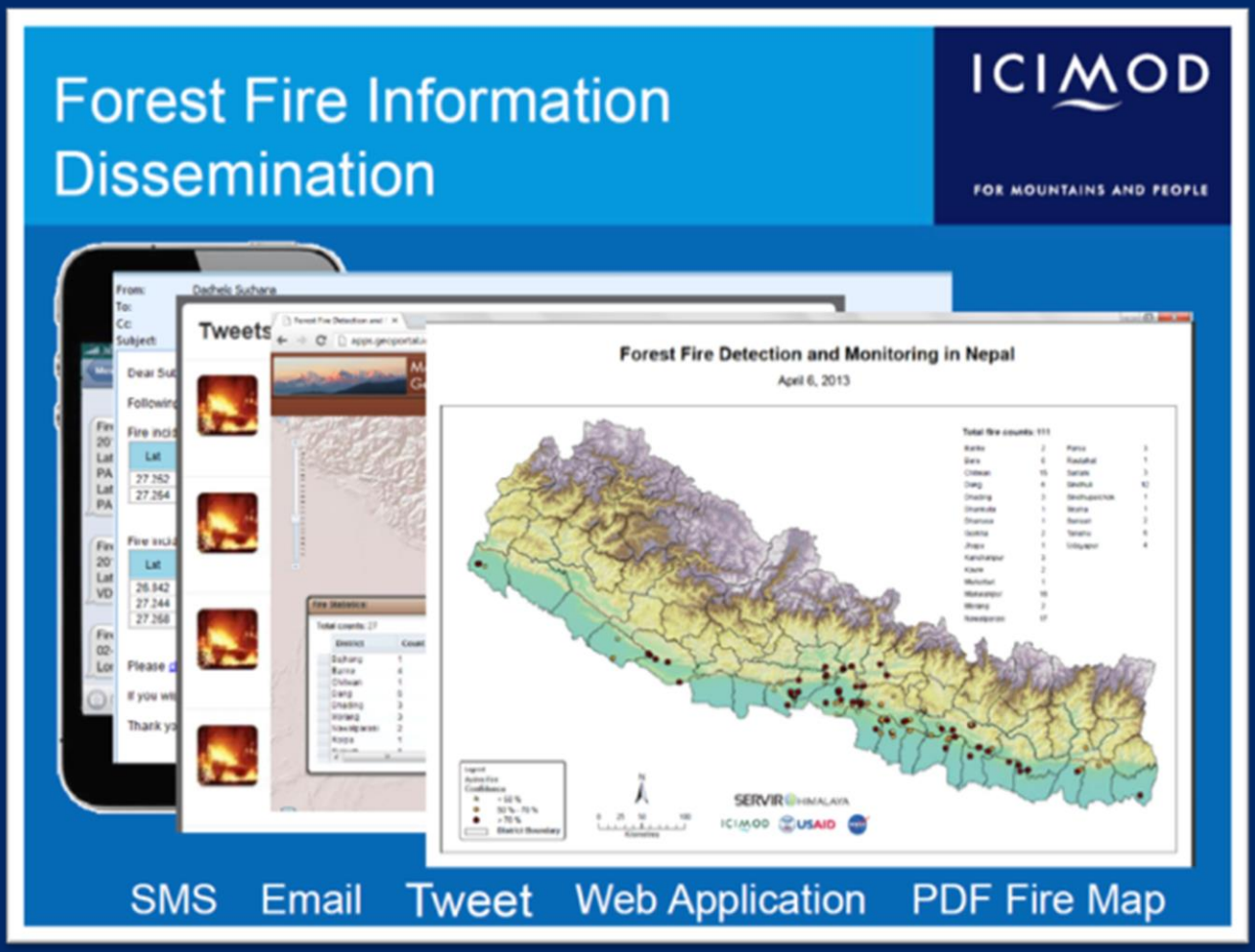
FOREST FIRE MONITORING AND ALERT SYSTEM

CASE STUDY FROM SERVIR-HIMALAYA



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FOREST FIRE MONITORNG AND ALERT SYSTEM

CASE STUDY FROM SERVIR-HIMALAYA

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ABBREVIATIONS

CFUG	Community Forest User Group
DEM	Digital Elevation Model
DFO	District Forest Officer (Nepal); Divisional Forest Officer (Bhutan)
DoF-Bhutan	Bhutan Department of Forest
DoF-Nepal	Nepal Department of Forest
DNPWC	Department of National Parks and Wildlife Conservation
DzFO	Dzongkhag Forest Officer
FECOFUN	Federation of Community Forest Users' Nepal
FFMAS	Forest Fire Monitoring and Alert System
ICIMOD	International Centre for Integrated Mountain Development
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NFMC- Nepal	National Forest Fire Management Chapter of Nepal
REDD	Reducing Emissions from Deforestation and forest Degradation
SMS	Short Message Service
SRTM	Shuttle Radar Topography Mission
USAID	United States Agency for International Development
USFS	United States Forest Service
VAS	Value Added System
VDC	Village Development Committee

EXECUTIVE SUMMARY

The Forest Fire Monitoring and Alert System (FFMAS), implemented in Nepal and expanded to Bhutan, is one of the flagship projects of SERVIR-Himalaya, and was chosen as a case study because it has garnered substantial publicity since its inception. In addition, it illustrates SERVIR's space to village mission in that the System relies on satellite information to relay alerts to the local level about forest fires. Furthermore, the FFMAS is a clear example of a SERVIR hub directly engaging with a stakeholder to drive the development of a tool.

SERVIR-Himalaya developed the FFMAS in response to the Government of Nepal's expressed need for a planning tool to improve forest fire management, including resource allocation and planning efforts within the national government. Before the implementation of the System, Nepal did not have a method for capturing data about the location of fires over time, nor did they have any type of alert system. The initial objective of the SERVIR-Himalaya project was to develop and implement a pilot system for monitoring fire incidence in Nepal and collect feedback from the users on its accuracy and usefulness. Based on the user feedback, SERVIR-Himalaya made improvements in the FFMAS and expanded a refined version to Bhutan.

To prepare this case study, the team employed both quantitative and qualitative methods, including 48 in-country interviews in five districts of Nepal and Bhutan. The information gathered during the interviews and group discussions, along with the quantitative data analytics from the SMS systems, email alerts, and Mountain GeoPortal,[1] answered key questions of *who* has been involved in using the FFMAS (or who else could be engaged going forward) and *why* those users were involved. Before the case study research began, SERVIR-Himalaya had collected anecdotal information from the Departments of Forestry in Nepal and Bhutan about specific forests that were using the System, or areas where SMS messages were being sent regularly due to high fire incidence rates. As a result of this anecdotal information about the current user base, an assumption was made that the districts receiving the FFMAS alerts (i.e. forest offices, parks, and community forest user groups) would be familiar with the System and have useful feedback for the team. The reality on the ground in terms of who was actually using the System, how people learned about it, and which tools from the System were being used, however, was somewhat different.

The System generates and disseminates three products: Short Message System (SMS) alerts, email notification, and a web application for visualizing the latest fire data as well as historical data. The web application can also be exported to a PDF fire map. In Nepal, the System currently has 256 SMS message subscribers and 211 email subscribers. These subscribers include District Forest Officers (DFOs) in 72 of Nepal's 74 districts and focal persons of Federation of Community Forestry Users Nepal (FECOFUN) in all of Nepal's districts. In Bhutan, individuals that are signed up for the email subscription also automatically have an SMS subscription because the SMS function was recently added during the 2014

[1] The Mountain GeoPortal is the online site where ICIMOD houses its interactive mapping applications (http://geoportal.icimod.org/)

fire season. There are a total of 59 email and SMS subscribers, the majority of whom are from the Department of Forests and Park Services and from the *Dzongkhag* (or "district") Forest offices.

Tracking statistics are available for the web mapping application since it is housed on ICIMOD's online portal, the Mountain GeoPortal. The visitor count to the web application is highly correlated to the fire season; the majority of traffic occurs in March, April, and May. For the Nepal fire application, most of the visitors are from Nepal, and though traffic to the site has varied over the past several years, an average of 500 visitors use the site during the three-month peak fire season.

In addition to the quantitative findings, the team identified several overall findings about who is using the FFMAS, which features are being used, as well as feedback on the performance of the System as a result of the qualitative research. In particular, interviewees perceived many benefits of the SMS alerts. Based on conversations with users and potential users in the field, the following six SMS-related themes emerged, in order of the frequency mentioned and perceived importance of each:

The monitoring and alert system:

1. Improves mobilization of resources for fighting fires.
2. Provides a secondary source of information for validating and verifying fires.
3. Is useful for supporting overall forest management at the national level, including historical tracking and monitoring of fire incidence.
4. Is useful at district level for identification of vulnerable areas and sharing information on neighboring districts.
5. Provides a good alert system for remote areas.
6. Builds community awareness.

Some overall findings from users of the system emerged as well. In particular, the following findings were most often cited:

The monitoring and alert system has:

- Had challenges in email and SMS enrollment.
- Fewer users than expected.
- Greater awareness of the SMS product than the email notifications or web mapper.
- High level of interest among potential users.

Both current and potential users expressed some limitations of the FFMAS. To a great extent, the majority of these limitations were due to a lack of training on the System, rather than a problem with the technology. The findings on the limitations of the FFMAS can be summarized as follows:

1. Data provided by the System may not be at a useful scale for the community level.
2. Timing of alerts could be improved.
3. Distinguishing between controlled fires and real threats presents reliability issues.

In response to these findings, the research team recommended that through trainings and simple communications materials, the enrollment of some strategic new users, and a few performance enhancements to the System itself, the application and use of the FFMAS could be greatly expanded throughout Nepal, Bhutan, and potentially beyond. In addition, the research team's discussions and interactions with the Department of Forest in Nepal led to several suggested next steps to better institutionalize and strengthen the System within the department.

Views about priority users for expansion of the FFMAS, however, seem to differ among the relevant SERVIR stakeholders. From the perspective expressed by USAID/Nepal, the priority for the growth of the FFMAS is to the community-level. On the other hand, the priority for the Department of Forest in Nepal is to ensure that its district officers have access to the System, understand the different components that are currently available, and have a systematic process in place for subscribing new users within the department. In terms of the cost implications for expansion, since the FFMAS was an activity funded under the SERVIR-Himalaya Program, the required investment to expand the system to other countries or regions would include primarily labor costs, with some infrastructure requirements (such as establishing a telecom provider, or maintaining hardware at ICIMOD). In order to scale the FFMAS to reach additional community level users, however, the enhancements required would be more significant because of the need for fine-scale community-level forest maps. Potential relationships with other community-based forestry projects in the region could also facilitate greater expansion to community level users, but would require time to build those relationships. In this case, strategic partnerships with existing USAID projects, such as Hariyo Ban and Forest Carbon Partnership Facility (FCPF), may be one possible approach.

1. INTRODUCTION

1.1 THE SERVIR PROGRAM

SERVIR is a joint development initiative of NASA and USAID, working in partnership with leading regional institutions around the globe. The objective of the SERVIR Program is to improve resilience to climate change by strengthening the capacity of governments and other key stakeholders to integrate Earth observation information and geospatial technologies into development decision-making. The project's activities include sharing, integrating, and mapping information from different sources, such as satellite imagery, geospatial data, and mapping applications from a multitude of continuous monitoring and assessment activities and assets. The primary anticipated results of the global SERVIR program include:

1. Improved capacity of analysts and decision-makers to use Earth observation information and geospatial information technologies.
2. Improved management, sharing, and access to geospatial information.
3. Generation and provision of user-tailored geospatial information to inform decision-making.

As part of this larger effort, the SERVIR Program Demand Activity or simply "SERVIR Demand," was launched in July 2012 as a complementary project designed to provide support in specific social science capacities to the overall SERVIR Program and to the regional partners which host SERVIR in the field. These "hub institutions" in Kenya and Nepal are leading geospatial information and technology organizations in their regions, and their expert staff serves as the interface between SERVIR's end users – the technical analysts and decision-makers who use SERVIR tools and products – and the support from NASA and USAID. Both the NASA Coordination Office and the Demand Activity are working collaboratively with hubs to implement the SERVIR Program in their regions. NASA's efforts focus on working with SERVIR hubs to develop and provide access to geospatial decision-support tools and information services – the "supply" of SERVIR program offerings. While closely linked to the science activities, the key objective of the Demand Activity is to support the hubs' efforts to strengthen the capacity of users to utilize the geospatial tools and decision-support applications created by the SERVIR program.

1.2 CASE STUDY OBJECTIVES

For the SERVIR Demand Activity, a critical step in building demand is to take stock of the suite of tools and services currently offered by the SERVIR Program and ensure it is well-documented. The following report on the Forest Fire Monitoring and Alert System (FFMAS) in Nepal and Bhutan was developed and co-authored in partnership with the International Centre for Integrated Mountain Development (ICIMOD), in order to provide an in-depth case study of one of the flagship projects of SERVIR-Himalaya[2]. The research and in-country interviews were used to facilitate exchange and learning in order to illustrate the who, what, when, where, why, and how a specific SERVIR program application influences decision-making processes. Table 1 summarizes the guiding research questions.

[2] ICIMOD is the hub institution for the SERVIR program within the Hindu-Kush Himalayan region. As such, SERVIR projects and activities implemented by ICIMOD within the region are referred to simply as SERVIR-Himalaya.

Table 1: Research Questions Guiding the Case Study

Who	a) Who defined the need, and who was involved in the conceptualization, design, development, operationalization, and funding? b) Who are the current and potential users and beneficiaries?
What	What products, tools, and services have been produced or derived from the original application?
When	What was accomplished when, and what is the timeline for any future activities?
Where	What is the geographical footprint and spatial scale and is there any planned or potential expansion?
Why	Who drove the development and why? What are the benefits and what impacts are hoped for or achieved? Why are people using the product and what were they using before?
How	How was the application in all its forms implemented (methods, partners)?

The FFMAS was chosen as a case study because it has garnered substantial publicity since its inception, notably in Nepal. Numerous articles have been written about FFMAS, particularly the SMS alert component, and questions circulate within USAID, both at the mission level and in Washington, and within NASA about the opportunities and actual usefulness of the tool on the ground. It also exemplifies SERVIR's space to village mission in that the System relies on satellite information to relay alerts to the local level about forest fires. Though less "sexy" in its journalistic appeal, the accompanying web mapping application also has the potential to greatly enhance the understanding of forest fire incidence and patterns, and directly impact management at the national and district level. The FFMAS is also a clear example of a SERVIR hub directly engaging with a stakeholder to drive the development of a tool. For these reasons, it was decided that the FFMAS be examined in more detail under the Demand Activity. While the FFMAS is being used in both Nepal and Bhutan, there is a greater emphasis on Nepal throughout the study because the System has been operational longer, more information is available, and there are many more stakeholders involved.

The Objectives of the case study are as follows:

- Document and analyze SERVIR-Himalaya's process for designing, developing, and launching a SERVIR tool.
- Identify the known users, elucidate additional potential users, and learn how users are employing the data they receive.
- Generate opportunities for growth and expand the landscape of users for SERVIR-Himalaya.
- Provide specific feedback to the SERVIR-Himalaya science teams on the performance of the tool, including recommendations for expansion.
- Provide lessons learned to the broader global SERVIR Program to help replicate and promote successes in engaging new users, increase linkages with existing users, and scale impacts.

In addition, for the Demand Activity in particular, this initial information gathering is necessary as we work with SERVIR-Himalaya over the third year of collaboration to identify new opportunities and potential for expanding and leveraging the investments made in the existing science projects.

1.3 METHODOLOGY

To establish an initial "baseline" of information, the Demand Activity team conducted an initial desk review of documents provided by NASA and ICIMOD. Further information was obtained in two site visits. During the inception period of the case study, the Demand team visited ICIMOD over a two-week period in late January and early February 2014 in Kathmandu. During this initial visit, the Demand team conducted interviews with members of the SERVIR-Himalaya team to gain insight into the history of the project, understand how the System operates, identify the intended user groups, and to collect documentation on the project. In collaboration with SERVIR-Himalaya staff, the conceptual framework and overall approach for the research was defined, including identification of potential organizations, entities, and types of individuals to interview. The team also used information obtained from these discussions and background research to develop the interview protocol to be used in the field. Quantitative research was also obtained from the Mountain GeoPortal and the SMS system to determine to what extent the System was being accessed (see Section 3.1 below for the findings associated with these data analytics).

The second field visit was conducted in April 2014 to complete the qualitative research. In total, three staff from SERVIR-Himalaya and one from the Demand Activity were involved in the fieldwork. Five districts were visited in Nepal and Bhutan, with a total of 48 individuals participating in semi-structured interviews or focus groups. The interview guides and focus group moderator guide can be found in Annex E. More information on the methodology for selection of field sites, timing and the profiles of the interviewees are included in the sections below. A complete list of interviews can be found in Annex D.

1.3.1 FIELD AREA SELECTION AND TIMING

Field visits were planned to observe several fire-prone districts in Nepal. For Bhutan, a visit was planned mainly at the administrative level in the capital city of Thimphu to investigate how stakeholders are using the forest fire products and to identify if additional measures are required to operationalize the tool at a similar level as is being done in Nepal. The team was also able to meet with one ranger station within the capital in Bhutan.

The locations in Nepal identified for this case study were selected based on the following criteria:

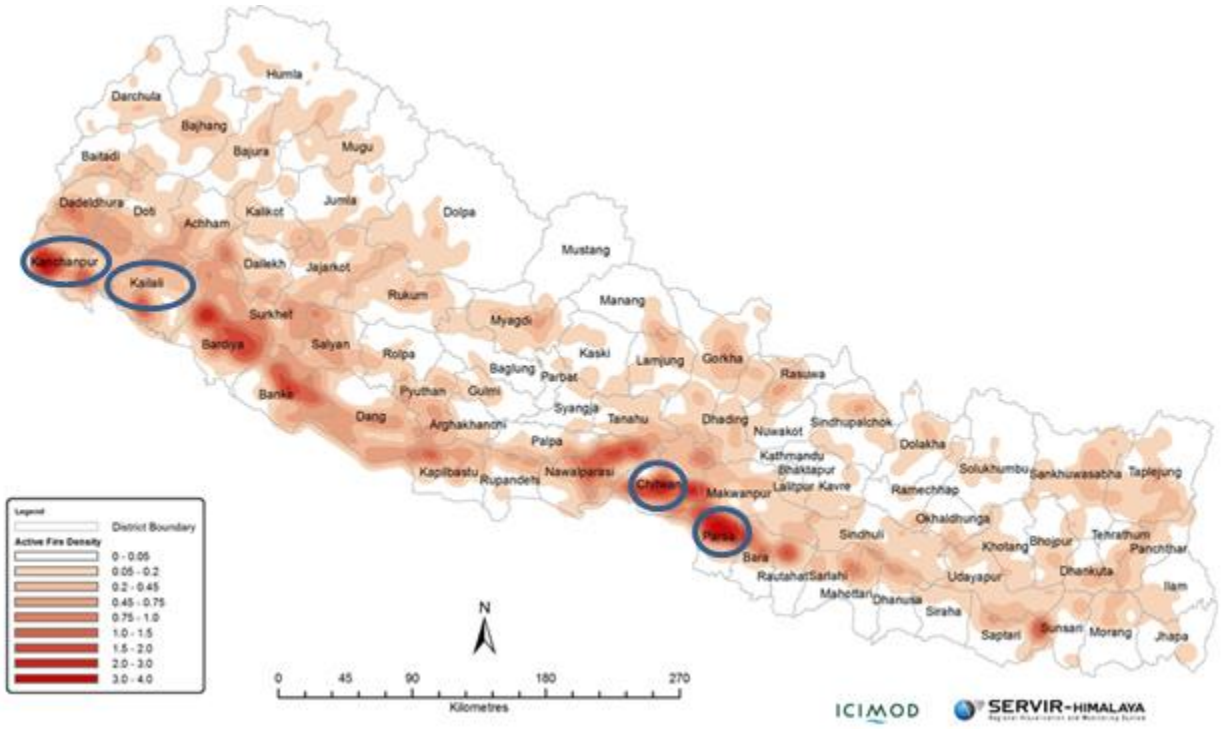
- Fire alert system has sent SMS to this area
- High incidence of fire has occurred[3]
- Accessible by field transport
- Department of Forestry (DoF) Nepal has interest in the area (i.e., active firefighting effort has taken place in the area)
- There are active community forest management groups in the area.

Figure 1 displays active forest fire density hot spots over time by district for Nepal. The greater the number of fires in a particular region, the darker red the color. The blue ovals designate the districts selected for field data collection based on the above criteria and where trips occurred. They include Parsa and Chitwan districts in the Central region, and Kailai and Kanchanpur in the Western region.

[3] Most of the fire incidents occur in the Terai and mid-elevation geographical regions of Nepal. As such, most fires reported are concentrated in the central and the western region, and less in the eastern region of Nepal.

Major fire incidences occurs during April and May in Nepal. Consequently, the field trip was planned during this peak season. Additionally, a visit to Thimphu, Bhutan, was included in May to discuss the FFMAS with DoF-Bhutan officials.

Figure 1: Map of Nepal Showing One-Year Fire Incidence



1.3.2 PREPARATION AND INTERVIEW DESCRIPTIONS

The development and roll out of the FFMAS was a truly collaborative effort. As such, the team determined that to best understand how the tool was conceptualized, developed, implemented and is being used, a number of different groups needed to be interviewed in the United States, Nepal, and Bhutan[4]. To select the organizations and individuals to interview in Nepal, groups were identified based on their involvement or potential involvement in product development, use, and dissemination. Fewer interviews were conducted in Bhutan than in Nepal primarily because the FFMAS is in its first year of operation in Bhutan and as such, the user community is relatively small.

In Nepal, a total of five officials from the DoF and the Department of National Parks and Wildlife Conservation (DNPWC) participated. Eight field officials from both departments also contributed. In addition, focus groups were held with two divisions of the Federation of Community Forestry Users

[4] The interviews conducted are from a small subset of the total districts in Nepal and the total number of subscribers.

(FECOFUN), and two Community Forest User Groups. In Bhutan, we interviewed a total of seven individuals from the Director General of the Department of Forests and Parks down to the ranger level.

The information collected via the focus group discussions and interviews varied based on the organizational affiliation of the participants and their role on the FFMAS. The interviewees can be grouped into the following four categories:

1. **Developers**: ICIMOD and SERVIR-Himalaya staff who developed FFMAS.
2. **Implementation Partners**: those at the institutional level, e.g., the DoF, responsible for guiding the System's development, dissemination, and use by at institutions.
3. **Users**: Field-based personnel who use the FFMAS tools.
4. **US Government Actors**: USAID and NASA staff.

Developers

The research team interviewed relevant ICIMOD and SERVIR-Himalaya staff who developed the FFMAS and worked closely with the government stakeholders in Nepal and Bhutan. Interviews with senior technical leadership were also conducted to gain a more complete understanding of the background and long-term plan for the FFMAS, including how it was initially conceptualized and developed, what trainings or capacity building activities were held, what challenges or opportunities arose from the process, and what the future plans are for the tool. Conversations were also held with an outside geospatial development firm (Spatial Dev) that had developed an initial SMS system for the FFMAS at the request of NASA, but which was later abandoned for an in-house system that better met the needs of the SERVIR-Himalaya development team and the tool subscribers.

Implementation Partners

Interviews were held with the FFMAS implementation partners, which include the DoFs in both Nepal and Bhutan. Initially, the purpose of these conversations was to determine how the tool was institutionalized and implemented across a broad spectrum of potential users and to learn about what training and education campaigns, if any, had been conducted. However, since the FFMAS principal partner was the DoF-Nepal, the interviews also focused on the role the implementing partner played in the direction of the tool's development, the dissemination of the tool, the future expansion of the tool, and desired or achieved benefits of the tool for decision-making.

Users

The team's field visits to four districts in Nepal and one district in Bhutan allowed for data collection directly from users who are familiar with and using the tool, as well as potential users who had not previously used the tool. In Nepal, current and potential users included District Forest Officers (DFOs), protected area managers, fire management units, sector forest officers, the Federation of Community Forest Users Nepal (FECOFUN), and several community forest user groups (CFUGs).

In Bhutan, on the other hand, the user community is still relatively small. As a result, many of the interviews were with forestry personnel spread across different branches of the DoF-Bhutan. Conversations and interviews were held with management officers at the DoF-Bhutan, divisional forest officers (there are twelve of these for 20 divisions nationwide), and a ranger who reports to the Divisional Forest Office level. This branch of the forest management system primarily deals with forest fire management, forest protection, and enforcement. A separate, but collaborating branch is the *Dzongkhag* (District) Forestry Sector, which keeps records and data for the DoF-Bhutan. This branch also fights forest fires under the coordination of the Divisional Forest Officer, and several people from this division

were interviewed as well. Bhutan does have 526 community forests, but they tend to be small. Please see Figure 11 on page 47 for a detailed chart of Bhutan's Forest Management Organizational Structure.

US Government Actors

Lastly, the data collection process included interviews with different US Government agency staff. The NASA SERVIR Coordination Office in Huntsville, Alabama was consulted to learn more about the role NASA has played in the development and implementation of the FFMAS. Information was also gathered from two US Forest Service employees who have recently been involved in trainings and research on forest fire management in Nepal. The US Forest Service representatives had visited several community forests and DFOs in Nepal and had some exposure to the ICIMOD tools. Their knowledge, experience, and recommendations for the tool are captured as well.

2. FOREST FIRE MANAGEMENT AND ALERT SYSTEMS IN NEPAL AND BHUTAN

2.1 THE PROBLEM OF FOREST FIRES

Forest fire is one of the key drivers of forest resource degradation in Nepal and Bhutan. Unplanned forest fires destroy valuable forest resources and reduce the regenerative ability of forests. According to MODIS[5] active fire records, about 2000 fire incidences occur every year in Nepal (Figure 2).[6] All of these fires occur during the dry season (November to June), with about 88% taking place during March, April, or May (Figure 3). Most of the fire incidences in Nepal occurs in the Terai region, located south of the outer foothills of the Himalayas, due to its hot climate and lush vegetation. In addition, some fires occur in the mid-hill region, located to the north of the Terai region (Figure 4). The terrain in the mid-hill region is much more mountainous and the steep geography further complicates suppression efforts. It also contains greater biodiversity and the potential consequences of soil erosion and habitat loss from fire may be greater.[7]

Figure 2: Annual Fire Incidence in Nepal as Detected by MODIS (Confidence Level Greater than 50%)

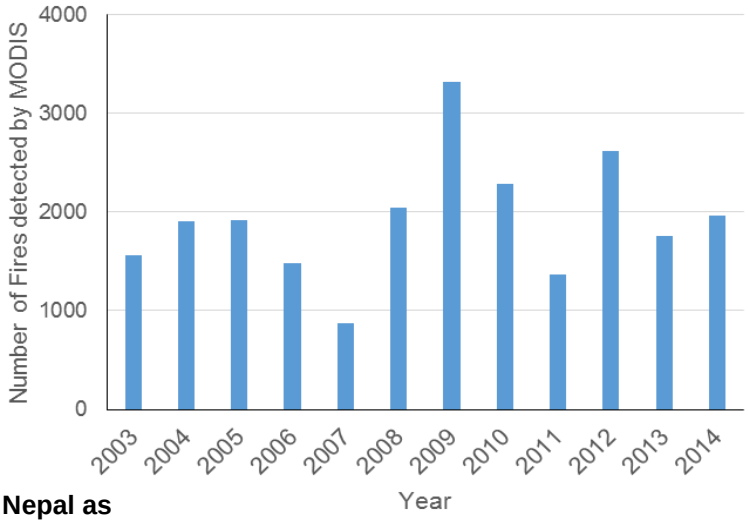
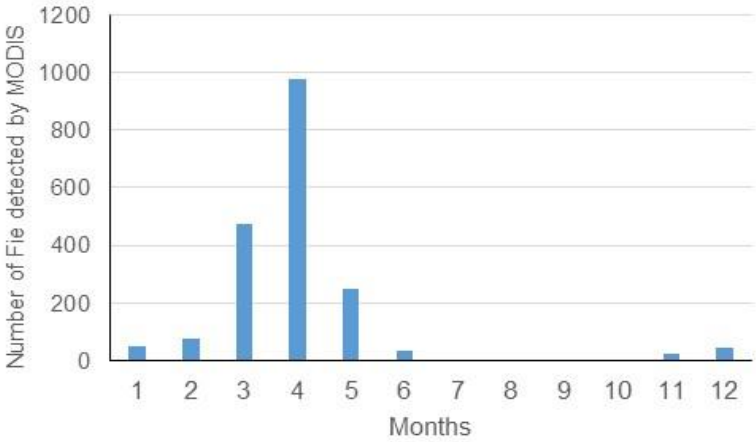
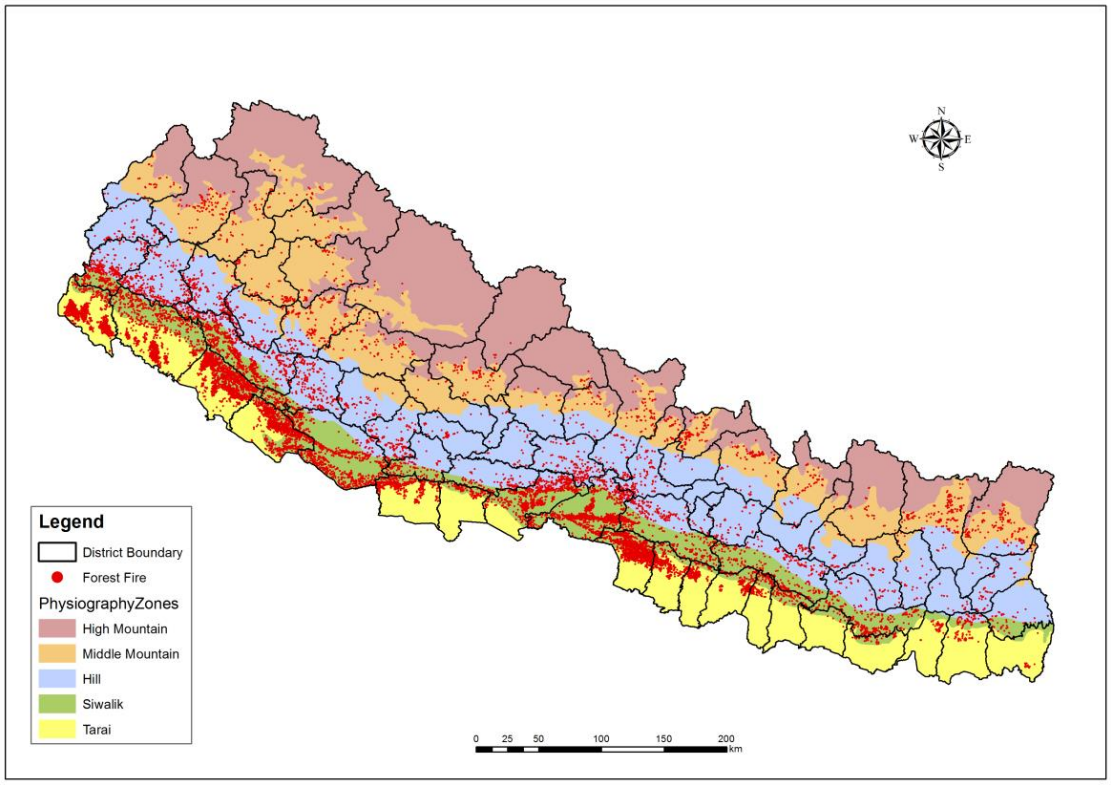


Figure 3: Average Monthly Fire Incidence in Nepal as detected by MODIS



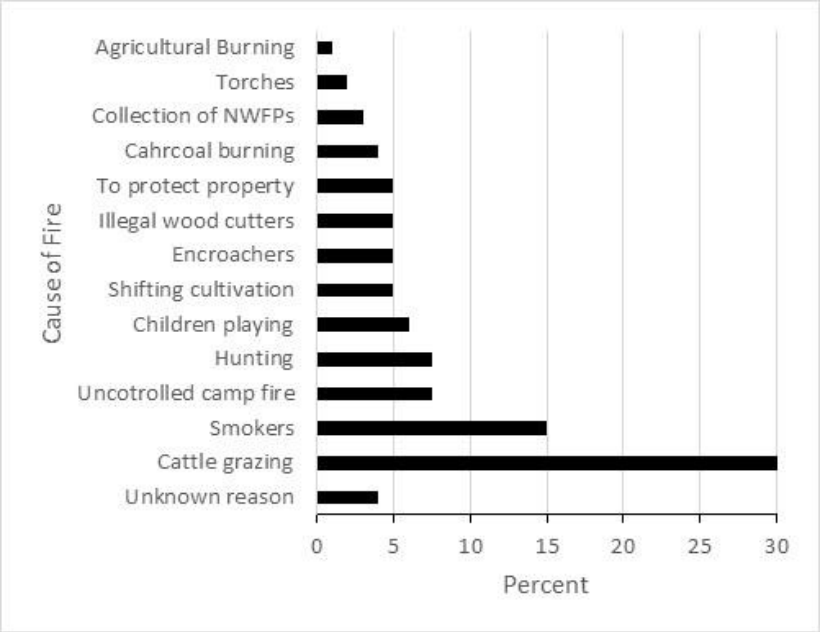
[5] Moderate Resolution Imaging Spectroradiaometer.
[6] Refer to Annex A for more information on the technical details of MODIS fire products.
[7] McHugh, C. (2013) "Observations and Recommendations of Fire Management in Nepal, Final Report May14, 2013". US Forest Service.

Figure 4: Fire Incidence Locations from 2003-2013 with Physiographic Units for Nepal



Most of the forest fires in Nepal and Bhutan are human induced, including the deliberate setting of fires and accidental causes, such as negligence. As illustrated in Figure 5, cattle grazing, smoking, hunting, and uncontrolled campfires are the four main causes of fire. Occasionally, people start fires due to personal conflict or dissatisfaction with the forest department. The largest problem cited by government officials in Nepal and Bhutan was cattle grazing, due to herders intentionally lighting illegal fires to clear land and generate fresh pasture for their herds. These fires often spread beyond the control of the herder and need outside assistance to suppress.

Figure 5: Cause of Forest Fire in Nepal



A forest fire management strategy was approved by the national government for Nepal in 2011.

The aim of this strategy is to improve the capability of the government and local communities to cope with forest fire disaster. The strategy has identified five focus areas:

1) Policy, legislative and institutional reforms
2) Education, awareness, capacity building and technology development
3) Participatory research and development on forest fires
4) Collaboration, partnership, network development and infrastructural development
5) Combatting forest fires through the use of an effective incident command system.

In response, the government established a three-step forest fire management process:

1) Detection of fire;
2) Mobilization of concerned agencies (information dissemination); and
3) Fighting the fire**.**

The FFMAS developed by SERVIR-Himalaya was a direct result of this process, and the Government of Nepal's expressed need for a planning tool to improve forest fire management, including resource allocation and planning efforts within the national government. Before the implementation of the System, Nepal did not have a method for capturing data about the location of fires over time, nor did they have any type of alert system. While Bhutan was capturing information about the fires after they occurred, they did not have an alert system.

Detection of Fire

There are two designations of forests in Nepal: those managed by the community and those managed by the government. In the community-managed forests, fires are mainly detected by community volunteers or forest watchers who identify a fire by spotting the smoke. In the government-managed forests, the range post staff and forest watchers also detect fire by identifying smoke, and then are responsible for notifying government officials in the central office (located in the capital). At present, there is no centralized mechanism for detecting fires and little uniformity to how the process is managed across forests.

Mobilization and Fighting the Fire

Once fire is detected in the community forests, volunteers or forest watchers determine whether it can be suppressed by traditional methods, which include beating back flames with green vegetation and wet grass. If not, the volunteers or forest watchers will contact government first responders, such as police, fire brigades, and District Forest Officers (DFOs).

In government-managed forest, no matter the size of the fire, DFOs or other DoF field officers are responsible for contacting first responders and mobilizing the services of fire fighters, army, police, etc. Recently, the DoF-Nepal also acquired firefighting equipment for all the districts. DFOs detecting fires on their land will work to quickly organize forest service fire fighters or others, as needed.

2.2 SERVIR-HIMALAYA INVOVEMENT

An inception workshop for SERVIR-Himalaya was held on October 7, 2010, and included participants from ICIMOD, relevant agencies from its member countries, and representatives from NASA and USAID. At that time, the SERVIR-Himalaya hub was just being established and the program had initiated an assessment of stakeholder needs. A forest fire monitoring system was identified as one of the priority applications to be implemented by SERVIR-Himalaya, mostly due to ICIMOD's established

relationships with the DoF and knowledge that DoF was looking for a technology solution to help with forest fire management. Based on the recommendation from the workshop, ICIMOD contacted the DoF-Nepal for a more detailed assessment of their needs and to identify the key stakeholders for a fire monitoring system.

The DoF-Nepal were aware of the satellite-based, active fire product available from MODIS and showed high interest in implementing an automated fire monitoring system based on it. ICIMOD was also collaborating with the National Forest Fire Management Chapter of Nepal (NFMC-Nepal), and a number of visits to NFMC members were organized. The initial objective of the SERVIR-Himalaya project was to develop and implement a pilot system for monitoring fire incidence in Nepal and collect feedback from the users on its accuracy and usefulness; this pilot system became the Forest Fire Monitoring and Alert System (FFMAS, or simply the "System"). Based on the user feedback, SERVIR-Himalaya planned to improve the System and expand a refined version to Bhutan. Furthermore, SERVIR-Himalaya designed the System with a long-term vision for DoF-Nepal to own and manage the information dissemination independently. ICIMOD's role was to develop the System, demonstrate its viability during the pilot phase, and then carry out the necessary capacity building within DoF, who in turn would scale the System themselves. Table 2 summarizes the roles of each key player in how FFMAS was developed, as well as how each of these roles was explored for this case study.

Table 2: Roles of Key Players in FFMAS Development

Role on the FFMAS	Organizational Affiliation	Relevance to Case Study Research
Product initiation and design	DoF-Nepal, ICIMOD, NASA, USAID	To understand the role of various organizations in defining the information needs and requirements of the System
Product development	ICIMOD, NASA, Spatial Dev	To understand the contribution of different organizations on developing the methodology, providing the data, developing the application, and maintaining the operation
Product dissemination	ICIMOD, DoF-Nepal, DoF-Bhutan	To understand the roles of both ICIMOD and DoF to identify potential users, maintain user information, and obtain and solicit feedback
Product users/Potential users	DoFs, DFOs, Community forest users, and FECOFUN groups	To understand how information products generated from the System are used and/or could be used for forest fire management at various levels and among different groups

The timeline for the System from initiation to expansion is summarized in Table 3. When the System was first launched in March 2012, it included automated data acquisition, processing, and reporting on locations of active fires present during the satellite's overpasses. Only daytime overpasses of MODIS-Terra and Aqua satellites were included for issuing the alert. Section 2.4.1-Satellite Overpass, discusses the relevance of this information.

Table 3: Timeline of key development milestones for SERVIR-Himalaya Forest Fire Monitoring System

Timeline	Key development
7 October 2010	During SERVIR-Himalaya inception workshop, the FFMAS was identified as one of the key priority systems to be developed by the program
2011	Further needs assessment and stakeholder engagement are conducted with DoF-Nepal and NFMC-Nepal. SERVIR-Himalaya initiates the design and development of the System
March 2011	Web map for MODIS fire data for Nepal is implemented
March 2011 to July 2011	Manual processing of MODIS active fire data to populate the web map for Nepal
5 March 2012	First operational system launched as pilot for Nepal; automated download, processing, and near real time alert (via SMS, email, and web map) system implemented
April 2012	Extension to Bhutan included with email alert and web map
10 January 2013	MODIS receiving station installed at ICIMOD supported by the Norwegian Government through the Royal Norwegian Embassy
March 2013	Active fire data from MODIS receiving station incorporated in the fire alert system, reducing time lag between satellite overpass to alert dissemination from 2-4 hours to 15-30 minutes
March 2014	SMS alert implemented in Bhutan fire alert system

2.3 HOW THE FOREST FIRE ALERT SYSTEM OPERATES

The follow section describes how the current FFMAS operates in two stages: 1) the delivery of the data via technology (i.e. data acquisition, data processing, and storage); and 2) product development and dissemination (i.e. how the technical outputs are translated into user-appropriate alerts). A few application modules have been developed using Python and C# .NET to carry out all the necessary tasks involved in these two stages, from acquisition to processing and sending alerts to the subscribers.

2.3.1 DATA ACQUISITION, PROCESSING, AND STORAGE

The MODIS active fire data are received four times daily from the satellite receiving station at ICIMOD: two times from Terra and two times from Aqua satellites.[8] These data are automatically downloaded and stored in the MODIS server. Enhancements developed by SERVIR-Himalaya create an interactive map that can be used by decision-makers and stakeholders not familiar with geoprocessing and remote sensing.

The acquired data are first clipped using the Nepal country boundary. The selected fire data are then filtered using the Nepal land cover data of 2010 to help avoid false alerts in the bare soil and non-forested areas. Fires are then filtered based on occurrences in forest, grassland, and shrub. Fires in all other land cover types are removed from the System. Administrative units, protected areas, and other land information are then attached using a spatial join to the fire shapefile. See Table 4 below for a listing of all of the data layers used in the FFMAS for Nepal and Bhutan.

[8] For more information on the technical details of MODIS fire products see Annex A.

Table 4: Data Layers Used for Forest Fire Product Generation

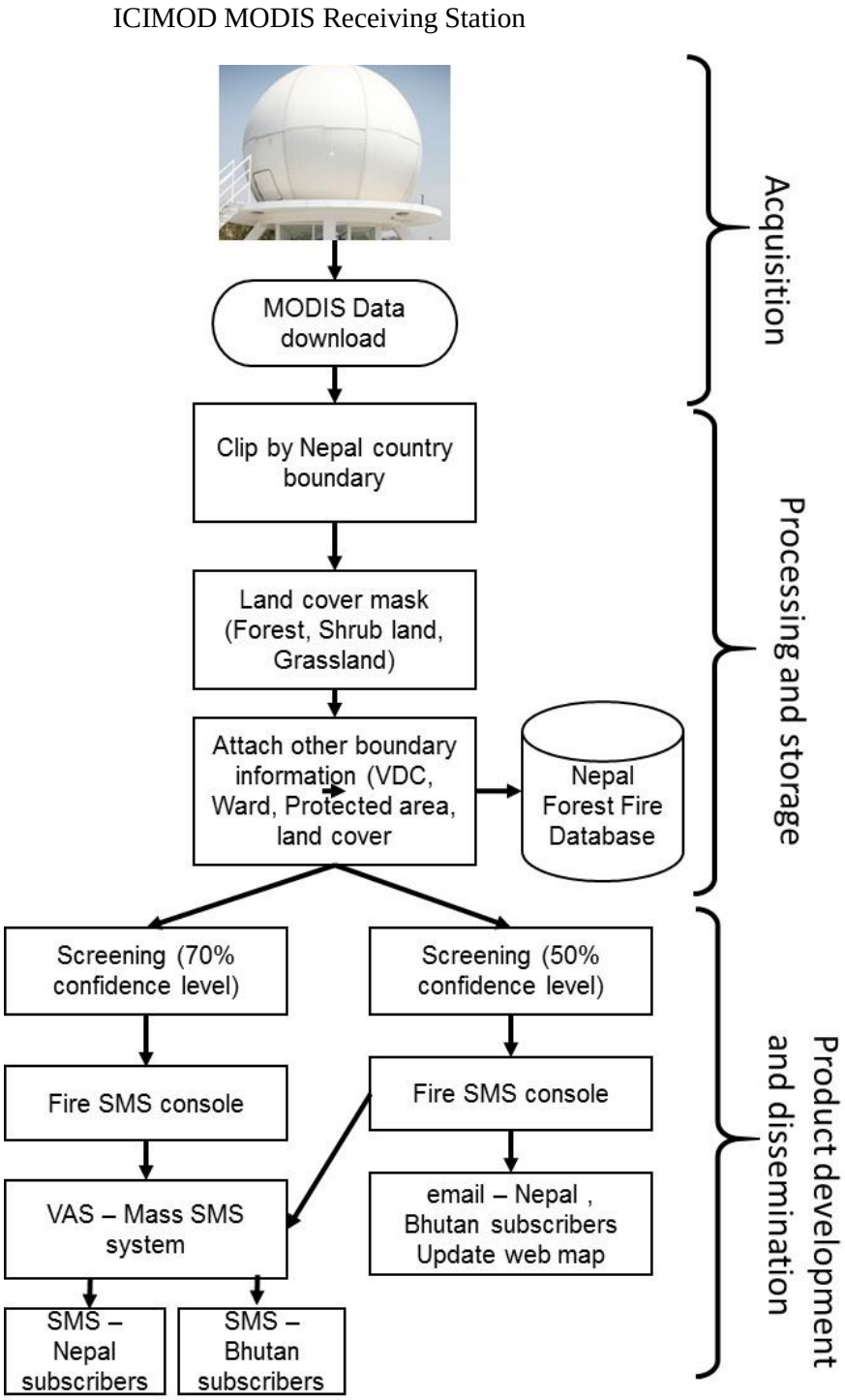
Data layer	Description	Purpose
	Nepal	
Ward boundary	1:25000 scale ward boundary from Survey Department of Nepal	Ward number, VDC (Village Development Committee), District
Protected area boundary	1:250000 scale protected area data from Department of Survey	Protected area
Shuttle Radar Topography Mission (SRTM) Digital Elevation Map (DEM)	SRTM 90m DEM	Elevation of the location
Land cover 2010	2010 land cover data of Nepal	Land cover of the location (Forest, Grass land, Shrub land)
	Bhutan	
Gewog boundary	Administrative boundary data, Department of Survey	*Gewog, Dzongkhag*
Protected area	Protected area boundary from Bhutan Land Commission	Protected area
SRTM DEM	SRTM 90m DEM	Elevation of the location
Land cover 2010	2010 land cover data of Bhutan	Land cover of the location (Forest, Grass land, Shrub land)

The processed data is saved in the forest fire database and used to generate various products for users. A python module has been developed to automatically process the active fire data. The script is synchronized with the MODIS receiving station application to check for new MODIS fire products. Once received, the fire location products are then processed to generate shapefiles, clipped with Nepal district/Village Development Committee (VDC) boundary, joined with other relevant information (i.e. land cover, protected area boundaries), and then generated into a fire incidence map. Figure 6 on the following page summarizes the flow from data MODIS data acquisition, processing and storage, and final product development and dissemination.

2.3.2 PRODUCT DEVELOPMENT AND DISSEMINATION

The System generates and disseminates three products: Short Message System (SMS) alerts, email notification, and a web application for visualizing the latest fire data as well as historical data. The web application can also be exported to a PDF fire map.

Figure 6: Flow Chart for Fire Alert System



Information on all fire incidents in a district is combined into a single text stream. Due to maximum character limitation of single SMS messages, sometimes the alerts are disseminated by multiple SMSs. Table 5 summarizes the content of the SMS alert:

Table 5: SMS Alert Metadata

Nepal	Bhutan
District name	*Dzongkhag* [9] name
Location of fire (Latitude, Longitude)	Location of fire (Latitude, Longitude)
For non-protected area: VDC name and ward number	For non-protected area: *Gewog*[10] name
For protected area: Protected area name	For protected area: Protected area name

Email Notification

A separate application was developed to automate the email distribution. A second database of email subscribers is also maintained in the database, and they are grouped by district as well. All the fire incidents having threshold values greater than 50% are included in the subscriber email notifications These notifications include more detailed information than SMS, and include a fire incidence location map attachment. Table 6 outlines the information included in the email:

Table 6: Email Alert Metadata

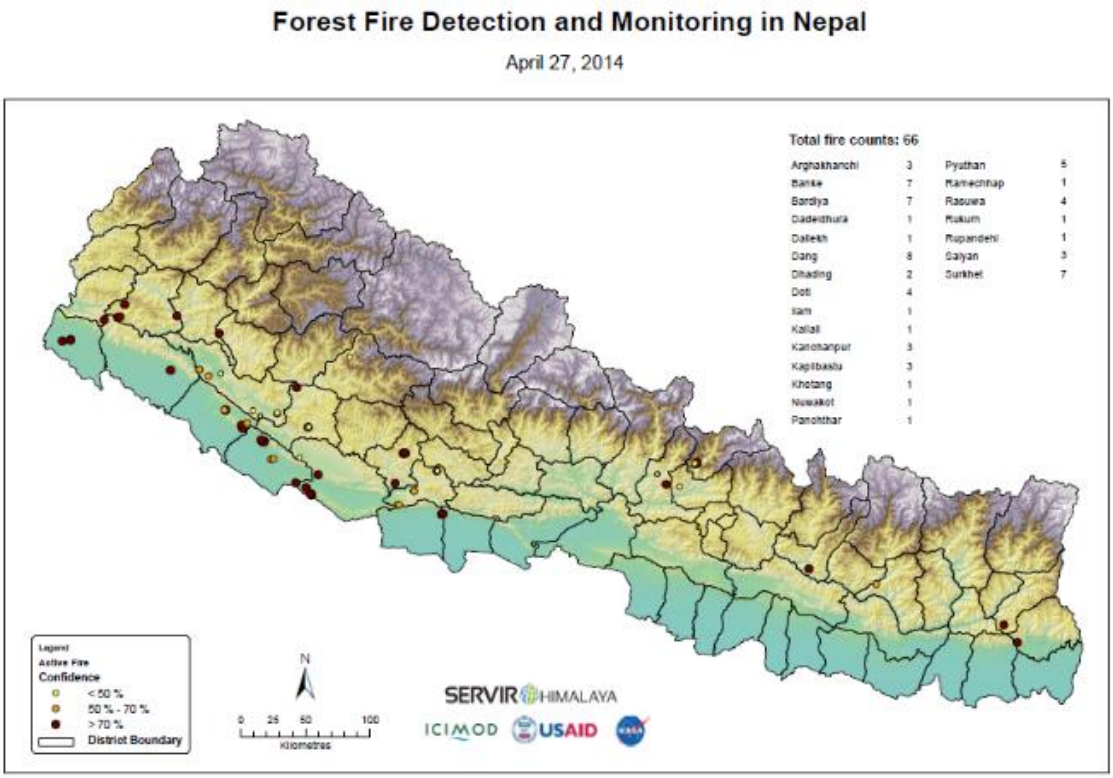
Nepal	Bhutan
Location of fire (Latitude, longitude)	Location of fire (Latitude, longitude)
Satellite (Terra, Aqua)	Satellite (Terra, Aqua)
District	*Dzongkhag*
VDC	*Gewog*
Ward number	Protected area name
Protected area name	Elevation
Elevation	Land cover
Land cover	Confidence level
Confidence level	

Print Map of Fire Locations

The PDF fire incidence map attached to the email includes fire incidence count by District (or *Dzongkhag)*, district boundary, and elevation. Figure 7 below provides an example. See Annex B for other examples.

[9] *Dzongkhag* is the term for the equivalent of District in Bhutanese
[10] *Gewog* is the term for the equivalent of Village Development Committee (VDC) in Bhutanese

Figure 7: Example of Fire Incidence Map Sent as PDF through Email Alert



2.4 LIMITATIONS OF THE SYSTEM

2.4.1 SATELLITE OVERPASS

Two MODIS satellites named Terra and Aqua pass over most locations on Earth twice a day. Combined, they detect fire incidence four times in 24 hours. The Terra satellite passes the same location in the morning at about 10:30 and again in the evening at about 22:30. The Aqua satellite passes the same location in the afternoon at 13:30 and during the night at 0:30. Although the fire alert system only sends SMS alerts using the two daytime overpasses, the web map records fire incidence from all four and displays them on the map.

> In January 2013, a **MODIS receiver and acquisition system were installed on the rooftop of ICIMOD Headquarters** with links to a processing facility in the Centre's central server room and a visualization system housed in the Mountain Environmental Regional Information System (MENRIS) section. The MODIS system was installed under the Cryosphere Monitoring Project, which is supported by the Norwegian Government through the Royal Norwegian Embassy in Kathmandu. With this new receiver, ICIMOD has direct access to real-time MODIS data from two NASA scientific research satellites, Terra and Aqua.

With the aid of the new MODIS receiving station at ICIMOD, the System is able to send an SMS within 30 minutes of the satellite overpass. Since the SMS only sends using the two daytime overpasses (10:30 Terra and 13:30 Aqua) any fire incidence occurring after 13:30 are missed. During the interviews for this case study, several interviewees expressed concern that a large number of fires mainly occur in

the evening before sunset. Most of them are also detected by the communities and stopped before the next satellite overpass at 22:30. These fires are missed by the System both in SMS and in the email.

2.4.2 SPATIAL RESOLUTION

MODIS active fires are detected by calculating the thermal anomalies on a pixel of 1x1 km. size, and the location of the fire is reported as the center of the pixel. The resolution of the pixel has the following consequences regarding the detection of fire:

- The fire location reported in the alert is the center of the image pixel, which is not necessarily the same location as the actual fire.
- Due to the coarse resolution of the fire pixel, fires occurring at one district or VDC may be reported falsely at another district or VDC if the fire occurs near a district or VDC border.
- The detectability of a fire depends on the flame size. Additionally, the surface heterogeneity, existence of fire in surrounding areas, clouds, heavy smoke, and sun glint affects the detectability.
- More than one fire simultaneously occurring within the area of a satellite pixel is reported as one fire.
- One large fire at the corner of four pixels is reported as four fires at the center of all four pixels.

2.4.3 OTHER ISSUES

There are few other issues that can affect fire detectability:

- Most of the fires in Nepal are creeping fires along the lower part of the forest floor and in understory vegetation. Where there is dense forest, views of these fires are obstructed by the overhead canopy and the probability of detection from the satellite decreases.
- False detection could happen due to hot surface temperatures, especially in the Terai region of Nepal, which has a warmer climate than other areas.

3. FINDINGS

The rich information gathered during the interviews and group discussions, along with the quantitative data analytics from the SMS systems, email alerts, and Mountain GeoPortal,[11] answered key questions of *who* has been involved in using the FFMAS (or who else could be engaged going forward) and *why* those users were involved. Before the case study research began, SERVIR-Himalaya had collected anecdotal information from the DoF in Nepal and Bhutan about specific forests that were using the System, or areas where SMS messages were being sent regularly due to high fire incidence rates. As a result of this anecdotal information on the current user base, there was an assumption made that the districts receiving the FFMAS alerts (i.e. forest offices, parks, and FECOFUN groups) would be familiar with the System and have useful feedback for the team. The reality on the ground of who was actually using the System, how people learned about it, and which tools from the System were being used, however, was somewhat different.

As mentioned previously, not everyone that was interviewed was aware of the System. In those cases, research questions were asked more hypothetically: how *could* you see this System benefiting you? To get at this information, it was first necessary to learn what features of the FFMAS are being used (SMS, email, web-mapping application, Twitter feed, paper maps, etc.) and for what purpose. In addition, the research team also gathered information on perceptions of the System's performance, both strengths and weakness, from users. One important overall finding was that where people were actually using the FFMAS, real benefits were identified and cited by every interviewee. The key findings discussed in this section are summarized into three sections:

1. **Data Analytics:** analyzes the extent to which the SMS systems, email alerts, and online web mapping application are accessed.
2. **User Engagement Analysis:** discusses overall findings on who is using the FFMAS and which features were being used.
3. **Performance of the FFMAS:** discusses the findings on the perceived benefits and limitations of the tool itself.

3.1 DATA ANALYTICS

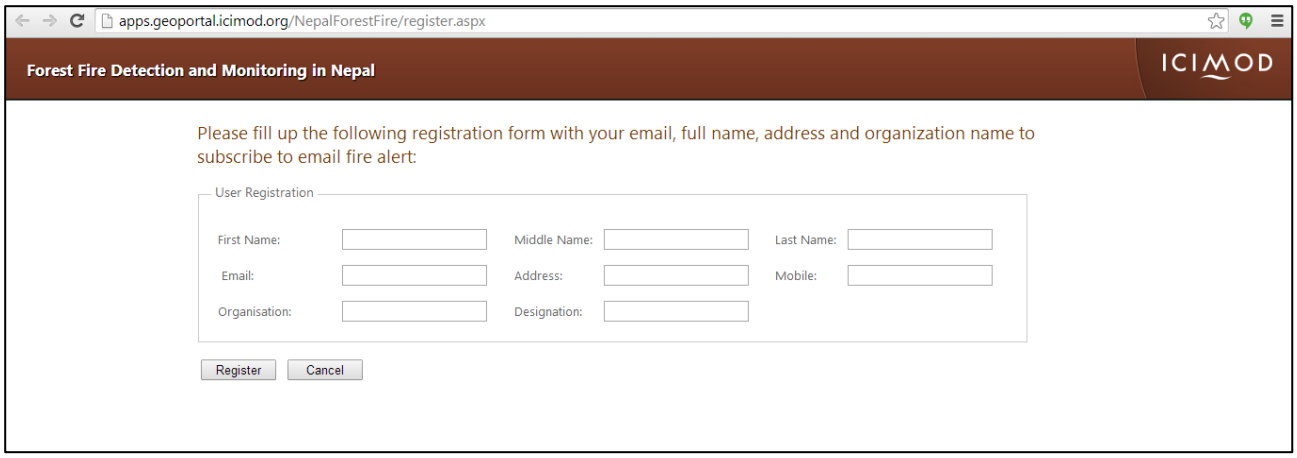
This section examines current users based on analytics of the FFMAS's three products: subscribers to SMS alerts, subscribers to email alerts, and visits to the online web mapping tool, which is accessible through the Mountain GeoPortal. It must be noted that the information presented in this section is limited to users who are currently subscribed to the System and are receiving alerts. While this data was an important first step in determining who is receiving outputs from the System and how users are enrolled, the data analytics alone are not sufficient to identify who is using the System in decision-making process. The findings from qualitative research collected through the interviews and focus group discussions, on the other hand, examine this question in Sections 3.2 and 3.3 below.

[11] The Mountain GeoPortal is the online site where ICIMOD houses its interactive mapping applications (http://geoportal.icimod.org/)

3.1.1 STATISTICS ON EMAIL ALERTS

SERVIR-Himalaya's primary strategy for enrolling subscribers to email alerts was to include all district level officers from the DoF and members of the CFUG network as part of the roll out of the System in both Nepal and Bhutan. After the launch, and once initial set up of the database was completed by ICIMOD, subscription to the email alerts was not automatic. In fact, enrollment must be done on an individual basis through the ICIMOD website, shown in Figure 8. The FFMAS also provides a self-subscription option in the Forest Fire Web Mapping application. Table 7 and 8 show the current number of email subscribers and their user group affiliation in Nepal and Bhutan respectively.

Figure 8: Email subscription registration form from ICIMOD's Mountain GeoPortal



3.1.2 STATISTICS ON SMS ALERTS

For SMS subscribers, a single individual at the DoF-Nepal was designated to modify and update subscriber information. In Nepal, the system currently has 256 SMS message subscribers. These subscribers include District Forest Officers (DFOs) in 72 of Nepal's 74 districts and focal persons of FECOFUN in all of Nepal's districts. Subscribers receive fire alerts on their mobile telephones if a fire incident is detected in the district of their subscription. Other subscribers include officials from Ministry of Forests and Soil Conservation, Nepal Army, World Wildlife Fund-Nepal, National Emergency Operation Centre of Nepal, Reducing Emissions from Deforestation and Forest Degradation (REDD) Network, and Asia Network for Sustainable Agriculture and Bioresources. In most of the districts, the primary subscribers are the DFOs and Chairperson/Secretary of FECOFUN.

Table 7: SMS and email subscribers in Nepal by affiliation

User Group	Number of SMS subscribers	Number of Email subscribers
District Forest Offices	97	67
FECOFUN	85	3
Department of Forest	15	22
Ministry of Forest	15	9
Other (National Level)	28	82
Other (District Level)	16	7
Unknown	0	21

Total	**256**	**211**

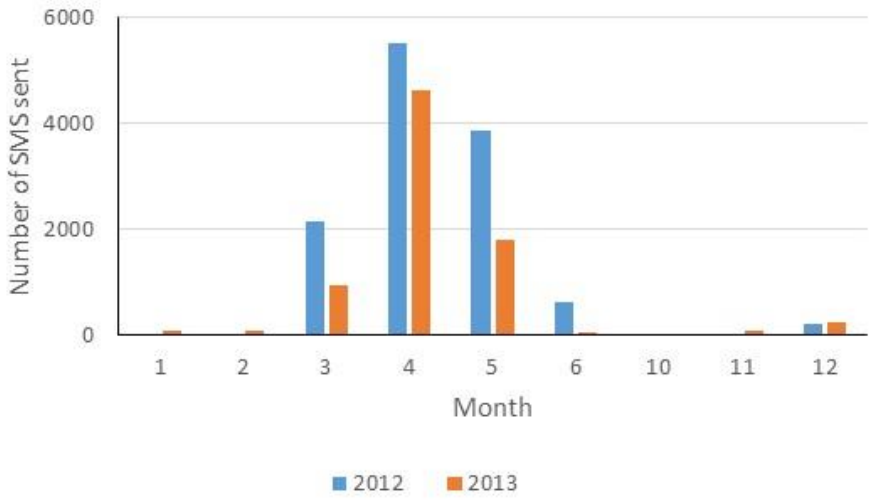
In Bhutan, individuals that are signed up for the email subscription also have an SMS subscription automatically because the SMS function was recently added during the 2014 fire season[12]. The majority of the subscribers in Bhutan are from the Department of Forests and Park Services and from the *Dzongkhag* Forest offices.

Table 8: SMS and Email subscribers in Bhutan by Affiliation

User Group	Number of subscriber (SMS and Email)
Department of Forests & Park services	31
Dzongkhag Forest Office	20
Other	8
Total	**59**

A total of 12,362 SMS messages were sent in 2012 and 7,902 in 2013 (there were more fire incidences in 2012, resulting in more alerts that year). At present, the number of SMS messages disseminated is about eight to nine times the number of fires detected, mainly due to repeated alerts about a fire burning continuously during multiple passes. There is no data yet available for Bhutan because at the time of the writing of this report, the 2014 statistics were still being compiled. Figure 9 shows the spike in SMS messages sent during the peak fire season in March, April, and May for years 2012 and 2013.

Figure 9: Number of SMS Sent to Subscribers by Month for 2012 and 2013



3.1.3 STATISTICS ON USE OF WEB MAPPING TOOL

Tracking statistics are available for the web mapping application since it is housed on ICIMOD's online portal, the Mountain GeoPortal. The visitor count to the web application is highly correlated to the fire season; the majority of traffic occurs in March, April, and May. For the Nepal fire application, most of the visitors are from Nepal, and though traffic to the site has varied over the past several years, there is roughly an average of 500 visitors during the three-month peak fire season. In addition, the visitor count to the Nepal application increased in 2013, which coincided with a US Forest Service training event that

[12] When interviewed, the Head of the DoF-Bhutan stated that only 9 people were subscribed to the SMS, so there is some discrepancy.

was held that year that featured the FFMAS. More detail on the number of visitors to the Nepal and Bhutan web maps by year are included in Annex C.

3.2 USER ENGAGEMENT ANALYSIS

Findings from the case study research on who are using the FFMAS and how they are using it – i.e. which features of the System are being used – are discussed below. To a great extent, the gap between expected and actual use was due largely to lack of awareness of the FFMAS, rather than limitations with the System itself. In response to these findings, suggestions for improving communication and raising awareness to grow the user base are included in the Recommendations Section. The key findings on user engagement are summarized as follows, and will be elaborated on in greater detail:

- Challenges in email and SMS enrollment.
- Fewer users than expected.
- Greater awareness of the SMS product vs. email or the web mapper.
- High level of interest in the FFMAS among potential users.

Enrolling users to email and SMS alerts in a systematic and consistent way has presented a challenge. When the System was originally rolled out in 2012 in Nepal, the DoF collected personal mobile numbers from all 75 of its DFOs and subscribed them to the SMS alert service. All official email addresses were supposed to be added to the email alert service as well. In addition, various park rangers, associate level field officers, and central forestry officers were added over time, either because they attended an event hosted by the DoF-Nepal in Kathmandu that mentioned the FFMAS or they had heard about the System from someone else. This proved problematic however, because the Forest Service is a very transient agency, and it is rare for foresters to stay in one district for more than two years. In fact, many move more frequently.

The DoF-Nepal is addressing this issue by subscribing the numbers of the official government supplied mobiles or SIM cards to the System rather than personal mobile numbers. Those phones stay with the district as the employees move around, so theoretically the incoming forester would be able to pick up the district phone and have access to the correct alert information. There was no mention from the DoF-Nepal if they changed the email subscriptions, though the findings also showed that not many of the interviewees were using that System.

Official government personnel who were interviewed and who are using the System in some way were almost always familiar with the FFMAS *prior* to arriving at their current post. Two of the DFOs interviewed in Nepal had previously worked in the central office in Kathmandu and had encountered the tool via trainings with ICIMOD or interactions with other forest staff that were directly involved in the implementation of the FFMAS in the field. A few others discovered the alerts on their phones, but did not know much about why they were receiving them. A possible explanation for why DFOs did not know why they were receiving SMS is that their personal mobiles had been subscribed earlier and they had not received any alerts while at a previous post. It is also possible that some SIMs or mobiles were not correctly entered into the System or that fires in those forests were never large enough to trigger an alert, since a few interviewees mentioned that they had been subscribed in the past but never received an alert.

Fewer people are using the FFMAS than expected. The gap between actual and expected use was due largely to lack of awareness of the FFMAS, rather than limitations with the System itself (more

discussion of the findings on this topic are included in the next section). Of the 14 government officials interviewed in Nepal, half were not familiar with it. This was true even if they were serving on a forest that was receiving alerts from the FFMAS, either because the district's mobile was in the System or the System was generating alerts for that district. This was not an expected finding, as both SERVIR-Himalaya and the central DoF-Nepal assumed the district officials were using the information for planning purposes of some kind.

In all cases, it was clear that there was no systematized way for the officers to learn about the FFMAS. No handover documents had been created, and no onboarding materials or trainings were standardized for the incoming officers by the central office in Kathmandu. In some cases, officers had not been receiving any messages from previous districts and when they started in their current post, they were not sure what the messages meant or where they were coming from. They also had no information about the intended uses and limitations of the System.

Overall, the use of the SMS alerts was not as uniform across the DFOs consulted for this case study as was expected. This was surprising, particularly because of both the emphasis the DoF-Nepal placed on them as their primary user group, and because of the high levels of interest in the System expressed by the DFOs during the interviews. With the exception of one district, none of the interviewees were aware of the web-mapping application (see Section 4.2.1 below for more discussion on this issue). Conversations with FECOFUN and community user groups showed that very few members of these groups are familiar with the FFMAS, nor are many of them using it. There are also very few users of the System at the community level outside of the DoF-Nepal, including army, police, Sector or Ilaka (sub-district) officers, though these were all recommended as groups that should be subscribed (see Section 4).

For Bhutan, the challenges are more straightforward. There has not been a clear roll out plan for the FFMAS within the central DoF-Bhutan office. At the time of the interviews, there was no DFO official managing a user database, as is the case in Nepal. However, discussions from the case study interviews led to one of the foresters being assigned this task, and he will work closely with SERVIR-Himalaya technical staff to establish the database. For Bhutan, since the System was still in a pilot phase, the DoF is open to expansion suggestions. Most of the interviews in Bhutan focused on how both the SMS and web-mapping application tools could be used and who should be subscribed and receiving training.

SMS alert is the most prominent feature of the System, while very few users are aware of the email and web mapping tool. In fact, according to a telephone survey completed by ICIMOD after the 2012 and 2014 fire season in Nepal, 67% and 78% of respondents respectively confirmed that they received the SMS. According to the 2012 survey, 78% people receiving SMS alerts found them accurate to moderately accurate, while in 2014, this increased to 88%. None of the respondents reported that the alerts were inaccurate in either survey. Refer to Annex F for more detail on the results of these surveys.

On the other hand, the use of the email alert and web application in Nepal was not significant. Of the 38 people interviewed in the field, only two were aware of the web-mapping application. One DFO user in Nepal stated it was helpful for communicating to the media about forest fires. He had also used it for developing a community-based forest fire management plan. With one exception – a Sector office in Kanchanpur – all of the groups interviewed had access to the internet, including the community forest groups, though there were some bandwidth issues that prevented a live demo during a couple of interviews. Similarly, the ICIMOD telephone survey from 2014 confirmed this finding as well. According to the survey, 83% of respondents reported that they did not receive or use email alerts. Furthermore, only 20% of the respondents used web application.

In Bhutan, where the SMS system was recently implemented, some users were aware of the email alert service and were receiving alerts this season. Also, a few users in the central DoF office of Nepal had been inundated with SMS messages. As a result, they had opted to unsubscribe from the SMS and keep the email notification instead. There was no feedback given about the email system.

There is a high level of interest in the FFMAS from those who are not currently using it. All of the DFOs and park wardens interviewed expressed an interest in being enrolled in the SMS system, even if they had only just learned about it from the interview. In addition, when asked to suggest potential users that should be subscribed to the System, the recommendations were consistent across the interviews. The ICIMOD telephone survey from 2014 also confirmed this finding. In fact, 93% of the respondents suggested that the SMS alerts should be sent to more recipients including communities, Ilaka staff of Department of Forests, CDO and DSP offices, local police and army units (more detail on this issue is discussed in Section 4.2). Similarly, almost all of the respondents (98%) would also like to receive SMS alert in the evening as well as the morning.

In Bhutan, because the System is so new, there are very few SMS subscribers. According to the Head of the DoF-Bhutan, *"There are only about 10 numbers or so in the system right now. But there are many more that could be added."* At least three of these subscribers are based in the central office in Thimphu. However, interviewees mentioned that in remote areas people may not be aware of fire without the system. The Bhutan Department of Forest and the Association of Foresters have expressed an interest in disseminating alerts at the community level, and also in discussing with them what kind of information would be useful.

3.3 PERFORMANCE OF THE FOREST FIRE MONITORING AND ALERT SYSTEM

Feedback from users on their perceptions of the performance of the FFMAS, both its strengths and weakness, are discussed below. In response to this feedback, suggestions for enhancing and improving the system's performance are included in the Recommendation Section (Section 4).

3.3.1 PERCEIVED BENEFITS OF THE FOREST FIRE MONITORING AND ALERT SYSTEM

Interviewees perceived many benefits of the SMS alerts. Based on conversations with users and potential users in the field, the following six SMS-related themes emerged, in order of the frequency mentioned and perceived importance of each:

1. Improves mobilization.
2. Provides a secondary source of information for validating and verification of fires.
3. Useful for supporting overall forest management at the national level, including historical tracking and monitoring of fire incidence.
4. Useful at the district level for identification of vulnerable areas and sharing information on neighboring districts.
5. Good alert system for remote areas.
6. Community awareness-building.

Improves mobilization. Almost all of the interviewees mentioned faster mobilization as the main benefit for having the SMS system. Receiving the SMS alert triggers deployment of field staff, police, army

officials, and other firefighting units in the vicinity of the fire. Attests the Kanchanpur DFO, *"It was helpful for mobilizing people. The mobilizing became easier with the System. That is [a] very important part of the System."* A community forest user group in Dullo (Kathmandu District), which had not yet used the System but was excited about it, expressed the same sentiment. Forest users might only detect fire from seeing smoke, but according to one CFUG member, the *"SMS alert would be helpful to detect fire and mobilize members faster."* They also felt it would be helpful if all the neighboring community forests were included in their list of alerts.

Bhutanese officials confirmed these assertions. According to the Head of DoF in Bhutan,

> *"We get all the fire incidents through the System and we could inform the Dzongkhag officers.... If we get the information, we call each of the individuals, which takes time. Some people are very into their duty. When they get the SMS they won't need to be informed from the central office and would save operation time. Now they call all the individuals and it takes a lot of time."*

The Dzongkhag Forest Officers (DzFO) interviewed also agreed this would improve mobilization and save time, stating, *"yes it [SMS] is important. If we get it immediately it will be helpful to mobilize."* More discussion of additional users to mobilize firefighting using the System is included in the Recommendations Section.

Provides a secondary source of information for validating and verification of fires. As the central DoF office is not always informed of each fire, several people mentioned that they use the SMS to verify and validate reports from the field. More than one manager in both Nepal and Bhutan told us that they do not always hear from the field units right away when a fire occurs, so the SMS alerts them to what is going on in the field. While the field units often already know the fire is occurring, it helps to verify their reports as well. One Nepalese DFO in Parsa mentioned that the SMS are helpful because *"there are a lot of things going on during a fire and I sometimes get informed incorrectly, so I like having the System to verify what's going on in the field."* Another DFO in the Kanchanpur district stated, "*After we started using the SMS, fire management improved. Now we have checks and balances. The field staff knows the district level officers will get SMS."*

The alert system provides the central office with more complete information about what is happening in their district and in turn, when an alert comes in, they are able to check in with their field offices. One sector officer in Kanchanpur mentioned that he is usually aware of the fires on the ground, but that, "*It is good to get information from different sources."* This sentiment was echoed by a park warden in Chitwan who stated, *"it would also be a helpful addition to our system."*

Useful for supporting overall forest management at the national level, including historical tracking and monitoring of fire incidence. Before the FFMAS, there was no way to systematically track fire incidence in Nepal. This was due to the fact that no incidence records are kept and also, as discussed in the previous section, the central office of the DoF in Kathmandu is not necessarily informed of each and every fire occurring in the field. As noted previously, this is because local communities play a primary role in detection and suppression, and do not always involve the DoF.

For instance, the Nawajagriti CFUG[13] in Nepal employs 10-15 full-time for patrols and has over 80 people per day in the forest during the fire season. When fires occur, the CFUG first informs their own communities of the fires, and then the local police. They also both said the DFO was informed last, or in some cases not at all – often because they do not see the DFO as able to provide support due to limited resources. The Kathmandu District DFO also said this is problematic because there are fires occurring on DoF-Nepal lands that the DoF is unaware of, since the community will suppress the fire near them even if the land is designated as a DoF protected area. One FECOFUN group said they used to call the DFO, but now they call the armed police because they respond quickly and have more equipment and a better rescue team. More discussion of the feasibility of additional users at the community level, such as these CFUGs and local police, is included in the Recommendations Section.

SERVIR-Himalaya and the DoF-Nepal see the Forest Fire tool as part of the overall fire management process. The System now enables users to access information for planning and strategic purposes by facilitating analysis of the overall fire context, which can help address nationwide fire management.

In Bhutan, the FFMAS is in place to support both the monitoring of forest fires, as well as the efforts underway to generate a historical dataset on incidence, which helps with planning for forest fires at the district level. The information is not necessarily directly useful for firefighting, but it gives advance warning to allow the department time for preparation and planning and to focus on the areas where the threat is more severe. In particular, the Head of DoF-Bhutan thought use of the web application would help build the capacity of the division, noting, *"It's 2014, we can't have paper maps. Internet is everywhere!"* In both Nepal and Bhutan's central offices, senior managers can see how many fires are happening nationwide and where.

> In Bhutan, traditionally villages would nominate a *Mee-sup* (fire watcher). The *Mee-sup* used to be on patrol and was funded by the community, but this has ended. The DoF-Bhutan is trying to reemploy them, but it has not been implemented in all villages. There are now 700 forest fire volunteers in all districts that inform the DoF central office in Thimphu of fire incidence. During peak forest fire season from October to May, forest rangers, forest beat officers, and *Desuups* (the King's volunteers who are mostly teachers) are all on patrol or alert.

Useful at the district level for identification of vulnerable areas and sharing information on neighboring districts. While many of the communities or FECOFUN groups in Nepal know the vulnerable areas, none of them are collecting fire incidence data. In fact, every interviewee related that no records are kept and no tracking exists at the district level, with the exception of Kanchanpur district in Nepal, where they are using the FFMAS web-application to track fire incidence. A warden in Sukla Phanta Reserve commented, *"There is no historical record, but it would be helpful."* In addition, one DFO in Chitwan mentioned he would *"like to know the frequency and places where fires are occurring."* Finally, another warden mentioned that there is no systematized way to exchange data between rotating wardens, but when they visit the park they can see scars from the fires.

In the districts where the FFMAS is being used, however, it has been helpful for planning and information exchange. For example, one FECOFUN group in Kailali District stated that the System served to ensure

[13] Community Forest User Groups (CFUGs) are community members who have a vested interest in their forest. A small percentage of the leaders from the CFUGs sit on the local FECOFUN chapter, which represents CFUGs across the region. There are many more CFUG members than FECOFUN members.

data is being captured for future fire planning, and identification of areas of high vulnerability. According to the Kailali FECOFUN,

> *"The SMS is good. This kind of information at district level would be useful to deal with concerned officials to show them that some areas are more vulnerable. That may not be sufficient for this year but may be useful next year for planning. Also valuable for the neighboring forest. On top of SMS there should be email circulated to people who could use the System without subscription."*

When asked if the SMS has improved fire management, another warden in Sukla Phanta Reserve affirmed, *"Yes. We are now more aware of the incidences."* Furthermore, many district level officials mentioned that the web-application and SMS combined would be beneficial in overall forest fire management in their communities.

Good alert system for remote areas. While most of the interviewees felt that communities and local field units would spot a fire before it was captured by the alert system, there were some accounts of the satellites capturing the fire on the ground in remote areas before people reported it. In the Kanchanpur District of Nepal where there are fewer settlements near the forests, this has occurred four to five times. Similarly, in the Kailali District, also in the western part of Nepal, the DFO has received notification about fires from the SMS before any other source. According to the DFO in Kailali, *"There was a fire I didn't know. I saw the email and I saw the fire. I called my Ilaka office even he didn't know that there was a fire. So he organized the [forest] users."* Similar reports came from the protected western areas which also have fewer settlements.

In Bhutan, a compelling example was shared about a remote fire in Trongsa district in the Black Mountains, more than a two-days hike from the nearest village. When the SMS came in, they informed the park manager who immediately sent firefighters to the blaze even though they had not received any other reports of the fire. When they arrived it was quite large, but they were able to put it out. The Head of the Department of Forests said he was thankful that he had received the alert, otherwise it would have continued to burn for a long time before anyone was notified.

Community awareness-building. A somewhat unexpected finding from the interviews was that the SMS alerts help to build community awareness about fires. While most of the DFOs interviewed stated that fire prevention education and awareness programs are an important part of their mission, a few specifically talked about how they are using the SMS, or how it *could* be used, to further educate communities. For instance, according to the Kanchanpur DFO,

> *"It has been very useful for sensitizing the community and relevant people about forest fire. The forest user group requested more firefighting equipment. When I got message it also had some positive influence in me. I was inspired to establish the fire management system. This also helps me to interact with media."*

During conversations with one FECOFUN group, the limitations of the alert system were discussed in detail, since many of the community forests are quite small and large fires are rarely undetected (this issue is address further in Section 3.3.2 on Limitations of the FFMAS). Still, given its current limitations at the community level, those interviewed were interested in expanding the SMS alert system. In fact, according to the Chitwan FECOFUN, *"by sending the SMS to a wider number of people, it will create awareness against forest fire. That awareness would be beneficial for overall fire management."*

3.3.2 PERCEIVED LIMITATIONS OF THE FOREST FIRE MONITORING AND ALERT SYSTEM

Both current and potential users expressed several limitations of the FFMAS. To a great extent, the majority of these limitations were due to a lack of training on the System, rather than a problem with the technology. Many users expressed frustration over what seemed to be an inconsistency in the generation of alerts from the system; for example, alerts were not being issued for all fires. One reason for this is that the FFMAS was designed to send alerts for fires based on a minimum size threshold. Because users were unaware of this, they interpreted it as an inconsistency in alert generation. Other perceived limitations were identified:

- Data provided by the System may not be at a useful scale for the community level
- Timing of alerts could be improved
- Distinguishing between controlled fires and real threats presents reliability issues.

Data provided by the System may not be at a useful scale for the community forest level. As discussed in Section 2.4.2, the FFMAS can only detect fires on a pixel of 1x1 km. size. As a result, many smaller fires are missed by the System, which raises a question about whether a RS-based system is useful or appropriate for community forest management; some community groups felt the size limitation required for satellite detection was too limiting to be useful for them. *"It's a news-making tool…but for real firefighting, it's not useful,"* according to one member of FECOFUN-Chitwan. This issue is addressed further in the Recommendations Section.

Timing of alerts could be improved. Another limitation mentioned many times was the timing of the alert. Many users expressed the need to receive alerts more frequently. The Chitwan FECOFUN group, for example, noted that if fires are intentionally set (i.e. by cattle herders), this is typically done around 16:00. However, due to the path of the MODIS satellite and the timing of the daily alert sent by the FFMAS, the System is missing these afternoon fires. The United States Forest Service (USFS) expert who visited several districts had a similar observation, noting that the morning pass of the satellite was too early to catch fires starting that day or too late if the fire started in the evening, and the afternoon pass also missed some because the alerts were only sent during daytime hours. Unless it is big, a fire set in the afternoon is usually suppressed by the evening, typically by the community if they live near where the fire originates. As a result, the evening satellite overpass (at around 22:30) will not capture those fires. Despite their comments on the alert spacing, the Chitwan FECOFUN interviewees felt it was an effective alert when combined with community mobilization on the ground.

Distinguishing between controlled fires and real threats presents a reliability issues. Distinguishing between controlled fires and real threats has also been problematic for FFMAS users. USFS experts also noted this frustration, since it can undermine the reliability of the alerts in identifying "real" fires. Some interviewees noted that they ignore the SMS partly because of this lack of reliability. Most of the controlled fires, however, happen in the protected areas, and for some field-based users, receiving alerts about controlled fires is not a problem because they are already aware of them. This is more problematic for officials in the central offices farther away, who are not aware when the controlled fires are taking place.

4. RECOMMENDATIONS

This section summarizes recommendations and proposed next steps based on research findings. For example, through trainings and simple communications materials, the enrollment of some strategic new users, and a few performance enhancements to the System itself, the application and use of the FFMAS could be greatly expanded throughout Nepal, Bhutan, and potentially beyond. In addition, the research team's discussions and interactions with the DoF in Nepal led to several suggested next steps to better institutionalize and strengthen the System with the department. These DoF-Nepal specific recommendations are included in Section 4.4.

4.1 IMPROVE COMMUNICATIONS AND ORIENTATION TO USERS OF THE SYSTEM

One of the clear gaps identified by almost every interviewee was a need for more training and information on the purpose, scope, and capabilities of the FFMAS. Up until now, trainings mostly occurred through ICIMOD staff, either formally to large groups or informally during meeting and presentations. For formal trainings, a guide has been developed for SERVIR in general, with a chapter devoted to the FFMAS. This guide was developed for a strictly technical audience. Some of the content, however, could be adapted, such as the explanation of the resolution and how fires are captured with the pixels, to address the needs of a more high-level orientation for decision-makers and non-technical users of the System.

A more common mode of information sharing has been via one-on-one conversations between ICIMOD staff and DoF personnel, mostly in Nepal. In these cases, government officials are aware of the FFMAS, but may not know any of the details or specifics of the purpose of the System. Based on the interviews conducted, it also appears that the DoF of both countries has not communicated much about the System with their staff or community networks. In fact, none of the interviewees had received formal training on the System – as these trainings were not designed to target field officers or users outside of the central office – and many were not clear on the capabilities of the System, including how the fires were being detected, what size fires would be captured, or why they were not receiving alerts for all the fires occurring over the season. Because of this, some thought the System was not very accurate because it did not send alerts on smaller fires.

Conversations with USFS experts who had visited districts in Nepal and talked with stakeholders in 2013 and 2014 confirmed this assertion. According to the USFS experts, a lack of communication about the System's purpose and capabilities was contributing to confusion at the district and community levels where word of the FFMAS had spread informally. The USFS representatives felt more dialog was needed to explain to users what the System can be used for and how it works. One USFS expert felt the people on the ground, including DFOs and CFUGs, have a misunderstanding of which stakeholder groups the tool is intended to serve and believe it was designed for the community level.

During the case study field visits, stakeholders on the ground also expressed their confusion about the FFMAS and SERVIR-Himalaya's intentions for its use, demonstrating a need for more communication from the DoF-Nepal or SERVIR-Himalaya about the intended uses and limitations of the System. In addition, the USFS expert was requested by the USAID/Nepal Mission to gather more information on the FFMAS and how it was being used at the community level. With respect to orientation and

communications, two main requests were made by the majority of interviewees: 1) training or orientation to the different tools (SMS Alerts, email Alerts, and the web application); and 2) brochures or information on the System. More detailed recommendations in these two areas are discussed below.

4.1.1 TRAINING

In almost all interviews, a brief orientation to the FFMAS was presented to participants to explain the SMS and email alert tools as well as the web-application. A brief demonstration of the System, including the web-application and an example of an SMS alert, was also given. The purpose of this introduction was to help interviewees gain a better understanding about the way the data were generated, the System's benefits, and its limitations. The most common response was that training and orientation was needed for the people using the FFMAS at the district level or in the community network groups. This response was repeated in many of the interviews conducted. Examples of comments received are listed below. Unless otherwise notes, quotes are from Nepal interviewees:

- *"It would be useful to have some orientation and training on the System."* Chitwan DFO
- *"I am the main user but if we can give some training to the sector officer and Ilaka officers they might use it better. Because I am very busy*." Kailali DFO
- "*We need some training.*" Sukla Phanta warden
- *"Conduct awareness campaign. Forest management sector and forest conservation units should be sensitized."* Kanchanpur DFO
- *"There should be some description of the SMS system to the users. That could be beneficial."* Kailali FECOFUN

Focus group participants also gave valuable inputs for training, and the discussion points can be summarized as follows:

- Would like training on the SMS limitations and uses, and also on the web-app – Parsa DFO
- There should be some orientation on the System – Sector Officer
- The warden and some of his staff should have some training on the web-map – Chitwan park ranger
- They would like training and capacity building. Another recommendation from CF is to organize small orientation program focusing on the tools. That will make people aware of the System and how it works. Then can also make a list of subscribers from the attendees – Dollu CFUG
- It would be great to have some training on the System for the DFOs and people who will be using the System [referring to web-app] – Head of DOF in Bhutan

The study team also observed that of all the places interviewed, the Kanchanpur district in Nepal seemed to be more aware of the ways the System can be used. This was most likely because the new DFO helped spearhead the System in Kathmandu in his previous position and was very familiar with the tool. The interviewees in Kanchanpur district were more aware of the tool and its functionalities because they had direct exposure and training from someone familiar with the System, instead of having to figure it out on their own.

4.1.2 COMMUNICATION MATERIALS

Several interviewees expressed a need for simple informational brochures that explained how the system worked that could be distributed to each new user. This could also be included in forest management

planning materials, and could accompany the official mobile phones during the transition to a new civil servant. Some related comments included:

- *"If you send some training material through email, that would be very useful."* Kailali DFO
- *"The sector could [then] train people if those materials were sent."* Kanchanpur Sector officer, when asked if providing a brochure and information packet would be enough
- Guidebook recommended for incoming DFOs to deliver information on the System to the new person – from focus group discussion with Chitwan DFO in Nepal

After a simple conversation explaining how the System worked, many of the questions that DFOs and park employees had were answered. After receiving additional information about the limitations of the fire monitoring alert and the size and intensity of the fires captured, some of the interviewees seemed more comfortable with the System. Regarding the web-mapping application specifically, training was requested from everyone, with the exception of one district with prior central office experience.

The USFS experts also recommended centralized communications around the intended uses of the tool. Building it into the DoF-Nepal's standard operating procedure is most likely the best way to do this, possibly by adding the materials to the Forest Preparedness Document created by DoF-Nepal. Both USFS experts consulted for this case study felt the FFMAS was a good tool, but people were misinformed about it and not using it because they did not understand it well. It seems that the increase in orientation and training on the System, combined with some simple materials about the functionality of both the SMS and the web-mapping application, would go a long way to increasing the use and understanding by the users.

4.2 DEVELOP AND IMPLEMENT ACTIVE USER EXPANSION AGENDA

After providing a brief explanation of the uses and potential uses of the FFMAS as well as its limitations, the research team then asked interviewees to recommend additional subscribers to receive alerts. The interviewees were also asked to expand on why these groups would benefit from receiving the alerts. For the most part, answers differed slightly among the interviewees based on their background and role in forest fire management. Government officials, for instance, tended to think about the big picture of fire management and mobilization, while communities wanted to make sure the right people were notified to help fight the fires. Overall, however, there were many common suggestions for additional subscribers in Nepal, and these recommendations are summarized below in Table 9.

4.2.1 NEPAL

All of the DFOs interviewed stated that the Sector Officers and Ilaka Officers should be getting the SMS. In fact, these two groups were mentioned more than any other for addition to the SMS database. There are 75 districts and 927 Ilaka in Nepal (please see Figure 10 below for more detail on Nepal's Forest Management Organizational Structure). Many of the DoF-Nepal staff interviewed recommended adding police and army as well, since those groups are often the first responders and better trained in firefighting than other emergency groups, especially at the local level. As one DFO in Kailali commented about including the police, *"We could better collaborate."* Several also mentioned notifying field forest officers from the DoF-Nepal, as well as the community in some way, either through specific officers in a CFUG, or through a broader Community Forest

> *"If we are only sending to DFO and FECOFUN chairperson, they won't really care where it is occurring, they will just be counting. If I get the information about my forest, I will have ownership over the information"*
>
> - Member, Nawajagriti CFUG

Coordination Committee.

This has significant scaling implications, as there are 18,000 community forests in the country, often with 25 or more members. Few if any CFUGs are currently subscribed. According to the DFO in Kanchanpur, a proposed solution was that the Department *"should identify a focal person in each District Forest Office who will coordinate to collect and update all the phone numbers."*

Protected area managers interviewed repeated the need for army or other military personnel SMS subscriptions; one park warden suggested that the Colonel stationed in the park should also receive the SMS. In addition, these interviewees felt that wardens, assistant wardens, rangers, and the local buffer communities adjacent to the protected areas boundaries should be subscribers as well.

The communities themselves waivered on whether they needed to receive the alerts. At first everyone wanted to be subscribed, but after the limitations of the System were explained, there was some debate. Some felt it would not be useful to receive an SMS about a fire that was at least 1 km^2 in size because they would already be aware of it long before the alert was received. Others felt it was still useful to receive it, especially if the fire was burning in an adjacent community forest or protected area – i.e., too far from eye witnesses in their community, but not too far for a fire to spread.

> *"If there is information at the community level on other fires happening in other community forests [nearby] we can better coordinate and help each other."*
>
> - Member, Dollu CFUG

Recommendations were made to include at least the FECOFUN members, and this was repeated in conversations with FECOFUN. According to a member of the Chitwan FECOFUN, for instance, *"By sending the SMS to wider number of people, it will create awareness against forest fire. That awareness would be beneficial for overall fire management."* Some community members also felt it was still useful for members of the CFUG executive board to be notified (which is generally about 10-15 people). Both FECOFUN and CFUG members also thought it would be useful if the local and regional police were notified.

One additional recommendation that ICIMOD staff mentioned had come out of previous meetings with the DoF-Nepal and FECOFUN officials was FM radio stations. Approximately 300 FM stations are registered nationwide. This would serve as a community awareness tool, but there were mixed reactions to this recommendation among the DFOs in the field. Some thought it might help spread the message, but others cautioned that the confidence rates would need to be very high to be sending to the FM stations.

Table 9: List of Recommended Additional Subscribers from Nepal Interviews

Interviewees	Subscriber Recommendations
District Forest Officers and related officials	Sector Officers Ilaka Officers Army Police Field level staff (forest guards) Assistant Forest Officers* Chairperson and Secretary of CFUG Community Forest Coordination Committee Chief District Officer* District Disaster Management Unit* Conservation networks*
Protected Area Managers	Local buffer communities Rangers Military officers Army officers (at least the Colonel) Warden and assistant warden
Community Groups	Executive committees of the CFUG Local Police Regional police Chairperson of the CFUG All FECOFUN members
ICIMOD Staff	FM radio stations

* Recommendations from a single DFO

4.2.2 BHUTAN

Since there was no community input to the case study from Bhutan, the recommendations for additional subscribers were mostly focused on government officials and response teams. Recommendations were made to include all 1450 field rangers and all 10 park managers, for instance. The DzFOs also recommended including governors, *Dzongkhag* forest sector people, the *Gewok* administrators, police, army, and possibly the *Desung* (royal volunteers who often fight fires). Figure 11 provides more detail on Bhutan's Forest Management Organizational Structure. Since the System is still relatively new in Bhutan, there was not as much discussion about how and why different groups should receive the alerts or have access to the web mapper.

The expansion in Bhutan went beyond simply subscribing new users to the System via email addresses and mobile numbers (refer to Table 3 for the timeline on the Bhutan rollout). For each new country, buy-in is needed from the host institution, in this case the DoF-Bhutan. In order for the SMS messages to originate domestically, the SMS alert system was also customized. In addition, the SMS alerts also incurred a recurring cost for DoF-Bhutan. This was not seen as a barrier to institutionalizing the System, however, as there was already a high level of interest with DoF-Bhutan.

Figure 10: Nepal Forest Management Organizational Structure

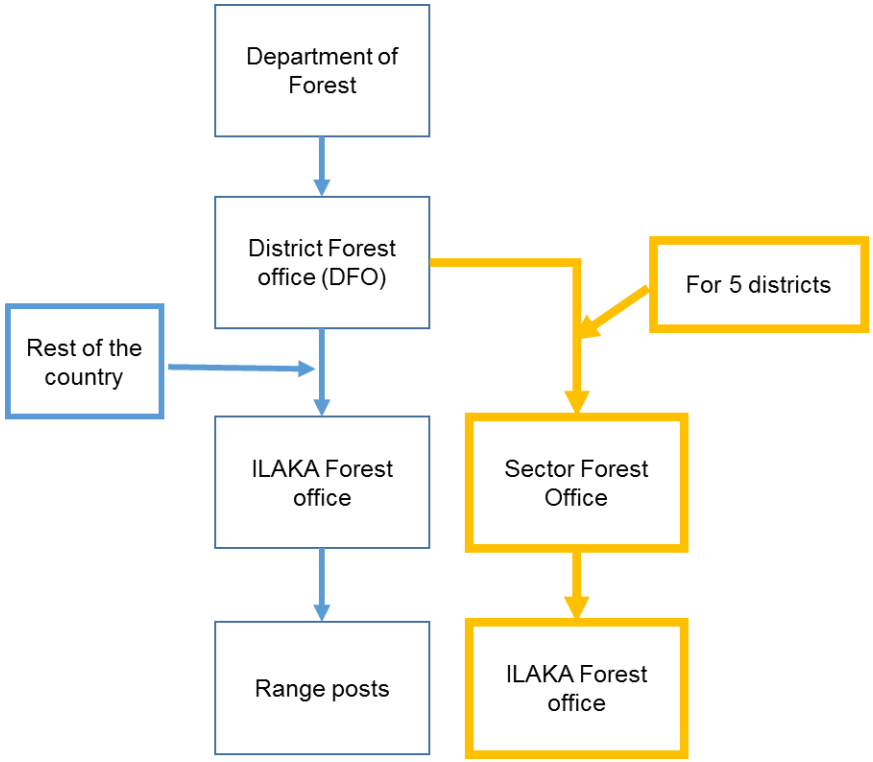
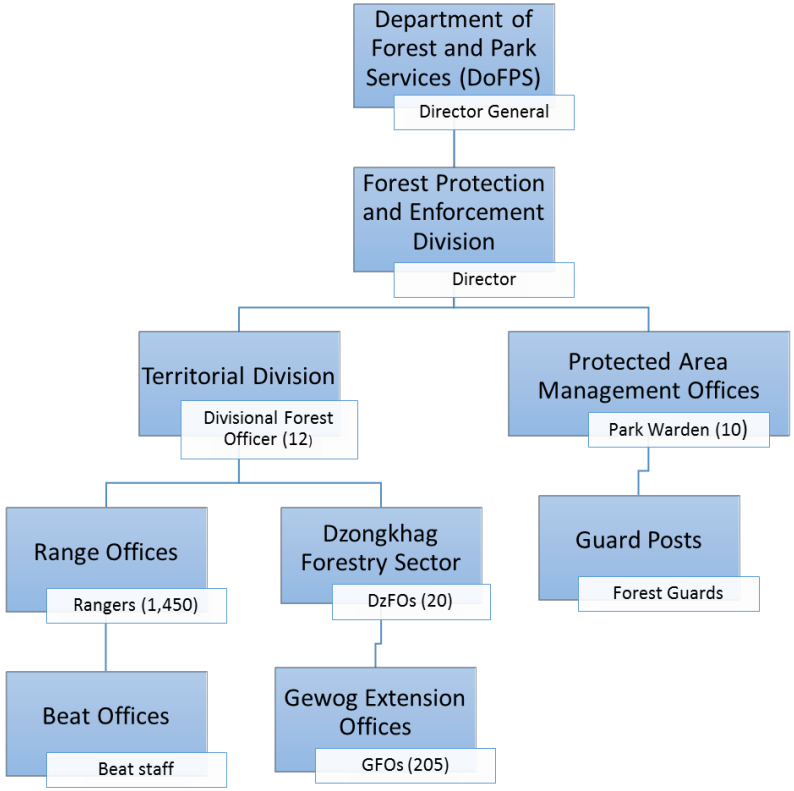


Figure 11: Bhutan Forest Management Organizational Structure



4.2.3 OTHER COUNTRIES WITHIN THE HINDU-KUSH HIMALAYA REGION

SERVIR-Himalaya has explored the expansion of the FFMAS into other countries in the region, including Bangladesh, Myanmar, and Pakistan. Bangladesh has expressed interest, but forest fires do not present a significant issue there. Pakistan has also expressed interest in the System, but as of the writing of this case study nothing has come of these discussions. Several ICIMOD interviewees felt that Myanmar may be the most logical place to expand the System because of the large number of forest fires there. Everyone was in agreement that technically the implementation would not be hard because of all the work that has already been done to set up the System. Initial discussions with implementing partners on the ground and setting the System up would take longer. USAID/Nepal also has suggestions for expanding the tool internationally through the Forest Carbon Partnership Facility (see more information on this below).

4.3 PERFORMANCE IMPROVEMENTS AND ENHANCEMENTS

With respect to System performance, the most common suggested improvements are 1) to increase the scale at which a fire is detected, and 2) improve the timing of the alerts. While these changes would mean overhauling the detection system, other smaller improvements were also proposed. The suggestion often reflects the view of the particular interviewee and their role (manager, community member, etc.), which may not match the intended users that SERVIR-Himalaya and the DoF-Nepal have targeted. Some of the key suggestions follow:

- **Develop a way to report back to SERVIR-Himalaya or the DoF-Nepal.** It would be helpful to have a dialog to 1) talk about the SMS tool's intended uses – that it is just *part* of a system for detecting and tracking fires, and that it is meant to help forest fire management; and 2) devise a way to allow people to report back to SERVIR-Himalaya and DoF if the alert is a false alarm, if there is a fire burning that is not being captured because the satellite hasn't passed yet, or if a fire is too small.
- **Consider additional investments in the System to add community forest boundary data to the model**.[14] This would allow for better targeting of SMS messages at the community level, and help to pinpoint when to alert local stakeholders on the ground, including first responders.
- Allow people access to the actual data and metadata from the FFMAS on the Mountain GeoPortal. This will allow other geospatial analysts to develop graphs or basic geospatial analysis in combination with other datasets, such as land cover maps and DEMs, that could result in fire simulations or fuel maps, or the ability to run cluster analyses (some of which ICIMOD has done and presented at conferences).
- **Provide calculations of burned area estimates,** possibly through a MODIS post-burn analysis package (Bhutan).
- **Provide additional information in the actual text of the SMS to make it clear where the fire alert is coming from**, e.g., provide more information on ward or VDC in all protected areas.
- **Create SMS in Nepali.**
- **Send alerts with a voice message** rather than text for communities where the CFUGs may not be literate.

[14] SERVIR-Himalaya recently awarded a small-scale application award to the DoF-Nepal for a community forest management system that will develop fire alerts based on community-level information. If it is successful, they would potentially scale this to more districts, though there might be additional costs associated with this plan given that there are very few community forest boundaries delineated digitally for Nepal.

- **Review confidence level threshold and frequency for sending alerts.** The SMS alert is only sent for fire incidence with a confidence over 70% in Nepal. Also, the evening and nighttime alerts are not sent through SMS. A pilot study is recommended to include alerts with 50% confidence threshold and also sending evening time SMS. Based on the outcome, decisions could be made for future inclusion of alerts.

4.4 NEXT STEPS FOR DEPARTMENT OF FOREST IN NEPAL

At the end of the data collection phase of the case study, discussions were held with senior administrative officials at the DoF in Nepal on how best to capitalize on the information gathered from the research. The following actions were agreed to by the DoF-Nepal for better institutionalizing the System and strengthening engagement with its users within the Department:

- The Department will strengthen the fire management unit at the DoF-Nepal headquarters and equip this unit with necessary hardware.
- SERVIR-Himalaya (and/or ICIMOD, depending on funding) will provide training to relevant people at the fire management unit regarding operation of the System.
- Before the onset of fire season, the Department will organize a workshop with all DFOs and representatives from other agencies working on forest management in Nepal.
- The strategy for distribution of fire alerts will be finalized in a workshop, including the preparation of a distribution list.
- The Department will allocate or arrange to cover the operational costs of the SMS.
- The Department will sensitize the field officers/staff about the fire alerts.

5. IMPLICATIONS FOR EXPANSION

5.1 COST CONSIDERATIONS

Since the FFMAS was an activity funded under the SERVIR-Himalaya Program, the cost to develop the System – including generating the code to automate and process the active fire data – can be seen as a sunk cost. At this time, the System is fully automated and running on the ICIMOD server. Therefore, the cost to operate the FFMAS cannot be differentiated from the costs of other applications on the server. In addition, the direct costs associated with expanding the system to other countries or regions would be primarily labor costs, with some infrastructure requirement. Table 10 summarizes the estimated days required to develop the System customizations for scaling FFMAS out to other countries or regions, based on ICIMOD's experience.

Table 10: Labor Resources Required for System Customizations

Task	Resource	Approximate person days
Data collection from the source on administrative boundaries, protected areas and other geographic units	GIS Analyst	7
Data processing	GIS Analyst	7
Modify scripts to subset fire data for the new geographic region	GIS application developer	7

In terms of operational costs, the only significant direct cost associated with the FFMAS for ICIMOD is that of sending SMS alerts [15]. The cost of SMS increases with an increase in the number of fire incidents and subscribers. Assuming an annual fire incidence of 1500, the cost estimation to expand alerts within Nepal is summarized in Table 11. At present, the cost of sending an SMS within Nepal is insignificant and covered by ICIMOD. However, the cost implications are different for expanding SMS alerts outside of Nepal. If the System is hosted at ICIMOD, for example, expansion to another country would require an arrangement with telecom service providers (like in Bhutan) to avoid international SMS charges, which is five times as costly as the local SMS. The idea of a "fee-for-service" model was also discussed with potential user groups during the field trip, specifically with community user groups; the response from those interviewed was not very positive, however.

[15] In order to host the System within the Department of Forest, however, additional operational costs may include the cost of hardware upgrades, hardware maintenance, electricity, and human resources.

5.2 PRIORITY STAKEHOLDERS

The USAID Mission in Nepal expressed excitement about the potential of the FFMAS. According to USAID/Nepal, the technology is achieving interesting results, but improvements could be made in building the capacity of the communities that benefit from the System. This raises issues of who determines and prioritizes the audiences and stakeholders for FFMAS. Based on conversations with the study team, USAID/Nepal sees local communities as key users of the System, with priority for growth given to the community level. In fact, in meetings with the Mission, there was a high level of interest in adding a community forest mapping component to the System. On the other hand, the priority for the DoF-Nepal is to ensure that its district officers have access to the System, understand the different components that are currently available, and that there is a systematic process in place for subscribing new users within the department. As a result, SERVIR-Himalaya and the DoF-Nepal have focused their efforts on DoF-Nepal personnel, including the subscribed DFOs and other technical staff that attend ICIMOD trainings.

In order to scale the FFMAS to the community level, strategic partnerships may be one alternative or complement to additional SERVIR funding. For example, USAID/Nepal expressed interest in brokering a partnership between SERVIR and other projects at the Mission, such as Hariyo Ban[16], to specifically target community-level users. Other programs may lend themselves to expansion of the FFMAS as well. For instance, Nepal recently signed an agreement related to REDD for the Terai region in connection with the Forest Carbon Partnership Facility (FCPF)[17]; USAID/Nepal views the FCPF as a potential avenue to expand the FFMAS internationally. Part of the payment from REDD initiatives, for example, may be used for operationalization of the FFMAS. According to a staff member at USAID/Nepal, *"My understanding is that neither the community nor the government is ready to pay for this…Still, there is room for internalization and refinement of the tool itself."*

[16] http://www.usaid.gov/nepal/fact-sheets/hariyo-ban-project
[17] http://forestcarbonpartnership.org/nepal

6. CONCLUSION

As the findings from the case study demonstrate, the FFMAS developed by SERVIR-Himalaya is seen as a valuable contribution to the government's overall forest fire management strategy in Nepal and Bhutan, including historical tracking, monitoring of fire incidence, and improving mobilization to fight fires. The results from the ICIMOD satisfaction survey after the 2012 and 2014 fires season serve to reaffirm the case study research and indicate that the System is working well and that subscribers are receiving accurate alerts (via SMS). Because of this, it is no surprise that the field team encountered high interest in Nepal and Bhutan – from both current and potential users – in using the System.

What the case study revealed about the extent to which the information generated by the FFMAS was being used on the ground and who was primarily benefiting from it, however, was somewhat surprising to the team. As mentioned previously, the research revealed that fewer people are using the FFMAS than expected. To a great extent, the gap between expected and actual use was due largely to lack of awareness within the DoFs of the FFMAS, rather than limitations with the System itself. While this presents a communication challenge, it also presents an opportunity to reach unmet demand within Nepal and Bhutan. Clearly, there is still untapped potential for the FFMAS to be expanded within the DoF-Nepal itself, as interest in the System remains high even with users unacquainted with its capabilities.

In order for this effort to succeed, however, further investment must be made in user engagement activities to orient current users and improve communication with potential users, both within DoF and beyond. The System was designed by SERVIR-Himalaya with a long-term vision for DoF-Nepal to own and manage the information dissemination independently. SERVIR-Himalaya's role was to develop the System, demonstrate its viability during the pilot phase, and then conduct capacity building within DoF, who would in turn scale the System within their institution. Given this approach, additional activities to strengthen user engagement within DoF and improve communication efforts about the FFMAS were not funded under SERVIR-Himalaya. That said, going forward SERVIR-Himalaya is actively exploring how to strengthen user engagement and communication at the district and community level, via the Demand Activity, including simple "how-to" guides in local languages as well as more systematic training. This stronger user engagement focus is not only related to the FFMAS, but across SERVIR-Himalaya; they are currently piloting a model for stakeholder analysis and an accompanying strategy to engage users in each of their projects.

Gaps in external communication about the purpose, scope, and capabilities of the FFMAS also led to confusion with other stakeholders, including USAID/Nepal. In addition, the differing missions and priorities of NASA and USAID – both seen as stakeholders of the FFMAS – presented a challenge for defining SERVIR-Himalaya's role in extending user engagement to the local level. SERVIR-Himalaya's purpose from the NASA perspective was to ensure the technology of the FFMAS functioned properly and that capacity was transferred to the intended users, i.e. the DoFs in Nepal and Bhutan. From the USAID/Nepal perspective, the FFMAS was viewed as a community-level alert system for local stakeholders fighting fires in the field; and from USAID/Washington, it was not clear how or if the "development" objectives were being reached. While a lack of communication and messaging was one aspect of this confusion, another factor is the difference between USAID and NASA objectives and expectations for a SERVIR hub and their view of a hub's role in user engagement. This will be an

important consideration to clarify for SERVIR-Himalaya as management transfers directly to USAID/Nepal going forward.

While the System was not designed as a tool for community forest fire management, but rather to support historical tracking and monitoring of fire incidence for planning and resource allocation, SERVIR-Himalaya and/or ICIMOD, perhaps in collaboration with other USAID projects or donors, could consider additional investments in the System to add community forest boundary data to the model. This would allow for better targeting of SMS messages at the community level, and help to pinpoint when to alert local stakeholders on the ground, including first responders.

Finally, SERVIR Global should explore the potential for adapting, customizing, and/or replicating the Fire Forest Monitoring and Alert System to other regions, whether through SERVIR hubs and/or in partnership with other entities and funders. One of the strengths of SERVIR is its geographic reach, and taking the FFMAS "global" could be an even greater success.

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ANNEX A: TECHNICAL DETAILS OF MODIS FIRE PRODUCTS

MODIS fire observations are made four times every day from the Terra (10:30 and 22:30) and Aqua (13:30 and 01:30) satellites. MODIS provides two fire products standard as part of the data package downloaded: the active fire product, giving the location of fire; and burned area products, showing the extent of burned area at the time of satellite overpass. The location of fire corresponds to the center of 1x1 kilometer fire pixel representing one or more fire incidence occurring within the pixel area. The active fire product mainly uses the brightness temperature from MODIS thermal bands (Band 21, 22, and 31). To prevent false alarms and cloud mask, other MODIS bands (Band 1, 2, and 32) are used. Band 7 is used to reject water-induced false alarms in coastal regions.

Table A shows the different MODIS bands – or channels – used for fire detection. A contextual algorithm compares each pixel with its background pixels to calculate temperature anomalies based on a preset threshold, therefore identifying pixels "on fire". Hugely important in the alerts are the confidence at which the pixel is determined to be "on fire". The confidence of the detection of fire is calculated based on the brightness temperature of the target pixel; the difference between the brightness of the target pixel and the mean of the surrounding pixels; the number of adjacent cloud pixels; and the number of adjacent water pixels. The final fire product also masks out false detection based on sun glint, desert boundaries and water. The MODIS bands used for the fire detection are also shown in Table A.[18]

Table A: MODIS Channels Used for Fire Detection

Channel number	wavelength (µm)	Purpose
1	0.65	Sun glint and coastal false alarm rejection; cloud masking
2	0.86	Bright surface, sun glint, and coastal false alarm rejection; cloud masking.
7	2.1	Sun glint and coastal false alarm rejection.
21	4	High-range channel for active fire detection.
22	4	Low-range channel for active fire detection.
31	11	Active fire detection, cloud masking.
32	12	Cloud masking.

[18] Additional details of the algorithm can be found in *The MODIS Fire Products* by Justice, Giglio et al. 2002 and Giglio, Descloitres et al. 2003)

The active fire data are processed by NASA's Land Atmosphere Near Real-time Capability (LANCE) System. It takes two to four hours for LANCE to process and post active fire data on NASA's Fire Information for Resource Management System (FIRMS) server. Data can be downloaded in text and shapefile format. The description of shapefile attributes are given in Table B.

Table B: Attributes of Shapefile Data Derived from MODIS Data

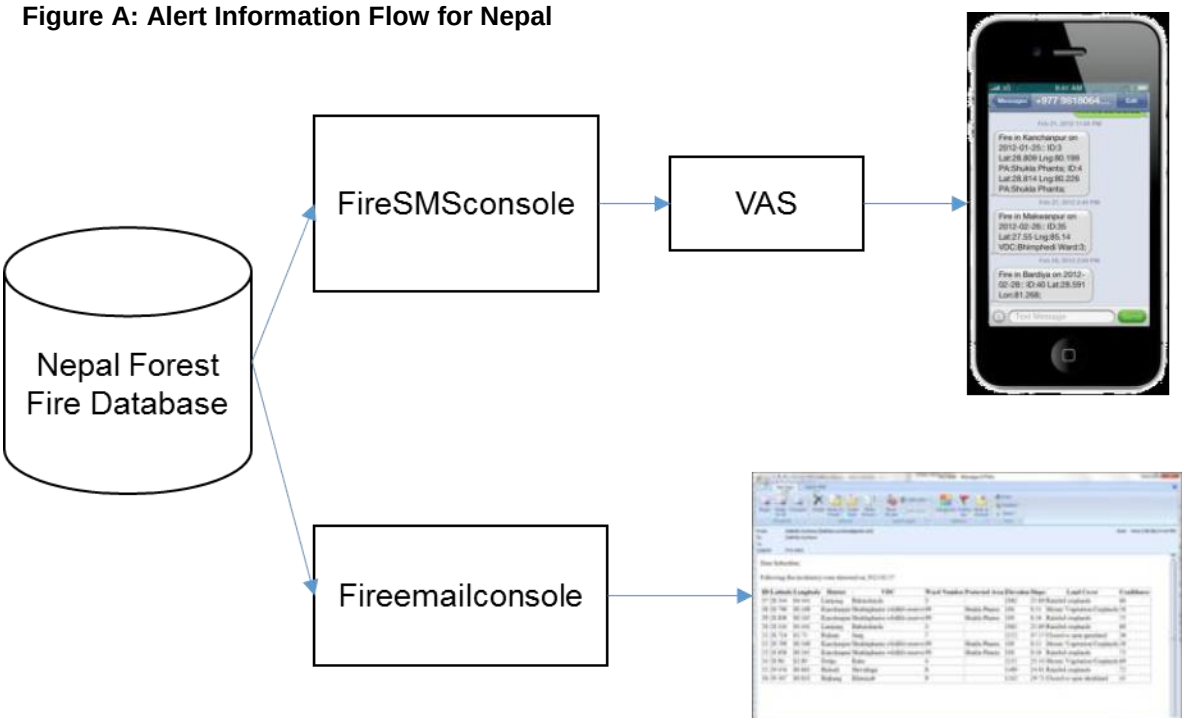
Column	Description
Latitude and Longitude	The center point location of the 1km.
Brightness	The brightness temperature, measured (in Kelvin) using the MODIS channels 21/22 and channel 31.
Scan and Track	The actual pixel resolution compared to pixel size at Nadir.
ACQ date	Date of acquisition
Time	Time of satellite over pass in Coordinated Universal Time (UTC)
Satellite	Source satellite used for detection (T=Terra, A=Aqua)
Confidence	Confidence of the detection in percent (0-100). This value is based on a collection of intermediate algorithm quantities used in the detection process. It is intended to help users gauge the quality of individual hotspot/fire pixels. Confidence estimates range corresponds one of the three fire classes: low-confidence fire (0-30%), nominal-confidence fire (30-80%), or high-confidence fire (70-100%).
Version	The processing collection and source data. The number before decimal refers to the collection (e.g. MODIS collection 5). The number after the decimal indicates source of level 1B data
Bright 31	The brightness temperature of Channel 31 (in Kelvin)
FRP	FRP represents the pixel-integrated fire radiative power in MW.

ANNEX B: SAMPLE OUTPUTS

B.1 SMS ALERT

Figure A shows the flow of information from the database of users to the email and SMS alert system. The SMS alerts in Nepal run through the VAS system to distribute messages to users subscribed mobile phones.

Figure A: Alert Information Flow for Nepal



B.2 EMAIL ALERT

Figure B: Sample Email Fire Alert for Nepal

Dear Subscriber,

Following fire incidents were detected on 2014-04-27:

Fire incidents with high confidence level (above 70%):

Lat	Lon	District	VDC	Ward No	Protected Area	Elevation (m)	Land Cover	Confidence (%)	Satellite
28.222	81.794	Banke	Mahadevpuri	2		234	Forest	77	Aqua
28.226	81.812	Banke	Mahadevpuri	2		339	Forest	76	Aqua
28.311	81.641	Bardiya	Bardiya national park		Bardia	239	Forest	90	Aqua
28.435	81.506	Bardiya	Bardiya national park		Bardia	251	Forest	85	Aqua
29.039	80.531	Dadeldhura	Alital	8		1034	Forest	73	Aqua
28.965	81.440	Dailekh	Sigaudi	5		890	Forest	73	Terra
27.855	82.188	Dang	Rajpur	9		362	Forest	74	Aqua
27.938	84.971	Dhading	Dhuw akot	7		1200	Forest	74	Aqua
29.059	80.632	Doti	Laksminagar	7		1449	Forest	87	Aqua
29.063	80.651	Doti	Laksminagar	7		1189	Forest	71	Aqua
29.081	81.104	Doti	Chamara chautara	6		834	Forest	79	Aqua
29.150	80.688	Doti	Saraswatinagar	4		1465	Forest	81	Aqua
26.795	87.689	Ilam	Banjho	2		421	Forest	74	Aqua
28.701	81.063	Kailali	Dododhara	6		224	Forest	71	Aqua
28.893	80.266	Kanchanpur	Shuklaphanta w ildlife reserve		Shukla Phanta	208	Forest	75	Aqua
28.883	80.202	Kanchanpur	Shuklaphanta w ildlife reserve		Shukla Phanta	203	Forest	77	Terra
28.895	80.270	Kanchanpur	Shuklaphanta w ildlife reserve		Shukla Phanta	200	Grassland	90	Terra
26.919	87.589	Panchthar	Limba	4		937	Forest	100	Aqua
27.942	82.846	Pyuthan	Bangesal	5		605	Forest	80	Aqua
28.150	82.911	Pyuthan	Lung	9		979	Forest	82	Aqua
28.153	82.926	Pyuthan	Tusara	9		1385	Forest	93	Aqua
27.339	86.081	Ramechhap	Ramechhap	3		949	Forest	74	Aqua
28.077	85.204	Rasuw a	Dandagaun	7		987	Forest	100	Aqua
28.079	85.215	Rasuw a	Haku	8		1110	Forest	100	Aqua
28.089	85.214	Rasuw a	Haku	8		1863	Forest	97	Aqua
28.324	82.155	Salyan	Hiw alcha	2		1063	Forest	79	Aqua

Fire incidents with medium confidence level (50-70%):

Lat	Lon	District	VDC	Ward No	Protected Area	Elevation (m)	Land Cover	Confidence (%)	Satellite
28.098	81.871	Banke	Kachanapur	5		202	Forest	58	Aqua
28.101	81.888	Banke	Kachanapur	4		219	Forest	65	Aqua
28.435	81.494	Bardiya	Bardiya national park		Bardia	251	Forest	66	Aqua
27.225	86.603	Khotang	Salle	3		500	Forest	67	Aqua
28.666	81.365	Surkhet	Taranga	3		715	Forest	51	Aqua

Please click here to download the fire map and visit http://apps.geoportal.icimod.org/NepalForestFire to view the interactive web mapping application.

If you wish to unsubscribe from email fire alert, please go to http://apps.geoportal.icimod.org/NepalForestFire/unsubscribe.aspx.

Thank you.

Figure C: Sample Email Fire Alert for Bhutan

Subject: Fire Alert

Dear Subscriber,

Following fire incidents were detected on 2014-04-27:

Fire incidents with high confidence level (above 70%):

Lat	Lon	Dzongkhag	Gewog	Protected Area	Elevation (m)	Land Cover	Confidence (%)	Satellite
26.828	91.224	Pemagatshel	Norbugang		377	Forest	79	Aqua
26.829	91.237	Pemagatshel	Norbugang		347	Forest	72	Aqua
26.829	91.752	Samdrupjongkhar	Phuntsthothang	Khaling	277	Forest	85	Aqua
27.211	90.105	Wangduephodrang	Athang	Jigme Singye Wangchuck	1089	Forest	75	Terra
27.229	90.162	Wangduephodrang	Athang	Jigme Singye Wangchuck	1183	Forest	73	Terra
27.231	90.141	Wangduephodrang	Athang	Jigme Singye Wangchuck	1231	Forest	83	Terra
27.232	90.157	Wangduephodrang	Athang	Jigme Singye Wangchuck	1253	Forest	91	Terra

Fire incidents with medium confidence level (50-70%):

Lat	Lon	Dzongkhag	Gewog	Protected Area	Elevation (m)	Land Cover	Confidence (%)	Satellite
26.888	92.017	Samdrupjongkhar	Langchhenphu	Khaling	605	Forest	57	Aqua

Please click here to download the fire map and visit http://apps.geoportal.icimod.org/BhutanForestFire to view the interactive web mapping application.

Note: Fire incidents below 50% confidence level are not included in the email.

B.3 PDF FIRE LOCATION MAP

Figure D: Sample PDF Fire Location Map (Nepal)

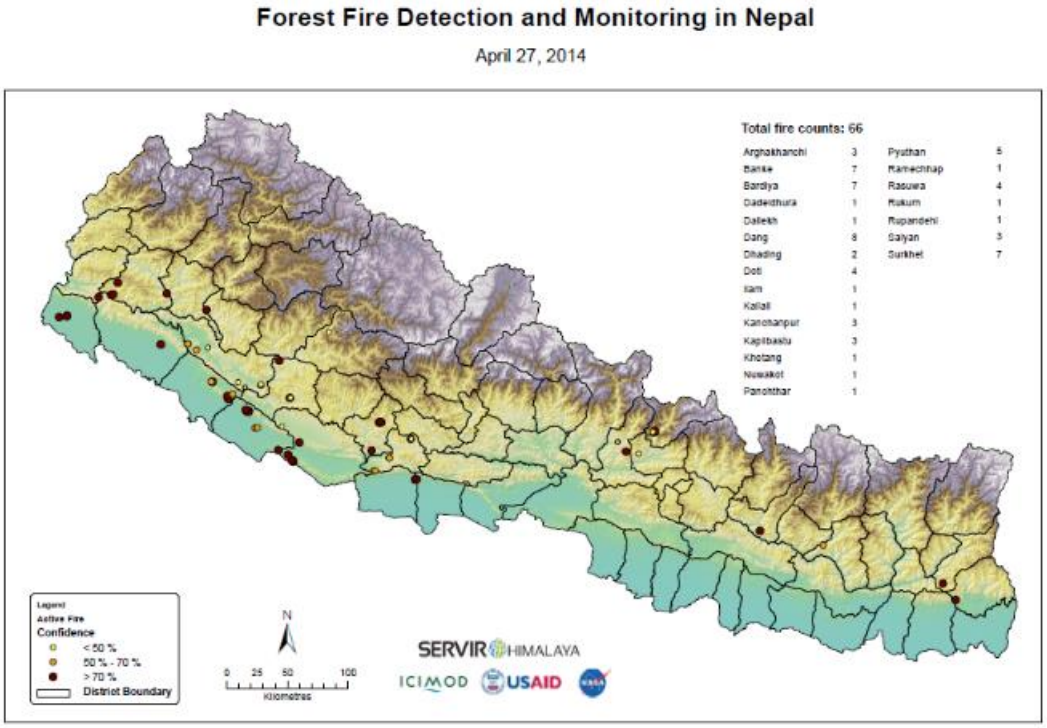
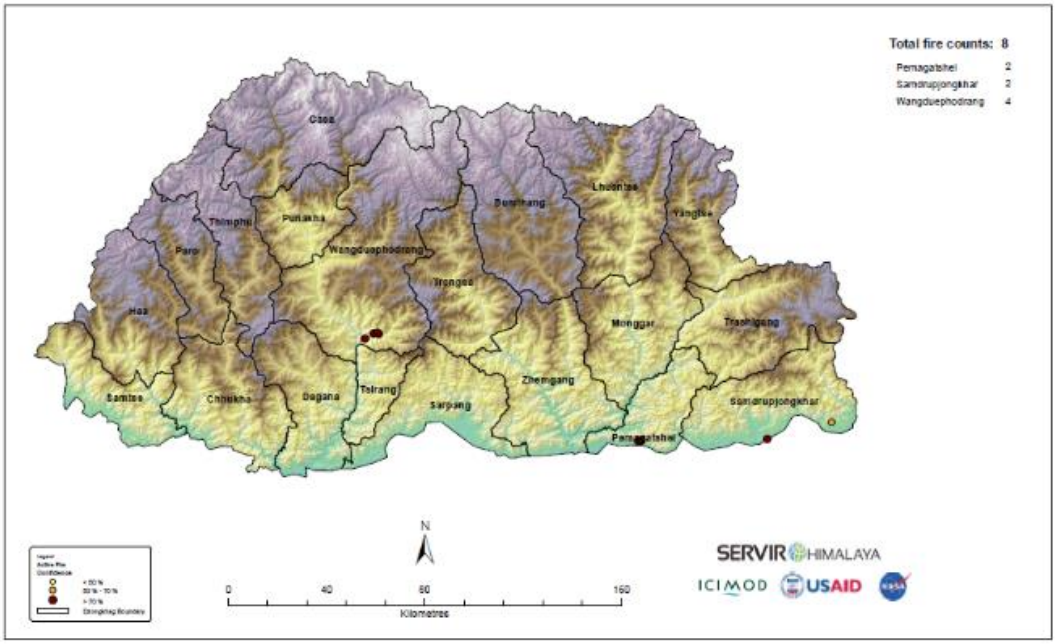
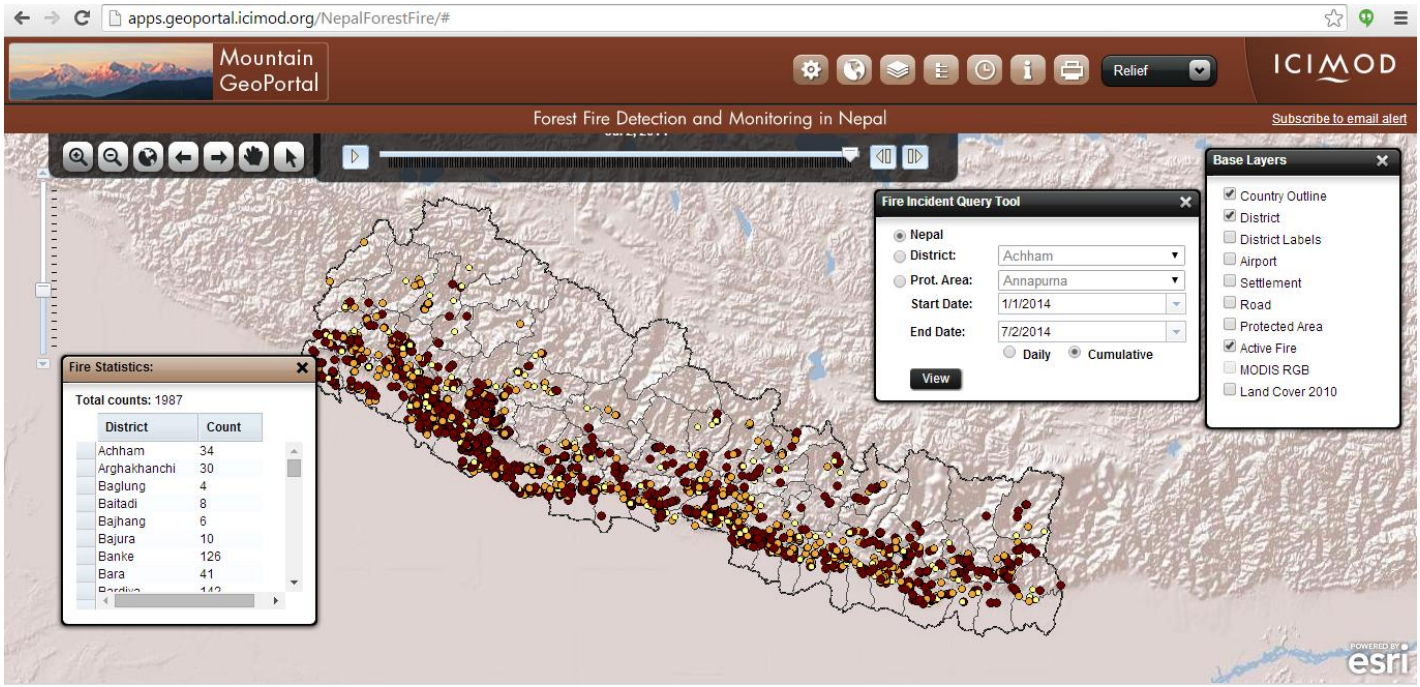


Figure E: Sample PDF Fire Location Map (Bhutan)



B.4 WEB MAP

Figure F: Web Map Showing Fire Incidence Locations from January 1, 2014 to July 2, 2014



ANNEX C: WEB MAPPING STATISTICS

Figure G: Number of Visitors to the Nepal Forest Fire Web Map by Year

Map shows visitors from a) Nepal b) ICIMOD regional member countries c) Other countries.

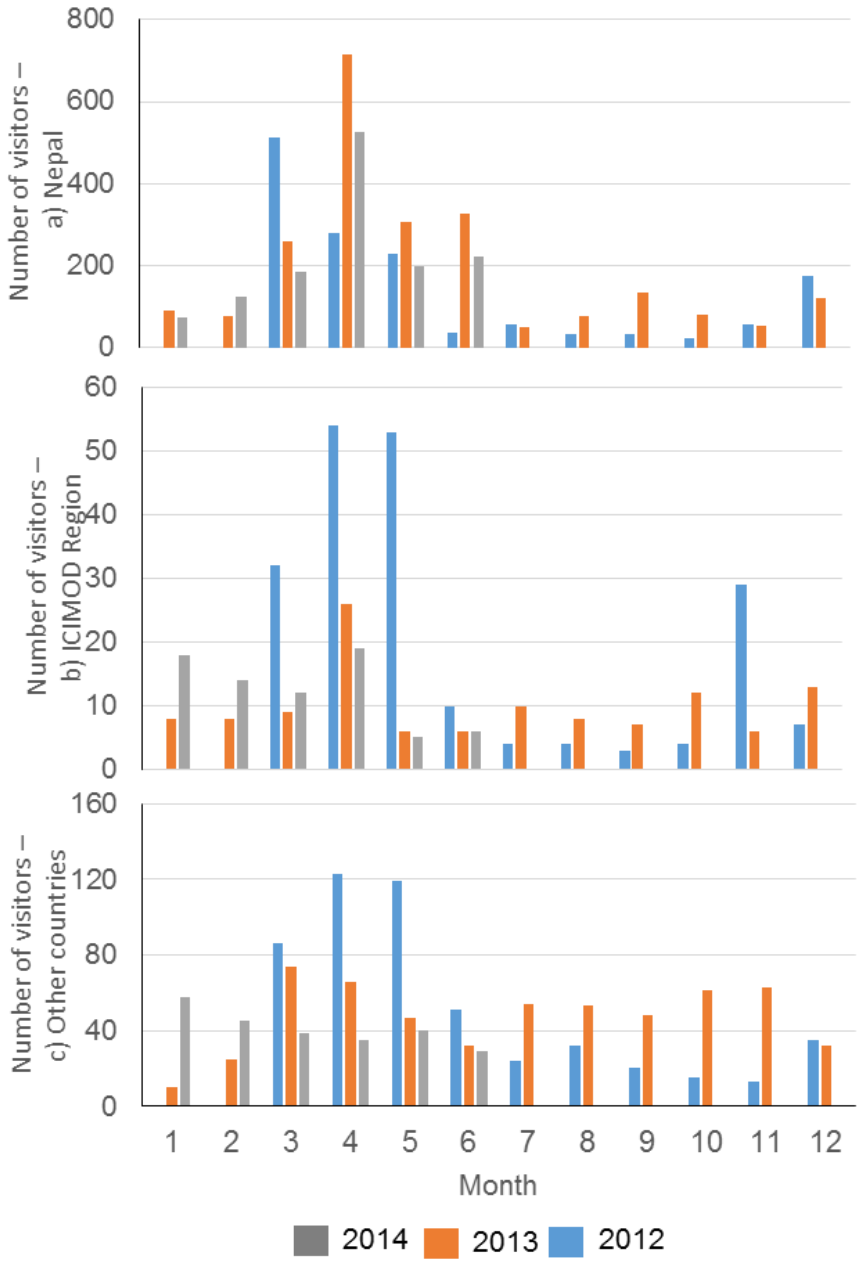
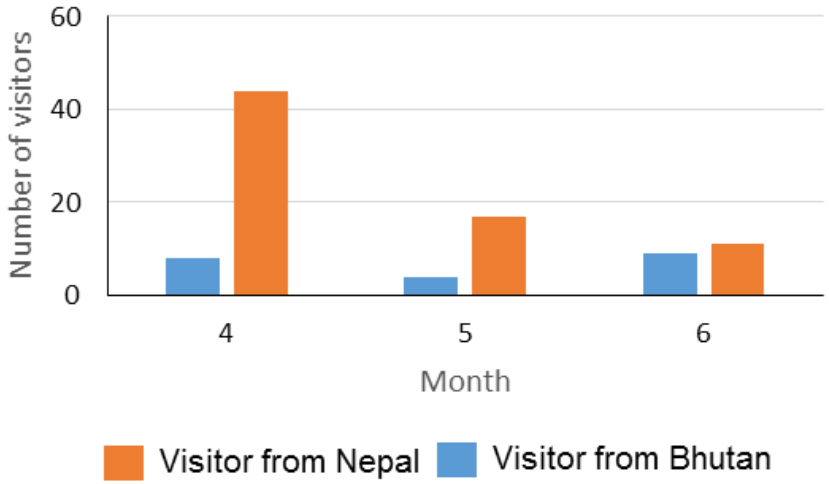


Figure H: Number of Visitors to Bhutan Forest Fire Web Map 2014



Note: The fire season in Bhutan is slightly later than Nepal, so the chart shows the data for April through June 2014.

ANNEX D: INTERVIEW LIST

Role/position	Location	Country	Interview Category
NASA Science	NASA	USA	US Gov't
USFS Geosptatial Expert	USFS	USA	US Gov't
USFS Fire Management	USFS	USA	US Gov't
Geospatial Developer	USA	USA	US Gov't Contractor/Developer
Technical / Science - Manager	Nepal - ICIMOD	Nepal	Developer
Technical / Science	Nepal - ICIMOD	Nepal	Developer
Technical / Science	Nepal - ICIMOD	Nepal	Developer
Forest Fire Tool POC	DoF- Central Office, Kathmandu	Nepal	Implementing Partner
Deputy DG Forest Dept	DoF - Central Office, Kathmandu	Nepal	Implementing Partner
Ecologist, Science Coordination Lead	Dept of Parks and Wildlife Conservation, Kathmandu	Nepal	Implementing Partner
Strategic Planning	DoF - Central Office, Kathmandu	Nepal	Implementing Partner
Unknown role	DoF - Central Office, Kathmandu	Nepal	Implementing Partner
DFO	Parsa District	Nepal	User/potential user
DFO	Chitwan District	Nepal	User/potential user
Assistant Forest Officer	Chitwan District	Nepal	User/potential user
DFO	Kailali District	Nepal	User/potential user
DFO	Kanchanpur District	Nepal	User/potential user
Forest Fire Monitoring Unit	Kanchanpur District	Nepal	User/potential user
Assistant Forest officer	Sector office Bani, Kanchanpur	Nepal	User/potential user
Warden	Chitwan National Park	Nepal	User/potential user
Warden	Suklapantha Wildlife Reserve	Nepal	User/potential user
Chairman, Dollu CFUG	Dollu Community Forest, Kathmandu District	Nepal	User/potential user
Member, Dollu CFUG	Dollu Community Forest, Kathmandu District	Nepal	User/potential user
Member, Chitwan FECOFUN	Dharapalli Watershed, Chitwan District	Nepal	User/potential user
Member, Chitwan FECOFUN	Chaturmukhi Community Forest, Chitwan District	Nepal	User/potential user

Role/position	Location	Country	Interview Category
Member, Chitwan FECOFUN	Chitwan District	Nepal	User/potential user
Chairman, Chitwan FECOFUN	Chitwan District	Nepal	User/potential user
Member, Chitwan FECOFUN	Chitwan District	Nepal	User/potential user
Secretary, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Secretary, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Chairman, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Member, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Treasurer, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Member, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Regional Chair, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Member, Nawajagriti CFUG	Nawajagriti CFUG, Chitwan District	Nepal	User/potential user
Secretary, Kailali FECOFUN	Kailali District	Nepal	User/potential user
Office Secretary, Kailali FECOFUN	Kailali District	Nepal	User/potential user
Member, Kailali FECOFUN	Kailali District	Nepal	User/potential user
Member, Kailali FECOFUN	Kailali District	Nepal	User/potential user
Member, Kailali FECOFUN	Kailali District	Nepal	User/potential user
Director General, Dept of Forests and Park Services	DoF - Central Office, Thiampu	Bhutan	Implementing Partner
Head of the Dept of Forests	DoF - Central Office, Thiampu	Bhutan	Implementing Partner
Forester	DoF - Central Office, Thiampu	Bhutan	Implementing Partner
Divisional forest officer	Thimphu	Bhutan	User/potential user
Ranger	Thimphu District	Bhutan	User/potential user
Dzongkhog Forest Officer (DzFO) out-going	Thimphu District	Bhutan	User/potential user
Dzongkhog Forest Officer (DzFO) in-coming	Thimphu District	Bhutan	User/potential user

ANNEX E: INTERVIEW AND FOCUS GROUP PROTOCOLS

E.1 CASE STUDY TECHNICAL INTERVIEW GUIDE (ICIMOD)

Case Study TECHNICAL INTERVIEW GUIDE (ICIMOD)
Forest Fire Detection and Monitoring System Case Study

22 April 2014

Name of Person Interviewed:

Position/title:

Department/Ministry: Country:

Name of Interviewer:

Name of Notetaker:

Date: Start time: End time:

Others present at interview:

Other Comments about the Interview:

Introduction: Persons, titles, etc.

Thank you for taking the time in your busy schedule, it is an honor for us to meet with you. We are here as part of the SERVIR project, a NASA and USAID joint initiative. SERVIR is a global program focused on strengthening the capacities of government institutions and other stakeholders to use Earth observations and geospatial data in environmental decision-making.

We are conducting a case study on the Forest Fire Detecting and Monitoring System at ICIMOD on behalf of USAID. The objective of this case study is to learn how the System was developed, the process used for the design, implementation, and outreach of new users, and ways we might engage new users, increase linkages, and promote successes and impacts.

The case study is intended to better inform USAID and their partners, particularly NASA, on the process in which ICIMOD develops and disseminates SERVIR products, how users are engaged and benefit from the product, and some of the impacts these tools may have on decision-makers. It is not an evaluation of the project.

The interview consists of 4 focus areas: History and Background of the Application, Methodology and User Engagement, Distribution and Dissemination, and Current Status and Future Plans. In order to get through the interview, we may ask that some responses be completed at the end of the interview if time allows. We expect the interview to last approximately 45 minutes.

IF ASKED: The information shared with us will not be linked to any specific individuals by name.

Note to assessment team: The interview may take longer depending on the number of active participants, and this should be clarified at the beginning of the interview. As a semi-structured interview, this protocol is meant to guide the assessment and generate similar types of information across interviews. However, it is up to the interviewer to make the discussion as conversational as possible.

Questions are in normal font. Prompts for interviewer are in *italics*.

A. Background and History of the Application

1. Please tell us more about how the FF System originated. PROBES: Who defined the need? Who was involved in concept, design, development, and operationalizing it? Why did ICIMOD decide to develop it?
2. When did ICIMOD begin working on the application and how has it been funded (any money other than SERVIR?)
3. Who drove development and why?
4. Who does training/capacity building? What activities/workshops/meetings have been held?
5. What are the benefits of the application? Hoped for impacts?

B. Methodology and User Engagement

a. How has it been implemented and who are all the partners involved? (what is the NASA CO role, DOF, others?)
b. What procedures are being employed by ICIMOD and what methodological documents (if any) are being accessed/developed for this? (e.g. SMS guides, training manuals, user lists, etc..)
c. What is the role of users in the project at various stages? (e.g., scoping, data acquisition, methodology development, “requirements” setting, etc.) What approaches (e.g., workshops, exchanges, meetings, etc.) have been used to engage users?)
d. Who are the intended users and beneficiaries of the products generated? PROBES: Who has access to the SMS, emails, web-maps, or printed maps? Who is actually using these products?

e. What impacts (or desired impacts) are resulting from the use of these products? PROBES: *How are they using it? What for?*

C. Distribution and Dissemination

a. If not yet mentioned, please tell us how the alerts are disseminated. PROBE: Who is on the list? How do people get added to the lists? Can you add yourself? How are the lists updated and managed?

b. What is the geographic footprint? Plans for expansion geographically?

c. How is usage of the tool or its distribution being tracked?

d. Are there any potential users identified that are not currently part of the distribution list? Are there plans to expand the dissemination of the application?

D. Current Status and Future Plans

a. Have partners/users made any commitment to uptake the final products for their own standard operating procedures?

b. What plans are in place for sustaining/expanding the product itself or its use?

c. Are there changes in store for the application on the horizon? PROBE: Any new methods, tool enhancements, or user group expansions?

d. What opportunities and constraints are envisioned for the future of the project/product?

e. What additional capacity building and technical assistance will ICIMOD conduct in the future and under what time frame? (ex: Web support, MODIS analytics, SMS fees, dissemination, etc.)

E. Is there anything else related to this that you would like to share with us?

Wrap up:

- Thank them for their time.
- Ask if they can be contacted again in the future, if necessary (by email).
- Ask if there are other individuals, departments, and/or entities they feel are relevant to contact, (noting that we may not be able to contact at this point).
- We are happy to share the Case Study Report once finalized.

E.2 CASE STUDY FIELD INTERVIEW GUIDE

Case Study FIELD INTERVIEW GUIDE

Forest Fire Detection and Monitoring System Case Study

22 April 2014

Name of Person Interviewed:

Position/title:

Department/Ministry: Country:

Name of Interviewer:

Name of Notetaker:

Date: Start time: End time:

Others present at interview:

Other Comments about the Interview:

Introduction: Persons, titles, etc.

Thank you for taking the time in your busy schedule, it is an honor for us to meet with you. We are here as part of the SERVIR project, a NASA and USAID joint initiative. SERVIR is a global program focused on strengthening the capacities of government institutions and other stakeholders to use Earth observations and geospatial data in environmental decision-making.

We are conducting a case study on the Forest Fire Detecting and Monitoring System at ICIMOD on behalf of USAID. The objective of this case study is to learn how the System was developed, the process used for the design, implementation, and outreach of new users, and ways we might engage new users, increase linkages, and promote successes and impacts.

The case study is intended to better inform USAID and their partners, particularly NASA, on the process in which ICIMOD develops and disseminates SERVIR products, how users are engaged and benefit from the product, and some of the impacts these tools may have on decision-makers. It is not an evaluation of the project.

The interview consists of 4 focus areas: History and Background of the Application, Methodology and User Engagement, Distribution and Dissemination, and Current Status and Future Plans. In order to get through the interview, we may ask that some responses be completed at the end of the interview if time allows. We expect the interview to last approximately 45-60 minutes.

IF ASKED: The information shared with us will not be linked to any specific individuals by name.

Note to assessment team: The interview may take longer depending on the number of active participants, and this should be clarified at the beginning of the interview. As a semi-structured interview, this protocol is meant to guide the assessment and generate similar types of information across interviews. However, it is up to the interviewer to make the discussion as conversational as possible.

Questions are in normal font. Prompts for interviewer are in *italics*.

F. Background and History of the Application
   a. How did you first learn about the Forest Fire detection and monitoring System?
   b. What other tools were being used to detect fires in the past? Are they still used?
   c. Who drove development and why?
   d. Who does training/capacity building? What activities have been held, and for whom?

G. User Engagement and Impacts
   a. What methodological documents (if any) are being developed for the DFOs? (e.g. SMS guides, training manuals, user lists, etc..)
   b. What approaches (e.g., workshops, exchanges, meetings, trainings, etc.) have been used to engage users?
   c. What products do you use from the System? (SMS, emails, web-app, paper maps, trend data, etc.)
   d. What impacts (or desired impacts) are resulting from the use of these products? PROBES: *How are they using it? What for?*
   e. Are there examples that you can share about how the application has impacted decision-making in some way? PROBES: have firefighting decisions been made based on these data? Have policy-makers used the fire trend data to shift people, funds, supplies, etc. Have plans been changed or made based on this application?
   f. Has the tool impacted firefighting? How? (have firefighting decisions been made based on these data? Have policy-makers used the fire trend data to shift people, funds, supplies, etc. Have plans been changed or made based on this application?)
   g. What additional groups could benefit from receiving the information from this application? In what format (SMS, email, printout, etc.)?

H. Distribution and Dissemination
   a. If not yet mentioned, please tell us how the alerts are disseminated. PROBE: Who is on the list? How do people get added to the lists? Can you add yourself? How are the lists updated and managed?

b. How successful do you feel the application is at monitoring and detecting forest fires?
c. How successful do you think the user interface options are for dissemination these data? (SMS, emails, web, printed maps, etc.)
d. What limitations exist for the application, and what about it would you like to see improved?

I. Is there anything else related to this that you would like to share with us?

Wrap up:

- Thank them for their time.
- Ask if they can be contacted again in the future, if necessary (by email).
- Ask if there are other individuals, departments, and/or entities they feel are relevant to contact, (noting that we may not be able to contact at this point).
- We are happy to share the Case Study Report once finalized.

E. 3 CASE STUDY FOCUS GROUP MODERATOR GUIDE

Forest Fire Case Study

Focus Group Moderator Guide

April, 2014

A. Introduction:

Hello. My name is Carmen Tedesco/Mir Matin, and I will be the moderator for this discussion about the Forest Fire Detection and Monitoring System developed by the International Center for Integrated Mountain Development (ICIMOD). Our purpose today is introduce you to the tool, to discuss your knowledge, perceptions, and opinions of the tool, to learn more about how you might use the tool, and discuss suggestions or recommendations you may have.

Agenda: We will be doing several things: participating in a discussion, brainstorming, and looking at some materials.

Mod. Info. I am a geospatial specialist working on SERVIR, a joint NASA and USAID project in partnership with ICIMOD. I'm based in Washington, DC and we are working with USAID and NASA to help build demand for products developed under the SERVIR project.

Feel free to make any negative or positive comments about any of the things we will be discussing today. This is a free flowing discussion and your collaboration is not being evaluated in any way. We are trying to learn as much as we can from you about your perceptions, opinions and experiences with this tool, even if you are not currently using the tool. The point of the discussion is to help learn more about the tool and its use in the field. This is in no way an evaluation or assessment of you or the tool.

B. Acknowledgements:

Thank you all for arranging your schedule today for this session.

C. Disclosures:

2. Mir Matin is taking notes to record our conversation so I can write an accurate report – not of who said what, but what was said. Your name will not be used in the report.

E. Self Intros:

PLEASE INTRODUCE YOURSELF TO THE GROUP (FOR MY BENEFIT) AND TELL US:

1. Your name
2. The institution or organization you work with
3. Your role within your institution or organization
4. What interested you in working with forests?

Issue 1: Background Information

1) How is your organization/institution involved in forest fires?
2) What kind of geospatial information (maps, imagery, GIS, etc.) do you use at your org?
3) What tools, if any, do you use to detect fires now?
4) Have you heard about the Forest Fire Detection and Monitoring System built by ICIMOD with the Dept of Forests?

Issue 2: Forest Fire System Products and uses – (Model the tool if possible from a PPT)

1) How are fire incidence data used or how could they be used by your org?
2) Which system components of a forest fire monitoring and detection system would be most helpful?

7. PROBE: SMS alerts, emails, web-application showing all fire incidence by admin unit/PA/etc., paper maps, trend data, other?
8. PROBE: what are some of the reasons?

3) Which of the components would you find least helpful?

9. PROBE: what are some of the reasons?

Issue 3: Impacts, and Users

1) How would a tool like this change decision-making in your organization?
2) In what ways would a tool like this impact firefighting? How?

10. PROBES: firefighting decisions made based on these data? policy-makers use the fire trend data to shift people, funds, supplies, etc.

3) What additional groups could benefit from receiving the information from this application? In what format (SMS, email, printout, etc.)?

G. Conclusion

With the remaining time we have, is there anything else anyone would like to add? Again, thank you very much for your honesty and time.

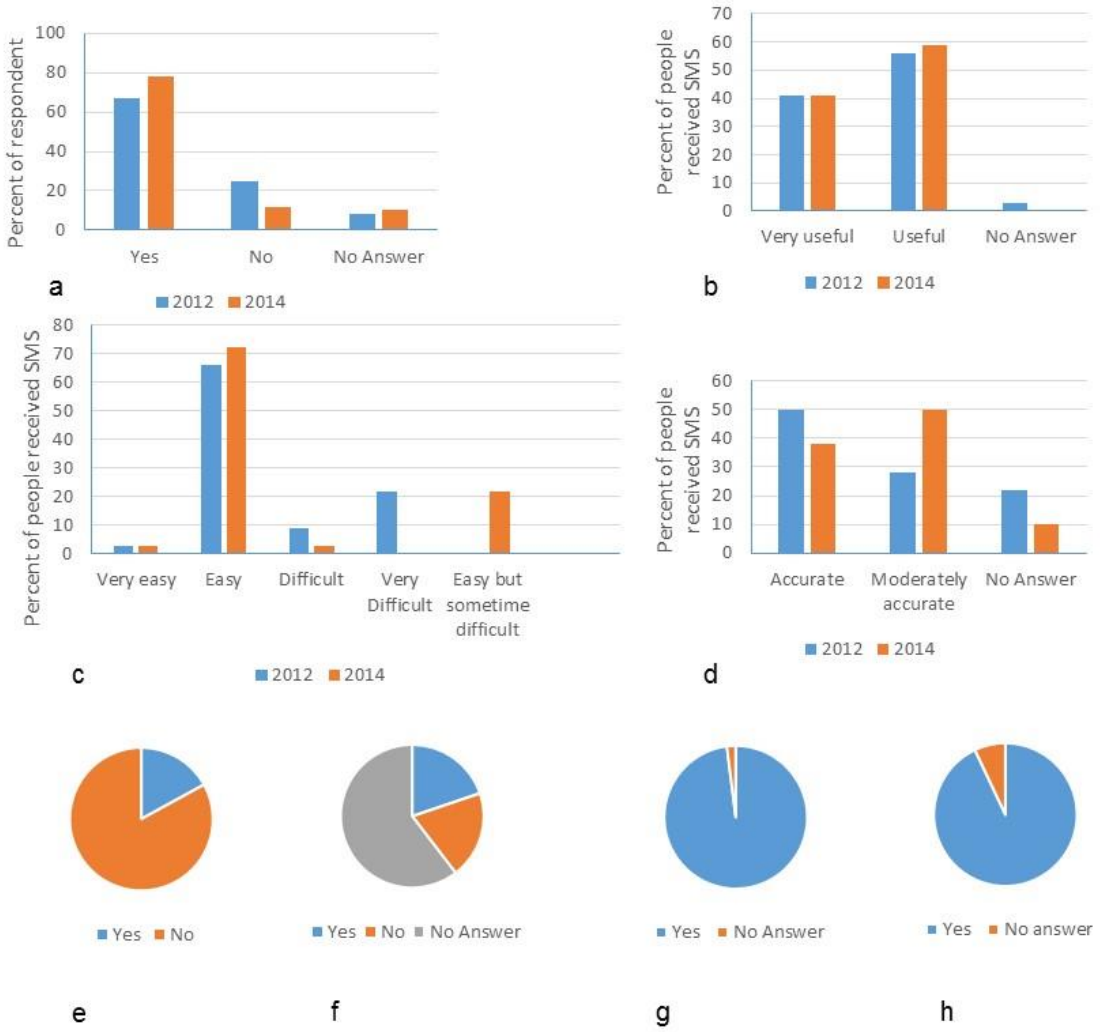
ANNEX F: SERVIR-HIMALAYA SURVEY RESULTS (2014)

After the 2012 fire season, a telephone survey was conducted by SERVIR-Himalaya staff with subscribers of the SMS alerts. A total of 48 people (25% of SMS subscribers) were contacted and asked a set of questions. A similar survey was also conducted after the 2014 fire season, with 41 respondents. The 2014 survey questionnaire included the same questions as the 2012 survey, with some additions. The feedback from both surveys is summarized below.

Survey Questions:

a. Have you been receiving SMS fire alerts?
b. Do you find the information provided in the fire alert useful?
c. Based on the information provided in the SMS (i.e. latitude, longitude, district, VDC, ward number, protected area information), how easy it is to identify the real fire location
d. In general, how accurate are the fire locations reported in the SMS alert?
e. Do you receive email alert
f. Do you use web map?
g. Do you think alert should be disseminated to wider audience
h. Do you think alert should be disseminated to wider audience?

Figure I: Percent Response Rate to Survey Questions
(see below for questions)



Out of 48 respondent in 2012, 67% confirmed that they received SMS, while in 2014, the percent of people confirmed that they received SMS was 78% out of 41 respondents. Some of the respondents in 2012 subscribed to the System very late when fire season was already over (Fig I, a).

Among the respondents who confirmed that they received SMS alerts all most all of them found it useful (Fig. I.b). In 2012, 31% of people informed that they found it difficult to identify the fire location using the information contained in the SMS. This percent is reduced greatly in 2014 to only 3%. However, 22% people reported that though most of the time it was easy to find fire location, sometimes it was difficult (Fig. I.c).

In 2012, 78% people receiving SMS alerts found them accurate to moderately accurate, while in 2014, this percent was 88%. None of them reported that the alerts were inaccurate although some people did not comment on the accuracy of the alert (Fig I.d).

75

The use of email alert and web application is not significant. The 2012 survey did not include questions about the email alert and web application. Among the 41 respondents in 2014, 83% reported that they did not receive or use email alerts (Fig. I.e). Only 20% of the respondents used web application (Fig I.f).

Almost all the respondents (93%) suggested that the SMS alerts should be sent to more recipients including communities, Ilaka staff of Department of Forests, CDO and DSP offices, local police and army units (Fig I.g). Almost all of them (98%) also would like to receive SMS alert in the evening (Fig I.h).