Tree coverage and tree coverage change in a highly urbanized country: the case of Uruguayan Cities 2000-2019

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Abstract

The urbanization process continues worldwide and it is expected that by 2050 two thirds of the global population will live in cities. In parallel to the urbanization process, global warming has increased global surface temperature between 0,8 and 1.5°C since pre-industrial levels. Urban areas are particularly vulnerable to the consequences of climate change, such as heat stress, urban flooding, landslides, air pollution, droughts, and water scarcity. The composition of urban land cover can influence the ability of urban areas to adapt to climate change. Urban vegetation such as trees and shrubs can play an important role to reduce the impact of heatwaves in cities; the permeable cover can help reduce potential urban flooding by absorbing and reducing runoff during heavy precipitation. Therefore, quantifying the extent and trends of urban land cover can provide important information for city planners to understand their urban landscape as well as the existing potential for climate change adaptation activities. In this study, we have measured the extension and trends (over a 20-year period) of tree cover and other surfaces (impervious, permeable, others) in 26 Uruguayan cities. Cover classes were identified by random sampling of points on the i-Tree Canopy platform. The results show an increase in tree cover, an increase in impervious cover, and a decrease in herbaceous cover in urban areas. This increase in tree cover is not in line with findings reported in several international studies. The present work is the first analysis for Uruguay in which the dynamics of cover loss and gain (trees, permeable, impervious) in an urban context.

1. Introduction

The urbanization process continues worldwide and it is expected that by 2050 two thirds of the global population will live in cities (UNEP, 2021). This urbanization process is happening at different trends in different regions in Uruguay, the process occurred earlier than in the rest of the Latin American region. Currently, 95% of the Uruguayan population lives in urban areas, 70% of which lives in the coastal zone (INE, 2011). Future scenarios show a continuous urbanization process (INE 2011; OPP, 2018). According to national data proportioned by the National Land Use Planning Office, in 2020 the urban areas occupied 1,543 Km^2 (0.88% land surface).

In parallel to the urbanization process, global warming has increased global surface temperature between 0,8 and 1.5°C since pre-industrial levels. This human-induced climate change is affecting every region with heatwaves, heavy precipitation, droughts and cyclones (IPCC, 2021). Urban areas are particularly vulnerable to the consequences of climate change, such as heat stress, urban flooding, landslides, air pollution, droughts, and water scarcity (IPCC, 2018). This vulnerability is exacerbated by inadequate planning, lack of infrastructure and services, poor quality housing, etc (UNEP, 2021).

The composition of urban land cover can influence the ability of urban areas to adapt to climate change. For example, the existence of urban vegetation such as trees and shrubs can play an important role to reduce the impact of heatwaves in cities; the permeable cover can help reduce potential urban flooding by absorbing and reducing runoff during heavy precipitation (Nowak and Dwyer, 2007; Selbig et al., 2022). Therefore, quantifying the extent and trends of different urban land cover categories such as urban tree canopy and permeable and impervious surfaces can provide important information for city planners to understand their urban landscape as well as the existing potential for climate change adaptation activities (Nowak and Greenfield, 2012a).

Urban trees and forests can also mitigate climate change by sequestering carbon dioxide. Having an urban tree canopy estimation provides basic structural data that can be used to model tree ecosystem services such as carbon dioxide sequestration or air pollution mitigation (Nowak, 2002; Nowak et al., 2008), as well as to guide urban tree management strategies. Impervious surface data are important for assessing the impacts of infrastructure development on urban temperatures, runoff, and water quality (Heisler et al., 2007; Theobald et al., 2009).

In addition, trees and green spaces in urban areas play an increasingly important role in creating livable urban spaces, maintaining the wellbeing of the population while contributing to mitigating the potential impacts of climate change and the development of sustainability and resilient cities. Urban trees fulfil a number of functions or ecosystem services such as improved air quality, temperatures reduction during heat weaves, increased biodiversity, improvement in the physical and mental health of urban inhabitants, among others (Boulton et al., 2018; Kabisch and Haase, 2014; Roy et al., 2012). For example, a study for ten megacities showed that urban trees contribute to pollution reduction resulting in health cost savings of around US$ 482 million per year (Endreny et al., 2020).

In this study, we have measured the extension and trends (over a 20-year period) of tree cover and other surfaces (impervious, grass, others) in 26 Uruguayan cities. These results can help urban planners understand the state and direction of their urban landscapes and how this trend can be limiting their ability to adapt to current and future climate change. In addition, data on the surface cover can also provide important information on existing opportunities for climate change adaptation action, such as the availability of areas to be planted in cities with low tree coverage.

2. Materials And Methods

2.1. Study area

Uruguay has a population of 3.286.314 inhabitants (INE, 2011). This study covers all cities with more than 20,000 inhabitants, which corresponds to 26 cities totalling 2,339,369 inhabitants or 75.2% of the total urban population (INE, 2011). These 26 cities occupy an area of 895 km² (75.62% of the total urban area).

The localities boundaries used for this work, elaborated by the National Land Use Planning Office (DINOT 2019), is an adaptation of the methodology used by the Joint Research Center of the European Commission (Florczyk et al., 2019). These boundaries constitute an objective delimitation of urban land. In the case of Las Piedras-La Paz-Progreso, Montevideo, and Ciudad de la Costa it was decided to use “administrative” boundaries because of the methodology used by DINOT (2019) these cities constituted one single urban conglomerate.

2.2. Estimation of urban land cover and trends

For the estimation of trees and other land covers for the 26 urban areas considered in this work, i-Tree Canopy was used. i-Tree Canopy is designed to allow the user to easily and accurately estimate tree and other land cover classes within urban areas. This tool consists of visual interpretation of randomly sampled points from satellite imagery, then estimating the proportions of cover classes (Nowak et al., 2008).

The cover classes defined for our study are listed in Table 1. The operational definition used to define urban tree cover is canopy cover of trees or shrubs within the boundaries defined as an urban area. We decided to include the category of permeable sidewalks in order to estimate the potential of easier to plant areas with high benefits for the reduction of heat stress in urban areas.

Table 1
Class cover for i-Tree Canopy classification.

Class cover	**Description**
Tree street	Tree/Shrub in street
Another tree	Tree/Shrub out street
Herbaceous	Herbaceous cover outside paths or flowerbeds
Building	Edification, house, industry, etc
Street	Paved roads, ballast roads, etc.
Impervious sidewalk	Impervious sidewalk
Sidewalks	Permeable sidewalk
Water	Water/beach sand/ watercourse
Others	Bare soil, not determined, etc.

Cover classes were identified by random sampling of points overlaid on Google Maps© satellite imagery as available for 2018–2019 on the i-Tree Canopy platform. A total of 600 points were used for each urban area to conduct the coverage characterization and to be statistically significant (USDA, 2011). In total, 15,600 points were sampled. This method has been applied for the assessment of tree cover and other surfaces in several cities worldwide (e.g., Nowak et al., 1996; Nowak and Greenfield, 2010, 2012b; Nowak and Greenfield, 2010; Nowak and Greenfield 2012; Benedetti et al., 2016; Celemin and Arias, 2018).

Land cover change analysis was done considering the 2000–2019 period. To conduct the land cover change analysis, sampling was obtained for the initial or zero year (ca 2000) by using the closest year for which Google Earth© had an image with good enough resolution to identify the different land use cover. Each point was placed in the same geographical position in both sets of temporal images of the city, and the interpretation was conducted. In cases of misregistration of the image or point, the interpreter corrected the location of the point to ensure that it was interpreted at exactly the same location.

Random points were taken for 2019 first, using existing urban boundaries developed by the National Land Use Planning Office (Dirección Nacional de Ordenamiento Territorial) with a 2018 imagery. Therefore, the sampling area for the initial year includes areas where some cities have expanded.

Within the boundaries of each city, the percentage of each coverage class is estimated as: $P = x_i/n$; P = percentage coverage, xi = number of points interpreted in class i, n = total number of points within the study area.

To determine the area (in metric units) we used: $Sup = P_i \times A$, where, Sup = area of cover of class i, P_i = percentage of cover of class i, A = total area of the study area.

The standard error (S.E) of the cover class estimation is calculated as: $S.E = \sqrt{(pq/N)}$, N = total number of points, n = total number of classified points of class i, p = n/N, q = 1 - p.

Table 2
Information about localities was considered in this study.

Departament	City	Área (Km²)	Image data Year 1	Image data Year 2
Colonia	Juan Lacaze	4.41	2007	2018
Canelones	Canelones	5.79	2003	2018
San José	Delta del Tigre	10.68	2003	2018
Flores	Trinidad	7.03	2007	2018
Rio Negro	Fray Bentos	6.02	2003	2019
Rocha	Rocha	9.82	2005	2019
Treinta y Tres	Treinta y Tres	13.16	2006	2019
Canelones	Pando	8.39	2004	2019
Colonia	Colonia del Sacramento	11.39	2006	2018
Maldonado	San Carlos	7.14	2003	2019
Canelones	Barros Blancos	12.5	2002	2019
Florida	Florida	9.27	2006	2018
Durazno	Durazno	10.76	2005	2019
San José	San José de Mayo	9.8	2006	2019
Lavalleja	Minas	11.33	2004	2018
Artigas	Artigas	10.31	2002	2019
Soriano	Mercedes	8.18	2005	2018
Cerro Largo	Melo	14.21	2004	2019
Tacuarembó	Tacuarembó	17.12	2002	2018
Maldonado	Punta del Este	36.54	2005	2019
Rivera	Rivera	22.9	2003	2018
Canelones	Ciudad de la Costa	47.71	2004	2019
Paysandú	Paysandú	27.9	2002	2019
Salto	Salto	23.69	2004	2019
Canelones	Las Piedras-La Paz-Progreso	21.79	2004	2019
Montevideo	Montevideo	527.3	2005	2019

2.3. Data analysis

To facilitate the analysis and interpretation of results some cover classes were merged (see Table 1). For example, the classes Street trees (ST) and Another tree (AT) in the Tree Cover (TC) class; Permeable Cover composed of the classes Herbaceous (H) and Permeable sidewalk (Sw). Impervious cover is composed of the classes Street (S), Building (B), and impervious sidewalk (Imp). The Potential Planting category includes the classes Sidewalk, Impervious Sidewalk, and Herbaceous; and the Other (O) category includes the class Other (Oth) and Water (W). For any of the aggregated categories, the standard error was estimated.

To assess the differences in land cover change between the reference period analyzed, a t-test was conducted. Correlation analysis was conducted between the impervious cover and tree cover, impervious cover and population density, and between population density and tree cover. Estimation of tree cover per capita was conducted for each city (Nowak and Greenfield, 2012a; Hsu et al., 2018).

[1]https://canopy.itreetools.org/

3. Results

3.1. Current urban land cover

Urban land cover at the national level (including all urban areas under study) is shown in Fig. 1. Tree cover (Tree Street and Another tree) is estimated at 19.71% ±0.32, equivalent to 20,423 hectares; permeable cover (Herbaceous and Permeable Sidewalk) has a national average value of 35.10% ±0.38; and impervious cover (Buildings, Streets and Impermeable sidewalk) occupies 41.24% ±0.39.

Tree cover values vary between 13.66% in Rivera and 30.83% in the urban conglomerate La Paz-Las Piedras-Progreso. There are 15 cities with a tree cover percentage below the national average. Permeable cover varies between 10.33% in La Paz-Las Piedras-Progreso and a maximum of 47.5% in Montevideo. The proportion of impervious cover varies between 21.3% and 55.5%, corresponding to the cities of Montevideo and Mercedes, respectively. It should be noted that the cities of San José (51.3%) and Punta del Este (53%) have values above 50% impervious cover and their tree cover values are below the national average (16.83% and 15%, respectively). In Fig. 2, we show values from different cover classes.

Tree cover per capita in urban areas averaged 63 m^2 and was greatest in Ciudad de la Costa (222 m^2) and lowest in Mercedes (33 m^2). Impervious cover per capita averaged 85 m^2 and was greatest in San Jose (397 m^2) and lowest in Montevideo (87m^2) (Table 3).

Table 3
Tree and impervious cover (m^2) per capita in Uruguayan urban area

Tree cover		**Impervious cover**	
City/Locality	m²/capita	City/Locality	m²/capita
Ciudad de la Costa	222	San Jose	397
Colonia	110	Punta del Este	310
Montevideo	104	Ciudad de la Costa	271
Delta del Tigre	95	Treinta y Tres	189
Barros Blancos	90	Delta del Tigre	181
Treinta y Tres	89	Rivera	163
Punta del Este	88	Juan Lacaze	162
Durazno	69	Rocha	155
Juan Lacaze	69	Trinidad	151
Pando	66	Colonia	146
Tacuarembó	62	Paysandu	138
Paysandu	61	Pando	128
Artigas	61	Barros Blancos	126
Trinidad	60	Minas	124
Minas	60	Canelones	123
Rocha	59	Durazno	121
Florida	54	Tacuarembó	117
Canelones	52	San Carlos	116
Fray Bentos	50	Melo	116
San Carlos	49	Fray Bentos	113
Rivera	49	Artigas	110
La Paz-Las Piedras-Progreso	45	Florida	109
San Jose	45	Mercedes	108
Salto	43	La Paz-Las Piedras-Progreso	107
Melo	38	Salto	107
Mercedes	33	Montevideo	87
National average	**63**	**National average**	**85**

No significant correlations were found between tree cover and population density (r = 0.08) but a significant strong negative correlation was found between tree cover and impervious cover (r= -0.61). A weak correlation was found between tree coverage and population size (r = 0,34).

3.2. Land cover change

Land cover change was assessed for each city for the periods shown in Table 2. Figure 3 shows percentage net loss and gain for all cover classes in all Uruguayan cities assessed in this study. Notably most net losses are for herbaceous land cover, with the exception of a few cities that are also net losing tree coverage, Permeable sidewalk and “other”. In addition, changes in classes were assessed in order to understand which class is Tree Cover being substituted by and which class is more frequently changed to Tree Cover (see Fig. 4).

Overall, we registered a 2% increase in Tree Cover in these 26 cities during the period under analysis, from 17.27–19.27%, which is an annual mean increase of 0.11%. In terms of surface area, there was an increase of 1,382 hectares, equivalent to 72.8 hectares per year. Of the 26 localities, eight showed a decrease in Tree Cover. These are Ciudad de la Costa (-1,67%), Florida (-0,33%), Fray Bentos (-7,5%), Melo (-2,0%), Mercedes (-0,16%), Rivera (-5,51), Rocha (-1,50%) and Salto (-5,17%).

The increase in Tree Cover was mainly in areas previously covered by Herbaceous (78.5%), the other categories are Others (8.3%), Permeable sidewalk (6.7%), Buildings (3.7%) and impervious sidewalk (1.4%). On the other hand, Tree Cover loss is explained by conversion to herbaceous (47.2%), buildings (35.9%), others (6.1%), permeable sidewalk (4.9%), impervious sidewalk (3.8%) and street (1.9%).

In the other categories, all cities registered a reduction in Permeable coverage, the total overall reduction was of 11,14% (6318 hectares). The highest percentages were registered in San Carlos (22.5%) and Pando (21.5%). Herbaceous land cover was also reduced by 10.76% (6,397 hectares). This loss is mainly explained by conversion to Tree (36.1%) and Building (32.6%). We also registered a minor reduction in Sidewalk (0,38%), most of which is explained by a transformation to Tree (40,4%) and impervious sidewalk (35,2%).

All localities showed an increase in Impervious cover from 33.55–41.23% (+ 7.68% or 3,837 hectares). Seven localities comprise 40% of this increase in Impervious coverage. These cities include San Carlos (+ 14.33%), Rivera (+ 13.67), Fray Bentos (+ 11.83), Durazno (+ 11.81), Salto (+ 11.66), Ciudad de la Costa (+ 11.51), Artigas (+ 10.34). Buildings cover also increased from 22.2–28.5% (3,314 hectares), which is explained mainly by loss of herbaceous (70.8%), and tree cover (19.9%). The rest of the categories showed a minor increase. Street increased 0,68%, which is again mainly explained by Herbaceous loss (56,4%). Finally, Impervious sidewalk increased by 0,6%, which is mainly explained by Permeable sidewalk loss (62,4%).

Figure 4 summarized overall transitions between categories for all cities for the entire period. It is particularly interesting to note that tree coverage is lost mainly to buildings and streets, losing 35.9% to buildings and 1.9% to streets. The increase in tree coverage comes mainly from herbaceous (78.5%), others (8.3%) and Permeable sidewalk (8.3%).

4. Discussion

Adaptation to climate change is one of the most pressing challenges faced by cities. When it comes to adaptation to extreme weather events, such as intense rainfall in short time periods or heat waves, Nature-Based Solutions can play a key role among the possible adaptation tools. Moreover, tree coverage in urban areas is proven to work when it comes to reducing surface temperature (Schwaab et al., 2021; Rahman et al., 2020) and runoff (Selbig et al., 2022) in urban areas. Understanding the current situation and trend of tree coverage in urban areas in Uruguay is an important tool for policymakers.

The total average Tree Cover of 19.7% is below the average tree cover in European Cities (28.5%-30.2%) below the average tree cover in the US which is 39.4% (Nowak and Greenfield 2018) and above of the average tree canopy cover in England which is 16% (Doick et al., 2014). When it comes to trends, the slightly increasing trend in overall urban tree coverage at a national level is opposite to trends found in other national scale studies. For example, Nowak and Greenfield (2018) show a decline in tree cover in urban areas in the USA and McGovern and Pasher (2016) also found a decline in urban tree coverage for Canada. The increase in urban Tree Cover (from 17.27–19.27%) between 2000 and 2019 is even more remarkable considering that the urban limits used for the study for both 2000 and 2019 were set based on the urban extent in the year 2019. This means that, despite cities having grown in the area into previously non “urban” areas, the urban tree coverage has grown. A follow-up study should analyze the trends around city boundaries to understand the changes in land cover categories in areas of transition.

Most of these studies do not account for the ecoregion in which cities are located, which could influence tree coverage. Uruguay is located in the Uruguayan Savanna ecoregion (Dinerstein et al., 1995), which is mainly constituted by grasslands, with gallery forests and palm lands and woodlands (Chebataroff,1960; Del Puerto, 1987).

There are two categories that can help us understand the potential that cities have for increasing tree coverage and the challenges they might face when trying to target the increase in areas of high positive impact. Herbaceous, sidewalk and impervious sidewalk are three categories that could be considered as easier to transform into tree coverage with different levels of difficulty. For example, the LA

Urban Forest Equity Streets Guidebook (CAPA Strategies 2021: 8) uses 3 Tiers to reflect the types of interventions and levels of investments needed to reach a more equitably distributed tree canopy. Using this tier system, we link the sidewalk category with a Tier 1 because little modification is needed and high impact is achieved, herbaceous is a Tier 2 because little modification is needed but the impact depends on the location of such herbaceous area within the urban matrix, and impervious sidewalk is a Tier 3 because its impact is high but important site modifications are needed.

Based on these categories we have prepared Table 4, in which we present, for each city, the amount of potential planting area by tier and the current tree canopy area. On average the potential planting area doubles the existing current canopy tree coverage. Tier 1 represents an average potential increase of 18% for all cities. However, if we don't include Montevideo, which is the largest urban center and has a potential increase with Tier 1 of 11%, the average of the remaining cities is 32%. This means that a high impact one-third increase could be achieved in a relatively easy way.

Table 4
Potential planting in urban areas

City/Locality	Potential Planting Area (Ha)				Current Tree Canopy Area (Ha)
	Tier 1	Tier 2	Tier 3	Total	
Artigas	50	260	40	350	247
Barros Blancos	71	434	0	505	284
Canelones	27	183	16	226	103
Ciudad de la Costa	200	1,250	8	1,458	1,307
Colonia	78	341	8	427	289
Delta del Tigre	128	330	7	465	193
Durazno	65	321	14	400	236
Florida	60	272	20	352	181
Fray Bentos	43	151	19	213	121
Juan Lacaze	6	128	8	142	88
La Paz-Las Piedras-Progreso	247	735	42	1024	489
Melo	102	454	40	596	195
Mercedes	40	161	44	245	138
Minas	59	307	51	417	231
Montevideo	1,498	23,610	617	25,725	13,565
Pando	28	242	18	288	171
Paysandu	238	872	84	1,194	467
Punta del Este	140	934	128	1,202	549
Rivera	142	685	115	942	314
Rocha	77	330	54	461	151
Salto	151	578	115	844	448
San Carlos	41	181	25	247	135
San Jose	52	262	34	348	165
Tacuarembó	100	557	57	714	338
Treinta y Tres	70	488	31	589	228
Trinidad	29	198	23	250	129
Total Area	3742	34264	1618	39624	20423

The increase in impervious cover is consistent with trends reported for Canada and the USA (McGovern and Pasher, 2016; Nowak and Greenfield, 2012b; 2018) as well as global studies (Nowak and Greenfield, 2020). It is important to note that 3 cities (Rivera, Artigas and Salto) with higher-than-average increase in impervious cover in Uruguay are cities facing greater climate vulnerability in relation to extreme temperature or flooding (NAP Ciudades, 2019). Most of this increase in impervious cover comes from loss of herbaceous vegetation, but some comes from loss of tree cover. That is, the conversion of natural cover types (trees and grasses) results in new impervious areas. According to Nowak and Greenfield (2012b), estimates of impervious cover are conservative, as tree canopies cover part of the impervious surface and, as tree coverage increases, the probability of detecting impervious cover decreases.

Although the information aggregated at the country level is interesting and shows a general trend, it is important that municipalities and urban decision-makers analyze the data for their cities. In addition, the data provided in this study shows the overall average for each city and it is a positive start to evaluate a large number of cities, but more detailed land cover mapping is needed for decision-makers to understand the state and trends within their cities. State and trends of land cover by micro watersheds, neighborhoods, etc. (e.g. Iverson and Cook, 2000; Walton et al., 2008; Zhou et al., 2009; Singh et al., 2012) will provide the level of information required to better understand land cover and also understand the links between land cover and socio-economic data (Boulton et al., 2018; Nessbit et al., 2019; Sun et al., 2022).

The proven importance of urban trees for climate change adaptation and the many other ecosystem services provided by them requires that national and municipal policies protect and favour the existence and increase of trees in urban areas. In Uruguay, there is a need to strengthen the protection that urban forests currently have, particularly considering that there appears to be a legal lagoon in relation to forests that fall within municipal or urban boundaries. According to the Forestry Law N 15.939, individual urban trees are the domain of the departmental governments and they are the ones who establish their own policies. However, it is not clear whose legal domain it is when it comes to urban forests that are extended within urban boundaries. In practice, the Forestry Division has been letting municipalities determine the fate of these forests, which has resulted in the loss of specific suburban forests in some cities.

Another important issue that has not yet been properly tackled by municipal authorities is the definition of tree species used in urban areas. There appears to be an increased interest in the use of species native to Uruguay, but data from the three cities that have an urban trees inventory show that between 90 and 96% of species used are exotic and, in some cases, exotic species classified as invasive alien species. In addition, there is a need to strengthen sub-national governments capacities for the planning, production, and renovation of public trees.

In relation to the ecosystem services provided by urban trees and using the methodology provided by the i-tree canopy tool, urban trees in Uruguayan have a carbon stock of 582,301 t/C and remove an average of 36,293 t/C per year. In addition, urban trees contribute with a reduction of 6,185,000 m^3 of runoff and absorption of 154,100 t/per year of PM10 and 16,922 t/per year of PM2.5.

[2] https://www.eea.europa.eu/data-and-maps/dashboards/urban-tree-cover

5. Conclusions

The present work is the first analysis for Uruguay in which the dynamics of cover loss and gain (trees, permeable, impervious) in an urban context. The results show an increase in tree cover, an increase in impervious cover, and a decrease in herbaceous cover. This increase in tree cover is not in line with findings reported in several international studies (Nowak & Greenfield, 2012b, 2018, 2020). This increased availability of tree cover implies greater environmental benefits to society, such as elimination of pollution, carbon sequestration, energy reduction, temperature reduction, runoff, among others. The strength of this methodology is that a precise understanding of the current situation and trends of a large number of cities can be obtained in a relatively short time period. Mapping methodologies provide more granularity but are expensive and time-consuming to be applied to a large number of cities.

Declarations

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Competing interests

The authors declare that they have no competing interests.

Availability of data and material (data transparency).

Data will be available upon request to the corresponding author.

Code availability (software application or custom code).

Not applicable.

Author's contribution

Conceptualization: Lucia Bernardi, César Justo, Juan Olivera and Diego Martino; Methodology: César Justo and Juan Olivera; writing-review and editing: Diego Martino and Maria Eugenia Riaño. Review and editing: Lucia Bernardi, Juan Olivera, Diego Martino; Writing-original draft preparation: César Justo. Data analysis: Maria Eugenia Riaño.

Ethics approval and consent to participate

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Consent for publication

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Figures

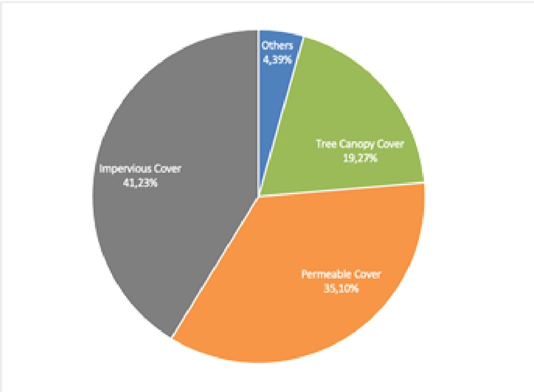

Figure 1

Current land cover in Uruguay

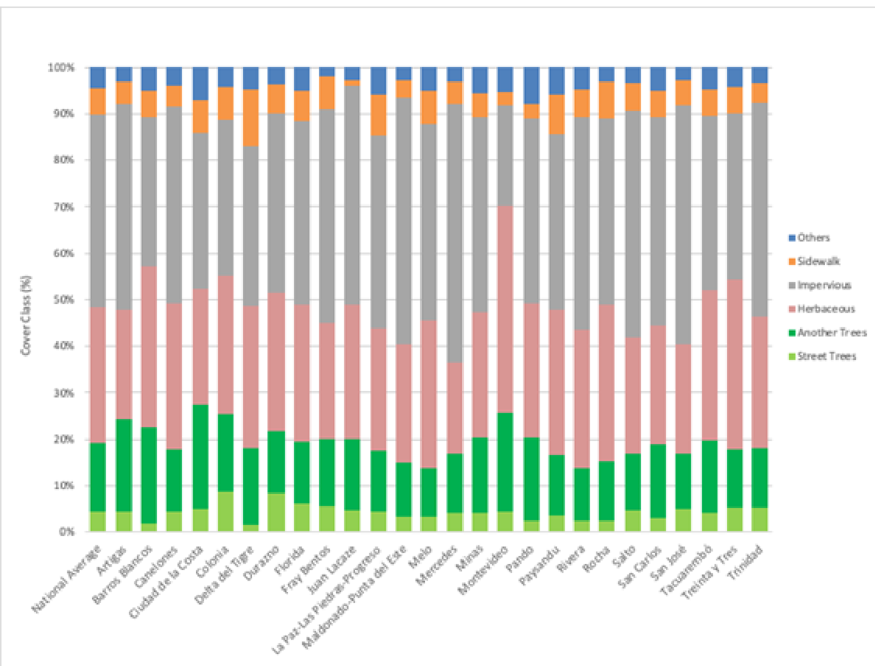

Figure 2

Percentages of Cover classes in Uruguayan urban areas.

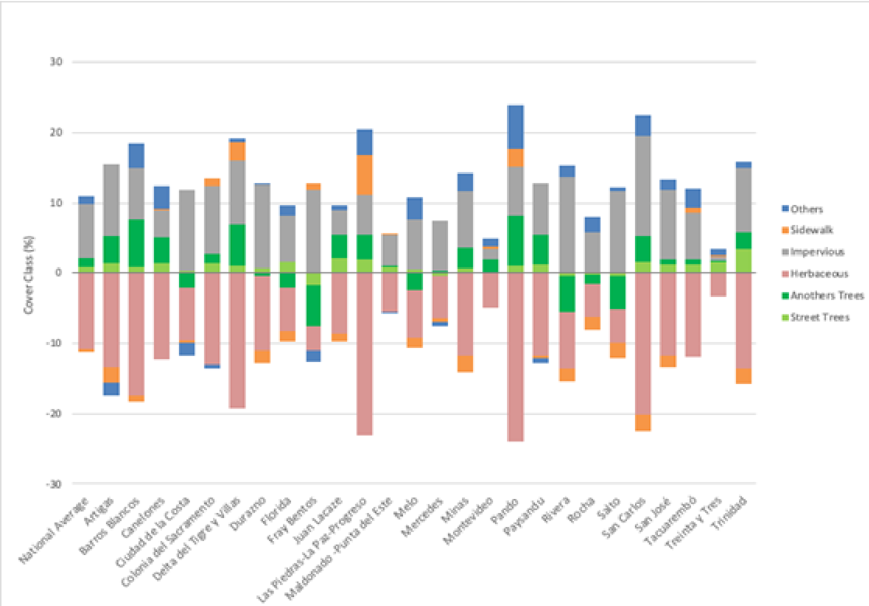

Figure 3

Percent Net loss and Gain for cover classes in Uruguayan cities.

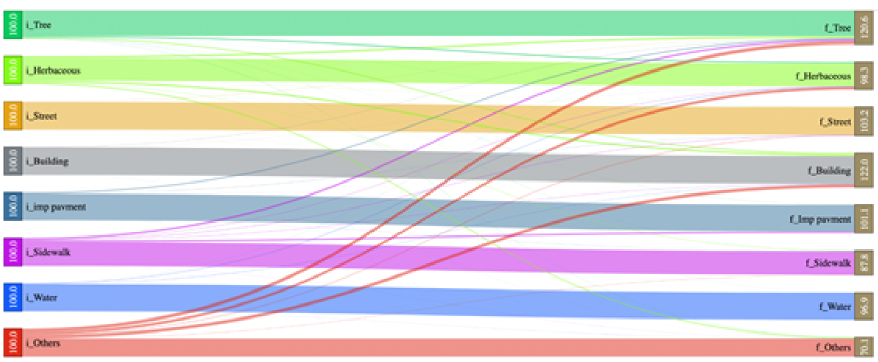

Figure 4

Percentage changes between land cover categories for the ca 2000-2019 period for all cities.