Ecosystem services determination on an Italian urban greenspace

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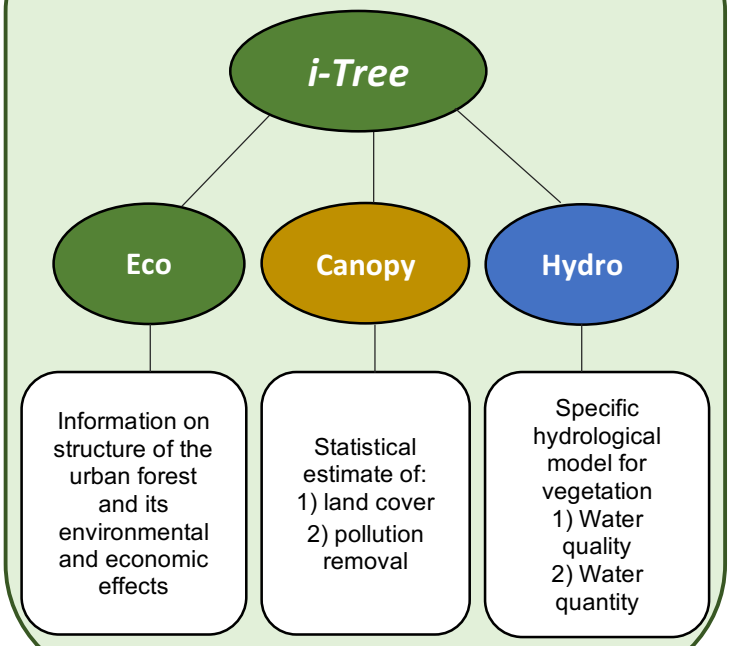
EGU General Assembly 2020

POLITECNICO DI TORINO

1. Introduction and motivation

- Ecosystem services are defined as "multiple benefits provided by ecosystem to humans" (MEA, 2005)
- The aim is to deepen an effective method to evaluate ES provided by vegetation and to test it on on a small urban greenspace

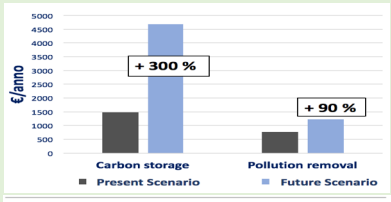
2. Methodology



3. Results

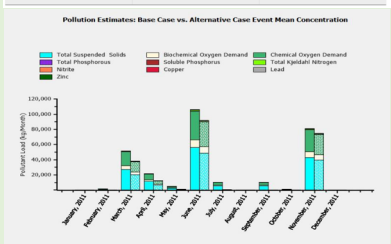
i-Tree application on a small urban park (5000 m^2)

Past scenario | Present scenario | Future Scenario



% GROUND COVER

	Past Scenario	Present Scenario
Tree	14,30	29,20
Non-Tree	65,30	1,30
Grass	10,90	64,60
Pervious	9,50	4,90



4. Current developments and ongoing works

-Enlargement of spatial scale on different and larger Turin green areas

-Provision of a territorial planning tool for urban greenspaces based on an economic analysis

Acknowledgments

Thanks to the Municipality of Turin, especially Simone Mangili (Department of Policies for the Environment and Public Green) and Matteo Castiglioni (Public Green Service), for the kind support given, through the supply of data and information. Thanks to Francesca Vigliocco for the support provided during the measurement campaign.

References

Brauman, K.A., Daily, G.C., Ka'eo Duarte, T. & Mooney, H.A. The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services, California, Hawaii, 2007.

Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis, Island Press, Washington, DC, 2005.

POLITECNICO DI TORINO

PhD in Civil and Environmental Engineering

Ecosystem services determination on an Italian urban greenspace

EGU2020: Sharing Geoscience Online

Phd student: Francesco Busca

Supervisor: Prof. Roberto Revelli

Goals

Introduction of Ecosystem Services

Potentiality evaluation of *i-Tree*

Mathematical Model and Water Balance Analysis

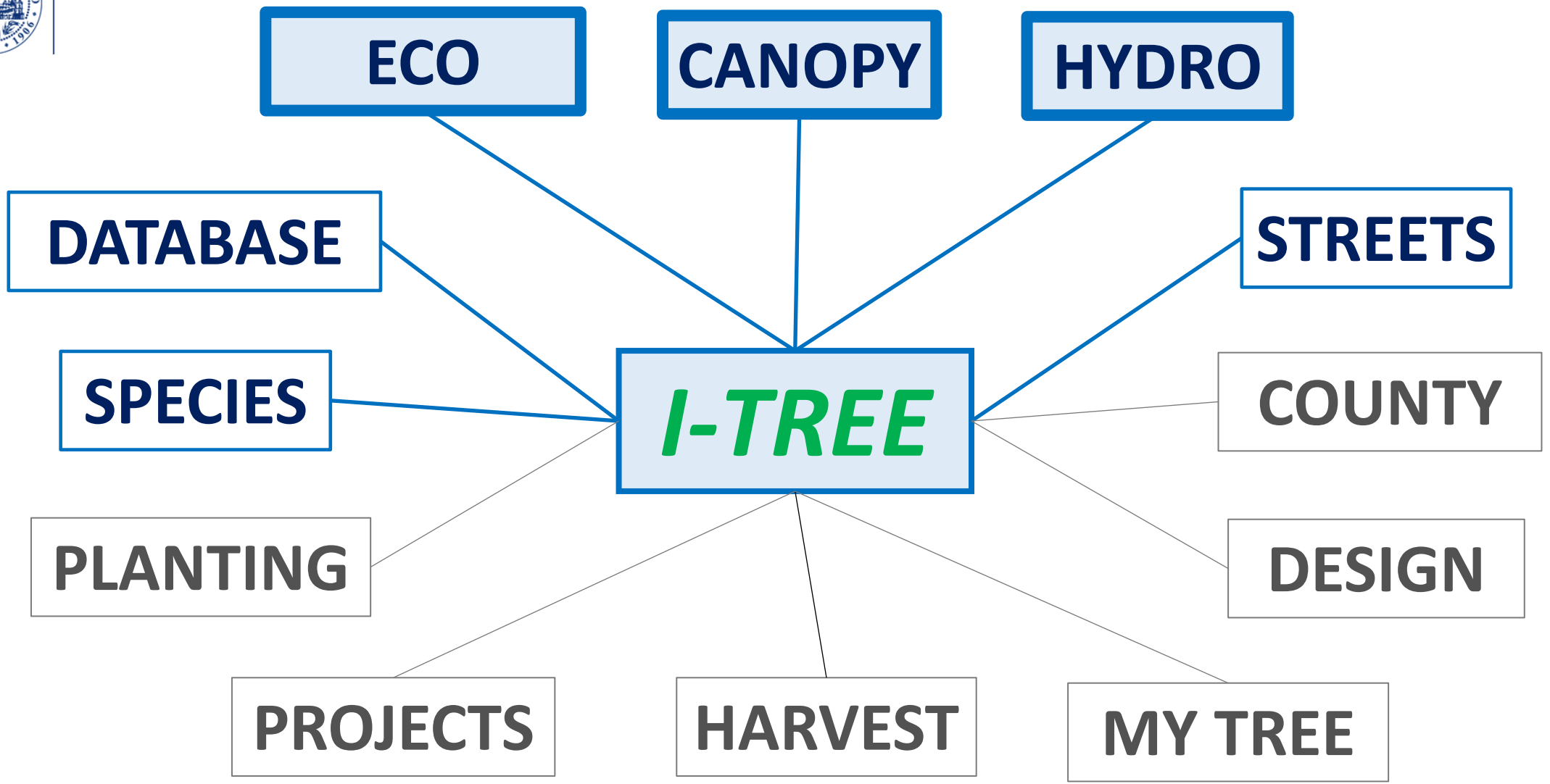
Software Components Deepening

Italian Park Application

Ecosystem services

«Multiple benefits provided by ecosystems to humans» (MEA, 2005)

Types	
PROVISIONING SERVICES	**REGULATING SERVICES**
Consumer goods withdrawable from ecosystems	Regulation of ecosystem processes
SUPPORTING SERVICES	**CULTURAL SERVICES**
Required for realization of all other services	Intangible benefits (related to music, architecture)


ECO
CANOPY
HYDRO
DATABASE
STREETS
SPECIES
I-TREE
COUNTY
PLANTING
DESIGN
PROJECTS
HARVEST
MY TREE

Application: “Via Revello” Park - Turin

Past Scenario (T0)

- **Land use**: Residential
- **Ground cover**: buildings and impermeable ground

Present Scenario (T1)

- **Land use**: Park
- **Ground cover**: grass, draining soil, trees
- **Trees**: 13

Future Scenario (T2, after March 2020)

- **Land use**: Park
- **Ground cover**: grass, draining soil, trees
- **Trees**: 25 (and 16 shrub types)

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i-Tree Canopy

INPUT

- Site map (Google Maps or as shapefile)
- Locality data (U.S.)
- Ground cover types

OUTPUT

- ***% Ground cover for each type***
- Economic value of pollutants removal [€]

Scenarios comparison

% GROUND COVER

	Past Scenario	Present Scenario
Tree	14,30	29,20
Non-Tree	65,30	1,30
Grass	10,90	64,60
Pervious	9,50	4,90

i-Tree Hydro

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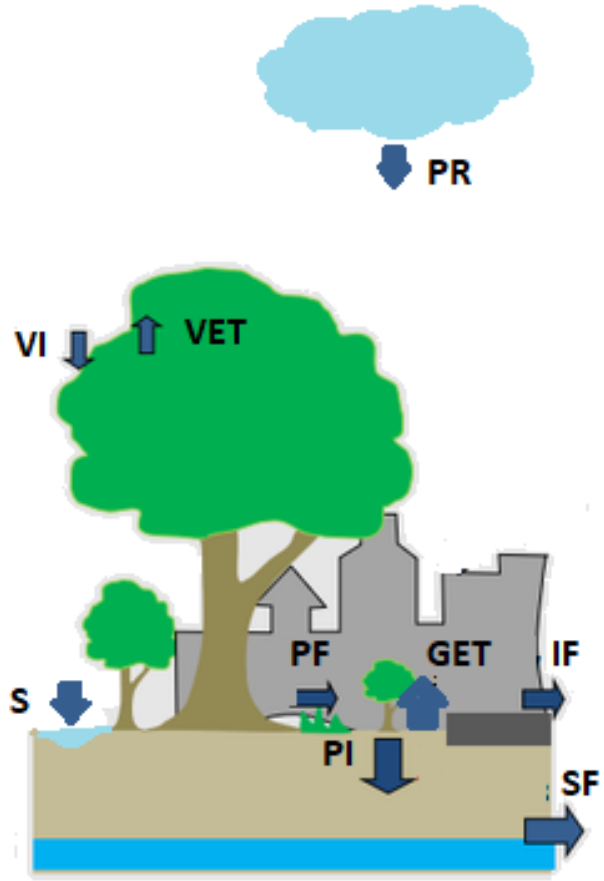
Water Balance

- **At "Park" Scale:**

$$PR = VET + VI + S + PI + PF + IF + SF + GET$$

con:

- PR (Precipitation),
- VET (Vegetation Evapotranspiration);
- VI (Vegetation Interception);
- S (Depression Storage);
- PI (Pervious Infiltration);
- PF (Pervious Flow);
- IF (Impervious Flow);
- SF (Subsurface Flow);
- GET (Ground Evapotranspiration).



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i-Tree Hydro

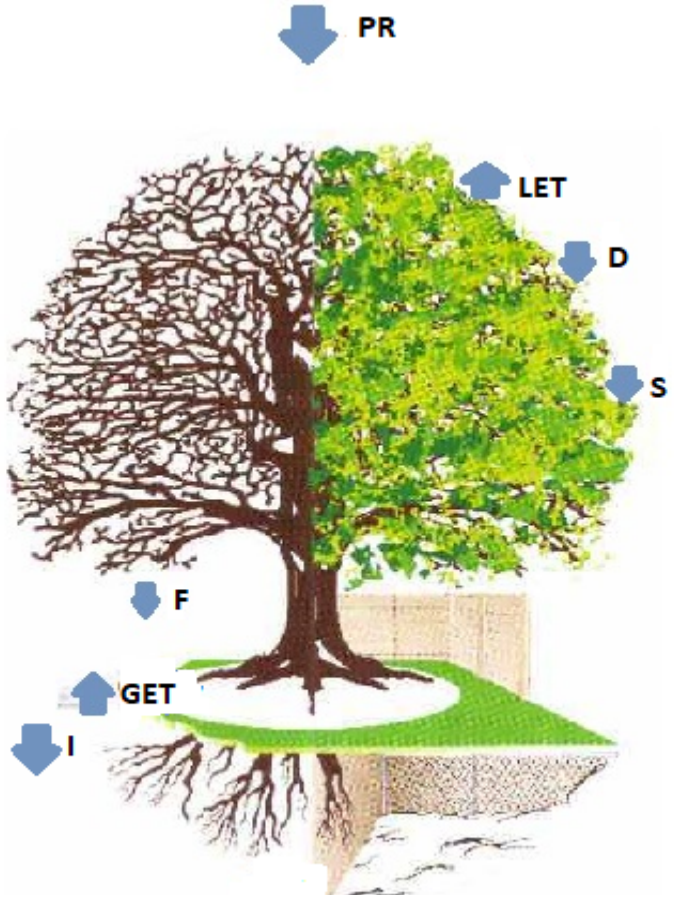
Water Balance

- **At "Tree" scale:**

$$PR = LET + D + S + F$$
$$F = GET + I$$

where:

- PR (Precipitation);
- LET (Leaf Evapotranspiration);
- D (Leaf Deposition);
- S (Leaf Storage);
- F (Falling Water);
- GET (Ground Evapotranspiration);
- I (Infiltration).



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i-Tree Hydro

Project: Watershed/Non-Watershed

INPUT

- Location data (U.S.)
- Simulation time period
- Topographical data (DEM o TI)
- Meteorological data (annuali)
- Calibration data
- Area extension [mq]
- DCIA
- ***OUTPUT i-Tree Canopy***
- Canopy parameters (***Eco***)
- Hydrological parameters

OUTPUT

- ***Water Quantity***
- Water Quality
- Advanced Outputs:
  - ***Vegetation Hydrology***
  - Subsurface Hydrology

i-Tree Hydro

Water Quantity

Vegetation Hydrology

Balance

$$TS = PF + IF + B$$

TS (Total Streaflow), PF (Previous Flow), IF (Impervious Flow), B (Baseflow)

$$VP = f(I, VET, D, F, GET)$$

con VP (Precipitation), I (Interception), VET (Vegetation Evapotranspiration), D (Leaf Deposition), F (Falling Water), GET (Ground Evapotranspiration)

Scenarios Comparison

	Past Scenario	Present Scenario
Pervious [m³/h]	10,0	12,0
Impervious [m³/h]	3,0	0,5

	Past Scenario	Present Scenario
Falling Water [m³/h]	8,0	27,0
Deposition [m³/h]	0,5	3,0

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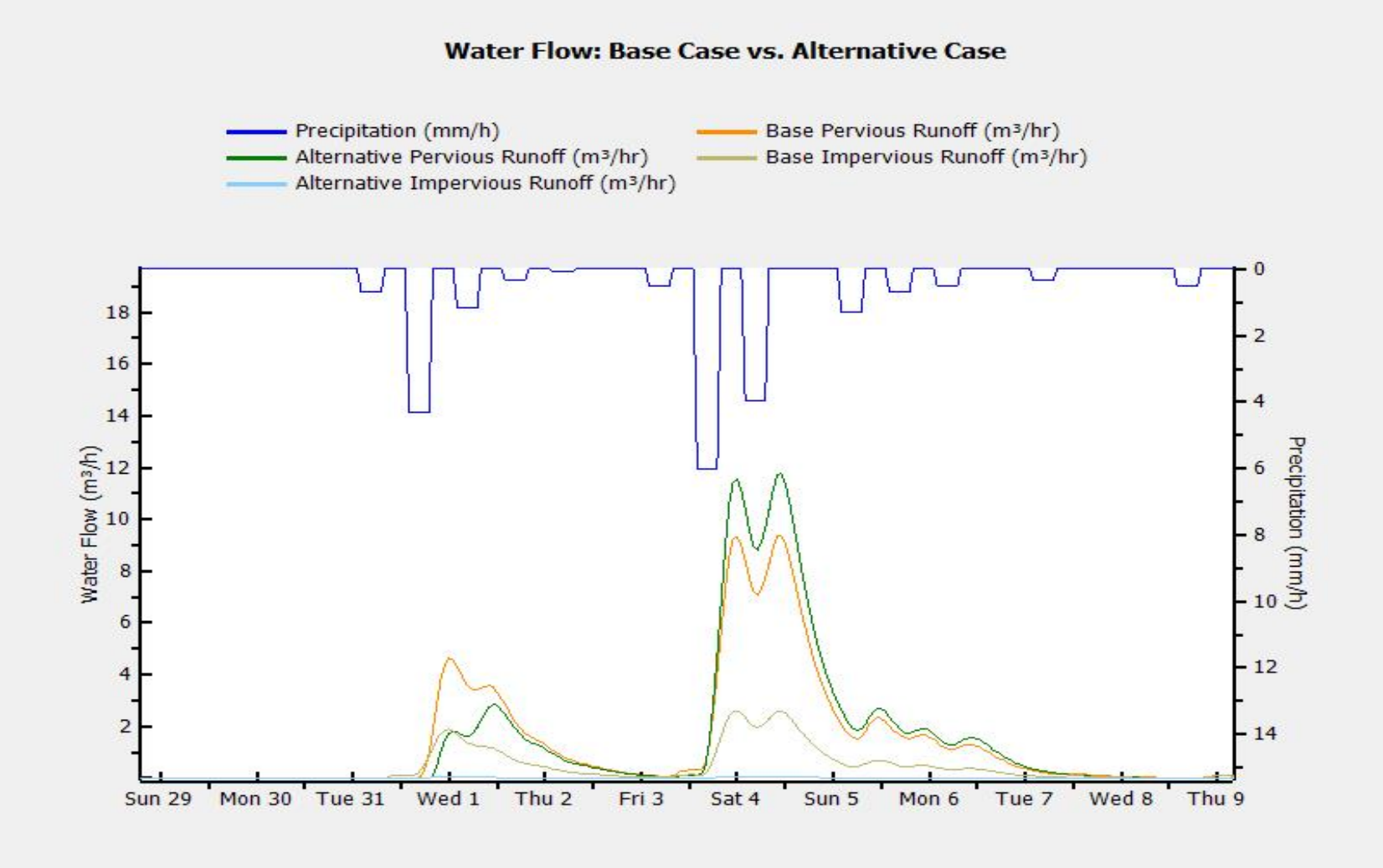
i-Tree Hydro

1) WATER QUANTITY



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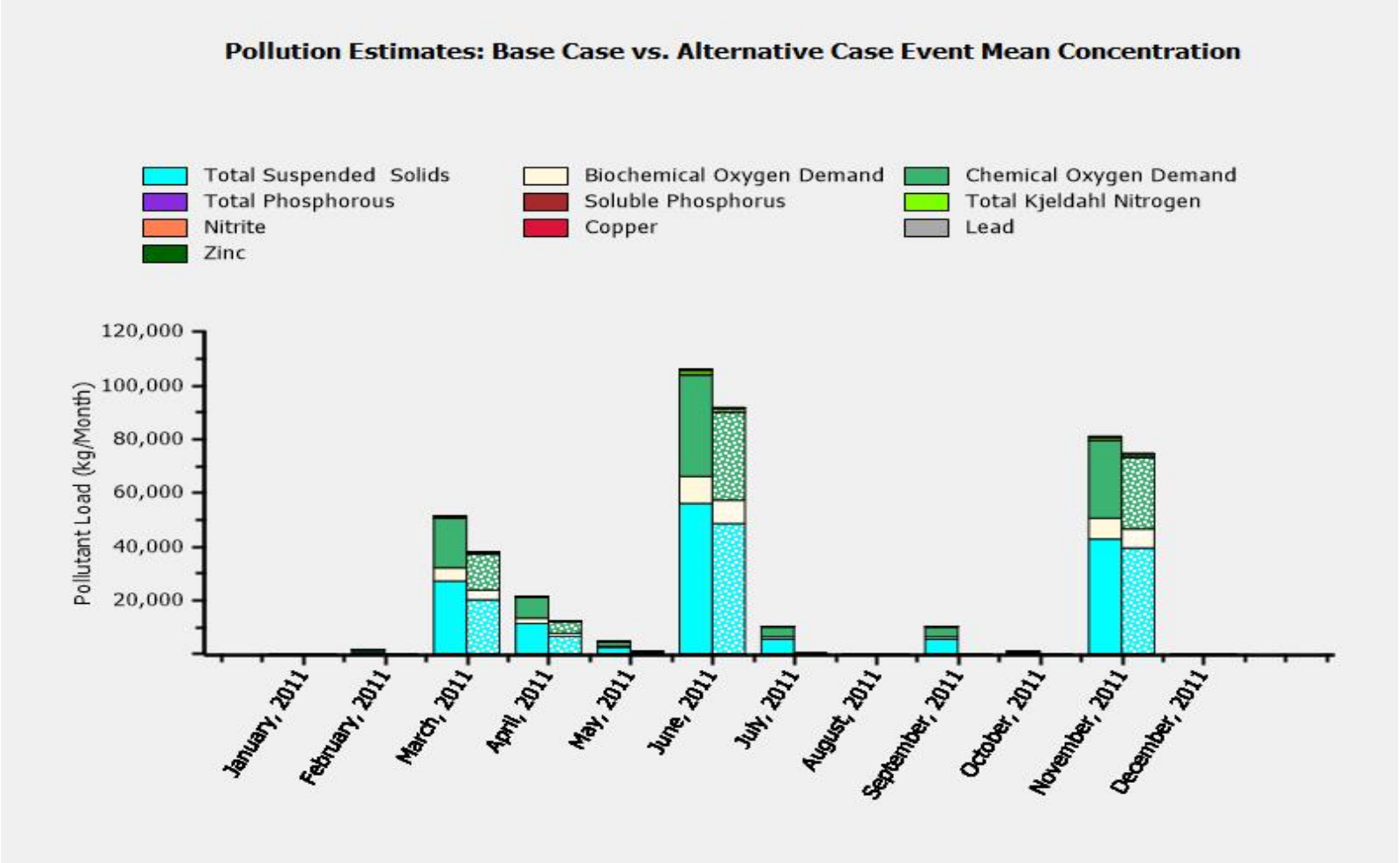
2) WATER QUALITY



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i-Tree Eco

INPUT Data

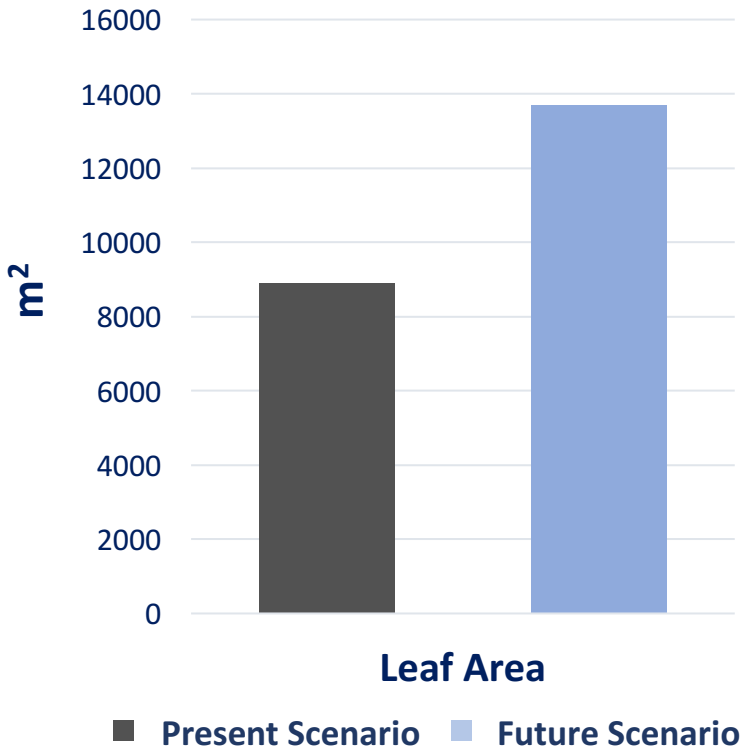
		Fundamental	Strongly Recommended	Optional
Complete Inventory		**Species, DBH**	Ground Use, Total Height, Crown Dimensions, Crown Health, Crown Exposure	Private/Public tree, GPS coordinates, Building interaction, etc.
Plot-Based Sample Inventory	**Plot Data**	**Measured Percentage, Canopy Covered Percentage**	Ground Cover	Shrub Percentage, Plantable Space, etc.
	Vegetation Data	**Species, DBH**	Ground Use, Total Height, Crown Dimensions, Crown Health, Crown Exposure	Private/Public tree, Distance to plot center, etc.

Common INPUT data: **Maintenance Cost [€], Electricity Cost [€(kWh], Carbon Cost[€/ton], Heating Cost [€/therm], Avoided Runoff Cost [€/m^3]**

i-Tree Eco

OUTPUT

Leaf Area (UFORE-A: Urban Forest Anatomy)



OUTPUT from Leaf Area

	Evaporation (m^3/year)	Transpiration (m^3/year)	Interception (m^3/year)
Present Scenario	65,60	119,30	65,60
Future Scenario	103,53	209,69	103,53
% Increase	**57,82 %**	**75,77 %**	**57,82 %**

	O_2 Production (m^3/year)
Present Scenario	65,60
Future Scenario	103,53

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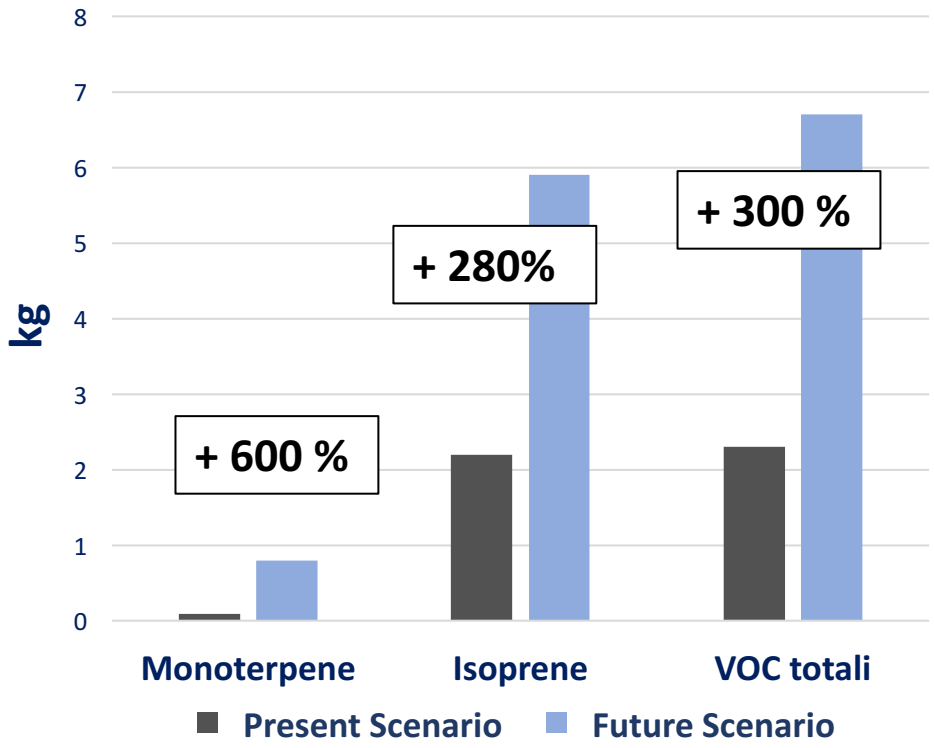
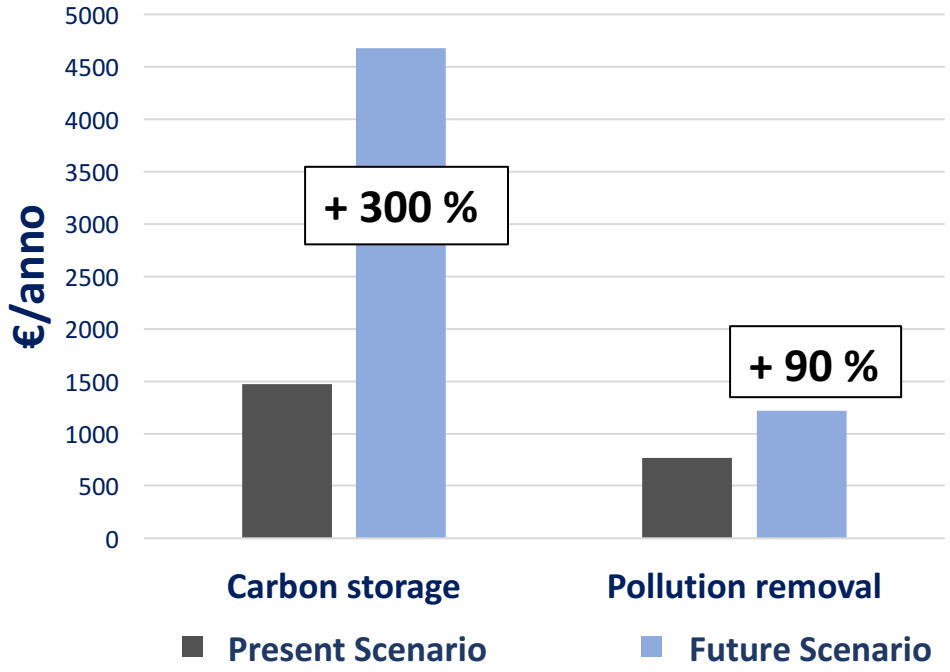
Dati OUTPUT

VOC
(UFORE-B: Biogenic Emissions)



Carbon Storage (UFORE-C)
Pollution Removal (UFORE-D)



Suggestions for Improvement

- ***i-Tree* Hydro**: a “Database” creation to share information for future applications
- ***i-Tree* Eco**: making the “Database” section on shrub species available also for Complete Inventory;
- ***i-Tree* Eco**: implementing the Forecast function with the possibility of adding species in the planting project.

Possible Project Developments

- ***i-Tree* Hydro**: using the Leaf Area data from Eco to improve Hydro outputs;
- ***i-Tree* Eco**: applying the Forecast function to Present Scenario comparing it with Future Scenario outputs;
- ***i-Tree* Eco**: applying a Plot-Based Sample Inventory for Future Scenario and comparing it with Complete Inventory data;
- ***i-Tree* Eco**: adding annual maintenance costs provided by municipal plan to obtain a costs/benefits comparison.

i-Tree

Thanks for your attention