



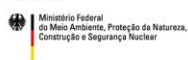
**BRAZILIAN-GERMAN COOPERATION PROJECT**  
**“PREVENTION, CONTROL AND MONITORING OF BUSHFIRES IN THE CERRADO”**

**INTEGRATED FIRE MANAGEMENT PROGRAM**

**Report 2015**

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Por ordem do



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## 1 INTRODUCTION

The Brazilian-German Cooperation Project “*Prevention, Control and Monitoring of Bushfires in the Cerrado*” has been developing Integrated Fire Management (IFM) strategies to achieve land use objectives, reduce greenhouse gas (GHG) emissions, protect biodiversity and enhance community livelihoods in the Brazilian Cerrado.

In 2013, the Project carried out several events, including national and international seminars, to introduce the principles and concepts of IFM and how these may contribute to strengthen protected area and selected municipality (Tocantins) fire management in Brazil.

In 2014, the Project supported IFM Program implementation in three pilot Conservation Units (CU): *Estação Ecológica Serra Geral do Tocantins*, *Parque Estadual do Jalapão do Tocantins* and *Parque Nacional Chapada das Mesas do Maranhão*. The focus of these Programs was to plan, implement and monitor controlled early dry season burning to reduce large-scale late dry season wildfire impacts and facilitate collaborative partnerships with local communities in, and around, CUs.

A multi-disciplinary team of Project partners, international consultants and GIZ technical advisors evaluated the performance and results of the IFM Programs in late 2014. Refer to the following Project Reports for further information: *Pilot IFM Program Planning and Implementation Report* (321Fire, 2014), *Pilot IFM Program Evaluation Report* (321Fire, 2014), *Relatório técnico das atividades realizadas durante o Programa Piloto de MIF 2014* (Moura, 2014) and *Monitoring deforestation, biomass estimation, vegetation type mapping and estimation of GHG emissions to support Integrated Fire Management in the Cerrado* (RSS & ZEBRIS, 2014).

During a workshop in November 2014 Project partners developed recommendations for IFM implementation in 2015 that form the basis of this consultancy:

1. Consolidate and extend IFM activities in two of the existing pilot areas from 2014 - *Parque Estadual do Jalapão* (PEJ) and *Estação Ecológica Serra Geral do Tocantins* (ESEC)
2. Extend IFM planning, implementation and evaluation to four new pilot areas: “*Terra Indígena Xerente* (TIX), *Parque Nacional Sempre Vivas* (PNSV), *Parque Nacional Araguaia* (PNA) and *Área de Proteção Ambiental do Jalapão* (APA)
3. Capacity build park managers, brigadistas, local government institution partners and other key stakeholders in the concept and technical skills of IFM.

This Report i) outlines IFM Program components and achievements of 2014; ii) summarizes the main findings and achievements in 2015; and iii) provides recommendations for the IFM Program in 2016.

## 2 INTEGRATED FIRE MANAGEMENT PROGRAM

Considerable fire management expertise and capacity exists in the Cerrado and many IFM elements are well established within existing fire management frameworks. Institutional approaches and interagency cooperation in Prevention and Education (Risk Reduction), Preparedness (Readiness) and Suppression (Response) have been the fire management focus over recent decades.

A central focus of the IFM Program is to further develop the **Key IFM elements** not yet widely recognized or institutionalized within existing fire management framework, involving:

- Controlled Fire Management - the strategic implementation of controlled burning in the early dry season to reduce fire intensity, reduce the area burnt annually and minimize uncontrolled large-scale fires.
- Community-Based Fire Management (CBFiM) - a collaborative IFM approach to promote and develop fire management capacity and responsibility amongst communities to improve land use objectives and community livelihoods.

IFM is an adaptive process and the IFM Program utilizes an adaptive management framework structured on an annual cycle of planning, implementation, monitoring and evaluation.

## **2.1 IFM PLANNING**

IFM Planning Activities are carried out in March/April and consist of:

1. Field Survey and Desktop Analysis of relevant documents and remotely sensed information to familiarize with existing scenarios and assess key fire management determinants
2. Key Stakeholder Consultations to review and plan fire management objectives, assess existing capacity / resources and determine IFM implementation
3. IFM Program Development to illustrate the analysis process, using the above information, to identify fixed Fire Management Zones (FMZ) and develop IFM plans.

## **2.2 IFM IMPLEMENTATION**

IFM Implementation Activities are carried out between April and July, including:

1. Controlled Fire Management
  - i) To introduce and demonstrate various techniques to implement efficient controlled burning of low intensity self-limiting fires in the early dry season
  - ii) To illustrate the benefits of low intensity controlled burning in reducing uncontrolled fire hazard, improving ecosystem function and habitat / biodiversity management.
2. Community-Based Fire Management
  - i) To introduce and demonstrate methods of community engagement and implementation of IFM approaches that improve community land use objectives / livelihoods
  - ii) To support community fire management responsibility / decision-making and integrate livelihood objectives with CU management through collaborative IFM approaches
3. Landscape Scale Fire Management to develop conceptual and operational understanding of applying these key IFM elements at landscape scales to achieve CU management objectives, reduce GHG emissions and support community livelihoods.

## **2.3 IFM MONITORING**

IFM Monitoring is conducted throughout year involving a multi-disciplinary approach, incorporating:

1. Operational Monitoring to assess the effectiveness of controlled burning in achieving CU management objectives and to ensure self-limiting fires were achieved
2. Key Stakeholder Consultation at strategic intervals to gauge IFM understanding and support by resident and neighboring communities, partner organizations and local level partners
3. Remotely Sensed information to support IFM Programs with active fire detections, estimates of fuel load, burned area, fire intensity, biomass burned and GHG emissions
4. Research to monitor ecological responses to applied fire regimes and validate remotely sensed fire information.

## 2.4 IFM EVALUATION

IFM Evaluation is carried out in November involving a multi-disciplinary team to assess results and implementation experiences and develop recommendations for future implementation, including:

1. Field Assessment of burnt areas (controlled / uncontrolled fires) in conjunction with remotely sensed information to characterize effects of fire intensity (early vs late dry season)
2. Fire Season Evaluation with key stakeholders including members of CU fire brigades, resident communities and local level partners
3. Evaluation Workshop with CU Management, Project partners and key stakeholders to share experiences, systematize results and develop recommendations to adapt and improve the IFM Program in the following year.

## 3 PROGRAM OBJECTIVES 2015

In 2015, the second year of implementation, the objectives of the IFM Program in the six pilot areas, were to:

- i) Introduce, demonstrate and strengthen understanding of the principles and techniques of Controlled Fire Management and CBFiM not yet widely recognized or institutionalized
- ii) Develop conceptual and operational understanding of applying these at landscape scales to achieve CU / biodiversity management, reduce GHG emissions and improve community livelihoods
- iii) Facilitate incorporation of key IFM elements into existing fire management frameworks through participatory and collaborative approaches with Project partners and key stakeholders.

## 4 MAIN FINDINGS and RECOMMENDATIONS

Main findings of the IFM Program in 2015 and recommendations for 2016 are presented in the following sections i) Integrated Fire Management Teams; ii) Controlled Fire Management and CBFiM; iii) Landscape Scale Application; and iv) Institutionalization. They are drawn upon the collective results and experiences of all pilot areas in 2014 and 2015.

### 4.1 INTEGRATED FIRE MANAGEMENT TEAMS

In 2015, the IFM Teams in each pilot area comprised a combination of CU managers and key staff, fire brigades and IFM agents. They coordinated and implemented activities with considerably greater confidence and enthusiasm integrating the skills and knowledge of diverse role players in IFM planning, implementation, monitoring and evaluating.

Operational IFM skills and knowledge, particularly controlled burning, takes years to develop and requires considerable responsibility and leadership. Training and support of IFM Teams in 2015 consisted of '*On the Job Training*' to develop personal experience in IFM principles and techniques.

#### 4.1.1 Managers and Key Staff

CU managers and key staff were responsible for the overall coordination of the IFM Program in each pilot area. Sound understanding of the key IFM Program components was developed through personal experience, exchange visits between pilot areas and inter-institutional sharing of experiences from 2014.

The managers and key staff coordinated IFM activities throughout the annual cycle of 2015 with considerably strengthened confidence and capacity. Of particular note are the participatory and collaborative approaches employed to ensure time and resources were available to integrate and skills and knowledge of the IFM Teams.

IFM information collection, input and organization including field-based ecological, fire and community mapping, as well as, remotely sensed land and fire information is a challenge in many pilot areas.

IFM monitoring improved in 2015, such as Burned Area products derived from Landsat 8 satellite imagery, however, remains insufficient to accurately represent fire history, management scenarios and effects on ecological and socio-economic values.

Organization, accessibility and presentation of IFM Planning information and its dissemination to key stakeholders, communities and local level partner organizations continue to be limited.

### Recommendations

#### *Operational IFM Training Courses*

- *Develop long-term operational IFM training courses in combination with IFM Program expansion into new areas in future years*
- *Design course 'On the Job Training' modules based on the annual cycle of IFM planning, implementation, monitoring and evaluation*
- *Design a three tier course structure (ie IFM Implementation Level / Year 1, 2 and 3) based on years of participation*
- *Offer course modules (1-2 weeks) independently and/or sequentially to complete a 3 Year course*
- *Deliver courses continuously for three years in each 'IFM Training Area' (new CU and protected area categories) to offer three levels of each module*
- *Deliver courses in numerous 'IFM Training Areas' concurrently.*

#### **4.1.2 Fire Brigades**

Fire brigades represent the operational arm of CU fire management and carried out IFM Program planning, implementation and monitoring activities with enthusiasm and confidence.

As a CBFiM initiative the IFM Program increased incorporation of resident and neighboring community members into the fire brigades of the pilot areas in 2015. This facilitated integration of local knowledge including landscape and weather, as well as, resident community land use, traditional fire management and livelihood challenges.

Fire brigades were typically contracted in May and consequently did not participate in the IFM Planning process (March/April) of many pilot areas in 2015. It is important brigadistas understand the annual IFM cycle and advantages of the key IFM principles and techniques provide to conventional prevention and suppression activities.

Operational field-based use of IFM information was not consistently available or effectively distributed to fire brigades at strategic intervals throughout 2015. This included remotely sensed fire data (active fire detections and burned area products), relevant weather forecasts and field-based information. Consequently, operational field-based navigation was typically limited to the knowledge of a few experienced individuals in each pilot area.

### Recommendations

- *Continue increasing incorporation of resident and neighboring community brigadistas in the regular CU fire brigade*
- *Explore further opportunities to contract brigadistas in March / April to include in IFM planning*
- *Strengthen collaborative management mechanisms with partner institutions and equipment / resource sharing agreements between fire brigades at the municipality level.*
- *Explore further opportunities to hire brigadistas in consecutive years*

#### **4.1.3 IFM Agents**

IFM agents were introduced into the IFM Program as small operational units to support CU managers, key staff and fire brigades to plan, implement and monitor IFM activities in 2015. They comprised of accomplished individuals, from resident and neighboring communities, with 5-10 years existing land / fire management experience in the region. IFM agents were established in selected pilot areas to enable:

- Contracting of operational field staff for participation in the complete annual IFM cycle (March – October)
- IFM planning and implementation of controlled burning in March / April, the transition period between wet and dry seasons
- Enable hiring of individuals in consecutive years based on merit for IFM skills and knowledge continuity.

Support to collaborative CBFiM planning and implementation with resident communities, together with broader community awareness of IFM experiences, were important roles of the IFM agents.

The IFM agents significantly contributed to the achievements of the IFM Program in 2015 and demonstrated the benefits of different hiring, structure and logistics of operational fire management staff / brigadistas.

### Recommendations

- *Continue hiring existing IFM agents in 2016 based on merit for IFM skills and knowledge continuity*
- *Explore opportunities to establish IFM agents as formal positions in each CU to plan, implement and monitor IFM activities.*
- *Establish IFM agents in all CUs and protected areas implementing IFM activities in 2016*

#### **4.1.4 Resources and Equipment**

Resources and equipment in the form of vehicles, personal protective equipment (PPE), fire management equipment, communication and navigation system availability significantly improved in 2015.

Many areas of the pilot areas are inaccessible by 4WD vehicles and limit implementation of controlled burning in landscape / fuel load scenarios during optimal 'windows of opportunity'. In 2015, motorbikes and quad bikes were introduced into the IFM Program with great effect significantly improving landscape scale implementation of strategic controlled burning.

Several drip torches (Pinga Fogo) designed for landscape scale controlled burning operations were introduced in 2015 to demonstrate safer and more efficient controlled burning techniques. Matches and lighters are cost-effective spot burning equipment and widespread use commenced in 2015.

Field-based navigation systems, in the form of Android OS cellular phones with GPS and open source GIS application (PDFMaps - <https://www.pdf-maps.com/>, Google Play Store), were supplied to CU managers, IFM agents and fire brigade chiefs in 2015. Other IFM team members used personal cellular phones to view operational maps and updated monitoring information. These devices also served as communication and significantly contributed to IFM Program achievements in 2015 (see Section 3.2.3).

Field communications with existing handheld VHF radios were essential to implementation and activities. Several license free VHF radios of limited range were supplied in 2015 and were proved effective for safe implementation of implementation activities in remote areas. They are inexpensive and readily available providing a short-term solution in the absence of broad scale VHF networks throughout CUs.

Equipment and resources to support resident communities in collaborative CBFiM implementation remained limited in 2015.

#### Recommendations

- *Procure drip torches (Pinga Fogo) designed for landscape scale controlled burning*
- *Procure motorbikes and quad bikes for use by IFM agents and brigade chiefs for controlled burning access of remote areas*
- *Explore opportunities to introduce aerial burning operations in 2016 to access remote areas of large CUs*
- *Procure Android OS Cellular Phones with GPS for CU managers, IFM agents and fire brigade chiefs and other key operational fire management staff in 2016*
- *Procure license free VHF radios for communication during for relatively small-scale implementation activities*
- *Further develop IFM resource and equipment sharing agreements amongst key fire management institutions in preparation for IFM implementation in 2016.*

## **4.2 CONTROLLED FIRE MANAGEMENT AND CBFiM**

Understanding of the key principles and techniques of Controlled Fire Management and Community-Based Fire Management were introduced and demonstrated in the new pilot areas and strengthened in the existing areas.

### **4.2.1 Controlled Fire Management**

In **2014**, the IFM Program introduced and demonstrated strategic implementation of controlled burning in the early dry season to reduce fire intensity, burned area and uncontrolled large-scale fires in three pilot CUs. The main achievements involved:

- i) Establishing controlled burning decision-making capabilities (when, where and how) of CU managers, key staff and fire brigades to implement self-limiting low intensity fires
- ii) Developing further understanding of fire seasonality (early vs late dry season), behavior (intensity) and effects in various vegetation types, fuel loads and landscapes



- iii) Demonstrating controlled burning benefits on CU fire management objectives, biodiversity conservation and ecosystem function.

In **2015**, IFM Teams and institutional support staff, in both existing and new pilot areas, carried out controlled burning decision-making and implementation with significantly greater confidence and security. Factors contributing to improved capabilities were:

- Commencement of controlled burning in March / April, the transition period between wet and dry seasons
- Cool, calm and humid weather conditions enabled time and flexibility to focus on assessing fire behavior and effects
- Greater understanding in the key IFM elements combined with institutional support provided security and confidence in controlled burning strategies
- Joint implementation combining skills and knowledge of key stakeholders, CU managers and key staff, IFM agents, fire brigades, institutional staff and resident communities
- Exchange visits between pilot areas facilitated the sharing of experiences further strengthening confidence and capacity of controlled burning.

Independent implementation of controlled burning in all six pilot areas in 2015 was an important step in building confidence and sharing experiences of operational controlled fire management. Based on these achievements Project partners independently expanded IFM activities to other CUs, beyond the scope of this consultancy, including Terra Indígena Parque Araguaia do Tocantins, Parque Nacional Serra de Cipó do Minas Gerais and Territória Quilimbola Kalunga do Goiás.

Understanding and operational experiences of fuel load management through strategic implementation of controlled burning in various vegetation types, fuel loads and landscapes were considerably strengthened in 2015. Experience and knowledge in controlled burning application to achieve multiple CU management objectives was acquired, including:

- Reducing fuel loads and fire intensity
- Fragmenting fuel loads to minimize the occurrence of uncontrolled large-scale fires
- Controlling fire behavior and intensity to protect fire-sensitive vegetation, improve ecosystem function (ie water cycling) and achieve biodiversity conservation outcomes.

This represents a paradigm shift from prevention and suppression oriented '*fire protection*' management to adaptive fuel load management oriented toward '*using fire to protect*'. Factors contributing to developments were:

- Commencing IFM planning activities in March / April, the transition between wet and dry seasons, highlighting available 'windows of opportunity' for controlled burning in 2015
- Contracting IFM agents to focus on controlled burning and fuel load management operations
- Development of FMZ Controlled Burning Calendars based on optimal 'windows of opportunity' to plan and implement activities
- Availability of remotely sensed Dry Biomass / Fuel Load maps derived from recent Landsat 8 of 30m satellite imagery
- Operational use of field-based navigation and fire information systems.

Applicability of the adaptive IFM management framework was highlighted through expansion of IFM activities into various Cerrado ecosystems and landscapes not represented in 2014.

There are inherent similarities in existing fire management scenarios, issues and challenges between CUs in the Cerrado. Conversely, each area is unique and fire management requires consideration of specific local environmental and socio-economic factors. To date, the adaptive IFM Program has experience and demonstrated applicability in:

- The campo (limpo, sujo and ralo) ecosystems of the Jalapão Region - Estação Ecológica Serra Geral, Parque Estadual do Jalapão and Área de Proteção Ambiental do Jalapão do Tocantins and Parque Nacional Chapada das Mesas do Maranhão
- The mountainous cerrado ecosystem of the Serra do Espinhaço Meridional Region, a transition zone (ecotone) between the Cerrado and Mata Atlântica Biomes - Parque Nacional Sempre Vivas and Parque Nacional Serra de Cipó do Minas Gerais
- The fluvial ecosystem of Ilha da Bananal, a transition zone (ecotone) between the Cerrado and Amazon Biomes - Parque Nacional do Araguaia and Terra Indígena Parque Araguaia do Tocantins
- The cerrado *sensu stricto* and cerradão ecosystems - Terra Indígena Xerente do Tocantins and the Vão do Paranã Region - Territória Quilimbola Kalunga do Goiás

#### Recommendations

- *Continue IFM Program commencement in March / April 2016*
- *Refine CU controlled burning objectives to protect fire-sensitive vegetation, improve ecosystem function (ie water cycling) and achieve biodiversity conservation outcomes*
- *Acquire Fuel Load Maps for 2016 and develop FMZ Controlled Burning Calendars based on optimal 'windows of opportunity' to plan and implement activities*
- *Encourage and support IFM Teams to increase independent implementation of controlled burning in the wet and early dry seasons*
- *Expand the IFM Program into new CUs and other protected area categories targeting Cerrado ecosystems and landscapes not represented in 2014 or 2015.*

#### **4.2.2 Community-Based Fire Management**

In **2014**, CBFiM approaches to promote and develop community fire management capacity and responsibility were introduced and demonstrated in three pilot CUs. The main achievements involved:

- i) Engaging resident communities to develop collaborative IFM approaches at the individual/household level
- ii) Joint planning and implementation of strategic controlled burning to improve land use (ie subsistence agro-pastoral) and protect community resources
- iii) Developing further understanding of traditional fire knowledge and burning practices including benefits to both community livelihood and CU management outcomes
- iv) Incorporating locally resident (or family origin) community members into CU fire brigades to develop positive community relations.

In **2015**, these CBFiM approaches were improved and strengthened through expansion of community engagement with significantly more individuals/households residing in existing and new pilot areas. Factors contributing to developments were:

- Commencing IFM planning in March / April with joint planning of controlled burning with resident individuals/households to improve land use and protect resources

- Contracting IFM agents to focus on liaison, support and awareness of IFM experiences with resident communities
- Recognizing the value of traditional fire knowledge and burning practices to CU management objectives
- Wider understanding of key IFM elements combined with institutional support provided security and confidence in CBFIM strategies

Joint implementation of controlled burns to support community land use facilitated integration of traditional fire knowledge and burning practices with modern fire management techniques. Collaborative management demonstrated benefits to both CU Management and community livelihoods strengthening community fire management ownership, decision-making and responsibility.

Consistent throughout the pilot areas was recognition, by resident communities, of the value and benefits CU Management can provide through collaborative IFM approaches. Acceptance by resident communities is particularly important in supporting fire brigades and IFM agents, typically members of the community, in performing their duties with security and confidence. Bringing people together and transforming conflict into capacity is a pivotal role of IFM.

In 2015, versatility of the adaptive IFM management framework was highlighted through expansion of IFM activities with communities and land use practices not represented in 2014. Every community is unique and the adaptive IFM Program has experience and demonstrated applicability in the following communities and socio-economic settings:

- Quilimbola communities with subsistence and smallholder agricultural livelihoods: Parque Estadual do Jalapão, Estação Ecológica Serra Geral and Área de Proteção Ambiental do Jalapão
- Indigenous communities with subsistence livelihoods: Terra Indígena Xerente, Parque Nacional do Araguaia and Terra Indígena Parque Araguaia do Tocantins
- Non-indigenous communities with smallholder agricultural livelihoods: Parque Nacional Sempre Vivas do Minas Gerais and Parque Nacional Chapada das Mesas do Maranhão

Considerable traditional fire management knowledge exists within Cerrado communities and the IFM Program supported activities in 2015 to research and document traditional burning practices, including:

- Quilimbola and non-indigenous communities of Parque Estadual do Jalapão and Parque Nacional Chapada das Mesas do Maranhão (University of Brasília)
- Xerente and Javaés indigenous communities of Terra Indígena Xerente, Parque Nacional do Araguaia and Terra Indígena Parque Araguaia do Tocantins (Consultant: Marcelo Santana).

#### Recommendations

- *Consolidate and expand collaborative IFM approaches with individual/households using working examples of collaborative IFM approaches from 2014 and 2015*
- *Facilitate authorization mechanisms (ie Permit to Burn) to enable independent implementation of controlled burning by community individual/households*
- *Continue adaptation of existing community burning practices to predominantly low intensity fires to achieve sustainable land use and biodiversity outcomes*
- *Develop collaborative IFM mechanisms between neighboring individual/households to create 'Community IFM Areas'*

- Integrate traditional fire management knowledge and burning practices into existing fire management frameworks
- *Expand the IFM Program into CUs and other protected area categories to incorporate communities, land use and socio-economic settings not represented in 2014 or 2015.*

#### **4.2.3 Field-Based Fire Information**

In **2014**, operational use of field-based navigation systems and fire information were introduced and demonstrated in three pilot CUs. The main achievements involved:

- i) Introducing navigation systems using updated Landsat 8 30m / MODIS 250m satellite imagery, burned area, active fire and land information in the field
- ii) Using Dry biomass/fuel Load maps, analyzed from recent Landsat 8 30m images to plan and implement IFM activities, in the field
- iii) Field validating Fire Radiative Power (FRP) from active fire detections (hotspots) for GHG emission modeling
- iv) Field validating automated burned area mapping product using Landsat 8 imagery developed and piloted by INPE.

In **2015**, operational use of field-based navigation systems (Android OS cellular phone with GPS and PDFMaps App) to view maps and updated monitoring information in the field significantly contributed to the achievements of the IFM Program.

A suite of operational PDF maps were developed in ArcGIS Software and disseminated to CU managers, IFM agents, fire brigade chiefs and other IFM team members.

The maps consisted of infrastructure information (roads, tracks and settlements) and boundaries (CU and FMZs) overlaid onto Landsat 8 satellite imagery, including:

- Landscape: Landsat image captured in March - May in any recent year to display a clear background highlighting landscape features
- Fire History 2014: Landsat image captured in October/November 2014 overlaid with 2014 burned areas distinguished as early (January–July) or late dry season (August–December)
- Fuel Load 2015: Analysis of Landsat image captured in, or after, October/November 2014 to highlight dry biomass (red), forest areas (green) and bare soil (blue)
- Fire History 2015: Landsat images captured end of July and October/November 2015 overlaid with 2015 burned areas distinguished as early or late dry season.

Use of commonplace Android OS cellular phones with GPS and simple GIS software to view operational maps enabled a wide variety of key stakeholders to access this modern technology. CU managers, IFM agents and fire brigade chiefs rapidly understood the functioning and benefits of the systems to CU fire management and enabled them to:

- Navigate safely and accurately in remote areas
- Monitor and document IFM activities through GPS tagged photographs
- Document information on access, settlements, community land use and traditional fire knowledge
- Facilitate the participation of key role players in collaborative IFM activities
- Share IFM experiences with a wider audience.

Information gaps, such as inconsistent burned area products and unavailable satellite images (cloud cover), hindered interpretation of maps in some instances, particularly understanding inter-annual fire and fuel load dynamics.

The Fuel load maps analyzed from recent Landsat 8 30m images were a pioneering and resounding success amongst the IFM teams and used with great accuracy in controlled burning operations. Availability of cloud free satellite images between the end of the fire season (October/November) and the end of the wet season (March/April) is an issue in providing up to date fuel load maps. Training in the complex analysis of fuel load map production (Jonas Franke, RSS) was delivered twice to Project partners in 2015.

Updating and disseminating maps to IFM teams, key stakeholders, communities and local level partner organizations remains an issue in many pilot areas.

#### Recommendations

- *Develop an IFM Information protocol to guide CU managers and key staff to acquire information and disseminate to IFM Teams at strategic timing in 2016*
- *Develop a training video for operational use of field-based navigation systems and interpretation of map products, particularly Fuel Load Maps*
- *Continue updating, documenting and mapping resident community information on access, settlements, infrastructure, community land use and fire for each FMZ*

### **4.3 LANDSCAPE SCALE APPLICATION**

In **2014**, conceptual and operational understanding of applying Controlled Fire Management and Community-Based Fire Management at landscape scales commenced. Small-scale 'operational units' were employed to demonstrate the key IFM principles and techniques in the pilot areas, including:

- i) Natural landscape features (ie drainage patterns) for controlled burning operations
- ii) Individual or community household groups for CBFiM approaches.

Numerous 'operational units' comprise the FMZs of a CU and represent the next level of scale. Similarly, numerous FMZs constitute a CU representing the institutional scale of management in 2014.

In **2015**, the IFM Program strengthened landscape scale implementation to commence changing fire regimes at the CU level.

Implementation within the context of the broader landscape commenced through structured collaborative management between neighboring CUs.

Further development of the collaborative management model concept for effective IFM Program expansion throughout the Cerrado Biome was explored.

#### **4.3.1 Changing Fire Regimes**

The long-term IFM objective at the CU level is to shift the existing fire regime of high intensity large-scale uncontrolled wildfires to a predominantly low intensity fire regime comprising:

- i) A patchwork mosaic of burnt and unburnt patches
- ii) Smaller-scale burnt and unburnt patch sizes
- iii) A variety of 'time since last burn' classes

In **2015**, landscape scale implementation of controlled burning in the early dry season, CBFiM and wildfire suppression in the late dry season combined to:

- Increase the proportion burnt in the wet and early dry season (January – July)
- Decrease the proportion burnt in the late dry season (August – December)
- Reduce the patch size of burnt and unburnt areas (fragmenting)

Three to four years of strategic landscape scale implementation are typically required to affect fire regime change in CUs situated within the fire-prone settings of the Cerrado. Important understanding of landscape fuel load dynamics was achieved in the pilot areas in their second year of implementation (ie ESEC and PNCM). Inaccessible areas of large CUs presented limitations to landscape controlled burning during relatively short optimal ‘windows of opportunity’.

Fire trend monitoring is providing early evidence of fire regime change in these areas, through analyzing:

- Proportion burnt in the Early Dry Season vs. Late Dry Season
- The average and maximum Patch size of burnt areas
- Time Since Last Burn (TSLB) – total area in each TSLB class and proportion in each class
- Fire Frequency (FF) – total area in each FF class and proportion in each FF class.

It is anticipated in 2016 that trend monitoring will provide solid evidence the IFM Program is shifting areas to low intensity fire regimes.

#### Recommendations

- *Define realistic 3 year operational targets related to i) proportion of Early vs. Late Dry Season burned area; ii) reductions in patch size of burnt areas; and iii) proportion in each Time Since Last Burn class*
- *Use FMZ Burning Calendars to anticipate when the ‘Window of Opportunity’ for controlled burning large areas occurs to ensure adequate resources and equipment are available*
- *Encourage and support IFM Teams to significantly increase implementation of controlled burning in the wet and early dry seasons*
- *Utilize field-based navigation systems, motorbikes, quad bikes and foot patrols for controlled burning access of remote areas*
- *Explore opportunities to incorporate resident communities in landscape controlled burning*
- *Explore opportunities to introduce aerial burning operations in 2016 to access remote areas of large CUs.*

#### **4.3.2 Collaborative Management**

Project partners and institutions are massively constrained in terms of available human, financial and technical resources to implement fire management throughout the vast areas of land under their jurisdiction.

In **2014**, the IFM Program highlighted the importance of managing fire within the context of the broader landscape. Numerous fires entered into the pilot areas from external sources and, conversely, fires traversed into neighboring areas from the pilot areas. Considerable interagency cooperation exists amongst Project partners and represents the basis to develop collaborative IFM strategies between neighbors.

In **2015**, the IFM Program commenced developing structured collaborative IFM mechanisms between neighboring CUs to establish effective fire management at landscape scales. A key focus was combined planning, implementation, monitoring and evaluation in 2015 between neighbor CUs. A good example is the collaboration between PEJ, ESEC and APA that incorporated:

- i) Alignment of IFM objectives
- ii) Sharing of human and technical resources and equipment
- iii) Sharing of workloads with joint controlled burning and suppression activities.

CBFiM activities played a critical role and established a fire management link, as well as, a social one between communities residing in the three CUs providing further incentive for participation.

Pooling management resources and harnessing community skills and knowledge are key components to developing mutually beneficial collaborative strategies with clear roles and responsibilities of local stakeholders.

#### Recommendations

- *Consolidate and expand collaborative IFM mechanisms between neighboring CUs with clear roles and responsibilities of local level stakeholders*
- *Prioritize collaborative landscape scale controlled burning operations with local level partner organizations and key stakeholders*
- *Further develop IFM resource and equipment sharing agreements amongst key fire management institutions in preparation for IFM implementation in 2016*
- *Monitor and evaluate fire information at the broader landscape scale, not CUs in isolation, to facilitate and support collaborative management strategy development*

#### **4.3.3 Expanding the IFM Program**

This collaborative management model (Section 4.3.2) represents a cost-effective approach to expand the IFM Program to achieve CU management objectives, reduce GHG emissions and improve community livelihoods.

In 2015, applicability of the adaptive IFM management framework was expanded to incorporate other CU and protected area categories not represented in 2014. To date, the adaptive IFM Program has experience and demonstrated applicability in:

- |                                                |                                                |
|------------------------------------------------|------------------------------------------------|
| - <i>Parques Nacionais</i>                     | - <i>Terras Indígenas</i>                      |
| - <i>Parques Estaduais</i>                     | - <i>Terras Indígenas no Parques Nacionais</i> |
| - <i>Estações Ecológicas</i>                   | - <i>Territórios Quilombolas</i>               |
| - <i>Áreas de Proteção Ambiental Estaduais</i> |                                                |

Combined, these CU and protected area categories represent a significant proportion of protected areas, and cover a considerable land area, of the Cerrado Biome.

Expansion into new areas was typically determined without consideration of the broader landscape (ie neighbors) and may limit effectiveness of landscape scale IFM throughout the Cerrado.

### Recommendations

- *Use the 'collaborative management model' to determine the most effective expansion strategy of the IFM Program throughout the Cerrado*
- *Incorporate CUs, other protected area and land tenure categories (ie private or leasehold land) not currently represented in the IFM Program*
- *Develop IFM Program expansion in future years in combination with operational IFM training course development*

## **4.4 INSTITUTIONALIZATION**

In **2014**, municipality, state and national level Project partners provided strong institutional and technical support to the IFM Program. Notable achievements included:

- i) Providing institutional environments and resources for pilot implementation
- ii) Inter-institutional collaboration to realize IFM Program objectives and share experiences
- iii) Increased IFM awareness amongst Project partners

In **2015**, Project partners displayed greater confidence in the key IFM elements and expressed strong commitment to incorporate these into existing fire management frameworks.

Institutional awareness was significantly widened through inclusion of additional Project partners in the IFM Program, involving:

- National level institutional staff from MMA, ICMBio, IBAMA/PrevFOGO, FUNAI, INPE, IBRAM and Defesa Civil do Brasilia
- State level institutional staff from SEMARH, RURALTINS and Defesa Civil do Tocantins, SAMADES do Minas Gerais
- Municipality level staff (Prefeitura), fire brigades and other institutional staff.

Institutional support staff's participation in field-based activities with IFM teams, key stakeholders, resident communities and researchers improved awareness within Project partner institutions through sharing experiences.

Research and monitoring of environmental and socio-economic responses to the applied fire regimes of the IFM Program were significantly strengthened in 2015 (ie University of Brasilia). A strong research component is required for adaptive management, awareness and building evidence to support the institutionalization process.

Incorporation of the key IFM elements into operational fire management plans at the CU (ie ESEC and PNCM) and municipal level (Plano Operativos - Federal University of Tocantins) was increased in 2015. However, these continue to be isolated until clear IFM policies and implementation strategies are developed at the state and national levels.

Further review of existing national and state legislative and policy frameworks was carried out to clarify the legality of implementing key IFM elements (ie controlled burning) beyond a pilot stage. It was determined the applicable legislations contain clauses for the use of controlled burning for purposes corresponding to those of the IFM Program. This is important to provide Project partners with security to develop IFM policies that support concrete and realistic institutional collaboration with clear and compatible roles and responsibilities.

Public awareness of the IFM Program was significantly increased in 2015 through television news reports (ie TV Anhanguera Tocantins, Terra Indígena Xerente Report), institutional website articles, local radio broadcasts and newspaper articles.



Applicability of the IFM Program was expanded to incorporate other states not represented in 2014. To date, the adaptive IFM Program has experience and demonstrated applicability in:

- *Estadual do Tocantins*
- *Estadual do Minas Gerais*
- *Estadual do Maranhão*
- *Estadual do Goiás*

Many other state level partners have expressed interest in participating in the IFM Program in future years.

#### Recommendations

- *Convene an International IFM Conference in 2016 to garner wider Project partner awareness, consolidate high level institutional support and secure higher level political support, through:*
  - *Summarizing international IFM experiences and achievements*
  - *Showcasing IFM Program achievements in Brazil*
  - *Proposing IFM policy and implementation strategy development steps*
- *Develop harmonized IFM policies at national and state levels, based on decentralization, to provide clear institutional mandates of IFM Program implementation in the various land tenures throughout the Cerrado*
- *Develop IFM awareness programs to disseminate IFM policy and implementation strategies to civil society, other government institutions and political levels*
- *Establish an IFM Program protocol / framework to:*
  - *Support CU managers to incorporate key IFM elements into existing CU Management / Protection Plans*
  - *Support institutional coordinators to structure approval and evaluation of IFM Program activities*
  - *Support integration of all key role players, local level partner organizations and other important stakeholders into IFM Program planning and implementation.*