HANDBOOK OF ACTIVE DEFENSE STRATEGIES IN RURAL AREA FIRES FOR LOCAL ADMINISTRATIONS, MILITARY TROOPS AND NON-GOVERNMENTAL ORGANIZATIONS

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PART I: STRATEGIES AND PLANNING BEFORE FIRE

1. What is Active Defense (AD) strategy in rural area firefighting?

Delivering the **firefighting teams** responding to the fires to **risky areas where it can be late** from the point of first respond in the direction of **threatening dominant windbefore the fire outbreak** within a plan.

In the active defense concept, **zone defense** can be performed against the fire **threat** in the **special and valuable block forests selected** primarily **with thecurrent resources** instead of protecting **all the region**. The possible **delays**occuring in the time of reaching to the **other small fires** which can break out **away from the valuable areas** and have little risk to get larger due to sabotage and extreme conditions can be **accepted within the threshold of damage**.



2. What are the operational factors to be used in (AD)?

Firstly, the strongest responding vehicles are deployed in the risky frontage in the **direction of dominant wind** according to the principle of **extinguishing the fire in the starting stage. Other appropriate vehicles and terrain equipment beloging to the public organizations** are guided to the areas discharged from such **teams** as a support powers (**van**, truck, caterpillar, **motorcycles**, water tanks, **tractors** which can tow the **water tanks in the villages and farms**.)



3. What are the primary areas to be protected in (AD) and the smallest defense units?

Defense can be performed by **selectingyoung afforestation zones, military strategical zones, tourism development** areas and **settlement areas having dense population** primarily as the current resources are restricted instead of protecting **all the region**.



AD recommends gathering the ground stones (all local risks) of pyramide to constitute country fire defense model in the basis of village, and enable the senior managers to make the most correct decisions in relation to the fires in the peak of pyramide.



Every firefighting department participating into AD takes actual defense positions to protect its own regionactively, and can be more productive as a respon team whose target and efficiency size are defined in the determined directions.

4. What are the recommendation of (AD) for defense plans and early response of local authorities?

One of the most **complex** matters in firefighting is that firefighting teams of municipality are **deployed away torisky** points preventing early response. Therefore, new defense plans should be prepared for **firefighting teams of municipality according to risk analysis results**, and **regional defense powers should be guided to the correct points**.

In the active defense plans for fires, municipalities should determine ground teams delivered for every village according to special fire risks, and the aerial vehicle deployment centers in order to provide maximum support to the mountenous regions difficult to reach.



5. What are the recommendation of (AD) for Regional Aerial Defense Plans of Metropolitan Municipalities?

Deployment places of optimum aerial vehicles should be determined for **common** aerial defense of all towns against fire after **combining the defense plans** to be constituted according to **the new fire risk** in the **provincial basis**.



6. What is the operational strategy of the fire crew to participate in (AD)?

The **primary** purpose is to firstly be able to reduce the first response time of the **land response** elements to the shortest possible time; to select the **available land** vehicles (such as **landfill, water supply, ranger, water tank**) **according to their topography and road superiority** and to deploy them to the **most appropriate points** in the land. In the second level, it is to be able to provide **air support** to ground intervention within the first 30 minutes.

While fighting from the land; fire teams in the closest second defense ring shall be shifted counterclockwise to the fire center (such as the tornadoes formed in the center of the hurricanes) to the places of the evacuated teams in the primary defense ring, and gradual logistical support shall be provided without leaving other areas vulnerable.

In the villages in remote points outside the range of existing land teams, it is recommended to successfully fight fire with the existing water tankers in the villages by assigning 1 tractor with its driver.





7. (AD) recommendations about the fixed deployment locations that the existing fire crews are stood by?

when meteorological early warning alarm conditions occur, active defense teams will be able to eat their lunches earlier and be shifted to the recommended alternative deployment points before the fires start (from 12: 00 to 19: 00 in the evening).



8. At what times of the year should (AD) be applied?

Since keeping the extinguishing teams in the **continuous alarm** position will increase the stress; it should only be implemented for the days when the risk is predicted. When a special fire alarm occurs by the Meteorological Early Warning System during the hot months when large fires occur the most, the fire crews should be shifted to the alternate points determined swiftly.



9. What are the climate parameters that will require switching to the (AD) alarm position?

Situations required for teams to go on alert according to meteorological conditions in **active defense** operation (for Turkey): **Wind speed:** 11 - 32 km/h (3 - 8.8 m/s); Temperature: 29 °C- 36.4 °C; **Humidity** is between 16%- 32% thresholds.

In areas and times where these three criteria occur simultaneously, teams need to be shifted to the designated points in a more advantageous position in the direction of the prevailing wind to be able to respond early to fires that may start.



10. (AD) recommendations on specialized decision-making technical staff to prevent possible large fires?

Since the risk analyses previously conducted in the implementation of critical decisions in a fire organization started by civil and administrative supervisors who are not experts on fires are still not available; tactical plans and maps related to the emergency cannot be created immediately and the necessary intervention suggestions cannot be made urgently.





The model will be able to bring countries the style of struggle in which **automatic** dispatch and management systems **with all the advantages** of **technology**, which are **least dependent** on people, are implemented.

Due to these technical reasons, AD recommends that all current fire risks be made available forcomputer-based analysis by computer processing systems; and that the management and management of the vehicles in the operation phase can be carried out fully automatically with 'Operational Fire Vehicle Routing Systems'.

11. What does AD foresee about global climate changes and new fire threats waiting for countries?

As a result of global warming, it is a fact that large rural fires and large areas burn in the **spring and late autumn periods**, **except for the fire season**, all over the world. In the near future, there is also a risk of new forest fires in areas where **no** major forest fires have occurred until today, **and** it is imperative to develop new **fire protection strategies** urgently for these places, which are considered less sensitive to fire.



it has been observed that it has emerged as a result of high heating, drought, and indirect sea effect on dam basins and valleys.

12. Recommendations of AD to prevent losses that may occur in the fire end feed line in growing RURAL FIRES?

It proposes to minimize the damage to the facilities by activating and wetting the existingsystems (water shields) before or as soon as the fire approaches the critical areas with the clay mixed water solution connected to the water resources in areas that can be determined to be risky in advance.

If these **defense measures** are taken **before** the fire, the main progress of the fire **can be stopped** and new losses that may arise can be prevented by the intervention of the existing teams **without distributing the forces** of the fire to the end progress line during the fire.



13. How should AD Plans be prepared by computer-based fire models where many more criteria can be jointly questioned by experts?

AD is recommended to be carried out with computer-based 'Forest Fire Risk Analysis Models', where all data can be analyzed together, instead of human memory, which is directly and indirectly affected by many factors. As a result of fire risk analysis, fire hazard risk weight centers can be determined for land, air, and sea first response teams and the teams can be redeployed at these points.

Thanks to the fire risk map to be obtained, the **newly appointed technical personnel** will be able to adapt to the region **in a very short time** and will be aware of the **risks**. Thus, **even if the administrative and technical personnel change,the system will update itself** and the **fire protection** operation can be successfully maintained in the medium and **long term**.



14. Recommendations of AD for the commission decisions taken by the boards responsible for fire prevention?

The AD fire defense system will **bring new perspectives to practitioners** and will help to take **new protection measures** by **drawing attention to the areas with the highest risk instead of all rural areas.**



15. What does AD recommend in terms of the life and work safety of fire teams involved in forest fire extinguishing activities?

The PRIORITY in Active Defense is the SAFETY OF THE PERSONNEL and then the protection of rural areas from fire.

Since fire teams have to make a **greater effort** than their normal performance **to save time** in the first intervention, **unfortunately**, a large number of **traffic accidents**, **helicopter and aircraft** accidents occur while going to fires; **life losses**, injuries, and economic losses occur. For these reasons, **maximum attention**, **agile movement**, and personnel safety are the basic principles of **active defense**.



The **technical maintenance** of the existing vehicles must be **complete** and **the speed limits on the roads must not be exceededbefore taking action quickly** with the team receiving the fire notification.



Aircraft should also be careful about taking their safety first, hitting the energy transmission lines, having to throw water in the sloping land and rise

suddenly, wrapping the water transport buckets around the tail propeller, rushing the fire extinguishing personnel during the landing, interrupting the operation when the wind conditions become negative.

AD also recommends that fire teams be given the **authority to withdraw** to the points where they can ensure their **life safety without intervening** in the fire if they **feel that they are at great risk ofland interventions** to the **fire progression end line**.



PART II: RECOMMENDATIONS FOR OPERATIONAL APPLICATION IN CASE

OF FIRE

A- FOR LAND RESPONSE VEHICLES

16. What new approaches will AD Plans bring to the Fire Department?

AD recommends **reorganizing** the firefighting systems where **more than one team is stood by together** in fixed centers of existing **fire departments** and **shifting some teams**. It recommends a **homogeneous shift to alternative new deployment points** where **teams away from** rural areas can intervene early at noon in identified risky areas.

In road and **traffic analysis**, there are at least 10 minutes delays in the arrival time of fire teams **deployed close to the city centers**. Such **delays** experienced **during the first response period** increase the risk of fire growth.



It also recommends that **fire experts** be assigned to general-purpose **helicopters** and **air patrols** for **instant evaluation of risky areas** and fire surveillance when meteorologically necessary, and **coordination and cooperation** between **fire** departments.

17. How will the AD overcome the decisive elements in transportation that prevent ground teams from reaching the fire?

To reach the risky areas without delay, ground teams that will respond to the fire must be able to overcome the separating elements that create physical obstacles such as highway-divided roads, deep valleys, streams, dam's lakes, and sea.

For fire departments, the **shortcuts** to the other side of the road should be provided with **highway** authorities at the points to be **needed** as a result of risk and road analysis; for the **fixed bridge** in very dangerous areas, or for **emergencies**, ease of crossing should be provided with **mobile engineering bridge** constructions.





18. What are the recommendations of the AD about the current locations of the first responders in charge?

In the growing fires, **only 20%** of the fires occur in the **interior** of the forests (**sabotages**); 80% of the danger comes from the outer borders of the forests or farming areas.

For this reason, new deployment locations that may be closer to the threats that may come from outside the forest borders should be identified.



19. Recommendations of AD to prevent fires that may start on the side of highways?

It recommends that the sub-branches of young trees with fire risk on the highways should be pruned up to **2 meters** above the ground by **volunteer students**, environmental associations, and **village legal entitiesbefore the fire season**. It recommends removing the dead cover (needle-like leaves and dry grasses on the ground) on the soil with a rake and preventing the ignition of the

flammables on the asphalt slopes by spraying and covering with **clay-enriched** water.



In the regions where these measures cannot be taken, the most appropriate solution will be the burning and removal of the existing production residues left in the field by the **fire crew** under the control of the **experts** with the controlled burn method.



20. Recommendations of AD for cigarette butts that are thrown from vehicles to the road on highways and cause fires?

it requires **awareness** of burning cigarette butts **thrown from the highways** to prevent forest fires.



In the application areas; sensitive routes with the highest risk of rural area fire should be determined and water-filled containers with the 'Fire Prevention' logo can be distributed free of charge at highway tolls or main road junctions at the most critical hours (12.00-15.00) by the responsible municipality, fire departments, traffic police teams, relevant municipal officials, fire workers or volunteer non-governmental organizations and students to the drivers who do not want their vehicles to be contaminated and who request or smoke in these areas.

This service will be announced **through the press** and the fires that may occur due to **cigarette butts** during the fire season will be **reduced**.

21. Solution proposals of AD for fires that may be sabotaged?

It was determined that **21.19** % of the major fires examined were **deliberately** started at **several points** outside the normally known times and regions, late at night, and away from the settlements.

The common characteristics of these fires, which are determined to be very likely to be sabotaged, are that they usually occur **lateto camouflage** some **illegal activities (such as smuggling and organized crime)** in forest areas and that the fire can **continue by suddenly** flashing in the following days despite the low initial rate of progress.

AD recommends **monitoring** the fire perpetrators in critical problem areas where similar fires have occurred before with **unmanned aerial vehicles**, **photo traps**, **or thermal camera** and satellite systems that can detect other live activities.



22. How many minutes is the target response time of AD?

Following **the ground intervention in the first 15 minutes**; it aims to control the fires with **two ground crews + 1 aircraft within the first30 minutes** by providing air response support within a maximum of **25 minutes.**



In cases where this cannot be achieved, it is recommended to try to be control with the **second aircraft support** absolutely within the **first 60 minutes**; even if the fire gets out of control despite all efforts, it is recommended to continue the intervention with **amphibious aircraft instead of new helicopter dispatch to the region**.



In the fires that continue and expand **as of the 2nd hour**, it is recommended to make interventions only for the protection and **evacuation** of the people in the **settlements**; if the appropriate conditions are met, it is recommended to stop the fire with counter-fire by **the expert** supervisors from behind the new **fire response** side, which is estimated to be reached in the **2nd or 3rd** hour.



23. Will AD reduce the growing risks of fires in the countries where it is applied?

As per AD principle to be prepared by conducting **multi-criteria fire risk analyses** in line with **active defense plans** and high-level **protection applications** before the fire, if the first response time from land is reduced from **15** minutes to **10minutes** and the first intervention time **from the air** is reduced from 25 minutes to **20 minutes**, it may cause the **growth rates** of rural fires in countries to be reduced by **60-70%**.



24. Recommendations of AD for support teams to be sent to major fires?

AD proposes a stronger defense position in a short time by **shifting the fire crew closest to** the **empty team** centers while responding to the fire, instead of **asking the fire crew at very long distances** without ignoring the fire risks throughout the country.



25. Recommendations of AD for motorcycle firefighting teams?

As an alternative to large firefighting groups, AD recommends that very successful activities can be carried out by extinguishing fires while starting them by responding faster in large areas with rural firefighting motorcycle crews consisting of one or two volunteers.



To support the economic aspects of these voluntary teams to be established, it is recommended to support local governments with grants or loans that can be provided by Development Agencies, Banks, and Foundations.



26. Road effectiveness analysis recommendations of AD of land response vehicles?

For the ground response teams to prepare and carry out the first response to the fire within 15 minutes;

Vehicle cruising speeds in the initial planning while determining effective intervention range radii:

70 km/h on paved roads for **water-tender** and **30 km/h** on forest roads; 90 km/h on paved roads for **Ranger** vehicles and **50 km/h** for forest roads;

30 km/h on paved roads for village intervention **tractor** teams, **15 km/h** for forest roads;

50 km/h on paved roads for single-seat with one sidecar motorcycle teams, 25 km/h for forest roads

and these speeds can be changed according to the **topography** criteria in **different vehicles** and **different regions**.



27. Recommendations of AD about the risks in areas that cannot be seen by fire watchtowers?

In such areas with vision weaknesses, great risks occur in terms of defense and cause active defense units to wait in a blind position in the dark! For this reason, based on the real heights from the ground of the forest fire observation towers that serve as surveillance in fire-critical areas, 'Tower Vision Analysis' should be prepared again in the computer environment and all rural areas that cannot be seen should be recorded on fire risk maps as very risky areas.

For towers with **visibility vulnerability rates of more than 40%**, it should be supported with **new observation points** and cameras that can increase the viewing angle.



28. Recommendations of AD on the functions of camera systems deployed for fire surveillance purposes?

It recommends technical support with thermal cameras that can give a fire warning - which can be mounted in a short time - without the need for new fire watch tower constructions in areas where no vision can be taken right at the border of the residential areas.

In addition to fire monitoring towers, it recommends successful observations in a wide range of areas with the installation of cameras on all kinds of television transmitter towers with electrical energy and GSM Base Station poles.

It emphasizes that island and peninsula and nature conservation parks, which any vision cannot be taken in terms of topography, can be observed with the 'thermal camera' system and can transfer a healthy image for intervention operations to fire operation centers.



29. What does AD foresee for village firefighting crews?

In the results of the completed fire investigation, it was determined that 95% of the 'large forest fires' occurred within 1- 3 km of the village settlement centers.

It has been observed that 'Village Water Tanks', which can be mounted behind the tractor to extinguish fires in these villages, cannot be usedeffectively in the first intervention works in rural fires. If the temporary task definition can be made in the fire departments units of the tractor and its driver that will take these water tanks to the operation, very successful results can be obtained.



Multi-purpose Fire Extinguishing Tanks distributed by public institutions to Forest Villages, single-person 'Village Fire Extinguishing Teams with Tractors' will create a water extinguishing effect as much as the first intervention of the helicopter to the villages with a water capacity of **3 tons**. The most effective defense against forest fires that may occur in the vicinity of the village can be realized by shifting it to the intersection points to be determined in the direction of the prevailing wind in the boundaries of the agricultural area/forest sections in the relevant village.

Working hours of the team are between 11.30 and 19.30 during the day and mobile phones can be used for communication.

With the rental fees to be paid to the tractor and its driver, savings can be achieved by preventing large fire extinguishing and compensation costs in the future, and the system will be able to provide economic resources for small employment and new village fire extinguishing teams in the relevant village by amortizing its own costs in a very short time.



The tractor to be rented with the driver for the village water tanks kept idle in the village centers

30. Recommendations of AD for the control of forest fires around energy transmission lines?

Small energy transmission lines (34.5 and 10.5 KW), which pass through rural areas and carry energy to settlements 24/7 and can highly be affected by external weather conditions, pose great dangers in terms of fire risks in areas where tree branches contact. Against these risks, the relevant company recommends the **establishment** of **2-person** motorcycle Energy Line Fire Control Teams for **technical maintenance** and **fire first response** near the risky energy transmission lines during the **fire season (3 months).**



Energy companies will not have to pay very high compensation costs thanks to the maintenance and preventive measures of these teams, which will be deployed near the transformer stations and can be assigned for half-day working shifts.

This team will be able to provide great support to the active defense before the fire by traveling on a motorcycle or foot; by macroscopic observations of the risks that may cause unseen fire on the poles and by cutting the tree branches that are touching the energy transmission line and by maintaining the wires and isolators that are about to break under the influence of the wind.



31. If all ground teams working in Municipal Fire Department are assigned to a major fire; the recommendations of AD for new fire protection gaps that may occur in the region?

During the shifting of the teams for ground response and support to the growing fires, the fire defense is **weakened** in **many regions** and the losses may **double** due to another fire that may arise in the evacuated areas and have a high risk of growth. For this reason, all teams should not be sent out of the region.

Provided that it remains in the **center of risky points** in each region, **1 water tender for fires should be kept on hold**; if there is an extra fire crew vehicle, support should be sent to the neighboring regions.

As soon as the fire is under control, the teams should be ensured to **return** to their positions in their areas of responsibility quickly, **starting from the outermost ring.**



32. Recommendations of the AD on the use of radios in the direction of fire vehicles assigned for fires outside the region?

As support for large fires, when teams from outside provinces **approach the fire scene**, they have to absolutely **navigate** and make radio communication for the **order of response**, and it is very **difficult** to prevent radio communication pollution that may be caused by a large number of teams at the fire scene.

For this reason, **computer**-based '**Operational Fire Vehicles Routing Models**' that can direct firefighting vehicles to the required region with **more visual instructions** are developed and it is recommended to fight with **automated systems** instead of **personal** supervisor **instructions**.

It is necessary to ensure that the closest teams to the fire zone **reach the big fire**using vehicle **navigation systems**.





33. Road and intersection analysis of AD for operations?

thanks to the road and intersection analysis to be made according to the fire risks, it will be possible for the teams to reach their targets in the shortest time and optimum deployment centers.

Intersection analyses should be carried out with the help of computerbased models, road **exit** routes in **the north**, **south**, **east and west directions within each region**, and **the most advantageous intersection points** at the weighted middle point of all risks in the center of the region should be determined and time of arrival to these points has to be determined with fire teams.





B- RECOMMENDATIONS ON METEOROLOGICAL FACTORS

34. What is the most important meteorological risk factor for AD?

As a result of the 'Examination of large forest fires in the light of meteorological data' project, it was determined that the **MOISTURE** factor, which was considered to be the most important factor in the growth of fires in the past, was important at the **third level**; the most important factor in the growth of fire was **WIND** at the **first level** and **TEMPERATURE** at the **second level**.

For these reasons, they will be able to **protect their regions most effectively** by shifting them from the stations where the first responders wait for them to the alternative intersections to be determined as of noon **in the direction of the prevailing wind that is effective on that day.**



35. What does AD propose about Meteorological Early Warning Systems?

The most basic principle of active defense is the operational implementation of warnings from Meteorological Early Warning Systems, which can make a high level of prediction of the implementation units that have to take into account even unreal fire notifications.



36. Recommendations of AD for forest fires due to lightning?



Since it will be very difficult to prepare in advance for the time and place of intervention in these types of fires, and since rain clouds follow these fires, fires are less likely to grow. It onlyrecommends that lightning-induced fires that have occurred in the past be marked on the risk map for information purposes.

C- RECOMMENDATIONS FOR AIR RESPONSE TO FIRES

37. Recommendations of AD on ideal deployment locations for helicopters to be deployed in the fight against fires?

It recommends the **identification of pre-fire deployment locations** and **effective air combat** of water throwing helicopters or amphibious aircraft to be deployed in **Metropolitan Municipalities** according to **newly identified risks and helicopter activity analysis**.



It has been calculated that helicopter can provide the most effective air support in a region within a circle with a radius of 30 to 40 km to reach new and growing forest fires in a minimum of 25 or 30 minutes.

At alternative stand-by points to be redetermined for helicopters, the **basic needs of the flight crew** such as semi-stationary containers, **refueling vehicles**, water supply pool in the immediate vicinity, and **electricity** should be met before the operation.

While determining the new helicopter deployment centers **to be proposed**, it should be planned not to overlap the **coverage areas** in the activity radius and to cover the risky **forest areas** in the **terrestrial** areas more.

They should be equipped with additional equipment to provide support against rural area fires in their twin duty areas in their helicopters used for coast guard purposes **on the sea coasts.**


38. Under what conditions does AD require aircraft to be ordered to participate in the operation?

As it is known, since all kinds of phone notifications coming to110, 112, and 177 Forest Fire Emergency Lines in critical regions are accepted as real, aircraft are instructed to start operation for possible intervention.



Following the return of the limited number of helicopters, which are of great importance in fire prevention works, to the base from the halfway route as a result of frequent flight orders and fake fire notification; at least 15 minutes of take-off may be delayed due to reduced fuel supply.

For this reason, it should be kept in mind that to stop a new and growing forest fire, it will not be able to realize the very important sorties it can make in the first hours.



In this way, the flight crew, who have to participate in the operation for all kinds of fires, is under intense stress, has fueling problems, and loses their concentration in large fires.

According to the results of the previous risk analysis, the AD recommends that the aircraft should be directed only to areas that are very difficult to access and ground teams are outside the effective fight limits and have a risk of growth. It only recommends ground intervention instead of aircraft for small areas with no risk of growth.

39. Recommendations of AD for air defense gaps that may occur as a result of the dispatch of a large number of aircraft to the same fire in growing forest fires?

It makes its main progress in the first or second hourof growing forest fires.

Aircraft that can **reach the fire zone in the first two hours**, which cannot be intervened by land, have to move away from the region for **fueling** after dropping water at the **edges** of the fire and **contributing to the operation**.

For this reason, it is **recommended** that some of the incoming air support elements should give **orders to return** to their **old places of duty** to respond effectively to **new forestfires that may occur** in **other parts of the country** and carry a risk of growth by making critical evaluations by **fire supervisors.In the fight after the second hour of the fire**, it is recommended to continue the cooling works with **amphibious planes that can discharge more water**.





For example: In case of helicopters in **Nazilli** and **Milas** on duty in Muğla go out of the region (Gray circles):

Helicopters in Marmaris and Fethiye (red circles) will be able to compensate for the 'air defense gap' created instead of helicopters going to external fire with the least damage.

In the case of the **Marmaris** helicopter is shifted to the **Akbük** Heliport near the **Milas** and

Marmaris borders, and the Fethiye helicopter to Göcek 20 km northwest

40. Recommendations of AD on simulation techniques in ongoing and growing forest fires?

According to the data **obtained** from the analysis of large forest fires **in Turkey**, it was determined that the **average** rate of progress of the growing fires was **4.76 km/h**. When the **general fire speeds** were evaluated **according to the flammable types**, it was observed that they continued at the **highest average speed(6.22 km/h)** in young wooded areas and at the lowest speeds (**3.96 km/h**) in regions with old trees.

It has been observed that all large forest fires have completed their **main progress** according to their own dynamics as of the **end of the first or second hour at the latest**, and in the following hours, they can make **different orientations depending on the wind** and intervention effect of the fires. Taking into account the **coordinates** of the endpoint of the forest fire and the **wind direction**, which continues in line with the new fighting strategies by the fire experts, the estimated distances that the fire can reach after the **next 1 hour** should be determined; for fire supervisors, the fighting line and the stopping front in the field and the areas where the counter-fire can be fired have to be revealed. (Google Earth Pro)



Figure: Fire simulation according to actual data



Picture: Large forest fire progression rates according to combustible material types (tree development ages)



Figure: Some Fire Simulation Models Used in the World

41. Recommendations of AD on helicopter accidents used in active defense firefighting?

Falling aircraft (helicopters) while fighting fire indicate major problems in air defense. For flight **safety measures**:

- 1- To reduce the stress in the aircraft **take-off instructions**, only the responsible **technical staff** should request an **emergency flight** and the intense psychological pressure on the flight crew should be reduced.
- 2- If a water pool can be created near the helicopter take-off bases; after taking some water, their arrival at the fire scene will prevent some accidents.
- 3- In case of fires caused by lightning with a low probability of growth; pilots should be authorized to postpone take-off until these conditions are lifted if there is a meteorological risk in air intervention.
- 4- For dry tree trunks, branches, or water transport buckets that may be caught in fishing nets that used to exist in ponds; it may be beneficial for pilots to mark the safe parts where water can be supplied in a way that they can be seen from the air.
- 5- Ground teams have to be ensured to evacuate the critical area with radios to prevent pilots from damaging ground crews remaining in the water firing line of the fire supervisor and technical personnel in the helicopter.



42. Recommendations of AD on water collection pits (pools), which are absolutely necessary for air and land operations?

It has been observed that a small number of helicopters that intervene in fires when there are not enough water resources have to go to the sea from long distances and replenish water and that the fires have grown because they cannot throw large amounts of water into fires **in a short time.**



To control the new fires that may occur in high-risk coastal areas that have previously experienced large forest fires, it is recommended to build new water collection pools in the vicinity of valuable tourism and nature conservation areas that cannot be intervened on land.

43. Recommendations of AD on the distances and importance of water supply pools in the success of helicopter operations?

The first factor that affects the first response time the most is the **physical distance of the helicopters to the fire starting points**. The second important factor is the **distance to the nearest water source** to the fire scene following the first water dropping.



For the fire to be suppressed by the helicopter closest to the region, it is the key to success that the second water dropping can be made accurately within the first 5 minutes and that it can be left to the fire scene with 3 droppings (2.5*3: 7.5 tons of water) in 12 minutes without the need for other helicopters.

Water supply pools must be established at optimum distances with a 5 km*5 km grid system in risky areas. It recommends placing the missing water supply pools in the vicinity of the most necessary risk areas such as fixed construction or semi-mobile eco-tank systems before the fire season.



44. Recommendations of AD on amphibious aircraft used in air response?



In forest fires that are growing by public institutions, there is a need for amphibious aircraft that can drop water from the body in CL-215 or Be-200 types (Canadair-Berujev) for air support purposes.

These aircraft are **not used for the first response to fires**; they are used to stop the fire end advance line and protect people in settlements in forest fires that **tend to grow** and spread over very wide areas.

Although some of the airports they have to deploy may be far away from the fire zones, they can reach the fires in **30 to 45 minutes** at the earliest.

The arrival time to a fire site at a distance of 80 km can be at least **15 min + 25 min: 40 min**; they can enter into operation around **50 min** with the **first water drop** because of exploring the appropriate approach angle and replenishing water, and they can contribute to the active defense **in the first 1 hour** for support.

45. Recommendations of AD for planning aircraft in firefighting on a country basis?

In line with risk analysis in the fight against forest fires, it is necessary to determine the most 'correct deployment places' of aircraft and to plan again throughout the country.

After planning, it is recommended that **new alternative deployment points** be experienced by the application units and pilots, and fixed bases are established in the future at the points where efficiency is seen.



After the aircraft leave the regions at the end of the season, it is necessary to respond to forest fires with ground teams and to continue the fire extinguishing works to be carried out from the sea when necessary.

It is recommended to use active defense by installing apparatuses that can carry water buckets to **the extent of the capacities** of administrative helicopters or **military helicopters** that provide exploration and coordination services to forest firefighting operations.

As in the case of Italy and Spain, it recommends the addition of a **water bucket** to existing **general-purpose helicopters (300-500 liters capacity)** in case of a possible fire in extraordinary climatic conditions outside the fire season.





46. What AD recommends for the countries which cannot make benefit of helicopter support?

It recommends renting single-seater-planes, which drop water from body with the capacity of 1,5 tons of water and take off from ground or sea, from private companies for 3 months in the critical season in order to protect islands and natural protection parks in the third world countries not having adequate aerial power in firefighting.

The economical loss of the fires can be minimized by means of the singleseater-planes dropping water from body. Even **only one plane with capacity of 1,5 tons of water** can perform a quite **successful active defense** for firefighting in the first **20 minutes**. Therefore, it is recommended to establish **short ground tracks**on which **small planes can land and take off and supply water in criticialareas** from the point of fires in the **countries** not having adequate aerial vehicles.



More efficient aerial defense can be performed by **renting2 planes** jointly in the larger areas having risk of fire by means of **2 simultaneous shoots**(totally 1,5+1,5= **3 tons of water**)





47. What are the recommendations of AD for extreme fires breaking out in the period when there is not any aerial vehicles out of the fire season?

Great benefits can be provided when central administrations or metropolitan municipalies charge one or two aerial vehicles in the most risky areas for extraordinary conditions in the weakest periods as there is not any aerial (helicopter) support out of the fire season for the fire defense of the country.

For example, (**3*1= 3 months/1 helicopter**) totally period of ... as months between the dates of and



48. What are the recommendations of AD for responding to fires breaking out in coastal areas from sea, dam or lakes?

It recommends to constitute **sea response team** for the purpose of **defense at the shortest** time for areas which have risky coasts from the point of fire and **cannot be respond from ground** due to **road matter**.

It has been observed that ground teams could not reach to the fires breaking out touristic coastal areason time due to the deficiency of adequate road, and that only aerial vehicles could support (if they were in such areas on that date), and that they could not take active roles in the periods when such possibilities were not available. Therefore, the firefighting can be performed by delivering water in quite efficient way in the coastal towns having road matters by means ofgasoline-powered waterpumps which can receive water from sea or rivers and can be carried by hand.

Motopumps, receiving water from sea or dam lakes, are of vital importance due to the fact that they deliver the water without stop for firefigting and that they can provide support as much as the aerial vehicles at least in fires on island and peninsulahaving transportation problem on road out of the fire season.





Valuable forest areas having tourism potential close to coast.

Such water pumps can be located in **fire brigade buildings close to sea**, and can start the operation from sea by **taking with the firefighting team and assembling on any current boats** when a fire breaks out on the coastal area.



Having **Zodiac Boats**towed by a vehicle and constituting **"Rural area fire sea teams" with 3 employees** at least in areas having no sea vehicle are quite significant to **protect touristic areas and nature** in the future and reinforce the prestige of firefighting teams in the community.

49. What are the recommendations of AD to protect fires breaking out in National Parks and Natural Protection Areas?

Fires in National Parks, which are one of the most important parts of world ecosystems, can **demolish all the endemic values** in a short time. So, **special motorized first response teams of national park**should be constituted urgently. Moreover, **Special Fire Defense Plans of National Park** should be prepared to present physical protection and fire defense precautions by means of **fixed water defense shields** around the national park recreation plants.



The required fire prevention investments under the budget resources should be priorized exactly in order toprevent fire destructions in national parks and to be ready.



It is recommended that Directorates of National Park, being close to sea coasts and having road transportation, should rent small planes which can **perform duties of survey, observation and protection** through the year and can **supply water** and **realize first response to fires**, in order to protect against the **destructions caused by people** and fire.

These planes, which can perform survey before the fire and response and **coordination** during the fire, can be quite beneficial for **active aerial defense** against fire.



Within the active defense precautions of fire, it is required to assembly water-delivering pulverizator with capacity of 400 lt to National Park service vehicles among the actual ground teams in the fire season, and toconstitute national park fire defense teams at any time in the year in the scope of coordination with other fire teams by using the national park protection allowances in order to rent aerial vehicles in the closest airport for aerial response support as well as one-man- fire extinguishing teams on motorcycle and sea fire extinguishing teams.

50. What are the recommendations of AD to protect afforestation areas against fire?

Allowances should be created for fire prevention activities in every afforestation area to be established newly. By means of this allowance, one-man motorcycle fire zone watchers provides active defense with on-site observation and early response, and therefore new afforestation areas can be defended. Water collecting pools and ponds to be established near the area will be vital for aerial defense during the fire, and can get rid of danger of large fires in a very short time.



51. What are the recommendations of AD for touristic facilities under the threat of fire?

Great financial loss and death can be prevented by establishing "water defense shields" to be received from sea or pools against the outer forest fires breaking out at the surrounding and threatening the area and break and for the internal defense against the fires breaking out within their own facilities for active defense in the touristic areas near the sea.





52. What are the efficient defense recommendations of AD for the farmers about the fires breaking out in agricultural areas and splashing to forests?

12,7% of the forest fires are originated from **agricultural areas** and **splashed** to forests **as the fire cannot taken under control** in the said areas, and therefore large fires occur.



The agricultural areas should be protected by establishing new "Rural Fires Prevention Teams" under Ministry of Agriculture to perform the first response to the terrain fires breaking out in the agricultural areas in the critical seasons. So, it will prevent the forest fire extinguishing teams to move away from the critical areas while protecting the sensitive regions strategically, and the most efficient active defense can be realized against the real larger fire threats.

Firerifighting operations can be supported by hiring **Special Agricultural Fire Extinguishing Teams** (1 small truck and driver) for 3 months by **starting the** **risky villages** where especially forest fires break out frequently, or hiring "**Village Fire First Response Teams**" (1 tractor and driver) for water tank of 3 tons towed by tractors.



Terrain-duty 4*4 small truck + mountable mobile gasoline-powered pulverizator device (with capacity of 400 lt) under the Directorate of Agriculture.



Firefighting water tanks with capacity of 3 tons, mountable on tractor in the villages.

53. What are the recommendations of AD about new fire preventing and extinguishing systems for strategic facilities?

In spite of the fact that most of such facilities take **indoor** fire precautions, it is observed that **actual extinguishing** equipment and precautions are **not adequate** against the fire threats originating from **outside environment**, and that terrible events at the size of **disaster** can be encountred in the near future.



Preliminary defense strategies should be developed against fires breaking out in the surrounding and threatening from outside and as internal defense against rural area fires breaking out in Military Strategical Facilities (missile, radar, battery, base), Petrochemical facilities and some Wind Power Plants especially located in forestry areas.

Great financial losses caused by fires can be prevented by establishing "fixed water defense shields" in the very risky areas which can be affected by fire after preparing and developing "Special Fire Defense Plans"



54. What are the recommendations of AD for fires breaking out in waste collection areas of local authorities?

Municipality Firefighting Teams are **charged** for responding to fires encountered in **waste collection areas** in summer months. Firefighting vehicles can perform efficient responses by reaching to the other rural area fires more rapidly if the water shield of waste collection centers defenses itself instead of such firefighting vehicles.

Forest firefighting sprinklers are available for fires which can break out in **daily usage and picnic** areas near the city centers, however early response cannot be performed to possible large fire breakout points due to such charges. Therefore, fire protection will be available by means of **one-man motorcycle municipality fire teams** in the recreation areas.

Therefore, valuable block forest areas can be protected with active defense as the sprinklers, which can move mountenous areas and are vital for rural area fire defense, deliver water in larger amount and more rapidly in the first response to dangerous forest fires.

55. Is AD a strategy to be applied for urban fire risks in metropolitan municipalities?

Fire brigade, being coordinated from fixed firefighting group centers, can create data about locations and reasons of urban fireslike the rural area fires according to numerical and geographical information systems, and determine settlement units having similar features in the urban fire risk analysis maps.



More efficient defence system can be operated by determining the areas in which **big** firefighting vehicles cannot reach early according to the **outbreak times and risk analysis of fires and road reaching analysis** and by confirming the **aerial** response possibility to such areas or the **new alternative deployment points** of **small and speedy** auxiliary firefighting vehicles.



Plans can be prepared for **new mobile firefighting support units** for one or two persons instead of big firefighting stations in the areas **far away** from city centers and newly established settlements in the border of city and forest, and **new urban fire response technics** can be created.

56. What are the recommendations of AD about preparing defense plans before fire in the settlements such as private holiday villages and touristic facilities in the border of forests?

It is recommended carrying out micro fire risk analyses of the facilities with regard to fire threats to be occurred from surroundings in an absolute manner through acceptance by these private sites and tourism facilities the fact that no extinguishing support will not come from outside sources. These analyses can offer new approaches for fire compensations and private fire insurance systems.



Against a potential fire threat in these facilities; it is required to prepare **private fire defense plans** which explains how people affected can be protected, **evacuation directions** and how they can defend their own houses by mains and **their own electricity and water resources** and offers solutions.



The permanent damages will be kept in minimum level **under favour of water shields** prepared physically in facilities prior to fire.



III. PART - LEGAL AND ECONOMIC RECOMMENDATIONS AFTER FIRE

57. What are recommendations of AD for villages and towns with high risk of crime regarding continuous fires breaking out?

In terms of 'Hazard Rates of Social Fire'; alternative solutions should be produced following analysis of the current social problems in problematic villages, towns and district centers where forest fires have been occurring continuously for many years in terms of social and economic. It should be supported with application projects for solution to be prepared by research specialists in line with recommendations of the folk living in the region.

It is recommended to move the problematic inner-village settlements **out** of the borders of the National Park or to move these to the new regions, to gain status to be supported the folk in terms of laws, to establish **new private security** organizations in order to prevent fires in problematic villages and to create extra fire teams and to ensure protection of these regions against fires by village legal entities personally, to get commitments and to introduce new approaches to existing practices such as awarding bonuses at the end of successful years.



58. What are recommendations of AD for catching offenders and legal proceeding after fire?

In examination of large forest fires; no legal results were obtained in the courts since teams who focused on firefighting did not carry out necessary researches on time regarding determination of criminals, legal proceeding and criminal evidence.

The matter of aversiveness in fight with fires and compensation of the damage occurred from offenders are a significant reality.



For this reason, it is recommended that a personnel from the first fire team should be authorized in order not to lose the evidence at the fire exit point until security forces arrive. In legal proceeding after fire; 'fire crime reports' which are prepared in crime scene by firefighting departments are crucial in terms of being a disincentive in the process of the fires that may occur after that.





In the matter of determination and pursuit of fire crimes; it is recommended that all kinds of technological opportunities are used by receiving support from criminal laboratories of Gendarmerie and Security for remote sensing images of fire detector track dogs and nearest fire start point in field surveys. It is emphasized that the rate of fire may be decreased through determination of offenders and compensation for damages and a realistic fire defense strategy may be applied.



59. What are recommendations about volunteer fire inspectors regarding decrease and prevention of AD fire crimes?

Such as Honorary Hunt Inspectorate; sensitivity can be increased in society with trained and equipped 'Honorary Fire Inspectorate' system to be authorized and who want to take part in firefighting voluntarily. Fire inspectors are encouraged for fires whose offenders can be determined in order to make detections in crime scene along with camera, feed for research and trail dogs, fuel support for vehicles by paying incentive bonus.



New volunteer fire teams should be created with local managements for citizens who want to take part in forest fire prevention teams voluntarily and civilian volunteer human elements should be evaluated in the most effective way in struggle with fire.



60. What are legal liabilities in municipalities that could not make AD plan and preparations and suffered large forest fires?

'Fire Inspection and Research Group' should be formed by expert inspectors who actively took part in fire defense by the relevant Ministry absolutely after every large fire and the fires should be evaluated by preparing 'Fire Inspection Report' in subjects like neglect of duty and imprudence by this group about administrators managing the fire.





In line with risks and threats of fire to be predicted previously, it will be possible for the relevant Fire Inspector to undertake responsibility through recording those aspects with regard to chiefs causing delays by way of keeping firefighters waiting who kept in position of dead defense in the opposite direction of the prevailing wind direction.

61. What are recommendations for visual media and broadcasting organizations to create awareness in society regarding exit points of AD fires?

The causes of fires and expose of offenders can provide disincentive effects in terms of prevention of the fires to be broken out in the future.



In order to arouse attention of society for fires more; it can be possible to increase sensitivity in next generations by way of results of the damages and the course of the fire from the starting point (field, forest, facility, residential area, etc.) to the point where the fire spread to the rural area and the damages it caused to the society.

For this reason, the relevant authorities should exchange healthy information and news in the most accurate and fastest way in cooperation with all the press members in order to prevent distorting news comments.



62. What does AD recommend about types of trees and afforestation techniques?

The afforested fields have a very high risk of lossing by burning again without taking new active defense measures in regions that have suffered a fire and where the risks still continue.

Thus, it is recommended that the active defense plans should be prepared firstly according to new fire risks and investments for establishment of more durable forest against fires after the security of the field is ensured.



AD emphasizes that the road construction works to be performed should be prioritised in order to separate the agro-forest section; therefore land teams will be more efficient and intervene early.

It is recommended that cypress trees (*Cupressus sempervirens*) which is known as its performance in large fires and multiserial 'Wind and Fire Prevention Curtains are established in respect of fire-resistant types of trees for new fires in fields and leafy natural oak trees(*Quercus*) are also protected.



63. What are recommendations to prevent fires which may break out near village centers of AD?



In the areas remaining 500 meters from the village centers with high risk of fire and forest borders; fire defense can be strengthened by minimising social risks through creating 'buffer village fire peace planting zones' with types of bearer trees to be protected and benefited by way of providing village legal entities.



IV. PART -RECOMMENDATIONS IN TERMS OF FIRE ECONOMY



64. Is it sensible to prepare AD plans and to take new measures without breaking out fires in terms of economics?

During fires, the extinguishing expenses can reach 500.000-1.000.000 USD on average in a potential large forest firest.

Considering the ecological and economic dimensions of fires, it obliges the fire management planners to use scarce resources in order to protect natural resources by taking into consideration humanf actor, economy and ecology through paying regard to the loss and gain caused by fires on natural resources.



Name of Fire Field	Burned Area (ha)	Total Extinguishing Expenditures (\$)	Extinguishing Cost per Hectare (\$)
* Hisarönü- 2003	319,0	357.848	1121,78
* Gelibolu- 2004	509,0	423.162	831,36
* Selçuk- 2006	850,0	532.761	626,78
* Çetibeli- 2002	1775,5	1.109.779	625,05
* Seferihisar- 2004	347,6	206.288	593,46
* Bodrum- 2006	2601,0	1.158.457	445,39
* Bayramiç- 2000	372,0	100.619	270,48
* Manavgat- 2000	2101,5	565.023	268,87
* Gelibolu- 2003	305,0	81.048	265,73
* Keşan- 2000	1688,5	332.382	196,85
* Hisarönü- 1997	1385,0	201.293	145,34
* Düzlerçamı- 1997	1715,0	222.008	129,45
* Kuşadası MP- 1996	1468,0	174.279	118,72
* Gökçeada- 1996	606,0	49.535	81,74
* Karaisalı- 2000	3138,0	239.422	76,30
* Karabiga- 2000	400,0	29.179	72,95
* Cetibeli- 1996	7090.0	499.203	70.41



Extinguishing costs of large forest fires which are examined (39 pieces)

In case of early arrival, coordination of air vehicles with successful active defense measures in terms of aerial intervention techniques and in the event that the land crews arrive at the fire in a shorter time, the growth of fires can be hindered.

Considering that the most spent items in extinguishing expenses are helicopter and plane expenses, the efficient defense can be sustained by establishing new land and air teams through these reduced fire extinguishing expenditures and great economic resource to be occurred.

65. What are the suggestions for economic values and savings which are lost in struggle expenditures with AD fires?

In the forests which suffered to the continuous fires, great economic expenses of up to millions of dollars are made during fire and thereafter.Except for fire extinguishing expenditures, thousands of kilometers of new roads are made and expenditures are made by establishing new afforestation fields.



A budget surplus in the rate of 80% can be formed under favour of fires that will not break out if the 20% of struggle expenses are separated for preventive active defense measures prior to fires. New economic resources can arise for more efficient protection and establishment of new green areas in fire defense expenditures along with these saving measures.

Thus, as in economy model where fire expenditures and economy are taken into consideration in developed countries (such as USA and Spain) that suffer great damage every year due to fires;

The preferences are made among struggle strategies in which economic losses are intense and some fires can be left to their course of nature without intervention at a high level and unspent extinguishing expenditures create new resources for rehabilition projects to be carried out after the fire.





Who is Cemhan Bucak,

He was born in 1966 and took his primary education in Ankara. He graduated from Istanbul University – Faculty of Forestry in 1987, and obtained title of Forest Engineer. His fields of interest are forest fires, national parks, wild life, forest protection (tree diseases) and endemic tree species ecology and optimum growing environment. Moreover, he took duty as expert in forest law cases. He started his duty in Ministry of Forestry in 1991, and has acquired experiences by working in various departments in an active way. He took charge as technical personnel in Regional Directorate of Forestry, Afforestation Directorate in burning areas, Cadaster Commission for determining forestry borders, Departments of Forest Protection (Smuggling) and Fight Against Pests (Diseases and Insects) and finally Branch Directorates of Forest of Forest Protection.

He took charge as Expert Researcher and Chief Engineer of Fire Researches in Aegean Research Institute of Forestry as of 2002, and he got retired in 1997, and has developed new fire-defense strategies. The large forest fires in which Cemhan Bucak intervened actually before developing the risk analysis model:

11.08.1997 :He started to take charge in Istanbul helicopter team and ground team to respond the large fire in Mugla-Marmaris-Hisaronuby air and ground.

17.08.1999 :He participated into the firefighting duties for the fires breaking out in Tupras Oil Refinery after the Major Earthquake of Izmit-Golcuk and the large forest fire breaking out in Province of Bilecik at the same day.
05.04.2000 :He was charged with ground teams for the large forest fire in Bursa-Orhaneli breaking out suddenly out of the fire season,

03.08.2000: He was charged to support with helicopter on air for the large forest fire in Adana-Karaisali.

He observed personally all the technical and administrative problems encountered during these four large fires, and made decision to develop new solutions for the problems in extinguishing and defensing systems. For this purpose, he completed his scientific research projects in relation with outbreak reasons of forest fire, fire behaviors, technical and administrative problems encountered, preventing fires before getting larger in 2008 while he was working in research dutyin Aegean Research Institute of Forestry in 2002, and submitted national and international pronouncement. He constituted active fire defense and risk analysis software to prevent the forest fires before getting larger, remove the problems in the application and offer new solutions, and established professionally his fire consultancy company in 2022 after observing all the results of the model within the application. As foreign language, he knows English in intermediate level and Russian in basic level.

Activities performed by Cemhan Bucak on abroad:

1- In 2000, he carried out researches about forest protection activities in Mongolia where he visited after getting scholarship and the large forest fire breaking out in 1996 and continued in the border of Mongolia-Russia (Siberia) for months. It was observed that Mongolia Firefighting Department was in the desperate straits causing fire spreading from the point of technical equipment. The technical report was submitted to the related authorities indicating that current two MI-8 helicopters located in Mongolia Airways could be more efficient in first respondingto such large fire organizations if they were equipped with water buckets in case of emergency.

2- In 2004, he submitted pronouncement related to cross-border forest fires in International Forest Fire Congress organized in Antalya in the scope of international cooperation.

3- In 2007, seminar was carried out for the forest fire authorities in **Turkish Republic of Northern Cyprus** about two large forest fire, sight analysis of fire watch-tower and the precautions taken against fires possibly to break out in the future.

4- In 2008, he acquired information from Dr. Enrico Tesi in forest fire monitoring center in Florence about coordination and efficient utilization of air vehicles in large fires in the scope of common scientific research project between Italy and Turkey.

5- In 2013, he exchanged information with forest fire specialists in the participation countries about firefighting technics, ongoing research projects in the training "Forest Fire Management in Direction of Climate and Socio-economic Changes" in CIHEAM (MediterraneanAgricultural Institute) in Province of Zaragoza in Spain.

Cemhan BUCAK

Forest Engineer Expert Researcher



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