PHASE

Public health Adaptation Strategies to extreme weather events

SCIENTIFIC SUMMARY for Public health on wildfires

What is known on the health effects of wild fires:

Wildfires take a heavy toll on human health worldwide, which is expected to increase since the main risk factors for wildfire - high temperatures, droughts and temporary dry spells - are exacerbated by climate change. Accidental health effects of wildfires are well-known. People involved in fires, firefighters but also local residents, face several life-threatening hazards including heat stress and fatigue as well as the risk of other injuries such as accidents, burns, cuts and scrapes. In the frame of PHASE, we conducted a systematic review of non-accidental health impacts of wildfire related to exposure to smoke, dust, ash and debris generated by the fire on which data are sparse by incorporating some lessons learned from recent experiences. Based on the literature, various studies have established the relationship between one of the major components of wildfire, particulate matter [particles with diameter less than 10 µm (PM_{10}) and less than 2.5 µm ($PM_{2.5}$)] and cardiorespiratory symptoms in terms of Emergency Rooms visits and hospital admissions and more recently diminished birth weight in children of mothers exposed to wildfires. Associations between wildfire emissions and all-causes and cardiorespiratory mortality or other diseases have been less investigated. A major difficulty related to health impact of wildfire exposure derives from the complexity of wildfire exposure assessments. The issue of complexity of wildfire exposure assessment has been addressed in detail in a paper in press in Atmospheric Environment. Several methods including satellite data, chemical transport models and, less often, personal exposure monitoring are available to assess exposure. Only some allow to separate wildfire emissions from those from other sources which is crucial in the assessment of health effects of wildfires. Overall, our investigations in the frame of PHASE show that data are few and more research is needed to better understand health impact of wildfire exposure.

Subgroups of the population most at risk (from results produced in PHASE, by WP8 or in literature)

Susceptibility to wildfire has not been addressed properly. Much of the information about how PM affects the population and whether there are specific groups that are more susceptible or

vulnerable has come from studies involving urban airborne particles. Sparse data exist on groups susceptible to wildfire smoke. The level and duration of exposure, age, and individual susceptibility, including the presence or absence of pre-existing lung or heart disease, and other factors play significant roles in determining whether someone will experience smoke-related health problems. The segments of the population that have been shown to be particularly vulnerable to smoke-related health risks in case of wildfires include people suffering with pre-existing cardiopulmonary conditions, elderly, smokers and, for professional reasons, firefighters. They may experience more severe short-term and chronic symptoms. In addition, individuals with smaller airways may be more susceptible to the respiratory health effects of wildfire smoke. These data have been impinged by the lack of data on direct exposure to wildfire smoke. Overall, existing figures show that more research is needed to identify risk of exposure to wildfires in susceptible individuals.

What the PHASE project has contributed (results from case studies and work carried out in PHASE)

The PHASE project has provided data for Europe between 2000 and 2006 on emissions strictly related to wildfires and the related characteristics (burnt surface, period of burning)[1]. For major European wildfires, wildfire concentrations of wildfire-related black carbon between 2002 and 2012. This is the first time such inventory has been provided for Europe. It has allowed totaling the extent of wildfire exposure in terms of fire emissions and concentrations in Europe in recent years. These data are of utility for quantifying health impact of wildfires. Furthermore, the WP decided to evaluate a concentrations/exposition/estimation response analysis for wildfire PM in Europe.

In addition, a case study was conducted to investigate health impact of a relevant wildfire occurred in Marseilles in 2009. The secondary purpose of the study was to explore the lag structure for emergency visits for respiratory disease, cardiovascular disease, psychiatric disease and emergency hospitalization with “SOS doctors” (private medical center that will carry out GP consultations or make house calls as requested) using daily $PM_{2.5}$ from all emissions, from anthropogenic emissions and from wildfire emissions respectively. The study period run from June 1st 2009 to August 31th 2009. Health data, $PM_{2.5}$ data and environmental data were collected daily in this period. According to Bouches-du-Rhône Directorate of Forestry and Agriculture where Marseilles is, there were from June 15 to August 31 the 2009, 391 fires in the Bouche-du Rhone region, which burned 1183 ha. Intense wildfires occurred in day 52-53 and day 64 corresponding to 2 major wildfires in Marseilles in the July 22th 2009 and in the cities of Muy and Roquebrune-sur-Argens in the Var near Marseilles on the August 3th 2009. Daily $PM_{2.5}$ concentrations from all source of pollution, from anthropogenic emissions and from wildfire emissions were obtained using regional climatic model ($RegCM_4$) between June 1st and August 31th 2009 and linked to daily health outcomes. Total and anthropogenic fine particles ($PM_{2.5}$) were found to have an immediate effect on total and cardiovascular hospital admissions, with a statistically significant effect in the case of total hospital admissions, while $PM_{2.5}$ from wildfire showed a delayed pattern and only on respiratory admissions. Indeed, using an appropriate statistical model showed that the relative risks associated with fine particles ($PM_{2.5}$) were generally higher than 1 at shorter lags for total and cardiovascular hospital admissions but at longer lag for respiratory admissions. Total and anthropogenic $PM_{2.5}$ showed more immediate pattern on cardiovascular and total admissions, whereas $PM_{2.5}$ from total and wildfire $PM_{2.5}$ showed delayed patterns on respiratory disease. If confirmed these results might indicate a more toxic effects of wildfire smoke responsible for respiratory symptoms compared to anthropogenic $PM_{2.5}$.

Lastly, the WP developed advice on prevention and mitigation measures for wildfires targeted in particular to vulnerable subgroups, and provide guidance on the methodology for assessing the health impacts of wildfires. These were based on a review of existing guidelines.

Implications for Public health (key public health messages for your EWE)

Because of the extent of damages provoked by wildfires on ecosystems and of potential related health effects on humans and animals and because the risk of wildfires is increasing due to climatic change, the key public health message consists of avoiding wildfires and protecting susceptible populations, both by adopting adapted preventive measures.

Preparedness and response tools necessary to define a Prevention Plan (eg. Warning system, surveillance, communication campaign, prevention guidelines for public, health care, front line responders, etc), identification of vulnerable subgroups and active monitoring)

In the case of wildfires, the preparedness necessary to define a prevention plan consists of the several steps and associated recommendations as follows:

Fire Prevention

Many forest fires are due to human imprudence, clumsiness, a non-respect for the law concerning the use of fire, and a lack of civil responsibility. Prudence and attention to local fire laws can prevent a fire and save a life!!
RECOMMENDATIONS:
(for the individual)
- find out which government agency is the local fire authority in your region
- **stay informed** of local fire restriction warnings and **respect** them
- never throw a **cigarette** from a moving car and never smoke **cigarettes in a forest**
- never use **fireworks** in high risk areas or in a forest
- When barbequing, use an enclosed **BBQ**, keep a screen over the chimney, create a nonflammable space surrounding the BBQ, keep a hose/extinguisher close by, and respect fire ban days.
- use a **gas/propane BBQ** whenever possible as then do not create embers
- when campfires are allowed, dig a 30 cm hole in which to build the fire, create a cleared space of 4 meter radius around the fire, maintain constant surveillance and keep an extinguisher near by

Fire Restriction

A fire restriction is when the local authorities ban the personal use of fire, such as camp fires and barbeques, during periods of high fire risk. To do your part in preventing fires, find out who is your local fire restriction authority and stay up to date!
RECOMMENDATIONS:
- find out which organization is the regional fire safety authority and stay informed
- Be respectful of fire restriction days—this can prevent a fire and save a life
- during high risk days, do not make outdoor fires such as BBQ or campfires
- do not throw cigarette butts from cars or in flammable areas.

Defensible Space

Transforming property into a “defensible space” is perhaps the best way to protect home from fire. Flames can travel from tree to tree and bush to bush directly to home. Furniture and bushes in yard can provide fuel for a fire. A simple wall plant could allow a fire to access house. Create a

“defensible space” of at least 30 meters out from home to prevent or slow the ignition of house. It may save life.

RECOMMENDATIONS:

- create defensible space of at least 30 m from your house in all directions. Consider as much as 50 m; the more space created, the safer your house and your family.
- maintain a distance of at least 3 meters between your house and tree branches
- keep tree limbs >3m from your chimney
- remove flammable debris from around the house and near windows
- remove dead vegetation
- remove shrubs that are directly underneath trees, as they could ignite a tree
- keep a distance of 3m between adjacent tree canopies
- keep a distance of at least 2m between vegetation plots
- fire spreads more quickly up slopes, so increase the distance between trees/shrubs on sloped ground
- limit the overall amount of vegetation to < 1/3 of the area of your defensible space. This provides less fuel for the fire.
- make sure vegetation do not create a continuous line for fire to travel to your house
- make sure fire trucks have sufficiently large entrances to access your property (>4m)

“Hardening” the Home

Taking several simple steps, such as cleaning your gutters and installing dual paned windows, can make houses more fire resistant. In combination with the creation of a defensible space, “hardening” homes can make houses a safe option to wait out a fire.

RECOMMENDATIONS:

- clean roof and gutters of debris (leaves, twigs, pine needles)
- build/replace a roof with fire resistant materials (metal, clay or slate tiles)
- place fire proof bronze or stainless steel screens over vents and windows
- install dual paned tempered glass windows as other windows can break from radiant heat, allowing fire entry
- if building or remodeling a home, consider consulting an expert on fire safe construction
- build decks with fire resistant materials
- consider installing metal shutters
- build or remodel walls with ignition resistant materials (stucco, fiber cement, fire treated wood)
- consider installing a home forest fire sprinkler system

Independent Water Supply

If people have a pool or another large water supply, this can help people and even fire fighters protect homes and its inhabitants. Even having multiple garden hoses cannot be underestimated.

RECOMMENDATIONS:

- a pool or basin can be used to fight fires
- if people have a pool, consider getting a non-electricity dependent water pump capable of pumping 30 cubic meters per hour
- ensure hoses long enough to wrap around house
- pools are NOT a safe refuge for people or your family during a fire, as your head and lungs are not protected from radiant heat

Fire Danger Ratings and Emergency Alert Systems

Local television, radio stations and other media sources as well as local fire authorities will announce when fire is a real threat to your area. Find out how your local authorities communicate when fire is a threat and actively stay informed. Take their warnings seriously. They have years (and hectares) of experience!

RECOMMENDATIONS:
- If people do not know what the local alert system is, FIND OUT!
- Call your local fire department or city hall to learn about how to stay informed of fire danger
- Possible means a local government may inform citizens: TV, radio, smart phone apps, sirens, telephone messages, and alert text messages.
- Adopt an active role in staying informed of fire danger ratings and alerts
- if danger is high, be prepared to evacuate and even defend your home, as fires can surge at any moment
- be prepared to evacuate if authorities tell to do so

Emotional and physical preparation

Some people underestimate the ferocity of forest fires. People could experience strong winds, intense radiant heat, flames, heavy and blinding smoke, loss of telephone, loss of electricity, darkness, burned skin, smoke and heat damage to lungs, and even death.
RECOMMENDATIONS:
- people have to ask themselves whether they are emotionally and physically capable of defending their home against a fire
- defending home on own or as a family should be a last resort
- evacuate when authorities tell
- people do NOT have to wait for an official announcement to evacuate. They can evacuate before if they feel in danger.

Preparing for Action in the Case of Fire

Fires can arise at any time, without warning. People must prepare supplies and have a plan to evacuate so that people can leave your house as quickly and as safely as possible. In the event that a fire surprises people, they must also have a plan to make your home as safe as possible.
RECOMMENDATIONS:
- be prepared for any scenario: evacuation, relocation, defending your home, and surviving after a fire

Evacuation
- make an evacuation plan and write it down
- make sure the entire household knows the evacuation plan
- determine when people will leave, i.e. what will trigger people to leave
- decide where to go
- know who will leave and who will stay (if any)
- specify several evacuation routes
- have a plan for evacuating your pets and animals
- assemble an **Emergency Supply Kit** for each home member and make sure it contains: 3 day supply of food, at least 10 liters of water, change of clothing, first aid kit, flashlight and batteries, a radio, prescription medicine. Protective clothing is natural fabric (cotton, denim, wool) which is thick and long sleeved. Wear thick leather shoes.

Communications
- make sure people have a **communication plan** and a meeting place in case people are separated. Consider designating an emergency contact person to coordinate communication.

Staying and defending
Prepare a **Survival Kit** in case people need to stay and defend your home. Consider adding:

- protective clothing for the whole family
- buckets and mops
- drinking water

- mobile phone charger
- woolen blanket for each person
- flash light
- fire extinguishers
- battery-operated radio
- first-aid kit
- spare batteries for flashlight and radio
- hoses and spare hose fittings
- shovel
- ladder
- medications

Recovery
Prepare a **Recovery Kit** that contains all that people will need to be comfortable in your home for 48 hours in case people are isolated in your home after the fire has passed.

When Fire Threatens or Strikes
It is very important that people stay informed of local fire activity and warnings so that people can act quickly. If fire strikes or threatens, we recommend evacuating the area to a safe place. This section describes steps to take for safe evacuation and steps to take if people stay in your home until the fire passes. Please do not decide to evacuate at the last minute, as people can be trapped in the fire!
RECOMMENDATIONS:
- actively stay informed of fire warnings via radio and TV
- If the local authorities tell people to evacuate, evacuate!
- do not evacuate at the last minute. People are often trapped and killed by fire while fleeing
- if an adequate defensible space is in place, your home is a very safe place during a fire, but evacuation is your safest option
- Only attempt to actively defend your home against fire as a last resort

Evacuation steps
- Review your Evacuation Plan and do not deviate from the plan
- tune your radio to an emergency broadcast station
- Ensure your Emergency Supply Kit is in your vehicle.
- Cover-up to protect against heat and flying embers. Wear long pants, long sleeve shirt, heavy shoes/boots, cap, dry bandanna for face cover, goggles or glasses. 100% cotton is preferable.
- Shut and unlock all house windows and doors
- Remove flammable window shades and close metal shutters
- Move furniture to the center of the room
- Shut off gas at the meter
- leave your lights on so firefighters can see your home
- Gather up flammable items from the exterior of the house and bring them inside (patio furniture, children's toys, door mats, etc.) or place them in your pool
- Turn off propane tanks
- Locate your pets and keep them nearby

IF PEOPLE STAY HOME FOR THE FIRE:
- this is not recommended, but people must be prepared for this situation

Before the Fire Approaches
- Dress all members of the household in adequate clothing and protecting eyes, head, and hands
- Let family or friends know that you are staying at home
- Locate your **Survival Kit**
- Remove flammable items from the exterior of the house

- fill gutters with water
- water down your house but do not use all of your water
- Shut all windows and doors and place wet blankets and towels around windows and door edges
- Prepare inside your house (e.g. remove curtains, move furniture away from windows, close doors & windows)
- Open the gate to your property
- Stay close to the house!!
- **Alert the authorities** by telephone as soon as smoke is visible and give them your location

As the fire front arrives:
- make sure people are adequately clothed; Do not wear synthetic fabrics as they can melt!!
- Take all firefighting equipment inside such as hoses and pumps. People will need them after the fire has passed
- Move inside the house until the fire front passes, ensuring you have two exits from the house
- Patrol the inside of the home-including the ceiling space-for embers or small fires.
- Close shutters
- Block any ventilation openings
- Keep a flashlight handy
- Put damp sheets under doors and in others openings of the house

After the fire has passed:
- Make sure people are unharmed
- Call the fire department
- Go outside and extinguish small spot fires and burning embers
- Patrol the property inside and out, including the ceiling space, and extinguish any fires
- Water hot areas
- cut down any trees that may fall on your house
- Call your insurance company

All these very practical recommendations can be prioritized and organized in a fac-sheet as follows:

1. Fire restriction and prevention
2. Fire alert
3. Fire protection
    i. Creation of a defensible space
    ii. Hardening of the home
    iii. Constitution of water reserve
4. Emotional and physical preparation
5. Actions in the case of fire

References and hyperlinks to published results:

- Youssouf H, Liousse C, Roblou L, Assamoi EM, Salonen RO, Maesano C, Banerjee S, Annesi-Maesano I on behalf of the Phase Study. Quantifying wildfires exposure for investigating related-health effects. Atm Env (in press).