Managing Peatland Fire Risk in Central Kalimantan, Indonesia

World Resources Report Case Study

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Suggested Citation: Someshwar, Shiv, Rizaldi Boer and Esther Conrad. "World Resources Report Case Study. Managing Peatland Fire Risk in Central Kalimantan, Indonesia." World Resources Report, Washington DC. Available online at http://www.worldresourcesreport.org

INTRODUCTION

Uncontrolled spread of fires in peatlands poses a serious risk to public health, livelihoods, and conservation efforts in Indonesia, and contributes significantly to climate change. In 1997-98, peatland fires across Indonesia resulted in major regional haze, millions suffering from respiratory problems, and billions in economic losses in Indonesia and across Southeast Asia (Tacconi, 2007). These fires contributed the equivalent of 13-40% of global carbon emissions from fossil fuels during that time (Page et al., 2002). The peatlands of Central Kalimantan province have undergone dramatic ecological and social change over past decades, as millions of hectares have been drained and converted from forest to agricultural land and palm plantations. Drained peatlands are at greater risk of fire, and impacts are especially severe when rainfall is below normal, as in some El Niño years. Yet, the livelihoods of small farmers, especially those practicing shifting cultivation, still depend upon fire as the only viable way to clear land. The provincial government's attempts to ban fire use at all times, whether or not the region is experiencing below normal rainfall conditions, have been met with resistance from farmers.

Since 2006, the International Research Institute for Climate and Society (IRI) at the Earth Institute of Columbia University and Bogor Agriculture University (*Institut Pertanian Bogor* or IPB) have worked with government and non-governmental organization (NGO) partners to help develop an early warning system for managing fires, at the sub-seasonal time scale, in the peatlands of Central Kalimantan. The effort, part of a larger project focused on restoring peatlands and enhancing local livelihoods, involved research on the linkages between climate and fire and on the institutions managing the current peatland fire response system; the development of tools to analyze rainfall patterns and predict the severity of fires several months ahead; and trainings for district, provincial and national-level government officials and NGOs. The tools were developed specifically to help provincial and district level officials, charged with fire suppression, to better target their efforts, while protecting farmers' livelihoods. For example, instead of the complete ban on fire preventing farmers from clearing their land, restrictions on burning in specific periods (when drier than normal conditions are expected) and advisories providing specific time windows for firing undergrowth would help focus fire use in the least risky periods. Accompanying these measures with meaningful incentives to farmers would further help to avoid

the extensive peatland fires responsible for the most serious impacts.

As a result of this project, provincial officials adjusted an August 2008 provincial policy softening the ban on fires to include provisions for the use of seasonal climate information in deciding when fire should be allowed. Since this time, the online early warning tool developed by IRI and Bogor Agriculture University has been regularly consulted by provincial-level government agencies in planning for the upcoming fire season. Trust and close collaboration with provincial and district-level agencies, involvement of local partners, a problem-driven research approach, and substantial efforts to make tools and research results accessible to local stakeholders helped lead to this success. However, widespread and formal operational use of seasonal early warning information has been limited by the fact that current institutions involved in fire management support reactive measures once fires have already occurred, and do not have sufficient remit for undertaking anticipatory steps to reduce fire risk based on seasonal information. Other barriers include the ways information is shared across provincial and district levels, the need for training on seasonal early warning across the full range of relevant government agencies, and staffing limitations. Further, our specific effort was focused on research, and was not designed nor had the funds required for testing an incentive system that would enable farmers to reduce fire use in high-risk years. This larger effort, which is urgently needed, will also require additional investigation of the practical alternatives to fire use, their costs to farmers, institutional mechanisms for offering incentives, and monitoring outcomes.

Peatland fires pose significant health and livelihood threats at the local level and across Southeast Asia, as smoke haze engulfs the region. While large-scale burning by company-owned plantations is part of the problem, in dry years, fire use by small-scale farmers can also ignite fires in the peat and cause major impacts. This case study examines how climate knowledge, combined with efforts to support farmers who depend upon fire for land-clearing, can help local government officials better plan for and reduce these fire impacts. It highlights how close collaboration across relevant scales of governance – down to the district level – is important for developing useful tools and approaches to managing climate risk. It also points to some of the institutional challenges involved in operationalizing the use of climate information for risk management.

SETTING

The province of Central Kalimantan is home to about 2.2 million people, the majority of whom depend upon agriculture and agro-forestry for their livelihoods (Government of Indonesia, 2010). Much of the land is composed of peat soils, formed by the partial decay of wood, plants and other organic matter when saturated with water. These rich soils support highly diverse forests, play a crucial hydrological role through water storage, and have sustained livelihoods through agro-forestry, timber for local construction, and other products. Peat soils store large amounts of carbon. Globally, peatlands store twice as much carbon as forest biomass, and about the same amount that is currently in the atmosphere. Each year, the oxidation of degraded peatlands contributes an estimated 3000 megatons of carbon dioxide emissions, and about two-thirds of this occurs in Southeast Asia, primarily in Indonesia (Parish et al., 2008). The majority of Indonesia's approximately 21 million hectares of peatland are located in the regions of Kalimantan (the Indonesian portion of the island of Borneo) and Sumatra (Wahyunto, 2006). These account for over 80% of peatlands in Southeast Asia and half of the world's tropical peatlands, storing an estimated 42,000 megatons of carbon (Hoojier et al., 2010).

The Dayak communities, indigenous to Central Kalimantan, have long sustained their livelihoods in the peat forests through agro-forestry practices for growing rice and food crops interspersed with rubber, rattan and other forestry products (de Jong et al., 2001). Clearing land for agriculture is a considerable challenge, given the area's dense and fast-growing forest and vegetation. Traditionally, Dayak households use fire to clear land, as it involves the least cost while at the same time helping to eradicate pests, especially rats, and improving soil fertility (Kinseng, 2008). They continue to practice shifting cultivation (also called swidden, or slash-and-burn), which involves clearing land and cultivating it for several years, and then letting it lie fallow while households move to other areas to repeat the practice. Shifting cultivators depend heavily upon fire when they clear land for the first year of cultivation. Other methods, such as clearing land by hand, machinery or herbicides, are costly – one estimate is about US $90/hectare for labor and herbicides – and do not offer protection against pests (Boer et al., 2007; Kinseng, 2008). For most households practicing agriculture for subsistence, such costs are prohibitive.

Figure 1: Clearing land using fire in Central Kalimantan (Francesco Fiondella, 2008).

In Central Kalimantan, fires occur mostly in the dry season, generally extending from May to September each year, when most land clearing takes place. However, small farmers are not the only group using fire to clear land. Since the 1990s, Central Kalimantan has seen considerable growth in large, company-owned plantations growing oil palm for export, which have made extensive use of fire (Casson, 1999). Despite national legislation prohibiting fire use by plantations, the practice persists. In addition, landowners, particularly those with property along roads, often use fire to clear the land to demonstrate use of land, since under Indonesian law, unused land is considered available for occupation. Analysis by Boer et al. (2007) shows that a significant portion of fires in Central Kalimantan occur near roadways, suggesting that this is also an important cause of fires.

The magnitude of fire impacts has been amplified by past government land use policies, associated particularly with the (so-called) "Mega Rice Project." Initiated in 1995 by then President Suharto, it resulted in the conversion of about 1.7 million hectares of peat swamp forests into land for rice cultivation in Central Kalimantan, and brought thousands of poor farming households from Java to settle and farm the area. Over 4,000 km of canals were built to provide access to the areas, and to enable timber removal following major logging operations (Hecker, 2005; Hooijer et al., 2008). Large areas of forest, fish ponds, and rattan gardens, important for the local Dayak livelihoods, were destroyed. The costs of this dramatic intervention were soon apparent, as the canals drained water from peatlands, leaving peat areas drier than before – and more susceptible to fire. In 1997-98, a major El Niño event led to dramatically reduced rainfall, and fires in the peatlands of Kalimantan – particularly in the "Mega Rice Project" area – spread uncontrollably, leading to massive local and regional air pollution, and serious economic losses. Greenhouse gas emissions from these fires have been estimated at 13-40% of all global carbon emissions in 1997 (Page et al., 2002).

The impacts of the 1997 fires were felt across Southeast Asia, placing pressure on the Government

of Indonesia to act. A 1999 national law (Act No 41/1999) and Government Regulation No. 4/2001 instituted penalties for plantations using fire to clear land, with uneven effect. In 2001, the newly created Environment Ministry assumed fire management of forest and non-forest lands, with primary responsibility delegated to provincial and district government agencies. Over recent years, the decentralization process in Indonesia has increased the authority of provincial and district governments, leading to changes in land use and forest management (Mayer, 2006). Today, the provincial government sets fire management policies for households and community-based plantations, and takes the lead in monitoring fire activity, while districts are responsible for implementation. While the national government still plays an overall role in guiding the direction of provincial-level policy, this increased "regional autonomy" opens opportunities to develop management approaches tailored to the causes of fire. However, institutional, financial, and human resources to undertake these activities locally are often limited.

The government-led fire management practice in Central Kalimantan has been focused on short-term fire suppression during the May–September dry season. It depends upon a fire monitoring and warning system, using weather and environmental data from agencies such as the Indonesian Space Agency (LAPAN), Ministry of Environment, ASEAN Specialized Meteorological Centre (ASMC), and the Indonesian Bureau of Meteorology, Climatology and Geophysics (referred to as the Indonesian meteorological service or BMKG). At the provincial level, the Natural Resource Conservation Agency (*Badan Konservasi Sumberdaya Alam* or BKSDA) uses hot spot data and the Fire Spread Risk Index Map (FSRIM), combined with on-the-ground observations, to assess current fire risk levels across the province (Ceccato et al., 2009). The Provincial Environmental Office (BLH) uses this system to set alert levels in local areas, some 48 hours ahead, which then trigger steps to be taken by district staff to increase vigilance, such as through patrols to monitor high risk areas, and prepare fire-fighting equipment and water supplies. The provincial government has also undertaken public information campaigns throughout the dry season, raising awareness about fire dangers and discouraging its use. Despite these efforts, fire impacts have continued to be serious. In 2006, the governor of Central Kalimantan took the unusual step of banning all use of fire by households and community plantations as well (as mentioned earlier, since 1999 a national law has banned the use of fire to clear land in corporate-owned palm oil plantations over all of Indonesia). Enforcement of this ban at the district level was variable, but in some cases, farmers were punished for using fire. At a public meeting in 2007 in the provincial capital of Palangka Raya, several district officials as well as farmers spoke out against this law, saying farmers have no other option besides using fire to clear land, and their livelihoods depend upon it (IRI, 2008).

TYPES OF RISK FACED

Extensive Peatland Fire Impacts and the Role of Climate

Fires occur in Central Kalimantan during the "dry season" from May to September. Farmers and plantations clear land during this time, when vegetation is drier. Although burning occurs every year, by far the greatest impacts occur when fires spread into the underlying peat layers. Once started, peat soil fires can spread underground and are very difficult to extinguish, leading to extensive forest damage and air pollution, both local and regional (Harrison et al., 2009). Carbon dioxide emissions are also far greater when peat is burned; tropical peatland fires emit between 4 to 40 times as much carbon as fires in other tropical habitats (Cochrane, 2003). Thus, the greatest need is to reduce the risk of these extensive peatland fires.

Substantial research – including IRI and Bogor Agriculture University's work in this project – has shown that rainfall patterns play a strong role in determining the risk of peatland fires in Central Kalimantan. While draining peatlands has increased fire risk overall, extensive fires occur primarily in years when rainfall is lower than normal (Harrison et al., 2009; Tacconi et al., 2007). The dominant source of year-to-year rainfall variability in Indonesia is the El Niño-Southern Oscillation (ENSO) phenomenon, affecting sea surface temperatures in the Pacific Ocean (Aldrian and Susanto, 2003; Chang et al., 2004). During the warm ENSO phase (El Niño), dry season rainfall tends to be below normal, and the length of the dry season is extended. Fire occurrence and magnitude increase significantly during El Niño years, such as in 1982-83, 1987, 1991, 1994, 1997-98, 2002 and 2006 (Harrison et al., 2009). For example, carbon emissions from fires on the island of Borneo were as much as 30 times greater during 2006, an El Niño year, than during 2000, a wet La Niña year (van der Werf et al., 2008).

The impacts of fire in dry years can be extremely serious. During the 1997-98 El Niño event, an estimated 10 million hectares across Indonesia burned, including 1.5 million hectares of peat swamp forests. Of these, six million total hectares burned in the Kalimantan provinces, including 750,000 hectares of peat forests. Estimates of economic losses across Indonesia and across Southeast Asia range from US$2.5 to 6.3 billion, including agriculture, tourism, forestry, public health, transportation, and environmental costs (Tacconi, 2003). Local and regional health implications of these peat fires were very serious, with an estimated nine million people suffering from respiratory problems due to smoke haze pollution in the eight provinces of Kalimantan and Sumatra during the 1997 fires (Government of Indonesia and UNDP, 1998). The peatland fires in Central Kalimantan have also led to serious pollution of watersheds and reduction in biological diversity. Air pollution, especially aerosols, produced by forest fires resulted in reduced visibility, disrupting land, air and sea traffic (Government of Indonesia, 2007). Local health and economic impacts of fires have continued, especially during the more recent El Niño years of 2002 and 2006. In 2006, Central Kalimantan experienced "unhealthy" or "dangerous" air quality on over 80% of days from September through November (Harrison et al., 2009). The province has the highest rate of asthma anywhere in Indonesia (DNPI, 2010).

The implications for climate change are also serious. A study by Page et al. (2002) estimated that the 1997 fires in Indonesia contributed the equivalent of 13-40% of global carbon emissions from fossil fuels during that year. There is also concern that climate change may worsen livelihood impacts and carbon emissions by increasing fire frequency. While there is still uncertainty associated with regional projections of future rainfall, 11 models used for the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC) show decreased rainfall during the dry season in Southeast Asia, whereas the same models show conflicting results over the Amazonia (Li et al., 2007).

ENSO-based predictions of Central Kalimantan fires

IRI-Bogor Agriculture University research in Central Kalimantan confirmed the relationship between rainfall levels and risk of severe fires. It also helped improve understanding of the linkage between large-scale climatic features, such as sea surface temperature anomalies associated with ENSO, and fire activity in the Kalimantan provinces. Since changes in sea surface temperatures can be predicted a season ahead, this enables seasonal forecasts of fire activity.

For all four Kalimantan provinces, the IRI, Bogor Agriculture University and the Indonesian meteorological service undertook an analysis of fire activity and rainfall from 1998-2006. This confirmed that in years with below normal rainfall, fire activity has been higher (see Figure 2).

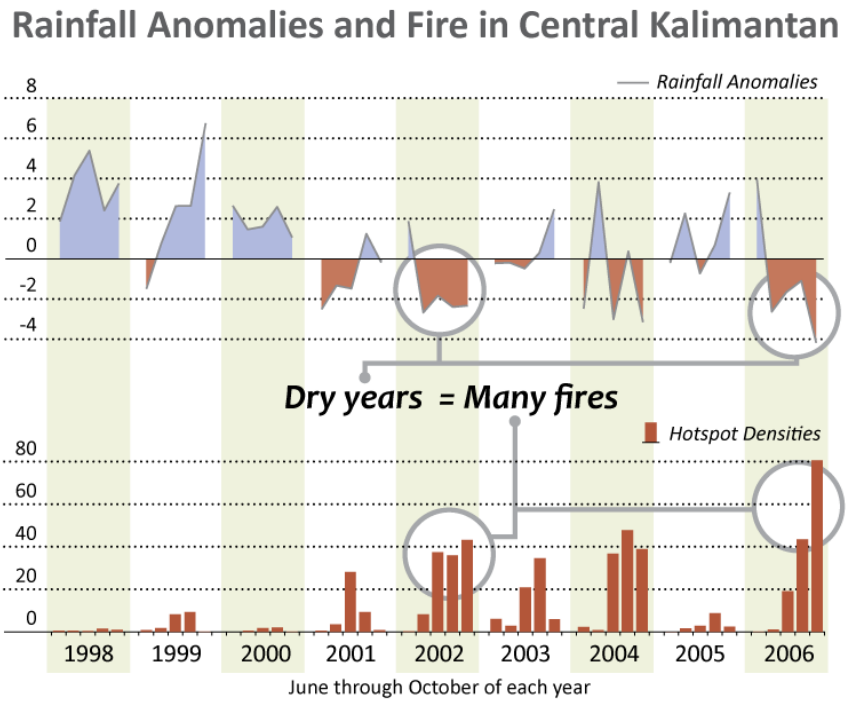

Figure 2: Rainfall anomalies and fire hotspots in Central Kalimantan. Rainfall data: NOAA CMAP and CMOPRH. Hotspot data: NOAA-AVHRR and TERRA MODIS. Lead scientist: Dr. Pietro Ceccato (IRI/IPB, 2009).

This provincial-level analysis made use of satellite-derived fire hotspot and rainfall data, since ground observations of both fires and rainfall are limited.[1] Both the fire hotspot and rainfall datasets were compared with other indicators, such as smoke emissions data and observations from several rainfall stations, to confirm that these satellite-derived datasets adequately represent realities on the ground. Other data commonly used as indicators of fire risk, such as vegetation greenness, relative humidity, and temperature, were also examined to determine whether variability in these factors could explain fire activity patterns. However, none of these indicators vary significantly throughout the year (IRI/IPB, 2009).

Our research also found that an indicator of sea surface temperature anomalies called NINO4 (thousands of miles away in the Pacific Ocean) shows a strong relationship with fire activity (as measured by hotspots) in Central Kalimantan *several months later*. For example, when the NINO4 index rises above about 0.4 in May, fire hotspots are higher than normal 1-2 months later, as illustrated in Figure 3 (IRI/IPB, 2009).

[1] Hotspot data from National Oceanographic and Atmosphere Administration's Advanced Very High Resolution Radiometer (NOAA-AVHRR) and the TERRA-Moderate Resolution Imaging Spectroradiometer (MODIS) were consolidated. Two satellite-derived rainfall datasets were used: NOAA's Climate Prediction Center Merged Analysis (CMAP), and the higher resolution NOAA CPC Morphing Technique (CMORPH) dataset.

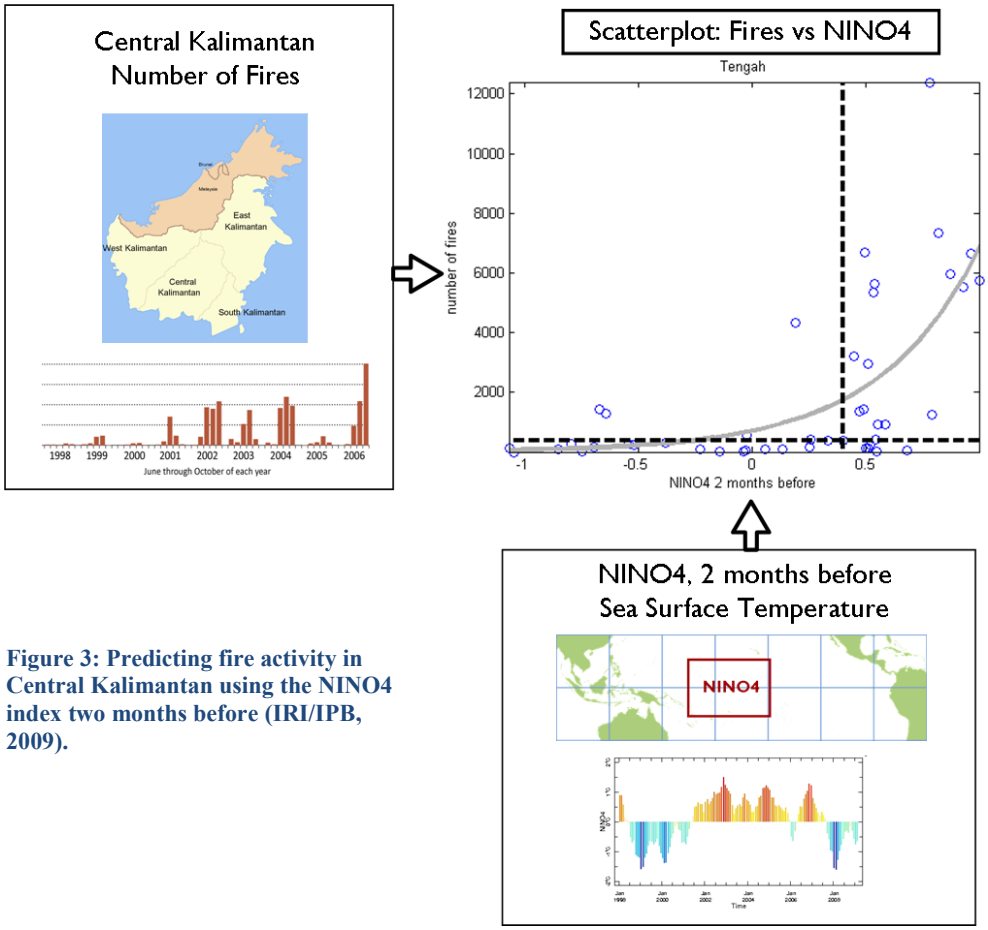

Figure 3: Predicting fire activity in Central Kalimantan using the NINO4 index two months before (IRI/IPB, 2009).

POLICY INTERVENTION

Since 2006, IRI at the Earth Institute, Columbia University and Bogor Agriculture University, in collaboration with CARE Indonesia and the provincial government, particularly the Provincial Environment Office, worked to help develop an early warning system for managing fires in Central Kalimantan. IRI and Bogor Agriculture University's work was part of a development-oriented effort called the Central Kalimantan Peatlands Project, with a goal to promote sustainable peatlands management for poverty alleviation and socio-economic development. Funded by the government of the Netherlands and managed by Wetlands International, key partners included the provincial government of Central Kalimantan, CARE International–Indonesia, World Wildlife Fund–Indonesia, Borneo Orangutan Survival, and the University Palangka Raya, based in Central Kalimantan. The Central Kalimantan Peatlands Project efforts focused on the hydrological restoration of peatlands, reforestation, biodiversity conservation, public health, and livelihood enhancement. CARE Indonesia was working closely with the provincial government to improve fire monitoring, and was supporting the development of community-based fire response efforts. CARE, aware of IRI and Bogor Agriculture University's work on climate risks elsewhere in Indonesia, invited our contributions.

The project efforts of IRI and Bogor Agriculture University first sought to understand the problems of peatland fires in the region, current scientific knowledge and capacity, and institutional constraints for early response. The Provincial Environmental Office in Central Kalimantan is responsible for fire monitoring, drawing upon satellite-derived hotspots data combined with on-the-ground observations. A unit within the Provincial Environmental Office, called the Centre for Environmental Information (PIL), uses a methodology derived from the Canadian Fire Danger Rating System to assess fire risk over the next few days, and to develop fire alert levels and response efforts. Given the challenges of monitoring fire activity, the limited resources available for responding to fires, and the enormous impacts of uncontrolled peatland fires, discussions with the Provincial Environmental Office and other local agencies helped identify the potential uses of a seasonal-scale early warning of fire severity.

Knowing ahead of time that the upcoming fire season was likely to be severe could help enable proactive steps to reduce fire use and prepare better to respond to fires.

Scientists at IRI and Bogor Agriculture University, along with CARE and the Provincial Environmental Office staff in Central Kalimantan, explored linkages between seasonal climate patterns and fire activity. CARE Indonesia and Bogor Agriculture University combined their data on fire hotspots, and IRI identified satellite-based rainfall datasets that could be used for the analysis. The Indonesian Space Agency and the Indonesian meteorological service were consulted on data used in the current danger rating system, and to validate the satellite-derived rainfall and hotspot data against locally available data. These analyses yielded the results described in the previous section – namely, that below-average rainfall was closely related with higher fire activity, and in turn, rainfall variability is linked with sea surface temperatures in the Pacific Ocean as part of the ENSO cycle. This understanding made it possible to use the NINO4 index (an indicator of sea surface temperature anomalies) as a predictor of the severity of fire activity, as shown in Figure 3.

An online fire early warning tool was developed with two dynamic, automated components:

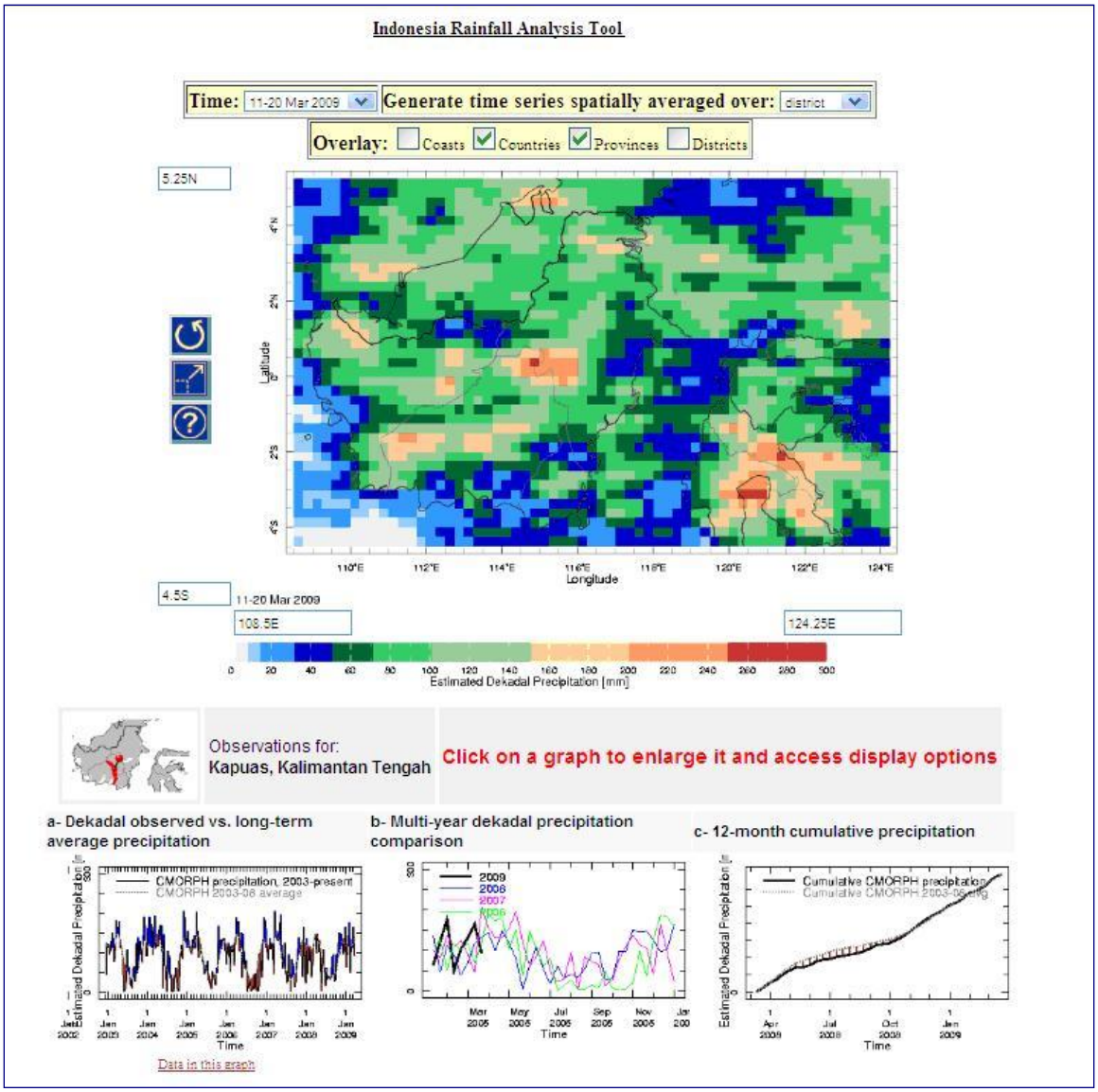

Figure 4: Automated district-level rainfall analysis in the online fire early warning tool.

1) seasonal forecasts, updated every month, of the likelihood of higher or lower than average fire activity at the provincial level; and 2) district-level

rainfall, updated every 10 days, to help assess how current rainfall levels compare with historical averages. The tools are online and available in both English and Bahasa Indonesia. Figures 4 and 5 illustrate the user interface for each. The fire early warning tool takes advantage of the IRI Data Library's sophisticated capacity for automated data analysis, and is available at http://iri.columbia.edu/maproom/fire.

As research and tool development proceeded, social scientists at IRI and Bogor Agriculture University worked to better understand the institutional context for fire management at district and provincial levels. This included an investigation of the current fire early warning system and practices, the roles of government agencies and local communities, and the availability of alternatives to fire use for land clearing. Through interviews and meetings at community, district and provincial levels, it became clear that while a 1–2 month early warning of the likely severity of fire risks would be useful. However, this represents a significant shift from current practice, which focused primarily on short-term fire suppression. Significant awareness and training would be needed to help relevant government and community stakeholders understand this seasonal early warning. For example, it would be critically important for decision makers to understand that the 2-month forecasts cannot provide certain (i.e., deterministic) information about future fire risks, but instead present them as probabilities of occurrence. In addition, discussions would be needed to clarify the types of anticipatory action that this early warning would make possible. These measures could include not only better planning for reactive measures for fire suppression, but also additional steps to reduce fire use by local populations. For example, in high-risk years, if farmers delay land clearing until the very end of the dry season, the risk of fires spreading into peat would be reduced. Extra measures could be taken to discourage landowners from using fire to demonstrate ownership. However, it is clear that farmers need support in order to delay or avoid fire use in high-risk years. By delaying land clearing, farmers may run the risk of planting too late if rains arrive earlier than predicted. For those farmers who may have capacity to use machinery or herbicides, costs would likely be higher. In both cases, incentives will be needed, whether financial or in-kind, community-based or by household.

Throughout the project, IRI, Bogor Agriculture University and CARE Indonesia held four formal workshops for district and provincial-level officials focused on seasonal fire early warning. In November 2007, a large workshop was held in Palangka Raya – the provincial capital – hosted by the Governor's office and involving relevant provincial government agencies such as the Provincial Environmental Office, Forests Office, Agriculture Office, Planning Office, and others. District-level officials and community representatives, including farmers' groups and those involved in CARE's community-based "fire brigades," also participated. The workshop introduced everyone to the research and concepts behind seasonal fire early warning, and provided an opportunity for discussion and questions.

Drawing upon input gathered at this workshop, the online tools described above were created. Bogor Agriculture University and IRI hosted a workshop in May 2008 at Bogor for key staff at CARE and the Provincial Environmental Office. At this meeting, it became clear that more in-depth training would be needed, including more background on how the seasonal forecasts are developed and what they mean. In addition, we needed to reach more provincial and district-level officials, not just technical staff but also those with decision-making authority. Since the fire season was about to begin, CARE, IRI and Bogor Agriculture University quickly organized a training just one month later at the Provincial Environmental Office in Palangka Raya. This intensive one-day training provided provincial and district-level decision-makers with an opportunity to understand and discuss the opportunities presented by this new 1–2 month forecast of the likely severity of fire activity in a given fire season.

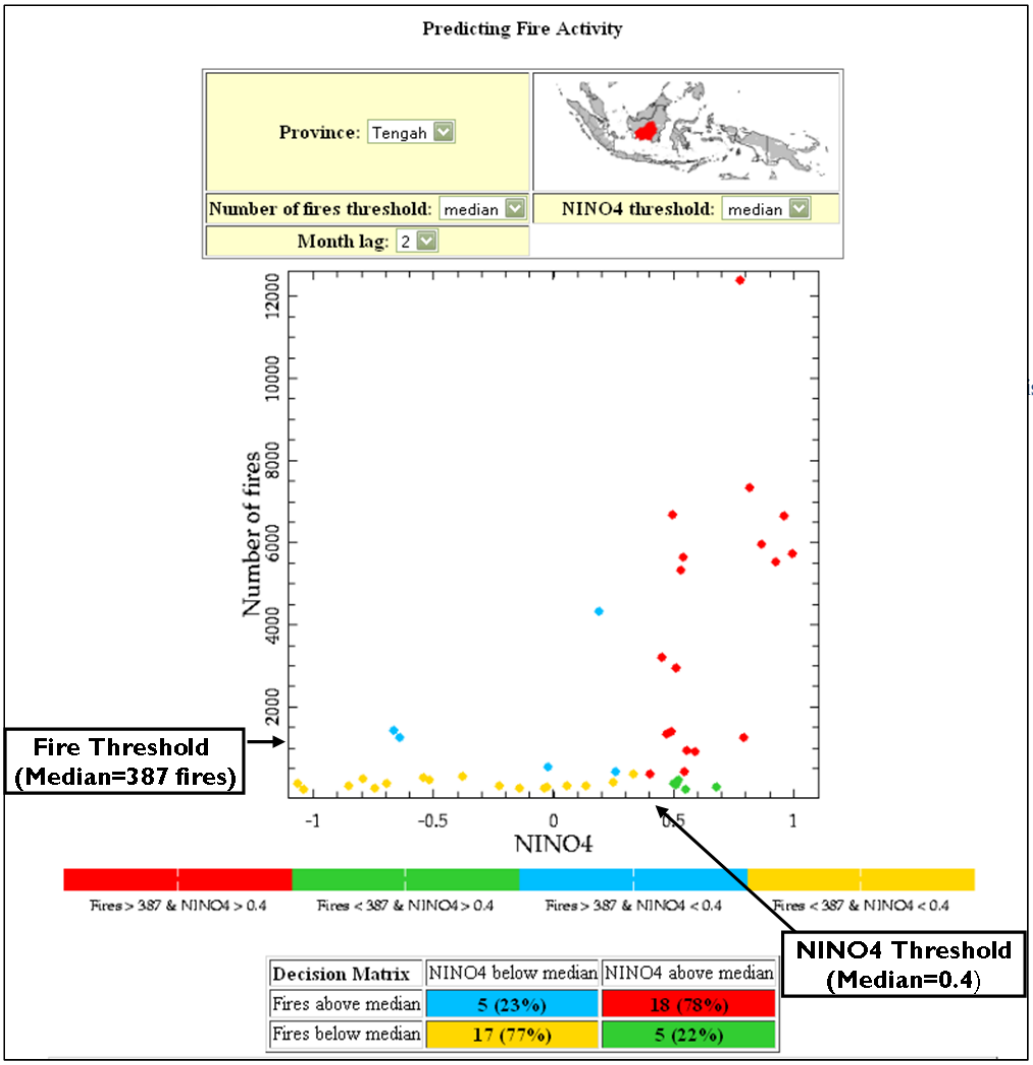

Figure 5: Using NINO4 to predict fire activity in the online early warning tool.

Although funding from the Central Kalimantan Peatlands Project for IRI and Bogor Agriculture University's work ended in June 2008 (the end of the project period), IRI drew upon funding from the US National Oceanic and Atmospheric Administration (NOAA) to support the creation of a "Climate Risk Knowledge System" for fire early warning in Central Kalimantan. This included updates of the online fire early warning tool to make it more user-friendly, a training manual that explains how the tool works and provides a step-by-step guide to its use, an in-person workshop including hands-on exercises, and creation of an online platform for all materials, accessible in English and Indonesian (available at: http://crk.iri.columbia.edu/fire).

The workshop, hosted at Bogor Agriculture University in May 2009, included national, provincial and district-level government and

university stakeholders. In addition to reinforcing understanding among previous training participants, it also introduced the seasonal early warning system to representatives from national-level agencies, including the Indonesian meteorological service and the Ministry of Environment. Although expansion beyond Central Kalimantan has not yet occurred, national agency participation in this workshop raised their awareness about this work, and the possibility of developing similar systems for other parts of Indonesia experiencing peatland fires. Finally, the workshop allowed for participants to gain a better understanding of what a probabilistic forecast means. For example, role-play and group exercises helped participants understand that if the forecast is for a 70% probability of high fire activity, in 3 out of 10 years fire activity will be low instead of high.

OUTCOMES

Project efforts appear to have directly influenced provisions in a 2008 regulation on the use of fire for land clearing. The 2006 regulation banning fire use by households and communities was quite unpopular, and provincial and district officials were under a lot of pressure from farmers to reverse this rule. Farmers in Kapuas and other districts held demonstrations to press for change. At the June 2008 workshop in Palangka Raya, we learned that a new provincial regulation, imminent from the governor, was expected to soften the unpopular ban. Staff from the governor's office participated in the workshop and were excited about the possibility of seasonal forecasts of fire activity. They discussed with workshop participants possible language that could be included in the regulation to make use of seasonal forecasts of fire risk.

In August 2008, Regulation 52/2008, "Guidance on Land and Yard Opening for People in Central Kalimantan," was issued. It establishes conditions under which fire can be used for land clearing, and allows for the use of seasonal climate information in deciding whether or not to allow burning. In addition to basing decisions on the current short-term fire danger rating system and an index of local air pollution, the regulation defines a "Fire Risk Index" as an estimate of the predicted extent of fire, based on "the El Niño Southern Oscillation (ENSO) or monthly rainfall forecast data," (Chapter 1, # 20). In deciding whether or not to issue a license for burning, district and sub-district officials are to consult these indices (Chapter 3, # 6). In addition, the Governor has the authority to declare "dangerous" fire conditions throughout the province, using the Fire Risk Index (Chapter 3, # 7), whereby no fire use is allowed.

The creation of the seasonal early warning tool in Bahasa and the provision of training to key provincial (Provincial Environmental Office) and district (Kapuas) staff enabled a high degree of awareness of the usability of season-ahead fire prediction. Over the past several years, the tool has been used by the staff at the Provincial Environmental Office to further supplement the early warning information.[2] It is also consulted in discussions at regular coordination meetings on fire control and management, chaired by the governor.[3] In a recent discussion, Mr. Adyaksa, sub-division head at the Provincial Environmental Office in Central Kalimantan, noted that the longer lead-time offered by the seasonal early warning tool not only helps the Provincial Environmental Office in its preparation for the fire season, but also could be instrumental in the development of an incentive-based fire management program, which was discussed at several project workshops. The incentive system would need to be designed carefully in terms of the amount of funds or support offered, and the governance structures to help

[2] Recent discussions with Mr. Adyaksa and Mr. Essau Tambang (Head of Sub-Division, PIL), Palangkaraya.
[3] Per personal communication, Mr. Humala Pontas, from Central Kalimantan Province Planning Agency.

influence the behavior of key stakeholders who use fire to clear land, particularly farmers.[4]
The potential for using seasonal fire forecasts has also begun to be recognized as important in implementing new national-level policy directives. In 2010, the Minister of Environment issued a new national regulation allows *adat* communities (those following traditional practices) to use fire to clear small land areas without seeking permission, but rather by informing the village head. However, the regulation states that this rule does not apply if Indonesia's meteorological agency declares seasonal rainfall below normal.[5] Key provincial officials have indicated that the seasonal early warning tool will be important in implementing this new regulation. Implementation could also be supported in other fire-prone provinces, such as in Sumatra, if similar early warning tools are be developed based on local conditions. Furthermore, the Provincial Environmental Office is planning to coordinate with the newly created Agency for Disaster Management to institutionalize the use of the seasonal fire warning tool for setting up fire alerts and to help develop an incentive system for villages in managing fires during high fire risk seasons. Since the Agency for Disaster Management is slated to take over the role of the Provincial Environmental Office in land and forest fire management, it is critical for the Agency to develop capacity in using the seasonal fire warning tool for developing fire management strategies and action plans.

FACTORS THAT FACILITATED GOVERNMENT ACTION

Decisions about the system for managing fire use by farming households and community plantations are primarily made at the provincial level, with their implementation (and funding) delegated to the district and village levels. This relative clarity of roles and responsibilities mean that a relatively small number of key staff at the provincial level needed to be convinced of the utility of seasonal fire risk information. This enabled its articulation in the provincial level fire use policy within a relatively short time. However, actual implementation of policies in the numerous districts and villages in Central Kalimantan has been slower, given the uneven technical capacities and lack of financial resources.

Timing of the research effort also proved to be fortuitous. In the years preceding our effort, the total ban on use of fire had begun to be felt. Farmers had become irate at the prospect of being punished if they resorted to their traditional practices of clearing land by burning. On a number of occasions in public and private meetings with provincial and district officials, they expressed their dismay and anger. Officials, especially elected ones at the district level, had begun to realize that the provincial ban on fire use was too draconian, since they had not been able to offer any practical

[4] To encourage the head of a village (particularly one with high fire risk) to monitor the implementation of the 2008 regulation, particularly in villages with high fire risk, the Provincial Environmental Office has developed a program for villages that could maintain their villages with low fire use. The Provincial Environmental Office provides certification (for the use of fire) as well as maintenance costs for fire control equipment to a number of villages in Kapuas District (per Mr. Adyaksa, Sub-division Head, Environmental Pollution Control, Central Kalimantan, personal communication).

[5] Further, in 2010, the Minister of Environment issued a new regulation on mechanisms to prevent pollution and/or environmental damage related to land and forest fires (Permenneg LH 10/2010). It allows the use of fire by '*adat*' communities (defined by affinity to a place as well as by the inherited value system to determine economic, political, legal and social institutions) are allowed to use fire in preparing their land, with a maximum area of 2 ha per household (Chapter 4, #1). Rather than seeking permission, the community now needs to inform the Head of the Village before using the fire (Chapter 4, #2). This rule is does not apply if the National Agency for Climatology, Meteorology and Geophysics (BMKG) declares the seasonal rainfall to be below normal or if the dry season is extended.

alternatives to the farming community. Technical staff at the district planning agency and the Provincial Environmental Office were increasingly aware of the need to come up with meaningful alternatives. At the same time, as international and regional concern has heightened about peatland fires, the national government placed increased pressure on provinces with significant peatlands to take strong measures to reduce fire. The possibility of identifying years in which fire risks are greatest offered an opportunity to balance these pressures.

Key partners in the effort were CARE International–Indonesia and the Provincial Environmental Office of Central Kalimantan province. While IRI and Bogor Agriculture University produced credible, high-quality research, it was the relationship that CARE Indonesia had built over several years of on-the-ground development project work on health and natural resources management in the villages of Central Kalimantan that enabled the project to gain acceptance . The everyday working relationship between CARE and the provincial government, such as through staff secondment to the Centre for Environmental Information within the Provincial Environmental Office, was also very important for establishing this trust.

The participation of Bogor Agriculture University was also critical. It enabled a more nuanced understanding of local dynamics, social and biophysical, for the research effort. Equally important was the high standing of the Bogor Agriculture University in Indonesian academic and official circles, which meant that the research results were respectfully received and scrutinized. Discussions with the governor's staff during the June 2008 workshop in Palangka Raya, for example, were eventually incorporated into the governor's new fire regulation.

A problem-oriented and inter-disciplinary approach to research was critical to success. There are vast areas of climate predictability, remote sensing, peatland fire management, and the socio-cultural and political economy context that require greater understanding. The IRI–Bogor Agriculture University research team spanned this range, combining climate scientists, remote sensing experts, foresters, agricultural scientists, policy experts, economists and sociologists. However, instead of pursing separate research angles within each of these fields, IRI and Bogor Agriculture University first sought to understand the specific challenges that provincial and district-level officials were facing with regard to peatland fires, the institutional context of decision-making, and existing local capacity. This helped focus project research to meet the need for seasonal climate information, as well as updated rainfall information, that would be relatively simple to access and understand for policymakers and technical staff. While more sophisticated climate modeling can – and hopefully will – be used to refine knowledge of climate predictability in Central Kalimantan, IRI–Bogor Agriculture University chose to use a relatively simple regression analysis to identify NINO4 as a predictor for the severity of fire activity. While this forecasting approach can be further refined and developed, a relatively simple approach initially helped local partners stay engaged, and facilitated uptake in the 2008 regulation.

Finally, efforts to develop user-friendly and accessible training materials were critical for enabling a wider range of stakeholders to engage in the effort. The early warning tool is freely accessible online, and is available in Bahasa Indonesia, as well as in English. The tool takes advantage of existing capacity in the IRI Data Library to conduct automated data analyses that help the user more easily understand trends in climate data. The tool's interface was refined based on feedback after each training held during the project. Rather than being the purview of a privileged few, a diversity of actors – farming leaders, elected village and district officials as well

as technical staff from the provincial and district levels – could access, understand and most importantly discuss the efforts. Simultaneous translations in all of the formal workshops meant that discussions carried a diversity of viewpoints that may not have been otherwise possible. For example, farmers participating in the November 2007 workshop expressed their displeasure at the ban on fire use that was imposed in 2006. A year later, translation enabled participants from the provincial governor's office to understand that seasonal forecasts could help target efforts fire reduction efforts to those periods of greatest risk. They incorporated this into the 2008 regulation that softened the complete ban on fire use.

BARRIERS TO ADOPTING AND ADVANCING THE INTERVENTION

On institutional architecture and capacities:
Using a seasonal fire early warning system for decision-making poses two broad challenges for the provincial and district-level institutions that are currently managing response to fire: 1) complementing the use of short-range weather information in the current system with forecast information with a longer time horizon with greater uncertainty; and 2) providing economic incentives to key stakeholders involved in managing fire.

Fundamentally, the current fire early warning system is a reactive one, and focused on 1–2 day weather forecasts. Based on information received from the Indonesian Space Agency and the Indonesian meteorological service, the formal system envisages the Centre for Environmental Information of the Provincial Environmental Office sending out weather-based warnings. The system at the provincial level mandated to fight fire, called "POSKO," utilizes this information to warn affected districts and rural communities. Actions that these agencies undertake are "fire-fighting" measures. While critically required to put out the fires, they need to be integrated within a more comprehensive system of fire risk management that provide choices of action over longer time horizons, such as alternative timings to fire land clearing, or providing advice on alternative livelihood activities.

The current institutional architecture and capacities in Central Kalimantan present several challenges in achieving the needed collaboration across agencies and scales for anticipatory action:

- Current institutions are set up exclusively to react to the occurrence of fires, rather than anticipating and seeking to reduce fire risks.
- In practice, the governance of fire suppression is one-way and top down: regulations are promulgated at the provincial level, policed at the district level and acted upon at the village and farm levels. The formal system offers very little opportunity for feedback from the local level. Hence, critical considerations such as of risk and reward for villagers in fire management are not fully appreciated at the provincial and district levels.
- Unreliable access to communication and high diversity of local fire situations contrasts with the use of a hierarchical approach to information dissemination and use (such as the need to sign off at the provincial level on all fire information)
- A propensity to work through government agencies, and a reliance on a "command and control" approach, rather than one characterized by participation and stakeholder value maximization.
- An undue (recent) emphasis on penalties for the use of fire rather than incentives. This may have yielded some reductions in fire incidence in 2007 (which was relatively a wet year), but also led to an increase in frustration on the part of local communities.

Addressing these barriers and institutionalizing the use of the seasonal fire risk forecast information for

developing anticipatory fire management programs will require further research and training, and development of specific policies and programs. Critical next steps include:

- Increase the understanding of policy makers on the potential use of the seasonal early warning tool, not only for setting up a fire alert system but also in the design of an incentive system for districts and villages during high fire risk season.
- Develop baseline information to measure the success of villages in reducing the impact of fires during prolonged dry seasons, critically required to design appropriate incentives.[6]
- The agency responsible for issuing the seasonal fire risk information needs to have full-time and permanent staff. Further, they need training in order to access, understand and explain the seasonal fire risk information. In previous years, well-trained staff have been promoted or have left for other jobs, and replacements have not received sufficient training.
- Develop capacity of provincial and district technical staff for translating the probabilistic fire risk forecast information into advisories that lay out the potential outcomes for policy makers. Current weather and climate forecasts in Indonesia are usually "deterministic," stating the most likely outcome but without conveying the probability associated with it. The early warning tool, on the other hand, offers probabilistic forecasts: for example, "a 78% likelihood that fire activity will be above normal." Workshops included training in how to interpret and use probabilistic information, but further such efforts are needed. Specific guidelines for interpreting fire risk information may be needed.
- Fire risk forecasts are currently available only at provincial and district levels. Since activities to reduce fire risk are inherently place-based, skillful forecasts of fire risks need to be available at district and village scales. Further research is needed in collaboration with the Indonesian meteorological service.

<u>On incentivizing the use of fire forecast information</u>
Currently, villagers who are involved with fire fighting do not receive any payments, either to help them fight fires or reduce their fire use. In many instances, time spent on fighting fires means time away from farming activities. While this can be sustained when fighting fires that are dangerous to their own welfare, it is not a sustainable system to get communities that are not immediately threatened by fire to contribute their labor. In the absence of a well-funded, efficient and professional fire fighting force, the inability of communities to jointly tackle fires is a serious issue.

An incentive system needs to be carefully designed, accounting for available alternatives to fire use, and their practical applicability in the agro-ecological and socio-cultural context(s) of Central Kalimantan. As noted earlier, fire is used for land clearing by shifting and sedentary farmers, palm oil plantations, and by landowners to indicate ownership in absentia. Theoretically, there are alternatives for land clearing, including manual labor, machinery, and herbicides (Kinseng, 2008). However, investigation in the field and discussion with farmers reveals limitations in applying these techniques, especially for shifting cultivation. For example, labor costs can be significant, and these methods may not deal as effectively with pest problems as fire does. Clearly, incentives will be

[6] The Government of Central Kalimantan has invited leaders from districts and scientists from various research agencies to inform decision makers about innovations to improve land-fire management. The first meeting in 2011 is to be organized in March, and it is expected that researchers from IRI and Bogor Agriculture University (CCROM-SEAP) could advance the awareness and understanding of the local policy makers on the potential use of the seasonal fire risk forecast information for improving fire management in Central Kalimantan.

required to help farmers adopt these techniques in high fire risk years.

For sources of fire other than land clearing by small farmers, there are additional policy and institutional barriers to address in implementing a seasonal fire early warning system. For example, current regulations require that landlords exhibit usage of land, and a common way to demonstrate ownership is to burn it annually. Incentives must be found to discourage this practice, particularly in high fire risk years. In addition, legal enforcement to prevent companies from using fire remains patchy, and needs to be strengthened. Social sanctions against these companies, as called for by the Governor of Central Kalimantan (Benyamin, 2008) have had limited effect. In most cases, the companies are not local and are quite large relative to the size of local communities. Article 25 of the law, providing authority to the governor and/or mayor to stop the company's operations for environmental pollution, is rarely exercised. Sanctions, to be effective, need to be complemented by enforcement measures such as the automatic suspension of company operations in the investigation phase.

An effective incentive system will need to be designed in a manner consistent with the local context, including cultural, institutional, and economic aspects. This will involve research on the relative costs of alternatives to using fire; whether household, community, village or some higher-order group payments are more appropriate; conditions of payment such as how, when, and by whom payments will be made; and how monitoring will be conducted. The governance of the system and its ability to balance governmental demands and local customs (*adat*) need to be carefully considered. This will require further research, perhaps undertaken in the context of a pilot effort. Finally, sustained funding must be found to support such a system. Government funds might become available, but this is likely to be insufficient, at least initially. Given the newly emerging international efforts for Reducing Emissions from Deforestation and Forest Degradation (REDD) and the enormous importance of peatlands for carbon storage, the possible role of carbon payments is now being explored through a formal provincial team established by Central Kalimantan's governor in 2009. Reducing peatland fires has been identified as a crucial step, representing the largest contribution to reducing future greenhouse gas emissions in the province (DPNI, 2010). However, many challenges remain, since such payments will depend upon verifying fire reduction efforts and linking these to avoided carbon emissions, and upon effective institutional linkages from international levels down to districts and even villages, where fire reduction efforts will be undertaken.

CONCLUSIONS AND LESSONS LEARNED

Given the serious impacts on health and livelihoods locally and regionally, as well as significant contributions to climate change, reducing peatland fires is a high priority for the Indonesian government. President Yodhoyono's recent two-year moratorium on commercial land clearing, made in exchange for a US$1 billion pledge from Norway to support projects under the newly emerging REDD program, illustrates a national commitment to reversing current trends. However, success depends upon effective provincial and local implementation of measures that account for the role of fire in local livelihoods, and the variability of rainfall levels that play a role in determining the magnitude of fire impacts. Current fire management policy in Central Kalimantan, where significant peatland area is at risk, has been primarily reactive, involving fire-fighting efforts coordinated around 1–2 day warnings of fire danger. A provincial ban on fire use for small-scale farmers has not been successful, given the lack of alternatives to fire use for land clearing in shifting cultivation.

IRI at the Earth Institute, Columbia University and Bogor Agriculture University worked with CARE

Indonesia and the provincial government to develop a seasonal early warning system that enables proactive measures in high fire risk years. Through interviews and meetings at community, district and provincial levels, IRI and Bogor Agriculture University assessed the current institutional context and existing levels of capacity, and focused project research and tool development around these needs. Taking advantage of the sophisticated capacity of IRI's online Data Library, and an understanding of the linkages between below-average rainfall in relation to higher fire activity and ENSO-based rainfall variability, IRI and Bogor Agriculture University created a "Climate Risk Knowledge System" for fire early warning in Central Kalimantan, including written and online training materials, and four workshops for stakeholders.

As a result of project efforts, a 2008 regulation in Central Kalimantan integrated the use of seasonal climate information to assess fire risk and decide whether or not to allow controlled burning during the upcoming fire season, superseding a previous regulation banning all use of fire. The creation of a freely accessible early warning online system, in Bahasa Indonesia, and the provision of training to key provincial and district staff through a number of workshops enabled a high degree of awareness of the usability of season-ahead fire prediction. At the provincial level, a relatively small number of key staff needed to be convinced of the utility of seasonal fire risk information, enabling it to be articulated in a fire policy framework within a relatively short time. The possibility of identifying years in which fire risks are greatest also offered an opportunity to balance local pressures for the use of fire with national and international pressures opposed to it.

A problem-oriented and inter-disciplinary approach to research was critical to success. Trusting relationships built by CARE Indonesia with the government and with farming communities, and the high standing of Bogor Agriculture University in academic and official circles, greatly facilitated acceptance of research and encouraged its embedding in official polices. Rather than being the purview of a privileged few, a diversity of actors – farming leaders, elected village and district officials as well as technical staff from the provincial and district levels – could access, understand and most importantly discuss the utility of fire risk forecasts. The early warning tool provides a basis for implementing more sustainable approaches to reducing fire risk and impacts at the provincial and district levels. The experience in Central Kalimantan could be extended to other fire-prone provinces in Indonesia, through the development of similar early warning tools tailored to local contexts.

However, a critical challenge remains to create appropriate incentives for farmers to reduce fire use in high-risk years. Currently, farmers, particularly those practicing shifting cultivation, do not have other economically viable options for land clearing besides fire. To avoid using fire, they would need to receive tangible support. The longer lead-time offered by the seasonal early warning system could be instrumental in developing an incentive-based fire management program that enables planning and action over a longer time horizon. Provincial-level officials are now aware of and interested in this opportunity. Careful consideration will be needed of alternatives to fire use and their practical applicability in the local context. This will require further research, perhaps undertaken in the context of a pilot effort. Finally, sustained funding must be found to support such a system. The newly emerging REDD efforts offer an important opportunity, given the enormous global importance of peatlands for carbon storage. Formal efforts are now underway to explore this in Central Kalimantan, including the role of fire reduction efforts. Our experience highlights the need for careful consideration of the provincial and district-level institutional context and capacity in developing climate-resilient policies and programs.

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