SISLA – INTERACTIVE SYSTEM FOR ENVIRONMENTAL LICENSING SUPPORT

Eduardo Antonio SPERANZA[1]
Julio César Dalla Mora ESQUERDO[2]
João dos Santos Vila da SILVA[2]
João Francisco Gonçalves ANTUNES[2,3]
Felipe Vilela LOURENÇO[4]
Victor Muniz CEZAR[4]

Abstract

The Interactive System for Environmental Licensing Support (SISLA) provides spatial data for environmental licensing in the state of Mato Grosso do Sul, both for private and governmental use. This paper describes the computational implementation of all modules from SISLA, as well as the methodology of NDVI/MODIS imagery processing and data inclusion in the system. SISLA is a Web Geographic Information System which aims to ease and accelerate the management and analysis of environmental licensing processes. Providing a geo-spatial database, SISLA performs useful analysis for environmental licensing decision making, confronting spatial information provided by producers and consultants with information of areas under protection provided by the Government of Mato Grosso do Sul.

Key Words: Environmental licensing. Geo-Technologies. Spatial Queries. Remote Sensing.

Resumo

SISLA – Sistema Interativo de Suporte ao Licenciamento Ambiental

O Sistema Interativo de Suporte ao Licenciamento Ambiental (SISLA) tem como objetivo disponibilizar dados geográficos de interesse ao licenciamento ambiental do estado do Mato Grosso do Sul, tanto para iniciativa privada como para os agentes ligados ao Governo. Esse trabalho descreve a implementação computacional de todos os módulos do SISLA, bem como a metodologia de inclusão de imagens NDVI/MODIS como uma camada desse aplicativo. O SISLA é um Sistema de Informações Geográficas para a Web, que pretende contribuir para facilitar e agilizar o gerenciamento e a análise de processos de licenciamento ambiental. Por meio da criação de uma base de dados georreferenciada, o SISLA realiza análises úteis à tomada de decisão para o licenciamento ambiental, confrontando áreas informadas pelos produtores e consultores com áreas protegidas pelo Governo do Mato Grosso do Sul.

Palavras-chave: Licenciamento Ambiental. Geotecnologias. Consultas Espaciais. Sensoriamento Remoto.

---

[1] Analyst of Embrapa Informática Agropecuária. Av. André Toselo, 209 – Caixa Postal 6041, 13083-886 – Campinas – SP – E-mail: speranza@cnptia.embrapa.br.

[2] Researcher at Embrapa Informática Agropecuária. Av. André Toselo, 209 – Caixa Postal 6041, 13083-886 – Campinas – SP – E-mails: {julio, jvilla, joaof}@cnptia.embrapa.br.

[3] PhD student at Engenharia Agrícola - Feagri/Unicamp - Caixa Postal 6011, 13083-875 – Campinas – SP

[4] Graduate student in Computer Engineering – Unicamp. Trainee at Embrapa Informática Agropecuária. Av. André Toselo, 209 – Caixa Postal 6041, 13083-886 – Campinas – SP – E-mails: {felipevl, victormc}@cnptia.embrapa.br

INTRODUCTION

The Environmental Licensing is an important management instrument of National Environmental Policy. Through it the public administration tries to conciliate economic development with the use of natural resources, in order to ensure the sustainability of ecosystems in its physical, biotic, social-cultural and economic variability. It must also lean on other planning instruments of environmental and management policies, such as the strategic and integrated environmental evaluation, the ecologic and economic zoning, management plans of conservation units, among others. (PNLA, 2010).

In some States and municipalities, besides data on texts, the processes for the request of environmental licensing require already from the entrepreneur, the presentation of vector geo-referenced maps on digital media. Taking the State of Mato Grosso do Sul as an example, such maps must contain information on: registration of the property; vegetation cover and present land use; activities to be licensed; floodable areas; areas of direct and indirect influence of the undertaking to be established. Beyond that, several factors are determinant for the project approval of an undertaking. In summary one seeks always to preserve those areas protected by government, in order to keep the development of flora and fauna from the region.

In this context, Geo-technologies have been of fundamental importance in the processes of acquisition, analysis and visualization of geo-spatial information. They can be defined as a set of tools which allow the collection, analysis and the availability of information with spatial reference. Thereby the information has also the geographic localization as an integration and analysis factor. Among the geo-technological tools the Geographic Information Systems (SIG), remote sensing and Global Positioning Systems (GPS) stand out. These tools, joined to Information Technology (IT), comprehend the broadest form of Geo-Technologies.

In the last years the use of Internet emerged as a help for the dissemination of geographic information. An efficient way to generate information as maps, is to make them available for groups of end users as Web pages. The Web Mapping sites are becoming each time more popular and allow the creation of static and interactive applications (MITCHELL, 2005).

When a Web Mapping application is said to be interactive, it must allow the user to perform basic operations on the maps, such as: enlargement, displacement, area and distance measurements. Besides that, most applications of this type have tools of advanced data search, allowing the combination of different maps stored on the data base, according to the user needs.

The idea of an Interactive System for Environmental Licensing Support - SISLA (VENDRUSCULO, et al., 2008; VENDRUSCULO et al., 2009a; VENDRUSCULO et al., 2009b)

arose from the need of State and municipal governments, to manage geo-referenced information on the processes of environmental licensing. The application was built up on a Web platform, and most of its functionalities are from Web Mapping. So it allows the government to perform the monitoring of all the environmental licensing process. This process includes from the analysis of the surroundings of the requestor undertaking, made the owners and consultants, until the support to decision-making for the granting or rejection of the process, done by the controllers.

SISLA was generated as one of the results of Project "Geo-referenced Information System as a support for decision-making – Case study Mato Grosso do Sul State" (Project GeoMS), an agreement between *Embrapa Informática Agropecuária* and the Governement of Mato Grosso do Sul State. The main functionalities of SISLA described in this paper are: analysis and report of the surroundings of the undertaking; cadastre and management of processes and its respective maps; technical analysis of processes; spatial consultation to processes and registered licensing. SISLA can still be integrated to general systems of

v. 36, Número Especial jun. 2011

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
Lourenço, F. V. / Cezar, V. M.

59

process management already implanted in States or municipalities. So, for environmental licensing processes, the databank of SISLA will be charged to store only geo-referenced data (vector and matrix data), while the other information about the processes, as well as its flow and emitted opinions will stay under the responsibility of the State or municipal system. In this case the communication between the systems occurs via Web Services.

Besides all the functionalities and Web Services for integration, SISLA also got an Interface for the availability of static themes such as satellite images, height data, hydrographic networks, maps of vegetation cover, conservation units, among others. These themes were obtained from public repositories, such as the *Instituto Brasileiro de Geografia e Estatística (IBGE)* [Brazilian Institute for Geography and Statistics], and from field surveys and geo-processing activities done in the frame of Project GeoMS. Some of these themes are periodically updated, such as the images from the NDVI (Normalized Difference Vegetation Index, ROUSE et al., 1973), extracted from products of MODIS (Moderate Resolution Imaging Spectrometer) made available free by LP-DAAC/NASA (Land Processes Distributed Active Archive Center/National Aeronautics and Space Administration). In order to do that, methods for the automatic processing of these images were developed, made available every 16 days and afterwards published in SISLA, according to the description in this paper. NDVI is the most widely vegetation index used and it presents a high correlation with biomass and the foliar area of vegetation (DEFRIES; TOWNSHEND, 1994; PRICE, 1993; JUSTICE; HIERNAUX, 1986). As for the environmental licensing, NDVI can provide information about the biomass condition in the vicinity of the undertaking and also be a reference to control the vegetation suppression in the entire State.

OBJECTIVES

The objective of this study is to describe the functionalities developed for the Interactive System for Environmental Licensing Support – SISLA, aiming to obtain a complete system for the management of environmental licensing processes focused in geo-technologies and able to be integrated to management systems of State and municipal processes. This work also describes automatic methodologies to obtain and process NDVI/MODIS images, updated every 16 days at SISLA.

MATERIAL AND METHODS

SISLA uses as a base the software i3Geo, a tool with free code for the access and integration of geographic data by Web, developed by the Ministry for Environment (MMA). With the inclusion of several free computer tools in an unique interface (MapServer, PostgreSQL/PostGIS, PHP, JavaScript), the tool permits the visualization and analysis of geographic data, creating interactive maps. Therewith it allows the access to a set of relevant information about the environment, besides being an efficient tool for management (GOVERNO ELETRÔNICO, 2010). PostgreSQL is a manager system of databank (SGBD) relational object, developed as an open code project. Its acceptance broadened to international companies, government agencies of several countries and universities with global prestige. PostgreSQL has a free code spatial extension, called PostGIS, which allows that geographic vector objects are stored in databanks. This extension supports functions for the basis analysis and processing of these objects. MapServer is an open code platform for the publication of spatial data and maps for the Web. Its function is to serve as an environment for the development of spatial applications for the Internet, focused on the presentation of data for the user.

Literature shows that the use of specialized software to attend similar needs as the one developed in this work are increasing in the last years. At Medeiros et al. (2010) the i3Geo was used for the development of a GIS to integrate social-economic and cartographic data of Ceará State in the Internet. IPEA (2010) used the available integrates social-economic information from Brazilian municipalities. Maia & Peixoto (2007) used GIS for environmental licensing of rural properties in the Federal District.

Besides i3Geo and the described tools, we used routines of module PHPMapScript which has functions and classes MapScript originated from MapServer in an development environment in PHP. These routines together with functions which execute geographic operations of PostGIS, such as intersection and distance calculus, were used at most operations with maps made dynamically by SISLA. All operations which involve geo-referenced consultation at SISLA were developed, using the technique of the least surrounding rectangle (ARAÚJO et al., 2009; VENDRUSCULO et al., 2009c), which optimize such consultations, reducing the computational cost.

The data base used for tests of the SISLA functionalities refers to environmental licensing processes of forest activities in Mato Grosso do Sul State, in the years 2008, 2009 and 2010. The distribution of referenced undertakings in the processes occurs at the entire State, and most of them are localized at the Upper Paraguay river basin (approximately 58% of the total). Figure 1 shows the coverage area of the properties, where the undertakings are localized.
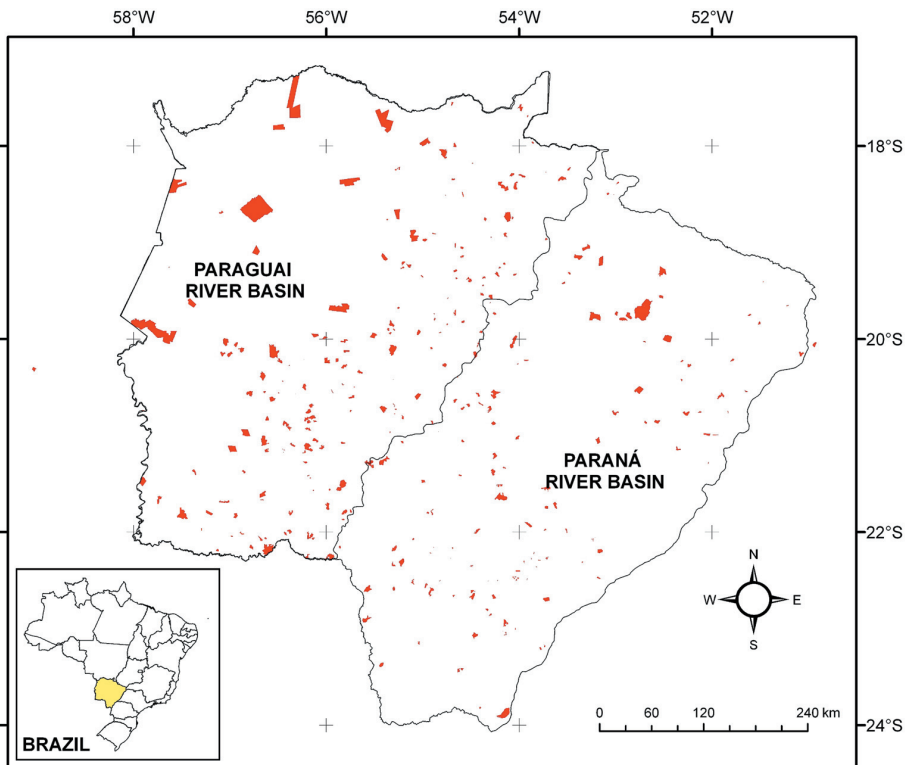
Figure 1 - Properties with environmental licensing ventures applicants - State of Mato Grosso do Sul

v. 36, Número Especial jun. 2011

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
Lourenço, F. V. / Cezar, V. M.   61

The analysis module and the report from the surroundings of the undertaking, of open public access, allows the consultants and the owners to verify the adequacy of the area from its property related to a possible intersection or proximity to areas protected by government, almost instantaneously. In order to do that, they must upload the files containing the geo-referenced vector information of the property, as well to inform the geographic projection and datum used. SISLA uses as a standard for vector data the shape file format, and allows only the uploading of this file type. After the geographic data from the property are stored in the memory, the system returns to the consultant or owner a report containing all intersection information and the distance to the protected areas.

The module for cadastre and management of processes, with restricted access, allows the cadastre of common property data, such as identification of the owner for fiscal use (CPF or CNPJ), address, name of the property, etc. and also the inclusion of geo-referenced maps in databanks with spatial extension. Before inserting maps and fields, the system checks the valid values, avoiding, for instance the cadastre of maps with a wrong projection and datum.

The module of spatial queries of licensing processes, of restricted access, allows obtain consolidated data about these processes, which are made available in textual format, as graphs and maps. The actual version allows the query by process, where only search can be made, considering textual data registered, such as year of process, type of activity and municipality, and also the query by spatial relation, which informs on undertakings in the vicinity or which intercept protected areas. The module for technical help of processes, of restricted access, allows the controllers to visualize individual maps of each process, allowing its confrontation with other themes available at SISLA. According to the options chosen by the user, the system builds up dynamically a vision that contains the themes attached to the process, as well as those selected by the user for visualization. For themes that use specifically mosaics for exhibition, such as images CCD/CBERS (China-Brazil Earth Resources Satellite) and SRTM (Shutte Radar Topography Mission), a special implementation was made to recover the maps composed by them. At SISLA the CBERS and SRTM images are divided in 34 charts for both themes. Since the zooming applied when the maps of a process are loaded by this tool is of approximately 500 m in relation to the perimeter of the property, it would be interesting that only those charts are loaded of interest for each visualization, reducing the computational cost of this operation.

So each file represented in a chart is considered a part or tile of a mosaic of images to be exhibited. The list of files forming a layer can be stored in a shape file which represents, in its attributes, the reference for each image in the operational system. This methodology is called "Tileindex" and works similarly for layers of vector type (MAPSERVER, 2010).

The Gdaltindex, a program available in the Library for Abstraction of Geo-Spatial Data (GDAL) allows the construction of shape files with the Titleindex methodology for matrix images. The MapServer itself supports the visualization of matrix images through the property TILEINDEX. The result can be represented in MAP files as a layer, but primarily the MapServer examines the index and assures that only those archives are loaded which contain matrix images that superpose the actual vision. Using this methodology, the problem on the decision which charts from the image mosaic of CBERS or SRTM should be loaded for the technical analysis of a process was solved.

The integration module with State or Municipal Systems was built up after the creation of Web services, allowing applications to send and receive data using the XML[5] (Extensible Markup Language) and the standard SOAP[6] (Simple Object Access Protocol). The great advantage for the use of Web services is the dynamic and safe communication among two

---

[5] Markup language capable to describe several types of data and facilitate information sharing by Internet.

[6] Protocol for the exchange of structured information on a decentralized and distributed platform.

distinct systems, without human intervention. Besides that, it allows that systems developed in different platforms communicate among each other. The first services created for the integration module of SISLA via Web services allow already a basic integration with control systems of Municipal and State processes. These services are based on two basic operations, which are the remittance of spatial data using strings WKT[7] (Well-know text) and requirements of spatial data already in the cadastre. For the execution of these operations, the State or Municipal system must act as a Client and SISLA as Server. In the first case SISLA always verifies if the data sent are valid, while in the second case there is always the return of a link to the State or Municipal system, making available the maps required for visualization via browser.

Taking into account this architecture, the SISLA databank was responsible only for the cadastre and management of spatial data, while the State or Municipal Process Manager System is responsible to manage the non-spatial data.

In order that the analysis executed by SISLA is coherent and precise, it is always necessary to keep the database of the State or Municipality updated. In the case of NDVI/ MODIS images, the update is made every 16 days, and automatic procedures were developed to expedite the insertion of these data in SISLA. The process starts with the download of images referring to product MOD13Q1, which contains the NDVI. This product is generated from MODIS sensor data and made available every 16 days by LP-DAAC/NASA (LP-DAAC, 2010) in HDF (Hierarchical Data Format) and in sinusoidal cartographic projection. In Mato Grosso do Sul State for each date four images or tiles are acquired which recover the State, each one encompassing an area of 10 x 10 degrees of Latitude / Longitude (the tiles H12V10, H12V11, H13V10 e H13V11). However, before these images are inserted at SISLA, they undergo processing activities, which include mosaicing of images, cartographic re-projection and masking of external areas to the State. These activities are executed using routines developed in IDL (Interactive Data Language) and programs of the computer package Modis Reprojection Tools (MRTools), version 4, according to the flowchart of figure 2. Although the NDVI values may vary between -1 and 1, in practice they are situated between 0.30 and 0.95 for the MODIS sensor. Therefore the NDVI values were divided in 13 classes with spacing smaller than 0.50 and 0.90, the zone with highest occurrence of NDVI values, allowing a stronger contrast of the image and also a better differentiation among the pixels of this section. The result of the process is a classified NDVI image covering the State in the geographic projection and in GeoTIFF format.
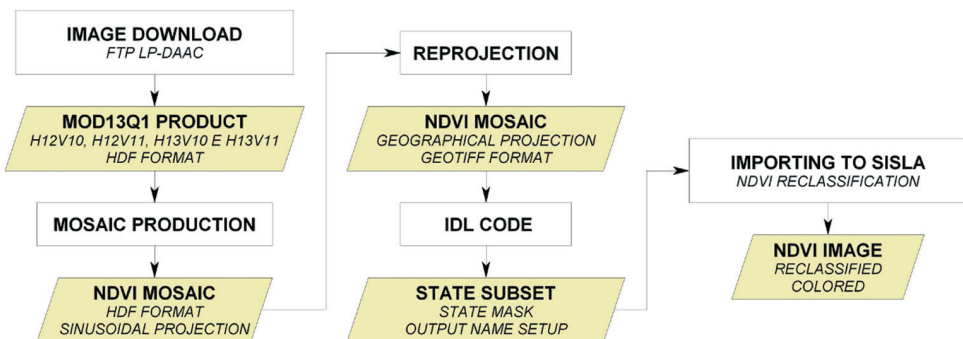
Figure 2 - Flowchart of image processing activities in NDVI/MODIS for later insertion in SISLA

---

[7] Markup language for the representation of geometric vector objects in maps, reference systems of spatial objects and transformations.

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
v. 36, Número Especial jun. 2011   Lourenço, F. V. / Cezar, V. M.   63

RESULTS

In this section some tools and its functionalities developed for SISLA are presented, as well as the result of the NDVI/MODIS image actualization process in the system.

Analysis and report of the vicinity of the undertaking

This module allows the consultant or producer to verify the correct positioning of the undertaking which will solicit the Environmental Licensing and also if it is localized in accordance with the norms required by government. In order to do that, the shape file must be uploaded, containing the areas demarcated from the undertaking or containing a geographic coordinate, if the user wants to verify just one point. Through PostGIS calculations are done referring to the distance and intersection of the undertaking informed, be it polygonal, linear or punctual (in this case just the geographic coordinate must be informed). SISLA exhibits the results of the calculations made in an informative report (Figure 3) and also creating a new theme where the user can visualize the proximities and intersections of his undertaking with the protected areas, in form of a map (Figure 4).

Unidades de Conservação, Terras Indígenas, Zonas de Amortecimento e Áreas Circundantes próximas até 15Km da Propriedade

	Nome	Distância
Unidades de Conservação encontradas		
APA_MUN_CORREGO_DO_SITIO	APTAP - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	6,021Km
APA_MUN_CORREGO_DO_SITIO	APTAP (3) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	6,049Km
APA_MUN_CORREGO_DO_SITIO	APTAP (2) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	6,342Km
APA_MUN_CORREGO_DO_SITIO	APTAP (4) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	8,578Km
APA_MUN_CORREGO_DO_SITIO	APSV (2) - Área do Projeto de Supressão Vegetal	8,637Km
APA_MUN_CORREGO_DO_SITIO	APQC - Área do Laudo ou Projeto para Queima Controlada	8,760Km
APA_MUN_CORREGO_DO_SITIO	APSV - Área do Projeto de Supressão Vegetal	8,815Km
Terras Indígenas encontradas		
Nada Encontrado		
Zonas de Amortecimento encontradas		
Nada Encontrado		
Áreas Circundantes encontradas		
Nada Encontrado		

Biomas presentes na Propriedade

	Nome	Presente
Biomas encontrados		
CERRADO	APQC - Área do Laudo ou Projeto para Queima Controlada	Presente
CERRADO	APSV - Área do Projeto de Supressão Vegetal	Presente
CERRADO	APSV (2) - Área do Projeto de Supressão Vegetal	Presente
CERRADO	APTAP - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	Presente
CERRADO	APTAP (2) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	Presente
CERRADO	APTAP (3) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	Presente
CERRADO	APTAP (4) - Área do Projeto para Termo de Averbação Provisória de Reserva Legal	Presente

Figure 3 - Part of the report generated by SISLA, showing protected areas near the new development and biomes present on the property
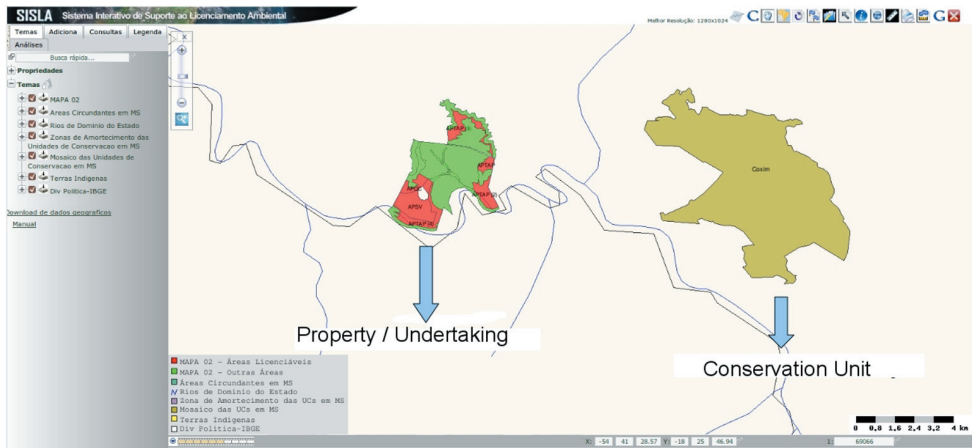
**Figure 4 – Map generated by SISLA showing a new development areas
and protected areas close to him**

Cadastre and process management

The actual version of SISLA allows to cadastre only the processes referring to forest activities, present in the case study of Mato Grosso do Sul State. The differential of this interface is the possibility of cadastre and update of shape files containing the geo-referenced mapping of the property from the requestor of environmental licensing. If the Web services for integration with local systems are used, this interface should not be used, and so SISLA receives these maps through these services. Figure 5 shows an example of interface for cadastre of forest processes.

Figure 5 – Interface registration process for forestry

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
Lourenço, F. V. / Cezar, V. M.

v. 36, Número Especial jun. 2011   65

Technical analysis of Licensing Processes

This tool allows the user to visualize all maps annexed to an environmental licensing process, and can be used in different moments of technical analysis done by the State or Municipal controllers, according to its need. Figure 6 shows some options available for the user, after selecting a process to be visualized.

Figure 6 – Technical Analysis Tool Options

Through this interface the user can inform himself/herself if he/she wants to exhibit or not the map corresponding to the perimeter of the property without the background color, besides exhibiting or not the legend directly in the map, and showing the map from other areas within the property, using colors which can be determined.

Besides that, the user can choose any theme available in the SISLA, so it can be visualized jointly with the maps of the undertaking. Figure 7 shows maps of a regularization process of a Legal Reserve, exhibited jointly with CBERS images from the region.

In this image all classes – except APCRH – were drawn without color, so that the CBERS image can be observed in the background.
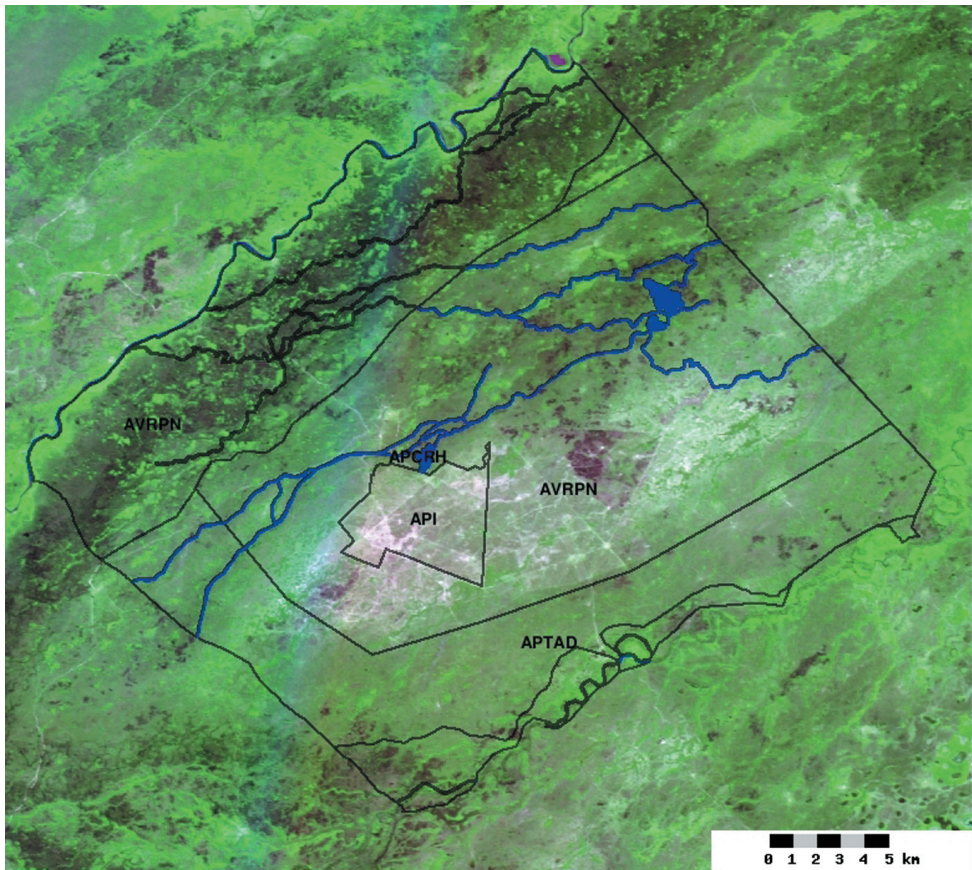
Figure 7 – Map showing areas of the property requesting to regularize the legal reserve: API (Area with Implanted Pasture); AVRPN (Grassland Vegetation Area with Native Pasture); APCRH (Preservation Area bordering on Natural Resources and Water); APTAD (Project Area for Legal Reserve Definitive Acceptance)

v. 36, Número Especial jun. 2011

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
Lourenço, F. V. / Cezar, V. M.

67

Figure 8 exhibits the areas of an environmental licensing process also jointly with CBERS images, where one can compare for instance, part of the area delimited as of Permanent Preservation confronting with water resource (APCRH), in blue, with the course of a river exhibited at the CBERS image.
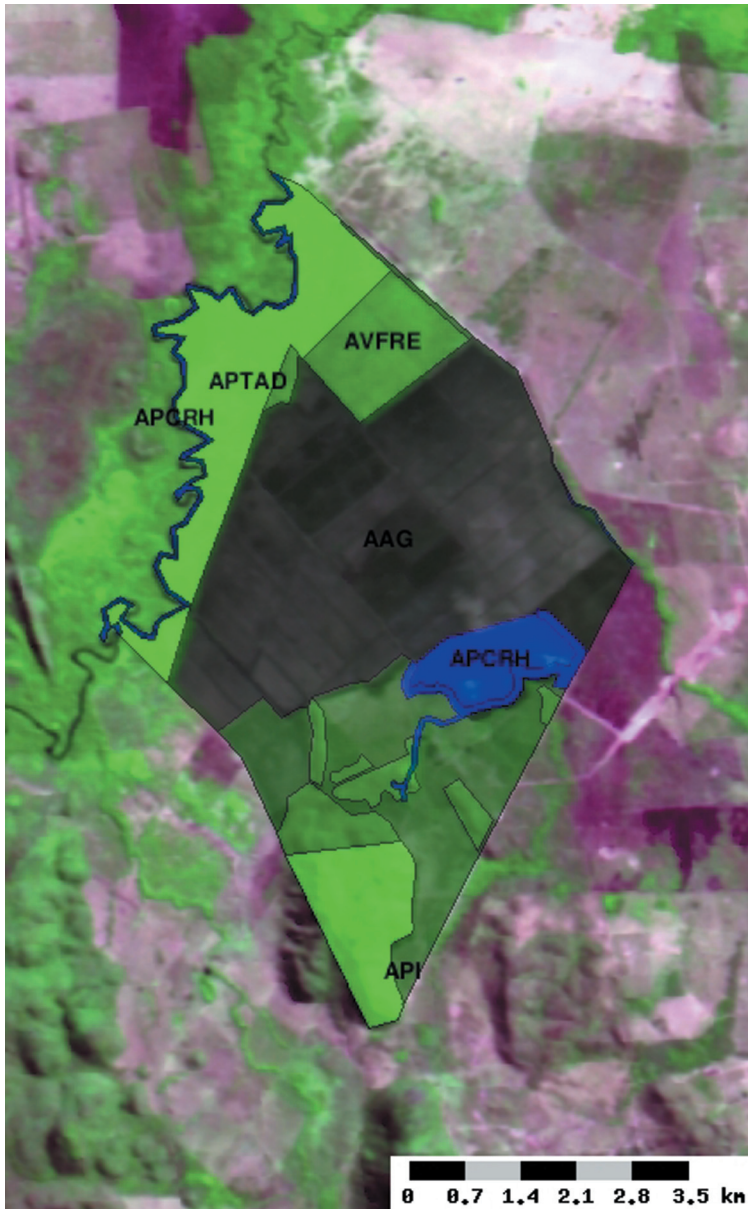

Figure 8 – Maps of the licencing processing - Comparison with CBERS image

Besides that, this tool allows even if only visually, an analysis of intersection areas. Figure 9, for instance, which shows a process of Vegetation suppression and at the background the Vegetation Map of Mato Grosso do Sul State, allows to verify that class APSV (demarcated by the red contour), that corresponds to the project area with Vegetation Suppression, is intercepting totally an area of vegetation from Enclave type.
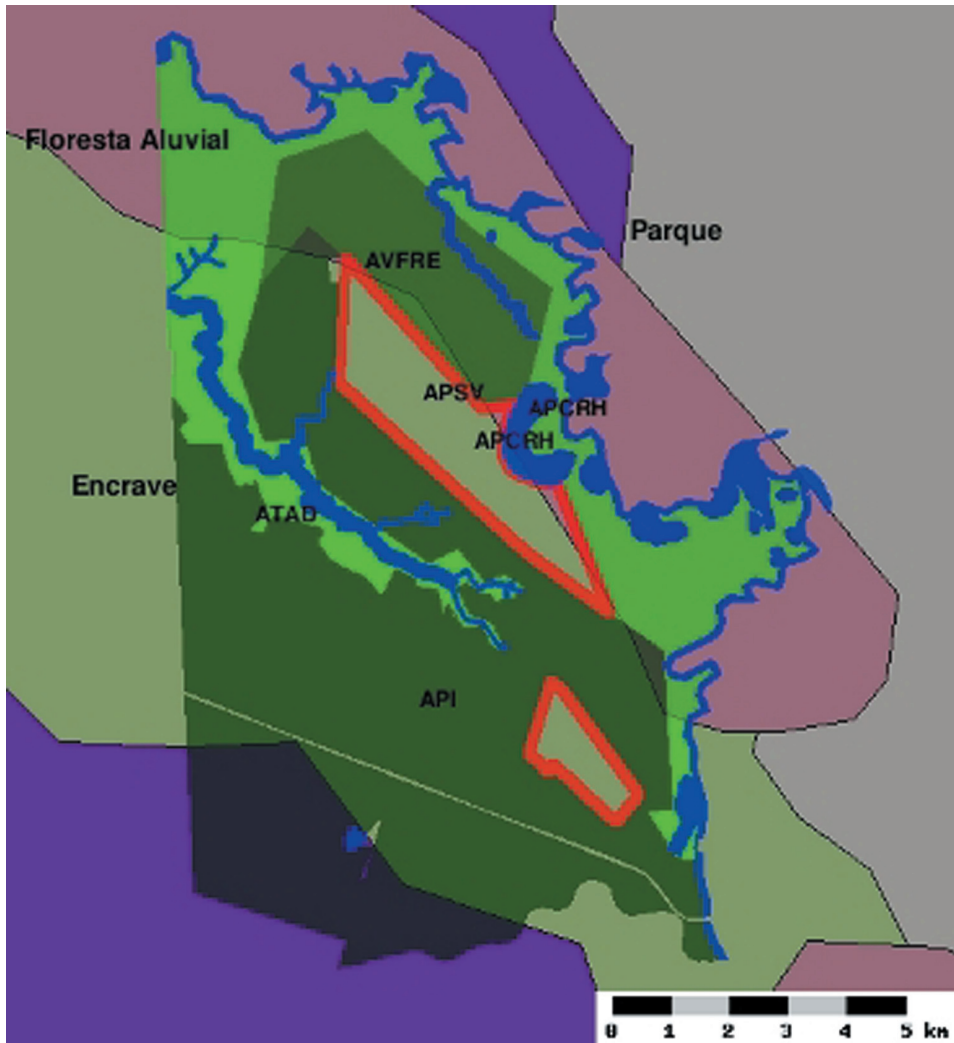

Figure 9 – Removal Process Plant and Vegetation Map

This observation can be an alert for the controller who is analyzing the process, to verify if there are incompatibilities between the local vegetation and the type of licensing project solicited.

v. 36, Número Especial jun. 2011

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
Lourenço, F. V. / Cezar, V. M.

69

Spatial consultations

The spatial consultations by process, allows the user to select different fields to limit the search at the databank, such as: process code, year of process, type of activity, river basin, sub-basin and municipalities. After the search, those undertakings found in accordance with the parameters chosen, are listed in a consultation guide, with zoom options and a report for each one of them, whereby the first option approaches the map to the corresponding area of the process and the second option exhibits textual data in cadastre for the process (Figure 10).
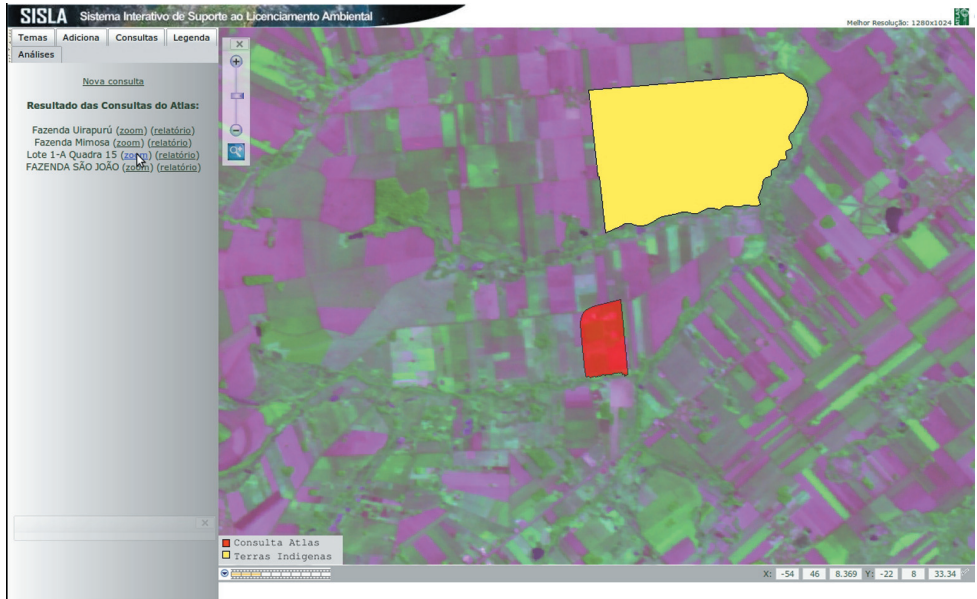
**Figure 10 – Search for environmental licensing processes relating to the
settlement of legal reserves in 2009**

The search for a special relation is done similarly, but it takes into account the proximity of the area from the surrounding of the undertakings related to the protected areas by government.

Special consultation can still exhibit consolidated data and comparative graphics among municipalities involved in the query.

Upgrade of NDVI/MODIS images in SISLA

Presently at SISLA NDVI/MODIS images for the period of January 2009 until the most recent date, made available by LP-DAAC. Figure 11 illustrates the screen of SISLA with the NDVI image referring to the first maximum composition of the year 2009, between Jan. 1st and 16th .At the lower left corner the legend is shown with the NDVI classes defined for exhibition. Higher NDVI values have greenish color, while lower values have reddish color. This color scale is not usual in maps with vegetation indexes, but it was chosen because it is more intuitive to the common user, relating green colors to the presence of vegetation and red colors to bare soil or low biomass.

Figure 11 – NDVI Image – First maximum composition 2009 – 01-16 January

Speranza, E. A. / Esquerdo, J. C. D. M. /
Silva, J. dos S. V. da / Antunes, J. F. G. /
v. 36, Número Especial jun. 2011   Lourenço, F. V. / Cezar, V. M.   71

In the image scale 13 classes are shown, and the first one is destined to invalid or absent values. The other classes present valid NDVI values with intervals which vary according to the bands of higher occurrence. The frequent observation of this type of product allows the user to analyze the dynamics of biomass along time. So it is an instrument to help the surveillance of vegetation suppression in the State and for the diction of agricultural expansion areas.

CONCLUSIONS

SISLA is being implanted with success in the Mato Grosso do Sul State. The module for the analysis of the vicinity from the undertaking allows the producer or consultant to execute a fast and precise analysis over the geo-referenced areas of his project. The cadastre of environmental licensing processes via Web, allowing the inclusion of maps in data banks, tends to facilitate very much the work of State or Municipal work, because it allows the rapid retrieval of them without the need of reading them by digital media. The technical analysis tool allows the recovery of several themes together with maps annexed to the process, allowing the controller to verify the truth of the information presented by the consultant or producer, besides any inconsistencies at the delimited areas. The spatial consultations provide useful information at management level, referring to the fast recovery of consolidated data.

The methodology presented is effective for the automation of processing activities and data insertion of NDVI/MODIS in SISLA. Maps containing the biomass conditions, updated every 16 days, present a potential for the temporal analysis of vegetation, whether natural or not, and it could also help in the environmental licensing processes and monitoring of the vegetation cover.

REFERENCES

ARAÚJO, L.B.; NAGLIATI, M.M.; VENDRUSCULO, L.G.; SILVA, J.S.V. Sistema de busca avançada de dados espaciais voltados ao licenciamento ambiental do Mato Grosso do Sul. In: SIMPÓSIO DE GEOTECNOLOGIAS NO PANTANAL, 2., 2009, Corumbá-MS. **Anais...** Campinas: Embrapa Informática Agropecuária, 2009, p.62-70.

DEFRIES, R. S.; TOWNSHEND, J. R. G. NDVI-derived land cover classifications at a global scale. **International Journal of Remote Sensing**, v.15, n.17, p.3567-3586, 1994.

GOVERNO ELETRÔNICO. **Governo disponibiliza solução para acesso e integração de dados geográficos.** Available at: <http://www.governoeletronico.gov.br/noticias-e-eventos/ noticias/governo-disponibiliza-solucao-para-acesso-e-integracao-de-dados-geograficos>. Access in: 21 jul. 2010.

IPEA. **Instituto de Pesquisa Econômica Aplicada – IPEA Mapas**. Available at: <http:// mapas.ipea.gov.br>. Access in: 20 ago. 2010.

JUSTICE, C.O.; HIERNAUX, P.H.Y. Monitoring the grasslands of the Sahel using NOAA AVHRR data: Niger, 1983. **International Journal of Remote Sensing**, v.7, n.11, p.1475-1498, 1986.

LP-DAAC. **Land Processes Distributed Active Archive Center - MODIS Data Pool Holdings**. Available at: <https://lpdaac.usgs.gov/lpdaac/get_data/data_pool>. Access in 10. nov. 2010.

MAIA, M.L.; PEIXOTO, J.V.B. **O uso do SIG no Licenciamento Ambiental das Propriedades Rurais do DF**. 2007. 40f. Trabalho de Conclusão de Curso (Obtenção do grau de Especialista em Geoprocessamento) Instituto de Geociências, Universidade de Brasília, Brasília-DF, 2007.

MAPSERVER. **MapServer 5.6.5 Documentation**. Available at: <http://www.mapserver.org>. Access in June 30th 2010.

MEDEIROS, C.N.; ARAGÃO, M.C.A.; GOMES, D.D.M. **Disponibilização e Análise de Informações Georreferenciadas utilizando um Sig-Web**. Fortaleza: IPECE, 2010. 27p. (Série Textos para discussão do Instituto de Pesquisa e Estratégia Econômica do Ceará / No. 78).

MITCHELL, T. **Web Mapping Ilustrated**. Sebastopol: O' Reilly Media, 2005. 367p.

PNLA. **Portal Nacional do Licenciamento Ambiental – Ministério do Meio Ambiente**. Available at: <http://www.mma.gov.br/index.php?ido=conteudo.monta&idEstrutura=46>. Access in: July 29th 2010.

PRICE, J.C. Estimating leaf area index from satellite data. **IEEE Transactions on Geoscience and Remote Sensing**, v.31, p.727–734, 1993.

VENDRUSCULO, L. G.; OLIVEIRA, S. R. de M; SILVA, J.S.V. ; BERNARDINO, J. ; COPATTI, A. SISLA - Um sistema web de mapas interativos para auxiliar o licenciamento ambiental. In: SEMANA DE INFORMÁTICA, GEOTECNOLOGIAS E ENCONTRO DE SOFTWARE LIVRE (SIGES) , 5., 2008, Santarém-PA. **Anais...** Santarém: Laboratório de Biosfera e Atmosfera, 2008.

VENDRUSCULO, L. G.; OLIVEIRA, S. R. de M; SILVA, J.S.V. **Tecnologia Web para suporte ao licenciamento ambiental**. Campinas: Embrapa Informática Agropecuária, 2009a (Technical Communication).

VENDRUSCULO, L. G.; SILVA, J. S. V.; ARAÚJO, L. B.; OLIVEIRA, S. R. de M; COPATTI, A. Uso da técnica de Web Mapping para disseminação de dados ambientais com enfoque no licenciamento ambiental In: OCTAVA CONFERENCIA IBEROAMERICANA EN SISTEMAS, CIBERNÉTICA E INFORMÁTICA (CISCI), 2009, Orlando, FL, 10 a 13 de julho de 2009**. Anais...** Orlando: International Institute of Informatics and Systemics, 2009b. p. 141-146.

VENDRUSCULO, L. G. ; ARAÚJO, L. B. ; NAGLIATI, M. M. ; SILVA, J. dos S.V. Sistema de Busca Avançada de dados espaciais voltados ao licenciamento ambiental do Estado do Mato Grosso do Sul. **Geografia**, Rio Claro, v. 34, Número especial, p. 769-782, 2009c.