

### Summary

Vegetation fires are widespread over the world but little attention has been paid to savanna fires in South America. Spatial distribution of savanna fires in Los Llanos Orientales of Colombia was investigated and estimates were made of the area burned as detected from satellite data in the dry season when most fires occur (December 2000, March 2001). A number of 3639 burned scars (with an extension of 488,235 ha) were detected in the period analyzed. This burned area accounted for 5.18% of the savanna area (9,419,741ha) and 2.87% of the total study area (17,017,854 ha). The mean size of the fire scars was 134.17ha and over 75% of the patches are smaller than 115 ha.



This data is the first local estimate of burned area in the Colombian savannas and might be of importance for future calculations of greenhouse and atmospheric trace gas emissions to the atmosphere from the country.

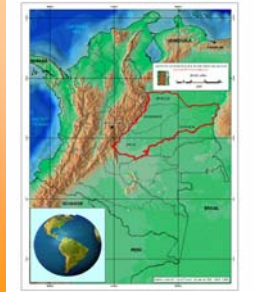


Keywords: vegetation fires, savannas, remote sensing, global change, Colombia

### Study Area

Colombian Orinoco Savannas are located in the northeastern part of the country, western part of the Orinoco between 2° 30' - 7° 0'N and 74°0' - 67°24'W. The Colombian together with the Venezuelan savannas constitute the main tropical savannas in northern South America and form a continuous plain between 86 - 300 m of altitude covering 8.507.191 ha approximately.

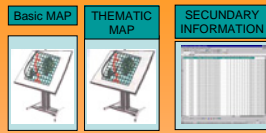
The climate in the study area has been classified as hot, tropical and humid to dry. Mean annual temperature is between 27-30°C in the dry months and 23-26°C in the rainy months. Annual average precipitation varies between 1000 and 3500 mm. The climate is seasonal with rains distributed with a dry period from 2 to 5 months (between November and March) depending in its longitudinal gradient (Eter, 1998).



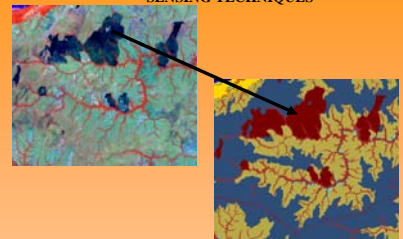
### Methodology

A vegetation map was carried out after acquiring the necessary basic and thematic cartography and the satellite images (Landsat ETM and TM, corresponding to the following months: December 2000, January, February and March 2001). The images were georeferenced and processed using ERDAS Imagine. Areas affected or transformed by fire were obtained using the different spectral gammas of the satellite images. Fires were not directly detected using this methodology, but burnt scars that fires left in the land. Ground testing was done where accessibility conditions allowed the field work. ArcInfo-ArcGIS was used for the interpretation and integration of the information into a geographic information system.

#### STEP 1: CONSTRUCTION OF THE GIS DATABASE

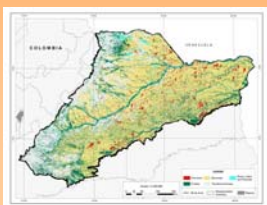


#### STEP 2: INTERPRETATION OF IMAGES USING REMOTE SENSING TECHNIQUES



**Unsupervised classification:** Using a computer-automated method of clustering.  
**Supervised Classification** Primarily controlled by the user who has a priori information about the data and the desired classes. These procedure delineates the different burned savanna scars

#### STEP 4: INTEGRATION AND ANALYSIS



#### STEP 3: GROUND TESTING



### Results



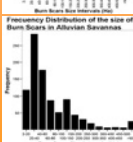
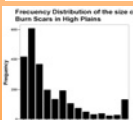
3639 different fire scars were detected in the savannas of Los Llanos Orientales of Colombia in the period analyzed (December 2000- March 2001)

Table: Number of patches and percentage of each vegetation type and burned areas

Ecotone type	Area (ha)	Number of Patches	Percentage of study area (%)
Forests	2,262,985	47118	19.11
Alluvial Savannas	2,980,277	12917	17.51
High plain Savannas	6,926,663	27322	36.79
Andeanian Savannas	30,677	476	0.18
Burn Scars in High plain Savannas	393,274	2469	2.19
Burn Scars in Macarena Savannas	19,683	290	0.12
Burn Scars in Alluvial Savannas	89,202	699	0.96
Transformed ecosystems	3,927,891	32138	23.06
Mountains, Lakes and Ditches	417,986	4391	2.46
<b>Total</b>	<b>17,017,854</b>	<b>127,890</b>	



The total of savanna area burned in the period analyzed for the year 2000 are 488,235 ha (2.87% of the study area).



Of all the fire scars detected in savannas, 76.45% were in high plain savannas, 19.52% in alluvial savannas and the rest belong to the Macarena area.



The size of the fire scars has an average of 134.17 ha, and a standard deviation of 298.89 ha. Figures illustrate the distribution of fire burn scars for each type of savannas.

### Discussion and Conclusions

- The spatial distribution of fire scars and an inventory of the extent of savanna burning with reference to Colombia is presented. The values for burned area depend on the savanna types.
- The **High Plain Savannas** are not permanently flooded over the year and soils are mainly sandy, this fact facilitates fire dispersion and gallery forest are usually the natural barrier to fire.
- In **Macarena Savannas**, not much natural savannas are left and the few patches are smaller than those from other areas and so are the fire scars detected.
- In the **Alluvial Savannas**, due to regional geomorphological conditions and more humidity, fires occur mostly during the last months of the dry season.
- The total figures differ from the global burned area products developed under the GBA-Initiative, from medium resolution imagery and at a coarse resolution of 1 km. A comparison of our results with the available through internet from the GBA-Initiative seems to indicate that the global estimates misclassified flooded areas as fire scars, probably overestimating burnt areas due to this effect.
- Also important is the detection of small fires, very frequent in the Colombian savannas and undetected in global estimates.
- The information presented provides a detailed and direct spatial estimate of savanna burning in Colombia and uncertainties are reduced from those from global estimates.



### Future Work

At What level are savanna fire burns associated with human-economic activities, with normal climatic variability or with climatic extreme events? A monitoring system that contributes to link anthropic factors, fire burns and climatic data is required.

Is important to know more about the ecology of savannas. Knowing these figures together with the data presented in this study will potentially help improve future estimates of greenhouse emissions from Colombia.

Information is urgently needed on the frequency of fires, the amount of biomass burnt and consumed by fire (above ground) and burning efficiency in each savanna type in Los Llanos Orientales.

After establishing the relationship between savanna fire burns and climate, to analyze the occurrence of this burns using climate change scenarios and new advances in Geographic information systems and modeling strategies.

### Who are We?

The Alexander von Humboldt Biological Resources Research Institute is an entity that provides scientific and technical support to the Ministry of the Environment. Its mission is to promote, coordinate, and carry out research that contributes to the conservation and sustainable use of biological diversity in Colombia. The Institute has worked in four main programs: inventories of biological diversity; conservation biology; use and valuation of biodiversity; and environmental policy and legislation.

In 2001 the Alexander von Humboldt Research Institute initiated a five year project called **"Biodiversity and development in Colombian strategic ecotones: Orinoquia"**. This project was designed and is being implemented with support of the German Government through GTZ. The main objective of the Orinoquia project is to formulate and implement a regional biodiversity action plan in the area. Among other things, the project is building a geographic information system to monitor and quantify changes at the ecosystem level in the Colombian Orinoquia.