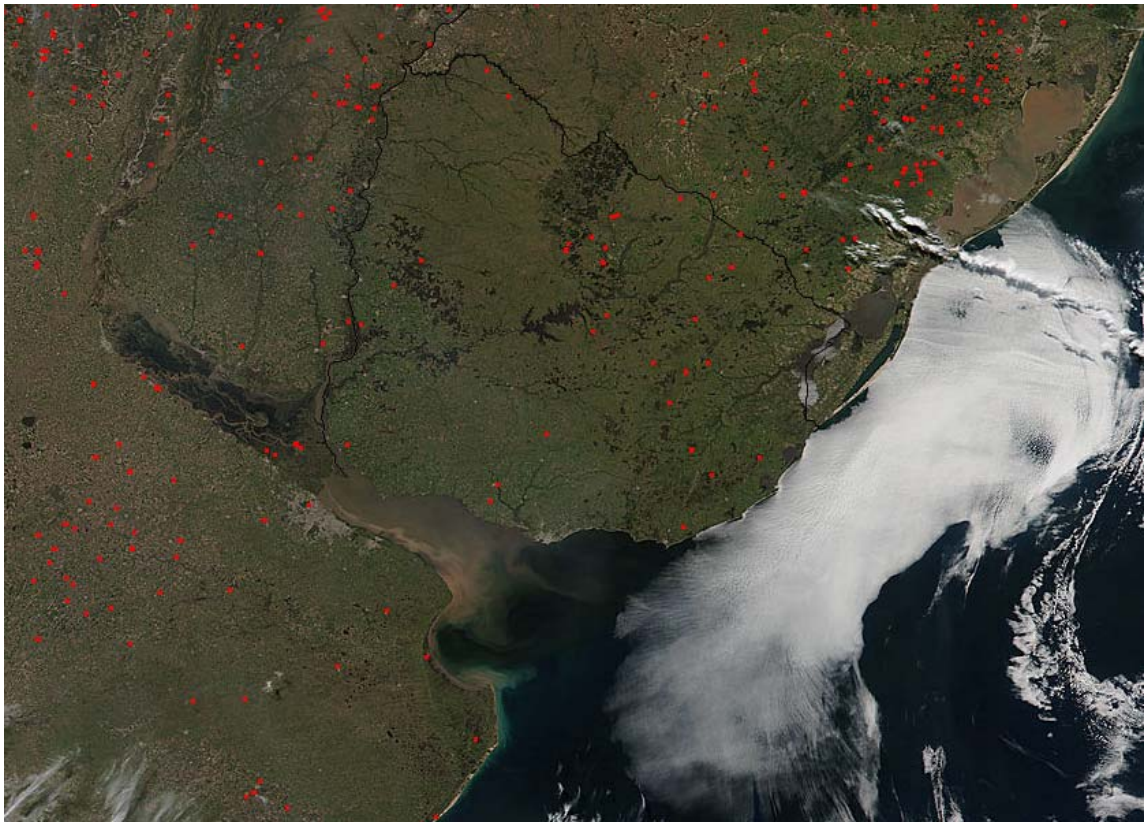
Study on the State of Wildfire Occurrence and Fire Management in Natural and Plantation Forests, and on Agricultural and Pasture Lands of Uruguay



Prepared by the Global Fire Monitoring Center (GFMC)

With support from

Federal Ministry of Food and Agriculture

by decision of the German Bundestag

2016

Study on the State of Wildfire Occurrence and Fire Management in Natural and Plantation Forests, and on Agricultural and Pasture Lands of Uruguay

Prepared by Esteban Beltrán Gándara, Global Fire Monitoring Center (GFMC)

in the frame of the project

Support of National and Regional Competency in Integrated Fire Management to Secure Sustainable Forest Management in Uruguay and through Cross-border Cooperation with Brazil and other Neighbouring Countries of South America

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Montevideo (Uruguay) and Freiburg (Germany)
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Executive Summary

Within the project *Support of National and Regional Competency in Integrated Fire Management to Secure Sustainable Forest Management in Uruguay and through Cross-border Cooperation with Brazil and other Neighbouring Countries of South America*, sponsored by the German Federal Ministry for Agriculture, by decision of the German Bundestag, the Global Fire Monitoring Center (GFMC) between 2015 and 2017 cooperated with the authorities of Uruguay in exchanging knowledge in applied fire science and expertise in fire management. Together with the Directorate General of Forests (*Dirección General Forestal* – DGF) of the Republic of Uruguay, the National Directorate of Fire Services (*Dirección Nacional de Bomberos* – DNB), the National Emergency System (*Sistema Nacional de Emergencias* – SINAE) and the Armed Forces of Uruguay (*Ejército del Uruguay*) the GFMC has conducted various field activities, notably a field assessment of the fire situation in Uruguay, organization of the "First Regional Symposium on Cross-Boundary Cooperation in Fire Management in South America" (hosted by Uruguay with participation of representatives of neighbouring countries Brazil, Chile, Argentina and Paraguay) and a first National Round Table on Fire Management in Uruguay.

This study summarizes the situation on vegetation fires and fire management in Uruguay and includes a first survey of fire occurrence in Uruguay by evaluating satellite information for the time period 2005 to 2015. The satellite maps of active fires (high-temperature events depicted by the MODIS sensors on board of NASA's satellites Aqua and Terra) show the widespread occurrence of fires in land-use systems and forests.

The national consultations in the frame of a Round Table on Fire Management revealed the need and recommendations for further strengthening fire management capabilities in Uruguay, especially by addressing the improvement effectiveness and efficiency of government institutions and inter-institutional cooperation in fire management, the options for developing a national fire management strategy or policy, cooperation with the private sector and civil society and the establishment of a National Inter-Agency Task Force on Fire Management.

Furthermore advantage should be taken of the inspirations and recommendations of the First Regional Symposium on Cross-Boundary Cooperation in Fire Management in South America, at which the countries concluded the vegetation fires be addressed in the context of climate change and to develop action with regards to mitigation and adaptation, encourage the leadership of countries to consider fire management as an important activity to meet the obligations by the Paris Agreement within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) of 2015. The participating countries Brazil, Chile, Argentina, Paraguay and Uruguay recommended action for systematic improvement of cooperation in fire management between South American countries through a more formalized membership and activities under the Regional South America Wildland Fire Network and the development of guidelines and SOPs for enhancing inter-operability of countries cooperating in cross-boundary fire management including wildfire emergencies. Furthermore more scientific research addressing the socio-economic, cultural and environmental (climate change related) trends affecting fire regimes and fire management in the region should be realized as well as an in-depth analysis of satellite data on type and extent of areas burned by wildfires or land-use fires.

1. Introduction

In 2015 the Global Fire Monitoring Center (GFMC), Secretariat of the Global Wildland Fire Network and the International Wildfire Preparedness Mechanism (IWPM), agreed with the Directorate General of Forests (*Dirección General Forestal* – DGF) of the Republic of Uruguay to cooperate within the frame of a project entitled "Support of National and Regional Competency in Integrated Fire Management to Secure Sustainable Forest Management in Uruguay and through Cross-border Cooperation with Brazil and other Neighbouring Countries of South America". The projects are partnering with the bilateral Uruguayan-German project "Elaboration of a Concept for the Sustainable Management of Natural Forests and Pilot Implementation in Uruguay". Both projects are financed by the German Federal Ministry for Agriculture, by decision of the German Bundestag.

The project aimed at exchanging knowledge in applied fire science and expertise in fire management between the GFMC and the authorities of Uruguay. During the implementation of the project the cooperation was extended to the National Directorate of Fire Services (*Dirección Nacional de Bomberos* – DNB), the National Emergency System (*Sistema Nacional de Emergencias* – SINAE) and the Armed Forces of Uruguay (*Ejército del Uruguay*).

The main activities of the project took place in 2015 and 2016 and included several consultations and field visits. In preparation of an initial National Round Table on Fire Management, which was held in Montevideo on 2 June 2016, a first draft of this study (in Spanish language) was circulated among the participating agencies. It was decided to finalize the study in English language for further internal circulation and for use in the context of international processes and projects.

In addition the project aimed at stimulating and enhancing regional cross-boundary cooperation in fire management between Uruguay and its neighbouring countries. For this purpose the First Regional Symposium on Cross-Boundary Cooperation in Fire Management in South America was organized by the GFMC and the authorities of Uruguay in Santa Teresa National Park (30 May to 2 June 2016). The objectives included:

- Regional exchange of information on wildfires occurrence, fire management and fire emergency response of the participating nations: Sharing of experiences in cooperation with neighboring countries in training and responding to wildfire emergencies.
- Briefing of participating countries about international initiatives in cooperation in fire management: Introduction of the work of the Global Wildland Fire Network operating under the United Nations International Strategy for Disaster Reduction (UNISDR) and the voluntary International Wildfire Preparedness Mechanism (IWPM).
- Introduction of training materials for capacity building in cross-boundary fire management: The EuroFire Competency Standards and Training Materials were presented in Spanish and Brazilian Portuguese for future international training, with emphasis for enhancing inter-operability between participating South American countries. Furthermore the concept of the International Fire Aviation Guidelines was introduced.
- Regional Fire Management Symposium: Discussion about the future use of the EuroFire training standards for joint regional trainings, as well as the test of the International Fire Aviation Guidelines; development for recommendations for official bilateral agreements or multilateral frameworks within South America to systematically enhance preparedness and response to wildfire emergencies by cross-border cooperation.

Representatives of authorities of Brazil (Ministério do Meio Ambiente – MMA and Centro Nacional de Prevenção e Combate aos Incêndios Florestais – PREVFOGO / Ibama), Chile (Corporación Nacional Forestal – CONAF), Argentina (Bomberos de Argentina) and Paraguay (Cuerpo de Bomberos Voluntarios) joined the symposium and agreed to develop an agenda for enhancing effectiveness and efficiency for regional cooperation in fire management.

This study summarizes facts, reports and – most importantly – maps of satellite-derived information on the occurrence of wildfires on the territories of the Republic of Uruguay. The materials presented shall contribute providing insight in the potential threats of fire to native forests, the forest plantation industry and society living at the interface between vegetated lands and residential areas.

2. Background and Rationale

Fire is a major disturbance factor in almost all vegetation zones around the globe. Apart of its influence on ecosystem dynamics vegetation fires significantly influence biogeochemical cycles, particularly the global carbon cycle. Moreover, the use of fire is part of the traditions and culture of many societies, particularly in the agriculture and grazing cultures. In those ecosystems where fire is not a natural phenomenon or which are sensitive to fire, its introduction leads to the destruction of vegetation and site degradation. In South America examples include the tropical rain forest of the Amazon region and the mountain forests of the Andes, which are highly fire-sensitive. In these forests the increase of populations, economic activities and land-use change have involved the use of fire with negative consequences on the stability and functioning of these ecosystems. The complete exclusion and protection of these vulnerable ecosystems is mandatory and needs to be prioritized.

Even in ecosystems which have some adaptation and resilience to natural and human-made fires, such as the Brazilian Cerrado, extreme dry seasons may create conditions for extreme, catastrophic wildfires causing severe damages. Such ecosystems may require a different management approach by using fire or allowing wildfires to burn under moderate and controlled conditions. Such management decisions and the operational skills of safely using or letting burn prescribed fires must rely on advanced science-based systems.

In Uruguay, a country with a long history of livestock husbandry economy, the burning of pastures has been a tradition – a common tool to renew the grasses on the periods previous to calve and to clear lands for different reasons. For instance, studies confirm that the accessibility, palatability and raw protein of *paja brava* grass (*Paspalum* spp.) re-sprouts after being burned (Gayo, 2002) is increased. However, like in many other countries worldwide, rapid social, demographic, economic and environmental changes are observed, especially in the rural space and at the interface between the rural space and metropolitan / urban areas. These changes involve higher risks of uncontrolled wildfires, which are likely to be exacerbated by extreme droughts caused by climate change.

Land-use fires set by stock farmers and getting out of control are a serious threat to natural forests, protected areas and plantation forests. Likewise there is an increasing threat of wildfires caused accidentally or negligently by urban people during leisure and vacation travel.

Natural and planted forests in Uruguay are precious environmental and economic resources. After the initiation of systematic reforestation and afforestation activities in the 1990s, the total forested surface of Uruguay increased significantly. According to the first forestry map of Uruguay (*primera carta forestal del Uruguay*) of 1980, and the forest cartography (*cartografía forestal*) of 2011, both elaborated by the DGF, the native forest surface has increased from 677,315 hectares (ha) to 849,960 ha. Meanwhile the surface of planted forest has increased from 170,140 ha to 695,093 ha. According to these numbers, Uruguay has increased its native forest and planted forest surface, ceasing to be a country of low forest cover (DGF 2016).[1] Forestry activities now generate export values of $US 1.2 billion and employ more than 24,000 people (Blanc Chalkling, 2015).[2]

The native forests are distributed in the following types (Pou, 2011):

- **Serrano**: Trees and bush formations stocking on rocky sites in Eastern and Northern Uruguay
- **Ribereño**: Forest along riversides and streams
- **Quebrada**: Growing on rocky sites, but at the deeper soils, in valleys
- **Parque**: Associated with ribereño forests, in the western part of the country, mainly growing on alkaline soils

These forest types are heterogeneous hardwood forests, home of more than 200 species belonging to several families, but most of them with low commercial value. *Sebastiania brasiliensis* (blanquillo) and *Scutia buxifolia* (coronilla) as well as *Prosopis* (algarrobo) are the economically most valuable species. These forests are mainly distributed along water courses and hillsides (Traversa-Tejero and Alejano-Monge, 2013). Many tropical, Patagonian and Andean species are be found on Uruguayan territory, with forest composition features like in Uruguay's neighbor countries Brazil, Paraguay and Argentina.

[1] Statistical data provided by the DGF in 2016. Due to different definitions of forest cover the FAO registered larger areas of planted forests, i.e. up to 1.2 million ha by 2011 (Echeverría, 2010; FAO, 2015).
[2] See also: Uruguay aumentó el área de bosque nativo. Source: El Observador, 26 November 2012. URL: http://www.elobservador.com.uy/uruguay-aumento-el-area-bosque-nativo-n237940

Wildfire statistics for the time period 2004 to 2011 have been compiled by the National Emergency System (*Sistema Nacional de Emergencias* – SINAE) (SINAE, 2011). In 2010-2011 wildfires affected 5,241 ha of vegetated land. Most of the fires occurred in the coastal area of the country. This area is characterized by a high concentration of population (half of the total population of the country is concentrated in these areas and frequently visited by tourists). Poor management of the vegetation has resulted in an increase of fuel loads and fire hazard accordingly. While the majority of these fires were grass fires, nearly 1,700 fires occurred at the interfaces of major populated urban und sub-urban areas such as Montevideo, Canelones and Rocha regions. During the fire season of 2011-2012 about 6,000 ha were affected by wildfires.[3] Individual fire cases may inflict a risk economic losses and human fatalities. During the recent fire season a wildfire burning along the *Interbalnearia* route in November 2015 affected 40 ha of pine (*Pinus* spp.) and eucalypts (*Eucalyptus* spp.). The fire threatened homes and a fuel station and covered the main highway, which connects Montevideo with the coastal resort of Punta del Este, with dense and dangerous smoke.[4]

3. Fire Management in Uruguay: Laws, Rules and Organization

One law and several decrees rule the prevention, use and combat of fire in Uruguay.

- Forestry Law N°15939 (1987) mandates the DGF to work and coordinate with the DNB in the protection from vegetation fires and empowers DGF to supervise and regulate every aspect related to fire and fuel management of public and private lands.[5]
- Decree N° 849/988 (1988) gives the exclusive mandate for fight fires to the DNB (under the Ministry of Interior) and the Fire Police (a body of the National Police). Firefighters are the only entity authorized to investigate the causes of the fires. The decree also obliges forest owners practice measures of fire prevention.[6]
- Decree N° 436 (2007) regulates that during the time period between 01 of December to the second week of April it is forbidden to conduct agricultural burnings and that its violation is punished with a fine. It also rules the establishment of firebreaks and fuel management in forested areas.[7]
- Decree N° 111/989 (1989) regulates the norms of fire prevention for public and private entities that administer a forested area (productive or recreational).[8]

The National Emergency System SINAE operates under the *Presidencia de la República* and is mandated to coordinate emergency services and firefighters to control forest fire emergency situations.[9]

During the fire season community firefighters are deployed, watch towers in the departments of Montevideo, Canelones, Maldonado and Rocha are manned and surveillance flights carried out (about 162 per season) along with an intense television and radio prevention campaign.[10] This campaign is concentrated mainly in the coastal and tourist areas in the South and Southeast of the country.

The private forest companies are obliged to develop and finance a fire protection plan. This plan establishes operative bases in three localities with accommodation for the personnel and equipment. By law the firefighting personnel must be professional firefighters. This seasonal firefighting force operates with equipment of the forest companies and is paid by them.

The fire protection plan counts with a surveillance system of watch towers and aerial reconnaissance along with fire risk index. This index determines preparedness and dispatch of the fire brigades and it is complemented by preventive silvicultural measures, fire break construction and educational campaigns (Blanc Chalkling, 2015).

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[3] http://www.elpais.com.uy/informacion/se-preve-intensa-temporada-incendios.html
[4] Please see compilation of wildfire news of the Global Fire Monitoring Center (GFMC) in the Annex.
[5] Law N° 15.939. Ley Forestal - Fondo Forestal - Recursos Naturales, Ministerio de Ganadería Agricultura y Pesca, Uruguay, 09 February 1988.
[6] Decree 849/988. Reglamentacion de la Prevencion y Combate de Incendios Forestales, Ministerio de Ganadería Agricultura y Pesca, Uruguay, 14 December 1988
[7] http://www.impo.com.uy/bases/decretos/436-2007, see also http://www.impo.com.uy/incendiosforestales/
[8] http://www.guayubira.org.uy/1989/05/decreto-n%c2%ba-111989-normas-para-prevencion-de-incendios/
[9] Law N° 18.621. Creación del Sistema Nacional de Emergencias Público y Permanente, Concejo de Ministros, Uruguay, 17 November 2009.
[10] Example: Plan Nacional de Prevención de Incendios Forestales Temporada 2010-2011: http://archivo.presidencia.gub.uy/sne/htm/presentaciones/docs/PNPIF_2010-2011-Presentacion.pdf

During the season 2014-15, the Group *Protección Ante Incendios Forestales* (Grupo PAIF) along with the forest companies *Grupo Forestal del Norte* and *Grupo Forestal Litoral* joined efforts to protect a patrimony of 720,000 ha of planted forest using an organized structure with detection systems (watch towers and detection airplanes, helicopters and a localization and reference software). This plan does not cover the total surface of the country but only the forests that belong to the companies that are members of the *Sociedad de Productores Forestales*. It is because of this reason that it has been proposed to expand the cooperation and to provide a protection system for the whole country (Senattore, 2015).

Fig. 1. The fragmentation of forest plantation parcels with non-forested open fuel breaks allows access for firefighters and significantly reduces the risk of large wildfires

Fig. 2. PAIF helicopters with heli-buckets provide valuable support of ground firefighting forces

Every year SINAE prepares a Forest Fire Prevention Plan (PNPIF). This plan regulates the construction of infrastructure for fire protection (only firebreaks), deploy of the National Direction of Firefighters to the most threatened and exposed areas (mainly the coast) and the coordination with the Air Force and road police to conduct aerial and ground patrolling. Planning at the level of a Department (Maldonado) is exemplary (SINAE, 2005).

In 2011 the SINAE invested in the establishment of meteorological stations to elaborate daily fire risk indexes with the support of a local University. A study of Fernández et al. (2014) showed the potential of applying fire danger rating systems for Uruguay. SINAE also invested in equipment of communal fire brigades for patrolling and in heavy machinery for high risk areas. Public relations and education campaigns have been carried out since 2011 involving TV and radio spots, flyers, brochures and didactic materials. The coastal tourist areas of the country are in the focus of PR.

Fig. 3. Posters and brochures for public awareness raising are an important tool for the reduction of wildfires from open camp fires.

4. Field Visits of the Project Team

During 2015 and 2016 several field visits were made. In June 2015 plantations owned by the forest company Atlántico Sur were inspected that had been affected by a wildfire (Fig. 4 and 5). According to the spokesperson of Atlántico Sur the main reasons of the forest fires are agricultural burnings that go out of control because the farmers do not have the means or necessary training to manage the fire. Failure of forestry machinery is another common cause of wildfires.

Fig. 4. Burned eucalypt forest

Fig. 5. Burned timber storage yard

In early 2016 an area affected by a fire in La Floresta along the *Ruta Interbalnearia* was visited. The fire extent was more than 40 ha, threatening homes of a densely populated interface area. It was easily recognizable that a drastic change in the fire behavior would have compromised a sawmill located right across a rural road of a forest of young eucalyptus. The fire almost overrun and ignited a petrol station – the fire was controlled several meters before reaching the station (Fig. 6). The smoke of the fire led caused traffic interruption and road closure on the *Ruta Interbalnearia*.

Fig. 6. The petrol station, which was almost overrun by the wildfire. The lack of fire breaks and very high fuel loads in the rear part should be noted. The perimeter of the fire could be contained only a few meters away from the station. At the right side the burned vegetation and the fire perimeter can be seen.

During the field assessment by the project team in June 2015 the Protected Area *Quebrada de los Cuervos* (Department of Treinta y Tres) was visited under the guidance of the park ranger (Fig. 7 to 10). The ravine of the Protected Area is characterized by native forest and palm trees. According to the park ranger and the on-site evaluation the fire protection plan of the protected area is poorly implemented. The elimination of grazing inside the area, although in principle desired in a protected area, has resulted in

significant increase of highly flammable fuel loads. The fire breaks are insufficiently constructed and maintained. Moreover, the area is under permanent threat by agricultural burnings on adjoining lands which often get out of control. The lack of firefighting resources in the area contributes to the risk that small wildfires may get out of control and become difficult to manage large fires. The project team was informed that wildfires are common in native vegetation outside the protected area (Fig. 11).

Fig. 7. *Quebrada de los Cuervos* ravine

Fig. 8. Palm trees in *Quebrada de los Cuervos*

Fig. 9. After the abandonment of grazing ecological succession is leading towards forest formation but also an increased wildfire hazard.

Fig. 10. Secondary vegetation characterized by high wildfire hazard bordering the the *Quebrada de los Cuervos* Protected Area

Fig. 11. Wildfire scars can be seen all over the country. This photograph taken during the assessment mission shows the interface between open grazing lands and the fire encroachment into native forests.

A visit was also paid to a private landowner who is cultivating fruit trees. Here fire is used on open land to improve the access of cattle for grazing. It was observed that the risk of escaping burnings is high and is a clear threat to the investment of the owner (Fig. 12 and 13).

Fig. 12. Plantation of fruit trees surrounded by high fuel loads

Fig. 13. Typical open land burn at the perimeter of orchards or native forests.

5. Satellite-derived Information on Fire Occurrence

The available narratives, statistics and the information gained during the field visits of the project team could not provide a comprehensive overview of the areas burned by land users or by wildfires. This is why it was decided to obtain open-source satellite information to develop a set of maps that would provide an overview on the extent of fire use and wildfires over the last decade.

In the first set of maps the datasets of high-temperature events (HTE) depicted by MODIS on board of the NASA satellites Aqua and Terra were downloaded for an area covering Uruguay and imported into a map, in which the border-region territories of Paraguay, Argentina and Brazil can be seen. The data was clipped with a political boundary shape layer provided by DGF to obtain the HTE in the Departments of Uruguay. The data was imported into Google Earth 7.1 and a set of maps were generated for each year from 2005 to 2015 (Maps 1 to 12). [11]

The second set of maps (Maps 15 to 32) was developed using Quantum GIS 2.14 Essen. First, the vector shape file Forest Cartography of Uruguay of 2012 provided by DGF (datum WGS 85 / UTM zone 21S) was imported. Afterwards the different attributes were simplified by merging and renaming them into more general attributes:

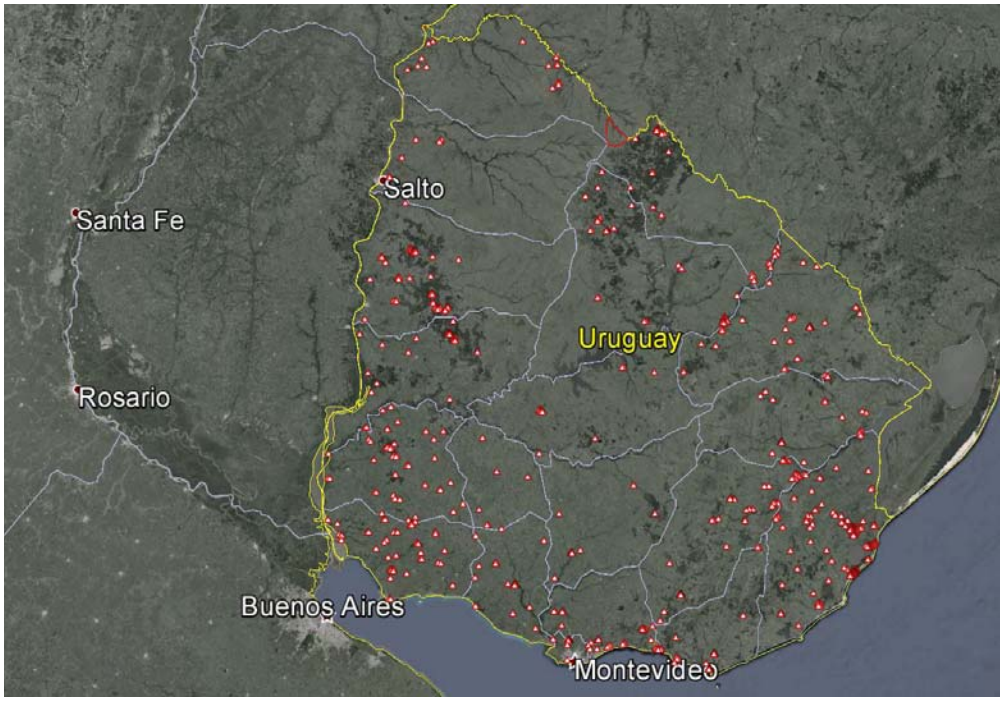
- Natural waters, flooded natural areas and artificial waters to water bodies
- Bushes, natural herbs and native forest to native vegetation
- Urban areas, disperse urban areas, bare areas; sand mines, quarries and open mines
- Cultivated lands and fruit orchards
- Palm trees
- Forest plantations

The reason for applying this merging method was due to the large amount of data in the shape file. The merged attributes ease the data load and processing times for the different stages of the map development.

It is important to note that the HTE data do not allow distinguishing between land-use fires and uncontrolled wildfire. A HTE may also be recorded occasionally by superheated surface. Vice-versa, active fires burning (only) during the time between the satellite overpasses cannot be recorded. In order to simply the language of the description of the maps displayed in the following the HTEs are referred to as active fires.

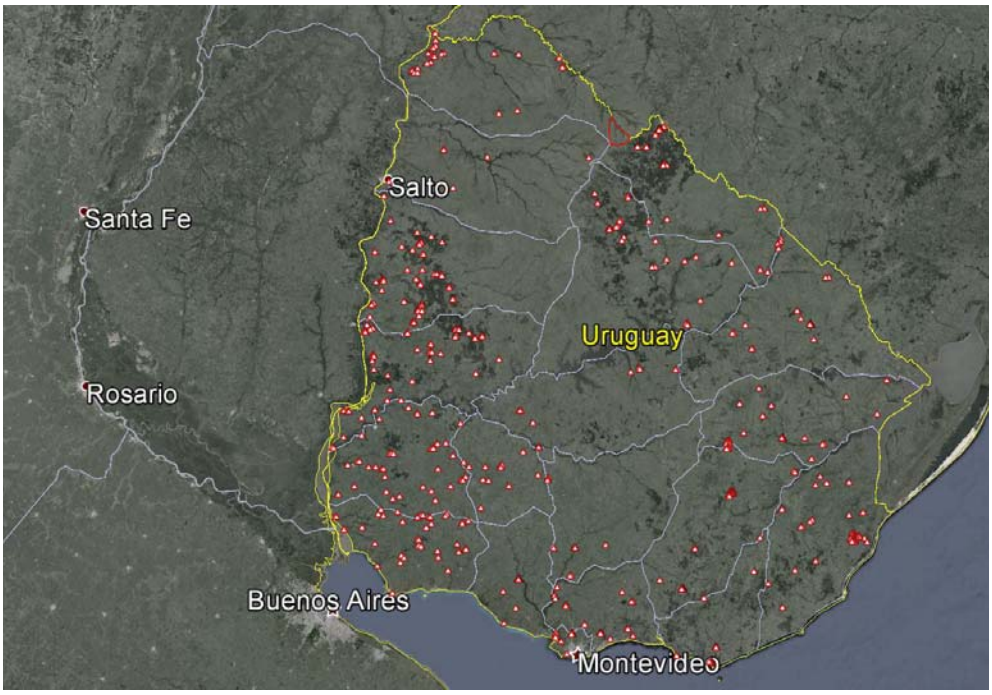
In 2005, the first year of the observation period, 730 active fires were depicted, concentrating mainly on the pastures of the department of Rocha and forests of Paysandú (Map 1).

[11] https://earthdata.nasa.gov/earth-observation-data/near-real-time/rapid-response



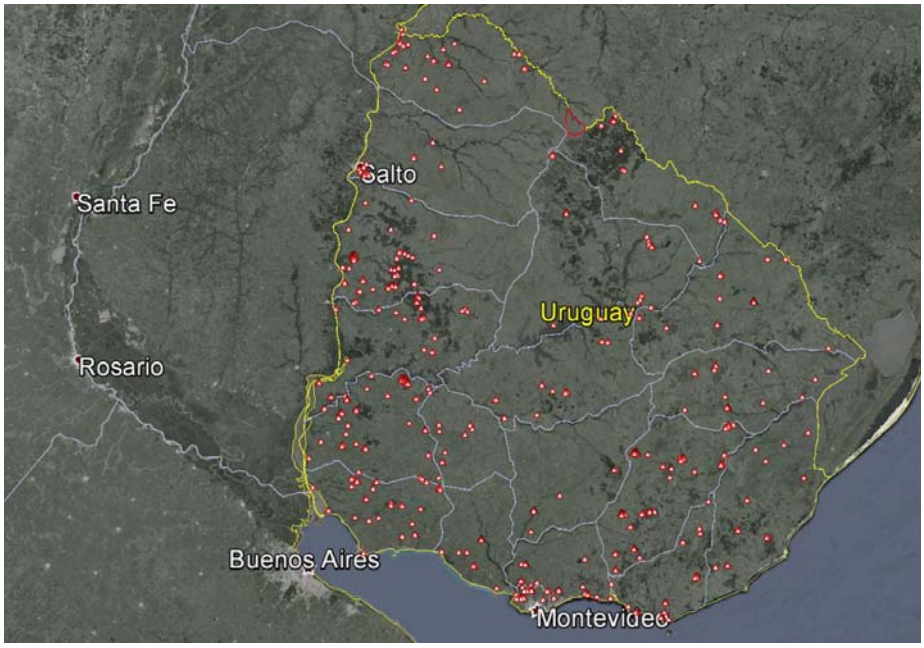
Map 1. Active fires in 2005

In 2006 about 550 fires were recorded, concentrating in Rocha and Treinta y Tres (Map 2).



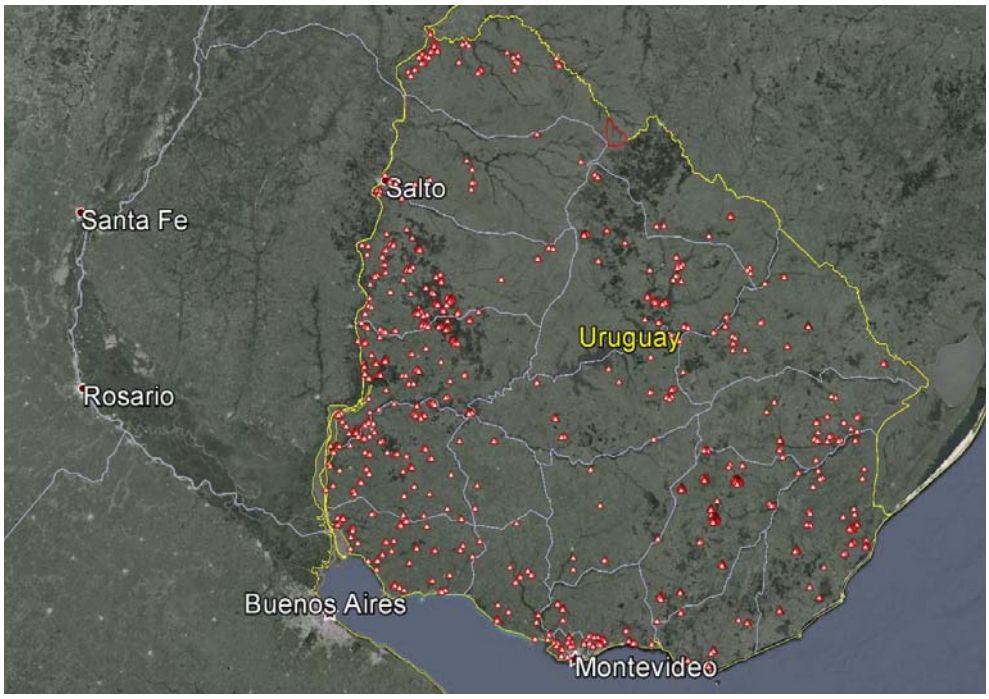
Map 2. Active fires in 2006

In Map 3 the 653 fires detected in 2007 occurred mainly in Paysandú and Soriano.



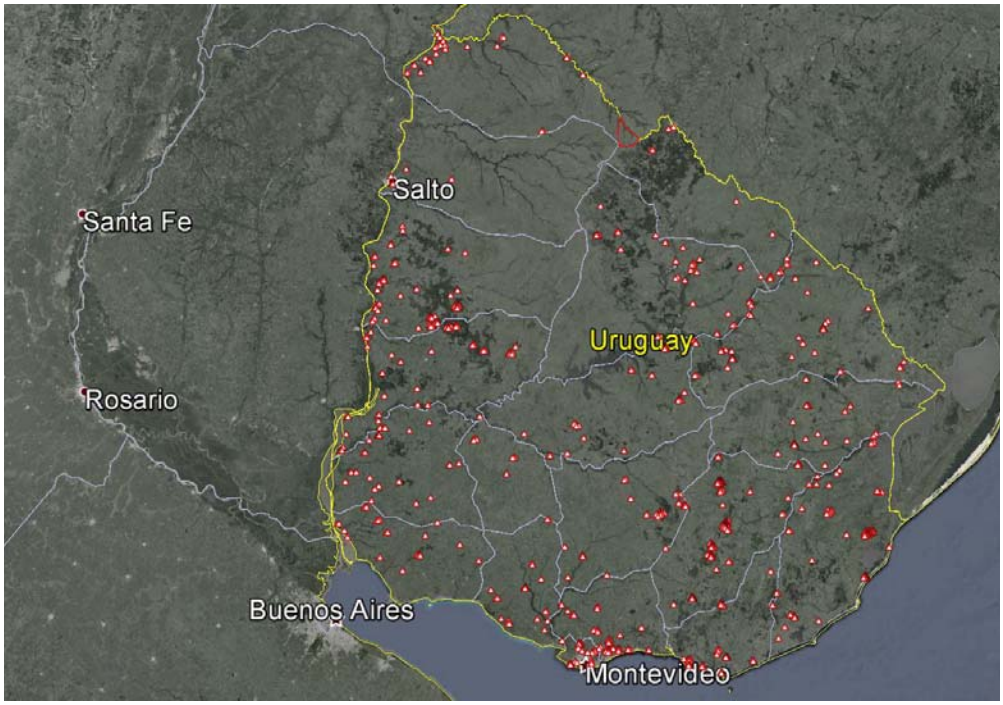
Map 3. Active fires in 2007

Map 4 shows the 1037 fire events that occurred in 2008, concentrating in Paysandú, Río Negro, Soriano, Colonia, Lavalleja and a high number in Tacuarembó.



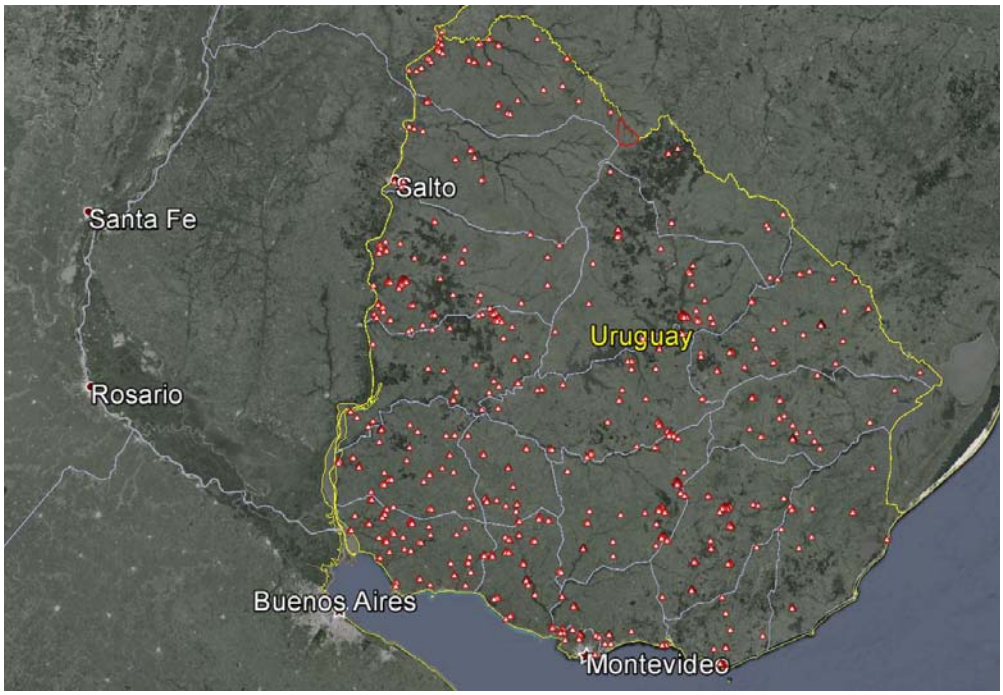
Map 4. Active fires in 2008

Map 5 shows a decrease in the events in relation to the previous year with a total of 843 cases.



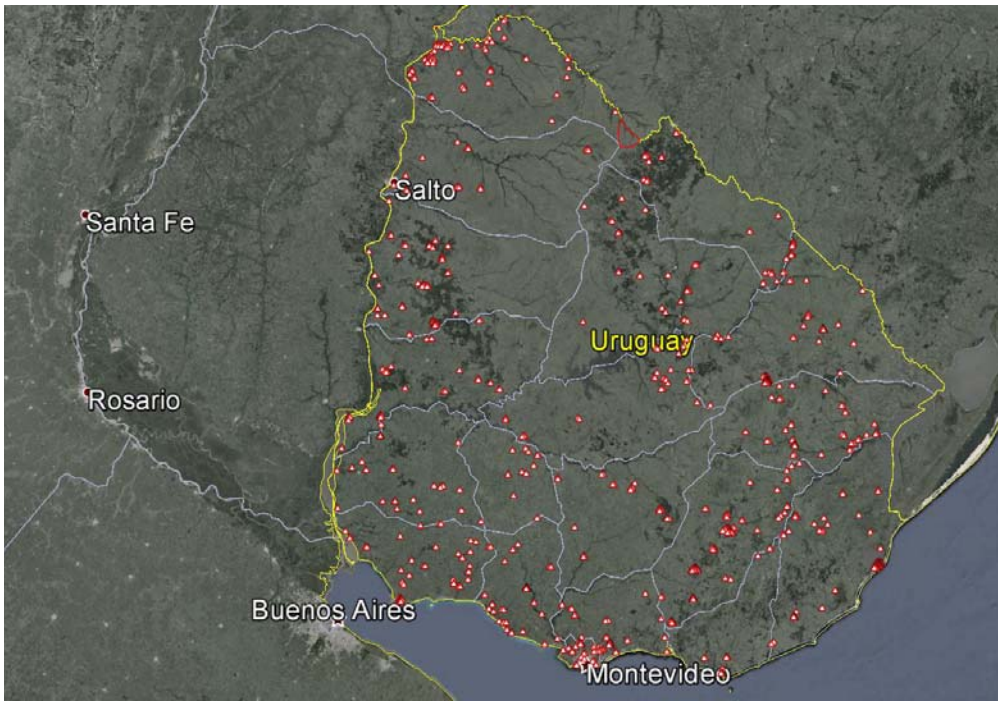
Map 5. Active fires in 2009

The next map shows the 868 fires that burned in 2010.



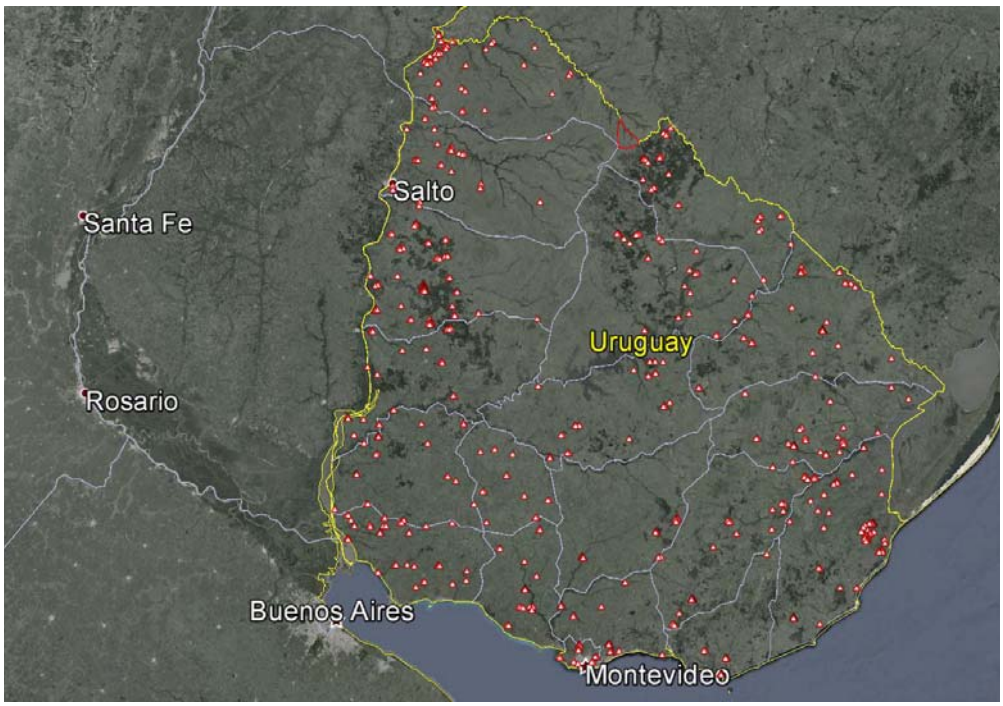
Map 6. Active fires in 2010

In Map 7 a minor decrease of fire events can be seen in 2011 (828 cases).



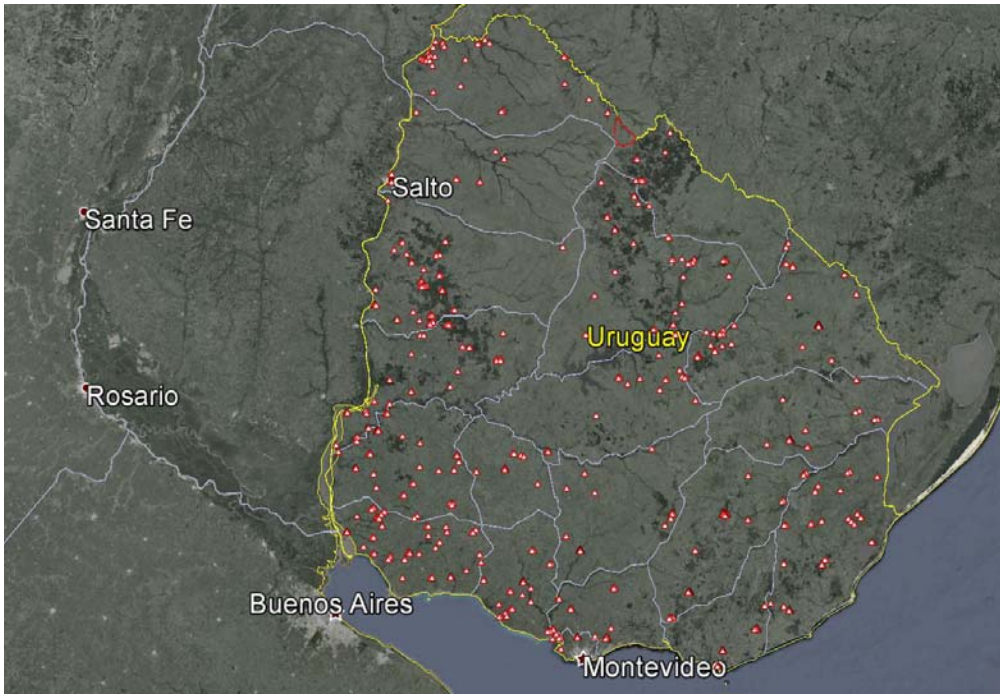
Map 7. Active fires in 2011

In the following maps of 2012, 2013 and 2014 the number of fires decreased again (722 / 649 / 497).



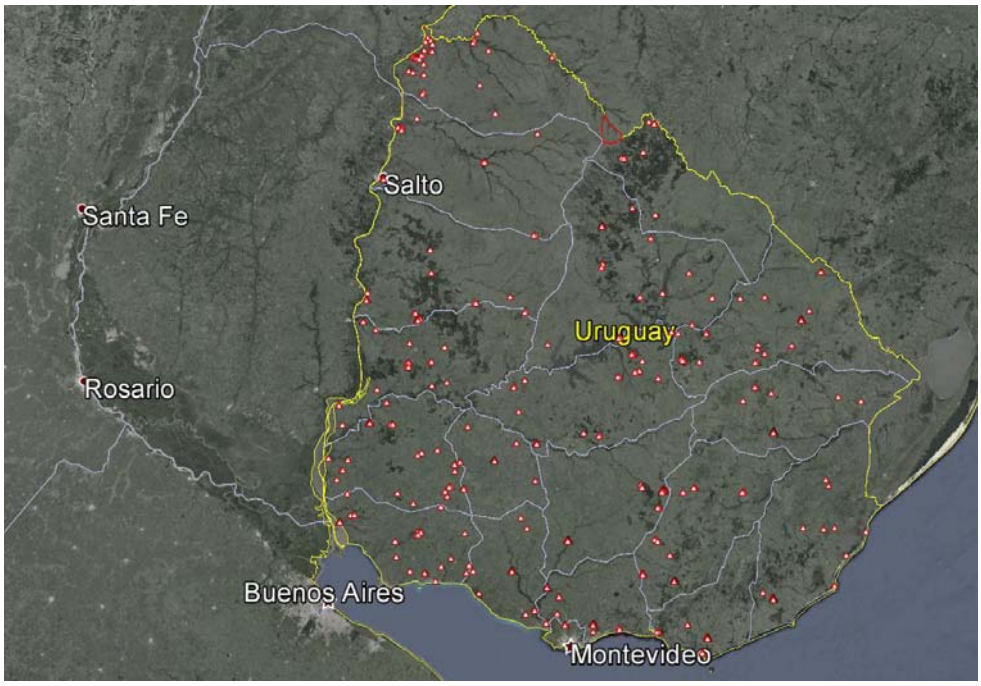
Map 8. Active fires in 2012

In 2013 the 649 active fires concentrated on the western part of the country (Map 9).



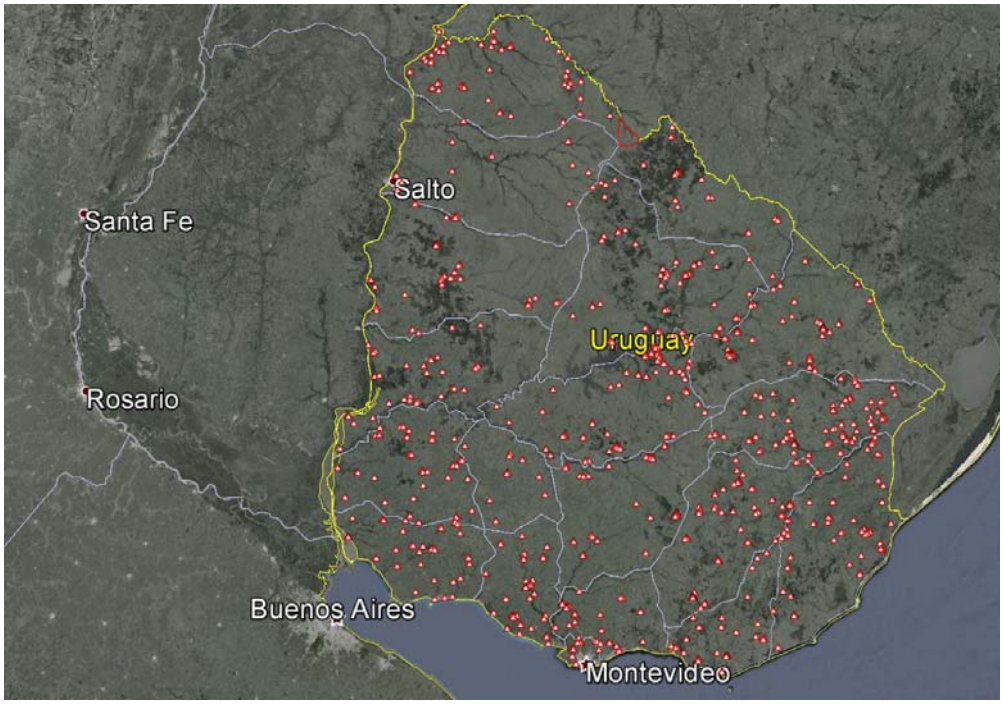
Map 9. Active fires in 2013

The year 2014 was one with lowest number of cases totaling 497 (Map 10).



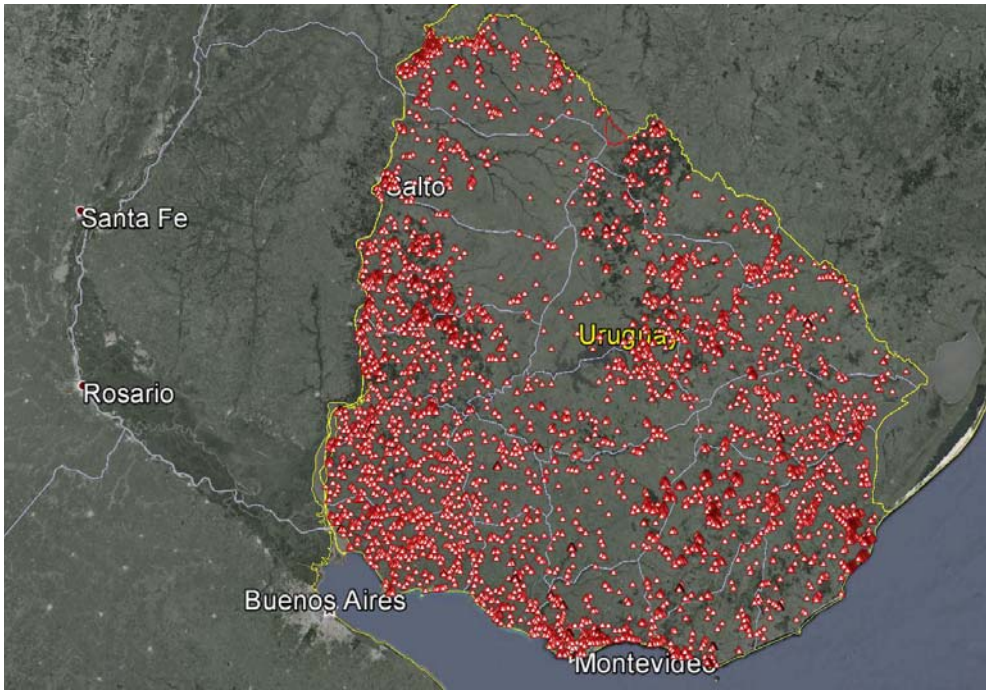
Map 10. Active fires in 2014

In 2015 a strong increment of events was detected with a total of 916 active fires all over the country (Map 11).



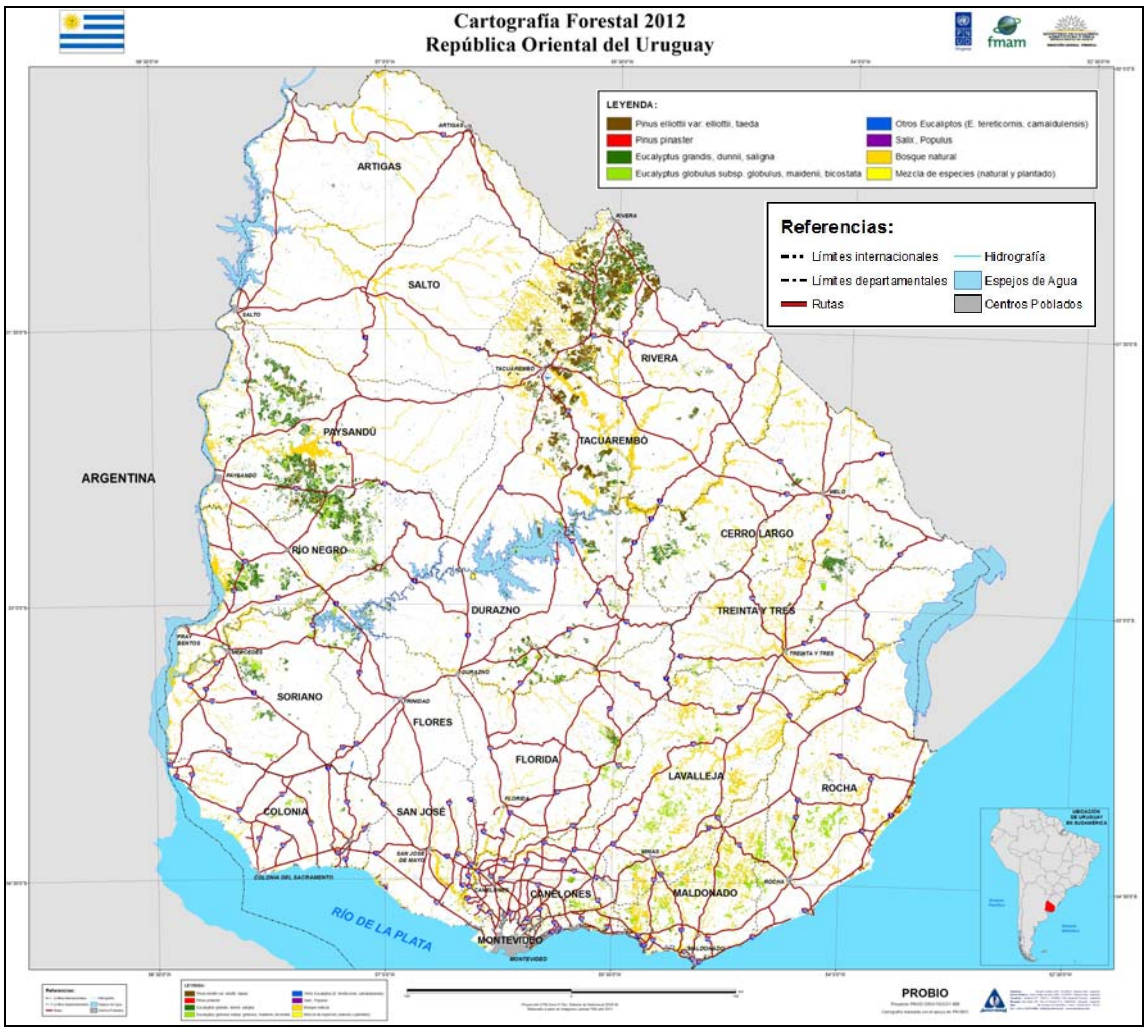
Map 11. Active fires in 2015

The following map shows the total of cases during the 11-years period. The total number of HTEs depicted by the MODIS sensors totaled 8293.



Map 12. Active fires affecting the territory of Uruguay in the period 2005–2015

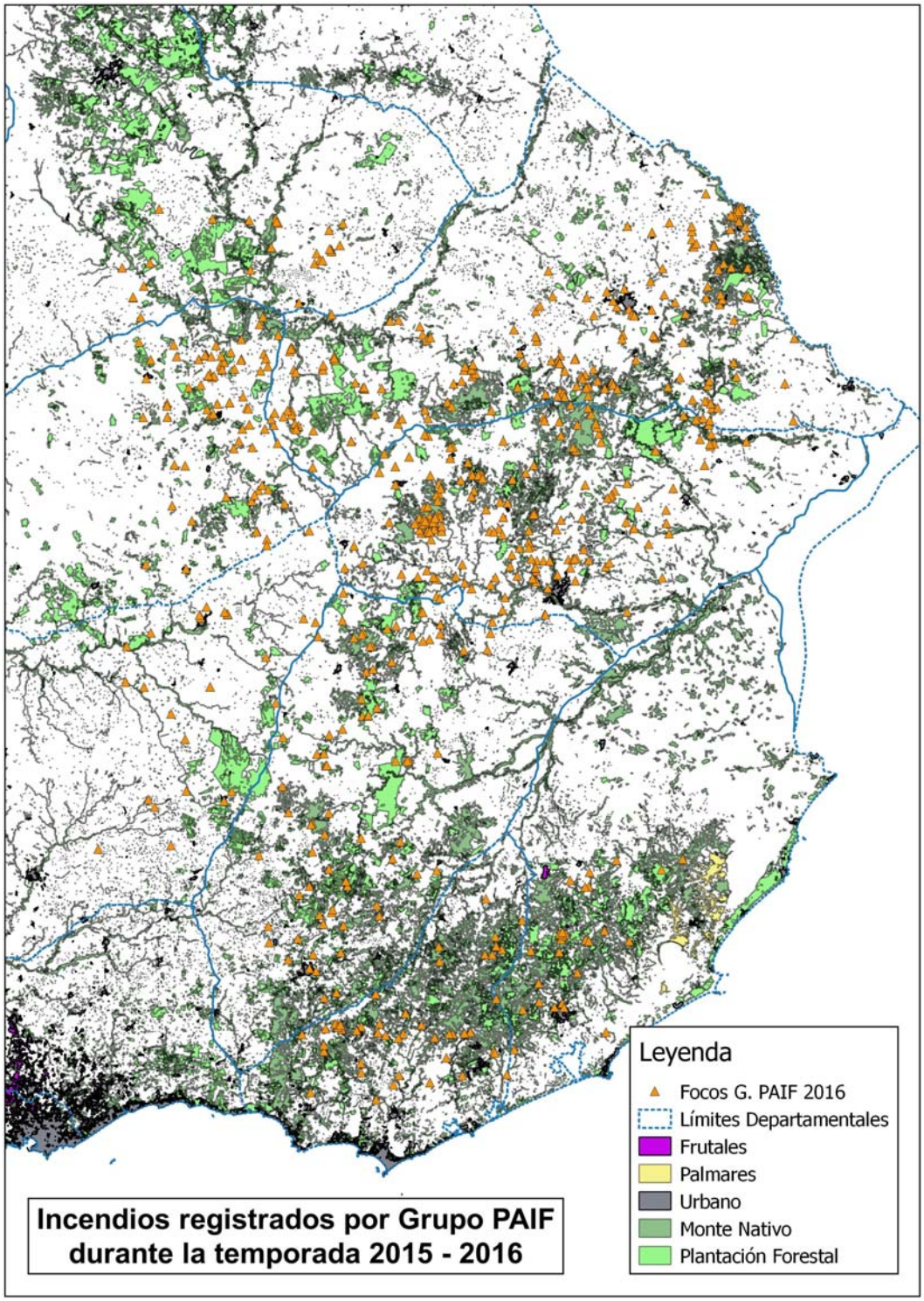
The next set of maps is the overlap of the layer of HTEs over a vegetation map of Uruguay, where the major vegetation types are represented, including native and exotic species. Map 13 shows the distribution of the vegetation of Uruguay in 2012. [12]



Map 13. Forest map of Uruguay in 2012

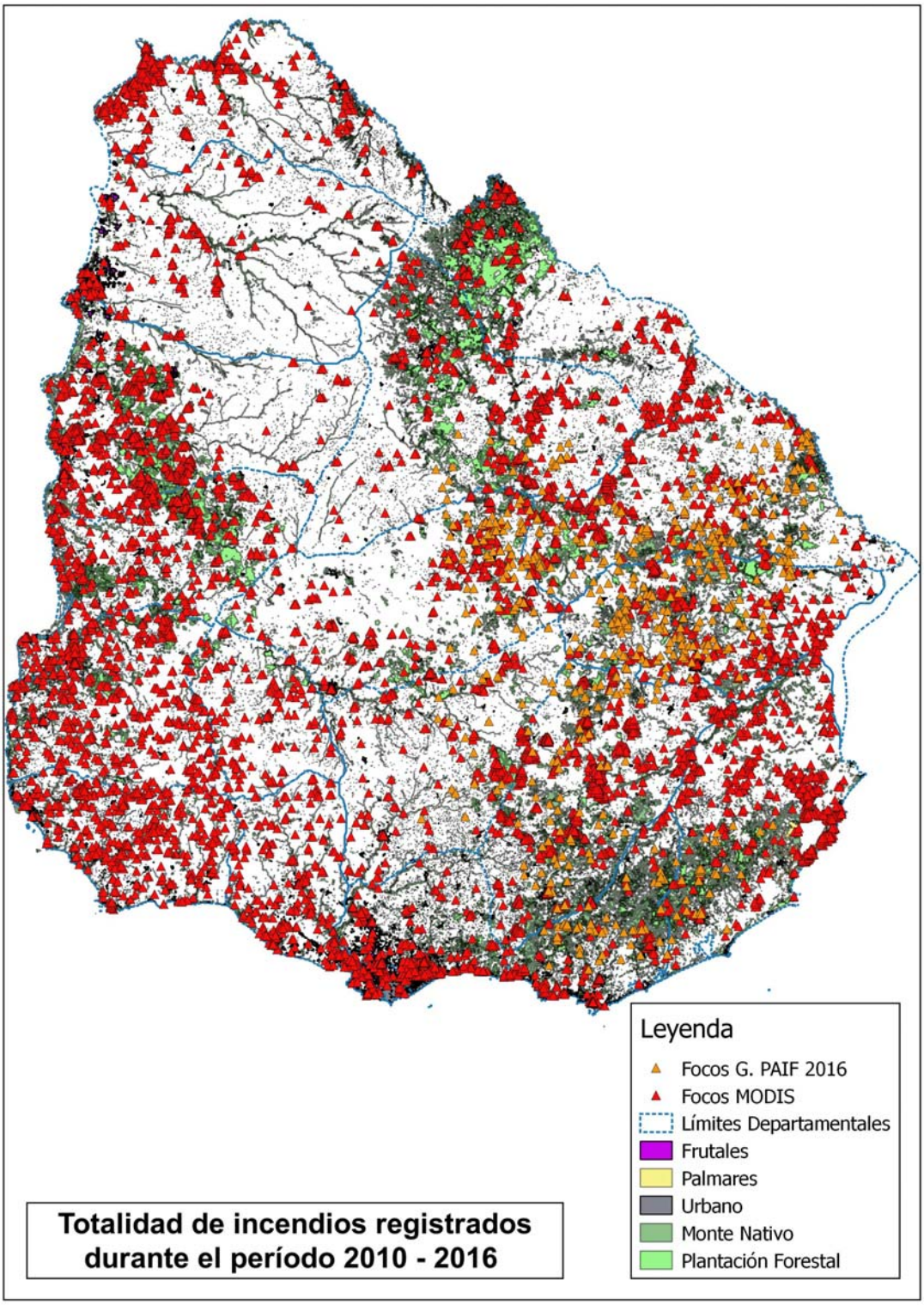
Map 14 shows the locations of 865 wildfires recorded by Grupo Forestal PAIF during the fire season 2015-2016. Most of the fires occurred in the Southwest of the country, particularly in the Departments of Treinta y Tres and Cerro Largo.

[12] Dirección General Forestal, Ministerio de Ganadería Agricultura y Pesca. 2012. Available at: http://www.mgap.gub.uy/portal/afiledownload.aspx?2,20,438,O,S,0,9083%3bS%3b1%3b105



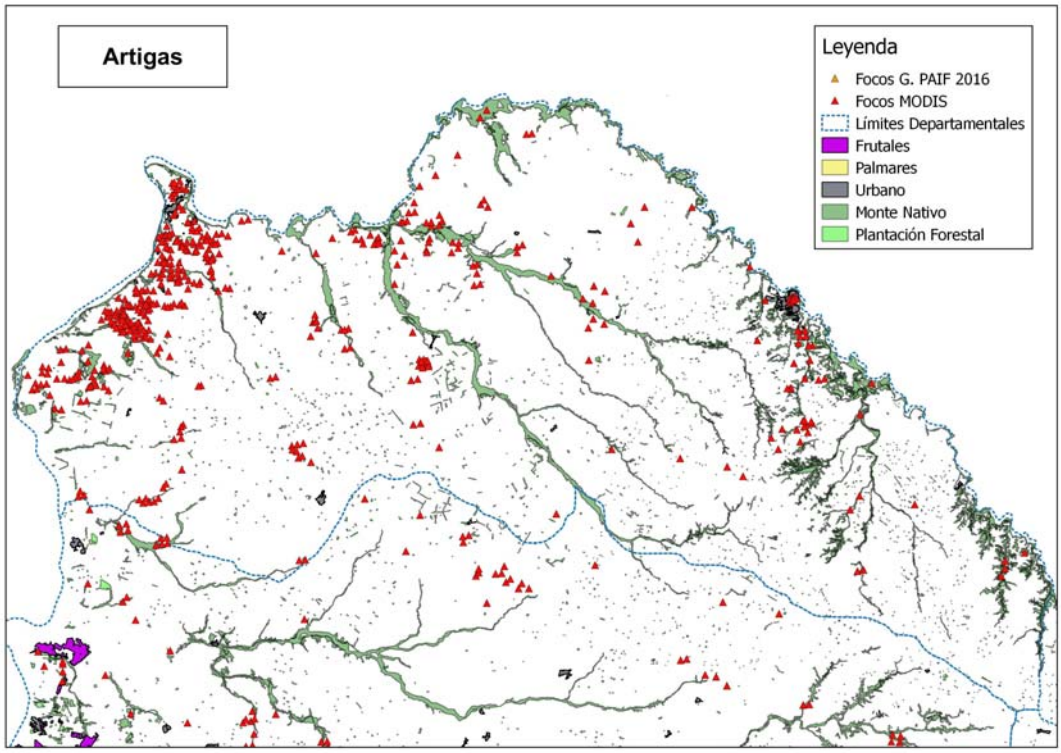
Map 14. Wildfires registered by Grupo Forestal PAIF during the season 2015–2016

According to the Soil Coverage and Change Detection 2000–2011 of the Soil Coverage Atlas of Uruguay the areas of native forests have decreased from 1,059,179 ha to 1,041,289 ha. The area of planted forest increased from 764,825 ha to 1,230,013 ha (FAO, 2015). In the following map can be seen that native forest and planted forest are the most affected by fires. The most affected departments are Lavalleja, Rocha, the limit between Tacuarembó and Cerro Largo and Paysandú (see Map 15).

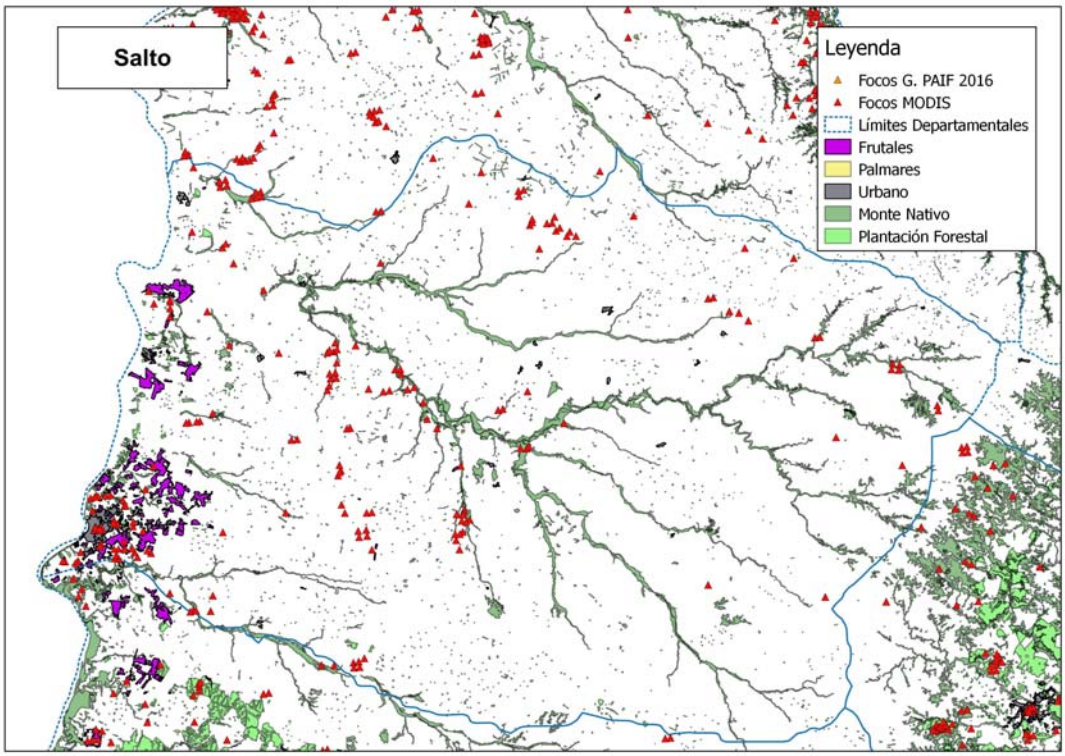


Map 15. Total of active fires registered by satellite and those registered on the ground during the period 2005–2016 compared in layers of native and planted forest

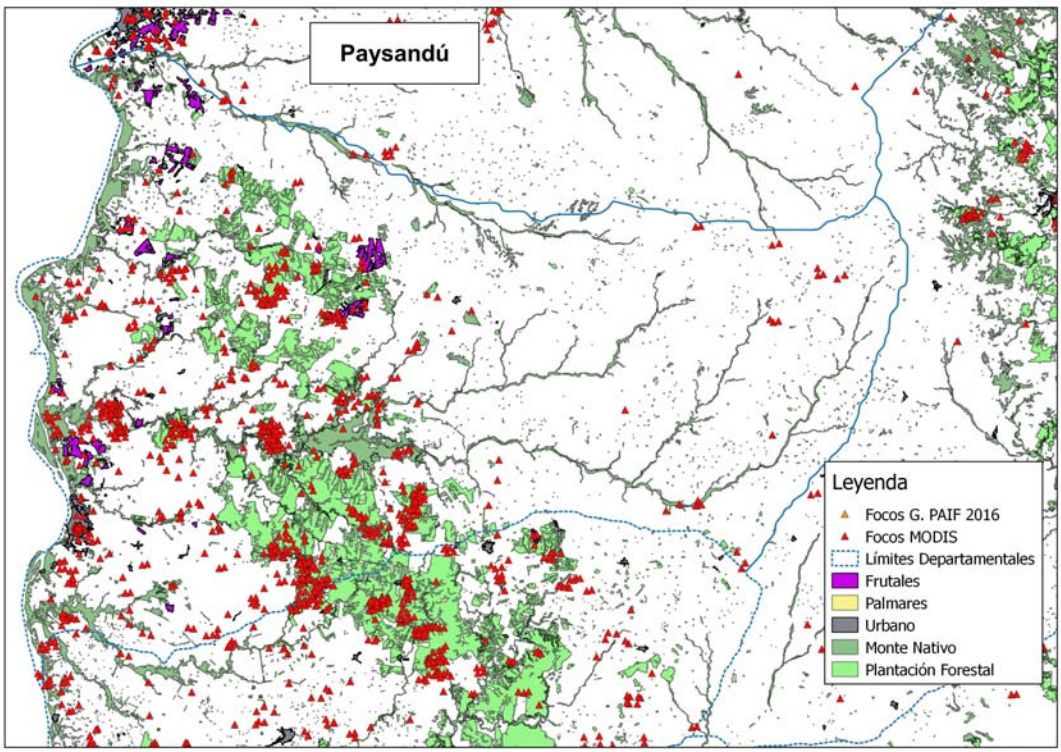
The following set of maps show in detail by department the fires and high temperature events that affected or threatened native forest, planted forest, palm tree stands or urban-rural interface fires for the period 2005–2016.



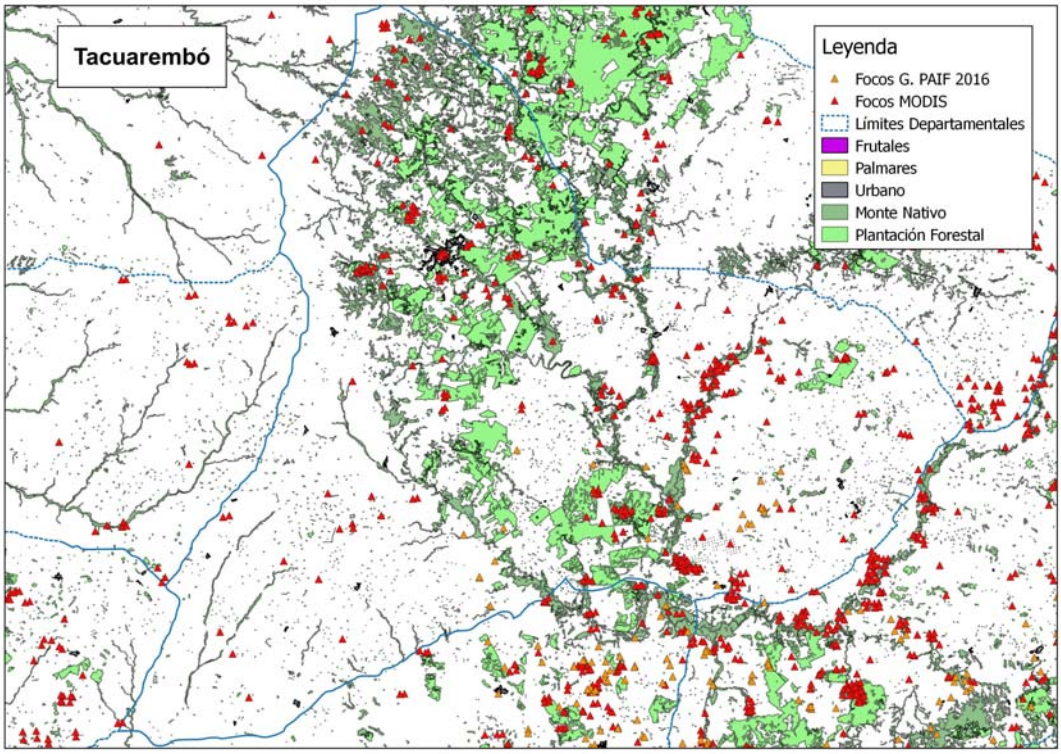
Map 16. Department of Artigas: 477 fires



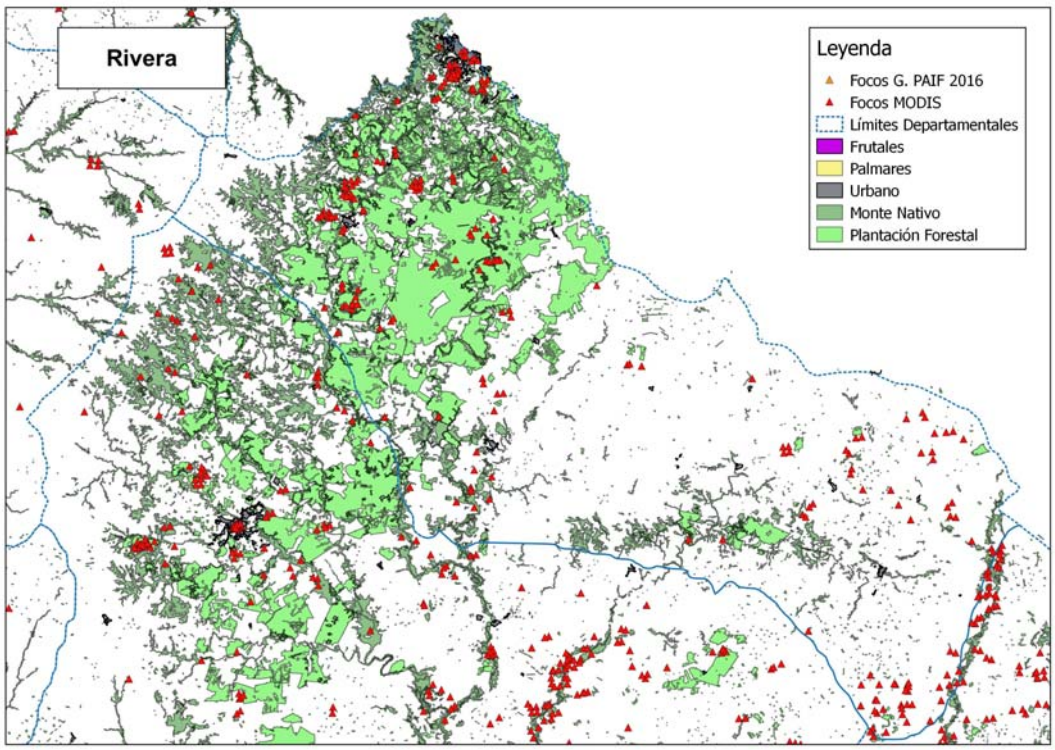
Map 17. Department of Salto: 197 fires



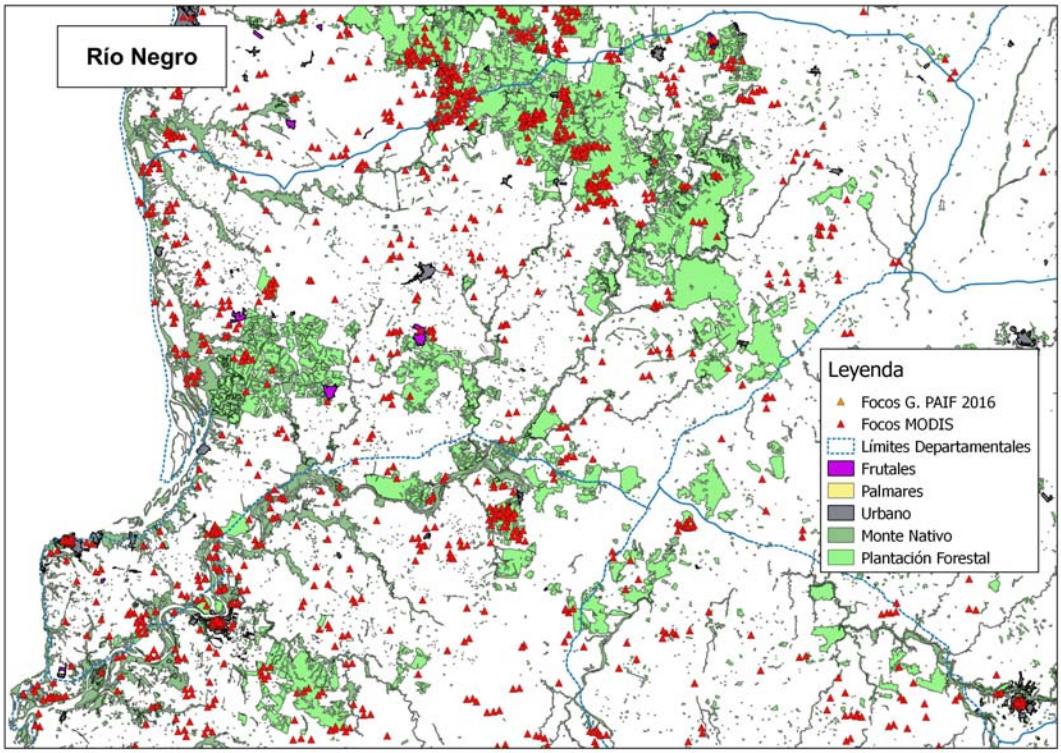
Map 18. Department of Paysandú: 800 fires, mainly planted forest adjacent to native forest



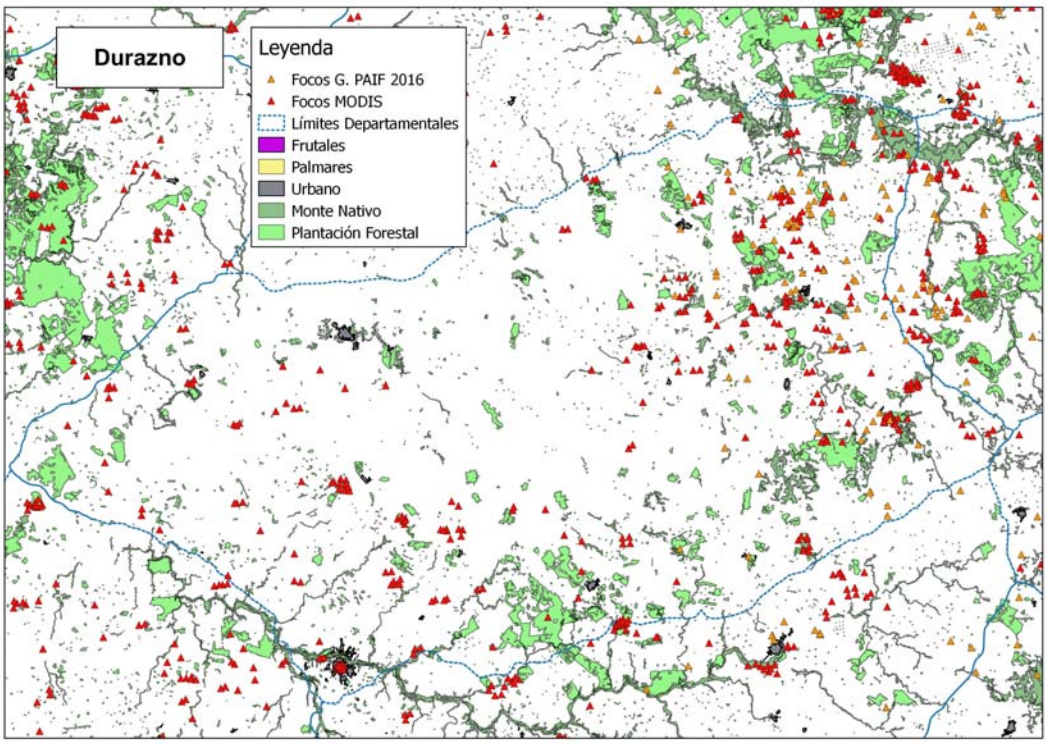
Map 19. Department of Tacuarembó: 444 fires, many of them in native forest and planted forest



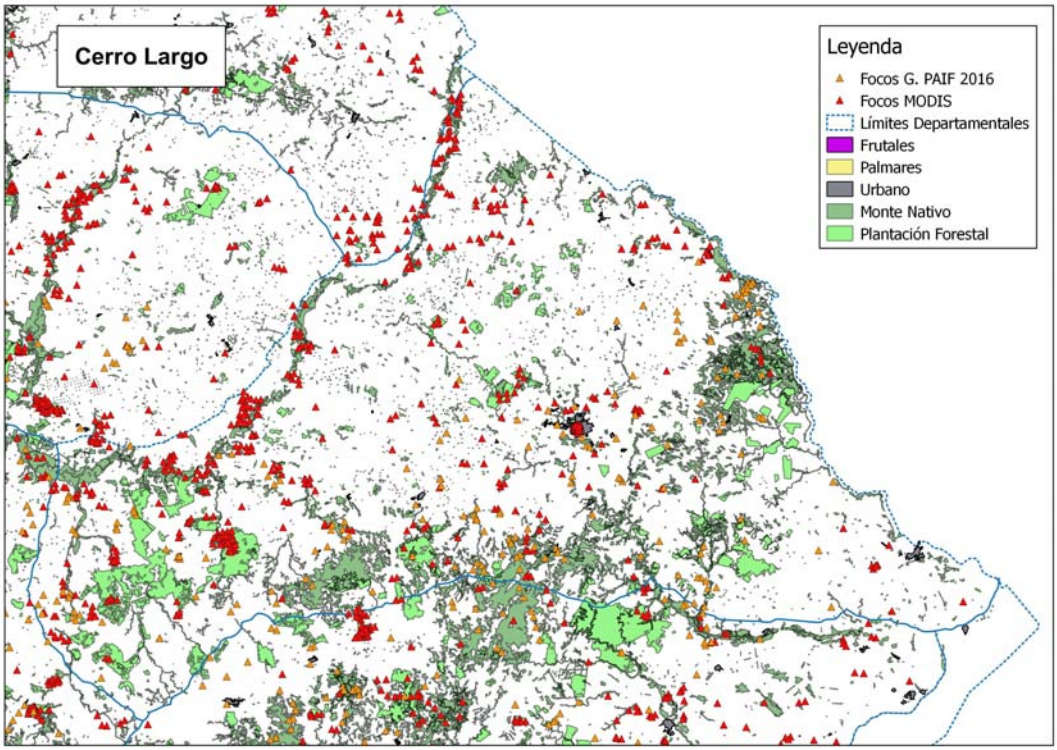
Map 20. Department of Rivera: 243 fires, mainly in private forests



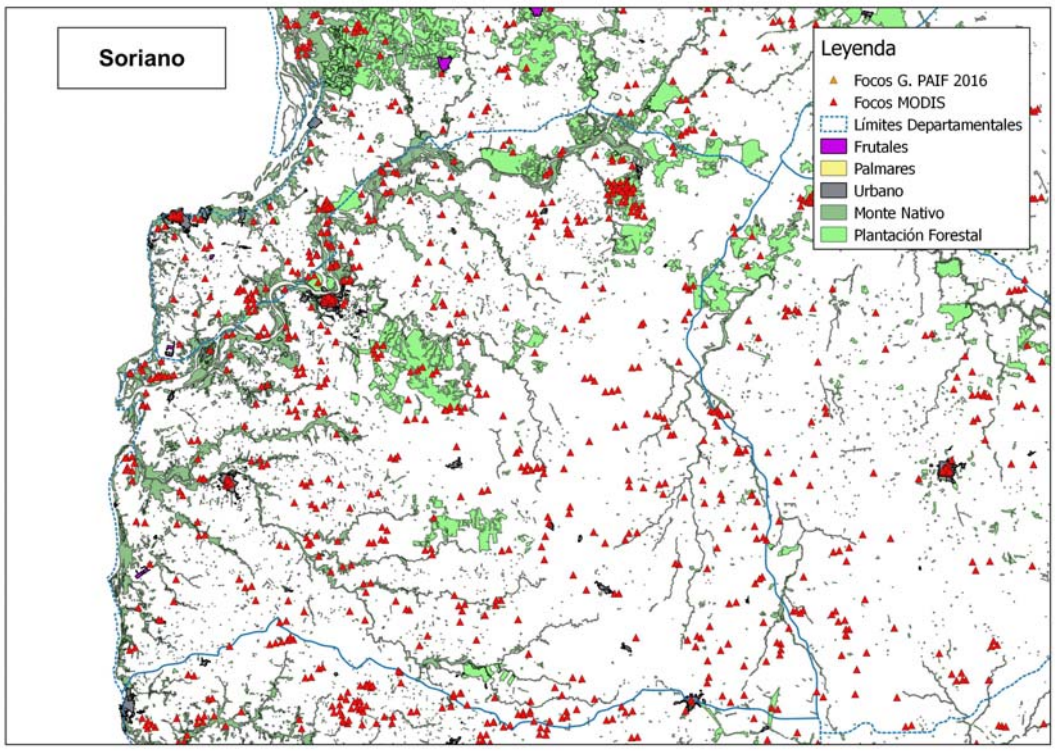
Map 21. Department of Río Negro: 533 fires, mainly in planted forests adjacent to native forest



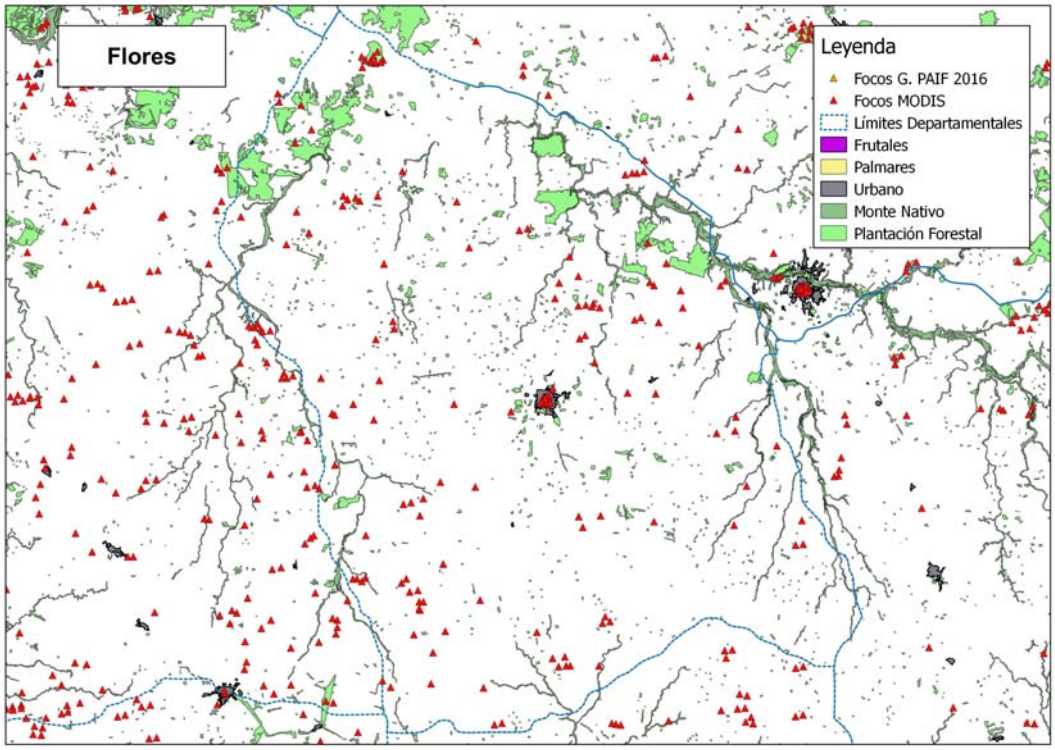
Map 22. Department of Durazno: 411 fires, mainly agricultural burnings



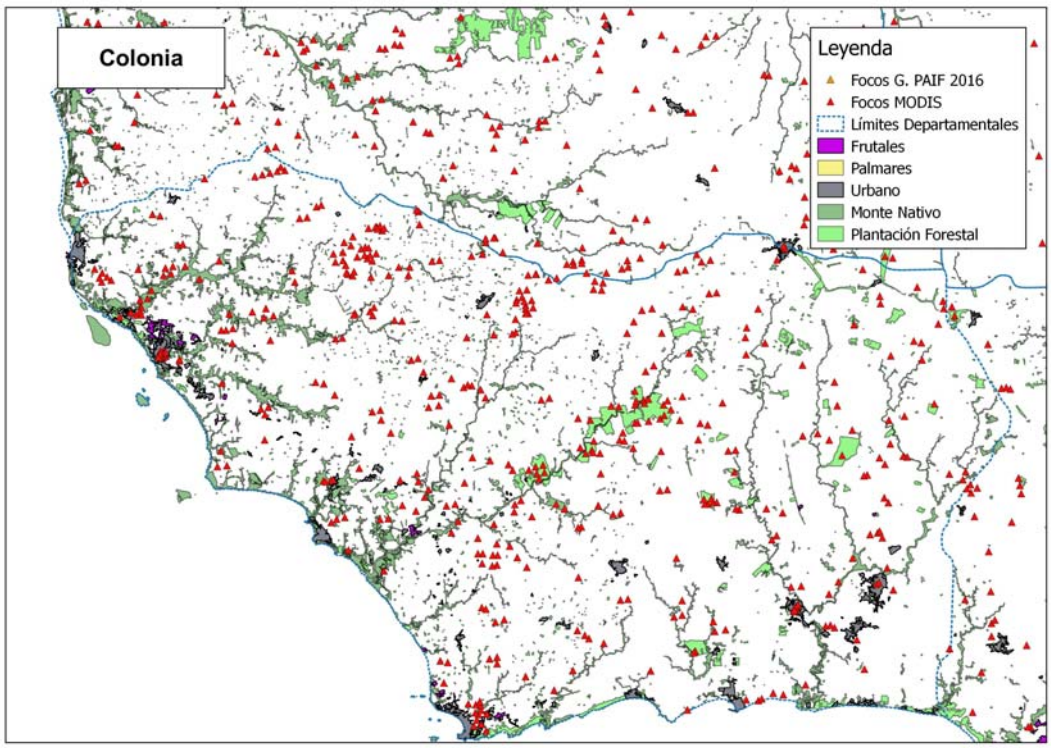
Map 23. Department of Cerro Largo- with 769 fires this is one of the departments with the highest wildfire occurrence and a high number in native forest



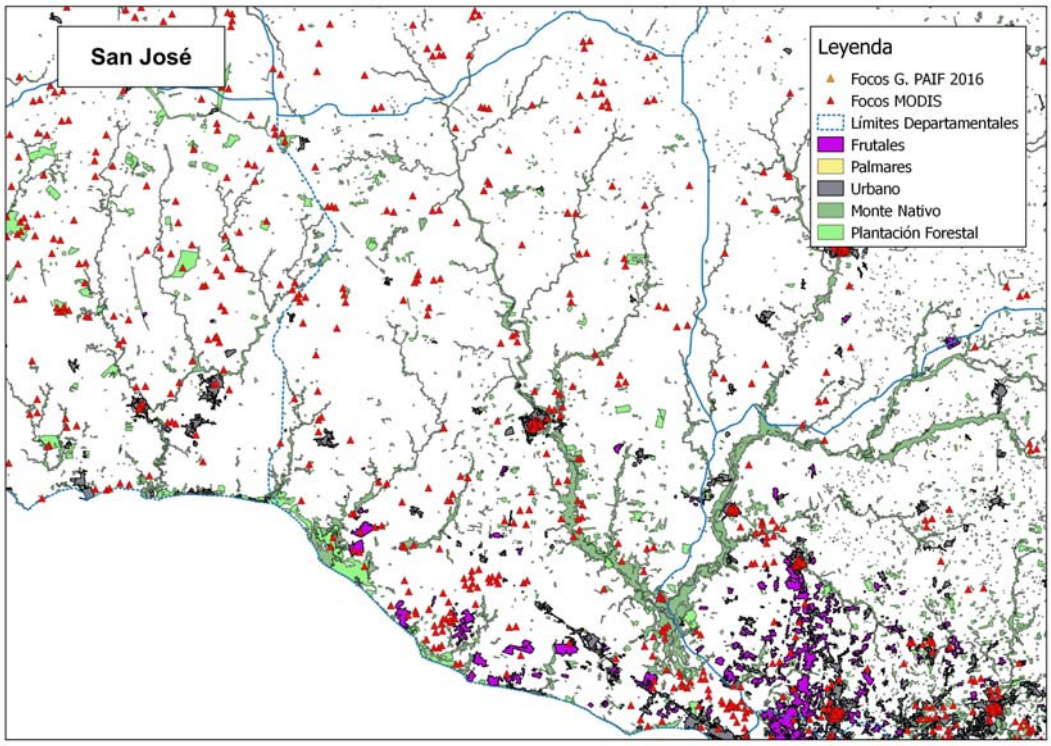
Map 24. Department of Soriano: 605 fires, mainly agricultural fires but a notorious concentration in planted and native forests in the limit with the Department of Rio Negro



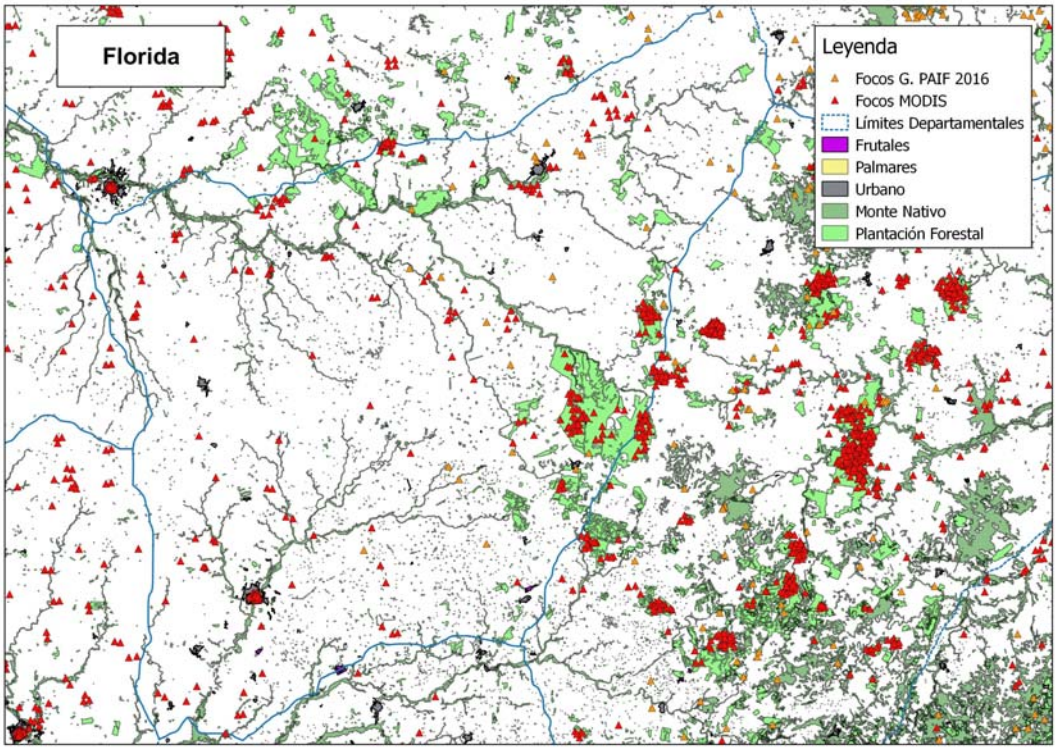
Map 25. Department of Flores: 164 fires



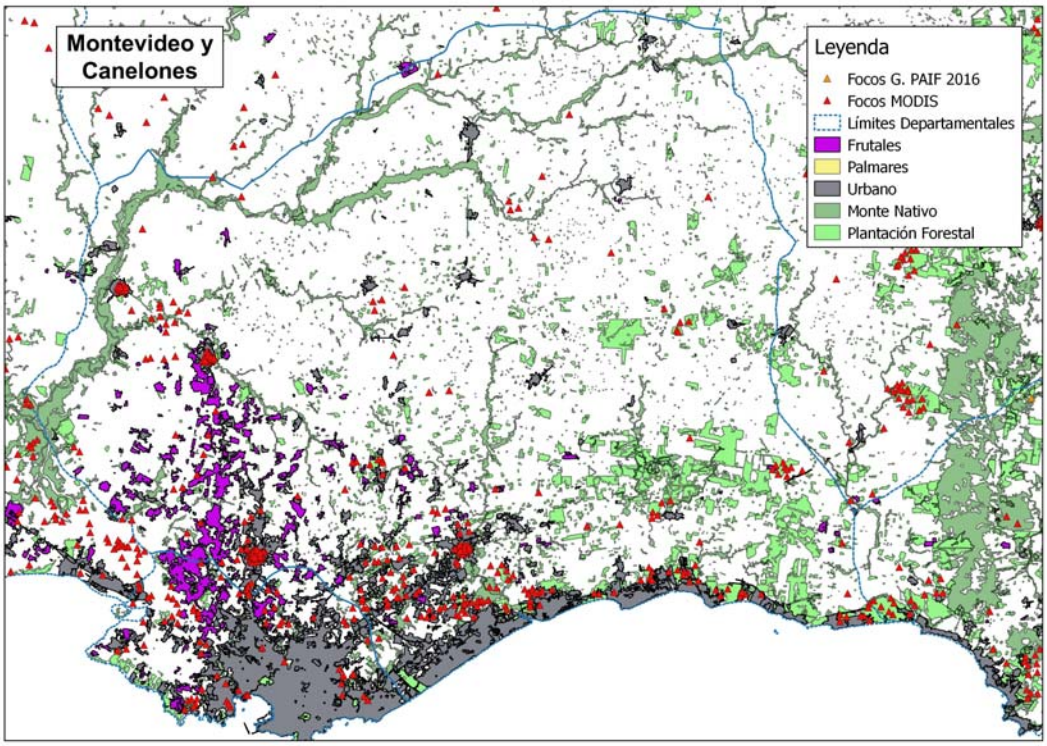
Map 26. Department of Colonia: 443 fires, mainly in the central and Northwestern parts



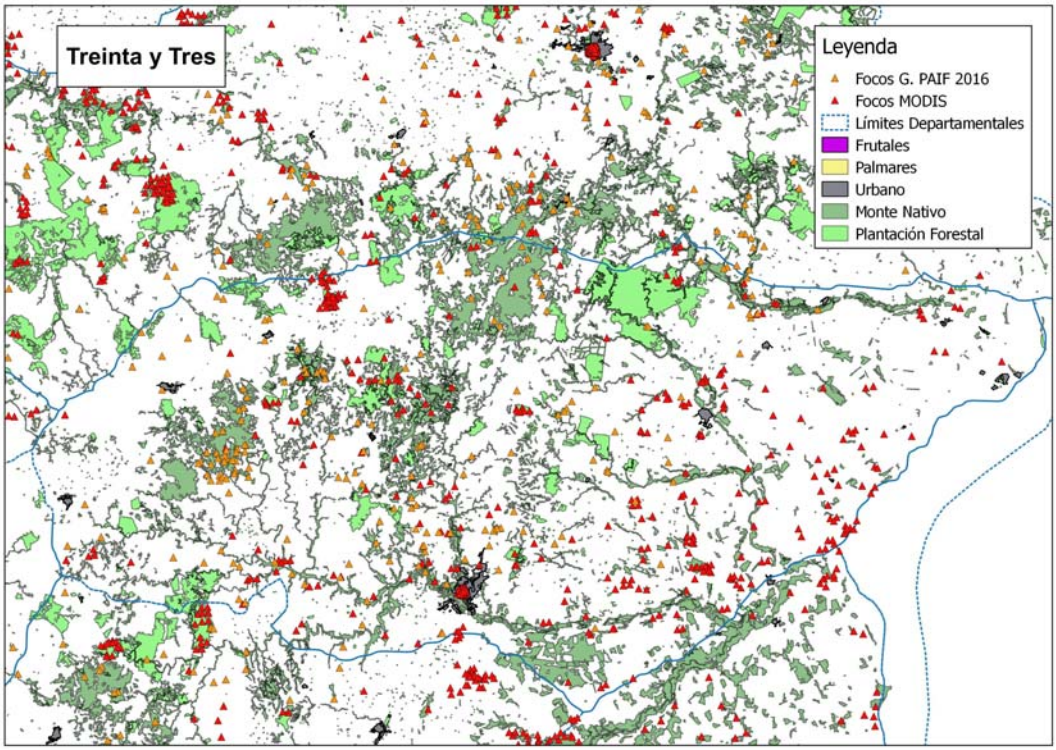
Map 27. Department of San Jose: 372 fires (mainly in native forests and agricultural burnings)



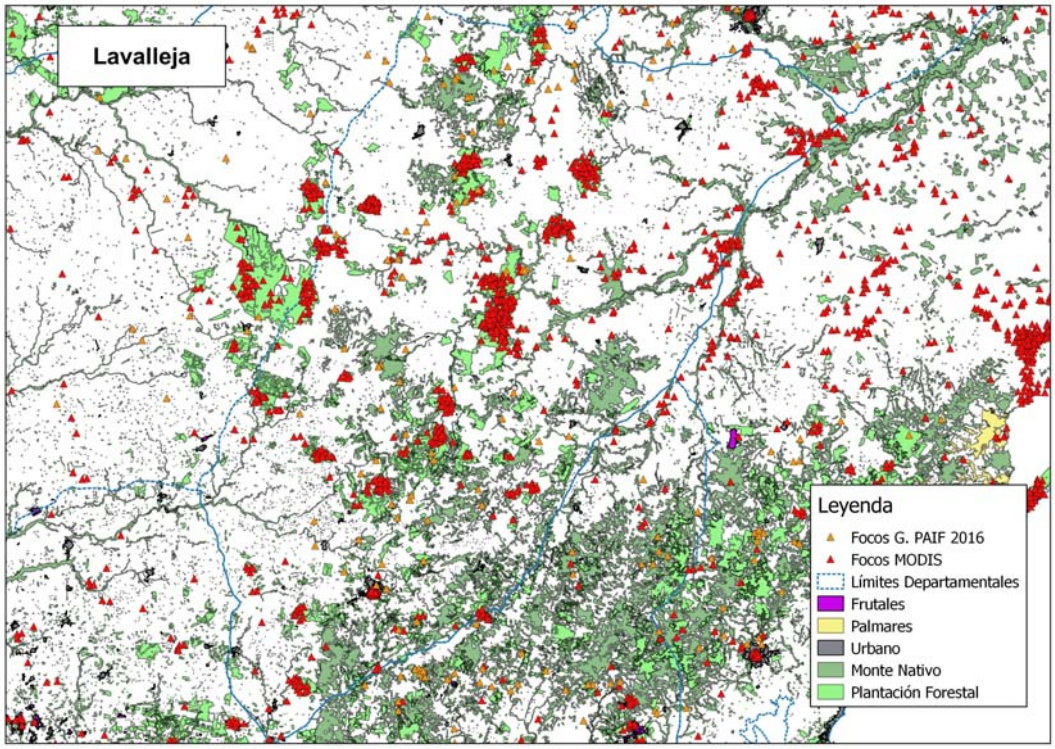
Map 28. Department of Florida: 328 fires, mainly planted forest



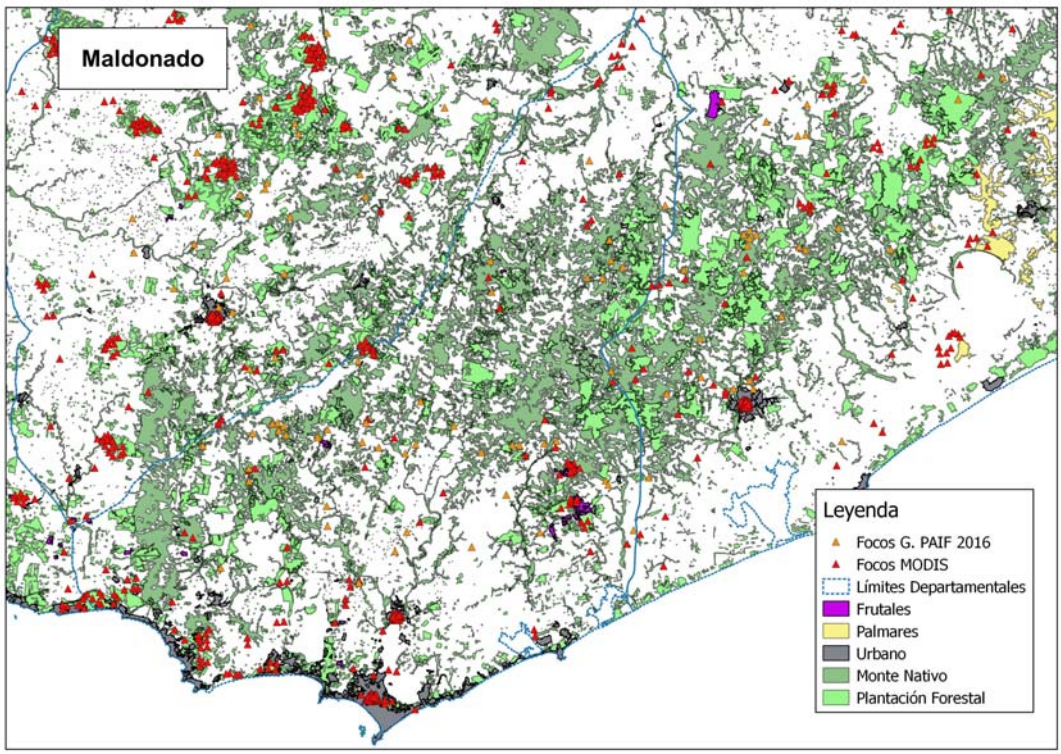
Map 29. On the territories of the Departments of Montevideo and Canelones together 519 fires have been registered, mainly in the *Ruta Interbalnearia*.



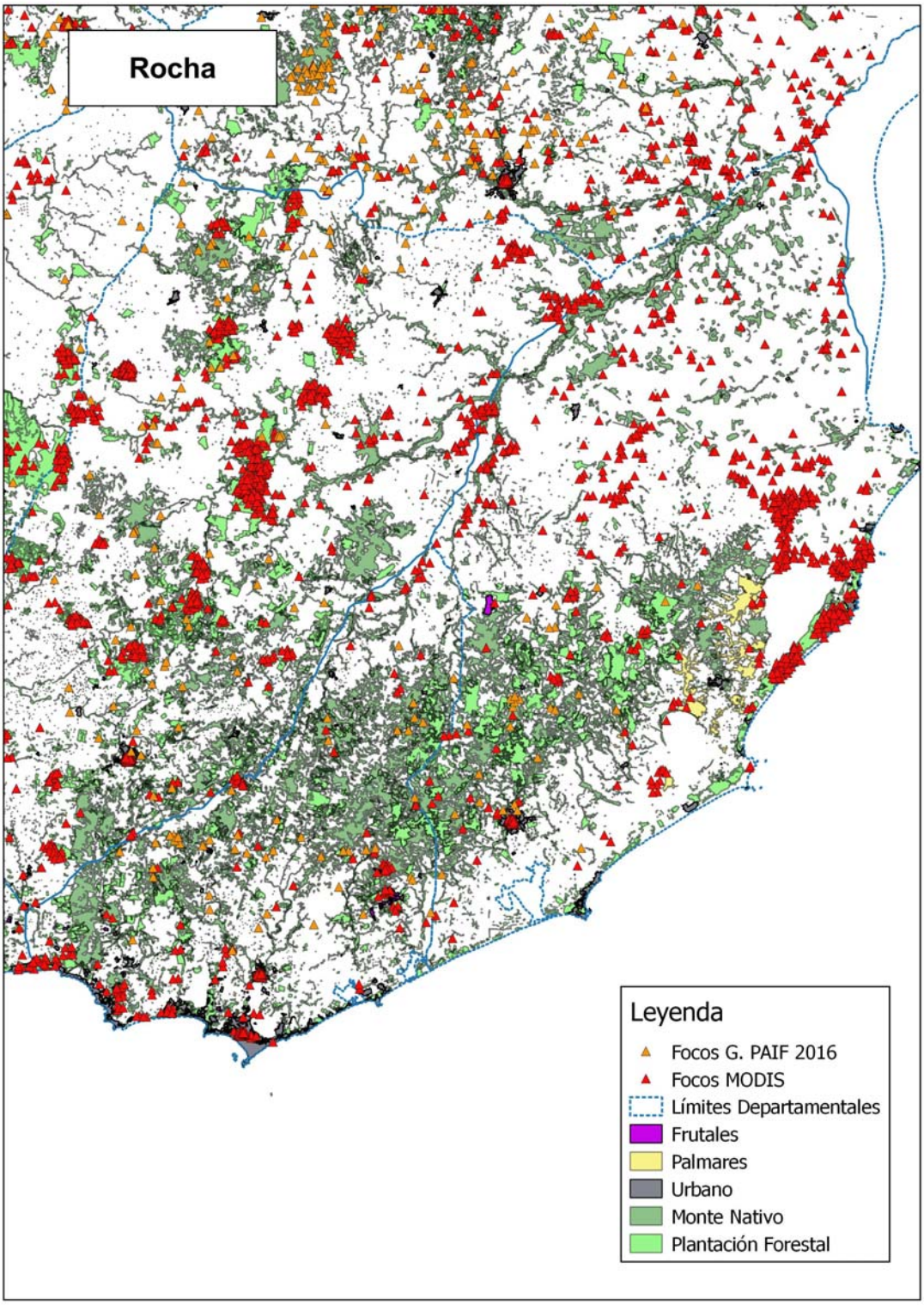
Map 30. Department of Treinta y Tres: 630 fires. Native and planted forest affected or threatened along with protected areas such as the Nature Reserve Quebrada de los Cuervos.



Map 31. Department of Lavalleja is the department that accumulates the highest number of fires with 1128 cases – mainly on private forest lands.

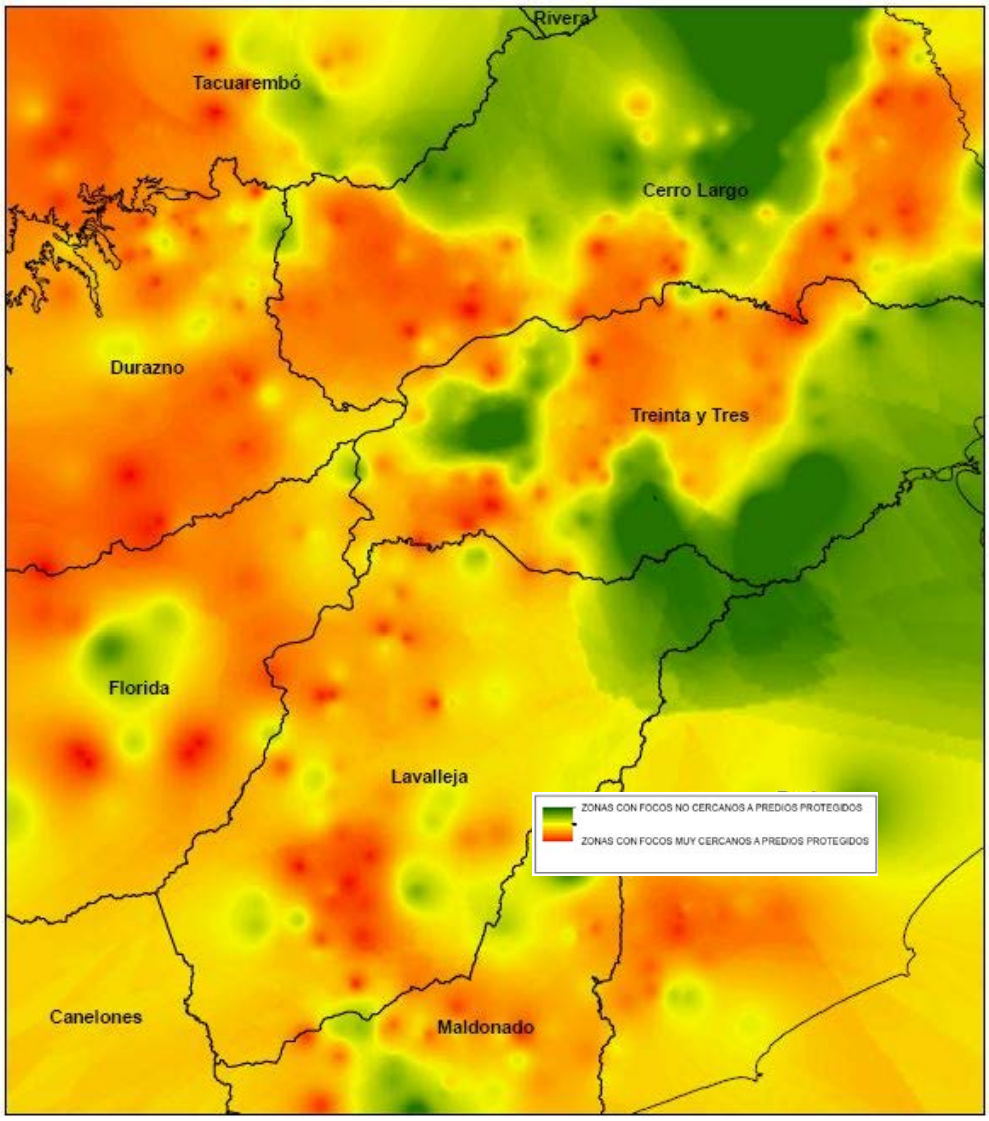


Map 32. Department of Maldonado: 336 Fires. The large area of native forest is at risk to be affected by a major wildfire.



Map 33. Department of Rocha: With 752 fires the Department is one of the most affected regions of Uruguay. The coastal area is highly populated and covered by highly flammable pine forests. This zone is strongly affected by urban-rural interface fires such as the *Ruta Interbalnearia*.

Map 34 shows that many fires not only threatened or affected private forests but got close or affected directly native vegetation areas. As stated above: According to sources of the private forestry sector, many of these fires start by negligence in agricultural burnings.



Map 34. Fire proximity analysis to private forests[13]

6. International Cooperation in Fire Management

Uruguayan firefighters count with international experience in fire management such as the support in the fire in Torres del Paine National Park in the region of Magallanes y Antartica Chilena, Chile, in January 2012. In this opportunity Uruguay sent a team of 26 firefighters to support the firefighting in the park along with Chilean brigades and firefighters.[14]

In September 2013 the *Dirección Nacional de Bomberos* supported Argentina by dispatching 32 firefighters to assist in the suppression of a wildfire in Cordoba, which affected 70,000 ha.[15]

[13] Map provided by Forestal Atlántico Sur
[14] http://radiopolar.com/noticia_54424.html
[15] http://www.defensa.com/frontend/defensa/fau-bomberos-uruguayos-ayudan-combatir-incendios-forestales-vn10067-vst167

Fig. 14 and 15. From 26 March to 4 April 2015, a task force of 30 firefighters of the *Dirección Nacional de Bomberos* supported Chile in the combat of wildfires burning in the National Reserve China Muerta and Marsella in Conguillío National Park.

Fig. 16. Participants of the First Regional Symposium on Cross-Boundary Cooperation in Fire Management in South America, which was held in Santa Teresa National Park between 30 May and 2 June 2016 (see Introduction).

Fig. 17. At the First Regional Symposium on Cross-Boundary Cooperation in Fire Management the EuroFire Competency Standards Spanish language for the use in South America, which were developed by the GFMC as an activity of the project, were introduced to the participating representatives of the national agencies responsible for training in fire management.[16]

[16] For the Spanish and Brazilian versions of the EuroFire Standards and Training materials see: http://www.euro-fire.eu/ (for the two language versions click on the Spanish and Brazilian flags)

7. Conclusions and Recommendations

Uruguay is a country with a growing problem of wildfires that, if not treated well, may severely affect the integrity of its natural forests and forest plantations and may put at risk the security of the population. This problem will likely be aggravated in one or another way by climate change. Some general recommendations are presented that were concluded from the field assessment and discussions with various agencies in 2015:

- Work on community based fire management with land owners, villagers and personnel from the protected areas more closely to improve the situation and response to possible emergencies related to fire.
- Strengthen and improve the early warning system of forest fires developed by the National Institute for Agricultural and Livestock Research (Instituto Nacional de Investigaciones Agropecuarias – INIA) and cooperate with neighboring countries that have already experience in fire danger rating and early warning, e.g. the National Institute for Space Research of Brazil (INPE).
- Collect detailed first party data by firefighters in the field after each fire event, including cause of fire, location, size of the affected area, human resources and equipment involved in firefighting and damages (injuries, fatalities, evacuations, burned houses, fences, infrastructures, etc.) and other details that may help to identify possible shortcomings in fire management and future needs for action.
- Carry out a national round table at which all stakeholders angageed and interested in fire management would discuss:
    - The situation of forest fires and fire management in the country
    - The utility of an Inter-agency Task Force on Fire Management as a cooperative platform for enhancing prevention of wildfires, preparedness and competency on fire suppression
    - The adoption of the EuroFire Standards and Training Materials for basic training on fire behavior, attack, security and safe use of fire for suppression and fuel reduction for professionals, volunteers, park rangers, cattle ranchers, etc. Enhancing community based fire management and a solid and efficient trans-boundary cooperation.
    - The adoption of the International Fire Aviation Guidelines for safe and efficient use in trans-boundary fire emergencies.

Following the field assessments an initial National Round Table on Fire Management was held in Montevideo on 2 June 2016. The topics discussed included the following:

- Improvement effectiveness and efficiency of government institutions and inter-institutional cooperation in fire management
- Management of information and data on vegetation fires and fire management
- Fire management planning
- Review of the current forest policy and eventually develop a national fire management strategy or policy
- Cooperation with the private sector and civil society
- Review practices and regulations of using fire in the agricultural and livestock pasture sector
- Finalization of the fire danger rating / early warning system by INIA
- Investigate opportunities to create a regional working group within the Union of South American Nations (Unión de Naciones Suramericanas – UNASUR)
- Apply to green funds (REDD+) and Euroclima[17] to further fire management capacities in the country
- Establishment of a national Inter-Agency Task Force on Fire Management

[17] http://www.euroclima.org/es/

Furthermore advantage should be taken of the inspirations and recommendations of the First Regional Symposium on Cross-Boundary Cooperation in Fire Management in South America, which was held in Santa Teresa National Park between 30 May and 2 June 2016 (see Introduction) and in which the neighbouring countries Brazil, Chile, Argentina and Paraguay and where all the countries presented their reality and the experiences in inner and cross boundary fire management and jointly concluded:

- Address vegetation fires in the context of climate change and develop action with regards to mitigation and adaptation, encourage the leadership of countries to consider fire management as an important activity to meet the obligations by the Paris Agreement within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) of 2015
- Systematic improvement of cooperation in fire management between South American countries through a more formalized membership and activities under the Regional South America Wildland Fire Network (officially nominated focal points) and aim at obtaining finances e.g. from the Southern Common Market (Mercosur) (Argentina, Brazil, Paraguay, Uruguay and Venezuela), and Pacto Andino (Bolivia, Colombia, Chile, Ecuador y Perú)
- Implementation and further development of the Regional Strategy for Fire Management[18]
- Development of fire management policies by countries participation in the regional network
- Improvement of consistent regional vegetation fire statistical data collection (development of guidelines / template) and evaluation (e.g. through the secretariat of the Regional South America Wildland Fire Network)
- Development of guidelines and SOPs for enhancing inter-operability of countries cooperating in cross-boundary fire management including wildfire emergencies
- Encourage more scientific research addressing the socio-economic, cultural and environmental (climate change related) trends affecting fire regimes and fire management in the region; and conduct an in-depth analysis of satellite data on type and extent of areas burned by wildfires or land-use fires.

In summary it is concluded that the public institutions and the private forest sector of Uruguay have recognized the needs for further action in enhancing national and regional fire management capacities.

Acknowledgements

The Global Fire Monitoring Center (GFMC) and the Uruguayan partner institutions are indebted to the sponsor of the project – the German Federal Ministry for Agriculture, based on a decision of the German Bundestag. The culture of international, regional and bilateral cooperation in fire management has been driven forward by the Uruguayan authorities – the Directorate General of Forests (*Dirección General Forestal* – DGF), the National Directorate of Fire Services (*Dirección Nacional de Bomberos* – DNB), the National Emergency System (*Sistema Nacional de Emergencias* –SINAE) and the Armed Forces of Uruguay (*Ejercito del Uruguay*).

[18] http://www.fire.uni-freiburg.de/GlobalNetworks/SouthAmerica/Estrategia-Cooperacion-America-Sur-TCP-RLA-3010.pdf

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http://www.sne.gub.uy/index.php?option=com_docman&task=doc_download&gid=137&Itemid=36
(currently not available), mirrored at GFMC:
http://www.fire.uni-freiburg.de/GlobalNetworks/SouthAmerica/Uruguay/Catalogo-Historico-SINAE-Incendios.pdf)

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Annex

Compilation of wildfire news by the Global Fire Monitoring Center (GFMC) between November 2015 and February 2016

Date	Situation	Link
08-11-2015	A wildfire in the area of La Floresta is fought by firefighters on the Sunday. There are four starting points, two on the northern side of the route and two on the southern side that are under "relative control". The first estimations are that they have affected 40 ha.	http://www.elpais.com.uy/informacion/bomberos-combate-voraz-incendio-interbalnearia.html
13-12-2015	Four detachments and Forest Fire Brigade continue to work on Thursday night to control a fire that has already affected about 80 hectares to 76,500 kilometer route *Interbalnearia*. Five houses in the area were already burned and it is possible that this number will increase.	http://www.elpais.com.uy/informacion/bomberos-incendio-interbalnearia-viviendas-afectadas.html
19-12-2015	Summer brings a peak of activity for firefighters and tests for a force which lacks 25% of staff.	http://www.elpais.com.uy/que-pasa/fuego-empezo-zafra.html
14-01-2016	At noon a fire in Punta del Este, en route to Los Ceibos near Route 9, was addressed by the rapid intervention of firefighters who extinguished it and prevented its expansion. Origin of the fire: A tree branch falling on a power line that started the fire in the dry grass.	http://www.elpais.com.uy/informacion/bomberos-apaga-incendio-punta-este.html
22-01-2016	Firefighting personnel responded to a fire on the North side of the *Interbalnearia* route, at kilometer 49. The fire affected between 8 and 10 ha. "It is a creeping surface fire, and there is a lot of smoke in the area."	http://www.elpais.com.uy/informacion/bomberos-combate-incendio-ruta-interbalnearia.html
25-01-2016	An area of about 1.5 ha, located opposite the airport of Laguna del Sauce, caught fire on Monday just hours after the fire was extinguished at Cerro del Toro. Because of the vicinity of houses on the periphery, the smoke pollution and the risk of spreading, it helicopters of the Air Force were dispatched.	http://www.elpais.com.uy/informacion/nuevo-incendio-maldonado-vez-laguna.html
28-01-2016	Firefighters rushed to another wildfire nearby the town of Paso del Rey, Department of Lavalleja. The fire burned in an industrial eucalypt forest.	http://www.elpais.com.uy/informacion/bomberos-combate-incendio-forestal-lavalleja.html
28-02-2016	Firefighters try to control Canelones in the village of El Pinar, in the outskirts of Montevideo, a fire that started yesterday and spread to a distance of about 4 kilometers. The fire started in a pine forest behind a sandbank, at kilometer 28.5 of the *Interbalnearia* national route, and moved in a southeasterly direction to kilometer 32 of the highway.	http://www.efe.com/efe/america/sociedad/bomberos-uruguayos-intentan-controlar-un-incendio-en-suburbio-de-montevideo/20000013-2853027