



# Zagađenje zraka i utjecaji na javno zdravlje

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# Sažetak

- Uvod
- Međunarodne procjene utjecaja zagađenja zraka
- Državni standardi U.S. EPA za kvalitet zraka (NAAQS)
  - Opšte informacije o utjecajima specifičnih zagađujućih materija na zdravlje
- Program U.S. EPA o zagađujućim materijama u zraku
- Obavješćavanje javnosti U.S. EPA o zdravlju i dijeljenje informacija
- Dodatni resursi



# Zagađenje zraka ima značajnu historiju



Donora, PA – 1948



London – 1952



New York City – 1966



Los Angeles – 1988



Grand Canyon National Park



Great Smoky Mountains National Park

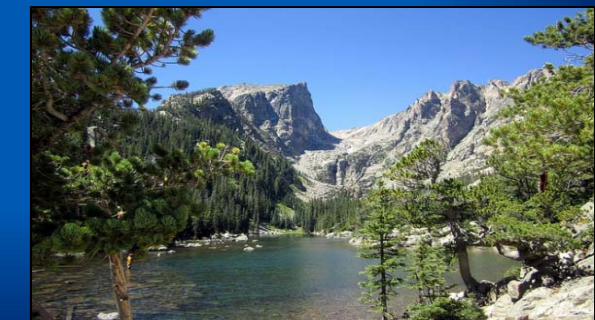
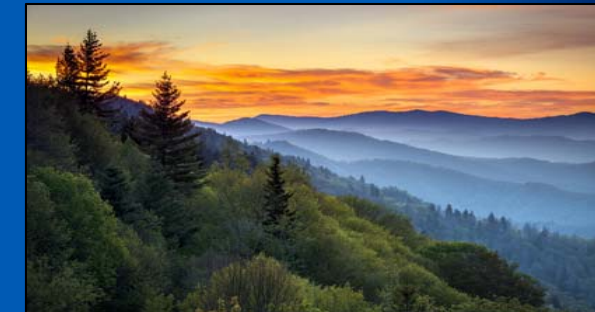


Rocky Mountain National Park

**Događaji koji su imali posljedice po zdravlje,  
a o kojima se dosta raspravljalo**

**Utjecaji na dobrobit javnosti**

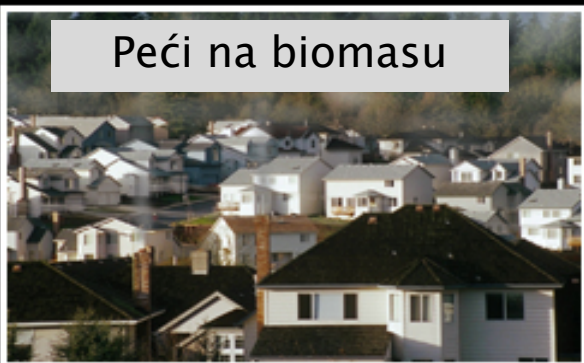
# ...značajni su i rezultati mjera poduzetih nakon tih događaja



**Nova era– mjesta za život, rad i igru**

# Izvori zagađenja zraka su različiti - par primjera...

Peći na biomasu



Termoelektrane



Dizel motori



Prirodni izvori



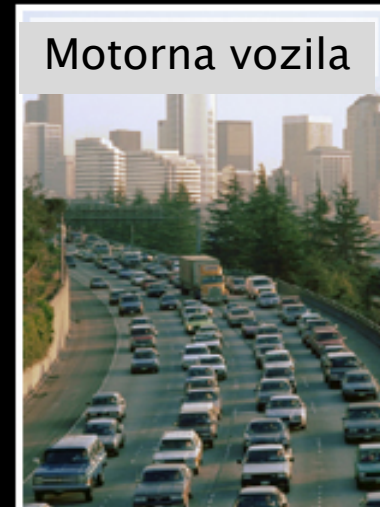
Rudnici



Boje i rastvarači



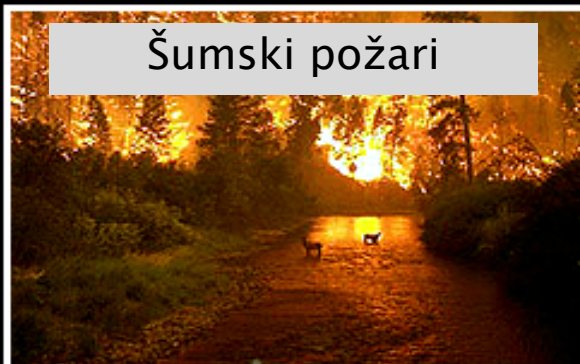
Motorna vozila



Vozila izvan puteva



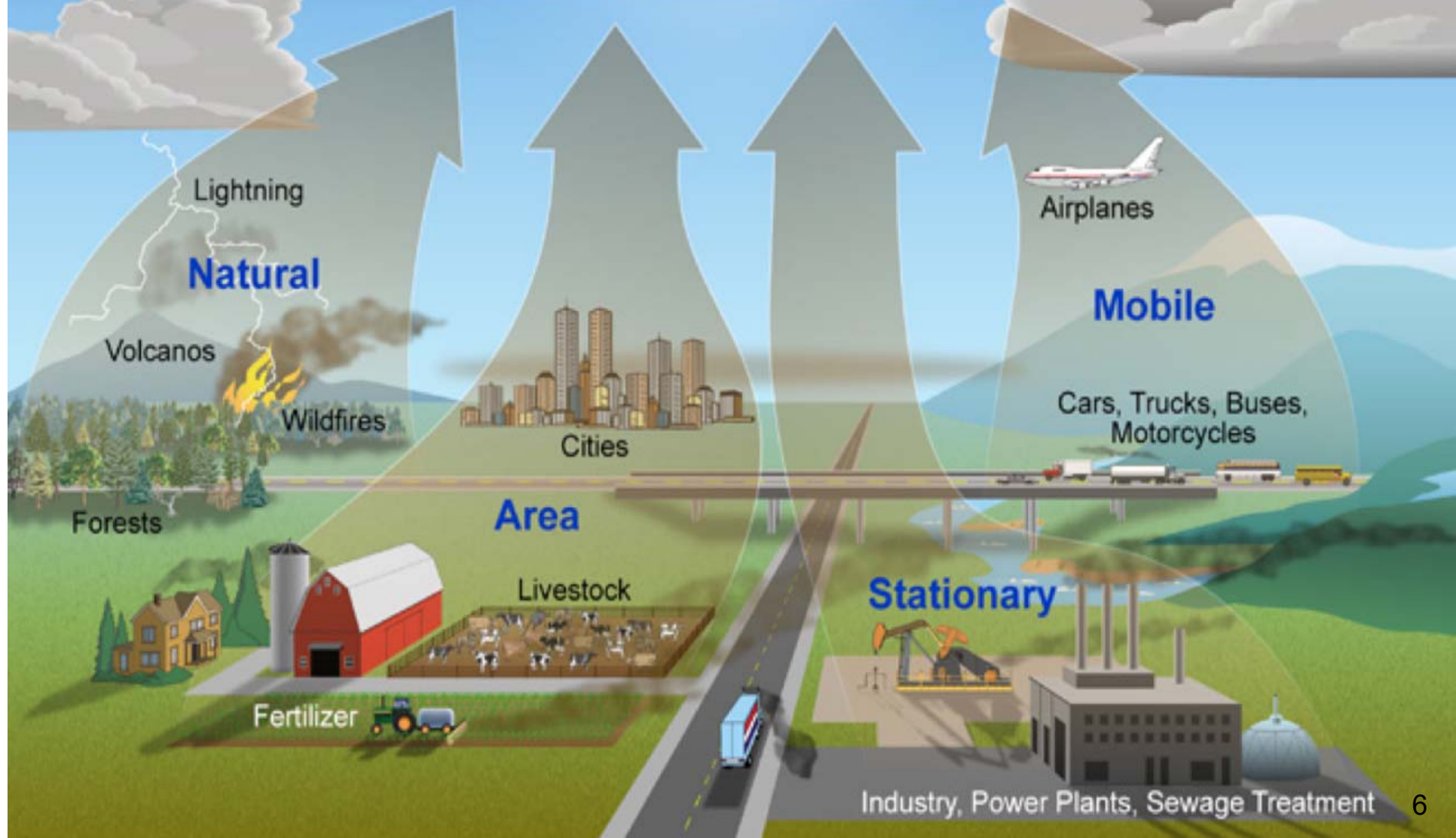
Šumski požari



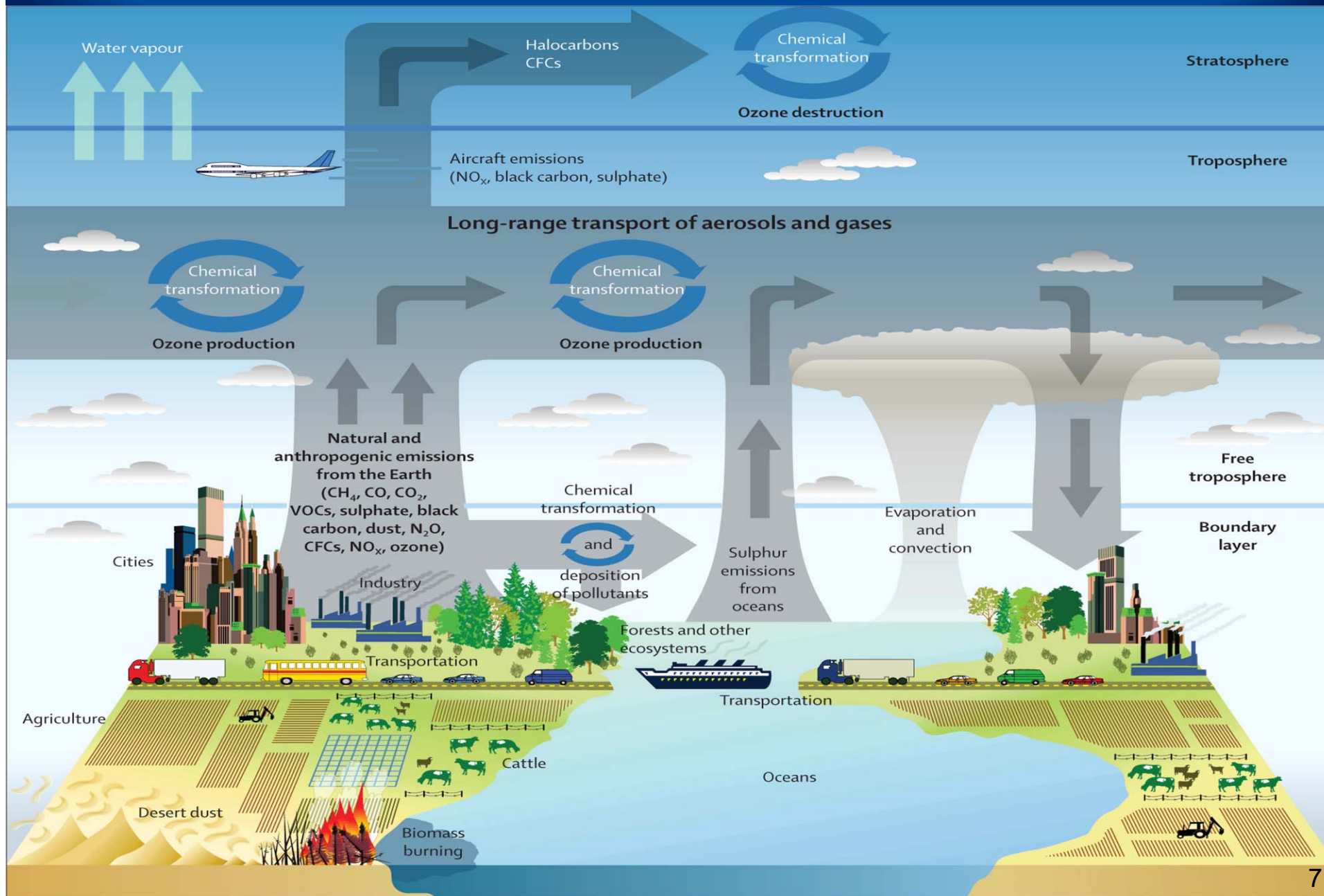
Industrijski izvori



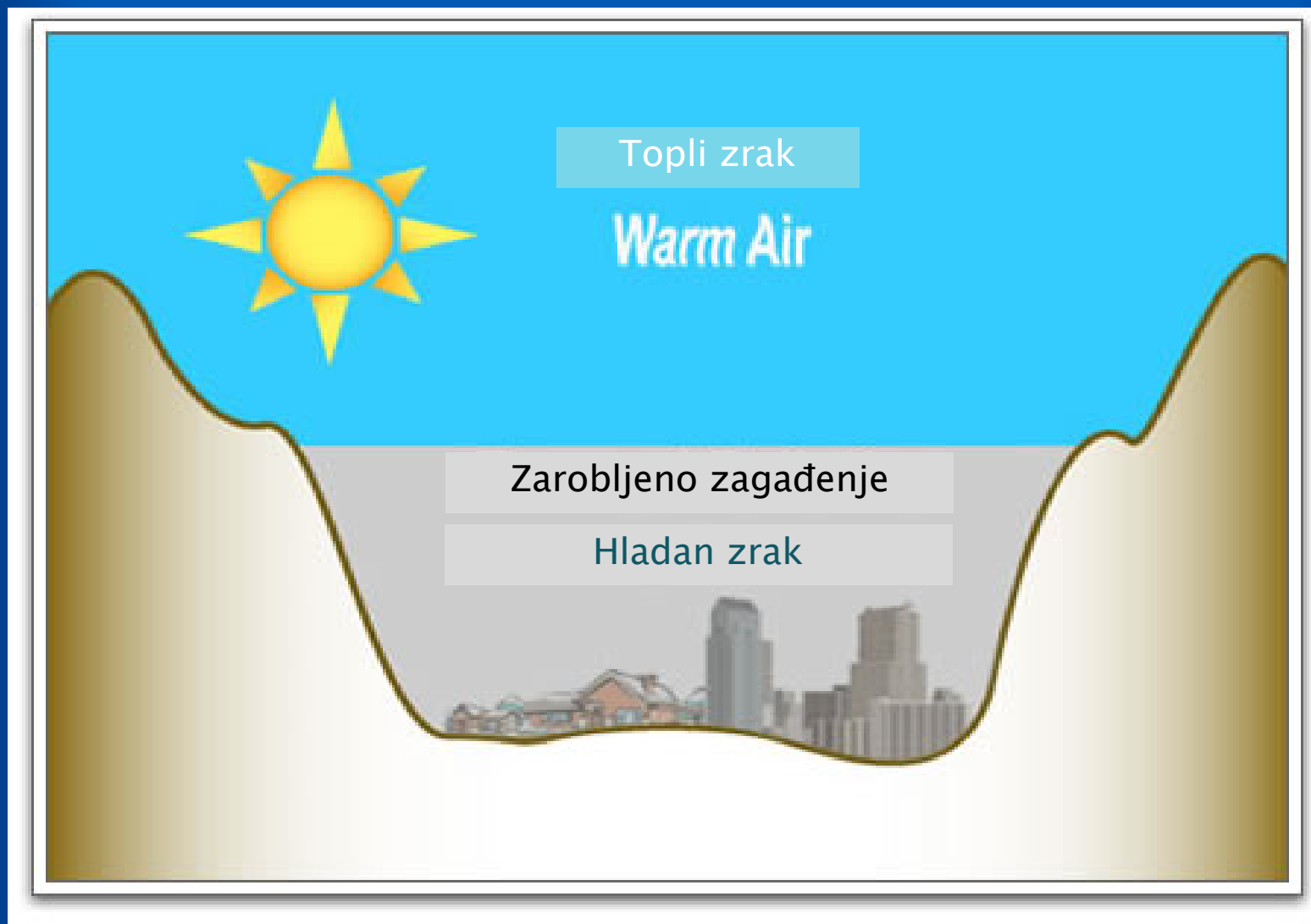
# Pollutant Emissions



# Složena mješavina primarnih i sekundarnih polutanata



# Temperaturne inverzije zimi: poseban problem u BiH





# Međunarodne procjene utjecaja zagađenja zraka

## The Lancet Commissions

### The Lancet Commission on pollution and health

Philip J Landrigan, Richard Fuller, Nereus J R Acosta, Olusoji Adeyi, Robert Arnold, Niladri (Nil) Basu, Abdoulaye Bibi Baldé, Roberto Bertollini, Stephan Bose-O'Reilly, Jo Ivey Boufford, Patrick N Breyse, Thomas Chiles, Chulabhorn Mahidol, Awa M Coll-Seck, Maureen L Cropper, Julius Fobil, Valentin Fuster, Michael Greenstone, Andy Haines, David Hanrahan, David Hunter, Mukesh Khare, Alan Krupnick, Bruce Lanphear, Bindu Lohani, Keith Martin, Karen V Mathiasen, Maureen A McTeer, Christopher J L Murray, Johanita D Ndahimananjara, Frederica Perera, Janez Potočnik, Alexander S Preker, Jairam Ramesh, Johan Rockström, Carlos Salinas, Leona D Samson, Karti Sandilya, Peter D Sly, Kirk R Smith, Achim Steiner, Richard B Stewart, William A Suk, Onno C P van Schayck, Gautam N Yadama, Kandeh Yumkella, Ma Zhong



#### Executive summary

Pollution is the largest environmental cause of disease and premature death in the world today. Diseases caused by pollution were responsible for an estimated 9 million premature deaths in 2015—16% of all deaths worldwide—three times more deaths than from AIDS, tuberculosis, and malaria combined and 15 times more than from all wars and other forms of violence. In the most severely affected countries, pollution-related disease is responsible for more than one death in four.

Pollution endangers planetary health, destroys ecosystems, and is intimately linked to global climate change. Fuel combustion—fossil fuel combustion in high-income and middle-income countries and burning of biomass in low-income countries—accounts for 85% of airborne particulate pollution and for almost all pollution by oxides of sulphur and nitrogen. Fuel combustion is also a major source of the greenhouse gases and short-lived climate pollutants that drive climate change. Key emitters of carbon dioxide, such as electricity-generating plants,

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[http://dx.doi.org/10.1016/S0140-6736\(17\)32345-0](http://dx.doi.org/10.1016/S0140-6736(17)32345-0)  
See Online/Comment  
[http://dx.doi.org/10.1016/S0140-6736\(17\)32588-6](http://dx.doi.org/10.1016/S0140-6736(17)32588-6) and  
[http://dx.doi.org/10.1016/S0140-6736\(17\)32545-X](http://dx.doi.org/10.1016/S0140-6736(17)32545-X)  
Arnold Institute for Global Health (Prof P J Landrigan MD), Mount Sinai Health

Published online October 19, 2017

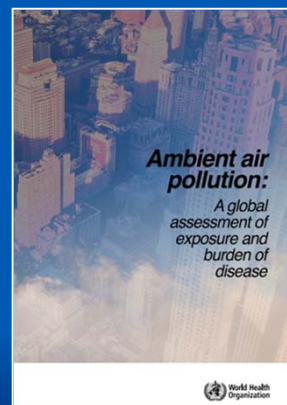
[http://dx.doi.org/10.1016/S0140-6736\(17\)32345-0](http://dx.doi.org/10.1016/S0140-6736(17)32345-0)

Svrha: "...da se poveća svijest javnosti o zagađenju, i zanemarivanju oboljenja vezanih za zagađenje, te mobilizacija resursa i političke volje neophodnih da se efikasno suprotstavimo zagađenju."

## Noviji izvještaji SZO:



[http://www.who.int/gho/publications/world\\_health\\_statistics/2017/en/](http://www.who.int/gho/publications/world_health_statistics/2017/en/)



<http://www.who.int/phe/publications/air-pollution-global-assessment/en/>

	GBD study best estimate (95% CI)	WHO best estimate (95% CI)
<b>Air (total)</b>	<b>6.5 (5.7-7.3)</b>	<b>6.5 (5.4-7.4)</b>
Household air	2.9 (2.2-3.6)	4.3 (3.7-4.8)
Ambient particulate	4.2 (3.7-4.8)	3.0 (3.7-4.8)
Ambient ozone	0.3 (0.1-0.4)	..
<b>Water (total)</b>	<b>1.8 (1.4-2.2)</b>	<b>0.8 (0.7-1.0)</b>
Unsafe sanitation	0.8 (0.7-0.9)	0.3 (0.1-0.4)
Unsafe source	1.3 (1.0-1.4)	0.5 (0.2-0.7)
Occupational	0.8 (0.8-0.9)	0.4 (0.3-0.4)
Carcinogens	0.5 (0.5-0.5)	0.1 (0.1-0.1)
Particulates	0.4 (0.3-0.4)	0.2 (0.2-0.3)
Soil, heavy metals, and chemicals	0.5 (0.2-0.8)	0.7 (0.2-0.8)
Lead	0.5 (0.2-0.8)	0.7 (0.2-0.8)
<b>Total</b>	<b>9.0</b>	<b>8.4</b>

Note that the totals for air pollution, water pollution, and all pollution are less than the arithmetic sum of the individual risk factors within each of these categories because these have overlapping contributions—eg, household air pollution also contributes to ambient air pollution and vice versa.

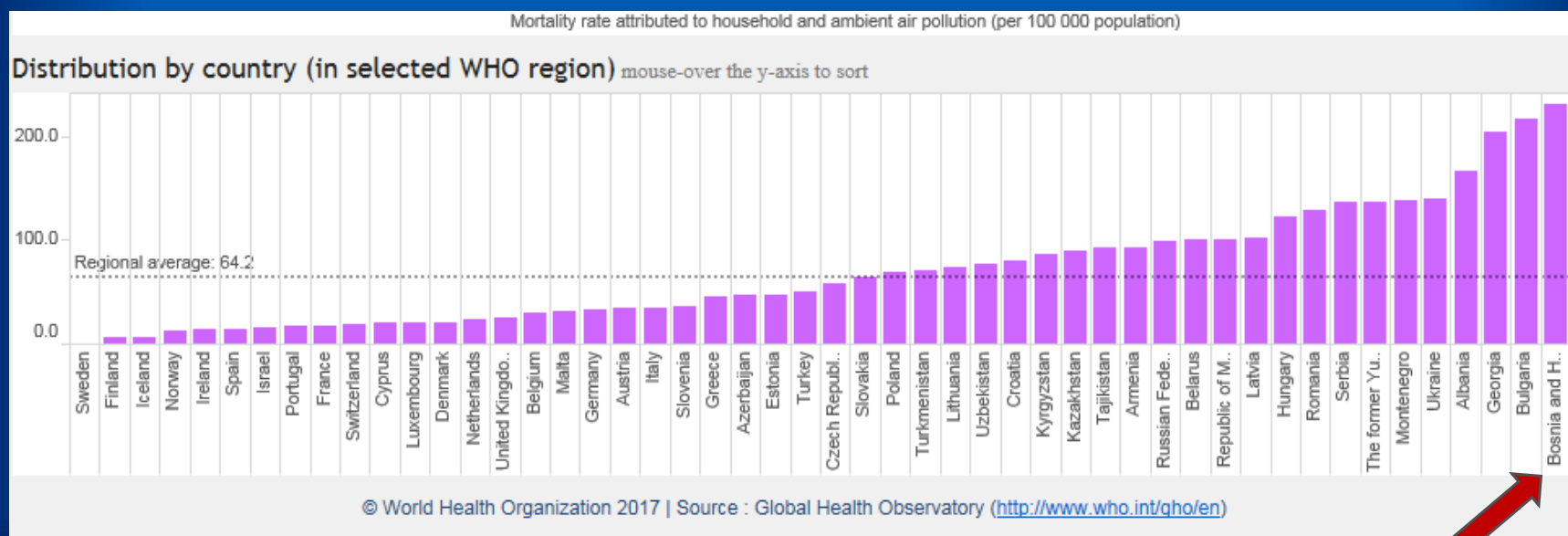
Table 1: Global estimated deaths (millions) due to pollution risk factors from the Global Burden of Disease study (GBD; 2015)<sup>a</sup> versus WHO data (2012)<sup>b</sup>

Najveći doprinos broju umrlih zbog zagađenja je od zagađenja zraka

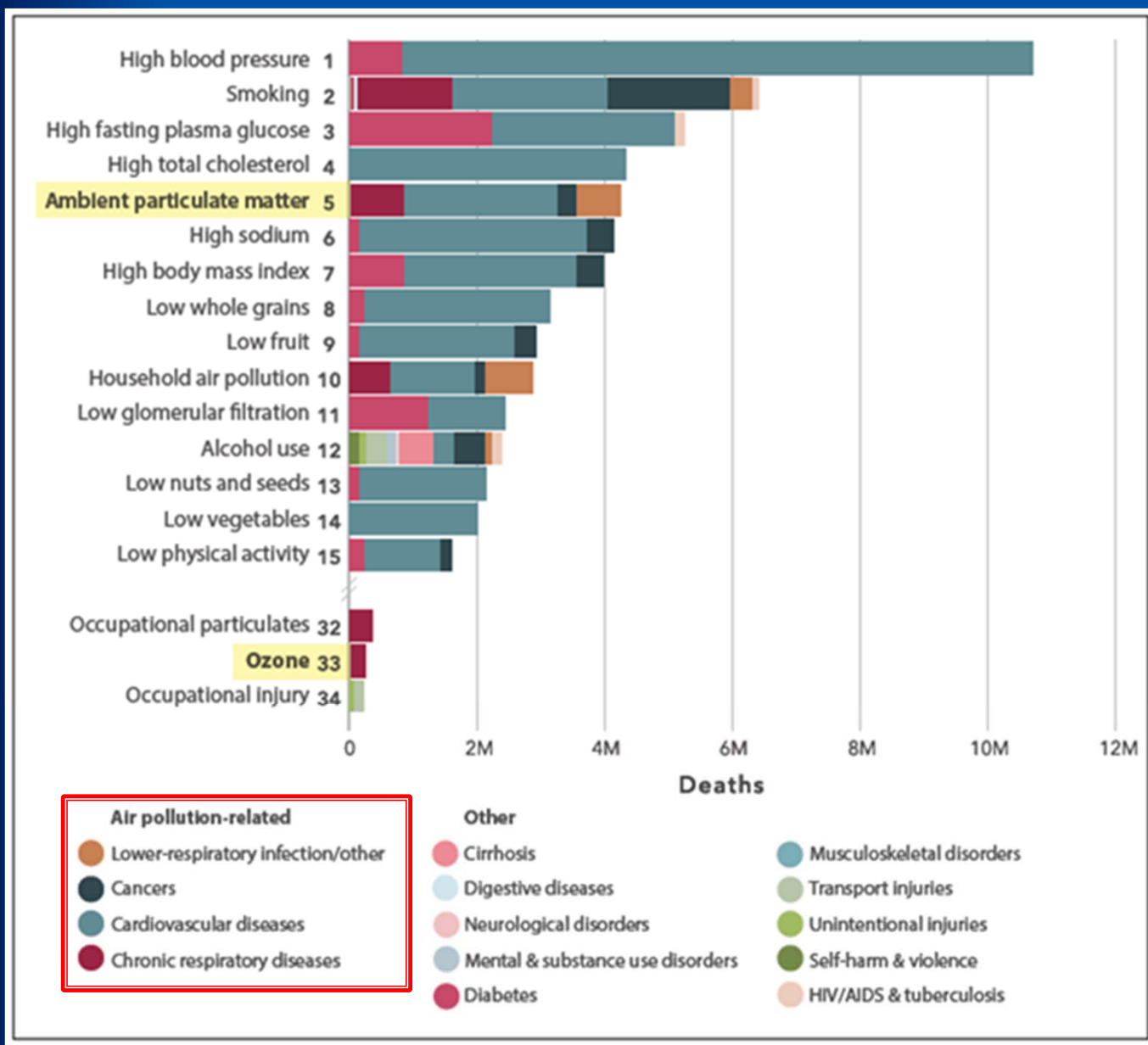
# Procjene SZO o mortalitetu - 2012

Država	Mortalitet zbog zagađenja zraka (u zatvorenim i otvorenim prostorima), broj umrlih na 100.000 ljudi
Bosna i Hercegovina	231*
SAD	12.1
Švedska	0.4

Više informacija dostupno na: [http://www.who.int/gho/phe/outdoor\\_air\\_pollution/en/](http://www.who.int/gho/phe/outdoor_air_pollution/en/)

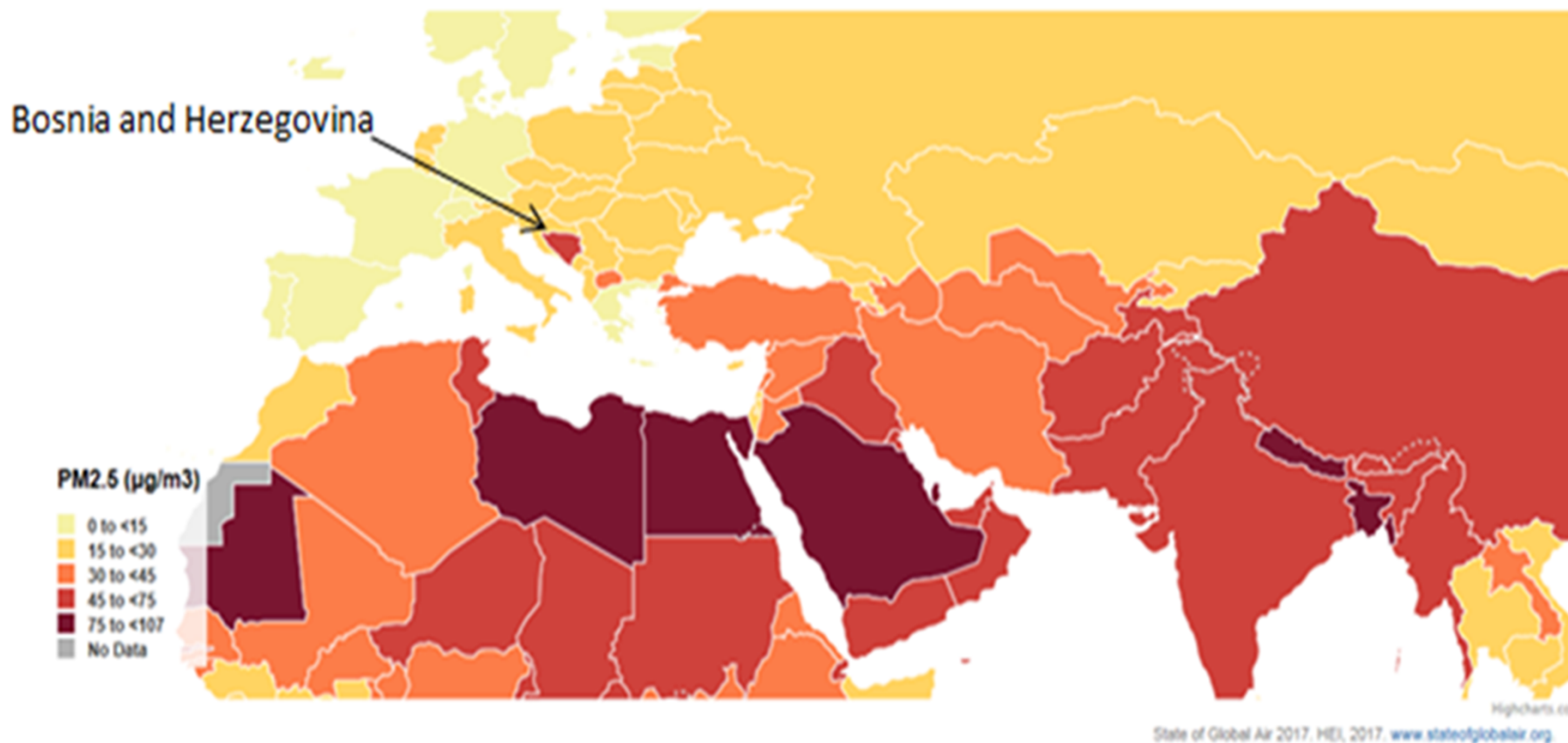


# Globalni teret oboljenja – 2015



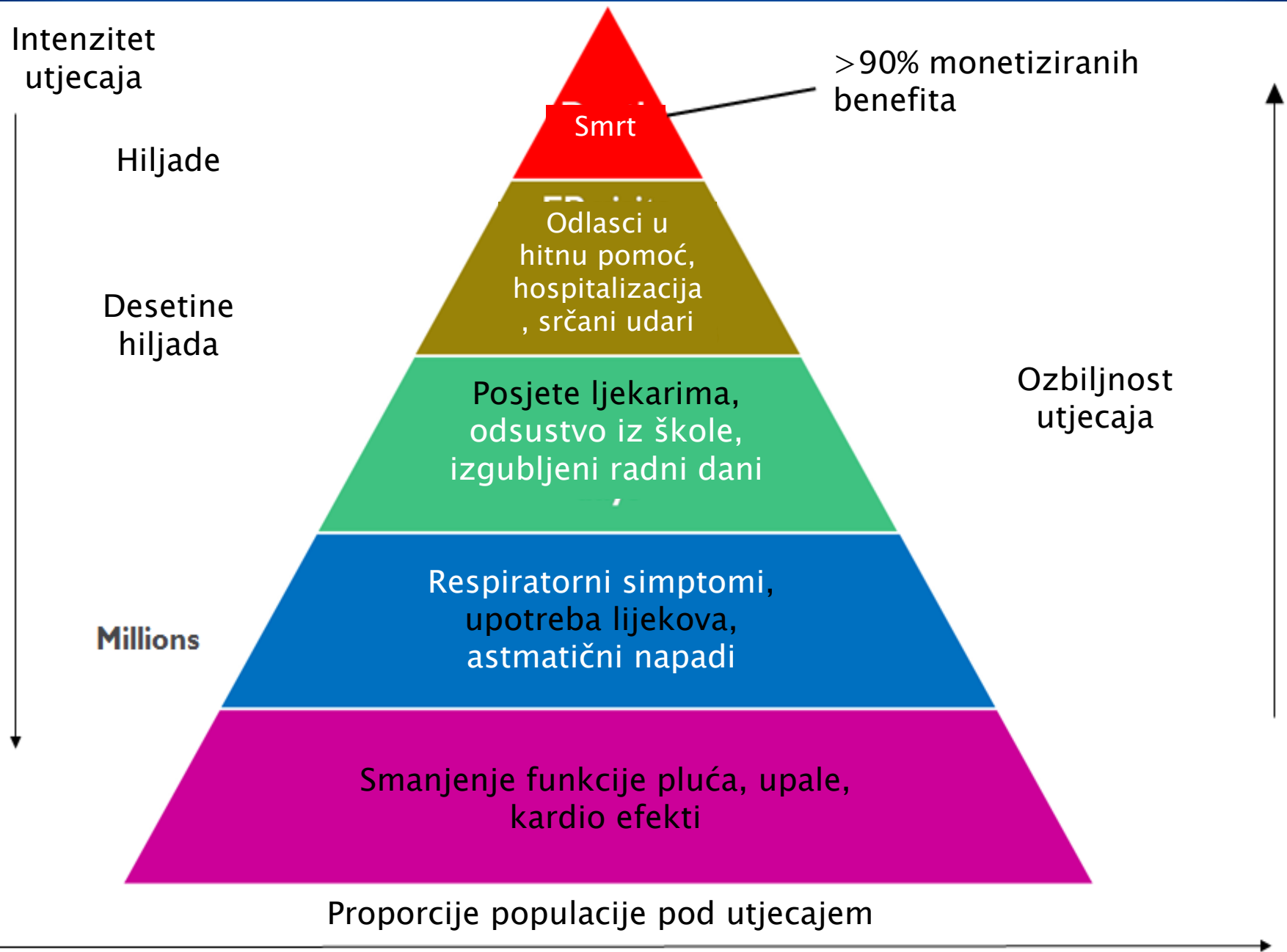
Izvor podataka: GBD Globalno rangiranje faktora rizika za ukupnu smrtnost od svih uzroka za sve starosne skupine i oba pola za 2015. godinu. Izvor: Health Effects Institute, 2017. [State of Global Air 2017](#). Special Report, Figure 1.

# Godišnji prosjek koncentracija PM<sub>2.5</sub> po broju stanovnika u 2015



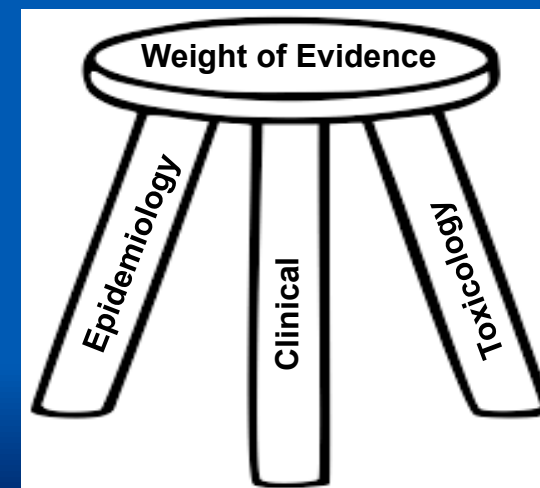
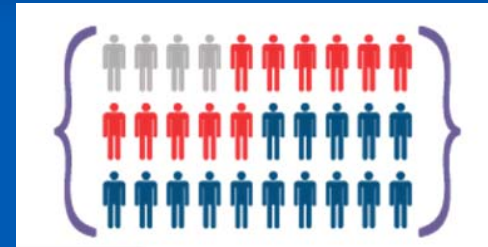
Izvor podataka: [State of Global Air 2017](http://www.stateofglobalair.org)

# “Piramida efekata” vezanih za izloženost zagađenju zraka



# Tipovi of zdravstvenih dokaza

- Epidemiološke/terenske panel studije
  - Izloženosti iz stvarnog svijeta
  - Može obuhvaćati osjetljive grupe
  - Procjene za budućnost (gledajući unaprijed) ili retrospektivne procjene (gledajući izloženosti iz prošlosti)
  - Potencijalni drugi uzroci (drugi faktori rizika) koje treba uzeti u obzir
- Kontrolisane studije izloženosti ljudi
  - Generalno kontrolirane izloženosti i mogući uzroci
  - Obično ograničene na zdrave osobe
- Životinjske/*in vitro* toksikološke studije
  - Visoke doze
  - Ekstrapolacija (relevantnost) na ljude



# Od U.S. EPA se tražilo uspostavljanje primarnih i sekundarnih državnih standarda za kvalitet zraka (NAAQS) po Zakonu o zaštiti zraka



## Primarni standardi: zasnovani na zdravlju

- Uzima u obzir populacije koje bi mogle biti pod većim rizikom
- U "procjeni Administratora" je "neophodni" nivo zaštite javnog zdravlja sa "adekvatnom granicom sigurnosti"



## Sekundarni standardi: zasnovani na dobrobiti

- Sadrže efekte na zemljište, vodu, usjeve, vegetaciju, vještačke materijale, domaće i divlje životinje, vremenske uvjete, vidljivost i klimu
- U "procjeni Administratora" je "neophodni" nivo zaštite javne dobrobiti od bilo kojih poznatih ili očekivanih neželjenih dejstava"

- Zakon o zaštiti zraka ne dopušta razatranje troškova u postavljanju NAAQS
  - Ipak, troškovi se mogu uračunati kod implementacije NAAQS

# Polutanti koji se koriste kao kriteriji

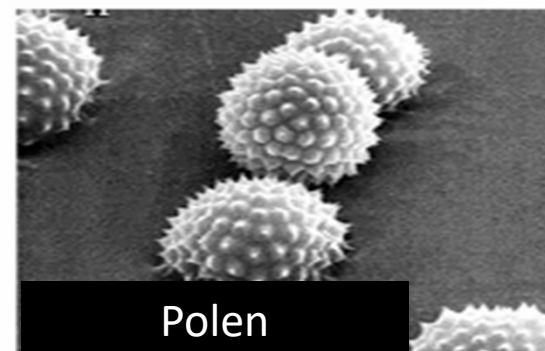
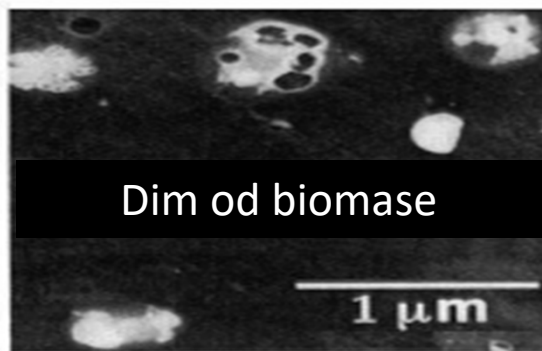
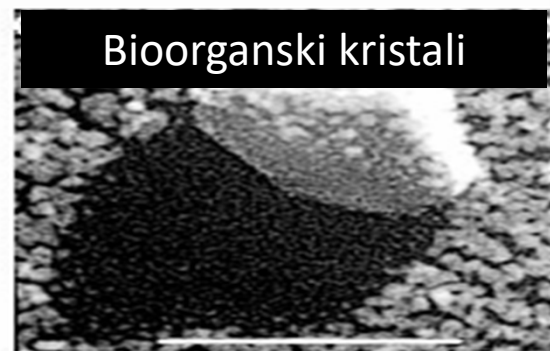
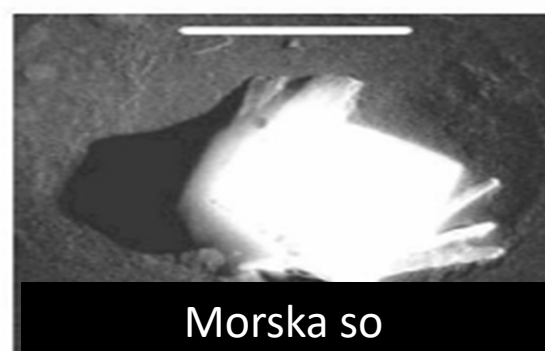
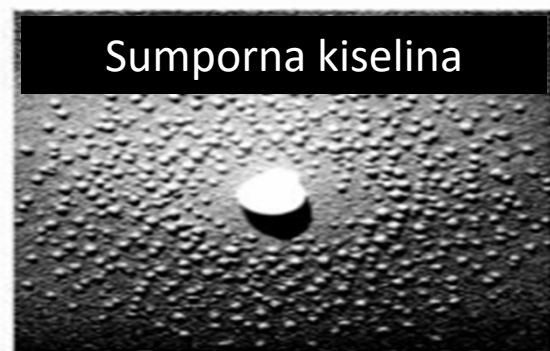
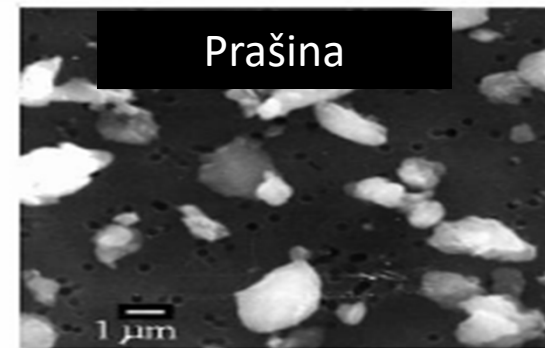
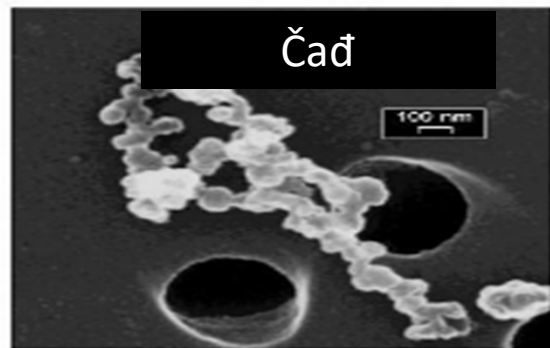
Po Zakonu o zaštiti zraka, U.S. EPA je postavila set državnih standarda za ambijentalni zrak (NAAQS) za šest uobičajenih "kriterijskih polutanata":

- Prašina (PM)
- Ozon ( $O_3$ )
- Sumpor dioksid ( $SO_2$ )
- Azotni dioksid ( $NO_2$ )
- Ugljen monoksid (CO)
- Olovo (Pb)





# Čestice se javljaju u raznim oblicima i veličinama



PM je složena mješavina čvrstih, poluisparljivih i tečnih materijala raznih veličina koji se javljaju u zraku

# Šta je prašina (Particulate Matter - PM)?

## Fine čestice prašine

*Sagorijevanje, od gasova do čestica*

- Sulfati/kiseline
- Nitrati
- Amonijak
- Organski spojevi
- Ugljik
- Metali
- Voda



### Izvori:

- Sagorijevanje uglja, nafte, benzina, dizela, drveta
- Transformacija SO<sub>x</sub>, NO<sub>x</sub>, organskih gasova
- Industrijski procesi sa visokom temperaturom (topionice, željezare)
- Šumski požari



### Izloženost/životni vijek:

Traju od nekoliko dana do nekoliko sedmica, prostorno rasprostiranje od granica naseljenih mjesta do više hiljada km

## Krupne čestice prašine

*Drobljenje, brušenje, prah*

- Resuspended dusts (blato, ulična prašina)
- Pepeo uglja/nafte
- Aluminijski oksidi, silicij, oksidi željeza
- Habanje guma i kočnica
- Biološki materijali, npr. blato i dijelovi biljaka

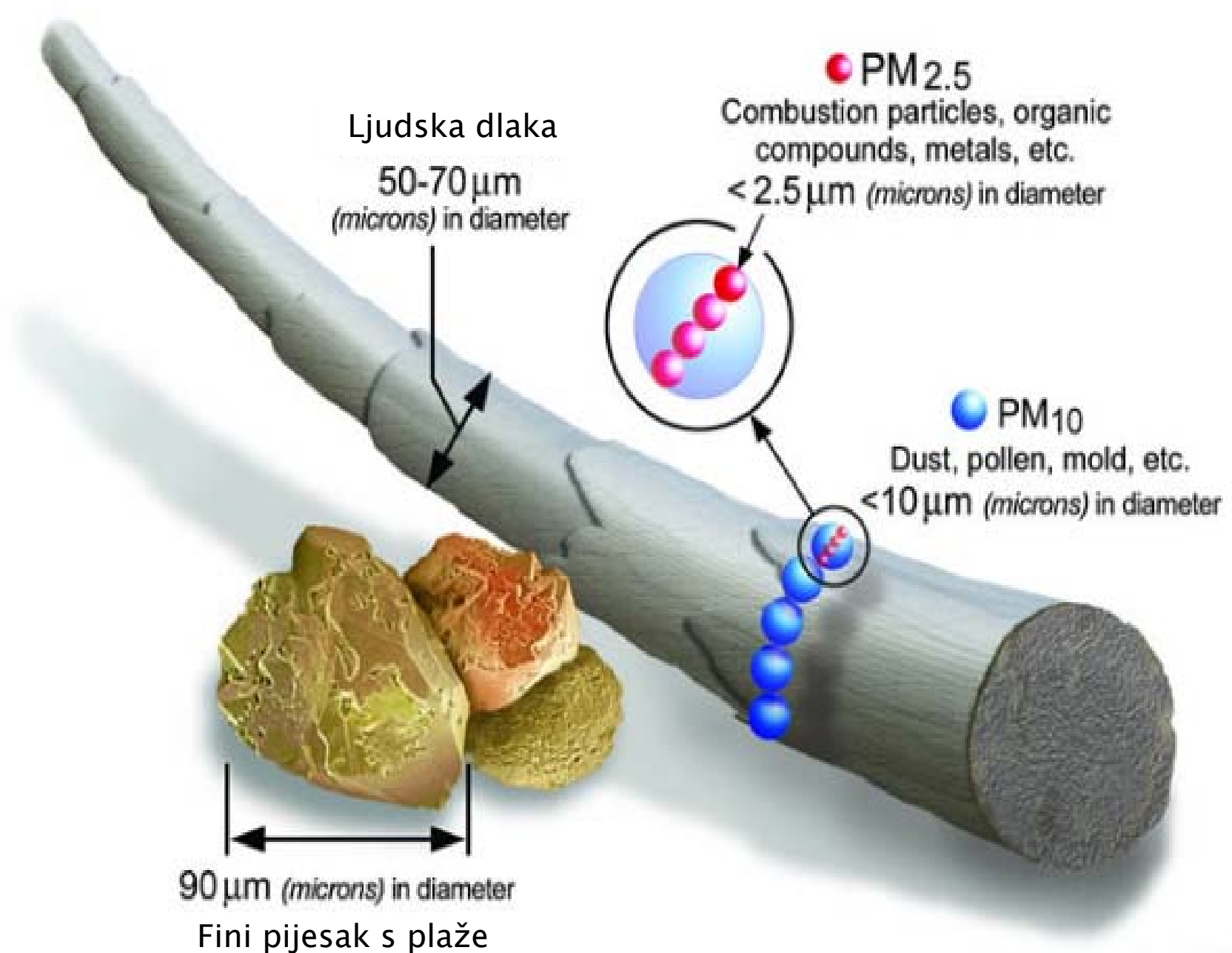


### Izvori:

- Resuspenzija drumske prašine
- Suspenzija sa zemljanih radova (farme, rudnici, makadamski putevi)
- Gradnja/rušenje objekata
- Industrijske fugitivne emisije
- Biološki izvori

### Izloženost/životni vijek:

- Krupne frakcije (2.5-10) opstaju od nekoliko sati do nekoliko dana, distribucija do par stotina km



Ljudska dlaka  
50-70 μm  
(microns) in diameter

● PM<sub>2.5</sub>  
Combustion particles, organic  
compounds, metals, etc.  
<2.5 μm (microns) in diameter

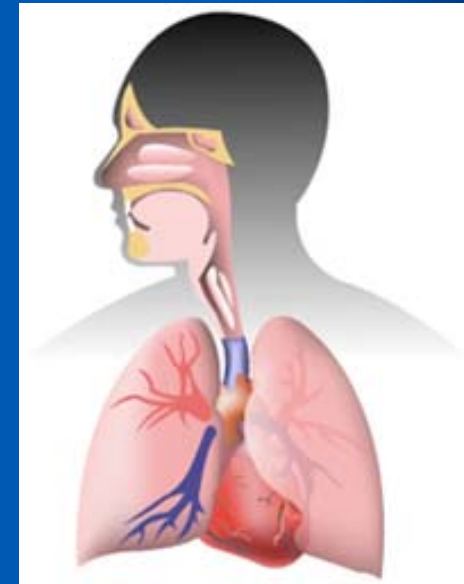
● PM<sub>10</sub>  
Dust, pollen, mold, etc.  
<10 μm (microns) in diameter

90 μm (microns) in diameter  
Fini pijesak s plaže

Image courtesy of the U.S. EPA

# Šta se dešava kad udahnete PM?

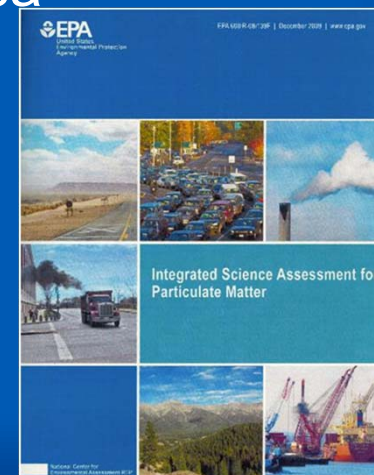
- Vće čestice ( $> PM_{10}$ ) se nakupljaju u gornjem respiratornom traktu
- *Manje čestice, koje se udišu ( $\leq PM_{10}$ ) prodiru duboko u pluća i tamo ostaju (lijepo se) ili se izdahnu*



- I gruba  $PM_{10-2.5}$  i fina prašina  $PM_{2.5}$  može prodrijeti u donji dio pluća
- Nataložene čestice se mogu akumulirati, stupati u reakcije, razrijediti se ili se apsorbovati

# Utjecaji na zdravlje vezani za prašinu

- Uz prašinu se vežu ozbiljne zdravstvene posljedice, poput:
  - Srčanih udara i infarkta
  - Teške astme, hroničnog bronhitisa i drugih respiratornih efekata
  - Preuranjene smrti
- Populacije pod povećanim rizikom obuhvataju djecu, starije osobe i ljude s prethodno dijagnosticiranim oboljenjima krvnih sudova i pluća, osobe nižeg socijalnog statusa



<https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter>

# Interventna studija

## Štrajk željezaraca iz Utah Valley (1985-87)

Geneva Steel

82% industrijskih emisija dok je radila  
47- 80% ukupnih emisija

Spaljivanje drveta

16%

Drumska prašina

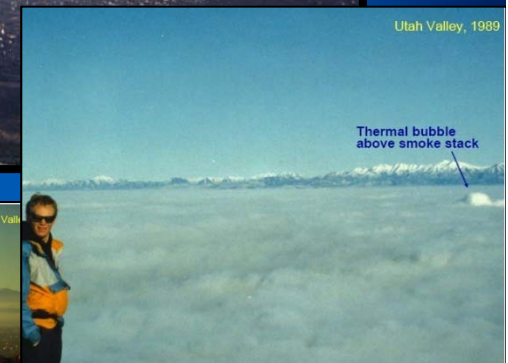
11%

Dizelska goriva

7%

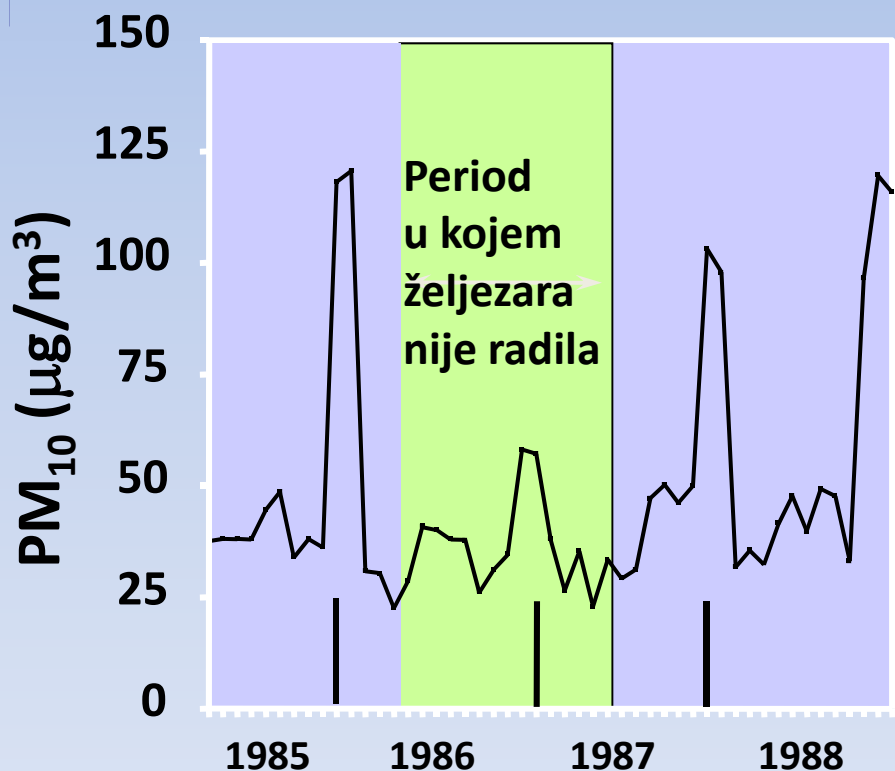
Sagorijevanje nafte

7%

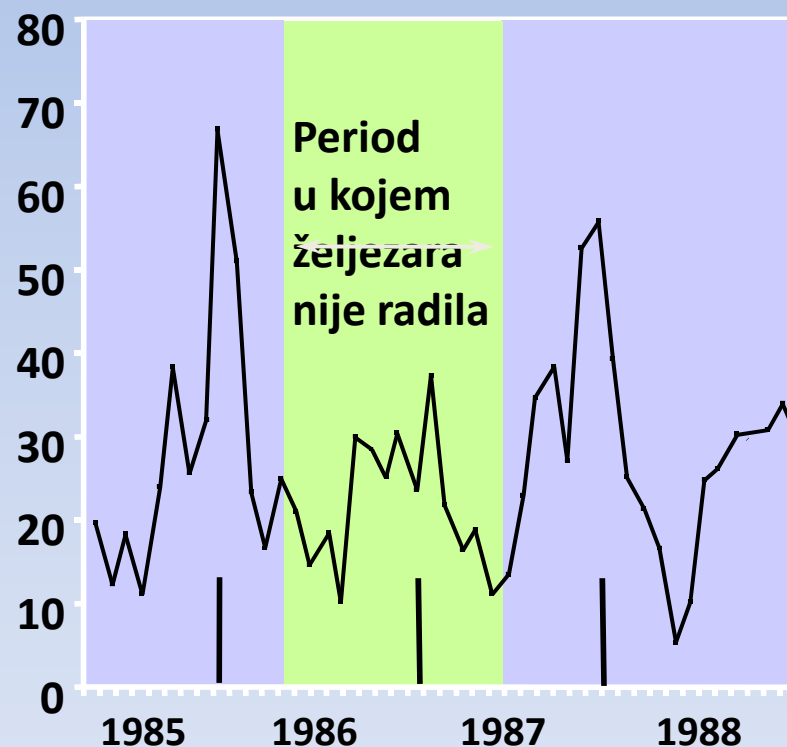


# Koncentracije PM<sub>10</sub> su u korelaciji sa brojem hospitaliziranih zbog respiratornih problema

Koncentracije PM<sub>10</sub>, lokacija Lindon

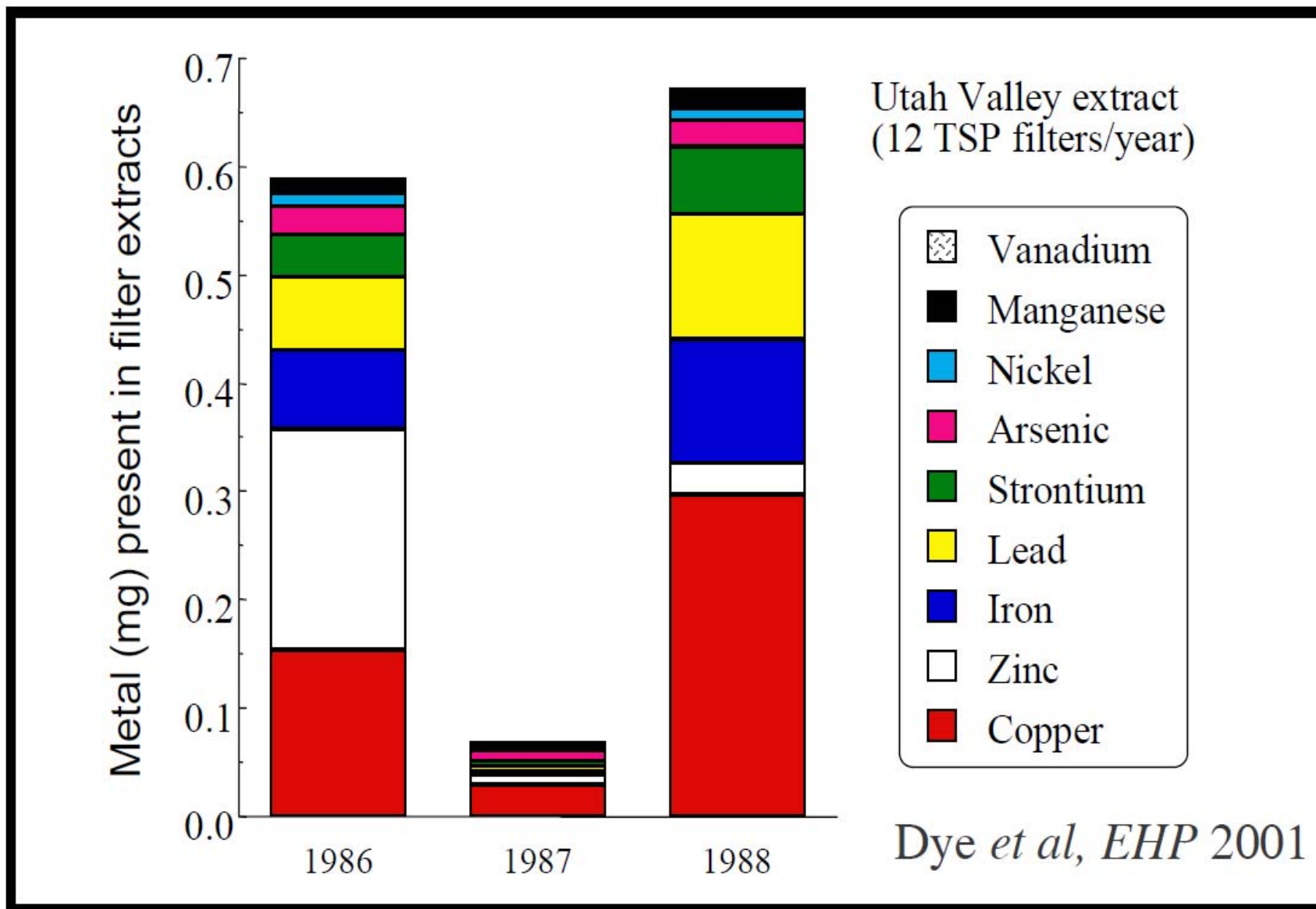


Broj hospitaliziranih sa Bronhiolitom i astmom mjesečno: sve starosne skupine



*Pope, Am J Public Health 79:623, 1989*

# Analiza metala u ekstraktu filtera iz Utah Valley








Eksperimentalni dokaz bioloških efekata prašine nakupljene u filterima (Ghio, Kennedy, Frampton, Costa, Dye, Devlin et al. 1998-2004)

- Akutna oštećenja disajnih puteva i upale kod pacova i kod ljudi
- *In vitro* oksidativni stres i ispuštanje proupalnih medijatora od strane uzgojenih respiratornih epitelnih ćelija
- Diferencijalne toksičnosti PM dok je fabrika radila, za razliku od perioda kad jeste (sadržaji metala i mješavine?)

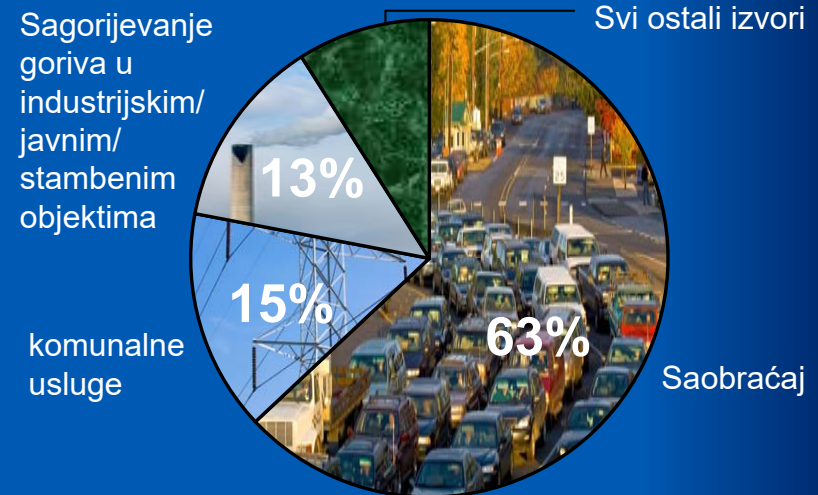
Pope, 2009; presentation for U.S National Ambient Air Monitoring [conference](#); *Evaluating the Human Health Costs of Air Pollution: Critical Joint Roles of Air Monitoring and Epidemiology*

# Ozon

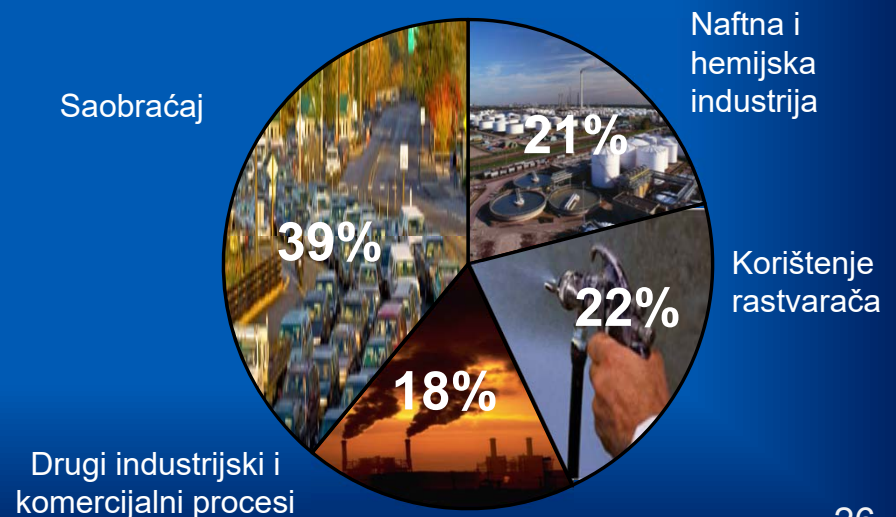
- Nastaje iz hemijskih reakcija u atmosferi od azotnih oksida (NOx) i volatilnih organskih spojeva (VOC), u prisustvu sunčeve svjetlosti 
- Najčešće je povišen tokom vrućih ljetnih mjeseci
- Ali, u dijelovima zapadnih SAD s visokim lokalnim emisijama VOC i NOx, ozon se formira kad je tlo prekriveno snijegom
- Nije samo gradski polutant: ozon, i polutanti od kojih nastaje, mogu se prenositi na velike udaljenosti, što dovodi do povećanih koncentracija ozona čak i u ruralnim područjima

## U S.A.D.

### Izvori NOx



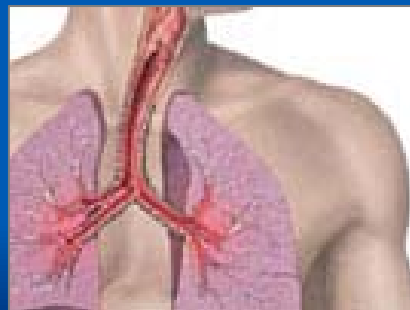
### Izvori VOC



# Efekti ozona na zdravlje (1)

## Veliki broj naučnih dokaza pokazuje da ozon:

- Izaziva kašalj i upaljeno grlo ili osjećaj peckanja u disajnim organima
- Smanjuje funkciju pluća, čime se otežava duboko disanje
- Oštećuje i izaziva upale disajnih puteva
- Pogoršava bolesti pluća, uključujući astmu, emfizem i bronhitis
- Povećava učestalost i intenzitet astmatičnih napada
- Ponavljajuća oštećenja pluća od ozona pluća osoba u razvoju mogu utjecati na djecu u odraslom dobu, izazivajući permanentno smanjenje funkcije pluća, i vjerovatno je jedan od brojnih uzroka razvoja astme



U.S. EPA, 2013  
<https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492>

# Efekti ozona na zdravlje (2)

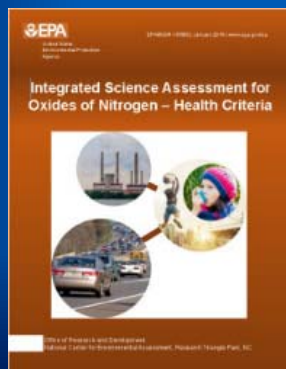
## Ovi efekti mogu dovesti do:

- Povećanog unosa lijekova kod astmatičara
  - Češće posjete ljekaru
  - Više propuštanja odlaska u školu
  - Više odsustvovanja s posla
  - Više obraćanja hitnoj pomoći i bolnici
  - Povećan rizik od prerane smrti
- Populacije pod većim rizikom obuhvaćaju djecu, starije osobe, astmatičare, radnike koji rade vani, te osobe koje su ranije imale zdravstvene smetnje

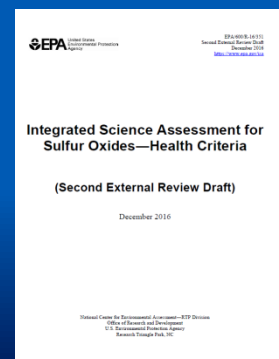


# Sumpor dioksid i azotni dioksid

- **Sumpor dioksid (SO<sub>2</sub>) i azotni dioksid (NO<sub>2</sub>)** su visoko reaktivni gasovi
  - NO<sub>2</sub> doprinosi formiranju prizemnog ozona a NO<sub>2</sub> i SO<sub>2</sub> doprinose formiranju prašine (PM)
  - Primarni izvori SO<sub>2</sub> su termoelektrane i druga industrijska postrojenja
  - Primarni izvori NO<sub>2</sub> su motorna vozila i termoelektrane
- I NO<sub>2</sub> i SO<sub>2</sub> se povezuju sa raznim efektima na respiratorni sistem
  - NO<sub>2</sub>: Pogoršanje simptoma astme; doprinosi razvoju astme
  - SO<sub>2</sub>: Smanjenje funkcije pluća i respiratornih simptoma
- Astmatičari su izloženi povećanom riziku

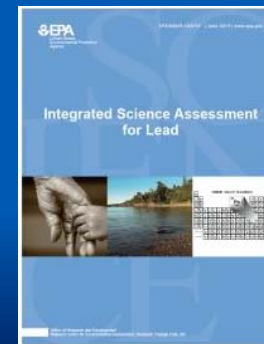


<https://www.epa.gov/isa>



# Ugljen monoksid i olovo

- **Ugljen monoksid (CO)** je gas bez boje i mirisa, koji nastaje iz procesa sagorijevanja, uključujući i motorna vozila
- CO može dovesti do štetnih posljedica po zdravlje smanjivanjem dotoka kisika u ljudske organe (kao što su srce ili mozak) i tkiva. Kod jako visokih koncentracija, CO može imati i smrtne posljedice.
- **Olovo (Pb)** je jako toksičan metal za koji je poznato da je opasan po ljudsko zdravlje
  - Izloženost olovu može izazvati smanjenje kognitivne funkcije kod djece (koja se mjeri smanjenjem IQ, slabijim rezultatima u školi i slabijim rezultatima na funkcionalnim testovima)
  - Pored toga, izloženost olovu može dovesti do otežane koncentracije, povećanja razdražljivosti i hiperaktivnosti, a može dovesti i do poremećaja ponašanja kod djece i mladih



<https://www.epa.gov/isa>

# U.S EPA: Težine dokaza za određivanje stepena uzročnosti

- ▶ Uzročno
- ▶ Može imati uzročnu relaciju
- ▶ Koji ukazuju na, ali nedovoljno da izazovu, uzročnu relaciju
- ▶ Nedovoljno da izazove uzročnu relaciju
- ▶ Nije vjerovatno da izazove uzročnu relaciju



# U.S. EPA Uzročne odrednice za efekte na zdravlje u vezi s kriterijskim zagađivačima zraka (do oktobra 2017)

Za više informacija pogledati U.S. EPA Integrated Science Assessments (ISAs), dostupne na: <https://www.epa.gov/isa>

Kategorija izlaza	Izloženost	PM <sub>2.5</sub>	PM <sub>10-2.5</sub>	O <sub>3</sub>	NO <sub>2</sub>	SO <sub>2</sub>	CO
<b>Kardiovaskularni morbiditet</b>	Kratkoročna	Uzročna	Ukazuje na	Moguća uzročna	Ukazuje na	Nedovoljna	Moguća uzročna
<b>Respiratorni morbiditet</b>	Kratkoročna	Moguća uzročna	Ukazuje na	Uzročna	Uzročna	Uzročna	Ukazuje na
<b>Mortalitet</b>	Kratkoročna	Uzročna	Ukazuje na	Moguća uzročna	Ukazuje na	Ukazuje na	Ukazuje na
<b>Kardiovaskularni morbiditet</b>	Dugoročna	Uzročna	Nedovoljna	Ukazuje na	Ukazuje na	Nedovoljna	Nedovoljna
<b>Respiratorni morbiditet</b>	Dugoročna	Moguća uzročna	Nedovoljna	Moguća uzročna	Moguća uzročna	Ukazuje na	Nedovoljna
<b>Reproduktivna/Razvojna</b>	Dugoročna	Ukazuje na	Nedovoljna	Ukazuje na	Ukazuje na smanjeni natalitet	Nedovoljna	Ukazuje na
					Nedovoljna za druge krajnje tačke		
<b>Smrtnost</b>	Dugoročna	Uzročna	Nedovoljna	Ukazuje na	Ukazuje na	Nedovoljna	Ukazuje na
<b>Rak</b>	Dugoročna	Ukazuje na	Nedovoljna	Nedovoljna	Ukazuje na	Nedovoljna	Neocijenjena



# Rezime U.S. EPA NAAQS\* (do oktobra 2017)

Polutant		Primarni/ Sekundarni	Period prosjeaka	Level	Form
Ugljen monoksid (CO)		primarni	8-sati	9 ppm	Ne smije se prekoračiti više od jednom godišnje
			1-sat	35 ppm	
Olvo (Pb)		primarni i sekundarni	3-mjeseca	0.15 µg/m <sup>3</sup>	Ne smije se prekoračiti
Azotni dioksid (NO <sub>2</sub> )		primarni	1-sat	100 ppb	98 <sup>th</sup> percentil 1-satnog dnevnog maksimuma koncentracija, u prosjeku tokom 3 godine
		primarni i sekundarni	Godišnje	53 ppb	Annual Mean
Ozon (O <sub>3</sub> )		primarni i sekundarni	8-sati	0.070 ppm	Godišnji četvrti najveći dnevni maksimum 8-satnih koncentracija, u prosjeku tokom 3 godine
Prašina (PM)	PM <sub>2.5</sub>	primarni	Godišnje	12 µg/m <sup>3</sup>	Godišnji prosjek, u prosjeku tokom 3 godine
		sekundarni	Godišnje	15 µg/m <sup>3</sup>	Godišnji prosjek, u prosjeku tokom 3 godine
		primarni i sekundarni	24-sata	35 µg/m <sup>3</sup>	98 <sup>th</sup> percentil, u prosjeku tokom 3 godine
	PM <sub>10</sub>	primarni i sekundarni	24-sata	150 µg/m <sup>3</sup>	Ne smije se prekoračiti više od jednom godišnje u prosjeku tokom 3 godine
Sumpor dioksid (SO <sub>2</sub> )		primarni	1-sat	75 ppb	99 <sup>th</sup> percentil 1-satnog dnevnog maksimuma koncentracija, u prosjeku tokom 3 godine
		sekundarni	3-sata	0.5 ppm	Ne smije se prekoračiti više od jednom godišnje

\*Za više informacija, posjetite <https://www.epa.gov/criteria-air-pollutants/naaqs-table>

# Naučni konsenzus

- Naučne izjave *American Heart Association* (AHA) (2004 and 2010)
- Dokument stručnog konsenzusa *European Society of Cardiology* (2015)
- Zajednička izjava politike *European Respiratory Society/American Thoracic Society* (ERS/ATS) (2017)

**AHA Scientific Statement**

**Air Pollution and Cardiovascular Disease**  
A Statement for Healthcare Professionals From the Expert Panel on Population and Prevention Science of the American Heart Association

Robert D. Brook, MD; Barry Franklin, PhD, Chair; Wayne Cascio, MD; Yuling Hong, MD, PhD; George Howard, PhD; Michael Lipsett, MD; Russell Luepker, MD; Murray Mittleman, MD, ScD; Jonathan Samet, MD; Sidney C. Smith, Jr, MD; Ira Tager, MD

*Abstract*—Air pollution is a heterogeneous, complex mixture of gases, liquids, and particulate matter. Epidemiological studies have described systemic and cardiovascular policies at section, 2004;109

**AHA Scientific Statement**

**Particulate Matter Air Pollution and Cardiovascular Disease**  
An Update to the Scientific Statement From the American Heart Association


Robert D. Brook, MD, Chair; Sanjay Rajagopalan, MD; C. Arden Pope III, PhD; Jeffrey R. Brook, PhD; Aruni Bhatnagar, PhD, FAHA; Ana V. Diez-Roux, MD, PhD, MPH; Fernando Holguin, MD; Yuling Hong, MD, PhD, FAHA; Russell V. Luepker, MD, MS, FAHA; Murray A. Mittleman, MD, DrPH, FAHA; Annette Peters, PhD; David Siscovick, MD, MPH, FAHA; Sidney C. Smith, Jr, MD, FAHA; Laurie Whitsel, PhD; Joel D. Kaufman, MD, MPH; on behalf of the American Heart Association Council on Epidemiology and Prevention, Council on the Kidney in Cardiovascular Disease, and Council on Nutrition, Physical Activity and Metabolism

*Abstract*—In 2004, the first American Heart Association scientific statement on “Air Pollution and Cardiovascular Disease” concluded that exposure to particulate matter (PM) air pollution contributes to cardiovascular morbidity and mortality. In the interim, numerous studies have expanded our understanding of this association and further elucidated the physiological and molecular mechanisms involved. The main objective of this updated American Heart Association scientific statement is to provide a comprehensive review of the new evidence linking PM exposure with cardiovascular disease, with a specific focus on highlighting the clinical implications for researchers and healthcare providers. The writing group also sought to provide expert consensus opinions on many aspects of the current state of science and updated suggestions for areas of future research. On the basis of the findings of this review, several new conclusions were reached, including the following: Exposure to PM <2.5 μm in diameter (PM<sub>2.5</sub>) over a few hours to weeks can trigger cardiovascular disease-related mortality and nonfatal events; longer-term exposure (eg, a few years) increases the risk for cardiovascular mortality to an even greater extent than exposures over a few days and reduces life expectancy within more highly exposed segments of the population by several months to a few years; reductions in PM levels are associated with decreases in cardiovascular mortality within a time frame as short as a few years; and many credible pathological mechanisms have been elucidated that lend biological plausibility to these findings. It is the opinion of the writing group that the overall evidence is consistent with a causal relationship between PM<sub>2.5</sub> exposure and cardiovascular morbidity and mortality. This body of evidence has grown and been strengthened substantially since the first American Heart Association scientific statement was published. Finally, PM<sub>2.5</sub> exposure is deemed a modifiable factor that contributes to cardiovascular morbidity and mortality. (*Circulation*. 2010;121:2331-2378.)

<http://circ.ahajournals.org/content/109/21/2655>

<http://circ.ahajournals.org/content/121/21/2331>

European Heart Journal Advance Access published December 9, 2014

 European Heart Journal  
doi:10.1093/eurheartj/ehu458

**CURRENT OPINION**

**Expert position paper on air pollution and cardiovascular disease**

David E. Newby<sup>1</sup>, Pier M. Mannucci<sup>2</sup>, Grethe S. Tell<sup>3</sup>, Andrea A. Baccarelli<sup>4</sup>, Robert D. Brook<sup>5</sup>, Ken Donaldson<sup>6</sup>, Francesco Forastiere<sup>7</sup>, Massimo Franchini<sup>8</sup>, Oscar H. Franco<sup>9</sup>, Ian Graham<sup>10</sup>, Gerard Hoek<sup>11</sup>, Barbara Hoffmann<sup>12</sup>, Marc F. Hoylaerts<sup>13</sup>, Nino Künzli<sup>14,15</sup>, Nicholas Mills<sup>1</sup>, Juha Pekkanen<sup>16,17</sup>, Annette Peters<sup>18,19</sup>, Massimo F. Piepoli<sup>20</sup>, Sanjay Rajagopalan<sup>21</sup>, and Robert F. Storey<sup>22\*</sup>, on behalf of ESC Working Group on Thrombosis, European Association for Cardiovascular Prevention and Rehabilitation and ESC Heart Failure Association

<https://academic.oup.com/eurheartj/article/36/2/83/2293343>

## A joint ERS/ATS policy statement: what constitutes an adverse health effect of air pollution? An analytical framework

George D. Thurston<sup>1</sup>, Howard Kipen<sup>2</sup>, Isabella Annesi-Maesano<sup>3</sup>, John Balmes<sup>4,5</sup>, Robert D. Brook<sup>6</sup>, Kevin Cromar<sup>7</sup>, Sara De Matteis<sup>8</sup>, Francesco Forastiere<sup>9</sup>, Bertil Forsberg<sup>10</sup>, Mark W. Frampton<sup>11</sup>, Jonathan Grigg<sup>12</sup>, Dick Heederik<sup>13</sup>, Frank J. Kelly<sup>14</sup>, Nino Kuenzli<sup>15,16</sup>, Robert Laumbach<sup>2</sup>, Annette Peters<sup>17</sup>, Sanjay T. Rajagopalan<sup>18</sup>, David Rich<sup>19</sup>, Beate Ritz<sup>20</sup>, Jonathan M. Samet<sup>21</sup>, Thomas Sandstrom<sup>11</sup>, Torben Sigsgaard<sup>22</sup>, Jordi Sunyer<sup>23</sup> and Bert Brunekreef<sup>13,24</sup>

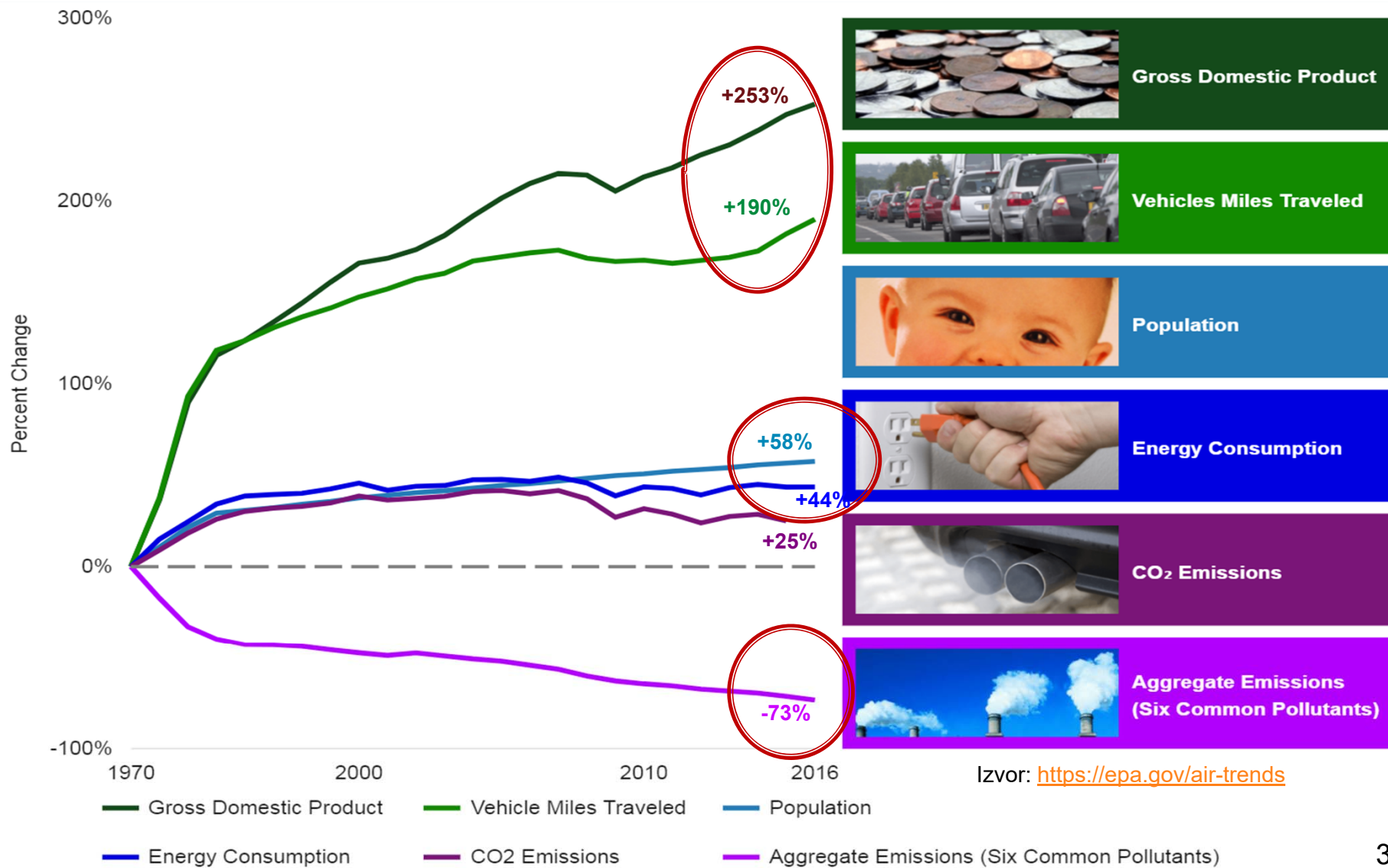
Thurston et al., Eur Respir J 2017; 49: 1600419

<http://erj.ersjournals.com/content/49/1/1600419>

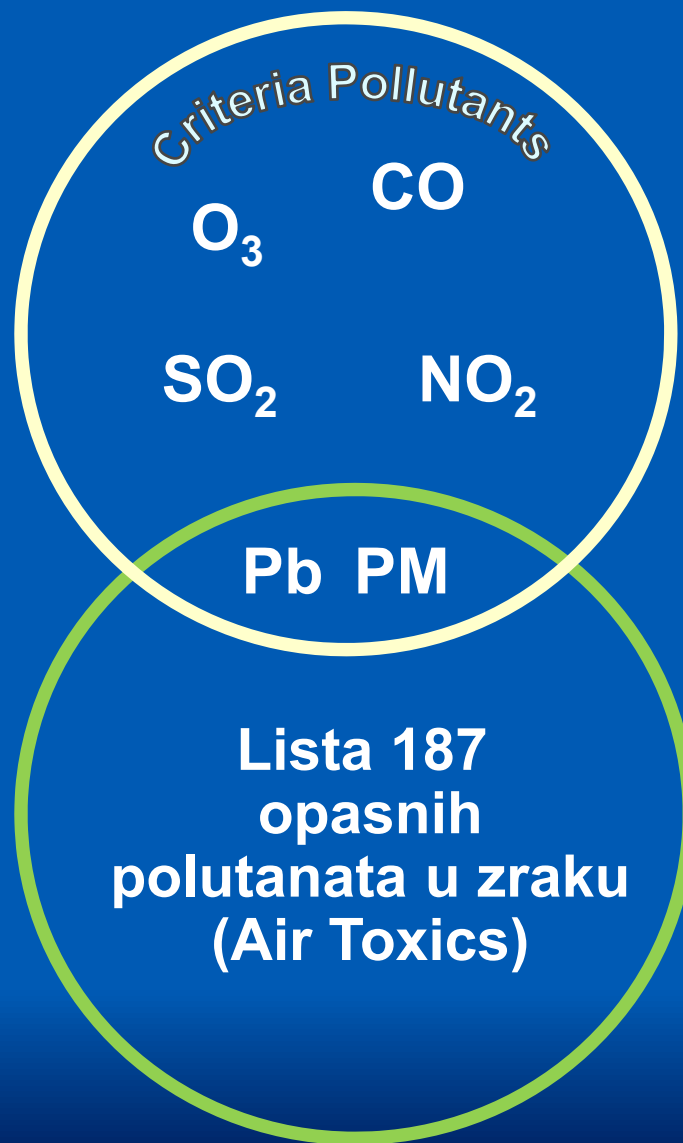
# SAD: Dobre vijesti... ali treba nastaviti rad

Poređenje područja rasta i smanjenja emisija

1970-2016



# Zagađivači u zraku: iza kriterijskih polutanata



# Zagađivači u zraku: Dvofazni pristup

## Zahtjevi iz Amandmana na američki Zakon o zaštiti zraka iz 1990:

- Faza 1 - prvo, regulirati kategorije izvora na osnovu postojeće tehnologije
  - Najveća moguća tehnologija kontrole  
*Maximum Achievable Control Technology* = MACT
  - Na osnovu nivoa emisije koji se već postižu kontroliranim i niskoemitirajućim izvorima u nekoj industriji
- Faza 2 – unutar 8 godina postavljanja MACT-zasnovanih standarda emisija, procjene tehnologija i preostalih rizika (npr., pregled rizika i tehnologije - *risk and technology review* - RTR)

Više o ovome na: <https://www.epa.gov/haps>

# Postrojenja integralne proizvodnje gvožđa i čelika

- Američki državni standardi za opasne zagađivače zraka (NESHAP) posljednji put su ažurirani 2006; trenutno se vrši RTR kategorizacija izvora, očekuju se odluke u junu 2019
- Obuhvata granice emisija za opasne polutante zraka (HAP) koje ispuštaju nove i postojeće aglomeracije, visoke peći, i konvertorske čeličane (BOF)
  - HAP obuhvataju metale (primarno mangan i olovo s malim količinama drugih metala) i tragovi organskih HAP (kao što su policiklične organske materije, benzen, i ugljen disulfid)
  - Dokazano je da izloženost ovim materijama izaziva razne posljedice po zdravlje, uključujući hronične i akutne bolesti krvi, srca, bubrega, reproduktivnog sistema, te centralnog nervnog sistema
  - U.S. EPA je klasifikovala emisije iz koksara u Grupu A poznatih ljudskih karcinogena

Saznajte više na: <https://www.epa.gov/stationary-sources-air-pollution/integrated-iron-and-steel-manufacturing-national-emission-standards#additional-resources>



# Izvori informacija o toksičnosti

Integrated Risk Information System

IRIS Assessments in Review

- [Ethyl Tertiary Butyl Ether \(ETBE\) \(External Review Draft\)](#)
- [Tert-butyl Alcohol \(tert-butanol\) \(External Review Draft\)](#)

Staying Connected

- [How IRIS connects with you](#)
- [How you can connect with IRIS](#)

Get email alerts

sign up

## U.S. EPA IRIS

<https://www.epa.gov/iris>

OEHHHA

Toxic Air Contaminants

According to section 39655 of the California Health and Safety Code, a toxic air contaminant (TAC) is "an air pollutant which may cause or contribute to an increase in mortality or an increase in serious illness, or which may pose a present or potential hazard to human health." In addition, substances which have been listed as federal hazardous air pollutants (HAPs) pursuant to section 7412 of Title 42 of the United States Code are TACs under the state's air toxics program pursuant to section 39657 (b) of the California Health and Safety Code. The Air Resources Board formally made this identification on April 8, 1993 (Title 17, California Code of Regulations, section 93001).

- [List of Toxic Air Contaminants and Associated Documents](#)

For more information:

- [Toxic Air Contaminant Identification Reports Table \(ARB\)](#)

## California EPA

<https://oehha.ca.gov/chemicals>

ATSDR - Toxic Substances Portal

Agency for Toxic Substances & Disease Registry

Toxic Substances Portal

**Benzene**

CAS ID #: 71-43-2

**Affected Organ Systems:** Hematological (Blood Forming), Immunological (Immune System), Neurological (Nervous System)

**Cancer Classification:** NTP: Known to be a human carcinogen. EPA: Known human carcinogen. IARC: Carcinogenic to humans.

Please contact NTP, IARC, or EPA's IRIS Hotline with questions on cancer and cancer classification.

**Chemical Classification:** Hydrocarbons (contain hydrogen and carbon atoms), Volatile organic compounds

**Summary:** Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

## U.S. ATSDR

<https://www.atsdr.cdc.gov/substances/index.asp>

# Obavješćavanje javnosti sa američkim Indeksom kvaliteta zraka (*Air Quality Index*)

- Indeks kvaliteta zraka (AQI) je alat EPA koji koristi boje za upozoravanje javnosti o količini zagađenosti zraka
  - Računa se od 5 kriterijskih polutanata (PM, O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, CO)
  - Uzima se ona koncentracija koja ima najviši indeks
- Preporučuje korake koje ljudi mogu poduzeti da bi smanjili svoju dnevnu izloženost zagađenju
- Indeks AQI pretvara koncentracije polutanata u broj na skali od 0 do 500
  - Generalno je vrijednost 100 jednaka nivou kratkoročnih NAAQS
- Američki gradovi i savezne države koriste AQI za izvješćavanje i predviđanje kvaliteta zraka



Saznajte više na:

<https://www.airnow.gov/index.cfm?action=aqibasics.aqi>



# AQI kategorije i zdravstvene obavijesti

Nivo opasnosti po zdravlje	Vrijednost indeksa	Obavijest
Dobro	0 do 50	Kvalitet zraka se smatra zadovoljavajućim, i zagađenje zraka predstavlja mali ili nikakav rizik.
Umjereno	51 do 100	Kvalitet zraka je prihvatljiv; ipak, za neke polutante može postojati umjerena opasnost po zdravlje za manji broj ljudi koji su obično osjetljivi na zagađenje zraka.
Nezdravo za osjetljive grupe	101 do 150	Pripadnici osjetljivih grupa mogu osjećati zdravstvene tegobe. Generalna javnost obično nije pogođena zagađenjem.
Nezdravo	151 do 200	Svi mogu osjećati zdravstvene tegobe; pripadnici osjetljivih grupa mogu osjećati ozbiljne zdravstvene tegobe.
Jako nezdravo	201 do 300	Upozorenje za zdravlje: svi mogu osjećati ozbiljne zdravstvene tegobe.
Opasno	301 do 500	Upozorenje za zdravlje ili uslovi uzbune. Kompletna populacija može imati ozbiljne zdravstvene tegobe.

# Granične vrijednosti za američki AQI indeks

O <sub>3</sub> (ppm) <sup>1</sup> 8-h	O <sub>3</sub> (ppm) 1-h	PM <sub>2.5</sub> (µg/m <sup>3</sup> ) 24-h	PM <sub>10</sub> (µg/m <sup>3</sup> ) 24-h	CO (ppm) 8-h	SO <sub>2</sub> (ppb) 1-h	NO <sub>2</sub> (ppb) 1-h	AQI	Kategorija
0.000-0.054	-	0.0-12.0	0-54	0.0-4.4	0-35	0-53	0 do 50	Dobro
0.055-0.070	-	12.01-35.4	55-154	4.5-9.4	36-75	54-100	51 do 100	Umjereno
0.071-0.085	0.125-0.164	35.5-55.4	155-254	9.5-12.4	76-185	101-360	101 do 150	Nezdravo za osjetljive grupe
0.086-0.105	0.165-0.204	55.5-150.4	255-354	12.5-15.4	186-304 <sup>(3)</sup>	361-649	151 do 200	Nezdravo
0.106-0.200	0.205-0.404	150.5-250.4	355-424	15.5-30.4	305-604 <sup>(3)</sup>	650-1249	201 do 300	Jako nezdravo
0.201- <sup>(2)</sup> <sup>(2)</sup>	0.405-0.504 0.505-0.604	250.5-350.4 350.4-500.4	425-504 505-604	30.5-40.4 40.5-50.4	605-804 <sup>(3)</sup> 805-1004 <sup>(3)</sup>	1250-1649 1650-2049	301 do 400 401 do 500	Opasno

(1) ppm = parts per million; µg/m<sup>3</sup> = mikrograma po kubnom metru; ppb = parts per billion

(2) 1-h O<sub>3</sub> AQI izračunat za mali broj područja gdje bi bilo predostrožnije i gdje je 8-h O<sub>3</sub> AQI >301

(3) SO<sub>2</sub> AQI vrijednosti ≥ 200 se računaju sa 24-h SO<sub>2</sub> koncentracijama

Vidjeti i AQI kalkulator - <https://www.airnow.gov/index.cfm?action=airnow.calculator>

# Primjeri proizvoda U.S. EPA koji angažuju javnost

**Healthy Heart Toolkit and Research: Steps You Can Take**

Steps You Can Take to Reduce Health Effects from Air Pollution

Studies show that air pollution can trigger heart attacks, stroke, and other health effects. People who are already at risk for these conditions, such as those with heart disease, are at risk for these conditions. If you have exposure to high levels of air pollution, you should take steps to reduce your exposure.

When are air pollution levels highest?

- Any time of year
- When weather is calm
- Near busy roads
- In urban areas
- In industrial areas
- When there is smoke

## Particle Pollution and Your Patients' Health

Helps health care providers advise their patients about particle pollution exposure.

cardiologists, and other medical professionals. Start the Course

Course developers

**AirNow** Local Air Quality Conditions

Zip Code:  State: Alabama Go My Current Location

Forecast Current AQI AQI Loop More Maps

**Today's AQI Forecast**  
Saturday, June 17, 2017

Map showing AQI forecast for Saturday, June 17, 2017. Legend: Good, Moderate, U.S.G., Unhealthy, Very Unhealthy, Hazardous, Action Day.

**Fires: Current Conditions**  
Click to see map

**U.S. Embassies and Consulates**  
Data from air quality monitors at select U.S. embassies and consulates around the world

**Announcements**  
6/15/17: National Air Quality Conference, September 11-13, 2017. Registration Now Open and Call for Presentations  
6/7/17: 2017 Air Quality Flag Program Spring Challenge Winners. More

**Air Quality Basics**  
Air Quality Index | Ozone | Particle Pollution | Smoke from Fires | What You Can Do

Health Learning Center

**Healthy Heart**

A healthier environment for healthier hearts

cardiologists, and other medical professionals. Start the Course

Course developers

**EnviroFlash** Current Location

Zip Code:  27707 Go

The Air Quality Index (AQI) for Raleigh-Durham-Chapel Hill

Current	Current
2/5/2013	2/5/2013
8:00 PM EST	8:00 PM EST
Pollutant: PM2.5	Pollutant: OZONE
40	23
Good	Good

## Heart Disease, Stroke, and Outdoor Air Pollution

**1 Did you know that air pollution can trigger heart attacks, stroke, and other health effects?**

Medical studies show that air pollution can trigger heart attacks, stroke, and irregular heart rhythms—especially in people who are already at risk for these conditions. Also, for people with a medical condition called heart failure, air pollution can further reduce the ability of the heart to pump blood the way that it should. Very small particles are the pollutants of greatest concern for triggering these effects. Particle pollution is found in haze, smoke, and dust—and sometimes in air that looks clean. This fact sheet tells you how you can:

**3 How can you protect your health?**

- Get up-to-date information about your

**Air Sensor** Citizen Science Toolbox

Measure · Learn · Share

## Efectos de los Contaminantes Comunes del Aire

**EFFECTOS RESPIRATORIOS**

Síntomas: Tos, Irritación en la garganta, Dificultad para respirar, Aumento de enfermedades y ataques de asma, Aumento de ataques de asma, Aumento de ataques de asma, Aumento de ataques de asma.

**EFFECTOS CARDIOVASCULARES**

Síntomas: Irritación en el pecho, Dificultad para respirar, Aumento de enfermedades y ataques de asma, Aumento de ataques de asma, Aumento de ataques de asma, Aumento de ataques de asma.

Diagram showing the respiratory system and the effects of pollutants.

## Air Sensor Guidebook

Reduce su riesgo, usando el Índice de Calidad del Aire (AQI) por sus sitios en inglés al planear actividades al aire libre - [www.airnow.gov](http://www.airnow.gov)

Nivel de calidad del aire y su impacto en la salud	Valor del Índice	¿Qué medidas deben tomar las personas?
Buena	0-50	Clases sin actividad.
Modorada	51-100	Personas particularmente sensibles a la contaminación del aire deben reducir las horas de su día que pasan al aire libre.
Difícil para la salud de los grupos sensibles	101-150	Grupos sensibles deben evitar actividades al aire libre que impliquen un esfuerzo físico intenso.
Difícil para la salud	151-200	Todos los grupos deben reducir las horas que pasan al aire libre.
Muy difícil para la salud	201-300	Todos los grupos deben evitar actividades al aire libre que impliquen un esfuerzo físico intenso.

**Smoke Sense** WEEK 2 OF 15

**AIR QUALITY INDEX** 27713

CURRENT AQI: 119 (UNHEALTHY FOR SENSITIVE GROUPS)

AQI TOMORROW: MODERATE

SYMPTOM & SMOKE OBSERVATIONS

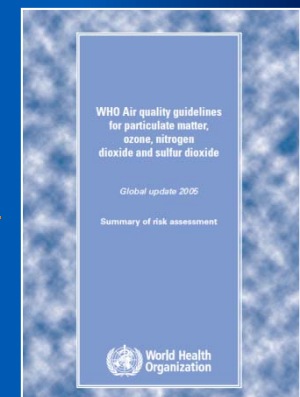
FIRE & SMOKE NEAR ME

ABOUT THE STUDY

AIR QUALITY 101

# Dodatne informacije

- ▶ Informacije o zagađenju zraka i američkom Zakonu o zaštiti zraka: <https://www.epa.gov/clean-air-act-overview>
- ▶ U.S. EPA NAAQS – naučne i tehničke informacije: <https://www.epa.gov/naaqs>
- ▶ Informacije Svjetske zdravstvene organizacije (WHO) o kvalitetu ambijentalnog (vanjskog) zraka i zdravlju: [http://www.who.int/phe/health\\_topics/outdoorair/outdoorair\\_agg/en/](http://www.who.int/phe/health_topics/outdoorair/outdoorair_agg/en/)
- ▶ Informacije za davaoce zdravstvenih usluga, uključujući i kurseve kontinuirane medicinske edukacije (CME) : [https://www.airnow.gov/index.cfm?action=health\\_providers.index](https://www.airnow.gov/index.cfm?action=health_providers.index)
- ▶ AirNow – Američki podaci o kvalitetu zraka: <https://www.airnow.gov/>
  - AirNow-International – podaci o kvalitetu zraka širom svijeta, BiH još nije obuhvaćena: <https://www.airnow.gov/index.cfm?action=airnow.intlpartners>



# Pitanja?



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