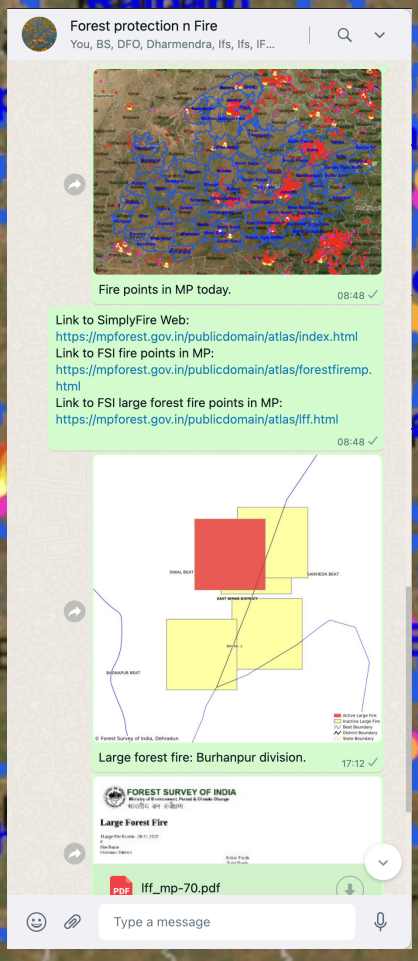
Fire fighting

10 lessons in management



वन विभाग
मध्यप्रदेश शासन, भारत

Fire fighting

10 lessons in management

Madhya Pradesh Forest Department

Contents

Message

Forest fires are disasters. They not only destroy biodiversity and habitats, but also disrupt the livelihoods of countless forest-dependent communities. Thus, their management is imperative. Through strategic management, Madhya Pradesh was able to reduce forest fire alert figures from 54,734 in the fire season of 2020-21, to 34,559 in the 2021-22 fire season, and further to 16,647 in the fire season of 2022-23. I congratulate all the officers and staff led by Dr. Ajit Kumar Shrivastava, PCCF Protection, for this achievement. I congratulate Dr. Ankur Awadhiya, DCF Information Technology for compiling our best practices in the form of book. I am sure this documentation will aid institutional memory in the days to come. My best wishes to all the officers and staff working hard towards the cause of forest and wildlife conservation.

Ramesh Kumar Gupta, IFS

PCCF & HoFF

Madhya Pradesh

18 August 2023

Foreword

Forest fires are close to the heart of every forester. As CCF Sagar, I first realised the havoc of forest fires while traversing Nauradehi Wildlife Sanctuary, where I witnessed first-hand the humongous destruction and annihilation of biodiversity. I was so moved that I resolved to leave no stone unturned, and to bring budget, infrastructure, awareness and training to the cause of forest fire mitigation. As in most fields of management, forest fires require leading from the front. There have been several instances where I — and even my family — got involved in extinguishing forest fires. But a larger domain was reached when I got posted in the Protection Wing of the department. Now I had the opportunity and wherewithals to work on forest fires at the state-level. As one of the nodal officers for forest fire management, I studied the best practices at the state, national, and international levels, through World Bank reports, conferences under the aegis of the National Disaster Management Authority and the Forest Survey of India, and the available literature. Two things were clear. One, that there was a scope for improvement. And two, that we required budget, infrastructure, training and awareness to bring upon that improvement. Thus we prepared projects for the Government of India, and persuaded the Ministry and the State Finance Department to make funds available to us. We worked on massive preparation, infrastructure, and training activities. In this regard, we were fortunate to receive the support of one and all. The ACS Forest, Shri J. N. Kansotiya and PCCF & HoFF, Shri Ramesh Kumar Gupta, were always encouraging. Mr Sunil Agarwal, PCCF CAMPA bestowed to us CAMPA funds for equipment and forest protection. Dr. Ankur Awadhiya, DCF IT helped with data analysis on a daily basis. The SimplyFire web application created by him helped us in locating and understanding the spread of forest fires. The CFs, DFOs and the field staff toiled beyond the call of their duties to manage forest fires at the urgency required. The results were phenomenal. Forest fires reduced

from 54,734 in the 2020-21 fire season to 16,647 in the 2022-23 fire season. The work received plentiful praise, and the ministry asked us to document our best practices. The current book is the result of that endeavour. I congratulate Ankur for putting up this fine document, and am certain that it will be found useful. I thank Ramesh Kumar Gupta sir, PCCF & HoFF, for believing in me and entrusting to me the responsibility of protecting our forests from forest fires as a nodal officer.

Dr. Ajit Kumar Shrivastava, IFS

PCCF Protection

Madhya Pradesh

18 August 2023

Author's preface

A hungry lion pursues a gazelle. The gazelle sprints away. In this drama, hunger and safety are motivations, a term originating from Latin *motivus, movere*, meaning to move. Motivations are the drives, reasons, and causes for doing something… anything…

In the fire season of 2020-21, we received 54,734 fire alerts from the Forest Survey of India. This is quite expected since Madhya Pradesh is an enormous state, with over 3 lakh square kilometres of land area, a third of which is enveloped by forests. We have 52 districts and over 8 crore people. Over 90% of our people are of rural or tribal backgrounds, which indicates a strong dependence and reliance of our population on forests and forest produce. This directly points to the fact that destruction of forests due to forest fires is going to have a direct impact on the lives — and livelihoods — of countless many people, especially those of rural or tribal backgrounds.

At the same time, our forests store upwards of 2 billion tonnes of carbon dioxide, and our numerous protected areas harbour majestic animals such as tigers, leopards, cheetahs, and elephants. Hence, destruction of forests due to forest fires will have large negative impacts on our efforts towards climate change mitigation, wildlife, and biodiversity.

These were reasons enough to motivate us to work towards diminution of forest fires and their impacts. We began by looking at data to analyse the main causal factors, and to identify those targets that would have the maximum impact.

The efforts bore fruit — and what a fruit it was! We brought about a massive reduction in forest fires (from 54,734 fire points in 2020-21 fire season, through 34,559 fire points in 2021-22 fire season, to 16,647 fire points in 2022-23 fire season).

But with good results come big responsibilities — to up-scale and expand the good deeds to other locales. For after all, forests — irrespective of their sites, situations, and species — play major roles in conservation of biodiversity and mitigation of climate change.

We were requested by the Central Government to prepare a report on our best practices in the management of forest fires.

Hence this book.

I wish to place on record the support that I've continuously received from several officials. APCCF IT, Dr. Sanjay Kumar Shukla prodded me to develop SimplyFire, then a computer application, into a web application for ease and extension of access. Data analyses were done through the nudges provided by PCCFs Protection Shri C. K. Patil and Dr. Ajit Kumar Shrivastava, and APCCFs IT, Dr. Sanjay Kumar Shukla and Dr. B. S. Annigeri. Ajit sir was also instrumental in setting up a WhatsApp group for quick dissemination of information. PCCF & HoFF, Shri Ramesh Kumar Gupta was especially considerate, and he personally monitored forest fires and fire-fighting activities, even when he was on tours. It was through his direction that SimplyFire, an app developed in 2016, got implemented throughout the state in 2021-22. ACS Forests, Shri J. N. Kansotiya forthcoming enough to be the first ACS to be involved in the forest protection group, and to re-kindle the periodic government-level monitoring of forest protection activities. I thank all of you.

I also thank my family, especially my mother for strength and support. A lot of my time and attention, that actually belonged to them in the first place, has been diverted into data analyses, monitoring, and documentation.

I hope this book is found advantageous. Comments and criticism may please be sent to mp572@ifs.nic.in

Dr. Ankur Awadhiya, IFS

31 July 2023

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Chapter 1

What cannot be measured, cannot be managed.

"Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know."

[Donald Rumsfeld, US Secy. of Defense]

Management is all about moving from the current state of things to a desired future state of things, through certain spatially and temporally explicit interventions. But how do we know that our interventions are actually taking us in the correct direction? We can only know this through measurements and data.

The course of events in any management can best be understood through Deming's cycle [Figure 1.1]. We make plans (to achieve the desired outcome), do the interventions, check (whether the interventions are taking us towards the desired outcome or not), and act on the results (continue if the path is correct, and do a course-correction, if not). It can easily be seen that data play key roles in each and every step of the cycle.

So what kinds of data and information do we need when we wish to control and manage the spread of forest fires? Well, there are several key pieces of information. In the state of Madhya Pradesh, all of the following were

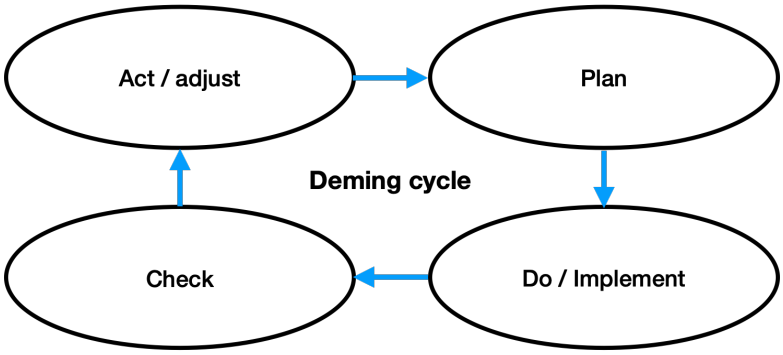

Figure 1.1: Deming's cycle.

collected.

Firstly, where do we get forest fires? If we know the divisions and ranges that are most fire-prone, we will, probably, deploy more resources there. Thus, a list of most fire-prone divisions [Figure 1.2] and ranges [Figure 1.3] was computed using historical forest fire data, as received from the Forest Survey of India, Dehradun. This data was made available to all through the department's website[1].

Next, we would wish to know the temporal distribution of forest fires — when do we get forest fires? If we know the most fire-prone times, we will, probably, deploy more resources at those times. Thus, monthly [Figure 1.4] and weekly [Figure 1.5] charts of fire alerts were prepared, computed using historical forest fire data, as received from the Forest Survey of India, Dehradun. This data was made available to all through the department's website.

The data show that March and April are the most fire-prone months in Madhya Pradesh.

The computations were not only done state-wide, but also circle-wise, so as to enable distributed decision-making. For example, the most fire-prone beats in Sagar Circle for the fire year of 2021-22 are shown in figure 1.6.

Similarly, data regarding division-wise fire atlas[2] (depicting the areas in a division with the largest and consistent levels of forest fires), division-wise burn

[1] Ankur Awadhiya, Madhya Pradesh Forest Fire Compendium (2022)
[2] Ankur Awadhiya, Fire atlas of Madhya Pradesh (2020)

Table 595: Top divisions with most fire points in year 2022

Division	No. of fire points
OBEDULLAHGANJ DIVISION	3083
SATNA DIVISION	3051
DEWAS DIVISION	2911
RAISEN DIVISION	2507
SEHORE DIVISION	2322
DINDORI DIVISION	2246
KHANDWA DIVISION	2203
SOUTH BALAGHAT DIVISION	1876
DAMOH DIVISION	1787
REWA DIVISION	1457
BANDHAVGARH NP DIVISION	1245
SINGRAULI DIVISION	1234
NORADEHI DIVISION	1226
VIDISHA DIVISION	1186
NORTH BALAGHAT DIVISION	1171
UMARIA DIVISION	1146
SOUTH BETUL DIVISION	1080
SOUTH SEONI DIVISION	1071
KATNI DIVISION	1053
NARSINGHPUR DIVISION	1031

Figure 1.2: List of top divisions with the largest number of forest fire alerts; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

Table 596: Top ranges with most fire points in year 2022

Range	Division	No. of fire points
BARKHERA RANGE	OBEDULLAHGANJ DIVISION	745
SINGRAMPUR RANGE	DAMOH DIVISION	610
MAIHAR RANGE	SATNA DIVISION	599
DINDORI RANGE	DINDORI DIVISION	592
BUDHNI RANGE	SEHORE DIVISION	535
UDAYNAGAR RANGE	DEWAS DIVISION	516
SINGHPUR RANGE	SATNA DIVISION	509
LADKUI RANGE	SEHORE DIVISION	499
CHANDGARH RANGE	KHANDWA DIVISION	469
GARHI RANGE	RAISEN DIVISION	469
LOUGUR RANGE	SOUTH BALAGHAT DIVISION	469
GHUNGHUNTI RANGE	UMARIA DIVISION	463
MAJHGAWAN RANGE	SATNA DIVISION	417
WEST KARANJIA RANGE	DINDORI DIVISION	417
PANIGOAN RANGE	DEWAS DIVISION	416
DEVENDRANAGAR RANGE	NORTH PANNA DIVISION	415
EAST KALIBHIT RANGE	KHANDWA DIVISION	415
MOHAN RANGE	SANJAY NATIONAL PARK DIVISION	410
BAHORIBAND RANGE	KATNI DIVISION	407
GYARASPUR RANGE	VIDISHA DIVISION	404

Figure 1.3: List of top ranges with the largest number of forest fire alerts; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

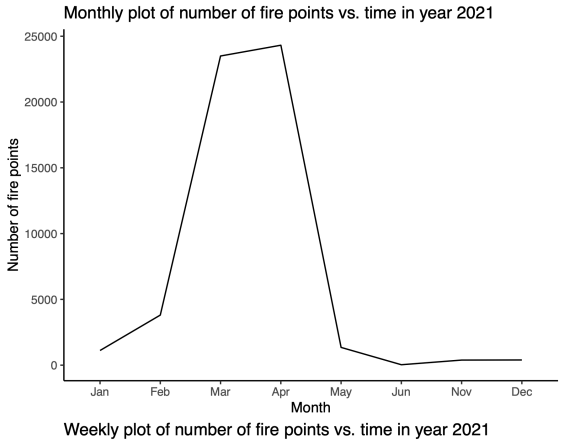

Figure 1.4: Monthly plot of fire alerts; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

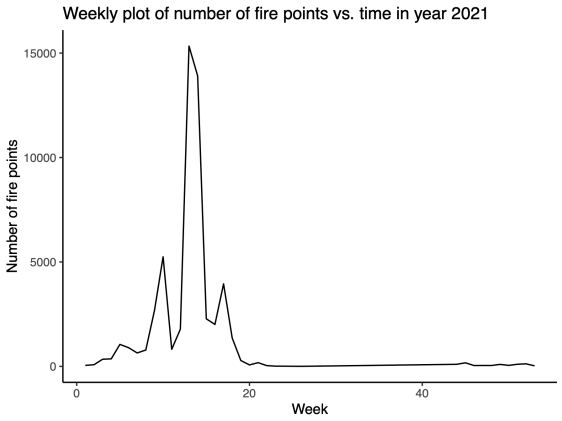

Figure 1.5: Weekly plot of fire alerts; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

Table 429: Top beats with most fire points in year 2022

Beat	Division	No. of fire points
SUREKHA BEAT	DAMOH DIVISION	85
SARRA BEAT	NORADEHI DIVISION	82
JHADA BEAT	DAMOH DIVISION	81
MAGRA BEAT	DAMOH DIVISION	76
DEOTARA BEAT	DAMOH DIVISION	74
HATHIBHAR BEAT	DAMOH DIVISION	60
KHAPA BEAT	NORADEHI DIVISION	56
BHINAINI BEAT	DAMOH DIVISION	54
MALKUHI-N BEAT	NORADEHI DIVISION	52
KUNDAM BEAT	DAMOH DIVISION	46
TARA BEAT	NORADEHI DIVISION	46
JHAPAN BEAT	NORADEHI DIVISION	44
KHARI BEAT	DAMOH DIVISION	44
TEJGARH KHURD BEAT	DAMOH DIVISION	44
DILONA BEAT	DAMOH DIVISION	43
LAKLAKA BEAT	NORADEHI DIVISION	41
AAMGHAT BEAT	DAMOH DIVISION	40
MEHKA BEAT	NORADEHI DIVISION	38
UNHARIKHERA BEAT	NORADEHI DIVISION	36
ANKHIKHERA-W BEAT	NORADEHI DIVISION	35

Figure 1.6: Most fire-prone beats in Sagar Circle for the year 2022; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

severity atlas[3] (depicting the degree to which an area has been altered or disrupted by fires) representing both forest and non-forest areas, division-wise nightlight atlas[4] (depicting the presence and abundance of human habitations and their affluence), division-wise height[5] and hillshade atlas[6] (representing the terrain and topography of various divisions), division-wise NDVI atlas[7] (representing vegetation and the fuel load in different areas in the divisions), division-wise MNDWI atlas[8] (representing the water sources in different divisions), and three-dimensional decision-support system maps, called Nirnayan (that people can play with to explore, say, the routes of fire progression and the ways of reaching areas quickly) were generated and hosted on the department's website.

To aid in quick processing of data, an in-house system called SimplyFire [figure 1.7] was also developed. The system automates the processes of downloading fire data from NASA and NOAA servers and expositing them on a web-based graphical user interface for expeditious comprehension of the information by the end users, resource managers and head quarter administrators. The system can be opened on any smartphone, tablet, or computer. By automating the processes of downloading, processing, and plotting the fire data, the system not only enhances speed, but also reduces the chances of errors. The home page depicts the fires at the state level, and zooming in (such as through pinch and zoom on a mobile phone) automatically shows fire information at division [figure 6.7], range, beat, and compartment [figure 6.8] levels. We found that representing fire data in the form of maps (in place of coordinates or lists) enables much faster processing of information, thus permitting the direction and concentrated channelisation of limited ground resources for their optimal utilisation in fire control operations. The system has since been extended to all areas in the state of Chattisgarh as well.

Some of the data presented stark results. The monthly distribution of fire alerts from Gwalior Circle depicted a very large peak in the month of November [figure 1.8], the height of which was comparable to the height during the summer months. An analysis of the data showed that this peak is predomi-

[3] Ankur Awadhiya, Burn severity atlas of Madhya Pradesh (2022)
[4] Ankur Awadhiya, Nightlight atlas of Madhya Pradesh (2022)
[5] Ankur Awadhiya, Height atlas of Madhya Pradesh (2022)
[6] Ankur Awadhiya, Hillshade atlas of Madhya Pradesh (2020)
[7] Ankur Awadhiya, NDVI atlas of Madhya Pradesh (2020)
[8] Ankur Awadhiya, MNDWI atlas of Madhya Pradesh (2020)

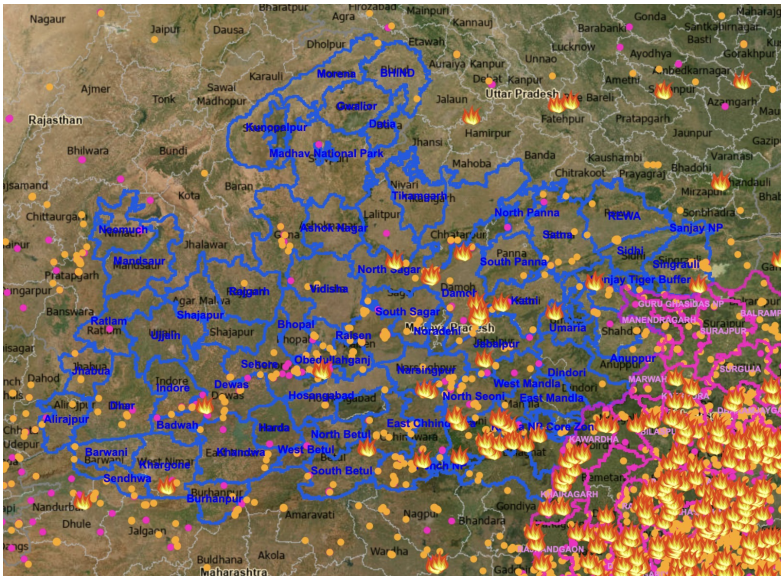

Figure 1.7: A view of the home screen of SimplyFire. Note the divisions of Madhya Pradesh and Chattisgarh together with fire data from several satellites depicted in pink circles, orange circles, and images of burning fire.

nantly due to burning of agricultural residues [figure 1.9].

Investigations on the ground revealed that crop residue burning is a by-product of modern agricultural practices, especially the use of harvesters. Harvesters reap cereals from the top of the stem, especially to protect their blades from stones, grit, and dirt. In the process, a large stem gets left behind as stalk. While earlier these stalks were processed into hay to be used as cattle fodder or thatch, these days the stalks have little use, if any. At the same time, farmers need to quickly prepare the fields for the next crops to maximise their income. Both of these reasons lead to a situation where the stalks on the field are deemed to be waste products that need to be swiftly gotten rid of. One easy and fast way out is to burn these stalks.

Burning of these agricultural "waste" stalks has, therefore, become extremely prominent in our country. For states like Madhya Pradesh having a continental climate, this creates a unique set of precarious conditions. On the one hand, the temperatures in summers become so high that we start getting local winds, called loos, that can carry these burning particles far and wide, even to the forest areas. On the other hand, our trees are predominantly

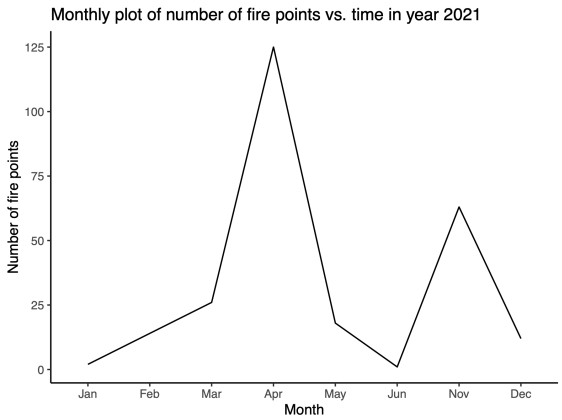

Figure 1.8: Monthly plot of fire alerts from Gwalior Circle; excerpt from Madhya Pradesh Forest Fire Compendium (2016–2022).

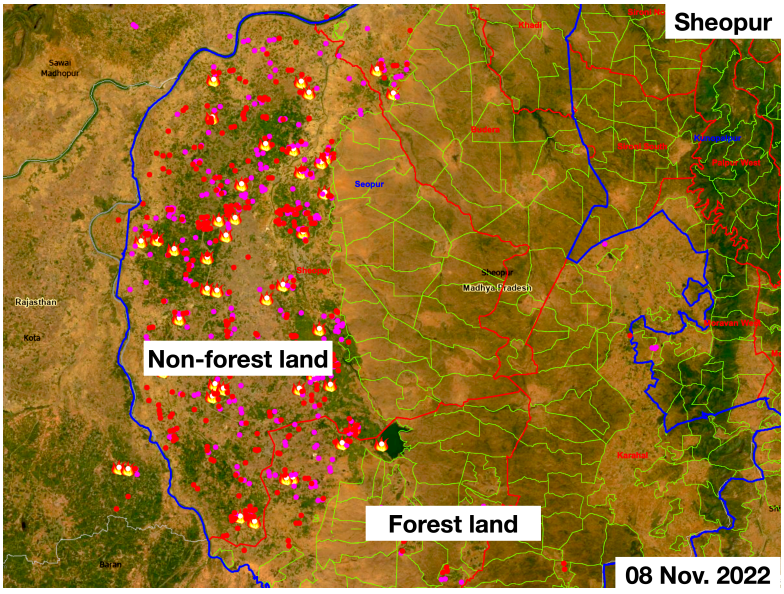

Figure 1.9: Fire alerts in Sheopur on 08 November 2022, as seen in Simply-Fire.

deciduous trees that shed their leaves in the pre-summer season to conserve moisture. And these leaves, making up the leaf litter on the ground, dry up in the scorching heat, thus getting ready to fire up upon getting in contact with the burning particles. The results are, of course, catastrophic.

One way to ascertain the burning of agricultural fields is through the use of satellite data to compute burn severity — the degree to which an area has been altered or disrupted by fires. Burn severity can be estimated by looking at the amount of fire damage, the charring of soil organic matter, the baking and blackening of soil, and other means, using either labour-intensive field visits, or high-resolution multi-spectral satellite imagery.

Healthy vegetation shows a strong reflectance in the near infra-red, while burnt soil shows a low reflectance in the near infra-red (being black in colour). On the other hand, vegetation shows little reflectance in the short-wave infra-red regions, while burnt areas show large reflectance in these wavelengths. These spectral characteristics can be converted to normalised burn ratio:

$$NBR = \frac{NIR - SWIR}{NIR + SWIR}$$

A high value of NBR represents healthy vegetation, while a low value represents burnt bared areas, with non-burnt areas having values close to zero.

The difference between pre-fire and post-fire NBR values gives the change in NBR:

$$dNBR = \Delta NBR = NBR_{postfire} - NBR_{prefire}$$

These dNBR values give the burn severity levels, classified by the United States Geological Survey (USGS) and codified by the United Nations platform for Space-based Information for Disaster Management and Emergency Response, implemented through the United Nations Office for Outer Space Affairs (OOSA).

We get a glimpse of the sorry state of affairs by perusing the burn severity maps derived from pre-fire satellite images (as in figure 1.10 panel 1) and post-fire satellite images (as in figure 1.10 panel 2), from which we compute the burn severity (as in figure 1.10 panel 3), where green represents unburnt areas, and shades of yellow, orange, red, and purple depict increasing accumulations of cinders and ash, indicating burnt areas. Almost always, we can trace forest fires to farming fields (as in figure 1.10 panels 4 and 5), or to human habitations (as in figure 1.10 panel 6).

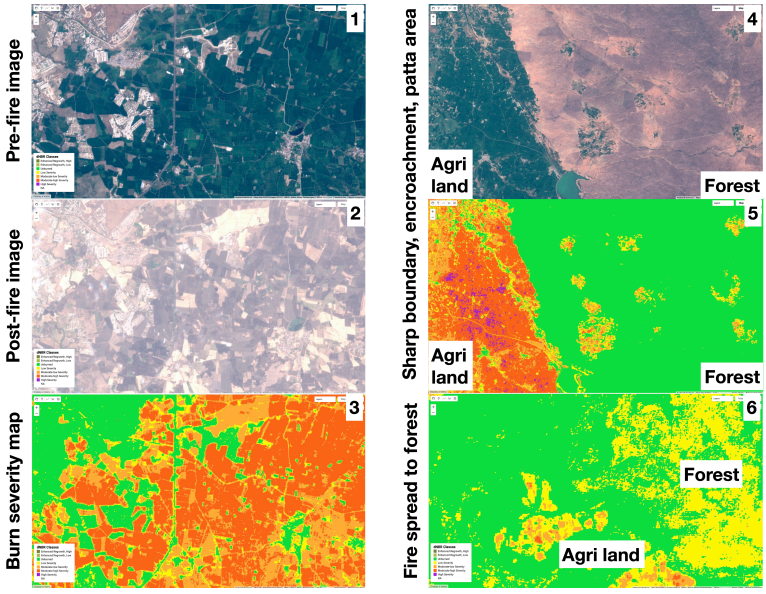

Figure 1.10: Analysis of spread of agricultural fires.

We repeated this exercise throughout the state[9], and with the same result — that most of our fires are anthropogenic [figure 1.11].

[9] Ankur Awadhiya, Burn severity atlas of Madhya Pradesh (2022)

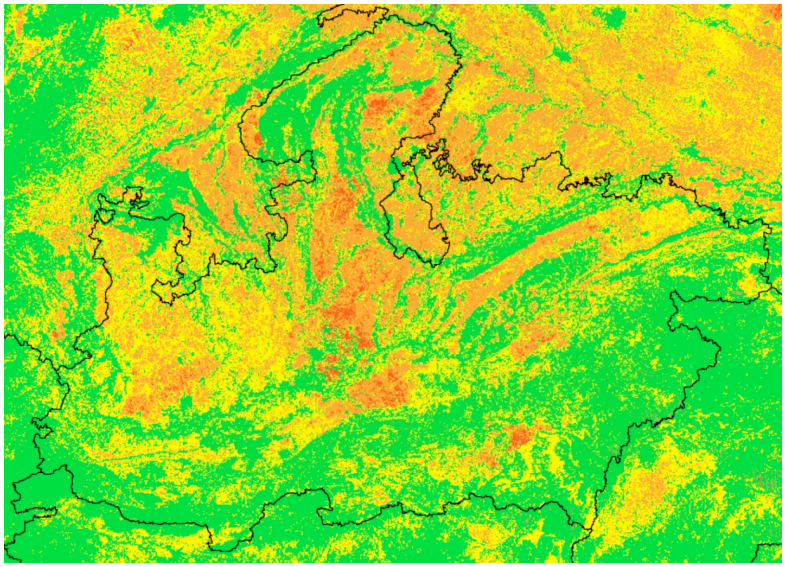

Figure 1.11: Burn severity map of Madhya Pradesh.

Chapter 2

Failing to prepare is preparing to fail.

"Give me six hours to chop down a tree and I will spend the first four sharpening the axe."

[Abraham Lincoln, US President]

Once we have the data and information about what needs be done, the next step is to plan and actually get the things done. This is where the preparation stage comes into being.

The state of Madhya Pradesh prepared on numerous fronts. On the one hand, we created systems for quick flow of actionable information, including SimplyFire and the atlases described in chapter 1. On the other hand, we imparted trainings to field functionaries about how to make best use of these systems. There were offline trainings, there were online trainings. There were classroom trainings, there were field trainings. There were trainings with in-house trainers, and there were trainings with external experts. At the same time, we also attended trainings with other states and nodal officers, with the Forest Survey of India (FSI), the National Disaster Management Authority (NDMA), and the US Forest Service (USFS), to learn, understand and implement the best techniques and strategies available with others, and to share our strategies and learnings for others' benefit.

We had discussions on the best site-specific strategies. In the case of Satpura

Tiger Reserve, for instance, we found[1] that compartments near the periphery have a much greater propensity of forest fires than compartments near the centre [figure 2.1]. Since the data is a long-term data, we can easily use it to make inferences, including that we require more resources — men, money, and materials — at the periphery, and less at the centre.

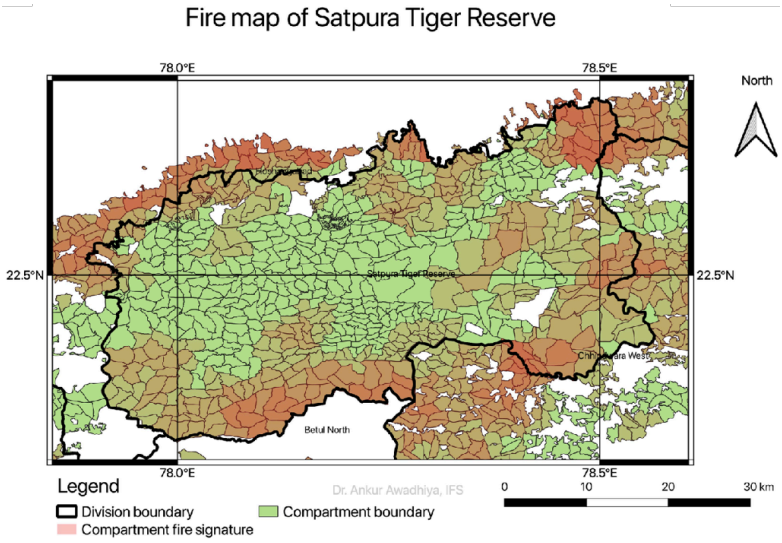

Figure 2.1: Five-year fire map of Satpura Tiger Reserve showing fire-sensitive compartments.

Comparing the map with the accessibility map of Satpura Tiger Reserve [figure 2.2], we can infer that, by and large, areas that are accessible to humans have a greater propensity to forest fires, while inaccessible areas are generally safe from forest fires. This again points to the anthropogenic origins of forest fires, and to the fact that we need to make different strategies for different areas, based on their accessibility to humans.

We also made heavy use of three-dimensional maps, called Nirnayan[2], [figure 2.3] for fire management preparation. While the use of contour maps[3] is useful for identification of sites including those for setting up fire watch towers or check-dams, the specialised nature of cartography and map-reading

[1] Ankur Awadhiya, Fire atlas of Madhya Pradesh (2020)
[2] hosted at https://mpforest.gov.in
[3] Ankur Awadhiya, Contour atlas of Madhya Pradesh (2020)

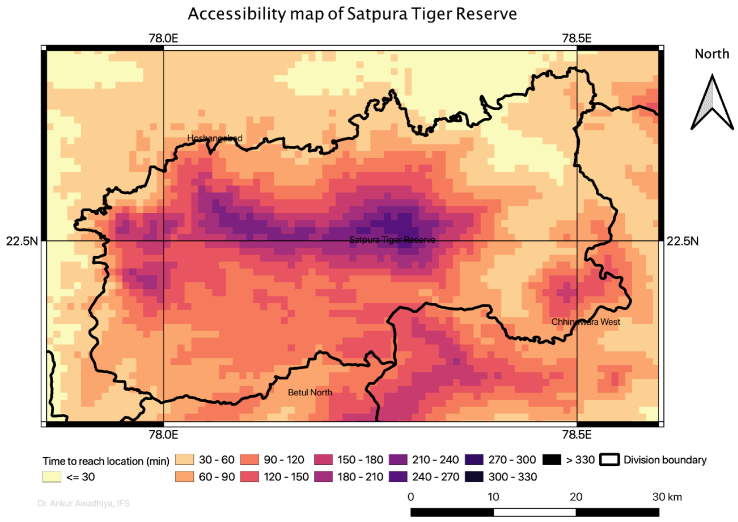

Figure 2.2: Accessibility map of Satpura Tiger Reserve showing the time required to reach any point from the nearest human habitation.

required often translates to poor utilisation on the ground. Creating web-based three-dimensional maps that anyone can play with eases the comprehension of information, and thus, its utilisation on the ground. In particular, over 200 new forest fire watch towers were proposed using these site-selection techniques.

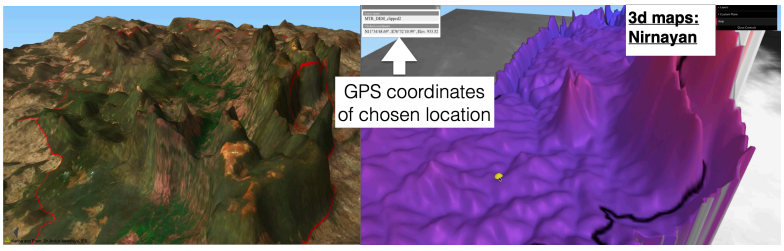

Figure 2.3: Three-dimensional map-based decision-support system (Nirnayan) was used to identify the best sites for site-specific interventions.

We also worked on predictive modelling of forest fires and their spread [figure 2.4], and on instrumentation [figure 2.5] to further enhance our capabilities.

Madhya Pradesh became the first state to submit forest fire management

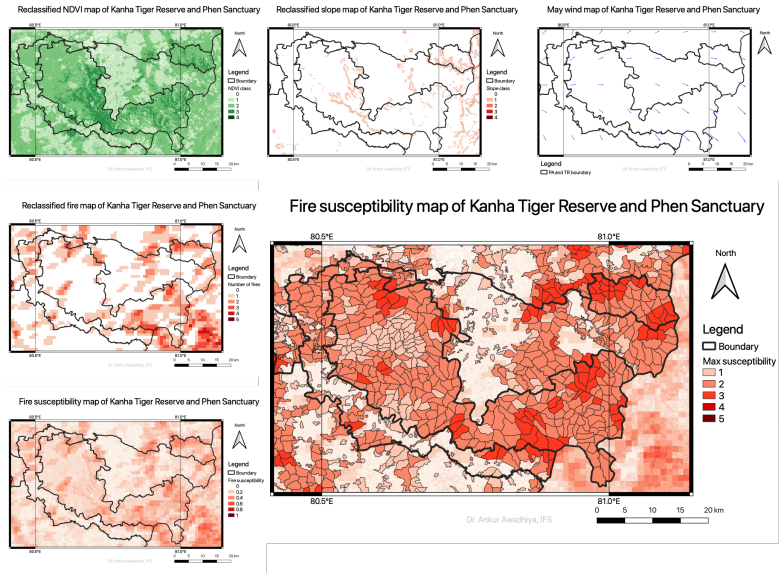

Figure 2.4: Prediction of forest fire propensity and spread in Kanha Tiger Reserve using fuel, topography, wind, and historical data layers.

proposals to the National Disaster Management Authority. The NDMA, in turn, proposed a funding of INR 80 crores over 4 years to 4 most fire-prone districts (Raisen, Khandwa, Chhindwara, Betul), comprising 9 forest divisions. We received a sanction of INR 21.32 crores under Centrally Sponsored Scheme (Forest Fire Prevention and Management) for 15 forest divisions, and a sanction of INR 7.41 crores under CAMPA scheme for procurement of fire-suppression devices, and an additional INR 17.84 crores for other fire-protection works.

These funds were put to good use. We modernised and mechanised our operations to include grass cutters, improved beaters, leaf blowers, and safety equipment [table 2.1].

We worked on increasing mobile registrations on the FSI's fire portal, and the numbers shot up from 6,886 in the year 2021 to 45,287 by the year 2023[4]. This facilitated a rapid flow of information to various field functionaries, JFM committee members, officials of Panchayat and Revenue departments, and

[4]Data from the Forest Survey of India's fire portal: https://fsiforestfire.gov.in/index.php

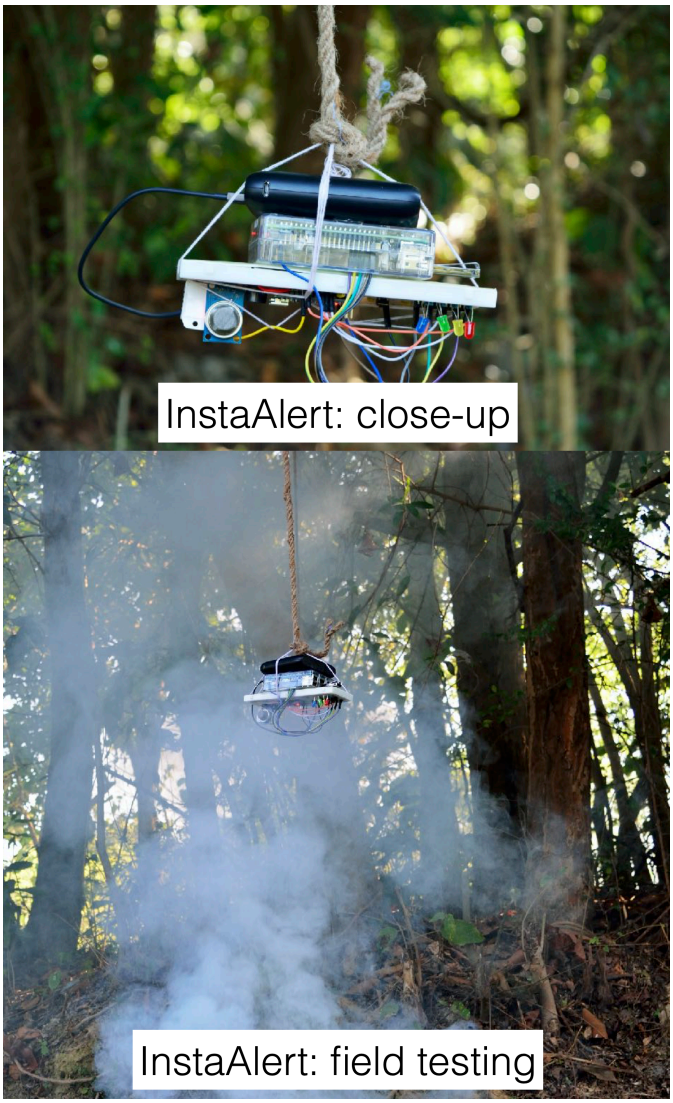

Figure 2.5: Instrumentation device InstaAlert for quick alerts of forest fires using smoke and temperature sensors.

Table 2.1: Numbers of equipments for fire-fighting available in the state of Madhya Pradesh.

Leaf blowers 466	Fire blankets 253	Safety goggles 246
Fire beaters 5036	Solar torches 1011	First aid kits 328
Brushwood cutters 215	Fire jackets 436	Water tankers 20
Fire extinguishers 84	Fire buckets 176	Safety helmets 916
Fire fighting kits 494	Drones 75	

general public able and willing to play a part in dousing forest fires. We expanded the system of fire monitoring control rooms to all ranges, divisions, circles and the forest headquarters, and created a WhatsApp group [figure 2.6] to lubricate the swift flow of information. This group comprises the Additional Chief Secretary (Forests), the Principal Chief Conservator of Forests and Head of the Forest Force (PCCF & HoFF), headquarter PCCFs and APCCFs, Conservators of Forests of all Circles, all Divisional Forest Officers, Sub-Divisional Officers, and Range Officers. Currently the group has around 700 members.

This preparation helped us a lot. At one occasion, we were able to forecast forest fires in Ujjain circle and alert the staff beforehand, preventing what could have been a large forest fire. On another occasion, we alerted officials about a fire that they had missed completely. The utilisation of WhatsApp group also permitted rapid escalation of events in times of need. When an area had fire alerts for three days in a row, or in cases where the fires were wide-spread, matters were brought to the attention of PCCF (Protection) and PCCF & HoFF. Instructions emanating from these higher functionaries were rapidly heeded to and the fires were brought under control.

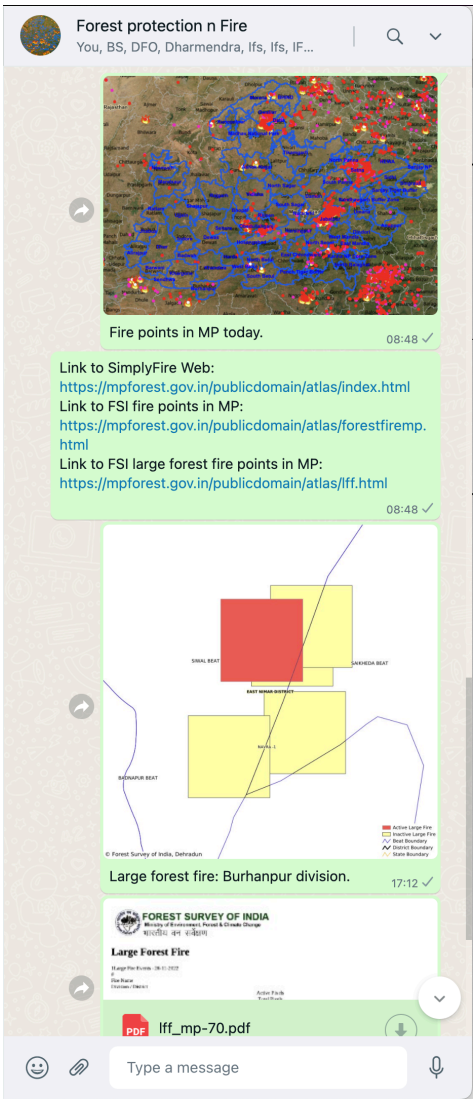

Figure 2.6: A screenshot of the WhatsApp group created for speedy flow of forest fire and management information.

Chapter 3

Much ado about nothing.

"Demigods like Indra are proud of their opulence, and out of foolishness they falsely consider themselves the Lord of the universe. I will now destroy such ignorance."

[Shrimad Bhagwad 10.25.16]

Many a times we tend to create a lot of fuss (ado) about things that matter little in the big picture. One such aspect is the presence and prevalence of rains.

Of course water can, and does, play a role in preventing the spread of forest fires. If the ground litter is wet, it won't burn that easily. There will be difficulty in the spread of fires. And if it does rain when the fires are there, the fires will get doused. But the role of rains is often over-exaggerated due to this simplicity of thought process, with precarious outcomes.

It is a known fact that most of the forest fires today are anthropogenic, or man-made. Be it firing to get a new flush of tendu leaves, firing to get new supple grasses for livestock, firing to clear ground for mahua collection, or to clear land for agriculture (or to get a patta), or to push animals towards traps (for poaching), or fires due to the impacts of climate change — one thing is pretty clear, and it is that all of these causes have a lot to do with humankind. One major factor that has come up today, and prominently so, is the burning of agricultural stubble due to modernisation of farming practices — and burning particles generated therefrom tend to move quickly to forest areas in the drier seasons due to local winds, loos.

Nevertheless, when we accept that these are the real causes of forest fires, the acceptance itself creates an obligation — to control these causes. Much easier, and convenient, then, to attribute things to causes beyond our reach — insufficiency of rains, lightning, rolling stones, and even rubbing of bamboos!

While this creates plausible deniability when things go wrong, it also precipitates the grand peril of failing to act on actionable points.

When Madhya Pradesh acted on the actionable points and brought about a massive reduction in forest fires (from 54,734 fire points in 2020-21 fire season, through 34,559 fire points in 2021-22 fire season, to 16,647 fire points in 2022-23 fire season)[1], most of the comments were like, "So there must have been good rains this year!" Comments such as this are often a discouragement to the field staff who have left no stone unturned to tackle forest fires.

The average number of rainy days in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23[2] are shown in figure 3.1. We observe that the numbers vary in each year, but the quantum of variation is little, and follows the same pattern. The most fire-prone months of March, April, and May 2023 received only two rainy days on average at each station. A mere total of 6 days of rainfall over 92 days (around 6% of days being rainy days) obviously cannot result in a massive drop in forest fires over the complete fire season.

The median number of rainy days in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23 are shown in figure 3.2. We observe that the numbers vary in each year, but the quantum of variation is little, and follows the same pattern. The most fire-prone months of March, April, and May 2023 received only two rainy days on median at each station. A mere total of 6 days of rainfall over 92 days (around 6% of days being rainy days) obviously cannot result in a massive drop in forest fires over the complete fire season.

The average rainfall in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23 is shown in figure 3.3. We observe that the numbers vary in each year, but the quantum of variation is little, and follows the same pattern. The most

[1]Data from the Forest Survey of India's fire portal: https://fsiforestfire.gov.in/index.php

[2]Data courtesy the India Meteorological Department and the Madhya Pradesh State Biodiversity Board

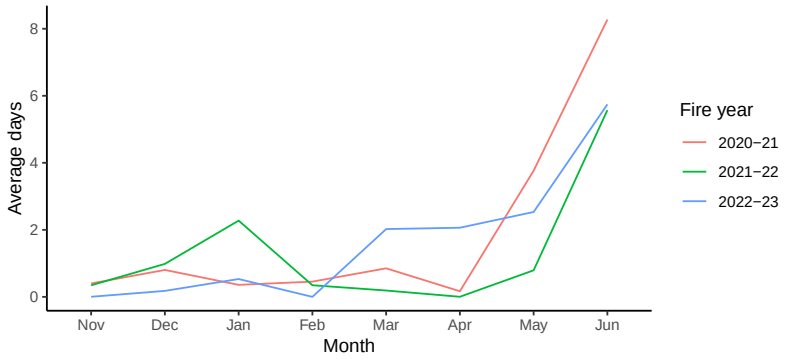

Figure 3.1: Average number of rainy days in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23.

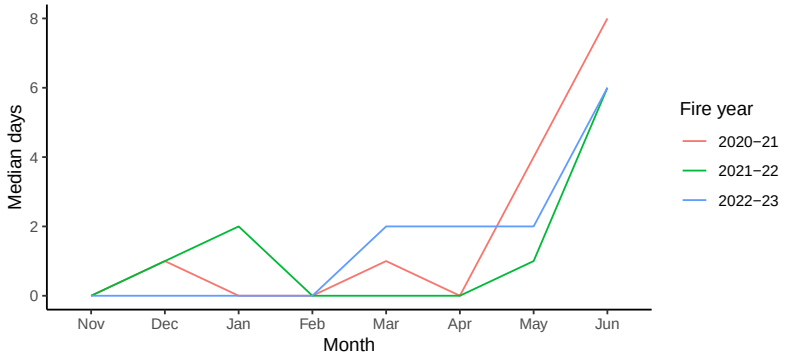

Figure 3.2: Median number of rainy days in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23.

fire-prone months of March, April, and May 2023 received only around 25 mm (1 inch) rainfall on average at each station. This small figure obviously cannot result in a massive drop in forest fires over the complete fire season.

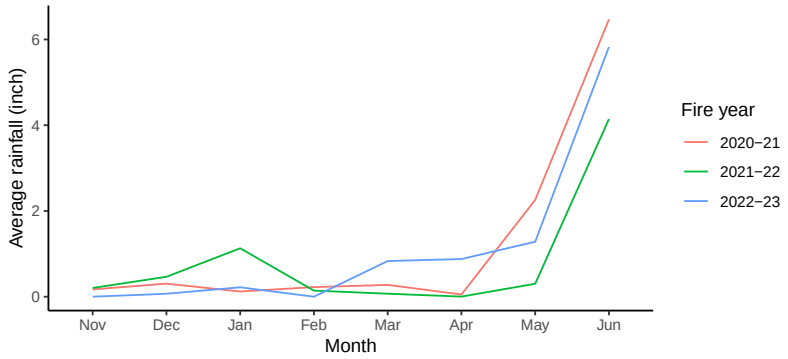

Figure 3.3: Average monthly rainfall at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23.

The median rainfall in each month at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23 is shown in figure 3.4. We observe that the numbers vary in each year, but the quantum of variation is little, and follows the same pattern. The most fire-prone months of March, April, and May 2023 only received around 25 mm (1 inch) rainfall on median at each station. This small figure obviously cannot result in a massive drop in forest fires over the complete fire season.

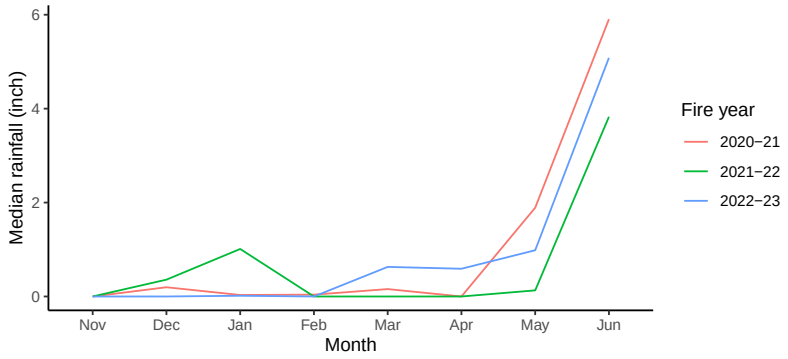

Figure 3.4: Median monthly rainfall at each of the 370 weather stations in Madhya Pradesh over the fire seasons of 2020-21, 2021-22, and 2022-23.

The fire burn areas in the recorded forest area of Madhya Pradesh are depicted in figures 3.5, 3.6, and 3.7. It is clearly evident that the reduction trend in burn areas over the years has continued despite changes in the number of rainy days.

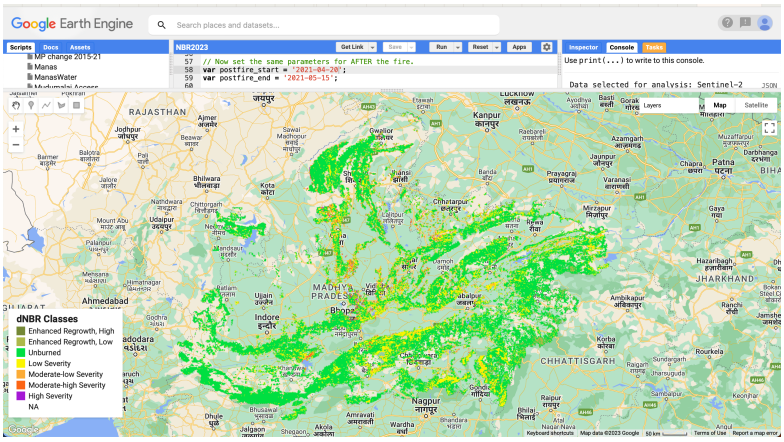

Figure 3.5: dNBR image of Madhya Pradesh for the fire season of 2020-21.

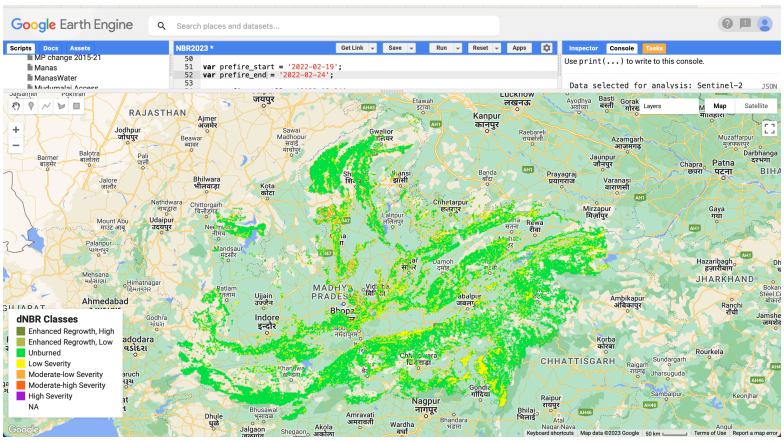

Figure 3.6: dNBR image of Madhya Pradesh for the fire season of 2021-22.

The continued decrease in the number of fire points in Madhya Pradesh, irrespective of decrease — or increase — in the number of rainy days is also seen in table 3.1, which depicts the numbers of fire points in top 5 states during the years 2021, 2022, and 2023. The number of fire alerts per unit

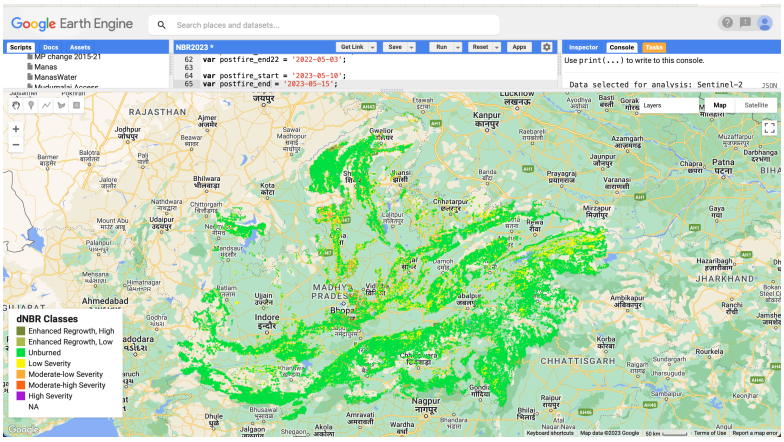

Figure 3.7: dNBR image of Madhya Pradesh for the fire season of 2022-23.

Table 3.1: Number of forest fire alerts in top 5 states for the years 2021, 2022, and 2023.

State	Year 2021	Year 2022	Year 2023	Change % (22-23)
AP	21972	15790	20689	31.0
CG	41253	25787	18370	-28.8
MP	55105	34559	16647	-51.8
MH	38210	22885	15994	-30.1
OD	57248	22941	31716	38.3

area in these states is depicted in table 3.2. We can observe that Madhya Pradesh has the lowest fire alert density among all top 5 states.

All these top 5 states are a part of East-Central India, and are close by. We can, therefore, expect similar weather patterns in all these states, except for coastal / hilly regions. Thus, the large decrease in the number of fire points in Madhya Pradesh, as against a much lesser decrease — or even increase — in nearby states must be attributed to factors other than rains and weather.

After all, when we've eliminated all which is impossible (the role of rains being the major force in reducing fire alerts), whatever remains (the efforts put in by the department, its officials, and the frontline staff), however improbable, must be the truth!

Table 3.2: Number of forest fire alerts per unit area in top 5 states for the 2022-23 fire season.

State	Fire points (2023 season)	Area ('000 Ha)	Fire points per 1000 Ha
AP	20689	3688	5.6
CG	18370	6314	2.9
MP	16647	8708	1.9
MH	15994	5220	3.1
OD	31716	5814	5.5

Chapter 4

80% results come from 20% efforts.

"There is nothing so useless as doing efficiently that which should not be done at all."

[Peter Drucker, the 'founder' of modern management]

Vilfredo Pareto gave the Pareto's principle, also known as the 80:20 rule. Essentially, it states that the majority of results come from a small amount of effort, and that the rest of the results require a much larger amount of effort. For instance, roughly 20% of products of a company are responsible for around 80% of its revenue, while the remaining 80% of the products are responsible for a mere 20% of the revenue. By studying 20%, a student can attain 80% marks, but it takes 80% of effort to achieve the rest 20% marks. The list goes on.

In the field of management, the rule posits that we must consider which of the works, when done, will bring the majority of gains. Essentially, before executing a task, we must closely scrutinise the low-hanging fruits, and focus our attention there. By doing that, we'll achieve a large chunk of the final outcome through minimal efforts.

These low-hanging fruits can be as simple as extending the time of monitoring. Historically, the state of Madhya Pradesh considered the period of 15 February to 15 June as the 'fire season'[1]. While it is true that the majority

[1]Example: Tiger Conservation Plan of Kanha Tiger Reserve

of forest-fires occur in this period, focussing all the attention here leaves out other low-hanging fruits, such as the winter fires. In many areas of the state, such as Gwalior circle, a large chunk of forest fires occur during the winter months, especially at the time of harvesting the kharif crops [figure 1.8]. The number of forest-fire events are roughly one-half of what occur during the summer months, in the traditional 'fire season'. Thus, by concentrating our attention to these areas in the winter months, we should be able to bring down the total number of fire incidents by roughly 33% ($\frac{0.5}{1.5} \times 100\%$). And this is what we did.

We extended the 'fire season' to the period from 01 November to 30 June[2]. By focusing attention during the hitherto 'non-fire season' periods, we brought a massive reduction in the total number of forest-fire alerts received during the year.

Similarly, we observed that we get multiple fire peaks every year [Figure 1.5]. One reason is that when the forest-fire alerts increase in number, the staff get extremely active to douse these fires. However, when the fires are controlled, there begins a period of tranquility and calm, after which there is a re-spurt in the number of forest-fire alerts. Alerting the staff to this phenomenon itself brought about a massive reduction in forest-fire alerts.

Deployment of resources — men, money, and materials — based on the spatial [e.g. figures 1.2, 1.3, and 2.1] and temporal distribution [e.g. figures 1.4, 1.5, and 1.8] of forest-fires again is an easy strategy that can be emulated by other states as well.

Being mindful of the negative results of fire-line burning is again an easily reproducible strategy. We found that in some cases, clearing and burning of fire-lines themselves burn the forests that the fire lines were being built to protect [figure 4.1]. Therefore, we began monitoring forest fires during the fire-line construction season as well, keeping staff on the ground to prevent runaway forest fires.

We also deployed the strategy of early morning forest fire control and dousing. Forests are inhospitable — even dangerous — areas in the night, but are equally so near noon during the summer months when there are large chances of heat-exhaustion and heat-stroke. We, thus, focused on the fire alerts

[2]Ref: Minutes of the meeting of the State-level monitoring committee on 05 December 2022

Figure 4.1: A portion of Kanha Tiger Reserve that got burnt in the process of constructing fire lines.

received around 3 am and 3 pm. The staff were trained to be ready around 3, check the alerts (and their maps on SimplyFire) and leave before 4 (am or pm, as the case may be). Thus, they reached the site of forest-fire before 5, and the fires were extinguished before 7. This not only ensured timely extinguishing of the majority of forest-fires, but also made certain that the staff worked primarily when the weather was not too inclement, thus boosting their comfort and compliance.

As the master strategist Sun Tzu said, “He will win who knows when to fight and when not to fight”. Strategising permits quick and effective deployment of the scarce resources to the greatest benefit. And the strategies employed by the Madhya Pradesh Forest Department are known to have bestowed prodigious returns!

Chapter 5

KISS: Keep it short and simple.

"That's been one of my mantras - focus and simplicity. Simple can be harder than complex: you have to work hard to get your thinking clean to make it simple. But it's worth it in the end because once you get there, you can move mountains."

[Steve Jobs, co-founder of Apple]

Behavioural Psychology provides several insights into 'shaping' behaviours — how to get something done by a subject. The prime method is through differential reinforcement of successive approximations. For example, if you wish to teach a puppy to come to you, you begin by rewarding any movement towards you when you say 'come'. But as the puppy starts to learn, you only reward it when it sprints and dashes towards you on hearing the command 'come'. And after some time, you'll have a puppy that always gallops on hearing the command 'come'.

As in most fields of Science, many insights in Psychology came through experiments on animals. B. F. Skinner studied the phenomenon of shaping in pigeons, but the principles discerned were later also found to be working in several other categories of organisms — dogs, dolphins, and even in humans. For man is, after all, a social *animal*.

One basic learning from the study of shaping is that the outputs, commands, and feedback need to be short and simple. This is true of pigeons, this is true of dogs. This is true of humans, and this is also true of computers. The first rule of Unix philosophy — a general set of principles used to write computer

programs — states: “Do one thing at a time, and do it well!”

However, most systems designed to gather ‘data’ and ‘monitor’ processes flout this basic norm. When we ask a forest guard to input data about a forest fire, we place a long questionnarie in front of her. Common data to be filled include the latitude of the place, the longitude of the place, the compartment number, the beat, the range, the division, distance to nearby village, number of persons involved in fire-fighting, the time of start of fire, the time when the fire-fighting party left their office, the time the fire-fighting party reached the spot, the time of ending the fire, the quantum of area burnt (typically in hectares), the number of trees damaged, the valuation of the loss, and other ‘comments’.

The complexity of data input required often translates to filling up of incomplete information, incorrect information, or no information. And even if one data entry is incorrect, the complete data set cannot be analysed to give correct results, ultimately defeating the whole exercise of ‘data collection’.

Add to it the fact that during the fire season the staff and resources are already strained. The staff need to decide whether to spend the precious few minutes on dousing forest fires, getting the goodwill of villagers, completing mandatory patrolling and other departmental activities (including checking of water sources for poisoning, monitoring electricity high tension lines for electrocution traps, constructing temporary check dams for wildlife, felling and haulage of timber before rains, and preparing for the upcoming plantation season, among others) or on filling ‘data’ that can better be obtained from other sources, and will likely never be used!

We in Madhya Pradesh, thus, simplified the procedures involved. Data about current forest fires is now being obtained through satellites and discerned through our SimplyFire system [figure 1.7]. The forest burnt area data is being computed using dNBR stats using multi-spectral satellite data [figure 1.11]. And whether forest fires are being attended to — and how effectively — is being monitored through our WhatsApp group [figure 2.6]. The staff is, thus, freed from the responsibility of filling in ‘data’.

Shifting from human-entered data to automated data collection through third-party, validated sources such as satellites also helped us to ameliorate our strategies, as understood through Deming’s cycle [Figure 1.1]. When data was being entered manually, there were huge chances of errors creeping in — not just intentional, but also procedural. A common mistake, for

instance, was the confusion between degree-minute-second and the decimal systems. We've had situations where 23.5° was entered as 23° 5', in place of 23° 30', thus erring the locational characteristics of the event. Similarly, not having the requirement to digitise and check data before doing analyses also meant that we could have access to faster analyses, permitting near-real-time monitoring and decision-making.

We also removed several steps from the interpretation of fire alerts. The Forest Survey of India, Dehradun has had an exquisite system that gives near-real-time forest fire alerts with locational data in the form of coordinates [figure 5.1].

Looking at the alert, we find that there are several pieces of information: the name of the satellite (SNPP), the resolution of the satellite ($375m \times 375m$), the date, time, and coordinates. Of course the name and resolution of the satellite do not have any useful information for the field staff entrusted with the responsibility of extinguishing forest fires. At the same time, the coordinates (in degree, minute, second format) need to be processed. The field staff must either punch in these coordinates into a GPS machine, set that location as a way-point, and let the machine guide her to the site. Or the staff must plot the coordinates into a map, preferably the compartment map, to understand where the site actually is. This again is easier said than done. The staff must try to plot the location on each and every compartment map in her possession to figure out which is the correct compartment, and then get the actual site plotted. Lots of things to be done, and lots of time required!

We eliminated all of these procedural requirements through the SimplyFire system [figure 1.7] that downloads and plots the locations in near real time. The staff only needs open the page and zoom into her jurisdiction and see whether there are any fire alerts in the jurisdiction. If there are, she has the satellite imagery (to ascertain if the fire is in a dense forest or in an agricultural field, industrial site, or a mining location), the compartment boundary (and the fire lines that can be used as roads to reach the site quickly), and the names of the nearby jurisdictions (if she needs to call for reinforcements). Much simpler than the earlier procedure!

We also created a simple set of standards — that we need to reduce our fire points by 50%, and ensure that every forest fire is tackled within a day, preferably as soon as possible. If this was not the case, the matter was quickly

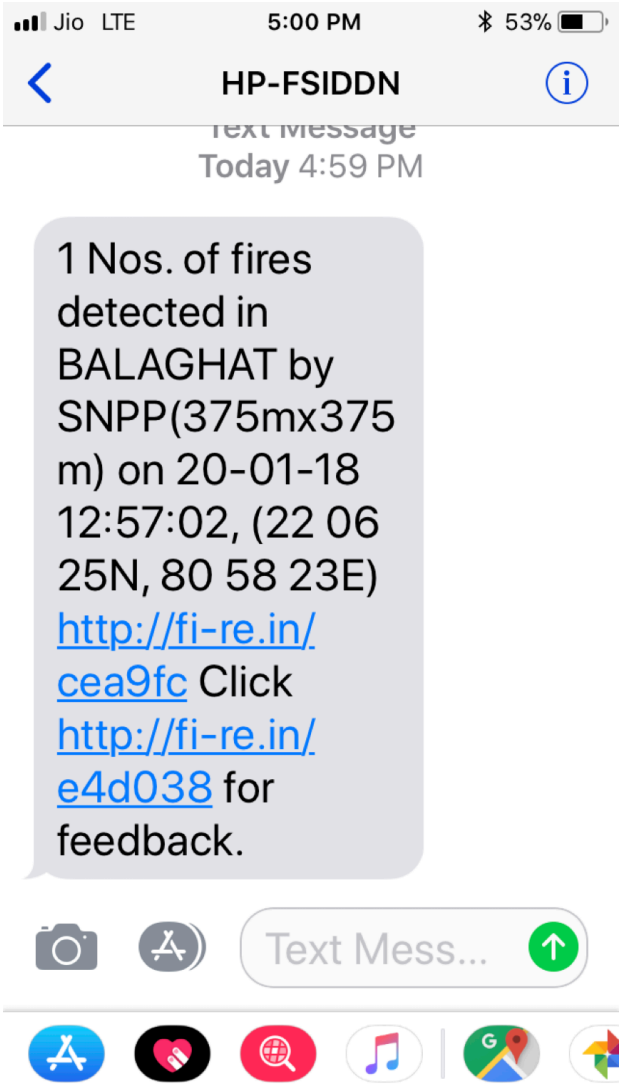

Figure 5.1: An SMS received from the Forest Survey of India's fire alert system.

Table 5.1: Percentage of large forest fires doused in different time periods in the state of Madhya Pradesh during the fire seasons of 2021-22 and 2022-23.

Dousing time	Season 2021-22	Season 2022-23
$<$ 1 day	58.22%	70.61%
1 – 2 days	16.83%	16.07%
2 – 3 days	11.14%	8.88%
3 – 4 days	6.54%	3.59%
4 – 5 days	2.91%	0.85%
5 – 6 days	1.82%	0.00%
6 – 7 days	0.97%	0.00%
7 – 8 days	0.85%	0.00%
8 – 9 days	0.24%	0.00%
9 – 10 days	0.24%	0.00%
$>$ 10 days	0.24%	0.00%
Total	100.00%	100.00%

escalated to PCCF Protection, HoFF and ACS levels. With easy, meaningful targets, the staff responded to get us phenomenal results [table 5.1].

We can observe that while in the fire season of 2021-22, some large forest fires managed to continue even beyond 10 days, in the fire season of 2022-23, all the large forest fires had been extinguished within 5 days. At the same time, the around 71% of large forest fires were extinguished within a day in the fire season of 2022-23, as against around 59% in the fire season of 2021-22, demonstrating beyond doubt that much superior results are achieved when the target is clear, and the instructions simple and crisp.

Chapter 6

A stitch in time, saves nine.

"In skating over thin ice, our safety is in our speed."

[Ralph Waldo Emerson]

Rivers flow, birds fly. Dogs bark, and fires spread. This is their tendency, their natural behaviour, their proclivity.

The spread of forest fires is easy to comprehend when we consider the forest floor [figure 6.1]. On the forest floor, we find a profusion of fuel materials — parched grass, fallen leaves, dried twigs, and the like. Given that around 21% of the air around us is oxygen, and fires, once started, increase the fuels' temperatures to levels far beyond their points of combustion, it is easy to see that fires will keep spreading to nearby areas when we have lots of fuel strewn around.

If we consider the forest floor to be an isotropic surface, that is having the same properties in any direction, forest fires will spread in circles [figure 6.2]. In many areas this is true, but the spread also gets altered depending on the anisotropicity of the forest — and of the forest floor — especially because of uneven topography and wind movement. That being said, we can simplify the spread by stating that fires will increase in size as the time progresses, leaving behind a charred central region.

This continuous increase in the size of the forest-fire presents certain unique challenges and opportunities. The challenge is that if we are late in reaching the site of a forest-fire, we'll only find a large circumference of fire and a colossal central burnt, charred area. The perimeter of the fire will be so large

Figure 6.1: Forest floor in Kanha Tiger Reserve depicting a profusion of fuel matter.

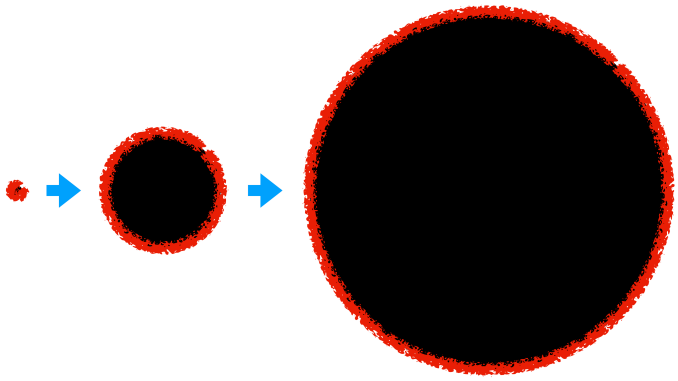

Figure 6.2: Schematic of the spread of forest fire on an isotropic surface.

that we'll have to decide whether to tackle the left front or the right front. In essence, it will merely be fighting a lost battle.

On the contrary, a distinctive opportunity also exists — tackling the forest-fire when it is small. Theoretically, if we manage to reach the fire site just as the fire is about to begin, we can douse the fire by stomping over it, or using a glass of water. Of course it may be a near impossibility to reach that fast, but we can, and should, focus on reaching asap, near real time.

Forest fires being an international phenomenon with global consequences regarding loss of biodiversity and release of sequestered carbon, there are several multi-national approaches and mechanisms that have been developed over the years to tackle the menace of forest fires. One such mechanism is the use of satellites.

NASA runs a program called FIRMS (Fire Information for Resource Management System). This system freely provides us near-real-time information as discerned by several sensors and satellites — MODIS (on Terra and Aqua satellites), and VIIRS (on SNPP and NOAA-20 satellites). The information is made available as ESRI shapefiles, Google Earth KML files, and CSV text files. We only need to process this data to get useful and actionable information.

In our country, the Forest Survey of India, Dehradun is the nodal agency to provide this information. Their data flow is depicted in figure 6.3, as available on their website. Essentially, data from NASA's servers is accessed by the National Remote Sensing Centre (NRSC), Hyderabad, which then processes the data and makes it available to the Forest Survey of India, Dehradun, which then further processes it and transmits the information to the states and forest officials. This information is transmitted in the form of SMS alerts [figure 5.1] and email alerts.

While centralisation of data processing has its own set of challenges (at times we did not receive fire alerts when the FSI did not receive data from the NRSC, at other times we could not access data from the FSI's servers [figure 6.4]), a bigger issue is what happens in the best-case scenario.

When the forest guard does receive the SMS on time, has a working GPS device, knows how to use it correctly, and is motivated and committed to do so, and she enters the coordinates into the device, the expectation is for the device to display the shortest distance to reach the fire point [figure 6.5].

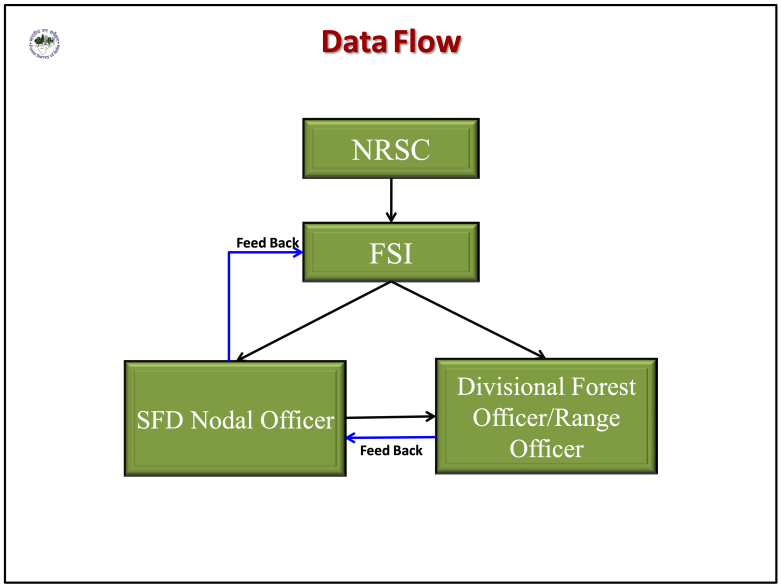

Figure 6.3: Data flow being utilised by the Forest Survey of India, Dehradun.

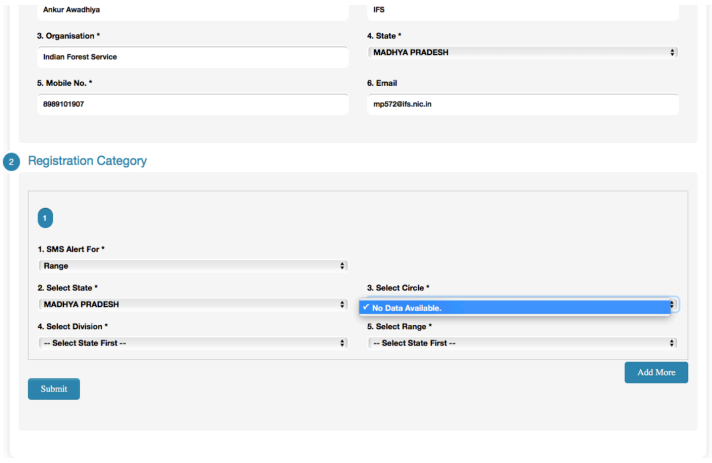

Figure 6.4: No data available from the Forest Survey of India's fire portal.

In technical parlance, we have a unique term for this strategy: "as a crow flies!" The expectation is that on an isotropic surface the shortest distance will also be the one that takes the least time to traverse. And thus, the forest guard should reach the spot in the least amount of time if she just follows the straight line 'shortest distance' path — in the 'isotropic' forest.

Figure 6.5: Reaching the coordinates "as a crow flies".

Unfortunately, it so turns out that humans are not crows, and they can't fly (at least till we make individual jet packs available to all the fire fighters). And the forest area is also not an isotropic surface!

We found that staff moving according to their GPS devices often encountered a thick patch of lantana, or a small hillock, or a cliff, or a stream — and all of these have a tendency to slow the staff down. In the absence of a map, the staff also don't have an idea of alternative routes to reach the fire spot. In Balaghat, we once had a situation where the staff climbed a hillock only to find that the fire was on the next hillock. Add to this the fact that fires spread, and by the time they reached the fire, it had grown to gargantuan dimensions. And this was in one of the best-case scenarios — where the staff had access to near-real-time alerts and GPS devices, and were able and willing to use those, and were motivated to reach the spot as quickly as possible!

A much better alternative, then, is to provide the fire spot data in the form of a map. If we plot the forest compartments and then the fire points, we also get faster routes to reach the forest fire site, since compartment boundaries also double as fire lines. These cleared fire lines can be used by staff to reach the fire spot much quickly, since they don't need to navigate through uneven topography, bushes, and undergrowth [figure 6.6]. Even though the staff need to traverse a longer path, it takes a much smaller time span.

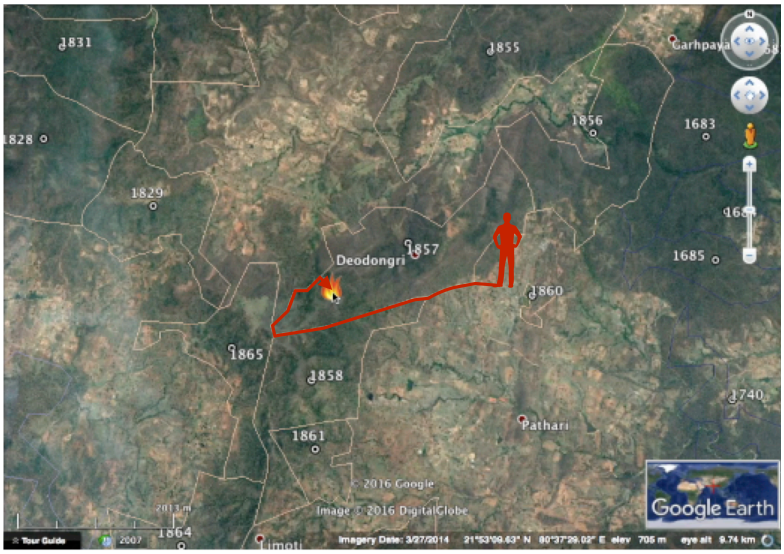

Figure 6.6: Reaching a fire spot through fire lines.

But how do we create these maps? Herein comes the role of automation and geographic information systems, specifically our in-house system called SimplyFire [figure 1.7].

SimplyFire takes data directly from NASA's servers, and does all the required processing itself. It also updates the data automatically every minute. We've added shapefiles of all our divisions, ranges, beats, and compartments into SimplyFire. We've also added mirror locations for data, so the system gets fire data even if one — or more — of the servers — or data formats — are inaccessible (over 2 years, there have been only three occasions where one of the NASA servers was inaccessible, and SimplyFire then took data — automatically — from an alternate NASA server).

At the headquarters, if we need to know the areas in the state where there

is an excess of fire alerts, we just need to open the webpage, either on a computer, a tablet, or a mobile phone [figure 1.7]. If a conservator needs to find the areas in her conservancy where there are fire alerts, she just needs to zoom in — and the division boundaries will start to show up. A divisional forest officer, similarly, will see the ranges in her division upon zooming in [figure 6.7].

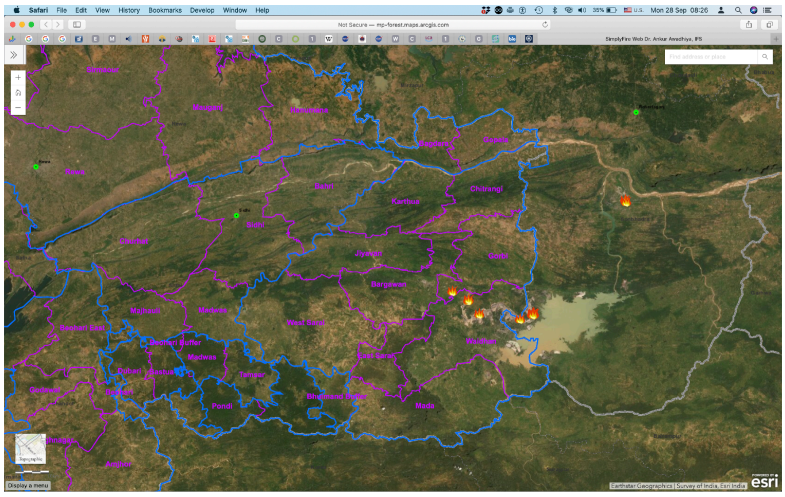

Figure 6.7: SimplyFire showing forest fire alerts in the ranges of Singrauli Forest Division.

The range officer, similarly, will observe the beats in her range, and the beat officer can see individual compartments by zooming in [figure 6.8]. Since SimplyFire also shows the satellite imagery in the background, the staff get to know the ground situation where the fire alert is.

We've experienced that in many situations we receive forest fire alerts in mining and industrial areas, especially where there are smokestacks. While earlier staff were required to reach the spot and then report that there is no danger to forests — eating into their time that could better be utilised in more productive pursuits — now the staff can get this information on their mobile phones, and avoid going to inessential locations.

On the other hand, if there is a fire alert in a non-forest area adjacent to a forest area, staff can also make use of SimplyFire for pre-emptive actions to save the forests even before the fires reach the forests. We've had situations in Ujjain where agricultural residue burning was not allowed to turn into

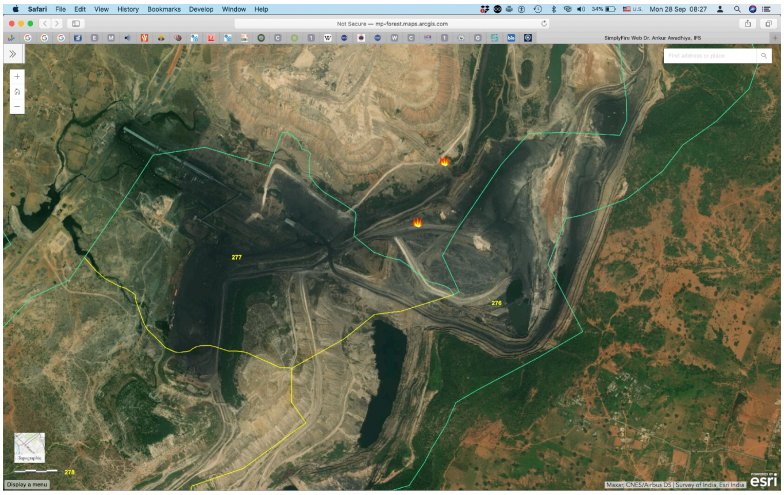

Figure 6.8: SimplyFire depicting forest compartments and fire alerts in a mining area.

a forest fire since staff reached the spot and convinced the villagers to be mindful of wind direction. That's an added benefit.

Strategically, SimplyFire helped because efforts could be better channelised to locations and times where they were most needed. Upon reaching a site late, a forest fire could have spread into multiple alerts, but by reaching the site fast, forest fires were prevented from generating manifold alerts. This fact is also reflected in tables 3.1 and 5.1.

Chapter 7

It's okay to ask.

"Don't be afraid to ask for help when you need it. I do that every day. Asking for help isn't a sign of weakness, it's a sign of strength because it shows you have the courage to admit when you don't know something, and that then allows you to learn something new."

[Barack Obama, US President]

No man is an island entire of itself. We work together, play together, and live together in a society. And when we talk about conservation, it's not just for the forest department, but for the society at large — for it's the society that'll reap the benefits of conservation — through reduced pollution, moderate climate, and other means.

Nevertheless, there is a hesitation of sorts, reluctance and reservation when it comes to asking other members of the society to lend their hand to the cause of conservation. A common thought process runs like this: "But isn't it the work of the forest department? Why should I ask others for help? *What would they think?*"

Whereas the fact remains that there is practically no person who doesn't feel a connect with nature, and doesn't wish to lend a helping hand. In our experience in Madhya Pradesh, we've found that people actually feel a deep sense of gratitude when provided with an opportunity to serve in the cause of conservation.

We've had several incidents where people provided different kinds of support — physical, financial, moral, and expertise — mostly *suo motu*, but also

when we requested them for help. There are numerous instances of our tiger reserves and national parks receiving funding, vehicles, equipment, and the like — often quite profusely. Every year we get requests from eco clubs in schools and colleges to partake in afforestation activities. There are innumerable companies, institutions, and organisations that donate as part of their CSR and CER responsibilities. Why can't the same be done to protect forests from fires? After all, forests saved are forests created!

And with this outlook, we asked for help — from anyone who could render help. We wrote to the government, we wrote to district administrations, we included topics about forest fires in our ecotourism activities, we took help from the State Biodiversity Board, and we communicated with the public and media.

The response was phenomenal. We received full support and resources of Panchayat, Revenue, Education, and Animal Husbandry departments. Publicity and awareness campaigns were undertaken in different departments of the government, schools, and colleges. Officials and staff from several departments volunteered to register their mobile numbers on the fire alert portal (the registration figures shot up from 6,886 in the year 2021 to 45,287 by the year 2023[1]). Van samitis and panchayats were roped in to create awareness about the negative impacts of burning crop residues. Igniting fires in forest areas, whether intentionally or through negligence, was dealt with legally. And forest fires were discussed in special task force meetings in each district every month to create viable district-level strategies and activities.

We received additional funding from the central government, the National Disaster Management Authority, and the CAMPA scheme, all running in to several crores. These were then utilised for fire prevention and control activities, and for the modernisation and capacity building of the department.

In essence, help is always there. We just need to ask for it!

[1]Data from the Forest Survey of India's fire portal: https://fsiforestfire.gov.in/index.php

Chapter 8

United we stand, divided we fall.

"We must all hang together, or, most assuredly, we shall all hang separately."

[Benjamin Franklin, US polymath]

There's strength in unity. There's strength in diversity. And there's strength in united diversity.

Economics teaches us that we achieve the maximum output (and outcome) — thus expanding the production possibility frontier — when all of us specialise in doing what we do best. Or, as Adam Smith put it, "all of them find it in for their interest to employ their whole industry in a way in which they have some advantage over their neighbours…"[1].

This is known as comparative advantage — having a lower opportunity cost than others. Consider any organisation, say, the Forest Department. There will be some people who are good with analysing data — and they can point out the low-hanging fruits. There are some others who are master strategists — and they know how to get the job done. Still others are exceptional communicators — they know how to get the message across to others. Some know how to train others — bring them up to the latest technologies and methods of fire detection and control. Yet others are extraordinary motivators — they fire up the masses to get the task done. Some are field people —

[1] Adam Smith, The Wealth of Nations (1776)

they like being in the field to tackle daily challenges and excitements. Who amongst these are needed for fire monitoring and control?

The short answer — all of them! This is why we need (and have) systems — groups of people and things working together as a mechanism to achieve a common goal. When they work in tandem, the whole becomes much greater than the sum of its parts. Put individual notes together, and a melody appears — much better than any of the individual notes. And this is why we need a master coordinator — an orchestrator. The key is harmony and synchrony. For in the absence of congruity, the calliphony transforms into a cacophony in no time.

The master coordinator has an exceedingly simple — but manifestly complicated — task: to put the right person to the job. In this regard, the biggest benefit of the Madhya Pradesh Forest Department is its colossal size. To care for forests present in roughly 30% of our total geographical area, we have 16 circles, 63 divisions, 473 ranges, and 8286 beats. Add to it the 180 senior duty posts, and 15,608 joint forest management committees (each with scores of people) — and we get an idea of the magnitude of human resource available to us.

But when it comes to protecting the natural resources, we are also blessed with the ardour and zeal of our citizens and personnel of several diverse departments. Pooling these resources, we can achieve prodigious outcomes in a swift manner.

A good case study here is the humongous forest-fire in Bandhavgarh National Park and Tiger Reserve in the year 2021. The forest fire began in the second week of March [figure 8.1] with the burning of agricultural residues. We can observe the fire plume even in the satellite image.

By the end of March, forest fires were clearly visible in the forest areas [figure 8.2]. Large tracts of burnt forests started to appear as black scars, and the extant fires and their smoke stacks were distincly discernible.

Even with lots of staff and resources, a large tract of the dense forest was completely burnt by the beginning of April [figure 8.3]. It appeared to be a lost cause.

But with the help of samiti members, the staff and administration were able to restore the area to its prime glory by the beginning of October. In the

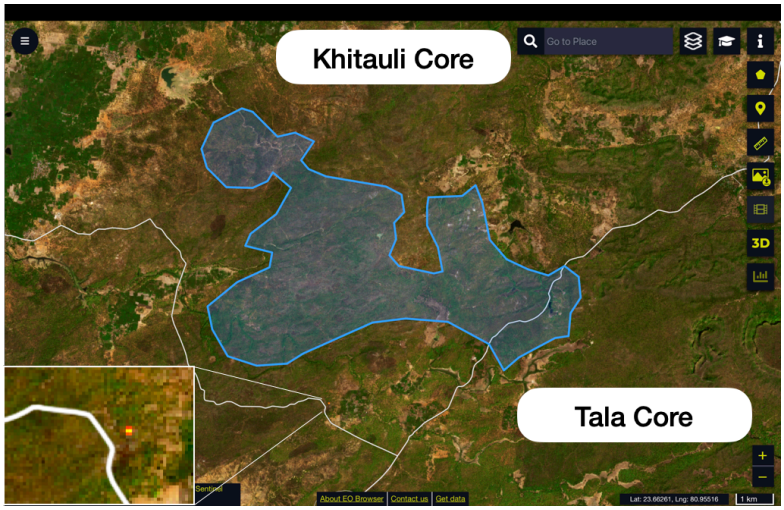

Figure 8.1: Beginning of the large forest fire in Bandhavgarh Tiger Reserve on 14 March 2021. Fire plume is visible in this satellite image.

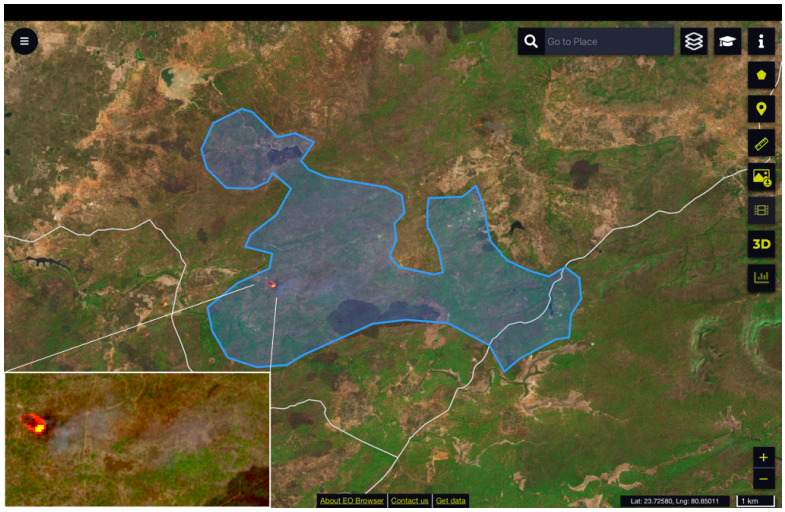

Figure 8.2: Scars and fire / smoke plumes of Bandhavgarh Tiger Reserve as seen in the satellite image of 29 March 2021.

Figure 8.3: Large tracts of Bandhavgarh Tiger Reserve were completely burnt, as seen in this satellite image from 03 April 2021.

satellite image [figure 8.4], there is hardly any trace of the damage done by the colossal forest fire.

The degradation and restoration are vividly perceptible in the NDVI plot reflective of the amount of foliage [figure 8.5]. The curve dips but then bounces back, reflecting the resilience of the forests to damages.

Some part of this resilience is natural, for vegetation spurts back in the rainy season. But in cases of large forest fires due to human causes, human interventions too are required for the restoration of forests. In Madhya Pradesh, we do post-fire restoration through regeneration — natural, assisted natural, and artificial — by planting saplings and growing trees. A large part of this regeneration activity is done with the help and active collaboration of the local samitis [figure 8.6]. The samitis benefit not only through the generation of employment for pre-plantation, plantation and post-plantation activities, but also through a share of revenue received from the forests for a long time to come.

Both consumptive (such as logging activities) and non-consumptive (such as tourism and ecotourism activities) utilisation of forests result in direct ploughing back of revenues to the local communities. The communities also receive usufruct benefits such as collection of tendu, mahua, and non-timber

Figure 8.4: Burnt area restoration in Bandhavgarh Tiger Reserve as seen in this satellite image from 10 October 2021.

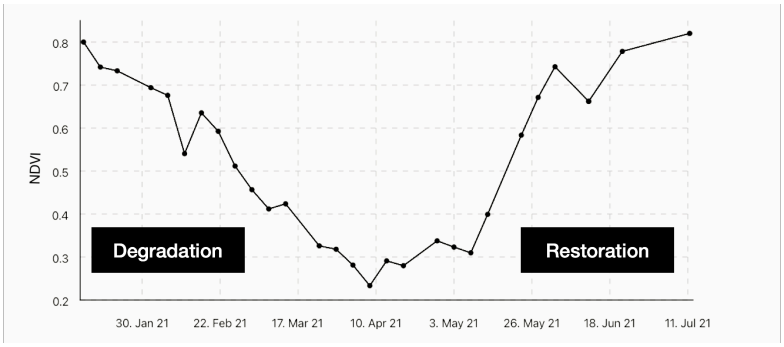

Figure 8.5: Degradation due to forest fire, and restoration of NDVI signature in Bandhavgarh Tiger Reserve in the year 2021.

Figure 8.6: Joint Forest Management Committee members restoring forests through artificial regeneration.

forest produce. In a large number of cases, we are also utilising restoration activities as a means of bringing our forests to more productive, resistant, and resilient states by shifting away from species like teak (that were encouraged historically for their timber, albeit at the risk of making the forests more fire-prone due to their deciduous nature) and towards species like tendu, mahua, and tamarind (that are not only useful to local communities and biodiversity, but also make the forests less fire prone, being non-deciduous).

With India's signing of the Kunming-Montreal Global Biodiversity Framework, there are now increasing opportunities to pool resources. The shift from production forestry to forestry for biodiversity and ecosystem services means that now we have the golden chance to increase the resistance and resilience of our forests towards forest-fires through dovetailing and amalgamation of our resources. After all, all the departments have the same basic objective — to best serve the interests of the society.

Chapter 9

Start where the last man left off.

"If I have seen further than others, it is by standing on the shoulders of giants."

[Sir Isaac Newton]

Animals mark their territories — using scent, scratch, even urine. It's in their nature to declare, "This tree is mine!" And humans, being social animals, have naturally inherited this tendency.

We find this tendency everywhere — from speeches highlighting 'I', to copyrights and restricted accesses. In numerous situations, activities such as these become counter-productive to management — for often, we are forced to re-create what exists already.

Much better — and faster — then it is to build upon the works of our predecessors. This is what we did in Madhya Pradesh.

Pablo Picasso had a point when he said, "Good artists copy; great artists steal!" We imbibed the motto of "beg, borrow, steal!" in all our endeavours at protecting forests (though we never did steal, and instead used things with permission and giving due credit). The same also applied to our products — they were released under Creative Commons licenses [figure 9.1].

Similarly, all our source codes were released in the public domain, to be used by anyone and everyone, freely. The term 'free' does not only refer to the

Figure 9.1: Creative Commons license in the book: Madhya Pradesh Forest Fire Compendium.

commercial aspect (as in the fact that users don't need to pay to use the code), but more importantly, refers to the rights that users have — freedom to run the program as they wish — for any purpose, freedom to study the workings of the code and to make changes to the source code, freedom to redistribute copies of the code — to help others, and freedom to redistribute modified copies of their codes to others.

This was also done to pay homage to those who freely made their works available to us — NASA and NOAA never asked us to pay for their fire alerts, and freely made their alerts available to us through their servers, the USGS never asked us to pay for their algorithms, and countless scientists made their works freely available to us. The concerted goal is the same — to protect forests, wildlife, and biodiversity. It is just as the Talmud states, "whoever saves one life saves the world entire."

Science is ultimately based on this philosophy of freely shared knowledge — even as part of the scientific method. Once we've created a hypothesis, tested it and found it to be true in a few situations, it gradually becomes a theory. But a theory becomes a law only when a large number of scientists have tested the same theory — over time, and possibly over different circumstances. How are they to test it if they do not have access to the theory in the first place? How can they know if an experiment works if they're not provided with all the details to replicate the experiment? And herein comes the case — and necessity — of sharing knowledge. This is also the foundation of peer-review, where a report is reviewed by other scientists in the field (the 'peers') before it gets published.

The science of conservation also needs to follow this approach. This is why we shared all our knowledge, methods, algorithms, and even source codes on our website, and with all our fellow 'peers' in different meetings and workshops. We presented our case and approaches. And whenever we got an input for improvement, amelioration, or refinement, we pounced upon it at the first

opportunity.

It turns out that sharing is not only caring, but a *sine qua non* for refinement!

Chapter 10

It is in giving that we receive.

"You cannot hope to build a better world without improving the individuals. To that end each of us must work for his own improvement, and at the same time share a general responsibility for all humanity, our particular duty being to aid those to whom we think we can be most useful."

[Marie Curie]

In 'Ahimsa or the Way of Non-violence', Gandhiji remarked, "if you want something really important to be done you must not merely satisfy the reason, you must move the heart also…" This is also true of department's workings, and the workings of any organisation.

Douglas McGregor created theories X and Y as theories of motivation and management. These talk about two 'styles' of management. The theory X manager tries to get things done through more and more supervision, luring employees through rewards and threatening them with punishments. On the contrary, the theory Y manager creates a situation full of job satisfaction, thus encouraging workers to work without a need for direct supervision. Gandhiji was more of a theory Y manager in this sense.

But given these classic theories of management, what should be the approach of the department when it comes to conservation? Well, it turns out that theory Y can work much better, especially when it comes to topics like forests and wildlife. This is because it is in the inherent nature of man to conserve trees, forests, wild animals, and birds. Especially so in our society where we grow up playing with butterflies, dragonflies, and damselflies, and are

encompassed with a culture that places a huge weightage on conservation. Consider any Hindu deity, and you're sure to find an associated animal. Goddess Durga has tiger, Kartikeya has peacock, and Vishnu has both eagle and serpent. The perils of killing wildlife are also vividly borne out of the stories of Dashratha, Pandu, and others. Consider Buddhist philosophy, and you're sure to encounter the story of how Siddhartha had a much greater right on a swan that he saved, as against his cousin Devadatta who shot it with an arrow. Buddhist theology has numerous references to elephants, lotus, and several trees — most famously the Bodhi tree. Same with Jainism. In fact, all the oriental religions are brimming with references to nature, nature spirits, forests, and wildlife.

Perhaps it is because of this cultural milieu that our Constitution also emphasises the conservation of nature and natural resources. Conservation is an intrinsic part of Fundamental Rights, Fundamental Duties, and the Directive Principles of State Policy. Owing to these, conservation has also become implicit in our educational system.

In essence, Indians are motivated enough to do conservation. We only need to cultivate, encourage, and nurture this intrinsic quality. But how should we go about doing that?

This brings us to the skill-will matrix [figure 10.1]. Essentially people (or workers in an organisation) can be divided into four categories, and each of them need be managed in a different manner. There are those that are both willing and able (represented as the green box) — in other words, motivated to do the job, and having the requisite skill-set to do the job. For such workers, the best strategy is delegation — the manager delegates the task, and there is hardly anything remaining to be done.

Some others are able but not willing (represented as the yellow box). These workers need to be provided with motivation and encouragement. The encouragement can be extrinsic — say, a reward or praise, or can be intrinsic — by changing the nature of the job such that doing it imparts meaning to the individual. Since these workers are able, and have the requisite skill-set, there is no need for an additional training.

Yet others are willing but not able (represented as the blue box). A majority of our citizens come under this category — they are motivated to work for the environment and nature, but do not know how to do that work. They lack training, or an avenue, or opportunity where they can exert themselves

Figure 10.1: The skill-will matrix.

in the cause of conservation. Providing them with an avenue is all they need. In Madhya Pradesh, our 15,608 joint forest management committees (each with scores of people) provide one such avenue. Eco clubs in schools and colleges provide another.

The remaining workers can be categorised as having neither the skill set, nor the willingness to do the work. They require both training and motivation.

In Madhya Pradesh, we employed every opportunity to provide both training and motivation. We have found that meetings of Joint Forest Management Committees are a good way to interact with citizens and make them aware of the issues relating to forests, wildlife, and their protection [figure 10.2]. Employees of various departments were addressed through offline and online workshops. Best-performing districts and joint forest management committees are being awarded. Fire protection was converted into a people's movement using mass media, schools, colleges, and the Anubhuti program of the Madhya Pradesh Ecotourism Development Board.

At the same time, the process of fire fighting was made more amenable through provisioning of all-terrain vehicles, fire fighting kits, mechanised leaf blowers, and safety equipment.

Figure 10.2: Meetings of Joint Forest Management Committees provide unique opportunities for the training and motivation of citizens.

In all, efforts to nurture staff, samiti members, and the general public to the cause of conservation were reciprocated several times by their toil to prevent and control forest fires. The story of forest fire management in Madhya Pradesh is indeed a tale of this team-work.

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