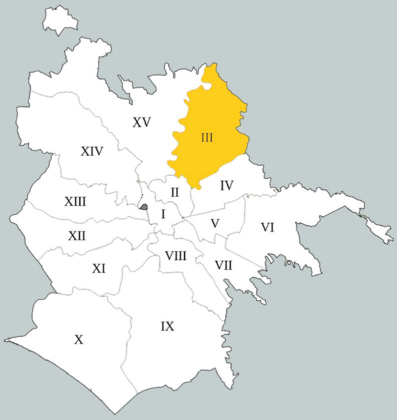
ROMA

RISORSE PER ROMA



15 MUNICIPI
15 PROGETTI
per la città in 15 MINUTI

progetti di riqualificazione dello spazio pubblico

MUNICIPIO III - TUFELLO: AREA "DETROIT"

RIQUALIFICAZIONE DEGLI SPAZI APERTI

PROGETTO DI FATTIBILITÀ TECNICO ECONOMICA

DOC 01 - RELAZIONE ILLUSTRATIVA

Roma Capitale
Assessore all'Urbanistica: Maurizio Veloccia
Assessore al Decentramento, Partecipazione e Servizi al Territorio per la Città dei 15 minuti: Andrea Catarci
Direttore Dipartimento Programmazione e Attuazione Urbanistica: Gianni Gianfrancesco
Direttore Trasformazione Urbana: Paolo Ferraro

Responsabile Unico del Procedimento: Enrica De Paulis

Municipio III
Presidente: Paolo Emilio Marchionne
Assessore all'Urbanistica e Rigenerazione Urbana: Biancamaria Rizzo
Assessore all'Attuazione Urbanistica, Lavori Pubblici e Mobilità: Matteo Pietrosante

Risorse per Roma SpA
Amministratore Unico: Simone De Santis
Direttore Area Territorio: Massimo Mengoni
Unità Pianificazione e Progettazione Urbana: Marco Tamburini

Gruppo di lavoro
Staff dell'Assessore all'Urbanistica: Elena Andreoni
Dipartimento Programmazione e Attuazione Urbanistica: Flavia Cipollone; Pietro Menichelli
Risorse per Roma SpA: Mariangela Meola (Responsabile di Progetto)
Claudia S. Giordano; Cristina Campanelli

Studio di progettazione: PRR Architetti

Responsabile di progetto:
Arch. Sara Pivetta

Gruppo di lavoro:
Paes. Alessandra Battaglini
Agr. Jr. Andrea Casiraghi
Arch. Matteo Polci
Paes. Luca Restelli
Paes. Luigi Serio
Arch. Daniele Volante

PRR Architetti

RELAZIONE ILLUSTRATIVA - INDICE

- **PREMESSA**

Il presente PROGETTO DI FATTIBILITA' TECNICO ECONOMICA – "AMBITO TUFELLO" fa parte del Programma denominato "15 Municipi 15 Progetti per la città in 15 minuti" sviluppato dall'Assessorato all'Urbanistica e l'Assessorato Decentramento, Partecipazione e Servizi al Territorio per la Città dei 15 minuti in attuazione.
Con Determinazione Dirigenziale rep. QI/1583-22 del 21.11.2022 è stato affidato allo studio PRR Architetti la redazione del "Progetto di Riqualificazione dello Spazio Aperto di relazione dell'ambito urbano: Ambito Tufello – Municipio III – CUP J87B22000520004 – CIG 9408767825.
Come previsto dal DIP, il progetto si è articolato in due fasi:

- Masterplan – Ambito Tufello
- Progetto di fattibilità tecnico economica (PFTE)

Con Delibera n. 274 della Giunta capitolina del 27.07.2023 Prot. RC n. 20380/2023 è stato approvato il Masterplan Ambito Tufello – Municipio III – CUP J87B22000520004 – CIG 9408767825.
Il PFTE dell'area oggetto di intervento è redatto secondo quanto previsto Nuovo Codice dei Contratti - Decreto legislativo 31 marzo 2023, n. 36 in vigore a partire dal 1 luglio 2023.

AREA OGGETTO DI INTERVENTO

A seguito di approvazione del Masterplan il Municipio III con comunicazione del 7 settembre 2023 ha individuato quale opera prioritaria di realizzazione l'area Detroit in oggetto, come riportata nella comunicazione seguente:

Oggetto: PROGRAMMA 15 INTERVENTI PER 15 MUNICIPI PER LA CITTA' IN 15 MINUTI
AMBITO TUFELLO – MUNICIPIO III
Individuazione, all'interno del Masterplan Tufello, dell'opera di prioritaria realizzazione

Gent.mi,
come anticipato nella nota *Condivisione contenuti del Masterplan sul Tufello, Municipio III* del 30/05/2023 (Prot. 78338) precedentemente inviatavi, con la presente siamo ad indicare l'opera che, nell'economia generale del Masterplan, il Municipio III ritiene opportuno realizzare in via prioritaria. Si tratta dell'area per attrezzature sportive definita "Detroit", facente parte della polarità culturale e sportiva situata nella parte sud del Masterplan, come evidenziato nello stralcio planimetrico di seguito allegato.
Cordiali saluti

OBIETTIVI GENERALI DEL PROGETTO – RISPONDENZA AL DIP

Il **DIP** – documento di indirizzo alla progettazione –elaborato dall'U.O. Rigenerazione Urbana e Progetti Speciali, definisce compiutamente il quadro programmatico della città dei 15 minuti ovvero azioni in *esito alle quali si prevede di riorganizzare gli spazi urbani in modo che la cittadinanza possa trovare, in un arco temporale prossimo ai 15 minuti a piedi o in bicicletta dalla propria abitazione, un ampio ventaglio di servizi e strutture utili per la migliore fruizione del proprio quartiere, con l'ottimizzazione dei caratteri identitari dello stesso, sia pur in un'ottica di ricucitura unitaria della città.*

Gli **obiettivi generali** del progetto dovranno tendere allo *sviluppo di azioni sostenibili e di interventi non solo di riqualificazione urbana ma anche di salvaguardia e valorizzazione delle risorse naturali e delle aree a verde.*
Tali Obiettivi sono stati sviluppati in una prima fase generale con una proposta che ha riguardato tutto il quartiere attraverso la redazione del Masterplan.

A partire dalla Sintesi valutativa e interpretativa e dagli incontri con i rappresentanti del Municipio il DIP indica anche gli **Obiettivi Specifici** per il progetto dell'Ambito Urbano Tufello e in particolare per l'area in oggetto:

Ambito POLO CULTURALE E SPORTIVO
Sub-ambito AREA «DETROIT»:
Gli interventi da prevedere per quest'area riguardano la realizzazione di:

- n. 1 campo da calcetto
- n.1 campo da basket
- n. 1 campo polivalente
- n. 1 chiosco / punto ristoro
- n.1 area ludica

- **STATO DI FATTO**

AREA D'INTERVENTO

- **LOCALIZZAZIONE**

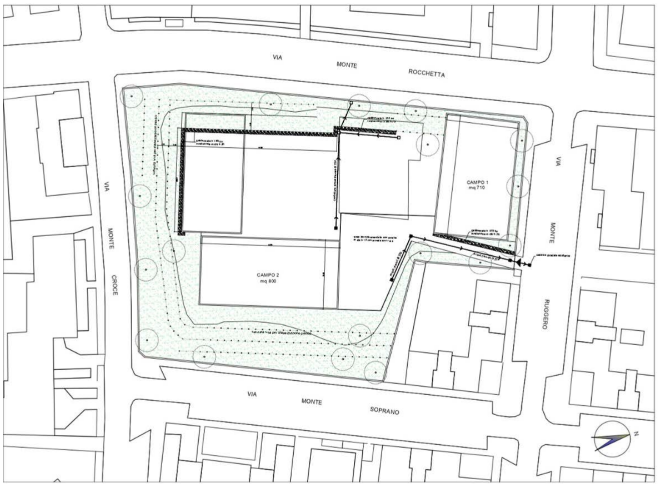
Il presente progetto riguarda la riqualificazione dell'area urbana localizzata nel **Municipio III**, nel quartiere Tufello e denominata **area "Detroit"**, compresa tra Via Monte Rocchetta a ovest, via Monte Ruggero a nord, via Monte Soprano a est e via Monte Croce a sud.

L'area si presenta come un lotto isolato; soltanto su una piccola porzione di angolo tra Via Monte Ruggero e Via Monte Soprano insite un fabbricato residenziale. L'ingresso all'area avviene da Via Monte Ruggero 25.

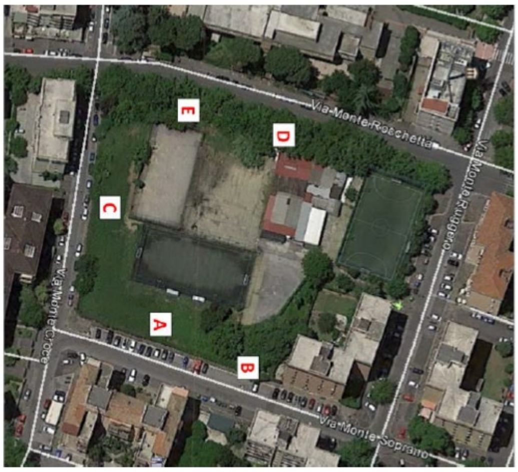
L'area è stata per molti anni utilizzata come centro sportivo da un soggetto privato che ha realizzato tre campi sportivi per calcetto, oltre a una serie di manufatti, costruiti in maniera del tutto posticcia con materiali di risulta di ogni tipo anche Eternit, adibiti a: spogliatoi, bagni, uffici e locali vari senza alcuna autorizzazione. Nei lavori di messa in sicurezza dell'area tutti questi volumi sono stati demoliti.

- DESCRIZIONE DELLO STATO DEI LUOGHI

Lo stato attuale dei luoghi è determinato da recenti lavori di messa in sicurezza e bonifica dell'area. Per una descrizione puntuale si riporta quindi estratto, scaricabile dal sito https://www.comune.roma.it/web/it/, della "Relazione Tecnica per la realizzazione di un Centro Sportivo" nell'area di progetto con realizzazione delle opere preliminari per la messa in sicurezza dell'area da parte dell'amministrazione comunale, eseguite nel 2019/2020:



Planimetria a seguito delle opere di consolidamento e messa in sicurezza area



La relazione tecnica riporta la seguente analisi:

A seguito di fenomeni di dissesto gravitativo sul lato est dell'area (via Monte Soprano, ***zona A*** *della mappa satellitare) che hanno interessato volumi di materiale piroclastico, presumibilmente di riporto antropico, collegato a precedenti interventi di sistemazione delle superfici originarie, e anche in direzione Via Monte Ruggero, sempre in posizione sovrastante via Monte Soprano (****zona B****) una porzione di scarpata maggiormente acclive con indizi di dissesto, si sono resi necessari interventi di messa in sicurezza di tali aree.*

Quanto precede, in termini di prevenzione del rischio di attivazione delle fenomenologie di dissesto, è stato necessario applicare anche al lato sud dell'impianto in oggetto (via Monte Croce, ***zona C*** *della mappa) ove, anche senza indizi di dissesto, ma situazioni geometriche e tipologie di materiali sovrapponibili a quelle della* ***zona A*** *non permettevano di escludere future attivazioni dei fenomeni.*

Per quanto riguarda il lato adiacente via Monte Rocchetta, ***zona D****, si sono rilevate criticità quali:*

• accumuli di terreno di riporto lungo il dislivello topografico di raccordo con la sottostante sede stradale, soggetti ad episodi di dilavamento ed interessamento della stessa sede stradale;

• manufatti adibiti a spogliatoio sul ciglio del dislivello topografico con evidenze di cedimento e disallineamento presso elementi complementari, quali scale, muretti, recinzioni;

• il ***campo 3*** *non agibile, con un angolo evidentemente interessato da cedimenti (****zona E*** *della mappa);*

• chiari indizi sia di una gestione problematica delle reti di smaltimento delle acque superficiali (con libero conferimento delle stesse proprio in corrispondenza del versante di raccordo) che terreni di riporto assolutamente incoerenti.

Anche su tutto questo versante della collina è stato necessario intervenire in maniera più incisiva con gli interventi di consolidamento del terreno, oltre all'eliminazione di tutta la vegetazione cresciuta in maniera incontrollata e spesso a ridosso di opere murarie costruite in maniera approssimativa (esempio muro di sostegno del campo 3 in blocchetti di tufo senza fondazione)

Allo scopo di limitare e ridurre al minimo i fenomeni precedentemente descritti e al recupero e futura utilizzazione dell'intera area, nell'anno 2019/2020 sono stati posti in essere i seguenti interventi:

1) Bonifica e pulizia di tutte le aree a verde con eliminazione delle essenze infestanti e quelle che compromettevano la stabilità dei manufatti, in particolare a ridosso dei campi 2 e 3 e lungo il muro di recinzione sul lato di via Monte Rocchetta e via Monte Croce. La superficie interessata è di circa mq 3.270,00;

2) Opere di ingegneria naturalistica per stabilizzazione pendii: su tutta l'area precedentemente bonificata si è proceduto al suo consolidamento mediante la realizzazione di una viminata viva, con filari ad una distanza di circa ml 3,50 uno dall'altro. Sono stati realizzati 4 filari sul pendio lungo via Monte Soprano, tre e due filari sul pendio lungo via Monte Croce e uno lungo via Monte Rocchetta;

3) Consolidamento Campo 3 e del piazzale a ridosso dell'area occupata dai manufatti abusivi contestualmente alla loro demolizione: detto intervento ha comportato la formazione di una gabbionata alta un metro su sottostante soletta di fondazione in calcestruzzo magro, a partire dall'angolo del campo 3 prospiciente via Monte Croce fino al campo 1 lungo via Monte Rocchetta;

4) Rifacimento muro rampa d'ingresso da via Monte Ruggero, che era in fase di crollo, con la realizzazione di un'altra gabbionata alta 1 metro su sottostante soletta di fondazione in c.a altezza 25 cm;

5) Demolizione dei manufatti presenti sull'area, costruiti con i materiali più disparati che vanno da lamiere, pannelli di legno, lastre di eternit reti metalliche, cartongesso e tanto altro….che creavano una situazione di pericolo sia per la stabilità del pendio su via Monte Rocchetta che per gli stessi utilizzatori;

6) Rifacimento della pavimentazione della rampa di accesso alla struttura e del piazzale superiore con la realizzazione di una soletta in calcestruzzo armata con r.e.s. e lisciata superiormente a macchina. A completamento dei lavori sono state realizzate condutture di raccolta e scarico acque pluviali dal piazzale e lungo la rampa di accesso oltre al rifacimento del tratto di fognatura che parte dal piazzale e allaccia su conduttura principale lungo via Monte Rocchetta.

Tale situazione, visionata durante i sopralluoghi e il rilievo in campo, che hanno evidenziato la scarsa tenuta di alcuni degli elementi di contenimento delle scarpate (palificate) e la presenza di vegetazione infestante, rappresenta l'attuale stato dei luoghi e punto di partenza per la progettazione del presente PFTE.

ANALISI STORICA

Il DIP ha compiutamente descritto la storia della nascita ed evoluzione del quartiere Tufello. Si rimanda quindi a tale documento per la descrizione analitica della storia del luogo riportando invece qui di seguito, attraverso immagini e grafica, in maniera sintetica l'evoluzione storica dell'ambito di progetto

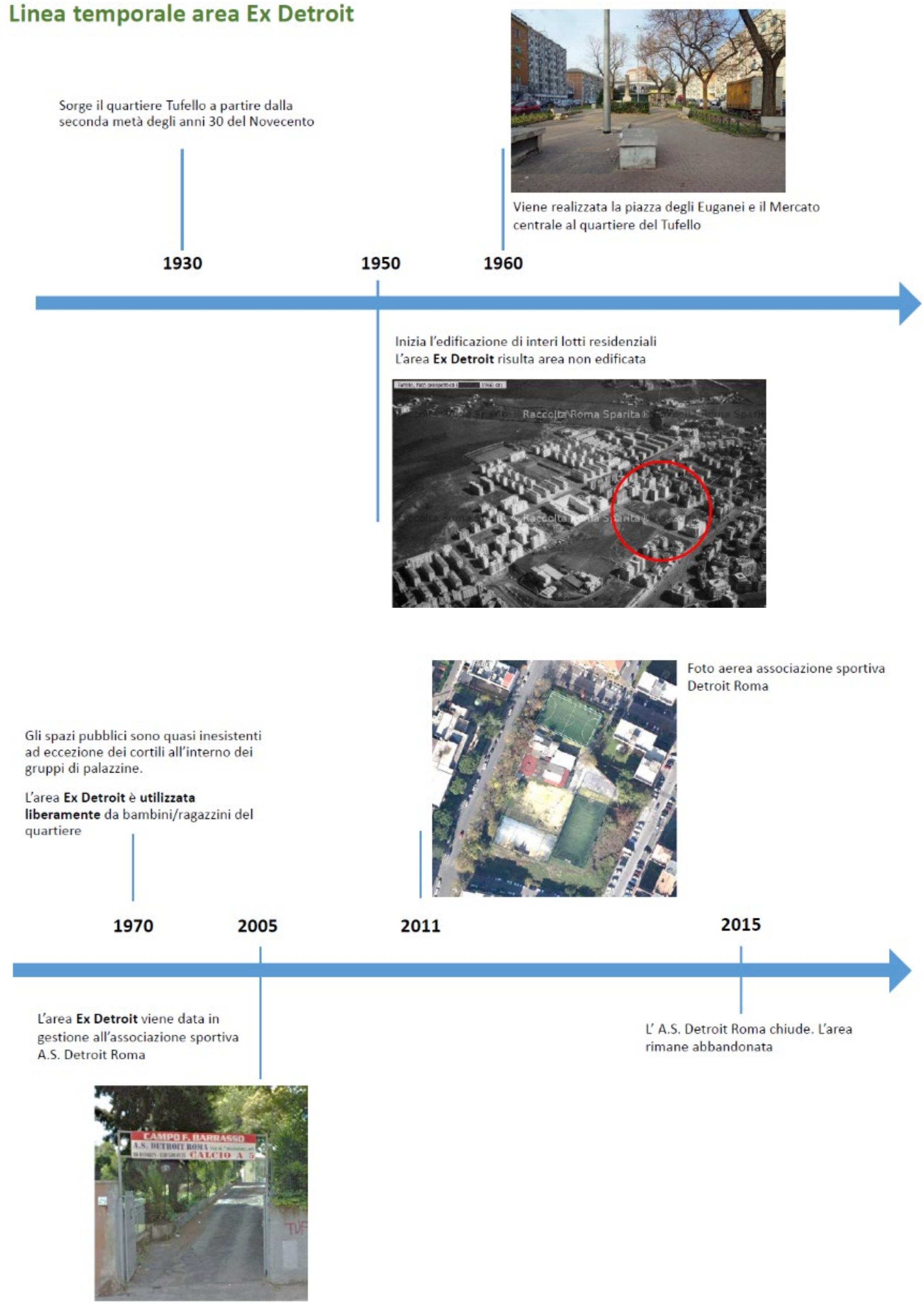


Foto aerea. L'area **Ex Detroit** risulta in stato di abbandono

2019

2019-2020

Lavori di demolizione, consolidamento e messa in sicurezza dell'area da parte del Comune

2021

Avviso pubblico di manifestazione di interesse per affidamento lavori di riqualificazione e gestione del centro sportivo dell'area

Feb 2022

Determinazione dirigenziale per sospensione e rinvio del procedimento di attivazione delle procedure per l'indizione del partenariato pubblico-privato (PPP)

Richiesta **correzione di destinazione d'uso area**

da: *città storica – tessuti TP*

a: *verde pubblico e servizi pubblici di livello locale*

Mag 2022

TUFELLO TUFELLO / VIA MONTE RUGGERO

Tufello, occupato l'ex Detroit. Ora a gestirlo sono gli abitanti del quartiere

Blitz al Tufello di attivisti e cittadini per prendere possesso dell'ex impianto sportivo, ormai abbandonato dal 2015, ribattezzato "Parco Sor Romano"

Occupazione dell'Ex Detroit da parte dei cittadini del quartiere.

L'amministrazione esprime la volontà di non dare seguito alla manifestazione di interesse, ma di ridare all'area una vocazione pubblica:

Parco pubblico a carattere ludico/sportivo

Lug 2023

Approvazione Masterplan progetto

15 MUNICIPI 15 PROGETTI 15 MINUTI

. . . . .

Infine grazie alle foto aeree è possibile visualizzare la trasformazione, nel recente passato, nell'area di intervento:

2007 – foto aerea - google earth

2020 – foto aerea - google earth

2019 – foto aerea - google earth

2023 – foto aerea - google earth

Le immagini testimoniano il passaggio dell'area da centro sportive, con campi ed edifici di servizio, gestito da un soggetto privato, ad area pubblica con demolizione degli edifice abusivi, bonifica dei luoghi e messa in sicurezza delle sponde ed infine lo stato attuale ove il mancato uso dell'area ha prodotto fenomeni di degrado dovuti a scarsa manutenzione in particolare con ampia crescita di la vegetazione spontanea e infestante sulle scarpate.

SINTESI DELLE COMPATIBILITÀ DELL'INTERVENTO CON LE PRESCRIZIONI DI PIANI PAESAGGISTICI, TERRITORIALI ED URBANISTICI - VINCOLI

Fatto salvo per la nota, di seguito riassunta, relativa alla classificazione dell'area, l'intervento proposto si inserisce all'interno di un quadro normativo e vincolistico analizzato nella Relazione Tecnica, parte integrante del seguente progetto, e risulta essere conforme alle prescrizioni dei piani paesaggistici, territoriali e urbanistici.
Le indicazioni e soluzioni indicate nei suddetti documenti sono pertanto assunte come base per lo sviluppo del progetto e non ha richiesto ulteriori studi o modifiche se non per gli aspetti di dettaglio.

L'analisi degli strumenti urbanistici ha evidenziato una criticità, per errore materiale, nella classificazione del PRG già evidenziata dal Municipio con richiesta di correzione con nota prot. n. CD/115137 del 12/11/2020 "*affinché l'intero lotto costituente l'impianto sportivo venga ricondotto alla giusta classificazione in **Verde e servizi pubblici di Livello Locale**.*" La procedura di correzione verrà effettuata nell'iter di approvazione del presente progetto.
Nella tabella di seguito si andrà quindi a considerare l'area come *Verde e servizi pubblici di Livello Locale* e non con la classificazione attualmente usata nel PRG di *Tessuti, Edifici isolati – T9.*

TABELLA RIASSUNTIVA ESITO ACCERTAMENTI INQUADRAMENTO URBANISTICO

Strumento urbanistico	COMMENTO
PTPR	L'area si configura come paesaggio degli insediamenti urbani.
PRG	NTA Art. 85. **Verde pubblico e servizi pubblici di livello locale** destinati a **Verde pubblico** *(parchi naturali, giardini ed aree per il gioco dei ragazzi e dei bambini e per il tempo libero degli adulti: eventualmente attrezzati con chioschi, punti di ristoro, servizi igienici, con esclusione del verde pubblico di arredo stradale; orti urbani sociali..).* Per queste aree si applicano i seguenti parametri e grandezze urbanistico-ecologiche: - ET: 0,5 mq/mq; 0,05 mq/mq per il verde pubblico; 0,25 mq/mq per il verde sportivo; 0,6 mq/mq per le attrezzature religiose (per le strutture esistenti sono consentiti interventi diretti di categoria MO, MS, RC, RE, nonché interventi di categoria DR ed AMP fino all'indice EF di 0,6 mq/mq); - IP (ST): 30%; 75% per il verde pubblico; - DA (ST): 20 alberi/Ha; DAR (ST): 40 arbusti/Ha; per la verifica dei seguenti parametri si rimanda al paragrafo successivo.
VINCOLI	Nell'area di intervento non sono presenti vincoli.

ANALISI DELLO STATO DI FATTO – DOCUMENTAZIONE FOTOGRAFICA – CRITICITÀ

Attraverso l'analisi documentale, sopralluoghi e rilievi fotografici è stato analizzato l'ambito di intervento evidenziandone **caratteristiche e criticità** qui in seguito riassumibili:

Planimetria dello stato di fatto

- **ZONA DELL'AREA SPORTIVA – EX TUFELLO**

1 rampa di ingresso da via Monte Ruggero

2 platea in calcestruzzo armato

3 campo sportivo in stato di abbandono

4 area degradata a sud del complesso

5 area in scarpata lungo via Monte Soprano

6 area ex campo pallavolo

Criticità:
- Area in stato di abbandono con ingresso non controllato;
- Presenza di fenomeni di vandalismo;
- Attrezzature e arredi degradati con aree sportive non utilizzabili;
- Degrado degli elementi di contenimento delle scarpate, palificate e muri in gabbioni, dovuti sia a scarsa manutenzione sia a posa non adeguata degli stessi;
- Versanti con abbondante presenza di vegetazione infestante;
- Mancata manutenzione del verde;

Potenzialità:
- Posizione strategica per la vicinanza a scuole e servizi di quartiere
- Area libera per l'organizzazione di nuove attrezzature e aree verdi;
- Area presente nella memoria storica del quartiere - identità
- Posizione panoramica;
- Differenze di quota che permettono un progetto articolato dal punto di vista paesaggistico;

- **VIA MONTE SOPRANO**


1 strada carrabile e parcheggi


2 marciapiede

Elementi di degrado e criticità:
- Scarsa qualità dello spazio urbano;
- Intero calibro stradale a servizio unicamente delle autovetture – mancanza di alberature, fasce verdi, marciapiedi fruibili, arredi;
- Isola di calore;

Potenzialità:
- Strada carrabile a servizio solo dei residenti, trasformabile in ambito a Zona 30;
- Presenza di allargamenti stradali;
- Calibro stradale adatto ad ospitare una strada multifunzionale (marciapiedi, fasce verdi con alberi, parcheggi…);
- Qualità del tratto pedonale da valorizzare per una migliore integrazione al progetto;
- Possibilità di migliorare la qualità urbana con nuove attrezzature e impianto alberi per fornire ombra e aumentare il valore paesaggistico.

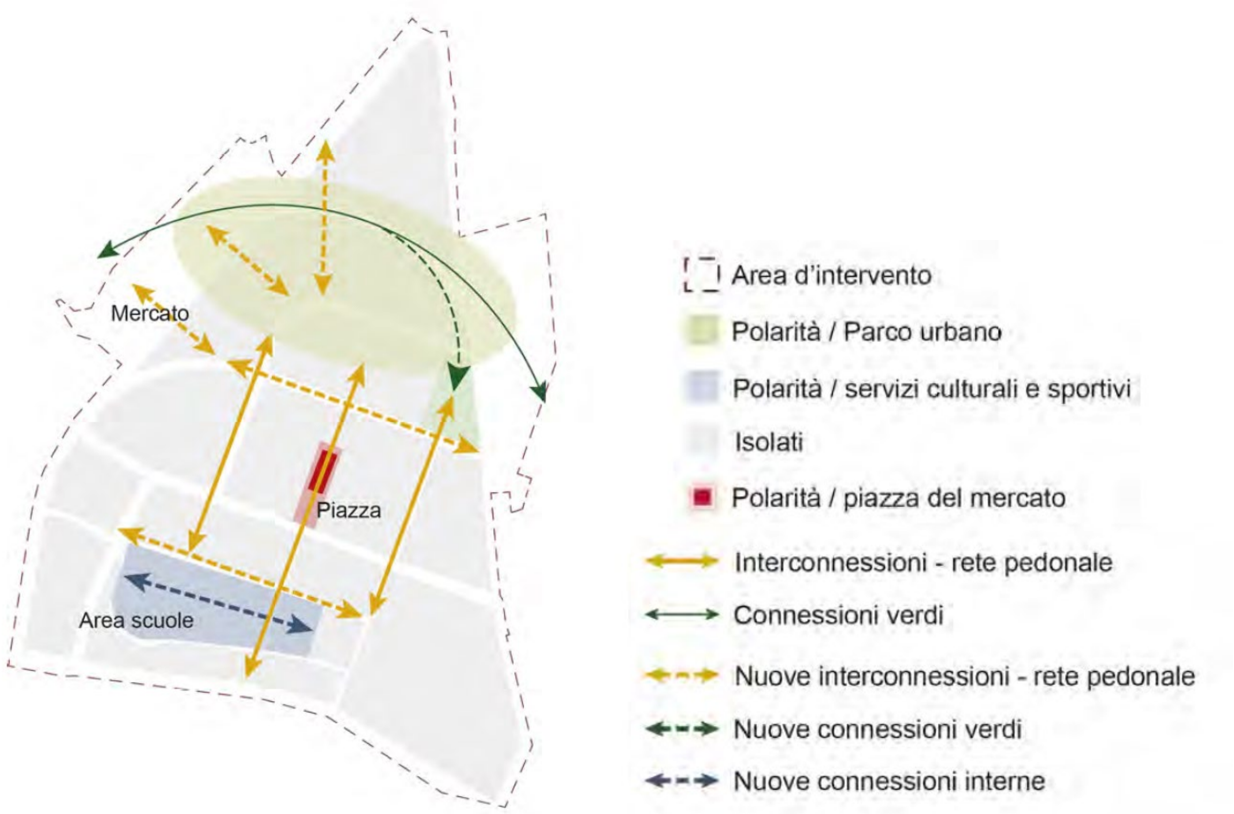
- **PROGETTO**

DEFINIZIONE E OGGETTO DEL PROGETTO

Il presente progetto riguarda la riqualificazione dell'area sportiva, destinata a giardino pubblico, localizzata nel Municipio III n. 3 area "Dertroit", localizzata tra le vie: a nord Via Monte Ruggero, a est Via Monte Soprano, a sud Via Monte Croce e a ovest Via Monte Rocchetta.

CONNESSIONI A SCALA AMPIA

A partire dal DIP il Masterplan ha evidenziato le connessioni ecologiche e fruitive a scala ampia del quartiere. In tale contesto l'area Ex Detroit si inserisce all'interno delle polarità relative ai servizi culturali e sportivi da incrementare e valorizzare. La sua posizione si pone infatti al centro di percorsi sia verso le aree con servizi sportivi, scolastici e di quartiere (biblioteca) sia lungo l'asse che porta alla piazza centrale e ai servizi commerciali di prossimità.
La sua riqualificazione costituisce quindi un importante tassello per la riqualificazione di tutto l'ambito.
Risulta inoltre evidente come sia strategico la possibilità di attraversamento e la permeabilità dell'area da più punti e non solo dal punto di ingresso esistente.



Masterplan Tufello

In maggior dettaglio quindi l'ambito di progetto persegue i seguenti obiettivi:

- Maggiore offerta ludico sportiva differenziata all'interno del quartiere Tufello;
- Maggiore relazione con il sistema di mobilità lenta e pedonale del quartiere;
- Rifacimento e riorganizzazione di Via Monte Soprano a ZONA 30 come progetto pilota all'interno del quartiere;
- Creazione di un nuovo punto focale di aggregazione sociale;

Al fine di calibrare gli interventi e le dotazioni è stata inoltre eseguita un'indagine sulla presenza delle dotazioni sportive del quartiere

Risulta evidente dall'analisi che la dotazione deve prevedere anche altre offerte rispetto a quelle tradizionali di campi da calcio quali arene multisportive, campetti e altro al fine di differenziarsi e incrementare quanto già presente.

<u>Offerta sportiva outdoor esistente nel Tufello: associazioni sportive, oratori, complessi scolastici, ecc…</u>

1 campo da calcio
campi da tennis
2 campi da calcio
3 campi da calcio
4 campi da calcio
campo da basket
5 campo da calcio
6 campo da calcio
7 campo da basket
8 campo da calcio

OBIETTIVI DI PROGETTO

La definizione degli obiettivi di progetto è stata condivisa con i rappresentanti del municipio attraverso incontri in presenza e in remoto.

Gli incontri oltre a confermare quanto già previsto dal DIP hanno definito maggiormente temi ed esigenze:

- Spazio ludico ricreativo a servizio della collettività
- Miglioramento delle dotazioni e della qualità delle attrezzature offerte
- Area a piazza: transitabile e fruibile
- Area sportiva: recintata
- Illuminazione
- Area presidio: Chiosco / servizi igienici
- Miglioramento della qualità del verde pubblico

ELENCO PAROLE CHIAVE – KEYWORD 	✓ Fruizione ✓ Area sportiva ✓ Connessioni ✓ Sicurezza ✓ Decoro urbano ✓ Rispetto delle regole ✓ Illuminazione ✓ Arredi e attrezzature ✓ Accessibilità ✓ Relazioni sociali ✓ Equilibrio delle funzioni ✓ Fruibilità per fasce di età diverse ✓ Apertura in tutte le ore del giorno e delle stagioni

SCELTA DELLE ALTERNATIVE

Le analisi riportate ai punti precedenti e gli incontri con UT e rappresentanti del municipio portano al seguente quadro di sintesi visualizzato secondo lo schema dell'analisi SWOT.

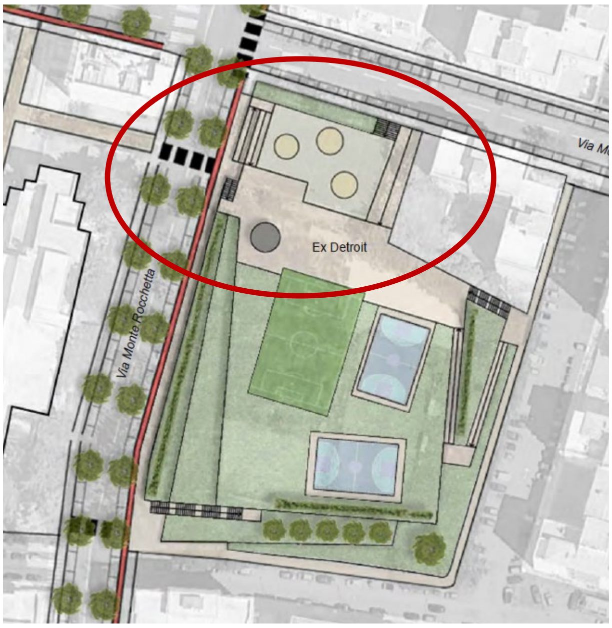
PUNTI DI FORZA	CRITICITA'
• Area unitaria di forma rettangolare • Area facilmente raggiungibile dalle diverse zone del quartiere • Vicinanza con scuole ed edifici pubblici (biblioteca, mercato centrale…) • Disponibilità di aree pubbliche per ampliare lo spazio: ambito viario su via Monte Soprano	• Attrezzature e arredi degradati o non funzionanti • Area sportiva ad oggi poco visibile e controllabile • Scarsa qualità dello spazio urbano • Verde perimetrale come filtro visivo • Isola di calore • Area difficilmente accessibile
OPPORTUNITA'	**MINACCE**
• Migliorare la qualità dello spazio urbano • Migliorare l'accessibilità all'area • Migliorare le connessioni con le funzioni «eccellenti» > stazione \ spazi commerciali\… • Definire meglio l'area come spazio per diverse fasce d'età • Migliorare la qualità dei percorsi e delle pavimentazioni • Migliorare la sicurezza con possibilità di mantenere l'area sportiva chiusa nelle ore notturne • Manutenzione del verde	• Scarsa manutenzione • Degrado • Sicurezza

A seguito di tale analisi gli **obiettivi d'intervento** si possono sintetizzare nello schema seguente:

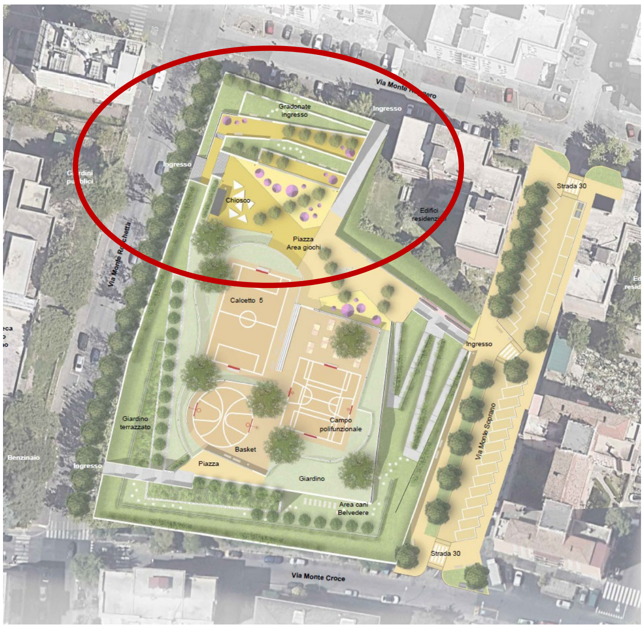
Per quanto riguarda la scelta delle alternative queste, dato il quadro condiviso già a livello di DIP e di Masterplan. si sono focalizzate sul punto di accesso a nord lungo via Monte Ruggero.

In particolare si sono analizzati due possibili scenari:

- **Scenario A** – La riqualificazione a nord del lotto in angolo tra via Monte Rocchetta e via Monte Ruggero prevede un sistema di rampe e scale per raggiungere la quota di progetto ipotizzata a +2 metri dal piano dei marciapedi pedonali perimetrali, con meno scavi e riporti ma minore permeabilità e accessibilità verso i fronti stradali;
- **Scenario B** - La riqualificazione a nord del lotto in angolo tra via Monte Rocchetta e via Monte Ruggero prevede un sistema di gradonate dolci con livelli progressivi di +0,40 metri, con maggiore riprofilatura del versante ma maggiore permeabilità e accessibilità verso il fronte stradale;



Scenario A



Scenario B

La soluzione scelta, condivisa con l'amministrazione del Municipio III, e approfondita in fase di PFTE è lo *Scenario B* al fine di garantire una maggiore permeabilità, visibilità e sicurezza dell'ambito riqualificato.

TEMI DI PROGETTO E RIFERIMENTI PROGETTUALI

I temi di progetto risultano quindi i seguenti:

- Migliore fruibilità delle piazze con creazione di zone di sosta e incontro;
- Migliorare la qualità dello spazio urbano;
- Migliorare l'accessibilità e la fruibilità dell'area da e verso il quartiere con un sistema di gradonate progressive, rampe e scale;
- Rendere percepibile la nuova area sportiva dalle strade limitrofe, sistemando le sponde dell'area con un sistema di piani terrazzati;
- Ampliare l'offerta di dotazioni ludiche, ginniche e sportive all'interno del quartiere;
- Migliorare il microclima urbano con la realizzazione di nuove aree verdi e la messa a dimora di nuovi alberi;
- Migliorare la qualità dei percorsi e delle pavimentazioni con superfici drenanti;
- Migliorare la sicurezza con un sistema di recinzioni e cancelli a chiusura dell'area sportiva nelle ore notturne;
- Riqualificare i marciapiedi perimetrali del lotto;
- Realizzare un'area a Zona 30 in via Monte Soprano;
- Regolamentare e recuperare spazi di sosta lungo la strada alberandoli;

Essendo ancora nella fase di PFTE temi e soluzioni sono anche rappresentati da riferimenti e scenari che saranno poi sviluppati nelle successive fasi di progetto a seguito di condivisione con i rappresentanti del Municipio.

Le immagini sottostanti illustrano alcuni possibili riferimenti per i temi sopra elencati:

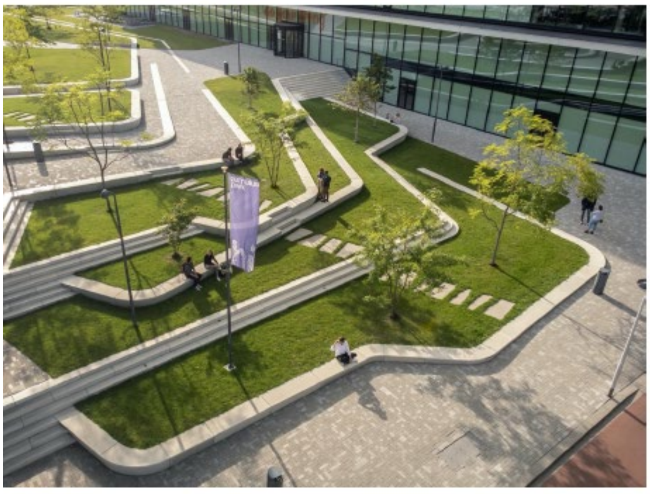
3. L'Area sportiva

le aree gioco

3. L'Area sportiva

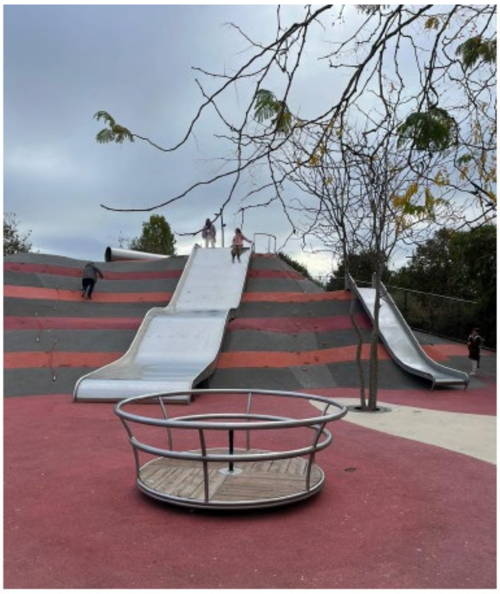
i limiti, le recinzioni

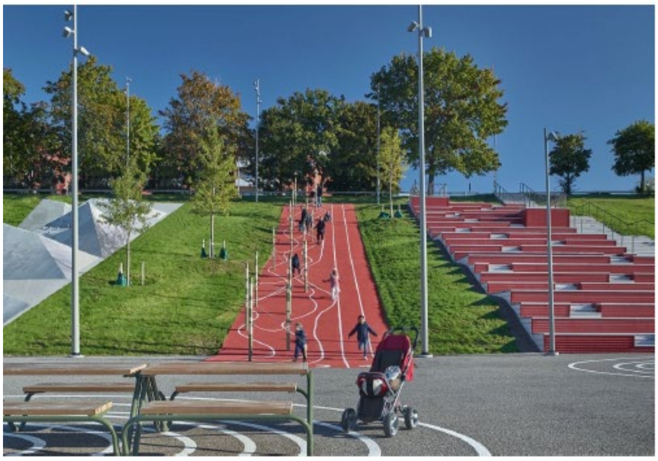
4. La Piazza terrazzata

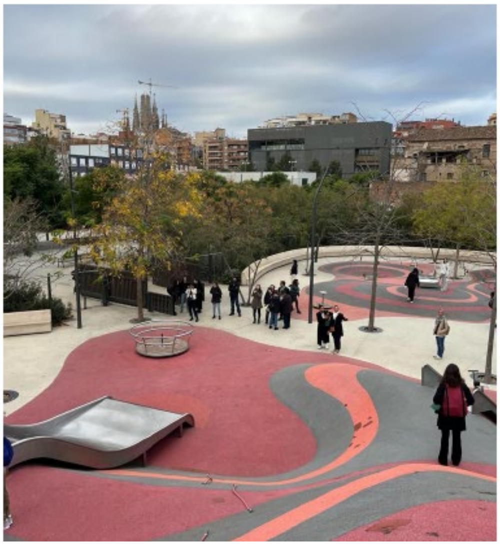


5. Rampe e dislivelli

i giochi





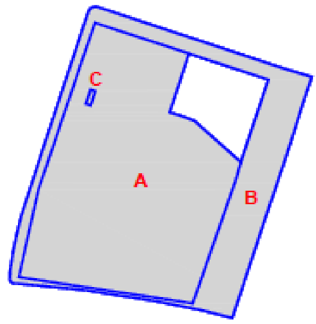


6. Zona 30

DESCRIZIONE PUNTUALE DELLA SOLUZIONE SELEZIONATA

L'area oggetto d'intervento, a seguito di una prima verifica dei costi sommari delle opere e per facilitare quindi la realizzazione delle stesse, a seguito anche di confronto con l'Amministrazione Comunale (Municipio III) è stata suddivisa in 3 lotti funzionali.

- **A** Area Sportiva "Detroit"
- **B** Via Monte Soprano – Ambito di Zona 30
- **C** Chiosco Bar – Blocco servizi igienici



Questi pur rappresentando parti distinte e autonome non pregiudicano la visione generale del progetto che viene qui di seguito descritta.

L'area di progetto

Il nuovo parco sportivo si presenta come uno spazio circoscritto ma permeabile dedicato allo svago e all'aggregazione con attenzione alle diverse fasce d'età (bambini, adolescenti, anziani…) in quanto caratterizzato da numerose attrezzature ginniche, ludiche e sportive.

Le attrezzature e i campi sportivi sono posizionati in maniera strategica sfruttano le diverse quote di progetto, rendendo le diverse aree ben definite e fruibili.

Gli interventi su Via Monte Soprano si pongono l'obiettivo di rendere maggiormente fruibile la via alla mobilità lenta e pedonale allargando i marciapiedi, integrando aiuole verdi, alberi ombreggianti e arredi come sedute.

Progetto- Planimetria di progetto

Come sopra indicato tra gli obiettivi principali di progetto l'accessibilità è la permeabilità di questa risulta tra i prioritari

La modellazione delle scarpate con importanti interventi di modellazione del terreno ha permesso di creare sia nuovi ingressi, accessibili anche ai disabili, e spazi intermedi terrazzati verdi, fruibili o solo visibili, che mediano il rapporto tra la parte alta del parco e l'intorno.

In particolare l'affaccio su via Monte Ruggero, il punto in cui il dislivello tra strade e interno dell'area è minore, si articola in una serie di basse gradonate che aprono lo spazio interno verso lo spazio pubblico della strada , rendendolo quindi visibile e sicuro, e permettono l'accesso al giardino attraverso il giardino e non solo l'ingresso esistente.

Anche l'allargamento su via Monte Soprano contribuisce a integrare maggiormente il parco con il tessuto residenziale esistente: i nuovi filari, le aree pedonali e i piccoli spazi di sosta si pongono infatti in continuità con il parco sia per i materiali, pavimentazioni drenati ecc, sia per le dotazioni, panchine, illuminazione ecc

Data la suddivisione in lotti funzionali risulta comunque utile una descrizione specifica per ognuno di questi.
Di seguito quindi si descrivono i vari ambiti – Lotti d'intervento

- **A – AREA SPORTIVA – EX DETROIT**

Il progetto individua i seguenti ambiti:

- Creazione di un **polo ludico sportivo** all'interno del quartiere del Tufello, in totale sicurezza (distanza fisica e percettiva tra l'area di progetto e le strade perimetrali) che garantisca un'offerta sportiva multifunzionale per gli abitanti del quartiere:
  - 1 campo da calcetto a 5;
  - 1 campo da basket;
  - 1 campo polifunzionale (pallavolo, giochi di gruppo vari…);
  - 1 area per giochi da tavolo (ping pong, teq ball, scacchiere, bigliardino…);
  - 1 gradonata per sostare o per manifestazioni di quartiere;

  Tale polo ludico è caratterizzato dalla presenza di pavimentazione drenante colorata, pavimentazioni in resina colorate per le aree sportive, muri e recinzioni perimetrali parapallone e per garantire una chiusura all'area nelle ore notturne, illuminazione specifica per le aree sportive, arredi e attrezzature varie.

- Creazione di una **piazza pubblica**, che garantisca:
  - aree giochi per bambini;
  - aree fitness per i giovani (calisthenics…);
  - attrezzature per giovani e anziani (palestra all'aperto…);
  - aree raffrescate - impianto di nebulizzazione ;

  Tale ambito pubblico, aperto e ben illuminato, è caratterizzato da pavimentazioni drenanti colorate, pavimentazioni antitrauma per gli attrezzi ludici/ginnici, alberature a filare che con l'ombra attenuino le alte temperature estive, arredi e attrezzature varie.

- Creazione di una **gradonata** dolce a nord del lotto, che funga da:
  - Punto di accesso verso la piazza e il polo sportivo;
  - Punto visivo/percettivo aperto sull'intero complesso;
  - Luogo di sosta e socializzazione;

  Tale ambito pubblico pensato con muretti/sedute prefabbricate alterna superfici pavimentate drenanti ad aree a prato e/o arbusti tappezzanti creando un giardino con fioriture e colori all'ingresso dell'area di oggetto di intervento.

- Creazione di **rampe e dislivelli** che garantiscano:
  - Accessibilità pedonale con scala: Ingresso sud/ovest da via Monte Rocchetta e via Monte Croce;
  - Accessibilità pedonale con scala e rampa (accesso disabili): Ingresso est da via Monte Soprano;

- Accessibilità pedonale con scala: ingresso ovest da via Monte Rocchetta;
- Accessibilità pedonale tramite gradonata: ingresso nord da via Monte Ruggero;
- Accessibilità carrabile per mezzi di soccorso e manutenzione: ingresso nord da via Monte Ruggero;

Tali accessi sono realizzati in calcestruzzo armato con parapetti e corrimani in acciaio.

- Riprofilatura **scarpate perimetrali** che preveda:
  - Piani rialzati terrazzati fruibili e/o solo percepibili dall'esterno;
  - Fasce arbustive con colorazioni e portamento differente a valorizzazione del perimetro dell'area;
  - Filari arborei monospecifici;

  I terrazzamenti sono pensati in muratura in calcestruzzo armato a vista e/o gabbioni.

- **B – VIA MONTE SOPRANO –AMBITO ZONA 30 E MARCIPIEDI STRADE PERIMETRALI**

- Realizzazione di una **strada multifunzionale a Zona 30** a servizio e utilizzo degli abitanti del quartiere che preveda una ridistribuzione delle seguenti funzioni:
  - carreggiata a senso unico con direzione sud-nord;
  - 33 parcheggi per autovetture;
  - Marciapiede lato ovest con calibro medio di circa 3m;
  - dossi a inizio, centro e fine via;
  - tasca verde di arbusti tappezzanti;
  - 16 nuove alberature;
  - Ricollocazione di cassonetti rifiuti;

  La strada multifunzionale è caratterizzata da pavimentazioni drenanti, cordolature in cls e/o pietra, illuminazione stradale e urbana, segnaletica orizzontale e verticale, arredi e attrezzature vari.

- Riqualificazione dei **marciapiedi perimetrali** su:
  - Via monte Rocchetta;
  - Via monte Ruggero;
  - Via monte Croce;

  Tali marciapiedi vengono rifatti in asfalto.

- **C – CHIOSCO - SERVIZI IGIENICI**

- Inserimento di un blocco prefabbricato che faccia da punto ristoro, aumenti le dotazioni offerte nel quartiere e funga da presidio attivo dell'intero complesso, così composto:
  - 1 chiosco bar;
  - 1 locale per servizi igienici disabili;
  - 1 area dehor con vele ombreggianti e/o ombrelloni;

Le finiture, i materiali, gli allacciamenti, le dotazioni interne all' edificio prefabbricato saranno da approfondire in fase di progetto esecutivo. Si riportano delle immagini di riferimento del blocco servizi prefabbricato ipotizzato:

- **VIA MONTE SOPRANO: VERIFICA BENEFICI AMBIENTALI OPERE A VERDE**

Gli ecosistemi urbani dipendono fortemente dall'ambiente naturale, il quale fornisce una serie di servizi indispensabili alla sopravvivenza di chi li abita; questi sono comunemente noti come **servizi ecosistemici** (SE).

Nell'ambito di questo progetto si è voluto quantificare i benefici forniti dalle alberature stradali utilizzando l'intervento di riqualificazione di via Monte Soprano come **intervento pilota**, il quale si configura come tassello di un più grande progetto di rinverdimento di vie e strade di quartiere. In quest'ottica, quantificare i benefici erogati dai sistemi verdi dei quali l'intera città può godere, risulta essere uno step verso il riconoscimento concreto del valore connesso al verde urbano. Il verde in città assume dunque un significato che va ben oltre quello meramente ornamentale bensì, se ben progettato e gestito, costituisce strumento essenziale per migliorare la qualità di vita dei cittadini.

Per la presente stima dei principali servizi ecosistemici di regolazione sono stati elaborati due scenari temporali:

- **baseline**, a 5 anni dall'impianto – periodo successivo alla messa a dimora in cui si considera avvenuto l'affrancamento;
- **stima a maturità**, a 30 anni dall'impianto – periodo in cui il sistema arboreo esprime il suo massimo potenziale nell'erogazione dei SE.

La riqualificazione di via Monte Soprano prevede il mantenimento di parte dei parcheggi esistenti, la sostituzione del manto stradale con una pavimentazione permeabile e la messa a dimora di n. 13 alberi. Le specie selezionate per tale intervento sono: n. 3 individui di *Gleditsia triacanthos* 'Sunburst' e n. 3 individui di *Acer* 'Pacific Sunset' in filare misto nel tratto più a nord, n. 5 individui di *Quercus frainetto* nel tratto a sud della via, e n. 2 individui di *Schinus molle* nelle aiuole a est.

Considerando un periodo di affrancamento di 5 anni (baseline), si stima che a 30 anni dalla messa a dimora la **copertura arborea** iniziale di 225 m2 raggiungerà una superficie quasi triplicata, pari a 605 m2.

Tra i benefici degli alberi direttamente apprezzabili vi è il miglioramento del microclima. La **mitigazione delle temperature** da parte delle piante avviene grazie all'effetto congiunto dell'ombreggiamento e della traspirazione, che sottrae calore latente all'atmosfera. Studi condotti in ambiente urbano (Rahman et al., 2019 – *Comparing the transpirational and shading effects of two contrasting urban tree species*. Urban Ecosystems, 22, 683-697) dimostrano che, per ogni punto di LAI (*Leaf Area Index* – indice di area fogliare), la riduzione della temperatura superficiale da parte del singolo albero può arrivare fino a 3°C (se si tratta di manto erboso) e fino a 6 °C (se si tratta di asfalto). Nel caso in oggetto si stima a 30 anni dall'impianto un LAI di 6.9 per *Acer* 'Pacific Sunset', di 4.3 per *Gleditsia triacanthos*, di 6.4 per *Quercus frainetto* e di 2.5 per *Schinus molle*, con una conseguente riduzione della temperatura superficiale dell'asfalto fino a 41.4, 25.8, 38.4 e 15 °C rispettivamente.

	BASELINE – 5 anni		**STIMA – 30 anni**	
	LAI	**ΔT (°C) asfalto**	**LAI**	**ΔT (°C) asfalto**
Acer 'Pacific Sunset'	**3.4**	**20.4**	**6.9**	**41.4**
Gleditsia triacanthos	**2.2**	**13.2**	**4.3**	**25.8**
Quercus frainetto	**2.6**	**15.6**	**6.4**	**38.4**
Schinus molle	**1.4**	**8.4**	**2.5**	**15**

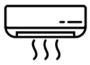
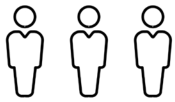
Considerando un tasso di traspirazione media giornaliera di 1,5 kg H2O per m2 di superficie fogliare, si stima che il sistema arboreo oggetto di studio a maturità consentirà un **risparmio energetico** di 3530 kWh all'anno, che equivalgono a 295 giorni di utilizzo di due condizionatori (considerando un consumo giornaliero di 1 kW e un utilizzo giornaliero di 6h).

Le attività antropiche producono come principale esternalità **anidride carbonica**, gas climalterante le cui concentrazioni in continuo aumento rappresentano una delle principali cause dei cambiamenti climatici. Gli alberi sono in grado di ridurre le concentrazioni atmosferiche di CO2 sequestrando carbonio nei tessuti di neo formazione ogni anno: la quantità di CO2 annualmente sequestrata dal filare di progetto, una volta superato il periodo di affrancamento, è stata stimata in 220 kg/anno. Maggiori sono le dimensioni e migliori sono le condizioni fitosanitarie delle piante, maggiore sarà tale valore. Allo stesso modo, crescendo, le piante stoccano una quantità di carbonio sempre maggiore, fissandola nella propria biomassa legnosa. Da una stima iniziale di 1.5 t di CO2 stoccata a 5 anni dall'impianto, gli alberi di progetto potranno arrivare a stoccare complessivamente 12.7 t di CO2 a maturità.

Fondamentale sottoprodotto della fotosintesi è l'**ossigeno**. La stima della quantità di ossigeno prodotto annualmente dagli alberi di progetto, negli intervalli di tempo studiati, è pari a 160 kg/anno nella baseline e 490 kg/anno a maturità. Considerando che una persona adulta consuma in media circa 180 kg/anno di ossigeno, gli alberi del sistema di verde analizzato possono arrivare a maturità a produrre annualmente ossigeno per circa 3 persone.

La scarsa qualità dell'aria è un problema che accomuna molte aree urbane, con conseguenze negative sulla salute umana, sui materiali che caratterizzano il paesaggio e sui complessi processi che avvengono all'interno dell'ecosistema. Il contributo che le piante di progetto apportano all'abbattimento complessivo degli inquinanti atmosferici gassosi e particellari (O3, NO2, SO2, PM2.5, PM10) è pari a 1 kg/anno nella baseline, che aumentano a 6 kg/anno nella simulazione condotta a 30 anni dall'impianto.

In conclusione a seguito della realizzazione del progetto proposto, nella tabella sottostante si riporta la stima dei principali servizi ecosistemici forniti dalle alberature stradali:

Benefici apportati	u.m.	Stima baseline - 5 anni		Stima a maturità - 30 anni	
Copertura arborea	m^2	225		605	
Energia risparmiata	kWh/anno	520	*equivalente a circa 90 giorni/anno di 1 condizionatore (6h di utilizzo)* 	3530	*equivalente a circa 300 giorni/anno di 2 condizionatori (6h di utilizzo)* 
Anidride carbonica sequestrata (CO_2)	Kg/anno	220		670	
Anidride carbonica stoccata (CO_2)	t	1.5		12.7	
Ossigeno prodotto (0_2)	Kg/anno	160	*equivalente all'ossigeno prodotto per 1 persona/anno* 	490	*equivalente all'ossigeno prodotto per 3 persone/anno* 
Inquinanti atmosferici:					
- **$PM_{2.5}$ rimosso**	g/anno	22		145	
- **PM_{10} rimosso**	g/anno	190		1250	
- **Carbonio (CO) rimosso**	g/anno	30		205	
- **Anidride solforosa rimossa (SO2)**	g/anno	5		35	
- **Biossido di azoto rimosso (NO2)**	g/anno	245		1620	
- **Ozono rimosso (O_3)**	g/anno	430		2860	

In Allegato a tale Relazione Illustrativa – **ALLEGATO 01** - si riportano le Analisi realizzate con i-Tree che hanno determinato i valori e gli effetti ecosistemici riportati nella tabella qui sopra.

- **ABACHI ED ELEMENTI TIPOLOGICI**

Il grado di definizione del progetto ha individuato una serie di elementi tipologici di massima che dovranno essere approfonditi nelle fasi successive di progetto

- **ABACO DETTAGLI TIPOLOGICI – OPERE CIVILI**

La scelta è stata orientata a criteri di sostenibilità, durabilità e facilità di manutenzione

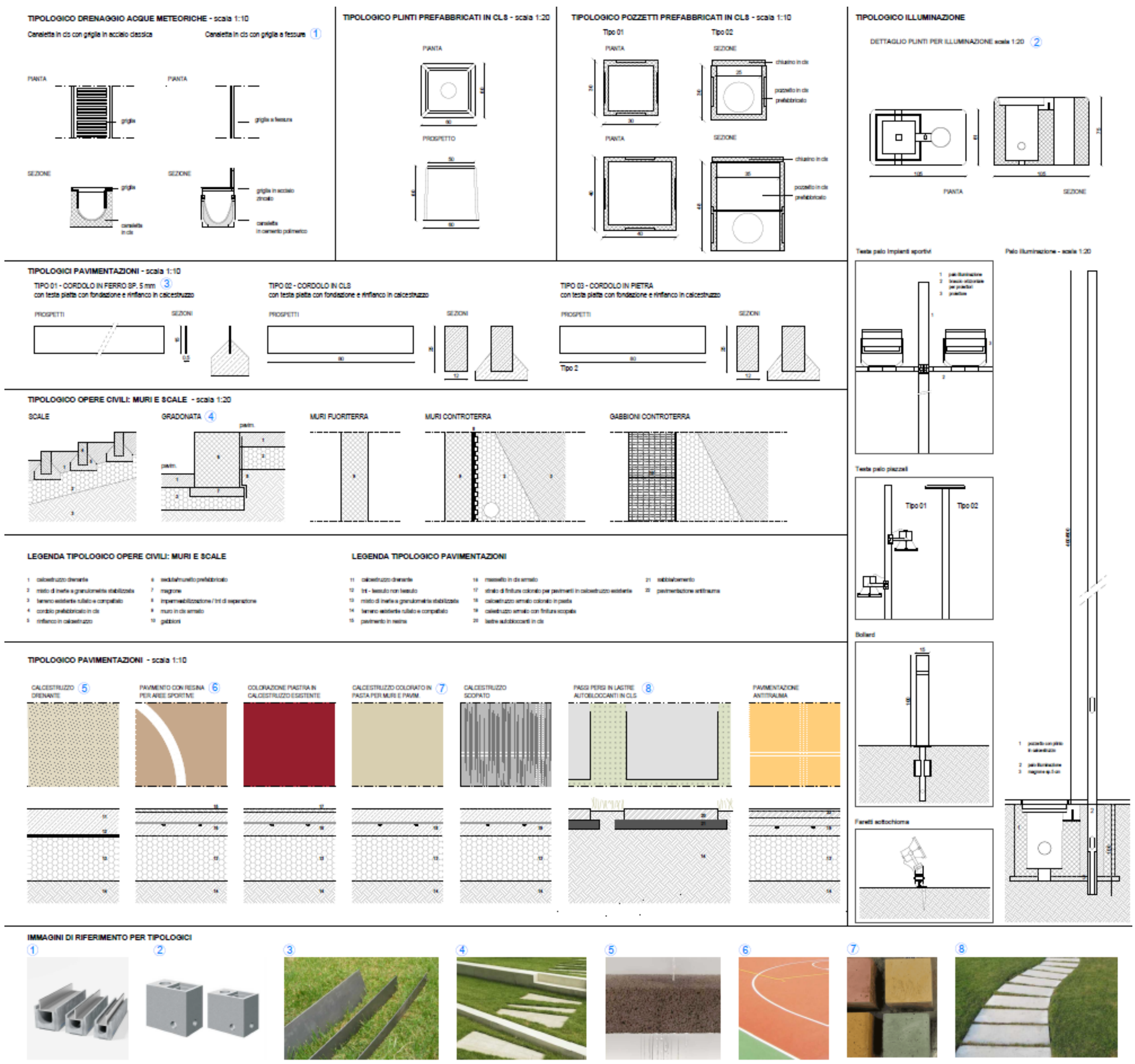
A seguito dell'esito dell'indagine geologica i muri di contenimento che organizzano il giardino in aree a differenti quote sono realizzati perlopiù con muri in gabbioni

Solo in corrispondenza degli accessi o in punti notevoli si prevede la realizzazione di muri in c.a colorati in pasta

Scale e pavimentazioni ove non richiesto da particolari usi (sportivo o di gioco) saranno perlopiù in materiale drenante

In sintesi sono stati individuati i seguenti elementi

- Muri / Gabbioni e scale
- Cordolature
- Pavimentazioni
- Drenaggio acque meteoriche
- Plinti prefabbricati
- Pozzetti prefabbricati
- Illuminazione



Abaco Dettagli Tipologici – Estratto Tav. 08

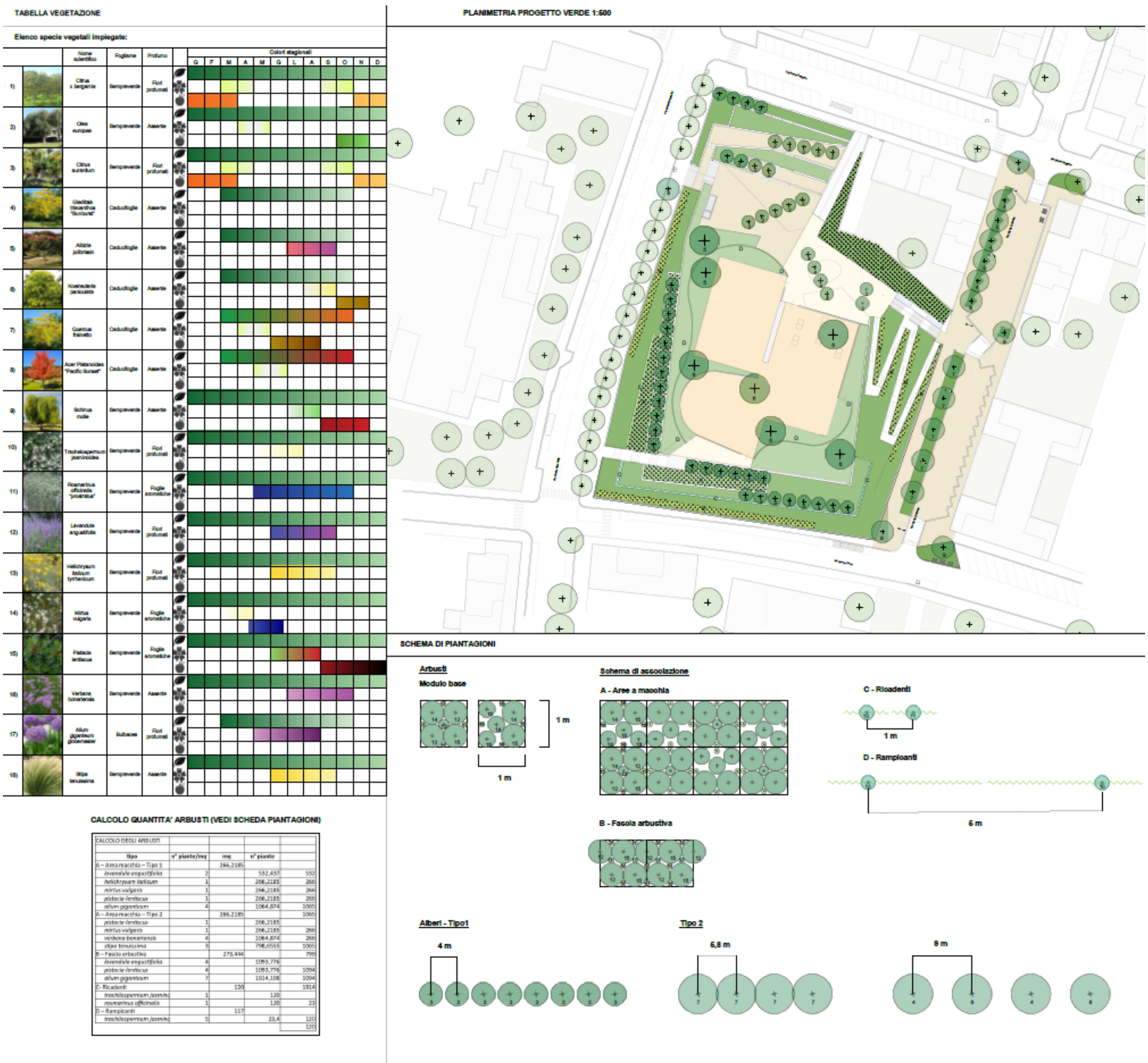
- **ABACO OPERE A VERDE**

Il progetto della vegetazione si articola nei seguenti elementi:

- Alberi isolati a creare punti di ombreggiamento nell'area sportiva
- Alberelli a filare a sottolineare i terrazzamenti e le aree di sosta
- Fasce di arbusti lungo le rampe e sui terrazzamenti
- Rampicanti e ricadenti lungo i muri di sostegno e contenimento del terreno
- Filari alberati in via Monte Soprano

La scelta delle specie vegetali tappezzanti, arbustive e arboree è idonea al tipo di areale in cui sono inserite (piante con clima mediterraneo) e risponde anche a quanto indicato dal PRG nelle linee guida per Qualità degli Interventi – Q2.

L'analisi come evidenziato nella tabella riassuntiva (colori, foglie, fiori, frutti) ha riguardato anche gli aspetti ornamentali al fine di fornire attrattività all'area durante tutti i mesi dell'anno.



Abaco Opere a Verde – Estratto Tav. 06

- **ABACO ARREDI E ATTREZZATURE**

Si riporta qui in seguito un estratto dell'abaco degli arredi e attrezzature con indicazione di materiali e tipologie da approfondire in fase di progetto esecutivo. In particolare sono indicati i riferimenti di:

- Panchine e sedute
- Recinzioni, pannelli sportivi e parapetti
- Giochi
- Attrezzature ginniche
- Nebulizzazione / Giochi d'acqua
- Attrezzature varie (cestini, rastrelliere bici)

Abaco Arredi e attrezzature – Estratto Tav. 09

VERIFICA INDICI URBANISTICI

Secondo quanto previsto dal PRG delle **NTA - Art. 85. Verde pubblico e servizi pubblici di livello locale,** del PRG di Roma, sono da verificare i seguenti parametri e grandezze urbanistico-ecologiche:

- ET: 0,5 mq/mq; 0,05 mq/mq per il verde pubblico; 0,25 mq/mq per il verde sportivo; 0,6 mq/mq per le attrezzature religiose (per le strutture esistenti sono consentiti interventi diretti di categoria MO, MS, RC, RE, nonché interventi di categoria DR ed AMP fino all'indice EF di 0,6 mq/mq);
- IP (ST): 30%; 75% per il verde pubblico;
- DA (ST): 20 alberi/Ha; DAR (ST): 40 arbusti/Ha;

Di seguito viene riportata la tabella di verifica degli indici urbanistici a seguito della quale si può concludere che il progetto risulta congruo e verificato.

NORME TECNICHE DI ATTUAZIONE				
INDICI	**UM.**		**UM.**	**QT.**
ST			mq	7480,00
ET	mq/mq	0,05	mq	374,00
IP	% di ST	75,00%	mq	5610,00
DA	alberi/ha	20	alberi	14,96
DAR	arbusti/ha	40	arbusti	29,92
PROGETTO				
INDICI	**UM.**	**QT. PROGETTO**	**QT. NORME T. A.**	**VERIFICA**
ET	mq	14,63	374,00	SI
IP	mq	1426,52	5610,00	SI
DA	alberi	55	14,96	SI
DAR	arbusti	9036	29,92	SI

- **FATTIBILITÀ DELL'INTERVENTO**

Ai sensi dell'art. 18 del DPR 207/2010 ai fini della verifica della fattibilità dell'intervento si sintetizzano nella tabella sottostante i criteri di fattibilità analizzati e gli esiti delle indagini:

Criteri di fattibilità	*Sintesi degli esiti delle indagini*	*Localizzazione approfondimenti*
INDAGINI GEOLOGICHE / IDROGEOLOGICHE E IDRAULICHE	L'area non rileva particolari situazioni di rischio idrogeologico e idraulico, nel PRG viene classificata come *'Aree nelle quali le indicazioni dirette e/o indirette sono scarse; …possibile .. presenza di cavità sotterranee isolate e di limitata dimensione'.* Si rimanda alla relazione geologica per maggior approfondimento.	Relazione Tecnica
VINCOLI ARCHEOLOGICI E PAESAGGISTICI	NO. Area non interessata da vincoli archeologici, paesaggistici o culturali.	Relazione Tecnica
FASCE DI RISPETTO	NO. L'area di progetto non ricade in nessun tipo di fascia di rispetto.	Relazione Tecnica
DISPONIBILITA' DELLE AREE - CATASTO	L'area è indentificata al Foglio 267 dal Mappale 834. Il mappale e l'area stradale di Via Monta Soprano sono di proprietà di Roma Capitale. La mappa catastale riporta due incongruenze: - presenza dell'edificio abusivo realizzato precedentemente e abbattuto quale intervento di bonifica; - confine difforme rispetto allo stato dei luoghi del lotto residenziale sul lato nord est; ove necessario, quindi, andranno effettuate le opportune regolarizzazioni in termini di volture, frazionamenti ecc.	Relazione Tecnica
DISPOBILITA' PUBBLICI SERVIZI / ALLACCIAMENTI	L'area risulta già infrastrutturata (reti luce e acqua – smaltimento acque bianche e nere – rete elettrica). Nel QE, quadro B, sono stanziate le risorse necessarie per gli allacciamenti a tali reti. Si rimanda alla fase successiva la verifica dei punti di allaccio.	Relazione Illustrativa
INTERFERENZE	Non si ravvisano interferenze tra linee aeree esistenti ed eventuali lavorazioni di progetto. Si rimanda alla fase successiva la verifica di eventuali interferenze sotterranee non ravvisabili.	Relazione Illustrativa
ACCESSIBILITA'	Le aree di progetto risultano tutte accessibili	Relazione Illustrativa

Alla luce come di quanto sopra, l'intervento, descritto nei capitoli precedenti, risulta fattibile.

Per un'analisi più approfondita si rimanda alla relazione tecnica per gli aspetti di inquadramento urbanistico, per quelli catastali e di vincolo nonché allo studio di prefattibilità ambientale.

- **ACCERTAMENTO DELLA DISPONIBILITÀ O DELL'INTERFERENZA CON PUBBLICI SERVIZI E DELLE MODALITÀ DEI RELATIVI ALLACCIAMENTI**

L'area risulta in parte già infrastrutturata (reti luce e acqua – smaltimento acque bianche e nere – rete elettrica)
Si rimanda alle fasi successive la verifica delle interferenze con i sottoservizi.
Per gestori reti si veda Doc.02 Relazione Tecnica CENSIMENTO DELLE RETI DEI SOTTOSERVIZI.

- **INDIRIZZI PER LA REDAZIONE DELLE SUCCESSIVE FASI DI PROGETTO**

Nella definizione delle successive fasi di progetto si deve tener conto delle modifiche introdotte dall'entrata in vigore, a partire dal 1 luglio 2023, con Decreto legislativo 31 marzo 2023 - n. 36, del Nuovo Codice dei Contratti. Questo all'art. 41 stabilisce due soli livelli di progettazione: il progetto di fattibilità tecnico-economica e il progetto esecutivo.

Pur essendo l'incarico stato affidato nel 2022 e quindi in data precedente all'entrata in vigore del Nuovo Codice si è concordato di procedere alla redazione del PFTE secondo quanto previsto dalla nuova normativa. Pertanto il livello successivo di progetto al presente è costituito dalla redazione del Progetto Esecutivo secondo i contenuti definiti dall'allegato I.7 alla SEZIONE III - PROGETTO ESECUTIVO.

A seguito di quanto emerso dall'esito indagini, dal rilievo topografico, dalla documentazione acquisita da altri enti, e in relazione a quanto previsto dall'allegato I.7 del Dlgs 36\2023 all'art 22 comma 4 che stabilisce che " Il progetto esecutivo contiene la definizione finale di tutte le lavorazioni e, pertanto, descrive compiutamente e in ogni particolare architettonico, strutturale e impiantistico, l'intervento da realizzare" risulta inoltre necessario prevedere nella fase successiva di progetto:

- Approfondimento delle indagini geologiche e geotecniche (vedi relazione geologica)
- Perfezionamento e aggiornamento dei dati catastali con le opportune regolarizzazioni in termini di volture, frazionamenti etc.
- Aggiornamento della classificazione urbanistica dell'area quale area a Verde e Servizi Pubblici di Livello Locale
- Rilievo di dettaglio dei sottoservizi esistenti soprattutto sulle aree stradali e in particolare in via Monte Soprano con verifica di eventuali interferenze non riscontrabili in fase preliminare.

- **NORMATIVA DI RIFERIMENTO**

Di seguito si riporta la principale normativa in materia di verde pubblico:
- L.10/2013 "Norme per lo sviluppo degli spazi urbani";
- Linee guida per la gestione del verde urbano e prime indicazioni per una pianificazione sostenibile MATTM;
- Criteri Ambientali Minimi D.M. n.63 del 10.03.2020;
- D.lgs. n.34/2018 – L.R. n.39/2002, R.R. n. 7/2005 (verifica della sussistenza di raggruppamento arboreo ascrivibile ad area boscata);

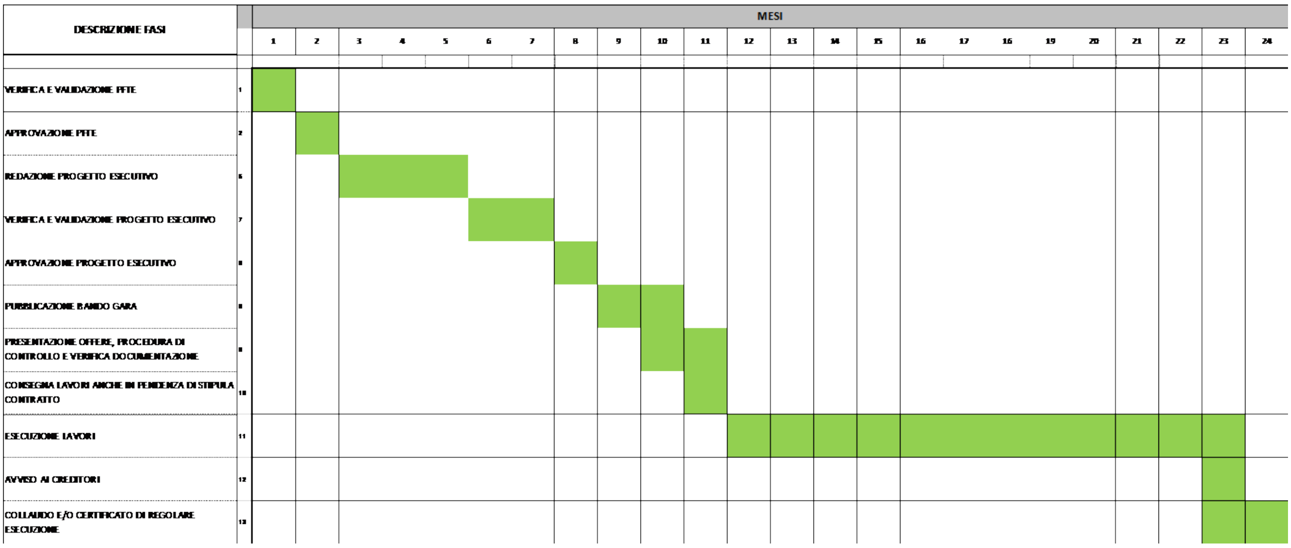
- Regolamento del Verde Pubblico e Privato e del Paesaggio di Roma Capitale D.A.C. n. 17/2021;
- Norme Tecniche di Attuazione del vigente P.R.G. di Roma Capitale;
- PAESC - Piano d'azione per l'energia sostenibile e il clima di Roma Capitale (testo di riferimento per la riduzione delle emissioni climalteranti);
- Deliberazione n. 2333 del 28.09.2021 "Indirizzi finalizzati alla predisposizione delle Linee Guida del Piano della Permeabilità dei Suoli –Progetto Europeo SOIL4LIFE -LIFE17;
- (cfr. "Inventario della flora vascolare alloctona d'Italia" in "Flora alloctona vascolare alloctona e invasiva delle Regioni di Italia" Celesti et all. 2010

Si segnalano inoltre la Determinazione Dirigenziale G14103 del 17 novembre 2021 della Regione Lazio n. G00683 di approvazione delle Linee Guida alla scelta di specie arboree e arbustive da utilizzare negli interventi di forestazione urbana e periurbana nel territorio della Regione Lazio e di alcuni elaborati del PRG utili alla definizione degli interventi progettuali sulla vegetazione nelle aree verdi (sezione elaborati gestionali).

- **CRONOPROGRAMMA DELLE FASI ATTUATIVE**

Nella definizione del cronoprogramma delle fasi attuative si deve tener conto delle modifiche introdotte dall'entrata in vigore con Decreto legislativo 31 marzo 2023, n. 36 del Nuovo Codice dei Contratti a partire dal 1 luglio 2023.

Di seguito quindi il cronoprogramma delle fasi attuative, con l'indicazione dei tempi massimi di svolgimento delle varie attività di progettazione, approvazione, affidamento, esecuzione e collaudo.



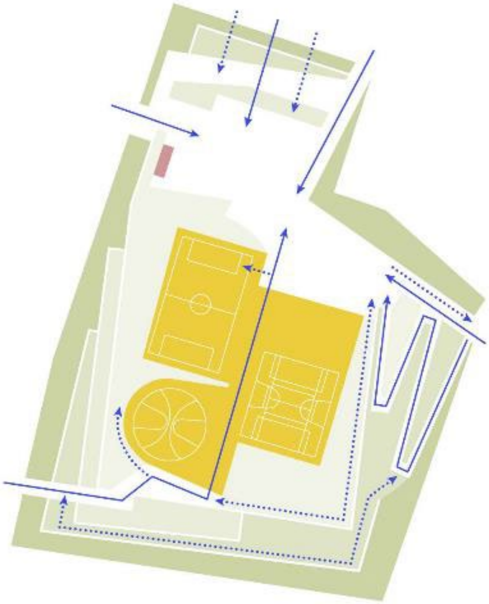
Il tempo totale è pari a 24 mesi. Il tempo per l'esecuzione dei lavori si stima pari a 12 mesi.

- **INDICAZIONI SU ACCESSIBILITÀ, UTILIZZO E MANUTENZIONE**

L'area ad oggi presenta un solo accesso da nord, tramite una rampa pedonale e carrabile.

Il progetto mira a incrementare i punti di accesso per rendere l'area maggiormente fruibile, differenziando gli accessi con rampe, scale e gradonate utilizzabili dalle diverse tipologie di fruitori (carrozzine, passeggini, biciclette, mezzi di manutenzione…).

Accessi attuali



Accessi di progetto

Gli aspetti relativi a utilizzo e manutenzione verranno affrontati nelle successive fasi di progetto. Si ritiene in ogni caso segnalare la necessità di un adeguato programma di interventi manutentivi al fine di garantire l'uso dei luoghi, la corretta conduzione degli impianti e delle attrezzature, oltre all'efficienza e alla funzionalità delle opere realizzate.

- **ASPETTI ECONOMICI E FINANZIARI**

Come indicato nel documento relativo al Quadro Economico il DIP al cap. 9 - Quadro Economico stima un importo complessivo dell'intervento in € 1.500.000,00. Tale importo è stato considerato quale importo massimo per la realizzazione del LOTTO A

Di seguito quindi si riportano i dati relativi al computo metrico estimativo delle opere e al quadro economico complessivo per il LOTTO A

L'ammontare complessivo dei lavori è pari a 1.130.000,00 € (unmilionecentotrentamila euro), cifra alla quale vanno aggiunto gli oneri per la sicurezza calcolati per un importo pari a 40.000,00 € (quarantamila euro).

Se ne desume un quadro economico complessivo riassuntivo per lavori e somme a disposizione secondo la seguente tabella:

	QUADRO ECONOMICO – LOTTO A	
A	Importo dei lavori e delle forniture	
	totale importo lavori	1.170.000,00 €
B	Somme a disposizione dell'Amministrazione	
	totale somme a disposizione	330.000,00 €
	TOTALE A + B	1.500.000,00 €

IL QUADRO ECONOMICO COMPLESSIVO DA FINANZIARE PER IL LOTTO A AMMONTA QUINDI A 1.500.000,00 €

Risulta comunque utile riportare anche il Quadro Economico per gli stralci altri funzionali: Lotti B e C
I lotti B (via Monte Soprano e marciapiedi strade) e C (chiosco) che ammontano rispettivamente a:

B) 239.458,75 €

C) 70.000,00 €

comportano un valore complessivo delle opere pari a 309.458,75 € cifra alla quale vanno aggiunto gli oneri per la sicurezza calcolati per un importo pari a 12.378,35 €.

Se ne desume un quadro economico riassuntivo per lavori e somme a disposizione secondo la seguente tabella:

	QUADRO ECONOMICO – LOTTI B e C	
A	Importo dei lavori e delle forniture	
	totale importo lavori	321.837,10 €
B	Somme a disposizione dell'Amministrazione	
	totale somme a disposizione	108.162,90 €
	TOTALE A + B	430.000,00 €

IL QUADRO ECONOMICO DA FINANZIARE PER I LOTTI B e C AMMONTA QUINDI A 430.000,00 €

Per maggiori dettagli si rimanda all'elaborato relativo al Quadro Economico

- **ALLEGATO 01**

i-Tree
Ecosystem Analysis

Tufello_SE

Urban Forest Effects and Values
dicembre 2023

Summary

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. An assessment of the vegetation structure, function, and value of the Tufello_SE urban forest was conducted during 2023. Data from 6 trees located throughout Tufello_SE were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station.

- Number of trees: 6
- Tree Cover: 197 square meters
- Most common species of trees: Acer campestre, Gleditsia triacanthos, Quercus frainetto
- Percentage of trees less than 6" (15.2 cm) diameter: 50,0%
- Pollution Removal: 1,749 kilograms/year (€1,58/year)
- Carbon Storage: 930,7 kilograms (€150)
- Carbon Sequestration: 54,11 kilograms (€8,69/year)
- Oxygen Production: 144,3 kilograms/year
- Avoided Runoff: 2,401 cubic meters/year (€4,57/year)
- Building energy savings: N/A – data not collected
- Avoided carbon emissions: N/A – data not collected
- Replacement values: €6,04 thousand

Metric ton: 1000 kilograms
Monetary values € are reported in euros throughout the report except where noted.
Ecosystem service estimates are reported for trees.
With Complete Inventory Projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition. Oxygen production in Plot Inventory Projects is estimated from net carbon sequestration.

For an overview of i-Tree Eco methodology, see Appendix I. Data collection quality is determined by the local data collectors, over which i-Tree has no control.

Table of Contents

I. Tree Characteristics of the Urban Forest

The urban forest of Tufello_SE has 6 trees with a tree cover of Acer campestre. The three most common species are Acer campestre (33,3 percent), Gleditsia triacanthos (33,3 percent), and Quercus frainetto (33,3 percent).

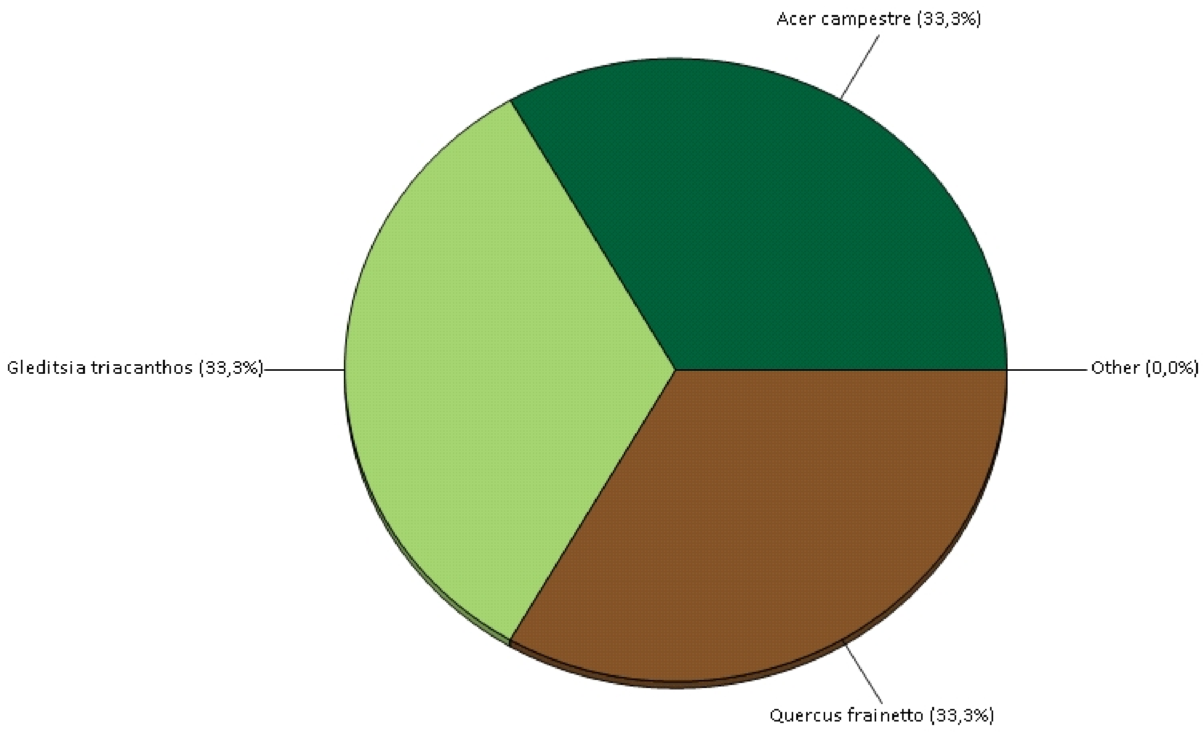


Figure 1. Tree species composition in Tufello_SE

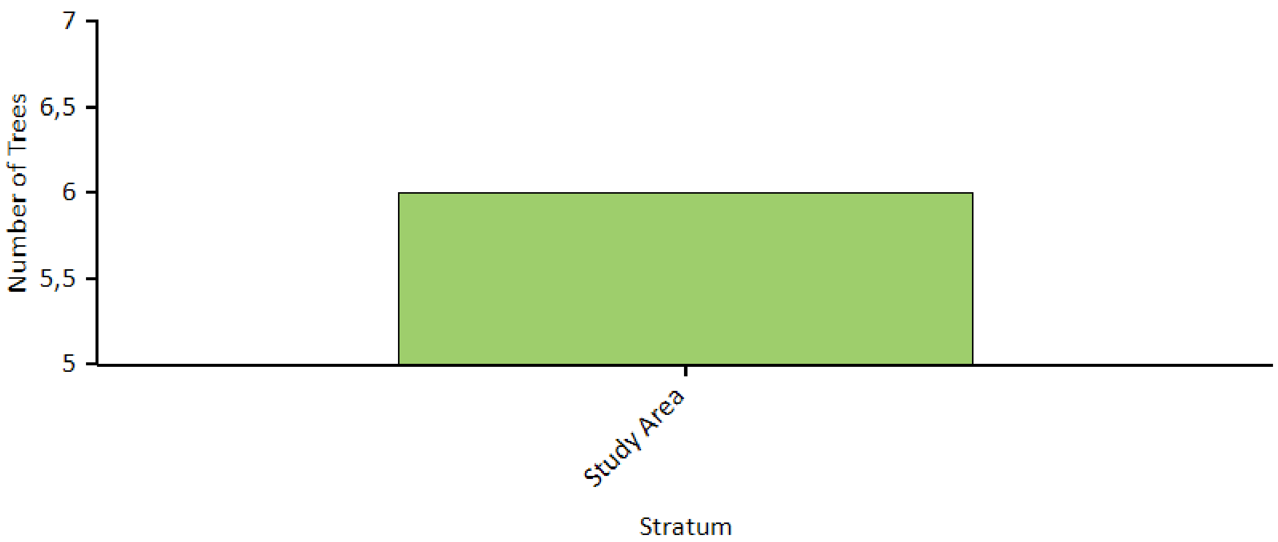


Figure 2. Number of trees in Tufello_SE by stratum

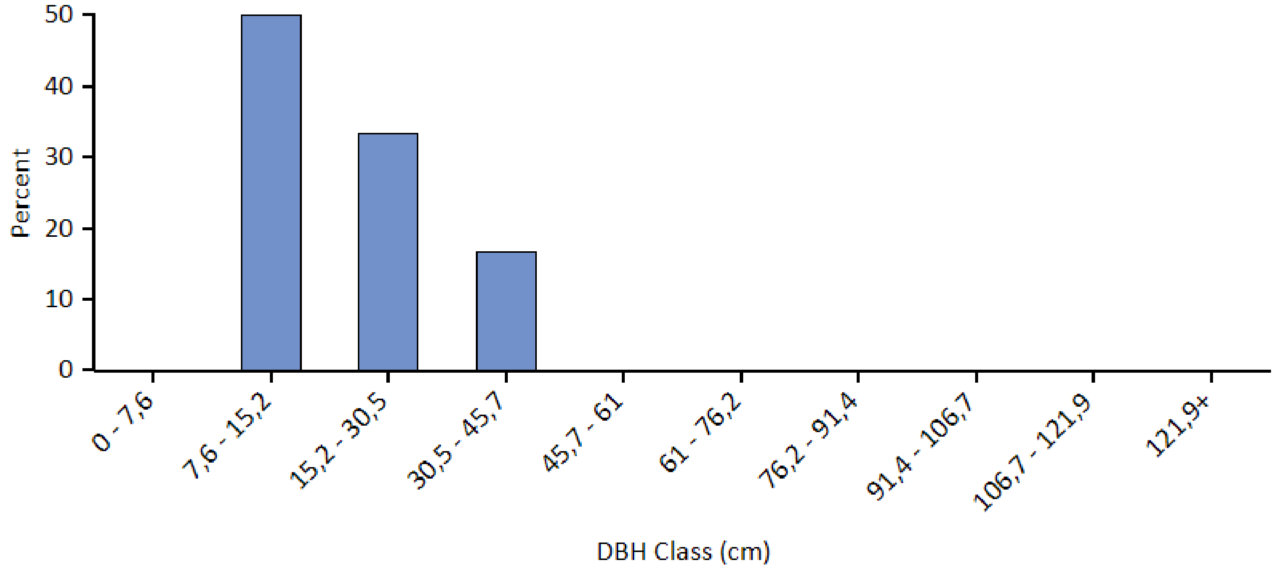


Figure 3. Percent of tree population by diameter class (DBH - stem diameter at 1.37 meters)

Urban forests are composed of a mix of native and exotic tree species. Thus, urban forests often have a tree diversity that is higher than surrounding native landscapes. Increased tree diversity can minimize the overall impact or destruction by a species-specific insect or disease, but it can also pose a risk to native plants if some of the exotic species are invasive plants that can potentially out-compete and displace native species. In Tufello_SE, about 33 percent of the trees are species native to Europe. Most trees have an origin from North America (33 percent of the trees).

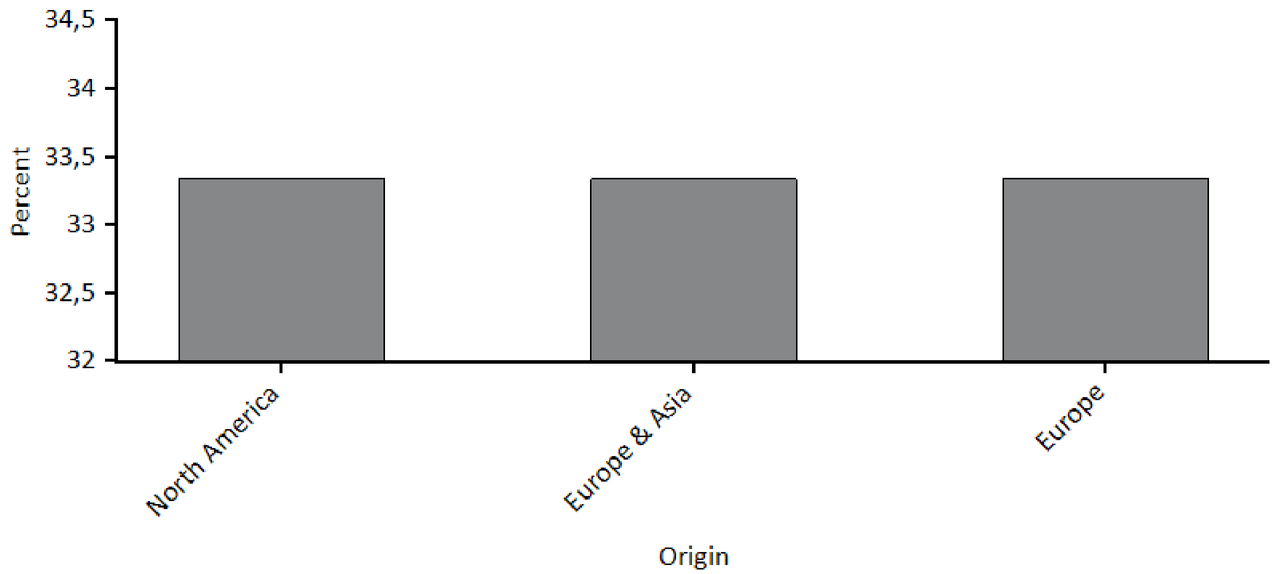


Figure 4. Percent of live tree population by area of native origin, Tufello_SE

Invasive plant species are often characterized by their vigor, ability to adapt, reproductive capacity, and general lack of natural enemies. These abilities enable them to displace native plants and make them a threat to natural areas.

II. Urban Forest Cover and Leaf Area

Many tree benefits equate directly to the amount of healthy leaf surface area of the plant. Trees cover about 197 square meters of Tufello_SE and provide 0,103 hectares of leaf area.

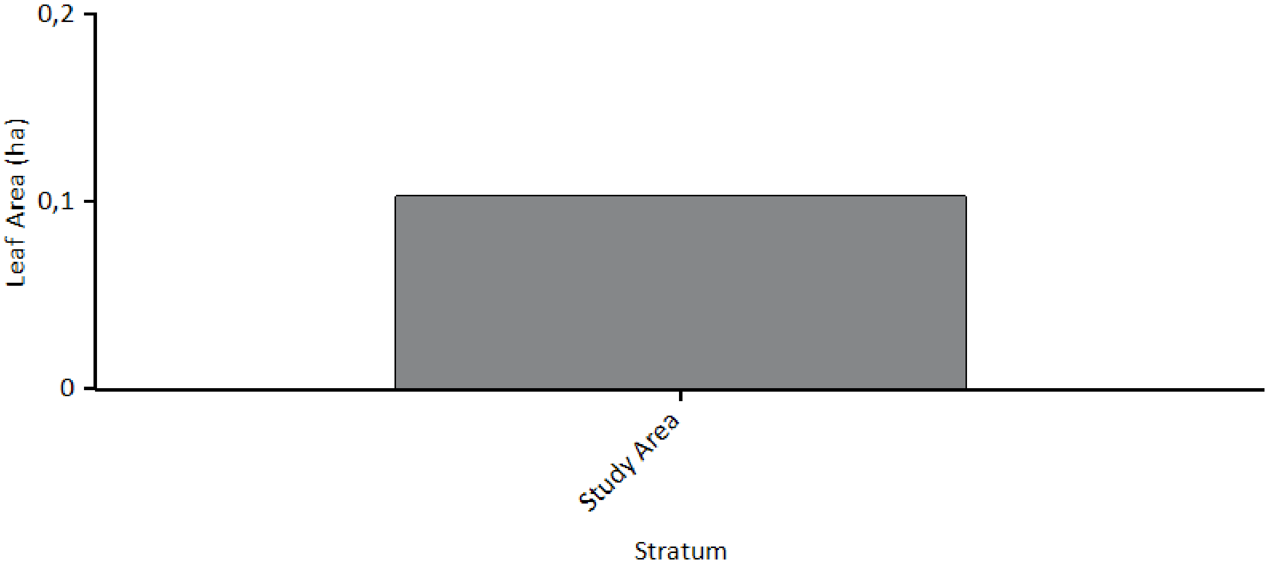


Figure 5. Leaf area by stratum, Tufello_SE

In Tufello_SE, the most dominant species in terms of leaf area are Acer campestre, Quercus frainetto, and Gleditsia triacanthos. The 3 species with the greatest importance values are listed in Table 1. Importance values (IV) are calculated as the sum of percent population and percent leaf area. High importance values do not mean that these trees should necessarily be encouraged in the future; rather these species currently dominate the urban forest structure.

Table 1. Most important species in Tufello_SE

Species Name	*Percent Population*	*Percent Leaf Area*	*IV*
Acer campestre	33,3	46,9	80,3
Quercus frainetto	33,3	33,1	66,4
Gleditsia triacanthos	33,3	20,0	53,3

Common ground cover classes (including cover types beneath trees and shrubs) in Tufello_SE are not available since they are configured not to be collected.

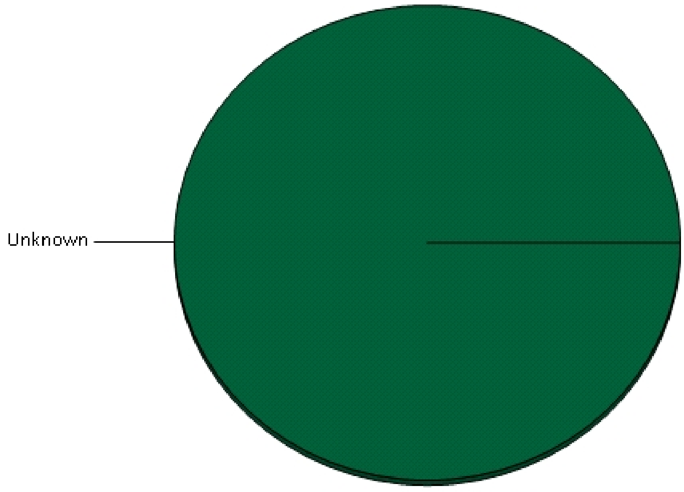


Figure 6. Percent of land by ground cover classes, Tufello_SE

III. Air Pollution Removal by Urban Trees

Poor air quality is a common problem in many urban areas. It can lead to decreased human health, damage to landscape materials and ecosystem processes, and reduced visibility. The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power sources. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation (Nowak and Dwyer 2000).

Pollution removal[1] by trees in Tufello_SE was estimated using field data and recent available pollution and weather data available. Pollution removal was greatest for ozone (Figure 7). It is estimated that trees remove 1,749 kilograms of air pollution (ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter less than 2.5 microns (PM2.5), particulate matter less than 10 microns and greater than 2.5 microns (PM10*)[2], and sulfur dioxide (SO2)) per year with an associated value of €1,58 (see Appendix I for more details).

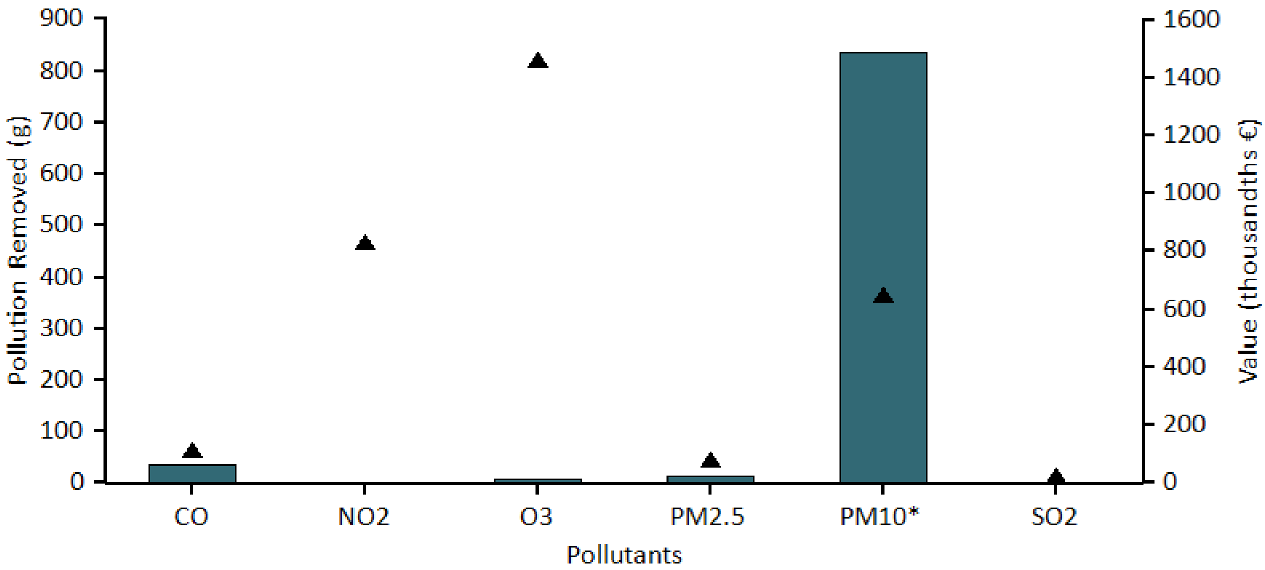


Figure 7. Annual pollution removal (points) and value (bars) by urban trees, Tufello_SE

[1] PM10* is particulate matter less than 10 microns and greater than 2.5 microns. PM2.5 is particulate matter less than 2.5 microns. If PM2.5 is not monitored, PM10* represents particulate matter less than 10 microns. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

[2] Trees remove PM2.5 and PM10* when particulate matter is deposited on leaf surfaces. This deposited PM2.5 and PM10* can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors (see Appendix I for more details).

In 2023, trees in Tufello_SE emitted an estimated 2,185 kilograms of volatile organic compounds (VOCs) (0,9504 kilograms of isoprene and 1,235 kilograms of monoterpenes). Emissions vary among species based on species characteristics (e.g. some genera such as oaks are high isoprene emitters) and amount of leaf biomass. One hundred percent of the urban forest's VOC emissions were from Quercus frainetto and Acer campestre. These VOCs are precursor chemicals to ozone formation.[3]

General recommendations for improving air quality with trees are given in Appendix VIII.

[3] Some economic studies have estimated VOC emission costs. These costs are not included here as there is a tendency to add positive dollar estimates of ozone removal effects with negative dollar values of VOC emission effects to determine whether tree effects are positive or negative in relation to ozone. This combining of dollar values to determine tree effects should not be done, rather estimates of VOC effects on ozone formation (e.g., via photochemical models) should be conducted and directly contrasted with ozone removal by trees (i.e., ozone effects should be directly compared, not dollar estimates). In addition, air temperature reductions by trees have been shown to significantly reduce ozone concentrations (Cardelino and Chameides 1990; Nowak et al 2000), but are not considered in this analysis. Photochemical modeling that integrates tree effects on air temperature, pollution removal, VOC emissions, and emissions from power plants can be used to determine the overall effect of trees on ozone concentrations.

IV. Carbon Storage and Sequestration

Climate change is an issue of global concern. Urban trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in tissue and by altering energy use in buildings, and consequently altering carbon dioxide emissions from fossil-fuel based power sources (Abdollahi et al 2000).

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees. The gross sequestration of Tufello_SE trees is about 54,11 kilograms of carbon per year with an associated value of €8,69. See Appendix I for more details on methods.

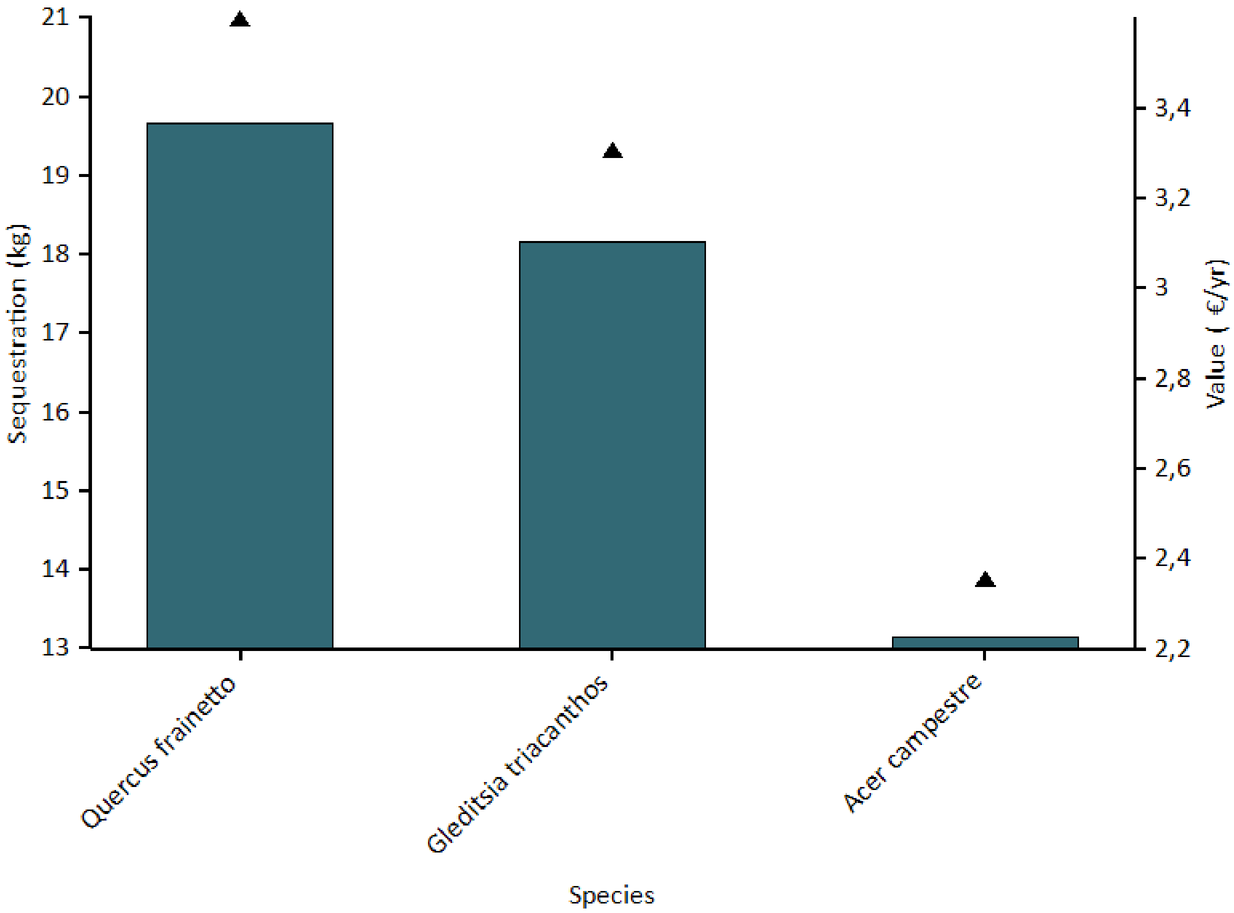


Figure 8. Estimated annual gross carbon sequestration (points) and value (bars) for urban tree species with the greatest sequestration, Tufello_SE

Carbon storage is another way trees can influence global climate change. As a tree grows, it stores more carbon by holding it in its accumulated tissue. As a tree dies and decays, it releases much of the stored carbon back into the atmosphere. Thus, carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose. Maintaining healthy trees will keep the carbon stored in trees, but tree maintenance can contribute to carbon emissions (Nowak et al 2002c). When a tree dies, using the wood in long-term wood products, to heat buildings, or to produce energy will help reduce carbon emissions from wood decomposition or from fossil-fuel or wood-based power plants.

Trees in Tufello_SE are estimated to store 0,931 metric tons of carbon (€150). Of the species sampled, Acer campestre stores the most carbon (approximately 40,6% of the total carbon stored) and Quercus frainetto sequesters the most

(approximately 38,7% of all sequestered carbon.)

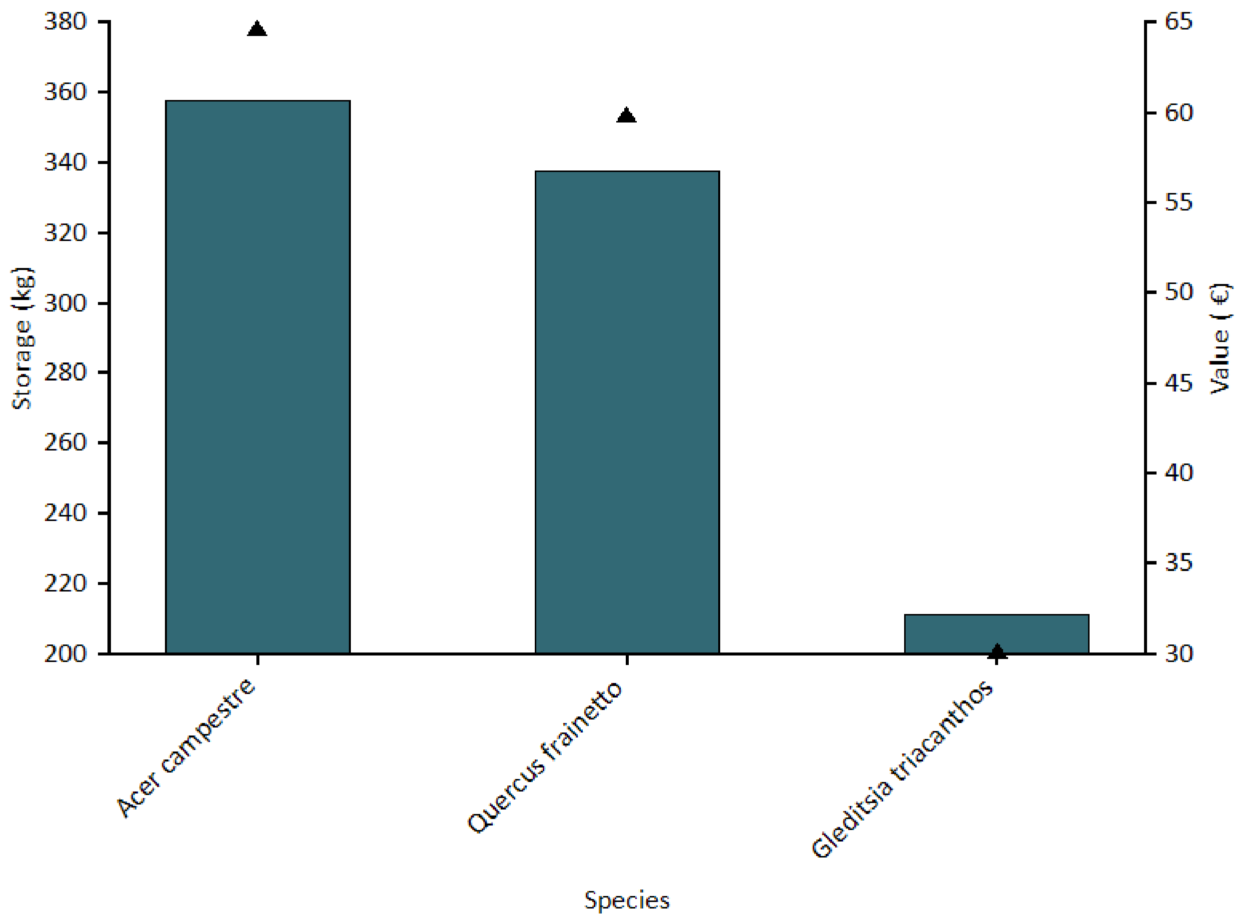


Figure 9. Estimated carbon storage (points) and values (bars) for urban tree species with the greatest storage, Tufello_SE

V. Oxygen Production

Oxygen production is one of the most commonly cited benefits of urban trees. The annual oxygen production of a tree is directly related to the amount of carbon sequestered by the tree, which is tied to the accumulation of tree biomass.

Trees in Tufello_SE are estimated to produce 144,3 kilograms of oxygen per year.[4] However, this tree benefit is relatively insignificant because of the large and relatively stable amount of oxygen in the atmosphere and extensive production by aquatic systems. Our atmosphere has an enormous reserve of oxygen. If all fossil fuel reserves, all trees, and all organic matter in soils were burned, atmospheric oxygen would only drop a few percent (Broecker 1970).

Table 2. The top 3 oxygen production species.

Species	*Oxygen (kilogram)*	*Gross Carbon Sequestration (kilogram/yr)*	*Number of Trees*	*Leaf Area (square meter)*
Quercus frainetto	55,89	20,96	2	0,00
Gleditsia triacanthos	51,46	19,30	2	0,00
Acer campestre	36,94	13,85	2	0,00

VI. Avoided Runoff

Surface runoff can be a cause for concern in many urban areas as it can contribute pollution to streams, wetlands, rivers, lakes, and oceans. During precipitation events, some portion of the precipitation is intercepted by vegetation (trees and shrubs) while the other portion reaches the ground. The portion of the precipitation that reaches the ground and does not infiltrate into the soil becomes surface runoff (Hirabayashi 2012). In urban areas, the large extent of impervious surfaces increases the amount of surface runoff.

Urban trees and shrubs, however, are beneficial in reducing surface runoff. Trees and shrubs intercept precipitation, while their root systems promote infiltration and storage in the soil. The trees and shrubs of Tufello_SE help to reduce runoff by an estimated 2,4 cubic meters a year with an associated value of €4,6 (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user-designated weather station. In Tufello_SE, the total annual precipitation in 2015 was 81,6 centimeters.

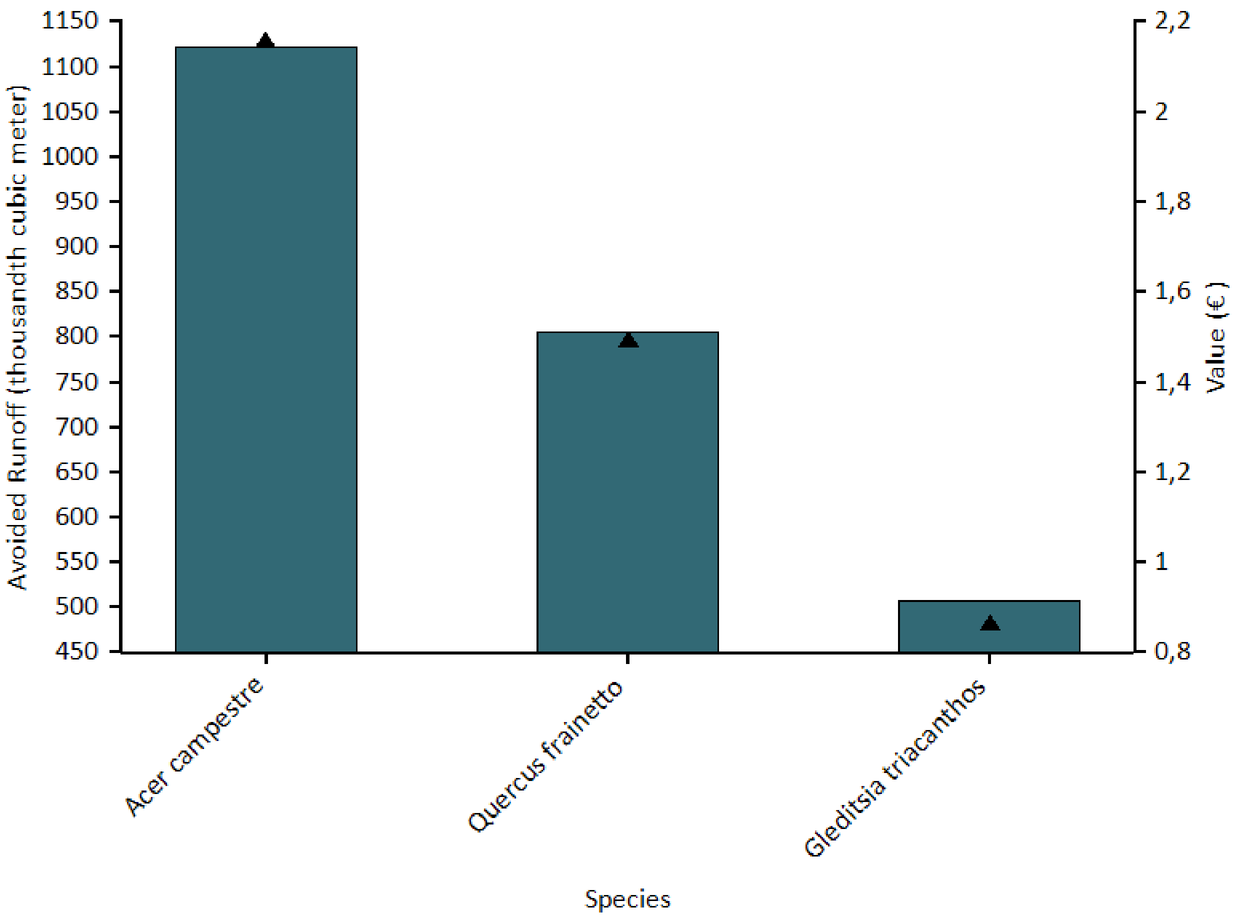


Figure 10. Avoided runoff (points) and value (bars) for species with greatest overall impact on runoff, Tufello_SE

VII. Trees and Building Energy Use

Trees affect energy consumption by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months and can either increase or decrease building energy use in the winter months, depending on the location of trees around the building. Estimates of tree effects on energy use are based on field measurements of tree distance and direction to space conditioned residential buildings (McPherson and Simpson 1999).

Because energy-related data were not collected, energy savings and carbon avoided cannot be calculated.

Table 3. Annual energy savings due to trees near residential buildings, Tufello_SE

	Heating	*Cooling*	*Total*
MBTU[a]	0	N/A	0
MWH[b]	0	0	0
Carbon Avoided (kilograms)	0	0	0

[a]MBTU - one million British Thermal Units
[b]MWH - megawatt-hour

Table 4. Annual savings [a](€) in residential energy expenditure during heating and cooling seasons, Tufello_SE

	Heating	*Cooling*	*Total*
MBTU[b]	0	N/A	0
MWH[c]	0	0	0
Carbon Avoided	0	0	0

[b]Based on the prices of €214 per MWH and €20,5149700574282 per MBTU (see Appendix I for more details)
[c]MBTU - one million British Thermal Units
[c]MWH - megawatt-hour

[5] Trees modify climate, produce shade, and reduce wind speeds. Increased energy use or costs are likely due to these tree-building interactions creating a cooling effect during the winter season. For example, a tree (particularly evergreen species) located on the southern side of a residential building may produce a shading effect that causes increases in heating requirements.

VIII. Replacement and Functional Values

Urban forests have a replacement value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The replacement value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al 2002a). Annual functional values also tend to increase with increased number and size of healthy trees. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Urban trees in Tufello_SE have the following replacement values:

- Replacement value: €6,04 thousand
- Carbon storage: €150

Urban trees in Tufello_SE have the following annual functional values:

- Carbon sequestration: €8,69
- Avoided runoff: €4,57
- Pollution removal: €1,58
- Energy costs and carbon emission values: €0

(Note: negative value indicates increased energy cost and carbon emission value)

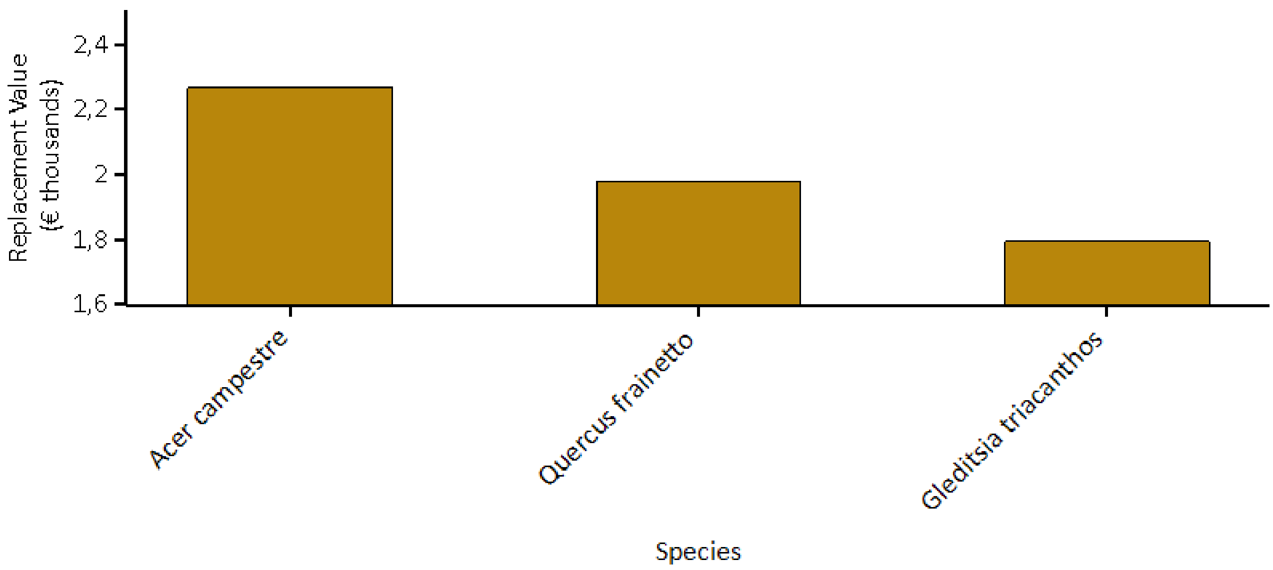


Figure 11. Tree species with the greatest replacement value, Tufello_SE

IX. Potential Pest Impacts

Various insects and diseases can infest urban forests, potentially killing trees and reducing the health, replacement value and sustainability of the urban forest. As pests tend to have differing tree hosts, the potential damage or risk of each pest will differ among cities.Fifty-three pests were analyzed for their potential impact.

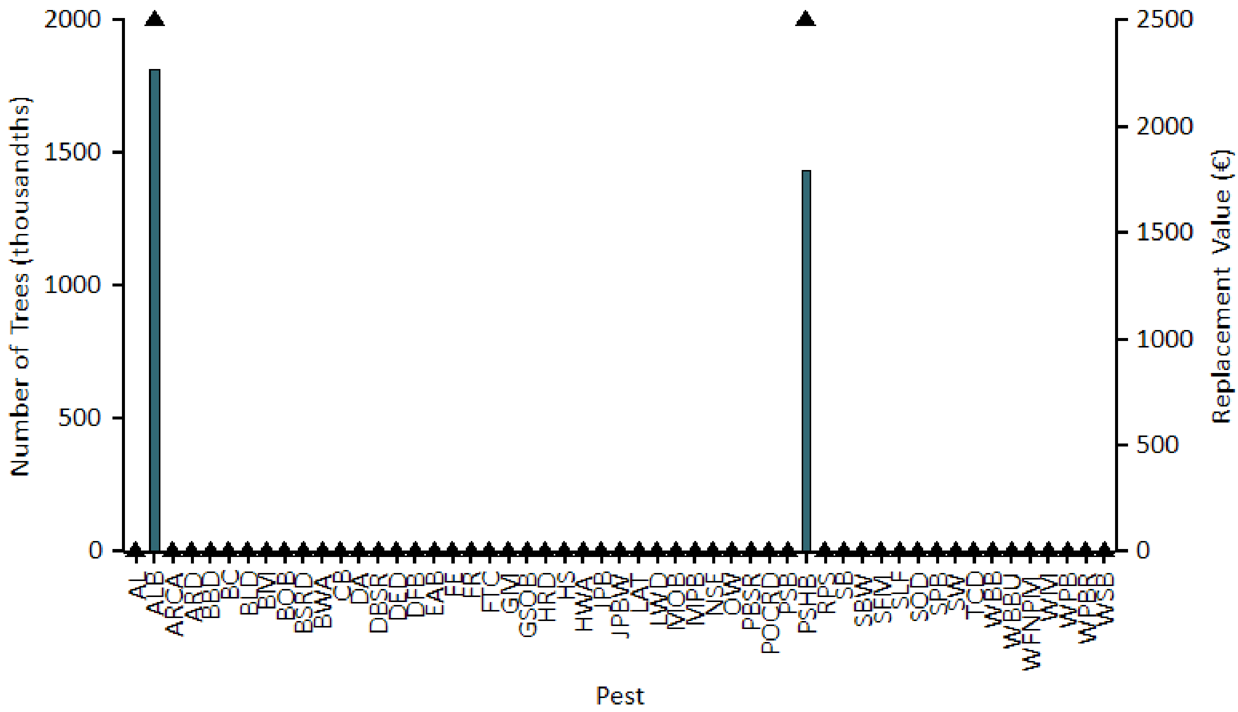


Figure 12. Number of trees at risk (points) and associated compensatory value (bars) by potential pests, Tufello_SE

Aspen leafminer (AL) (Kruse et al 2007) is an insect that causes damage primarily to trembling or small tooth aspen by larval feeding of leaf tissue. AL has the potential to affect 0,0 percent of the population (€0 in replacement value).

Asian longhorned beetle (ALB) (Animal and Plant Health Inspection Service 2010) is an insect that bores into and kills a wide range of hardwood species. ALB poses a threat to 33,3 percent of the Tufello_SE urban forest, which represents a potential loss of €2,27 thousand in replacement value.

Aspen Running Canker (ARCA) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Armillaria Root Disease (ARD) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Beech bark disease (BBD) (Houston and O'Brien 1983) is an insect-disease complex that primarily impacts American beech. This disease threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Butternut canker (BC) (Ostry et al 1996) is caused by a fungus that infects butternut trees. The disease has since caused significant declines in butternut populations in the United States. Potential loss of trees from BC is 0,0 percent (€0 in replacement value).

Beech Leaf Disease (BLD) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Browntail Moth (BM) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Bur Oak Blight (BOB) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Black Stain Root Disease (BSRD) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Balsam woolly adelgid (BWA) (Ragenovich and Mitchell 2006) is an insect that has caused significant damage to the true firs of North America. Tufello_SE could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

The most common hosts of the fungus that cause chestnut blight (CB) (Diller 1965) are American and European chestnut. CB has the potential to affect 0,0 percent of the population (€0 in replacement value).

Dogwood anthracnose (DA) (Mielke and Daughtrey) is a disease that affects dogwood species, specifically flowering and Pacific dogwood. This disease threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Douglas-fir black stain root disease (DBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks Douglas-firs. Tufello_SE could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

American elm, one of the most important street trees in the twentieth century, has been devastated by the Dutch elm disease (DED) (Northeastern Area State and Private Forestry 1998). Since first reported in the 1930s, it has killed over 50 percent of the native elm population in the United States. Although some elm species have shown varying degrees of resistance, Tufello_SE could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

Douglas-fir beetle (DFB) (Schmitz and Gibson 1996) is a bark beetle that infests Douglas-fir trees throughout the western United States, British Columbia, and Mexico. Potential loss of trees from DFB is 0,0 percent (€0 in replacement value).

Emerald ash borer (EAB) (Michigan State University 2010) has killed thousands of ash trees in parts of the United States. EAB has the potential to affect 0,0 percent of the population (€0 in replacement value).

One common pest of white fir, grand fir, and red fir trees is the fir engraver (FE) (Ferrell 1986). FE poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Fusiform rust (FR) (Phelps and Czabator 1978) is a fungal disease that is distributed in the southern United States. It is particularly damaging to slash pine and loblolly pine. FR has the potential to affect 0,0 percent of the population (€0 in replacement value).

Forest Tent Caterpillar (FTC) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

The gypsy moth (GM) (Northeastern Area State and Private Forestry 2005) is a defoliator that feeds on many species causing widespread defoliation and tree death if outbreak conditions last several years. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Infestations of the goldspotted oak borer (GSOB) (Society of American Foresters 2011) have been a growing problem in southern California. Potential loss of trees from GSOB is 0,0 percent (€0 in replacement value).

Heterobasidion Root Disease (HRD) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Hemlock Sawfly (HS) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

As one of the most damaging pests to eastern hemlock and Carolina hemlock, hemlock woolly adelgid (HWA) (U.S. Forest Service 2005) has played a large role in hemlock mortality in the United States. HWA has the potential to affect 0,0 percent of the population (€0 in replacement value).

The Jeffrey pine beetle (JPB) (Smith et al 2009) is native to North America and is distributed across California, Nevada, and Oregon where its only host, Jeffrey pine, also occurs. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Jack Pine Budworm (JPBW) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Quaking aspen is a principal host for the defoliator, large aspen tortrix (LAT) (Ciesla and Kruse 2009). LAT poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Laurel wilt (LWD) (U.S. Forest Service 2011) is a fungal disease that is introduced to host trees by the redbay ambrosia beetle. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Mediterranean Oak Borer (MOB) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Mountain pine beetle (MPB) (Gibson et al 2009) is a bark beetle that primarily attacks pine species in the western United States. MPB has the potential to affect 0,0 percent of the population (€0 in replacement value).

The northern spruce engraver (NSE) (Burnside et al 2011) has had a significant impact on the boreal and sub-boreal forests of North America where the pest's distribution overlaps with the range of its major hosts. Potential loss of trees from NSE is 0,0 percent (€0 in replacement value).

Oak wilt (OW) (Rexrode and Brown 1983), which is caused by a fungus, is a prominent disease among oak trees. OW poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Pine black stain root disease (PBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks hard pines, including lodgepole pine, Jeffrey pine, and ponderosa pine. Tufello_SE could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

Port-Orford-cedar root disease (POCRD) (Liebhold 2010) is a root disease that is caused by a fungus. POCRD threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

The pine shoot beetle (PSB) (Ciesla 2001) is a wood borer that attacks various pine species, though Scotch pine is the preferred host in North America. PSB has the potential to affect 0,0 percent of the population (€0 in replacement value).

Polyphagous shot hole borer (PSHB) (University of California 2014) is a boring beetle that was first detected in California. Tufello_SE could possibly lose 33,3 percent of its trees to this pest (€1,79 thousand in replacement value).

Red Pine Scale (RPS) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Spruce beetle (SB) (Holsten et al 1999) is a bark beetle that causes significant mortality to spruce species within its range. Potential loss of trees from SB is 0,0 percent (€0 in replacement value).

Spruce budworm (SBW) (Kucera and Orr 1981) is an insect that causes severe damage to balsam fir. SBW poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Subalpine Fir Mortality (SFM) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Spotted Lanternfly (SLF) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Sudden oak death (SOD) (Kliejunas 2005) is a disease that is caused by a fungus. Potential loss of trees from SOD is 0,0 percent (€0 in replacement value).

Although the southern pine beetle (SPB) (Clarke and Nowak 2009) will attack most pine species, its preferred hosts are loblolly, Virginia, pond, spruce, shortleaf, and sand pines. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

The sirex woodwasp (SW) (Haugen and Hoebeke 2005) is a wood borer that primarily attacks pine species. SW poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Thousand canker disease (TCD) (Cranshaw and Tisserat 2009; Seybold et al 2010) is an insect-disease complex that kills several species of walnuts, including black walnut. Potential loss of trees from TCD is 0,0 percent (€0 in replacement value).

Western Bark Beetle (WBB) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Western Blackheaded Budworm (WBBU) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Western Five-Needle Pine Mortality (WFNPM) poses a threat to 0,0 percent of the Tufello_SE urban forest, which represents a potential loss of €0 in replacement value.

Winter moth (WM) (Childs 2011) is a pest with a wide range of host species. WM causes the highest levels of injury to its hosts when it is in its caterpillar stage. Tufello_SE could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

The western pine beetle (WPB) (DeMars and Roettgering 1982) is a bark beetle and aggressive attacker of ponderosa and Coulter pines. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Since its introduction to the United States in 1900, white pine blister rust (Eastern U.S.) (WPBR) (Nicholls and Anderson 1977) has had a detrimental effect on white pines, particularly in the Lake States. WPBR has the potential to affect 0,0 percent of the population (€0 in replacement value).

Western spruce budworm (WSB) (Fellin and Dewey 1986) is an insect that causes defoliation in western conifers. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Appendix I. i-Tree Eco Model and Field Measurements

i-Tree Eco is designed to use standardized field data and local hourly air pollution and meteorological data to quantify urban forest structure and its numerous effects (Nowak and Crane 2000), including:

- Urban forest structure (e.g., species composition, tree health, leaf area, etc.).
- Amount of pollution removed hourly by the urban forest, and its associated percent air quality improvement throughout a year.
- Total carbon stored and net carbon annually sequestered by the urban forest.
- Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power sources.
- Replacement value of the forest, as well as the value for air pollution removal and carbon storage and sequestration.
- Potential impact of infestations by pests, such as Asian longhorned beetle, emerald ash borer, gypsy moth, and Dutch elm disease.

Typically, all field data are collected during the leaf-on season to properly assess tree canopies. Typical data collection (actual data collection may vary depending upon the user) includes land use, ground and tree cover, individual tree attributes of species, stem diameter, height, crown width, crown canopy missing and dieback, and distance and direction to residential buildings (Nowak et al 2005; Nowak et al 2008).

During data collection, trees are identified to the most specific taxonomic classification possible. Trees that are not classified to the species level may be classified by genus (e.g., ash) or species groups (e.g., hardwood). In this report, tree species, genera, or species groups are collectively referred to as tree species.

<u>Tree Characteristics:</u>

Leaf area of trees was assessed using measurements of crown dimensions and percentage of crown canopy missing. In the event that these data variables were not collected, they are estimated by the model.

An analysis of invasive species is not available for studies outside of the United States. For the U.S., invasive species are identified using an invasive species list for the state in which the urban forest is located. These lists are not exhaustive and they cover invasive species of varying degrees of invasiveness and distribution. In instances where a state did not have an invasive species list, a list was created based on the lists of the adjacent states. Tree species that are identified as invasive by the state invasive species list are cross-referenced with native range data. This helps eliminate species that are on the state invasive species list, but are native to the study area.

<u>Air Pollution Removal:</u>

Pollution removal is calculated for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter less than 2.5 microns, and particulate matter less than 10 microns and greater than 2.5 microns. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

Air pollution removal estimates are derived from calculated hourly tree-canopy resistances for ozone, and sulfur and nitrogen dioxides based on a hybrid of big-leaf and multi-layer canopy deposition models (Baldocchi 1988; Baldocchi et al 1987). As the removal of carbon monoxide and particulate matter by vegetation is not directly related to transpiration, removal rates (deposition velocities) for these pollutants were based on average measured values from the literature (Bidwell and Fraser 1972; Lovett 1994) that were adjusted depending on leaf phenology and leaf area. Particulate removal incorporated a 50 percent resuspension rate of particles back to the atmosphere (Zinke 1967). Recent updates (2011) to air quality modeling are based on improved leaf area index simulations, weather and pollution processing and interpolation, and updated pollutant monetary values (Hirabayashi et al 2011; Hirabayashi et al 2012; Hirabayashi 2011).

Trees remove PM2.5 and PM10* when particulate matter is deposited on leaf surfaces (Nowak et al 2013). This deposited PM2.5 and PM10* can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors. Generally, PM2.5 and PM10* removal is positive with positive benefits. However, there are some cases when net removal is negative or resuspended particles lead to increased pollution concentrations and negative values. During some months (e.g., with no rain), trees resuspend more particles than they remove. Resuspension can also lead to increased overall PM2.5 and PM10* concentrations if the boundary layer conditions are lower during net resuspension periods than during net removal periods. Since the pollution removal value is based on the change in pollution concentration, it is possible to have situations when trees remove PM2.5 and PM10* but increase concentrations and thus have negative values during periods of positive overall removal. These events are not common, but can happen.

For reports in the United States, default air pollution removal value is calculated based on local incidence of adverse health effects and national median externality costs. The number of adverse health effects and associated economic value is calculated for ozone, sulfur dioxide, nitrogen dioxide, and particulate matter less than 2.5 microns using data from the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program (BenMAP) (Nowak et al 2014). The model uses a damage-function approach that is based on the local change in pollution concentration and population. National median externality costs were used to calculate the value of carbon monoxide removal (Murray et al 1994).

For international reports, user-defined local pollution values are used. For international reports that do not have local values, estimates are based on either European median externality values (van Essen et al 2011) or BenMAP regression equations (Nowak et al 2014) that incorporate user-defined population estimates. Values are then converted to local currency with user-defined exchange rates.

For this analysis, pollution removal value is calculated based on the prices of €1.100 per metric ton (carbon monoxide), €12 per metric ton (ozone), €1 per metric ton (nitrogen dioxide), €0 per metric ton (sulfur dioxide), €498 per metric ton (particulate matter less than 2.5 microns), €4.121 per metric ton (particulate matter less than 10 microns and greater than 2.5 microns).

Carbon Storage and Sequestration:

Carbon storage is the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation. To calculate current carbon storage, biomass for each tree was calculated using equations from the literature and measured tree data. Open-grown, maintained trees tend to have less biomass than predicted by forest-derived biomass equations (Nowak 1994). To adjust for this difference, biomass results for open-grown urban trees were multiplied by 0.8. No adjustment was made for trees found in natural stand conditions. Tree dry-weight biomass was converted to stored carbon by multiplying by 0.5.

Carbon sequestration is the removal of carbon dioxide from the air by plants. To estimate the gross amount of carbon sequestered annually, average diameter growth from the appropriate genera and diameter class and tree condition was added to the existing tree diameter (year x) to estimate tree diameter and carbon storage in year x+1.

Carbon storage and carbon sequestration values are based on estimated or customized local carbon values. For international reports that do not have local values, estimates are based on the carbon value for the United States (U.S. Environmental Protection Agency 2015, Interagency Working Group on Social Cost of Carbon 2015) and converted to local currency with user-defined exchange rates.

For this analysis, carbon storage and carbon sequestration values are calculated based on €161 per metric ton.

Oxygen Production:

The amount of oxygen produced is estimated from carbon sequestration based on atomic weights: net O2 release (kg/yr) = net C sequestration (kg/yr) × 32/12. To estimate the net carbon sequestration rate, the amount of carbon sequestered as a result of tree growth is reduced by the amount lost resulting from tree mortality. Thus, net carbon sequestration and net annual oxygen production of the urban forest account for decomposition (Nowak et al 2007). For complete inventory projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition.

Avoided Runoff:

Annual avoided surface runoff is calculated based on rainfall interception by vegetation, specifically the difference between annual runoff with and without vegetation. Although tree leaves, branches, and bark may intercept precipitation and thus mitigate surface runoff, only the precipitation intercepted by leaves is accounted for in this analysis.

The value of avoided runoff is based on estimated or user-defined local values. For international reports that do not have local values, the national average value for the United States is utilized and converted to local currency with user-defined exchange rates. The U.S. value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series (McPherson et al 1999; 2000; 2001; 2002; 2003; 2004; 2006a; 2006b; 2006c; 2007; 2010; Peper et al 2009; 2010; Vargas et al 2007a; 2007b; 2008).

For this analysis, avoided runoff value is calculated based on the price of €1,90 per cubic meter.

Building Energy Use:

If appropriate field data were collected, seasonal effects of trees on residential building energy use were calculated based on procedures described in the literature (McPherson and Simpson 1999) using distance and direction of trees from residential structures, tree height and tree condition data. To calculate the monetary value of energy savings, local or custom prices per MWH or MBTU are utilized.

For this analysis, energy saving value is calculated based on the prices of €214,00 per MWH and €20,51 per MBTU.

Replacement Values:

Replacement value is the value of a tree based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree). Replacement values were based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al 2002a; 2002b). Replacement value may not be included for international projects if there is insufficient local data to complete the valuation procedures.

Potential Pest Impacts:

The complete potential pest risk analysis is not available for studies outside of the United States. The number of trees at risk to the pests analyzed is reported, though the list of pests is based on known insects and disease in the United States.

For the U.S., potential pest risk is based on pest range maps and the known pest host species that are likely to experience mortality. Pest range maps for 2012 from the Forest Health Technology Enterprise Team (FHTET) (Forest Health Technology Enterprise Team 2014) were used to determine the proximity of each pest to the county in which the urban forest is located. For the county, it was established whether the insect/disease occurs within the county, is within 400 kilometers of the county edge, is between 400 and 1210 kilometers away, or is greater than 1210 kilometers away. FHTET did not have pest range maps for Dutch elm disease and chestnut blight. The range of these pests was based on known occurrence and the host range, respectively (Eastern Forest Environmental Threat Assessment Center; Worrall 2007).

Relative Tree Effects:

The relative value of tree benefits reported in Appendix II is calculated to show what carbon storage and sequestration, and air pollutant removal equate to in amounts of municipal carbon emissions, passenger automobile emissions, and house emissions.

Municipal carbon emissions are based on 2010 U.S. per capita carbon emissions (Carbon Dioxide Information Analysis Center 2010). Per capita emissions were multiplied by city population to estimate total city carbon emissions.

Light duty vehicle emission rates (g/mi) for CO, NOx, VOCs, PM10, SO2 for 2010 (Bureau of Transportation Statistics 2010; Heirigs et al 2004), PM2.5 for 2011-2015 (California Air Resources Board 2013), and CO2 for 2011 (U.S.

Environmental Protection Agency 2010) were multiplied by average miles driven per vehicle in 2011 (Federal Highway Administration 2013) to determine average emissions per vehicle.

Household emissions are based on average electricity kWh usage, natural gas Btu usage, fuel oil Btu usage, kerosene Btu usage, LPG Btu usage, and wood Btu usage per household in 2009 (Energy Information Administration 2013; Energy Information Administration 2014)

- CO_2, SO_2, and NO_x power plant emission per KWh are from Leonardo Academy 2011. CO emission per kWh assumes 1/3 of one percent of C emissions is CO based on Energy Information Administration 1994. PM_{10} emission per kWh from Layton 2004.
- CO_2, NO_x, SO_2, and CO emission per Btu for natural gas, propane and butane (average used to represent LPG), Fuel #4 and #6 (average used to represent fuel oil and kerosene) from Leonardo Academy 2011.
- CO_2 emissions per Btu of wood from Energy Information Administration 2014.
- CO, NO_x and SO_x emission per Btu based on total emissions and wood burning (tons) from (British Columbia Ministry 2005; Georgia Forestry Commission 2009).

Appendix II. Relative Tree Effects

The urban forest in Tufello_SE provides benefits that include carbon storage and sequestration, and air pollutant removal. To estimate the relative value of these benefits, tree benefits were compared to estimates of average municipal carbon emissions, average passenger automobile emissions, and average household emissions. See Appendix I for methodology.

Carbon storage is equivalent to:

- Amount of carbon emitted in Tufello_SE in 5 days
- Annual carbon (C) emissions from 1 automobiles
- Annual C emissions from 0 single-family houses

Carbon monoxide removal is equivalent to:

- Annual carbon monoxide emissions from 0 automobiles
- Annual carbon monoxide emissions from 0 single-family houses

Nitrogen dioxide removal is equivalent to:

- Annual nitrogen dioxide emissions from 0 automobiles
- Annual nitrogen dioxide emissions from 0 single-family houses

Sulfur dioxide removal is equivalent to:

- Annual sulfur dioxide emissions from 0 automobiles
- Annual sulfur dioxide emissions from 0 single-family houses

Annual carbon sequestration is equivalent to:

- Amount of carbon emitted in Tufello_SE in 0,3 days
- Annual C emissions from 0 automobiles
- Annual C emissions from 0 single-family houses

Appendix III. Comparison of Urban Forests

A common question asked is, "How does this city compare to other cities?" Although comparison among cities should be made with caution as there are many attributes of a city that affect urban forest structure and functions, summary data are provided from other cities analyzed using the i-Tree Eco model.

I. City totals for trees

City	*% Tree Cover*	*Number of Trees*	*Carbon Storage (metric tons)*	*Carbon Sequestration (metric tons/yr)*	*Pollution Removal (metric tons/yr)*
Toronto, ON, Canada	26,6	10.220.000	1.108.000	46.700	1.905
Atlanta, GA	36,7	9.415.000	1.220.000	42.100	1.509
Los Angeles, CA	11,1	5.993.000	1.151.000	69.800	1.792
New York, NY	20,9	5.212.000	1.225.000	38.400	1.521
London, ON, Canada	24,7	4.376.000	360.000	12.500	370
Chicago, IL	17,2	3.585.000	649.000	22.800	806
Phoenix, AZ	9,0	3.166.000	286.000	29.800	511
Baltimore, MD	21,0	2.479.000	517.000	16.700	390
Philadelphia, PA	15,7	2.113.000	481.000	14.600	522
Washington, DC	28,6	1.928.000	477.000	14.700	379
Oakville, ON , Canada	29,1	1.908.000	133.000	6.000	172
Albuquerque, NM	14,3	1.846.000	301.000	9.600	225
Boston, MA	22,3	1.183.000	290.000	9.500	257
Syracuse, NY	26,9	1.088.000	166.000	5.300	99
Woodbridge, NJ	29,5	986.000	145.000	5.000	191
Minneapolis, MN	26,4	979.000	227.000	8.100	277
San Francisco, CA	11,9	668.000	176.000	4.600	128
Morgantown, WV	35,5	658.000	84.000	2.600	65
Moorestown, NJ	28,0	583.000	106.000	3.400	107
Hartford, CT	25,9	568.000	130.000	3.900	52
Jersey City, NJ	11,5	136.000	19.000	800	37
Casper, WY	8,9	123.000	34.000	1.100	34
Freehold, NJ	34,4	48.000	18.000	500	20

II. Totals per hectare of land area

City	*Number of Trees/ha*	*Carbon Storage (metric tons/ha)*	*Carbon Sequestration (metric tons/ha/yr)*	*Pollution Removal (kg/ha/yr)*
Toronto, ON, Canada	160,4	17,4	0,73	29,9
Atlanta, GA	275,8	35,7	1,23	44,2
Los Angeles, CA	48,4	9,4	0,36	14,7
New York, NY	65,2	15,3	0,48	19,0
London, ON, Canada	185,5	15,3	0,53	15,7
Chicago, IL	59,9	10,9	0,38	13,5
Phoenix, AZ	31,8	2,9	0,30	5,1
Baltimore, MD	118,5	25,0	0,80	18,6
Philadelphia, PA	61,9	14,1	0,43	15,3
Washington, DC	121,1	29,8	0,92	23,8
Oakville, ON , Canada	192,9	13,4	0,61	12,4
Albuquerque, NM	53,9	8,8	0,28	6,6
Boston, MA	82,9	20,3	0,67	18,0
Syracuse, NY	167,4	23,1	0,77	15,2
Woodbridge, NJ	164,4	24,2	0,84	31,9
Minneapolis, MN	64,8	15,0	0,53	18,3
San Francisco, CA	55,7	14,7	0,39	10,7
Morgantown, WV	294,5	37,7	1,17	29,2
Moorestown, NJ	153,4	27,9	0,90	28,1
Hartford, CT	124,6	28,5	0,86	11,5
Jersey City, NJ	35,5	5,0	0,21	9,6
Casper, WY	22,5	6,2	0,20	6,2
Freehold, NJ	94,6	35,9	0,98	39,6

Appendix IV. General Recommendations for Air Quality Improvement

Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmosphere environment. Four main ways that urban trees affect air quality are (Nowak 1995):

- Temperature reduction and other microclimate effects
- Removal of air pollutants
- Emission of volatile organic compounds (VOC) and tree maintenance emissions
- Energy effects on buildings

The cumulative and interactive effects of trees on climate, pollution removal, and VOC and power plant emissions determine the impact of trees on air pollution. Cumulative studies involving urban tree impacts on ozone have revealed that increased urban canopy cover, particularly with low VOC emitting species, leads to reduced ozone concentrations in cities (Nowak 2000). Local urban management decisions also can help improve air quality.

Urban forest management strategies to help improve air quality include (Nowak 2000):

Strategy	*Result*
Increase the number of healthy trees	Increase pollution removal
Sustain existing tree cover	Maintain pollution removal levels
Maximize use of low VOC-emitting trees	Reduces ozone and carbon monoxide formation
Sustain large, healthy trees	Large trees have greatest per-tree effects
Use long-lived trees	Reduce long-term pollutant emissions from planting and removal
Use low maintenance trees	Reduce pollutants emissions from maintenance activities
Reduce fossil fuel use in maintaining vegetation	Reduce pollutant emissions
Plant trees in energy conserving locations	Reduce pollutant emissions from power plants
Plant trees to shade parked cars	Reduce vehicular VOC emissions
Supply ample water to vegetation	Enhance pollution removal and temperature reduction
Plant trees in polluted or heavily populated areas	Maximizes tree air quality benefits
Avoid pollutant-sensitive species	Improve tree health
Utilize evergreen trees for particulate matter	Year-round removal of particles

Appendix V. Invasive Species of the Urban Forest

Invasive species data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

Appendix VI. Potential Risk of Pests

Pest range data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

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i-Tree
Ecosystem Analysis

Tufello_Schinus

Urban Forest Effects and Values
dicembre 2023

Summary

Understanding an urban forest's structure, function and value can promote management decisions that will improve human health and environmental quality. An assessment of the vegetation structure, function, and value of the Tufello_Schinus urban forest was conducted during 2023. Data from 2 trees located throughout Tufello_Schinus were analyzed using the i-Tree Eco model developed by the U.S. Forest Service, Northern Research Station.

- Number of trees: 2
- Tree Cover: 45,06 square meters
- Most common species of trees: Schinus molle
- Percentage of trees less than 6" (15.2 cm) diameter: 50,0%
- Pollution Removal: 316,3 grams/year (€0,263/year)
- Carbon Storage: 196,9 kilograms (€31,6)
- Carbon Sequestration: 19,46 kilograms (€3,13/year)
- Oxygen Production: 51,9 kilograms/year
- Avoided Runoff: 452,8 thousandth cubic meters/year (€0,861/year)
- Building energy savings: N/A – data not collected
- Avoided carbon emissions: N/A – data not collected
- Replacement values: €1,4 thousand

Metric ton: 1000 kilograms
Monetary values € are reported in euros throughout the report except where noted.
Ecosystem service estimates are reported for trees.
With Complete Inventory Projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition. Oxygen production in Plot Inventory Projects is estimated from net carbon sequestration.

For an overview of i-Tree Eco methodology, see Appendix I. Data collection quality is determined by the local data collectors, over which i-Tree has no control.

Table of Contents

I. Tree Characteristics of the Urban Forest

The urban forest of Tufello_Schinus has 2 trees with a tree cover of 45,06 square meters. The common species is Schinus molle (100,0 percent).

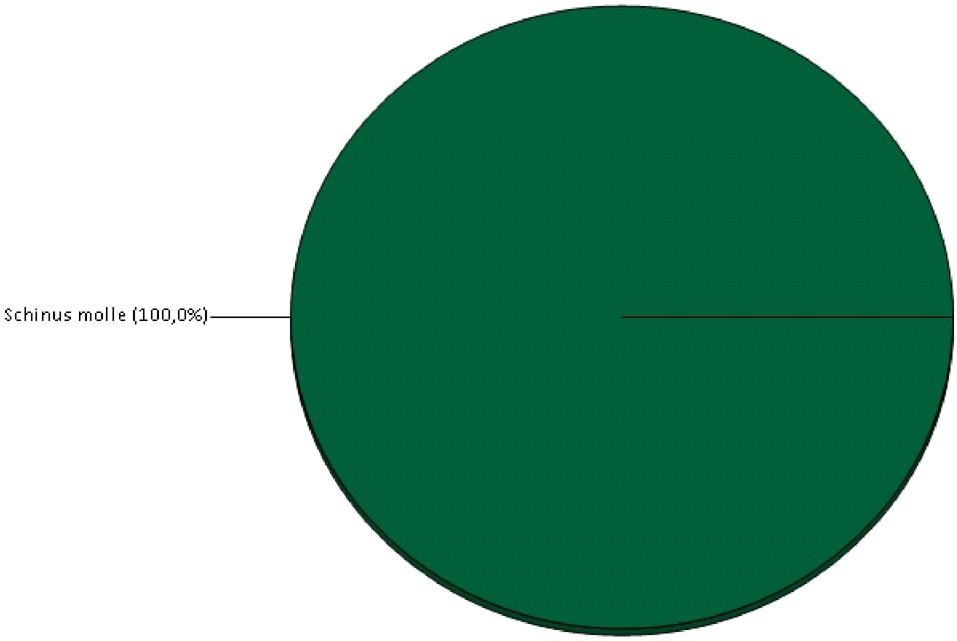

Figure 1. Tree species composition in Tufello_Schinus

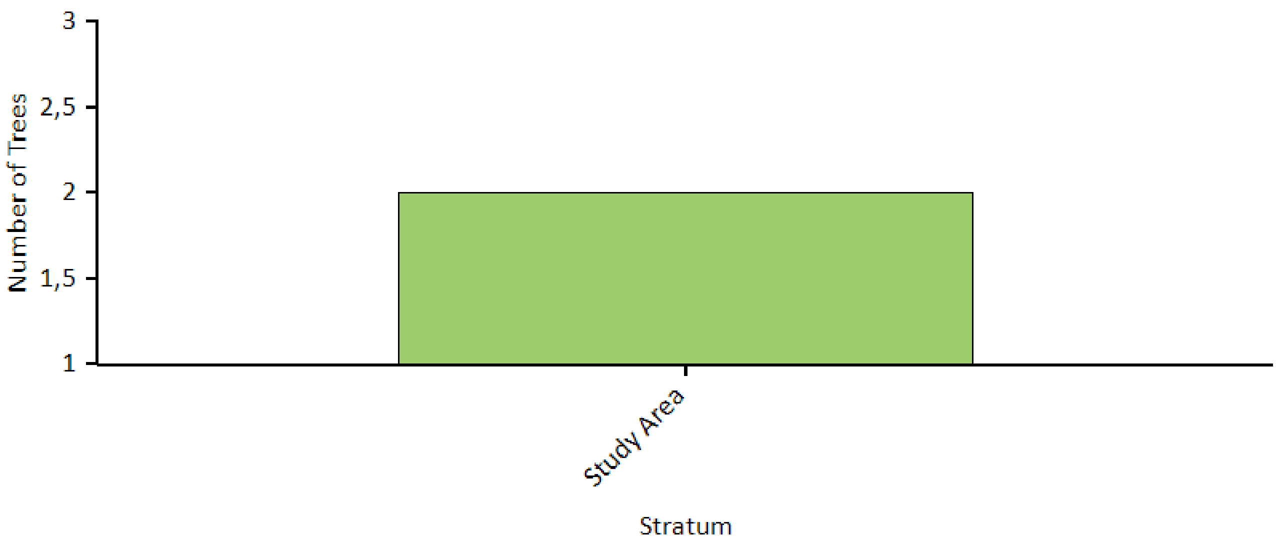

Figure 2. Number of trees in Tufello_Schinus by stratum

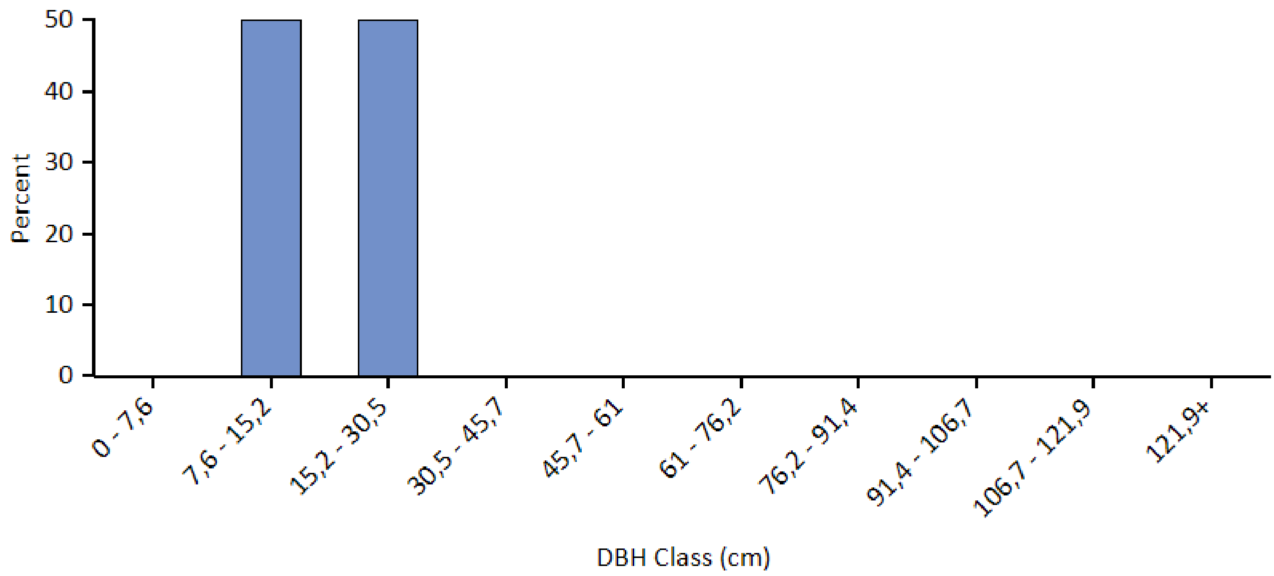

Figure 3. Percent of tree population by diameter class (DBH - stem diameter at 1.37 meters)

Urban forests are composed of a mix of native and exotic tree species. Thus, urban forests often have a tree diversity that is higher than surrounding native landscapes. Increased tree diversity can minimize the overall impact or destruction by a species-specific insect or disease, but it can also pose a risk to native plants if some of the exotic species are invasive plants that can potentially out-compete and displace native species. In Tufello_Schinus, about 0 percent of the trees are species native to Europe. Most trees have an origin from South America (100 percent of the trees).

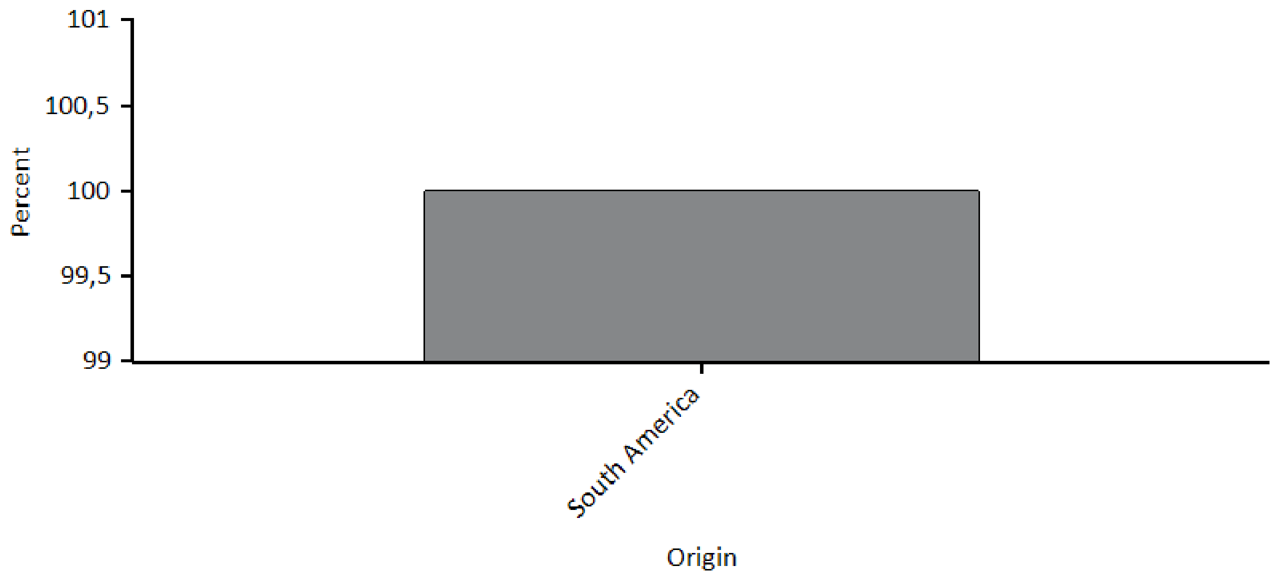

Figure 4. Percent of live tree population by area of native origin, Tufello_Schinus

Invasive plant species are often characterized by their vigor, ability to adapt, reproductive capacity, and general lack of natural enemies. These abilities enable them to displace native plants and make them a threat to natural areas.

II. Urban Forest Cover and Leaf Area

Many tree benefits equate directly to the amount of healthy leaf surface area of the plant. Trees cover about 45,06 square meters of Tufello_Schinus and provide 9,793E-05 square meters of leaf area.

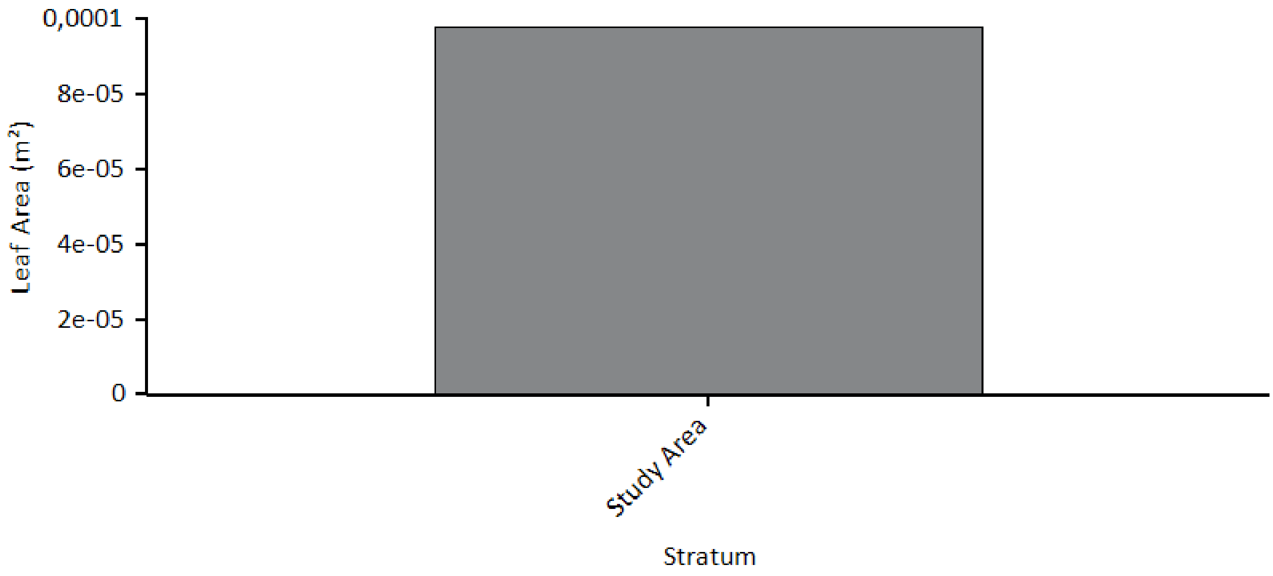

Figure 5. Leaf area by stratum, Tufello_Schinus

In Tufello_Schinus, the most dominant species in terms of leaf area is Schinus molle. The 1 species with the greatest importance values is listed in Table 1. Importance values (IV) are calculated as the sum of percent population and percent leaf area. High importance values do not mean that these trees should necessarily be encouraged in the future; rather these species currently dominate the urban forest structure.

Table 1. Most important species in Tufello_Schinus

Species Name	*Percent Population*	*Percent Leaf Area*	*IV*
Schinus molle	100,0	100,0	200,0

Common ground cover classes (including cover types beneath trees and shrubs) in Tufello_Schinus are not available since they are configured not to be collected.

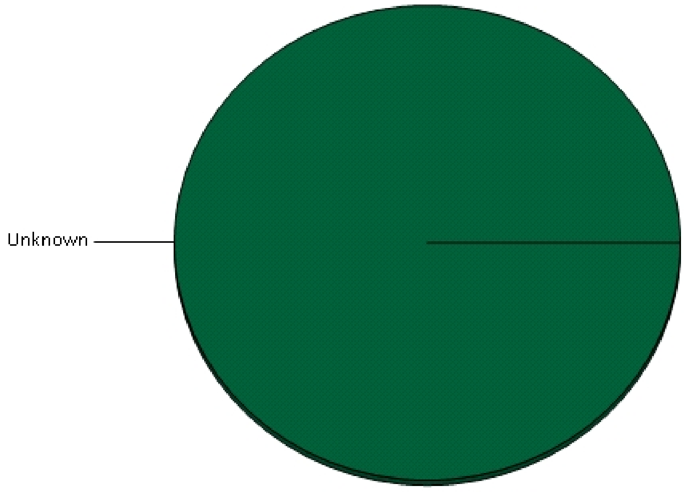

Figure 6. Percent of land by ground cover classes, Tufello_Schinus

III. Air Pollution Removal by Urban Trees

Poor air quality is a common problem in many urban areas. It can lead to decreased human health, damage to landscape materials and ecosystem processes, and reduced visibility. The urban forest can help improve air quality by reducing air temperature, directly removing pollutants from the air, and reducing energy consumption in buildings, which consequently reduces air pollutant emissions from the power sources. Trees also emit volatile organic compounds that can contribute to ozone formation. However, integrative studies have revealed that an increase in tree cover leads to reduced ozone formation (Nowak and Dwyer 2000).

Pollution removal[1] by trees in Tufello_Schinus was estimated using field data and recent available pollution and weather data available. Pollution removal was greatest for ozone (Figure 7). It is estimated that trees remove 316,3 grams of air pollution (ozone (O3), carbon monoxide (CO), nitrogen dioxide (NO2), particulate matter less than 2.5 microns (PM2.5), particulate matter less than 10 microns and greater than 2.5 microns (PM10*)[2], and sulfur dioxide (SO2)) per year with an associated value of €0,263 (see Appendix I for more details).

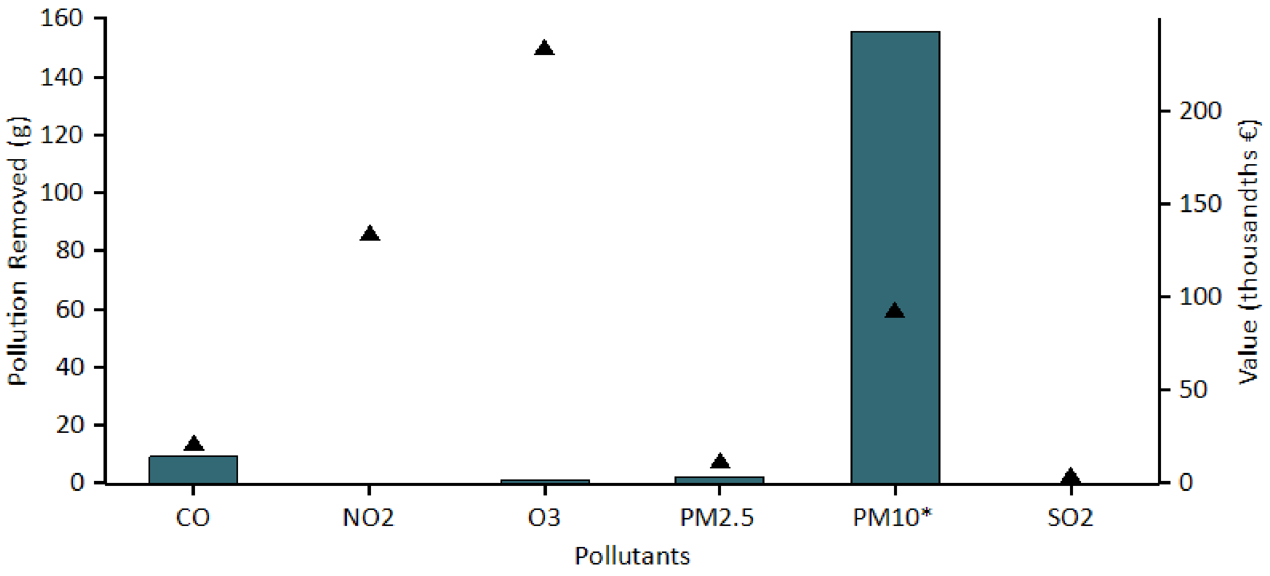

Figure 7. Annual pollution removal (points) and value (bars) by urban trees, Tufello_Schinus

[1] PM10* is particulate matter less than 10 microns and greater than 2.5 microns. PM2.5 is particulate matter less than 2.5 microns. If PM2.5 is not monitored, PM10* represents particulate matter less than 10 microns. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

[2] Trees remove PM2.5 and PM10* when particulate matter is deposited on leaf surfaces. This deposited PM2.5 and PM10* can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors (see Appendix I for more details).

In 2023, trees in Tufello_Schinus emitted an estimated 278,5 grams of volatile organic compounds (VOCs) (0 grams of isoprene and 278,5 grams of monoterpenes). Emissions vary among species based on species characteristics (e.g. some genera such as oaks are high isoprene emitters) and amount of leaf biomass. One hundred percent of the urban forest's VOC emissions were from Schinus molle. These VOCs are precursor chemicals to ozone formation.[3]

General recommendations for improving air quality with trees are given in Appendix VIII.

[3] Some economic studies have estimated VOC emission costs. These costs are not included here as there is a tendency to add positive dollar estimates of ozone removal effects with negative dollar values of VOC emission effects to determine whether tree effects are positive or negative in relation to ozone. This combining of dollar values to determine tree effects should not be done, rather estimates of VOC effects on ozone formation (e.g., via photochemical models) should be conducted and directly contrasted with ozone removal by trees (i.e., ozone effects should be directly compared, not dollar estimates). In addition, air temperature reductions by trees have been shown to significantly reduce ozone concentrations (Cardelino and Chameides 1990; Nowak et al 2000), but are not considered in this analysis. Photochemical modeling that integrates tree effects on air temperature, pollution removal, VOC emissions, and emissions from power plants can be used to determine the overall effect of trees on ozone concentrations.

IV. Carbon Storage and Sequestration

Climate change is an issue of global concern. Urban trees can help mitigate climate change by sequestering atmospheric carbon (from carbon dioxide) in tissue and by altering energy use in buildings, and consequently altering carbon dioxide emissions from fossil-fuel based power sources (Abdollahi et al 2000).

Trees reduce the amount of carbon in the atmosphere by sequestering carbon in new growth every year. The amount of carbon annually sequestered is increased with the size and health of the trees. The gross sequestration of Tufello_Schinus trees is about 19,46 kilograms of carbon per year with an associated value of €3,13. See Appendix I for more details on methods.

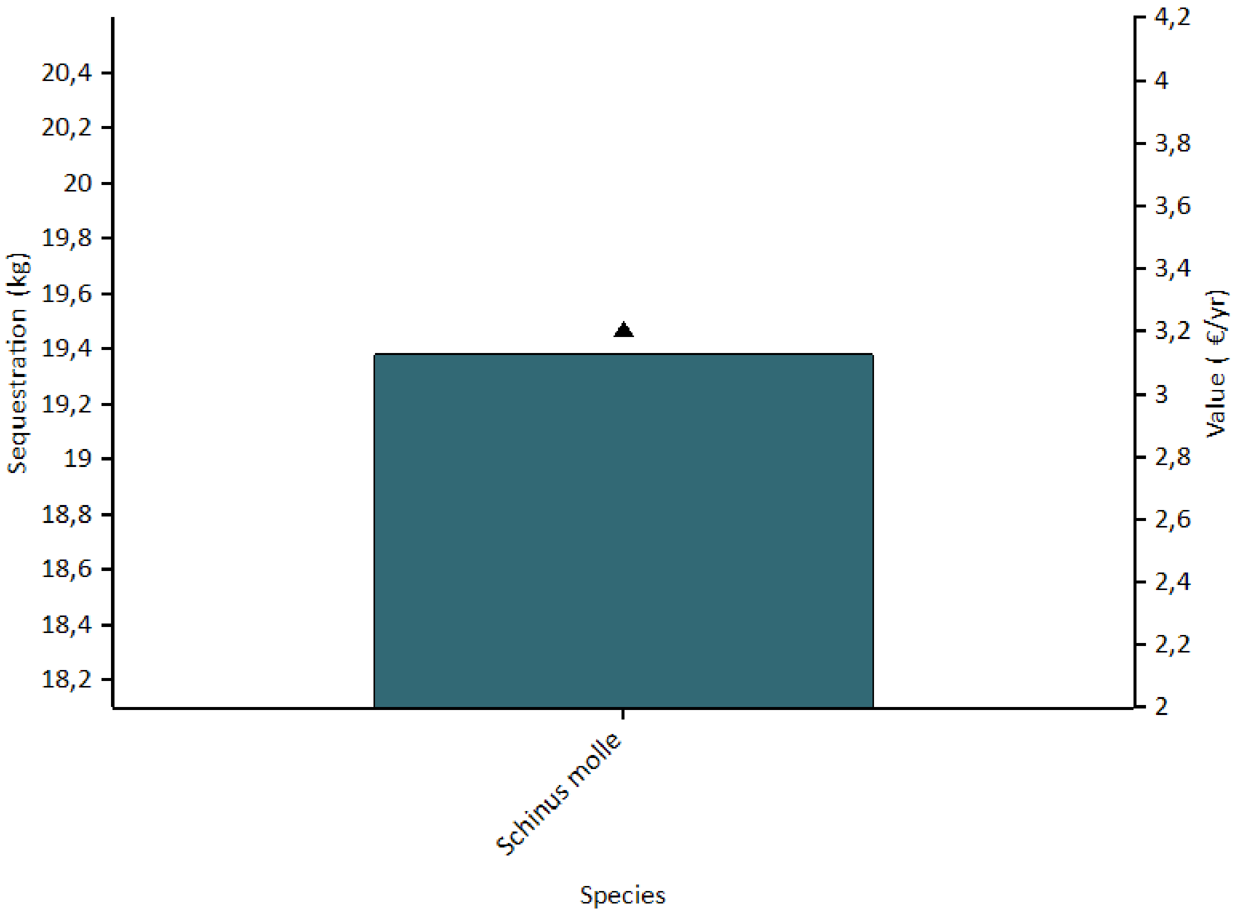

Figure 8. Estimated annual gross carbon sequestration (points) and value (bars) for urban tree species with the greatest sequestration, Tufello_Schinus

Carbon storage is another way trees can influence global climate change. As a tree grows, it stores more carbon by holding it in its accumulated tissue. As a tree dies and decays, it releases much of the stored carbon back into the atmosphere. Thus, carbon storage is an indication of the amount of carbon that can be released if trees are allowed to die and decompose. Maintaining healthy trees will keep the carbon stored in trees, but tree maintenance can contribute to carbon emissions (Nowak et al 2002c). When a tree dies, using the wood in long-term wood products, to heat buildings, or to produce energy will help reduce carbon emissions from wood decomposition or from fossil-fuel or wood-based power plants.

Trees in Tufello_Schinus are estimated to store 0,197 metric tons of carbon (€31,6). Of the species sampled, Schinus molle stores and sequesters the most carbon (approximately 100% of the total carbon stored and 100% of all sequestered carbon.)

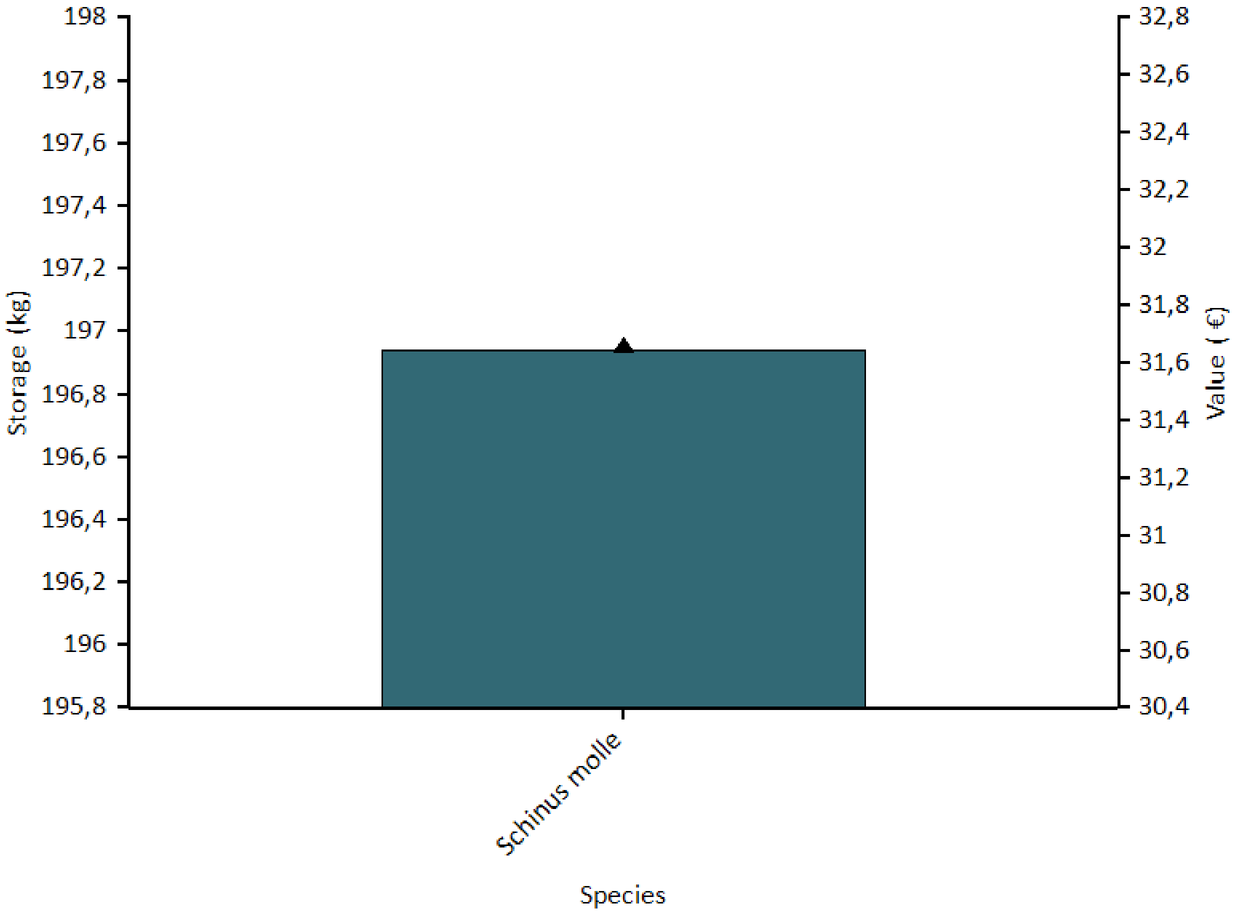

Figure 9. Estimated carbon storage (points) and values (bars) for urban tree species with the greatest storage, Tufello_Schinus

V. Oxygen Production

Oxygen production is one of the most commonly cited benefits of urban trees. The annual oxygen production of a tree is directly related to the amount of carbon sequestered by the tree, which is tied to the accumulation of tree biomass.

Trees in Tufello_Schinus are estimated to produce 51,9 kilograms of oxygen per year.[4] However, this tree benefit is relatively insignificant because of the large and relatively stable amount of oxygen in the atmosphere and extensive production by aquatic systems. Our atmosphere has an enormous reserve of oxygen. If all fossil fuel reserves, all trees, and all organic matter in soils were burned, atmospheric oxygen would only drop a few percent (Broecker 1970).

Table 2. The top 1 oxygen production species.

Species	*Oxygen (kilogram)*	*Gross Carbon Sequestration (kilogram/yr)*	*Number of Trees*	*Leaf Area (square meter)*
Schinus molle	51,90	19,46	2	0,00

VI. Avoided Runoff

Surface runoff can be a cause for concern in many urban areas as it can contribute pollution to streams, wetlands, rivers, lakes, and oceans. During precipitation events, some portion of the precipitation is intercepted by vegetation (trees and shrubs) while the other portion reaches the ground. The portion of the precipitation that reaches the ground and does not infiltrate into the soil becomes surface runoff (Hirabayashi 2012). In urban areas, the large extent of impervious surfaces increases the amount of surface runoff.

Urban trees and shrubs, however, are beneficial in reducing surface runoff. Trees and shrubs intercept precipitation, while their root systems promote infiltration and storage in the soil. The trees and shrubs of Tufello_Schinus help to reduce runoff by an estimated 0,453 cubic meters a year with an associated value of €0,86 (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user-designated weather station. In Tufello_Schinus, the total annual precipitation in 2015 was 81,6 centimeters.

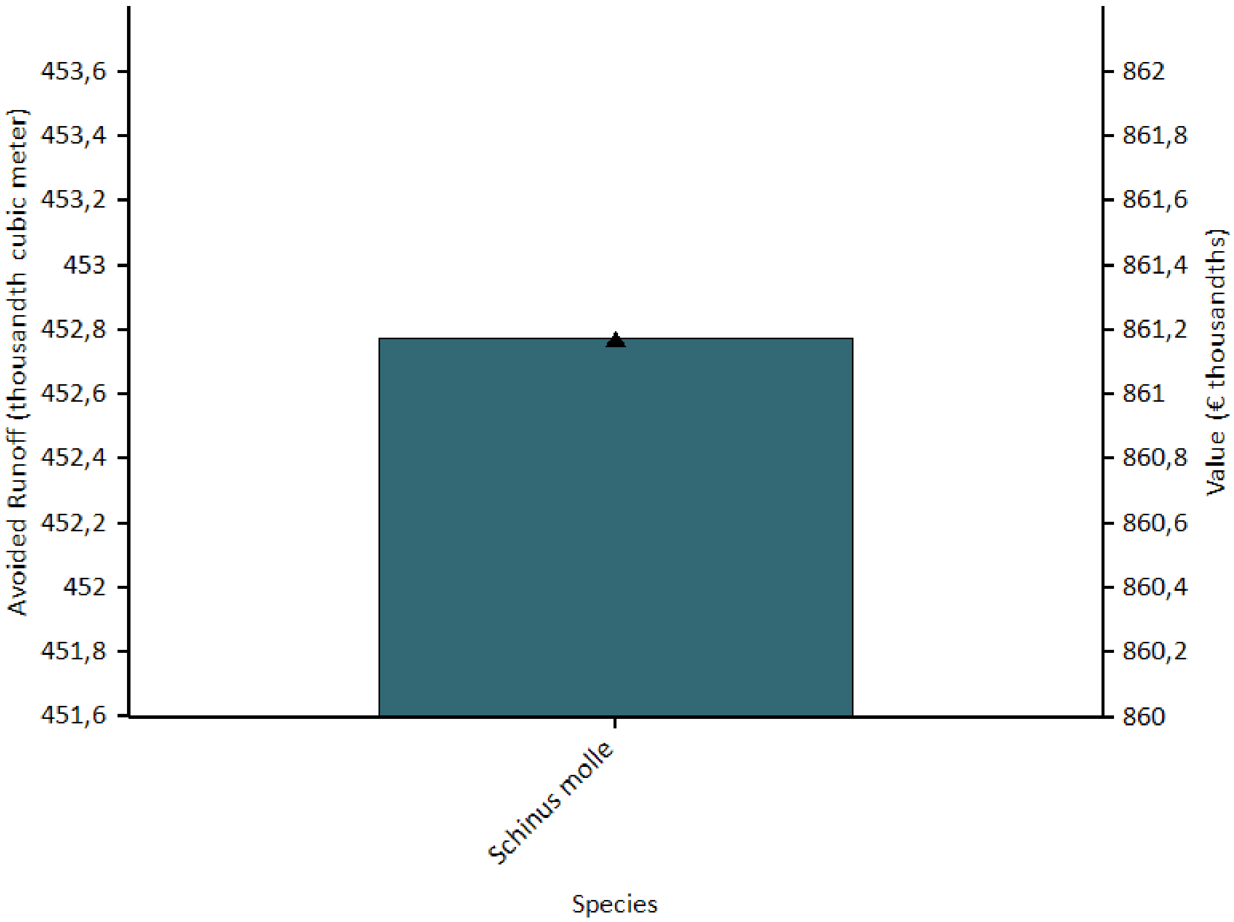

Figure 10. Avoided runoff (points) and value (bars) for species with greatest overall impact on runoff, Tufello_Schinus

VII. Trees and Building Energy Use

Trees affect energy consumption by shading buildings, providing evaporative cooling, and blocking winter winds. Trees tend to reduce building energy consumption in the summer months and can either increase or decrease building energy use in the winter months, depending on the location of trees around the building. Estimates of tree effects on energy use are based on field measurements of tree distance and direction to space conditioned residential buildings (McPherson and Simpson 1999).

Because energy-related data were not collected, energy savings and carbon avoided cannot be calculated.

Table 3. Annual energy savings due to trees near residential buildings, Tufello_Schinus

	Heating	*Cooling*	*Total*
MBTU[a]	0	N/A	0
MWH[b]	0	0	0
Carbon Avoided (kilograms)	0	0	0

[a]MBTU - one million British Thermal Units

[b]MWH - megawatt-hour

Table 4. Annual savings [a](€) in residential energy expenditure during heating and cooling seasons, Tufello_Schinus

	Heating	*Cooling*	*Total*
MBTU[b]	0	N/A	0
MWH[c]	0	0	0
Carbon Avoided	0	0	0

[b]Based on the prices of €214 per MWH and €20,5149700574282 per MBTU (see Appendix I for more details)

[c]MBTU - one million British Thermal Units

[c]MWH - megawatt-hour

[5] Trees modify climate, produce shade, and reduce wind speeds. Increased energy use or costs are likely due to these tree-building interactions creating a cooling effect during the winter season. For example, a tree (particularly evergreen species) located on the southern side of a residential building may produce a shading effect that causes increases in heating requirements.

VIII. Replacement and Functional Values

Urban forests have a replacement value based on the trees themselves (e.g., the cost of having to replace a tree with a similar tree); they also have functional values (either positive or negative) based on the functions the trees perform.

The replacement value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al 2002a). Annual functional values also tend to increase with increased number and size of healthy trees. Through proper management, urban forest values can be increased; however, the values and benefits also can decrease as the amount of healthy tree cover declines.

Urban trees in Tufello_Schinus have the following replacement values:

- Replacement value: €1,4 thousand
- Carbon storage: €31,6

Urban trees in Tufello_Schinus have the following annual functional values:

- Carbon sequestration: €3,13
- Avoided runoff: €0,861
- Pollution removal: €0,263
- Energy costs and carbon emission values: €0

(Note: negative value indicates increased energy cost and carbon emission value)

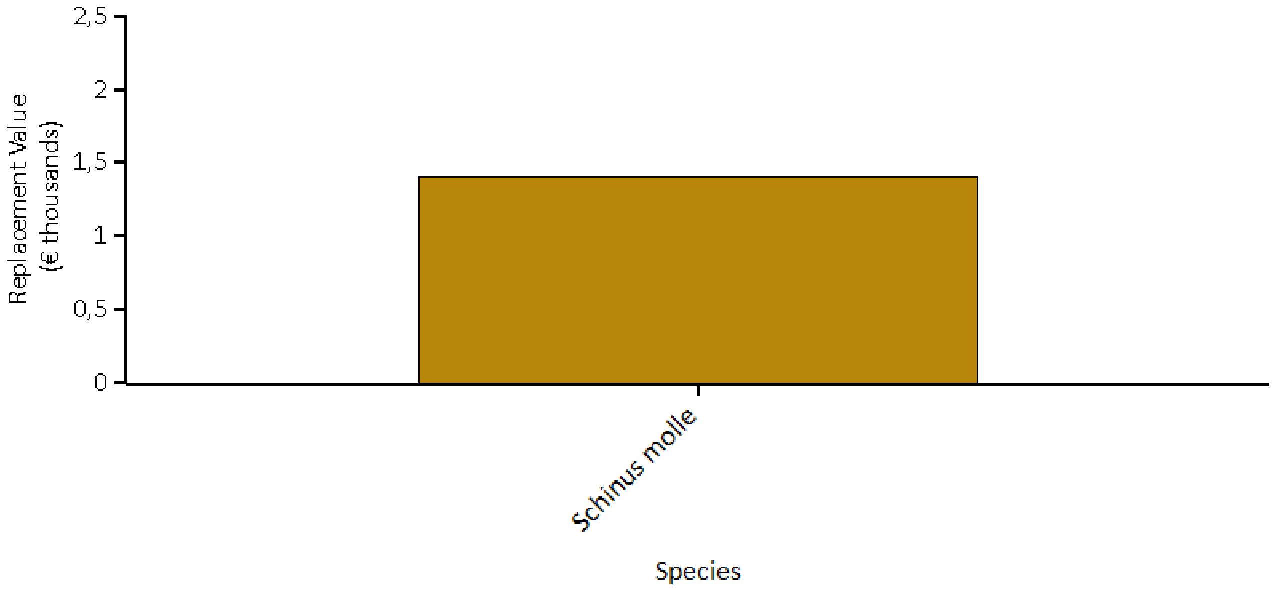

Figure 11. Tree species with the greatest replacement value, Tufello_Schinus

IX. Potential Pest Impacts

Various insects and diseases can infest urban forests, potentially killing trees and reducing the health, replacement value and sustainability of the urban forest. As pests tend to have differing tree hosts, the potential damage or risk of each pest will differ among cities.Fifty-three pests were analyzed for their potential impact.

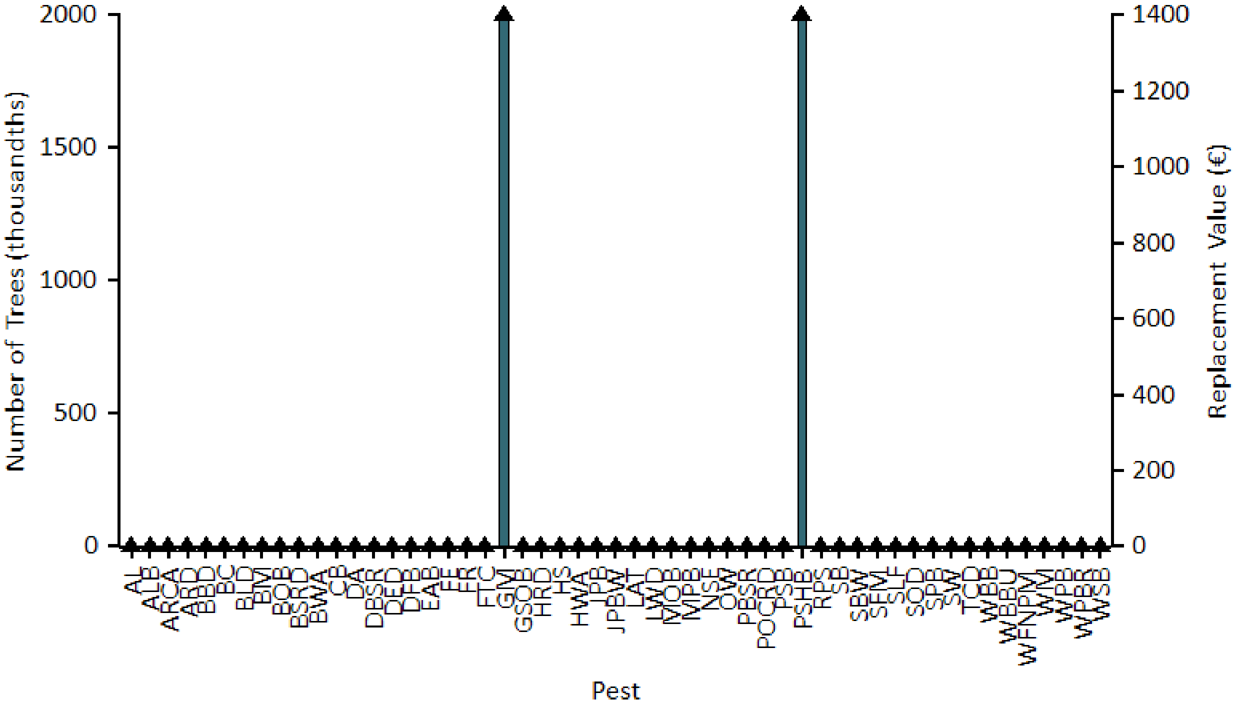

Figure 12. Number of trees at risk (points) and associated compensatory value (bars) by potential pests, Tufello_Schinus

Aspen leafminer (AL) (Kruse et al 2007) is an insect that causes damage primarily to trembling or small tooth aspen by larval feeding of leaf tissue. AL has the potential to affect 0,0 percent of the population (€0 in replacement value).

Asian longhorned beetle (ALB) (Animal and Plant Health Inspection Service 2010) is an insect that bores into and kills a wide range of hardwood species. ALB poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Aspen Running Canker (ARCA) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Armillaria Root Disease (ARD) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Beech bark disease (BBD) (Houston and O'Brien 1983) is an insect-disease complex that primarily impacts American beech. This disease threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Butternut canker (BC) (Ostry et al 1996) is caused by a fungus that infects butternut trees. The disease has since caused significant declines in butternut populations in the United States. Potential loss of trees from BC is 0,0 percent (€0 in replacement value).

Beech Leaf Disease (BLD) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Browntail Moth (BM) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Bur Oak Blight (BOB) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Black Stain Root Disease (BSRD) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Balsam woolly adelgid (BWA) (Ragenovich and Mitchell 2006) is an insect that has caused significant damage to the true firs of North America. Tufello_Schinus could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

The most common hosts of the fungus that cause chestnut blight (CB) (Diller 1965) are American and European chestnut. CB has the potential to affect 0,0 percent of the population (€0 in replacement value).

Dogwood anthracnose (DA) (Mielke and Daughtrey) is a disease that affects dogwood species, specifically flowering and Pacific dogwood. This disease threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Douglas-fir black stain root disease (DBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks Douglas-firs. Tufello_Schinus could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

American elm, one of the most important street trees in the twentieth century, has been devastated by the Dutch elm disease (DED) (Northeastern Area State and Private Forestry 1998). Since first reported in the 1930s, it has killed over 50 percent of the native elm population in the United States. Although some elm species have shown varying degrees of resistance, Tufello_Schinus could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

Douglas-fir beetle (DFB) (Schmitz and Gibson 1996) is a bark beetle that infests Douglas-fir trees throughout the western United States, British Columbia, and Mexico. Potential loss of trees from DFB is 0,0 percent (€0 in replacement value).

Emerald ash borer (EAB) (Michigan State University 2010) has killed thousands of ash trees in parts of the United States. EAB has the potential to affect 0,0 percent of the population (€0 in replacement value).

One common pest of white fir, grand fir, and red fir trees is the fir engraver (FE) (Ferrell 1986). FE poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Fusiform rust (FR) (Phelps and Czabator 1978) is a fungal disease that is distributed in the southern United States. It is particularly damaging to slash pine and loblolly pine. FR has the potential to affect 0,0 percent of the population (€0 in replacement value).

Forest Tent Caterpillar (FTC) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

The gypsy moth (GM) (Northeastern Area State and Private Forestry 2005) is a defoliator that feeds on many species causing widespread defoliation and tree death if outbreak conditions last several years. This pest threatens 100,0 percent of the population, which represents a potential loss of €1,4 thousand in replacement value.

Infestations of the goldspotted oak borer (GSOB) (Society of American Foresters 2011) have been a growing problem in southern California. Potential loss of trees from GSOB is 0,0 percent (€0 in replacement value).

Heterobasidion Root Disease (HRD) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Hemlock Sawfly (HS) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

As one of the most damaging pests to eastern hemlock and Carolina hemlock, hemlock woolly adelgid (HWA) (U.S. Forest Service 2005) has played a large role in hemlock mortality in the United States. HWA has the potential to affect 0,0 percent of the population (€0 in replacement value).

The Jeffrey pine beetle (JPB) (Smith et al 2009) is native to North America and is distributed across California, Nevada, and Oregon where its only host, Jeffrey pine, also occurs. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Jack Pine Budworm (JPBW) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Quaking aspen is a principal host for the defoliator, large aspen tortrix (LAT) (Ciesla and Kruse 2009). LAT poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Laurel wilt (LWD) (U.S. Forest Service 2011) is a fungal disease that is introduced to host trees by the redbay ambrosia beetle. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Mediterranean Oak Borer (MOB) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Mountain pine beetle (MPB) (Gibson et al 2009) is a bark beetle that primarily attacks pine species in the western United States. MPB has the potential to affect 0,0 percent of the population (€0 in replacement value).

The northern spruce engraver (NSE) (Burnside et al 2011) has had a significant impact on the boreal and sub-boreal forests of North America where the pest's distribution overlaps with the range of its major hosts. Potential loss of trees from NSE is 0,0 percent (€0 in replacement value).

Oak wilt (OW) (Rexrode and Brown 1983), which is caused by a fungus, is a prominent disease among oak trees. OW poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Pine black stain root disease (PBSR) (Hessburg et al 1995) is a variety of the black stain fungus that attacks hard pines, including lodgepole pine, Jeffrey pine, and ponderosa pine. Tufello_Schinus could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

Port-Orford-cedar root disease (POCRD) (Liebhold 2010) is a root disease that is caused by a fungus. POCRD threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

The pine shoot beetle (PSB) (Ciesla 2001) is a wood borer that attacks various pine species, though Scotch pine is the preferred host in North America. PSB has the potential to affect 0,0 percent of the population (€0 in replacement value).

Polyphagous shot hole borer (PSHB) (University of California 2014) is a boring beetle that was first detected in California. Tufello_Schinus could possibly lose 100,0 percent of its trees to this pest (€1,4 thousand in replacement value).

Red Pine Scale (RPS) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Spruce beetle (SB) (Holsten et al 1999) is a bark beetle that causes significant mortality to spruce species within its range. Potential loss of trees from SB is 0,0 percent (€0 in replacement value).

Spruce budworm (SBW) (Kucera and Orr 1981) is an insect that causes severe damage to balsam fir. SBW poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Subalpine Fir Mortality (SFM) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Spotted Lanternfly (SLF) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Sudden oak death (SOD) (Kliejunas 2005) is a disease that is caused by a fungus. Potential loss of trees from SOD is 0,0 percent (€0 in replacement value).

Although the southern pine beetle (SPB) (Clarke and Nowak 2009) will attack most pine species, its preferred hosts are loblolly, Virginia, pond, spruce, shortleaf, and sand pines. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

The sirex woodwasp (SW) (Haugen and Hoebeke 2005) is a wood borer that primarily attacks pine species. SW poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Thousand canker disease (TCD) (Cranshaw and Tisserat 2009; Seybold et al 2010) is an insect-disease complex that kills several species of walnuts, including black walnut. Potential loss of trees from TCD is 0,0 percent (€0 in replacement value).

Western Bark Beetle (WBB) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Western Blackheaded Budworm (WBBU) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Western Five-Needle Pine Mortality (WFNPM) poses a threat to 0,0 percent of the Tufello_Schinus urban forest, which represents a potential loss of €0 in replacement value.

Winter moth (WM) (Childs 2011) is a pest with a wide range of host species. WM causes the highest levels of injury to its hosts when it is in its caterpillar stage. Tufello_Schinus could possibly lose 0,0 percent of its trees to this pest (€0 in replacement value).

The western pine beetle (WPB) (DeMars and Roettgering 1982) is a bark beetle and aggressive attacker of ponderosa and Coulter pines. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Since its introduction to the United States in 1900, white pine blister rust (Eastern U.S.) (WPBR) (Nicholls and Anderson 1977) has had a detrimental effect on white pines, particularly in the Lake States. WPBR has the potential to affect 0,0 percent of the population (€0 in replacement value).

Western spruce budworm (WSB) (Fellin and Dewey 1986) is an insect that causes defoliation in western conifers. This pest threatens 0,0 percent of the population, which represents a potential loss of €0 in replacement value.

Appendix I. i-Tree Eco Model and Field Measurements

i-Tree Eco is designed to use standardized field data and local hourly air pollution and meteorological data to quantify urban forest structure and its numerous effects (Nowak and Crane 2000), including:

- Urban forest structure (e.g., species composition, tree health, leaf area, etc.).
- Amount of pollution removed hourly by the urban forest, and its associated percent air quality improvement throughout a year.
- Total carbon stored and net carbon annually sequestered by the urban forest.
- Effects of trees on building energy use and consequent effects on carbon dioxide emissions from power sources.
- Replacement value of the forest, as well as the value for air pollution removal and carbon storage and sequestration.
- Potential impact of infestations by pests, such as Asian longhorned beetle, emerald ash borer, gypsy moth, and Dutch elm disease.

Typically, all field data are collected during the leaf-on season to properly assess tree canopies. Typical data collection (actual data collection may vary depending upon the user) includes land use, ground and tree cover, individual tree attributes of species, stem diameter, height, crown width, crown canopy missing and dieback, and distance and direction to residential buildings (Nowak et al 2005; Nowak et al 2008).

During data collection, trees are identified to the most specific taxonomic classification possible. Trees that are not classified to the species level may be classified by genus (e.g., ash) or species groups (e.g., hardwood). In this report, tree species, genera, or species groups are collectively referred to as tree species.

<u>Tree Characteristics:</u>

Leaf area of trees was assessed using measurements of crown dimensions and percentage of crown canopy missing. In the event that these data variables were not collected, they are estimated by the model.

An analysis of invasive species is not available for studies outside of the United States. For the U.S., invasive species are identified using an invasive species list for the state in which the urban forest is located. These lists are not exhaustive and they cover invasive species of varying degrees of invasiveness and distribution. In instances where a state did not have an invasive species list, a list was created based on the lists of the adjacent states. Tree species that are identified as invasive by the state invasive species list are cross-referenced with native range data. This helps eliminate species that are on the state invasive species list, but are native to the study area.

<u>Air Pollution Removal:</u>

Pollution removal is calculated for ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter less than 2.5 microns, and particulate matter less than 10 microns and greater than 2.5 microns. PM2.5 is generally more relevant in discussions concerning air pollution effects on human health.

Air pollution removal estimates are derived from calculated hourly tree-canopy resistances for ozone, and sulfur and nitrogen dioxides based on a hybrid of big-leaf and multi-layer canopy deposition models (Baldocchi 1988; Baldocchi et al 1987). As the removal of carbon monoxide and particulate matter by vegetation is not directly related to transpiration, removal rates (deposition velocities) for these pollutants were based on average measured values from the literature (Bidwell and Fraser 1972; Lovett 1994) that were adjusted depending on leaf phenology and leaf area. Particulate removal incorporated a 50 percent resuspension rate of particles back to the atmosphere (Zinke 1967). Recent updates (2011) to air quality modeling are based on improved leaf area index simulations, weather and pollution processing and interpolation, and updated pollutant monetary values (Hirabayashi et al 2011; Hirabayashi et al 2012; Hirabayashi 2011).

Trees remove PM2.5 and PM10* when particulate matter is deposited on leaf surfaces (Nowak et al 2013). This deposited PM2.5 and PM10* can be resuspended to the atmosphere or removed during rain events and dissolved or transferred to the soil. This combination of events can lead to positive or negative pollution removal and value depending on various atmospheric factors. Generally, PM2.5 and PM10* removal is positive with positive benefits. However, there are some cases when net removal is negative or resuspended particles lead to increased pollution concentrations and negative values. During some months (e.g., with no rain), trees resuspend more particles than they remove. Resuspension can also lead to increased overall PM2.5 and PM10* concentrations if the boundary layer conditions are lower during net resuspension periods than during net removal periods. Since the pollution removal value is based on the change in pollution concentration, it is possible to have situations when trees remove PM2.5 and PM10* but increase concentrations and thus have negative values during periods of positive overall removal. These events are not common, but can happen.

For reports in the United States, default air pollution removal value is calculated based on local incidence of adverse health effects and national median externality costs. The number of adverse health effects and associated economic value is calculated for ozone, sulfur dioxide, nitrogen dioxide, and particulate matter less than 2.5 microns using data from the U.S. Environmental Protection Agency's Environmental Benefits Mapping and Analysis Program (BenMAP) (Nowak et al 2014). The model uses a damage-function approach that is based on the local change in pollution concentration and population. National median externality costs were used to calculate the value of carbon monoxide removal (Murray et al 1994).

For international reports, user-defined local pollution values are used. For international reports that do not have local values, estimates are based on either European median externality values (van Essen et al 2011) or BenMAP regression equations (Nowak et al 2014) that incorporate user-defined population estimates. Values are then converted to local currency with user-defined exchange rates.

For this analysis, pollution removal value is calculated based on the prices of €1.100 per metric ton (carbon monoxide), €12 per metric ton (ozone), €1 per metric ton (nitrogen dioxide), €0 per metric ton (sulfur dioxide), €498 per metric ton (particulate matter less than 2.5 microns), €4.121 per metric ton (particulate matter less than 10 microns and greater than 2.5 microns).

<u>Carbon Storage and Sequestration:</u>

Carbon storage is the amount of carbon bound up in the above-ground and below-ground parts of woody vegetation. To calculate current carbon storage, biomass for each tree was calculated using equations from the literature and measured tree data. Open-grown, maintained trees tend to have less biomass than predicted by forest-derived biomass equations (Nowak 1994). To adjust for this difference, biomass results for open-grown urban trees were multiplied by 0.8. No adjustment was made for trees found in natural stand conditions. Tree dry-weight biomass was converted to stored carbon by multiplying by 0.5.

Carbon sequestration is the removal of carbon dioxide from the air by plants. To estimate the gross amount of carbon sequestered annually, average diameter growth from the appropriate genera and diameter class and tree condition was added to the existing tree diameter (year x) to estimate tree diameter and carbon storage in year x+1.

Carbon storage and carbon sequestration values are based on estimated or customized local carbon values. For international reports that do not have local values, estimates are based on the carbon value for the United States (U.S. Environmental Protection Agency 2015, Interagency Working Group on Social Cost of Carbon 2015) and converted to local currency with user-defined exchange rates.

For this analysis, carbon storage and carbon sequestration values are calculated based on €161 per metric ton.

<u>Oxygen Production:</u>

The amount of oxygen produced is estimated from carbon sequestration based on atomic weights: net O_2 release (kg/yr) = net C sequestration (kg/yr) × 32/12. To estimate the net carbon sequestration rate, the amount of carbon sequestered as a result of tree growth is reduced by the amount lost resulting from tree mortality. Thus, net carbon sequestration and net annual oxygen production of the urban forest account for decomposition (Nowak et al 2007). For complete inventory projects, oxygen production is estimated from gross carbon sequestration and does not account for decomposition.

<u>Avoided Runoff:</u>

Annual avoided surface runoff is calculated based on rainfall interception by vegetation, specifically the difference between annual runoff with and without vegetation. Although tree leaves, branches, and bark may intercept precipitation and thus mitigate surface runoff, only the precipitation intercepted by leaves is accounted for in this analysis.

The value of avoided runoff is based on estimated or user-defined local values. For international reports that do not have local values, the national average value for the United States is utilized and converted to local currency with user-defined exchange rates. The U.S. value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series (McPherson et al 1999; 2000; 2001; 2002; 2003; 2004; 2006a; 2006b; 2006c; 2007; 2010; Peper et al 2009; 2010; Vargas et al 2007a; 2007b; 2008).

For this analysis, avoided runoff value is calculated based on the price of €1,90 per cubic meter.

Building Energy Use:

If appropriate field data were collected, seasonal effects of trees on residential building energy use were calculated based on procedures described in the literature (McPherson and Simpson 1999) using distance and direction of trees from residential structures, tree height and tree condition data. To calculate the monetary value of energy savings, local or custom prices per MWH or MBTU are utilized.

For this analysis, energy saving value is calculated based on the prices of €214,00 per MWH and €20,51 per MBTU.

Replacement Values:

Replacement value is the value of a tree based on the physical resource itself (e.g., the cost of having to replace a tree with a similar tree). Replacement values were based on valuation procedures of the Council of Tree and Landscape Appraisers, which uses tree species, diameter, condition, and location information (Nowak et al 2002a; 2002b). Replacement value may not be included for international projects if there is insufficient local data to complete the valuation procedures.

Potential Pest Impacts:

The complete potential pest risk analysis is not available for studies outside of the United States. The number of trees at risk to the pests analyzed is reported, though the list of pests is based on known insects and disease in the United States.

For the U.S., potential pest risk is based on pest range maps and the known pest host species that are likely to experience mortality. Pest range maps for 2012 from the Forest Health Technology Enterprise Team (FHTET) (Forest Health Technology Enterprise Team 2014) were used to determine the proximity of each pest to the county in which the urban forest is located. For the county, it was established whether the insect/disease occurs within the county, is within 400 kilometers of the county edge, is between 400 and 1210 kilometers away, or is greater than 1210 kilometers away. FHTET did not have pest range maps for Dutch elm disease and chestnut blight. The range of these pests was based on known occurrence and the host range, respectively (Eastern Forest Environmental Threat Assessment Center; Worrall 2007).

Relative Tree Effects:

The relative value of tree benefits reported in Appendix II is calculated to show what carbon storage and sequestration, and air pollutant removal equate to in amounts of municipal carbon emissions, passenger automobile emissions, and house emissions.

Municipal carbon emissions are based on 2010 U.S. per capita carbon emissions (Carbon Dioxide Information Analysis Center 2010). Per capita emissions were multiplied by city population to estimate total city carbon emissions.

Light duty vehicle emission rates (g/mi) for CO, NOx, VOCs, PM10, SO2 for 2010 (Bureau of Transportation Statistics 2010; Heirigs et al 2004), PM2.5 for 2011-2015 (California Air Resources Board 2013), and CO2 for 2011 (U.S.

Environmental Protection Agency 2010) were multiplied by average miles driven per vehicle in 2011 (Federal Highway Administration 2013) to determine average emissions per vehicle.

Household emissions are based on average electricity kWh usage, natural gas Btu usage, fuel oil Btu usage, kerosene Btu usage, LPG Btu usage, and wood Btu usage per household in 2009 (Energy Information Administration 2013; Energy Information Administration 2014)

- CO_2, SO_2, and NOx power plant emission per KWh are from Leonardo Academy 2011. CO emission per kWh assumes 1/3 of one percent of C emissions is CO based on Energy Information Administration 1994. PM_{10} emission per kWh from Layton 2004.
- CO_2, NOx, SO_2, and CO emission per Btu for natural gas, propane and butane (average used to represent LPG), Fuel #4 and #6 (average used to represent fuel oil and kerosene) from Leonardo Academy 2011.
- CO_2 emissions per Btu of wood from Energy Information Administration 2014.
- CO, NOx and SOx emission per Btu based on total emissions and wood burning (tons) from (British Columbia Ministry 2005; Georgia Forestry Commission 2009).

Appendix II. Relative Tree Effects

The urban forest in Tufello_Schinus provides benefits that include carbon storage and sequestration, and air pollutant removal. To estimate the relative value of these benefits, tree benefits were compared to estimates of average municipal carbon emissions, average passenger automobile emissions, and average household emissions. See Appendix I for methodology.

<u>Carbon storage is equivalent to:</u>

- Amount of carbon emitted in Tufello_Schinus in 1 days
- Annual carbon (C) emissions from 0 automobiles
- Annual C emissions from 0 single-family houses

<u>Carbon monoxide removal is equivalent to:</u>

- Annual carbon monoxide emissions from 0 automobiles
- Annual carbon monoxide emissions from 0 single-family houses

<u>Nitrogen dioxide removal is equivalent to:</u>

- Annual nitrogen dioxide emissions from 0 automobiles
- Annual nitrogen dioxide emissions from 0 single-family houses

<u>Sulfur dioxide removal is equivalent to:</u>

- Annual sulfur dioxide emissions from 0 automobiles
- Annual sulfur dioxide emissions from 0 single-family houses

<u>Annual carbon sequestration is equivalent to:</u>

- Amount of carbon emitted in Tufello_Schinus in 0,1 days
- Annual C emissions from 0 automobiles
- Annual C emissions from 0 single-family houses

Appendix III. Comparison of Urban Forests

A common question asked is, "How does this city compare to other cities?" Although comparison among cities should be made with caution as there are many attributes of a city that affect urban forest structure and functions, summary data are provided from other cities analyzed using the i-Tree Eco model.

I. City totals for trees

City	*% Tree Cover*	*Number of Trees*	*Carbon Storage (metric tons)*	*Carbon Sequestration (metric tons/yr)*	*Pollution Removal (metric tons/yr)*
Toronto, ON, Canada	26,6	10.220.000	1.108.000	46.700	1.905
Atlanta, GA	36,7	9.415.000	1.220.000	42.100	1.509
Los Angeles, CA	11,1	5.993.000	1.151.000	69.800	1.792
New York, NY	20,9	5.212.000	1.225.000	38.400	1.521
London, ON, Canada	24,7	4.376.000	360.000	12.500	370
Chicago, IL	17,2	3.585.000	649.000	22.800	806
Phoenix, AZ	9,0	3.166.000	286.000	29.800	511
Baltimore, MD	21,0	2.479.000	517.000	16.700	390
Philadelphia, PA	15,7	2.113.000	481.000	14.600	522
Washington, DC	28,6	1.928.000	477.000	14.700	379
Oakville, ON , Canada	29,1	1.908.000	133.000	6.000	172
Albuquerque, NM	14,3	1.846.000	301.000	9.600	225
Boston, MA	22,3	1.183.000	290.000	9.500	257
Syracuse, NY	26,9	1.088.000	166.000	5.300	99
Woodbridge, NJ	29,5	986.000	145.000	5.000	191
Minneapolis, MN	26,4	979.000	227.000	8.100	277
San Francisco, CA	11,9	668.000	176.000	4.600	128
Morgantown, WV	35,5	658.000	84.000	2.600	65
Moorestown, NJ	28,0	583.000	106.000	3.400	107
Hartford, CT	25,9	568.000	130.000	3.900	52
Jersey City, NJ	11,5	136.000	19.000	800	37
Casper, WY	8,9	123.000	34.000	1.100	34
Freehold, NJ	34,4	48.000	18.000	500	20

II. Totals per hectare of land area

City	*Number of Trees/ha*	*Carbon Storage (metric tons/ha)*	*Carbon Sequestration (metric tons/ha/yr)*	*Pollution Removal (kg/ha/yr)*
Toronto, ON, Canada	160,4	17,4	0,73	29,9
Atlanta, GA	275,8	35,7	1,23	44,2
Los Angeles, CA	48,4	9,4	0,36	14,7
New York, NY	65,2	15,3	0,48	19,0
London, ON, Canada	185,5	15,3	0,53	15,7
Chicago, IL	59,9	10,9	0,38	13,5
Phoenix, AZ	31,8	2,9	0,30	5,1
Baltimore, MD	118,5	25,0	0,80	18,6
Philadelphia, PA	61,9	14,1	0,43	15,3
Washington, DC	121,1	29,8	0,92	23,8
Oakville, ON , Canada	192,9	13,4	0,61	12,4
Albuquerque, NM	53,9	8,8	0,28	6,6
Boston, MA	82,9	20,3	0,67	18,0
Syracuse, NY	167,4	23,1	0,77	15,2
Woodbridge, NJ	164,4	24,2	0,84	31,9
Minneapolis, MN	64,8	15,0	0,53	18,3
San Francisco, CA	55,7	14,7	0,39	10,7
Morgantown, WV	294,5	37,7	1,17	29,2
Moorestown, NJ	153,4	27,9	0,90	28,1
Hartford, CT	124,6	28,5	0,86	11,5
Jersey City, NJ	35,5	5,0	0,21	9,6
Casper, WY	22,5	6,2	0,20	6,2
Freehold, NJ	94,6	35,9	0,98	39,6

Appendix IV. General Recommendations for Air Quality Improvement

Urban vegetation can directly and indirectly affect local and regional air quality by altering the urban atmosphere environment. Four main ways that urban trees affect air quality are (Nowak 1995):

- Temperature reduction and other microclimate effects
- Removal of air pollutants
- Emission of volatile organic compounds (VOC) and tree maintenance emissions
- Energy effects on buildings

The cumulative and interactive effects of trees on climate, pollution removal, and VOC and power plant emissions determine the impact of trees on air pollution. Cumulative studies involving urban tree impacts on ozone have revealed that increased urban canopy cover, particularly with low VOC emitting species, leads to reduced ozone concentrations in cities (Nowak 2000). Local urban management decisions also can help improve air quality.

Urban forest management strategies to help improve air quality include (Nowak 2000):

Strategy	*Result*
Increase the number of healthy trees	Increase pollution removal
Sustain existing tree cover	Maintain pollution removal levels
Maximize use of low VOC-emitting trees	Reduces ozone and carbon monoxide formation
Sustain large, healthy trees	Large trees have greatest per-tree effects
Use long-lived trees	Reduce long-term pollutant emissions from planting and removal
Use low maintenance trees	Reduce pollutants emissions from maintenance activities
Reduce fossil fuel use in maintaining vegetation	Reduce pollutant emissions
Plant trees in energy conserving locations	Reduce pollutant emissions from power plants
Plant trees to shade parked cars	Reduce vehicular VOC emissions
Supply ample water to vegetation	Enhance pollution removal and temperature reduction
Plant trees in polluted or heavily populated areas	Maximizes tree air quality benefits
Avoid pollutant-sensitive species	Improve tree health
Utilize evergreen trees for particulate matter	Year-round removal of particles

Appendix V. Invasive Species of the Urban Forest

Invasive species data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

Appendix VI. Potential Risk of Pests

Pest range data is only available for the United States. This analysis cannot be completed for international studies because of a lack of necessary data.

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