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A focus group study of factors that promote and constrain the use of satellite-derived fire products by resource managers in southern Africa

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Abstract

Semi-structured focus group interviews were employed to examine factors that affect the likelihood that resource managers in southern Africa will use information on vegetation fires provided by two satellite-derived products: an active fire product and a burned area product. The two products are updated regularly and aim to deliver the state-of-the-art in the global monitoring of fires from satellite remote-sensing. Both products are derived from data transmitted by the Moderate Resolution Imaging Spectroradiometer (MODIS) sensors carried onboard NASA's Aqua and Terra satellites. The active fire product can be accessed for free via the internet and on media by users working anywhere in the world; the burned area product will be accessible in a similar manner in 2006. The MODIS fire products provide systematic, near-global coverage and are freely available; as such, they give resource managers new opportunities to obtain or supplement information they need to manage vegetation fires effectively. However, the availability of these products does not mean that resource managers will use them, and many other factors are involved. To understand factors that affect whether southern African resource managers will use the two products, two focus groups were held with members of the Southern African Fire Network (SAFNet) in Malawi, Africa, August 2004. Analysis of the group discussions reveals a number of factors that influence whether they will use the products. The qualitative, in depth nature of the group discussions revealed 12 main factors that influence product use; not least the low international internet bandwidths for African countries outside of South Africa. Analysis of the group discussions also suggests how the uptake of MODIS fire products by resource managers in southern Africa might be enhanced by affecting specific changes to how MODIS products are packaged and delivered.

Keywords: MODIS; Fire; Utility; Validation

1. Introduction

Vegetation fires occur every year and extensively in southern Africa in areas where an annual rainy season and a long dry season produce ideal fire conditions (Edwards, 1984a,b; Scholes, 1995). Fire is integral to many African agricultural practices and is an important land management tool, being used for example, to clear land for cultivation, to control bush encroachment, to make fire breaks that protect property and fields, to provide nutrient-rich ash for crops, to maintain and improve pasture and grasslands for livestock grazing and also to attract game (Trapnell, 1959; Booysen and Tainton, 1984; Oyama, 1999; Roques et al., 2001). The region is experiencing substantial social, economic, and environmental changes (UNEP, 2002). A perceived increase in uncontrolled, destructive vegetation fire, coupled with increasing demand for land, reinforce the need for fire management (UNEP, 2002; ECE/FAO/ILO, 2003).

Fires have been managed for decades in southern Africa (Phillips, 1965; Edwards, 1984a,b; Van Wilgen et al., 1990, 2004), and practices and policies have evolved as new evidence on the role of fire has emerged (Mentis and Bailey, 1990; Bond and Archibald, 2003). The tasks of formulating fire policy and practice are complex (Van Wilgen et al., 2004), both because fire's effects on vegetation are not well

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understood, and because of conflicting environmental, social, and economic considerations (Frost, 1999). For example, although fire causes loss of life and property (De Ronde, 2002), it also plays an important role in maintaining ecosystem dynamics, biodiversity, carrying capacity and productivity (Frost and Robertson, 1987; Bond and Van Wilgen, 1996; Csiszar et al. 2004).

A fundamental challenge to fire management is that it requires difficult-to-obtain information on the locations, size distributions, and trends in fire numbers and areas burned. This information is needed by resource managers to understand fire history, identify areas that are most under threat from too-frequent burning, the fire's likely points of origin, and to decide what management strategies and operations would enable fires to be controlled more effectively (Frost, 1999; Parr and Brockett, 1999). Such information is generally only available, however, within southern Africa's better-resourced national parks, commercial forests, and conservation areas, where fires are mapped using expensive and/or labour-intensive methods including observations from watch towers, and ground-based and aerial survey (Du Plessis, 1997; Parr and Brockett, 1999). Given the challenges involved with these methods, fire managers are interested in obtaining alternative and/or complementary fire information from satellite remote-sensing systems.

The satellite remote-sensing of vegetation fire is not new (Robinson, 1991a; Csiszar et al., 2004). The National Air and Space Administration (NASA) launched the first of a series of Landsat satellites in 1972 to provide observations over 185 × 170 km regions every 16 days, with coverage equivalent to about 5000 low-altitude aerial photographs (Jensen, 1996). Landsat data have since been used for environmental applications including fire mapping (Minnich, 1983; Hudak and Brockett, 2004; Cohen and Goward, 2004); however, due to the characteristics of Landsat data, such studies are necessarily confined to small areas. Capability to monitor fire on a regional to global basis was established in 1981 with daily observations at 1 km resolution from the Advanced Very High Resolution Radiometer (AVHRR) on the National Oceanic and Atmospheric Administration polar-orbiting satellite series (Robinson, 1991a). Subsequently, AVHRR data have been used to map the extent of burned areas and the locations of actively burning fires at local to global scales (Robinson, 1991b, Kasischke et al., 1993; Barbosa et al., 1999; Stroppiana et al., 2000). In the last decade, the remote-sensing of fire has advanced further as space agencies have launched environmental remote-sensing systems with specific fire-monitoring capabilities, including NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) (Justice et al., 2002a) and the German Aerospace Center's experimental Bi-spectral Infrared Detection (BIRD) sensor (Briess et al., 2005).

Recent NASA Earth Observing System (EOS) satellites observe the globe every day as required to derive time-series of global data products on a systematic basis (Townshend and Justice, 2002). Although developed primarily for global change research (Kaufman et al., 1998), these satellite data products are used for other applications, including resource management activities involving vegetation fire (Justice et al., 2003). MODIS is the primary EOS sensor used to monitor fire and is carried onboard the polar orbiting Terra satellite (launched December 1999) and Aqua satellite (launched May 2002). A suite of systematic land products has been processed for MODIS data sensed from 2000 onwards (Justice et al., 2002b). The MODIS active fire product maps the locations of burning fires detected within a pixel size of 1 km (Giglio et al., 2003). More recently, a MODIS burned area product has been developed that maps the extent of fire-affected areas at a pixel size of 500 m (Roy et al., 2002, 2005a); this latter product will be released in 2006. The two MODIS fire products are intended to provide state-of-the-art systematic global fire monitoring, and, because they are internally consistent, allow fire activity to be compared across space and time.

As with any map, the accuracy of satellite products should be assessed. This is required to provide information to help users decide if and how to use a product and to identify needed product improvements (Congalton and Green, 1999; Morisette et al., 2002; Roy et al., 2005b). Given these requirements, the accuracy of the MODIS fire products has been assessed quantitatively at a sample of locations in southern Africa through NASA-funded research (Morissette et al., 2005; Roy et al., 2005b). Although product accuracy statistics provide useful information to scientists, they may not be comprehensible to the broader community of users, including fire managers (Roy et al., 2005b). Accuracy statistics also provide an incomplete idea of the fitness of a given product to delivering a particular fire management objective.

An important step in understanding the utility of satellite products then, is to supplement quantitative measures of product accuracy with information on the full range of factors that promote and constrain their use. This paper employs a qualitative focus group methodology to examine factors that affect the likelihood that resource managers in southern Africa will use the MODIS fire products. Findings will also help to identify potential improvements in current and future satellite fire products and their delivery systems.

2. Methods

2.1. Rationale for use of focus groups

A qualitative focus group interview approach was used to gain insights into the factors that promote and constrain the use of the MODIS fire products. Qualitative interviews provide a useful means to access in-depth information on the attitudes and behaviors of subjects toward different phenomena (e.g., practices, concepts, interventions, products), with example statements left in their narrative state

(Miller and Dingwall, 1997). The focus group is an established qualitative interview technique designed to promote interaction between members of a group, in order to stimulate deeper discussion, reduce social and cultural constraints on participation, and reveal new facets of the discussion topic (Corbetta 2003). An advantage of focus groups is that the interaction of participants stimulates their thinking as well as an exchange of attitudes that may not emerge during direct questioning (Kitzinger and Barbour, 1999).

Focus groups involve discussion among a small number of participants, typically 6–12, following a semi-structured format set by a moderator whose primary role is to promote discussion (Krueger, 1994). An underlying premise is that "People who share common experiences, problems, or concerns are willing to reveal them in a group atmosphere" (Cabañero-Versoza et al., 1993, p. 98). This revelatory process can also reduce interview biases that may otherwise be introduced by social and cultural differences between the interviewer and the participants, and by the interviewer's preconceptions of the discussion topic. In this sense: "Group discussions are a useful way of sampling the stock of arguments available within a particular culture where the researcher is interested in the arguments produced rather than in the individuals producing the arguments" (Farr, 1995, p. 6).

Focus group discussions have been employed within numerous disciplines, including anthropology (Malinowski, 1922), political science (Merton, 1987), medicine (Prosser and Walley, 2005), biological research (Bates et al., 2005), and healthcare (Civic and Wilson, 1996; Crawford et al., 2004). Of particular relevance to this study is their use to assess *behavior* in using products, as well as *attitudes* towards potentially using them (Corbetta, 2003), along with factors that influence the use of new products and technology (Ambra and Rice, 2001, Griffith, 1998). Also relevant is their use in multicultural and international contexts, for example, as a rapid appraisal method used to gather information and ideas on the design and implementation of development projects in Africa (Cabañero-Versoza et al., 1993).

2.2. Description of focus groups

Focus group interviews were conducted at the Fifth annual Southern Africa Fire Network (SAFNet) meeting, 9–13 August 2004, Mangochi, Malawi (UNEP, 2005). The SAFNet is an open network of southern Africa fire scientists, managers and communicators that are concerned with the local process of fire and have strong interests in obtaining long-term fire information to support their research and operational agendas in resource management, and environmental assessment (WWW1). Thirty-four participants attended the meeting that had the theme: "Towards Meeting Fire Management Challenges in Southern Africa". The meeting participants came from Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe, and included observers from Senegal and the US, and Malawian administrative staff (UNEP, 2005).

Focus group participants were recruited using a screening questionnaire presented to the 28 non-administrative African meeting attendees. The screening questionnaire posed questions concerning the attendee's willingness to participate in a focus group, their professional affiliation, and their academic qualifications and professional working experience with remote-sensing. All 28 responded that they were willing to participate in a focus group. Thirteen indicated that they used remote-sensing in a professional capacity and held bachelors degrees or higher that included remote-sensing training, 5 had limited professional remote-sensing experience but degrees that included remote-sensing training, 5 had no formal training and limited professional experience with remote-sensing, and 5 had no remote-sensing training or professional experience. From the 28 screening questionnaire respondents, 15 were recruited to participate in two focus groups:

Group 1: Technical-users: participants with formal qualifications in the use of remote-sensing, including participants who use satellite fire products in a professional capacity (8 participants selected from 18 possible candidates).

Group 2: End-users: participants with no formal qualifications in remote-sensing and no or limited experience in the use of remote-sensing (7 participants selected from 10 possible candidates).

This grouping was chosen based on the assumption that the participant's familiarity with remote-sensing data and methods would influence how they perceive the usefulness of the MODIS fire products and the factors that affect the likelihood of their use. Efforts were made to select within each focus group a diversity of professional affiliations and resource management experiences to obtain a diversity of opinions and perspectives. The occupations of the focus group participants are summarized anonymously in Table 1.

The Technical-Users were all familiar with using one or more of the following types of remotely sensed information: aerial photographs, Landsat (Thematic Mapper and Enhnaced Thematic Mapper plus), AVHRR, and MODIS satellite data. All had used one or more of these professionally for one or more of the following activities: resource management; provision of data and technical support to resource management organizations, and academic research (including remote-sensing techniques and development research). Two of the Technical-Users acted as brokers of AVHRR and MODIS fire products and were familiar with the systematic production and dissemination of satellite products. The End-Users were less familiar with remote-sensing concepts and data and had no formal education in this field. Those End-Users who had used remote-sensing had done so in a limited capacity using aerial photography, Landsat, and/or MODIS images supplied by technical colleagues. Unlike the

Table 1
Generalized occupations of focus group participants (group 1 = Technical-Users, group 2 = End-Users, speaker codes are denoted: <group number>-<participant number>)

Speaker code	Type of organization	Country
1-1	Government, Research Institute	South Africa
1-2	Academic	Senegal
1-3	Government, Forestry and wildlife	Mozambique
1-4	Government, Research Institute	South Africa
1-5	Government, National Park	Namibia
1-6	Private Game Reserve	South Africa
1-7	Government, National Park	South Africa
1-8	Private remote-sensing company	Zimbabwe
2-1	Government, National Park	South Africa
2-2	Conservation NGO	Botswana
2-3	International Aid Organisation	Mozambique
2-4	Conservation NGO	Botswana
2-5	Government, Ministry	Angola
2-6	Academic	Lesotho
2-7	Government, National Park	Malawi

Technical-Users, the End-User's experience was restricted to examining printed images rather than viewing and manipulating digital data.

2.3. Format of focus group discussions

The focus group discussions were conducted using a semi-structured format that allowed the moderator to pose open-ended questions to clarify participant's statements and initiate new discussion when necessary. A moderator discussion guide was used to promote consistency between the two focus groups (Krueger, 1994). Use of the guide ensured that, although the moderator established topics of conversation, the content of each group was dominated by group discussion (Corbetta, 2003). The guide was developed following established procedures recommended for data gathering using focus groups (Krueger, 1994, Greenbaum, 2000), in conjunction with a review of the focus group literature cited above.

The focus group discussions were conducted in English, the only language spoken by all participants. The discussions were moderated by Dr. Roy, who has a background in remote-sensing and a good understanding of facilitating focus groups gained through literature review and role-playing. The moderator has also worked extensively with resource managers in Africa; this choice of moderator was considered sensible given the specialized and technical nature of much of the discussion.

The discussions were structured to move from the general to the specific. At the beginning of each group, the moderator briefly described the purpose of the study, why it was important, and the voluntary nature of participation and confidentiality of responses. The role of the moderator as a discussion facilitator and not a discussion leader was then clarified along with the focus group discussion etiquette (Krueger, 1994). After the participants introduced themselves, the moderator initiated group discussion using both verbal and visual cues. First participants were prompted to discuss their general experiences using remotely sensed products — including products unrelated to fire. Then the moderator gave each participant examples of the two MODIS fire products printed in colour with explanatory legends (Figs. 1 and 2) and asked them to briefly discuss the product information content with the rest of the group. Following this preliminary focusing stage, the session moved on to address key questions contained in the moderator discussion guide (Appendix A).

The focus group discussions lasted approximately 70 min and were recorded onto audio-cassette. The recordings were subsequently transcribed verbatim. Summary notes made by the moderator after each session were also retained for analysis.

3. Results

The preliminary focusing exercise in which participants first discussed their experiences with remote-sensing and then interpreted the visual stimuli (Figs. 1 and 2) both affirmed the correct group placement of participants, and, as desired, led to free-flowing, open discussions focused on the two fire products and in response to the key questions (Appendix A).

The analysis of focus group transcripts is less complicated when the views of participants coalesce around common opinions and patterns are clearly identifiable (Krueger, 1994); this proved to be the case for our analysis. Therefore, as with other focus group studies, (e.g., Crawford et al., 2004; Stjerna et al., 2004), the transcripts were analyzed iteratively and findings were grouped into recurrent themes. From the two focus group discussions, 12 broad themes emerged; these are summarized in Table 2 and are discussed below. Where appropriate, example narrative statements are quoted with anonymous speaker identity codes (Table 1).

Theme 1. Products should be generated with consistent and reported accuracy: Both groups discussed the accuracy of MODIS fire products as an issue that affects their use for resource management. Technical-Users mentioned the word "accuracy" explicitly, whereas the End-Users made more general statements that suggested the need for products to be accurate. For example:

> 2-3: We don't want to have a product that says there are fires all over the place, make a decision and send resources out there, if there's no fire.

The Technical-Users discussed accuracy concepts twice as often as the End-Users, perhaps reflecting their greater familiarity with this theme. Both group discussions revealed a range of attitudes toward accuracy, from participants who considered accuracy as a primary factor:

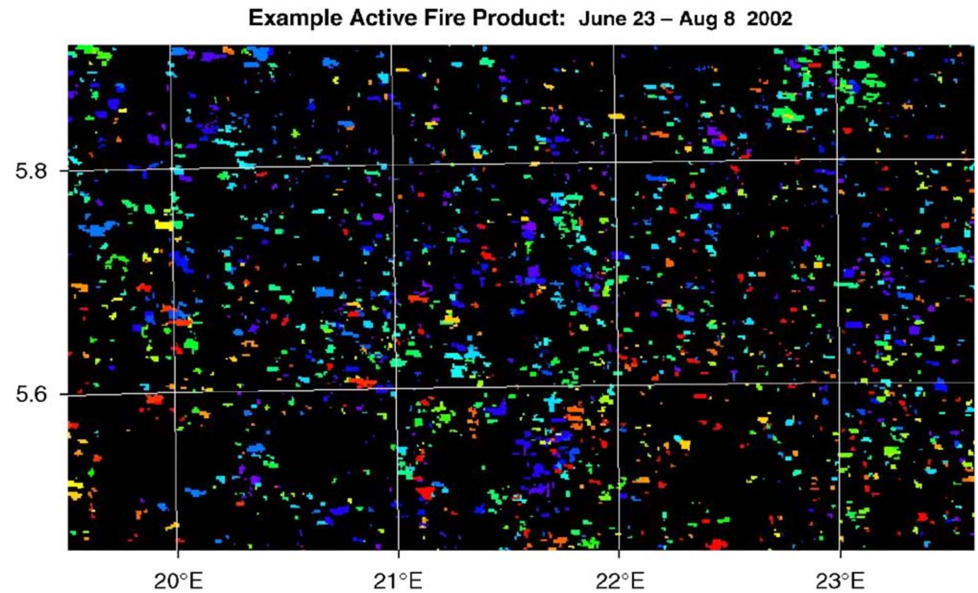

Fig. 1. Example MODIS active fire product and explanatory text used as the first visual stimulus. Explanatory text: This image shows a sample of the MODIS **active fire product** for a 450 by 250 km region that includes part of the border between Angola and the Democratic Republic of Congo (not shown). The pixel size of the product is 1 km. Notice how active fires detected on different dates are shown in different colours, with earlier (June 23rd) fires shown in violet, and later (August 8th) fires shown in red. Black is used to show areas where no active fires were detected. This example provides geographical context for the active fires by showing a one degree map grid (white lines).

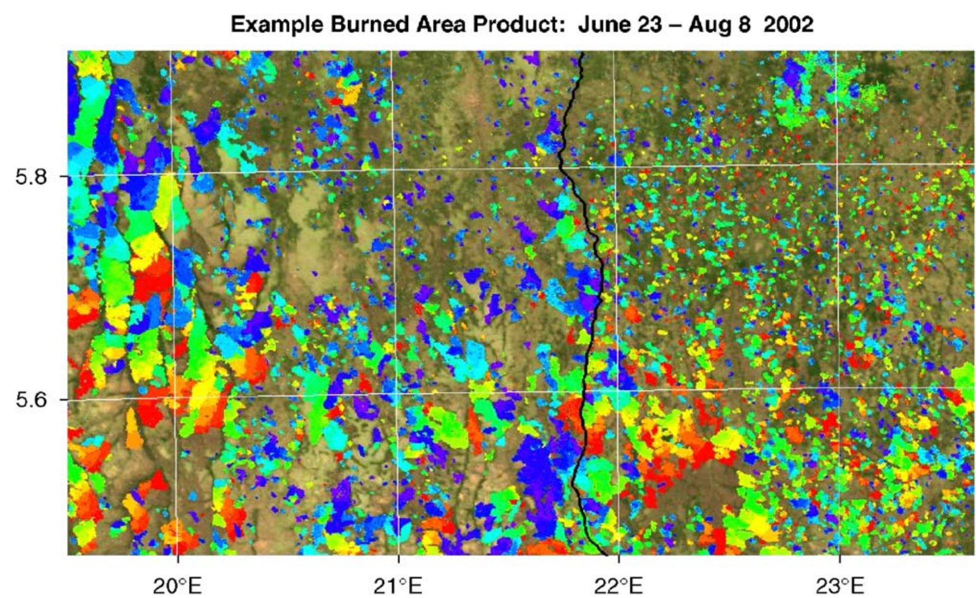

Fig. 2. Example MODIS burned area product and explanatory text used as the second visual stimulus. Explanatory text: This image shows a sample of the MODIS **burned area** product for a 450 by 250 km region that includes part of the border between Angola and the Democratic Republic of Congo (near-vertical black line). The pixel size of the product is 500 m. Notice how burned areas detected on different dates are shown in different colours, with earlier (June 23rd) fires shown in violet and later (August 8th) fires shown in red. This example provides geographical context for the burned areas in two ways: First, by displaying the burned areas on top of a MODIS image that closely represents the true colours of the surrounding unburned landscape (for example, so that trees appear green and dry grass appears light brown); second by showing a one degree map grid (white lines).

> 1-6: For the burned area product, the factor that would determine whether we use it or not is the accuracy.

to those who regarded accuracy as of little concern:

> 1-8: For my applications … I'm not really worried about accuracy.

Despite the variable range of opinions, both groups posited that products should be delivered with associated accuracy information. Only the Technical-Users discussed the types of needed accuracy information and then only in terms of standard remote-sensing accuracy metrics (Congalton and Green, 1999). For example:

Table 2
Main themes that emerged from the SAFNet focus group discussions

Theme number	Themes
1	Products should be generated with consistent and reported accuracy
2	Product spatial resolution is too coarse for certain applications
3	Immediacy of application requirements determines product utility
4	Additional fire characterization information is desired for certain applications
5	Products desired in familiar digital formats and/or as printed maps
6	Product documentation and user guides desired
7	Access to satellite products is improving, although technological constraints remain
8	Internet access constraints may be mitigated by within-region networks
9	Technical-Users envisage potential problems disseminating products to third parties
10	Insufficient training and access to product examples constrain product use
11	Certain users may benefit from value-added internet delivery systems
12	Technical-Users perceive constraints due to uncertain long-term continuity of product availability

> 1-2: There must be some kind of [associated] statement or something that says the accuracy of these maps is approximately so much.
>
> 1-5: For some users, a very important thing for them is the accuracy in terms of the errors of omission and commission.

Despite these statements in support of accuracy figures, no participants ventured to define an acceptable level of product accuracy numerically; rather, all accuracy requirement statements were made qualitatively, for example:

> 2-3: We need a product that really represents what's on the ground.
>
> 1-8: We would like to know can we trust it, what is the confidence we have in the product.

Furthermore, the End-Users raised a concern that accuracy information is not comprehensible to all potential and actual users, for example:

> 2-4: I'm very conscious about how much light does make of this [accuracy discussion] to somebody who never went to school.

This concern was also reflected by discussion on the need for training and for access to product examples (Theme 10). End-User concerns with the comprehensibility of accuracy information were also articulated in discussions on the desire for users to participate in product assessment activities in order to better understand the products and their accuracies:

> 2-2: It's very important to involve local people in the product assessment, so that they can understand how they [the products] are derived, and also what their accuracies are.

To summarize, participants expressed needs for the MODIS fire products to both represent reality accurately and include accuracy figures; however, the discussion on the quantitative specifics of what constitutes an acceptable level of accuracy was not well developed. As such, it seems unlikely that providing resource managers with figures for product accuracy will exert a strong control on whether they use them. Many other factors are involved, as revealed by the 11 other themes that emerged, as described below.

Theme 2. Product spatial resolution is too coarse for certain applications: Attitudes toward the pixel sizes of the MODIS fire products (a measure that is related to the product spatial resolution) varied considerably. Several Technical-Users welcomed the improved 500 m pixel size of the MODIS burned area product relative to that provided by 1 km AVHRR heritage data, and the 1 km MODIS active fire product:

> 1-1: Well, I'm used to mapping of AVHRR data, so going from 1 km to 500 m, it's a lot more useful.
>
> 1-3: If you look at the active fire product [Fig. 1] it looks sort of evenly spaced across the image. If you look at the burned area one [Fig. 2] there's a very marked difference in the size of the fires, more information about the actual size of the fire within the timeframe captured …

Comments by End-Users on desired pixel size were tentative, reflecting their apparent uncertainty of what is detected within pixels:

> 2-1: But what is size of fire? Is it the heat, or the area?
>
> 2-5: Often it's not 400 [separate active] fires, it's 400 spots [1 km pixels], and they're hot and they've been picked up [detected]?

Some End-Users made pragmatic observations that the desired pixel size should be proportional to the management area.

> 2-2: If you've got to manage a large area, I think that a large pixel is fine.

End-Users also recognized that some applications require smaller pixels than provided by MODIS:

> 2-2: But if you want to look at fire behavior, then I think it would be nice to have it at a finer scale as well.

The Technical-User discussion on pixel size revealed a greater appreciation of fire detectability issues and led to the contention that the pixel sizes of both MODIS products are too large to detect the full range of fire sizes:

> 1-7: At the moment, fires start that are much smaller than what MODIS can map, so, those fires are also left out. So, if there is a way to improve on that … that would be very useful for us.

1-3: Certainly some of the underlying issues could be related to land use and land fragmentation, which are more pronounced at a much higher spatial resolution than probably can be captured at the maximum resolution at which you can work with MODIS.

Such comments suggest that the spatial resolution of the MODIS products is too coarse for many applications.

Theme 3. Immediacy of application requirements determines product utility: The perceived usefulness of the two MODIS fire products varied with the application being discussed; it was also closely related to how immediately fire information was required. For example, participants working in fire fighting and warning applications, said they require information while the fires are still burning and so considered the active fire product most useful:

1-4: I need near-real-time fire detections to monitor fires burning beneath power lines: so active fire is much more important than the burned area … because it's basically for control … if you want to use active fires for near-real time monitoring and you can't get it quickly, it's useless.
2-1: So, you're sitting down, and you get a time and a location, then we can react to that … it improves our ability to respond to fire.
1-5: The current active fire product has real value in early warning terms.

When time-criticality is less important, the burned area product was considered more useful:

2-6: For commercial resource managers … the information of interest is always linked to area burned. You cannot do that assessment when the fire is [still] burning.
1-6: We are interested in the ecological management of the park, so we need to know the amount of area that has been burned within a specific season.
2-1: [The burned area product] would help in wildlife management, to follow the distribution of the animals, where they are after the burn, when the grass is sprouting. You know that animals will move into those areas. And you'll be able to follow, and even plan your anti-poaching patrols because maybe there will be lots of poachers going into those burned areas.

While an application's time-criticality was found to exert a strong control on which MODIS product is useful, the participants did not emphasize time-related product attributes. For example, the product's temporal resolution was not discussed explicitly; nor was the time period that the product depicts, although a number of qualitative requirements were articulated on the desired frequency of product delivery for different applications:

1-2: I think the more frequent you get [the products], the better, especially during the fire season.

These discussions clarify that since the relative usefulness of the MODIS active fire and burned products were considered to vary strongly with application, further assessment of product utility should elicit participants views on the fitness of the products to their specific applications.

Theme 4. Additional fire characterization information is desired for certain applications: The discussions highlighted that ecosystem managers would like additional fire characterization information that is not included in the MODIS fire products; specifically on the fire's intensity, rate of spread and temperature:

1-6: What fire managers need to know is what the effect of their burning policies are in terms of intensity and rate of spread, because that is related to top kill [a factor that determines whether a shrub will die] on the vegetation and what managers want to achieve. Now from these [MODIS] overpasses you cannot really calculate fire intensity or rate of spread in a meaningful way.
1-5: So what this doesn't tell us, and what is needed for conservation areas … is, how the area burned. … If we can... somehow show the intensity of the fire that it burnt, that would be very useful.
2-1: You know, where there's a clean burn, hot burn, cool burn, that's the combination that really affects the vegetation out there, animals' response to the fires, what's going to happen out there, so, besides getting a blob like this, anything you could say within the blob would be very useful.

Some of this information on fire temperature and radiative energy can already be derived from remote-sensing (Giglio and Justice, 2003; Wooster et al., 2003). However, these information relate only to how fires are burning at the instant that the satellite data are sensed; they do not provide the information that resource managers desire on how the energy released by a fire varies across all of a burned area. Furthermore, although several studies have mapped burned areas in terms of a related parameter called fire severity (e.g., Michalek et al., 2000; Rogan and Yool 2001), the efficacy of the approaches used is questionable over large areas (Roy and Landmann, 2005; Roy et al., 2005c).

At present, there is no operational way to provide satellite information on how fire intensity, severity, rate of spread, and temperature varies across entire burned areas. It is unclear how this lack of within-burn fire characterization information will limit product uptake, despite the clear needs expressed for this information for management activities concerned with fire's effects on vegetation.

Theme 5. Products desired in familiar digital formats and/or as printed maps: Attitudes toward the formats of the MODIS fire products varied between the Technical and End-Users. As expected, the End-Users were uncertain of format issues, and often discussed them generically, or stressed their limited knowledge:

2-3: I've fought quite a lot with my zero knowledge in GIS [Geographic Information Systems software], to try and orientate Landsat pictures — it took me way over

three days just to put the pictures together and georeference them … if NASA could provide them [MODIS fire products] already georeferenced, then it would be easier for our application.
2-1: Probably users can select the kind of projection that they prefer because people can choose different projections for different areas?

End-Users also wanted products delivered in a familiar format, for example, to be compatible with software they already knew, or packaged to make them "easy-to-use":

2-5: It would be nicer if it would come readily useable in Arc View [a GIS package].
2-2: Bring [the product] together in such a way that it's useful for the people, but you must deliver it like in a package, like McDonalds.

The specific format of the MODIS fire products was of less concern to Technical-Users, who, unlike the End-Users, were confident they could re-format the products as necessary to meet their particular needs. For example:

1-2: At some level, size of file, format, type of file, projection are important but at another level, we [Technical-Users] all have the [software] tools to handle this.

The Technical-Users suggested, however, a need for printed maps which they felt may be more suitable for certain policy makers and technologically disadvantaged users:

1-4: There are people in the region who don't have computers—they need a print out.
1-6: For some of the politicians, to understand in a meaningful way, pretty pictures are the best way.

End-Users also considered the use of printed maps, but stressed that the frequency with which printed maps are delivered will influence their utility:

2-3: I can use printed maps, if I get them, like, for every three months.
2-6: You can use a [printed] map, but then how frequently are we going to get it, that would be the thing. I mean, you get the first one, there's only one fire there, that's good enough, we've got the map and we know the location. The next day, there's another fire in another area; we need to know that.

The different emphasis each group placed on the need for familiar digital formats and the relative utility of digital and printed products may reflect differences between the roles of Technical-Users (predominantly product providers) and End-Users (product users). Although some of these needs may appear self-evident, it is important to document them here, especially as the End-User discussion indicates that the format used to deliver products may influence whether non-remote-sensing experts can access and use them.

Theme 6. Product documentation and user guides desired: Although both groups expressed the need for product documentation tacitly, only the Technical-Users discussed documentation issues explicitly:

1-3: An important [consideration] is not so much the product format, but explaining it … the metadata is very important.

Some Technical-Users noted deficiencies in the documentation provided with MODIS land products (Justice et al., 2002b). For example:

1-5: At the moment, if you download a MODIS product [from the US Land Processes Data Active Archive Centre, WWW2], you get that metadata file, which is a lot of numbers all over the place, and you don't know what the hell you're looking at.

Other Technical-Users suggested documentation should be comprehensive, to include not only information on product accuracy but also specific instructions on how to manipulate the products, especially in a way that is compatible with different software packages:

1-4: [Documentation should provide] an easily understandable explanation of what the data [is], the format of the data, and how it [can be] converted, an example of how it's converted too, and an example of how it can be used.
1-8: It's very important to have some information on how to actually open files in a way that information can be read. Or, if this cannot be done, how, in a very easy or acceptable way, can one georeference or put the data to a format that is compatible with older and slower software systems?

The Technical-User discussion on documentation may illustrate that some users are unaware of the MODIS product documentation that is available at a variety of web sites in the United States [WWW3]. The fact that End-Users did not discuss documentation probably reflects their limited experience using remote-sensing products rather than a lesser need for product documentation. The Technical-User discussions on documentation may also reflect broader issues of technology transfer and information access in developing countries and/or a failure of the MODIS product providers to publicize their documentation sufficiently or make it widely available in such countries. This issue links to discussions on internet access and training, summarized below.

Theme 7. Access to satellite products is improving, although technological constraints remain: Both groups discussed how capacity to access satellite products in southern Africa is evolving with reduced costs and the emergence of computer and internet technology. Prior to the 1990s global internet revolution, satellite data were obtained by installation of a satellite-receiving station, or by data requests to such stations. Data were typically mailed to users on analogue tape media or as printed photographs/diapositives, and could only be sent digitally between interconnected institutions on dedicated computer networks. Today, users can submit requests via the internet using personal computers, and can request data to be sent on tape and compact disk media, or digitally over the internet using file transfer protocols.

Both groups suggested that although satellite products can now be accessed over the internet, media-based methods of product delivery are still needed:

> 2-3: Some people would not necessarily have the need for these [MODIS fire] products every day … they won't be in dire need of an internet connection, so it's packaged on a CD on a monthly basis.
> 1-2: they [users] can perhaps try and get them [products] off the internet, otherwise … budget for postage and mail it.

Technical-Users related experiences to suggest that access to satellite data is becoming cheaper and easier, making it a more viable tool for use in resource management:

> 1-8: I remember six years ago … I was using Landsat TM to assess vegetation, biomass, and we were buying Landsat images for six hundred US dollars. So, we could only cover a small piece of land, we couldn't cover the whole country because of the cost. So now the images are available for free [through a recent South African data sharing policy], which means that we can do more in the way of assessment with imagery.
> 1-2: Well, I'd say that in the past, satellite data, was quite difficult to access it was also very expensive … but over the period it's much easier now and much cheaper and… so it's becoming more of a tool to be used in management.

The End-Users expressed similar sentiments but with less detail and perhaps echoing what they perceived were widely held beliefs. For example:

> 2-5: But probably now with more accessibility to computing and everything, and other IT [Information Technology] infrastructure, it might be relatively easy. And they [satellite data] were … very, very, expensive.
> 2-6: Access to internet is spreading, and it would be the easiest and most convenient and clear means of transmission…

Although participants suggested access to satellite data has improved, they also stressed that the need for an internet connection and the expense involved with maintaining it, present an important potential obstacle. For example:

> 2-1: Access to internet, yes, I was coming to that.
> 2-3: And, if you haven't got it, then…
> 2-1: Yes, then you have a problem.
> 2-6: This is a major problem in all of our countries, because it's very expensive.

It emerged that internet access is problematic in all SAFNet countries, although less so in South Africa; this is illustrated in the two statements below, the first made by a Mozambican, the second by a South African:

> 1-3: I come from outside of South Africa where our download speeds are pretty slow, and unless something changed drastically it [the internet] would probably be a disadvantage in terms of downloading the information.
> 1-1: I think any country outside of South Africa probably has an internet access feed problem. So downloading would take too long.

Even then, a South African Technical-User noted problems with download speeds:

> 1-7: Downloading data from the internet is actually complicated... we've been trying to download MODIS images [unknown type], it takes between 30 and 40 min, because of the set up [computers and network] we have.

Each of the preceding statements on internet connectivity is consistent with previous studies of internet access in Africa; for example, Roycroft and Ananthob (2003) report that in 2001 South Africa had the highest international bandwidth, 300 Mega bits per second (Mbps), of any African nation, followed by Botswana (14 Mbps). Of the remaining 10 SAFNet countries, only six appear in Roycroft and Anthrob's league table of the top 25 African countries ranked by international bandwidth (3.2 Mbps mean international bandwidth for these 25 countries). The relative difficulties in accessing large data volume files over the internet in southern Africa are emphasized when these African bandwidths are compared with the equivalent US bandwidth (27,0000 Mbps, also in 2001). The high international bandwidth available from the US likely prevents US-based designers of internet delivery systems from appreciating fully the difficulties that internet users experience in Africa.

Given the challenges posed by poor internet connectivity, a Technical-User suggested that product delivery systems should be adapted to minimize the product file size, as illustrated in the following exchange:

> 1-5: Here's a point. If we get the burned areas or active fires on a daily basis it will zip [compress] down to nothing.
> 1-4: How do you mean?
> 1-5: Because you've got one value burned or not burned. So, it's a very small file you've got. You've got some coordinates and a value of one or nothing. It's only when you have a year's worth of burned area or six months or seasons worth that it's a really complex… every cell [pixel] has a different value, and then it doesn't get compressed, so then it's a big file, but if you get it daily it's small — you could probably get it emailed.

These discussions indicate that slow internet connectivity need not pose an insurmountable constraint to accessing the MODIS fire products. Furthermore, although studies based in the US have posited that fast internet connectivity is essential to transfer products efficiently from data providers to users (Kalluri et al., 2003), the reality of slow internet connectivity in Africa rather places the onus on product providers to facilitate product uptake by minimizing product file size.

Theme 8. Internet access constraints may be mitigated by within-region networks: Recognizing that not all organizations within southern Africa possess computers and internet connections of their own, both groups suggested that the uptake of the MODIS fire products could be improved through the establishment of networks within the region. For example:

> 1-5: The networking I was talking about… NASA simply puts the fire product on the internet and is now worried the guy without a computer is not going to get it. But they [NASA] don't have to worry because, they don't have to supply computers to everyone, he [the user without a computer] must network with people locally to do that job.

In other words, resource managers within southern Africa who possess the necessary infrastructure can access the MODIS fire products; those who do not possess this capacity can obtain products from those who do.

The structure of networks envisaged by participants varied. One participant constructed the idea of a formal network to include a focal point with the capability to access the products:

> 2-6: NASA are going to support us, probably with the technology…but we also can provide something, because we have still got our own computers, and we are connected with the internet, some of us, and so we can come back to our countries and identify focal points.

Other participants envisaged more individualized network relationships that placed the onus on individuals who do not have the requisite capability to find and establish data supply from those who do. Comments from other participants implied that the major MODIS southern African satellite receiving station, located at the Council for Scientific and Industrial Research (CSIR) Satellite Application Centre (SAC) in South Africa, could usefully serve users:

> 1-4: within South Africa, you've got the advantage that you can use the CSIR.
>
> 2-7: … if it's accessible from South Africa, this is good for building … capacity … and maybe the future, is to see how we develop it in southern Africa.

Although both groups considered networks as potentially useful, some participants nevertheless anticipated problems, as access difficulties may be replicated within the network. For example:

> 2-4: If we don't have [internet access] then it's not easy for me to drive 200 km to pick [the MODIS products] up every week [from a network data broker].
>
> 2-3: Our protected areas are mostly located in very remote areas where there's no access to any email, or computers, nothing. It would be useful if headquarters gets this information. But the communication between headquarters and the remote areas is far more important — it's very difficult to inform them that there's a fire somewhere. That's the problem I think.

Such comments place limits on the efficacy of networks with distance and suggest the need to improve the availability of MODIS fire products in remote locations.

Theme 9. Technical-Users envisage potential problems disseminating products to third parties: Technical-Users discussed how the creation of networks (Theme 8) could lead to potential problems. In particular, Technical-Users anticipated problems when they, or network representatives, provide MODIS fire products to third party users. Specifically, such third party users may not understand either the meaning of the product or its limitations. Such concerns emerge and are reinforced during the following exchange:

> 1-5: Now, the problem with printing them [products] out and giving them… Is that you've got to make sure that all of these users actually understand … or there must be some kind of a statement or something that says "the accuracy of these maps is approximately so much"…
>
> 1-2: The limitations …
>
> 1-5: Yes. Because otherwise, people treat these things as reality. And also then what they're going to do is they're going to look for faults in this thing, and say "oh, this product, it's no good".
>
> 1-6: I agree with that. I think you should say that these are fire predictions, or fire scar probabilities that, cannot be used in a court of law, when, for example, checking security or insurance risk, I think that's very important to say.

Moderator: But arguably, couldn't the same criticisms be applied to digital data? Can you comment on that?

> 1-6: Yes, for sure. But what I was thinking is that the people you're printing it out for might be the people who are not technically skilled.
>
> 1-5: Yes, it's something you explain to them the first time, and that's it.
>
> 1-3: Or if you want to go to the extreme, a disclaimer, that there's this data, it's only accurate to a certain extent, and after that there's no other problem.

Explicit here is the view that users who need someone else to acquire fire products for them might lack the experience and knowledge to interpret correctly their meaning. This in turn could result in products being used inappropriately by people unaware of their limitations; perhaps even leading to litigation.

Associated discussions reinforced the need for documentation and other approaches to explain the meaning of each product as well as its limitations; all to help ensure that products can be passed on to third party users without fear of adverse consequences.

Theme 10. Constraints perceived due to insufficient training and access to product examples: The End-Users discussed how insufficient education and training limit the uptake and utility of satellite products in southern Africa. Many southern Africa countries have significant social and economic development issues, and resources are limited for tertiary education, especially in remote-sensing (Aseno, 1997). The End-Users suggested that two types of training are needed to enable a broader uptake of remotely sensed products; the first, prerequisite training, would be in remote-sensing and GIS:

> 2-6: I assume that many people lack the training in GIS or remote-sensing ... so that's what stops us to take this further.

The second type of training would focus on how to interpret and use products:

> 2-7: I'm seeing this product for the first time… but I don't really understand it, I need to understand it, even now, to do some practical kind of work you know, to compare this piece of paper [Visual Stimulus Example] to the actual ground and to actually see that it means what it means.
> 2-5: Not a long training course, but just to get a real picture of what this thing is you know, and, so that we will be able to interpret this and make use of it as we want it.

Participants also suggested that confidence in using and understanding MODIS products could be built through the use of example products. In particular, example products could serve as the basis for case studies that demonstrate different applications. Results could then provide useful educational material:

> 1:2: Something that would be awfully useful is for people to do studies in different countries about the usefulness or how these burned area information, active fires, are used in their every day working agenda.
> 1-5: To help other people to know, to inform them it's not just a product for one application, but it can be used for a whole range of other activities.

Although End-Users emphasized the need for training to enable greater uptake of MODIS products, the Technical-Users did not emphasize this need. This is consistent with the confidence expressed by Technical-Users in their ability to use and manipulate the MODIS fire products. It also reinforces the valid role that Technical-Users can play in enabling a broader usage of MODIS products by providing training and by brokering products to users.

Theme 11. Certain users may benefit from value-added internet delivery systems: The participants discussed the role that value-added internet delivery systems could play in providing fire information derived from the MODIS fire products. They discussed how such systems could deliver additional information and circumvent the experience and software that users need to manipulate satellite products.

Participants from both groups related how the MODIS fire products may be more easily interpreted when displayed with additional information that provide geographic and/or biophysical context. This concept was first mentioned during discussions of the grid lines, country borders, and background MODIS image shown in the visual stimuli (Figs. 1 and 2). For example:

> 1-2: to convince the local decision makers where the fires are located … you have to superimpose a country boundary or a national park or something … not just a grid showing latitude and longitude, but a map showing where things happen.

Ten additional types of thematic information were mentioned in this context, namely: country boundaries, national park boundaries, land use units, land cover units, vegetation type, meteorological conditions, topography, water bodies, management infrastructure, and fires from previous years.

The Technical-Users noted that although these kinds of additional information can be superimposed on the MODIS fire products by individual users, this functionality was also provided by existing value-added internet delivery systems:

> 1-1: The Web Fire Mapper [an internet based MODIS active fire delivery system, WWW4] [lets the user] click on buttons and to add different layers [ancillary data], and they can either download the map or print it out [from the internet].
> 1-3: I think I have at least two systems. One is something like a Web Fire Mapper for people who don't have a GIS where they can access the datasets [MODIS fire products], they can click on buttons to add different layers, and they can either download the map or print it out or something like that [via the internet]. And a different one … one, for people who want [to order] the datasets so that they can have the data [MODIS fire products] and put on layers and print it out themselves.

The participants noted the value-added internet delivery system would ideally provide additional information in a way tailored to meet the needs of different users, but that not all such information can practically be provided:

> 2-1: Another important thing with this [MODIS fire] product, is if you put other land use layers [ancillary information], what have you, [you can] make it function of your own specific application.
> 1-3: The specific person will require specific layers of information for the specific user requirement and how are you [the value-added internet delivery systems] going to manage all that ?

These discussions clarified that value-added internet systems may facilitate product uptake by a broader community of internet connected users. Other factors affecting this broader uptake include the value-added internet system interface design and internet connectivity.

Theme 12. Technical-Users perceive constraints due to uncertain long-term continuity of product availability: The Technical-Users expressed concerns with the temporal continuity of the MODIS fire products. They were concerned by how the product specifications change as different product versions are released; also about the uncertain mission life of the MODIS sensor and so the long-term availability of the MODIS fire products.

The first set of concerns, related to product versioning, are illustrated by the following remarks:

> 1-6: I think one of the most important things for managers is probably continuity of the data…if you've got different products in two years which are differently derived… then, for systematic monitoring systems, that might be problematic.
>
> 1-1: It is important to try to keep people [users] updated on how the data product will be used and how it will be possibly improved in the future.
>
> 1-5: The irritation is, six weeks down the line, getting a [new product version] file for six weeks ago. Because now [if] the geolocation's [the positions that the image pixels are mapped] been updated, where was the fires the first time? Because I sent it [the original fire product] out to people and said there's a fire on your doorstep. And then later I get a new file that puts it [the fires] somewhere else.

These extracts reinforce how resource managers value continuity in how fire products are prepared; both so that they can develop a consistent data set suitable to compare fires between years, and so that they pass these products on to third parties with the confidence that they will not encounter the inconvenience of having to explain subsequent revisions.

The second set of concerns pertains to the longevity of the MODIS mission, and includes worries that MODIS products will cease to be transmitted or provided for free:

> 1-5: You get people all excited, you're delivering real time active fire products, you're delivering burned area. Everyone shuts down their NOAA [AVHRR] systems and chucks away the data. And then after a few years or whatever, the MODIS data's not free any more, it's not being processed anymore.

These discussions highlighted that although the MODIS satellite mission is finite (6 years), the resource manager's need for systematic fire information is continuous. Other comments reinforce concerns about NASA's commitment to continue to operate MODIS and deliver fire products:

> 1-4: And there are different teams…working on the delivery of the fire scar [burned area] product, but, you know, they are not responsible for the long term operation.
>
> 1-6: There's a fear, an apprehension that there's no long term future, that in five years time it's going to stop.

These continuity concerns echo findings from earlier studies of remote-sensing transfer. For example, Specter (1988) reported continuity as a major barrier to the transfer of Landsat technology to both developed and developing countries, specifically, due to the then-anticipated withdrawal of US government financial support for the Landsat system. Similarly, a more recent study conducted in the USA (Kalluri et al., 2003) emphasized that users expect remotely sensed data to be provided in a consistent data format and need to be assured of data longevity before they are willing to switch to remote-sensing data products for operational decision making. Continuity is thus a recurrent issue whose importance was reinforced by the Technical-User Group who would like to see fire products given operational status in the long term.

4. Conclusions

This study employed semi-structured focus group interviews to examine factors that affect the likelihood that resource managers in southern Africa will use information provided by the MODIS active fire and burned area products. Analysis of two focus group discussions held with 15 members of the Southern Africa Fire Network (SAFNet) revealed 12 main factors (Table 2) that exert some control.

Of these factors, the provision of quantitative product accuracy figures was found to be relatively unimportant. Although participants said they value accuracy figures, or some indication of how fires depicted in MODIS products relate to "the reality on the ground", none defined numerically the accuracy that products would need to attain in order to make them "good enough" for a particular application. This lack of specificity mirrors difficulties with defining acceptable accuracy found in other applications. For example, the degree that the atmospheric modeling community have defined their requirements of fire products they need to model emissions of greenhouse gases was recently described as "not well developed" (WWW5; IFFN, 2003). It seems that many users want to use the most accurate product that can be produced from a given data source, but do not consider it necessary to state their accuracy requirements any more precisely than that. Since user requirements of satellite-derived products have not been articulated in terms of numerical thresholds of acceptable accuracy, we do not expect the provision of accuracy figures to exert a strong control on whether a given product is used. Rather, we expect that many users will decide whether to adopt a product based on their exposure to example products or cases studies, and on the degree that the incidence and extent of fires recorded in the MODIS products are verified or refuted through their experiences using them.

The above may suggest a need by the remote-sensing community to expand the way it assesses the worth of remotely sensed products; that is, to complement product accuracy figures with a more routine consideration of the broader range of factors that affect whether a given product will be used. For example, rather than product accuracy, perhaps the major determining factor we encountered is the difficulty participants experience with accessing satellite products over the internet. Since many SAFNet members prefer to access fire products over their (albeit slow) internet connections, a major determinant to uptake will be the file size of both the product and the internet interface required to download it. Such insights are directly useful to organizations that produce and/or distribute satellite products and who want satellite products to reach the broadest population of users possible.

The poor internet availability and low internet bandwidth in southern Africa also suggest that uptake of the MODIS fire products can be improved through within-region networks, whereby a user working in an office with sufficient internet connectivity can download products and broker them to other users unable to download the products for themselves. Findings suggest the need for network brokers to provide the product in different formats depending on the requirements of different third party users, for example, as printed maps or on tape or disk media, that may then be delivered by courier or mailed via the postal system.

Other than slow or non-existent internet connectivity, participants generally did not perceive serious obstacles to using the MODIS fire products. Nevertheless, the study did reveal actions that product providers could consider implementing in order to improve the likelihood that products will be used. Such actions include improving the availability of product documentation and its range and content (e.g., to include user-friendly usage instructions, metadata, and disclaimers), and adapting value-added internet delivery systems (e.g., to minimize the file sizes of fire products as well as the time delay involved in serving them). A more difficult improvement to implement would be the participant's suggestions that the MODIS fire product pixel sizes were too coarse to capture all fires – here technical remote-sensing constraints restrict what is practical. Similarly, technological and scientific constraints currently limit the implementation of requests for the products to include information on how the energy released by a fire varies across burned areas. This serves as a reminder that satellite fire products, while useful, can alone help to answer only a subset of fire-related questions framed by resource managers (Frost, 1999).

The study encountered less than expected divergence of opinion between the End-User and Technical-User groups. Three important differences did, however emerge: first, the End-Users tended to internalize the obstacles to using products more than the Technical-Users. For example, whereas the End-Users referred to their own lack of training as an obstacle, Technical-Users rather focused on obstacles that originate within either the product itself or the product delivery system (e.g., product documentation, insufficient timeliness). Second, End-Users generally did not anticipate adverse consequences to using the fire products, whereas the Technical-Users envisaged several (e.g., being blamed for errors in the product, fear of litigation). Third, unlike the End-Users, the Technical-Users expressed several concerns with the consistency and continuity of the MODIS mission.

The latter concerns were manifest both as inconvenience and annoyance at how the MODIS fire product specifications may change as different product versions are released and as doubts about long-term product availability. These concerns were found to echo findings from earlier studies of remote-sensing transfer. Product continuity is thus a recurrent issue whose importance is reinforced here, demonstrating how fire managers would like to have fire products given operational status, reflecting their long-term need for systematic and continuous fire information.

The SAFNet focus group discussions did not reveal the availability of computer hardware and software as one of the major constraints. Arguably, the End-Users may not have emphasized these constraints due to their lack of technical familiarity with the subject, and the Technical-Users may have assumed such constraints were obvious. Other factors not articulated in the focus groups may also have been important. In both focus groups however the need for adequate hardware and software seemed mitigated to a degree by the perceived possibility of obtaining the MODIS fire products either as hard copy or as images delivered over the internet or from a local broker. Discussions in this context were linked to the need for training in order to obtain and utilize such information.

Despite the focused nature of the study, the factors revealed in Table 2 are generally relevant to other types of satellite product and to other user communities. Even the one factor that was specific to the MODIS fire products (concerning the desire for additional fire characterization information) reflects a common desire for products to be more descriptive. The relative importance of the factors revealed by the present study will vary with respect to different satellite products and user communities. For example, internet access and training issues may be less important in more economically developed parts of the world. Factors not discussed by the SAFNet focus groups may also be important to other user communities and to users of other satellite products.

This study, coupled with other ongoing SAFNet activities, contributes to the international Global Observations of Forest Cover/Global Observation of Landcover Dynamics (GOFC/GOLD) program objective of enabling user communities to play an active role in evaluating and testing pre-operational satellite products and algorithms (Justice et al., 2003, WWW6). It adds to previous work that finds focus group interviews an insightful means to understand the range and depth of opinion that forms the voice of users of a certain product. As such, focus groups could prove a useful tool with which to supplement our knowledge of how NASA's Earth Observation Science initiative is transforming the Earth sciences and of what needs to be done to strengthen this transformation.

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Appendix A. Moderator discussion guide key questions

1. What do the products tell you about fire in the particular area shown in the pictures [Fig. 1 and 2]?
2. How do you think the fire products can be used in fire management, or other applications?
3. How do you think the products could be improved to make them more useful ?
4. Both of the MODIS fire products we've looked at will be delivered from America to users in Africa. How do you feel about this?
5. What factors determine whether you use or will use the MODIS fire products ? In particular [moderator giving cues (a) to (c) below as needed]:
   (a) I'd like to hear about factors you think relate to the product itself.
   (b) Other than the characteristics of the product, what else needs to be in place to make the product most useful?
   (c) Of the two types of factors (aspects of the product/ aspects outside of the product), which are most important in deciding whether MODIS fire product are used?
6. Imagine you are talking to the No. 1 decision maker at NASA who decides how the fire products will be made and delivered to countries in Africa in the future. What would you advise him or her to do to make MODIS fire products as useful to you as possible?
7. Have we missed anything?

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