acknowledging the need to improve existing flood protection plans for the regions that fall within its jurisdiction area. These modifications had to be started in 2016, and further enhanced in 2019. Hence, starting from 2016, Basin Authorities were required to reconsider the boundaries of hazard and risk areas and their classification, considering historic flood data, such as the ones owed to the 2015 events. The Management Plan for Flood Risk states that in 2019 all flood protection plans have to introduce new prevention, preparation and recovery measures. For the Calore River, the prevention measures should include: the development of a river bank monitoring service, the improvement of ecological corridors along the river and a management policy for the vegetation surrounding the river, the recognition of green areas to drain the river's overflow (Distretto Idrografico dell'Appennino Meridionale, 2015).

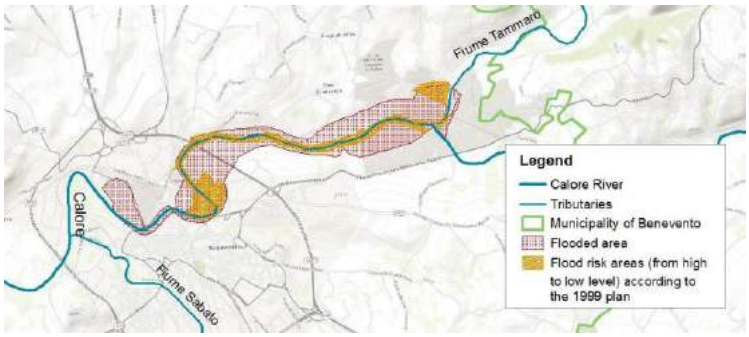

Figure 3: Comparison between the area flooded during the 2015 event and the area considered at flooding risk by the 1999 "Extract Plan for Flood Defence: Volturno Basin". Source: own elaboration.

Furthermore, the areas along the Calore River, are safeguarded by the "Territorial Plan for Provincial Coordination" approved in 2012, as part of the foreseen provincial ecological network (Provincia di Benevento, 2012). In line with the Territorial Plan for Provincial Coordination, the Municipal Master Plan, approved in 2012, envisaged for the areas included in the provincial ecological network, the creation of naturalistic or thematic parks (Comune di Benevento, 2011b). Although both the mentioned Plans were already in force, none of the planned interventions had been implemented when the 2015 floods occurred. As a matter of fact, only on January 2017, the city has announced that an Agreement between the Municipality and the Liri-Garigliano Basin Authority for the preparation of a work program to implement the City Fluvial/Territorial Park had been signed[1].

Finally, it is worth mentioning that so far Benevento has not adhered to any European initiative aimed to develop adaptation plans.

Summing up, more than one year after the 2015 flooding events, more effective prevention strategies have been only envisaged both at Basin and at the Municipal scale and, although they seem to outline a green strategy for preventing future fluvial floods, they are at a very early stage, hindering an assessment of their effectiveness.

4.2 HINTS TO SHIFT FROM A "COPING" TOWARD A "TRANSFORMATIVE" APPROACH FOR FLOOD ADAPTATION

Learning from the adaptation strategies that numerous cities, within and outside Europe, are developing to face the increased frequency and severity of flood events, in the following we will provide some hints of how to shift from the "coping" approach, that has guided so far the Benevento' response to flood events, towards a "transformative" approach that, overcoming current sectorial strategies and grounding on a systemic perspective, "seeks to integrate adaptation with other aspects of urban development and turns the challenge into an opportunity, capitalising on many additional, non-climatic benefits" ().

Bearing in mind that current urban vulnerability to flood impacts is ascribable not only to the current urban development patterns but also to the limited awareness among local decision-makers, citizens and economic stakeholders toward climate related challenges, the key pillars for developing an effective local adaptation strategy, capable of turning current challenge into an opportunity for a sustainable urban development by combining green and soft measures, can be synthesized as follows:

- Reducing the river's load, by reducing superficial run-off through SUDSs;
- Preventing the river's load from increasing, by controlling the loss of permeable soils in future urban developments;
- Enhancing the river's capacity, by creating a fluvial park;
- Raising local awareness, by promoting an active engagement of citizens and local business.

The first pillar, reducing the river's load, entails the control and reduction of the risk of pluvial flood that occurs when large amounts of superficial run-off are produced. This phenomenon is usually due to the prevailing of impervious surfaces that characterize urban areas and to the consequent overload of the sewer system, often inadequate even to the ordinary load, in case of heavy rains. An effective response to this phenomenon can been sought not only in the improvement of the existing sewer system, a measure that has been recently approved by the Municipality of Benevento in 2017[2], but also in enhancing city's ability to absorb superficial run off through the widespread implementation of SUDSs.

The most critical area within the Benevento Municipality is represented by the compact historical city that, according to the data provided by the Corine Land Cover programme, is characterized by 88% of artificial surfaces and only 12% of permeable surfaces (Figure 4). In this area the main opportunities to reduce superficial run-off, and consequently the amount of water channelled toward the surrounding water bodies, can be sought through the redesign of public open spaces and namely from the redesign of public streets,

[1] http://www.comune.benevento.it/bn2_pagine/notizie/comunicato.php?id=5775&allComunicati=1

[2] The intention to improve the sewer system has been notified on Benevento's website: http://www.comune.benevento.it/bn2_pagine/notizie/comunicato.php?id=5775&allComunicati=1

squares and parking lots through permeable pavements, trapping rainfall underground and directing it to bioswales and rain gardens.

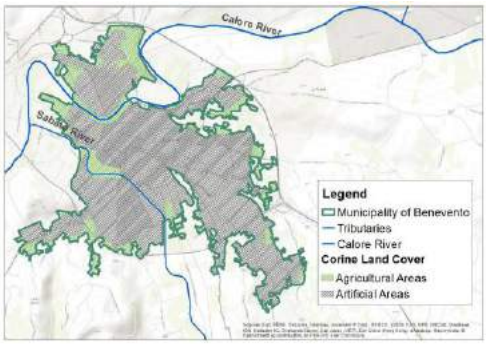

Figure 4: Types of land uses in Benevento's compact city, according to the Corine Land Cover programme.
Source: own elaboration.

The development of SUDSs would allow restricting water flowing into the sewage systems, by enhancing meanwhile the environmental quality of the historical city. The second pillar refers to the need for preventing the river's load from increasing. To this aim the loss of permeable soils in future urban developments should be significantly reduced. Current Masterplan allows new residential development areas within the Municipal area, comprising in the Compact City (Figure 5). As a matter of fact, these areas would further increase the percentage of impervious surfaces. However, the introduction of the principle of "hydraulic invariance" for future urban developments would allow to keep the superficial run off unchanged. This principle – already introduced by the flood management plans in Emilia Romagna in the early 2000s and forcing new urban developments "to preserve peak discharges from urbanized areas to the values corresponding to pre-existing agricultural conditions through adequate flood detention" (Pistocchi et al., 2015) – could be easily adopted by the basin plans, currently under preparation, as well as by current Master Plan.

The third pillar, referred to the enhancement of the river's capacity, could be achieved by realizing a green flood storage area along the Calore River. This solution, which has already been implemented in the Sheffield case-study, would constitute a temporary water storage area in case of heavy rainfall and, during dry periods, an important recreational asset both at Municipal and at wider scale. As mentioned above, both the Territorial Provincial Plan and the Municipal Master Plan envisaged the proposal of a Fluvial Park along the Calore River. Nevertheless, only after the 2015 flood events an Agreement between the Municipality and the Liri-Garigliano Basin Authority had been signed: the Agreement establishes the need for developing a work program addressed to implement the City Fluvial/Territorial Park. However, in order to define such a work programme in a shared and participatory way, the opportunities arising from the development of a River

Contract, intended as a participative management structure capable to bring together multiple different stakeholders and already tested in numerous European countries, should be explored.

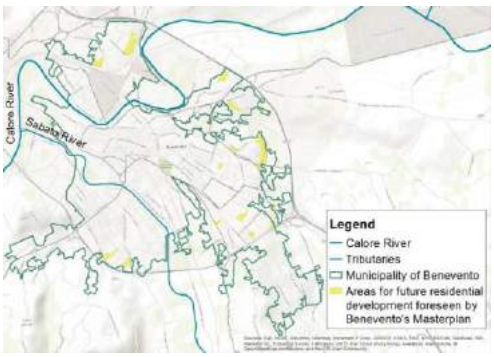

Figure 5: Foreseen new residential developments in the Compact City.
Source: own elaboration based on the Benevento's Master Plan.

The last pillar refers to the need for raising local awareness: according to the Sendai Framework, indeed, effective disaster risk governance requires not only "clear vision, plans, competence, guidance and coordination within and across sectors" but also the effective engagement of all relevant stakeholders to decision-making processes. Thus, the involvement of citizens, local businesses and other stakeholders in developing shared visions for a climate-proof urban development has to be considered as a crucial element to guarantee the effectiveness of a flood adaptation urban strategy. So far, although numerous local news websites handled by activists prove a significant population's concern for these issues, no effective public initiatives aimed at raising local awareness on occurred flood events or at involving local stakeholders in developing a shared vision for the future, have been undertaken. The introduction of "soft measures", such as the creation of an open knowledge platform capable to combine and integrate different sources and types of available information (e.g. on historical and recent flood events and related damage, implemented recovery actions and on-going initiatives, current regulations, etc.) as well as to facilitate the interaction among different stakeholders, including civil society, could allow to increase local awareness and address flood risk in a more effective and participatory way. Moreover, the establishment of the Calore River Contract as well as the implementation of a crowdfunding platform, as in the Ghent case study, could allow local stakeholders, including citizens, to be actively engaged in decision-making processes and could stimulate bottom up initiatives capable to complement public action, opposite to the currently prevailing top-down approach to flood management.

5 CONCLUDING REMARKS

Over the past years, in the face of the significant increase of flooding events and their costs, European institutions have largely contributed to raise National and Local Authorities' awareness and promoted numerous initiatives that are being successfully acknowledged and implemented by most State Members as well as by numerous cities. Up to date more than 600 European cities have undertaken an adaptation process in the frame of European or international initiatives (EEA, 2016b), and many of these chose to rely on green infrastructure, capable to guarantee multiple benefits and proving a successful overall progress toward Europe's climate-proof goal.

However, some State Members are still straining to implement adaptation strategies and their progress status is delayed. In Italy, for example, very few cities have put into action adaptation strategies – with a predominance of grey measures (technological, infrastructural, etc.) compared to green ones (Giordano et al., 2014) – while most of them haven't even addressed the issue. Among these, the city of Benevento that, even though it has been struggling with flood risk for decades, is still far from embracing a "transformative" perspective, by starting an adaptation processes effectively integrated into city's development issues and capable to turn the climate challenge into an opportunity for improving the overall quality of the urban environment. The response of the city to the latest flood events has been, indeed, mainly based on a "coping" approach, by implementing actions aimed to repair and reinstate the pre-event conditions, whereas the potential of green infrastructures to improve Benevento's resilience against flood has been so far only envisaged.

As a matter of fact, the best practices of Sheffield and Ghent proved how green strategies for flood prevention strategies offer the opportunity to improve not only inhabitants' safety but also cities' landscape and availability of recreational facilities, providing cities with numerous environmental, social and economic benefits. Moreover, Ghent's experience of involving stakeholders and citizens through the implementation of soft measures, suggests a cue to enhance people engagement in public decisions and to strengthen the ownership of the implemented actions.

Therefore, grounding on the experiences so far developed by European cities, Benevento should reverse its current "coping" approach to flood disaster – largely emergency-driven, fragmented and discontinuous – leading the way to a transformative adaptation strategy, based on the discussed pillars and effectively integrated in sectorial and spatial planning processes. Moreover, citizens' participation and activism emerged in the aftermath of the recent flooding events point out the potential to actively engage local communities in decision-making processes as well as to encourage bottom-up adaptation initiatives complementing institutional ones, which could represent key issues for a successful adaptation process.

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