LUEAP
Bologna adaptation plan for a resilient city
Bologna città resiliente

Pilot Actions Outcomes (Summary)

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Introduction

This document summarizes the main results obtained in the design, start-up and implementation of the pilot actions defined in the Adaptation Plan. Considering the feedbacks coming from internal and external stakeholders, different kind of experimental applications were implemented both in the public and in the private sector. These actions have been developed through a multi-step involvement of stakeholders.

The Municipality of Bologna focused mainly in the drafting of new rules and guidelines such as the Building Code, the Green Regulation and the Public Works guidelines, but it also realised potable water saving measures in the public park Giardini Margherita and it has been regulating the disposal of domestic sewage through the elimination of wastewater release into the Fiaccacollo Canal and the collection of wastewater into the public sewer.

Moreover, the Municipality, together with the neighbouring Municipality of Zola Predosa and the Land Reclamation Consortium have designed and discussed the development of a multi-function wetland for the water treatment and lamination in the North-Western part of city.

Associations and large scale retail companies have been involved in the promotion and implementation of the "Green up Bologna" campaign.

One of the biggest insurance company at national level has been involved in testing risk assessment tools and designing and implementing awareness campaigns about the understanding of increasing risks connected to the climate change effects.

Specific rain water management solutions have been designed for a new commercial building’s parking lot and the Faculty of Agriculture has studied how to collect water with a rooftop harvesting system and to use the collected water to irrigate an experimental orchard.

All the actions are summarized in the following paragraphs. Actions sheets with a full description of every single action have been edited in Italian and inserted as Annex in the present document.

Municipality Regulations

1) New targets for water saving in the Building Code

The Municipal Building Code (RUE) contains provisions for water saving and reuse: they are divided into compulsory requirements and voluntary requirements, designed to gain better environmental performances in the new buildings.
The Building Code set a maximum daily water consumption of 150 l/capita/day for new constructions, renovation works or emergency maintenance works in buildings for residential use; the water system has to be rebuilt with clear water and wastewater systems, as well as with devices to limit water consumption.
New buildings have to be equipped with water re-use systems for irrigation and other uses: the rule refers to housing and rural areas with green areas exceeding the 100 square meters and industrial, craft and commercial buildings exceeding the 3,000 m^2.
Finally, there are volume incentives of 10% and 20% for all those building projects which provide higher performances in water consumption (120-130 l/capita/day) by rainwater harvesting techniques and wastewater reusing techniques.
The water recycling system has to recover at least 50% of the water used.
The building projects have to be detailed and to report the technical specification of the interventions (volumes, storage ponds, etc.) and of the installation procedures of the devices.
Starting from the existing rules, new performance levels and specific requirements have been inserted in a new revised technical annex of the Building Code, approved in April 2015.

Compulsory requirements
The maximum daily consumption is decreased from 150 to 140 l/capita/day.
Rainwater harvesting in new buildings for residential and rural uses:
• A specific reference was added, regarding the water distribution system for non-potable uses: the delivery points have to be pointed out through special alerts / labels;
• The exemption not to collect water for the irrigation of green areas smaller than 100 m^2 per housing unit is abrogated
Rainwater harvesting in new buildings for industrial/commercial/tertiary use:
• A specific reference was added, regarding the water distribution system for non-potable uses: the delivery points have to be pointed out through special alerts / labels;
• The storage basin has to be increased from Sc x 0:03 (m) to Sc x 0:05 (m);
• The exemption not to collect water for built-up areas smaller than 3.000 m^2 is abrogated.

Voluntary requirements
The levels of excellence and improvement in reduction per capita consumption

remain unchanged, but they can be achieved only through the rainwater harvesting and grey water reuse (no more through other water saving actions) It is also expected than a higher rainwater storage capacity will cover the non-potable water demand.

Controls
In the technical report that has to be drafted for the Municipality officers, the performances of bathroom fixtures and rainwater harvesting plants have to be detailed.

2) New arboreal varieties in the Municipality Green Regulation

Through the Public and Private Green Regulation, Bologna Municipality aims to protect both private and public urban green spaces, regardless of their environmental and cultural importance. Through the protection of trees and plants, as crucial elements of the landscape, Bologna Municipality intends also to achieve the improvement of the local environment and of its micro climate, and the biodiversity safeguard**.**
To protect the public and private green, it is necessary to define the means of intervention as well as the transformation of the territory better suited to the maintenance and development of the existing vegetation. Therefore, the number of trees in the urban areas and the connections between different green areas should be increased, creating a complex system of urban ecological networks.

Following the conclusions reached during several meetings with the relevant authorities and stakeholders, in the new Public and Private Green Regulation of the Bologna Municipality a specific annex has been attached, named "Plant species with high environmental efficiency". The attachment reports the main features of each species in terms of "environmental effectiveness", according to a series of specific parameters.
The Annex identifies some particular species of plants, referring to their ability to adapt to some limiting factors, such as: the reduction of water resources and their deterioration quality; the permeability, compaction and depletion of soils; drainage problems; salinization of aquifers; air pollution, etc.

At the same time, the CO_2 absorption capacity issue was also discussed, along with other features useful for the planning of the urban areas, such as the emission of volatile organic compounds (VOC) and, in particular, the formation of ozone and of allergenic substances.
The Annex aims to show the most appropriate species of plants, according to these new environmental aspects.

Guidelines to key infrastructures at risk

3) SUDS integration in the Public Works' Guidelines

The construction of new roads, squares or parking lots and the maintenance and restoration of existing ones give the opportunity to improve the hydrological response of sealed urban areas if we start to consider the possibility of retrofitting urban spaces using sustainable urban drainage systems (SUDS www.wsud.org) too.

Bologna Municipality in its Public Works' Guidelines (2009 version) concerning the design of roads, squares and other public spaces, provided technical prescriptions to be followed by designers in charge of new urban projects or restorations. Such guidelines include a section concerning rainwater collection systems that, beside general information, provide detailed design prescriptions for the following items:

- Sewage network;
- Pipelines;
- Inspection and access manhole;
- Runoff drainage systems;
- Manholes coverage;
- Technical plants (pumps, degreaser, etc.).

To spread sustainable drainage solutions, this pilot action envisages the elaboration of technical guidelines for the design of SUDS technologies, already evaluated within the BLUEAP project as easily applicable to the local context of Bologna. These SUDS guidelines will be integrated in the existing Public Works Guidelines, including three new items concerning rainwater collection systems: swales or conveyance channels, infiltration trenches, retention areas.

- Infiltration trenches: Infiltration trenches are shallow excavations with rubble or stone that create temporary subsurface storage of stormwater runoff, thereby enhancing the natural capacity of the ground to store and drain water. Infiltration trenches allow water to exfiltrate into the surrounding soils from the bottom and sides of the trench.
- Swales (or conveyance channels): Swales are usually shallow grassed or vegetated channels used to collect and/or move water. The shallow side slopes and flat bottom means that for most of the time water flows in a thin layer, some of them can be under drained with the use of perforated pipe. Swales can also provide some storage and filtration as well.
- Retention areas: Retention areas are surface storage basins or facilities that provide flow control through attenuation of stormwater runoff. They also facilitate some settling of particulate pollutants and can allow soil infiltration of the stored water. Retention areas are normally dry and in certain situations the land may also function as a recreational facility.

For each of the above techniques, as for the other items already included in the guidelines, detailed technical information has been provided in order to to allow the correct design.

Promotional Campaign

4) "Green up Bologna" Information campaign

The City of Bologna shows a great deal of associations as well as formal and informal groups of citizens that are committed to the promotion and care of the urban green. On the one hand, the opportunities for the implementation of green buildings, through more or less articulated and structured interventions, have not been completely developed, despite the incentives on new buildings provided in the Building Code (RUE). On the other hand, there are some forerunner experiences of green roofs and buildings such as, for example, the one realized by the University of Bologna on the roof of the Faculty of Engineering or the one on the new university residence called "Fioravanti".

Dealing with this situation, it is essential to enable a structured permanent promotion system of the awareness and realization of urban greening interventions through a coordination of the various urban realities, in order to make their action more effective and relevant .
The single association or private company should then help to multiply the interventions on public and private spaces as well as to raise citizens' awareness , with a special focus on schools, highlighting the benefits that would result from the energy consumption reduction and from the improvement of the micro-climate, especially in summer months.

In addition to these initiatives independently promoted by groups and associations, or events sponsored by the City or by private companies, dedicated campaigns should envisage the effective installation of new plants, especially in private spaces.

In this regard the city week "Bologna Green Up" will be organized in two distinct periods of the year, with the purpose of implementing the promotion of urban greening. Between November and December 2015 the city week will be focused on the promotion of planting in the courtyards (trees, bulbs and so on). Between March and April 2016 the focus will be the making of blooming balconies and the terrace home-grown. The Municipality of Bologna will spread the promotion of these initiatives through its communication channels, ensuring the dissemination within the most topic structured events about greening (eg. festival of trees, evenings in greenhouses, etc.) and carrying out information seminars and a comprehensive program on all the available events.

The aim is to actively involve citizens not only in decorating terraces and private courtyards with plants and flowers, but also to offer them the basics information on the proper housing, sun exposure and disease control, as well as the possibility to design small soil desealing measures.
Private companies will be involved by promoting various activities such as offering discounts on articles and green / plants, adding seeds / bulbs / plants as gifts for their clients, organizing small training and/or information about the green topic and promoting initiatives related to the events.
During the week it will be offered to the various associations working on these issues the possibility to organize demonstrations of embellishments of private and public spaces that will also be functional to the outdoor climate well-being.
The initiative will be repeated on an annual basis, and its contents can be used by the other initiatives promoted, on their own, by the different associations and companies involved in the campaign.

Permeable parkings/areas

5) Sustainable management of rain water in a new commercial building. (Via Larga)

The Operative Municipality Plan (POC) includes the construction of a new commercial area (intervention R5.7). It is an open area, bordered to the North with the "San Donato" railway station, to the East with Via Larga, to the South with Via dell'Industria and to the West with the warehouses of the Municipal Theatre.

In order to make the construction of this new commercial area consistent with the guidelines set out in the BLUEAP Strategy, the project has been revised in the summer 2014, in cooperation with the staff of BLUEAP. Thanks to the review of the project, different elements have been integrated within the Urban Building Plan (PUA), allowing a better management of the rains during intense rainfall events, as well as a reduction of water consumption of the new structure.

The PUA provides semi-permeable interlocking concrete pavers, laid on a bed of gravel and sand for all parking spaces, both public and private. This solution allows to deliver in the sewer a smaller amount of rain water by exploiting the drainage capacity of the sub-floor. Filtering trenches (that is, excavations filled with materials, gravel and sand, wrapped in non-woven fabric to prevent clogging), have been provided for the collection of water which fall on the green areas and on pedestrian paths, while the remaining paved and covered areas are served by specific laminating systems.
The green areas affected by the system of trenches filter have an area of about 8,500 m^2 while the linear trenches can reach a length of about 560 meters.

The final dimensions of the trenches will be defined during the executive project, taking into account the characteristics of the soil.

Lamination and detention ponds

6) Multi functional area in the Canocchia Superiore drain

Canocchia Superiore drain is a small ditch fed by a combined sewer overflow located on the border of the Municipality of Bologna and Zola Predosa; the drain flows north and merges into the Reno river from the Bologna Airport. The drain suffers of water flow overload, as already pointed out by a study carried out in 1998 by the University of Bologna; the drain capacity is 500 litres per second but nowadays its twenty-five flow rate is about 5,200 litres per second. This is due to the high soil impermeability caused by the great development of the industrial areas. The overflow causes frequent and wide floods on the Municipalities of Bologna and Zola Predosa.

Starting from this critical situation, the BLUEAP team analysed the area and proposed some solutions to gain the following goals:
• Deal with the emergency of run-off water on sealed surfaces which grew up in the past years without adequate regulations in terms of stormwater management;
• Reduce the hygienic/sanitary and environmental negative impact on the Canocchia drain, being fed by water coming from a combined sewer overflow;
• Prevent an increase of water overload due to the expansion of the built up areas upstream the drain, providing rainwater harvesting and run-off management systems aiming to facilitate the direct infiltration into the soil and lamination.
The proposed alternative solutions are:
1. Complete separation of the drainage system, creation of a lamination pond and reshape of the drain section up to via Morazzo;
2. Multi-function wetland for the water treatment and lamination (run-off from A1 area and local lamination of clean water coming from A2 and A3 areas);
3. Multi-function wetland for the water treatment (run off from A1 area, lamination of waste water coming from A1 area and of clean water coming from A2 area, local lamination of clean water coming from A2 area – 1,500 m^3 – and A3 area – 4,500 m^3).
The following table shows the strengths and weaknesses of the proposed solutions:

	Alt.1	Alt.2	Alt.3
Costs (thousand €)	2.38	2.87	1.87
Occupation of agricultural areas	Minimum	Minimum	Maximum
Environmental and landscape rehabilitation of the area	Minimum	Medium	Maximum
Possibility of intervention in different rounds	Low	High	High

The solution 1 was already developed in the study of the University. It will definitively solve the flood risk at least for the return period used as reference by the study (shorter than the one quoted in the Water Plan made by the Reno River Basin Authority).
In addition, the separation of clear water from the wastewater eliminates the existing spillway and consequently the pollution load currently delivered to the drain.
Critical issues are the hygienic/sanitary problems for the lamination pond (till the drainage network still mix clean water and wastewater) and the poor quality of the landscape/environmental design in the present proposal. The design should be revised and improved, with increasing costs and of occupation of agricultural area.

The solution 2 aims to realize lamination ponds within the industrial area, in the parts with an available separate network (A2 and A3 areas).
No network separation is available in the A1 area: the reduction of the lamination basin capacity can make the area available for a multifunctional system able to laminate about 11,000 cubic meters with natural techniques. A reference is the lamination design made by the City of Gorla Maggiore (VA), and currently evaluated with a participatory multi-criteria process within the project OPENNESS (http://www.openness-project.eu, case study 15). This solution is the most expensive because it is necessary to provide underground tanks in order to laminate the A2 area (which is completely built up).

The solution 3 is similar to the solution 2; the difference is the lack of lamination ponds in the A2 area, and the realization of a bigger lamination ponds into the multifunctional system. This solution is the less expensive, but need a wider occupation of the agricultural area (with higher expropriation costs).

All the proposed solutions were discussed together with the Land Reclamation Consortium responsible for the water management of the Canocchia drain (Consorzio della Bonifica Renana), the Municipalities of Bologna and Zola Predosa and Ambiente Italia.

The key issue of the discussion has been the feasibility of separation of black and white water in the drainage system the water network separation in the industrial area close to Canocchia drain.
Moreover, three alternative solutions for the reduction of hydrological risk along Canocchia Drain have been presented and preliminary evaluated during the meeting.

Municipality of Zola Predosa, in charge for interventions in the industrial area, commited itself to go into a deep evaluation of proposed solutions in order to consider and choose the best one according to economic issues and its effect on the hydrological behaviour of Canocchia drain.

Rainwater harvesting

7) Rainwater Harvesting in the Faculty of Agriculture (Cadriano)

The University of Bologna promotes building solutions improving the environmental performance of new or under renovation buildings, such as green roofs or water saving systems.

The Faculty of Agriculture, together with the BLUEAP team, studied how to collect water with a rooftop harvesting system and to use the collected water to irrigate an experimental orchard 17,700 square meters wide. Rainwater will be collected in an old pumping mill (artificial pond once used for the hemp production). The collection area is about 3,440 square meters wide and the pumping mill provides a volume of 2,100 cubic meters.
The water balance highlights that the orchard water demand can be fulfilled by rainwater harvesting for almost 1/3 of the total water demand, in particular in May, June and part of July. In July the water demand exceeds the capacity of the irrigation tank and the rainfall is not enough to balance irrigation needs. Indeed the system is worthy, as it allows to reduce to nearly 2,400 cubic meters per year of water consumption for irrigation; furthermore installation costs are strongly reduced using an existing storage basin.
The designed solution connects the drainpipes (to be equipped with filters containing suspended solids) coming down the roofs to the existing artificial pond through a specific plastic pipeline network, in order to storage rainwater for irrigation uses.

In order to manage the irrigation water deficit during summer months (July and August), a specific research study should better investigate the possibility to implement rainwater harvesting systems in the external paved surfaces of the Institute. In this case, a treatment plant or a phyto-purification wetland system for run-off water will be required in order to avoid anaerobic processes and smells.
A more complex constructed wetland system with the same overall dimensions could allow a grey water treatment of about 4 cubic meters/day ensuring the self-sufficiency of the irrigation system.

The cost of the intervention has been evaluated about € 60,000. A constructed wetland system for grey water treatment as big as the one for run-off water treatment costs about € 9,000. The price depends on the existing wastewater and grey water collection system: if the systems are not already separated, a

total remake of the water system of the building is required and will cause a considerable cost increase.

8) Irrigation of Giardini Margherita substituting drinking water with other water sources

The case of Giardini Margherita park – that get supplies for irrigation from the public aqueduct, that is using drinking water - is a clear example of the need to intervene to reduce unnecessary public water consumption.
Giardini Margherita park is a quite huge and important green area for the city of Bologna, just outside the Old Town, in the South East. The area covers about 26 hectares and requires irrigation from April to October. In the middle of the gardens there is a pond, which has mainly an aesthetic function, but it is also the source of the irrigation system for the whole park, ensuring the storage of about 11,000 m^3. The irrigation of the park - which takes place from April to October requires about 42,000 m^3 per year, while losses due to evaporation from the surface of the pond are between 11,000 and 14,000 m^3 per year, depending on weather conditions. In 2011 - the last year with water balance data available - the water supply of the whole system required 65,960 m^3 of drinking water, equal to the annual consumption of almost 1,400 inhabitants.

Since it is possible to irrigate green areas using lower quality water, a new well has been dug in the park: it can provide up to 44,000 m^3 of water per year, which are needed for the irrigation of the green areas and for compensating evaporation losses from the pond, without risks in terms of subsidence. The remaining volumes (9,000 – 12,000 m^3 per year) necessary to ensure the water balance will be obtained from the rainwater collection. Exploiting the lower level of the existing pond compared to the average level of the park, surface ducts have been built to collect and convey rainwater in the pond.
In addition, in order to contain as much as possible the quantities of water pumped through the new well, the irrigation system has been equipped with rain sensors: in the rainy days the irrigation system will remain switched off, as well as the system that pumps water from the well.

The works ended in Autumn 2014 and their effects could be monitored starting from the end of 2015. The measures carried out for the Giardini Margherita can be replicated in other municipal green areas, where it could be possible to evaluate even different supply resources, such as non-conventional waters and purified grey water.

Insurance of losses

9) Involving the Unipol Group in communicating and managing the climate change risks

The Unipol Group, one of the major Italian insurance companies, will cooperate with the Municipality of Bologna focusing on the information and knowledge transfer aiming to reduce damages and losses, more than the damages' insurance coverage itself (an issue which need to be discussed and better analysed at the national level).
In particular, there are interesting synergies between the implementation of some BLUE AP strategies and the tools that Unipol is going to develop thanks to a new LIFE+ project: DERRIS - DisastEr Risk Reduction InSurance (foreseen in 2016-2017). The main project's targets are:

- To transfer the existing knowledge about risk assessment and risk management of climate change effects (floods, landslides, typhoons, ecc.) from the insurance to the public administration and the private companies, in particular SME;
- To design and test, in particular for SME, a self-assessment tool which will be able to measure the risk and will enable companies to adopt prevention and management measures in case of emergency;
- To develop innovative public-private partnership involving insurance, public administration and private companies which will create better synergies and opportunities increasing the safety and the resilience of the territory;
- To study new financial instruments which will be able to collect market assets financing the climate change risk reduction.

The cooperation with the Unipol group started sharing the data collected and elaborated in the Local Climate Profile in order to improve the hydrogeological risk maps that Unipol is developing in order to evaluate the price of new insurance policies covering the flooding risk. The information collected in the Local Climate Profile about some flooding areas in Bologna is more detailed than the information Unipol gathered from the River Basin Authority and this could turn useful to better define the real risk at local level and the related price of the insurance policy, giving the possibility to incentivize private companies in reducing the risk, implementing proper adaptation measures.

Then Unipol agreed to test the risk assessment tool that will be developed in the DERRIS project during 2016-2017 in a sample of selected companies that will be involved, together with the Bologna Municipality, also in the adoption of another financial tool aiming to promote public-private partnerships financing adaptation and mitigation measures.

Unipol will also cooperate with the municipality in designing and implementing awareness campaigns about the understanding of increasing risks connected to the climate change effects and the effective strategies and measures that could be done to fight them.

One of the areas which has been identified to test a pilot awareness campaign is between Reno and Borgo Panigale neighbourhoods where there are some zones lying in the Reno's active riverbed. In this area of the city the Lungo Reno Park and some basements and cellars of surrounding buildings have been flooded more frequently in the last years. Some of the companies set here (mainly arts and crafts) will have to deal with an increasing – even if small - hydrological risk. In the neighbourhoods the cooperation between Unipol, the Municipality and the associations and companies working there could lead to an improvement of the citizens' awareness about the risks related to climate changes and, at the same time, some specific prevention measures could be decided and developed together.

10) Sustainable water management: the Recovery of Fiaccacollo Canal

The Reclamation Consortium "Chiusa di Casalecchio", which manages the canal network running through and under the city and that currently has the important task to manage rainwater flow from he hills to the valley, carried out a survey of their own private networks for verifying the regularity of water discharges from buildings built over the centuries. The survey revealed a number of canals rather compromised by the presence of wastewater not in accordance with the rule, therefore requiring recovery works. An analysis of the above mentioned network has been made, assessing the following issues: the hydraulic importance of the section and the qualitative impairment of the network, any technical intervention of restoration conceivable, a cost-benefit analysis of any recovery intervention. Following this study, the network has been divided into canals where a recovery is necessary and sustainable, and canals for which the recovery is not sustainable, that therefore will be disconnected from the white waters network and will be delivered to the public sewer.
The focus was primarily addressed on Fiaccacollo Canal, one of the most important canals of the network, running through the historic city centre in the S. Stefano district, closely linked to the surface-water bodies: during rainfall events, it drains into Aposa River and then into Navile Canal. The study of the Consortium identified in this canal the presence of 400 irregular inlets.
Starting from these premises and in order to continue the improvement measures, the Municipality of Bologna committed itself in processing documents addressed to the owners and the managers of the buildings and properties affected by the illegal dumping, in order to regulate the disposal of domestic sewage through the elimination of wastewater release into Fiaccacollo Canal and the collection of wastewater into the public sewer. The connection to the public sewer will be made independently by each building, if technically possible; it should be made without passing through other properties and without changing the sewer position through heavy interventions in the properties.
If the sewer position does not permit a simple connection to the public sewer, a

separate sewage system will be realized an placed in closed concrete trunks inside the original pipeline. This sewage system will have a private connotation, being built inside the canals owned by the Reclamation Consortium.
This work will be divided into different tranches of intervention, identified by functional technical uniformity of recovering.

Annexes

1. Pilot actions sheets (in Italian)