



# SPATIO-TEMPORAL CHANGES OF FOREST COVER IN GUJARAT STATE

Holly Dehingia<sup>1</sup>, P Surendra<sup>2</sup>

<sup>1</sup> M.Sc. Student, Department of Geography, Bangalore University, Bengaluru, India

<sup>2</sup> Assistant Professor, Department of Geography, Bangalore University, Bengaluru, India



OPEN ACCESS

Received: 12.08.2020

Accepted: 18.11.2020

Published: 12.12.2020

**Citation:** Dehingia H, Surendra P. (2020). SPATIO-TEMPORAL CHANGES OF FOREST COVER IN GUJARAT STATE. *Geo-Eye*. 9(2): 59-65. <https://doi.org/10.53989/bu.ge.v9i2.10>

**Funding:** None

**Competing Interests:** None

**Copyright:** © 2020 Dehingia & Surendra. This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Published By Bangalore University, Bengaluru, Karnataka

ISSN

Print: 2347-4246

Electronic: XXXX-XXXX

## Abstract

The Spatio-temporal study can be a significant way for researchers and decision-makers to monitor the status of any particular phenomena or process and so is the study of forest cover. The study reflects how forest cover has changed in different parts of Gujarat and why. The overall objective of this study is to access the Spatio-temporal changes in forest cover in Gujarat. The study is based on data collected from the Gujarat Forest Department and Forest Survey of India. Quantitative techniques were mostly used for the analysis of the data collected from 2001 to 2019. By using simple statistical techniques, it was observed that the forest cover in many areas of Gujarat has been decreasing due to natural causes as well as anthropogenic activities. Tables and figures show the Spatio-temporal changes in forest cover remarkably from 2001-2002, 2010-2011, and 2018- 2019.

**Keywords:** Forest cover; temporal changes

## Introduction

A Forest is land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use (FAO). According to SOFO, forests cover 31 percent of the global land area but are not equally distributed around the globe. Forest cover is defined as an area more than 1 ha in extent and having a tree canopy density of 10 percent and above (FSI). Forest cover today is altered primarily by direct human use and any conception of global change must be due to the pervasive influence

of human activity on land surface conditions and processes (Yang, X. and Lo, C. P, 2002).

Assessment of Spatio-temporal changes in forest cover plays an important role in monitoring the changes in the forest resources along with the forest cover over certain spatial extents and forms the basis to support the policymakers in making decisions to ensure that a forest cover and its resources are protected. Also, there have been no known studies of the Spatio-temporal changes in the forest cover of Gujarat as a whole, which is why this study has been conducted by dividing the forest cover under three sub-heads i.e., dense forest, open forest, and scrub land.

## Objectives

- The present study is to assess the Spatio-temporal change in forest cover in Gujarat state.

## Study Area

Gujarat, the Land of the Legends stands bordered by Pakistan and Rajasthan in the northeast, Madhya Pradesh in the east, and Maharashtra and the Union territories of Diu, Daman, Dadra and Nagar Haveli in the south. The Arabian Sea borders the state both to the west and the southwest. It is located between 20°01' to 24°07' north latitudes and 68°04' to 74°04' East longitude. It experiences diverse climatic conditions, wet in the southern districts and deserts in the north-west region. Summer temperature varies between 25 degrees to 45 degrees. Winter temperature varies between 15 degrees to 35 degrees and monsoon temperatures from 27 degrees to 35 degrees. Its ecosystem ranges from deserts, scrublands, grasslands, deciduous forests, and wetlands to mangroves, coral reefs, estuaries, and gulfs.

The topography of Gujarat shows wide variations. It is located near the Thar desert, therefore most of the land is dry and arid in nature. Moreover, the topography of Gujarat is characterized by the small hilly tracts especially around the Rann of Kutch region.

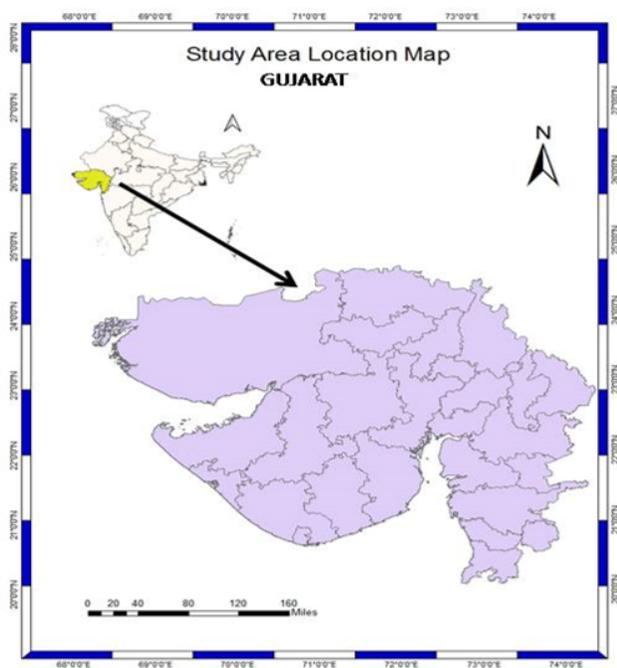


Fig. 1. Study area location map

## Methodology

The present study based on secondary data was collected from various sources such as Gujarat Forest Department, Forest Survey of India, and review of literature. Quantitative techniques were mostly used for the study. Simple statistical techniques were used to facilitate visual interpretation.

a) Forest cover data of Gujarat were collected from the Gujarat Forest Department and Forest Survey of India for the period of 2001-02 to 2018-19. Here we have studied how the area under dense forest, open forest, and scrub differs in different divisions of Gujarat state. We have also included the temporal changes in the forest cover of different divisions during the period of 2001-02 to 2010-11, 2010-11 to 2018-19, and 2001-02 to 2018-19.

b) The state has been categorized into four divisions i.e., Central Gujarat, north Gujarat, Saurashtra-Kutch & south Gujarat, and the assessment has been done for 18 years.

## Results and Discussions

### Classification of Forest Cover

Forest cover, in general, refers to the relative (in percent) or sure (in square kilometers/square miles) land area that is covered by forests.

Table 1 shows Division Wise Classification of Forest Cover 2001-02 in Gujarat state. It has been depicted in the figure, which shows that-Central Gujarat has the lowest Dense Forest Cover of about 7.5% in comparison to the other divisions due to less rainfall, Open Forest of about 6.9%, and Scrub land of about 2% of the total forest cover of the state. North Gujarat has a Dense Forest Cover of about 8.3%, has the lowest Open Forest of about 4.6%, and Scrub land of about 3.3% of the total forest cover of the state. Saurashtra-Kutch Gujarat has 10% of Dense Forest, has the highest Open Forest cover as compared to the other divisions of about 16.3% due to success in social forestry plantations and re-growth of *Prosopis Juliflora* and highest Scrub land cover of about 7.7% of the total forest cover of the state. South Gujarat has the highest Dense Forest cover of about 22.9% due to the highest rainfall received in the hills than in the plains, Open Forest cover of 9.2%, and Scrub land of about 0.7%.

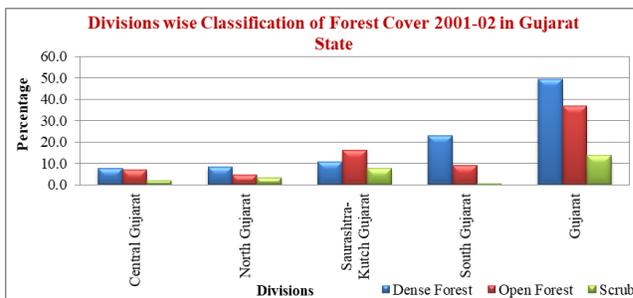
Divisions	No. of District	Name of District	Area (in Sq.Km)
Central Gujarat	8	Ahmedabad	7090
		Vadodara	6354
		Anand	3204
		Chota Udaipur	1192
		Dahod	3642
		Kheda	3442
		Mahisagar	2261
		Panchmahal	3481
North Gujarat	6	Gandhinagar	2140
		Aravalli	3308
		Banaskantha	10743
		Mehasana	4401
		Patan	5792
		Sabarkantha	4086
Saurashtra-Kutch	12	Rajkot	7750
		Amreli	7397
		Bhavnagar	8487
		Botad	2564
		Dev Bhumi	4051
		Dwarka	
		Gir Somnath	3289
		Jamnagar	5980
		Junagadh	5542
		Morbi	8786
		Porbandar	2316
		Surendranagar	9238
Kachchh	45674		
South Gujarat	7	Surat	4549
		Bharuch	6509
		Dang	1766
		Narmada	2817
		Navsari	2246
		Tapi	3139
		Valsad	3008

Class	Description
Very Dense Forest	Tree canopy density of 70% and above.
Moderately Dense Forest	Tree canopy density of 40% and more but less than 70%.
Open Forest	Tree canopy density of 10% and more but less than 40%.
Scrub	Degraded forest lands with canopy density less than 10%.

**Table 1.** Divisions wise Classification of Forest Cover 2001-02 in Gujarat State

S.N	Divisions	Area in Sq. Km				
		Dense For-est	Open For-est	Scrub	Total	
1	Central Gujarat	Area	1319	1207	350	2876
	%	7.5	6.9	2.0	16.4	
2	North Gujarat	Area	1457	806	579	2842
	%	8.3	4.6	3.3	16.2	
3	Saurashtra-Kutch	Area	1871	2854	1358	6083
	%	10.7	16.3	7.7	34.6	
4	Gujarat South	Area	4026	1612	121	5759
	%	22.9	9.2	0.7	32.8	
	Gujarat	Area	8673	6479	2408	17560
	%	49.4	36.9	13.7	100.0	

Source: Gujarat Forest Department



**Fig. 2.** Forest Cover in Gujarat State from 2001-02



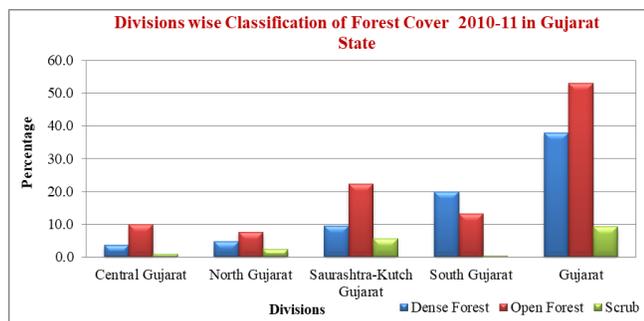
Table 2 shows the division-wise classification of forest cover 2010-11 in Gujarat state. It has been depicted in the figure, which shows that-

Central Gujarat has the lowest Dense Forest cover of about 3.7% due to less rainfall compared to the rest of the divisions, Open Forest of 9.9%, and Scrub land of about 0.9% of the total forest cover of the state. North Gujarat has a Dense Forest cover of 4.7%, Open Forest cover of 7.6%, and Scrub land of about 2.4% of the total forest cover of the state. Saurashtra-Kutch Gujarat has a Dense Forest cover of 9.6%, has the highest Open Forest cover due to afforestation within and outside recorded forest area, and Scrub land of about 22.3% and 5.6% respectively. South Gujarat has the highest Dense Forest cover of 19.9% due to the highest rainfall received in the hills than in the plain areas, Open Forest cover of 13.2%, and has the lowest Scrub land cover of 0.3% of the total forest cover of the state.

**Table 2.** Divisions wise Classification of Forest Cover 2010-11 in Gujarat State

S.N Divisions		Area in Sq. Km				
		Dense For-est	Open For-est	Scrub	Total	
1	Central Gujarat	Area	593	1600	153	2346
		%	3.7	9.9	0.9	14.5
2	North Gujarat	Area	755	1227	383	2365
		%	4.7	7.6	2.4	14.6
3	Saurashtra-Kutch Gujarat	Area	1557	3611	903	6071
		%	9.6	22.3	5.6	37.5
4	South Gujarat	Area	3233	2139	56	5428
		%	19.9	13.2	0.3	33.5
Gujarat		Area	6138	8577	1495	16210
		%	37.9	52.9	9.2	100.0

Source: Gujarat Forest Department



**Fig. 3.** Forest Cover in Gujarat State from 2010-11

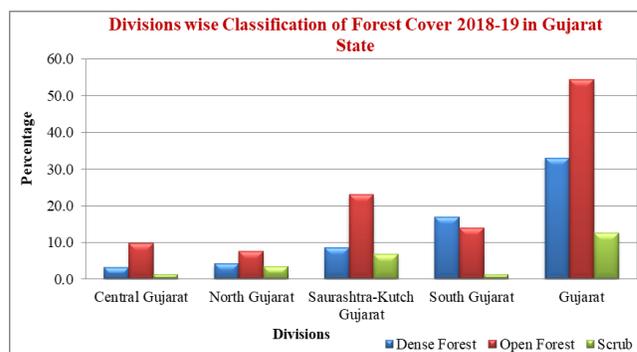
Table 3 shows the Division Wise Classification of Forest Cover 2018-19 in Gujarat state. The data depicted in the figure shows that-

Central Gujarat has the lowest Dense Forest cover of 3.1%, Open Forest cover of 9.8%, and the lowest Scrub land cover of 1.2% of the total forest cover of the state. South Gujarat has 4.3% of Dense Forest cover, has the lowest Open Forest cover of about 7.6%, and Scrub land of about 3.4%. Saurashtra-Kutch Gujarat has a Dense Forest cover of 8.7%, has the highest Open Forest cover, and Scrub land of about 23% and 6.8% respectively. South Gujarat has the highest Dense Forest cover of 16.9%, Open Forest cover of about 14%, and has the lowest Scrub land of about 1.2% of the total forest cover of the state.

**Table 3.** Divisions wise Classification of Forest Cover 2018-19 in Gujarat State

S.N Divisions		Area in Sq. Km				
		Dense For-est	Open For-est	Scrub	Total	
1	Central Gujarat	Area	532	1657	210	2399
		%	3.1	9.8	1.2	14.2
2	North Gujarat	Area	730	1278	578	2586
		%	4.3	7.6	3.4	15.3
3	Saurashtra-Kutch Gujarat	Area	1462	3887	1146	6495
		%	8.7	23.0	6.8	38.5
4	South Gujarat	Area	2853	2357	200	5410
		%	16.9	14.0	1.2	32.0
Gujarat		Area	5577	9179	2134	16890
		%	33.0	54.3	12.6	100.0

Source: Gujarat Forest Department



**Fig. 4.** Forest Cover in Gujarat State from 2018-19



Table 4 depicts the temporal changes of the Dense Forest cover of Gujarat state for the period of 2001-2019. It has been observed that-From 2001-02 to 2010-11, Central Gujarat has witnessed a change of -3.8% and an additional decrease of -0.6 from 2010-11. From 2001-02 to 2018-2019, there has been an overall change in the

The dense forest cover of -4.4%. From 2001-02 to 2010-11, North Gujarat has witnessed a change of -3.6% and an additional decrease of -0.4% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Dense Forest cover of -4%. From 2001-02 to 2010-11, Saurashtra-Kutch Gujarat has witnessed a change of -1.1% and an additional decrease of -0.9% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Dense Forest cover of -2%. From 2001-02 to 2010-11, South Gujarat has witnessed a change of -3.0% and an additional decrease of -3.0% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Dense Forest cover of -6.0%.

Table 5 depicts the Division Wise Temporal Changes in the Open Forest Cover of Gujarat State from 2001 through 2019. It has been observed that-From 2001-02 to 2010-11, Central Gujarat has witnessed an increase of 3% but it got decreased by -0.1% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Open Forest covers of 2.9%. From 2001-02 to 2010-11, North Gujarat has witnessed a change of 3% of its Open Forest cover and there has not been any further change till 2018-19. From 2010-02 to 2010-11, Saurashtra-Kutch Gujarat has witnessed an applauding increment in its Open Forest cover by 6% and an additional increment of 0.7% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Open Forest covers of 6.7%. From 2001-02 to 2010-11, South Gujarat has witnessed an increase of 4% in the Open Forest cover and an additional increase of 0.8% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change of 4.8% in the Open Forest covers of the state.

Table 6 depicts the Division Wise Temporal Changes in the Scrub Cover of Gujarat State from 2001 through 2019. It has been observed that-

From 2001-02 to 2010-11, Central Gujarat has witnessed a decrease of -1.1% of its Scrub covers but it got increase by 0.3% from 2010-11 to 2018-19. From 2001-02 to 2018-

19, there has been an overall change in the Scrub covers of -0.8%. From 2001-02 to 2010-11, North Gujarat has witnessed a change of -0.9% but it got increase by 1.0% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Scrub cover of 0.1%. From 2001-02 to 2010-11, Saurashtra-Kutch Gujarat has witnessed a change of -2.1% but it got increase by 1.2% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Scrub covers of -0.9%. From 2001-02 to 2010-11, South Gujarat has witnessed a change of -0.4% but it got increase by 0.9% from 2010-11 to 2018-19. From 2001-02 to 2018-19, there has been an overall change in the Scrub covers of 0.5%. We can further observe that Dense Forest is seen to be gradually decreasing its forest cover due to private felling in trees outside the forest, large scale uprooting of *Prosopis Juliflora* from private and revenue lands, clearance in encroached areas, forest fires, etc while Open Forest cover is seen to be increasing in all the four divisions due to conservation efforts and afforestation within and outside recorded forest areas, management interventions like regeneration and departmental plantations, agroforestry, etc and there have not been many changes in the Scrub cover in all the divisions since minutes changes are only to be seen there.

## Conclusion

Assessing the Spatio-temporal changes in the forest cover facilitates monitoring the changes over a certain areal extent and clears the way for researchers and decision-makers in planning for its management and ensuring its safety. But in today's world due to most of the anthropogenic activities such as deforestation, encroachment, infrastructure projects, etc. every year large areas of forest are being destroyed for direct human use. This study shows Gujarat as well has witnessed a decrease in the dense forest cover and scrub lands from the period 2001-2019 due to forest fires, deforestation, private felling of trees, etc. Apart from it, Gujarat has also witnessed an increase in open forest cover due to management interventions like regeneration, agro forestry, etc. Thus, it is seen that, though the illicit human behavior has brought many changes in the forest cover, the Gujarat government is making a great effort and has managed to restore some of the areas to a great extent.

**Table 4.** Divisions wise Temporal changes of Dense Forest Cover in Gujarat state

S.N	Divisions	2001-02	2010-11	2018-19	Changes from 2001-02 to 2010-11	Changes from 2010-11 to 2018-19	Changes from 2001-02 to 2018-19
1	Central Gujarat	7.5	3.7	3.1	-3.8	-0.6	-4.4
2	North Gujarat	8.3	4.7	4.3	-3.6	-0.4	-4.0
3	Saurashtra-Kutch Gujarat	10.7	9.6	8.7	-1.1	-0.9	-2.0
4	South Gujarat	22.9	19.9	16.9	-3.0	-3.0	-6.0
	Gujarat	49.4	37.9	33.0	-11.5	-4.8	-16.4

Source: Gujarat Forest Department

**Table 5.** Divisions wise Temporal changes of Open Forest Cover in Gujarat state

S.N	Divisions	2001-02	2010-11	2018-19	Changes from 2001-02 to 2010-11	Changes from 2010-11 to 2018-19	Changes from 2001-02 to 2018-19
1	Central Gujarat	6.9	9.9	9.8	3.0	-0.1	2.9
2	North Gujarat	4.6	7.6	7.6	3.0	0.0	3.0
3	Saurashtra-Kutch Gujarat	16.3	22.3	23.0	6.0	0.7	6.7
4	South Gujarat	9.2	13.2	14.0	4.0	0.8	4.8
	Gujarat	36.9	52.9	54.3	16.0	1.4	17.4

Source: Gujarat Forest Department

**Table 6.** Divisions wise Temporal changes of Scrub Forest Cover in Gujarat state

S.N	Divisions	2001-02	2010-11	2018-19	Changes from 2001-02 to 2010-11	Changes from 2010-11 to 2018-19	Changes from 2001-02 to 2018-19
1	Central Gujarat	2.0	0.9	1.2	-1.1	0.3	-0.8
2	North Gujarat	3.3	2.4	3.4	-0.9	1.0	0.1
3	Saurashtra-Kutch Gujarat	7.7	5.6	6.8	-2.1	1.2	-0.9
4	South Gujarat	0.7	0.3	1.2	-0.4	0.9	0.5
	Gujarat	13.7	9.2	12.6	-4.5	3.4	-1.1

Source: Gujarat Forest Department

## References

- Yang X, Lo CP. Using a time series of satellite imagery to detect land use and land cover changes in the Atlanta, Georgia metropolitan area. *International Journal of Remote Sensing*. 2002;23(9):1775–1798. Available from: <https://dx.doi.org/10.1080/01431160110075802>.
- Saha T. Urban Forestry: Strategy and Planning I Indian Context. *International Journal of Humanities and Social Science Studies*. 2017;(1).
- Gujarta Forest Statistics.2018-19, "Area Classification", 15-28. .
- India State of Forest Report. 2011, "Forest and Tree Resources in States and Union Territories". .
- Fuwape JA, Onyekwelu JC. Urban Forest Development in West Africa: Benefits and Challenges?. *Journal of Biodiversity and Ecological Sciences*. 2010;1(1).
- Chaudhry P, Tewari VP. Urban forestry in India: development and research scenario. *Interdisciplinary Environmental Review*. 2011;12(1):80. Available from: <https://dx.doi.org/10.1504/ier.2011.038881>.
- Gujarat Forest Statistics.2001-02, "Area Classification", 11-22. .
- Endreny TA. Strategically growing the urban forest will improve our world. *Nature Communications*. 2018;9(1). Available from: <https://dx.doi.org/10.1038/s41467-018-03622-0>.
- Gujarat Forest Statistics.2010-11, "Area Classification", 12-23. .
- Bhalla P, Bhattacharya P. Urban Biodiversity and Green Spaces in Delhi: A Case Study of New Settlement and Lutyens' Delhi. *Journal of Human Ecology*. 2015;52(1-2):83–96. Available from: <https://dx.doi.org/10.1080/09709274.2015.11906933>.
- Chaudhry P, Bagra K, Singh B. Urban Greenery Status of Some Indian Cities: A Short Communication. *International Journal of Environmental Science and Development*. 2011;2(2):98–101. Available from: <https://dx.doi.org/10.7763/ijesd.2011.v2.104>.
- Dobbs C, Eleuterio AA, Amaya JD, Montoya J, Kendal, D. The Benefits of Urban and Peri-Urban Forestry. *Unasylva*. 2018;69.
- Tripathi M, Joshi H. Carbon Flow in Delhi Urban Forest Ecosystem. *Annals of Biological Research*. 2015;6:13–17.
- Kuo FE. Social Aspects of Urban Forestry, the Role of Arboriculture in a Healthy Social Ecology". *Journal of Arboriculture*. 2003;29(3).
- Dwivedi P, Rathore CS, Dubey Y. Ecological benefits of urban forestry: The case of Kerwa Forest Area (KFA), Bhopal, India. *Applied Geography*. 2009;29(2):194–200. Available from: <https://dx.doi.org/10.1016/j.apgeog.2008.08.008>.
- Tasoulas E, Varras G, Tsirogiannis I, Myriounis C. Development of a GIS Application for Urban Forestry Management Planning. *Procedia Technology*. 2013;8:70–80. Available from: <https://dx.doi.org/10.1016/j.protcy.2013.11.011>.



- 17) Adam G, Hermawan R, Prasetyo LB. Use of Geographical Information System (GIS) and remote sensing in development of urban forest types and shapes in Tangerang Selatan City. *IOP Conference Series: Earth and Environmental Science*. 2017;54:012051. Available from: <https://dx.doi.org/10.1088/1755-1315/54/1/012051>.
- 18) Pearlmutter D, Carinanos P, Calaza P, Hiemstra J, Vilgar U. The Role of Urban and Peri-Urban Forests in Reducing Risks and Managing Disasters. *Unasylva* . 2018;69.
- 19) Salbitano F, Borelli S, Conigliaro M, Yujuan C. Guidelines On Urban And Peri Urban Forestry. 2016.