DELIVERABLE D.T3.3.1.

ASSESSMENT OF SOIL AND CLIMATE CONDITIONS FOR 4 SMALL SPOTS WITH RECOMMENDATION OF PLANTS

Alessandria

Final version
03/2020

Fabrizio Furia, Angelo A. Ranzenigo, Giuseppe Zicari, Jody Abate, Marta Pogrzeba, Jacek Krzyżak, Szymon Rusinowski, Alicja Szada-Borzyszkowska, Leszek Trząski, Waldemar Szendera

Table of Contents

List of Tables

List of Diagrams

List of Figures

Introduction

The project SALUTE4CE provides the conception of strategies for implementing environmental acupuncture's principles in urban area. The principles of the urban acupuncture can be realized with small low-cost interventions on small areas, in order to improve the quality (or variety) of the city green area through the creation of native plants areas, that are fit for climate change. One of the innovative parts of this method is the collaboration, from the earliest stages of the project, among municipal authority, specialists and citizens. The last ones have been involved, right from the beginning, in the selection of the most suitable sites according to the parameters previously designed by the sector specialists.
Thanks to the involvement of the citizens three small areas have been selected, they are located in different parts of the city of Alessandria and it needs to add the fourth intervention project that is popular in the old town, according to which it is expected to work on several dozens of flower pots. The three functional areas are similar in terms of dimensions, history and composition of the soil. The climatic conditions are similar too, but it must be considered that the area, nearest to the urban centre, is more strongly affected by the heat island, produced by the existence of big cemented and paved areas (where there is one of the selected sites and the flower pots). According to the macroscopic characteristics of these areas and to the analysis, that have been performed on them (ex: chemical analysis of the soil), it will be proposed the planting of native species because it will have a thermo-regulating and mitigation function of the pollution effects. Every project has been created for its next scientific/didactic usability in the environmental field and for its low-cost reproducibility.
This document summarizes the main elements of the four types of intervention, among which it should be noted the designing of an urban orchard (with the aim of promoting the protection of the pollinating insects) and a shelter forest (in order to support bird fauna). In the centre of the town the small flower pots will be redeveloped and they will contain native and Mediterranean bushes. Different species of plants will be used in order to test their resistance to the effects of the climate change and of the urban development. The future aim is to be able to equip some of these flower pots, that will be strategically placed, with probes, that will detect some sources of pollution. In this way a survey for the supervision of pollutants in urban areas could be promoted.
One of the reasons, that led us to project the planting of vegetables that support pollinators, is the current serious emergency. The all-over-the-world monitoring nets detect an alarming reduction of the biodiversity of the wild pollinators and a serious crisis of the beekeeping sector (*Apis mellifera*).
An indicator of the condition of the agricultural environment and of bees, even if indirect, is the production of honey. The spring of 2019 has been characterized in Piemonte by abnormal climatic trend, a mixture of temperatures sometimes too high and sometimes too low, with long periods of rainfall and of excessive drought, and that has caused enormous damages to the beekeeping sector. This year in Italy the estimated loss of production (Ismea data) of acacia and citrus honey is more than 10 thousand tons, that means more than 40% of the expected mean yearly in normal conditions, and that causes a total loss of 73 million euros. Piemonte is the first region for the honey production, with more than evaluated 5000 tons in 2018, followed by Toscana (3,000 t.) and Emilia Romagna (2,000 t.). The professional firms, that perform beekeeping migratory in Piemonte, produce a mean of 33 kg of honey for each hive (the national mean is 30 kg). The production of acacia honey in Piemonte, according to Ismea surveys is

halved: considering 164.296 hives for the commercial production, more than a half suffered damages of 100%, for a revenue loss of 16,5 millions of euros[14]. Due to the serious situation that has occurred this year for the beekeeping of Piemonte, the Agricultural Council member of Piemonte Region has decided to launch concrete measures to support the sector, that suffers a serious crisis[16]. So, for these reasons too, the project provides for an awareness in relation to these facts.

1. General information about the city

Alessandria is an Italian City and a Country Town situated in the south-east area of the Piemonte region, in the floodplain formed by rivers Tanaro and Bormida, near their point of intersection (mean altitude of 95 m above sea level or mals). For this reason, in the past, it was known as *Palea* o *Alexandria de Palea*, that means Alessandria of the swamp. The area is characterized both by industrial sector (ex: petrochemical one) and by agricultural sector (arable in autumn-winter cycle, barley and wheat in spring cycle; corn, sugar beet and plantation of poplars).
The City of Alessandria had a population of 93.631 inhabitants at the beginning of 2019 and it is the third City in Piemonte[5]. It is the ninth Italian City for population density (460 inhabitants/km^2) and it is 3 times greater than the regional mean (175 inhabitants/km^2).
The composition of the soil, the water and of the air reflects the strong urban and industrial development of the area, and that are strongly changed over the years. The water system of the urban and surrounding areas is subjected to chemical pollution as that is generated by the agricultural sector (pesticides and nitrate) and the eutrophication of the surface water (nitrogen and phosphorus) is important. In some areas, that surround the city, the pollution of soils, caused by industrial activities, is important like, for example, the hexavalent chromium.

2. Natural vegetation of the area

In 2016 in the area of Alessandria there was a forest area of 123.607 ha, of which 7.499 ha for forest tree farming[6]; but less than 10% of planning surface was covered by forest trees (mainly cultivated). In 2016 in the area of Alessandria about 8% of the soil has been eroded because of different factors as the urban development[10]. The agricultural employed surface was about 148.578 ha in 2018[9] (3.586 ha of organic farming and at least 32.000 ha were irrigated)[7, 8]. The area of Alessandria is characterized by plantations of soft wheat and spelt (gramineous plants) but also of corn, with a employed portion of agricultural area of 22% and 15%. The alternating pastures with alfalfa and other pastures are 19% of the agricultural area[7].
The most of agricultural crops are herbaceous plants and host weed with growing and reproductive season synchronized with that of the cultivated type. The surveys, performed on the area, have shown that the crops with spring-summer cycle host mainly neophytes such as common barnyard grass (*Echinocloa crus-galli),* white goosefoot (*Chenopodium album*), fall panicum (*Panicum dicotomiflorum*) and red-root amaranth (*Amaranthus retroflexus),* that are infesting species of American origin. Instead the river area is invaded by riparian vegetation, in which the white willow dominates, associated to nitrophilous and ruderal species such as bramble and nettle. Even now there are few common oak and field elm forest areas, and you can observe scraps of forest, dominated by white poplar and small bushes such as elder, blackthorn, common dogwood too.

In the wild abandoned field of the city's suburbs, you can observe an intense colonization of nitrophilous species as common ragweed (*Ambrosia artemisiifolia*)[1]. Some surveys observe that in the green wild areas of the city natural flora is composed, with high frequency, by annual species of gramineous and composite plants with short biological cycle, and by biennial or perennial hemicryptophytes. That shows an environment disturbed by the anthropic impact. The presence of these species let us to suppose some features of the soil, that is formed by compact silty-clay substratums, with low water drainage and with a pH, that changes from neutral to sub-alkaline[3].
In the central areas of the city there are many samples of thermophilic and xerophilous species, that show the effect of the "heat island" tied to the urban development. This temperature difference validates the attempt of cultivating Mediterranean and native plants in flower pots. The analysis of the health condition of the plants in flower pots will allow to estimate the effect of the urban microclimate[1].

3. Health condition of water

Agriculture is the main worldwide user of fresh water, that is returned polluted. A recent report, published in 2018, about the monitoring of residue levels of pesticides in the surface and groundwater in Italy, confirms the alarming situation[13]:

- In 2016, in particular, there were pesticides for 67% of the sampling points of the surface water and for 33,5% of the groundwater (national mean data). The presence of mixtures was more and more evident, with a mean of 5 substances and a maximum of 55 substances in a single sample.
- On the whole the contamination was most common in the Po-valley
- The herbicides and some of their metabolites were the most common substances, and in particular in the surface water. You could find insecticides too, that damage heavily the pollinator as neonicotinoids.

4. Climatic condition

2018 in Piemonte was the 2nd warmest year of the last 61 years with a mean thermal anomaly of about +1,6 °C compared to the climatology in the period 1971-2000[11]. In particular, the summer of 2018 in Piemonte was the fourth warmest one according to the historical distribution of summer seasons from 1958 up to today, showing a positive thermal anomaly of about +2,1°C compared to the standard of the period 1971-2000.
The summer of 2015, according to the climatology's point of view, has registered 77 days characterized by heat waves, the highest data among the examined years, but above all the period of time lasted so long, from the last days of June to the end of July, during which the temperatures were always higher than the mean, so causing very persistent and long "heat waves" and it has caused an increase of deaths, that were registered in the summer of 2015[11].
Comparing the data of the single month of July 2015 to the available longer historical sequence, it resulted the warmest month from 1958 up to today.
Another signal is the increasing frequency according which abnormal temperatures has been registered. In this historical sequence of 15 years, there were 3 years during which the days characterized by heat waves were more than 70. Also this data shows the rapid climate change

we are witnessing and how much that determines an important impact on environment and health.
In the following diagrams you can compare the temperatures and the mean rainfall in different period of time. In particular in the first one you can compare the mean monthly temperatures (expressed in Celsius degrees) and the mean monthly rainfall (expressed in mm) during the years 1926-1972 and 1990-2018, instead in the next one you can compare the years 1926-1972 and 2009-2018.

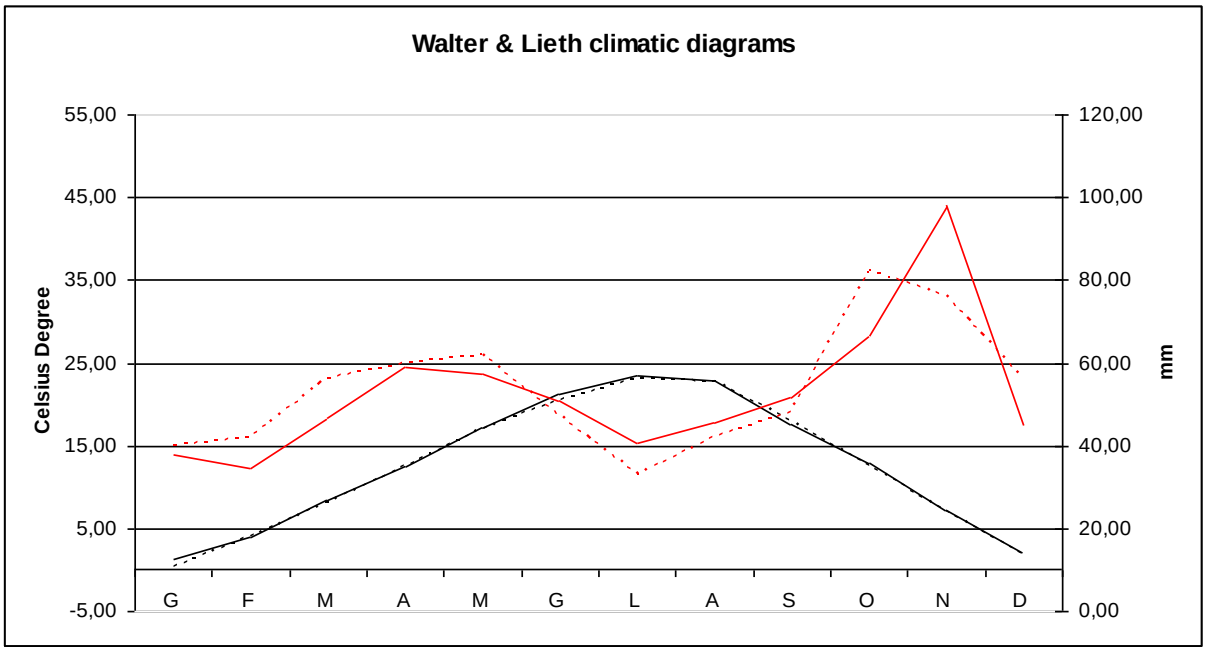

Diagram 1. Mean trend of the temperatures (black line) and the rainfall (red line) in the years 1926-1972 (dotted line) and 1990-2018 (full line).

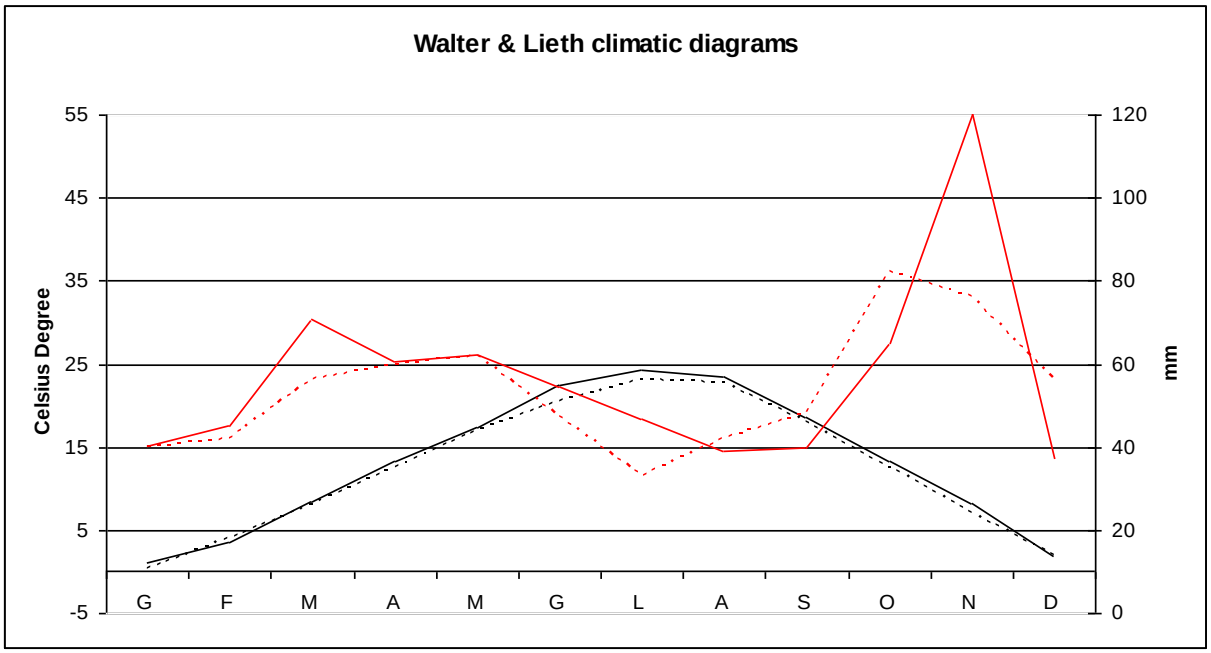

Diagram 2. Mean trend of the temperatures (black line) and the rainfall (red line) in the years 1926-1972 (dotted line) and 2009-2018 (full line).

The yearly rainfalls in the city of Alessandria amount about to 640 mm, the mean yearly temperature is about 12,5°C, with a minimum one in January and a maximum one in July. The bioclimatic characterization, carried out through the Rivas-Martinez index (1995), allows to define the area as continental macrotype, as temperate macrobioclimate, hylly thermotype, sub-humid ombrotype, temperate padano-type. The water deficit is very high in the month of July and August, but it can be registered already in June and can continue in September.
In the climatic analysis, the data of the historical sequences, that have been recorded by Agenzia Regionale per la Protezione Ambientale del Piemonte[2] (agency of the Region Piemonte that acts for the environmental protection of Piemonte), have been compared. The historical sequences have been developed through the comparison of the trend lines of years 1854-1986, the last 30 years with the last 10 years. Some information are contained in the following table.

Table 1. Basic climatic parameters for Alessandria city (data taken from ARPA Piemonte database).

	Mean temperaure (° C) 2018	Min. temperature (° C) 2018	Max. temperature (° C) 2018	Rainfall (mm) 2018	Rainy day (per months) 2018	Mean rainfall (mm) 1857-1986
Jan	3,7	-2,6	12,8	40,8	6	641,4
Feb	n.a	n.a.	n.a.	25,4	4	
Mar	6,5	-9,5	18,8	82,6	10	
Apr	14,6	2,3	28,3	59,8	6	Mean rainfall (mm) 1990-2018
May	18,1	7,2	30,1	91,4	13	
Jun	22,0	13,3	33,6	70,4	3	633
Jul	24,4	16,2	34,9	152,6	4	
Aug	24,0	11,1	35,3	77,2	6	Rainfall (mm) 2018
Sep	20,3	5,7	31,3	21,8	6	
Oct	14,7	4,0	26,2	179,0	6	867,8
Nov	9,6	-1,6	17,0	61,0	11	
Dec	2,7	-4,1	16,7	5,8	1	

If you compare the rainfall data of 2018 (867,8 mm)[4] to the previous means, that refers to years 1857-1986 (641,4 mm) and years 1990-2018 (633 mm), you can define the year as rainy, in contrast with the previous periods of time. It's necessary to explain that the water revealed in the rainiest two months fell in a very short period of time (respectively in 4 and 6 days) and in a period of time, during which broadleaved plants didn't require so much water. The water supply to plants and therefore the bioavailable one for this type of rainfall is minimum. In particular for clay fields, even if you consider the field capacity, the slow speed of water penetration in the soil (infiltration speed) facilitates the surface runoff and its loss, in urban area, in the city drainage system. So, of the total 867,8 mm of 2018 including loss rates (ex: for runoff), you can suppose that the bioavailable water is near the mean of the last decade (about 600, with a decreasing trend line according to the data calculated in 1999 by Agenzia Regionale per la Protezione Ambientale). The following diagramss report the amount of rainfall water and rainy days, that have been registered over 20 years. You can observe the trend to decrease .

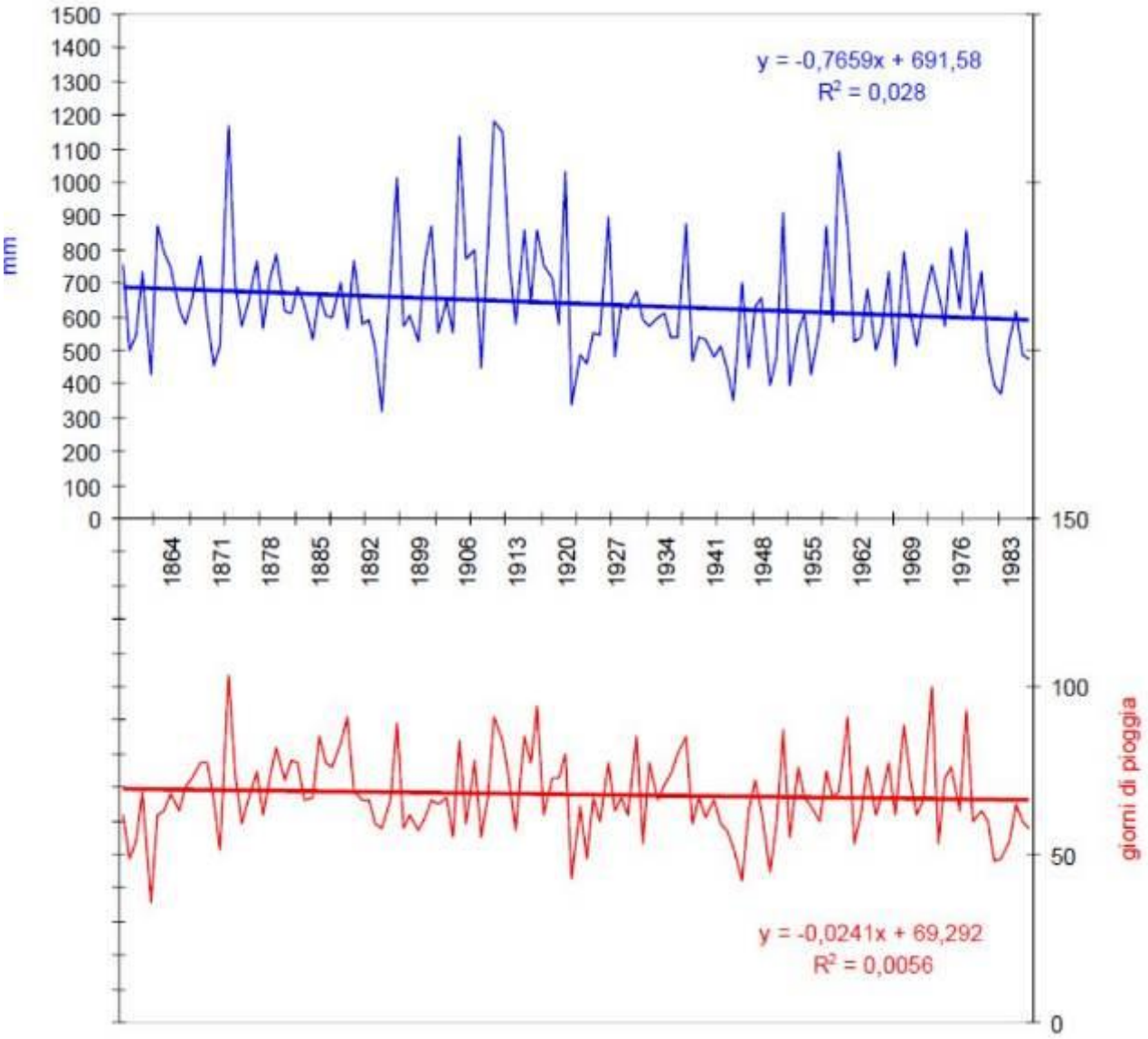

Diagram 3. Trend of the rainfall (mm) and of the number of rainy days (1854-1987).

The increase, in excess, of the exceptional weather phenomenon is underlined also by the amount of period of hydro-geological crisis, that the area of Alessandria must deal with, from the disastrous flood in the 1994 and in 2014, to the frequent and unvaried dangers of floods during the autumn.
In conclusion, according to a superficial analysis of data, that refer to the last 23 year (not-validate data from 1995 to 2018), you can suppose a cyclical trend, a period of 4-5 years, during which there is a period of 3-4 years with rainfall lower than 550 mm (drought years), is alternated with a period of 1-2 years with a rainfall higher than 800 mm (year of much rain), with a gradual postponement of the autumnal peak from September-October to November. The following diagram reports the trend of the total yearly rainfall from 1995 to 2018.

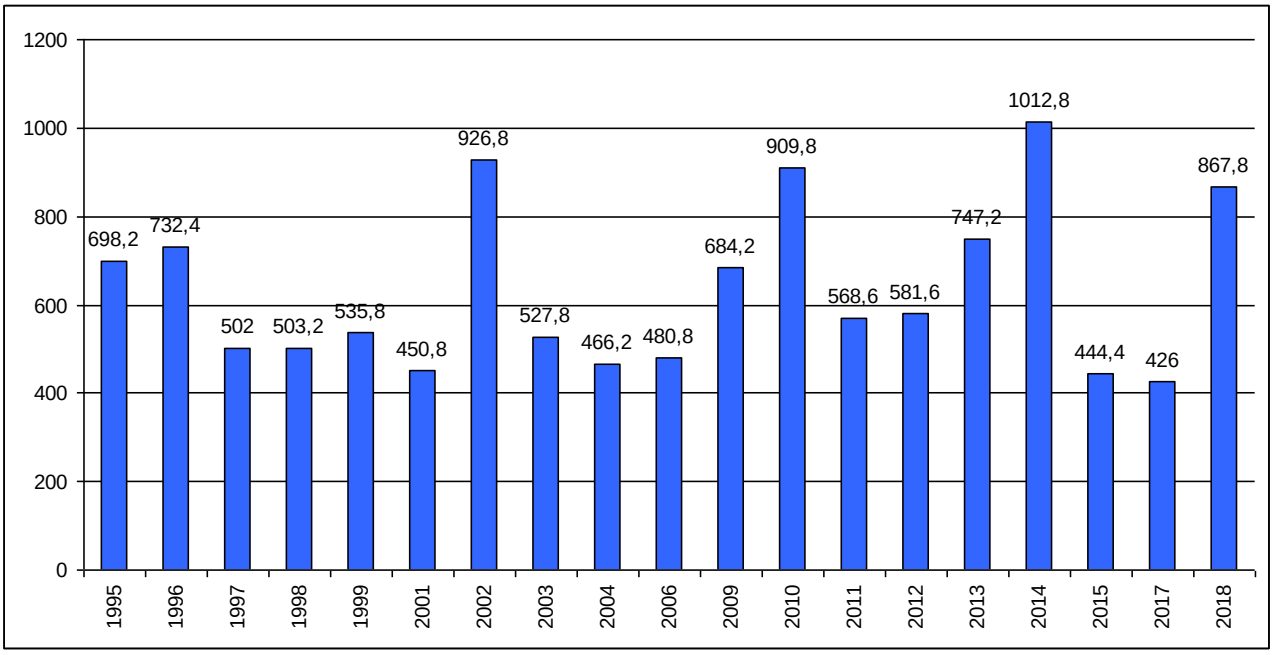

Diagram 4. Trend of the total yearly rainfall from 1995-2018 (2016 data not available).

As highlighted in the following diagram, with regard to the temperature, you can observe an increase of the mean temperature during the warmest month (July and August, including June) and a lower extent during the coldest months (January and December).

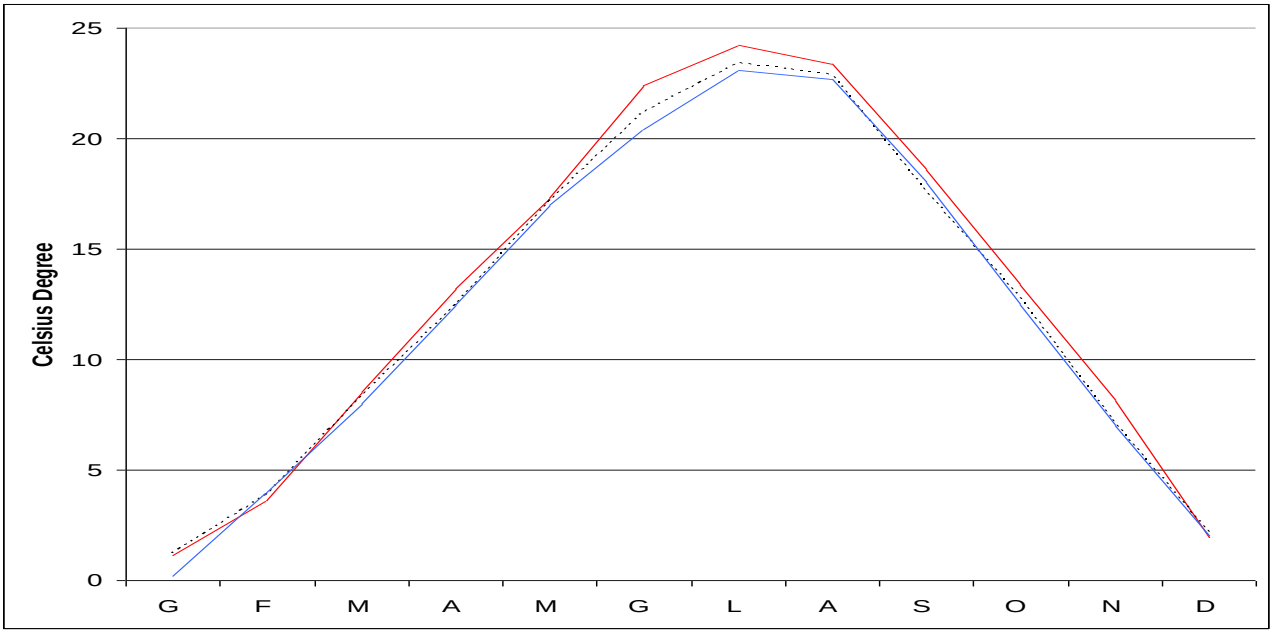

Diagram 5. Trend of the mean monthly temperatures in the years 1926-1972 (blue line), 1190-2018 (dotted line) and 2009-2018 (red line).

5. Description of the area of intervention, including results of soil analyses

5.1. Sampling and samples analyses methodology

Collected using a split tube soil sampler or garden shovel

- soil was taken from the depth 0-20 cm

- five representative soil samples were taken, location of the sampling points was determined on the base of detailed plan, depend on the area shape and size

- separate five soil samples from each investment area were labelled (i.e.):

A) sample No. 1 (No. from 1 to 5)

B) date of the sampling : 31.10.2019

C) investment place: Alessandria - A/1 (De Gasperi St.)

- weight of the each of the soil sample was at least 500 g of fresh weight

- each of the taken sample got own GPS coordinates

- collected soil was putted into plastic sample bag[21]

Physicochemical soil characteristic as pH and electrical conductivity were measured according to standardized methods. The pH was determined in H_2O and 1M KCl (ratio 1:2.5 m/v) with a combination glass and calomel electrode (OSH 10-10, METRON, Poland) and pH-meter (CPC-551, Elmetron, Poland). While, EC was measured by an ESP 2ZM electrode (EUROSENSOR, Poland)) according to the Polish standard PNISO 11265:1997, using the same device as for pH. Available phosphorus and potassium in soil were assessed by means of Egner-Riehm method. Total N content of soil was determined by the Kjeldahl method.

Fig. 1. Sample A/1/3 and sampling points distribution within site 3.

5.2. Results

5.2.1. Site 1. Via De Gasperi, 44°54'02.6"N 8°37'20.5"E, via Galvani

The spot is a rectangular grass-grown level ground, 1600 m^2 large, situated at the corner of via De Gasperi and via Galvani crossroad, in Europa's neighbourhood. In the west side of this zone is situated the primary school "Villaggio Europa". Teachers, students and their families will be involved in the achievement's phases, in the didactic and green-care activities. This area has been uncultivated and badly equipped for a long time: the goal's project is the realization of the "Urban orchard" through the plantation of native fruit-trees and the sowing of a wildflower's mix useful for pollinating insects. The pictures below provide a representation of the area before and after the intervention.

Fig. 2. General view of the investment area at Via De Gasperi.

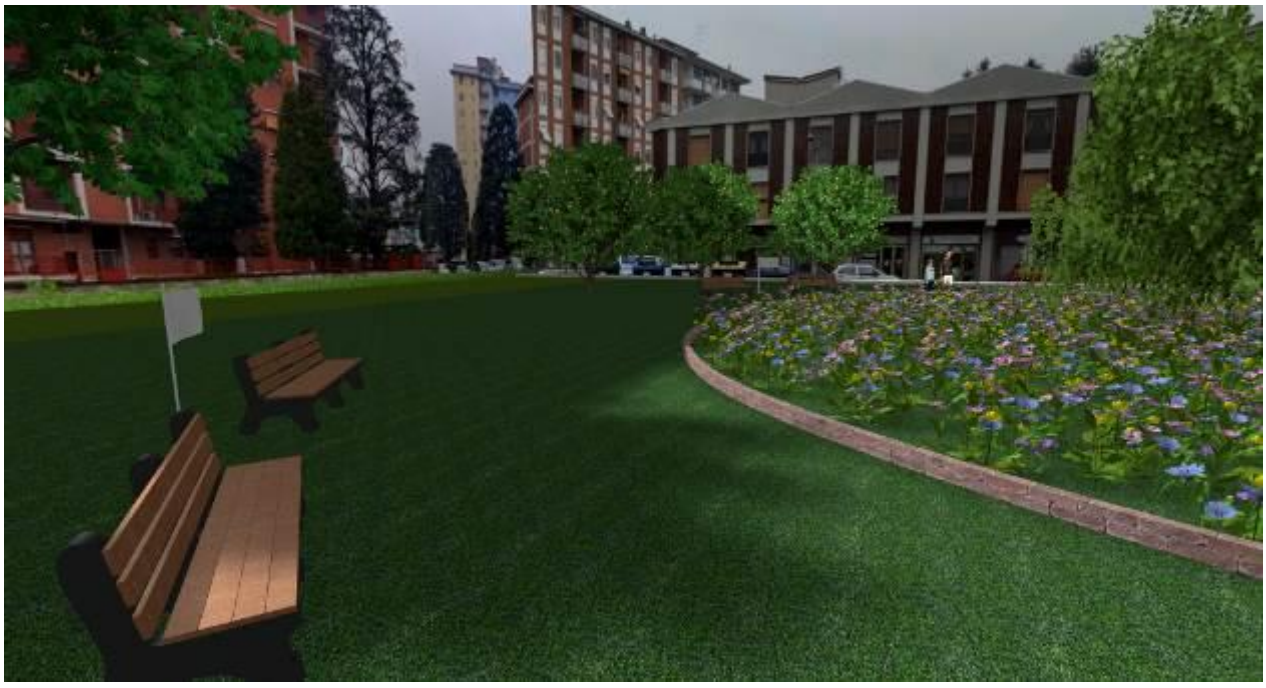

Fig. 3. Rendering view of the investment area at Via De Gasperi.

The soil was characterized as clay which indicates heavy soil texture with high water retention. The pH on this site is close to neutral (7 pH) with the balance shifted towards alkali, what was detected for both pH measurement methods: in H_2O and 1 M KCl. Soil Electrical conductivity (EC) is at the higher appropriate range detected in different agricultural sites that might refer to higher ion contents such as Na^+, K^+, Mg^{+2}, Ca^{+2}, Cl^-, HCO_{3-}, NO_{3-}, $SO4_{-2}$, and $CO3_{-2}$. Despite this fact, those values of EC do not indicate salinity in that soils. The organic matter was measured at a high level referring to agricultural soils. Amount of primary macronutrients such as N_{total}, $P_{available}$, $K_{available}$ is at the lower levels while referring to the agricultural soils. Based on the plant nutritional requirements additional fertilization might be needed. This especially refers to the available phosphorus content which is very low. Nitrogen is present in the sufficient amount.

Table 2. Soil characteristics for Site 1.

Parameters	Values
Soil texture	clay
pH (H_2O)	7.76 ± 0.1
pH (KCl)	7.27 ± 0.02
EC (µS cm^{-1})	182.63 ± 13.76
OM (%)	8.91 ± 1.12
N (%)	0.31 ± 0.04
P (mg $100g^{-1}$)	0.18 ± 0.13
K (mg $100g^{-1}$)	30.70 8.31

Values are mean ± SE (n=5)

5.2.2. Site 2. Via Benedetto Croce, 44°55‘02.2“N 8°37‘43.2“E

Site description

The interested area is an irregular shaped, grass-grown irregular leveled ground, 1225 m^2 large. This area is crossed by a huge asphalt string in front of the primary school “Morando”, sited in via Benedetto Croce. Also in this case the Institute will be involved in the green-care (es. plantation) and in didactic activities. The project’s goal is the realization of the “Refuge forest” through the plantation of trees and berry bushes in order to help the wild avifauna.
The following images provide a partial area’s modern representation and how it could be retrained by this plan.

Fig. 4. General view of the investment area at Via Benedetto Croce.

Fig. 5. Rendering view of the investment area at Via Benedetto Croce.

Soil characteristics

The soil was characterized as clay which indicates heavy soil texture with high water retention. The pH on this site is close to neutral (7 pH) what was detected for both pH measurement methods: in H_2O and 1 M KCl. Soil Electrical conductivity (EC) is at the higher appropriate range detected in different agricultural sites that might refer to higher ion contents such as Na^{+}, K^{+}, Mg^{+2}, Ca^{+2}, Cl^{-}, HCO_3^{-}, NO_3^{-}, SO_4^{-2}, and CO_3^{-2}. Despite this fact, those values of EC do not indicate salinity in those soils. The organic matter was measured at a really high level even for agricultural soils. Amount of primary macronutrients such as N_{total}, $P_{available}$, $K_{available}$ is sufficient even for agricultural soils.

Table 3. Soil characteristics for Site 2.

Parameters	Values
Soil texture	clay
pH (H_2O)	7.43 ± 0.17
pH (KCl)	6.54 ± 0.19
EC (µS cm^{-1})	170 ± 14.57
OM (%)	10.37 ± 0.75
N (%)	0.22 ± 0.04
P (mg $100g^{-1}$)	1.63 ± 0.54
K (mg $100g^{-1}$)	21.35 2.20

Values are mean ± SE (n=5)

5.2.3. Site 3. Via Teresa Michel, 44°55‘17.2l“N 8°37‘42.8“E, Cimitero Urbano Alessandria

Site description

The spot is a rectangular grass-grown area, leveled in the middle and featured by a perimetrical ditch, 2000 m^2 large. On the south side the area is delimitated by a foot-way planted with trees, and on the north side by the extension of the urban cemetery of Alessandria.
The project’s goal is the realization of the “City’s green lung” through the plantation of native forest trees with thermo-regulation and depurative functions. It could be included also tools for outdoor sports.

Fig. 6. General view of the investment area at Via Teresa Michel.

Fig. 7. Rendering view of the investment area at Via Teresa Michel.

Soil characteristics

The soil was characterized as clay which indicates heavy soil texture with high water retention. The pH on this site is close to neutral (7 pH) what was detected for both pH measurement methods: in H_2O and 1 M KCl. Soil Electrical conductivity (EC) is at the higher appropriate range detected in different agricultural sites that might refer to higher ion contents such as Na^+, K^+, Mg^{+2}, Ca^{+2}, Cl^-, HCO^{3-}, NO^{3-}, SO_4^{-2}, and CO_3^{-2}. Despite this fact, those values of EC do not indicate salinity in that soils. The organic matter was measured at a really high level even for agricultural soils. Amount of primary macronutrients such as N_{total}, $P_{available}$, $K_{available}$ is at the lower levels while referring to the agricultural soils. Based on the plant nutritional requirements additional fertilization might be needed.

Table 4. Soil characteristics for Site 3.

Parameters	Values
Soil texture	clay
pH (H_2O)	7.48 ± 0.1
pH (KCl)	7.08 ± 0.08
EC (µS cm^{-1})	199.31 ± 6.24
OM (%)	10.42 ± 0.94
N (%)	0.36 ± 0.04
P (mg $100g^{-1}$)	0.90 ± 0.32
K (mg $100g^{-1}$)	20.04 1.53

Values are mean ± SE (n=5)

5.2.4. Site 4. Centro cittadino, 44°54‘48.2“N 8°36‘58.1“E, centro città Alessandria

Site description

This is a wide-spreaded area: the project provides the retraining of 300 planters in the main streets of the city centre. The old town is characterized by a lack of greenery because of the almost total deficiency of green areas. The goal’s project is the “metamorphosis” of this area with the presence of planters containing bio-indicator plants, on which it will be done analysis in order to value air pollution.
The goal’s project is the implementation of the “greenery in the city center”.

Fig. 8. General view of the investment area at historic city center.

Soil characteristics

It was not considered as appropriate to proceed with sample planter’s soil analysis because this could have been conditioned by huge increase of mould, compost and organic pelleted manure. Moreover in all probability it will be considered to replace the whole substrata in order to make them homogeneous and then suitable for subsequent measurements.

6. Proposed plant species to be potentially used during the Pilot action.

Selection took into account results of soil characteristics, climatic conditions as well as final proposed land use type.

Site 1. Via De Gasperi, 44°54l02.6llN 8°37l20.5llE, via Galvani

“Urban orchard” through the plantation of native fruit-trees and the sowing of a wildflower’s mix useful for pollinating insects.
Species and varieties to choose from:

<u>Native species of fruit trees:</u>

- *Malus domestica* (apple)

- varieties traditionally grown in Piedmont: ‘Bella di Barge’, ‘Buras’, ‘Renetta grigia di Torriana’, ‘Contessa’, ‘Calvilla Bianca’, ‘Renetta di Champagne’, ‘Runsè’, ‘Rosa D’Aosta’, ‘Piatlin’

- other varieties, with low soil requirements, suitable for cultivation in the Alessandria climate, and also particularly resistant to pests and pathogens: 'Coop 39', 'Crimson Crisp', 'Dalinette', 'Fujion', 'Inored Story'

- *Pyrus communis* (pear)

- varieties traditionally grown in Piedmont: 'Pera cocomerina', 'Williams', 'Conference',
- other varieties, with low soil requirements, suitable for cultivation in the Alessandria climate, and also particularly resistant to pests and pathogens: 'AC Arrow Crisp', 'Harrow Love', Selena, Elliot, 'Harovin Sundown',

- *Prunus domestica* 'Gabbaladro' (greengage))
- *Sorbus domestica* (SORB-APPLE)
- *Ficus carica* (fig tree)
- *Punica granatum* (pomegrnate)

Fruit trees traditionally grown, though of foreign origin:

- *Cydonia oblonga* (quince)
- *Prunus cerasus* (cherry) – varieties, with low soil requirements, suitable for cultivation in the Alessandria climate, and also realtively resistant to pests and pathogens: 'Kordia', 'Regina', 'Early Star', 'Panaro 2', 'Folfer', 'Giorgia', 'Mariant Giant Red', 'Grace Star', 'Ferrovia', 'Fertard' .
- *Citrus sp.* (oranges, lemons)
- *Prunus* x *dasycarpa* (purple or black apricot)
- *Prunus persica* 'Sanguinella'(peach)

Native fruit shrubs:

- *Cornus mas* (cornelian cherry)
- *Arbutus unedo* (strawberry tree)
- *Ribes grossularia* (gooseberry
- *Ribes rubrum* (redcurrant)
- *Rubus idaeus* (raspberry)
- *Rubus fruticosus* (blackberry)

Fruit shrubs traditionally grown, though of foreign origin:

Crataegus azarolus (Italian dogwood)
Ziziphus zizyphus (jujube)

Wildflowers for sowing (to choose from):

ANNUAL	BIENNIAL	PERENNNIAL
Adonis annua	*Campanula rapunculus*	*Allium truquetrum*
Agrostemma githago	*Centaurea nigrescens*	*Althaea cannabina*
Anacyclus clavatus	*Centaurium erythraea*	*Anchusa azurea*
Anagallis arvensis	*Cynoglossum creticum*	*Anemone hortensis*
Anthemis cotula	*Daucus carota*	*Anthemis arvensis*
Bartsia trixago	*Echium vulgare*	*Antirrhinum latifolium*
Blackstonia perfoliata	*Foeniculum vulgare*	*Antirrhinum siculum*
Borago officinalis	*Galactites elegans*	*Ballota nigra*
Calendula arvensis	*Knautia arvensis*	*Bellis perennis*
Campanula dicotoma	*Melilotus officinalis*	*Bituminaria bituminosa*
Carthamus lanatus	*Silene armeria*	*Calamintha nepeta*
Centaurea napifolia	*Silene latifolia Poir. subsp.*	*Centranthus ruber*
Coleostephus myconis	*alba*	*Cichorium intybus*
Cyanus segetum	*Tragopogon porrifolius*	*Ferulago nodosa*

Diplotaxis erucoides *Echium plantagineum* *Fumaria officinalis* *Glebionis coronaria* *Heliotropium europaeum* *Lathyrus latifolius* *Matricaria chamomilla* *Melilotus albus* *Pallenis spinosa* *Papaver rhoeas L. subsp. rhoeas* *Raphanus raphanistrum L. s.l.* *Reseda alba* *Sinapis alba* *Sinapis arvensis L. subsp. arvensis* *Trifolium campestre* *Trifolium stellatum* *Vicia villosa*	*Verbascum blattaria* *Verbascum sinuatum* *Verbascum thapsus*	*Glaucium flavum* *Hypochaeris radicata* *Leontodon tuberosus* *Leucanthemum vulgare Lam. subsp. vulgare* *Lobularia maritima* *Malva sylvestris L. subsp. sylvestris* *Narcissus tazetta* *Ranunculus acris* *Salvia nemorosa L. subsp. Nemorosa* *Salvia verbenaca L.,* *Saponaria officinalis* *Scabiosa columbaria* *Scolymus grandiflorus* *Silene vulgaris* *Sulla coronaria* *Trifolium pratense* *Verbascum nigrum* *Verbena officinalis*

Site 2. Via Benedetto Croce, 44°55l02.2llN 8°37l43.2llE,

"Refuge forest" through the plantation of trees and berry bushes in order to help the wild avifauna, (additional wildflower's mix useful for pollinating insects).

Forest tree species to choose from:

Castanea sativa, *Fraxinus excelsior*, *Fraxinus oxycarpa*, *Acer campestre*, Populus alba, *Populus tremula*, *Quercus robur*, *Quercus petraea*, *Quercus pubescens*, *Prunus avium*, Sorbus aria, *Sorbus torminalis*, *Carpinus betulus*, *Ostrya carpinifolia*, *Ilex aquifolium*, *Laurus nobilis*

Berry bushes for avifauna to choose from:

Rubus ulmifolius, *Prunus spinosa*, *Sambucus nigra*, *Vitis vinifera subsp. sylvestris*, *Cornus mas*, *Ribes grossularia*, *Ribes rubrum*, *Rubus idaeus*, *Rubus caesius*, *Rosa sempervirens*, *Viburnum opulus*, *Euonymus europaeus*, *Philadelphus coronarius*

Wild flowers to be sowed/planted in the trees:

Campanula cervicaria, *Campanula rapunculus*, *Lilium bulbiferum*, *Ranunculus ficria*, *Anemone nemorsa*, *Lilium martagon*, *Salvia nemorosa*, *Malva sylvestris*, *Viola reichembachiana*, *Viola riviniana*, *Polygonatum multiflorum*, *Polygonatum odoratum*, *Vinca minor*, *Aruncus dioicus*, *Lamium orvala*

Wildflowers in sunny places: see Site 1.

Site 3. Via Teresa Michel, 44°55I17.2IIN 8°37I42.8IIE, Cimitero Urbano Alessandria

Native, forest, fast-growing tree species to choose from:

Castanea sativa, *Tilia cordata*, *Fraxinus angustifolia*, *Populus alba*, *Populus tremula*, *Cerasus avium*, *Salix alba*, *Sorbus torminalis*

Wild flowers to be sowed/planted in the trees: see Site 2.

Wildflowers in sunny places: see Site 1.

Site 4. Centro cittadino, 44°54I48.2IIN 8°36I58.1IIE, centro città Alessandria

Small trees in planters – as bioaccumulators (pollutants deposited in leaves/bark):

Carpinus betulus dwarf varieties*, Olea europea*, *Laurus nobilis*, *Ginkgo biloba* – dwarf varieties (*e.g.* 'Anny's Dwarf', 'Chris Dwarf', 'Mariken'), *Quercus ilex 'Ditha Jung'*, *Robinia pseudoacacia* - dwarf varieties (*e.g.*'Umbraculifera', 'Lace Lady', 'Twisted Baby'), *Carpinus betulus*

Mosses as bioaccumulators:

Thuidium tamariscinum, *Hylocomium splendens*, *Scleropodium purum*, *Hylocomium cupressiforme*,

Scleropodium touretii, *Pseudoscleropodium purum*

Lichens as biosensors:

Usnea sp., *Umbilicaria sp., Ramalina lacera*,

Lichens as bioaccumulators:

Xanthoria parietina, *Parmelia caperata*,*Ramalina calicaris and Usnea sp*

Proposed species of lichens and/or mosses can grow in the planter along with any plants, including those that do not have the properties of bioindicators.

References

1. *Flora e vegetazione spontanea della città di Alessandria (Piemonte-Italia)* - Fitosociologia vol. 43 (2): 77-95, 2006
2. *Serie Climatiche Ultracentenarie* – Regione Piemonte, CSI Piemonte 1999
3. *Guida al Giardino botanico comunale D. Bellotti di Alessandria*, 2008
4. *Serie dati Stazione di Lobbi 1988-2018, ARPA Piemonte*
5. https://www.tuttitalia.it/piemonte/24-alessandria/statistiche/popolazione-andamento-demografico/ (consulted on il 11/27/2019).
6. http://www.sistemapiemonte.it/montagna/sifor/dwd/aggiornamenti2016/confronto_sup_boscate_2000_2016.pdf (consulted on il 11/27/2019).
7. https://www.istat.it/it/files//2013/02/Agricoltura-Piemonte.pdf
8. CENSIMENTO GENERALE DELL'AGRICOLTURA IN PIEMONTE https://www.istat.it/it/files//2013/02/Agricoltura-Piemonte.pdf (consulted on il 11/27/2019).
9. http://www.arpa.piemonte.it/reporting/indicatori-on_line/uso-delle-risorse/agricoltura-zootecnia/agricoltura_superficie-agricola-utilizzata-sau; http://www.arpa.piemonte.it/reporting/indicatori-on_line/componenti-ambientali (consulted on il 11/27/2019).
10. http://www.arpa.piemonte.it/reporting/core-set-of-indicators/water-1/land-use (consulted on il 11/27/2019).
11. http://relazione.ambiente.piemonte.it/2019/it/clima/impatti/ondate-di-calore (consulted on il 11/27/2019).
12. It defines the amount of water in teh soil, in terms of relative humidity, in optimal conditions reffering to the ratio between air and qater in the soil (https://it.wikipedia.org/wiki/Capacit%C3%A0_di_campo; (consulted on il 11/27/2019).
13. ISPRA, RAPPORTO NAZIONALE PESTICIDI NELLE ACQUE 2015-2016 (2018).
14. http://www.torinoggi.it/2019/08/13/leggi-notizia/argomenti/economia-4/articolo/annata-amara-per-il-miele-confagricoltura-chiede-sostegni-per-i-produttori.html (consulted on il 11/27/2019).
15. *Guidelines and requirements on sampling in 4 cities* SALUTE4CE | LP | Marta Pogrzeba, Institute for Ecology of Industrial Areas, Katowice, Poland.
16. Antonelli M, T. Mascherucci, Pizzicannella, A. Pacini (2001). Guida al riconoscimento di alberi ed arbusti del Parco Regionale dei Castelli Romani. © Parco Regionale dei Castelli Romani http://www.parcocastelliromani.it/inners/pages/altre-pubblicazioni
17. Amal Mohamed E., Abdel-Razik Kamel E., 2013. Olive Plants (Olea europaea L.) as a Bioindicator for Pollution. Pakistan Journal of Biological Sciences, 16: 551-557.
18. Birdgardening – birdwatching in giardino. http://www.bwnovara.it/?page_id=67
19. Biscotti N., Guidi S., Forconi V., Piotto B., (2010). Frutti dimenticati e biodiversita recuperata. ISPRA, Quaderni - Natura e Biodiversità n. 1/2010, ISBN 978-88-448-0462
20. http://www.isprambiente.gov.it/it/pubblicazioni/quaderni/natura-e-biodiversita/frutti-dimenticati-e-biodiversita-recuperata-1

21. Bretzel, Francesca & Romano, Daniela & Benvenuti, Stefano & Piotto, Beti. (2013). Specie erbacee spontanee mediterranee per la riqualificazione di ambienti antropici. ISPRA, Manuali e Linee Guida 86/2013. ISBN 978-88-448-0590-6
22. http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/specie-erbacee-spontanee-mediterranee-per-la-riqualificazione-di-ambienti-antropici.-stato-dell2019arte-criticita-e-possibilita-di-impiego
23. Coltivazione biologica. Coltiva anche tu il tuo orto biologico. https://www.coltivazionebiologica.it
24. Chrabąszcz M, Mróz L. Tree Bark, a valuable source of information on air quality. Polish Journal of Environmental Studies. 2017;26(2):453-466. doi:10.15244/pjoes/65908
25. Dadea, C., A. Russo, M. Tagliavini, T. Mimmo, S. Zerbe. (2017). Tree Species as Tools for Biomonitoring and Phytoremediation in Urban Environments: A Review with Special Regard to Heavy Metals. Arboriculture & Urban Forestry. 43. 155-167.
26. De Temmerman, Ludwig & Bell, N.B. & Garrec, Jean-Pierre & Klumpp, Andreas & Krause, G.H.M. & Tonneijck, A.E.G.. (2001). Biomonitoring of air pollutants with plants - Considerations for the future. Urban Air Pollution, bioindication and Environmental Awareness.
27. East of Eden Plants. https://www.eastofedenplants.co.uk/index.htm
28. Ebone A., P. Camerano, F. Gottero, P. G. Terzuolo, A. Guaraldo, A. Canepa. (2007). I Boschi Del Piemonte.
29. Conoscenze e indirizzi gestionali© Regione Piemonte 2007 http://www.regione.piemonte.it/foreste/images/files/pubblicazioni/boschi_del_piemonte.pdf
30. Flora Italiana http://luirig.altervista.org/
31. Giardini & Ambiente. https://www.giardini.biz/piante/piante-da-frutto/ugo-e-giacono-fiorini/
32. Hamza Badamasi, Biomonitoring of Air Pollution Using Plants. MAYFEB Journal of Environmental Science - ISSN 2371-7092 Vol 2 (2017) - Pages 27-39
33. Il mondo in un giardino. Blog di giardinaggio ecosostenibile, amore per la natura e gli animali, birdgardening, idee costruttive per il tempo libero e altre mie passioni. http://ilmondoinungiardino.blogspot.com/
34. Italian Interpretation Manual of the 92/43/CEE Directive habitats (in Italian). http://vnr.unipg.it/habitat/index.jsp
35. Italy: Cherries to renew Piedmont agriculture https://www.freshplaza.com/article/2178058/italy-cherries-to-renew-piedmont-agriculture/
36. Italy: Apple and pear organic production increasing in Piedmont. https://www.freshplaza.com/article/2172120/italy-apple-and-pear-organic-production-increasing-in-piedmont/
37. Maatoug, Mohamed & Taïbi, Khaled & Akermi, A. & Achir, Mohamed & Mestrari, M.. (2012). Bio-Monitoring of Air Quality Using Leaves of Tree and Lichens in Urban Environments. 10.5772/31963.
38. Mediterranean Garden Society http://www.mediterraneangardensociety.org/index.html
39. Paramount Plants. https://www.paramountplants.co.uk/blog

40. Picco, F., F. Ravetti(2000). Flora Vascolare del Parco Naturale Regionale di Rocchetta Tanaro (Provincia di Asti, Piemonte). RIV. PIEM. ST. NAT., 21, 2000: 19-85.
41. Terzuolo P.G., Boni I., Giannetti F., Brenta P.P., Mondino G.P., I Boschi collinari. Regione Piemonte, Blu Edizioni, Torino 2001, pp. 119. https://www.regione.piemonte.it/web/sites/default/files/media/documenti/2019-03/boschi_collinari.pdf

Supplemental information

Introduction

In 2016 the total worldwide agricultural production was 2,6 trillion dollars[17], instead that one related to the production, that depends on pollinators was between 235 and 577 billion dollars[18]. In the last 50 years the amount of the agricultural production, that depends on the pollination of animals, has increased up to 300%: the wild bees contribute to the production for at least 20% of these crops. Probably a third of the worldwide agricultural surface depends on pollinators. Furthermore, it is estimated that 90% of wild flowers (310.000 known species) depends on animal pollination. On global scale 41% of the species of insects are decreasing and yearly there's a loss of 2,5% of the biomass[19]. In Europe 44% and in the USA 51% of insect species have registered a fast decrease. According to the Red List on the International Union for the preservation of nature, 9% of the bees and butterflies is threatened. In the European pastures, between 1190 and 2011, the abundance of butterflies is decreased of 50%[20].

In 2017 a survey, lasted 27 years (1989-2016) in Germany showed a decrease of 76,7% of the biomass of flying insects (the monitoring was fulfilled in 63 natural protected areas and during summer the registered decrease was higher: 82%)[20]. 94% of the catching points of the insects was near cultivated areas. This rate of decrease is higher than registered for wild vertebrates during a period of 42 years until 2012, it was 58% (total abundance)[20].

Health condition of water

In some Regions the presence of pesticides is more common than national data, it reaches over 90% of the points of the surface water in Friuli Venezia Giulia, in the area of Bolzano, in Piemonte and Veneto, and over 80% of the points in Emilia Romagna and Toscana. It overtakes 70% in Lombardia and in the area of Trento. In the groundwater the presence of pesticides is particularly high in Friuli 81%, in Piemonte 66% and in Sicilia 60%

It's still possible to find substances, that are banned for years, and their metabolites such as atrazine, metholachlor, oxadixyl and DDT.

In particular, referring to the water condition of Piemonte, this research shows that in 2016 the surveys examined 1.979 sample for the amount of 138.547 analytical measurements. The data referred to 117 points of surface water and 580 of groundwater. In surface water there were residues for 91,5% of the points and for the 44,5% of the examined samples. 59 substances were detected: the most common were oxadiazon, metholachlor, chloridazon, terbuthylazine. In the groundwater the residues were detected for 65,9% of the points and for 41,6% of samples. 57 substances were detected: the most common were terbuthylazine-desethyl, atrazine, desethyl, terbuthylazine, dimethenamid, quinclorac. The concentrations are higher that the limit-levels for 28 points of surface water (23,9% of the total amount) and for 86 points of groundwater (14,8% of the total amount).

In Piemonte there are over than 14 million animals among them there are bovines, pigs and poultry. The livestock manure is employed principally for fertilizing agricultural soils. The

agricultural census of 2008 shows the following subdivision of the different zones according to the amount of nitrogen, that are distributed in the fields:

Piemonte 2008	Area Hectare	N. companies with fields
Within NVZ	262.944,3 (24%)	22.819
Out of NVZ	820.114,4	52.171

NVZ = nitrogen vulnerable zone, that mean the zone in which you can't distribute more than 170 kg/N/ha/year because of the impairment of the water, that has been already registered.

In 2007 in Piemonte there was a Used Agricultural Surface of little more than a million ha (http://www.sistemapiemonte.it), of which:

- 506.000 ha sowable surfaces (ex: corn and wheat)
- 236.000 ha pastures;
- 119.000 ha paddies;
- 63.000 ha forests;
- 45.000 ha grapevines;
- 26.000 ha orchards (of which 19.000 ha with shelter plants e 5.000 ha with peach and percoca trees).

The livestock manure can be distributed effectively only on a part of the available surface, because they aren't employed for example for pastures, forests and for sloping soils. Moreover, it's not so cheap and environmentally sustainable their transport for big distances. So in some areas the only livestock manure exceeds the possibilities of their employement according to the good agronomic practises and to the principles for the protection of water (nitrogen) and soil. On the agricultural soils are employed other fertilizers too. To the livestock manure you must add a certain amount of compost (aerobic digestion of solid urban waste and sewage sludges; in 2003 in Piemonte 352.000 t were produced, according to APAT data), sludges (in 2007 99.000 t of dry substance was produced by sewage tratement of wastewater) and chemical fertilizers. To these amounts, today, you must add the anaerobically digested matters for the production of biogas through the use of dedicated crops like corn and that increase the organic and inorganic loads. So the organic and inorganic molecules, that are potentially dangerous, will be distributed in many areas and they will generate negative changes because excessive. According to the following hypothesis and simplifing the situation of Piemonte[15]:

- only 50% of the Usable Agricultural Surface can be properly fertilizes;
- the livestock companies are uniformly distributed on the usable agricultural surface, so the transport of manure is not a limit (very optimistic hypothesis);

virtually for every 10.000 m^2 you have the availability of livestock generated by 2 bovines, 3 pigs, 22 poultries, 700 kg of compost from solid urban waste (it means the organic portion produced by 5-7 people in a year) and up to 200 kg of sludge from sewage treatment of wastewater. To this matrix you must add chemical fertilizers and digested matters originated by anaerobic fermentation, that dedicated crops, like corn, use. As already highlighted, a portion

(more than a quarter probably) of the surface has been already classified with by nitrates polluted water and it's evaluated vulnerable. Therefore this situation produces a remarkable, systematic and foreseeable pollution of the water.

References:

15. Zicari Giuseppe et al., The management of livestock manure: chemical risk (review). La gestione delle deiezioni zootecniche: il rischio chimico (review). Progress in nutrition n. 2/2013.
16. https://www.regione.piemonte.it/web/pinforma/notizie/emergenza-apicoltura-dalla-regione-provvedimenti-concreti-sostegno-settore-crisi (consultato il 27/11/2019).
17. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Seventh session Paris, 29 April–4 May 2019. Report of the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on the work of its seventh session Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://www.ipbes.net/system/tdf/ipbes_7_10_add.1_en_1.pdf?file=1&type=node&id=35329 (consultato l' 11/11/2019).
18. Press release: pollinators vital to our food supply under threat. https://www.ipbes.net/article/press-release-pollinators-vital-our-food-supply-under-threat (consultato l'11/11/2019).
19. Francisco Sánchez-Bayoa and Kris A.G. Wyckhuys. Worldwide decline of the entomofauna: A review of its drivers. Biological Conservation 232 (2019) 8–27.
20. Caspar A. Hallmann, Martin Sorg, Eelke Jongejans, Henk Siepel, Nick Hofland, Heinz Schwan, Werner Stenmans, Andreas Muller, Hubert Sumser, Thomas Horren, Dave Goulson, Hans de Kroon (2017). More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoS ONE 12 (10): e0185809. https://doi.org/10.1371/journal.pone.0185809.